

MEMORIE DELLA SOCIETÀ ENTOMOLOGICA ITALIANA

Volume 97

Supplemento al Bollettino della Società Entomologica Italiana 152(3) (31.12.2020)

aprile 2021



SOCIETÀ ENTOMOLOGICA ITALIANA via Brigata Liguria 9 Genova

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Fondata nel 1869 - Eretta a Ente Morale con R. Decreto 28 Maggio 1936

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REGISTRATO PRESSO IL TRIBUNALE DI GENOVA AL N. 76 (4 LUGLIO 1949)
Prof. Achille Casale - Direttore Responsabile
Pubblicazione a cura di PAGEPress - Via A. Cavagna Sangiuliani 5, 27100 Pavia
Stampa: Press Up s.r.l., via E.Q. Visconti 90, 00193 Roma, Italy

SOCIETÀ ENTOMOLOGICA ITALIANA via Brigata Liguria 9 Genova

**SISTEMATICA, FAUNISTICA E ZOOGEOGRAFIA
IN ALCUNI GRUPPI DI ARTHROPODA
VOLUME IN MEMORIA DI AUGUSTO VIGNA TAGLIANTI**

A CURA DI:

Pier Mauro GIACHINO – Achille CASALE – Pietro BRANDMAYR – Andrea DI GIULIO



Augusto Vigna Taglianti (25.06.1943 - 7.06.2019).

In alto: al South African Museum di Capetown nel 1995.
(Foto di Stefano Zoia)

A destra: nelle Alpi Marittime nel 2000.
(Foto di Andrea Di Giulio).



Prefazione

Augusto Vigna Taglianti, naturalista nato, entomologo, faunista e biogeografo, ha lasciato un'eredità scientifica e umana di enorme valore. La lunga carriera accademica ha fatto di lui un Professore in grado di trasmettere agli allievi le ricchezze della sua mente e del suo animo, amplificandone così l'impatto oltre ogni limite temporale. Non solo chi ha seguito le sue orme, ma anche chi le ha incrociate ha la piena consapevolezza dell'importanza di averlo incontrato e di quanto significativa sia stata questa esperienza di vita, una vera fortuna sotto tutti i punti di vista.

Molte di queste persone sono qui a ricordare Augusto nel migliore dei modi, continuando un percorso di Scienza su alcuni dei più importanti sentieri da Lui tracciati con grande passione e dedizione. Credo che questo sia il modo migliore per onorare la Sua memoria, almeno uno dei tanti possibili, che certamente Augusto apprezzerrebbe molto. Schivo ed essenziale, sarebbe felice di dare un contributo alla Scienza anche adesso, attraverso chi rimane qui a continuare il Suo operato, idealmente unito dal filo della conoscenza e dall'amore per la Natura.

Questo volume delle "Memorie" dedicato ad Augusto vuole essere un tributo di grande riconoscenza da parte della Società Entomologica Italiana che ha goduto per lunghi anni della Sua guida illuminata come Presidente, durante i quali sono stati raggiunti traguardi di enorme importanza, di cui ancora oggi raccogliamo i frutti.

Sono particolarmente onorato di poter rappresentare l'intera Comunità Entomologica Italiana, unita nel celebrare ancora una volta e con immensa gratitudine una delle più importanti figure scientifiche che l'ha animata e guidata, e che continuerà a farlo attraverso il patrimonio culturale che ci ha lasciato in temporanea custodia.

Personalmente, quasi alla fine di un lungo periodo di presidenza della SEI, non potevo avere occasione migliore per esprimere il mio più profondo ringraziamento per quanto Augusto Vigna Taglianti ha fatto, che mi ha consentito di proseguire agevolmente il Suo operato e di arrivare dove siamo oggi, pronto a passare il testimone nel segno della continuità.

Di Lui conserveremo sempre un ricordo indelebile e luminoso, come il Suo sorriso.

FRANCESCO PENNACCHIO
Presidente della Società Entomologica Italiana

Roberto POGGI

Qualche dato sulla collezione entomologica di Augusto Vigna Taglianti donata al Museo Civico di Storia Naturale “G. Doria” di Genova

Riassunto: Si riferisce sulla donazione al Museo Civico di Storia Naturale “G. Doria” di Genova della collezione entomologica del Prof. Augusto Vigna Taglianti (1943-2019), sul suo riordinamento e, sinteticamente, sui suoi contenuti (Coleoptera Carabidae e Dermaptera).

Abstract: *Some data on the entomological collection of Augusto Vigna Taglianti donated to the Museo Civico di Storia Naturale “G. Doria” of Genova.*

The Author makes a short report on the donation to the Museo Civico di Storia Naturale “G. Doria” of Genova of the entomological collection gathered by Prof. Augusto Vigna Taglianti (1943-2019), providing some news about its reordering and, succinctly, its contents (Coleoptera Carabidae and Dermaptera).

Key words: Coleoptera Carabidae, Dermaptera, Collection Augusto Vigna Taglianti, Genoa Natural History Museum.

Pochissimi giorni dopo la scomparsa di Augusto Vigna Taglianti, avvenuta il 7 giugno 2019, Giuliana, sua moglie, mi comunicò telefonicamente l'intenzione della famiglia di donare al Museo di Genova la collezione entomologica radunata da Augusto, volendo rispettare pienamente un desiderio da lui espresso. Il personale scientifico del Museo, subito da me informato sulla proposta e ben conscio dell'importanza della donazione, si attivò immediatamente per esaminare e risolvere i vari problemi amministrativi e logistici legati al trasferimento e alla collocazione dei materiali; un grande aiuto in questo senso fu fornito da Marco Bologna e Marzio Zapparoli, i quali a Roma effettuarono la ricognizione della collezione e compilarono un suo primo sommario inventario.

Giuliano Doria (Direttore del Museo) svolse il più rapidamente possibile le pratiche per formalizzare l'accettazione della donazione da parte del Comune di Genova a favore del Museo di Storia Naturale mentre Maria Tavano (Conservatore) condivise con me le ipotesi di riorganizzazione spaziale delle sale delle collezioni di studio per poter ospitare la nuova raccolta.

Trovati gli spazi, sorse però il problema dell'acquisto di nuovi armadi, essendo quelli disponibili in Museo non sufficienti, e del non banale trasporto della collezione da Roma a Genova. In



Augusto Vigna Taglianti a Genova, il 13.VI.2011, durante il XXIII Congresso Nazionale Italiano di Entomologia (in secondo piano R. Poggi).

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aiuto del Museo intervenne allora, come tante altre volte in un passato più o meno recente, l'Associazione "Amici del Museo Doria"; esposte le necessità alla Presidente, Carla Olivari, il Consiglio Direttivo decise all'unanimità di sostenere le spese per acquistare 8 grandi armadi entomologici metallici (prodotti dalla ditta Sacchi di Torino), per far imballare e trasportare in sicurezza in Museo la collezione (rivolgendosi alla ditta Sciutto di Genova, specializzata nella movimentazione di opere d'arte) e per il suo successivo riordino, stanziando a tal fine complessivamente la somma (IVA compresa) di 27.000 Euro.

Completate le procedure burocratiche, il 24 e il 25 luglio Giuliano Doria e io ci recammo a Roma

per coordinare il prelievo e l'imballaggio dei materiali, che furono collocati in un centinaio di scatoloni, pervenuti poi a Genova la mattina del 26 luglio.

Nei giorni successivi la Direzione del Museo mi chiese di sovrintendere alle operazioni di disimballo, pulizia, disinfezione e riordinamento delle scatole e dei materiali sfusi pervenuti con la collezione, mentre gli Amici del Museo, sempre in pieno accordo col personale scientifico del Museo, individuarono la persona adatta per effettuare il delicato lavoro sopra indicato in Alessandro Bisi, a cui si aggiunse spesso, a titolo volontario, Massimo Meli.

Con l'arrivo degli armadi (18 settembre) si



Inizio delle operazioni di scarico della collezione a Genova (26.VII.2019).

poté iniziare la collocazione definitiva delle scatole e il lavoro si completò poco prima del blocco legato alla pandemia da Covid-19 (marzo 2020).

Fornire dati precisi sul numero di esemplari effettivamente presenti nella raccolta radunata da Vigna è al momento praticamente impossibile, ma si possono per lo meno indicare le consistenze in contenitori.

La collezione ordinata dei Coleotteri Carabidi mondiali comprende 812 scatole vetrate medie (della misura standard 39x26 cm) e 44 scatole cieche piccole (26x19,5 cm) per un totale equivalente a 834 medie.

L'ordinamento generale di sottofamiglie, tribù e generi segue essenzialmente quello proposto da

Lorenz nel 2005 nella sua "Systematic List" mentre le specie italiane sono ovviamente collocate nella successione che Vigna stesso adottò nel 2005 nel suo catalogo steso per il Manuale APAT; i taxa esotici sono di solito collocati in scatole diverse da quelle destinate ai paleartici e di seguito ad esse. Per dare un'idea della ricchezza dei materiali presenti, basta ricordare che al genere *Carabus* sono destinate 177 scatole medie, mentre i Trechini occupano 20 scatole medie e 38 piccole.

A fianco della collezione sopra descritta esiste poi un settore, che si potrebbe indicare come deposito o magazzino, ma senza un'accezione negativa del termine, composto da 158 scatole medie e 116 piccole (equivalenti dunque nel



Alessandro Bisi durante il lavoro di pulizia e disinfezione delle scatole della collezione (18.IX.2019).

complesso a 216 medie), queste ultime del tipo Gruppioni da spedizioni (cieche, in cartone con coperchio “a marmotta”) e che comprende una grande varietà di materiali, radunati per provenienza geografica.

In ogni scatola sono collocati gli esemplari raccolti durante un singolo campionamento o una campagna di ricerche, tutti preparati e provvisti di cartellini di località ma privi di etichetta di identificazione; in genere sopra il coperchio di ogni scatola è appoggiata una serie di fogli quadrettati, piegati in due, con le determinazioni autografe degli esemplari contenuti all'interno di quella medesima scatola; le righe ordinate di spilli presentano spesso dei vuoti più o meno estesi e gli elenchi delle specie in tale corrispondenza risultano marcati con una “X”, il che sta a significare che gli esemplari così contrassegnati sono stati prelevati dalla scatola “geografica” e collocati nella collezione ordinata

illustrata in precedenza. È stato quindi fondamentale non separare contenitori e relativi elenchi, altrimenti si sarebbero perse le identificazioni effettuate da Vigna.

In questo lotto sono quantitativamente, e qualitativamente, meritevoli di segnalazione ad esempio i materiali provenienti dalle raccolte effettuate nel corso di molti anni in Turchia (26 scatole medie e 18 piccole), in Grecia, nelle Alpi occidentali (Marittime in particolare), nel Lazio, in Abruzzo, in Etiopia, ecc.

Insieme alle scatole delle cacce sono pervenute anche decine e decine di piccole scatolette, della più varia foggia e a tenuta spesso precaria, con singoli o pochi esemplari inviati di quando in quando in omaggio a Vigna da vari colleghi e amici, ma privi di determinazione, che, nel corso del riordino, sono stati trasferiti in scatole standard, per assicurare loro una corretta conservazione.



Scatola di *Carabus* (*Sphodristocarabus*) *akkusensis* di Turchia.

In totale quindi il materiale preparato e più o meno identificato è disposto nell'equivalente di $834+216=1.050$ scatole medie.

All'interno di una quindicina di scatoloni sono state invece radunate le svariate centinaia di tubi e tubetti con moltissimi Carabidi di ogni provenienza, ancora da preparare, insieme a numerosi barattoli contenenti i materiali in alcool, in genere frutto di tesi di laurea svolte con l'uso di trappole a caduta sull'Appennino centrale o sulle Alpi occidentali, solo una minima parte dei quali è stata preparata e inserita nel settore ordinato.

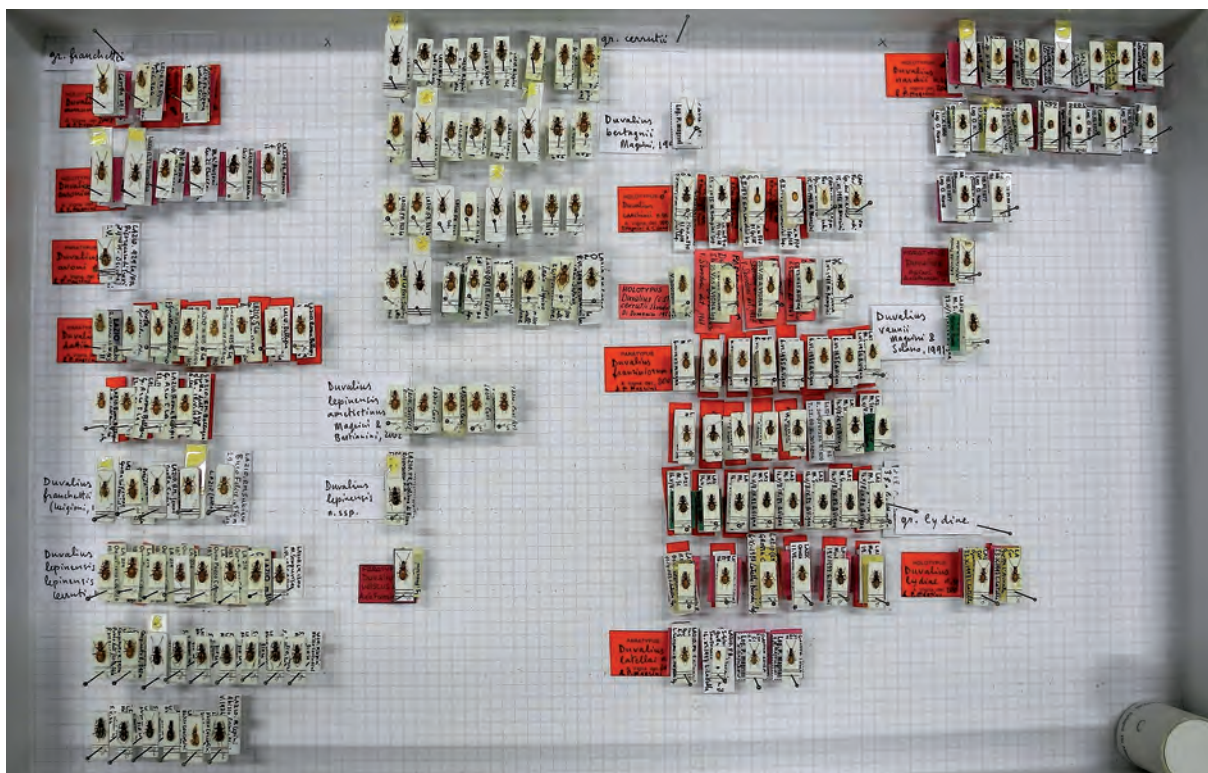
Alla collezione degli adulti si affianca quella delle larve dei Carabidi, in massima parte ipogei, che è formata da quasi 800 preparati microscopici collocati nelle classiche scatole portavetrini in legno e che comprende anche circa un centinaio di larve preparate a secco su cartellino.

Per quanto riguarda poi la collezione dei

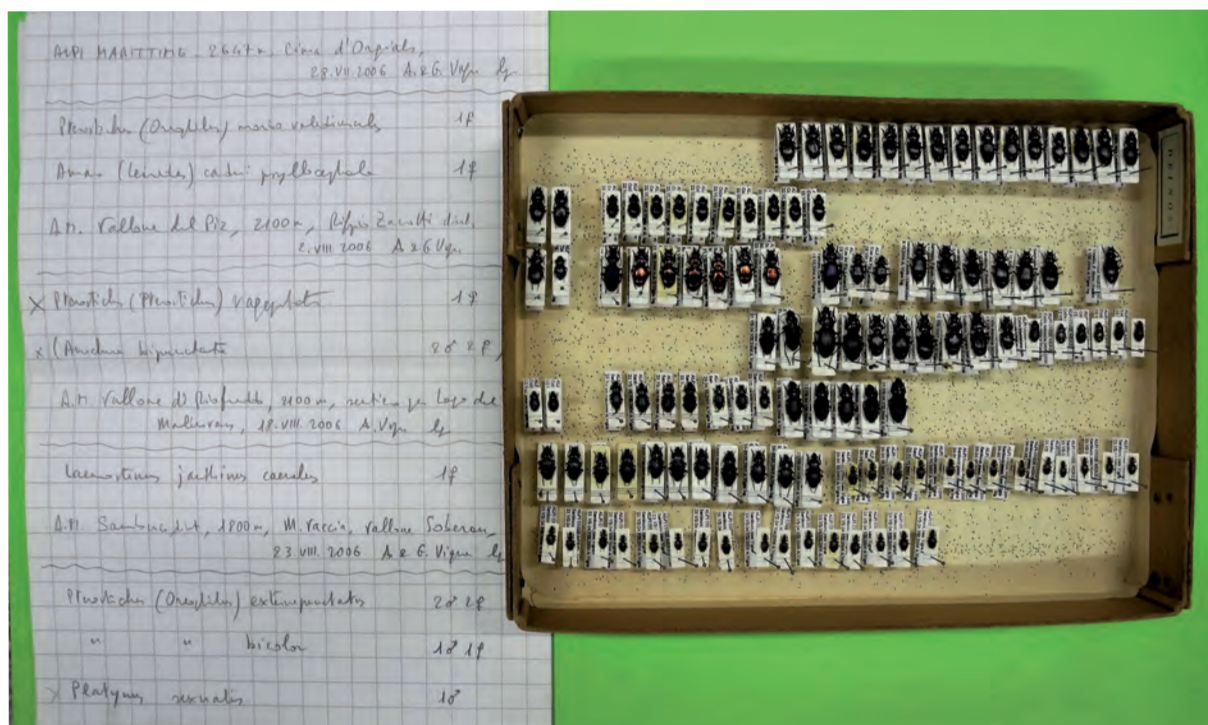
Dermatteri, a copertura mondiale come quella dei Carabidi, essa è contenuta in 62 scatole medie, con molti materiali ancora da smistare inseriti in 2 scatole medie e 10 piccole e con quelli da preparare collocati in alcuni barattoli.

Anche in questo caso si tratta di una raccolta di notevolissimo interesse e che inoltre dal punto di vista quantitativo supera di gran lunga quella già presente in Museo, che pure comprende, a fianco della collezione generale, ricca di tipi, i numerosi esemplari radunati da Felice Capra e da me e quelli pervenuti da Baccio Baccetti.

A corollario di quanto sopra sono state donate al Museo di Genova anche le miscellanee (estratti, non volumi od opere monografiche) concernenti i Carabidi (60 grossi faldoni) e quelle riguardanti i Dermatteri (9 faldoni più piccoli), insieme ai relativi schedari e ad altra documentazione scientifica legata alle raccolte.



Scatola di *Duvalius* d'Italia centrale.



Scatola di Carabidi raccolti nelle Alpi Marittime e relativa lista coi nomi manoscritti.



Scatola di Dermatteri italiani del genere *Chelidurella*.



Alcuni dei faldoni contenenti la miscellanea.

Per concludere resta da segnalare che nel lotto dei materiali pervenuti a Genova erano presenti anche numerose scatole di Carabidi preparati a secco e diversi vasi con esemplari in alcool, di proprietà di vari musei italiani e stranieri o di alcuni specialisti privati, che Vigna aveva chiesto in studio per completare qualche revisione o che gli erano stati inviati per ottenerne l'identificazione. Essendo in genere presente anche la documentazione dei prestiti, sto procedendo gradualmente alla restituzione dei campioni ai legittimi proprietari; il totale degli esemplari coinvolti in questa operazione si aggira sugli 8-9.000, 2.500 dei quali sono stati già resi.

Dai dati, pur sintetici, qui sopra riportati risalta chiaramente l'importanza della collezione entomologica radunata da Augusto Vigna Taglianti; la sua donazione, decisa dalla famiglia e accolta con riconoscenza e profonda gratitudine dalla Civica Amministrazione di Genova, ha comportato uno dei più significativi incrementi del patrimonio scientifico che il Museo Civico di Storia Naturale "Giacomo Doria" ha registrato negli ultimi anni.

Pietro BRANDMAYR

An outlook on the evolutionary history of Carabid beetles (Coleoptera, Adephaga)

Abstract: The paper is an attempt to take stock of recent research on the evolutionary history of the megadiverse beetle family Carabidae. First, the evolution of the carabid body is presented in its fundamental characteristics, in relation to the thoracic structure and locomotory and morphofunctional constraints, taking into account also what we know about fossil findings. Changes are described in the ten fundamental life forms that are recognizable in the larval body, from primitive surface runner to the arboreal tree/bark dweller and the parasitoid life style. The influence of biotic factors, first of all the food preferences, are examined for the best-known subfamilies/tribes, and a synthetic frame is presented of relationships between prey and age of the lineages in the three types of feeding modes: fluid, fragment and mixed feeders. On the whole, Harpalinae lineages seem more adapted to preys that appeared in recent times after the angiosperm flourishing, though exceptions have found. The availability of the biomasses of social insect nests, ants and termites, was of fundamental importance for several carabid stems. The influence of predators surely contributed to the refinement of chemical defenses, and some avoidance behaviours as gregariousness and Müllerian mimicry. Ordering the relevant fossil findings by age and taxon the absence of modern carabid fossils in the first part of Mesozoic appears clearly, only in the Cretaceous some extinct forms belonging to the actual suprageneric taxa have been found. Thus, Cenozoic era should be retained the age of modern forms, even if extinct taxa are recorded at least until the late Miocene.

Concerning the old question of ancestral habitat of Adephaga, if terrestrial or aquatic, the intermediate hypothesis of Erwin seems still valid, that is a waterside life on shores rich of animal biomass, from which both directions into inland waters and subaerial ecosystems may have started.

Finally, the taxonomic position of Rhysodidae has examined in the light of recent studies. Morphology of adult and larval beetles is poorly in accordance with a place in Scaritinae (Clivinini), the preimaginal features remember that of Archostemata also in the probable presence of a fused labrum, molecular evidence is mainly indicating a position within Carabidae but still not conclusive. A place as separate family within basal Geadephaga should be maintained.

Riassunto: *Uno sguardo d'insieme alla storia evolutiva dei coleotteri Carabidi (Coleoptera, Adephaga).*

Viene presentata una visione d'insieme della storia evolutiva dei Coleotteri Carabidi basata sugli studi più recenti. È stata esaminata dapprima l'evoluzione morfologica degli adulti, con riferimento soprattutto alla struttura del torace e delle modalità di locomozione nei suoi aspetti morfofunzionali, tenendo conto anche dei reperti fossili ormai consolidati. In parallelo viene riesaminata anche la morfologia larvale, per la quale sono individuati dieci forme biologiche fondamentali, dalla primitiva dei "surface runners" a quelle più evolute della vita arborea e dei parassitoidi. L'influenza dei fattori biotici, in particolare della disponibilità delle prede, è vista in un quadro sintetico suddiviso nei tre modi fondamentali di acquisizione del nutrimento: fluido, in frammenti o misto. Nel loro complesso, gli Harpalinae sembrano adattati a prede apparse in tempi geologici più recenti, dopo l'avvento massiccio delle Angiosperme, ma non mancano eccezioni. Di grande importanza è stata la disponibilità delle biomasse rappresentate dagli insetti sociali, formiche e termiti. L'influsso dei predatori ha contribuito sicuramente alla diversificazione delle difese chimiche dei carabidi, come pure lo sviluppo di comportamenti antipredatori quali il gregarismo ed il mimetismo Mülleriano. Ordinando i reperti fossili più rilevanti per era e taxon appare evidente l'assenza di carabidi fossili moderni nella prima parte del Mesozoico, solo nel Cretaceo compaiono alcune forme, estinte, ascrivibili agli attuali taxa sopragenerici. Il Cenozoico è quindi da ritenersi l'era delle forme moderne, anche se non mancano taxa estinti sino almeno al tardo Miocene.

Riguardo alla vecchia questione dell'habitat ancestrale degli Adephaga, cioè della loro origine terrestre o acquatica, sembra ancora valida l'ipotesi intermedia di Erwin, cioè di una vita al bordo delle acque correnti o stagnanti, su spiagge ricche di biomassa animale, dalle quali sarebbero partite entrambe le direzioni evolutive, quella per la vita nelle acque interne e quella verso gli ecosistemi subaerei.

È stata infine esaminata alla luce degli studi più recenti la posizione sistematica dei Rhysodidae. La morfologia immaginale e preimmaginale è scarsamente in accordo con un'affinità verso gli Scaritinae (Clivinini), le caratteristiche delle larve ricordano molto gli Archostemata, anche per la probabile presenza di un labbro superiore fuso con il clipeofrons. Le evidenze molecolari rivelerebbero una posizione entro i carabidi, ma non sono ancora conclusive, è quindi preferibile mantenere un rango di famiglia basale all'interno dei Geadephaga.

Key words: Carabidae, Rhysodidae, evolution, functional morphology, behaviour, larval life forms, food preferences, fossil records.

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*This work is devoted to the memory of
Augusto Vigna Taglianti,
remembering the lovely and pleasant conversations
about biology and evolution of carabid beetles and
his deep fondness for nature.*

INTRODUCTION

In the last decades the evolution of Adephaga, a large suborder of Coleoptera, lies in the focus of increasing interest by scientists, and this topic has been debated in several congresses and symposia (e.g. Ball *et al.*, 1998). The most recent comprehensive paper on the phylogeny of this group, that contains more than 45,000 species described, is that of Beutel *et al.* (2019), it summarizes the actual knowledge on the morphological evolution of the Hydradephaga (seven families: Meruidae, Noteridae, Aspidytidae, Amphizoidae, Hygrobiidae, Dytiscidae, Gyrinidae) and Geadephaga (two families: Trachypachidae, Carabidae). In the last family the authors enclose taxa often considered separate families: Rhysodidae, e.g. by Jeannel (1941, 1942), Crowson (1955, 1967), Regenfuss (1975), Nagel (1979), Beutel (1992b), Lawrence & Newton (1995), Bousquet (2012); Cicindelidae, e.g. by Shelford (1907), Kryzhanovskij *et al.* (1995), Ball (1960, 1979), Vogler & Pearson (1996), López-López & Vogler (2017), Duran & Gough (2020); Paussidae, e.g. by Crowson, Jeannel, (cit.), but also Deuve (1993). On the contrary, the same taxa were considered a partition (subfamily, supertribe, tribe) of the Carabidae, i. e. Rhysodinae (or Rhysodini), Cicindelinae (-itae, -ini), Paussinae by a plenty of authors, especially in recent times (Darlington, 1950; Bell & Bell, 1962; Bell, 1967, 1996; Reichardt, 1977; Baehr, 1979; Erwin, 1985; Liebherr & Will, 1998; Casale *et al.*, 1982; Di Giulio *et al.*, 2003; Bousquet, 2012 [not for Rhysodidae]; Baehr & Will, 2019).

Recent research on the molecular phylogeny of carabids is giving an enormous contribution to the knowledge of the intra-adephagan relationships and to the geological timing of past splitting of subfamilies and subordinate taxa. The first published analyses were inferred by 18S ribosomal DNA, 28S rDNA, wingless nuclear gene (Maddison *et al.*, 1999; Ober, 2002; Ribera *et al.*, 2005; Ober & Maddison, 2008; Maddison *et al.*, 2008) or combining analysis of mitogenomes and nuclear 18S gene (López-López & Vogler, 2017). Gough *et al.* (2019) combined several

precedent datasets into a supermatrix analysing the relationships inside Cicindelinae and its position within Carabidae, recovering the tiger beetles into an unusual position as sister group of Rhysodinae (also known as “wrinkled bark beetles”). In this work the monophyly of Cicindelinae + Paussinae + Rhysodinae + Scaritinae, now called the “CPRS quartet” was strongly supported, as in some precedent papers (e.g. Beutel *et al.*, 2008; Mc Kenna *et al.*, 2015). Nevertheless, in all these works the need of further research and a more exhaustive taxon sampling is emphasized, as a consequence of the fluctuating position of several “key taxa”, like the basic stocks of the most disputed carabid lineages.

Based on the comparison of available molecular data, in Mc Kenna *et al.* (2015) a first proposal of time scale of Coleoptera evolution is presented. Here the separation of “Coleopterida” from neuropteroid taxa is posed in the middle Permian, and the split between Polyphaga and the Archostemata + Mixophaga + Adephaga complex dates at the end of the same period. In the lower Triassic Adephaga take a new route and at the end of Triassic/first Jurassic the fundamental split between Hydro- and Geadephaga is attained. Around middle Jurassic Carabinae (*Calosoma*) and Trachypachidae may have split from other Carabidae, the remaining representatives of the family radiating from upper Jura to the end of Cretaceous, e.g. Rhysodidae like *Omoglymmius* and *Clinidium* even at the beginning of the Cenozoic. The datings of McKenna *et al.* (2015) were shifted earlier (Toussaint *et al.*, 2017) by reanalysing the original dataset MCK15 of McKenna at the light of a large list of fossil calibrations, so anticipating the divergence estimate of crown Adephaga around the permo-triassic transition, thus about 60 Mya before. In a second work Toussaint & Gillet (2017) tested the hypothesis of the gondwanan origin of a charismatic Carabinae tribe, the caterpillar hunters Calosomini, by a supermatrix approach. Based on a large taxon sampling and on the previous timetree of Coleoptera the divergence time for the Carabinae was estimated in the Jurassic, as supposed by Jeannel (1940). Cychrini are recovered as separating early and radiating in the Cretaceous, the lineages of *Calosoma* as diverging from each other in the Palaeogene. Several other data on fossil carabids and extinct forms of Adephaga have been gathered to reach an exhaustive frame of their evolution, in particular we checked the revised lists

of Eodromeinae (a subfamily of Trachypachidae) presented by Ting *et al.* (2011, see also Wang *et al.*, 2012) and that of Protorabinae, an extinct subfamily of Carabidae given by Wang & Zhang (2011) and the reported literature. Of great help were also some inclusive work about important “Lagerstätten” as the Baltic amber (Spahr, 1981), the Burmese amber (see Burmese Amber Biota in the references), Kirejtshuk & Ponomarenko (2020), as well Beutel *et al.* (2019b), Strada *et al.* (2014), Sundukov (2019) and several other authors reported later.

Aim of this paper is the attempt to take stock of the actual knowledge on carabid phylogeny, biology, morphology and ecology to outline a possible evolutionary history of this megadiverse family. I’m aware that the ideas about carabid phylogeny seem at the moment extremely unstable, even the “ancestral habitat of Adephaga, either terrestrial or aquatic, remains ambiguous” (Beutel *et al.*, 2019), but sometimes put things together helps for a better understanding of the problem and brings out parallels and contradictions. First, we will analyse the morphological evolution of the carabid body, also in the larval stages, then the habitat selection and its constraints on the morpho-functional features. Thereafter, a geological time-linked approach to the prey is presented, and the behavioral specializations connected to the food choice and enemies of carabids are discussed. Last but not least, a brief taxon history is dealt with focusing on the original habitat of Adephaga, with phylogenetic remarks on a highly debated taxon, the Rhysodidae.

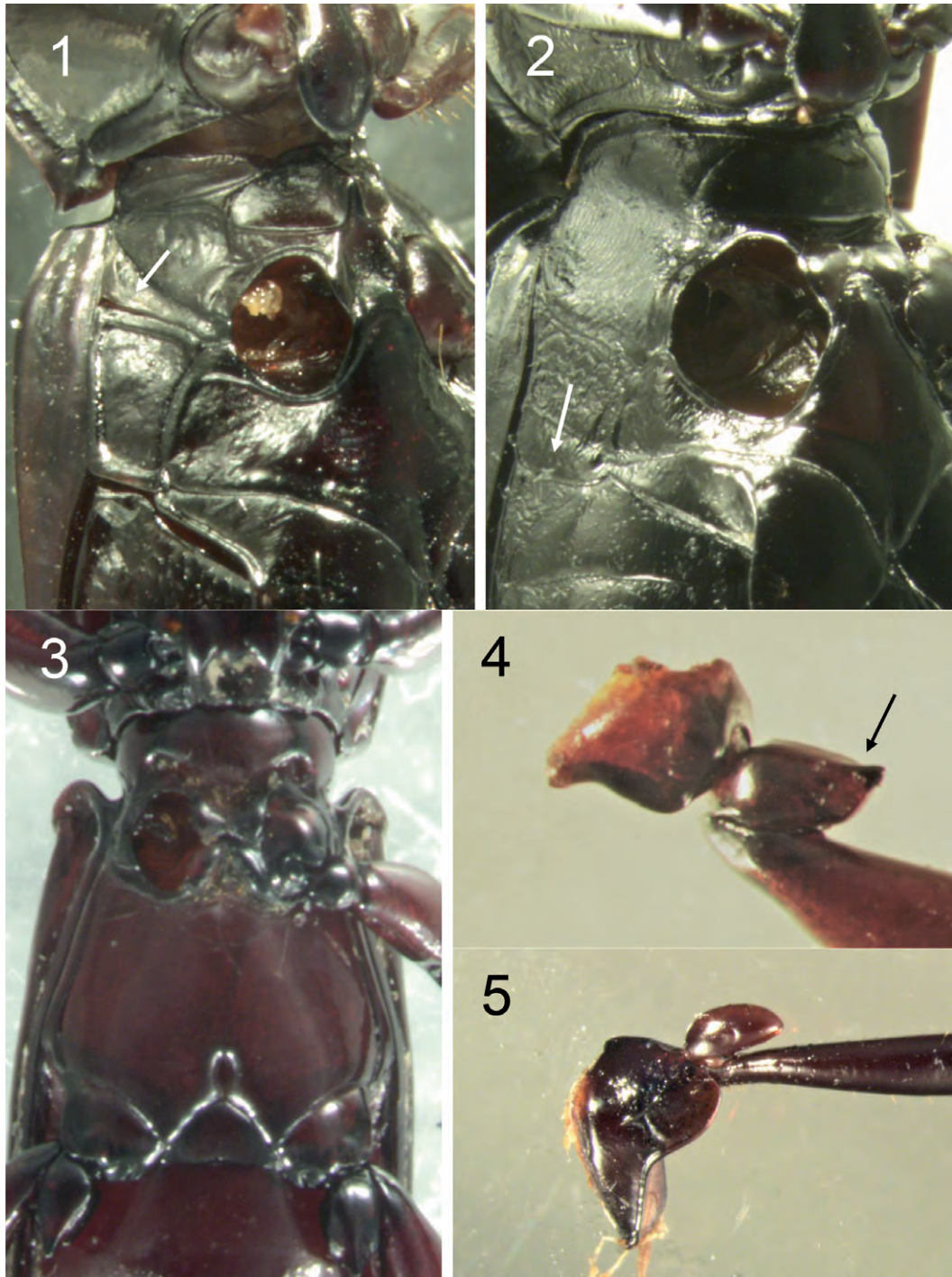
THE MORPHOLOGICAL EVOLUTION OF CARABID BODY

Adult beetles

The suborder Adephaga is marked by some outstanding features that are at least in part apomorphic for the group: prothorax nearly always with visible notopleural suture, the metacoxae fused to the metasternum, the first three visible abdominal sterna (2-4) connate and forming a more or less stiff part of the exoskeleton, a transverse suture on the metasternum, eleven-jointed antennae, larvae with six-jointed legs, mandibular mola and a distinct labrum absent, urogomphi at least primarily present. Some of such characteristics, the notopleural suture, the transverse suture of metasternum and the legs of six articles are probably inherited by the primitive suborder Ar-

chostemata, that is considered by several authors the lineage from which the Adephaga may have evolved. The oldest protocoleopterans belonged to extinct families of the late Permian like the Tshkardocoleidae and the Permocupedidae, which showed small and closed procoxae and probably not fused metacoxae that reached the lateral wall of the thorax, near the mesocoxae also the mesotrochantinus was still visible. From such primitive forms, probably all Coleopterans are derived (Beutel, 1995, Beutel & Haas, 2000, Beutel *et al.*, 2008). Already in the upper Permian some derived Archostemata, the Schizophoridae, developed more close elytral borders, a sort of longitudinal groove along the outer margin (the “schiza”), that probably permitted to crawl under water (Ponomarenko, 2002; Tan *et al.*, 2012). Some members of that family, like *Hadeocoleus gigas* (lower Triassic, Ponomarenko, 1977, see also the beautiful reconstruction of a *Hadeocoleus* sp. in Ponomarenko & Prokin, 2015) developed a remarkable size (40 mm), a prognate head with robust mandibles, long and thin legs and antennae, suggesting running ability and predatory habits (Crowson, 1975). Basing on this evidence, Ponomarenko pointed out that the ancestors of Adephaga may be related to the old Schizophoridae, inasmuch some other representatives of the group, *Hadeocoleus calus*, showed also enlarged metatrochanters (Ponomarenko, 1977; Evans, 1982).

The thorax morphology is perhaps the Ariadne’s thread of adephagan evolution (Figs. 1-3), it was deeply investigated by Beutel (1991). The basic “groundplan” of Adephaga is found in Hydradephaga and in Trachypachidae, that show metacoxae extended laterally and a parallel sided metepimeron more or less triangular and partly hidden by the elytral border, as in fossil and extant Archostemata. Here the metacoxae are broader than the preepisternum and separate the thorax (metanepisternum and metanepimeron) from the abdominal segments. In the Geoadephaga the metacoxae are as broad as the preepisternum and the complex metepisternum-metepimeron is quadrangular, with the latter parallel-sided and almost at right angle with the body axis. This change from an Archostematan-Hydroadephagous thorax model to the new caraboid arrangement represents a crucial moment, it happened probably when an old lineage near to ancient Trachypachidae, the Eodromeinae, gave rise to a more terrestrially adapted stock, the Protorabinae (Figs. 6, 8, 9). Both taxa share an older model of



Figs. 1-5. 1 – Thorax of *Nebria kratteri*, ventral view, showing the open procoxae and the pro-mesothoracic intermembrane, white arrow: mesepimeron reaching the mesocoxal cavity; 2 – thorax of *Abax carinatus*, ventral view, showing the close procoxal cavities, white arrow: lobate metepimeron; 3 – thorax of *Clinidium canaliculatum* (Rhysodidae), showing the widely separate metacoxae and the absence of the transverse suture on the metaventre; 4 – *C. canaliculatum*, right metacoxa, black arrow: calcar, a heavily sclerotized protrusion of the metatrochanters; 5 – *N. kratteri*, right metacoxa. Various scales.

pterothorax structure, where the metepisternum joins the mesocoxal cavity, but in the extinct Protorabinae, that appeared in the Jurassic period, the basic form of the carabid pterothorax is reached, with anepisternum and anepimeron attaining the first visible abdominal ventrite. This transformation has interpreted by Beutel (1991) as the result “of complex, correlated structural transformations of the posterior part of the metathorax and significant synapomorphies of Geadephaga excl. Trachypachini”. The metepimeron is not exposed and covered by the metepisternum in Opisthiini, Carabini, Cychnini, Nebriini and Notiophilini, reduced to a narrow lamella in Gehringiini, Cicindelinae, Omophroninae, Elaphrini, Loricerini, Siagonini, Scaritini and Rhysodini (-idae), thus in several more primitive subfamilies or tribes (Beutel, 1991). In “higher” carabids the metepimeron becomes lobate, and overlaps the anterior part of the abdominal sternite II (the first visible), Jeannel (cit.) defined the ground beetles with that character as “Caraboidea Limbata”. Nearby parallel evolves the form of the mesepimeron, which in primitive groups reaches the mesocoxal cavities, but in Limbata becomes shorter and retreats laterally. An exception is given by Scaritinae (and Hiletinae), where both characters are present, a lobate metepimeron and a mesepimeron attaining the mesocoxae. In higher carabids (Limbata) the mesepimeron reduces also in its external part, and the anterior edge of the metepisternum connects to the mesothorax, generating a more robust “meso-metathoracic interlocking mechanism” (Beutel, 1991).

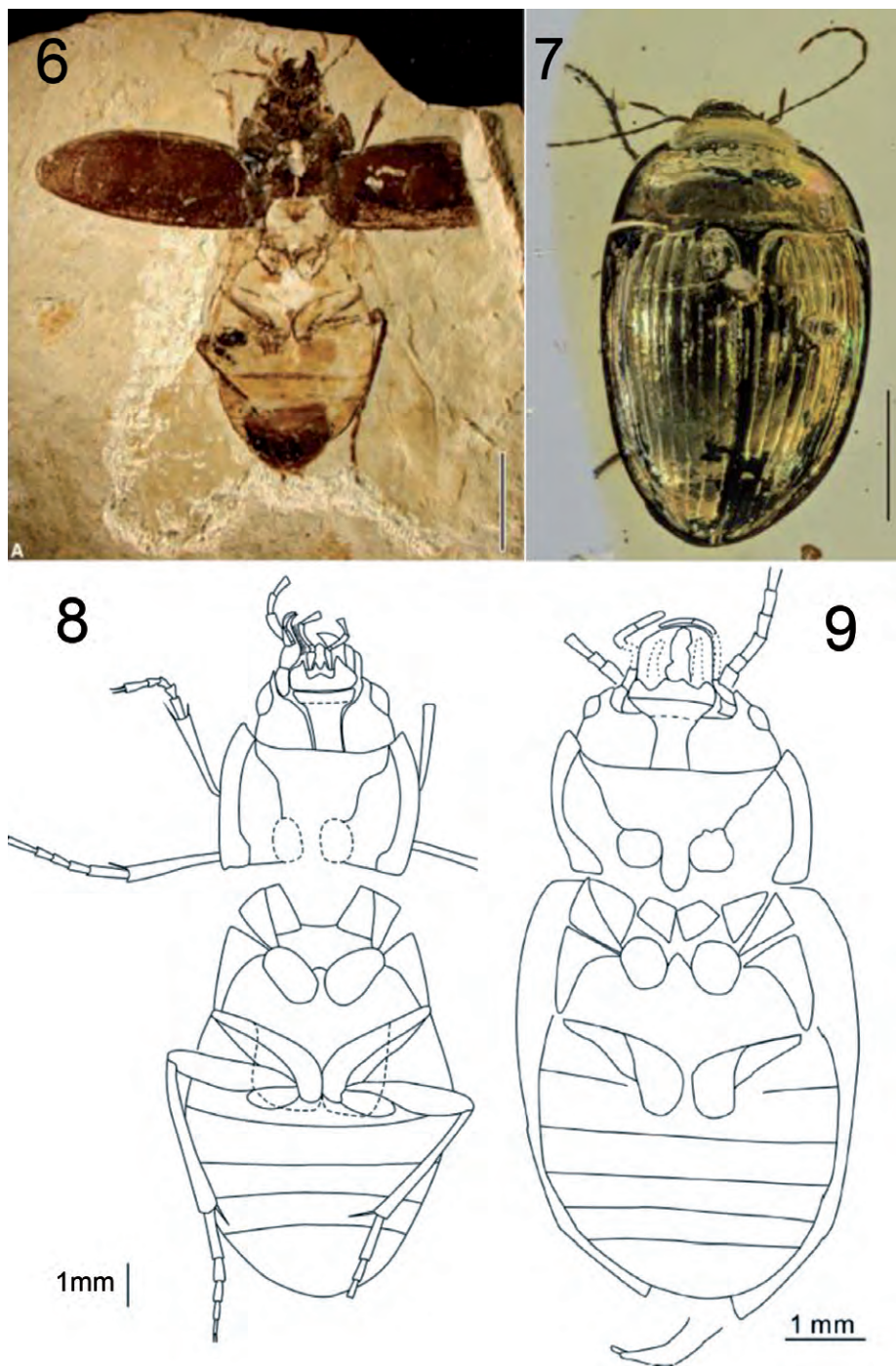
Further important changes in the carabid thorax are found in the procoxal cavities (Figs. 1, 2), which are open and with a pronounced prosternal process that fits into a hexagonal groove of the mesothorax (Fig. 10), that makes the thorax complex stiff but hardly movable (low grade ventral motility mechanism; Hlavac, 1975). In the Caraboidea Limbata and in some other groups the apex of the prosternal process is reduced, the procoxae become closed and the prosternal process shorter, the ventral hexagonal groove of the mesothorax disappears and a distinct collar is developed that fits into the closed posteroventral margin of the prothorax (Fig. 11). This multiple structural transformation allows a better lateral mobility of the head-prothorax complex and avoids that the ventral intersegmental membrane is exposed by vertical movements (high grade ventral motility mechanism of Hlavac, 1975). This more advanced thorax

morphology has probably evolved separately (convergent) also in some older caraboidea like Cicindelinae, Elaphrini, Loricerini, Migadopini and in the Rhysodine stock. Summarizing the previous observations, we can state that the thorax morphology of carabids shifts from a more basic groundplan in which pro- and mesothorax fit closer when the body is arched ventrally to a derived state in which a collar expansion of the mesothorax allows also upwards and lateral bending by not exposing the intersegmental membranes. In the Limbata also the abdominal-metathorax articulation becomes closer and reinforced, with the lobate metepimeron covering part of the abdominal sternite II. (Fig. 2). In “higher” carabids the metathoracic legs show also larger trochanters (Fig. 12), a characteristic that allows a more effective “wedge pushing”, an issue that will be analyzed in the next paragraph.

A largely used morphological characteristic of Geadephaga in taxonomy is also represented by the protibial antenna cleaner, that seems related to the position of the apical spurs. In some primitive groups the spurs are located at the apex of the protibiae (“Isochaeta” of Jeannel, 1941-42: Trachypachidae, Gehringiinae, Paussinae), but a toilet organ is present in Paussinae and Gehringiinae independently from the spurs (for Gehringiinae see also the remarks of Deuve, 2005). In about all other carabids the inner spur tends to migrate to the tibio-femoral articulation (“Anisochaeta” of Bell, 1967 and several authors), and the toilet organ develops first as an open channel and later as a deep notch surrounded by a comb of setae (Figs. 13 and 14). Regenfuss (1975) studied the morphological evolution of the antenna cleaner in Isochaeta and Anisochaeta, concluding that in the highly evolved representatives of both lineages this structure reached a similar form and “perfection” by parallel evolution, thus independently.

Behavioural and morpho-functional aspects of Geadephagan evolution in adults

The changes in body morphology of adult caraboidea gave rise to interesting hypotheses on their evolutionary history, thanks to the comparison of locomotory, predatory and feeding behaviour of today extant taxa. Several aspects of a possible sequence of events have proposed by Evans (1982) and reprised or disputed in recent papers, especially by palaeontologists (e.g. Wang *et al.*, 2012; Strada *et al.*, 2014). Evans argues that extinct carabids (Protorabinae) and



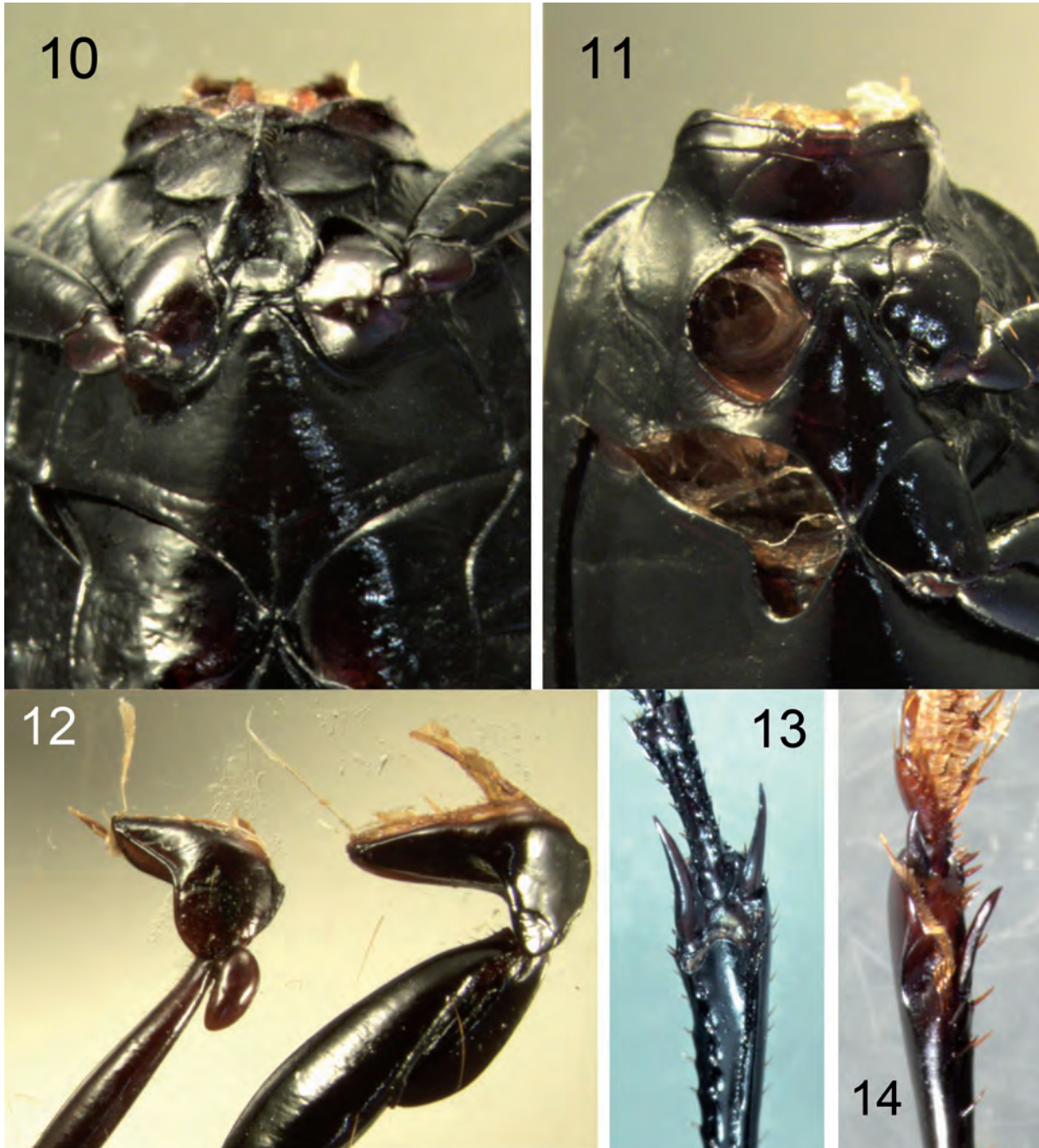
Figs. 6-9. Examples of fossil Trachypachidae and Carabidae. 6 – *Sinodromeus liutiaogouensis* Wang, Zhang & Ponomarenko 2011, holotype (Trachypachidae Eodromeinae), from Lower Cretaceous Yixian Formation of Liutiaogou. Reproduced from Wang *et al.* (2011), scale bar: 5 mm. 7 – *Burmapseudomorphus planus* Beutel *et al.* 2020, holotype (Carabidae, Pseudomorphinae), from the Burmese amber of Northern Myanmar, reproduced from Beutel *et al.* (2020), scale bar 1 mm; 8 – *Sinodromeus liutiaogouensis*, line drawing from Wang *et al.* (2011); 9 – *Cretorabus rasnitsyni* Wang & Zhang 2011, (Carabidae Protorabinae), drawing of the holotype from lower Cretaceous Yixian Formation of Inner Mongolia. Reproduced from Wang & Zhang (2011).

Trachypachids (Eodromeinae) were mainly fast runners with thin cursory legs like the modern Nebriinae, habits that were highly favoured by the ancient bare soils in waterside habitats. Only later, with the appearance of broad-leaved forests, “both carabid and trachypachid ground beetles were drastically affected by the angiosperm revolution of the mid-Cretaceous which provided widespread deciduous litter”. This allowed stronger wedge-pushers but slightly slower running stocks of Carabidae to become dominant, and may have caused the major decline of the Trachypachidae. The “wedge pushers”, as we have observed in the precedent paragraph, are carabids with stronger, robust legs (Fig. 12) and large metatrochanters (Forsythe, 1981) that are able to penetrate the stratified leaf litter, under stones or under bark. This action is facilitated by the wedge shaped fore-body and by the ability of hind legs to “produce a vertical oscillatory movement of the hind-body (moving upon the prothorax) which tends to enlarge the crevice...” (Evans, 1977, 1982, Fig. 1). In fact, the presumably primitive lineages, Cicindelinae, part of Carabinae, Nebriinae, Cicindinae, Elaphrinae, Loricarinae are all of the fast runner type, their fore-body is less or no wedge shaped, several taxa show distinct enlargement of the compound eyes and belong to the “visual predator” morphotype (Bauer, 1981; Bauer & Kredler, 1998; Pearson & Vogler, 2001; Erwin & Aschero, 2004). This adaptation is typical of beetles living on bare soils, where the visual perception of the prey may be of advantage, even if the basic olfactory function remains of importance (Riggins & Hoback, 2005). From the basic runner type all other locomotion modes could have differentiated: stronger wedge pushers in relation to a more complex soil layers and a rich leaf litter, diggers in loose or also compact soils, plant climbers, but also the ability to swim on the water surface or, in Cicindinae, that of “meniscus skating” (Evans, 1982; Erwin & Aschero, 2004). We find the best “wedge pushers” in more tribes of Harpalinae, e.g. Pterostichini, especially Molopina, Harpalini, Sphodrini, Zabryini and others (remember anyway that the locomotion of carabids is always a combination of running and pushing). Some other authors (Wang *et al.*, 2012) retain anyway that also in Eodromeinae a wider variety of locomotion types were present before their extinction in the early half of Cretaceous, before the mid-Cretaceous radiation of angiosperms. *Eodromeus* for example was a genus with flat body and

short legs and probably a good wedge pusher, so the reasons for the eodromeine extinction are perhaps independent from the decrease of open ground conditions.

Related to the appearance of large conifers and broad-leaved trees is the ability of carabids to behave as plant climbers, i. e. the achievement of arboreality, the life on trunks and in the canopies. Erwin (1979, 1998) judged this one the main “taxon pulses” exhibited by carabids especially in the tropics, that involved megadiverse genera, as e.g. *Agra*. Morphological adaptations to life on trees are commonly found in several Harpalinae carabids: slender body, long and thin legs, bulged eyes, toothed or pectinate tarsal claws, bilobed tarsomeres with large brushes of sub-tarsal adhesive or spatulate setae (Habu, 1967; Erwin, 1979; Stork, 1987, 1980; Ober, 2003). Ober (2003) analysed a phylogenetic tree based on a 28S + wingless dataset of 186 Harpalinae species searching for independent arboreality origins and its relations with the morphological characters listed above. She found that the life on trees could have originated by convergence at least 21 (max 27) times in the course of Cretaceous, but also that several cases of reversal from arboreality to terrestrial life (life on the soil surface) may have occurred at more times. Characters like expanded/bilobed 4th tarsomere, adhesive setae, pectinate claws and elongate prothorax were found to be clearly linked with arboreality, whereas bulged eyes, elytral length/width and relative leg length were scarcely correlated. We must remember that outside the Harpalinae an equal impressive arboreal evolution is observed in Cicindelinae (e.g. Cassola, 2000; Naviaux, 2004;), perhaps favoured by a particular exaptation, the bulged eyes and the long legs.

Arboreal activity is nevertheless found also in less specialized taxa, as in some Calosomini and in certain longimandibular *Carabus* species: *auronitens* (Weber & Heimbach, 2001), *caelatus*, *lefebvrei* (pers. obs.). Pectinate claws are nearly always a marker of climbing behaviour, at least in the ancestors, f. e. the doubtful case of Sphodrines, retained by Ober (2003) a merely terrestrial group (in the sense of “ground dwelling”), is easily explained by the poorly known climbing behaviour of several metallic blue colored species like *Laemostenus venustus*, *barbarus*, *dalmatinus*. Denticulate claws are present also in some other Sphodrini genera, e.g. *Synuchus* and *Dolichus*, especially in Sphodrini a transition has often observed in



Figs. 10-14. Morphological details of the adult carabid body. 10 – Anterior part of mesothorax of *Nebria kratteri*, showing the hexagonal groove that corresponds to the prosternal process when the forebody is bent down; 11 – Mesothorax of *Abax carinatus*, showing the spherical joint with the prothorax; 12 – left: metathoracic leg of a “runner” carabid, with the small trochanter (*N. kratteri*); right: leg of a wedge pusher with the long trochanter (*A. carinatus*); 13 – foreleg of a primitive anisochaete carabid with its toilet channel (*Carabus preslii*); 14 – foreleg of an advanced anisochaete (*Abax carinatus*) with the toilet comb and the inner tibial spur shifted. Various magnifications.

the same species, with epigeal forms showing finely toothed claws and cave dwelling populations with smooth ones. Smooth-edged claws were found f.e. in the “races cavernicoles” of *Laemostenus* (*Actenipus*) *oblongus* or in the Iberian populations of *L. (Prystonichus) terricola* (see Casale, 1988, for more details on these morphological changes).

Whereas the arboreal life forces carabids to maintain bright colours and powerful wings, the opposite direction of taxon pulses towards mountains and down into soil crevices transforms these beetles in short-winged wedge pushers and thereafter, step by step, first in microphthalmous brown-reddish troglophilous soil/cave entrance dwellers and finally in blind, apterous, pale-yellow and thin-legged “troglobionts”. Another well-known adaptation is the life as “endogenous” deep soil dweller, both adaptations refer to the subterranean compartment, but the two pathways are quite different, as clearly pointed out by Casale *et al.*, (1998). The endogenous forms are present most in some Clivinini (Reicheiina) and Bembidiini (Anillina), their size is very small and the legs short to favour movements in the deep soil pores. The cave inhabitants on the contrary live in the net of fissures of the rock massifs and may reach the soil surface in the MSS (mesovoid shallow substrate, or “milieu souterrain superficiel” of french authors). These forms appear in a larger group of subfamilies, first of all Trechini (several hundreds of species worldwide with about hundred genera), in Bembidiini (Lovriciina), in Pterostichini, Sphodrini, Platyninae, Clivinini, Zuphiini, Paussinae (Ozaenini) and, recently discovered, in the Promecognathinae (*Dalya mirabilis* Mateu & Belés, 2003). The true troglobiontic forms are remarkable by the larger size, the long thin legs and antennae, their pale integuments, the narrow forebody, the more or less swollen elytrae (pseudophysogastry) that form a subelytral chamber that probably buffers the air humidity oscillations, the dorsal trychobothria, the prolonged life span and, in some cases, by shortened larval development. The subterranean life has arisen independently several times in the above listed suprageneric lineages, but in contrast with the arboreal habits a reversion to an epigeal life style seems less probable. This blind evolutionary end enriched the unglaciated areas of the continents with impressive relict faunal hotspots that still wait to be better endeavoured in their biogeography, ecology and indicator traits (Assmann *et al.*, 2010).

A third important morpho-functional aspect of carabid evolution is found in the feeding apparatus and in the modes of feeding. The relationships between the food choice and the morphology of mouthparts, head and feeding apparatus stimulated the curiosity of several authors in the past as well as today. In the past the gut content of carabids was inspected most by microscope (Thiel, 1936; Balfour-Browne, 1944; Reichenbach-Klinke, 1953; Skuhřavý, 1959; Zhavoronkova, 1969). More detailed studies on the feeding mechanisms were carried out by Evans (1964, 1965) in *Nebria* and *Cicindela* and by Forsythe (1982, 1983) comparatively on a total of 29 carabid species. In more recent times the molecular identification of prey is prevailing (e.g. Symondson *et al.*, 2000; Šerić *et al.*, 2014). Several approaches were focused in particular on the mandible morphology, e.g. by Sharova (1981), Acorn & Ball (1991) in a study on herbivory, Baulechner *et al.* (2020) in a morphometric analysis of food specialization.

The most complete picture of carabid feeding mechanisms is found in Evans & Forsythe (1985). These authors recognize three feeding mechanisms in the “caraboidea”:

- 1) Fluid feeding. Zoophagous species with extraoral digestion that pass the midgut enzymes into the prey body, the food intake is “as fluid or semi-fluid with fine particles”. There is a strong cibarial-pharyngeal pump and the proventriculus act as a simple filtering system. The mandibles are at least twice longer than wide, often with sharp point and incisor lobes, with a setal fringe that helps in conduct the enzymes into the prey and in lead back the liquid food to the mouth. The mesial edge of the maxillae shows a lacinial comb with eight or more setal rows (“brush-like lacinia”). With variants it is found in Carabini, Cychnini, Scarites, in the ant brood preying Paussini. In the Cicindelinae a highly specialized “pre-oral food mill” (Evans, 1965) is found in the cibarium, where the prey is squeezed and soaked by digestive enzymes that come dorsolaterally from the sides of the epipharynx. The food is drawn into the mill by the robust laciniae and the fluid part ingested until only the dry cuticle remains. Fluid feeding seems to be present also in other, less primitive carabid lineages, like the lebiine *Eurycoleus*, and in the majority of the larvae, e.g. in the blood sucking larvae of *Epomis* (Chlaeniini), which prey on terrestrial

amphibians (Elron *et al.*, 2007), sometimes with specialized channelled mandibles as in *Graphipterus* (Zetto Brandmayr *et al.*, 1993).

- 2) Mixed feeding. Food intake is semifluid, mushy or with fragments, but a variable part of extraoral digestion is possible at least in some species. Mainly fluid feeding is found in *Broscus*, *Trechus* and *Agonum*. In *Broscus* the posterior region of the proventriculus shows chitinous teeth able to crush cuticular fragments. Mixed feeders are also many unspecialized feeders with an opportunistic diet, which intake fluids, fragments and plant material (*Pterostichus niger*, *madidus*, *melanarius*). Following Forsythe, also many omnivorous seed feeders belong here, they alternate both animal and vegetable food and are able to crush also hard seeds by the strong, short and basally widened mandibles typical of Harpalini and Amarini. The extraoral digestion becomes minimal and the food is reduced to a mush by the proventriculus, which is coated by spines, teeth, combs and needles.
- 3) Solid food feeding or fragmentary feeders. Zoophagous species more or less specialized in grasping small preys like collembolans or smaller arthropods that show shorter and dilated mandibles in comparison with fluid feeders. These carabids swallow pieces of arthropods that have been chopped by the sharp incisor lobes with their shearing edges, the ventral side of the mandibles shows generally neither grooves nor setal fringes. The mouth opening is large, the pharyngeal pump little developed and the proventriculus has strong crushers and functions as a triturating machine, as demonstrated by Cheeseman & Pritchard (1984). The maxillae show a “rake-like” lacinial comb with few rows of setae, in *Drypta* the enlarged lacinia compete with mandibles in grasping the prey. The solid food feeding has been ascertained for *Nebria*, *Leistus*, *Notiophilus*, *Loricera*, *Chlaenius*, *Patrobus*, Ball *et al.* (2011) added *Pelophila* to this type.

The shape of the mandibles is, generally speaking, one of the best markers of food choice/specialization, as it has been found by several authors (Skuhřavý, 1959; Zhavoronkova, 1969; Sharova, 1981; Brandmayr & Zetto Brandmayr, 1986; Acorn & Ball, 1991). Ball *et al.* (2011, Fig. 18) hypothesize an evolution of Geadephaga based on the mandibular structure that starts from the basic type of the mixed

feeder, with a distinct terebra and retinaculum probably similar to the *Pelophila* type and a movable labrum. This ancestor gave rise to the Trachypachidae with their short mandibles, a two toothed retinaculum, a smooth terebral teeth, a small basal brush and a ventral groove with sparse microtrichia. On the other branch the Carabidae ancestors gave rise to two lineages: the Carabidae-Cicindelidae complex and the remaining stocks represented by the Nebriidae + the “other Carabidae”. The first ones evolved mandibles adapted to soft bodied invertebrates and pre-oral digestion, with a densely setose basal brush and a labrum fused with the head capsule. Whereas Cicindelidae evolve towards highly mobile prey and develop multi-toothed terebras, Carabidae specialize on larger, slower soft preys with increasing snail consumption in the “carabi longimandibulares” lineages. In the rest of Carabidae, Nebriidae and related descendants or adelphotaxa specialize as fragment feeders of small arthropods, but in other lines a great variability of mandibular mechanisms will continue, in which the mixed feeding goes from one extreme to the other. In higher carabids and especially in Harpalinae the shape of the mandibles reveals often the possible food specialization of the genus or the tribe: the seed eating Harpalini and Zabryni (incl. Amarina) show stout mandibles with large primary condyles and incisor apex more or less blunt (Acorn & Ball, 1991), the unspecialized carnivores show most mandibles about two times longer than at basis and a less developed ventral groove with microtrichia, the incisor tooth well curved. The snail crushing Licinini share asymmetric mandibles, very short and robust with no pointed apex, that are used to open the snail shells along the coil (Brandmayr & Zetto Brandmayr, 1986). The macrocephalic *Scarites* exhibit extremely large and robust mandibles to seize large, hard preys like darkling beetles or snails. *Promecognathus* species (Promecognatinae) have three times longer than wide, scissor-like mandibles with which they “dissect” poisonous millipedes of the species *Xystocheir dissecta* (Weary & Will, 2020). The ant predating *Siagona* (Siagoninae) have strongly recurved mandibles and a robust retinaculum that resemble a pincer, to leave any escape to the quickly moving prey (Bauer *et al.*, 2005). The morphofunctional meaning of mandibles are unknown for several groups or genera and are often issue of speculation, it seems that the most adaptive forms are the result of convergence more than of pylogenetic

affinity. Baulechner *et al.* (2020) analysed the morphometry of mandibles in 32 species of (European) carabids and found only four different types connected to feeding: the mollusc-annelid specialists, the collembolan specialists, the zoophagous generalist and the herbivore group. They concluded that “phylogenetic relationship is a poor proxy of FD (functional diversity) in carabids”. Worldwide this statement does not include neither ant predators/symphiles nor other specialist feeders, parasitoids, etc., a morphofunctional synthesis of food specialization is perhaps premature. What we can state with some certainty is that in the course of the evolutionary history carabids diverged precociously in fluid feeders and fragmentary feeders, but that the large majority radiated as mixed feeders, and they covered nearby all food resources, from small to large invertebrate prey, and finally also plant matter, especially seeds, by modifying their mouthparts and the digestive apparatus.

The larval body

The adephagan larvae share with the Archostemata the legs with six articles, but several other features can be considered apomorphic for the suborder (Arndt, 1993): the fusion of labrum, clypeus and frons to a unique piece, the frontale (epistoma, fronto-clypeo-labrum), the anterior border of which is called “nasale”; the absence of a mola at the mandibular basis. The presence of egg-bursters in the first instar characterizes the family Carabidae (excl. Rhysodidae) and Trachypachidae + Dytiscoidea. Following Crowson (1967) the Geadephaga are marked by a well developed 9th abdominal segment and 10th forming a pygopod, or 8th and 9th transformed in a terminal disk (Paussinae), finally an open tracheal system typical of terrestrial life habits. Probably also some other body parts may belong to the groundplan of carabid larvae, as e.g. the presence of a row of small denticles or a “hypodon” on the ventral border of the frontale and, in the first instar, urogomphi fused to the 9th segment, not jointed and with 5 large primary setae (Arndt, 1993). Another hypothesis could be that primarily the urogomphi may have been long and articulated at the basis (Zetto Brandmayr *et al.*, 1998; Sharova, 2008).

In the course of their evolutionary history carabid larvae exhibited a manifold morphological variation, among the most diverging adaptations we have to remember at least the ambush-predatory habitus of Cicindelinae, whose head and prothorax complex

form the external closure of a vertical burrow. So aberrant in its morphology is the terminal disk of Paussinae, which was used first as a predatory sticky and attractive device and later as a glandular “appeasement” of ants in their nests (Moore & Di Giulio, 2019).

Being less protected and sclerified, the larval body of Carabids has more affected by habitat constraints if compared with the more homogeneous adult morphology, but this helps us in understand the larval response to the physical and biological habitat requirements. Some hypotheses have been proposed in the past to explain the morphological variation of these larvae, the first was done by Sharova (1960, 1981). She distinguished nine “morpho-ecological” types, the first four predatory, the fifth saprophagous, 6th-8th phytophagous or saprophagous more or less able to move on soil surface or by digging in the soil, the 9th parasitoid and hypermetamorphic. Zetto Brandmayr *et al.* (1998) updated and modified such types and assigned to each new type an English denomination, as in Tab. 1. Later on, a new system was proposed anew by Sharova (2008), in our opinion a little too complex in the definitions, but we refer to this article for the magnificent illustrations of nearly all types here described.

The larval morphotypes, in the following “life-forms”, reflect more the habitat adaptations than carabid phylogeny, but in some subfamilies/tribes the larval body is surprisingly constant and reflects in all probability an old divergence from the basic groundplan. This is particularly clear in Paussinae (Ozaenini + Metriini + Paussini), all marked by a terminal disk (the “discotelic” morphotype) that becomes more rounded and complete in the higher symphiles, as *Paussus* (Di Giulio *et al.*, 2011, 2017), starting from a less refined form of non myrmecophilous trapdoor predators as *Mystropomus* or *Goniotropis* (Vigna Taglianti *et al.*, 1998; Di Giulio & Moore, 2009; Moore & Di Giulio, 2006, 2019). A similar uniformity of larval morphology has observed in the highly debated subfamily Cicindelinae, where all the species conserve the peculiar habitus of ambush trapdoor predator at the top of vertical burrows, that we could define burrow trappers or “cicindeloid”. The same form has maintained in every possible habitat, also in arboreal dweller Cicindelinae (Naviaux, 1996; Naviaux & Pinratana, 2004; Gough *et al.*, 2019).

In several other carabid groups, the evolution of larval morphology is less canalized and it is re-

Tab. 1. The main larval “life forms” of Carabidae, as rearranged by Zetto-Brandmayr *et al.* (1998). The old term “spermophagous” has changed in “granivorous”, as in Talarico *et al.* (2016). The “trychome disk symphiles” have been changed in “discotelic” according to Di Giulio *et al.* (this volume). The “bark dwellers” form is proposed here for the first time.

Name and morpho-functional details	Behaviour	Selection pressures
SOIL PORE EXPLORERS (I of Sharova) Small or medium size, mandibles not specialized, often blind, cerci short and unarticulated, with 5-8 macrochaetae	Life in leaf litter or deeper in the soil, prey specialization rare (Molops)	Typical of forest soils rich of leaf litter and crevices, far from subsoil water level. Very frequent in mountain soils or karstic habitats
SURFACE RUNNERS (II of Sharova) Thin and long legs, stemmata always well developed, mandibles specialized, often a neck constriction, cerci long and jointed or whip like, flexible	Hunting on the soil surface and fast running, scanning for prey (Collembola, earthworms, other small objects), head often horizontally swinging	Soils with scarce upright extension, near the subsoil water, alluvial, bare and muddy. The prey shows fast movements and is able in attack avoidance
SURFACE WALKERS (III of Sharova) Medium or large size, tergites or the entire dorsal side well sclerotized and often metallic, paratergal lobes developed, mandibles with large retinaculum, cerci short and thorn shaped	Hunting on the soil surface or on trees, preys large (earthworms, caterpillars, slugs, snails). The prey is consumed in shelters or in short galleries dug out with legs and head. Cerci are used also for defense or attack.	Probably large preys seized on the soil surface or on trees (Calosoma). The large size attained reinforced the digging behavior as escape from predators, sun radiation selected a well pigmented and sclerotized dorsum
SAND DIGGERS (IV of Sharova) Medium or large size, body cylindrical, eyes normal or flattened, sometimes absent (Scarites s. str.), cerci very short, stout and robust	Behaviour poorly known, the larvae are hunting by digging in loose sand until 1 m depth, <i>Omophron</i> larvae show a <i>Gryllotalpa</i> “habitus”	Sandy soils in habitats close to river banks or on marine strands, the integuments are pale because of the subterranean life
GRANIVOROUS (V, VI and VII of Sharova) Head wide and robust, mandibles with high width/length ratio, sometimes with additional teeth on the terebra, tergites from pale to reddish, legs spiny, cerci short and knotty	Diet most polyphagous or restricted to plant seeds, some-times specialized on a single plant genus, seed storage is described for some species. Burrows often in very hard soils	Selection started in parallel to herbaceous flowering plants (graminaceous and umbel plants, crucifers, etc.) and shifted from waterside habitats to arid steppe biomes
C-SHAPED HARPALINES (VIII of Sharova) Body form scarabeoid, physogastric, eyeless, mandibles extremely stout, body pale and pubescent, cerci rudimentary, legs robust and spiny	Unable to walk as campodeiform larvae, but strong diggers also in very compact soils. <i>Carterus</i> larvae feed on the seeds cumulated by the mother in subterranean nests	Summer aridity and hard soils common also in the Mediterranean region are probably at the origin of this larval ecomorph
PARASITOIDS (IX of Sharova) First instar very mobile and triunguline-like, small and with enlarged olfactory lobe on the third antennomere. Older instars with shorter legs and physogastric body, pale	The first instar is searching for coleopteran pupae, insect egg clutches or ant nests. The older instars live at the expense of the so found prey and pupate in the host chamber or near the ant nests	Selection pressures in the high density of parasitoidized preys in certain habitats, or in the highly concentrated biomass offered by subsocial aggregations of by eusocial insect nests.
BURROW TRAPPERS (cicindeloid) Body deeply modified, forebody (head and part of the thorax) sclerotized and often metallic, ventral part of the head swollen and convex, cerci absent, anchor hooks on abdominal terga	A more sedentary life in vertical burrows ambushing on preys, the more sclerotized forebody is extruded when the prey is walking in the neighbor of the opening	Sunny bare soils with a high humidity and rich of fast running prey
DISCOTELIC (TRICHOME DISK PREDATORS/ SYMPHILES) First instar like the aged ones, larvae with more or less physogastric body, cerci and ninth segment transformed into an “terminal disk” rich in trichomes and sensilla., symphiles blind	Primitive forms predatory in short burrows closed by the terminal disk that is used as adhesive trap. evolved forms live as hosts of ant nests. Paussini larvae secrete an ant appeasing substance from their trichome disks	Selection pressures should be sought in the eusocial insect nest environment and are well known for many coleopteran families other than Carabidae. The life form is known only from Paussinae
BARK/TREE DWELLERS The body form resembles that of a snakefly larva (Raphidioptera), the head is elongate, the abdomen at its largest width in the middle, the cerci very short (<i>Dromius</i>) or long and flexible (<i>Agra</i>), tarsal claws denticulate, the 10 th segment short and ending with a crown of short sclerotized small hooks	The behavior is poorly known, but the larva is continuously balancing its body on the pygopodium used as a center of gravity. The 10 th segment is used as a sort of anchor that probably helps during the prey grasping and during walking on the trees	The selection pressures are that of the arboreal environment, as suggested by the strong abdominal musculature and by the toothed tarsal claws

flected at best by the variation of the cerci (Figs. 15-27), a body part that is extremely dependent on the physical and biotic selection pressures acting in the environment. Of course, the remaining body parts are also of importance, from head shape to chaetotaxy, and we will remember such details from time to time. The cerci articulated at the base could be regarded as belonging to the caraboid groundplan (Fig. 19 – hemicyptobiont of Sharova, 2008) and are found in many primitive lineages: Loricerinae, Nebriini, Opisthiini, Notiophilini, in *Opisthius*, all surface runners, but also in some primitive Carabinae as Ceroglossini, in Siagonini, where the urogomphi are whip-like and flexible, and others. This speaks for an adaptation to wet mineral or hydromorphic soils that could be typical of waterside habitats. The shift to forest soils or to drier habitats seems coupled to the pore explorers and the new “pushing” function of the cerci, which become fused to the 9th abdominal tergum as a rigid support for crawling through the soil cavities (Fig. 21). A transition from long cerci to short, “pterostichoid” ones can be followed in several taxa: *Abax*, where the shortest cerci are seen in the alpine *Pterostichoabax* species, or in *Stomis*, where the mountain species (as *rostratus*) show much shorter cerci if compared with the lowland species *pumicatus* (Zetto Brandmayr & Marano, 1993). In mountain environments and in caves the pore explorer type is the most common. The non-articulated urogomphi become particularly short in the granivorous type, with a peak in larvae that live digging in summer-arid soils. The cerci eventually disappear in the scarabaeoid C-shaped type, like in the Ditomines, the larvae of which are fed in paedotrophic nests dug out by the mother which stores the seeds collected on the plants. It should be emphasized that in some surface runners a reversal from the pusher type to the runner type may have occurred more times (Figs. 15-27, double arrow from 21 to 20), but the cerci become secondarily articulated only in their distal part, whereas the basis remains fused to the 9th tergite (*Abax*, several Platynini). In higher carabids (Harpalinae) we observe several times a shift to the surface runner type that occurs e.g. in Chlaeniini, Odacanthini, Galeritini, Physocrotaphini, formerly Helluodini, (excl. *Pogonoglossus*, Moore, 1998), Lebiini (partim), but here often the cerci become whip-like, long and flexible, often with a white tip. This happens for instance on heavy mud soils (*Chlaenius*, *Epomis*, *Galerita*) or in the arboreal envi-

ronment (*Agra*). In some *Chlaenius* species, perhaps as a response to the high larval density on the suitable muddy flats, the larvae reached an unexpected performance, the ability to communicate by touching each other with the long and flexible cerci to avoid cannibalism (Zetto *et al.*, 2004).

The walker type evolved also very early from the basic runner form, first we find it in the Carabinae, where in Calosoma we can observe the shift from even articulate cerci of the 1st instar to the robust thorn like form of the aged larvae (Fig. 16). In higher Carabini the cerci become still longer and bifid (Fig. 15), assuming the role of attack weapons against snails through the typical “scorpion hit” exhibited by the Carabi longimandibulares. The walker type appears also in Cychrini (where the cerci become rudimentary), in the Pamborini, in some Scaritinae, Licinini and Chlaeniini, in some better studied cases surely connected to a specialized snail feeding.

The sand digger form is found in several Scaritini, in Elaphrinae (e.g. *Blethisa*), in the Omophroninae, where also the head with its strongly pointed nasale (Beutel, 1991) is transformed into a “digging machine”, perhaps in *Gehringia olympica* (Lindroth 1960), in some Broscinae, in Promecognatini (Bousquet & Smetana, 1986), Helluonini (Bousquet, 1987) and Anthiini (Chopard, 1936).

In hypermetamorphic parasitoids the urogomphi play a little role and are rudimentary also in the first instar, but such life style is always recognizable by the enlarged shape of the sensory appendage of the third antennomere, as pointed out by Giglio *et al.* (2008). This morphotype is found most in higher Carabidae: Brachinini (e.g. Saska & Honek, 2004; Frank *et al.*, 2009), in some Lebiini (Silvestri, 1905; Erwin & Erwin, 1976), in Loxandriini (Will, 2008), here at the expense of anuran eggs in the foam nests of *Leptodactylus fuscus* (Costa *et al.*, 2011). The same characteristic is found in some Pseudomorphinae (Erwin, 1981), in the termitophilous Orthogoniini (Makarov, 1998), in the ant predatory symbionts Graphipterini (Zetto Brandmayr *et al.*, 1993) and in Peleciini (*Eripus*, Liebherr & Ball, 1990). The parasitoid life form should not be confused with other kinds of symbiotic life or food specialization, for an exhaustive list of more of such relationships see e.g. Erwin (1979).

Finally, the most intriguing change is present in Paussinae (Figs. 22-23), as remembered above, where anyway a progressive specialization from am-

bush predation in short galleries to a highly integrated ant nest predatory symphily is observed in the course of the evolutionary pathway (Di Giulio *et al.*, 2015).

From a comprehensive look at the evolution of larval life forms it appears clear that several characters are the result of convergent adaptations to abiotic or biotic environmental factors. Nevertheless, also in this semaphoront some evolutionary “rules” reflect the evolutionary history of carabids. The first that probably appeared were the surface runners, similarly as it happened in the adults, where the fast runners made their appearance when forest ecosystems were still loose and composed mainly by conifers. In recent taxa the cerci tend to become whip-like and show often a more specialized function. The sand diggers also belong at least in part to older taxa, the younger ones, e.g. *Anthia*, are specialized predators living in arid sand habitats. The surface walkers originate from the runner type (*Ceroglossus*, Prüser & Arndt, 1995) and shifted to larger preys transforming the cerci into a weapon that was used also for digging in forest soils. At the same time the expansion of broad-leaved forests favored the soil pore explorers (and the wedge pusher adults) and the rise of several arboreal lineages, that belong to at least three types: the cicindeloids, the surface runners and the bark dwellers. Only later the flowering of the herbaceous Angiosperms offered new food to the granivorous forms, which with their robust mandibles and fossorial legs conquered the open land biomes. In summary, we can speak of a certain parallelism between the adult and the larval evolutionary history.

THE BIOTIC FACTORS DRIVING CARABID EVOLUTION

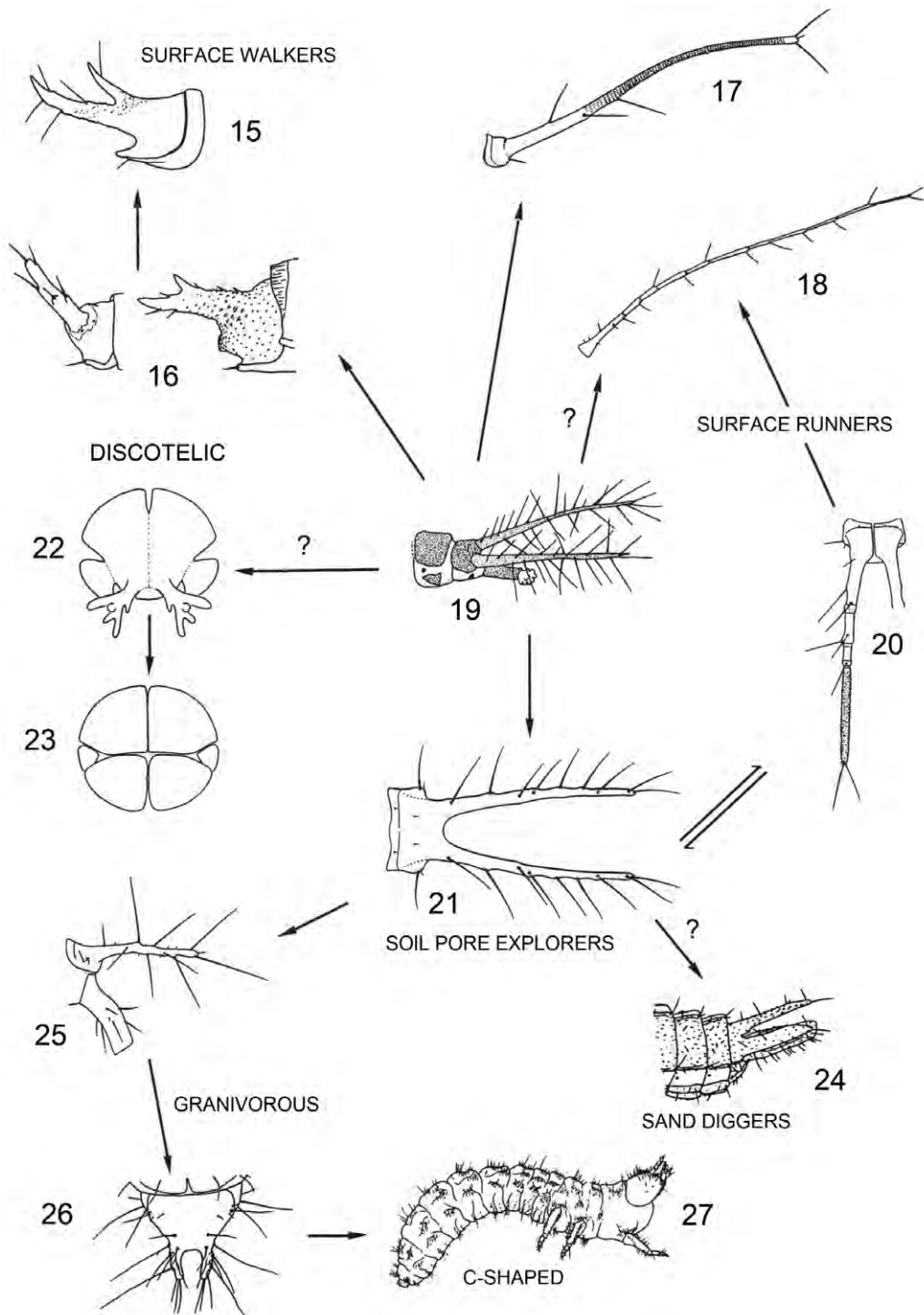
Food resources and preferences

In the previous chapters we addressed the basic morphological and morphofunctional changes observed along the carabid evolutionary history. Now we attempt, starting from some considerations about food specialization and availability (see also Evans, 1982), to frame such factors and facts into a temporal sequence. Fossil records so far ascertained say us that the first Geodephaga appeared on the life scenario no early than in Triassic (250 Mya), when terrestrial communities were already of high complexity and diversity. Even much before, in the Devonian Lagerstätte of Rhynie Chert in Scotland (409–411 Mya, see Gar-

wood & Edgecombe, 2011; Dunlop & Garwood, 2017) a remarkable diversity of terrestrial animals, mainly arthropods, has described: Nematoda (*Palaeonema phyticum*), Trigonotarbid Arachnida (*Palaeocharinus*, two spp.), Acariformes (five species belonging to as many genera), Opiliones (*Eophalangium*), Chilopoda (*Crussolum*), Diplopoda? (*Rhynimonstrum*), Collembola (*Rhyniella praecursor*). In a previous paragraph we remembered the specialized food choice of *Promecognathus* for millipedes, a slight preference for young moulting millipedes was observed also for *Pelecium sulcatum* (Peleciini) by Salt (1928). Among arthropods, also Crustacea represent an important food item for caraboids, first of all terrestrial Isopods (Oniscidea), which probably appeared in the Cretaceous (Broly *et al.*, 2013), whereas true fossil freshwater Isopods are known from the Carboniferous. Very old is also the origin of fairy shrimps (Anostraca), which are predated by the enigmatic genus *Cicindis*, and appeared probably during the Carboniferous as witnessed by the fossil *Lepidocharis* (Olesen, 2007).

Thus, the first Geodephaga, Eodromeinae and Protorabinae, were already in front of a wide choice of prey, that enclosed surely also many phytophagous/predator insects of several orders flourished in the Carboniferous (e.g. Blattodea, Ephemeroptera, Orthoptera, Palaeodyctioptera, Protodonata, and new evolved lineages of the Permian: Protelytroptera (primitive relatives of Plecoptera), Psocoptera, Mecoptera, Coleoptera, Raphidioptera, Neuroptera and the “modern” Odonata (Missbach *et al.*, 2014; Wiegmann *et al.*, 2009; fossil records of Insects: <http://insects.about.com/od/evolution/a/Timeline-of-Fossil-Insects-by-Order.htm>). The waterside dwellers were abundant, and prey biomass must have been abundant at the borders of the riverine and lacustrine habitats. Particular attention needs the appearance of Isoptera, which probably separated from *Cryptocercus* roaches about 170 Mya (Bourguignon *et al.*, 2014, Jurassic), with higher taxa (Termitidae) diversifying later, in the Paleogene (54 Mya).

Concerning the origin of other endopterigote orders, most of them appeared within the Triassic, but with the crown group diversification only in the Jurassic (Wiegmann *et al.*, 2009). Only higher Hymenoptera and Lepidoptera appear later, the first ones at the jurassic/cretaceous transition, the other, if based on fossil records (Sohn *et al.*, 2015) most during the Creta-



Figs. 15-27. Morphological trends in carabid urogomphi, redrawn from various authors in Zetto Brandmayr *et al.* (1998). 15 – *Carabus violaceus*; 16 – *Calosoma inquisitor*, I and II instar; 17 – *Chlaenius costiger*; 18 – *Drypta japonica*; 19 – *Nebria lacustris*; 20 – *Abax parallelus*; 21 – *Pterostichus diligendus*; 22 – *Metrius contractus*; 23 – *Paussus kannegieteri*; 24 – *Clivina fossor*; 25 – *Ophonus stictus*; 26 – *Zabrus orsinii*; 27 – *Ditomis calydonius*, entire body. Various magnifications.

ceous, the Macroheterocera even in the second half of this period. Within the Hymenoptera a crucial group is represented by ants, whose eusocial nests started during the Cretaceous, but with diversification also in the Paleogene (Peters *et al.*, 2017).

Food items of carabids are not limited to Arthropods, earthworms and snails represent main part of the diet of larger species, especially of Carabini. The earthworm fossils are a difficult matter, with doubtful findings already in the Ordovician (Morris *et al.*, 1982), anyway a thorough phylogenomic analysis of Anderson *et al.* (2017) suggest an ancient origin in Pangaea with a mesozoic split between a northern- and a southern hemisphere clade around ~161–185 Mya. Eupulmonate Gastropods share with earthworms the highest food preferences of larger carabids, most of them appeared in the Cretaceous (Tracey *et al.*, 1993). Several families are known only from the Cenozoic (Helicidae, Vitrinidae, Limacidae, Arionidae and others). Finally, we have to deal with the plant food, that is mainly composed by dicotyledon and monocotyledon seeds of Violaceae, Asteraceae, Brassicaceae, Lamiaceae, Apiaceae and Poaceae. Such Angiosperm families appeared very late in the geological times, most in the second part of the Cretaceous (Bell *et al.*, 2010), the gramineous plants even later, in the lower Eocene (Linder & Rudall, 2005).

The results of a reconstruction of prey/food preferences of some carabid subfamilies or tribes versus prey appearance throughout geological eras are presented in Tab. 2. Here I reported the possible time of origin of subfamilies/tribes looking at the already published datings or at the relative position of branches. Some groups, like the Calosomines, the “caterpillar hunters” have been adjusted according to the preferred prey. The chronological sequence of the prey/food availability seems more or less coherent with what we know about the origin of several suprageneric taxa of Carabidae (Rhysodidae have been omitted). Especially the datings given by Ober & Heider (2010) for the Harpalinae taxa were useful for some adjustments. In a possible first phase fluid feeders concentrated on arthropod prey, but later Carabinae shifted to soft larger preys given by earthworms (Carabi brevimandibulares), terrestrial snails (Cychrines, longimandibular Carabini), and macroheteroceran caterpillars (Calosomines). The attempts to dating the origin of the Calosomini, recorded previously in the Introduction, i.e. permo-triassic transition

by Toussaint *et al.* (2017) or jurassic by McKenna *et al.* (2015) don’t seem in agreement with the late origin of the larger Heterocerans, unless we suppose that first calosomines were generic arthropod/insect predators. On the contrary, the dating of calosomine stem group between 90 and 50 Mya and their flourishing in the Paleogene as winged dispersants (Toussaint & Gillet, 2017) seems in good agreement with the availability of Macroheterocerans.

Instead, fragment feeders seeking for small arthropods (grey lines) found probably a broad spectrum of prey at the first beginning of their divergence, because arthropods were well represented since the Devonian, much earlier than the first Eodromeinae and Protorabinae. Millipeds also are of ancient origin, thus Promecognathines could be dated much before the Peleciines, which developed lately their parasitoid relationships.

The mixed feeders contain the large majority of Stylifera and Conchifera sensu Jeannel and is represented basically by generalist predators (pale yellow lines), but at the same time by an impressive spectrum of feeding adaptations, that range from termites and ants in the tropics to the seed feeders which expanded also in the temperate zones of the northern hemisphere after the origin of the herbaceous angiosperms. Some crown groups like the Chlaeniines became even predators of small vertebrates, anuran or caudate amphibians. Here we find the highest number of parasitoid taxa, from *Loxandrus oophagus*, the larvae of which develop on the eggs of a small rainforest frog, *Leptodactylus*. Parasitoid life is found also in evolved Pseudomorphines (*Pseudomorpha*), in Chaetodactyliini, in Lebiini and in Brachinini (Erwin, 1967). Also, the life style of predatory symbionts is widespread: it varies from the incipient adaptation of Siagoninae to the extremely refined relationship of Paussini, with all possible intermediate stages in *Graphipterus*, *Anthia*, Helluonini, Orthogonini, Helluodini. The overall strategy of Carabids in the course of the time seems an increasing rely on the resources of social insects, ants and termites on one side, and to become ectoparasitoids of primary consumers on the other. In Brachinines finally also intraguild predation is attained, as it has been demonstrated by Saska & Honek (2004, 2008) for *Brachinus*, that feed on *Amara* pupae. *Amara*, *Zabrus* and all Harpalines represent another “modern strategy”, they became by themselves at least in part primary consumers at the

Tab. 2. Food preferences of some better-known carabid tribes, subdivided for feeding types, a reconstruction through geological times (Cambrian omitted). Black solid arrows: same prey in adults and larvae – dashed arrows: larval food specialization – white arrows: larval hypermetamorphic parasitoids. The starting point of the arrows corresponds more or less to the presumed appearance of the taxon, the coloured lines to the possible appearance of the potential prey. The info's on prey choice base also on some additional references: Sasakawa (2016), Rajagopal & Prasad (1988), Alluaud (1935), Liebherr & Short (2006), Roy *et al.* (2020), Liu *et al.* (2011), Mawsdley *et al.* (2011a, b), Makarov (1998), Adis *et al.* (1997), Topoff (1969), Prasad & Rajagopal (1990), Casale & Shi (2018).

ERA		PALEOZOIC					MESOZOIC			PALEOGENE			NEOGENE			
PERIOD		Ordovic ian	Siluri an	Devonian	Carboniferou s	Permian	Triassic	Jura	Cretaceous	Paleo cene	Eocene	Oligo cene	Miocen e	Plioc ene	PL	
Mya		486-443	442-419	441-358	357-298	297-252	251-202	201-146	145-66	66-56	56-33.8	33.8-23	23-5.3	5.3-2.5	0	
FLUID FEEDERS	Cicindelinae			arthropods												
	Carabinae (i) (brevim.)			arthropods &	mainly earthworms											
	Carabini (longim.)			arthropods &	land snails, Helicoidea											
	Cychrini			small land snails, slugs												
	Calosomini			arthropods ?		Heterocera caterpillars										
	Paussinae (i)						Ants									
	Metriini			arthropods												
	Ozaenini			arthropods												
FRAGMEN T FEEDERS	Physeae						Ants									
	Omophroninae			arthropods ?												
	Nebriinae			small arthropods												
	Opisthiini			small arthropods ?												
	Notiophilini			springtails												
	Elaphrinae			small arthropods												
	Loricarinae			small arthropods, springtails												
	Cicindinae			early Branchiopods		fairy shrimps <i>Thamnocephalus</i> sp.										
MIXED FEEDERS	Promecognathinae			early millipeds		Polydesmidans										
	Scaritinae				dark beetles and snails											
	Parallelommorphus						Oniscidea, Tylos									
	Oxylobus dekkanus					Termites										
	Siagoninae						Ants									
	Pseudomorphinae						Ants									
	Sphallomorpha						Ants									
	Broschinae			arthropods and any other prey												
	Trechinae			arthropods and any other prey												
	Patrobinae			arthropods and any other prey												
	Harpalinae:															
	Loxandriini			arthropods and any other prey ?												
	Loxandrus oophagus larvae			parasitoid on eggs of the anuran <i>Leptodactylus fuscus</i>												
	Peleciini			Larvae parasitoid on moulting millipedes and beetle pupae												
	Chaetodactyliini					Cetoniine pupae										
	Pterostichini			arthropods and any other prey												
	Molopina larvae, e. g. <i>Abax</i>					earthworms										
	Platynini			arthropods and any other prey, (Chironomids underwater)												
	Zabrinini				seeds of Poaceae, Violaceae, Asteraceae...											
	Harpalini				seeds of several angiosperm families, Ficus											
	Licinini					land snails										
	Chlaeniini			arthropods and any other prey												
	Epomis				Amphibians, mainly young anurans											
	Panagaeini				Land snails, <i>Achatina</i>											
	Masoreini			arthropods and any other prey												
	Graphipterus						Ants									
	Collurini			arthropods and any other prey, esp. Diptera												
	Ctenodactyliini (Askalaphium)						Larvae of Hispine <i>Cephaloleia</i>									
	Leptotrachelus						Larvae of the Crambid <i>Diatraea saccharalis</i>									
	Orthogonilini						Termites									
	Lebiini						Chrysomelidae, Endomychidae									
	Calleidina (Calleida, Parena)				caterpillars of Tortricidae, Pyralidae, Xyloryctidae etc.											
	Agra			arthropods and any other prey ? Flowers/foliage exudates?												
	Physocrotaphini						Termites									
	Galeritini (Zuphiini)			arthropods and any other prey ?												
	Helluonini						Army ants <i>Neivamyrmex</i>									
	Omphra						Termites, <i>Odontotermes wallonensis</i>									
	Anthiini			arthropods, insects of all orders and other...												
	larvae						Ants									
	Brachininae			arthropods, insects of all orders and other...												
	larvae				beetle pupae, eggs of mole crickets											

expense of plant seeds (Talarico *et al.*, 2016). Carabids thus exhibit an enormous diversification of food preferences in the course of the time, and this is one of the reasons for their importance in the biological control (Lövei & Sunderland, 1996; Symondson *et al.*, 2002; Kulkarni *et al.*, 2015), but see also the problem of network interactions in the field (De Heij & Willenborg, 2020). Nevertheless, Table 2 demonstrates yet again how the studies on carabid food preferences and connected behavioral adaptations are disregarded and anecdotal, compared to the lack of knowledge about dozens of other tribes.

Enemies and predation avoidance

Predators (and parasites) deeply influence the evolutionary history of every animal group and carabids are not an exception, Thiele (1977) and several other authors enumerate a wide variety of organisms that prey or invade the body of ground beetles. Task of this work is not a thorough re-examination of this wealth of relationships, but simply to identify some of the most striking biotic pressures that may have driven the carabid defenses. Evans (1982) identifies in the bare soils of the pre-Angiosperm era one of the major predation risks, as the running Eodromeines, Protorabines and other caraboid ancestors were chased by arachnids, centipedes, reptiles as lizard-like lepidosaurs (Triassic), true lizards (Jurassic), mammals like the Chinese fossil Eutherian incertae sedis *Eomaia scansoria*, (Ji *et al.*, 2002) from the lower Cretaceous. Frogs were also diurnal active like lizards since Jurassic (Holdrege, 2016), but their actual flourishing exploded after the Cretaceous–Paleogene (K–Pg) extinction event (Feng *et al.*, 2017). Later, starting from the Paleogene, carabids were persecuted by modern mammals, especially insectivores, by ground predating bats, and by several carnivores, enclosed foxes and wolves. In the same time modern birds expanded in all continents and “forced” carabids to adopt new strategies of survival.

Looking at the evolution of carabid defenses, they are still today poorly known, excepted for their chemical avoidance, that has been studied thoroughly (Will *et al.*, 2000 and several authors quoted here). These authors mapped chemical classes onto a phylogenetic hypothesis and found that: “formic acid or other relatively strong irritants are correlated with tribes having a high species diversity in tropical regions, whereas tribes exhibiting higher diversity in

temperate regions use milder saturated/unsaturated carboxylic acids”. An important selection pressure for the secretion of formic acid by the pygidial glands could have been exerted by ants, that are strong competitors of carabids both in communities as well as biogeographically. A possible relationship put forward by Will *et al.* (2000) is that spraying formic acid may disorient the ants when attacking a carabid.

Anyway, the presence of such glands and their secretions is a common feature of all Geadephaga, Rhysodidae enclosed, and was surely the first defense possibility starting from the stem lineages. More toxic substances have been elaborated several times, as quinones in *Clivina*, Paussinae and Brachininae (flanged- and typical “bombardier beetles”) or phenols in Chlaeniini and Panagaeini, suggesting a wide variety of solutions depending on habitat and enemies, but a strict correlation with phylogenesis is still hampered by the lack of studies on several minor tribes ((Will *et al.*, 2000). Much less investigated are the defensive substances secreted by other glands of the carabid body, like the abdominal glands of the pupae, studied by Giglio *et al.* (2009) on *Carabus lefebvrei*, where a large spectrum of substances has found, with a high percentage of linalool and alfa-terpinene.

Brandmayr *et al.* (2009) reviewed the defense mechanisms of carabids subdividing them in chemical, morphological and behavioral strategies. The morphological ones have been identified in cryptism or camouflage, aposematism and mimicry. Crypsis is rare in carabids, but in some ant predatory groups the simple contact with the ant environment or the ant devouring may resort in a chemical camouflage, as put forward for *Anthia (Thermophilum)* and *Graphipterus* (Dinter *et al.*, 2002) or *Siagona* (Talarico *et al.*, 2009) studying the cuticular profiles. The interaction between chemical defenses and chromatic vision predators like birds is perhaps at the origin of aposematism and Batesian or Müllerian mimicry circles observed in some carabid groups. Aposematism is more widespread and often coupled with aggregation and mimicry. Gregariousness is well known in carabids, e.g. in *Calomera* tiger beetles (Uniyal & Bhargav, 2007), especially well protected beetles like *Brachinus* (Schildknecht & Koob, 1969) are found in multispecies aggregations (Wautier, 1971; Juliano, 1985; Zetto Brandmayr *et al.*, 2006; Schaller *et al.*, 2018) to enhance reciprocal protection against predators, an exchange or transmission of defensive substances seems possible (Bonacci *et al.*, 2011). The

color patterns exhibited by aposematic carabids correspond to a predation avoidance, both from vertebrates, the lizard *Podarcis sicula* (Bonacci *et al.*, 2008) and from invertebrates, e.g. *Ocypus olens* (Bonacci *et al.*, 2006).

Mimicry cases are also known or at least hypothesized in carabids, Lindroth (1971) supposes that some *Lebistina* species exhibit Batesian mimicry in respect to the flea beetles *Diamphidia* and *Polyclada*, very poisonous and used by indigenous people for their arrows. Cassola & Vigna Taglianti (1988) suppose mimicry between some less protected tiger beetles of the genera *Elliptica*, *Lophyra* and *Neolophyra* and *Graphipterus*, which could be unpalatable to Vertebrate predators. Similar Müllerian relationships could involve several Southafrican *Anthia*, marked by flashy black/white/yellow patterns and able to spray highly concentrated formic acid and other compounds (Mawdlsey *et al.*, 2011). Müllerian circles are surely more diffused in ground beetles, as we can argue from the lively colors of so many tropical beetles, or also looking at European species, e.g. *Odacantha melanura* and its possible relationships with the highly protected *Paederus* rove beetles.

If we exclude the aggregation, behavioral mechanisms of avoidance are surely the least studied in carabids, the most ancient and widespread is perhaps the stridulation or chirping, a sound production that is generated by apparatuses located in various parts of the body. Chirping has been documented for Cicindelinae, *Elaphrus*, *Cychrus*, *Carabus* (see papers cited in Brandmayr *et al.*, 2009), Pausinae (Di Giulio *et al.*, 2015, see above) and others. In non-symphilous species this behavior probably allows to spare pygidial glands chemicals when threatened by predators, Bauer (1976) observed sand pipers (*Actitis hypoleucos*) capturing *Elaphrus* individuals after their stridulation apparatus was muted, and found that chirping beetles were less appetized by the birds. Chirping was interpreted as a warning signal for large predators which probably are confused by the signal or associate it to the chemical spraying. Behavioral signals are often depending from particular structures, as observed in *Colliuris* larvae, that probably communicate their presence to the conspecific adults to avoid cannibalism using the white tips of their cerci hold upright (Adis *et al.*, 1997), and similarly some *Chlaenius* larvae recognize their conspecifics by crossing their long flexible cerci when meeting together or sharing a prey (Zetto *et al.*, 2004).

Defense mechanisms of carabids have been challenged for millions of years in a sort of arms race that produced the actual variety of responses. It is highly probable that also some parts of the body were improved in the course of the time, like the promesothoracic articulation (Figs. 10, 11), the closure of procoxae, the metathorax-abdomen interlocking, perhaps by the predation pressure exerted by large spiders, Terebrantia or aculeate Hymenopterans. Spiders for example penetrate their chelicera into the ventral intersegmental membranes of the neck or of the promesothorax junction by arching the carabid body (personal observations), and this could explain the novelties of the Harpalinae thorax we remembered in a previous chapter. The relationships between ground beetles and their surrounding biota are far from being understood in their complexity.

AN OVERALL VIEW

I synthesized the most relevant data on carabid and trachypachid fossils in Fig. 28, by ordering the findings from Permian to Pleistocene and with separately recording some more interesting subfamilies or tribes. Immediately apparent is the complete absence of modern carabids in the Triassic and Jurassic period. Exceptions are only the upper Cretaceous of Orap (Botswana), where among others the first presumable Promecognathinae was found, *Paleoaxinidium orapensis* (Mc Kay, 1990, 1991), the 99 Mya old Burmese amber, from which the Pseudomorphine stem group member *Burmapseudomorphus planus* has recently described (Beutel *et al.*, 2020) and also an Oodine species is known, *Oodes kachinensis* (Liu *et al.*, 2014). The absolutely oldest finding, the Cicindeline *Oxycheilopsis cretacicus* (Cassola & Werner, 2004), has described from Brazilian lower chalk of the Santana formation in Nova Olinda, dates about 125 Mya and belongs allegedly to the Oxycheilini(a) (sub)tribe. The Cretaceous frame is completed by some possible Harpalini, Pterostichini and Abacetina, some doubtful *Siagona* and two surely identified Scaritinae beetles, all found in the Orap site, for which Mc Kay (cit.) emphasizes the nearby total absence of Isoptera, Lepidoptera, Apoidea and Formicidae. Finally, to the Cretaceous age belong some apparently modern genera that Ponomarenko (1977) referred to the Coniunctiini, with two genera that show isochete protibiae and conjunct mesocoxae, and a high number of species (25) recovered under the same genus

name *Carabites*, but very difficult to refer to any known suprageneric taxon (“subfamilia incerta”). On the whole, it seems that the appearance of Harpalinae, the higher carabids, agrees with the results of Ober & Heider (2010), who propose an origin in the Cretaceous but a strong diversification only in the Tertiary, after about 30 Mya of more cryptic evolution (“fuse”). The finding of an Oodine in the Burmese amber seems at the moment the only contrasting evidence to this scheme.

A true explosion of modern carabids is observed in the Eocene Baltic amber, 44 Mya, (Spahr, 1981 for older findings, other authors listed under Fig. 28), with a flourishing of Paussinae taxa, now most extinct (Nagel, 1987), some cicindelinae, and a plenty of still extant genera included the first arboreal ones (e.g. *Coptodera*, *Dromius*, *Agatoides*) and the first anophthalmous trechine (Schmidt *et al.*, 2016).

Equally rich of modern Carabidae are the Miocenic sites, with still extant *Carabus* species like *cancellatus* Illiger, but at the same time the extinct *Carabus neli* and *Ledouxnebria brisaci* (Deuve, 1988). In the late Miocene, Pliocene and Pleistocene the (sub)fossil faunas contain practically only contemporary carabids and trachypachids (*Trachypachus*).

In the older Mesozoic periods, Triassic and Jurassic, Eodromeinae and Protorabinae were largely dominating, together with a plenty of Archostemata species, partly reported in the first chapter. This opens the old question about the evolutionary pathway of Geadephaga, that has been debated several times but remains still unsolved (Beutel *et al.*, 2019a). Ponomarenko (1977, 2002, see also Ponomarenko & Prokin, 2015), retains that the plesiomorphic structure of the metathorax found in Permian Coleoptera (en-

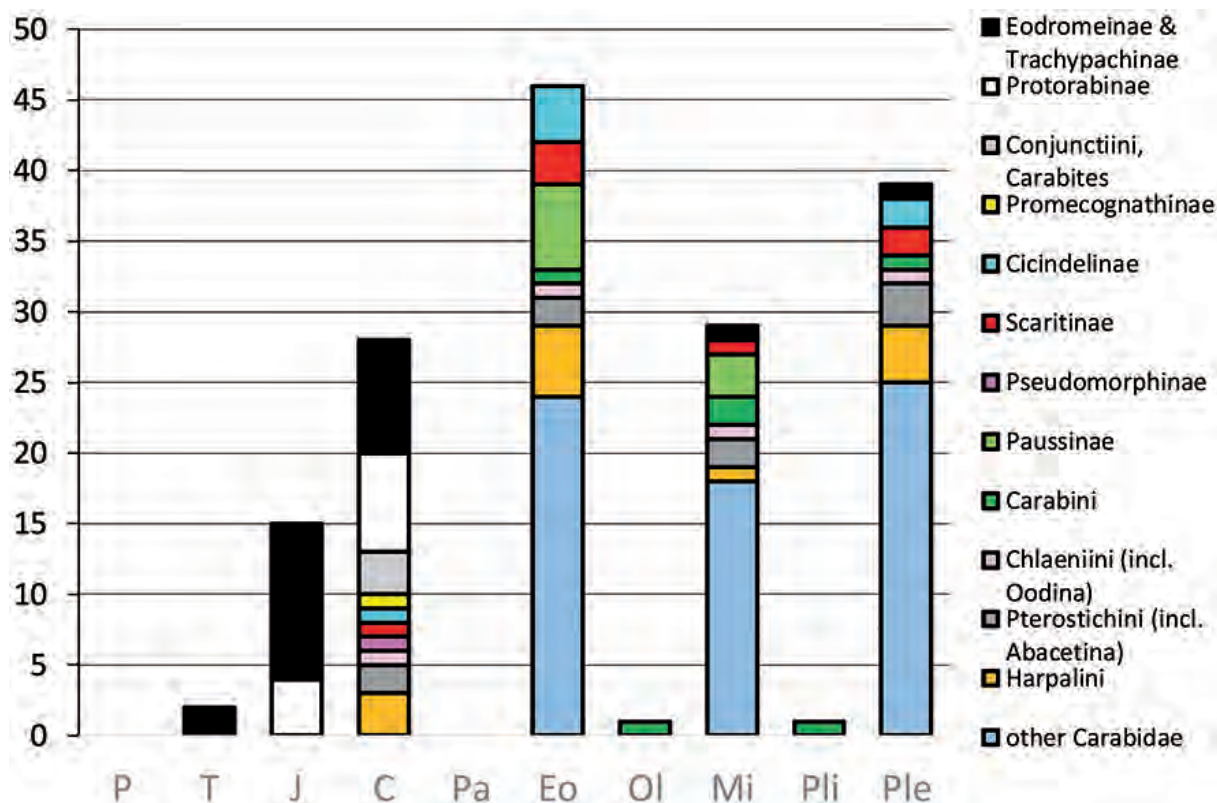


Fig. 28. Synopsis of the most important findings of fossil Carabid and Trachypachid genera found in the best studied Lagerstätten or amber/copal sites. Horizontal axis: geological periods from Permian to Pleistocene. Based on the following literature: Arillo & Ortuño, 2005; Beutel *et al.*, 2020; Cai *et al.*, 2017; Cassola & Werner, 2004; Coope, 1979; Deuve, 1988; Kirejtshuk & Ponomarenko (site); Liu *et al.*, 2014; Matthews, 1979; McKay, 1990, 1991; Nagano *et al.*, 1992; Nagel, 1987; Spahr, 1981; Ross, 2017; Schmidt *et al.*, 2016; Strada *et al.*, 2014; Ting *et al.*, 2011; Wang & Zhang, 2011; Wang *et al.*, 2012.

larged coxae that reach the elytral border, metepisterna reaching mesocoxae and metacoxal plates) have been conserved in some derived families like the extinct Schizophorids, and that the terrestrial Eodromeinae, the old Trachypachidae, are derived from primitive aquatic forms. In a first version the intermediate form was individuated by Ponomarenko in the fossil *Necronectulus*, later recovered as “incertae sedis” (Ponomarenko & Prokin, 2015), but in fact some Schizophoridae, like *Dicerocoleus calus* of the terminal middle Permian show already a slender caraboid structure with elongate mandibles. Recent findings of new middle Jurassic Schizophorids with prognathous head, large mandibles and metatrochanters, long and thin legs enclosed in the new genus *Abrohadeocoleodes* agree with the hypothesis (Tan *et al.*, 2012). Thus, in Ponomarenko’s opinion, the Adephagan ancestors were aquatic or at least crawling in water thanks also to the “schiza”. On the contrary, Erwin (1979) and Evans (1977, 1982) regard the enlarged metacoxae as derived from the Geadephaga ground-plan and the Hydradephaga entering the inland waters starting from a terrestrial habitat. This second hypothesis seems less parsimonious because all primitive Coleoptera (Tshekardocoleidae, Permocupedidae, etc.) present the same pterothorax structure with metacoxae wider than metaventrite extending to the elytral border, a condition that has maintained in Hydradephaga but progressively lost in Geadephaga. Actually, Erwin suggested a third possibility, that the Adephagan ancestors were waterside dwellers (like perhaps, at least in habits, *Amphizoa*). The life at the borders of inland waters, a habitat rich of animal biomass, is compatible with both directions of the evolutionary pathway, that into the water and that towards more xeric terrestrial environments. The second way has probably attempted more times, first by Trachypachids, then by Protorabines from which the other ground beetles arose lately. The Schizophoridae hypothesis of Ponomarenko seems anyway in contrast with the phylogeny of Archostemata proposed by Beutel *et al.* (2008), who found a precocious divergence of Adephaga + Myxophaga + Polyphaga from basic permo-triassic stems of Tshekardocoleidae – Permocupedidae – Triadocupedinae, recovering the Schizophorids in a more derived group with the extinct *Jurodes*, Ademosynidae, Catiniidae and the still extant *Crowsoniella* and *Micromalthus*. The inclusion of fossils, as Beutel *et al.* (cit.) observe, is a necessary

condition for a reliable analysis, but it is highly probable that the definition of this fossil family is perhaps too broad, if beetles like *Hadeocoleus* and *Dicerocoleus* are assigned to the same suprageneric taxon (see Ponomarenko & Prokin, 2015).

ARE RHYSODIDS “TRUE” CARABIDAE?

The family Rhysodidae, known as wrinkled bark beetles, encompasses more than 370 so far described species (Bell & Bell, 1978; Beutel, 2016), found most in tropical forests where they live as saproxylics under the bark or deep inside rotting wood. It has been suggested (Bell, 1998) that they live at the expense of Myxomycetes, now Mycetozoa, in their amoeboid stage. This taxon represents the most diverse group of Amoebozoa and their evolution probably was in part antecedent or accompanied that of the land plants (Fiz-Palacios *et al.*, 2013).

As already remembered in the Introduction, the position of the Rhysodids is one of the highest debated topics of Geadephaga taxonomists. The group was traditionally placed outside Carabidae in a separate family (Jeannel, 1941; Crowson, 1955, 1967, 1981; Regenfuss, 1975), Nagel, 1979; Beutel, 1993; Bousquet, 2012), or as a member of the family as Rhysodinae(i): Bell & Bell (1962, 1978), Reichardt (1977), Erwin (1985), Bell (1998), here with the proposal that the group should be recovered in the Scaritini(ae) as sister taxon of *Solenogenys*, an inhabitant of flooded tropical forests. In recent times, also larval morphology contributed to their knowledge, especially by the descriptions of Grandi (1956, 1972), Burakowsky (1975), Mamaev & Pototskaya, 1979; Costa *et al.*, 1988. Beutel (1992b) examined the head morphology of some larval genera and found a large set of autapomorphic characters of Rhysodidae and that the hypothesis of an affinity with Scaritini was not in accord with the results of his study. Later on, Makarov (2008) examined the chaetotaxy of two species of *Rhysodes* and found the relationships with larval carabidae to be insignificant, whereas affinities with larval Archostemata (Grebennikov, 2004) were seen in some essential characters: the strongly enlarged labium, which forms, together with maxillae, a functionally unique structure, the labial palps vestigial, one-jointed and stick shaped in *Rhysodes*, inserted ventrally and caudally to the apex of labium and more or less fused

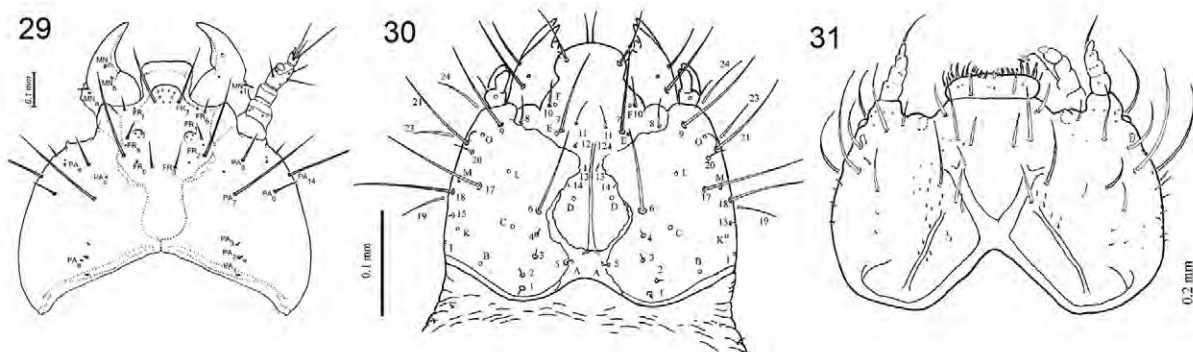
with prementum in Archostemata, a shortened gular area, galea and lacinia merged at least in part with the stipes and forming in Rhysodid larvae a typical labiomaxillar complex.

On the contrary, the molecular evidence about Rhysodids indicates a stricter relationship with Carabidae, Maddison *et al.* (1999) place the group in the CRPS quartet (Cicindelinae, Rhysodinae, Paussinae, Scaritinae) near the Harpalinae, thus not as basal clades like supposed by morphology. This was tentatively explained but not confirmed by long branch attraction. Ober (2002) shows similar results, but in none of her analyses is the CRPS quartet the sister group to harpalines, instead it was recovered as sister group to austral psydriines + brachinines + harpalines. Maddison *et al.* (2008) study with wingless amino acids, excluding the indel-rich region, plus 18S rDNA and 28S rDNA confirms the quartet but ML analysis with 28S rDNA separates CRP with Nebriinae and S (Scaritinae) near Loricera and related taxa. Lopez-Lopez & Vogel (2017) analyzing the available mitogenomes found that Cicindelidae should be separated from the quartet forming with Trachypachidae a basal sister group to all other Geadephaga. In another combination using only mitochondrial fragments Rhysodinae appear basal to all other Adephaga (Lopez Lopez & Vogel, Fig. 6b). Mc Kenna *et al.* (2015) finally recover the Rhysodines again as sister group to Paussinae or anyway inside Carabidae (*sensu lato*, Mc Kenna *et al.*, 2019).

At the light of the non-conclusive outcome of the molecular approach it seems appropriate to draw at least some morphological conclusions on the position of Rhysodids. In my opinion Makarov's (2008) idea of an Archostematan affinity could be accepted, if we imagine a precocious divergence of such beetle lineage from a basic Geadephagan stock, probably before Trachypachids, that immediately evolved as a saproxylic rotten wood dweller, perhaps more or less contemporary to some ancient Archostematan lineages. The adult morphology doesn't speak for a Carabidae subfamily and not even for a Scaritinae or Clivinini affinity. The elongate shape of metathorax, the absence of a transversal suture of the metaventre, the widely separate metacoxae, the hardly visible metepimera (Beutel, 1992a, 2016) and several other characters, as e.g. the cephalic glands, are too far from any true Carabid groundplan. Another point seems extremely important: in Bell & Bell's (1978) monograph the illustrations of several

Rhysodids show metacoxae reaching the elytral epipleura, another character that is not perfectly coinciding with the Carabid diagnosis and relates to primitive Archostemata. Beutel (1990) reports that in Rhysodids the metacoxae fit with the carabid groundplan, i.e. that metaventre and metacoxae are of equal width, but that in *Omoglymmius*, *Dhysores* and *Rhysodes* the metacoxae and are nearby in contact with epipleurae, and this could perhaps indicate that in these genera the plesiomorphic condition common to members of Cupedidae, Trachypachidae and Hydradephaga is at least in part conserved. Also, the larval features show besides the mouthpart's affinities remembered above, a general head structure which makes possible a more conservative Archostematan origin. Grandi (1956, 1972) and Burakowsky (1975) in describing respectively the clypeofrons morphology of *Omoglymmius* (as *Rhysodes*) *germari* and *Rhysodes sulcatus* wrote of a labrum fused with the frons, Beutel (1992b) in *Omoglymmius hamatus* larvae of a snout-like prominence of the nasale. The comparison of larval rhysodine heads with that of Archostemata revisited by Grebennikov (2004) shows a high resemblance in the structure, suggesting that the "snout" of the first derives from a fused labrum (Figs. 29-31).

In the light of this, the first hypothesis of Makarov (2008), that the Rhysodidae originated from a common ancestor with Geadephaga, seems at the moment the most acceptable, bearing in mind that some characters of the family, enclosed the shape of male genital structures and female terminalia ("type nebridien" of Deuve, 1993), are compliant with the suborder. A precocious adaptation to a life in rotten wood at the expense of Mycetozoans may have driven these beetles to the maintenance of several ancestor features. At the moment, also the evolutionary scheme of Adephaga proposed by Beutel *et al.* (2019), with Rhysodids as sister taxon to Carabidae, without Trachypachidae, is supported by a robust phylogenetic background, nevertheless this implies that the group attained an "archostematoid" convergent larval habitus driven by the strong selective pressures acting in the necromass microhabitat. The scarcity of fossil findings belonging to the family (only an adult is known from the Eocene and Miocene amber, Grimaldi & Engel, 2005) makes the task of a definitive attribution of the taxonomic status even more difficult, so a family status as proposed by Beutel (2016) is still preferable.



Figs. 29-31. Larval heads of Rhysodidae and some Archostemata. 29 – *Rhysodes comes*, third instar larva, dorsal view, from Makarov (2008). 30 – First instar larva of *Priacma serrata*, with fused labrum (Archostemata, Cupedidae Priacminae), from Grebennikov (2004). 31 – Aged instar larva of *Omma* sp., showing a distinct labrum, separated by a clypeo-labral suture (Archostemata, Ommatidae), mandibles and left maxilla removed. From Grebennikov (2004).

ACKNOWLEDGEMENTS

The author is highly grateful to all people who helped in manifold modes for the completion of this manuscript, in particular prof. Achille Casale (Turin) for literature and advice, Prof. Dr. Rolf Beutel (FSU

Jena) for kindly providing some older works, Dr. Antonio Mazzei (University of Calabria) for his contribution for the photographs, and Dr. Maria Luigia Vommaro (PhD student at the University of Calabria) for gathering several old papers from public institutions.

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Description and illustration of the discotelic larvae of *Pachyteles vignai* Deuve, 1999 and *P. digiulioi* Deuve, 1999 from the Otonga cloud forest (Ecuador)
(Coleoptera, Carabidae, Ozaenini)

Abstract: The peculiar morphology of the discotelic larvae of three species of *Pachyteles* (Coleoptera, Carabidae, Paussinae, Ozaenini) collected in an Andean cloud forest in Ecuador (Otonga Nature Reserve, Cotopaxi) is here analyzed. All instars of *Pachyteles vignai* Deuve, 1999, 2nd and 3rd instars of *P. digiulioi* Deuve, 1999, and the 3rd instar of another undetermined *Pachyteles* species are described. A particular emphasis on the illustration of the aberrant larval morphology is given by using both traditional drawing techniques and macro multifocal image acquisition, combined with scanning electron microscopy (SEM) for analyzing the details. The diagnostic characters of these larvae are compared to those of the other known larvae of Ozaenini.

Riassunto: Descrizione e illustrazione delle larve discoteliche di *Pachyteles vignai* Deuve, 1999 e *P. digiulioi* Deuve, 1999 della foresta pluviale di Otonga (Ecuador) (Coleoptera, Carabidae, Ozaenini).

Le larve di tre specie del genere *Pachyteles* (Coleoptera, Carabidae, Paussinae, Ozaenini) raccolte nella foresta pluviale di Otonga (Otonga Nature Reserve, Cotopaxi) sono descritte e illustrate. Tutte e tre le età di *Pachyteles vignai* Deuve, 1999, la seconda e terza età di *P. digiulioi* Deuve, 1999 e la terza età di un'altra specie di *Pachyteles* non ancora identificata vengono analizzate comparativamente. Le descrizioni delle larve sono corredate di numerose illustrazioni effettuate mediante macrofotografia, ricostruzione ottica multifocale, disegni con camera lucida e microscopia elettronica a scansione (SEM). I caratteri diagnostici che distinguono queste larve da quelle descritte di altri Ozaenini vengono brevemente discussi.

Key words: Larvae, Paussinae, Flanged Bombardier Beetles, *Pachyteles vignai*, *Pachyteles digiulioi*, SEM.

INTRODUCTION

The ground beetle subfamily Paussinae (Coleoptera, Carabidae) includes free-living (Metriini, Mystropomini and Ozaenini) and myrmecophilous tribes (Protopaussini and Paussini), with all the about 800 known species characterized by distinctive apomorphies, at both adult and larval stages; myrmecophily is also present in some unrelated Ozaenini genera. Adults are known as “flanged bombardier beetles” for their peculiar explosive pygidial defensive system (Muzzi & Di Giulio, 2019), with a subapical elytral fold (flange of Coanda), that directs forwardly the hot discharged quinonoid spray (Eisner and Aneshansley, 1982). This elytral flange, only absent in members of the basal tribe Metriini (Muzzi *et al.* 2019), easily distinguishes paussines from brachinines (Coleoptera, Carabidae, Brachininae), the only other

bombardier beetle group (Aneshansley *et al.*, 1969; Di Giulio *et al.*, 2015a), and from all other beetles. Like other ground beetles, adults of free-living paussines are usually found under stones, bark, and rotting wood, and are nocturnal predators of other arthropods (Moore & Di Giulio, 2006; 2019). Myrmecophilous paussines, also known as “ant nest beetles”, instead, live as social parasites in ant nests, where they feed upon ant larvae, pupae and teneral, thanks to the evolution of peculiar strategies that allow them to circumvent the ant recognition systems (Di Giulio *et al.*, 2009; Maurizi *et al.*, 2012; Di Giulio *et al.*, 2015b; Fattorini *et al.*, 2020; Muzzi & Di Giulio, 2019).

Paussine larvae are very different from other, “standard” ground beetle larvae, due to a unique predatory ambush strategy present in the free-living tribes, which parallels that of the tiger beetle

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(Coleoptera, Carabidae, Cicindelinae) larvae (Di Giulio, 1999; Di Giulio & Vigna Taglianti, 2001). These peculiar larvae share a hyperprognathous head and an unusual upcurved abdomen (Figs 1-4), with segments VIII-IX flattened and plate-like, forming, together with the branched urogomphi (on segment IX), a transverse terminal structure, rounded and strongly sclerotized, known as “terminal disk”, “anal plate” or “trichome disk” (Di Giulio, 1998, 1999). This multilobed structure is an undisputed apomorphy of the subfamily (Bousquet, 1986; Di Giulio *et al.*, 2003, Di Giulio & Moore, 2004) and the larvae are defined as “discotelic larvae” (Di Giulio, 1999; Di Giulio & Vigna Taglianti, 2001; Di Giulio, 2008). However, this complex structure differs among tribes, genera and species, providing a variety of taxonomic and phylogenetic characters often used in identification keys (Moore & Di Giulio, 2006; Di Giulio & Moore, 2009) and cladistic analyses (Beutel, 1992, 1993; Di Giulio, 1998; Di Giulio *et al.*, 2003; Di Giulio & Moore, 2004).

Unlike the physogastric myrmecophilous larvae of the tribe Paussini, which likely use their small, round and immobile terminal disks with plate-like urogomphi as glandular symphilous organs (Oberprieler, 1985; Bousquet, 1986; Luna de Carvalho, 1989; Di Giulio & Moore, 2004; Di Giulio, 2008; Di Giulio *et al.*, 2011), free-living predatory larvae belonging to the tribes Metriini, Mystropomini and Ozaenini use the moveable components of the terminal disk both as a defensive door to close the burrows they construct in rotten wood, humid soil, caves, or sandy riverbanks (Figs 5-9), and as a foldable trap, where prey is seized by the sharp mandibles of the beetle through a backward spring-like snap (Costa *et al.*, 1988; Di Giulio, 1999; Di Giulio & Vigna Taglianti, 2001).

Until the end of last century, larvae of Paussinae were only known for few species belonging to eight genera, with most of the original descriptions not detailed enough to permit good morphological comparisons, when not so imprecise to be even



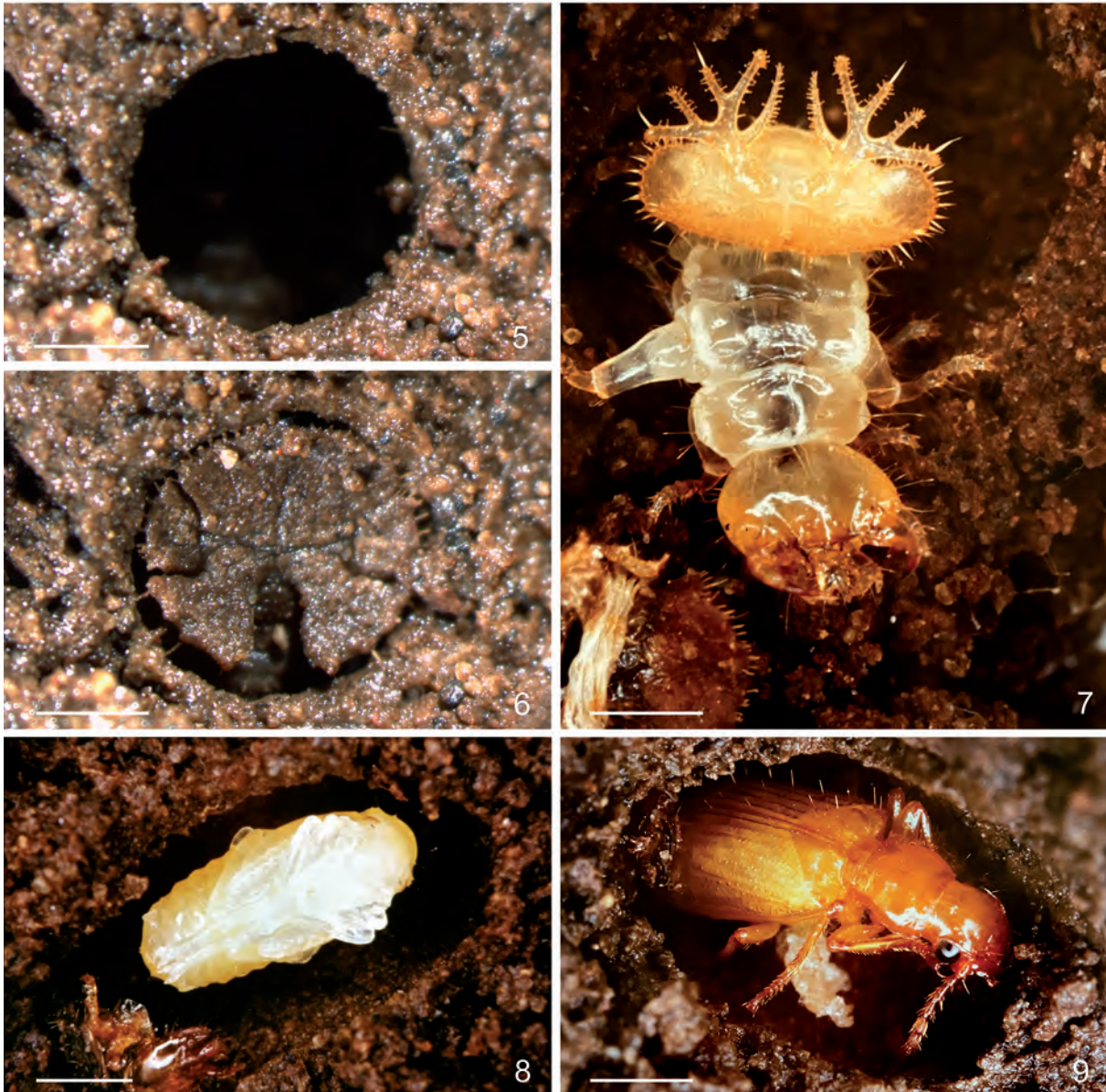
Figs 1-2. *Pachyteles vignai* Deuve, 1999, larva of 1st instar. 1: habitus, dorsal view; 2: habitus, left lateral view. Scale bars: 1 mm



Figs 3-4. *Pachyteles digiulioi* Deuve, 1999, larva of 2nd instar. 3: habitus, dorsal view; 4: habitus, left lateral view. Scale bars: 1 mm

misleading. Because of these reasons, over the past 20 years, we re-described larvae of the genera *Physea* Brullé, 1834 (tribe Ozaenini, see Di Giulio *et al.*, 2003), *Platyrhopalopsis* Desneux, 1905 (tribe Paussini, Di Giulio *et al.*, 2003) and *Paussus*

Linnaeus, 1775 (Di Giulio, 2008), and we put a great effort in finding and describing new paussine larvae through collecting expeditions, breeding adults, analyzing undetermined material from museums and asking colleagues to look for these larvae in many



Figs 5-9. *Pachyteles vignai* Deuve, 1999, 5: opening of the burrow with larva inside (photo A. Di Giulio); 6: terminal disk of 2nd instar larva closing the opening of the burrow (photo A. Di Giulio); 7: newly emerged larva L₃ with exuvia of 2nd instar (photo P. Maltzeff); 8: pupa and exuvia of 3rd instar inside a burrow closed with earth plug (photo A. Di Giulio); 9: newly emerged female teneral with pupal exuvia (photo P. Maltzeff). Scale bars 5-6, 8: 1 mm; 7, 9: 2 mm

different regions of the world. As a result, we were able to improve our knowledge of paussine larvae through the description of eleven species belonging to seven genera: *Arthropterus* W.S. MacLeay, 1838 (Di Giulio & Moore, 2004), *Goniotropis* Gray, 1832 (Moore & Di Giulio, 2006; Moore & Di Giulio, 2019), *Mystropomus* Chaudoir, 1848 (Di Giulio & Moore, 2009), *Paussus* (Di Giulio *et al.*, 2011; Di Giulio *et al.*, 2017), *Eustra* Schmidt-Goebel, 1846 (Moore *et al.*, 2011), *Ozaena* Oliver, 1812 (Moore & Di Giulio, 2019), and *Pachyteles* Perty, 1830 (Di Giulio, 1999; this paper), while the description of new larvae (*Metrius* spp., *Sphaerostylus* sp., *Paussus* spp.) or the re-description of other poorly described larvae (e.g. *Heteropaussus* Thomson, 1860 and *Pentaplatarthrus* Westwood, 1833) are still in progress.

The seed of these great advances in the knowledge of paussine larval morphology and behavior was the exceptional finding of several Ozaenini larvae and one adult female of a *Pachyteles* species in June 1997, collected by ADG (Di Giulio, 1999; Di Giulio & Vigna Taglianti, 2001) during an entomological expedition of Sapienza University (Rome, Italy) to the Otonga Nature Reserve (Ecuador, Cotopaxi), headed by Augusto Vigna Taglianti and Achille Casale, and the finding of the larvae of another *Pachyteles* species collected in the same year and in the same locality, whose adults emerged in captivity (Di Giulio & Vigna Taglianti, 2001). Our colleague Dr T. Deuve (1999) recognized both as new species and described the first as *Pachyteles digiulioi* Deuve, 1999 and the second as *P. vignai* Deuve, 1999.

Several studies were then performed on these larvae, and shortly *P. vignai* (Figs 1-2, 6-9) and *P. digiulioi* (Figs 3-4) became reference model taxa for the study of Ozaenini from different perspectives: (1) their predatory larval strategy and life history were carefully described and analyzed by Di Giulio & Vigna Taglianti (2001); (2) the fine structure of their terminal disk was shown in a morphological scanning electron microscopy study (Di Giulio *et al.*, 2000); (3) the most phylogenetically informative morphological features were included in a cladistic analysis of Paussinae larvae (Di Giulio *et al.*, 2003); (4) the pupal morphology was published in a comparative work (Di Giulio *et al.*, 2007); (5) the study of the ultrastructure of the explosive defensive system is in progress (Di Giulio & Muzzi, in prep.).

However, larvae of these species, studied from

the morphological point of view in the Ph.D. thesis of ADG (Di Giulio, 1999), remained so far formally undescribed.

In this paper, larval morphology of all instars of *Pachyteles vignai*, 2nd and 3rd instars of *P. digiulioi* and 3rd instar of another undetermined *Pachyteles* species from Ecuador, are described. A particular emphasis to the illustration of the discotelic larvae of *Pachyteles* is given by using both traditional drawing techniques and optical multifocal image acquisition, combined with scanning electron microscopy (SEM) for analyzing the details.

MATERIALS AND METHODS

Morphological descriptions. The descriptions presented in this paper are based on the following material:

- 1) *Pachyteles vignai*, five 1st instar larvae and one exuvia, two 2nd instar larvae and eight exuviae, three 3rd larvae and twelve exuviae, "Ecuador, Cotopaxi. San Francisco de las Pampas, str. San Francisco de las Pampas-La Union del Toachi, Km 1.300, 1550 m, 7.XII.1997, I. Tapia legit", collection A. Di Giulio (Rome, Italy).
- 2) *Pachyteles digiulioi*, one 2nd instar larva, thirteen 3rd instar larvae and two exuviae, "Ecuador, Cotopaxi. Between Otonga and Las Pampas, about 1700 m, 1.VI.1997, A. Di Giulio & A. Tapia leg."; one 3rd instar larva "Ecuador, Cotopaxi. Otonga, IV. 97, E. Tapia", collection A. Di Giulio (Rome, Italy).
- 3) *Pachyteles* sp., "Ecuador, prov. Sucumbios, km 9 W La Bonita (sur la route La Bonita - Santa Bárbara, le long de la frontière colombienne), El Higuerón, 1850 m, 27.VII.98, bord deruisseau, dans un gros tronc pourri très humide, P. Moret"; one larva, collection P. Moret. The identification by T. Deuve of the adult specimen collected together with this larva is still in progress.

Larvae were preserved in EtOH 70%, after fixing them shortly (15 seconds) in boiling water, while exuviae were directly preserved in EtOH without boiling. They were dissected, studied and drawn by using a stereomicroscope (Olympus SZX16) equipped with drawing tube (especially for the habitus, coloration and main measures).

For the study of the chaetotaxy and of other

small characters some larvae were re-hydrated, cleared in 10% KOH, transferred in hot lactic acid, dehydrated through a series of EtOH baths of increasing concentration (10-20-50-70-90-95-100%), left overnight in a clove oil bath, and mounted on a slide with Canada balsam. The slide mounted specimens were studied and illustrated by using a light microscope (Olympus BX51) equipped with drawing tube.

The pictures of the larval habitus were captured using a Visionary Digital LK Lab System (Visionary Digital, Palmyra, VA) equipped with a Canon EOS 6D mark II dSLR camera and MP-E 65mm f/2.8 1-5× lens. This device allowed the automatic capture of stacks of images on different focal planes, which have been modified in Adobe Photoshop and combined with Helicon Focus software in order to extend the depth of field.

For the analyses at scanning electron microscopy (SEM), some specimens were dehydrated through a series of EtOH baths of increasing concentration (70-80-90-95-100%), critical point dried (Bal-Tec CPD 030), mounted on aluminum stubs (by using self-adhesive carbon disks), sputtered with gold (Emitech k550 sputter coater), and observed with FEI Dualbeam FIB/SEM Helios Nanolab (at L.I.M.E. laboratory, University Roma Tre, Rome, Italy).

Notation of primary setae and pores follows the system of Bousquet & Goulet (1984) modified for *Metrius contractus* (Bousquet, 1986). An asterisk (*) following a coded seta means that homology of the seta with the corresponding structure in Bousquet & Goulet (1984) is questionable. Notation of microsculpture and urogomphi lobes follows Bousquet (1986) and Di Giulio (1998).

Classification of sensilla present on the abdominal segments and on the terminal disk follows Bousquet (1986), originally stated for *Metrius contractus* Eschscholtz, 1829, and then modified for *Pachyteles mexicanus* Chaudoir, 1848 and *Itamus cavicola* Moore, 1978 (Vigna Taglianti *et al.*, 1998) and for *Pachyteles* spp. (Di Giulio, 1998, 1999; Di Giulio *et al.*, 2000), is reported in the following:

1. Rosette-like sensillum (S-I). Minute candle-shaped sensilla perpendicular to the plane of insertion, each with a regular, cylindrical cuticular stem bearing at the apex a short-modified seta, similar to a frayed rope or to a little rose. These sensilla are regularly spaced and cover the ventral surface

of the terminal disk (especially on median plates and on the branched urogomphi).

2. Flat trichoid-like sensillum (S-II). Elongate sensilla particularly strong and thick, emerging along the perimeter of dorsal and lateral plates from cuticular protuberances covered by elongate microsculptures. The apices of these sensilla are often broken or frayed probably because of the rubbing against the walls of the larval burrows.
3. Small trichoid-like sensillum (S-III). These short sensilla, variable in number, emerge from the extremity of the urogomphal lobes (especially on C, E₁ and D lobes).
4. Long trichoid-like sensillum (S-IV). These sensilla are only present on the ventral surface of the urogomphal branch C and are always in triplets, increasing in size from basal to medial and apical.
5. Cluster of three long trichoid-like sensilla (S-V). This cluster of sensilla is present at the lateral (external) extremity of the E1 lobe of urogomphi, and the three S-IV emerge from a common base.
6. Club-shaped sensillum (S-VI). These are very small sensilla emerging from cuticular pores. They can be found close to the base of sensilla S-I on plates and urogomphi. These sensilla show different shapes in different Ozaenini species, but in *Pachyteles* appear club-shaped.
7. Stiff pointed sensillum (S-VII). Sensilla chaetica of various size, emerging from cylindrical denticulate base, regularly spaced on dorsal surface of the plates.

Morphometric analysis. To test for differences in morphometric variables between the larvae of the two species, Mann-Whitney U-tests were applied to the following measures for larvae of the 2nd instar (the only instar for which we had a sufficient number of measures for both species): head length (hl), head width (hw), disk width (dw), dorsal plates length (dpl), dorsal plates width (dpw), the ratio of head width to head length (hw/hl), and the ratio of dorsal plates width to dorsal plates length (dpw/dpl). The use of ratios has been questioned by some authors (Atchley *et al.*, 1976), but supported by others who highlighted the values of using ratios to measure shape (Hills, 1978; Dodson, 1978; Belfiore, 1996; Baur & Leuenberger, 2011). In many animal groups, such ratios are used in species descriptions, diagnoses, or identification keys (e.g., Mayr & Ashlock, 1991). This is par-

ticularly common in insects, where morphologically similar species may be more easily differentiated according to their body proportions, than on the basis of qualitative characters. In certain insect groups, such as parasitic hymenopterans, numerous ratios are routinely reported (e.g., Townes & Townes, 1981; Kasparyan, 1989; Guerrieri & Noyes, 2000; Noyes, 2004; Horstmann, 2009). We used ratios calculated on both original and $\log_{10}$ -transformed values (Leo & Fattorini, 2002). As results did not differ qualitatively, only those based on original values are reported.

We also investigated, with the same morphometric variables, differences between instars of *P. vignai* larvae. We could not analyse this aspect in *P. digiulioi* because of the lack of larvae of 1st instar and the presence of only one larva of 2nd instar in our sample. Differences between instars were tested using Kruskal-Wallis non-parametric tests, followed by pairwise comparisons with Mann-Whitney U-tests. Probability values were adjusted for multiple testing using

Bonferroni correction, with $k=3$. We adopted non-parametric approaches due to the small sample sizes. All tests were two-tailed, with α set at 0.05.

DESCRIPTION OF LARVAE

Pachyteles vignai Deuve, 1999 (Figs 1-2, 10-66)

1st instar larva

HABITUS AND COLORATION. Body weakly sclerotized, flattened, 4-5 mm long (from the tip of the mandibles to the terminal disk), white colored (Figs 1-2); thoracic tergites, cephalic capsule, mouth parts, anal plate, urogomphi and extremity of legs yellowish; terebra, retinaculum, anterior margin of frontoclypeolabral sclerite, egg-busters and claws reddish-brown to piceous. Abdomen bellows-like, upcurved (Figs 10-13).

MICROSCULPTURE. Cephalic capsule and legs without

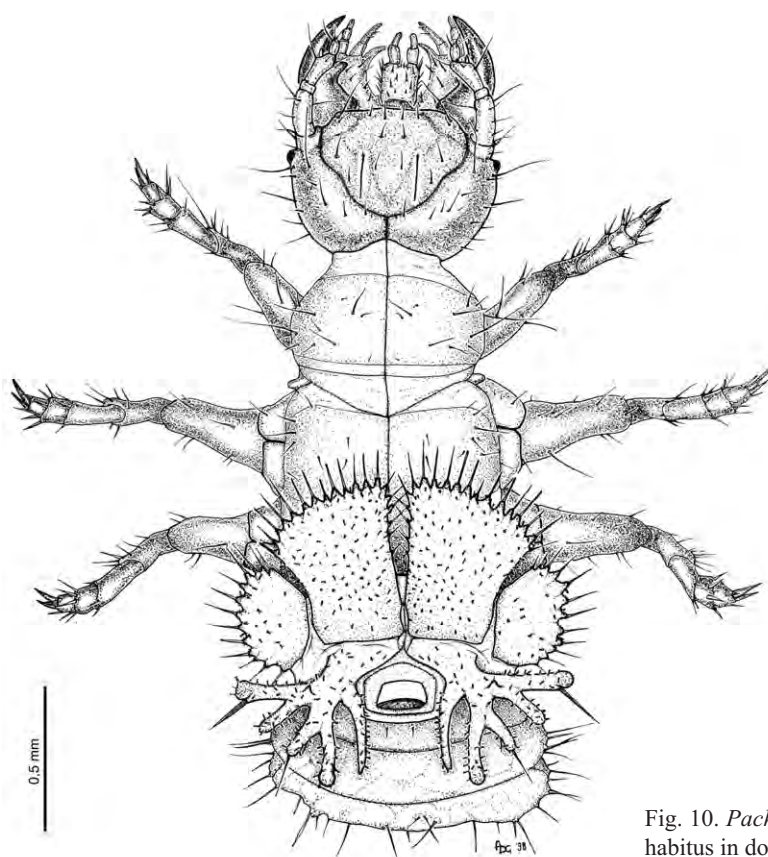
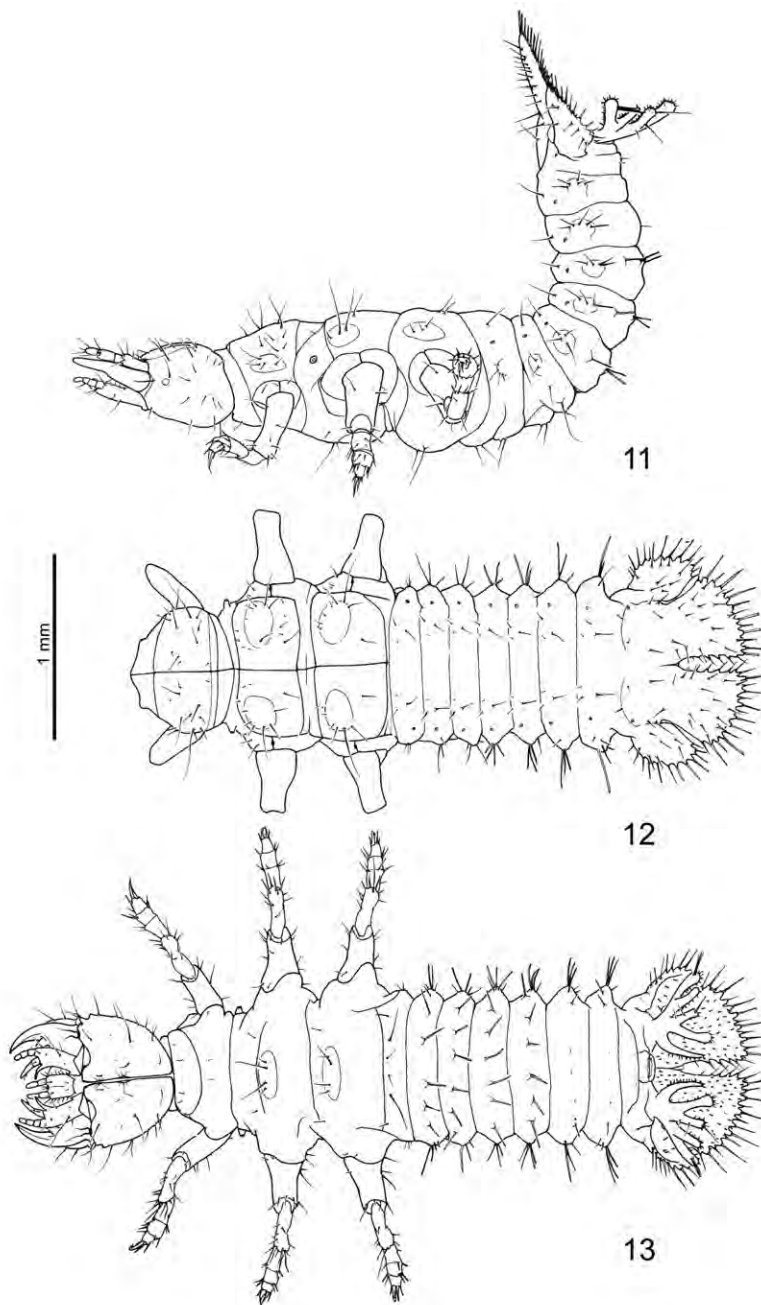


Fig. 10. *Pachyteles vignai* Deuve, 1999, larva of 1st instar, habitus in dorsal view.

microsculpture (Figs 43-46, 49, 54); epipharynx (Fig. 27) with many short rows of forwardly directed spines (5-20 elements, 2-15 μm each) in median part (palatum); hypopharynx (Fig. 21) with many long concentric comb-like rows, each composed of hundreds

of small (1-3 μm) forwardly directed sculpticells; both epi- and hypopharyngeal systems of processes, together with setae, forming a sort of filter apparatus of the mouth; tergites of thorax smooth or widely corrugate (Fig. 47), with sparse or absent microsculpture; tergites



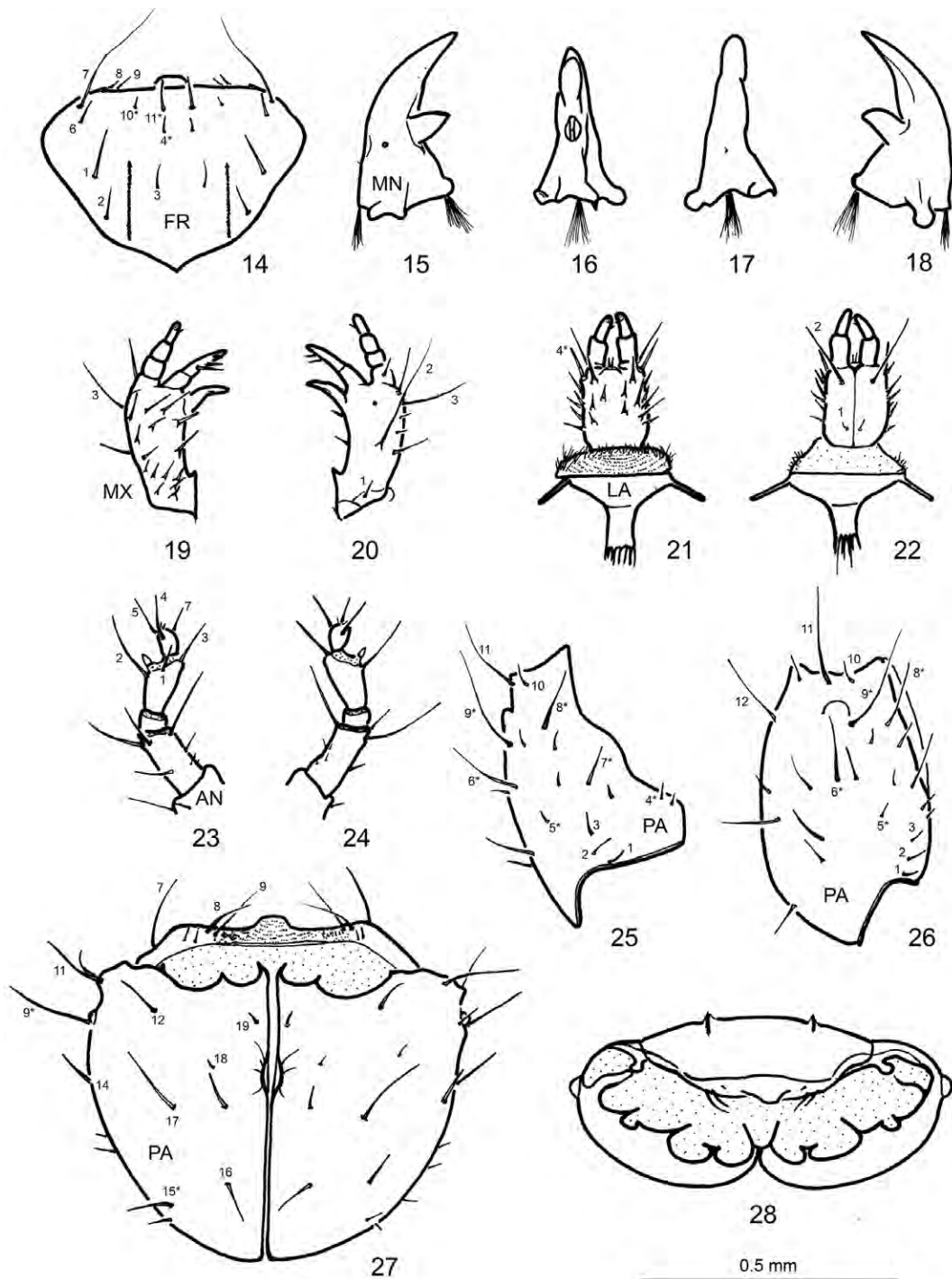
Figs. 11-13. *Pachyteles vignai* Deuve, 1999, larva of 1st instar. 11: habitus, left lateral view; 12: habitus of thorax and abdomen, dorsal view; 13: habitus, ventral view.

of abdomen with multipointed microsculpture, sparse near the setae; dorsal and lateral plates of the terminal disk and urogomphi with pointed to multipointed microsculpture (Figs 57-59, 63-65); membranous areas of the body rugulose (Figs 46-47), with cone-like pointed microsculpture (Fig. 60).

CHAETOTAXY. Frontoclypeolabrum (Fig. 14) with setae FR_2 and FR_3 similar in length and shorter than FR_1 ; seta FR_2 posterior to FR_3 ; seta FR_7 longer than FR_1 ; seta FR_5^* very small; setae FR_{10}^* and FR_{11}^* lined just behind the transverse frontal keel; seta FR_{10}^* slightly anterior to FR_{11}^* ; one small additional seta between the transverse frontal keel and the anterior margin of this sclerite (clipeolabral groove), not visible in dorsal view; pores FR_a and FR_b absent. Parietale (Figs 25-27) with few additional setae, mostly on dorsal and lateral sides. Antennomere I (Figs 23-24) with some small additional setae mostly on the basal half, and a crown of three long setae apically; antennomere II with lateral additional seta only in few 1st instar specimens. Mandibles (Figs 15-18) without additional setae. Setal group gMX on stipes (Figs 19-20) with about 15 setae, mostly on the basal half; seta MX_5^* dorsal seta MX_6 very small, in a medial groove; one additional seta moderately long dorsally on the second galeomere; seta MX_8^* close to the MX_9^* ; maxillary palpomere IV with 1 additional seta. Prementum (Figs. 21-22) with about 20 additional setae on lateral and dorsal sides; seta LA_1 close to the midline; labial palpomere II with 1 additional seta. Epipharynx (Fig. 27) with two setae posterior to the couple FR_8 - FR_9 . Pronotum, mesonotum and metanotum (Figs 10-12) with two or three additional setae on each side of the ecdysial line. Abdominal tergites I-VII (Figs 11-12) with few setae. Anal plates (Figs 12, 55-59) with numerous stiff pointed setae dorsally, about 20 on each dorsal plate (epipleurite IX + tergite VIII) and about 10 on each lateral plate (epipleurite VIII); margins of dorsal and lateral plates with sensilla S-I and S-II (Figs 55, 57, 61, 63); apical margin of each dorsal plate with 15 S-II of two different sizes, large and small, alternated (Figs 55, 57); inner side of each dorsal plate (Figs 55, 58, 61) with six S-II small; margin of each lateral plate with ten large S-II (Figs 10-13, 55, 61); ventral side of the anal plates with many sensilla S-I (Figs 63, 65, 66); about 100 S-I on each dorsal plate (Figs 10, 61), mostly basally and medially, and about 15 on each lateral plate (Fig. 10). Epipleurites (Figs 11-13, 40-41) of the abdominal segments I-III with

three-five setae, those of segments IV-VII with four-six S-II and few small setae; hypopleurites (Figs 11, 13) of segments II-VI with two-for S-II; hypopleurites of abdominal segment I and VIII with no setae, those of segment VII with only one seta. Sternal area of abdominal segments I-III with setae (Fig. 13), that of segments IV-VIII with setae and S-II. Urogomphi (Figs 10, 61-62, 64) with S-I mainly on dorsal and apical areas, about 25 on the inner branch A and 10-15 on each B, C, E_2 and E_1 ; additionally, branch B with two-three S-III apically, branch C with one apical and one sub-basal S-IV, branch E_2 with four-five S-III apically and one S-V subapically, branch D with one S-III apically. Trochanter (Figs 11, 13, 48) with few additional setae ventrally; seta TR_8 as long as TR_4 ; seta FE_5 as long as TR_4 in the forelegs; setae TA_2 and TA_7 on tarsus as big as TI_2 and TI_7 .

HEAD. Cephalic capsule (Figs 10, 43-44) transverse, hyperprognathous (Figs 2, 11, 41-42, 46), with the sides rounded, mostly in the basal half. Egg-bursters (10, 28, 43, 45-46, 54) extended to the level of seta FR_1 , consisting of many closely set microspines fused into a carena on the posterior half, with a spine larger than the others anteriorly. Anterior margin of frontoclypeolabrum double-edged (Figs 28, 45), the nasale transformed into a slightly convex transverse keel (Figs 43, 45-46, 49), extended to the adnasalia; at a lower level, the margin of frontoclypeolabrum serrulate, medially produced into a subquadrate labral tooth (labral spine *sensu* Beutel, 1992), as large as the distance between the setae PA_{11}^* , protruding under the transverse keel (Figs 10, 14, 27, 43, 45, 49); adnasalia rounded and slightly protruding. Anterior arms of frontal suture sinuate (Figs 10, 43), converging between level of FR_1 setae; coronal suture distinct. Parietale with a stemma (Figs 10-11, 43, 46) on each side (probably the fore medial). Ocular and cervical grooves absent. Antennae (Figs 23-24, 43, 46, 49) slightly shorter than mandibles, 4-jointed and directed forward; antennomere I about four times longer than antennomere II, about as long as antennomere III and about three times longer than antennomere IV; sensorial appendage on antennomere III (Fig. 53) conical, well developed. Mandible (15-18, 43, 49) two times longer than wide (at the base), moderately curved toward apex; retinaculum triangular, with the apex slightly curved inwards; penicillus absent; medial margin of terebra double and smooth (Fig. 46). Maxilla (Figs 19-20, 43, 46, 49) with stipes two times



Figs. 14-28. *Pachyteles vignai* Deuve, 1999, larva of 1st instar. 14: frontoclypeolabral sclerite; 15: left mandible, dorsal view; 16: left mandible, ental view; 17: left mandible, outer view; 18: Left mandible, ventral view; 19: left maxilla, dorsal view; 20: left maxilla, ventral view; 21: labium dorsal view; 22: labium ventral view; 23: left antenna, dorsal view; 24: left antenna, ventral view; 25: left wall of parietale, dorsal view; 26: left wall of parietale lateral view; 27: head capsule, ventral view; 28: head capsule frontal view.

longer than wide, with some setiferous protuberances dorsally, and a conspicuous pointed mesal stipital protuberance, sub-basal on the inner side; lacinia slightly shorter than galea, pointed and curved inwards from the distal half; galeomeres apparently fused; galeomere II longer than galeomere I, pointed, with a small dorsal sensorial area subapically; maxillar palpomeres regularly decreasing in size from I to IV. Prementum (Figs 10, 21-22, 43, 49) rectangular, longer than wide, with setiferous tubercles on dorsal and lateral surface; ligula only slightly convex, cupule-like, subapical; labial palpomere I about as long as palpomere II.

THORAX. Pronotum (Figs 10, 12, 40, 47) transverse, with sides slightly rounded; marginal area absent. Mesonotum and metanotum (Figs 12, 40, 47) transverse, subrectangular, with the anterior margin slightly concave; marginal area absent, notal carena absent. Mesothoracic spiracle (Fig. 47) cupule-like, protruding, twice than the abdominal ones.

LEGS. Legs 5-jointed (Figs 10, 11, 1340-42, 48). Coxa stout, longer than the trochanter; coxae of prothorax cylindrical, slender and longer than the others; trochanter as long as the femur and functionally fused with this; tibia shorter than femur; tarsus about as long as tibia; two unequal claws, posterior claw slightly shorter and more slender than anterior claw.

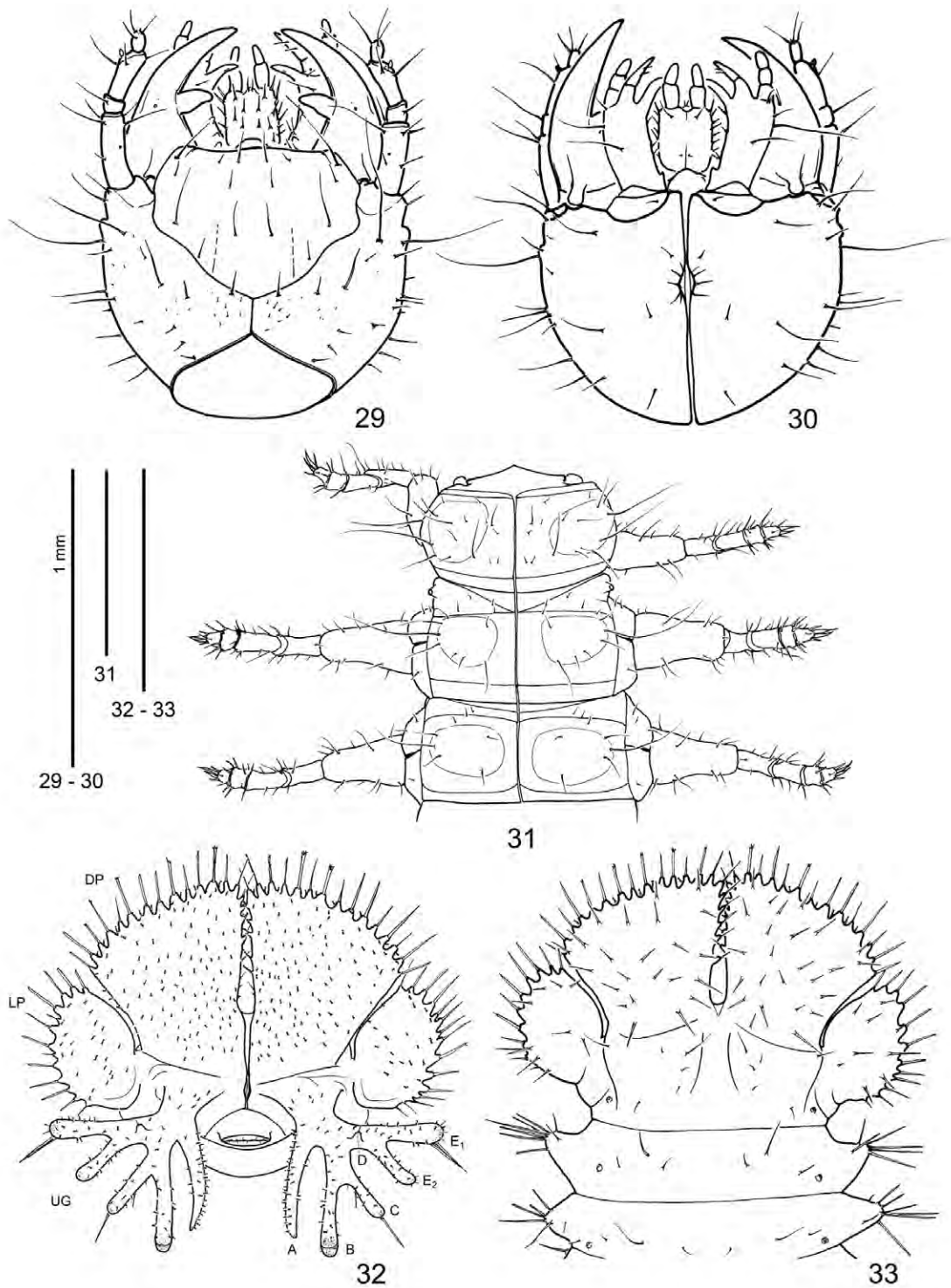
ABDOMEN. Tergum of segments I-VII (Figs 1-2, 40-42) with sclerites hardly visible. Hypopleurites of segments I, VII and VIII reduced (Fig. 11). Epipleurites gradually increasing in dimensions from segment I to VIII (Figs 1, 12-13, 40-42); epipleurites of segment IX greatly enlarged and fused with tergum of segment VIII into a plate (anal plate *sensu* Bousquet, 1986), displacing the urogomphi and the tenth segment into a vertical plane (Figs. 12, 42, 55); anal plate completely divided into two wide, subtrapezoidal, thin symmetrical plates (dorsal plates) (Figs 10, 12, 42, 55, 61), enlarging from the base to the apex, well sclerotized and deeply separated in the middle; epipleurites of segment VIII flattened and enlarged into two sclerotized, ear-like lateral plates (Figs 42, 55, 61), smaller than the dorsal ones; dorsal plates, lateral plates and urogomphi articulated at base by membranous integument, and independently movable (mostly dorsal + lateral plates *vs* urogomphi), forming a round foldable terminal disk (Figs 6, 10, 61). Median, inner and outer sternites gradually narrowed from segments I to VI (Fig. 13);

median sternite absent in segments VI to VIII; sternum of segments VII to VIII without sclerites. Urogomphi and pygidium oriented in a vertical plane (Figs 6, 11); urogomphi (Figs 1-2, 10, 56, 61-62) wide, each composed of six branches (longer than lobes of *Metrius contractus*): A, B, C, D, E₂, E₁ (respectively from the inner to the outer); branch A, slender and pointed slightly shorter than B; branch B stout and clavate distally, partially two-lobed at the tip; branch C short, as long as E₂; branch E₁ slightly clavate at tip; branch D, dorsal, emerging vertically from the base of branch E; pygidium oval located between urogomphi (Figs 10, 61). Spiracles cupule-like, slightly prominent, dorso-laterally positioned on segments I-VIII (Figs 11-12, 60), above the epipleurites.

2nd and 3rd instar larvae

DESCRIPTION. No relevant morphological differences from the 1st instar were observed in 2nd and 3rd instar larvae, except for morphometric characters related to ponderal growth (see section "Morphometric analysis") and to a stronger sclerotization of head, mouthparts, sclerites, terminal disk and urogomphi. In the following, minor differences are reported.

Many additional setae present in 2nd (Figs 29-33) and 3rd (Figs 8, 34-39, 44, 50-52) instar larvae all over the body, mostly on pleural and sternal areas of the abdomen, on legs, tergites of thorax and head; parietalia dorsally covered by many small additional setae, like pubescence (Fig. 29); antennae and antennomeres gradually more slender and longer in L₂ and especially in L₃ (see Figs 49-50); antennomere II with long additional seta laterally (Fig. 29, 50); antennomere III with sensorial appendage relatively smaller in second and third instar (Figs 49-50); maxillary stipes (Figs 50, 52) with dorsally four-five strong setiferous protuberances and basally a strong mesal pointed protuberance long and tooth-like, forwardly directed. Number of sensilla S-I on the terminal disk (Figs 32, 38) proportionally increased to cover the raced surface of dorsal and lateral plates and of urogomphi. 2nd instar larvae with remains of egg-busters on the frontoclypeolabrum (Fig. 29), like two longitudinal dark lines, without any microspine or carina. Dorsal plates greatly enlarged from the base to the apex, touching in the middle (Figs 32-33, 38-39). Apex of lobe B of urogomphi distinctly divided into lobes B₁ and B₂ (Fig. 38).



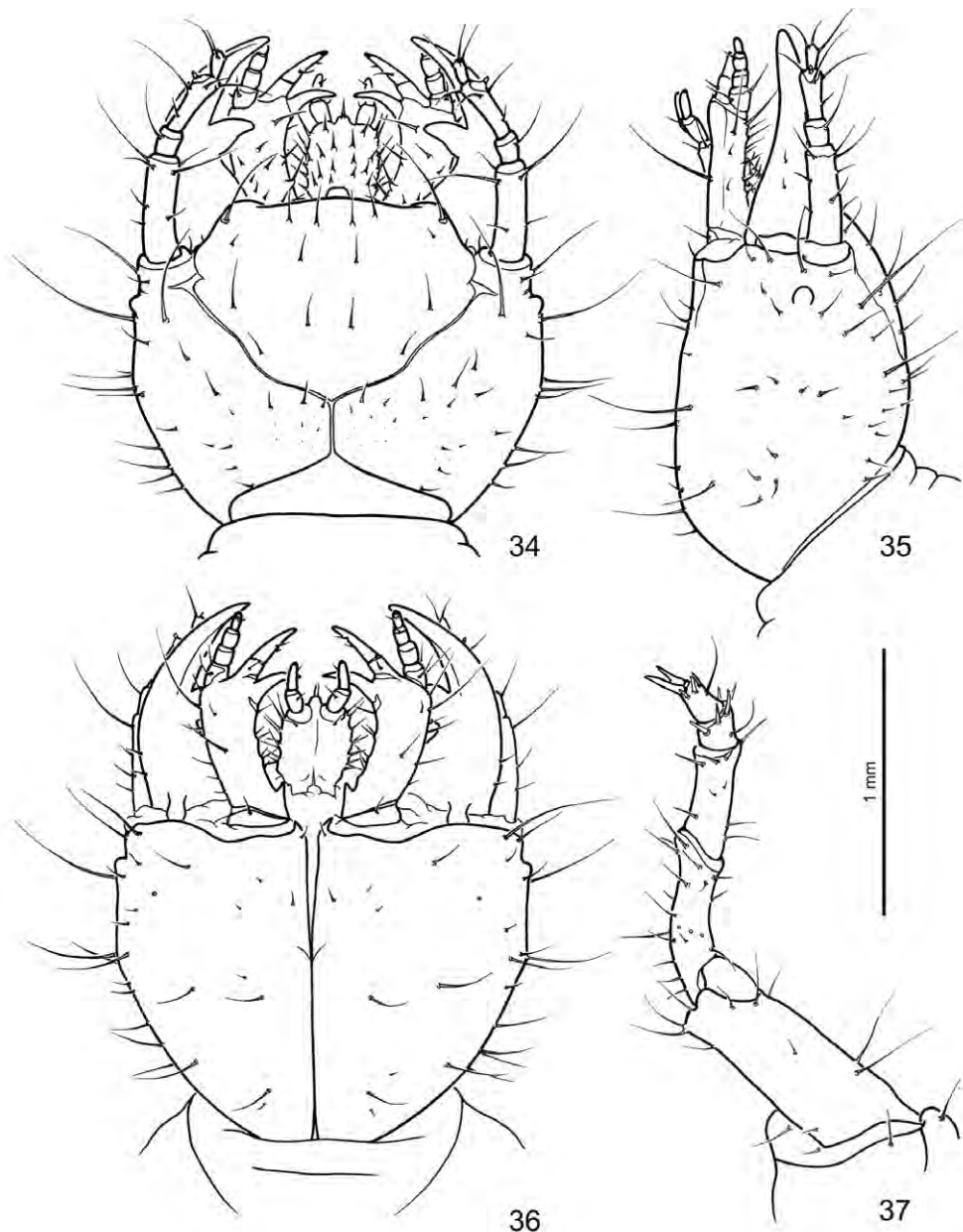
Figs. 29-33. *Pachyteles vignai* Deuve, 1999, larva of 2nd instar. 29: head, dorsal view; 30: head ventral view; 31: thorax with legs, dorsal view; 32: terminal disk, apical view; 33: apex of abdomen with terminal disk, dorsal view. DP: dorsal plate; LP: lateral plate; UG: urogomphus; A-E₂: lobes of urogomphi.

Pachyteles digiulioi Deuve, 1999 (Figs 67-94)

2nd and 3rd instar larvae

DESCRIPTION. No 1st instar larvae of this species were available for comparison, but the morphology of 2nd

and 3rd instar larvae of *P. digiulioi* looks quite similar to the 2nd and 3rd instar larvae of *P. vignai*, except for few differences in dimensions (*P. digiulioi* is larger than *P. vignai*, see section “Morphometric analysis”). For the description of the larval morphology of this

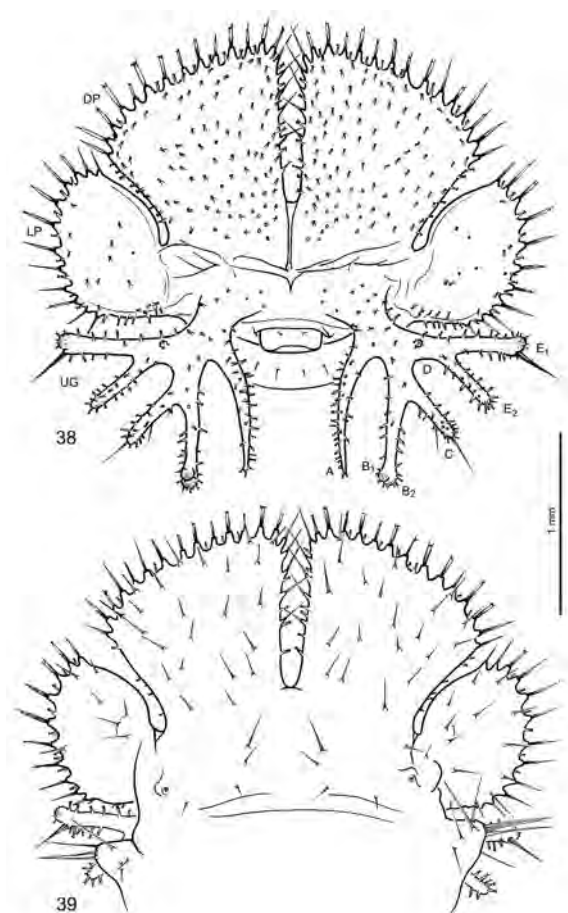


Figs. 34-37. *Pachyteles vignai* Deuve, 1999, larva of 3rd instar. 34: head, dorsal view; 35: head lateral view; 36: head ventral view; 37: left hind leg, posterior view.

species we refer to that of *P. vignai* (2nd and 3rd instar larvae), while in the following we only report some minor differences between the larvae of the two species.

Frontoclypeolabrum with 2 or 3 additional setae near FR₃ (Figs 68-69); labral tooth small and slender, more prominent, distinctly visible in dorsal view; clipeolabral groove between the transverse frontal keel and the anterior margin of frontoclypeolabrum slender (Figs 78-79); anterior margin of frontoclypeolabrum transverse, slightly convex and serrulate. Frontal margin with two pores over the labral spine in 3rd instar, absent in first and second instar (Figs 87-88). Parietalia with small stemmata (Figs 68-69, 77-80); sides

of cephalic capsule, in dorsal view, slightly rounded at the basal half (before the seta PA₆*), straight and subparallel at the distal half (Figs 68, 70, 77, 80). Antennae (Figs 68-69, 77, 83-84) with long antennomere I bearing many additional setae, four of them subapical and long; article III with sensorial appendage larger in second instar and small in third instar (Figs 85-86); antennal joints proportionally longer and slenderer in 2nd and especially in 3rd instar larvae. Mandibles sickle-shaped (Figs 68, 76-79, 83-84) with well-developed retinaculum concave basally in 2nd instar and convex basally in 3rd instar; terebra of mandibles slender, longer in 3rd instar than 2nd instar. Maxillae with longer stipes. Prementum (Figs 68, 70, 83-84) longer than in *P. vignai*, with moderately hypertrophic ligula protruding from the apex. Abdomen wide and flattened (Figs 67, 74, 76), with slightly convex sides; dorsal plates of anal disk (Figs 72-73, 76, 89-90) subrectangular, well separated in the middle, with straight sides only slightly enlarged from base to apex. Urogomphi (Figs 67, 72, 89, 92) with lobe B clearly divided in the two lobes B1 (dorsal) and B2 (ventral), like the mature larva of *P. vignai*, branch E₂ upcurved (Figs 72, 89, 92) after the sensilla S-V, and clavate at the tip; branch D longer (Figs 72, 92) than in *P. vignai*, and slender, emerging from the branch E more distally than in *P. vignai*, just at the base of the branch E₂. Sensilla S-I with fringed apical seta (Figs 93-94) instead of the "rosette-like" apical seta of *P. vignai* (Figs 65-66)



Figs. 38-39. *Pachyteles vignai* Deuve, 1999, larva of 3rd instar. 38: terminal disk, apical view; 39: terminal disk, dorsal view. DP: dorsal plate; LP: lateral plate; UG: urogomphus; A-E₂: lobes of urogomphi.

Pachyteles sp. (Figs 95-101)

3rd instar larva

DESCRIPTION. The 3rd instar larva of this undescribed species differs from those of the other species of the genus *Pachyteles* only for the few characters reported in the following. For general morphology we refer to the description of the 1st instar of *Pachyteles vignai*, modified for the 3rd instar.

Head with isodiametric hexagonal microsculpture. Thorax and abdomen with pointed to multipointed microsculpture. For the chaetotaxy of the head see Fig. 95-98. Labral tooth small, two-lobed at the tip (Fig. 95). Antennomere III slender at the base and distinctly enlarging at the tip (Fig. 95). Mandible with large and pointed retinaculum (Fig. 95). Labial palpomere II elongate and slender (Figs 95, 98). Stipes with strong

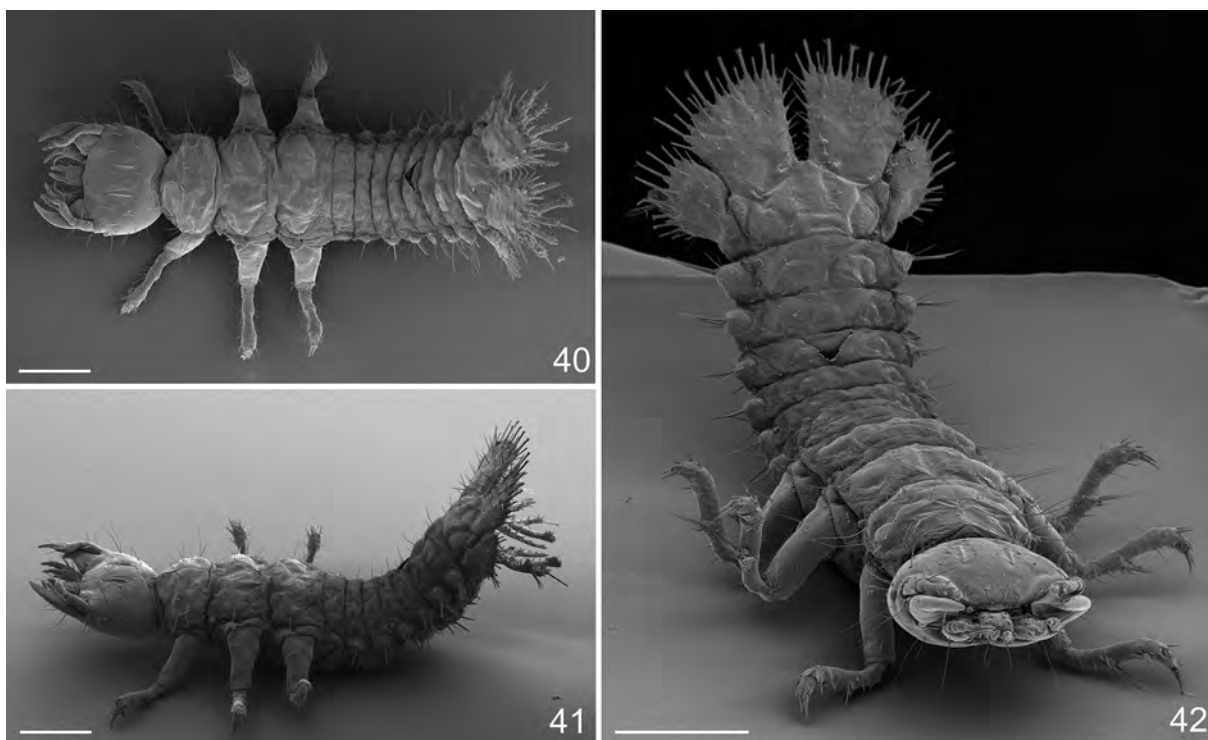
and pointed setiferous protuberances on dorsal and lateral sides (Fig. 95). Longer mesal protuberance present at the base of the stipes (Fig. 98). Mesothoracic spiracle dark-brown because of the strong sclerotisation. First abdominal spiracle much larger than the other abdominal ones, dark-brown colored as well as the small area surrounding it (Fig. 99). Terminal disk relatively larger than in *Pachyteles vignai* (Fig. 100), with branches A, B, C and E₂ very slender; branch D well developed at the base of lobe E.

MORPHOMETRIC ANALYSIS

Morphometric measures taken on larvae of *P. vignai* and *P. digiulioi* are given in Tab. 1. Only measures of sclerotized parts were taken into consideration. Summary statistics for morphometric variables measured on 2nd instar larvae of the two species are reported in Tab. 2. All morphometric variables differed significantly between the two

species (Tab. 3, Figs 102-108). *P. digiulioi* showed significantly higher values than *P. vignai* for all original measures (Figs 102-105, 108), which indicates that the larvae of *P. digiulioi* are significantly bigger than those of *P. vignai*. *P. digiulioi* also showed a significantly higher hw/hl ratio (Fig. 106). The higher hw/hl ratio in *P. digiulioi* indicates that the cephalic capsule is more transverse in *P. digiulioi* than in *P. vignai*. By contrast, the dpw/dpl ratio was higher in *P. vignai* than in *P. digiulioi* (Fig. 107). The higher dpw/dpl in *P. vignai* indicates that dorsal plates are more transverse in this species than in *P. digiulioi*.

Summary statistics for morphometric variables measured on 1st, 2nd and 3rd instar larvae of *P. vignai* are reported in Tab. 4. Kruskal-Wallis tests revealed significant differences among instars of *P. vignai* (Tab. 5, Figs. 109-115). Pairwise comparisons (Tab. 6, Figs. 109-112, 115) indicate that all original measures increased during the growth from the 1st to the 2nd instar and from 2nd to 3rd, as expected in case of ponderal growth. The behavior of ratios was



Figs. 40-42. *Pachyteles vignai* Deuve, 1999, SEM micrographs of larva of 1st instar. 40: habitus, dorsal view; 41: habitus, left lateral view; 42: habitus, anterolateral view. Scale bars: 500 μ m

Tab. 1. Principal morphometric measures of larvae/exuviae of *Pachyteles vignai* and *P. digiulioi* (in millimeters). L1, L2 and L3 indicate the 1st, 2nd, and 3rd instars, respectively.

Taxon	Head length (hl)	Head width (hw)	Disk width (dw)	Dorsal plates length (dpl)	Dorsal plates width (dpw)
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Pachyteles vignai

L ₁	0.43	0.70	1.06	0.57	0.92
L ₁	0.43	0.70	1.1	0.57	0.92
L ₁	0.43	0.70	1.09	0.57	0.92
L ₁	0.43	0.70	1.08	0.57	0.92
L ₁	0.43	0.70	1.08	0.57	0.92
L ₂	0.60	1.05	1.70	0.92	1.42
L ₂	0.65	1.05	1.84	0.92	1.56
L ₂	0.64	1.05	1.84	0.91	1.42
L ₂	0.64	1.02	1.70	0.85	1.35
L ₂	0.62	1.05	1.70	0.92	1.42
L ₂	0.62	1.04	1.84	0.92	1.29
L ₂	0.64	1.04	1.84	0.94	1.29
L ₂	0.64	1.04	1.84	0.94	1.42
L ₂	0.64	1.04	1.84	0.89	1.39
L ₃	0.78	1.46	2.55	1.20	2.03
L ₃	-	1.46	2.70	1.23	2.20
L ₃	1.04	1.49	2.55	1.13	2.03
L ₃	1.02	1.52	2.70	1.28	2.13
L ₃	-	-	2.62	1.20	2.06
L ₃	0.93	1.48	2.60	1.28	2.09
L ₃	-	-	2.70	1.30	2.17
L ₃	-	-	2.55	1.28	2.06
L ₃	-	-	2.62	1.28	2.13
L ₃	-	-	2.62	1.28	2.20
L ₃	-	1.49	2.70	1.28	2.06
L ₃	1.04	1.55	2.70	1.28	2.34
L ₃	1.04	1.48	2.70	1.28	2.13
L ₃	1.02	1.52	2.70	1.28	2.13

Taxon	Head length (hl)	Head width (hw)	Disk width (dw)	Dorsal plates length (dpl)	Dorsal plates width (dpw)
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Pachyteles digiulioi

L ₂	0.78	1.23	1.99	1.04	1.52
L ₃	1.13	1.90	2.96	1.48	2.22
L ₃	1.13	2.06	3.09	1.48	2.29
L ₃	1.13	1.80	3.21	1.60	2.47
L ₃	1.23	1.96	3.14	1.56	2.40
L ₃	1.23	1.94	3.16	1.58	2.40
L ₃	1.28	2.06	3.33	1.73	2.59
L ₃	1.28	1.99	3.33	1.60	2.59
L ₃	1.20	2.06	3.21	1.48	2.47
L ₃	1.28	1.99	3.21	1.48	2.47
L ₃	1.28	2.09	3.21	1.53	2.47
L ₃	1.23	2.06	3.21	1.48	2.47
L ₃	1.28	2.06	3.21	1.43	2.47
L ₃	1.28	2.04	3.21	1.48	2.47
L ₃	1.20	2.01	3.21	1.48	2.47

equivocal. The ratio hw/hl (Fig. 113) did not change significantly between the 1st and the 2nd instar. Difference between the 2nd and the 3rd instar did not resist the Bonferroni correction, as well as difference between the 1st and the 3rd instar. Although this ratio is, on average, much lower in the 3rd instar than in the 1st and 2nd instars, data for the 3rd instar had a very large variation (Fig. 113). Thus, the ratio hw/hl seems to decrease in the 3rd instar, which suggests that the cephalic capsule assumes a more elongated shape, but this is uncertain due to the small number of individuals examined and the high variability of measures in the 3rd instar. As with the ratio dpw/dpl (Fig. 114), difference between the 1st and the 2nd instar did not resist the Bonferroni correction, and difference between the 1st and the 3rd instar was not significant,

Tab. 2. Summary statistics for morphometric variables measured on 2nd instar larvae of *P. vignai* and *P. digiulioi*. Acronyms of morphometric variables: hl: head length, hw: head width, dw: disk width, dpl: dorsal plates length, dpw: dorsal plates width. Measures are in millimeters.

	Mean	Standard Error	Minimum	Maximum	Sample size
<i>P. vignai</i>					
hl	0.981	0.037	0.780	1.040	7
hw	1.494	0.010	1.460	1.550	9
hw/hl	1.541	0.059	1.423	1.872	7
dw	2.644	0.017	2.550	2.700	14
dpl	1.256	0.013	1.130	1.300	14
dpw	2.126	0.022	2.030	2.340	14
dpw/dpl ratio	1.694	0.018	1.609	1.828	14
<i>P. digiulioi</i>					
hl	1.226	0.016	1.130	1.280	14
hw	2.001	0.021	1.800	2.090	14
hw/hl	1.635	0.020	1.555	1.823	14
dw	3.191	0.026	2.960	3.330	13
dpl	1.532	0.022	1.430	1.730	13
dpw	2.445	0.028	2.220	2.590	13
dpw/dpl ratio	1.599	0.022	1.497	1.727	13

but difference between the 2nd and the 3rd instar was. Thus, it seems that this ratio increased substantially in the 3rd instar, which suggests that the dorsal plates become more transverse in this instar. However, further studies are needed to properly test these possible allometric relationships.

DISCUSSION

The genus *Pachyteles* from Central and South America is part of the New World clade of the Ozaenini, the Ozaenina subtribe, which represents an intricate monophyletic group, object of several taxonomic discussions in the past (see Moore, 2008). While some genera in this group, such as *Ozaena*, *Platycerozaena* Bänninger, 1927, *Physeia*, and *Entomoantyx* Ball & McCleve, 1990, are very well defined by clear apomorphies in the adults, morphological characters of others, such as *Goniotropis*, *Pachyteles*, and *Tropopsis* Solier, 1849, do not allow a clear separation between taxa. These uncertainties are reflected by the fact that the two most recent taxonomic treatments classify species in this clade into either six (Ball & McCleve, 1990) or 17 separate genera (Deuve, 2001, 2004, 2005), indicating general disagreement on what constitutes natural lineages in the group (see Moore, 2008).

Most recently, Moore (2008) provided the first phylogenetic analysis of the Western Hemisphere Ozaenini using DNA sequence data from mi-

Tab. 3. Results of Mann-Whitney U-tests applied to morphometric variables measured on 2nd instar larvae of *P. vignai* and *P. digiulioi*. Acronyms of morphometric variables: hl: head length, hw: head width, dw: disk width, dpl: dorsal plates length, dpw: dorsal plates width.

Morphometric variable	U	Z	p-level
hl	0	-3.656	<0.0001
hw	0	-3.969	<0.0001
hw/hl	17	-2.387	0.017
dw	0	-4.416	<0.0001
dpl	0	-4.416	<0.0001
dpw	0	-4.319	<0.0001
dpw/dpl	43	2.329	0.020

tochondrial and nuclear genomes, which dramatically changed many deeply consolidated taxonomical assumptions about relationships of the genera in this clade. On the whole, this molecular analysis allowed the recognition of three main well supported groups: (1) the *Ozaena* group (*Ozaena* + *Platyerozaena* Bänninger, 1927 + *Goniotropis*), (2) the *Tropopsis* group (*Tropopsis* Solier, 1849 + *Entomoantyx* Ball and McCleve, 1990); and (3) the *Pachyteles* group (*Pachyteles* + *Physea* + *Tachypeles*

Deuve, 2001 + *Inflatozaena* Deuve, 2001 + *Filicerozaena* Deuve, 2001 + *Proozaena* Deuve, 2001 + *Serratozaena* Deuve, 2001). As *Goniotropis* is placed in a clade different from those of *Pachyteles* and *Tropopsis*, in turn placed into two distinct clades, this result strongly contrasts with past views, in which all these taxa were considered strictly related or even subgenera of *Pachyteles* s.l.. This molecular reconstruction also provided evidence for polyphyly of the genera *Pachyteles* and *Tachypeles* as currently

Tab. 4. Summary statistics for morphometric variables measured on 1st, 2nd and 3rd instar larvae of *P. vignai*. Acronyms of morphometric variables: hl: head length, hw: head width, dw: disk width, dpl: dorsal plates length, dpw: dorsal plates width.

Morphometric variable	Mean	Standard Error	Minimum	Maximum	Sample size
1st instar					
hl	0.430	0.000	0.430	0.430	5
hw	0.700	0.000	0.700	0.700	5
hw/hl	1.628	0.000	1.628	1.628	5
dw	1.082	0.007	1.060	1.100	5
dpl	0.570	0.000	0.570	0.570	5
dpw	0.920	0.000	0.920	0.920	5
dpw/dpl	1.614	0.000	1.614	1.614	5
2nd instar					
hl	0.632	0.005	0.600	0.650	9
hw	1.042	0.003	1.020	1.050	9
hw/hl	1.650	0.016	1.594	1.750	9
dw	1.793	0.023	1.700	1.840	9
dpl	0.912	0.009	0.850	0.940	9
dpw	1.396	0.027	1.290	1.560	9
dpw/dpl	1.531	0.032	1.372	1.696	9
3rd instar					
hl	0.981	0.037	0.780	1.040	7
hw	1.494	0.010	1.460	1.550	9
hw/hl	1.541	0.059	1.423	1.872	7
dw	2.644	0.017	2.550	2.700	14
dpl	1.256	0.013	1.130	1.300	14
dpw	2.126	0.022	2.030	2.340	14
dpw/dpl	1.694	0.018	1.609	1.828	14

defined, thus calling for an urgent taxonomic revision for a correct reassignment of the species to monophyletic genera.

The new phylogenetic scenario emerging from molecular relationships affects our interpretation on the evolution of larval morphology and lifestyle adaptations (*i.e.* free-living vs myrmecophilous species) in the New World Ozaenini genera and species. Unfortunately, the current known larvae in this clade represent only a very small fraction of its species diversity. Only 11 species are known at larval stage and descriptions are not always sufficiently accurate: *Physea setosa* Chaudoir, 1868 (van Emden, 1936); *Goniotropis kuntzeni* Bänninger, 1927 (Moore & Di Giulio, 2006); *G. parca* LeConte, 1884 (Moore & Di Giulio, 2019); *Ozaena lemoulti* Bänninger 1932 (Moore & Di Giulio, 2019); one mature larva assigned with doubt to *Pachyteles* ‘*ex societate imarginis*’ by van Emden (1942); some larvae of one unidentified *Pachyteles* species from Brazil, reared to adults by Costa *et al.* (1988); one troglophilous larva of *Pachyteles mexicanus* from a Mexican cave (Vigna Taglianti *et al.*, 1998); and the three larvae of *Pachyteles vignai*, *P. digiulioi* and *P. sp.* described in this paper.

According to molecular relationships (Moore, 2008), *Pachyteles* (which have free-living predaceous larvae) is more closely related to *Physea* (which has a myrmecophilous larva, see Di Giulio *et al.*, 2003) than to *Goniotropis* (which has a free-living predaceous larva); while *Goniotropis* is more closely related to *Ozaena* (which has a myrmecophilous larva, see

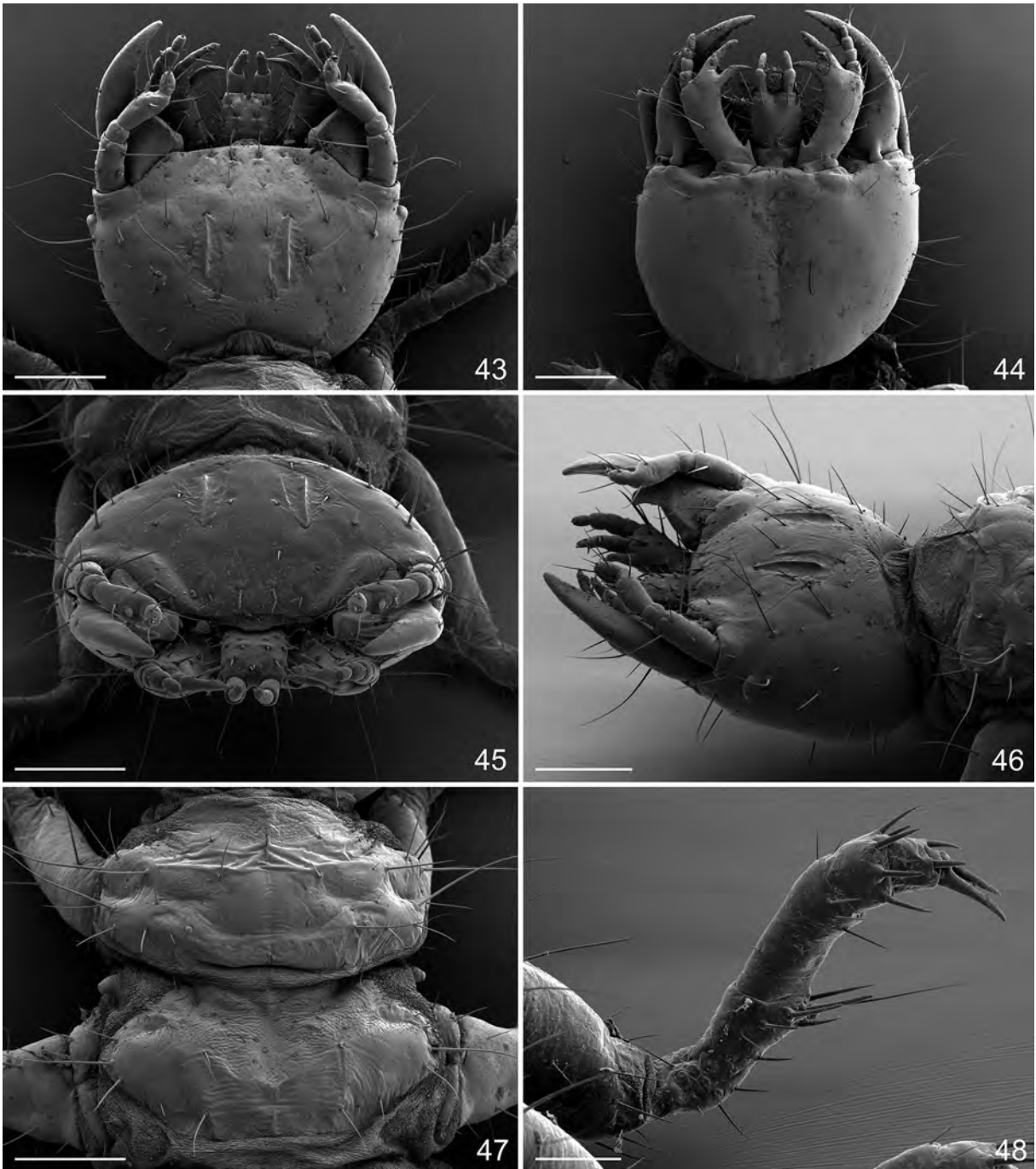
Moore & Di Giulio, 2019) than to *Pachyteles*. Such relationships imply a multiple evolution of myrmecophily in the Ozaenina, possibly starting from a selective myrmecophagy, as already hypothesized in the past, based on larval (Vigna Taglianti *et al.*, 1998; Di Giulio, 1998; Di Giulio, 1999; Di Giulio & Vigna,

Tab. 6. Results of Mann-Whitney U-tests applied to morphometric variables measured on 1st, 2nd, and 3rd instar larvae of *P. vignai*. Acronyms of morphometric variables: hl: head length, hw: head width, dw: disk width, dpl: dorsal plates length, dpw: dorsal plates width. Values in italics resisted the Bonferroni correction.

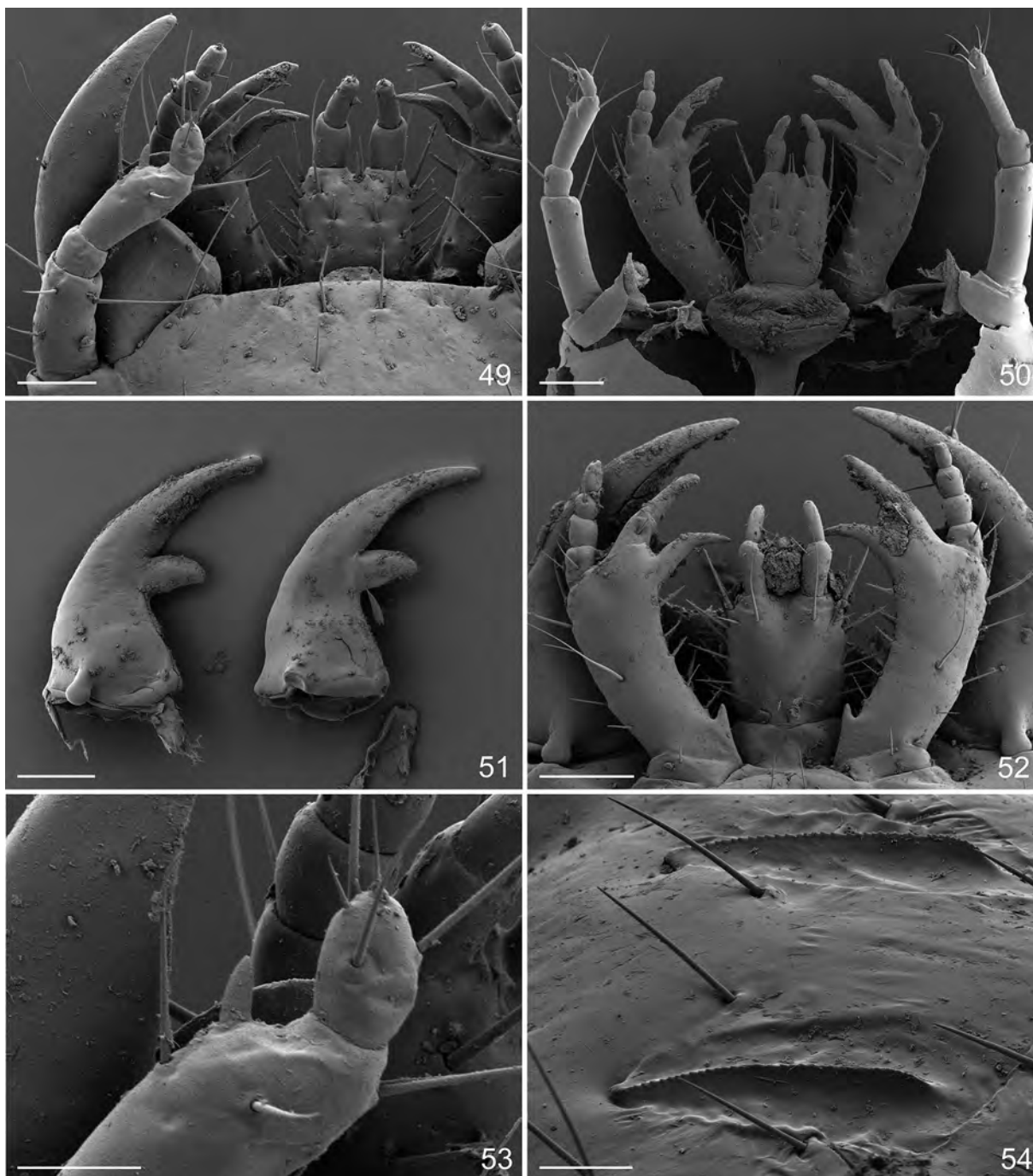
	U	Z	p-level
First instar vs second instar			
hl	0	-3.000	<i>0.003</i>
hw	0	-3.000	<i>0.003</i>
hw/hl	20	0.333	0.739
dw	0	-3.000	<i>0.003</i>
dpl	0	-3.000	<i>0.003</i>
dpw	0	-3.000	<i>0.003</i>
dpw/dpl	5	2.333	0.020
Second instar vs third instar			
hl	0	-3.334	<i>0.001</i>
hw	0	-3.576	<i><0.001</i>
hw/hl	9	2.382	0.017
dw	0	-3.969	<i><0.001</i>
dpl	0	-3.969	<i><0.001</i>
dpw	0	-3.969	<i><0.001</i>
dpw/dpl	9	-3.402	<i>0.001</i>
First instar vs third instar			
hl	0	-2.842	<i>0.004</i>
hw	0	-3.000	<i>0.003</i>
hw/hl	5	2.030	0.042
dw	0	-3.240	<i>0.001</i>
dpl	0	-3.240	<i>0.001</i>
dpw	0	-3.240	<i>0.001</i>
dpw/dpl	10	-2.315	0.021

Tab. 5. Results of Kruskal-Wallis tests applied to morphometric variables measured on 1st, 2nd, and 3rd instar larvae of *P. vignai*. Acronyms of morphometric variables: hl: head length, hw: head width, dw: disk width, dpl: dorsal plates length, dpw: dorsal plates width.

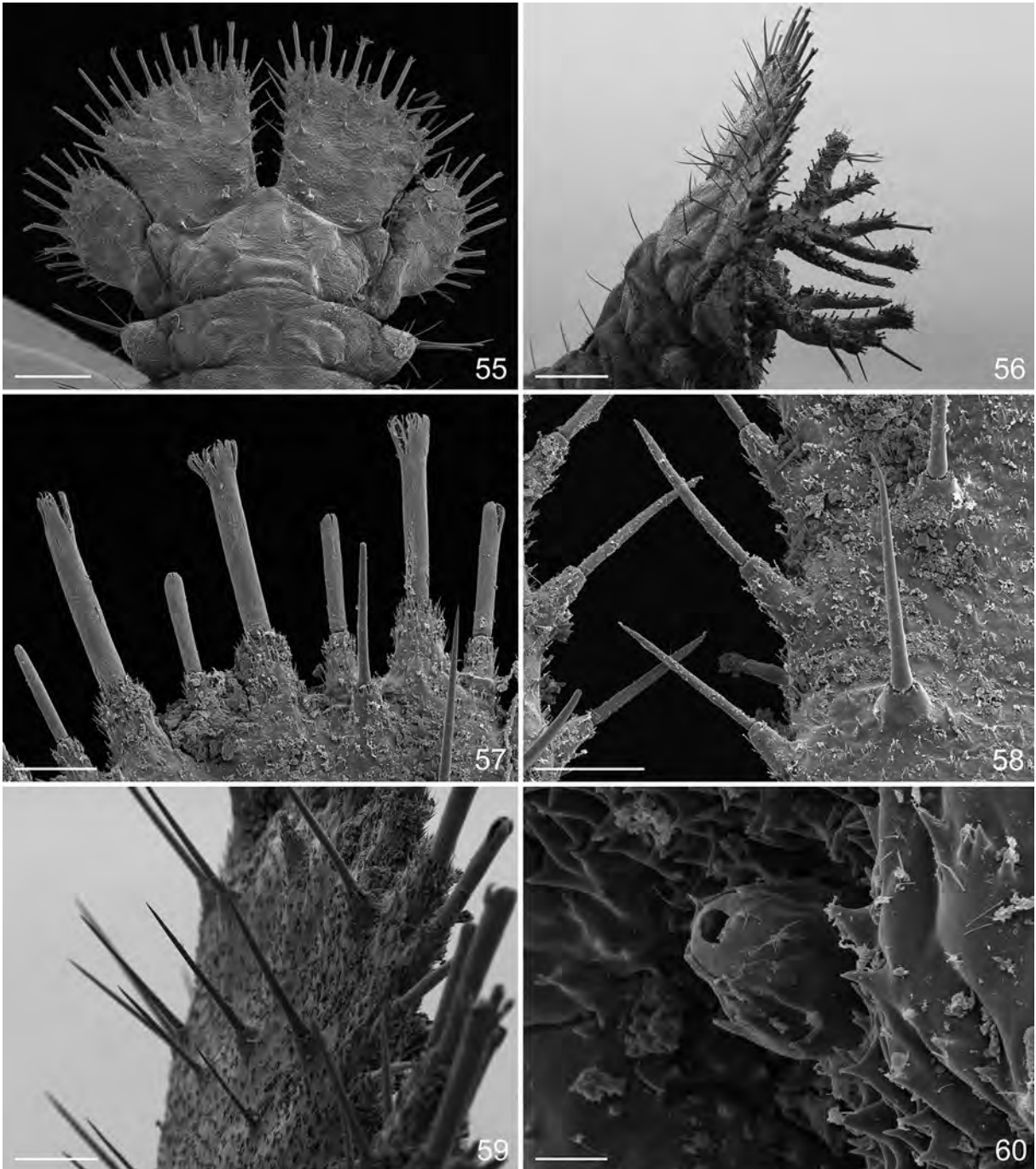
Morphometric variable	H	p-level
hl	17.992	<0.001
hw	19.600	<0.001
hw/hl	6.982	0.031
dw	23.266	<0.001
dpl	23.585	<0.001
dpw	22.898	<0.001
dpw/dpl	15.283	<0.001



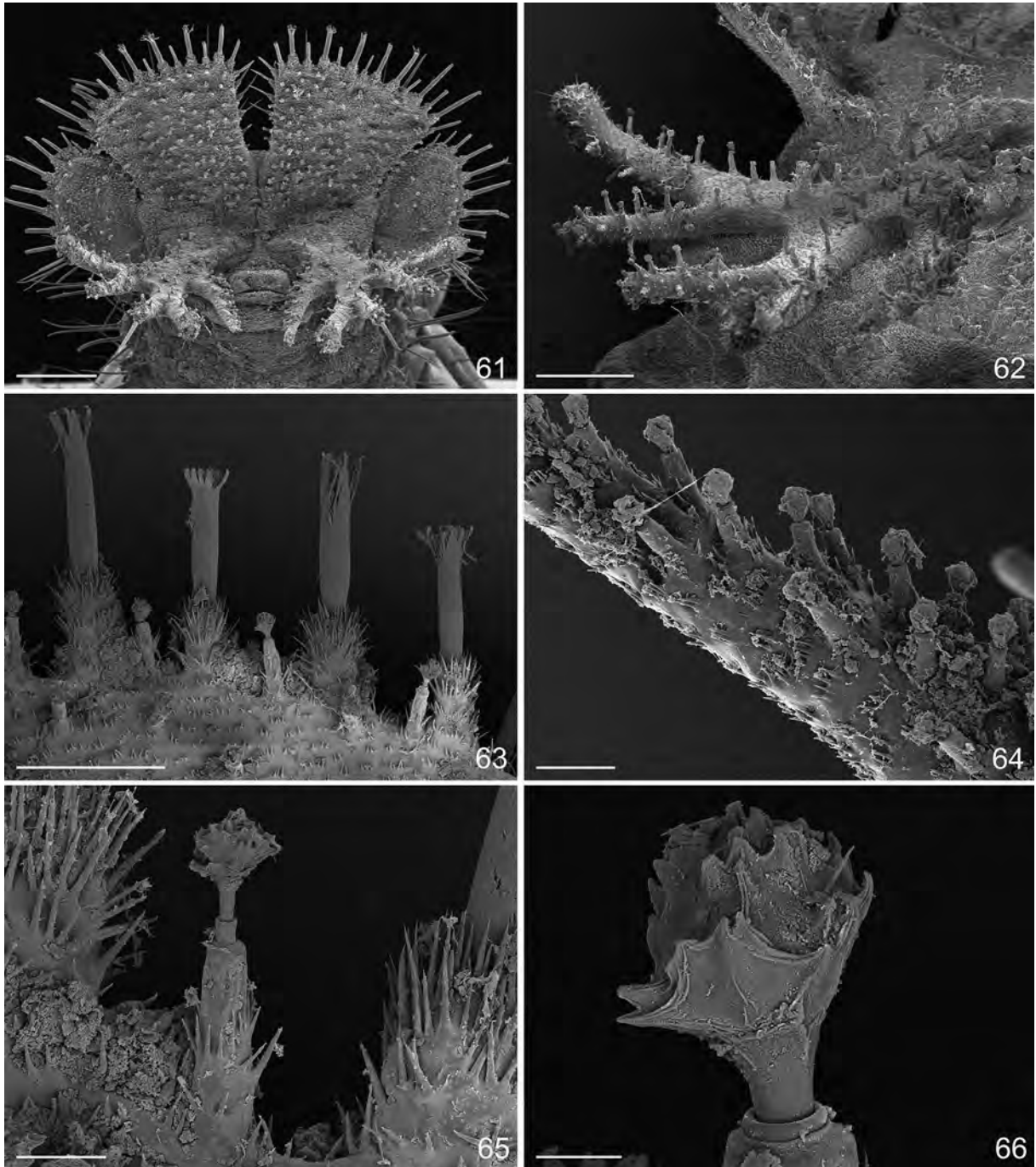
Figs. 43-48. *Pachyteles vignai* Deuve, 1999, SEM micrographs of larvae of 1st (L₁) and 3rd (L₃) instar. 43: head of L₁, dorsal view; 44: head of L₃, ventral view; 45: head of L₁, frontal view; 46: head of L₁, left lateral view; 47: pro- and mesonotum of L₁, dorsal view; 48: hind leg of L₁, anterior view. Scale bars 43, 45-47: 200 µm; 44: 400 µm; 48: 100 µm



Figs. 49-54. *Pachyteles vignai* Deuve, 1999, SEM micrographs of larvae of 1st (L₁) and 3rd (L₃) instar. 49: left antenna and mouthparts of L₁, dorsal view; 50: antennae and mouthparts of exuvia L₃, dorsal view (frontoclypeolabrum absent); 51: mandibles of L₃ (on the left right mandible in ventral view, on the right left mandible dorsal view); 52: mouthparts, ventral view; 53: apex of left antenna with hyaline vesicle of L₁, dorsal view; 54: egg bursters on frontoclypeolabrum, left lateral view. Scale bars: 49, 54: 80 µm; 50-52: 200 µm; 53: 40 µm.



Figs. 55-60. *Pachyteles vignai* Deuve, 1999, SEM micrographs of larvae of 1st instar. 55: apex of abdomen with terminal disk, dorsal view; 56: apex of abdomen and terminal disk, left lateral view; 57: sensilla S-II on apex of right dorsal plate, dorsal view; 58: sensilla S-II in the incision between dorsal plates (on the left) and sensilla S-VII (on the right), dorsal view; 59: sensilla S-VII, lateral view; 60: right spiracle at the base of right dorsal plate. Scale bars: 55-56: 200 μ m; 57-59: 40 μ m; 60: 5 μ m.



Figs. 61-66. *Pachyteles vignai* Deuve, 1999, SEM micrographs of larvae of 1st instar. 61: terminal disk, apical view; 62: left urogomphus, mesolateral view; 63: sensilla S-II apically fringed with sensilla S-I at their base on right dorsal plate, ventral view; 64: sensilla S-I on dorsal side of urogomphal lobe A; 65: sensillum S-I; 66: detail of the apical seta of sensillum S-I (note the rosette-like apical seta). Scale bars: 61-62: 200 μ m; 63: 40 μ m; 64-65: 20 μ m; 66: 5 μ m.

Taglianti, 2001; Di Giulio *et al.*, 2003) and adult (see Moore & Di Giulio, 2008; Moore *et al.*, 2011; Moore & Di Giulio, 2019) pre-adaptations.

Larvae of the three *Pachyteles* species described in this paper are not myrmecophilous and show structural adaptations to a generalized predation on small arthropods and other invertebrates by using the ambush strategy reported by Di Giulio & Vigna Taglianti (2001). Though highly derived, compared to the larvae of other ground beetles, larvae of *Pachyteles* described here are representative of the basal ground plan of the larval morphology of free-living Ozaenini. These larvae are quite similar to one another, and to the other described larvae of *Pachyteles* (unfortunately it is not possible to compare the chaetotaxy in older descriptions), except for diagnostic details mostly dealing with size, head shape, mouthparts, and terminal disk. In particular, a morphometric analysis revealed that 2nd instar larvae of *P. digiulioi* were bigger than those of *P. vignai* and with a more transverse cephalic capsule. The possibility of

studying all three instars of *Pachyteles vignai* allowed the observation that some characters also slightly vary in Ozaenini larvae among different subsequent instars, like the relative length and thickness of the antennomeres and the size of the sensorial appendage on the antennomere III.

The most variable characters among *Pachyteles* larvae are relative to the shape of dorsal and lateral plates and to the urogomphal lobes, especially the length of lobe A, length and branching of lobe B (apically subdivided in B₁ and B₂ sublobes), and on relative length and position of lobe D.

The use of SEM permits the observation of additional fine morphological diagnostic characters not visible by using optical microscopy. For example, it was possible to observe the S-I sensilla of the terminal disk form different structures in *P. vignai* and *P. digiulioi*. In *P. vignai* apical setae are short and composed of concentric layers similar to the petals of a little rose. In *P. digiulioi* the structure resembles a frayed rope, with multiple cylindrical protuberances. Also, the fine structure of other sensilla, such as the

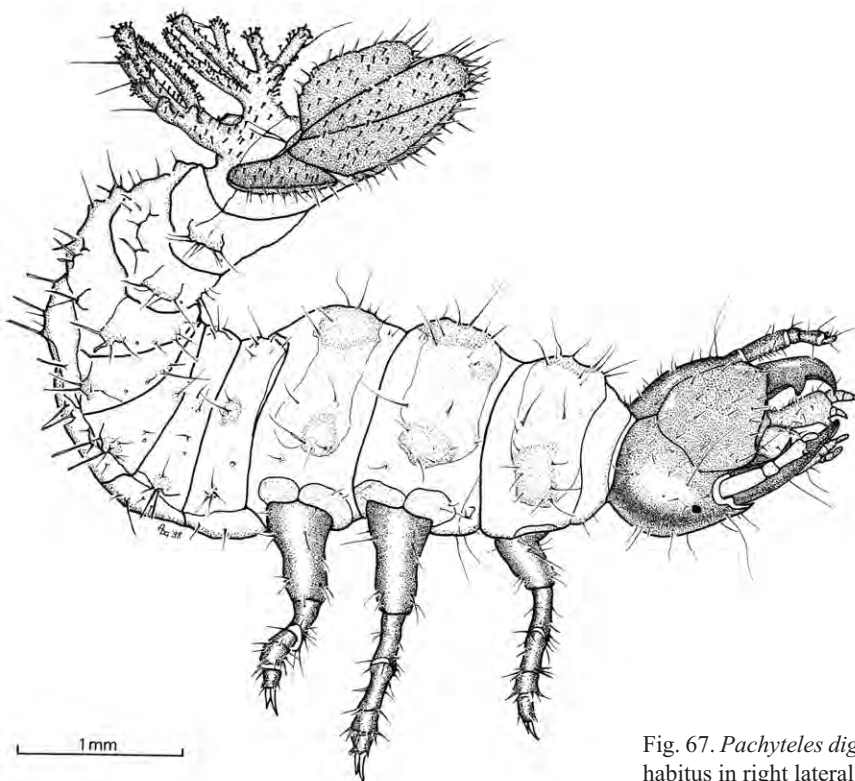
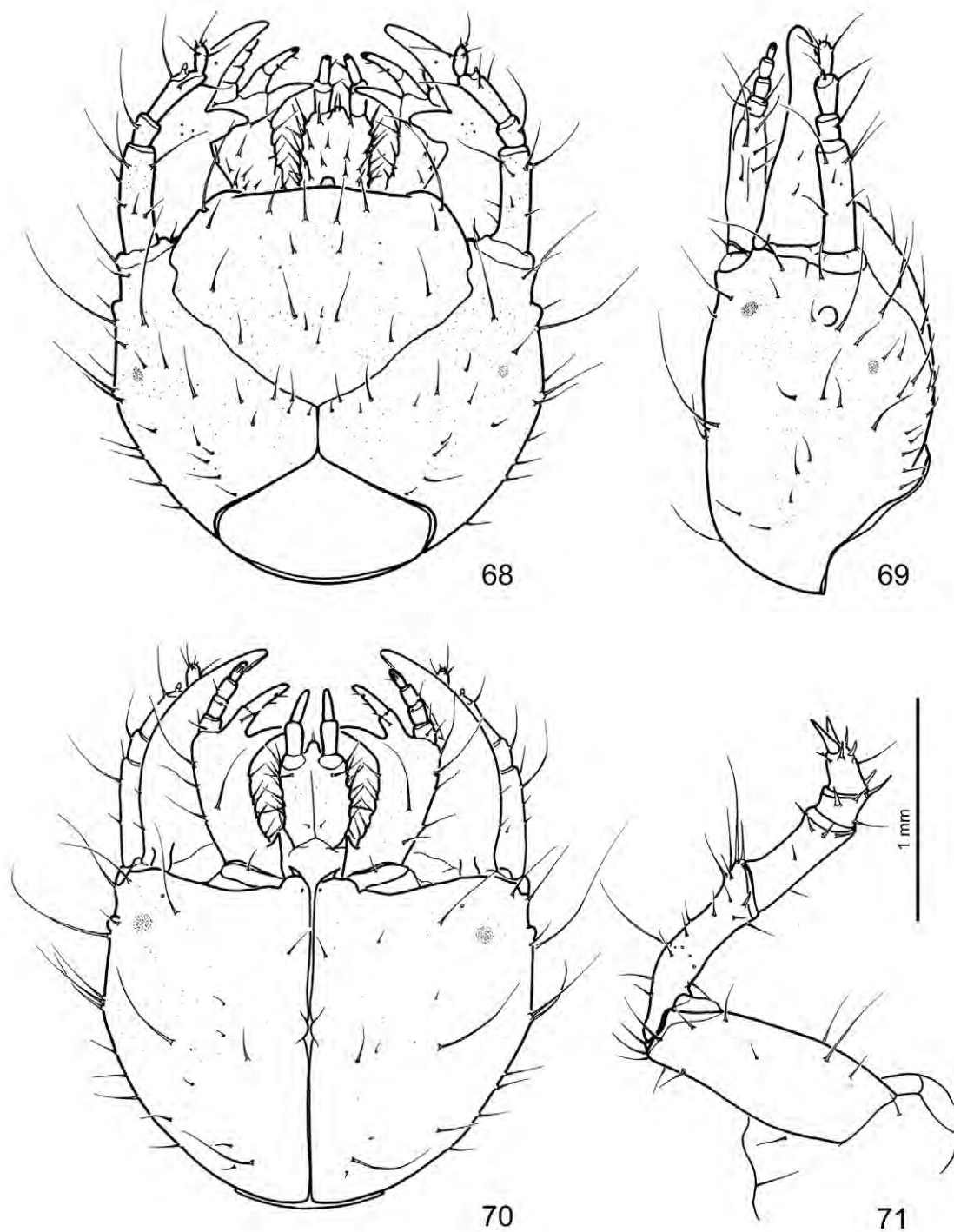


Fig. 67. *Pachyteles digiulioi* Deuve, 1999, larva of 3rd instar, habitus in right lateral view.



Figs. 68-71. *Pachyteles digiulioi* Deuve, 1999, larva of 3rd instar. 68: head, dorsal view; 69: head lateral view; 70: head ventral view; 71: left hind leg, posterior view.

minute sensilla S-VI, and the microsculpture of the different parts of the body can be carefully studied only by using the SEM.

All these characters have been analyzed, compared to those of other paussine larvae and discussed in phylogenetic and adaptive perspectives in previous papers (Vigna Taglianti *et al.*, 1998; Di Giulio, 1998; Di Giulio, 1999; Di Giulio *et al.*, 2003), which highlighted how *Pachyteles* larvae differ from those of other taxa.

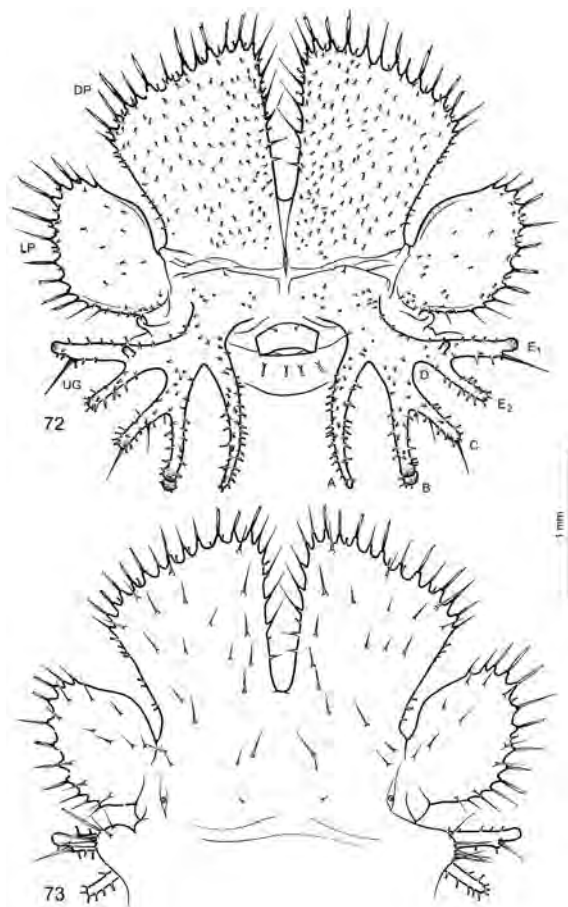
Namely, *Pachyteles* larvae differ:

- from *Metrius* (Bousquet, 1986) and *Mystropomus* (Di Giulio & Moore, 2009) larvae in having the additional E2 lobe on the urogomphi (like most

described Ozaenini larvae), and in missing a 4-toothed nasal prominence, replaced by a transverse keel;

- from *Itamus* larvae (Vigna Taglianti *et al.*, 1998) in having relatively stout and short urogomphal lobes, and for the ligula of praementum short, only slightly convex;
- from *Goniotropis* larvae (Moore & Di Giulio, 2006, 2019) in showing much smaller relative dimensions of the terminal disk, with dorsal plates trapezoidal and not rectangular, and shorter and stouter mandibles, antennae and maxillae, including a dome-shaped ligula instead of the longer ligula of *Goniotropis*;
- from *Ozaena*, (Moore & Di Giulio, 2019) for a completely different shape of body, head, mouthparts and terminal disk, highly derived in these myrmecophilous larvae.
- from *Sphaerostylus* (unpublished, ADG pers. obs.) for the different structure of B1 lobe and the reduced number of sensilla SII on the margin of dorsal plates;
- from *Physeia* for many characters, like absence of body physogastry, completely different dimensions and structure of the terminal disk and for many characters of the mouthparts (Di Giulio *et al.*, 2003);
- from the aberrant larvae of *Eustra* (Moore *et al.*, 2011) for many characters of head (*e.g.*, mandibles without bidentate apex and fused antennomeres) and terminal disk (*e.g.*, different arrangement and shape of urogomphi and different structure of sensilla S-I and S-II).

Most paussine larval descriptions before that of *Metrius contractus* (Bousquet, 1986) were scarcely or inadequately illustrated, except for the larva of *Paussus kannegieteri* Wasman, 1826 by Bøving (1907). Following new modern standards, in the present paper all larval instars of *Pachyteles vignai* and 2nd and 3rd instars of *P. digiulioi*, which become model species for the Ozaenini larvae (Di Giulio, 1999), are richly illustrated by using different complementary microscopy approaches (multifocal macro-photography, optical microscopy and scanning electron microscopy) and subject to preliminary morphometric analyses, with the aim of showing these aberrant, fascinating ground beetle larvae, in the most effective way, emphasizing the surprising adaptations to a unique predatory strategy.



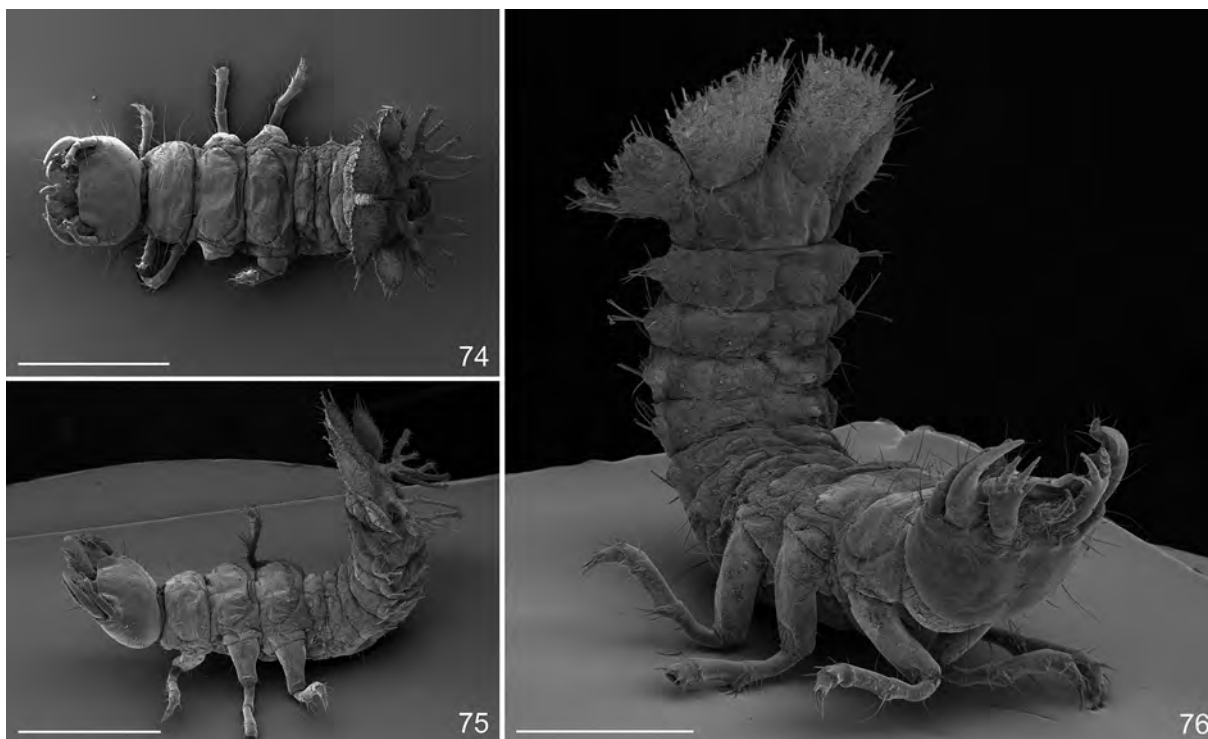
Figs. 72-73. *Pachyteles digiulioi* Deuve, 1999, larva of 3rd instar. 72: terminal disk, apical view; 73: terminal disk, dorsal view. DP: dorsal plate; LP: lateral plate; UG: urogomphus; A-E₂: lobes of urogomphi.

ACKNOWLEDGEMENTS

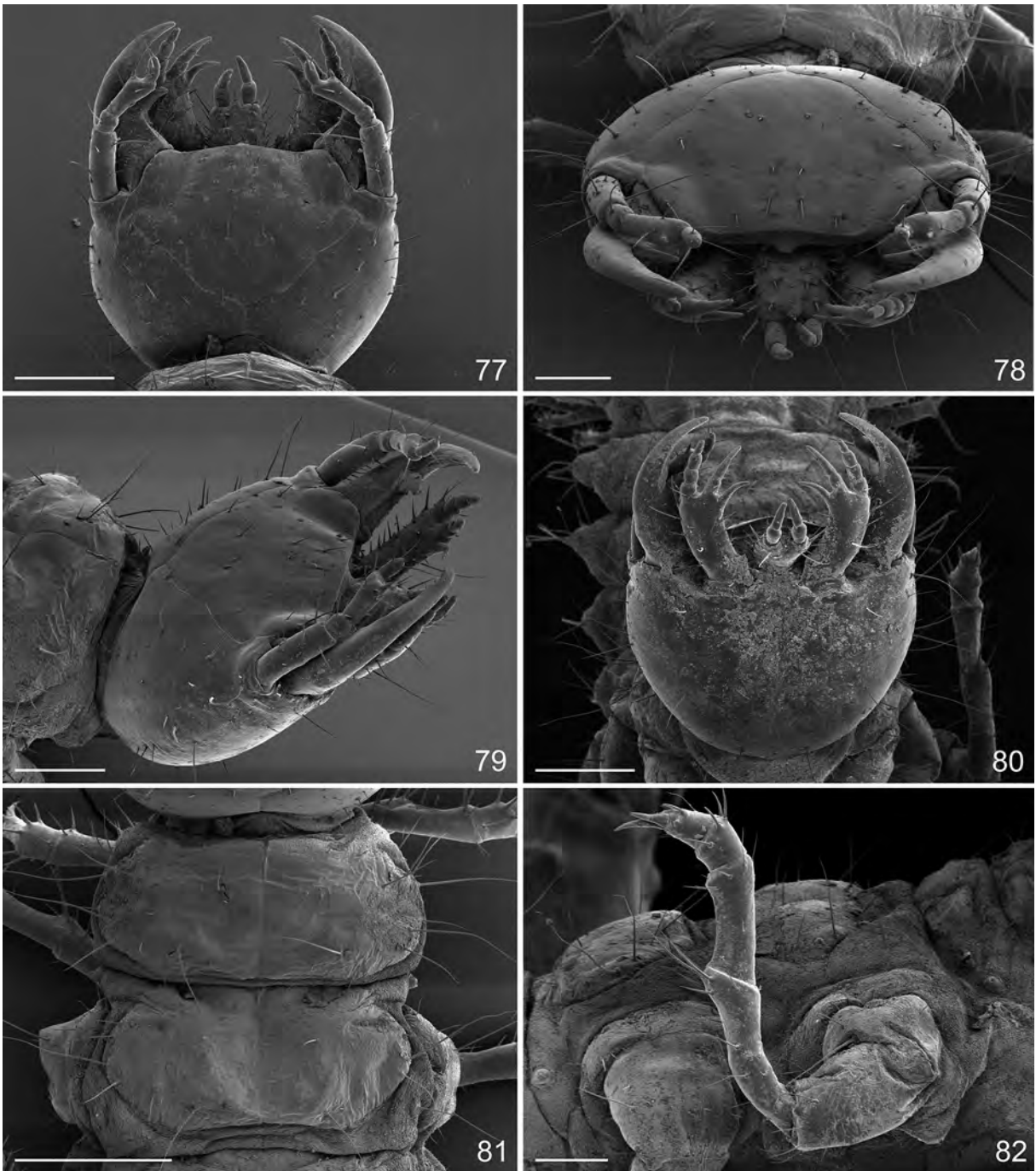
We wish to thank many people who helped ADG in the field in finding the rare *Pachyteles* larvae, subject of this paper and of his PhD project: Augusto Vigna Taglianti, Achille Casale, Giovanni Onore, Arturo and Italo Tapia and Fernanda Salazar. Paussidologist friends and colleagues Wendy Moore and Peter Nagel are thanked for their continuous and fruitful collaboration and discussions over the past 20 years, working as a team for tackling the secrets of Paussinae. Pierre Moret is kindly acknowledged for the loan of the *Pachyteles* sp. larva here described, and for his patience in waiting so long before its formal

publication. ADG is particularly grateful to Thierry Deuve for studying the adults of *P. vignai* and *P. digiulioi* and for species dedication. The co-Editors of this volume, Pietro Brandmayr, Achille Casale and Pier Mauro Giachino are thanked for encouraging ADG for the publication of this paper and for their patience and suggestions.

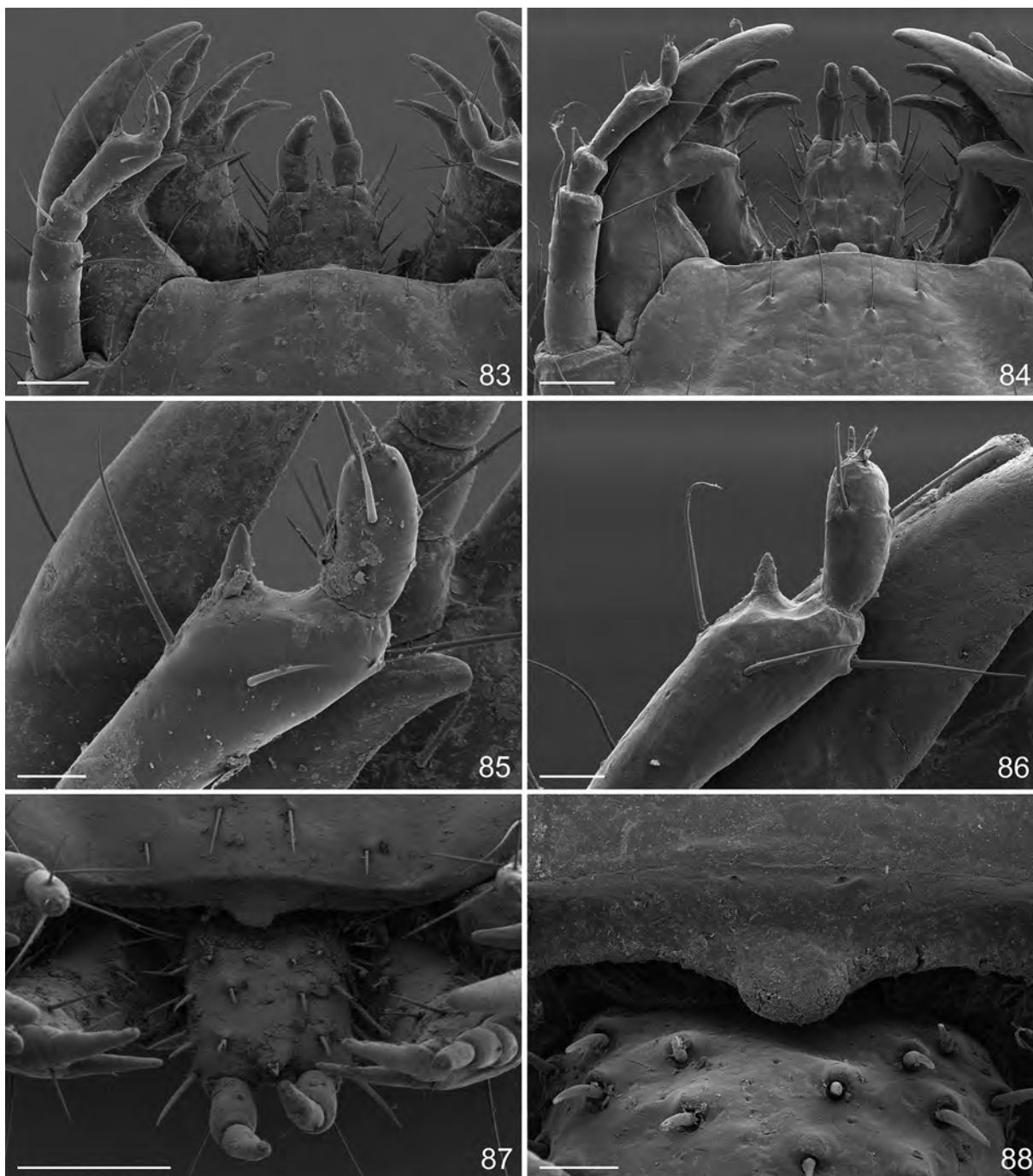
The subject of this paper and the multiple illustration approach here presented would have been greatly appreciated by the late Augusto Vigna Taglianti, mentor of the Ph.D. project of ADG on paussine larvae and of SF on phylogeny of tenebrionid beetles, to whom this paper is cordially dedicated.



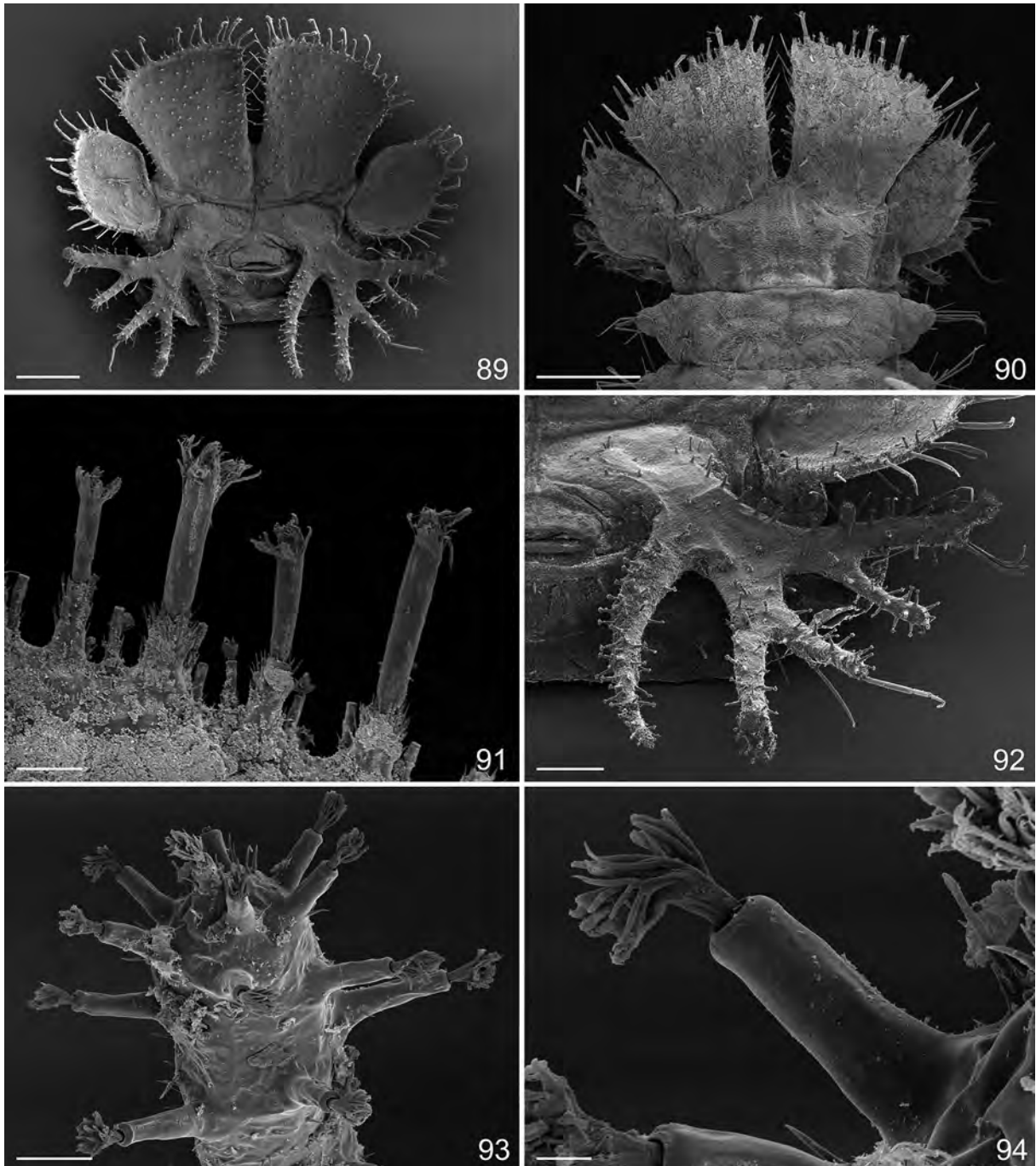
Figs. 74-76. *Pachyteles digiulioi* Deuve, 1999, SEM micrographs of larva of 2nd instar. 74: habitus, dorsal view; 75: habitus, left lateral view; 76: habitus, anterolateral view. Scale bars: 74-75: 1 mm; 76: 2 mm.



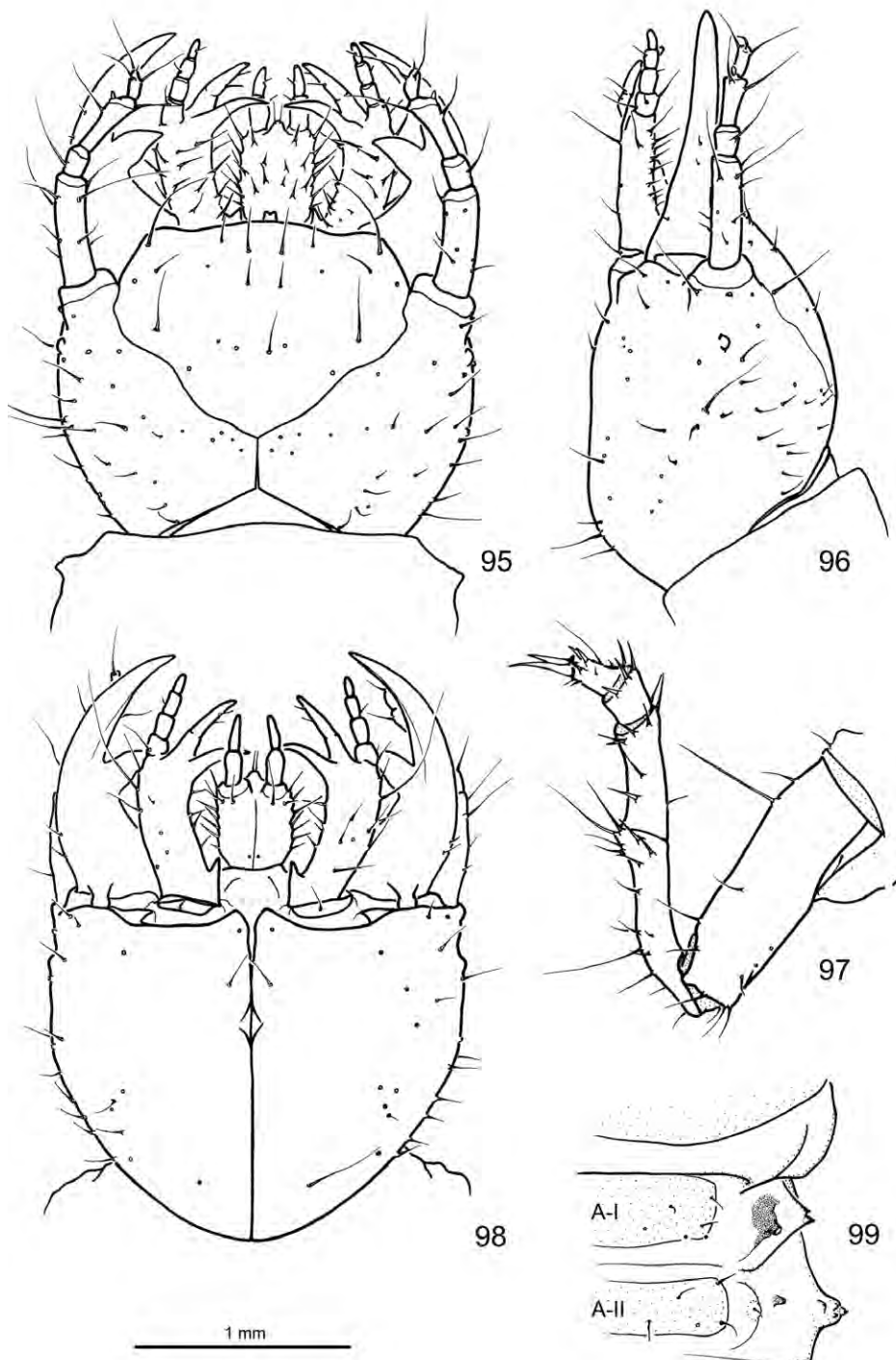
Figs. 77-82. *Pachyteles digiulioi* Deuve, 1999, SEM micrographs of larva of 2nd instar. 77: head, dorsal view; 78: head, frontal view; 79: head, right lateral view; 80: head, ventral view; 81: pro- and mesonotum, dorsal view; 82: mid leg, posterior view. Scale bars: 77-80: 400 μ m; 78-82: 200 μ m; 79: 300 μ m; 81: 500 μ m.



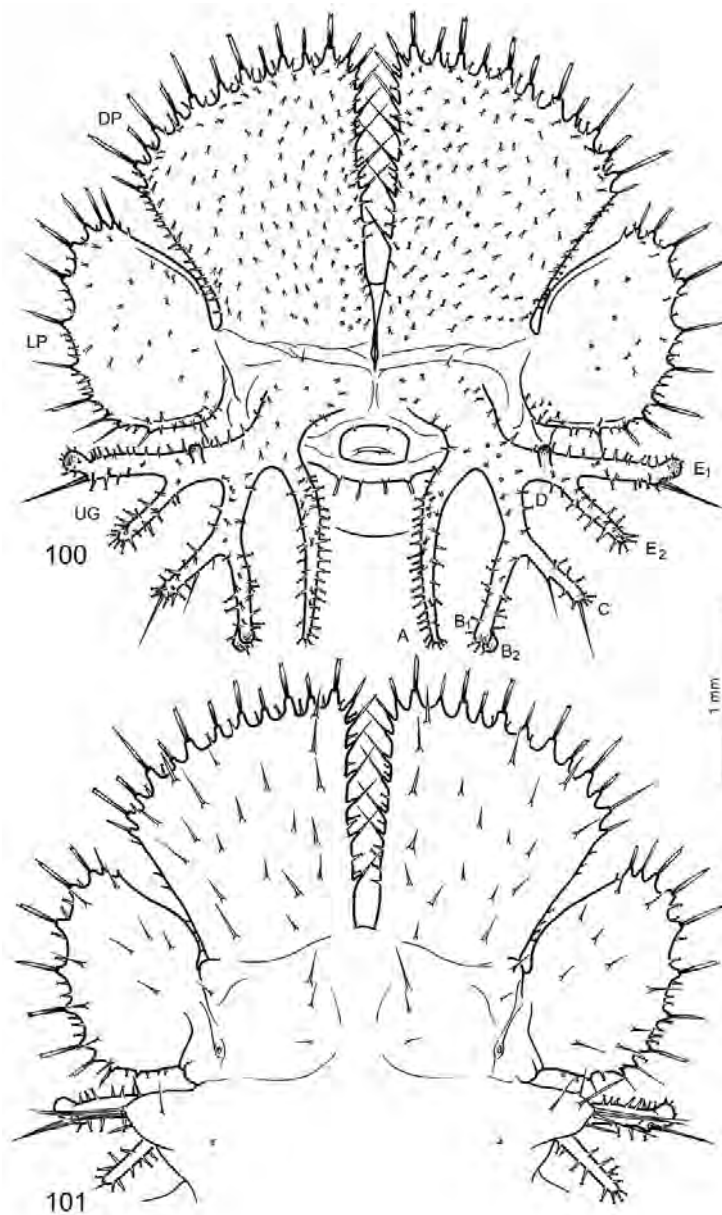
Figs. 83-84. *Pachyteles digiulioi* Deuve, 1999, SEM micrographs of larvae of 2nd (L₂) and 3rd (L₃) instar. 83: antennae and mouthparts of L₂, dorsal view; 84: antennae and mouthparts of L₃, dorsal view; 85: apex of left antenna with hyaline vesicle of L₂, dorsal view; 86: apex of left antenna with hyaline vesicle of L₃, dorsal view; 87: anterior margin of frontoclypeolabrum on L₂; 88: labral spine on L₃ (note the two medial pores over the spine. Scale bars: 83-84, 87: 200 µm; 85-86: 50 µm; 88: 500 µm.



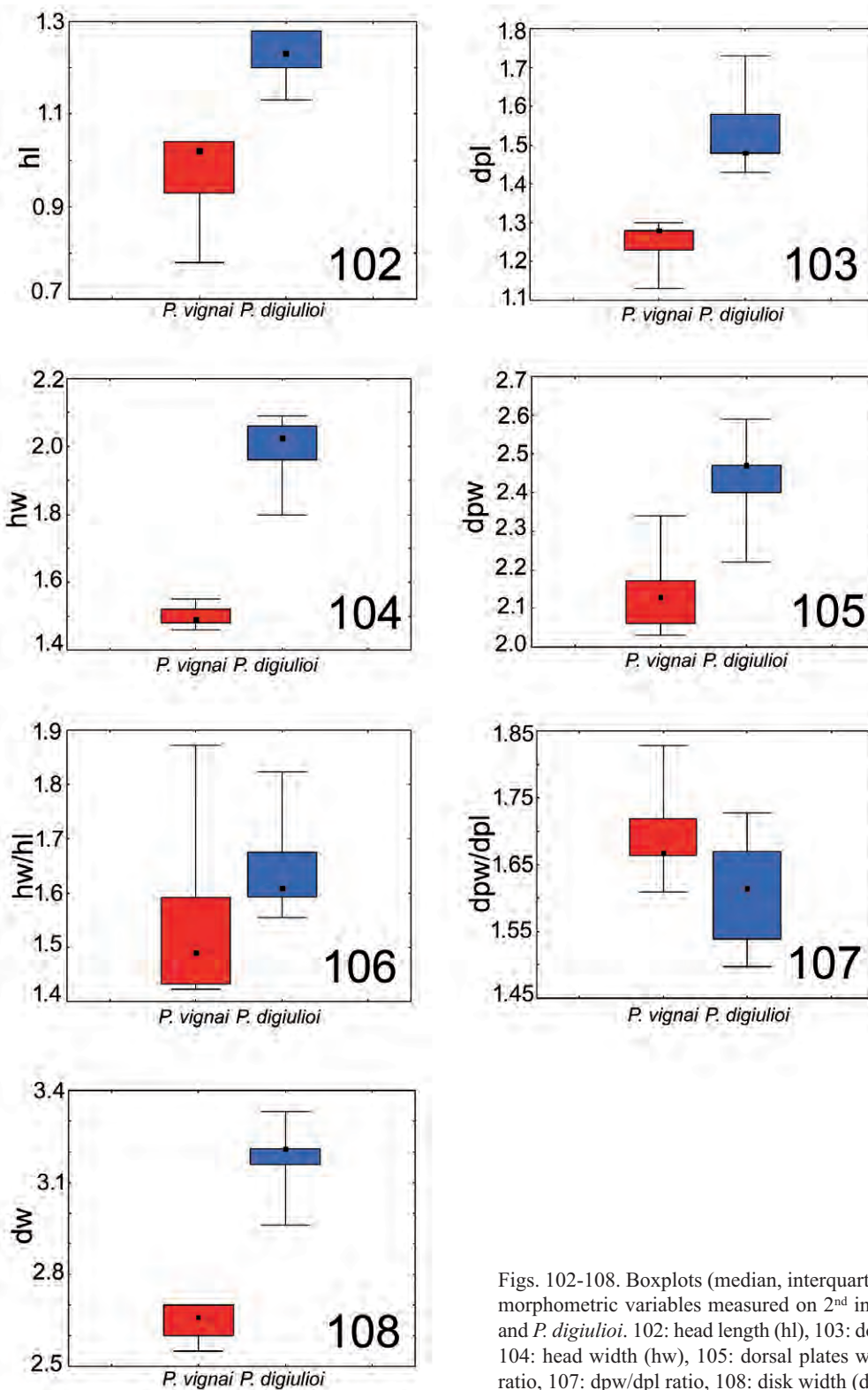
Figs. 89-94. *Pachyteles digiulioi* Deuve, 1999, SEM micrographs of larvae of 2nd (L₂) and 3rd (L₃) instar. 89: terminal disk of L₃, apical view; 90: apex of abdomen with terminal disk of L₂, dorsal view; 91: sensilla S-II apically fringed with sensilla S-I at their base on right dorsal plate of L₂, ventral view; 92: right urogomphus, dorsal view; 93: apex of lobe E₂ with sensilla S-I; 94: detail of a sensillum S-I on apex of lobe E₂ (note the fringed apical seta). Scale bars: 89-90: 500 µm; 91: 50 µm; 92: 200 µm; 93: 30 µm; 94: 5 µm.



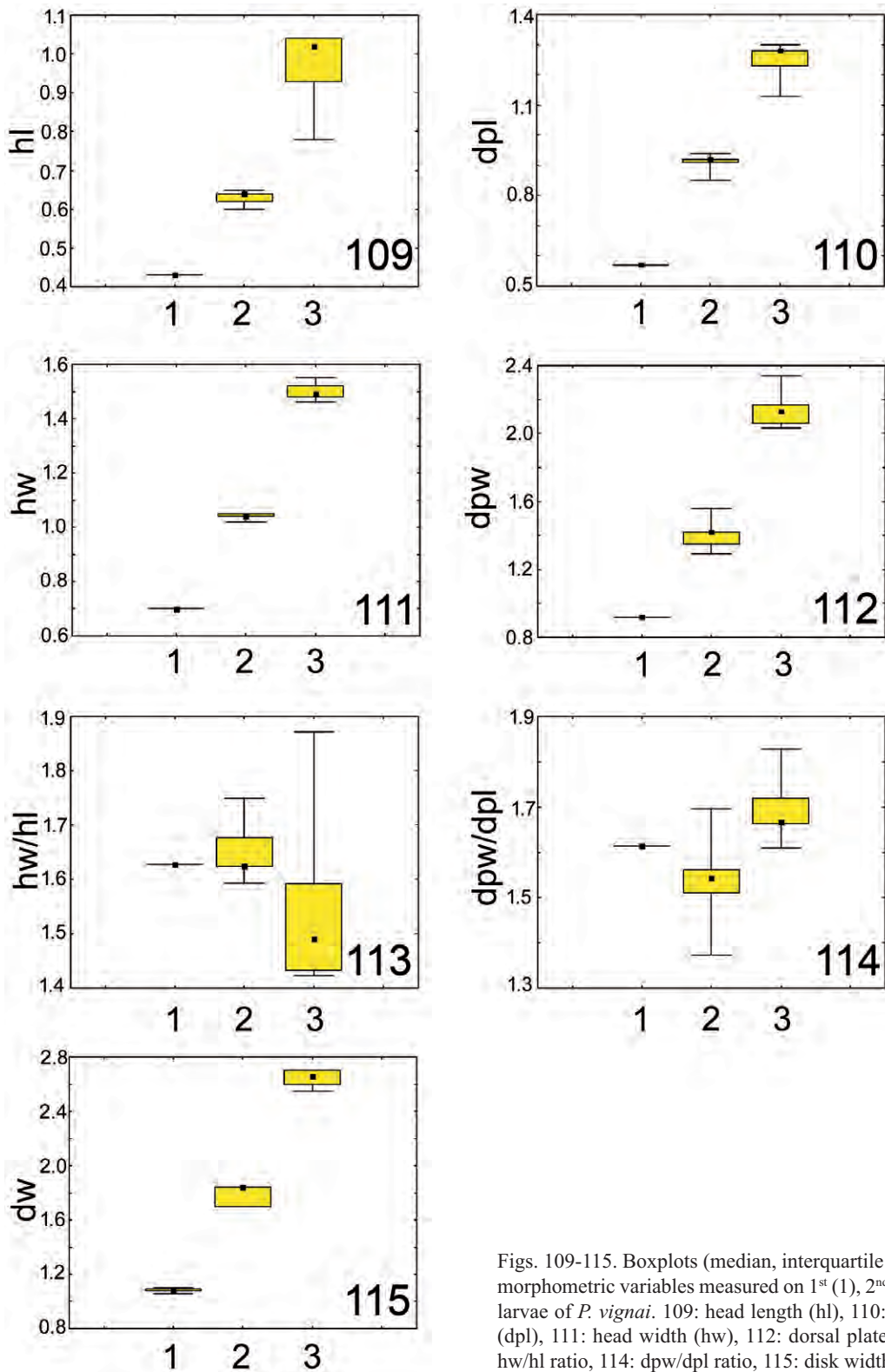
Figs. 95-99. *Pachyteles* sp., larva of 3rd instar. 95: head, dorsal view; 96: head lateral view; 98: head ventral view; 99: abdominal segments I-II (A-I, A-II) dorsal view (note the sclerotization around the spiracle I).



Figs. 100-101. *Pachyteles* sp., larva of 3rd instar. 100: terminal disk, apical view; 101: terminal disk, dorsal view. DP: dorsal plate; LP: lateral plate; UG: urogomphus; A-E₂: lobes of urogomphi.



Figs. 102-108. Boxplots (median, interquartile range, and range) of morphometric variables measured on 2nd instar larvae of *P. vignai* and *P. digiulioi*. 102: head length (hl), 103: dorsal plates length (dpl), 104: head width (hw), 105: dorsal plates width (dpw), 106: hw/hl ratio, 107: dpw/dpl ratio, 108: disk width (dw).



Figs. 109-115. Boxplots (median, interquartile range, and range) of morphometric variables measured on 1st (1), 2nd (2) and 3rd (3) instar larvae of *P. vignai*. 109: head length (hl), 110: dorsal plates length (dpl), 111: head width (hw), 112: dorsal plates width (dpw), 113: hw/hl ratio, 114: dpw/dpl ratio, 115: disk width (dw).

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Description of larvae of Mexican *Calosoma* Weber, 1801 species, with faunal records (Coleoptera Carabidae Carabini)

Abstract: On the basis of the materials collected on site, the larvae of six species of Mexican *Calosoma*, namely *Calosoma* (*Callitropa*) *porosifrons* Bates, 1891, and five species of the subgenus *Carabomimus* Kolbe, 1895 are figured and described for the first time. Though these larvae are quite similar for most characters, some important differences can be found in the two subgenera *Callitropa* Motschulsky, 1865 and *Carabomimus*, confirming the distinctness of these taxa. Through an accurate study of the collected adult specimens and of the relevant literature, the distribution of the population afferent to each of these same species is clarified. With the occasion, the distribution of all Mexican *Calosoma*, is discussed, distinguishing between winged species, usually widely spread, and apterous species, linked to humid, temperate or semi-cold climates. In this context, the distribution of the subgenus *Carabomimus*, appears to be more sensitive to the influence of geographic barriers and the differentiation of the species was clearly helped by geographic isolation at high altitude in the volcanic massif of Central Mexico.

Riassunto: Descrizione di larve di specie messicane di *Calosoma* Weber, 1801, con distribuzione faunistica (Coleoptera Carabidae Carabini)

Sulla base dei materiali raccolti in loco, vengono illustrate e descritte per la prima volta le larve di sei specie di *Calosoma* messicane, ovvero *Calosoma* (*Callitropa*) *porosifrons* Bates, 1898, e cinque specie del sottogenere *Carabomimus* Kolbe, 1895. Queste larve risultano molto simili, ma con alcune differenze sensibili relative ai due sottogeneri *Callitropa* Motschulsky, 1865 e *Carabomimus*, a conferma della distinzione di questi taxa. Attraverso un accurato studio degli esemplari adulti raccolti e della relativa letteratura, viene chiarita la distribuzione delle popolazioni afferenti a ciascuna di queste stesse specie. In questo lavoro viene anche discussa la distribuzione di tutte le specie di *Calosoma* messicane, distinguendo tra specie alate, generalmente ad ampia diffusione, e specie attere, legate a climi umidi, temperati o semifreddi. In questo contesto, la distribuzione del sottogenere *Carabomimus* risulta essere più sensibile all'influenza delle barriere geografiche e la differenziazione delle specie è stata chiaramente influenzata dall'isolamento geografico ad alta quota nel massiccio vulcanico del Messico Centrale.

Key words: *Calosoma*, *Callitropa*, *Carabomimus*, Mexico, larvae, distribution, biogeography.

INTRODUCTION

This paper presents with some delay the results of a research started years ago under the coordination of Augusto Vigna Taglianti, recently deceased. The manuscript was in fact discussed, revised and updated several times until, by now almost ready for publication, all activities had been temporarily suspended due to the illness and death of the main author. However, despite the delay, the data are still significant and the conclusions maintain their validity.

The analysis of larval instars of six species of Carabidae *Calosoma* collected in Mexico in 1987 by S. Bruschi and E. Migliaccio allows to better define their systematic position.

After the general revision by Jeannel (1940) the Mexican *Calosoma* were studied taxonomically by Gidaspow (1959), in a work concerning all North American species. Nevertheless, even if they were

based on examination of a substantial number of samples, some of Gidaspow's taxonomic conclusions seem less convincing than those of Jeannel (1940).

Jeannel, in fact, linked systematic and phylogenetic points of view together with zoogeographical interpretations, mostly seen through an historical perspective, while Gidaspow based her work primarily on morphological characters. Several taxa previously described were in this sense re-evaluated using characters which are very variable within the same species. Such forms, which Jeannel (1940) considered as individual variations or as subspecies, were raised to specific level by Gidaspow, on the basis of possible sympatries according to bibliographic quotations, difficult to verify, and not checked in nature.

After Gidaspow's paper (1959), we are acquainted with some more descriptions of species or

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subspecies that have been made by various authors. Among them, we note the papers of Korell & Frisch (2004), Lassalle (2009), Lassalle & van den Berghe (2010, 2011a, 2011b, 2013), Häckel, Heinz & Sehnal (2011), Häckel & Heinz (2011). All of them, based on new findings and on the review of the historical material, did much to clarify the relationships between the various entities related to the more difficult and still little known subgenera *Callitropa*, *Carabomimus* and *Calopachys* Hauray, 1880.

Jeannel (1940) identified 20 genera within his Calosomini. Some years later Gidaspow (1959: 231), as part of the American fauna, recognized only two genera: *Calosoma* and *Callisthenes* Fischer von Waldheim, 1822, maintaining the other genera of Jeannel as subgenera. Most of the subsequent authors (Lorenz, 2005) have adopted this approach, albeit articulating the subgenus *Callisthenes* in different ways or recognizing some more genera: *Calopachys*, *Carabomorphus* Kolbe, 1895, *Carabops* Jakobson, 1900.

The paper of Jeannel (1940) represented a milestone for the knowledge of this taxonomic group, but his genera are sometimes difficult to defend and therefore in the following pages most of his genera will be tackled as subgenera of the genus *Calosoma*, that in its turn is included in the tribe Carabini.

These subgenera are morphologically homogenous and geographically well defined, but the hypothesis that we are dealing with monophyletic groups has been partly questioned by the results of recent studies based on mitochondrial DNA (Osawa *et al.*, 2003; Su *et al.*, 2005) or on all nuclear DNA sequence data available in GenBank (Toussaint & Gillett, 2017). These studies suggested that subgenera and species of *Calosoma* are phylogenetically equivalent and that their origin is more recent than what had been hypothesized by Jeannel. Also, as a consequence of these results, has been proposed, when dealing with *Calosoma* to replace the concept of subgenus with that of species-group (Häckel, 2013), and the use of subgenera has been drastically rejected in one of the most recent catalogs where all formally recognized species of *Calosoma* are simply listed alphabetically (Häckel, 2017: 63-69).

On the contrary, we think still useful, and we prefer to adopt, the system used by Jeannel (1940) that has the great advantage to explicitly consider the phylogenetic relationship (Ball & Bousquet, 2001:

66), leaving room for future, comprehensive and multi-approached phylogenetic analyses.

For the six species, of which we describe the structural features of their larvae we provide some taxonomic notes, and chorological and ecological records.

MATERIALS AND METHODS

The examined material is preserved in several collections, as the following list of abbreviations:

AMNH	American Museum of Natural History, New York
BMNH	Natural History Museum, London
MCZR	Museo civico di Zoologia, Roma
MNHN	Muséum national d'Histoire naturelle, Paris
NBC	Naturalis Biodiversity Centre, Leiden
NMNH	National Museum of Natural History, Washington; http://collections.nmnh.si.edu/search/ento/
UASM	University of Alberta, E. H. Strickland Entomological Museum; http://www.entomology.ualberta.ca/
UNAM	Instituto de Biología - Universidad Nacional Autónoma de México; http://unibio.unam.mx/
ZMUH	Zoologisches Museum Universität Hamburg
AVT	A. Vigna Taglianti, Museo Civico di Storia Naturale Giacomo Doria, Genova
EM	E. Migliaccio, Roma
GP	G. Pontuale, Roma
SB	S. Bruschi, Roma

The larvae were all collected in the 1987 expedition, by S. Bruschi and E. Migliaccio, identified when possible through association with adults collected in the same area (*ex societate imaginis*), and deposited in the A. Vigna Taglianti collection, Museo Civico di Storia Naturale Giacomo Doria (Genova, Italy). The larvae are preserved in 70% ethanol; the mouth parts and antennae of some specimens were mounted in Euparal on microscope slides.

Notation of primary setae and pores follows that of Bousquet & Goulet (1984), notation of microsculpture follows that of Bousquet (1985), and length ratios of appendages that of Thompson (1979).

The ranking system follows Jeannel (1940) with minor adjustment as detailed in Bruschi & Vigna Taglianti (2012) and the systematic among the species is consistent with what has already been indicated in Bruschi (2013).

***Calosoma (Callitropa) porosifrons* Bates, 1891 (Figs. 1, 2)**

Calosoma porosifrons Bates, 1891: 229 (type locality: Refugio); type material in BMNH, (Jeannel, 1940: 220). *Carabomimus porosifrons* Csiki, 1927: 30.

Calosoma (Blaptosoma) porosifrons Breuning, 1928b: 52.

Calosoma (Blaptosoma) porosifrons laevifrons Breuning, 1931: 621 (type locality: Mexico); holotype ♀ in NBC (de Boer, 2002: 69).

Blaptosoma (Carabomimus) porosifrons Lapouge, 1932: 391.

Callitropa (Blaptosoma) porosifrons Jeannel, 1940: 220.

Calosoma (Blaptosoma) porosifrons Gidaspow, 1959: 281.

EXAMINED SPECIMENS. Durango, Refugio, Höge, (H. W. Bates, Biol. Cent. Amer.), 1 ♂ (SB); Durango, 6 ml. E. El Salto, 8200 feet, 12.VIII.1972 ME-73, R.R. & M.E. Murray, 4 ♀♀ (SB); Durango, 9 km East El Salto, m 2400, 14.VII.1987, S. Bruschi & E. Migliaccio leg., 22 ♂♂, 22 ♀♀, 1 larva L3, 1 larval exuviae L2 (EM, SB); Durango, Santiago Papatquiaro, 3.VIII.2001 1 ♀ (GP)

SYSTEMATIC POSITION AND DISTRIBUTION. The affinities of *porosifrons* with other wingless Mexican

Calosoma, were long discussed among the specialists until Jeannel (1940: 220), basing on the characteristics of its ligule, placed it finally in *Callitropa* subgenus *Blaptosoma* Géhin, 1876. However, in the same time, Jeannel found it necessary to stress its relative geographic isolation in a narrow area of the north Mexico, far away from the other species of *Callitropa*. So far, it has been only found in a few mountainous areas of the state of Durango.

KNOWN PLACES IN MEXICO. Durango: Refugio (SB), El Salto 2400 m (EM, SB), Otinapa (UASM); Palos Colorados (Gidaspow, 1959: 281), Santiago Papatquiaro (GP), Coyotes (Gidaspow, 1959: 281), Rio Nazas (Breuning, 1928b: 46), Pueblo Nuevo, Km 90 on Rte. 40 from Durango city (UASM)

ECOLOGICAL NOTES. Brachypterous. It lives at an altitude of about 2500 m in clearings, pastures and fallows. Activity was observed in cloudy daytime, but during the actual rain the beetle immediately found temporary shelters under stones, dry dung, twigs. Adults have been found in July and August, together with larvae, and they should be active from June to September according to Erwin (2007: 104).

DESCRIPTION OF LARVA (Figs. 3-12). This description is based on one third-instar larva and one second-instar exuvia, both from 9 km East of El Salto.

THIRD-INSTAR LARVA

Habitus. Total length about 26 mm (from tip of mandibles to that of urogomphi); color dark brown, with metallic bronze reflections.

Microsculpture. Discal areas of tergites and urogomphi with rough aspect; small cuticular processes quite regularly separated (Figs. 11-12); microsculpture isodiametric.

Chaetotaxy. FR₁ absent, FR₂ very long, FR₃ reduced to a pore, FR₆ shifted to the internal side of FR₇; FR_{8,9} thorn-like and thick, pores FR_{8,9} at internal side of FR₂; FR_{10,11} absent (Fig. 5); PA_{5,8} absent, PA₇ very long, PA₉ short, PA₁₅ reduced to a pore; 3 short additional setae on the antennomere II in the external lateral side (Figs. 3-4); mandibles with 5-7 small additional setae below MN₁ in a groove on median external edge, MN₂ absent (Fig. 6); labium with 12 additional thorn-like setae on dorsal face of



Figs. 1-2. *Calosoma (Callitropa) porosifrons* Bates, 1891 - Durango: 9 km Est El Salto, m 2400, 14.VII.1987, S. Bruschi leg. ♂ (1) ♀ right (2). Body length 18 mm.

praementum, 1 short additional seta on palpomere 1, medium-dorsally positioned (Fig. 8); stipes with group of setae gMX including about 70 elements (Fig. 7); pronotum, mesonotum, metanotum and tergites with reduced chaetotaxy, setae PR_{4,5,7,13} absent (Fig. 3); tarsi with two ventral rows of spines of 5 elements and 1-2 pairs of dorsal spines (Fig. 10); TE₁ very small, TE_{2,4,5} reduced to a pore or absent, TE₈ absent; 2 additional setae on discal area (Figs. 11-12): one internal to TE₁₁ and one between TE₆ and TE₁; one or two additional thorn-like setae above TE₇; epipleurites with 7-8 additional setae on anterior sclerite and 3-6 short additional setae in the posterior one (Fig. 12); hypopleurites with 6-9 small setae; external sternites with 2-3 additional setae; inner sternites with 3-4 additional setae (Fig. 12); median sternites with 10-14 additional setae; anterior sternites each of 3 small areas with one seta each; urogomphi with 3-4 short additional setae on anterior half; one additional seta on external edge of urite IX anteriorly to UR₂, seta UR₃ reduced to a pore or absent (Figs. 11-12); pygidium with rich chaetotaxy (Figs. 11-12) especially on its ventral part.

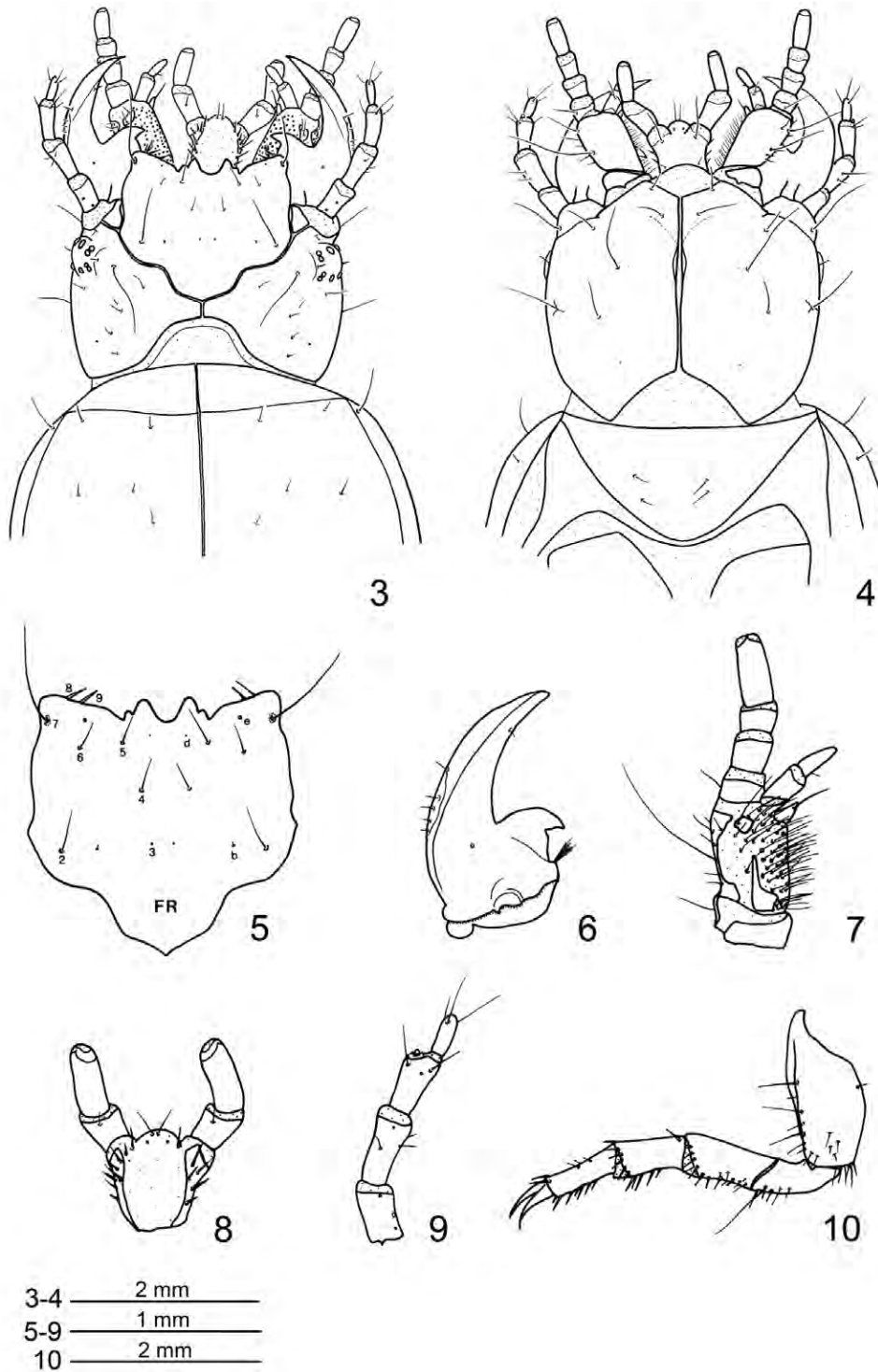
Head (Figs. 3-9). Cephalic capsule transverse (width/length = 1.75, see Tab. 1) with subparallel sides slightly convex (Figs. 3-4), coronal suture shorter than antennomere IV (Fig. 3); each ocular area, distinctly relieved, with 8 stemmata rather than 6, each stemma of dorsal pairs divided transversally in two smaller round subunits (Fig. 3); distinct ocellar prominence

between setae PA₉ and PA₇; frontal sclerite about as long as wide (Figs. 3, 5); nasale quadridentate protruding, about as wide as a lateral lobe, with four teeth, two internal sub-triangular teeth, with pointed apex, partially fused, on their external sides, together with two smaller ones; inner teeth distinctly separated by a deep U-shaped notch, anterior part of frontal sclerite with short longitudinal concavity; tips of internal teeth distant 0.35 mm; apex of internal teeth not reaching the level of adnasalia (Figs. 3, 5); hypodon absent; adnasalia slightly lobate, with anterior edge sloped; labial palps (Fig. 8) with two joints similar in length, tip of palpomere II with membranous sensorial area partially divided; ligula convex with two adjacent setae; maxillae (Fig. 7) with stipes twice longer than wide, with slightly sclerotized irregular areas on their upper side; maxillary palpi with four joints, I, II and III similar in length, palpomere IV twice as long as each of others (IV-I-II-III) and with two membranous sensorial areas on a partially divided apex (Fig. 7); galeomere I longer than II; lacinia conical with subapical seta; mandibles (Fig. 6) elongate, twice as long as their width at the base, with stout curved retinaculum at occlusal edge slightly dentate and incised; terebra sharp and pointed; penicillum present; antennae four jointed (Fig. 9) with antennomere II longest, III slightly longer than I, IV shortest and subulate (II-III-I-IV); small sensorial appendage on antennomere III in ventro-lateral position.

Tab. 1. Main larval measures of head and prothorax.

Taxon	Instar	w	l	d	pw	pl
<i>C. (Callitropa) porosifrons</i>	2 nd	2.2	1.3	1.3	3.6	2.5
	3 rd	2.8	1.6	1.7	4.55	3.05
<i>C. (Carabomimus) laevigatum</i>	2 nd	2.35	1.1-1.25	1.25-1.3	3-3.15	2.25-2.38
	3 rd	2.75-3	1.35-1.7	1.6-1.7	3.8-4.3	2.7-3.2
<i>C. (Carabomimus) politum</i>	2 nd	2.2	1.2	1.2	2.7	2.1
	3 rd	2.55-2.7	1.4-1.5	1.48-1.6	3.8	2.6-2.85
<i>C. (Carabomimus) morelianum</i>	3 rd	2.9	1.6	1.77	4	2.6
<i>C. (Carabomimus) depressicolle</i>	2 nd	2.55	1.4	1.5	3.6	2.4
<i>C. (Carabomimus) flohri</i>	2 nd	2.35	1.3	1.33	3.15	2.1

Abbreviations: w = maximum width of cephalic capsule; l = length of cephalic capsule from the extremity of coronal suture to the notch that divides the two pairs of nasal teeth; d = distance between adnasalia; pw = maximum width of prothorax; pl = maximum length of prothorax.



Figs. 3-10. *Calosoma* (*Callitropa*) *porosifrons*. 3rd instar larva: head, dorsal (3) and ventral view (4). 2nd instar larva: frontal sclerite (5); left mandible, dorsal view (6); left maxilla, dorsal view (7); labium, dorsal view (8); left antenna, dorso-lateral view (9); mesothoracic left leg, postero-lateral view (10).

Thorax. Pronotum wide and transverse (width/length = 1.49, Tab. 1); legs (Fig. 10) with tarsus longer than tibia, with two sharp equal claws.

Abdomen. Tergites wide, lobate, with blunt posterior corners rough because of small cuticular processes (Figs. 11-12); epipleurites adjacent, divided in a wide anterior sclerite and in a posterior one smaller (Fig. 12); inner sternites fused starting from VII abdominal segment; anterior sternal sclerites divided in 2-3 small areas; urogomphi (Fig. 11-12) thin and pointed, twice as long as abdominal segment IX and directed slightly dorsally; upper spine pointed, lateral spine scarcely developed.

SECOND-INSTAR LARVA

Same character states as in third instar, except: length of body about 19 mm (see other morphometric differences in Tab. 1); cephalic capsule with ratio width/length = 1.7, pronotum with ratio width/length = 1.44; praementum with 10 additional setae; maxillary stipes with about 60 setae in the gMX group.

Calosoma (Carabomimus) laevigatum Chaudoir, 1869 (Figs. 13, 14)

Calosoma laevigatum Chaudoir, 1869a: 374 (described from: Mexico); holotype ♂ (no locality

label) designated by Deuve (1978: 251) by monotypy in MNHN [examined].

Calosoma (Blaptosoma) striatulum ssp. laevigatum Breuning, 1928b: 49.

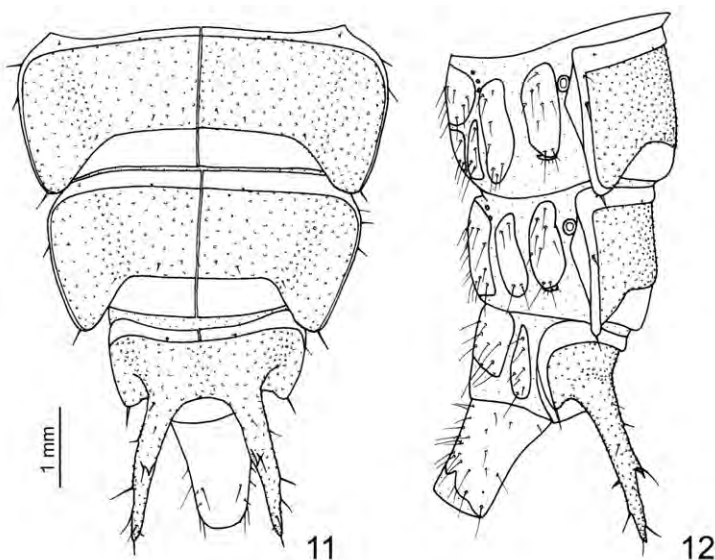
Blaptosoma (Carabomimus) striatulus laevigatus Lapouge, 1929-32: 391.

Carabomimus laevigatus Jeannel, 1940: 226.

Calosoma (Carabomimus) laevigatum laevigatum Gidaspow, 1959: 291.

EXAMINED SPECIMENS. Mexico, between S. Juan del Rio and Atlacomulco, loc. Puerto Cruz Colorada, m 2700, 17/18.VII.1987, S. Bruschi & E. Migliaccio leg. 25 ♂♂ 28 ♀♀, 4 larvae L3, 3 larvae L2 and 1 incomplete larval exuviae (AVT, EM, SB); Hidalgo, Real del Monte Pachuca, Mex. Richardson 1 ♂ (AMNH)

SYSTEMATIC POSITION AND DISTRIBUTION. Chaudoir, (1869: 374) described *C. laevigatum* from an unprecise locality of Mexico. Breuning and Jeannel knew *laevigatum* only from Hidalgo on specimens collected by Höge. Gidaspow (1959: 291) writes that *C. laevigatum* should be widespread in all states of the south-eastern Mexico, Guanajuato, Hidalgo, Puebla (Sierra Negra), Vera Cruz, up to the state of Durango. Lassalle & van den Berghe (2011b: 297), stated that *C. laevigatum* is confined to the high-altitude mountain areas north of Mexico state and south of Hidalgo, from where all the specimens we have been able to examine come.

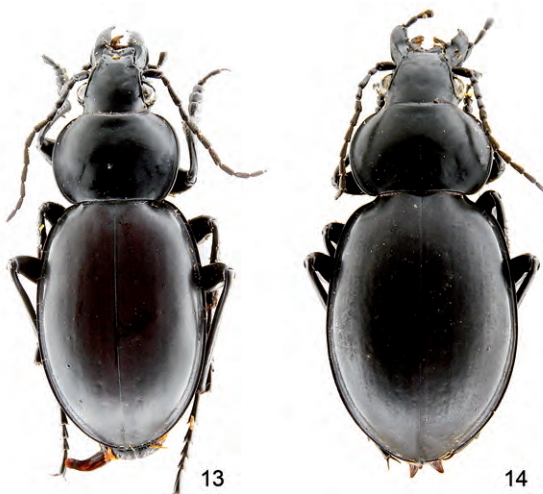


Figs. 11-12. *Calosoma (Callitropa) porosifrons* 3rd instar larva: apex of the abdomen (segments VII-X), dorsal (11) and lateral view (12).

However, according to the data reported by the Global Biodiversity Information Facility (<http://www.gbif.org/>), there are specimens of *C. laevigatum*, preserved in the collection of EH Strickland Entomological Museum of the University of Alberta, that have been captured at Puebla (Tlaxco, Tlachichuca) and Vera Cruz (Cofre de Perote). Moreover, there are the quotes relative to *C. laevigatum* from biosphere reserve La Michilia in the state of Durango (Ball & Shpeley, 1991: 43).

We have not seen the specimens referred to in the previous quotation and, before drawing a distribution of this species into two largely separated areas, we must suspend judgment, and wait for further confirmation. Moreover, as for the presence of *C. laevigatum* in the states of Puebla and Vera Cruz, before accepting the sympatry with *C. striatulum* Chevrolat, 1835, we have to remember the superficial similarity between the two species (especially with regard to slightly larger individuals of *C. striatulum*, having almost smooth elytra) if one does not take into account the differences in the shape of apex of aedeagus.

KNOWN PLACES IN MEXICO. Durango: Hidalgo: Real del Monte (AMNH), Ajacuba (Gidaspow, 1959: 291);



Figs 13-14. *Calosoma* (*Carabomimus*) *laevigatum* Chaudoir, 1869 - Mexico: between S. Juan del Rio and Atlacomulco, Pue.rto Cruz Colorada 2700 m, 17/18.VII.1987, S. Bruschi leg. - ♂ (13) ♀ (14). Body length 17 mm.

Mexico: between S. Juan del Rio and Atlacomulco 2700 m (AVT, EM, SB).

ECOLOGICAL NOTES. It has been found on field and pastures and along edges of cultivated fields, under stones and blades of prickly pear on the ground in July, but according to Erwin (2007: 97) it is diurnal, as well as nocturnal, and lives also in fir forests where it is active in April-June and August.

DESCRIPTION OF LARVA (Figs. 15-24). Based on 4 third-instar, 3 second-instar larvae and one damaged second-instar (?) exuvia from Puerto Cruz Colorada (between S. Juan del Rio and Atlacomulco).

THIRD-INSTAR LARVA

Habitus. Total length about 23 mm (from tip of mandibles to that of urogomphi); color dark brown.

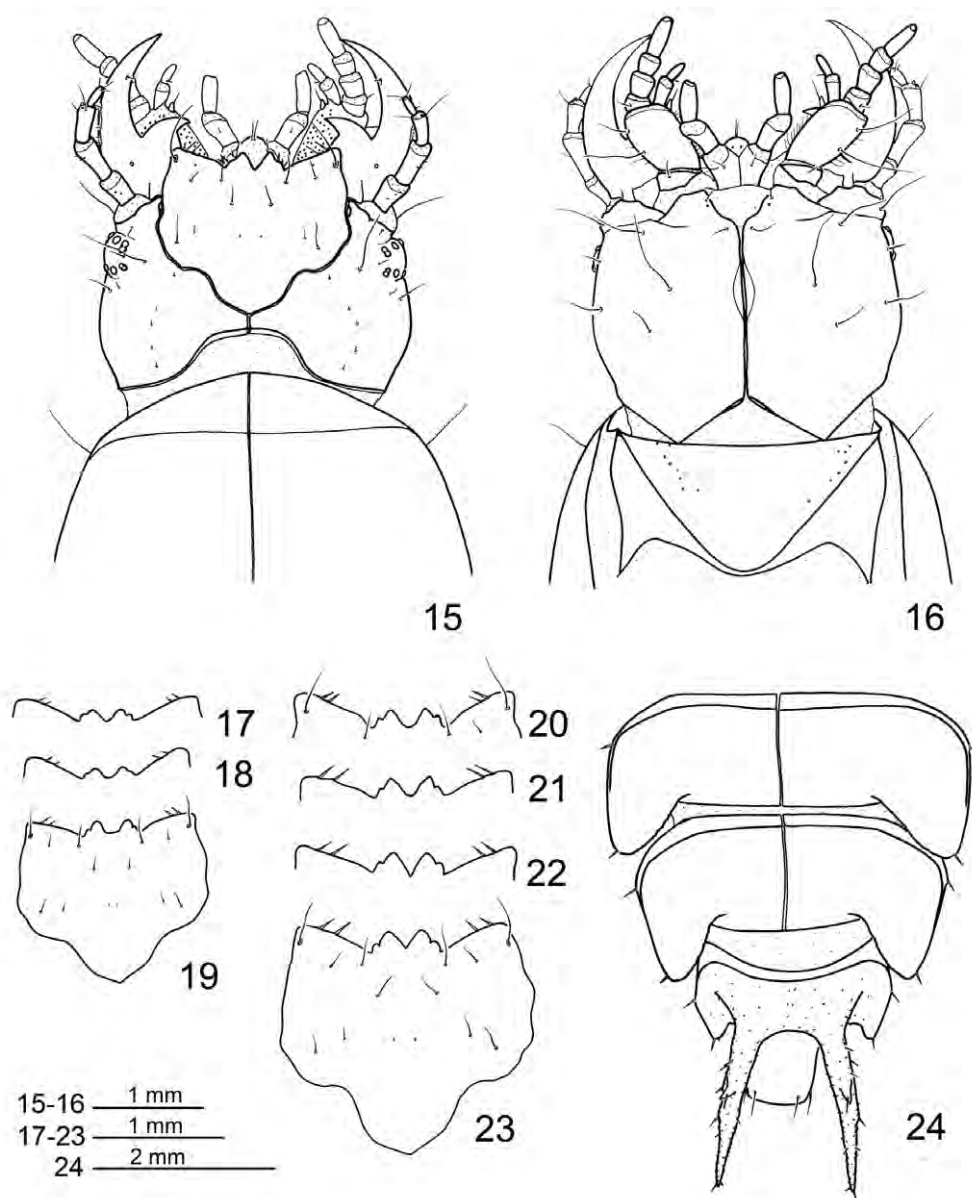
Microsculpture. Discal areas of tergites and urogomphi smooth (Fig. 24); microsculpture isodiametric.

Chaetotaxy. FR₁ absent, FR₂ long, FR₃ a pore, FR₆ on internal side of FR₇ (Figs. 15, 20-23); FR_{8,9} thorn-like and strong, short additional seta at internal side of FR₂; FR₁₀ and FR₁₁ absent; PA₄ absent, PA₁₅ a pore (Figs. 15-16); 3 short additional setae on antennomere II in the external lateral side; mandibles with 5-7 small additional setae below MN₁ in a groove on the median external edge; labium with 12 additional thorn-like setae on dorsal face of praementum, 1 short additional seta on palpomere I, medium-dorsally positioned; stipes with group of setae gMX including about 70 elements; pronotum, mesonotum, metanotum and tergites with reduced chaetotaxy, setae PR_{4,5,7} absent, 2 additional setae near PR₈ and PR₁₄; tarsi ventrally with two rows of spines of 4-6 elements; TE_{4,5,8} each a pore or absent; 2-3 additional setae on discal area between TE₆ and TE₁; one or two additional thorn-like setae above TE₇; epipleurites with 4-6 additional setae on anterior sclerite and 4-6 short additional setae in the posterior one; hypopleurites with 4-6 setae; external sternites with 1-2 additional setae; inner sternites without additional setae; median sternites with 3-4 pairs of additional setae; anterior sternites each of 3 small areas with one very small seta each, or a pore; urogomphi with 10-15 short additional setae not regularly positioned, particularly on anterior half; one

additional seta on external edge of urite IX anteriorly to UR₂, seta UR₃ a pore or absent, UR₉ very small or pore-like; pygidium with abundant setae, especially on ventral part.

Head. Cephalic capsule markedly transverse (width/length = 2, see Tab. 1) with convex sides

rounded mostly at the basal half (Figs. 15-16), coronal suture shorter than length of antennomere IV (Fig. 15); each ocular area, distinctly convex, with 3 pairs of stemmata; each stemma of dorsal pair more or less completely divided transversally in two smaller round subunits (Fig. 15); slight ocellar prominence above



Figs. 15-24. *Calosoma (Carabomimus) laevigatum*. 3rd instar larva: head, dorsal (15) and ventral view (16). 2nd instar larva: anterior margin of frontal sclerite (17-19). 3rd instar larva: anterior margin of frontal sclerite (20-23). 2nd instar larva: extremity of the abdomen (segments VII-X), dorsal view (24).

ocular area, between setae PA₉ and PA₇; frontal sclerite (Figs. 20-23) slightly transverse (width/length = 1.3); nasale quadridentate protruded, about as wide as a lateral lobe, with four teeth: two internal sub-triangular teeth, with pointed or rounded apex, partially fused, on their external sides, together with two smaller ones. Two pairs of teeth distinctly separated by a deep notch, varied in shape from a sinus to an angle more or less acute; apex of internal teeth not extended to level of adnasalia (Figs. 20-23); hypodon absent; adnasalia slightly lobate, with anterior edge sloped; labial palps (Figs. 15-16) with two joints similar in length, tip of palpomere II with membranous sensorial area partially divided; ligula convex with two adjacent setae (Fig. 15); maxillae with stipes twice as long as wide (Fig. 16), with slightly sclerotized irregular areas on their upper side; maxillary palps of four joints, with palpomeres I and III similar in length; palpomere II slightly longer and wider than I and II; palpomere IV about twice as long as I or III (IV-II[I-III]) and with two membranous sensorial areas on a partially divided apex; galeomere I longer than II; lacinia conical with subapical seta; mandibles sharp and pointed (Fig. 15), enlarged at base, with stout curved retinaculum at internal edge slightly dentate and incised; penicillum present; antennae four jointed (Fig. 15), with antennomere II longest, III slightly longer than I, IV shortest and subulate (II-III-I-IV); small sensorial appendage on antennomere III in lateral position.

Thorax. Pronotum wide and transverse (width/length = 1.33, see Tab. 1); legs with tarsus longer than tibia with two sharp equal claws.

Abdomen. Tergites 1-7 wide, markedly lobate, with blunt posterior corners rough, with small cuticular processes (Fig. 24); epipleurites divided in a wide anterior sclerite and in a posterior one smaller; inner sternites fused starting from II abdominal segment; anterior sternal sclerites divided in 2-4 small areas; segment IX with pointed corners directed posteriorly; urogomphi thin and pointed, spaced at base and slightly divergent, twice length of abdominal segment IX and directed oblique dorsally; upper spine thick and pointed, lateral spine scarcely developed (Fig. 24).

SECOND-INSTAR LARVA

Same character states as for third instar, except: body length about 18 mm; each stemma of dorsal pair

less distinctly divided than in L3; nasale with small and round teeth, separated by a deep U-shaped notch (Figs. 17-19).

Calosoma (Carabomimus) politum Chaudoir, 1869 (Figs. 25-26)

Calosoma politum Chaudoir, 1869a: 373 (described from: Toluca); lectotype ♂ (no locality label) designated by Deuve (1978: 251) in MNHN [examined].

Blaptosoma laevigatum var. *nitidum* Géhin, 1885: 66, note 70 (described from: Vera-Cruz); lectotype ♂ designated by Deuve (1978: 253) in MNHN.

Calosoma diminutum Bates, 1891: 227 (type locality: Salazar); type in BMNH (Jeannel, 1940: 227).

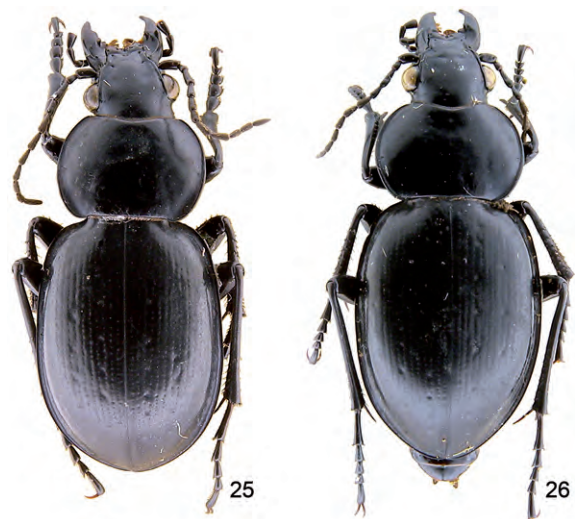
Callisthenes laevissimum Casey, 1920: 170 (type locality: Mexico); type in NMNH (<https://collections.nmnh.si.edu/>).

Calosoma (Blaptosoma) striatulum ssp. *politum* Breuning, 1928b: 51.

Calosoma (Blaptosoma) striatulum ssp. *diminutum* Breuning, 1928b: 52.

Blaptosoma (Carabomimus) striatulus politus Lapouge, 1932: 390.

Blaptosoma (Carabomimus) striatulus diminutus Lapouge, 1932: 391.



Figs. 25-26. *Calosoma (Carabomimus) politum* Bates, 1891 - Mexico: 10 km West Ciudad de Mexico, Puerto La Guardia, m 3000, 9.VII.1987, S. Bruschi leg. - ♂ (25) ♀ (26). Body length 16 mm.

Carabomimus politus Jeannel, 1940: 227.
Carabomimus diminutus Jeannel, 1940: 229.
Calosoma (Carabomimus) politum Gidaspow, 1959: 291.
Calosoma (Carabomimus) diminutum Gidaspow, 1959: 292.
Carabomimus politus Lassalle & van den Berghe, 2011b: 299.
Carabomimus politus diminutus Lassalle & van den Berghe, 2011b: 296.

EXAMINED SPECIMENS. Mexico, cold region, (H. W. Bates, Biol. Cent. Amer.), 1 ♂ (SB); Salazar 3050 m (holotype of *C. diminutum*, MNHN); Federal District, Salazar, m. 3050, 21.IX.1975, T.G. Zoebisch, 1 ♀ (AVT); Federal District, Salazar, m 3100, 30.VII.1972, 1 ♂ (EM); Toluca (lectotype of *C. politum* MNHN); Mexico, Mexicalcingo (MCZR); Mexico, 10 km West of Ciudad de Mexico, loc. Puerto La Guardia, m 3000, 9.VII.1987, S. Bruschi & E. Migliaccio leg., 22 ♂♂, 22 ♀♀, 3 larvae L3 and 1 larva L2 (SB, EM, AVT); Mexico, Cañada de Alferes m 2500, VI.1998, 1 ♂ (GP); Mexico, between Toluca and Nevado de Toluca, loc. La Puerta, m 3200, 9.VII.1987, S. Bruschi & E. Migliaccio leg., 1 ♂, 3 ♀♀, 1 L3 (SB, EM).

SYSTEMATIC POSITION AND DISTRIBUTION. As Gidaspow (1959: 292) observed, distinction between *C. politum* and *C. diminutum* is problematic. According to Jeannel (1940: 227, 229), *C. politum* differs from *C. diminutum* in generally larger size, longer elytra, without visible punctuation, pronotum not narrowed at base, and males with apex of aedeagus shorter and slightly inflected. Most collected specimens exhibit elytral intervals perfectly even, but indicated by a series of fine punctures, which in the specimens with reddish-dark elytra appear as black dots; some individuals from Toluca show slightly elevated intervals, with a more evident punctuation. The oval-lengthened elytral shape is identical, and males have an aedeagus with apex rounded and spatulate.

Based on the above character, we think that *C. politum* and *C. diminutum* are conspecific. In fact, external morphological differences, as observed by Gidaspow (1959: 292), are very slight; also, the differences in the shape of the aedeagus, noted by Jeannel (1940: 229) and confirmed by Gidaspow

(1959: 293), who studied long series of specimens from the type locality, are inconsistent. Similar conclusions have been reached by Lassalle & van den Berghe (2011b: 299). Moreover, the same authors, having studied the type of *Blaptosoma laevigatum* var. *nitidum* Géhin, 1885, have recognized its identity with *C. diminutum* (= *C. politum*) and stated the unreliability of the locality indicated by Géhin.

Jeannel (1940: 227) reported Toluca as the only known locality of *C. politum* and lists only Salazar, Mexico, for *C. diminutum*. Gidaspow (1959: 293) confirmed Salazar for *C. diminutum* and indicated additional localities for *C. politum*, such as the slopes of Nevada de Toluca. Salazar is a locality of the State of Mexico and of the municipality of Lerma, on the way from Mexico City to Toluca. Here, we have found *C. politum* quite in numbers, while the range of *C. morelianus* Bates, 1891 (see in the following) starts slightly farther to the south.

KNOWN PLACES IN MEXICO. Mexico D F: Salazar 3050 m (holotype of *diminutum*, MNHN) (AVT, EM), 10 km West of Ciudad de Mexico 3000 m (EM, SB); Mexico: Mexicalcingo (MCZR), Toluca (lectotype of *C. politum* MNHN), between Toluca and Nevado de Toluca 3200 m (EM, SB), Cañada de Alferes 2500 m (GP).

ECOLOGICAL NOTES. *C. politum* has been found on tilled field, pastures and disturbed areas, in June-July and September. Specimens have been collected either under stones in pastures and grass or wandering during the warmest hours of the day. In this period, in July, several couples actively copulating have been observed. Therefore, probably, the phases of diurnal activity are also connected to mating behavior, as already noted by Vigna Taglianti & Bruschi (1986) in various species of carabomorphous *Calosoma* from tropical high mountains.

DESCRIPTION OF LARVA (Figs. 27-28). Description is based on 3 third-instar and 1 second-instar larvae, all from La Puerta (between Toluca and Nevado de Toluca) and Puerto La Guardia (10 km West of Ciudad de Mexico) (1 specimen, third-instar). Concerning microsculpture, chaetotaxy and external structural features, see description of *Calosoma (Carabomimus) laevigatum*; in the following we exclusively report the most distinctive differences.

THIRD-INSTAR LARVA

Habitus. Total length about 20 mm (from tip of mandibles to that of urogomphi); head dark, tergites dark brown.

Chaetotaxy. PA_{8,15} absent, PA₇ long; labium with 10 additional thorn-like setae on praementum; pronotum with seta PR₁ a pore or absent, PR₁₀ absent; tarsi with two ventral rows of spines of 3-5 elements; hypopleurites with 7-10 setae; external sternites with 2-3 additional setae; urogomphi with 10-18 small additional thorn like setae not regularly positioned, particularly on dorsal anterior half.

Head. Cephalic capsule markedly transverse (width/length = 1.9, see Tab. 1); ocellar prominence absent; ocular area, between setae PA₉ and PA₇; notch between inner teeth of nasale V-shaped (Fig. 28); inner teeth sub triangular with pointed apex; adnasalia with anterior edge slightly sloped; mandibles thick.

Thorax. Pronotum wide and transverse (width/length = 1.35 see Tab. 1).

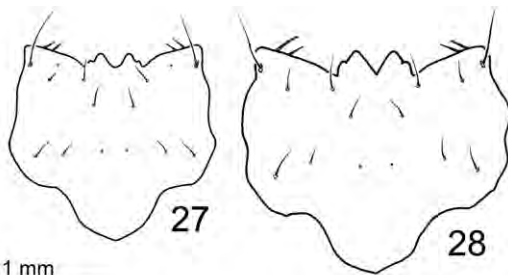
Abdomen. Inner sternites partly fused starting from abdominal segment III.

SECOND-INSTAR LARVA

Same character states as in third instar, except: length of body about 15 mm; ratio width/length of cephalic capsule = 1.83, of frontal sclerite = 1.14 (Fig. 27), of pronotum = 1.29; chaetotaxy of sternites and pleurites simplified.

Calosoma (Carabomimus) morelianum Bates, 1891 (Figs. 29-30)

Calosoma diminutum ssp. *morelianum* Bates, 1891:



Figs. 27-28. *Calosoma (Carabomimus) politum*. Frontal sclerite of 2nd (27) and 3rd instar larva (28).

228 (type locality: Morelos, Huitzilac); lectotype ♀ designated by Deuve (1978 : 254) in MNHN, Paris [examined].

Calosoma (Blaptosoma) striatulum morelianum Breuning, 1928b: 52.

Blaptosoma (Carabomimus) striatulus morelianus Lapouge, 1932: 391.

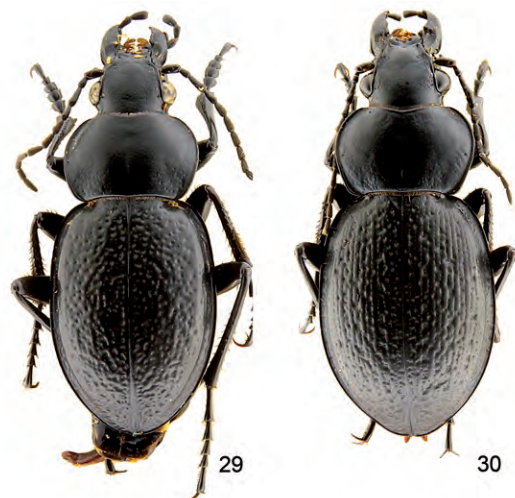
Carabomimus diminutus morelianus Jeannel, 1940: 229.

Calosoma (Carabomimus) morelianum Gidaspow, 1959: 293.

Calosoma (Carabomimus) cicatricosum balli Rotger, 1976: 293 (type locality: Mexico, 1ml. from Santa Marta), holotype ♂ in coll. Rotger; paratypes in UNAM.

Carabomimus politus morelianus Lassalle & van den Berghe, 2011b: 296.

EXAMINED SPECIMENS. Mexico, between Huitzilac and Coatepec, loc. S. Marta, m 2700, 18.VII.1987, S. Bruschi leg., 3 ♂♂, 2 ♀♀, 1 larva L3 (SB); id. E. Migliaccio leg. 2 ♂♂ (EM); Mexico, Coatepec m 2500, VII.2008 1 ♀ (GP); Mexico, El Guardia, 3.000 m., J. Nègre leg., 1 ♂ (SB); Mexico, Est de Mejico, La Marquesa, VI.67, Hallfren leg., 1 ♂ (SB); Morelos, Huitzilac, Höge ♂ (lectotype of *Calosoma diminutum* ssp. *morelianum*, MNHN).



Figs. 29-30. *Calosoma (Carabomimus) morelianum* Bates, 1891 - Mexico: between Huitzilac and Coatepec, S. Marta, m 2700, 18.VII.1987, S. Bruschi leg. - ♂ (29) ♀ (30). Body length 15 mm.

SYSTEMATIC POSITION AND DISTRIBUTION. *Calosoma diminutum* ssp. *morelianum* Bates, 1891 has have been described from Huitzilac. This locality, and the others in which the species has been collected by us and those cited in the literature are included in a relatively small area on the border between the states of Mexico and Morelos.

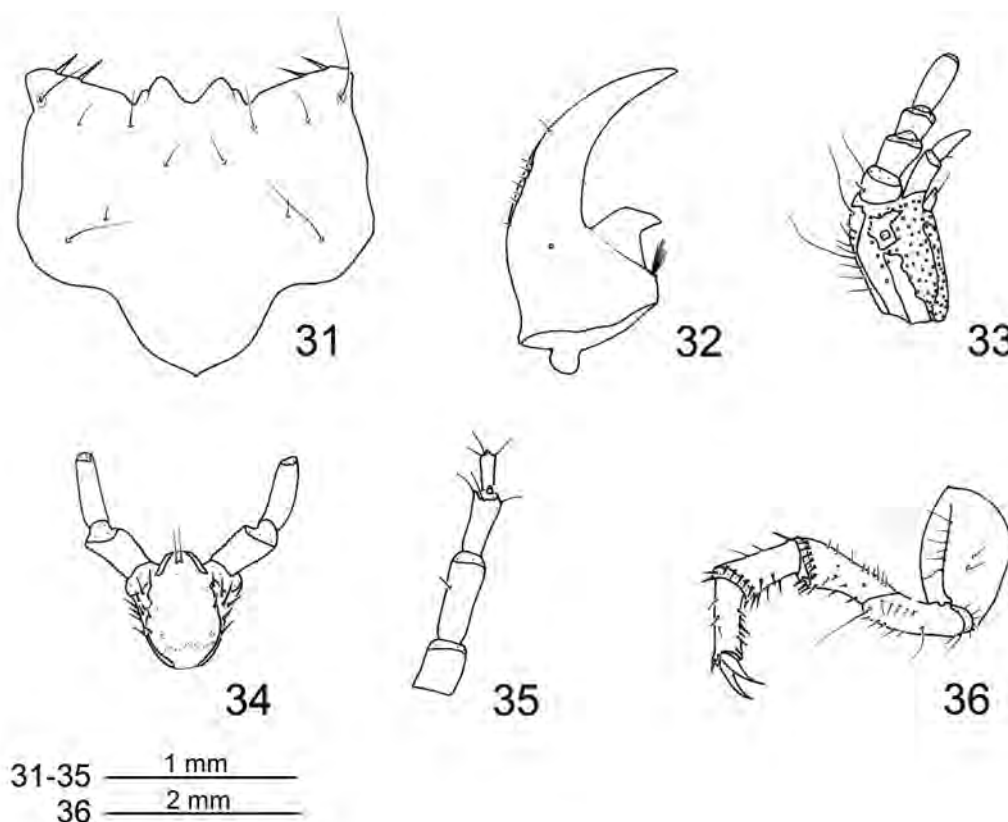
Jeannel (1940: 229) considered *C. morelianum* as a subspecies of *C. diminutum*. For our part, while we think that *C. politum* and *C. diminutum* are conspecific, we prefer to consider *C. morelianum* as a distinct species because of the constantly smaller size, the pronotum with scattered punctures on its rear part, the more marked microsculpture, less glossy aspect, almost glazed, the sculpture of elytra, with surface strigulose and covered with larger points and because of the differences in the shape of the apex of penis that is slightly less elongated. Finally, we agree with Lassalle & van den Berghe, (2011b: 296),

considering *Calosoma* (*Carabomimus*) *cicatricosum balli* Rotger, 1976 (described from the same locality as the material we have studied) as conspecific with *C. morelianum*.

KNOWN PLACES IN MEXICO. Mexico D F: El Guardia, 3000 m (SB), La Marquesa (SB); Mexico: San Nicolás Coatepec 2500 m (GP), Santa Marta, Ocuilan 2700 m (EM, SB), 1ml. from Santa Marta, Ocuilan (paratype *cicatricosum balli*, UNAM); Morelos: Huitzilac (lectotype *morelianum*, MNHN).

ECOLOGICAL NOTES. Nocturnal. It has been found at an altitude of 2500-3000 m, under stones, on field and pastures on the fringe of woodland. It is active in June-July and, according to Erwin (2007: 101), also in May.

DESCRIPTION OF LARVA (Figs. 31-36). The following is based on a single third-instar larva from S.Marta



Figs. 31-36. *Calosoma* (*Carabomimus*) *morelianum* (L3): frontal sclerite (31); left mandible, dorsal view (32); left maxilla, dorsal view (33); labium, dorsal view (34); right antenna, ventral view (35); metathoracic left leg, postero-lateral view (36).

(between Huitzilac and Coatepec) (slide L22). As for microsculpture, chaetotaxy and external structural features, this specimen is the same as *Calosoma* (*Carabomimus*) *laevigatum* (above); below, we report only the most distinctive differences.

THIRD-INSTAR LARVA

Habitus. Total length about 20 mm (from tip of mandibles to that of urogomphi); head dark, tergites dark brown.

Chaetotaxy. PA₅ a pore, PA₇, PA_{9,10} short, PA_{8,15} absent; mandibles with 8 small additional setae below MN₁ in a groove on median external edge; labium with 10 additional thorn-like setae on praementum, tarsi with two ventral rows of spines of 3-5 elements, and 1-2 pairs of spines dorsally positioned; TE_{2,3,4} a pore or absent; one additional seta internal to TE₁₁, near median line; epipleurites with 6-8 additional setae on the posterior sclerite; hypopleurites with 7-10 setae; median sternites with 8 additional setae.

Head. Cephalic capsule transverse (width/length = 1.8, see Tab. 1) with convex sides rounded mostly at level of parietalia; inner teeth of nasale (Fig. 31) distinctly separated by a deep U-shaped notch, distant at apexes 0.54 mm; adnasalia with anterior edge slightly sloped; maxillary palpi (Fig. 33) four jointed, with palpomere II slightly longer than I and III which are similar in length, palpomere IV the longest (IV-II[I-III]).

Thorax. Pronotum wide and transverse (width/length = 1.54, see Tab. 1).

Abdomen. Tergites with marked oval depressions anteriorly, between TE₁ and TE₆ setae; urogomphi sub parallel, thin and pointed, directed dorsad.

Calosoma (*Carabomimus*) *depressicolle* Chaudoir, 1869 (Figs. 37-38)

Calosoma depressicolle Chaudoir, 1869: 375 (described from: Toluca); lectotype ♂ (no locality label) designated by Deuve (1978: 251) in MNHN [examined].

Calosoma (*Blaptosoma*) *depressicolle* Breuning, 1928b: 54.

Blaptosoma (*Eutelodontum*) *depressicolle* Lapouge, 1932: 392.

Carabomimus depressicollis Jeannel, 1940: 229.

Carabomimus depressicollis asper Jeannel, 1940: 229 (described from Mexico); type presently not to be found (Deuve, 1978: 257).

Carabomimus depressicollis altipeta Jeannel, 1940: 229 (type locality: volcan du Nevada de Toluca); type material: one couple; lectotype ♂ designated by Deuve (1978: 257) in MNHN [examined].

Calosoma (*Carabomimus*) *depressicolle* Gidaspow, 1959: 296.

Calosoma (*Carabomimus*) *asper* Gidaspow, 1959: 297.

Calosoma (*Carabomimus*) *altipeta* Gidaspow, 1959: 297.

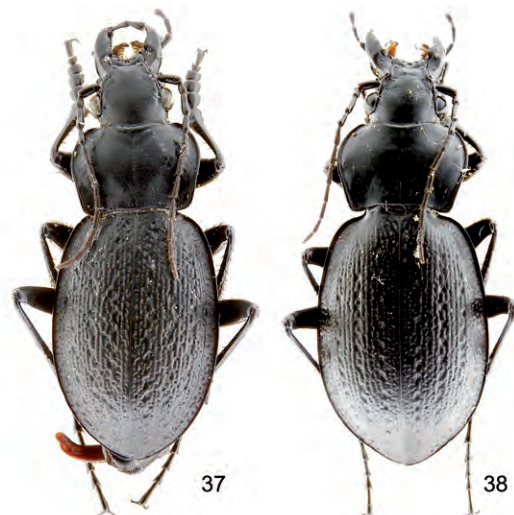
Carabomimus depressicollis silvestris Lassalle, 2009: 3 (type locality: Rio Frio); holotype ♂ in coll. Lassalle, paratypes in coll. Lassalle and in coll. van den Berghe.

Calosoma (*Carabomimus*) *depressicolle asper* Häckel *et al.*, 2011: 48.

Calosoma (*Carabomimus*) *altipeta* Häckel *et al.*, 2011: 51.

Calosoma (*Carabomimus*) *silvestre* Häckel *et al.*, 2011: 51.

EXAMINED SPECIMENS. Federal District, Salazar m 2000 VIII.07, 2 ♂♂ (GP); Federal District, 10 km



Figs. 37-38. *Calosoma* (*Carabomimus*) *depressicolle* Chaudoir, 1869 - Mexico: between Ciudad de Mexico and Tuxmelucan, Rio Frio, m 3200, 16.V.1980, S. Bruschi leg. ♂ (37) ♀ (38). Body length 20 mm.

west of Ciudad de Mexico, loc. Puerto La Guardia, m 3000, 9.VII.1987, E. Migliaccio leg., 1 ♀, (EM); Mexico: between Ciudad de Mexico and Tuxmelucan, loc. Rio Frio, m 3200, 16.V.1980, S. Bruschi leg., 11 ♂♂, 8 ♀♀ (SB, AVT); Mexico: between Rio Frio and S. Miguel Canoas, m 3200, 22.VII.1987, E. Migliaccio leg., 1 ♂ (EM); Mexico: between Huitzilac and Coatepec, loc. S. Marta, m 2700, 18.VII.1987, S. Bruschi & E. Migliaccio leg., 2 ♂♂, 7 ♀♀, 1 larva L3 (SB, EM); Mexico: Nevado de Toluca VII.2006, 3 ♂♂ 3 ♀♀ (GP); Mexico: Toluca, Volcan de Nevado, 3200 m., L Diguat 1 ♂ (lectotype of *C. depressicollis altipeta* Jeannel) (MNHN).

SYSTEMATIC POSITION AND DISTRIBUTION. All the populations of *C. depressicolle* have the same shape of penis, simple, without any apophysis, and similar characteristics of the sculpture of elytra, with evident and confused intervals. The dimensions are somewhat greater in eastern populations.

Jeannel (1940) on the basis of a comparison with the type from Toluca, that is small, with narrower pronotum and less elevated sculpture of elytra, described, from the surroundings of Ciudad de Mexico, a population (*C. depressicollis asper*) distinguished by the larger size, slightly wider pronotum and less regular sculpture of elytra, with raised intervals.

From the mountain near Toluca but on higher altitude, Jeannel (1940) described another population (*C. depressicollis altipeta*) of smaller dimension and more stout body shape, with sculpture of elytra always strong enough, but with sharper apex of the penis.

Finally, Jeannel considered *Calosoma (Blaptosoma) lesnei* Breuning, 1931 as subspecies of *C. depressicollis*. However, this taxon, considering the body shape, the sculpture and the unmistakable apophysis of the aedeagus, must be considered synonymous with *C. flohri* Bates, 1884 (see below).

Gidaspow (1959), based on the descriptions of Jeannel, but according to the criterion of sympatry, or contiguity of areal, has considered all these populations as distinct species.

Lassalle & van den Berghe (2011), in a general revision of the group, came back to the interpretation of Jeannel, dealing with all these populations as subspecies, including the population of Rio Frio (Mexico) that Lassalle (2009: 3) had previously described as *C. depressicollis silvestris*,

taking into account an average larger size and more confused sculpture of elytra.

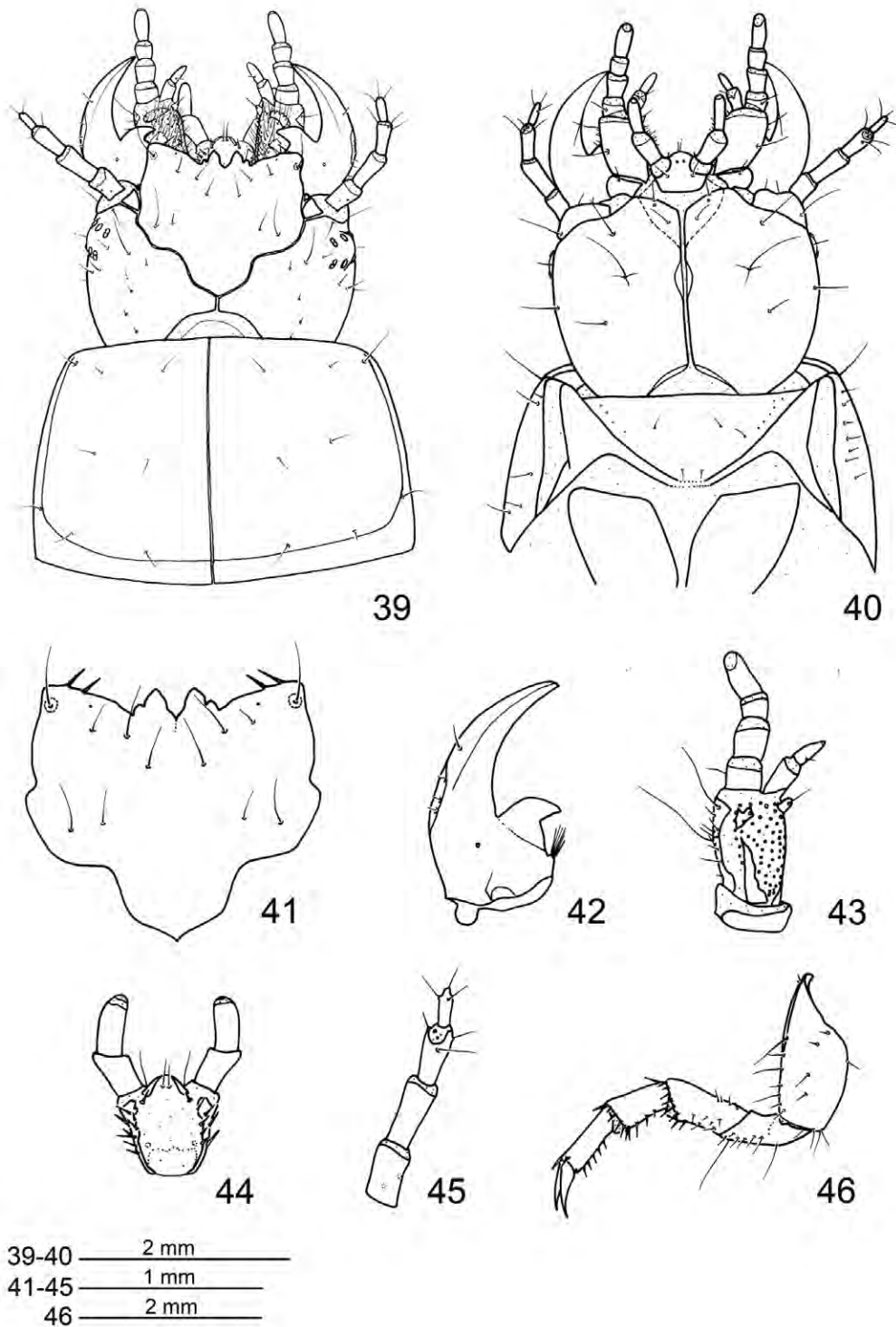
Häckel *et al.* (2011), accepted *C. depressicolle asper* at subspecies level, but have considered *altipeta* and *silvestre*, as distinct species, even collecting them together in the same group of species.

Any way, we think that geographical considerations, together with the inconsistency of morphological differences, should lead to collect all these populations within *C. depressicolle*, remaining separated from *C. flohri*, by the differences of the aedeagus. The various populations of *C. depressicolle*, are found in the state of Mexico, and penetrate, just beyond the border states of Michoacán (Zitacuaro, Häckel *et al.*, 2011) and Morelos (Huitzilac, Breuning, 1928b: 55).

KNOWN PLACES IN MEXICO. Distrito Federal: El Guardia, 3000 m (EM), Salazar 3050 m (GP), Volcán Ajusco (Häckel *et al.*, 2011: 51); Mexico: Rio Frio, 3200 m (AVT, EM, SB), Santa Marta, Ocuilan 2700 m (EM, SB); Cañada de Alferes 2500 m (GP); Volcan du Nevada (lectotype of *C. depressicollis altipeta*, MNHN); Nevado de Toluca (GP); Toluca (lectotype of *C. depressicolle* MNHN); between Toluca and Nevado de Toluca 3200 m (EM), Vale de Bravo, Villa de Allende, Coatepec (Häckel *et al.*, 2011: 51) Tenancingo, Amanalco, Bosencheve National Park, San Cayetano, W of Toluca N of Agua Bendita, Amecameca, La Hortaliza 43 km W of Toluca, 6.6 km E of Rio Frio (UASM); Michoacan: Zitacuaro (Häckel *et al.*, 2011: 51); Morelos: Huitzilac (Breuning, 1928b: 55)

ECOLOGICAL NOTES. *C. depressicolle* is nocturnal, and lives in woodlands, or in their fringe, where it is active in April-May and July-September, or up to November, according to Erwin (2007: 88).

DESCRIPTION OF LARVA (Figs. 39-48). The comparative morphological notes reported in the following are based on a single second-instar larva, from S. Marta (between Huitzilac and Coatepec) (slide L23). Concerning microsculpture, chaetotaxy and external structural features, see the more extensive description of *Calosoma (Carabomimus) laevigatum*; below we report only the most distinctive differences.



Figs. 39-46. *Calosoma* (*Carabomimus*) *depressicolle*. 3rd instar larva: head, dorsal (39) and ventral view (40). 2nd instar larva: frontal sclerite (41); right mandible, dorsal view (42); left maxilla, dorsal view (43); labium, dorsal view (44); left antenna, ventral view (45); mesothoracic right leg, postero-lateral view (46).

SECOND-INSTAR LARVA

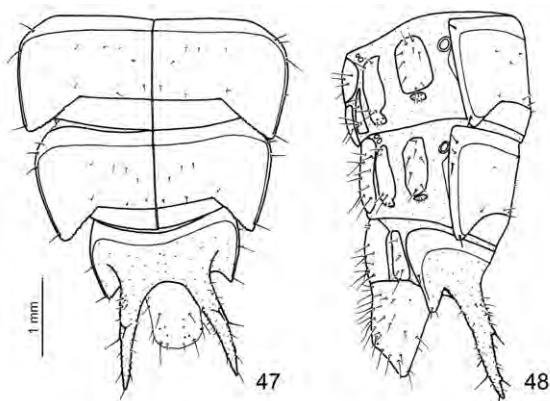
Habitus. Total length about 20 mm (from tip of mandibles to that of urogomphi); head dark brown, legs, mandibles and tergites lighter.

Chaetotaxy. PA_{8,15} absent, PA₇ long, located anteriorly beside PA₉; PA₉ short, one additional seta above PA₆; abdominal tergites with 3-5 additional setae on discal area between TE₁ and TE₆ and one internal to TE₁₁ near the median line; epipleurites with 5-7 additional setae on anterior sclerite and 4-6 short additional setae in the posterior one; hypopleurites with 7 setae; external sternites with 2-3 additional setae; median sternites with 8 additional setae; urogomphi with 25-30 small additional thorn-like setae not regularly positioned, particularly on the dorsal anterior half.

Head. Cephalic capsule transverse (width/length = 1.82, see Tab. 1) with convex sides regularly rounded (Figs. 39-40); inner teeth ogival (Figs. 39, 41), distinctly separated by a deep median notch, distance at apices 0.21 mm; maxillary palpi (Fig. 43) four jointed, with palpomere II slightly longer than I and III latter similar in length, palpomere IV the longest (IV-II(I-III)); mandibles short and thick (Fig. 42).

Thorax. Pronotum (Fig. 39) wide and transverse (width/length = 1.5, see Tab. 1).

Abdomen. Tergites lobate with pointed posterior corners (Figs. 47-48). Upper spine of urogomphi small.



Figs 47-48. *Calosoma (Carabomimus) depressicollis*. 3rd instar larva: extremity of the abdomen (segments VII-X), dorsal (37), and lateral view (38).

Calosoma (Carabomimus) flohri Bates, 1884 (Figs. 49-50)

Calosoma flohri Bates, 1884: 262 (type locality: Uruapan); lectotype ♂ designated by Deuve (1978 : 254) in MNHN [examined].

Calosoma (Blaptosoma) laeve var. *gebieni* Breuning, 1928b: 46 (type locality: Pazcuaro); holotype and paratype ♂♂ in ZMUH, presently not to be found (Häckel *et al.*, 2011: 52).

Calosoma (Blaptosoma) cicatricosum ssp. *flohri* Breuning, 1928b: 53.

Calosoma (Blaptosoma) lesnei Breuning, 1931: 54 (type locality: Sierra de Tlapujahua), holotype ♂ and paratypes in MNHN, Paris [examined].

Blaptosoma (Eutelodontum) cicatricosum flohri Lapouge, 1932: 392.

Carabomimus depressicollis lesnei Jeannel, 1940: 229.

Carabomimus depressicollis flohri Jeannel, 1940: 229.

Carabomimus gebieni Jeannel, 1940: 229.

Calosoma (Carabomimus) gebieni Gidaspow, 1959: 289.

Calosoma (Carabomimus) flohri Gidaspow, 1959: 295.

Carabomimus flohri Lassalle, 2009: 8.

Calosoma (Carabomimus) ortrudae Häckel & Heinz, 2011: 2 (type locality: Michoacan, 48km E Morelia 2900m.); holotype ♂ in coll. Heinz, paratypes in coll. Häckel and in coll. Heinz.



Figs. 49-50. *Calosoma (Carabomimus) flohri* Bates, 1884 - Michoacan: between Uruapan and Paracho, m 2200, 11.VII.1987, S. Bruschi leg. - ♂ (49) ♀ (50). Body length 18 mm.

Calosoma (Carabomimus) flohri gebieni Häckel *et al.*, 2011: 52.

Calosoma (Carabomimus) lesnei Häckel *et al.*, 2011: 54.

Calosoma (Carabomimus) flohri zirostense Häckel *et al.*, 2011: 54. (type locality: Michoacan, env. Nuevo Zirosto 800m.), holotype ♂ in coll. Heinz, paratypes in coll. Häckel and in coll. Heinz).

Carabomimus lesnei Lassalle & van den Berghe, 2011a: 50

EXAMINED SPECIMENS. Michoacan, Uruapan (lectotype of *Calosoma flohri* Bates) ♂ (MNHN); Michoacan, between Uruapan and Paracho, m 2200, 11.VII.1987, S. Bruschi & E. Migliaccio leg., 25 ♂♂, 25 ♀♀, 1 larva L2 (SB, EM, AVT); Michoacan, San Juan Tumbio, Höge, (H. W. Bates, Biol. Cent. Amer.), 1 ♀ (SB); Michoacan, 10 km. South of Paracho, m 2340, 22.V.1972, 1 ♂ (EM); Michoacan, 15 km West of Ciudad Hidalgo, m 2200, 10.VII.1987, S. Bruschi & E. Migliaccio leg., 3 ♂♂, 4 ♀♀, (SB, EM); Michoacan, Sierra de Tlapujahua, env. de Toluca 2400 2700 m., L Diguët (type & paratype of *Calosoma (Blaptosoma) lesnei*) 2 ♂♂ (MNHN).

SYSTEMATIC POSITION AND DISTRIBUTION. As *C. depressicolle*, *C. flohri* is characterized by heart-shaped pronotum but it has a less raised and more regular sculpture of elytra. Moreover, it is distinct from *C. depressicolle*, which is found more south, because of the strong punctures on the head and pronotum and because of the apex of penis which has a characteristic angular apophysis projecting on the left edge.

C. flohri was described from Uruapan in the state of Michoacán. and it is widespread in the mountain ranges of this state. Gidaspow (1959: 296) also indicates Colima and Mexico states (near Toluca), and Erwin (2007: 92) adds Jalisco. The presence of *C. flohri* near Toluca is very unlikely and possibly comes from a misinterpretation of a quote by Breuning (see below), but it cannot be excluded that *C. flohri* can also be found somewhere beyond the border in neighboring states of Colima, Mexico, and Jalisco.

From Patzcuaro, a few kilometers east of the type locality, Breuning (1928b: 46) described *Calosoma (Blaptosoma) laeve* var. *gebieni*. It was revised and illustrated by Jeannel (1940) that stated it should belong to a distinct species. According to the

diagnosis of Jeannel, *C. gebieni* has the same type of genital of *C. flohri*, its base of pronotum and head are dotted on the margins only, the and elytra are oblong, smooth and shiny. According to Lassalle (2009: 8), *C. gebieni* is a synonym of *C. flohri*, because the features, on which the description is based, are within the variability of this last species.

Later, Breuning (1931) described another population (*C. depressicollis lesnei*) from the Sierra of Tlapujahua on the border between Michoacán and Mexico and not near Toluca as erroneously stated by Jeannel (1940: 231) and Gidaspow (1959: 295). *C. depressicollis lesnei* is characterized by less raised sculpture of the elytra and by a less pronounced apophysis projecting on the apex of penis. Considering that the characters on which the description was based, including the shape of the apex of penis, appear to be identical or may fall within the variability of *C. flohri* Gidaspow (1959: 296) expressed the opinion that it should be a sinonomous to this last species, and, after having examined the type and the specimens above referred to, we agree with this interpretation. However, we have to add that Lassalle & van den Berghe (2011), in a general revision of the group, considered *C. lesnei* a separate species.

Also, *Calosoma (Carabomimus) ortrudae* Häckel & Heinz 2011, described as distinct species and found between Morelia and Ciudad Hidalgo, considering the exterior morphological appearance and its localisation, is probably a population of *C. flohri* even if the descriptors have seen it as close to *C. digueti*.

As for the remaining described subspecies, we prefer to avoid to use the concept of complex of species or to limit the recourse to infraspecific divisions and we collect under *C. flohri* all the populations that in some way can be referred to this species, whatever the level of the hierarchy proposed by the authors.

KNOWN PLACES IN MEXICO. Michoacán: Uruapan (lectotype of *C. flohri*, MNHN); Angahuán, S of Carapán (Häckel *et al.*, 2011: 52); Corupo, Tancitaro, cerro Taretzuruan (Gidaspow, 1959: 296); 10 km. S. Paracho 2340 m (EM); between Uruapan and Paracho 2200 m (EM, SB); Cerro de Capatzun, Angahuan (UASM); San Juan Tumbio (SB); between Uruapán

and Pátzcuaro (Häckel *et al.*, 2011: 52); Pátzcuaro (type of *C. gebieni*, Breuning, 1928b: 46); Periban de Ramos, Cheran, Zamora, Carapan (UASM), between Cheran and Carapán, 6,2 miles W of Quiroga, Ojo de Agua Grande (sub *flohri gebieni* Häckel *et al.*, 2011: 52); Sierra of Tlapujahua (holotype of *lesnei*, MNHN), 15 km W Ciudad Hidalgo 2200 m (SB); Laguna Verde (sub *C. lesnei* Häckel *et al.*, 2011: 55); Nuevo Zirosto (type of *C. flohri zirostense*, Häckel *et al.*, 2011: 54); José de la Cumbre (type of *C. ortrudae*, Häckel & Heinz, 2011: 2).

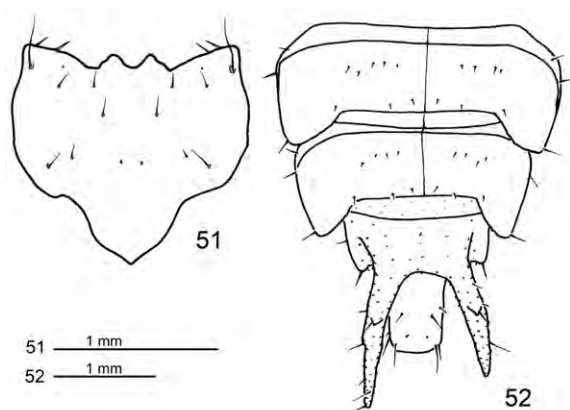
ECOLOGICAL NOTES. *C. flohri* is nocturnal, in daytime takes frequently refuge under stones or pieces of wood. It lives in woodlands, their fringe, radures, pastures and grasslands where it is active from May to August.

DESCRIPTION OF LARVA (Figs. 51-52). The following is based on a single second-instar larva, collected between Uruapan and Paracho.

Concerning microsculpture, chaetotaxy and external structural features, see description of *Calosoma* (*Carabomimus*) *depressicolle*; below we report only the most distinctive differences.

SECOND-INSTAR LARVA

Tergites, head and legs light brown; epipleurites with 5-6 additional setae on anterior sclerite and



Figs. 51-52. *Calosoma* (*Carabomimus*) *flohri*, 2nd instar larva: frontal sclerite (51); extremity of the abdomen (segments VII-X), dorsal view (52).

3-4 short additional setae in the posterior one; tarsi with 3-4 ventral spines; cephalic capsule slightly transverse; nasale with inner teeth rounded at the apex and separated by a deep U-shaped notch (Fig. 51); external teeth scarcely developed.

Pronotum transverse; abdominal tergites less lobate and with posterior corners more rounded than in *C. depressicolle*.

OBSERVATIONS ON LARVAE

Larvae of Mexican *Calosoma* described in this paper are for most characters very similar. Because of this reason, we cannot be sure that the subtle differences which have been noticed, including chaetotaxy, and here reported, are due to real specific differences or to individual variability, as exemplified in Figs. 20-23 for the morphological variations of nasale in third-instar larvae of *C. laevigatum*. More extensive studies, based on longer series of larval specimens, are needed in order to test the stability of the differential characters here outlined.

Like other larvae of *Calosoma*, the body is dark brown colored, but with metallic bronze reflections. In particular all larvae exhibit a four-toothed nasal prominence formed by two pairs of teeth, divided in the middle by a deep U- (generally in second-instar larvae) or V-shaped notches (generally in third-instar larvae). The apices of inner teeth vary from pointed to blunt (due to abrasion?), but are not extended beyond the upper level of adnasalia. Labial and maxillary palpi show joints almost similar in length with double sensorial area at tip of the last palpomere IV. Similar also is the relative length of the antennomeres (II-III-I-IV). A peculiar feature of all these larvae, especially evident in third instars, is that the dorsal pair of stemmata, are transversally divided, more or less completely, into two small rounded subunits (as far as we know unusual for carabid larvae). Tergites are wide and markedly lobate covering the pleural areas in dorsal aspect, with posterior corners slightly denticulate because of small cuticular processes.

Some evident differences, however, are found in larvae of the two subgenera *Callitropa* and *Carabomimus*, particularly in microsculpture, dimensions and shape of cephalic capsule, in ocular prominence and on fusion of abdominal sternites, confirming the distinctness of these taxa.

KEY TO LARVAE

1. Discal area of tergites rough; ocellar prominence between PA₇ and PA₉ marked; inner sternites fused starting from abdominal segment VII; cephalic capsule with subparallel sides only slightly convex ..
.....*Calosoma (Callitropa) porosifrons*
- Discal area of tergites smooth; ocellar prominence between PA₇ and PA₉ scarcely visible or absent; inner sternites fused starting from abdominal segments II, III or VI; cephalic capsule with rounded sides distinctly convex.....2
2. Inner sternites fused starting from abdominal segment VI.....
.....*Calosoma (Carabomimus) morelianum*
- Inner sternites fused starting from abdominal segment II or III.....3
3. Upper spine of urogomphi very small
.....*Calosoma (Carabomimus) depressicollis*
.....*Calosoma (Carabomimus) flohri*
- Upper spine of urogomphi thick and pointed
.....*Calosoma (Carabomimus) laevigatum*
.....*Calosoma (Carabomimus) politum*

DISCUSSION

Analysis of characters of *Calosoma (Callitropa) porosifrons* larvae, and that of five species of the subgenus *Carabomimus*, confirms the substantial homogeneity among the group of apterous species, at various levels of evolution towards carabomorphous types.

Larvae of Mexican carabomorphous *Calosoma* appear rather homogeneous unlike those of African ones (Vigna Taglianti & Bruschi, 1986). In fact, larvae of the species located in the high mountains of eastern Africa (*Orinodromus* Kolbe, 1895) distinctly differ from the winged forms and from the apterous forms less specialized (*Carabops* Jakobson, 1900), in particular for the more lengthened body general shape and for the shortening of urogomphi. For Mexican forms instead, in spite of the evident evolution of imaginal characters, among which Jeannel (1940: 221) stressed hypertrophy of ligula, the larval stage appears much less diversified.

Considering the distribution of Mexican *Calosoma*, we must distinguish between winged species, usually widely spread, and apterous species, normally linked to precise climatic areas.

Among winged species it is possible to distinguish Neotropical (*Castrida* Motschulsky, 1865) and Nearctic elements. Among these latter, a group of more typically northern species is recognizable, which ranges southward to Central America (*Calodrepa* Motschulsky, 1865 and *Chrysostigma* Kirby, 1837) (Erwin, 1991) and a more southern group, which penetrates more or less extensively towards Northern areas (*Camedula* Motschulsky, 1865 and *Callitropa* Motschulsky, 1865). Among these, most of the species of the subgenus *Camedula* show a distribution which corresponds well to the climatic band with dry or semi-dry climate of southwestern United States and northwestern Mexico (Sonoran transitional zone).

On the contrary, almost all apterous species (all species of the subgenera *Callitropa*, *Carabomimus* and *Calopachys*) are linked to humid, temperate or semi-cold climates. In particular, distribution of *Carabomimus* and *Calopachys*, apparently more stenoecious than the apterous species of the subgenus *Callitropa*, with a preference for colder temperatures and higher atmospheric humidity, seems to be more sensitive to the influence of geographic barriers, as the interruptions of mountain chains, already explained by Ball (1970).

For *Calodrepa*, *Castrida*, *Chrysostigma*, *Callitropa* and *Camedula* published data are certain enough and concordant.

Calodrepa, a subgenus of North and Central America, is represented in Mexico by two species: *C. aurocinctum* Chaudoir, 1850, distributed along the coast of Gulf of Mexico, up to Texas and *C. scrutator* (Fabricius, 1775), whose range extends from southeastern Canada to Mexico, reaching Nicaragua through Guatemala, El Salvador and Honduras but it is doubtful that it could arrive in Venezuela, as stated by Gidaspow (1959: 250).

Castrida, a subgenus putatively South American in origin, is represented in Mexico by one species: *C. sayi*, Dejean, 1826 which is widely distributed also in the eastern and southern parts of United States.

Chrysostigma is a typically Nearctic subgenus, with one species (*C. semilaeve* LeConte, 1852) whose ranges reach Baja California.

Camedula, a subgenus essentially Central American, except for one species present in the northern part of South America (*C. glabratum* Dejean, 1831, known from Panama and Colombia), includes species present in the South-West of United States and in North Mexico.

The subgenus *Callitropa* includes three-winged species: one *C. externum* (Say, 1823) distributed in the eastern part of United States and two (*C. macrum* LeConte, 1853 and *C. protractum* LeConte, 1862) in northern Mexico and southwestern United States. *C. palmeri* Horn, 1876, with rudimentary wings, is limited to the Mexican island of Guadalupe. The remaining apterous six species, are exclusive to central Mexico (*C. viridisulcatum* Chaudoir, 1863, *C. atrovirens* Chaudoir, 1869, *C. anthracinum* Houlbert, 1907), with penetration into northern Mexico (*C. laeve* Dejean, 1826) or limited to northern Mexico (*C. porosifrons* Bates, 1891), or present in northern Mexico with penetration into the southwestern part of United States (*C. haydeni* Horn, 1870).

For the subgenera *Carabomimus* and *Calopachys*, available data are less numerous and some of it is contradictory. As a preliminary approach, we used as a base both the general conclusions of Jeannel and some results of the more recent partial revisions of Lassalle. Records given by Gidaspow, which were not based on a direct review of the quoted material, are exposed to risk of repetition of mistakes either for classification or interpretation of older authors.

An accurate revision of the materials and literature do not confirm the sympatric situations on which Gidaspow bases her review. Only *C. depressicollis*, in the places at higher altitudes of its range, can be found sympatric but not syntopic with other species.

According to our conclusions, the species of *Carabomimus* seem to be limited to the central Mexican Sierras (Ball's "Transvolcanic Sierra", 1970).

In its western part, going towards East, we firstly find *C. digueti* (Lapouge, 1924) in Jalisco, that spreads up to the state of Zacatecas, in a region with a decidedly semi-dry climate. *C. flohri* follows more south and it is present in northern Michoacan in forested areas at medium altitudes. *C. depressicollis* arrives to central Mexico as it is found from the

eastern border of Michoacan to the centre north of Mexico state, generally at higher altitudes.

In Central Mexico, *C. laevigatum*, reported by Gidaspow (1959: 291) as being present in all southeastern Mexican states, more likely occupies only the mountain areas at high altitude of northern Mexico state and Hidalgo, but possibly with an isolated population in Durango state.

C. costipenne Chaudoir, 1869, a species very similar to the previous one, is limited to Mexico and Hidalgo, without overlays.

C. politum lives, it too, in Mexico state around 3000 m of altitude and its range is adjacent to that of *C. morelianum*, but this spreads farther south up to Morelos state.

C. striatulum is found in the eastern part of the Transvolcanic Sierra. Ranging from the eastern slopes of Cofre de Perote, it occupies high altitudes on the volcanic mountains in the states of Hidalgo, Puebla and Veracruz with populations slightly differentiated.

We are not able to draw any conclusions concerning *C. orizabae* (Jeannel, 1940), that is known from only two specimens, respectively from Orizaba in Veracruz and from Guanajuato almost 400 km most northern. The same as for *C. cicatricosum* Chaudoir, 1869 that shares with *C. morelianum* marked similarity in the details of elytral structure, however easily distinguishable for the different body shape, and that also has been found in Mexico state. Nor can any definitive conclusions be drawn about *Calosoma (Blaptosoma) bulleri* Beheim & Breuning, 1943, from Jalisco, described as very similar to *C. omitemium* (Bates, 1891) and ascribed by Gidaspow (1959: 298) to *Carabomimus*, on the only basis of the protruded hind angles of the pronotum. Finally, as for *Calosoma (Carabomimus) enigmaticus* Lassalle & van den Berghe, 2013 it is difficult to identify its affinities and systematic position, as indeed its name suggests.

The subgenus *Calopachys* includes three species, with the southern Mexican Sierra as center of distribution (Oaxacan Sierra by Ball, 1970): *C. blaptoides* Putzeys, 1845 appears widely spread, in all Southern states, while *C. omitemius* is known of only two localities a short distance away in Sierra Madre do Sur, and *C. viridissimus* Hauray, 1880, the original description of which is based on a single female with unspecified locality, is known from the east of Oaxaca City in oak-pine forest.

AKNOWLEDGEMENTS

We want to thank our friends and colleagues who have provided the material from their collections or gathered during their field researches, particularly Enrico Migliaccio who participated in the expedition to Mexico of July 1987 and generously made available the materials and the documentation he collected.

We also want to remember Professor George Eugene Ball, University of Alberta, Edmonton, Canada, who corresponded with his friend Augusto Vigna Taglianti during the long gestation of this work, providing useful information and tips.

Moreover, we warmly thank the curators of the museums that have allowed us to examine the

specimens present in the collections entrusted to them, Roberto Poggi, former Director of the Museo civico di Storia naturale “G. Doria”, Genova; Max Barclay of the British Museum of Natural History, London; Thierry Deuve and Azadeh Taghavian, of Muséum national d’Histoire naturelle, Paris; Alberto Zilli formerly of the Museo civico di Zoologia, Roma; Lee H. Herman, of the American Museum of Natural History, New York. Roberto Poggi is also thanked for his kind and precious help in finding (and mailing) the original larval drawings of ADG in the material of the collection AVT, now moved to Genoa. Achille Casale, Pietro Brandmayr, Pier Mauro Giachino and Simone Fattorini are thanked for their suggestions on the last version of the manuscript.

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Paolo NERI* - Luca TOLEDANO**

Notes on genus *Bembidion*, subgenus *Peryphanes*, from “Anatolo-Caucasian-Turanian” region with description of two new taxa from Iran (Coleoptera: Carabidae: Bembidiina)

Abstract: Some taxonomic and geographic aspects of genus *Bembidion* Latreille, 1802 subgenus *Peryphanes* Jeannel, 1941 are discussed here. Two new taxa are herewith described: *Bembidion (Peryphanes) augusti* sp. n. (Iran) and *B. (P.) grandipenne safavidense* ssp. n. (Iran and Iraq). We describe some further characters of *Bembidion (Peryphanes) antennarium* (Morvan, 1972), belonging to subgenus *Peryphanes*, “*weiratherianum*” group. Some distributional data for *B. (P.) grandipenne freyi* Netolitzky, 1937 (mention for Syria) and *B. (P.) brunnicorne* Dejean, 1831 (mentions for Azerbaijan and Turkey) not reported in Marggi *et al.* (2017) are reported here. A key for the *Peryphanes* species of Anatolic-Caucasian-Turanic area is provided in Italian and in English.

Riassunto: Note sul genere *Bembidion*, sottogenere *Peryphanes*, dell’area “Anatolo-Caucasico-Turanica” e descrizione di due nuovi taxa dell’Iran. (Coleoptera: Carabidae: Bembidiina).

Sono discussi alcuni aspetti tassonomici e geografici del genere *Bembidion* Latreille, 1802 sottogenere *Peryphanes* Jeannel, 1941. Sono descritti i seguenti nuovi taxa: *Bembidion (Peryphanes) augusti* sp. n. (Iran); *B. (P.) grandipenne safavidense* ssp. n. (Iran e Iraq). Di *Bembidion (Peryphanes) antennarium* (Morvan, 1972), appartenente al gruppo del “*weiratherianum*”, vengono descritti ulteriori caratteri. Vengono risegnalati dati di distribuzione per *B. (P.) grandipenne freyi* Netolitzky, 1937 (citazione per Siria) e *B. (P.) brunnicorne* Dejean, 1831 (citazioni per Azerbaijan e Turchia) non riportati in Marggi *et al.* (2017).

Viene fornita la chiave di identificazione del sottogenere *Peryphanes* per le specie abitanti l’area “Anatolo-Caucasico-Turanica” con l’inserimento dei nuovi taxa, in italiano e in inglese.

Key words: *Bembidion*, *Peryphanes*, taxonomy, new species, Iraq, Iran, identification keys.

To meet the requirements by the International Code of Zoological Nomenclature (ICZN), this article was registered at ZooBank (31 March 2021) under the ZooBank Life Science Identifier (LSID): F66C8919-08F5-4B81-BF72-D4DE13293A4C.
Published: 23 April 2021.

INTRODUCTION

Recently collected material sent us by our friends David Wrase, Christoph Reuter and Jan Muilwijk, together with several specimens of *Bembidion antennarium* (Morvan, 1972) allowed us to establish its correct position in the subgenus *Peryphanes* Jeannel, 1941 (Neri & Toledano, 2020), argument that we will deal more in detail in the present work. In addition, we found in this material two undescribed taxa belonging to the same subgenus which we describe here. A new key for the identification of all the species of the subgenus present in the Anatolic-Caucasian-Turanic area (corotype in Vigna Taglianti *et al.*, 1999) is provided.

MATERIALS AND METHODS

The systematic treatment of the Bembidiina and the geographical acronyms follow Löbl & Löbl, 2017.

The body length was measured for card-mounted specimens from the front margin of the labrum to the apex of the elytra. The measurement of the aedeagus does not include the portion of endophallus protruding from the basal opening.

Dissections were made using standard techniques. Genitalia and small parts were preserved in Euparal on acetate mounts fixed on the same pins as the specimens.

The photographs of habitus were made by Luca Toledano with Nikon DSFi1 and Nikon DS-L2 on Leica Z6 and those of the male genitalia by Gabriele Fiumi with Nikon D300 on Leitz Dialux 20 EB; the drawings of the spermathecae are made by Ivo Gudenzi.

The examined material is preserved in the following collections:

CTVR coll. Luca Toledano, Verona, Italy

CR coll. Christoph Reuter, Hamburg, Germany

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DW	coll. David W. Wrase, Gusow-Platkow, Germany (part of Zoologische Staatssammlung München, Germany)
JM	coll. Jan Muilwijk, Bilthoven, Holland
PN	coll. Paolo Neri, Forlì, Italy
PS	coll. Peer Schnitter, Halle, Germany

Bembidion (Peryphanes) antennarium (Morvan, 1972) (Figs. 3, 8, 11)

Peryphus depressum Morvan, 1972

Bembidion farsense Marggi & Huber, 1999

HISTORICAL NOTES. Morvan (1972) describes *Peryphus antennarius* on a single, male specimen from Iran (Zagros, Kurang, 2800 m); the description, although sufficient, does not mention the elytral microsculpture. In the same paper the author describes *Peryphus depressus* on a single, female specimen collected in the same locality as *antennarius*, but at a slightly different altitude (Zagros, Kurang, 3200 m). Müller-Motzfeld (1986), includes both species in the newly described subgenus *Ocyturanus*, in the species group “with elytra showing apical spots”.

Marggi & Huber (1999) change the name *depressum* to *farsense*, being a name preoccupied by *depressum* Ménétriers, 1832.

Neri & Toledano (2017), after the examination of the type specimens of both species synonymize *depressum* Morvan, 1972 with *antennarium* and ascertain that the type specimen of *antennarium* lacks the aedeagus, possibly preserved separately from the specimen and, therefore, possibly lost (aedeagus anyway figured, although in a simplified way, in Morvan, 1973); the Morvan collection is currently located in the Muséum National d'Histoire Naturelle, Paris.

Neri & Toledano (2018), following the Müller-Motzfeld's (1986) statements, include *antennarium* in the keys of subgenus *Ocyturanus*, *signatipenne* du Val, 1852 group (= group “with elytra showing apical spots”). Finally, Neri & Toledano (2020), after the examination of the male genitalia of several new specimens of *antennarium* collected in localities very close to the type locality, state that the species actually belongs to the subgenus *Peryphanes*, *weiratherianum* Netolitzky, 1932 group (Neri & Gudenzi, 2013).

TAXONOMICAL NOTES. Having been allowed to study

numerous specimens of *antennarium* we provide further information on the characteristics of this species. For completeness we report here the original description (Morvan, 1972): “Longueur: 6 mm. Ailé; noir à reflet bleu verdâtre, le tiers apical des élytres testacé rougeâtre englobant une tache plus claire d'un rouge orange; palpes et antennes noires, pattes testacées, les femurs noirs avec l'extrême sommet rougeâtre, pattes et antennes longues et grêles. Tête aux yeux petits, la soie susorbitaire postérieure un peu après le bord postérieur de l'oeil, sillons frontaux peu profonds, larges. Pronotum cordiforme, sa plus grande largeur au niveau de la soie antérieure, les côtés rétrécis en arrière jusqu'à la base, les angles vifs, fossettes basales peu profondes, larges, la carinule externe peu saillante, la base avec quelques points épars, bord antérieur peu échancré, bord basal droit; promotum déprimé. Elytres oblongs, larges, épaules bien marquées; toutes les stries visibles jusqu'à l'apex, fortement ponctuées, moins en arrière. Organe copulateur droit, épais à la base, l'apex large et arrondi, pièce copulatrice avec le stylet épais; style gauche avec l'extrémité distale courte et large, l'apex avec quatre soies, le droit allongé avec trois soies. Holotype: 1 ♂, Iran, chaîne montagneuse du Zagros, Kurang, 3200 m, VI-1970 (P. Morvan) (ma coll.). Femelle inconnue.”. In addition to the description, unfortunately made upon a single male specimen and with drawings that seem not to match with the type photographed here, we report: the length ranges from 4.90 to 5.70 mm (holotype 5.08 mm, Fig. 3); blackish elytra with blue-green reflections and with apical third dark testaceous-reddish, often with an orange spot; eyes poorly protruding with temples short and barely oblique towards the neck; pronotal base wide as anterior margin or slightly larger; elytra with faint microsculpture, short and transverse or irregular in the apical third or fourth; the microsculpture may also be visible at sides up to the humeri, but always missing on disc.

Aedeagus (Fig. 8), 1.02 - 1.09 mm long, characteristic for *weiratherianum* group, with central brush not or slightly protruding from the basal opening, apical third gradually narrowing towards apex, ventral margin more or less rectilinear and apical third bent ventrally.

Spermatheca (Fig. 11) with duct simple, not spiralled.

COMPARATIVE NOTES. *B. antennarium* differs from *morvanianum* Müller-Motzfeld, 1986 by the larger

size and the aedeagal ventral margin lacking the gibbosity; from *augusti* n. sp., *kulzeri* Netolitzky, 1935 and *hissaricum* Netolitzky, 1943 for the antennae completely darkened; from *augusti* n. sp. for the aedeagus with ventral margin lacking gibbosity; from all the remaining *Peryphanes* species present in the same area by the elytral apical third reddish, often showing an orange spot or for having elytral microsculpture present at least in the apical fourth.

***Bembidion (Peryphanes) augusti* n.sp.** (Figs 2, 7, 10)
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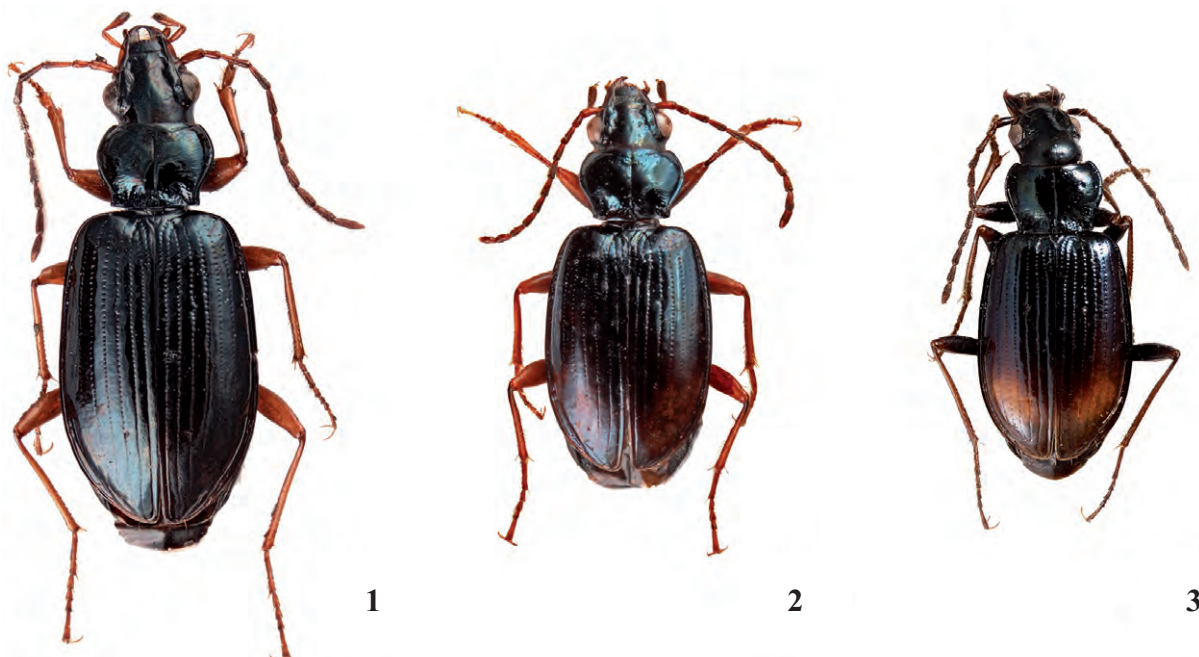
DIAGNOSIS. A *Peryphanes* of *deletum* Serville, 1821 group (aedeagus with central brush protruding from basal opening and spermatheca with spiralled or twisted duct) from Iran.

TYPE LOCALITY. Iran, Kohkiloeh & Buyer Ahmad, Tobady Valley, 5 Km N Yasud.

TYPE SERIES. Holotype (CTVR) ♂: “Iran, Kohkiloeh & B. / Tobady Valley / 5 km N Yasud / 26.9.2005 / Muilwijk leg.” [printed]. The aedeagus, preserved in

Euparal, is pinned on the same pin as the specimen. We added to the specimen the following label: “*Bembidion (Peryphanes) augusti* Neri & Toledano, 2020 – HOLOTYPE” [red, printed].

Paratypes: 4 ♂♂, 3 ♀♀ with the same label as the holotype (JM, PN, CTVR). 1 ♂, 2 ♀♀: “Iran, Kohkiloeh & B. / Abshar Yasud / 28.9.2005 / Muilwijk leg.” (JM, PN). 2 ♂♂: “IR, Kohkiloeh & B. / Sisakht / 30.4.2006 / Muilwijk leg.” (JM). 1 ♂: “IR, Fars Sepidan / Tang e Tizab / 29.4.2006 / Muilwijk J.” (CTVR). 1 ♂: “IR, Fars / Chamriz / 15.5.2006 / Muilwijk J.” (PN). 1 ♀: “IR Kohkiloeh & B. / Babahasan Pass / 2.5.2006 / Muilwijk leg.” (PN). 3 ♀♀: “IR, Kohkiloeh & B. / Tobady Valley / 3.5.2006 / Muilwijk leg.” (JM). 2 ♀♀: “IR, Fars Shiraz / Ghoyom / 12.5.2006 / Muilwijk J.” (JM). 1 ♂: “IR, Fars / Tang e Tizab / 1.5.2008 / Muilwijk leg.” (JM). 1 ♂, 2 ♀♀: “IR, Kohkiloeh / Baba Hasan / 4.5.2008 / Muilwijk leg.” (JM). 1 ♂: “IR, Fars / Mogtarabad / 29.4.2008 / Muilwijk leg. (JM). 1 ♀: “IR, Kakhkiloeh / Kohgol Valley / 3.5.2008 / Muilwijk leg.” (CTVR). 1 ♂: “IR, Kohgiluyeh Va Boyer / Ahmad, Stream near lake / Googol 9.VI.2018 2954m / Muilwijk leg.” (JM).



Figs. 1-3. Habitus of: 1 – *Bembidion (Peryphanes) grandipenne safavidense* n. ssp., holotype (CTVR), 6.60 mm; 2 – *B. (P.) augusti* n.sp., holotype (CTVR), 5.40 mm; 3 – *B. (P.) antennarium* (Morvan), holotype (coll. Morvan, MNHN), 5.08 mm.

1 ♂: “IR, Kohgiluyeh Va Boyer / Ahmad, lake Googol / 9.VI.2018 2714m / Muilwijk J.” (JM). 6 ♂♂, 2 ♀♀: “IR, Fars Barm-e Mad Ab / 1 Km W Hoseyn Khany / 9.VI.2019 2750m / 30°36'14"N 51°46'52"E / Muilwijk J.” (JM, PN, CTVR). 2 ♂♂, 1 ♀: “Iran, (Kohkilyeh va Būyer Ahmadi) / Zagros Mts., Dena Mts., Sisakht, / Kugol vall., 2750 m / N30°49'49" E51°32'50" / (muddy shore of a small lake / under stones) / 25.IV.2018 Wrase & Laser” (DW). 6 ♀♀: “W IRAN (Lorestan) / 10 Km SW Dorūd 1431m / 33°26'N 49°00'E (lux) / 9.VII.2004 M. Rejzek” (DW, CTVR). 1 ♂: “NW Iran p. Azarbaygan-e / Garbi, 10 Km S Hoy / 8.VI.1999 / lgt. E. & P. Hajdaj” (CTVR). 1 ♀: “C. Iran p. Fars, Yasug NW / Siraaz (vill. Kakan) / 30°40'N 51°43'E, 13.VI.1999 / lgt. P. Kabatek” (CTVR). 1 ♂: “SW IRAN (Fārs) / Kākān E Yasūğ 2315 m / 3042N 5138E (lux) / 14.VII.2004 M. Rejzek” (DW). All specimens bear printed labels.

We added to all paratypes the following label: “*Bembidion (Peryphanes) augusti* Neri & Toledano, 2020 – PARATYPUS” [red, printed].

DESCRIPTION OF THE HOLOTYPE (Fig. 2). Total length 5.40 mm. Head and pronotum black, glossy; elytra blackish, with two preapical reddish spots, with undefined edges, oblique, divided by the first interval, apex brown. Legs orange with femora darkened in the basal two-thirds. Antennae orange, slightly darkened from the apical half of antennomere 2. Penultimate palpomere darkened in the apical half.

Head: maximum width, including eyes, 1.13 mm;

distance between eyes 0.70 mm; frons smooth and glossy with a few scattered punctures, frontal furrows wide, evident. Eyes normally protruding, temples oblique, short. Antennae long 2.71 mm.

Pronotum: length along midline 1.02 mm; width of anterior margin 0.99 mm, maximum width 1.37 mm, width of base 1.00 mm; pronotal width / pronotal length ratio 1.34; moderately convex, transverse; sides entirely bordered, narrowing and sinuate towards base, with which they form an almost right angle, due to the base slightly oblique towards the angles; lateral gutter of uniform width; whole surface smooth and glossy; laterobasal carina evident; median line and anterior, semilunar transverse impression evident; basal transverse impression punctured and subquadrate basal foveae with a few punctures.

Elytra: length 3.60 mm, maximum overall width 2.17 mm; maximum elytral width slightly behind middle, evident shoulders and sides subparallel in the median third, completely microsculptured with short and sharp transverse, polygonal sculpticells. Striae evidently and clearly punctured, puncturation visible up to the apex, where it is very faint, barely visible; stria 7 evident while with punctures less impressed than in the inner striae. Macropterous species.

MALE GENITALIA (Fig. 7). Aedeagus of large size (1.61 mm), central brush completely protruding from the basal opening, ventral margin with strongly marked gibbosity, apical fourth bent ventrally. Each paramere with four apical setae.



Figs. 4-5. Humeral part of elytra of: 4 – *B. (P.) augusti* n.sp.; 5 – *B. (P.) adygorum* Belousov & Sokolov, 1996 (photo Luca Toledano).

INTRASPECIFIC VARIABILITY. Males and females vary in length from 5.10 to 6.00 mm. The aedeagus is long, from 1.42 to 1.61 mm. The preapical elytral spot may be more or less visible (not visible in a few specimens). The antennae may have antennomere 2 light and femora may be darkened almost up to the apex. Elytral stria 7 sometimes barely visible. Spermatheca: 0.15 mm (Fig. 10) with spiralled duct with 5-6 loops.

DERIVATIO NOMINIS. The species is named after our friend Augusto Vigna Taglianti, for several years undisputed leader of Italian entomology, that we regard with affection. The name is genitive.

COMPARATIVE NOTES. *B. augusti* differs from *adygorum* Belousov & Sokolov, 1996 by the elytral striae showing less impressed punctures and by the flat intervals; from *kulzeri* Netolitzky, 1935, *hissaricum* Netolitzky, 1943, *stephensi* Crotch, 1866, *cilicicum cilicicum* De Monte, 1947, *cilicicum syriacum* De Monte, 1947 (♀), *weiratherianum* Netolitzky, 1932, *klimai* Neri & Gudenzi, 2012 and *antennarium* (Morvan, 1972) by the antennomere 1 and 2 light; from *brunnicornis* Dejean, 1831 and *lirykense* Reitter, 1908 by the femora darkened at least for the basal three-fourth; from all remaining species of *Peryphanes* present in the same region, by the smaller size of body and aedeagus or for the full elytral microsculpture.

DISTRIBUTION. The species is known from the Iranian provinces of Fars and Kohkiluyeh & Buyer Ahmad.

Bembidion (Peryphanes) grandipenne safavidense
n. ssp. (Figs 1, 6, 9)

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DIAGNOSIS. An Iranian and Iraqi population of *Bembidion (Peryphanes) grandipenne* Schaum, 1862, (*deletum* Serville, 1821 group): inner sac of aedeagus protruding from basal opening and spermatheca with duct spiralled or twisted.

TYPE LOCALITY. Iran, Lorestan, Lake Gahar, 2413 m, 33°17'41"N 49°18'37"E

TYPE SERIES. Holotype, ♂, “IR Lorestan Lake Gahar / 3.VI.2019 2413 m / 33°17'41"N 49°18'37"E / Muilwijk J.” [printed] (CTVR). The aedeagus, in Euparal, is preserved on the same pin as the specimen. We added to the specimen the following label: *Bembidion (Peryphanes) grandipenne safavidense* P.

Neri & L. Toledano, 2020—HOLOTYPE [red, printed]. Paratypes. 3 ♀♀, 5 ♀♀ with the same label as the holotype (CTVR, PN, JM). 1 ♂: “W Iran, Prov. Ilam / 30 Km NW Ilam / 33°43'N 46°25'E 1786m / S. Kadlec lgt. 7.VII.2004” (JM). 1 ♂, 2 ♀♀: “W Iran, Prov. Ilam / 7 Km S Ilam 1619 m / 33°40'N 46°29'E / S. Kadlec lgt. 25.VII.2004” (JM, PN). 1 ♂: “Iran, Lorestan prov. / Dorud 52 Km SE / Borugerd. 2-3.VI.2005 / F. Pavel leg.” (PN). 1 ♀: “Iran, Lorestan prov. Dorud (Lan- / jabad 33°26'57"N 49°01'14"E / 8-10.X.1998, 1700 m / leg. P. Kabatek” (PN). 1 ♂: “Iran, Kushk / N Masiri 1800m / 12.6.1973” (JM). 1 ♂, 1 ♀: “W Iran, Prov. Lorestan / 25 Km NWW Dorud / 33°33'N 48°53'E – 1874m / S. Kadlec lgt. 8.VII.2004” (JM). 1 ♂: “SW Iran 30°51'N 51°30'E / Buyer Ahmand-o-Kuhgiluye / Sisaht 2267m (E Yasug) / S. Kadlec lgt. 12.VII.2004” (JM). 1 ♂, 1 ♀: “Iran, Isfahan / Dena 3000 m / 17.V/2016 / Muilwijk leg.” (JM). 1 ♂: “Iran Isfahan / 1 Km O Sarbaz / 17.V.2016 / Muilwijk leg.” (CDVR). 1 ♀: “IR Esfahan Ab Malikh / Kata river / 7.VI.2019 Muilwijk J. / 31°08'46"N 51°22'30"E” (JM). 1 ♀: “Iran Zagros Mrs. 4.VII.2016 / Shakhre-Quord, near Shelemzar / Dasthena 2200-2400m / J.Riegr kgt.” (PN). 3 ♂♂: “IR Chaharmahal and / Bakhtiari, Sateh cave / 6.VI.2018 / 31°25'10.3"N 50°43'29.1E / E. Ghasemian, S. Rahideh & J. Muilwijk” (PN, CDVR, JM). 1 ♀: “Iran (Kohkilyeh va Büyer Ahmadi) / 4 Km S Yasouj, 1850 m / N30°42'16 E51°35'13” / (river bank, in coarse gravel) / 24.IV.2018 Wrase & Laser” (DW). 1 ♀: “Iran (Kohkilyeh va Büyer Ahmadi) / Zagros Mts., Dena Mts. / pass W Podena, ca 2800-3190 m / N30°52'40" E51°31'35" / (subalpine slopes with steep / rock walls, in gravel/under / stones along brooks/snowfields) / 26.IV.2018 Wrase & Laser” (DW). 1 ♂, 2 ♀♀: “Iran (Kohkilyeh va Büyer Ahmadi) / Zagros Mts., Dena Mts. / Gorge NW Sisakht vill., ca 2600m / N30°51'08" E51°31'16" / (brook bank, in gravel) / 25.IV.2018 Wrase & Laser” (DW, CTVR). 1 ♂, 1 ♀: “Iran (Kohkilyeh va Büyer Ahmadi) / Zagros Mts., Zard Koh Mt. / Cheri pass 20 km W Samsani / 2775 m, N32°09'55" E50°13'37" / (subalpine slopes/under stones) / 21.IV.2018 Wrase & Laser” (DW). 1 ♂: “N30°49'49" E51°32'50" Iran / Zagros Mts. p. Kohkilyeh va / Büyer Ahmadi, Dena Mts. / Sisakht, Lugol vall. subalpine / pasture 25.IV.2018 2750 m / leg. Schnitter” (PS). 1 ♂, 2 ♀♀: “Iran Kohkiloeh & B. / Tobady Valley / 5 Km N Yasud / 26.9.2005 / Muilwijk leg.” (JM, CDVR). 1 ♂, 1 ♀: “Iran Kohkiloeh

/ Kohgol Valley / Sisakt / 27-9-2005 / Muilwijk leg.” (JM). 2 ♂♂, 2 ♀♀: “Iran Kohkiloeh & B. / Abshar Yasud / 28.9.2005 / Muilwijk leg.” (JM, PN). 1 ♂: “Iran Kohgiluyeh va / Boyer Ahmad, Zagros / Kabootari valley 1/8/2017 / Mohammad Javad Malek- / Hosseini” (JM). 3 ♂♂, 1 ♀: “IR Kohgiluyeh Va Biyer / Ahnad Stream / 14.VI.2018 / 31°14’59”N 50°40’46”E / Muilwijk J.” (JM). 2 ♂♂, 1 ♀: “IR Kohgiluyeh and Boyer / Ahamad 8 Km N Ceshmeh / Chenar 8.VI.2018 / 30°46’29”N 51°38’14”E / Muilwijk j.” (JM). 1 ♂: “IR Kohgiluyeh Va Boyer- / Ahmad Stream near lake / Googol 9.VI.2018 2954 m / Muilwijk J.” (PN). 1 ♂: “IR Kohgiluyeh Va Boyer- / Ahmad upper lake Googol / 6.VI.2019 / 30°50’092N 51°32’28”E / Muilwijk J.” (CDVR). 1 ♂: “Iran Fars / Sepidan / 21-9-2005 / Muilwijk leg.” (JM). 1 ♀: “IR Fars / Tang e Tizab / 1-5-2008 / Muilwijk leg.” (JM). 1 ♂: “IR Fars Barm-e Mad Ab / 1 Km w Hoseyn Khany / 9.VI.2019 2750 m / 30°36’14”N 51°46’52”E / Muilwijk J.” (CR). 1 ♀: “IR Fars Barm-e Firooz / 10.VI.2019 Muilwijk J. / 3350-3400 m / 30°22’45”N 51°56’31”E “ (JM). 1 ♂: “N-Iraq, Rawandoz env. / 36°38’N 44°33’E / Akolan Valley, May 2019 / 1900-2000m leg. C. Reuter” (PN). All specimens bear printed labels.

We added to all paratypes the following label: “*Bembidion (Peryphanes) grandipenne safavidense* Neri & Toledano, 2020 – PARATYPUS” [red, printed]. DESCRIPTION OF THE HOLOTYPE (Fig. 1). Total length 6.60 mm. Head, pronotum and elytra blue-blackish, glossy, with faint reddish reflections in the elytral apical half. Legs orange with femora faintly darkened at base. Antennae orange, slightly darkened from the apical half of antennomere 3. Penultimate palpomere darkened in the apical half.

Head: maximum width, including eyes, 1.25 mm; distance between eyes 0.78 mm; frons smooth and glossy, wide and evident frontal furrows. Eyes considerably protruding, temples oblique, short. Antennae long 3.47 mm.

Pronotum: length along the mid line 1.13 mm; width of anterior margin 1.02 mm, maximum width 1.44 mm, width of base 1.08 mm; pronotal width / pronotal length ratio 1.27; moderately convex, transverse; sides entirely bordered, narrowing with a sinuature towards base, with which they form right angles; lateral gutter of uniform width; all surface smooth and glossy; laterobasal carina evident; median line and anterior semilunar transverse impression evident;

basal transverse impression punctured and subquadrate lateral foveae with a few punctures.

Elytra: length 4.13 mm, maximum overall width 2.46 mm; moderately ovoid, with sides subparallel in the basal third, maximum width slightly behind middle, evident shoulders, completely microsculptured with narrow, transverse polygonal sculpticells. Striae evidently punctured, the puncturation is visible up to the apex where is very faint, barely visible; stria 7 formed by faint punctures only. Macropterous species.

MALE GENITALIA (Fig. 6). Aedeagus of large size (1.82 mm), central brush completely protruding from basal opening, ventral margin with evident gibbosity, apical quarter bent ventrally. Each paramere with four apical setae.

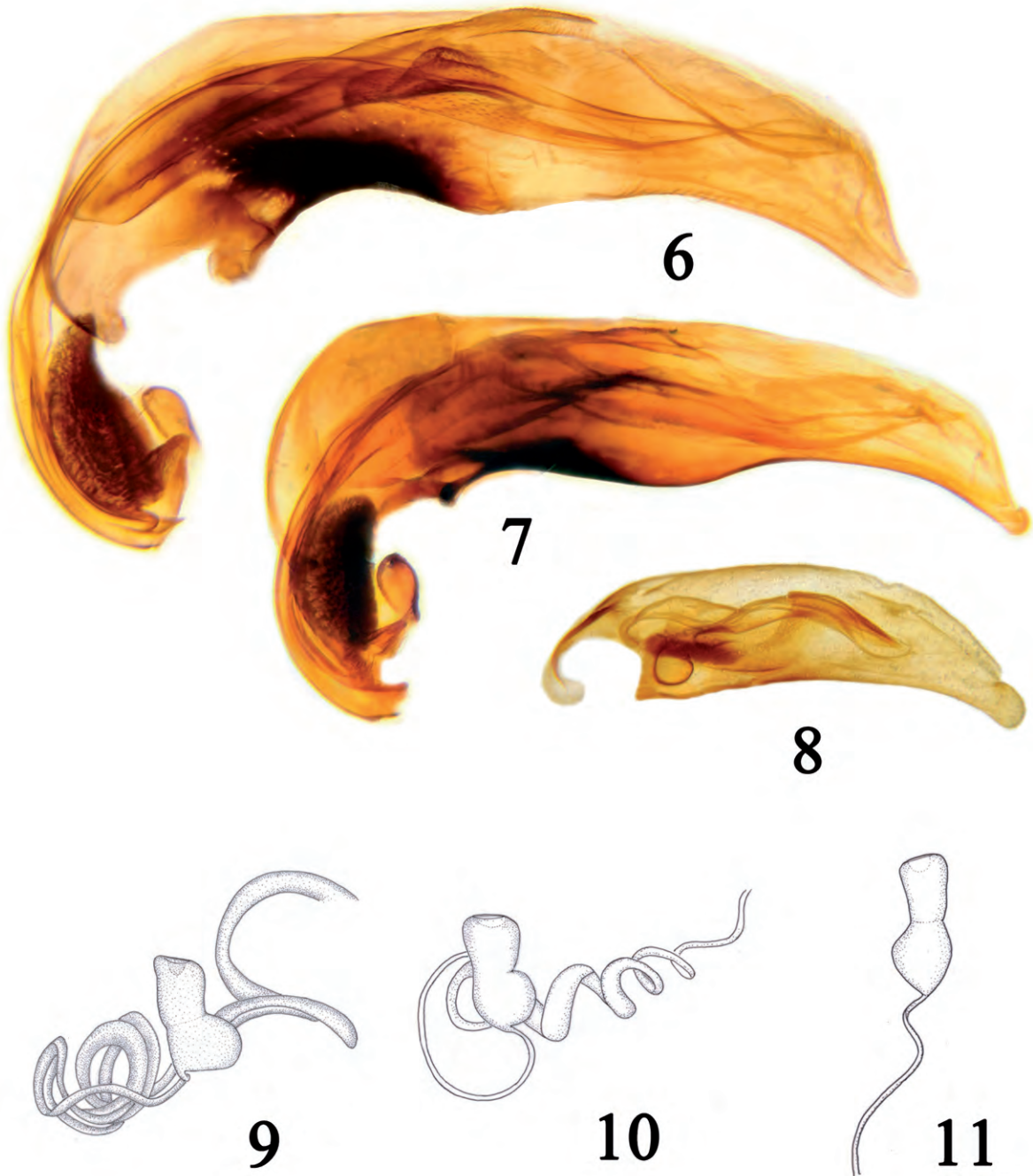
INTRASPECIFIC VARIABILITY. Paratypes range in length from 6.40 to 7.10 mm. The aedeagus is long, from 1.82 to 1.97 mm. Elytra more ovoid in the females; the elytra sometimes have a reddish reflection more or less evident according the maturity of the specimen. Antennomere 2 sometimes may be slightly darkened at apex and legs may be completely orange. Stria 7 can be barely visible, strongly evanescent.

Spermatheca: 0.14 mm (Fig. 9) with duct large and twisted (see figure).

DERIVATIO NOMINIS. The name, neutral, is an adjective and derives from the Safavid Dynasty that ruled Persia from 1501 to 1736.

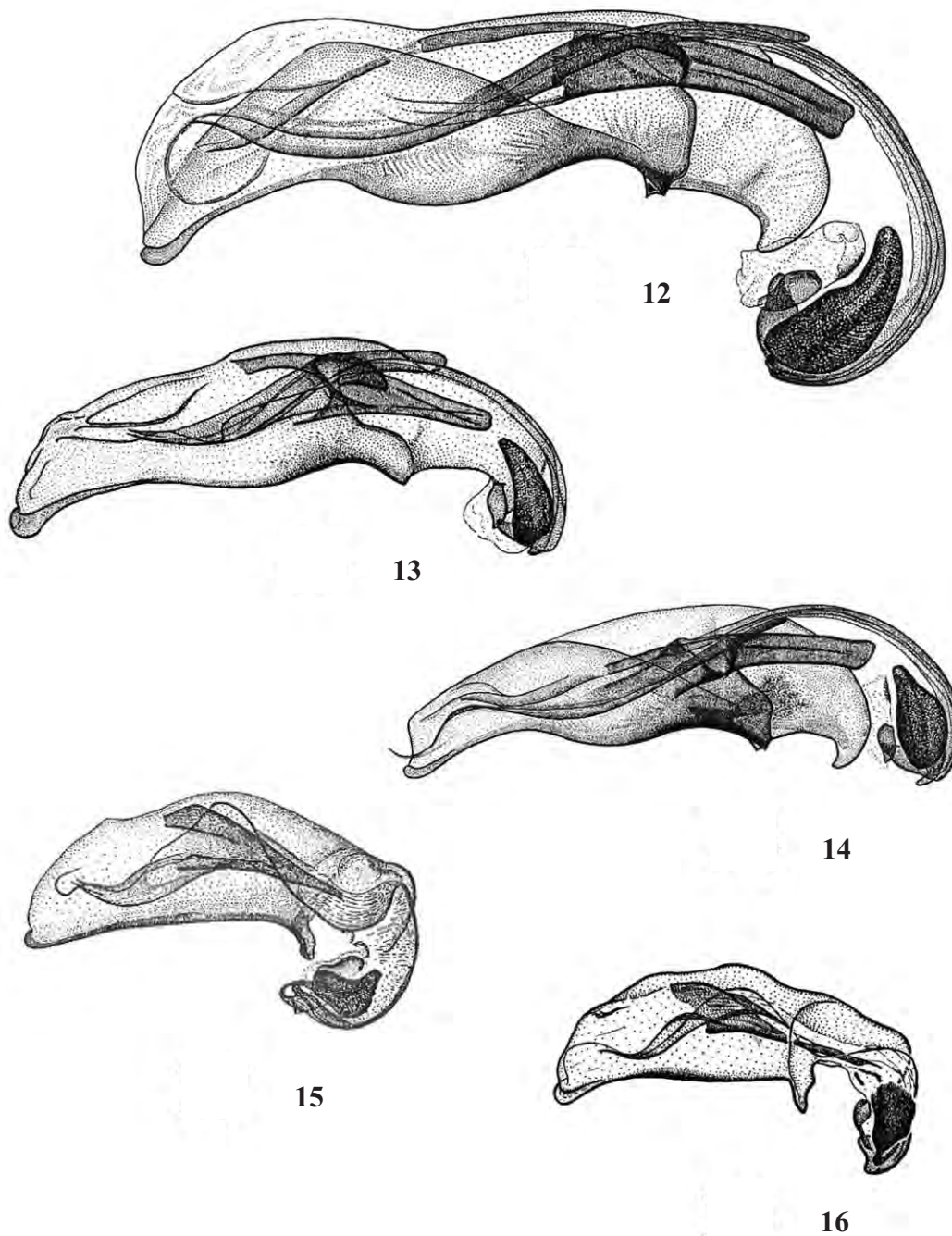
DISTRIBUTION. This taxon is at present known from the Central-Western Iranian Provinces and the and North Eastern Iraq.

COMPARATIVE NOTES. *B. grandipenne safavidense* n. ssp. differs from *grandipenne bulgardagense* Fassati, 1990 and *grandipenne freyi* Netolitzky, 1937 by the blue-blackish elytral colour and for the aedeagus with apical third less pointed; from *phryganobium* Belousov & Sokolov, 1996 by the blue-blackish elytral colour and by the more slender aedeagus; from *imereticum* Belousov & Sokolov, 1996 by the smaller size of body and aedeagus; from *olegleonidovici* Fassati, 1990 by the moderately ovoid elytra and the third antennomere 1.5 times as long as the second; from *grandipenne grandipenne* Schaum, 1862 for the eyes more protruding, moderately ovoid elytra, almost parallel in the basal third; from all the remaining *Peryphanes* species occurring in the region by the larger size of body and aedeagus.

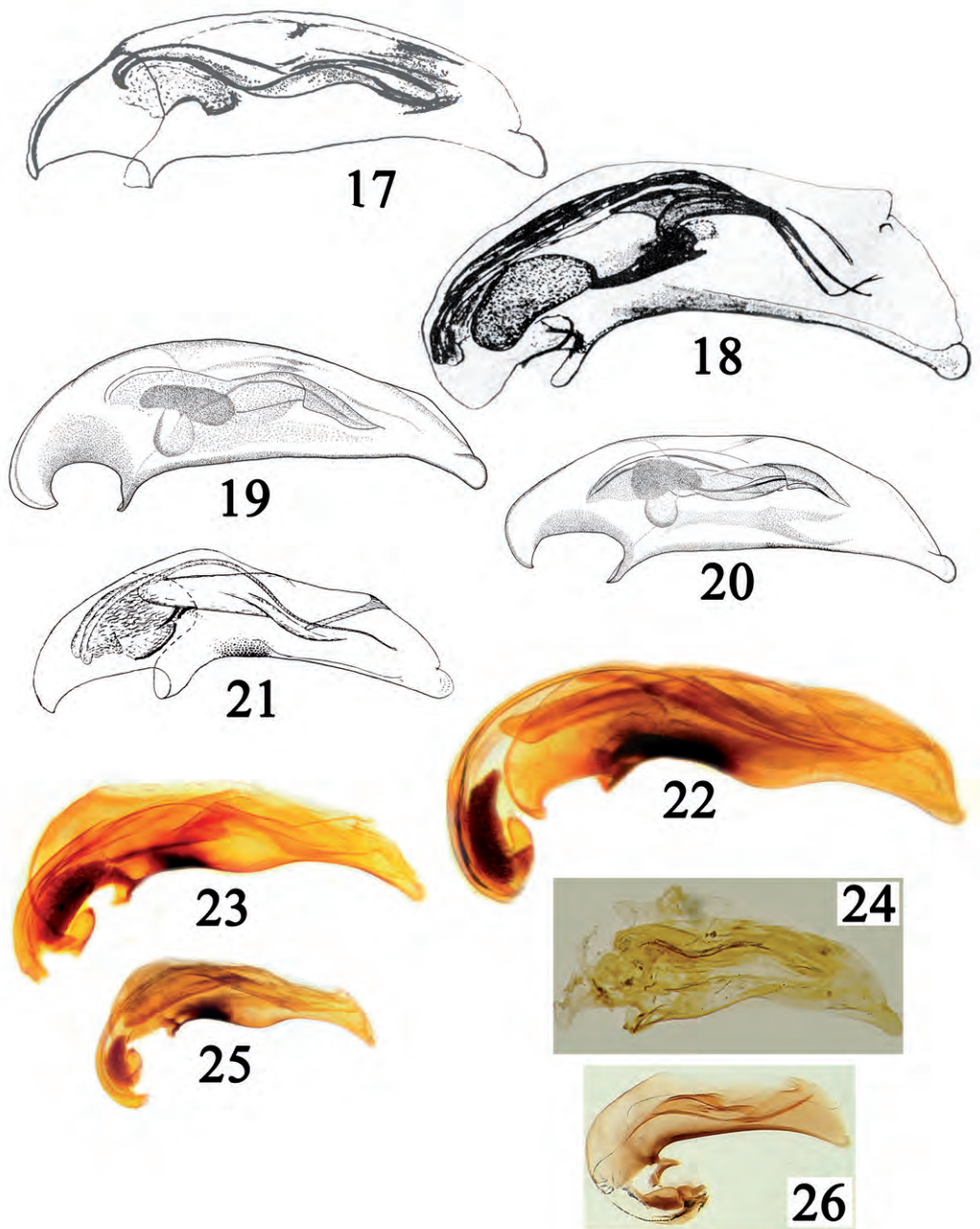


Figs. 6-8. Aedeagi of: 6. *Bembidion (Peryphanes) grandipenne safavidense* n.sp., holotype (CTVR), 1.82 mm; 7. *B. (P.) augusti* n.sp., holotype (CTVR), 1.61 mm; 8. *B. (P.) antennarium* (Morvan, 1972), Iran, Zagros Mts., p. Chahar Mahallva Bachtari, Boldaghi vill., Sibak 3km S (PN), 1.06 mm (photo Gabriele Fiumi).

Figs. 9-11. Spermathecae of: 9. *B. (P.) grandipenne safavidense* n.sp., paratypus, IR Lorestan Lake Gahar 2413 m (PN), 0.15 mm; 10. *B. (P.) augusti* n.sp., paratype, IR Kohkiloeh & B. Babahasan Pass (PN), 0.14 mm; 11. *B. (P.) antennarium* (Morvan, 1972), IR, Esfahan, 3 Km E Dena Peak, 3500 m (PN), 0.17 mm. Drawings of Ivo Gudenzi.



Figs. 12-16. Aedeagi of: 12 – *Bembidion (Peryphanes) imereticum* Belousov & Sokolov, 1996 (From Belousov & Sokolov, 1996); 13 – *B. (P.) olegleonidovici* Fassati; 14 – *B. (P.) phryganobium* Belousov & Sokolov, 1996 (From Belousov & Sokolov, 1996); 15 – *B. (P.) hissaricum* Netolitzky, 1943 (From Belousov & Sokolov, 1996); 16 – *B. (P.) lirykense* Reitter, 1908 (From Belousov & Sokolov, 1996).



Figs. 17-26. Aedeagi of: 17. *Bembidion* (*Peryphanes*) *weiratherianum* Netolitzky, 1932, holotype (from Müller-Motzfeld, 1986), 1.33 mm; 18. *B. (P.) kulzeri* Netolitzky, 1935, holotype (from Müller-Motzfeld, 1986), 1.50 mm; 19. *B. (P.) klimai* Neri & Gudenzi, 2013 paratype, (from Neri & Gudenzi, 2013), 1.24 mm; 20. *B. (P.) cilicicum* De Monte 1947, cotype (from Neri & Gudenzi, 2012), 1.15 mm; 21. *B. (P.) brunnicorne* Dejean, 1831 (from De Monte, 1943), 1.06 mm; 22. *Bembidion* (*P.*) *grandipenne* Schaum, 1862, Turkey, Yala Kuzdere (PN), 1.91 mm, (photo Gabriele Fiumi); 23. *B. (P.) dalmatinum* Dejean, 1831, Croazia (Dalmazia), Zara, cimitero (PN), 1.69 mm, (photo Gabriele Fiumi); 24. *B. (P.) weiratherianum* Netolitzky, 1932, paratypus, (from Neri & Gudenzi, 2012), 1.29 mm; 25. *B. (P.) morvanianum* Müller-Motzfeld, 1986, Iran, Zagros Mts., p. Cahar Mahall va Bachtari, Asad Abad 5 km SW, 2500-2770 m (PN), 1.10 mm (photo Gabriele Fiumi); 26. *B. (P.) geberti* Marggi, 2011, holotype (from Marggi, 2011), 1.10 mm.

KEYS FOR IDENTIFICATION OF *PERYPHANES*

FROM CAUCASUS (E: AB, AR, GG, ST),
ASIAN TURKEY (TR), IRAN (IN), AFGHANISTAN (AF),
MIDDLE EAST (CY, IQ, IS, LE, SY).

Abbreviations: A = distal cavity of spermatheca without annular narrowing; B = distal cavity of spermatheca with annular narrowing.

- 1 elytral microsculpture absent or present in the apical quarter only2
 - elytral microsculpture on whole elytra or at least in the apical half.....13
- 2 elytra with apical third testaceous reddish and/or preapical spots with edges more or less defined, sometimes barely visible3
 - elytra without preapical spots7
- 3 first antennomere and part of second and third testaceous-yellow, remaining antennomeres mostly or completely blackish; penultimate palpomere and femora, excluding apical third or apex, blackish; elytra microsculptured at maximum at apex; aedeagus long 1.46 to 1.57 mm, central brush protruding from basal opening and ventral margin with evident gibbosity; spermatheca A and spiralled duct; body long 5.20 to 5.95 mm; **E:** AB, AR; **A:** IN, IQ, SY, TR (Marggi *et al.*, 2017)
.....**dalmatinum haupti** Reitter, 1908
 - antennae completely blackish or with first antennomere reddish or only partly blackish; femora and palpi completely blackish or brown-blackish or femora reddish only at apex4
- 4 elytral microsculpture absent or present only at apex5
 - elytral microsculpture present at least in the apical quarter6
- 5 slightly larger species, 5.00 to 6.00 mm; elytra microsculptured at maximum at apex, preapical spots with more or less sharp edges and divided from one another, olive green brownish or blackish.brown; antennae, palpi and femora completely blackish; aedeagus with central brush

slightly protruding from basal opening and ventral margin with evident gibbosity long 1.35 mm; **A:** IN, TR (Marggi *et al.*, 2017)
.....**lacrimans** Netolitzky, 1935

- slightly smaller species, 4.70 to 4.90 mm; elytra without microsculpture, blackish-brown with two small yellowish preapical spots, apex blackish; antennae, palpi and femora blackish; aedeagus long 1.10 to 1.18 mm, with central brush completely protruding from basal opening, ventral margin without gibbosity (Fig. 26); **A:** TR (Marggi *et al.*, 2017)**geberti** Marggi, 2011
- 6 smaller species, 3.80 to 4.80 mm; elytra microsculptured in the apical fourth, apical spot lunate almost always reaching apex; antennae blackish with first antennomere from blackish to reddish, palpi blackish and femora blackish with reddish apex; aedeagus long 1.02 to 1.05 mm, with half of central brush protruding from basal opening, ventral margin with evident gibbosity (Fig. 25); spermatheca A and duct with a few spirals; **A:** AF, IN (Marggi *et al.*, 2017).....
.....**morvanianum** Müller-Motzfeld, 1986
 - larger species, 4.90 to 5.70 mm (Fig. 3); elytral microsculpture short and transverse or irregular from apical quarter or third, the microsculpture may be present also at sides, up to the shoulders, and lacking on the disc; elytra blackish with greenish-blue reflections and apical third dark reddish often with an orange spot; antennae and palpi completely brown-blackish; femora brown-blackish with extreme of apex barely reddish; aedeagus long 1.02 to 1.09 mm (Fig. 8), with central brush not or barely protruding from basal opening, apical third gradually narrowing towards apex, ventral margin more or less rectilinear, without gibbosity; spermatheca A and duct simple (Fig. 11); **A:** IN (Marggi *et al.*, 2017).....
.....**antennarium** (Morvan, 1972)
 - 7 elytra microsculptured at least in the apical fourth, often with more extended microsculpture; aedeagus, smaller, 0.95 to 1.33 mm, gibbosity of ventral margin absent or very faint, central brush only barely protruding from basal opening8

- elytra not microsculptured or with microsculpture only at apex: aedeagus larger, 1.38 to 1.62 mm, ventral margin with evident gibbosity, central brush evidently protruding from basal opening; spermatheca A with spiralled duct10
- 8 femora completely reddish-yellow; elytra with microsculpture reaching at least apical fourth, often more extended; antennae usually darkened from third or fourth antennomere, rarely completely reddish-yellow; elytra blue-greenish; aedeagus smaller, 0.95 to 1.06 mm, ventral margin without gibbosity (Fig. 21); spermatheca A with simple duct; body long 4.10 to 5.00 mm; E: AL, BH, BU, CR, FR, GG, GR, HU, MC, RO, SB, SL, ST, TR, YU (Marggi *et al.*, 2017); AB (Belousov & Sokolov, 1986); A: TR (Neri & Gudenzi, 2013)*brunnicornes* Dejean, 1831
- femora largely brown, darkened, with light apex9
- 9 larger species, 5.50 to 6.00 mm; wider pronotal base (1.07 to 1.12 mm) and maximum pronotal width (1.36 to 1.43 mm), pronotal base evidently wider than anterior margin; elytra microsculptured in transverse sculpticells in the apical fourth, microsculpture that may be barely visible also at sides almost up to the shoulders, central disc without microsculpture; aedeagus larger, 1.29 to 1.33 mm (Figs 17, 24); spermatheca B with simple duct; A: TR (Marggi *et al.* 2017).....*weiratherianum* Netolitzky, 1932
- smaller species, 4.60 to 5.50 mm; narrower pronotal base (0.86 to 1.00 mm) and maximum pronotal width (1.36 to 1.31 mm), base usually more or less as wide as the anterior margin; elytral microsculpture with transverse sculpticells at apex in the ♂♂, in the apical fourth in the ♀♀; aedeagus smaller, 1.13 to 1.17 mm, gradually narrowing towards apex, ventral margin rectilinear, with apical fourth slightly bent ventrally, central brush slightly protruding from basal opening (Fig. 20); spermatheca B with simple duct; A: TR (Marggi *et al.*, 2017).....*cilicicum cilicicum* De Monte, 1947
- 10 first antennomere brown or dark brown, remaining antennomeres dark brown, often with reddish base; palpi brown-blackish; legs brown with femora in part darkened; elytra brown, without microsculpture; aedeagus long 1.38 to 1.49 mm; body long 5.00 to 6.00 mm; E: BH, BU, GR, TR; A: IS, LE, SY, TR (Marggi *et al.*, 2017).....*castaneipenne* duVal, 1852
- first antennomere, sometimes also the second one, yellowish or light testaceous, remaining antennomeres more or less darkened; elytra metallic, dark blue-greenish11
- 11 femora yellow-reddish; elytra as a rule microsculptured only at the extreme apex; aedeagus long 1.50 mm; A: IS, LB (Marggi *et al.*, 2017); SY (Všetečka, 1941).....*dalmatinum levantinum* Všetečka, 1941
In Marggi *et al.* (2017) it is mentioned also from Cyprus; report to be cancelled (Neri & Toledano, in prep.).
- femora at least in part darkened.....12
- 12 temples short, oblique and eyes protruding; antennae darkened from second or third antennomere; elytral sides as a rule more or less parallel in the median third; elytral microsculpture present only at the extreme apex, sometimes microsculpture absent mainly in the ♀♀; aedeagus long 1.46 to 1.62 mm (Fig. 23); body long 4.9 to 6.0 mm; E: AL, AU, BH, BU, CR, CZ, GR, HU, MC, MD, RO, SK, SL, ST, TR, UK, YU; A: TR (Marggi *et al.*, 2017); CY (Neri & Toledano in press)..... *dalmatinum dalmatinum* Dejean, 1831
- temples longer and less oblique; antennae darkened from third antennomere; elytra as a rule more ovoid, microsculptured up to apical fifth; aedeagus long 1.51 mm; body long 4.5 to 5.8 mm; E: AB, AR, GG, ST; A: IN, TR (Marggi *et al.*, 2017).....*fraxator* Ménétériés, 1832
- 13 elytra with apical third dark reddish, often with an orange spot or elytra with more or less evident preapical spots.....14
- elytra without preapical spots16
- 14 antennae and palpi completely blackish-brown

- with extreme of apex barely reddish; elytra with apical third dark reddish often with an orange spot; elytral microsculpture with short, transverse sculpticells or irregular from apical fourth or third, microsculpture sometimes present also at sides up to the shoulders, missing on disc; body long 4.90 to 5.70 mm (Fig. 3); aedeagus long 1.02 to 1.09 mm (Fig. 8), with central brush not or slightly protruding from basal opening, apical third gradually narrowing towards apex, ventral margin more or less rectilinear, without gibbosity; spermatheca A with simple duct, not spiralled (Fig. 11); **A: IN** (Marggi *et al.*, 2017).....*antennarium* (Morvan, 1972)
- at least first antennomere light; elytra completely microsculptured with preapical spots more or less evident.....15
- 15 aedeagus long 1.42 to 1.61 mm (Fig. 7), central brush completely protruding from basal opening, ventral margin with evident gibbosity; penultimate palpomere darkened in the apical half; antennomere 1, sometimes also 2, light; femora more or less darkened for the basal two-thirds, sometimes almost completely; elytra blackish, with two preapical reddish spots with undefined edges, oblique, divided by interval 1, apex brown; the spots may be more or less visible, sometimes not visible in a few specimens; spermatheca A with spiralled duct (Fig. 10); body long 5.10 – 6.00 mm (Fig. 2); **A: IN***augusti* n. sp.
- aedeagus long 1.50 mm (Fig. 18), central brush partially protruding from basal opening, ventral margin without gibbosity; penultimate palpomere light, slightly darkened at apex; first three antennomeres and basal half of fourth as a rule light; femora barely darkened at base; elytra blue-blackish with small and slightly oblique preapical spots situated between stria 3 and 7; body long 5.50 to 6.00 mm; **A: TR** (Marggi *et al.*, 2017)*kulzeri* Netolitzky, 1935
 - aedeagus long 1.50 mm (Fig. 15), central brush completely protruding from basal opening, ventral margin without gibbosity; penultimate palpomere darkened; base of antennae largely light; legs light; elytra blue-blackish with small, light preapical spots with undefined edges; spermatheca B with simple duct; body long 4.00 to 5.00 mm; **A: KI, KZ, TD, UZ** (Marggi *et al.*, 2017)*hissaricum* Netolitzky, 1943
- 16 temples flat, only slightly oblique towards neck; eyes small and slightly convex; elytra evidently rounded with maximum width about at middle; antennae yellow-orange darkened from the apex of antennomere 4; legs completely yellow orange; elytra dark blueish with reddish reflections, completely microsculptured with very transverse sculpticells, thin and compact; aedeagus very large, 1.84 to 2.05 mm, with apical third in general bent ventrally and extreme of apex curved ventrally, ventral margin with evident gibbosity, central brush completely protruding from basal opening; spermatheca A with spiralled duct; body long 5.00 to 6.55 mm; probably in whole Europe, excluding Caucasian area; **A: TR** (Marggi *et al.*, 2017).....*stephensi* Crotch, 1866
The species is mentioned from Turkey and described as aberration (Salur, près Isparta, sub “*stephensi* ab. *angustus* nov.”; 1 ♂ 1 ♀ leg. Coiffait) by Schuler (1957); we were not able to study the typical series and we believe that the presence in the area should be checked.
- species without at least one of the above characters17
- 17 smaller species, 4.10 to 6.00 mm: aedeagus smaller, 0.95 to 1.61 mm;18
- larger species, 6.00 to 8.40 mm; aedeagus larger, 1.80 to 3.00 mm, always with ventral margin showing evident gibbosity; spermatheca with distal cavity showing one annular narrowing or, often, a trace of annular wrinkle24
- 18 femora completely yellow reddish, yellow orange or darkened only at base19
- femora completely darkened or slightly darkened, with light apex, or darkened only in the basal half20
- 19 femora completely yellow reddish; elytra microsculptured at least up to the apical fourth,

- very frequently more extensively, sometimes over the whole elytra; antennae normally darkened from third or fourth antennomere, rarely completely yellow reddish; elytra blue-greenish; aedeagus small, 0.95 to 1.06 mm (Fig. 21), ventral margin without gibbosity, central brush slightly protruding from basal opening; spermatheca A with simple duct; body long 4.10 to 5.00 mm; **E:** AL, BH, BU, CR, FR, GG, GR, HU, MC, RO, SB, SL, ST, TR, YU (Marggi *et al.*, 2017); **AB** (Belousov & Sokolov, 1986); **A:** TR (Neri & Gudenzi, 2013).....*brunnicornes* Dejean, 1831
- femora yellow reddish or yellow orange slightly darkened at base; antennae darkened from the distal half of antennomere third or fourth; elytra dark blue green with reddish reflection towards apex, completely microsculptured; aedeagus larger, 1.36 to 1.40 mm (Fig. 16), ventral margin without gibbosity, central brush almost completely protruding from basal opening; spermatheca B, twisted duct; body long 5.00 to 5.85 mm; **E:** AB, AR; **A:** IN (Marggi *et al.*, 2017).....*lirykense* Reitter, 1908
- 20 elytra completely microsculptured, with isodiametric sculpticells; head with temples only slightly oblique towards neck; antennae, penultimate palponere dark brown, femora dark brown excluding the extreme apex; elytra dark brownish with reddish reflections, with maximum width about at middle; medium sized aedeagus, 1.24 mm (Fig. 19), gradually narrowing towards the apex, ventral margin rectilinear with apical quarter evidently bent ventrally, central brush partially protruding from basal opening; spermatheca A with simple duct; body long 5 to 5.9 mm; **A:** TR (Marggi *et al.*, 2017).....*klimai* Neri & Gudenzi, 2012
- elytra with complete or partial microsculpture, with transverse sculpticells21
- 21 antennae with at least first antennomere yellow testaceous or yellow testaceous, slightly ferruginous from fourth antennomere22
- antennae completely dark brown23
- 22 antennae yellow testaceous, slightly ferruginous from fourth antennomere; femora testaceous slightly darkened; head with temples only slightly oblique towards neck; elytra dark brown, ovoid, evidently widened behind middle; subspecies described upon a single ♀; body long 5.30 mm; **A:** TR (Marggi *et al.*, 2017).....*cilicicum syriacum* De Monte, 1947
- first two antennomeres yellow testaceous and the following darkened from the apical half of the third one; femora darkened at least in the basal half; head with temples short and oblique; elytra with almost complete microsculpture but difficult to see in the basal half, more evident in the ♀♀; punctures of elytral striae deeply and strongly impressed, so that the intervals are convex; at basal third of striae 3 and 4 (often also of stria 2) the puncture separated by half their diameter (Fig. 5); aedeagus long 1.44 to 1.48 mm, half of central brush protruding from basal opening, ventral margin with evident gibbosity; spermatheca A with spiralled duct; body long 4.75 to 5.85 mm; **E:** AB, AR, GG, ST; **A:** TR (Marggi *et al.*, 2017).....*adygorum* Belousov & Sokolov, 1996
The mentions for Turkey of *deletum* Serville, 1821 (Neri & Toledano, 2013; Neri & Toledano, 2016) must be referred to *adygorum*.
 - first antennomere, sometimes also second one, light; femora more or less darkened for the apical two thirds, sometimes almost completely excluding apex; head with temples short and oblique; elytra completely microsculptured, rarely completely blackish, more frequently with two preapical reddish spots with undefined edges, oblique, divided by the first interval, apex brown; elytral striae normally punctured, elytral intervals flat, puncture separated by their diameter (Fig. 4); aedeagus long 1.42 to 1.61 mm (Fig. 7), central brush completely protruding from basal opening, ventral margin with evident gibbosity; spermatheca A with spiralled duct (Fig. 10); body long 5.10 to 6.00 mm (Fig. 2); **A:** IN*augusti* n. sp.
- 23 larger species, 5.50 to 6.00 mm; wider pronotal base (1.07 to 1.12 mm) and maximum pronotal width (1.36 to 1.43 mm), pronotal base evidently wider than anterior margin; elytral microsculpture in

- transverse sculpticells in the apical quarter, sometimes faint but visible also at sides almost up to the shoulders, disc without microsculpture; aedeagus larger, 1.29 to 1.33 mm (Figs. 17, 24); spermatheca B with simple duct; **A:** TR (Marggi *et al.*, 2017).....*weiratherianum* Netolitzky, 1932
- smaller species, 4.60 to 5.50 mm; narrower pronotal base (0.86 to 1.00 mm) and maximum pronotal width (1.36 to 1.31 mm), as a rule pronotal base as wide as the anterior margin; elytra with microsculpture in transverse sculpticells at apex in the ♂♂, in the apical quarter in the ♀♀; aedeagus smaller, 1.13 to 1.17 mm, gradually narrowing towards apex, ventral margin rectilinear with apical quarter slightly bent ventrally, central brush poorly protruding from basal opening (Fig. 20); spermatheca B with simple duct; **A:** TR (Marggi *et al.*, 2017)*cilicicum cilicicum* De Monte, 1947
- 24 elytra yellow reddish, yellow brownish, brown reddish, or brown25
- elytra blue or greenish-blue, shining, sometimes with reddish or brownish reflections26
- 25 mature specimens with elytra brown or dark brown and a greenish metallic lustre; eyes less convex and temples very short, almost absent; elytra gently rounded at sides; third antennomere 1.5 times as long as the second; subspecies described from southern slopes of Cilician Taurus, Central and Eastern Taurus up to Gyaour Dag (Fassati, 1990); aedeagus (1.91 mm) slender, of uniform width, with central brush almost completely protruding from basal opening; body long 6.70 to 7.50 mm; **E:** GG; **A:** TR (Marggi *et al.*, 2017).....*grandipenne bulgardagense* Fassati, 1990
- mature specimens with elytra from ochre yellow to light brown or brown; eyes less convex and temples very short, almost absent; elytra with almost parallel sides in the basal third, then evidently rounded; third antennomere 1.5 times as long as the second; subspecies described from Lebanon; aedeagus (1.91 mm) slender, of uniform width, with central brush almost completely or completely protruding from basal opening; body long 7.0 to 8.0 mm; **A:** IN, IS, LE, TR (Marggi *et al.*, 2017); SY (Fassati, 1990)*grandipenne freyi* Netolitzky, 1937
Possible misidentification with the former taxon. We believe that the presence of the subspecies in Turkey should be confirmed.
- elytra distinctly brownish; species on average smaller (6.00 to 7.25 mm); eyes more convex and temples more evident; third antennomere 1.75 times as long as the second; aedeagus (1.85 mm) with apical third more pointed (evidently thicker basally to the gibbosity than apically to the gibbosity), central brush completely protruding from basal opening (Fig. 14); distal cavity of spermatheca with a trace of annular wrinkle, twisted duct; **E:** AB (Marggi *et al.*, 2017)*phryganobium* Belousov & Sokolov, 1996
- 26 very large species, 7.10 to 8.40 mm; very large aedeagus (2.65 to 3.00 mm), central brush completely protruding from basal opening (Fig. 12); eyes small and poorly convex, temples long, barely oblique towards neck; antennae slightly darkened from the apical half of quarter antennomere, very long, reaching the middle of the elytra; elytra evidently widened in the apical third; distal cavity of spermatheca with a trace or annular wrinkle, duct wide and twisted; **E:** GG; **A:** TR (Marggi *et al.*, 2017).....*imereticum* Belousov & Sokolov, 1996
- species on average smaller (6.20 to 7.25 mm); eyes more convex with temples short and more oblique towards neck; aedeagus of large size (1.82 to 2.17 mm), central brush totally or partially protruding from basal opening.....27
- 27 elytra evidently rounded at sides, maximum elytral width at the middle and disc distinctly depressed; third antennomere slightly less than twice as long as the second; pronotal width / head width ratio 1.21 to 1.32; aedeagus long 2.17 mm, thicker all along its length (Fig. 13); spermatheca B, twisted duct; body long 6.60 to 7.25 mm; **E:** ST (Marggi *et al.*, 2017)*olegleonidovici* Fassati, 1990
- elytra more or less ovoid, with maximum width behind middle; third antennomere 1.5 times as long as the second one, or slightly more; pronotal

- width / head width ratio 1.17 to 1.23; aedeagus slender, less thick all along its length28
- 28 elytra ovoid with maximum width behind middle; head with eyes less protruding; aedeagus (1.82 to 2.11 mm) slender, of uniform width (Fig. 22); distal cavity of spermatheca with more or less evident annular narrowing, duct wide and twisted; body long 6.20 to 7.00 mm; **E:** AL, BU, GR, KO, MC, ME, YU; **A:** CY, IN, TR (Marggi *et al.*, 2017).....
.....**grandipenne grandipenne** Schaum, 1862
- elytra moderately ovoid, almost subparallel in the basal third, widening behind, with maximum width after the middle, especially in the ♀♀; head with eyes more protruding, aedeagus (1.82 to 1.97 mm) slender, with apical third more pointed (wider basally to the gibbosity than apically to the gibbosity) (Fig. 6); spermatheca with a duct wide and twisted (Fig. 9); body long 6.40 to 7.10 mm (Fig. 1); **A:** IN.....**grandipenne safavidense** n. ssp.
- CHIAVI DI IDENTIFICAZIONE DEI *PERYPHANES*
DEL CAUCASO (**E:** AB, AR, GG, ST),
TURCHIA ASIATICA (TR), IRAN (IN), AFGHANISTAN (AF),
MEDIO ORIENTE (CY, IQ, IS, LE, SY).
- La misura dell'edeago esclude la parte del pacchetto squamigero che fuoriesce dal bulbo basale. Abbreviazioni: A = cavità distale della spermateca senza strozzatura anulare; B = cavità distale della spermateca con strozzatura anulare.
- 1 elitre senza reticolazione o con questa presente solo nel quarto apicale2
 - elitre completamente reticolate o con reticolo presente almeno nella metà apicale13
 - 2 elitre con terzo apicale testaceo rossastro e/o due macchie preapicali, a contorni più o meno distinti e a volte appena visibili3
 - elitre senza macchie preapicali7
 - 3 primo articolo delle antenne e parte del secondo e del terzo giallo testaceo, i rimanenti in gran parte o totalmente, nerastri; penultimo articolo dei palpi e femori ad esclusione dell'ultimo terzo o dell'apice, nerastri; elitre reticolate al massimo all'apice; edeago 1.46 – 1.57 mm, pacchetto squamigero che fuoriesce dal bulbo basale e margine ventrale provvisto di notevole gibbosità; spermateca A, dotto spiraliforme; 5.20 - 5.95 mm; **E:** AB, AR; **A:** IN, IQ, SY, TR (Marggi *et al.*, 2017).....**dalmatinum haupti** Reitter, 1908
 - antenne completamente nerastre o con primo articolo rossastro o anche parzialmente nerastro; femori e palpi completamente nerastri o bruno nerastri o femori con solo l'apice rossastro4
 - 4 elitre senza microscultura o con reticolo al massimo all'apice5
 - elitre reticolate almeno nel quarto apicale6
 - 5 taglia più grande, 5.00 – 6.00 mm; elitre reticolate al massimo all'apice, macchie preapicali a margini più o meno distinti e divise tra loro, verde-oliva brunastre o bruno-nerastre; antenne, palpi e femori completamente nerastri; edeago con pacchetto squamigero che appena fuoriesce dal bulbo basale e margine ventrale provvisto di notevole gibbosità, 1.35 mm; **A:** IN, TR (Marggi *et al.*, 2017)
.....**lacrimans** Netolitzky, 1935
 - taglia appena più piccola, 4.70 – 4.90 mm; elitre senza microscultura, bruno nerastre con due piccole macchie preapicali giallastre, apice nerastro; antenne, palpi e femori nerastri; edeago, 1.10 – 1.18 mm, con pacchetto squamigero che fuoriesce completamente dal bulbo basale, margine ventrale senza gibbosità (Fig. 26); **A:** TR (Marggi *et al.*, 2017)**geberti** Marggi, 2011
 - 6 taglia più piccola, 3.80 – 4.80 mm; elitre reticolate nel quarto apicale, macchia apicale a forma di lunula quasi sempre raggiungente l'apice; antenne nerastre con primo articolo da nerastro a rossiccio, palpi nerastri e femori nerastri con apice rossiccio; edeago, 1.02 – 1.05 mm, con pacchetto squamigero che fuoriesce per metà dal bulbo basale, margine ventrale con evidente gibbosità (Fig. 25); spermateca A e dotto con alcune spirali; **A:** AF, IN (Marggi *et al.*, 2017)
.....**morvanianum** Müller-Motzfeld, 1986

- taglia più grande, 4.90 – 5.70 (Fig. 3); elitre con reticolo corto e trasverso o irregolare dal quarto o terzo apicale, il reticolo può essere presente anche ai lati fino agli omeri, è mancante sul disco; elitre nerastre con riflessi blu verdastri e terzo apicale rossastro scuro con spesso una macchia aranciata; antenne e palpi completamente bruno nerastri; femori bruno nerastri con estremo apice appena rossastro; edeago, 1.02 – 1.09 mm (Fig. 8), con pacchetto squamigero che non fuoriesce dal bulbo basale o fuoriesce ma rimane nel bulbo basale, terzo apicale che si attenua gradatamente verso l'apice, margine ventrale più o meno rettilineo, senza gibbosità; spermateca A e dotto semplice, senza spirali (Fig. 11); **A:** IN (Marggi *et al.*, 2017).....**antennarium** (Morvan, 1972)
- 7 elitre reticolate almeno nel quarto apicale, molto spesso reticolazione più estesa; edeago di dimensioni minori, 0.95 – 1.33 mm, margine ventrale senza o con leggerissima gibbosità, pacchetto squamigero che fuoriesce solo un poco ma all'interno del bulbo basale8
- elitre non reticolate o con reticolo presente solo all'apice; edeago di maggiori dimensioni, 1.38 – 1.62 mm, margine ventrale con evidente gibbosità, pacchetto squamigero che fuoriesce notevolmente dal bulbo basale; spermateca A, dotto spiraliforme10
- 8 femori completamente giallo rossicci; elitre reticolate almeno dal quarto apicale, molto spesso reticolazione più estesa; antenne solitamente inscurite dal terzo o quarto articolo, raramente completamente giallo rossicce; elitre bluastro verdastre; edeago di piccole dimensioni, 0.95 – 1.06 mm, margine ventrale senza gibbosità (Fig. 21); spermateca A, dotto semplice; 4.10 – 5.00 mm; **E:** AL, BH, BU, CR, FR, GG, GR, HU, MC, RO, SB, SL, ST, TR, YU (Marggi *et al.*, 2017); AB (Belousov & Sokolov, 1986); **A:** TR (Neri & Gudenzi, 2013).....**brunnicornes** Dejean, 1831
- femori in gran parte bruno inscuriti, con apice chiaro9
- 9 specie di maggiori dimensioni, 5.50 – 6.00 mm; pronoto più largo alla base (1.07-1.12 mm) e nel punto di larghezza massima (1.36-1.43 mm), base del pronoto evidentemente più larga del margine anteriore; elitre reticolate a maglie trasverse nel quarto apicale, reticolo che può essere accennato anche ai lati fino quasi agli omeri, disco centrale senza reticolazione; edeago di maggiori dimensioni, 1.29 – 1.33 mm (Figg. 17, 24); spermateca B, dotto semplice; **A:** TR (Marggi *et al.*, 2017).....**weiratherianum** Netolitzky, 1932
- specie di minori dimensioni, 4.60 – 5.50 mm; pronoto più stretto alla base (0.86 - 1.00 mm) e nel punto di larghezza massima (1.31 -1.36 mm), base larga più o meno come il margine anteriore; elitre con reticolo a maglie trasverse all'apice nei ♂♂, nel quarto apicale nelle ♀♀; edeago di minori dimensioni, 1.13 – 1.17 mm, che si attenua gradualmente verso l'apice, margine ventrale lineare con quarto apicale appena piegato ventralmente, pacchetto squamigero che fuoriesce ma all'interno del bulbo basale (Fig. 20); spermateca B, dotto semplice; **A:** TR (Marggi *et al.*, 2017).....**cilicicum cilicicum** De Monte, 1947
- 10 antenne con primo articolo castano o castano inscurito, i rimanenti castani inscuriti spesso con base rossiccia; palpi castano nerastri; zampe castane con femori in parte inscuriti; elitre castane, senza reticolazione; edeago 1.38 – 1.49 mm; 5.00 – 6.00 mm; **E:** BH, BU, GR, TR; **A:** IS, LE, SY, TR (Marggi *et al.*, 2017)**castaneipenne** duVal, 1852
- antenne con primo articolo giallastro o testaceo chiaro, a volte anche il secondo, i rimanenti più o meno inscuriti; elitre blu verdastro metallico scure11
- 11 femori giallo rossastri; elitre reticolate solitamente all'estremo apice; edeago 1.50 mm; **A:** IS, LB (Marggi *et al.*, 2017); SY (Všetečka, 1941);**dalmatinum levantinum** Všetečka, 1941
In Marggi *et al.* (2017) è segnalato anche Cipro; areale da depennare (Neri & Toledano, in prep.).
- femori almeno parzialmente inscuriti12
- 12 tempie corte, notevolmente oblique e occhi sporgenti; antenne inscurite dal secondo o terzo articolo; lati delle elitre solitamente, nel terzo

- mediano, più o meno paralleli; elitre reticolate solo all'estremo apice, a volte reticolo assente soprattutto nelle ♀♀; edeago 1.46 – 1.62 mm (Fig. 23); 4.90 – 6.00 mm; **E:** AL, AU, BH, BU, CR, CZ, GR, HU, MC, MD, RO, SK, SL, ST, TR, UK, YU; **A:** TR (Marggi *et al.*, 2017); CY (Neri & Toledano in prep.)
.....**dalmatinum dalmatinum** Dejean, 1831
- tempie più lunghe e meno oblique; occhi meno sporgenti; antenne inscurite dal terzo articolo; elitre solitamente più ovoidali, reticolate dal quinto apicale; edeago 1.51 mm; 4.50 – 5.80 mm; **E:** AB, AR, GG, ST; **A:** IN, TR (Marggi *et al.*, 2017).....
.....**fraxator** Ménétriés, 1832
 - 13 elitre con terzo apicale rossastro scuro con spesso una macchia aranciata o elitre con macchie preapicali più o meno evidenti.....14
 - elitre senza macchie preapicali16
 - 14 antenne e palpi completamente bruno nerastri, femori bruno nerastri con estremo apice appena rossastro; elitre con terzo apicale rossastro scuro con spesso una macchia aranciata; elitre con reticolo corto e trasverso o irregolare dal quarto o terzo apicale, il reticolo può essere presente anche ai lati fino agli omeri, è mancante sul disco; 4.90 – 5.70 mm (Fig. 3); edeago, 1.02 – 1.09 mm (Fig. 8), con pacchetto squamigero che non fuoriesce dal bulbo basale o fuoriesce ma rimane nel bulbo basale, terzo apicale che si attenua gradatamente verso l'apice, margine ventrale più o meno rettilineo, senza gibbosità; spermateca A, dotto semplice (Fig. 11); **A:** IN (Marggi *et al.*, 2017) ...
.....**antennarium** (Morvan, 1972)
 - antenne con almeno il primo articolo chiaro; elitre completamente reticolate con macchie preapicali più o meno evidenti.....15
 - 15 edeago 1.42 – 1.61 mm (Fig. 7), pacchetto squamigero che fuoriesce completamente dal bulbo basale, margine ventrale con notevole gibbosità; penultimo articolo dei palpi inscurito nella metà apicale; antenne con il primo o anche il secondo articolo chiaro; femori più o meno inscuriti per due terzi, a volte quasi totalmente; elitre nerastre, con due macchie preapicali rossastre, a contorni indefiniti, oblique, divise dalla prima interstria, apice bruno; le macchie possono essere più o meno visibili fino a scomparire in alcuni esemplari; spermateca A, dotto spiraliforme (Fig. 10); 5.10 – 6.00 mm (Fig. 2); **A:** IN.....
.....**augusti** n. sp.
 - edeago 1.50 mm (Fig. 18), pacchetto squamigero che fuoriesce all'interno del bulbo basale, margine ventrale senza gibbosità; penultimo articolo dei palpi chiaro, appena inscurito all'apice; antenne con i prime tre articoli e metà del quarto solitamente chiari; femori appena inscuriti alla base; elitre nero bluastre con macchie preapicali piccole e leggermente oblique poste tra la terza e la sesta stria; 5.50 – 6.00 mm; **A:** TR (Marggi *et al.*, 2017)**kulzeri** Netolitzky, 1935
 - edeago 1.50 mm, pacchetto squamigero che fuoriesce completamente dal bulbo basale, margine ventrale senza gibbosità (Fig. 15); penultimo articolo dei palpi inscurito; base antennale estesamente chiara; zampe chiare; elitre nero bluastre con macchie preapicali piccole, chiare, a margine indistinto; spermateca B, dotto semplice; 4.00- 5.00 mm; **A:** KI, KZ, TD, UZ (Marggi *et al.*, 2017)
.....**hissaricum** Netolitzky, 1943
 - 16 tempie piatte e solo leggermente oblique verso il collo; occhi piccoli e appena convessi; elitre notevolmente tondeggianti con la massima larghezza situata verso la metà; antenne giallo aranciate inscurite dall'apice del quarto articolo; zampe completamente giallo aranciate; elitre bluastre scure con riflessi rossastri, completamente reticolate a maglie molto trasverse, fini e serrate; edeago molto grande, 1.84 – 2.05 mm, con terzo apicale normalmente piegato ventralmente ed estremo apice maggiormente curvato ventralmente, margine ventrale con evidente gibbosità, pacchetto squamigero che fuoriesce completamente dal bulbo basale; spermateca A, dotto spiraliforme; 5.00 – 6.55 mm; probabilmente in tutta Europa escluso l'area caucasica; **A:** TR (Marggi *et al.*, 2017).....**stephensi** Crotch, 1866
La specie è citata di Turchia e descritta come aberrazione (Salur, près Isparta, sub "*stephensi* ab. *angustus* nov."; 1 ♂ 1 ♀ leg. Coiffait) da Schuler (1957);

- non siamo riusciti a trovare la serie tipica; riteniamo che la presenza nell'area debba essere verificata.
- specie che si differenziano almeno per un carattere tra quelli sopracitati17
 - 17 specie di taglia minore, 4.10 – 6.00 mm: edeago di taglia minore, 0.95 – 1.60 mm18
 - specie di taglia maggiore, 6.00 – 8.40 mm; edeago di taglia maggiore, 1.80 – 3.00 mm, tutti con margine ventrale provvisto di notevole gibbosità; spermateca con cavità distale provvista di una strozzatura anulare o solitamente di un accenno di piega anulare24
 - 18 femori completamente giallo rossicci, giallo aranciati o inscuriti solo alla base19
 - femori completamente inscuriti o leggermente inscuriti, con apice chiaro, oppure inscuriti per metà20
 - 19 femori completamente giallo rossicci; elitre reticolate almeno dal quarto apicale, molto spesso reticolazione più estesa, anche completa; antenne solitamente inscurite dal terzo o quarto articolo, raramente completamente giallo rossicce; elitre bluastro verdastre; edeago di piccole dimensioni, 0.95 – 1.06 mm, margine ventrale senza gibbosità, pacchetto squamigero che fuoriesce ma all'interno del bulbo basale (Fig. 21); spermateca A, dotto semplice; 4.10 – 5.00 mm; **E:** AL, BH, BU, CR, FR, GG, GR, HU, MC, RO, SB, SL, ST, TR, YU (Marggi *et al.*, 2017); AB (Belousov & Sokolov, 1986); **A:** TR (Neri & Gudenzi, 2013)*brunnicornes* Dejean, 1831
 - femori giallo rossicci o giallo aranciati leggermente inscuriti alla base; antenne inscurite dalla metà del terzo o quarto articolo; elitre blu verde scuro con riflessi rossastri verso l'apice, completamente reticolate; edeago di maggiori dimensioni, 1.36 – 1.40 mm, margine ventrale senza gibbosità, pacchetto squamigero che fuoriesce quasi completamente dal bulbo basale (Fig. 16); spermateca B, dotto contorto; 5.00 – 5.85 mm; **E:** AB, AR; **A:** IN (Marggi *et al.*, 2017)*lirykense* Reitter, 1908
 - 20 elitre completamente reticolate a maglie isodiametriche; capo con tempie solo leggermente oblique verso il collo; antenne, penultimo articolo dei palpi bruno oscurati, femori bruno oscurati escluso l'estremo apice; elitre brunastre scure con riflessi rossastri, con la massima larghezza circa alla metà; edeago di medie dimensioni, 1.24 mm, che si attenua gradualmente verso l'apice, margine ventrale lineare con quarto apicale chiaramente piegato ventralmente, pacchetto squamigero che fuoriesce ma all'interno del bulbo basale (Fig. 19); spermateca A, dotto semplice; 5 – 5.9 mm; **A:** TR (Marggi *et al.*, 2017)*klimai* Neri & Gudenzi, 2012
 - elitre con reticolo, totale o parziale, a maglie trasverse21
 - 21 antenne con almeno il primo articolo giallo testaceo oppure giallo testaceo leggermente ferruginee dal quarto articolo22
 - antenne completamente bruno oscurate23
 - 22 antenne giallo testacee, leggermente ferruginee dal quarto articolo; femori testacei appena inscuriti; capo con tempie solo leggermente oblique verso il collo; elitre a colorazione bruno scura, ovoidali, molto allargate dopo la metà; sottospecie descritta su di una sola ♀; 5.30 mm; **A:** TR (Marggi *et al.*, 2017)♀ *cilicicum syriacum* De Monte, 1947
 - antenne con i primi due articoli giallo testacei ed i seguenti oscurati dalla metà del terzo; femori oscurati almeno per metà; capo con tempie brevi ed oblique; elitre quasi completamente reticolate, ma di difficile visibilità nella metà basale, maggiormente distinguibile nelle ♀♀; strie elitrali fortemente e profondamente punteggiate, tanto che le interstrie appaiono leggermente convesse; nel terzo basale delle strie 3 e 4 (spesso anche della 2) la distanza tra i punti è uguale alla metà della larghezza di un punto (Fig. 5); edeago, 1.44 – 1.48 mm, pacchetto squamigero che fuoriesce per metà dal bulbo basale, margine ventrale con evidente gibbosità; spermateca A, dotto spiraliforme; 4.75 – 5.85 mm; **E:** AB, AR, GG, ST; **A:** TR (Marggi *et al.*, 2017)*adygorum* Belousov & Sokolov, 1996

- Le citazioni per la Turchia di *deletum* Serville, 1821 (Neri & Toledano, 2013; Neri & Toledano, 2016) sono da riferirsi ad *adygorum*.
- antenne con il primo articolo, a volte anche il secondo, chiaro; femori più o meno inscuriti per due terzi, a volte quasi totalmente escluso l'apice; capo con tempie brevi ed oblique; elitre completamente reticolate, raramente completamente nerastre, più spesso con due macchie preapicali rossastre, a contorni indefiniti, oblique, divise dalla prima interstria, apice bruno; strie elitrali normalmente punteggiate, interstria piana, la distanza tra i punti è pari alla grandezza del punto (Fig. 4); edeago 1.42 – 1.61 mm (Fig. 7), pacchetto squamigero che fuoriesce completamente dal bulbo basale, margine ventrale con notevole gibbosità; spermateca A, dotto spiraliforme (Fig. 10); 5.10 – 6.00 mm (Fig. 2); **A:** IN*augusti* n. sp.
 - 23 specie di maggiori dimensioni, 5.50 – 6.00 mm; pronoto più largo alla base (1.07-1.12 mm) e nel punto di massima larghezza (1.36 -1.43 mm), base evidentemente più larga del margine anteriore; elitre reticolate a maglie trasverse nel quarto apicale, reticolo che può essere accennato anche ai lati fino quasi agli omeri, disco centrale senza reticolazione; edeago di maggiori dimensioni, 1.29 – 1.33 mm (Figg. 17, 24); spermateca B, dotto semplice; **A:** TR (Marggi *et al.*, 2017)*weiratherianum* Netolitzky, 1932
 - specie di minori dimensioni, 4.60 – 5.50 mm; pronoto più stretto alla base (0.86 - 1.00 mm) e nel punto di massima larghezza (1.36 - 1.31 mm), base in genere larga quanto il margine anteriore; elitre con reticolo a maglie trasverse all'apice nei ♂♂, nel quarto apicale nelle ♀♀; edeago di minori dimensioni, 1.13 – 1.17 mm, che si attenua gradualmente verso l'apice, margine ventrale lineare con quarto apicale appena piegato ventralmente, pacchetto squamigero che fuoriesce ma all'interno del bulbo basale (Fig. 20); spermateca B, dotto semplice; **A:** TR (Marggi *et al.*, 2017)*cilicicum cilicicum* De Monte, 1947
 - 24 elitre giallo rossastre, giallastre, giallo brunastre, brunastre rossastre o marroni25
 - elitre blu o blu verdastre, splendenti, a volte con riflessi rossastri o brunastri26
 - 25 esemplari maturi con elitre color marrone o marrone scuro e un riflesso metallico verdastro; occhi meno convessi e tempie cortissime, indistinte; elitre a lati debolmente arrotondati; terzo articolo delle antenne una volta e mezzo la lunghezza del secondo; sottospecie descritta delle pendici meridionali del Tauro di Cilicia, Tauro centrale e orientale fino al Gyaour dag (Fassati 1990); edeago (1.91 mm) slanciato, di larghezza uniforme, con pacchetto squamigero che fuoriesce quasi completamente dal bulbo basale; 6.7 – 7.5 mm; **E:** GG; **A:** TR (Marggi *et al.*, 2017)*grandipenne bulgardagense* Fassati, 1990
 - esemplari maturi con elitre da giallo ocre a marrone chiaro o marrone; occhi meno convessi e tempie cortissime, indistinte; elitre con lati, nel primo terzo, quasi paralleli, poi fortemente arrotondati; terzo articolo delle antenne una volta e mezzo la lunghezza del secondo; sottospecie descritta del Libano; edeago (1.91 mm) slanciato, di larghezza uniforme, con pacchetto squamigero che fuoriesce completamente o quasi completamente dal bulbo basale; 7.0 – 8.0 mm; **A:** IN, IS, LE, TR (Marggi *et al.*, 2017); SY (Fassati, 1990)*grandipenne freyi* Netolitzky, 1937
Possibile confusione con il taxon precedente. Riteniamo che la presenza della sottospecie in Turchia debba essere confermata.
 - elitre distintamente brunastre; specie mediamente più piccola (6.00 – 7.25 mm); occhi più convessi e tempie più distinte; terzo articolo delle antenne una volta e tre quarti la lunghezza del secondo; edeago, 1.85 mm (Fig. 14), con terzo apicale più attenuato (larghezza, prima della gibbosità, notevolmente più grande della larghezza dopo la gibbosità), pacchetto squamigero completamente fuoriuscito dal bulbo basale; cavità distale della spermateca con un accenno di piega anulare, dotto contorto; **E:** AB (Marggi *et al.*, 2017)*phryganobium* Belousov & Sokolov, 1996
 - 26 specie di grande taglia, 7.10 – 8.40 mm; edeago enorme (2.65 - 3.00 mm), pacchetto squamigero che fuoriesce completamente dal bulbo basale (Fig. 12);

- occhi piccoli e poco convessi, tempie lunghe, appena oblique verso il collo; antenne appena inscurite dalla metà del quarto articolo, molto lunghe, raggiungenti la metà delle elitre; elitre notevolmente allargate nel terzo apicale; cavità distale della spermateca con un accenno di piega anulare, dotto ampio e contorto; **E:** GG; **A:** TR (Marggi *et al.*, 2017).....
*imereticum* Belousov & Sokolov, 1996
- specie di taglia mediamente inferiore (6.20 – 7.25 mm); occhi più convessi con tempie corte e più oblique verso il collo; edeago di grande taglia, 1.82 – 2.17 mm, pacchetto squamigero che fuoriesce totalmente o parzialmente dal bulbo basale27
- 27 elitre ampiamente arrotondate ai lati, il punto più largo è posto a metà della loro lunghezza e il disco è distintamente depresso; terzo articolo delle antenne poco meno di due volte la lunghezza del secondo; larghezza del pronoto / larghezza del capo: 1.21-1.32; edeago 2.17 mm, dall'aspetto più voluminoso per tutta la sua lunghezza (Fig. 13); spermateca B, dotto contorto; 6.60 – 7.25 mm; **E:** ST (Marggi *et al.*, 2017)
*olegleonidovici* Fassati, 1990
- elitre più o meno ovoidali, che hanno la maggiore larghezza dopo la metà; terzo articolo delle antenne una volta e mezzo, o poco più, la lunghezza del secondo; larghezza del pronoto / larghezza del capo: 1.17 - 1.23; edeago slanciato, dall'aspetto meno voluminoso per tutta la sua lunghezza28
- 28 elitre ovoidali che hanno la maggiore larghezza dopo la metà; capo con occhi meno sporgenti; edeago (1.82 – 2.11 mm) slanciato, di larghezza uniforme (Fig. 22); cavità distale della spermateca con strozzatura anulare più o meno distinta, dotto ampio e contorto; 6.20 – 7.00 mm; **E:** AL, BU, GR, KO, MC, ME, YU; **A:** CY, IN, TR (Marggi *et al.*, 2017).....
*grandipenne grandipenne* Schaum, 1862
- elitre moderatamente ovoidali, nel primo terzo quasi subparallele, che si allargano posteriormente ed hanno la maggiore larghezza dopo la metà, particolarmente nelle ♀♀; capo con occhi più sporgenti; edeago 1.82 – 1.97 mm (Fig. 6), slanciato, con terzo apicale più attenuato (larghezza, prima della gibbosità, più grande della larghezza dopo la gibbosità); spermateca con dotto ampio e contorto (Fig. 9); 6.40 – 7.10 mm (Fig. 1); **A:** IN.....*grandipenne safavidense* n. ssp.

ACKNOWLEDGEMENTS

We wish to thank Jan Muilwijk (Bilthoven), Peer Schnitter (Halle), Christoph Reuter (Hamburg) and David Wrase (Gusow - Platkow), for kindly allowing us to study the material in their availability, this last also for some corrections to the final text; Werner Marggi (Thun), Igor Belousov (Saint Petersburg) and Maurizio Pavesi (Milano) for useful contributions or concessions; Ivo Gudenzi (Forlì) for the drawings; Gabriele Fiumi (Forlì) for some photos, software editing (Adobe Photoshop CS3) and layout of tables; Paolo Bonavita (Roma) and Achille Casale (Torino) for the critical review of the text; Jon Cooter (Oxford) for the linguistic correction.

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Bembidiina of Afrotropical Region. 2- *Odontium* subg. *Microserrullula* Netolitzky, 1921 (Coleoptera, Carabidae, Bembidiina)

Abstract: The Afrotropical species of the subgenus *Microserrullula* Netolitzky, 1921, of the genus *Odontium* LeConte, 1848 are here revised. We redescribe the three-known species, *Odontium aegyptiacum* (Dejean, 1831), *O. icterodes* (Alluaud, 1933) and *O. pogonopsis* (Alluaud, 1933), and describe four new species: *Odontium australe* n. sp. (Kenya, Mozambique, Madagascar, South Africa); *Odontium basilewskyi* n. sp. (Democratic Republic of Congo); *Odontium okavangum* n. sp. (Angola, Namibia, Zambia); *Odontium clarkei* n. sp. (Ethiopia). A key for the identification of the African species of the subgenus *Microserrullula* is presented.

Riassunto: *Bembidiina della regione afrotropicale. 2- Odontium subg. Microserrullula* Netolitzky, 1921 (Coleoptera, Carabidae, Bembidiina). Le specie afrotropicali del sottogenere *Microserrullula* Netolitzky, 1921, del genere *Odontium* LeConte, 1848, sono revisionate. Vengono ridescritte le tre specie già conosciute, *Odontium aegyptiacum* (Dejean, 1831), *O. icterodes* (Alluaud, 1933) e *O. pogonopsis* (Alluaud, 1933), e descritte quattro nuove specie: *Odontium australe* n. sp. (Kenya, Mozambique, Madagascar, South Africa); *Odontium basilewskyi* n. sp. (Democratic Republic of Congo); *Odontium okavangum* n. sp. (Angola, Namibia, Zambia); *Odontium clarkei* n. sp. (Ethiopia). Viene inoltre presentata una chiave di identificazione di tutte le specie africane.

Key words: Africa, new taxa, identification key, distribution, *Bembidion*.

To meet the requirements by the International Code of Zoological Nomenclature (ICZN), this article was registered at ZooBank (31 March 2021) under the ZooBank Life Science Identifier (LSID): F373E758-1BCE-4982-AAAE-07BC3432406E.
Published: 23 April 2021.

INTRODUCTION

This paper continues the work series on the review of Afrotropical Bembidiina, after Bonavita *et al.* (2016) on *Omotaphus* Netolitzky, 2014.

Netolitzky (1910) described *Serrula* as subg. of *Bembidion* Latreille, 1802 for the species *Bembidion aegyptiacum* Dejean, 1831 (type species), *quadricolle* (Motschulsky, 1844) and *apicale* Ménetriés, 1832, and considered the new subgenus near to the subg. *Pogonidium* Ganglbauer, 1891.

Netolitzky (1921) himself renamed *Serrula* (nomen praeoccupatum) as *Microserrullula*. Then, only Alluaud (1933, as subg. of *Bembidion*) and Schuler (1959, as genus) take up the study of *Microserrullula*, producing a key for species identification, with Schuler also drawing the picture of genitalia of some of the species.

At present we know 11 species (Lorenz, 2005: 217), three of which occur in Afrotropical region. These are reviewed in this paper and four new ones are described for the same area.

Following Maddison (2012), we consider here *Microserrullula* as subgenus in the “*Odontium* series”. In our opinion, however, such “series” should

be considered as a good genus, and not only as a group inside the big genus *Bembidion*.

MATERIALS AND METHODS

We studied a lot of material, from the following museums and private collections.

Museums: The Carnegie Museum of Natural History, Pittsburgh, USA (CMNH); Museum für Naturkunde, Berlin, Germany (MNB); Muséum national d'Histoire naturelle, Paris, France (MNHN); Naturalis Biodiversity Center Leiden, Holland (NBCL); Naturhistorisches Museum Wien, Austria, general collection, included coll. Hauser and coll. ex mus. Vindob (NHMW-V), coll. Netolitzky (NHMW-N), coll. Meyer (NHMW-M); Musée Royal de l'Afrique Centrale, Tervuren, Belgique (MRAC); Natural History Museum, London, Great Britain (NHML); Royal Belgian Institute of Natural Sciences, Bruxelles, Belgique (RBINS); Ditsong National Museum of Natural History, Pretoria, RSA (former Transvaal Museum) (DNMNH).

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Acronyms of measured or derived sizes:

- TB – total body length, from the apex of clypeus to the apex of elytra
- WP – maximum width of pronotum
- LP – length of pronotum, measured along the median line
- BP – width of the base of pronotum, measured between the two hind angles.
- AP – width of pronotum in the anterior part, measured from right to left front angle.
- LWP – length/width ratio of pronotum
- LE – length of elytra, from the base of scutellum to the apex of elytra
- WE – maximum width of elytra
- AL – aedeagus length
- SL – spermatheca length

DIAGNOSIS AND DESCRIPTION OF *MICROSERRULLULA*

Microserrullula is a very characteristic subgenus of *Odontium* LeConte, 1848. The main characteristics are: prominent suborbital ridge, serrulate elytral margin, brush sclerite missing, two flagelliform sclerites of the median lobe of aedeagus more or less long, or very long, parameres bearing two setae.

GENERAL CHARACTERISTICS. Relatively large Bembidiina species, from 4.88 mm for *Odontium icterodes* (Alluaud, 1933), to 6.28 mm for *Odontium clarkei* n. sp., with pronotum broad and transverse, and habitus “*Pogonus*-like”. Colour uniform, generally with a yellow apical spot, more or less defined. Microsculpture occurs always on the head and pronotum, with isodiametric sculpticells, and on the entire elytra, with isodiametric to transverse sculpticells.

HEAD. Frontal furrows simple and parallel, so superficial (more than in *Bracteon* Bedel, 1879, where

they are slightly deepened) to result sometimes indistinguishable or almost so; prominent suborbital ridge. Mentum with only one simple central tooth.

THORAX. Pronotum flat, with broad base; furrow between the internal and external fovea more or less impressed; laterobasal carina reduced or missing; the lateral margin presents, at the fore angles, a serrulation similar to the elytral margin, but very reduced, with only 3-7 small setae re-approached; lateral setae at the basal angle and at middle. Metasternal process simple, prominent, not bordered.

ELYTRA. Serrulate elytral margin; humeral margin angled, until the base of the fourth or the fifth elytral stria. Umbilical series: 4 humeral setae + (2+2) sub-apical setae, with seta eo1 often detached from eo2-eo4, as in *Bracteon* (Maddison, 1993). Striae less or more deepened and punctulate, evident to the apex. Two setae, discal and apical, on the third interval, but very near to the stria; in some specimen on the third stria. The basal seta, that is on the first puncture of the first stria, and the first puncture of the sutural stria are positioned on the same transversal line as the base of the scutellum. Eight striae impressed and lightly punctuate, from the base of elytra joining to the ninth stria until the first humeral seta, then touching the other 3 humeral setae and becoming independent, then coming together again at the ninth stria at the first two apical setae, then branching out again until the third and fourth apical seta, where they rejoin the ninth stria before the apex (as in *Bracteon*).

LEGS. In the male, the first protarsomere is slightly widened and elongated, with fore inner tooth; also the second protarsomere is broader, shorter, with a more protruding tooth. Protarsomeres are not widened in the female.

GENITALIA. Male: the sclerites of the median lobe are very similar in all species and quite different from the other Bembidiina. A peculiar characteristic is the absence of the brush sclerite, while the main sclerite (S) is always long, straight and stout. Other two sclerites (F1, F2; Fig. 7) occur in all the species, always flagelliform. The first one (F1) is very long, extending from the base to the apical area: it begins from the basal margin, turning in apical area. The second elongated sclerite (F2) begins also in the basal area, could be homologous to the flagellar sheath of Maddison (1993: 257 Fig. 99). F1 and F2 can cross

together in dorsal part of median lobe, sometimes overlapping. *Odontium clarkei* n. sp. presents another flagelliform sclerites (F3; Fig. 7), clearly marked. Parameres left and right with only two setae.

Female: spermathecal duct with multiply coiled, from 2 to 25 spirals; annulus receptaculi missing. The number of coils of the spermathecal duct seems to be related with the length of the first flagellum (F1) of the endophallum.

DISTRIBUTION AND ECOLOGY

Microserrullula shows a wide geographical range in the Palearctic, Afrotropical and Oriental regions, in spite of the rarity of the species, occurring almost entirely in Africa, SE-Europe, S-Asia from W-Asia towards India, Laos and Cambodia.

On the basis of the label indications by the collectors, *Microserrullula* species seem to have adapted to living along the shores of the great rivers, such as Congo, Nile, Zambesi, Firat (Euphrates) and the Tigris. Personal observations (especially in the Mediterranean area) suggest they are very active and fly quickly in case of danger.

SYSTEMATICS NOTES

The diagnostic characters of *Microserrullula* induced different considerations regarding the systematic position and the relatives of this genus, mostly considered in basal position of the whole “genus *Bembidion* s. l.”. According to Schuler (1959) “les espèces de ce genre possèdent à un haut degré la plupart des caractères attribués aux formes les plus primitives des Bembidiini” and again “genre aussi ancien”. Darlington (1959) was the first to consider *Microserrullula*, with some doubts, near to *Odontium*.

Perrault (1981), in his supraspecific classification of Bembidiini, didn't take into consideration the African taxa, and so didn't discuss about *Microserrullula*.

According to Maddison (1993) *Microserrullula* may belong to *Odontium* group, also because “Judging by the apparent uniqueness of these features [possession of serrulate elytral margin; prominent sub-orbital ridge; broad pronotal base; very long flagellum of male genitalia; long multiply coiled spermathecal

duct] within the bembidiines, they are probably derived traits”.

From the taxonomical point of view, *Microserrullula* was differently considered by the authors. According to G. Müller (1918), Netolitzky (1942), Maddison (1993), Krizhanowskij *et al.* (1995) and Marggi *et al.* (2003, 2017) *Microserrullula* is considered subgenus of *Bembidion*, while according to Lorenz (1998, 2005) and Vigna Taglianti (2004) is considered at level of genus. For a more detailed discussion on the use of Bembidiina taxa as generic or subgeneric level see Maddison (1993, 2012), Toledano (2002), Bonavita & Vigna Taglianti (2010).

The recent and illuminating work by Maddison (2012) seems to remove any doubts about the systematic position and the relatives of *Microserrullula*: this genus belongs to *Odontium* complex, where it's the sister group of all other taxa (*Ochthedromus* LeConte, 1848, *Pseudoperyphus* Hatch, 1950, *Odontium*, *Bracteon*).

TAXONOMY

1. *Odontium (Microserrullula) australe* n. sp.

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DBEE4320-65A9-4DDC-BA29-8526A6A3EA22

DIAGNOSIS. Species (Fig. 14) relatively small, pronotum with laterobasal carina absent and latero-hind area, between the internal foveae and the lateral margin, fully smooth; apical elytral spot as a “lunula” in the apical three-quarters, larger and well contrasted. This species occurs in the austral area of Africa.

TYPE LOCALITY. Delagoa Bay [= Maputo Bay], Mozambico.

TYPICAL SERIE. *Mozambique*. Holotypus ♂: “Coll. Mus. Congo, Mozamb.; Delagoa Bay [= Maputo Bay], Col. P. Basilewsky”, with genitals prepared in Euparal on the same pin (MRAC).

Paratypes: “Coll. Mus. Congo, Mozamb.; Delagoa Bay [= Maputo Bay], Col. P. Basilewsky”, 1 ♀ (MRAC); *Kenya* - “KENYA Eastern 6.4.2007 / E of THIKA W of MWINGI / Lgt. Snizek”, 2 ♀♀ (SC); “KENYA / Bushwackers Camp / Athi River Beach / 11-13 II 1977 / J C A van Etten // Museum Leiden / coll. J. van Etten / rec. 1987”, 22 exx. (NBCL, BO, CTVR); *Zambia* -

“Zambia 23.iii.1993, 13°06'03”S/31°47'32”E, South Luangwa NP, Mfuwe Crocodile Farm, 450 m, lux, leg. M. Uhlig”, 1 ♀(MNB); *South Africa* - “S. Afr., Zululand, Mtubatuba, 28.22 S – 32.19 E / 4.4.1974; E-Y: 318, sandy shore washing, leg. Endrödy-Younga”, 4 ♀♀ (2 ♀♀ gen. prep.)(DNMNH); “Rep. South Africa: Pretoria dist., Transvaal, Boekenhouts Kloof, 6 Apr. 1992, 25 31' S, 28 29' E, Robert D. Ward”, 1 ♀!(CMNH); “SÜDAFRIKA – RSA\ Prov.Ost Cape\ Port St. Johns, R61, 10m\ Farm House Lodge\ S 31°36'22.3''E 29°29'06.7''\ leg.A.&A.Puchner 1.XII.2017”, 2 ♂♂, 2 ♀♀ (SC); *Madagascar*: “Madagascar W, Tsiribihina river between Miandrivazo-Antsirataka, 22-24.XI.2005, leg. J. Štátný”, 2 ♂♂, 1 ♀!(BO, BU).

BIBLIOGRAPHIC CITATIONS. Basilewsky (1968 sub *M. aegyptiaca*): “MADAGASCAR SUD. District de Betioky: Tongobory (R. CATALA, 1934)”; we didn't see the specimen from Madagascar, according to Basilewsky “identique à deux spécimens provenant de la Delagoa Bay”.

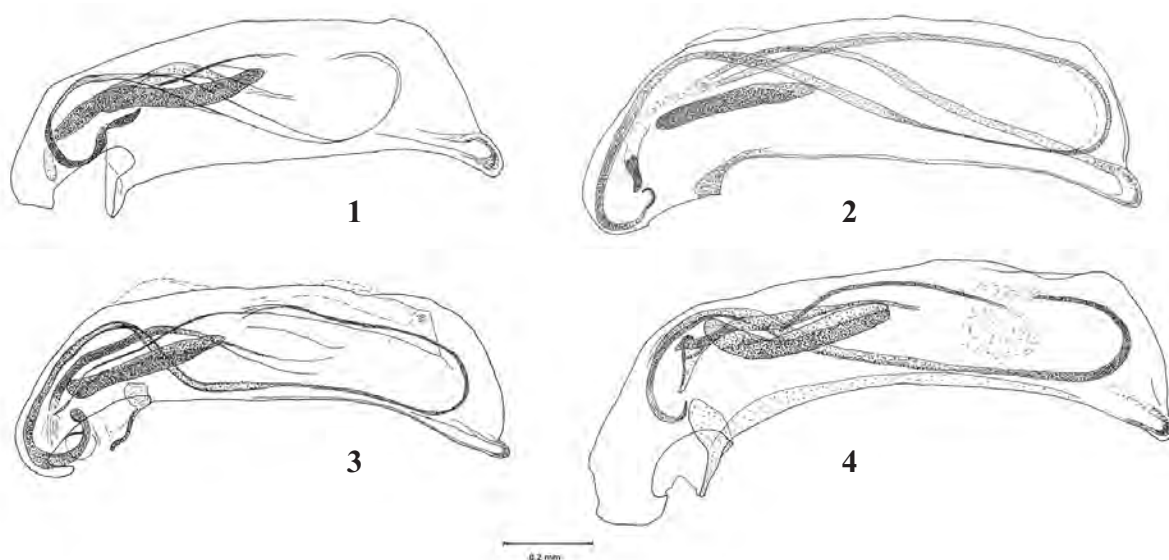
DERIVATIO NOMINIS. The name refers to the known distribution of this species, that occurs in the austral region of Africa, from Kenya to South Africa and Madagascar.

DESCRIPTION OF THE HOLOTYPE. Specimen ♂ (TB 5.37 mm) brown with apical spots, fully reticulated, with isodiametric sculpticells. Palpi and antennae clear, only the last 5-6 antennomeres hardly obscured.

Pronotum (LP 1.20 mm, WP 1.85 mm, LWP 1.54) with sides sinuated before the hind angles, with the base larger than anterior margin; laterobasal carina absent; anterior margin narrow, with sides convergent and angles protruding but rounded; anterior and hind areas, especially in the central area, with longitudinal wrinkles less impressed than in *pogonopsis*; latero-hind area, between the internal fovea and the lateral margin, fully smooth; furrow, between the internal fovea and the hind angle, more or less impressed, parallel to the hind edge of pronotum and not detached from it; hind angles right.

Elytra (LE 3.48 mm, WE 2.20 mm) wide but not elongated, shorter than in *pogonopsis*, parallel almost until the apex; striae and punctuation superficial and less impressed than in *pogonopsis*, with flat interval; apical spot forms a “lunula” in the third-fourth apical, greater and more contrasted than in *pogonopsis*, with the superior limit well defined.

Legs clear; missing the tibia and tarsi of the left posterior leg.



Figs. 1-4. Median lobe of the aedeagus of: 1 - *O. australe*, Mozamb., Delagoa Bay (holotypus); 2 - *O. pogonopsis*, Democratic Republic of Congo, près Bombesa [= Bambesa], Alipago; 3 - *O. icterodes*, Gabon, Kangvé, Ogové; 4 - *O. basilewskyi*, Congo Belge, Libenge, Zambi (holotypus).

Aedeagus (AL 1.13 mm) small (Fig. 1); main sclerite S straight, parallel to the sides; sclerite F1 with the flagellum less evident after the turned; sclerite F2 shorter, visible until the center of the aedeagus; apex proportionally bigger.

DESCRIPTION OF THE PARATYPI AND VARIABILITY OF THE POPULATION. Almost all characters as in the holotypus; specimens brown, bronzed, TB ♀♀ 5.55 mm (5.18-5.85). Palpi and antennae fully clear or, more often, very lightly obscured from fifth antennomere.

Pronotum - LP ♀♀ 1.19 mm (1.10-1.30), WP ♀♀ 1.87 mm (1.73-2.02); LWP ♀♀ 1.56 (1.46-1.60); laterobasal carina always absent; latero-hind area fully smooth; furrow well impressed.

Elytra - LE ♀♀ 3.57 mm (3.35-3.78), WE ♀♀ 2.20 mm (2.01-2.38); basal margin of the elytra ending between the fourth and fifth stria, rarely nearer to the fifth stria. The yellow spots are always well contrasted and well delimited; they occur on the 1/3-1/4 apical, and lunula-shaped.

Genitalia ♀ - (Fig. 8) SL 0.12 mm; spermatheca very simple, with a small bottleneck less evident than in *pogonopsis*, between the anterior and posterior cavity; duct with 4-5 spirals.

DISTRIBUTION. Kenya, Zambia, Mozambique, Madagascar, South Africa.

NOTES. Similar to *pogonopsis*, from which it is distinguishable by the pronotum more sinuated and less wrinkled at margins, by the shorter elytra and the more extended (about apical 1/3-1/4) and well delimited apical spots. In Basilewsky (1968) is mentioned as *aegyptiacum* a specimen from Madagascar (District de Betioky: Tongobory) described as similar to two other specimens from Delagoa Bay (South-Mozambique). He noticed the differences in the sculpture of pronotum and in the coloration of elytra if compared with the specimens from Uganda and Ethiopia. Probably it should refer to *O. australe*.

2. *Odontium (Microserrullula) pogonopsis* (Alluaud, 1933)

Microserrullula pogonopsis Alluaud, 1933: 2

DIAGNOSIS. Species (Fig. 15) of large size (TB ♂♂

5.83 mm (5.61-6.22), ♀♀ 5.87 mm (5.61-6.04), with palpi and antennomeres yellow testaceous, pronotal laterobasal carina reduced, not or scarcely visible and yellow spot in the apical fifth, with the anterior limit not clearly defined.

TYPE LOCALITY. Democratic Republic of Congo, along the Congo river, from Léopoldville [Kinshasa] to Coquilhatville [Mbandaka].

EXAMINED MATERIAL. *Democratic Republic of Congo* - Holotypus: "Moyen-Congo [retro] de Léopoldv., à Coquilhatv., VI-27 / TYPE / Bembid. pogonopsis type Alluaud. Det. 1932", 1 ♂!(MNHN); "Léopoldv., VI.27.", 1 ♂!(MNHN); "MUSÉE DU CONGO, près Bambesa: Alipago - II-1935, J. Leroy", 1 ♂!(MNHN); "Congo Belge, Libenge, Zambi 6.1.1948, R. Cremer -M. Neumann / R. I. Sc. Nat. Belg. , I.G. 16.655 / Institut royal des Sciences naturelles de Belgique, Bruxelles ", 1 ♀ imm.!(RBINS); "MUSÉE DU CONGO, près Bombesa [= Bambesa], Alipago - II-1935, J. Leroy", 2 ♂♂ (gen. prep.), 2 ♀♀ (gen. prep.)(MRAC, BO).

OTHER MATERIAL IN MRAC COLLECTION. *Cameroun* - Cameroun, Yaoundé, 1 ♂, 1 ♀ (MRAC); *Democratic Republic of Congo* - Ubangi, Bambesa, près Alipago, II.1935, J. Leroy, 8 ♂♂ (1 ex. comparé au TYPE pur Alluaud), 17 ♀♀ (MRAC); Ubangi, Dongo, 6.XII.1931, H.J. Brédo, 1 ♀ (MRAC); Eala, VI.1935, J. Gesquière, 4 ♀♀ (MRAC); B. C., Kimpangu Riv, Fulezi 650 m, VII.49, N. Leleup, 1 ♂, 1 ♀ (MRAC); Stanleyville, Yangambi, 5.IX.1952, J. Decelle, 2 ♀♀ (MRAC); Belgian Congo Oriental, Yangambi, 19.VI.1960, 1 ♀ (MRAC); Belgian Congo Oriental, Yangambi, 269.VI.1960, 1 ♂ (MRAC); Tshuapa, Bokuma, IV.1952, R.P. Lootens, 1 ♂, 1 ♀ (MRAC); Tshuapa, Bokuma, 1953, R.P. Lootens, 2 ♂♂, 3 ♀♀ (MRAC).

DESCRIPTION. Specimens brownish, opaque, entirely reticulated with isodiametric sculpticells. Palpi and antennomeres yellow testaceous.

Pronotum - LP ♂♂ 1.26 mm (1.18-1.34), ♀♀ 1.26 mm (1.22-1.32); WP ♂♂ 1.96 mm (1.85-2.09), ♀♀ 1.95 mm (1.90-2.02); LWP ♂♂ 1.54 (1.50-1.57), ♀♀ 1.54 (1.53-1.56); sides slightly sinuated before the hind angles, and the base larger than anterior margin;

fore angles protruding but rounded. Laterobasal carina reduced, not or scarcely visible; furrows more or less impressed, often clearly visible and parallel to the posterior margin of pronotum and more detached from it; hind angles straight or, more rarely, obtuse; fore and hind areas, especially at middle, with longitudinal wrinkles. Microsculpture with isodiametric sculpticells.

Elytra - LE ♂♂ 3.85 mm (3.78-3.96), ♀♀ 3.84 mm (3.72-3.96); WE ♂♂ 2.26 mm (2.20-2.32); ♀♀ 2.32 mm (2.32-2.32); wide and elongated, almost parallel up to the apex; striae and punctuation shallow but clearly impressed, reducing near to apex, with flat interval; sutural stria with 12-14 points; yellow spot in the apical fifth, with the anterior limit not clearly defined.

Legs yellow testaceous.

Genitalia - aedeagus (AL 1.25 mm) (Fig. 2) with a long flagellum and a typical big and long sclerite S in ventral position; the F1 long, turned at the apex until to the base; F2, less visible, connect with the apex; apex thicker and protruding than in *basilewskyi*. Spermatheca (SL 0.13-0.14 mm) (Fig. 9) very simple, with a small bottleneck between the anterior and posterior cavity; the duct with 4-5 spirals.

DISTRIBUTION. This species occurs in Central Africa (Democratic Republic of Congo and Cameroun), along large rivers in tropical forest.

NOTES. Easily recognizable from *O. basilewskyi* n. sp. and *O. icterodes*, sympatric species, in the stouter and enlarged body; elytra parallel almost until to the apex, with striae and punctuation superficial and a yellow spot in the apical fifth with the anterior limit not clearly defined.

3. *Odontium (Microserrullula) icterodes* (Alluaud, 1933)

Microserrullula icterodes Alluaud, 1933

DIAGNOSIS. Species (Fig. 16) of medium-small size, with pronotum transverse and clearly sinuated, with laterobasal carina evident and the base with wrinkles hardly indicated, with elytra relatively shorter and apical spot with indefinite margins.

TYPE LOCALITY. Democratic Republic of Congo, along

the Congo river, from Léopoldville [Kinshasa] to Coquilhatville [Mbandaka].

EXAMINED MATERIAL. *Democratic Republic of Congo* - Holotypus: "de Léopoldv., à Coquilhatv., VI-27 / Bembid. icterodes Alluaud det. 1932, Type / TYPE / TYPE/ cf. Afra, 6, 1933, p. 3 / *Bembidion (Microserrullula) icterodes* Alld., P. Basilewsky vid, 1947 / Institut royal des Sciences naturelles de Belgique, Bruxelles", 1 ♀ imm.!(RBINS); "de Léopoldv., à Coquilhatv., VI-27 / Bembid. icterodes Alluaud det. 1932, cotype", 1 ♂ imm.!(MNHN);

"Gantchou, 19.VI.1927, A. Collart / *Bembidion (Microserrullula) pogonopsis* All. P. Basilewsky det., 1947 / Institut royal des Sciences naturelles de Belgique, Bruxelles", 1 ♂ (gen. prep.)(RBINS); *Gabon* - "Ogové R., A.C. Good / Holland Collection", 1 ♀ without abdomen!(CMNH); "Kangvé, Ogové R., A.C. Good / Holland Collection", 1 ♂ (gen. prep.)(CMNH).

BIBLIOGRAPHIC CITATIONS. Alluaud (1933: 3): "Congo belge, entre Léopoldville et Coquilhatville"; Basilewsky (1948: 12-13 sub *pogonopsis*): "N'Ganchou, .., en aval de Kwamouth, sur la rive droite du fleuve, ... capturée à quelques reprises dans le Nord du Congo".

REDESCRIPTION OF THE HOLOTYPE ♀. Specimen immature (TB 5.37 mm), yellow with the head brown, fully reticulated, with transverse or isodiametric sculpticells. Palpi and antennae light, with the last antennomeres hardly obscured.

Pronotum (LP 1.08 mm; WP 1.78 mm; LWP 1.64) with sides clearly sinuated before the right hind angles; base hardly larger than anterior margin; laterobasal carina evident and relieved; furrow, between the internal fovea and the lateral margin, well impressed, with the line tightly parallel to the posterior margin of pronotum; anterior margin with sides slightly convergent and angles slightly acute; anterior and posterior margins, especially in the central area, with longitudinal striae weakly impressed. Microsculpture with isodiametric sculpticells.

Elytra (LE 3.48 mm; WE 2.01 mm) not elongated, relatively shorter, with the maximum width in the anterior third; striae and punctuation superficial and slightly impressed, intervals flat; lighter apical spot in the apical fifth-sixth; thorax and abdominal

sternites brown. Microsculpture with transverse or isodiametric sculpticells.

Legs clear.

VARIABILITY OF THE POPULATION. In addition to the type, we saw only four more specimens, including the immature cotype. Specimens of medium size, TB ♂♂ 5.26 mm (5.18-5.37); ♀♀ 5.12 mm (4.88-5.37). The mature specimens, of colour brownish, have an apex slightly lighter, without a well-defined spot.

Pronotum - LP ♂♂ 1.10 mm (1.08-1.13), ♀♀ 1.03 mm (0.98-1.08); WP ♂♂ 1.70 mm (1.68-1.73), ♀♀ 1.67 mm (1.56-1.78); LWP ♂♂ 1.56 (1.49-1.60), ♀♀ 1.61 (1.58-1.64), transverse, more than in the other species, with weak wrinkles at the centre of anterior and posterior margins; furrow, between the internal fovea and the angle of pronotum, well impressed and tightly parallel to the hind edge of pronotum and not detached from it. Microsculpture well defined on the whole pronotum with isodiametric sculpticells. Anterior angles protruding and slightly rounded.

Elytra - LE ♂♂ 3.39 mm (3.35-3.41), ♀♀ 3.29 mm (3.11-3.48); WE ♂♂ 2.17 mm (2.13-2.20); ♀♀ 1.98 mm (1.95-2.01). Elytra shorter with striae superficially punctured and intervals flat or slightly convex; the spots are represented only by an apical area slightly lighter, not yellow.

Aedeagus - AL 1.12 mm (1.10-1.13) (Fig. 3); small; main sclerite S in basal position, straight and slightly oblique; sclerite F1 with the flagellum protruding from the basal margin with a hairpin-like bend, and then, after the bend, becomes less evident up to the center of the aedeagus; sclerite F2 shorter, well visible only in the whole basal half of the aedeagus.

Spermatheca - unknown. The female type is immature, while in the other female the abdomen is missing.

DISTRIBUTION. Democratic Republic of Congo and Gabon.

NOTE. Both Alluaud (1933) and Schuler (1959) described this species as having a pronotal microsculpture more superficial and hardly visible; in the mature specimens we noticed the same development than in the other species of *Microserrullula*.

4. *Odontium (Microserrullula) basilewskyi* n. sp.

urn:lsid:zoobank.org:act:

15315D66-034C-4F6A-B579-3FAFEDFADDE4

DIAGNOSIS. Species (Fig. 17) brown, elongate, characterized by strongly convex body and long elytra with maximum width at the anterior third and subparallel sides, narrowing towards the apex. A small yellow spot occur at the elytral apex; legs clear.

TYPE LOCALITY. Zambi, along the Ubangi river, tributary of Congo river, to South of Libenge, in the Democratic Republic of Congo.

TYPICAL SERIES. *Democratic Republic of Congo* - Holotypus ♂: "Congo Belge, Libenge, Zambi 6.1.1948, R. Cremer-M. Neumann / R. I. Sc. Nat. Belg. , I.G. 16.655 / Institut royal des Sciences naturelles de Belgique, Bruxelles"!(RBINS); Paratypes: "Congo Belge, Libenge, Zambi 6.1.1948, R. Cremer-M. Neumann / R. I. Sc. Nat. Belg. , I.G. 16.655 / Institut royal des Sciences naturelles de Belgique, Bruxelles", 7 ♂♂, 5 ♀♀!(RBINS, BO); "Congo Belge, Libenge, Izato 16.XII.1947, R. Cremer -M. Neumann / R. I. Sc. Nat. Belg. , I.G. 16.655 / Institut royal des Sciences naturelles de Belgique, Bruxelles", 1 ♂!(RBINS); "Congo Belge, Libenge, Zambi 6.1.1948, R. Cremer - M. Neumann / COLL. MUS. CONGO, don RBINS, col. P. Basilewsky", 2 ♂♂, 3 ♀♀!(MRAC).

DERIVATIO NOMINIS. We dedicate, with great pleasure, this species to Pierre Basilewsky, the father of the African carabidology.

DESCRIPTION OF THE HOLOTYPE. Specimen ♂ (TB 5.67 mm) brown-reddish, entirely reticulated, with isodiametric sculpticells on the pronotum and isodiametric or slightly transverse sculpticells on the elytra. Palpi and antennomeres yellow testaceous.

Pronotum (LP 1.22 mm; WP 1.85 mm) convex, transverse (LWP 1.51), hardly sinuated before the hind angles, with the base distinctly larger than anterior margin; anterior angles protruding and acute. Laterobasal carina unnoticeable; basal area strongly wrinkled, with striae longitudinal in the middle; furrows shallow, not clearly recognizable; hind angles right; anterior areas with longitudinal wrinkles. Microsculpture with isodiametric sculpticells.

Elytra (LE 3.66 mm; WE 2.13 mm) elongated and narrow; strongly enlarged in the anterior third, where they have their maximum width, gradually narrowing up to the apex. Sutural stria long. Striae and punctuation strongly impressed until the apex. Apical spot short and undefined. Microsculpture with isodiametric or slightly transverse sculpticells.

Legs entirely yellow testaceous.

Aedeagus (AL 1.32 mm) (Fig. 4) with a typical sclerite S in basal position; F1 recurved at the apex and overlapping F2 in dorsal area; apex short and thin.

DESCRIPTION OF THE PARATYPI AND VARIABILITY OF THE POPULATION. Almost all characters as in the holotypus. TB ♂♂ 5.63 mm (5.89-5.65), ♀♀ 5.65 mm (5.43-5.91).

Pronotum - LP ♂♂ 1.23 mm (1.18-1.30), ♀♀ 1.21 mm (1.15-1.25); WP ♂♂ 1.83 mm (1.70-1.92), ♀♀ 1.84 mm (1.75-1.92); LWP ♂♂ 1.49 (1.42-1.55), ♀♀ 1.52 (1.49-1.58); basal furrow of the pronotum sometimes visible, but always shallow; laterobasal carina always unnoticeable.

Elytra - LE ♂♂ 3.64 mm (3.48-3.78), ♀♀ 3.67 mm (3.54-3.90); WE ♂♂ 2.08 mm (1.95-2.13), ♀♀ 2.07 mm (2.01-2.13); sutural stria with 10-12 points; apex always yellow.

Genitalia - aedeagus (AL 1.32 mm; SL 0.12 mm) as in the holotypus. Spermatheca (Fig. 10) very simple, with a little bottleneck between the anterior and posterior cavity; duct with 4-5 spirals.

DISTRIBUTION. The specimens of this species, actually present only in the collection at RBINS, were identified as *pogonopsis*. This new species is known only of Libenge area, along Ubangi river, right tributary of Congo river, that is a boundary between Centrafrican Republic and Democratic Republic of Congo to North, and Republic of Congo and Democratic Republic of Congo to South.

5. *Odontium (Microserrullula) okavangum* n. sp.

urn:lsid:zoobank.org:act:

EF5FA78F-EAD8-4CEB-A5AA-E6BB1C340AC2

DIAGNOSIS. Species (Fig. 18) of small to medium size, with head and pronotum from red-brownish to brownish, antennae yellow, and elytra red-yellowish to brown; pronotum sinuated, with laterobasal carina hardly indicate, often not visible, with basilateral wrinkles not or hardly indicate.

TYPE LOCALITY. Popa Falls near Bagani, along the Okavango river, Namibia.

TYPICAL SERIES. *Namibia* - Holotypus ♂: "Namibia bor. or., Okavango river, Bagani, Popa Falls, 25.1-6.2.1995, lgt. M. Snizek / cfr. *B. aegyptiacum* det. L. Toledano / *Bembidion aegyptiacum* det. L. Toledano" with genitals prepared in Euparal on the same pin (CTVR); Paratypus: "Namibia bor. or., Okavango river, Bagani, Popa Falls, 25.-6.2.1995, lgt. M. Snizek", 1 ♂, 2 ♀♀ (1 imm.) (1 ♀ gen. prep.)(CTVR); "Namibia bor. or., Okavango river, Bagani, Popa Falls, 25.-6.2.1995, lgt. M. Snizek", 1 ♂ (gen. prep.)(BO); "Namibia bor. or., Okavango river, Bagani, Popa Falls, 25.1-6.2.1995, lgt. M. Snizek", 1 ♀ imm.)(NE); "Namibia Exp.ZMB 1992, East Caprivi: Katima, Mulilo. Lux. 17°29'S/, 24°17'E.3.-8.III.1992, leg. M. Uhlig", 1 ♀!(MNB); *Angola* - "Angola, riv. Cuilo, Cacolo, Alto Cuilo, VI-1954, 3694.3, E. Luna de Carvalho / Musée Royal de l'Afrique centrale Tervuren", 1 ♀!(MRAC); "Angola: riv. Cuilo, Cacolo, / Alto Cuilo VI-1954 / 3694.3 / E. Luna de Carvalho", 1 ♂ (CTVR); *Zambia* - "ZAMBIA, Western 13.1.2010 / 30km NW Sesheke / S20°17.08 E24°08.49 / P. Schüle leg.", 1 ♂ (SC); "D.Sambesi Gebt./ 10.06 / F. Seiner S.G.", 10 exx.!(MNB).

DERIVATIO NOMINIS. The name is referred to the Okavango river, where this species occurs, famous for his beautiful internal delta, flowing into the desert.

DESCRIPTION OF THE HOLOTYPE. Specimen ♂ (TB 5.55 mm) entirely reticulated, with isodiametric sculpticells on head, pronotum and elytra. Antennae and palpi entirely clear; thorax sternite brownish and abdominal sternite reddish or clearer.

Pronotum (LP 1.18 mm, WP 1.78 mm; LWP 1.51) brown reddish, sinuated before of the posterior angles, with the base larger of the anterior margin; laterobasal carina absent or hardly indicate; area latero-posterior, between the internal fovea and the lateral margin, smooth with slight wrinkles hardly indicate; furrow, between the internal fovea and the posterior angle, well impressed, tightly parallel to the hind edge of pronotum and not detached from it; posterior sides slightly obtuse; anterior margin of the

pronotum with sides convergent and angles acute; anterior and posterior margins, especially in the central area, with longitudinal striae hardly indicate (especially posteriorly) or not evident (anteriorly).

Elytra (LE 3.48 mm, WE 2.13 mm) yellow reddish, elongated, with the maximum width in the anterior third; striae and punctuation superficial and slightly impressed, with intervals flat; apex slightly clearer.

Legs yellow.

Genitalia - aedeagus (1.42 mm) (Fig. 5) smaller than in *aegyptiacum*, with the main sclerite S stout, flagellum F1 double at the base and visible up to the apex and F2 short, visible on the main sclerite; apex stout and lightly curved.

DESCRIPTION OF THE PARATYPI AND VARIABILITY OF THE POPULATION. Specimens of small-medium size, TB ♂♂ 5.29 (5.00-5.55) ♀♀ 5.47 mm (5.30-5.61); sometimes distal antennomeres slightly obscured; thorax sternite brownish to reddish, and abdominal sternite clearer, reddish to yellowish.

Pronotum - LP ♂♂ 1.12 mm (1.08-1.18), ♀♀

1.14 mm (1.10-1.15); WP ♂♂ 1.68 mm (1.63-1.78), ♀♀ 1.74 mm (1.70-1.78); LWP ♂♂ 1.50 (1.50-1.51); ♀♀ 1.53 (1.52-1.54), brown reddish to reddish brown; postangular carina absent or, in a female, reduced but visible to high magnification; posterior angles right or slightly obtuse.

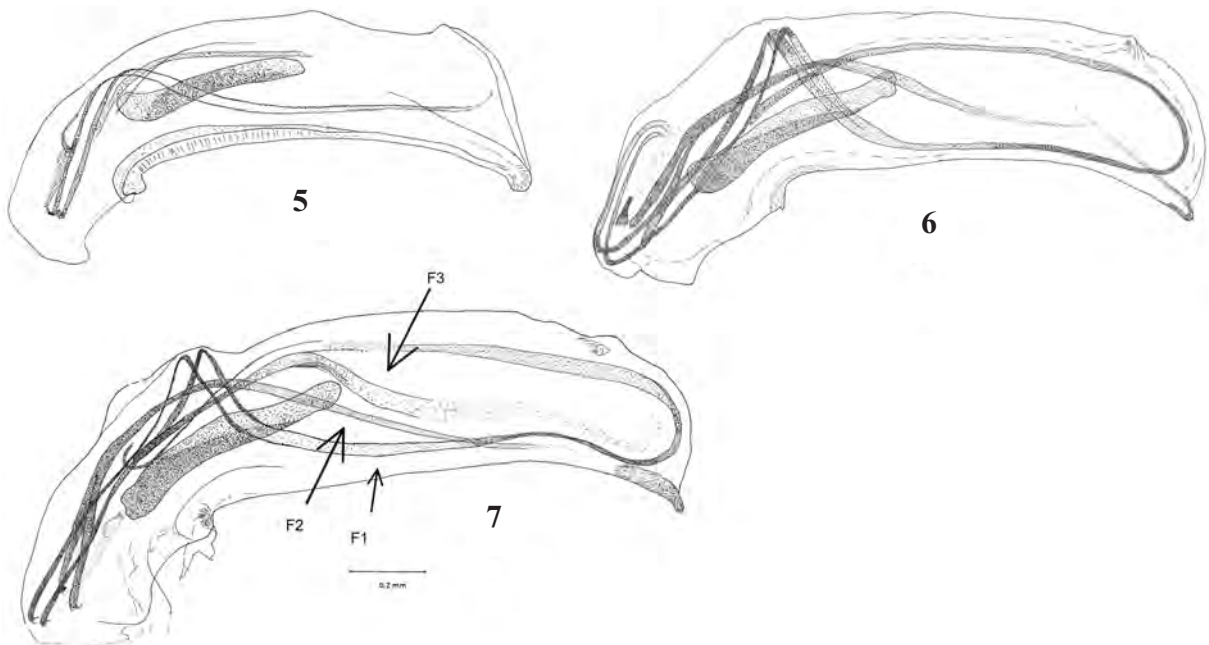
Elytra - LE ♂♂ 3.35 mm (3.17-3.48), ♀♀ 3.54 mm (3.41-3.66), WE ♂♂ 2.03 mm (1.95-2.13), ♀♀ 2.11 mm (2.01-2.20); yellow reddish, sometimes with the first intervals more obscured; brown elytra in the specimens of Angola; apex slightly clearer without a defined spot.

Thorax sternite usually brownish, while abdominal sternite usually yellowish.

Genitalia - aedeagus: 1.39 mm (1.37-1.42); spermatheca (Fig. 11) with 2 cavities and duct with 8-10 spirals.

DISTRIBUTION. Angola, Namibia, Zambia.

COMPARATIVE NOTE. Species very similar to *O. aegyptiacum*, with which was confused and from which is distinguishable especially by the different morphology of the median lobe of aedeagus and the



Figs. 5-7. Median lobe of the aedeagus of: 5 - *O. okavangum*, Namibia bor. or., Okavango river, Bagani, Popa Falls (holotypus); 6 - *O. aegyptiacum*, Egypt, Kitchener; 7 - *O. clarkei*, Ethiopia, Blue Nile Gorge (holotypus); F1, F2, F3 - flagelliform sclerites.

spermatheca. “Kuntzen la cite du Sud-Ouest africain, mais l’identité de ces spécimens devrait être vérifiée” (Basilewsky, 1953): the mention of the species, identified as *aegyptiacum* while occurring in South-West Africa, actually refers to this new species.

6. *Odontium (Microserrullula) aegyptiacum* (Dejean, 1831)

Bembidium aegyptiacum Dejean, 1831: 90

= *Bembidium senegalense* Dejean, 1831: 92

DIAGNOSIS. Species (Fig. 19) of small-medium size, with head and pronotum red-brownish, antennae yellow, and entirely red-yellowish elytra; pronotum sinuated, with laterobasal carina hardly visible, often not visible, with basilateral wrinkles not or hardly indicate; abdominal sternite in the lateral area yellowish.

TYPE LOCALITY. Dejean (1831) indicates, without clear localities, that the provenance of the typical form is Egypt, and that of *B. senegalense* is Senegal.

EXAMINED MATERIAL. “Schaum – 852 / Coll. Mus. Vindob.”, 1 ex.!(NHMW-V); “Kots 6.59.”, 2 ♀♀!(NHMW-V); “Kots 6”, 1 ♂, 1 ♀!(NHMW-V); “H. E. Andrewes coll. B. M. 1945-97”, 1 ♀!(NHML); *Egypt* - “Egypt / Sharp Coll. 1905-313. / Bembidion aegyptiacum Dej., V. Lutschnik d.”, 1 ♂, 1 imm.!(NHML); “Aegyptus Reitter. / aegyptiacum Dej. Aeg. Luxor / H. E. Andrewes Coll. B.M. 1945-97.”, 1 ♀!(NHML); “Bowering. 63-47* / 2915 / aegyptiacum Dej. Cairo.”, 1 ♂!(NHML); “Goedl 1852. Egypt.”, 1 ♀!(NHMW-V); “Aegypten / Collect. Plason / aegyptiacum det. Netolitzky”, 2 ♂♂!(NHMW-V); “Aegypt. V. M. Duchoň / Collect. Hauser / aegyptiacum det. Netolitzky / B. aegyptiacum Dej.”, 1 ♂!(NHMW-V); “Aegypt. V. M. Duchoň / Collect. Hauser / aegyptiacum det. Netolitzky”, 2 ♂♂!(NHMW-V); “Elephantine Aeg. Reimoser”, 1 ♂, 1 ♀!(NHMW-V); “Luxor Aeg. Reimoser”, 4 ♂♂, 2 ♀♀!(NHMW-V); “Luxor”, 1 ex., 2 ♂♂, 1 ♀!(NHMW-V); “Kitchener J. Aeg. Reimoser”, 7 ♂♂ (2 ♂♂ gen. prep.), 6 ♀♀ (2 ♀♀ gen. prep.)(NHMW-V); “Aegypt. V. M. Duchoň / [illegible] Neto / coll. Netolitzky / aegyptiacum det. Netolitzky / Coll. Netolitzky”, 1 ♀!(NHMW-N); “Aegyptus Luxor / aegyptiacum Dej. / [illegible] / coll. Netolitzky /

aegyptiacum det. Netolitzky”, 1 ♂!(NHMW-N); “Luxor Agypten / coll. Netolitzky / aegyptiacum det. Netolitzky”, 1 ♂!(NHMW-N); “Aegypten, Luxor Slg. W. Meier / coll. Netolitzky / aegyptiacum det. Netolitzky”, 1 ♀!(NHMW-N); “Luxor Aeg. Reitter / coll. Netolitzky / aegyptiacum det. Netolitzky”, 1 ♂ (senza addome)!(NHMW-N); “Assuan Nil, Nil-Ufer 25.- I / Assuan Bänninger / coll. Netolitzky / aegyptiacum det. Netolitzky”, 1 ♂!(NHMW-N); “Aegypt. V. M. Duchoň / Luxor V. M. Duchon. / coll. Paul Meyer / aegyptiacum Dej. det. P. Meyer / Acqu.-Nr. 1951-23 / Coll. P. Meyer”, 1 ♂!(NHMW-M); “Lüxor Ägypten / aus Sammlg. E. Buchka-Frkf. / coll. Paul Meyer / aegyptiacum Dej. det. P. Meyer / Acqu.-Nr. 1951-23”, 1 ♀!(NHMW-M); “Luxor / Aegypt. V. M. Duchoň / coll. Paul Meyer / aegyptiacum Dej. det. P. Meyer / Acqu.-Nr. 1951-23”, 1 ♀!(NHMW-M); “Luxor V. M. Duchon / coll. Paul Meyer / aegyptiacum Dej. det. P. Meyer / Acqu.-Nr. 1951-23”, 1 ♀!(NHMW-M); “Nil / collectio Paganetti / Coll. Mus. Vindob. / aegyptiacum Dej. det. P. Meyer / Inserenda”, 2 ♀♀(NHMW-V); “Alexandria Aegyptus / collectio Paganetti / Coll. Mus. Vindob. / 4”, 1 ♂, 1 ♀!(NHMW-V); “Aegyptus Reitter / Coll. Hampe / Coll. Mus. Vindob. / Pogonidium aegyptiacum Dej. det. Breit”, 1 ♀!(NHMW-V); “Helwan 94 Egy. Dr. Fényes B./ Coll. Hampe / Coll. Mus. Vindob.”, 1 ♀!(NHMW-V); *Sudan* - “Kodroko, 8.IV.13, (W.T.R.L., Bureau Ec. Ent.), N° 5021, H. H. D. King”, 1 ♀!(NHML); “British Sudan, H.H. King (Pres. By Imp. Bur. Ent. Brit. Mus. 1923-541)”, 1 ♂!(NHML); “E. Africa, Sudan, Merowé, 5.ii.1947. B.M. 1947-147. / Pres. By B. J. Lewis 22.iv.1947.”, 1 ex.!(NHML); “Sudan 16.10.1962, W. Alfa distr., 2nd Catarakt, [leg.] S. Panelius / Mus. Zool. Helsinki, Loan No. C219 / Coll. Mus. Tervuren, Coll. P. Basilewsky”, 1 ♀!(MRAC); “Wadihalfa”, 1 ♂, 1 ♀!(NHMW-V); *Sudan*, Khartoum, X.1967, leg. Dr. P. Štys, 1 ♀!(KM); *Ethiopia* - “Éthiopie Mérid., Nanoropus, bords du Rodolphe, 565 m / Muséum de Paris, Mission de l’Omo, C. Arambourg, P.-A. Chappuis, & R. Jeannel, 1932-33 / Coll. Mus. Congo, Col. P. Basilewsky”, 1 ♂!(MRAC); *Kenya* - “Kenya bor. occ., Lodwar, 20.12.95, ing. Snizek lgt.”, 1 ♂!(CTVR); “Kenya bor. occ., Lodwar, 20.12.95, ing. Snizek lgt.”, 3 ♀♀!(FA); “Kenya bor. occ., Lodwar, 20.12.95, ing. Snizek lgt.”, 1 ♀!(MO); “Kenya bor. occ., lake Turkana, Kalekol

env., 17.12.95, Lgt. M. Snizek", 1 ♂, 2 ♀♀(FA); Kenya bor. occ., lake Turkana, Kalekol env., 17.XII.1995, leg. M. Snizek, 1 ♂!(WR); "KENYA / Lodwar / Turkwell River / 4 VIII 1978 / J C A van Etten // Museum Leiden / coll. J. van Etten / rec. 1987", 3 exx (NBCL); *Uganda* - "Uganda: Turkana Prov., D. R. Buxton / L. Rudolf Rift Val., Expedition 1934., B.M. 1935-267 / *Bembidion aegyptiacum* Dej. v. *senegalense* Dej.", 1 ♂!(NHML); *Senegal* - "Senegal (Thomson coll. 77-15 k) / *B senegalense* Dej. Senegal", 1 ♀!(NHML).

OTHER MATERIAL IN MRAC COLLECTION. *Sudan* - C.I.P.A.S., Dogo, lumière, (Macina) Soudan Fr, 2 X 50, G.Remaudière, 1 ♀ (MRAC); *Sudan*, 16.10.1962, W. Halfa distr. 2nd catarakt, S. Panerius / Mus. Zool. Helsinki lo.C219, 1 ♀ (MRAC); *Sudan*, Wadi Haifa, 10.IV.1964, J. Kaisila / Mus. Zool. Helsinki lo.C219, 1 ♀ (MRAC); *Ethiopia* - Ethiopie mérid., Nanoropus, Bords du Rodolphe 565 m / Muséum de Paris, Mission de l'Omo C. Arambourg, P.A. Chappuis & R. Jeannel 1932-33, 1 ♂ (MRAC); *Burkina Faso* - Dyoko-Iunda, 10.VIII.1921, excrement humain, Lt. Gesquière, 1 ♂ (MRAC); *Uganda* - Uganda, Turkana Prov., D.R. Buxton / L. Rudolf Rift Val. Expedition 1934, B.M. 1935-267, 1 ♂ 1 ♀ (MRAC).

BIBLIOGRAPHIC CITATIONS. Dejean (1831: 91-92): "Égypte" and (sub *senegalense*) "Sénégal"; Alluaud (1933: 3 sub var. *senegalense*): "Sénégal et de Gao sur les bords du Niger"; Schatzmayr (1936): "Rod El Farag, Tura, Matarie, Marg, Mazguna (F); Heluan, Luxor (S); Delta (A); Barrage! Assiut! U. Halfa!"; Alluaud (1939: 2 sub *Bembidion (Microserrullula)*): "Nanoropus, extrémité boréale du lac Rodolphe, 565 m"; Basilewsky (1953: 1553): "Dogo [Central African Republic], à la lumière, 2-5-VIII, 9-X-1950; deux exemplaires"; Kaszab (1959: 284): "Assuan, Isl. Kitchener, 26.X.1957"; Basilewsky (1968: 516): *Uganda* and *Ethiopia*; Abdel-Dayem (1998: 184): "very common in upper Egypt on banks of the river Nile and on shores of the Lake Nasser...in the Nile Delta and in lower Egypt, and is rare along the sea coast, whereas only one record is thus far known From Sinai".

DESCRIPTION. Small to medium sized species, TB ♂♂ 5.52 mm (5.24-6.16), ♀♀ 5.75 mm (5.18-6.22), entirely reticulated, with sculpticells isodiametric on

pronotum and elytra. Palpi and antennae entirely yellow.

Pronotum - LP ♂♂ 1.20 mm (1.08-1.37), ♀♀ 1.21 mm (1.08-1.30); WP ♂♂ 1.78 mm (1.58-2.02), ♀♀ 1.85 mm (1.70-1.99); LWP ♂♂ 1.49 (1.32-1.57), ♀♀ 1.54 (1.46-1.68); from dark brown to reddish brown, sinuated before the posterior angles; base wider than anterior margin; laterobasal carina hardly indicate, often not visible; latero-posterior area, between the internal fovea and the lateral margin, smooth or with slight wrinkles hardly indicate; furrow, between the internal fovea and the angle of pronotum, well impressed and tightly parallel to the hind edge of pronotum and not detached from it; posterior sides right or slightly obtuse; anterior margin of the pronotum with sides convergent and angles slightly acute; anterior and posterior margins, especially in the central area, with longitudinal striations hardly indicate or not evident.

Elytra - LE ♂♂ 3.62 mm (3.41-3.90), ♀♀ 3.72 mm (3.41-3.96); WE ♂♂ 2.24 mm (2.01-2.44); ♀♀ 2.29 mm (2.13-2.44); red-yellowish, shorter, with parallel sides; striae and punctuation clear and superficial, with intervals flat; apex sometimes clearer; thorax sternite usually brownish, while abdominal sternite usually yellowish at sides.

Legs - clear.

Genitalia - aedeagus: AL 1.69 mm (1.63-1.80) (Fig. 6), bigger, with a big and long main sclerite (S) obliquely positioned in the basal area, F1 double and turned at the base, with a very long flagellum turning in the apical part and coming back to the base, above the main sclerite S; F2 double at the base; apex short and thin. Spermatheca: (Fig. 12) LS 0.17 mm, with a bottleneck between the anterior cavity, larger and curved, and the posterior cavity; duct with about 30 spirals.

DISTRIBUTION. Mali, Burkina Faso, Senegal, Central African Republic, Egypt, Sudan, Uganda, Ethiopia, Kenya.

NOTE. Dejean (1831) described *senegalense*, on specimens from Senegal; Alluaud (1933) distinguish it by bigger size and punctures of elytra more spaced from one another, while Schuler (1959) by the punctures stronger and less (serrata). We consider

these characters included in the variability of the species.

7. *Odontium (Microserrullula) clarkei* n. sp.

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DIAGNOSIS. Species (Fig. 20) of great size, the bigger of the subgenus, with wide elytra, very similar to *pogonopsis*; elytra with striae and punctuation shallow and intervals flat; yellow spot of elytra reduced, present in the apical fifth.

TYPE LOCALITY. Blue Nile Gorge, 1100 m, in Ethiopia.

TYPICAL SERIES. *Ethiopia* - Holotypus ♂: "Blue Nile Gorge, 1100 m, 10.XI.1971 / Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke / Musée Royal de l'Afrique centrale Tervuren", with genitals prepared in Euparal on the same pin (MRAC); Paratypi: "Blue Nile Gorge, 1100 m, 10.XI.1971 / Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke / Musée Royal de l'Afrique centrale Tervuren", 1 ♂ (gen. prep.), 2 ♀♀ (gen. prep.)(MRAC, BO).

DERIVATIO NOMINIS. We dedicated, with great pleasure, this species to †R.O.S. Clarke, that collected all known specimens.

DESCRIPTION OF THE HOLOTYPE. Specimen ♂ (TB 5.85 mm) of large size, brown, entirely reticulated. Palpi and antennomeres yellow testaceous.

Pronotum (LP 1.34 mm, WP 1.90 mm, LWP 1.41) wide with sides sinuated before the hind angles; the base larger than anterior margin; laterobasal carina reduced but clearly visible; basal area almost without wrinkles; furrow well impressed, parallel to the hind margin and detached from it; hind angles straight; anterior margin less narrow with angles protruding and rounded; fore and hind areas, especially in the middle, with longitudinal wrinkles. The lateral margins, next to the anterior angles, serrulated, as in the elytral margin, with 3 very small setae.

Elytra (LE 3.78 mm, WE 2.32 mm) wide with parallel sides; striae and punctuation superficial and intervals flat; yellow spot occurs at the elytral apex, with the anterior limit not clearly defined.

Legs yellow testaceous.

Aedeagus big (AL 1.80 mm) (Fig. 7), with a big and long main sclerite (S) obliquely positioned in basal area and F1 with a very long flagellum that turned until to the base; apex thin, short and weakly curved.

DESCRIPTION OF THE PARATYPI AND VARIABILITY OF THE POPULATION. Almost all characters as in the holotypus. TB ♂♂ 5.95 mm (5.85-6.04), ♀♀ 6.22 mm (6.16-6.28). Antennae lightly obscured from fourth antennomeres or almost not obscured.

Pronotum - LP ♂♂ 1.33 mm (1.32-1.34), ♀♀ 1.38 mm (1.37-1.39); WP ♂♂ 1.94 mm (1.90-1.99), ♀♀ 2.03 (2.02-2.04); LWP ♂♂ 1.46 (1.41-1.51), ♀♀ 1.47 (1.45-1.49). The lateral margin, near to the anterior angles, serrulated with 3-4 setae. Basal margin of the elytra ending between the fourth and fifth stria, sometimes nearer to the fifth stria.

Elytra - LE ♂♂ 3.81 mm (3.78-3.84), ♀♀ 3.96 mm (3.90-4.02); WE ♂♂ 2.38 mm (2.32-2.44), ♀♀ 2.47 mm (2.44-2.50); sutural stria with 12-14 points; yellow apex, with the anterior limit not clearly defined.

Genitalia - aedeagus (AL 1.80 mm, SL 0.19 mm); spermatheca (Fig. 13) very simple, with rounded margins and a little bottleneck between the anterior and posterior cavity; the duct is very long with 25-30 spirals.

DISTRIBUTION. Species known only from the type locality, in Ethiopia, along the Blue Nile.

CATALOGUS OF THE AFRICAN SPECIES
OF *MICROSERRULLULA*

Odontium (Microserrullula) australe Bonavita & Vigna Taglianti, 2021

Odontium (Microserrullula) icterodes (Alluaud, 1933)

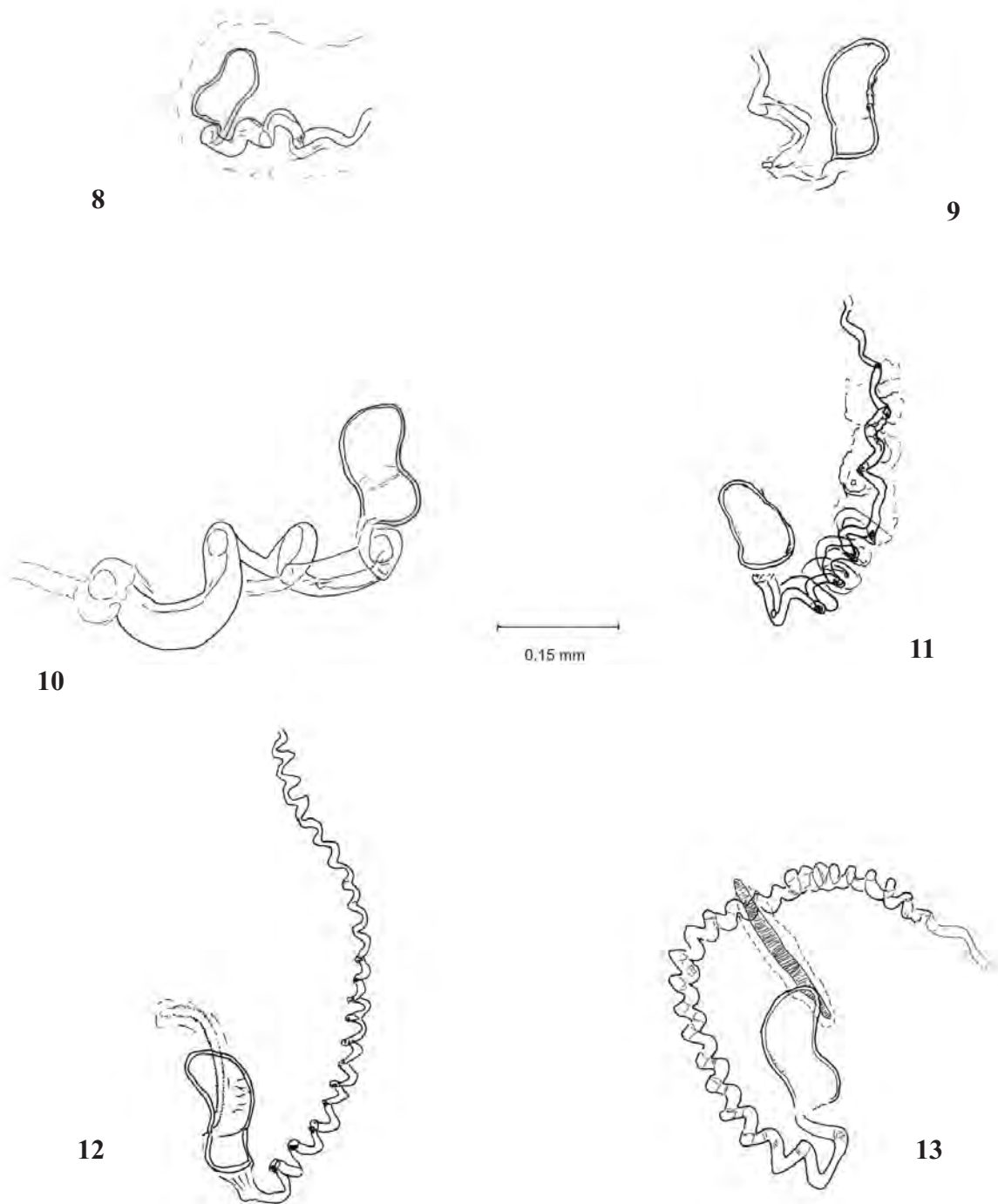
Odontium (Microserrullula) basilewskyi Bonavita & Vigna Taglianti, 2021

Odontium (Microserrullula) pogonopsis (Alluaud, 1933)

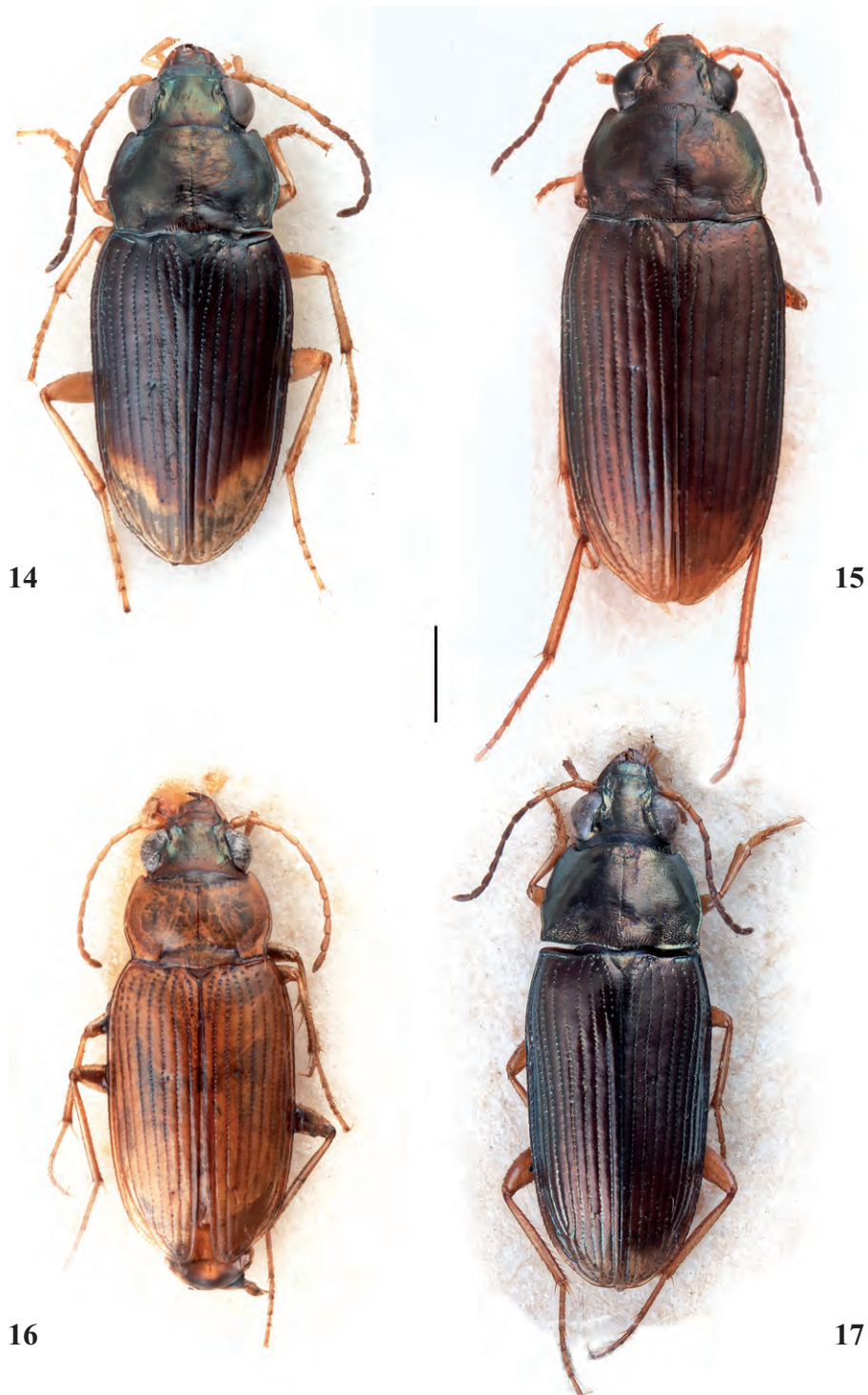
Odontium (Microserrullula) okavangum Bonavita & Vigna Taglianti, 2021

Odontium (Microserrullula) aegyptiacum (Dejean, 1831)

Odontium (Microserrullula) clarkei Bonavita & Vigna Taglianti, 2021



Figs. 8-13. Spermathecae of: 8 - *O. australe*, South Africa, Zululand, Mtubatuba; 9 - *O. pogonopsis*, Democratic Republic of Congo, près Bombesa [= Bambesa], Alipago; 10 - *O. basilewskyi*, Congo Belge, Libenge, Zambi; 11 - *O. okavangum*, Namibia bor. or., Okavango river, Bagani, Popa Falls; 12 - *O. aegyptiacum*, Egypte, Kitchener; 13 - *O. clarkei*, Ethiopia, Blue Nile Gorge.



Figs. 14-17. Habitus of: 14 - *O. australe*, Kenya, Bushwackers Camp, Athi River Beach; 15 - *O. pogonopsis*, Democratic Republic of Congo, près Bombesa [= Bambesa], Alipago; 16 - *O. icterodes*, Democratic Republic of Congo, Gantchou; 17 - *O. basilewskyi*, Congo Belge, Libenge, Zambi.



Figs. 18-20. Habitus of: 18 - *O. okavangum*, Angola, riv. Cuilo, Cacolo, Alto Cuilo; 19 - *O. aegyptiacum*, Sudan, Wadi Hatta; 20 - *O. clarkei*, Ethiopia, Blue Nile Gorge.

IDENTIFICATION KEY

- 1 bicolor species, with pronotum brownish and elytra entirely reddish or yellow-reddish with apex clearer; abdominal sternites clearer, yellowish; laterobasal carina often not visible or at least hardly visible.....2
- unicolor species, with pronotum and elytra brown with apex clearer; abdominal sternites brownish3
- 2 median lobe of aedeagus bigger, with a very long flagellum and the apex shorter and thinner (Fig. 6); L ♂♂ 5.24-6.16 mm, ♀♀ 5.18-6.22 mm; North to Equator: Mali, Burkina Faso, Senegal, Central African Republic, Egypt, Sudan, Uganda, Ethiopia, Kenya.....*aegyptiacum* (Dejean, 1831)
- median lobe of aedeagus smaller, with a flagellum clearly shorter and the apex with a small lip (Fig. 5); L ♂♂ 5.00-5.55 mm, ♀♀ 5.30-5.61 mm; South to Equator: Angola, Namibia, Zambia*okavangum* n. sp.
- 3 pronotum not or lightly wrinkled; pronotal furrow, between the internal fovea and the hind angle, more or less impressed; elytra less elongated and punctures more superficial.....4
- area, between the internal fovea and the lateral margin of pronotum, more strongly wrinkled; pronotal furrow, between the internal fovea and the hind angle, superficial and not clearly visible; laterobasal carina unnoticeable; elytra narrowed and strongly elongated with striae and punctures strongly impressed; apical spot smaller, occurs only at the far apex; L ♂♂ 5.65-5.89 mm, ♀♀ 5.43-5.91 mm; Democratic Republic of Congo....*basilewskyi* n. sp.
- 4 species smaller (5.18-5.85 mm); sides of pronotum clearly sinuated; elytra not elongated, proportionally shorter with punctures superficial; latero-hind area, between the internal fovea and the lateral margin, entirely smooth or with weakly wrinkled; furrow, between the internal fovea and the hind angle, superficial and more or less impressed5
- species bigger (5.61-6.28 mm); sides of pronotum sinuated; elytra wide; latero-hind area, between the internal fovea and the lateral margin, less or more wrinkled; furrow, between the internal fovea and the hind angle, well or strongly impressed6
- 5 pronotum entirely smooth; laterobasal carina not distinguishable; apical spot as a lunula of big size, with superior limits clearly delimited; L ♂ 5.37 mm, ♀♀ 5.18-5.85 mm; Kenya, Mozambique, Madagascar, South Africa*australe* n. sp.
- pronotum with longitudinal striole weakly impressed; laterobasal carina clearly evident and relieved; apical spot clearer, in the fifth-sixth apical; L ♂♂ 5.18-5.37 mm; ♀♀ 4.88-5.37; Democratic Republic of Congo, Gabon.....*icterodes* (Alluaud, 1933)
- 6 pronotal laterobasal carina reduced but clearly visible; latero-hind area wrinkled; anterior angles protruding and less rounded than in *pogonopsis*; anterior and hind margins, especially in the central area, with distinct longitudinal striole. Elytra wide with parallel sides; apical spot occurs in the apical fifth only near the sides, with the superior limit not clearly defined; L ♂♂ 5.85-6.04, ♀♀ 6.16-6.28; Ethiopia*clarkei* n. sp.
- pronotal laterobasal carina strongly reduced, visible only at high magnifier; latero-hind area lightly wrinkled; anterior margin narrower, with sides more convergent. Elytra wide; apical spot as a lunula of big size, with the superior limit not clearly delimited; L ♂♂ 5.61-6.22 mm, ♀♀ 5.61-6.04 mm; Democratic Republic of Congo, Cameroun.....*pogonopsis* (Alluaud, 1933)

ACKNOWLEDGEMENTS

We wish to thank Robert Davidson (CMNH); Ben Brugge, Hans Huijbregts (NBCL), Azadeh Taghavian and Thierry Deuve (MNHNP); Manfred Jaech (NHMW), Marc De Meyer, Didier Van den Spiegel, Stéphane Hanot (MRAC); Beulah Garner, Max Barclay (NHML); Alain Drumont (RBINS); Ruth Müller (DNMNH) for kindly loaning for study the material in their care and Sergio Facchini, Riccardo Monguzzi, Paolo Neri, Peter Schüle and Luca Toledano for allowing the study of the material of their collections; Vasily Grebennikov for informing us about the presence of specimens of a new species (*O. australe*) in DNMNH collections; Pier Mauro Giachino for the critical review of the text; Luca Toledano for the help in obtaining some materials (MNHNP, NBCL, RBINS), for the critical review of the text and for the photos of the habitus, and Leslye Mills for the linguistic revision of a part of the paper.

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Luca TOLEDANO* - Paolo BONAVITA** - Joachim SCHMIDT***

Bembidiina of Afrotropical Region: 3. *Bembidion* subgenus *Peryphus* Dejean, 1821 and related subgenera (Coleoptera, Carabidae)

Abstract: The six known Afrotropical species attributed to *Bembidion* subgenus *Peryphus* Dejean, 1821 in the previous literature (*B. scottustulatum* Netolitzky, 1937, *B. muscicola* Basilewsky, 1953, *B. melanocentrum* Chaudoir, 1876, *B. jeanneli* Alluaud, 1939, *B. sjoestedti* Alluaud, 1926 and *B. africanum* Chaudoir, 1876) are here revised. For one of them, *B. muscicola* Basilewsky, 1953, secondary homonym of the North American *B. (Semicampa) muscicola* Hayward, 1897, a synonymy with *B. basistriatum* Fairmaire, 1893, is proposed. *Bembidion basistriatum*, *B. melanocentrum* and *B. africanum* are transferred to the subgenus *Ocydromus* Clairville, 1806. In addition, *B. fontinale* Raffray, 1885 currently assigned to the genus *Sinechostictus* Motschulsky, 1864, is placed into the *Bembidion* subgenus *Ocydromus* Clairville, 1806. For *B. jeanneli* the lectotype and two paralectotypes are designated. Four new species from Ethiopia are also described: *Bembidion (Ocydromus) augustovignai* n.sp., *B. (Ocydromus) melanocentroides* n.sp., sister species of *B. melanocentrum*, and two species closely related to *B. scottustulatum*: *B. (Peryphus) damota* n.sp. and *B. (Peryphus) baleense* n.sp.

Riassunto: *Bembidiina della regione afrotropicale: 3. Bembidion sottogenere Peryphus Dejean, 1821 e sottogeneri vicini (Coleoptera, Carabidae)*

Vengono qui riviste le sei specie Afrotropicali attribuite nella precedente letteratura a *Bembidion* sottogenere *Peryphus* Dejean, 1821 (*B. scottustulatum* Netolitzky, 1937, *B. muscicola* Basilewsky, 1953, *B. melanocentrum* Chaudoir, 1876, *B. jeanneli* Alluaud, 1939, *B. sjoestedti* Alluaud, 1926 e *B. africanum* Chaudoir, 1876). Per una di esse, *B. muscicola* Basilewsky, 1953, omonimo secondario del Nordamericano *B. (Semicampa) muscicola* Hayward, 1897, è proposta la sinonimia con *B. basistriatum* Fairmaire, 1893. *Bembidion basistriatum*, *B. melanocentrum* e *B. africanum* sono trasferiti al sottogenere *Ocydromus* Clairville, 1806. Inoltre, *B. fontinale* Raffray, 1885 attualmente attribuito al genere *Sinechostictus* Motschulsky, 1864, viene qui trasferito in *Bembidion*, sottogenere *Ocydromus* Clairville, 1806. Per *B. jeanneli* sono designati il lectotipo e due paralectotipi. Sono anche descritte quattro specie di Etiopia: *Bembidion (Ocydromus) augustovignai* n.sp., *B. (Ocydromus) melanocentroides* n.sp., specie gemella di *B. melanocentrum*, e due specie in stretta relazione con *B. scottustulatum*: *B. (Peryphus) damota* n.sp. e *B. (Peryphus) baleense* n.sp.

Key words: Bembidiina, Africa, new taxa, *Ocydromus*, *Sinechostictus*, *Testedium*, distribution, systematics, taxonomy, synonymy, key to subgenera, key to species.

To meet the requirements by the International Code of Zoological Nomenclature (ICZN), this article was registered at ZooBank (31 March 2021) under the ZooBank Life Science Identifier (LSID): 772D253B-E114-4AF4-B1FC-7ACF40FD9AFE.
Published: 23 April 2021.

INTRODUCTION

With few exceptions, the *Bembidion* Latreille, 1802 species inhabit moist habitats in temperate and colder environments. Those in tropical Africa can be found mainly along brooks, rivers and moorland of the mountains and in the afroalpine zone. This study, published in parallel with another revisionary paper (Bonavita & Vigna Taglianti, 2021) which deals with the *Bembidion* subgenus *Microserrullula* Netolitzky, 1921, is a further step to revising the Afrotropical fauna of Bembidiina. The first one (Bonavita *et al.* 2016) regarded the subgenus *Omotaphus* Netolitzky, 1914.

Six species presently attributed to the subgenus *Peryphus* Dejean, 1821, one species of the subgenus *Testedium* Motschulsky, 1864, and one species of the Bembidiina genus *Sinechostictus* Motschulsky, 1864, are known to occur in the mountains of tropical East Africa, all of which are characterized by relatively restricted geographical distributions (Ethiopia, Tanzania, Kenya). This is the first study that attempts to review these species all together, and describe some new species related to them.

Morphologically, most Bembidiina of East

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Africa share the typical marked shoulders of winged species, with exception of *Sinechostictus fontinale* Raf-fray, 1885 (Ethiopia), *Bembidion jeanneli* Alluaud, 1939 (Kenya) and *B. sjoestedti* Alluaud, 1926 (Tanza-nia), showing rounded humeri. *Bembidion sjoestedti*, also due to the relatively small size, is highly conver-gent in habitus with species of the subgenus *Hyp-sipezum* Alluaud, 1917 occurring in the same region.

After the investigation of comprehensive material, including type material of all known species and the material collected during expeditions conducted in Ethiopia by Augusto Vigna Taglianti (1973 and 1991) and more recently (2013-2020) by a team of researchers leaded by one of us (JS), we were able to discover four undescribed species from Ethiopia and make clear the systematic position of formerly poorly known taxa.

One of these new species was collected at Anderaccia (Ethiopia, Kaffa Province) by Augusto Vigna Taglianti in 1973: his student (PB) notes that this species was the preferred one of Augusto; for this reason, we decided to dedicate the species to him, with the name of *B. augustovignai* n.sp. The entire study presented here is dedicated to the late Augusto who, before us, already suspected that some of the taxa described here were new to science.

MATERIALS AND METHODS

This paper is based on the study of about 1900 specimens of *Bembidion* subgenus *Peryphus* Dejean, 1821 and related subgenera. The specimens are from or will be deposited in the collections of the following institutions and individuals:

AVT	Augusto Vigna Taglianti private collection, now preserved in the Museo Civico di Storia Naturale di Genova, Italy (Roberto Poggi, Maria Tavano)
NHMUK	The Natural History Museum, London, UK (Max Barclay, Beulah Garner)
CDW	David Wrase private collection, Gusow-Platkow, Germany (part of Zoologische Staatssammlung München, Germany)
CE	Dominique Echaroux private collection, Etrecty, France
CH	Ingmar Harry private collection, Freiburg, Germany
CSCHM	Joachim Schmidt working collection, Rostock, Germany

CTVR	Luca Toledano private collection, Verona, Italy
MNHN	Muséum National d'Histoire Naturelle, Paris (Thierry Deuve, Azadeh Taghavian)
MRAC	Musée Royal de l'Afrique Centrale, Tervuren, Belgium (Marc De Meyer, Didier Van den Spiegel, Stéphane Hanot)
NHMW	Naturhistorisches Museum, Wien, Austria (Heinrich Schönmann, Manfred Jäch, Harald Schillhammer)
OSAC	Oregon State Arthropod Collection, Oregon State University, Corvallis, USA (David Maddison)
PB	Paolo Bonavita private collection, Roma, Italy
ZMAA	Zoological Museum, Addis Ababa University
ZSM	Zoologische Staatssammlung München, Germany (Michael Balke)

Body measurements were made with Leica M205C stereomicroscopes at 25x magnification. Ratios and measurements are abbreviated in the text as follows:

Al	antennal length
Bl	body length
El	elytral length
El/Ew	elytral length / elytral width ratio
Ew	elytral width
Ew/Pw	elytral width / pronotal width ratio
Hw	head width
Paw	width of pronotal anterior margin
Pbw	width of pronotal base
Pl	pronotal length
Pw	pronotal maximum width
Pw/Pl	pronotal width / pronotal length ratio

The body length was measured, in mounted specimens, from the front margin of the labrum to the apex of the elytra, and the length of antennae from the base of antennomere 1 to the apex of antennomere 11. The head width is the maximum width, including the eyes. The pronotal length was measured along the midline from the anterior to the posterior margin. The elytral width was measured at the widest point across both elytra.

Dissections were made using standard techniques. Genitalia and small parts were preserved in Euparal, attached to label-size acetate sheets and mounted on the same pins as the specimens.

The photographs made by LT (Figs. 5, 6, 10, 11) are composite images with progressive focusing obtained with a Nikon DSFi1 digital camera controlled by Nikon DS-L2 stand alone remote controller mounted on a Leica Z6 microscope equipped with a 1.0x Leica lens and a customized motorized stand made by LT, then processed with Helicon Focus® 6.4.3 and optimized with Photoshop® Elements 14. Photographs of the aedeagi (Figs. 13-23) are made with the same setup and processing method described above, although using a 5x Infinity Corrected Nikon Fluor lens on the Z6 microscope. The photos made by JS (Figs. 1-4, 7-9, 12) were taken with a Leica M205-C stereomicroscope and a Leica DFC450 digital camera using a motorised focusing drive, light base Leica TL5000 Ergo, diffused light with Leica hood LED5000 HDI, subsequently processed with Leica LAS application software, and enhanced with CorelDRAW Graphics Suite X5.

The systematic treatment of the subtribe Bembidiina follows Maddison (2012). In the following text, “type seen” means that we were able to study the type of a given species in the past but not during the compilation of this paper.

TAXONOMIC RESULTS

***Bembidion* subgen. *Peryphus* Dejean, 1821**

Type species: *Carabus littoralis* Olivier, 1795 = *Bembidium tetracolum* Say, 1823

SYSTEMATIC NOTE. Based on morphology of the endophallus, particularly due to the high similarity in the respective shapes of the central sclerite complex, the flagellum, and the ostidial fold, the following four species seem closely related to the Western Palearctic species *B. scapulare* Dejean, 1831 and *B. fluvatile* Dejean, 1831.

***Bembidion* (*Peryphus*) *scottustulatum* Netolitzky, 1937 (Figs. 1, 2, 13)**

DIAGNOSIS. Mid-sized Ethiopian *Bembidion* subg. *Peryphus* with light apical elytral spots and endophallus showing relatively small central sclerite and narrow flagellum.

TYPE LOCALITY. Jem Jem Forest, central Ethiopia.

MATERIAL EXAMINED. Type (NHMUK) seen (LT); 1 Paratype, “Abyssinia, / Djem Djem Forest / from river

bed. / circa 8,000 ft. / 2.x.1926 / Dr. H. Scott. // Para / type [round, printed, bordered in yellow] // Coll. / Netolitzky [printed] // scottustulatum / cotypus [handwritten] det Netolitzky [printed] // CO [handwritten] / TYPE [red. printed]” (NHMW); 3 exx., Athiopien: Prov. Gondar, Simien: Jinbar Wenz 3200-3400m 15.-19.4.1976 Leg. Löffler (CTVR); 15 exx., Begemdir Prov., Gimbar stream 5 km S. of Geech 3170m, 22-X-73 // Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke (MRAC, CSCHM, CTVR, PB); 2 exx., Begemdir Prov.: Semiens Mts.; Jimbar stream, 22-X-73 // Coll. Mus. Tervuren, Ethiopie, G. de Rougemont (MRAC, CTVR); 1 ex., Begemdir Prov.: from Debanak to Ankober, 3000-3170 m 22-X-73 // Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke (MRAC); 24 exx., Ethiopia, Simien, Mecana torrent, below Mecana Abbo, c. 10,000 ft., 9.xii.1952. // N. Ethiopia, 1952-1953. Hugh Scott, B.M. 1953-335 (NHMUK, MRAC, CTVR, PB, JS); 2 exx., Ethiopia: Simien, ravine on W side of Mal Shaha Valley, c. 9,000 ft. 14.xii.1952. // Coll. Mus. Congo, Col. P. Basilewsky (MRAC); 12 exx., Ethiopie N. Wollo Amhara, bord ruisseau Col Abuna Youssef 3993m 7.1.2013 leg. Queinnec (CE, CTVR); 4 exx., ETHIOPIA Amhara, Mt. Abuna Yosef, S-slope, 3700-3800 m, 12°09'10"N 39°09'35"E, 5.III.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM); 55 exx., ETHIOPIA Amhara, W-slope Mt. Choke, 2750-2900 m, 10°38'N 37°45'E, 1.III.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM, CTVR, OSAC: DNA 5626, PB, ZMAA); 28 exx., ETHIOPIA Amhara, N-slope Mt. Choke, 3800-3950 m, 10°43'16"N 37°51'15"E, 26.II.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM); 11 exx., Gojjam Prov.: 8 km W of Falega Birhan, Anguata river, 2820m, 18.XII.1972 // Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke (MRAC, CSCHM, CTVR); 1 ex., Shoa Prov.: Mussolini pass 3000/3200m., I.VIII-73 // Coll. Mus. Tervuren, Ethiopie, G. de Rougemont (MRAC); 4 exx., Akaki River, Old Airport, Addis Abeba, 27.XII.1970 // under stone, by river // Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke (MRAC, CTVR); 1 ex., Meta Ambo, 13 km west of Addis Abeba, 27.XII.1970 // Under rock, by waterfall // Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke (MRAC); 1 ex., Shoa Prov.: Sabeta, 23-XI-73 // Coll. Mus. Tervuren, Ethiopie, G. de Rougemont (MRAC); 1 ex., Coll. Mus. Tervuren, Ethiopie: Addis Abeba, 1971, G. de Rougemont (MRAC); 3 exx., Bale Prov.: 20 km E de Adaba, 2500m, 16.XII.1971, Coll.

Mus. Tervuren, Ethiopie, R.O.S. Clarke (MRAC, CTVR); 2 exx., Bale Prov.: 20 km E de Adaba, 2509m, 16.XII.1971, Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke (MRAC, CTVR); 4 exx., ETIOPIA - Arussi - Loc. 28, Gondi, m 2200 circa - 3-XI-1973, A. Vigna (AVT, PB); 19 exx., ETHIOPIA Oromia, Bale Mts., Finchaya Habera Camp, river valley, 3400-3500 m, 07°00'N 39°43'E, 20-21.II.2013, leg. J. Hagge, Y. Teklu, J. Schmidt (CSCHM); 10 exx., ETHIOPIA Oromia, Bale Mts., Sebsebe Washia Forest, Salgen Vall. 2720-2800 m, 07°01'N 39°34'E, 3.II.2019, leg. R. Emmerich, J. Schmidt, Yeshitla M. (CSCHM); 1 ex., "Bale Prov.: 3 km W de Dinshu 3040m, 17-XII-1971 // Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke" (MRAC); 1 ex., "Bale prov.: 8 km W de Dinshu, 3050 m, 19.XII.1971 // Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke" (CTVR).

REDESCRIPTION. Bl = 5.04 to 5.84 mm. Colour: head and pronotum piceous-black; elytra brown to dark brown, slightly lighter at shoulders; yellowish apical lunula with undefined edges, extending to the elytral epipleura. Legs reddish-testaceous; antennomeres 1 to 3, basal half of 4 and basal end of the remaining reddish, rest of antenna darkened.

Head (Hw = 1.0 to 1.2 mm) with parallel frontal furrows, rather deep, wrinkled in most specimens; eyes convex, temples short. Microsculpture of the frons very superficial, in some specimens not visible, if visible, in weakly transverse superficial sculpticells, becoming slightly more evident and isodiametric at neck. Al = 2.8 to 3.0 mm.

Pronotum cordate, convex, transverse (Pl = 1.00 to 1.16 mm, Paw = 0.96 to 1.10 mm, Pw = 1.32 to 1.60 mm, Pbw = 1.00 to 1.20 mm, Pw/Pl = 1.29 to 1.38); anterior transverse impression and median line rather superficial; basal transverse impression finely punctate; basal foveae rather superficial; laterobasal carina present, but rudimentary. Sides rounded, sinuate before the square and sharp hind angles. Lateral gutter narrow, with one pore puncture bearing a seta at the anterior third and one exactly at the corner. Basal margin slightly arcuate at posterior convexity. Pronotal microsculpture absent at magnification of up to 100x, only faint traces at hind corners visible at 100x.

Elytra (El = 3.16 to 3.68 mm, Ew = 2.08 to 2.44 mm, El/Ew = 1.32 to 1.70, Ew/Pw = 1.35 to 1.85) oval, shoulders somewhat rounded but evident, apex rounded. Elytral striae 1 to 7 evident, punctate with punctures very close to one another in the basal $\frac{3}{4}$, then

only sulcate or very superficially punctate in the apical fourth. Apical stria short, isolated in the specimens with apical portion of striae completely wanting, or connected with stria 5. Two discal pores in the third interval, adjoining stria 3. Intervals convex, more markedly in the basal half, slightly flatter in the apical half. Elytral microsculpture consists of sharp, irregular, evidently transverse sculpticells.

Fully winged species.

MALE GENITALIA (Fig. 13). Median lobe of the aedeagus with ventral margin almost rectilinear, bent ventrally at apex. Central sclerite oval, relatively small, diagonally oriented; flagellum relatively narrow and short; basal end of ostial flag regularly rounded, sometimes simply folded near ventral side of median lobe.

COMPARATIVE NOTES. *Bembidion scottustulatum* is distinguishable from *B. damota* n.sp. mainly by endophallic characters: by the smaller size of the central sclerite and the narrower flagellum.

DISTRIBUTION. The species is known from northern, central and southern Ethiopia south to the Arsi and Bale Mountains. In the latter, the species was only found on the northern slope of the mountain range. At the type locality (Jem Jem Forest) the species is sympatric with *B. africanum* Chaudoir, 1876, and on northern slope of the Bale Mountains it is sympatric and syntopic with *B. baleense* sp.n.

HABITAT. The species occurs on the banks of different kinds of mountain streams at elevations of about 2200 - 3900 m. At lower elevations, the species prefers river shores moderately shaded by trees. At higher elevations, open shores of creeks and springs are the preferred habitat of *B. scottustulatum*.

Bembidion (Peryphus) damota n.sp. (Figs. 3, 14)

urn:lsid:zoobank.org:act:

C9B9AD5A-A47D-4E34-AA57-0BE9CE531FB7

DIAGNOSIS. *Bembidion* subg. *Peryphus* from southwestern Ethiopia with light apical elytral spots and endophallus showing, in respect to *B. scottustulatum*, larger central sclerite, and thicker flagellum.

HISTORICAL NOTES. This species is extremely similar to *B. scottustulatum* for body characters. The Basilevsky's (1957) mention of *B. scottustulatum* from the Gughe Highlands most probably refers to this species.

TYPE LOCALITY. Mt. Damot, Southern Nations Nationalities and people, Ethiopia.

TYPE SERIES. Holotype, male, "ETHIOPIA Sodo, Mt. Damot, 2380 m, 06°53'26"N 37°46'51"E, 3.XII.2017, leg. D. Hauth, J. Schmidt, Yeshitla M." (CSCHM). Paratypes: 56 exx. same collecting data as the holotype (CSCHM, CTVR, PB, ZMAA); 1 ex., "ETHIOPIA Sodo, Mt. Damot, 2800-2900 m, 06°54'24"N 37°47'07"E, 3.XII.2017, leg. D. Hauth, J. Schmidt, Yeshitla M." (CSCHM); 30 exx., "ETHIOPIA Gughe Highlands, env. Dorze and Chench, 2600-2700 m, 06°15'N 37°34'E, 4.XII.2017, leg. D. Hauth, J. Schmidt, Yeshitla M." (CSCHM, CTVR, OSAC: DNA5779, PB); 4 exx., "ETHIOPIA Gughe Highlands, near Tola vill., 2950 m, 06°18'48"N 37°33'57"E, 5.XII.2017, leg. D. Hauth, J. Schmidt, Yeshitla M." (CSCHM); 1 ex., "ABYSSINIA: Gamo Prov, near Ezo, c. 9,600 ft., 20.21.xi.1948. [printed] // From bed of stream. [printed] // ETHIOPIA 1948-1949. Hugh Scott., B.M. 1949-184" (MRAC); 1 ex., "ABYSSINIA: Gamo Prov., Gughé highlands, between Bonghé and Algudi, 9,000-10,000 ft., 30.xii.1948 - I.I.1949. // ETHIOPIA 1948-1949. Hugh Scott., B.M. 1949-184 // Coll. Mus. Congo, Col. P. Basilewsky" (MRAC); 1 ex., "ABYSSINIA: / Gamo Prov., / Gughé highlands / between Bonghé and / Algudi, 9,000-10,000 ft. / 30.xii.1948 - I.I.1949. // ETHIOPIA / 1948-1949. Hugh Scott. / B.M. 1949-184" (NHMUK); 1 ex., "Coll. Mus. Tervuren, Ethiopie: Kaffa Prov. Beletta for. 19.XI.71 G. de Rougemont" (MRAC); 6 exx., "ETHIOPIA - Kaffa - Loc. 18, Anderaccia, ponte naturale di Gurgutto, m. 1650 circa - 26-X-1973 [printed], Vigna [handwritten]" (AVT, CTVR, PB); 2 exx., "Kaffa Prov.: Tukur, c. 15 mls N of Jimma, 2600m, 6.III.1972, Coll. Mus. Tervuren Ethiopie, R.O.S. Clarke" (MRAC, CTVR); 1 ex., "28 km S de Jimma, 2000m, 5-X.1971, Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke" (MRAC); 1 ex., Abyssinia, M. Chillalo. Dr. H. Scott 1926 [handwritten] // Brit. Mus. dedit [handwritten] // basis thoracis fere inpunctata, rugosa prope africanum Chd, det. Netolitzky [handwritten] // Spur eines Basalrandes? [handwritten] // coll. Netolitzky [printed] // fontinale Raff. / ? Netolitzky [handwritten] // coll. Netolitzky [printed] // coll. Netolitzky [printed]" (NHMW); 1 ex., "Abyssinia Mt. Chillalo, forest, circa 9,000ft., 15-16.xi.1926, Dr. H. Scott. [printed] // Brit. Mus. 1927-127. [printed] // Under stones near stream [printed] // cf. fontinale Raffr., det. Netolitzky [handwritten]" (NHMUK).

DESCRIPTION. Bl = 4.7 to 6.2 mm. Colour: head and pronotum piceous-black; elytra brown to dark brown, yellowish apical lunula with undefined edges, extending to the elytral epipleura. Legs reddish-testaceous; antennomeres 1 to 3, basal half of 4 and basal end of the remaining reddish, rest of antenna darkened.

Head (Hw = 0.98 to 1.24 mm) with parallel frontal furrows, rather deep, wrinkled in most specimens; frons with some scattered punctures and wrinkles; eyes very convex, temples short. Microsculpture superficial, isodiametric, only at neck. Al = 2.8 to 3.1 m.

Pronotum cordate, convex, transverse (Pl = 0.92 to 1.20 mm, Paw = 0.88 to 1.12 mm, Pw = 1.24 to 1.60 mm, Pbw = 0.90 to 1.16 mm, Pw/Pl = 1.33 to 1.35); anterior transverse impression and median line rather superficial; basal transverse impression finely punctate; basal foveae rather superficial, laterobasal carina present, but rudimentary. Sides rounded, less sinuate than the preceding species before the slightly obtuse and sharp hind angles. Lateral gutter relatively wide, with one pore puncture bearing a seta at the anterior third and one exactly at the corner. Basal margin slightly arcuate at posterior convexity. Pronotal microsculpture very superficial near the sides and hind corners, in a few specimens also on disk, visible at 100x.

Elytra (El = 2.88 to 3.80 mm, Ew = 2.02 to 2.56 mm, El/Ew = 1.42 to 1.48, Ew/Pw = 1.60 to 1.63) more oval than in the preceding species, shoulders slightly rounded, apex rounded. Elytral striae 1 to 7 evident, punctate with punctures very close to one another in the basal ¾, then only sulcate or very superficially punctate in the apical fourth. Apical stria short, connected with stria 7. Two discal pores in the third interval, adjoining stria 3. Intervals convex, more markedly in the basal half, slightly flatter in the apical half. Elytral microsculpture in very sharp, evidently transverse sculpticells.

Fully winged species.

MALE GENITALIA (Fig. 14). Median lobe of the aedeagus with ventral margin almost rectilinear, bent ventrally at apex. Central sclerite larger and flagellum thicker and longer than in *B. scottustulatum*.

ETYMOLOGY. The name derives from the type locality, the Mt. Damot (= Mt. Damota) in southwestern Ethiopia and it is given in apposition.

COMPARATIVE NOTES. *Bembidion damota* is distinguishable from *B. scottustulatum* mainly by the

larger size of the central sclerite and the thicker flagellum.

DISTRIBUTION. The species is known from the mountains in southwestern Ethiopia west of the Rift Valley and from foot of Mt. Chillalo east of the Rift Valley. It occurs at elevations of about 2000 - 3000 m.

HABITAT. In the Gughe Highlands and on Mt. Damot the species was found on the banks of mountain streams moderately shaded by trees.

Bembidion (Peryphus) baleense n.sp. (Figs. 4, 15)

urn:lsid:zoobank.org:act:

95B38E04-AC91-4384-8508-0CBF4680BCE1

DIAGNOSIS. Unicolourous, piceous-brown *Bembidion* subg. *Peryphus* from the Bale Mountains of southern Ethiopia with rounded shoulders and endophallus very similar to that of *B. damota*, i.e. showing large central sclerite, and thick flagellum.

TYPE LOCALITY. Ethiopia, Oromia, Bale Mountains, Sebsebe Washia Forest, Salgen Valley 3130 m.

TYPE SERIES. Holotype, male, "ETHIOPIA Oromia, Bale Mts., Sebsebe Washia Forest, Salgen Vall. 3130 m, 07°02'08"N 39°36'06"E, 4.II.2019, leg. R. Emmerich, J. Schmidt, Yeshitla M." (CSCHM). Paratypes: 172 exx., same collecting data as the holotype (CSCHM, CTVR, PB, ZMAA, ZSM); 3 exx., "ETHIOPIA Oromia, Bale Mts., Sebsebe Washia Forest, Salgen Vall., upp. Salgen Vall. 3340-3500 m, 07°03'N 39°37'E, 4.II.2019, leg. R. Emmerich, J. Schmidt, Yeshitla M." (CSCHM); 98 exx., "Ethiopia Oromia 10-11.XII.16 western Bale Mts. above Dodola 2700-2850m, leg. J. Schmidt 06°53'49"N 39°11'32"E" (CSCHM, CTVR, OSAC: DNA5182, PB); 8 exx., "ETHIOPIA Oromia, N-slope Bale Mts above Goba, 3650 m, 06°54'43"N 39°55'6"E, 17.XII.16, leg. J. Schmidt" (CSCHM); 13 exx., "ETHIOPIA Oromia, N-slope Bale Mts, river valley above Goba, 2990 m, 06°56'08"N 39°57'20"E, 7+18.II.17, leg. Berndt & Schmidt" (CSCHM, OSAC: DNA5184); 1 ex., "ETHIOPIA Oromia, N-slope Bale Mts, brook valley above Goba, 3750-3800 m, 06°54'42"N 39°54'38"E, 19.II.17, leg. Berndt & Schmidt" (CSCHM); 2 exx., "ETHIOPIA Oromia, Bale Mts, Tegona valley above Goba, 3550 m, 06°54'42"N 39°53'35"E, 20.II.17, leg. Berndt, Renken & Schmidt" (CSCHM); 6 exx., "ETIOPIA - Bale - Loc. 39 / Goba. M. Sgona / m. 3650 circa - 8-XI-1973 [printed] / Cottarelli [handwritten]" (AVT, CTVR, PB); 23 exx., "ETHIOPIA Oromia, Bale Mts.,

Angeso Vall. S Goba, 3050 m, 6.932923, 39.951341, 5.II.2020, leg. J. Schmidt, C. Wirkner, Yeshitla M., Yitbarek W." (CSCHM); 2 exx., "ETHIOPIA Oromia, Bale Mts., Angeso Vall. S Goba, 3750 m, 6.897265 39.922529, 7.II.2020, leg. J. Schmidt, C. Wirkner, Yeshitla M., Yitbarek W." (CSCHM).

DESCRIPTION. Bl = 5.5 to 6.1 mm. Colour: dorsal surface dark brown to blackish, moderately shiny, elytral epipleurae brown. Legs reddish-brown, with darker knees; antennomeres 1, 2 and base of 3 reddish-brown, the rest of antennae piceous-brown. Sometimes antennomere 2 darkened at middle, with base and apex reddish-brown. Last maxillary palpomere yellowish, penultimate dark brown, rest of palps reddish.

Head (Hw = 1.10 to 1.24 mm): frons smooth, with frontal furrows slightly converging, rather deep and uneven. Eyes moderately convex, with temples oblique; antennae elongate (Al = 3.1 to 3.36 mm). Microsculpture very superficial, isodiametric on neck, in most specimens absent on the frons and in the frontal furrows, if present then in weakly transverse sculpticells. Pronotum (Pl = 1.04 to 1.16 mm, Paw = 0.96 to 1.10 mm, Pw = 1.36 to 1.50 mm, Pbw = 1.02 to 1.12 mm, Pw/Pl = 1.29 to 1.31): moderately cordate and transverse, less convex than in the preceding species; anterior transverse impression variable in shape, from shallow to deep in the median part, to represented by a series of short longitudinal wrinkles; median line sharp; basal transverse impression wide, with longitudinal wrinkles in most specimens, with a few scattered punctures at middle in some other specimens; basal foveae small but rather deep, wrinkled; laterobasal carina absent or barely visible. Lateral gutter of irregular width, narrow in the anterior third, then widened in correspondance with the anterior lateral seta, then narrowing again after the seta and evidently widening at the sinuation before the hind angles; these last from square to barely acute. Microsculpture completely absent in some specimens, superficial and restricted to the pronotal sides in some other.

Elytra (El = 3.44 to 3.76 mm, Ew = 2.20 to 2.44 mm, El/Ew = 1.54 to 1.56, Ew/Pw = 1.62 to 1.63): oval, with rounded shoulders, maximum width slightly behind middle and round apex. Elytral striae 1 to 7 evident, punctate with punctures very close to one another in the basal $\frac{3}{4}$, then only sulcate or very superficially punctate in the apical fourth. Apical stria short, connected with stria 5. Two discal pores in the third interval, adjoining stria 3. Intervals flat. Elytral

microsculpture consists of weakly transverse, rather large irregular sculpticells.

A polymorphic species, with hindwings shortened or fully developed.

MALE GENITALIA (Fig. 15). Almost identical to those of *damota*, only a slight difference in the shape of the basal end of the ostial flag, regularly rounded in *B. baleense*, somewhat waved in *damota*.

ETYMOLOGY. The name is an adjective, neutral, that derives from the Bale Mountains of southern Ethiopia.

COMPARATIVE NOTES. *Bembidion baleense* is the unique species near *B. scottustulatum* lacking elytral spots with rounded shoulders living in Ethiopia. It is distinguishable from *B. sjoestedti* (Tanzania) by the evidently larger size and the more convex eyes, and from *B. jeanneli* (Kenya) by the narrower pronotum more sinuate at sides.

DISTRIBUTION. Based on current knowledge, the species seems endemic to the Bale Mountains of southern Ethiopia.

HABITAT. The species was found on the banks of mountain streams at elevations of 3100 - 3800 m. At the type locality, it was found syntopic with *B. scottustulatum*.

Bembidion (Peryphus) jeanneli Alluaud, 1939 (Figs. 5, 16)

DIAGNOSIS. Large sized (5.8 to 6.2 mm) dark brown *Bembidion* subg. *Peryphus* from Kenya with wider pronotum (> 1.5mm) in respect to the other African *Peryphus* species with rounded shoulders.

TYPE LOCALITY. Mount Aberdare, central Kenya.

NOTES ON THE TYPE MATERIAL. We were allowed to examine three male specimens of *Bembidion jeanneli* Alluaud, 1939 with the same collecting data. One, from the Musée Royal de l'Afrique Centrale, Tervuren, was labelled as "Paratypus", while the other specimens, from the Muséum National d'Histoire Naturelle, Paris, were both labelled as "Type", therefore we designated here one of these specimens as Lectotype and the other two as Paralectotypes.

MATERIAL EXAMINED. Lectotype, male, "KENYA / for. bambous . Kinangop / Mt. ABERDARE, VERS' OUEST / 2900-3100 [printed] // MUSEUM DE PARIS / Mission de l'Omo / C. Arambourg / P.A. Chappuis & R. Jeannel / 1932-33 [blue, printed] // TYPE [red. printed] // *Bembidion / Peryphus / jeanneli* / Type All. [handwritten, bordered in red] // Lectotypus / *Peryphus jeanneli* / Alluaud, 1939 / Des. Toledano,

Bonavita & Schmidt [red, printed]" (MNHN); paralectotypes: 1 male, "Kenya / for. bambous du Kinangop / Mt. Aberdare, vers'ouest / 2900-3100 m [printed] // Paralectotypus / *Peryphus jeanneli* / Alluaud, 1939 / Des. Toledano, Bonavita & Schmidt [red, printed] // Museum de Paris / Mission de l'Omo / C. Arambourg / P.A. Chappuis & R. Jeannel / 1932-33 [blue, printed] // Coll. Mus. Congo / ex Muséum Paris) / Coll. P. Basilewsky // PARATYPUS [red, printed] // jeanneli [handwritten]" (MRAC); 1 male, "KENYA / for. bambous . Kinangop / Mt. ABERDARE, VERS' OUEST / 2900-3100 [printed] // MUSEUM DE PARIS / Mission de l'Omo / C. Arambourg / P.A. Chappuis & R. Jeannel / 1932-33 [blue, printed] // TYPE [red. printed] // jeanneli [handwritten] // Paralectotypus / *Peryphus jeanneli* / Alluaud, 1939 / Des. Toledano, Bonavita & Schmidt [red, printed]" (MNHN).

REDESCRIPTION. Bl = 5.8 to 6.2 mm. Colour: brown to piceous-brown, legs reddish, antennomere 1 reddish, antennomere 2 darkened at middle, with apex and base reddish, base of antennomere 3 reddish, rest of antennae darkened. Palps reddish, except for last maxillary palpomere yellowish, and penultimate darkened.

Head (Hw = 1.20 to 1.28 mm) with frons rather smooth; parallel, uneven and rather superficial frontal furrows. Eyes normally convex, with temples short. Antennae elongate (Al = 3.2 to 3.3 mm). A very faint trace of microsculpture in weakly transverse sculpticells on the frons and in the frontal furrows, evident, isodiametric, on neck.

Pronotum (Pl = 1.08 to 1.24 mm, Paw = 1.14 to 1.16 mm, Pw = 1.54 to 1.58 mm, Pbw = 1.08 to 1.16 mm, Pw/Pl = 1.27 to 1.42): relatively flat; large and weakly sinuate at sides before the hind angles that are, consequently, obtuse. Anterior transverse impression and median line very superficial; basal transverse impression wide, wrinkled; basal foveae superficial, rugose. Lateral gutter wide. At magnification of 100x, microsculpture absent on the pronotal disc, very superficial but present, in weakly transverse sculpticells, at sides.

Elytra (El = 3.60 to 3.88 mm, Ew = 2.28 to 2.40 mm, El/Ew = 1.58 to 1.62, Ew/Pw = 1.48 to 1.52): oval, with rounded shoulders, maximum width slightly behind middle and round apex. Elytral striae 1 to 7 evident, punctate-sulcate with punctures very close to one another in the basal half, then only sulcate or very

superficially punctate in the apical half. Apical stria short, connected with stria 5. Two discal pores in the third interval, adjoining stria 3. Intervals flat. Elytral microsculpture in weakly transverse, rather large irregular sculpticells.

Micropterous species.

MALE GENITALIA (Fig. 16). Endophallus very similar to that of *B. damota*.

COMPARATIVE NOTES. *B. jeanneli* is distinguishable from the other unspotted African species of *Peryphus* mainly by the wider pronotum.

DISTRIBUTION. The species is known from central Kenya, Mt. Aberdare, where it is sympatric with *Bembidion* (*Hypsipezum*) *aberdarensense* Alluaud, 1939 (the holotype of this last species bears the same collecting label as the lectotype of *B. jeanneli*) and *B. (Omotaphus) kilimanum* Alluaud, 1908 (also the holotype of *B. altipeta* Alluaud, 1917, synonym of *B. kilimanum*, shares the same collecting label with the two aforementioned types).

HABITAT. The specimens of the type series were found in the bamboo forest zone at an elevation of 2900 - 3000 m.

Bembidion (Peryphus) sjoestedti Alluaud, 1926 (Figs. 6, 17)

DIAGNOSIS. A *Bembidion* from Tanzania with discal elytral pores in the third interval, adjoining stria 3, rounded shoulders, flat eyes and long temples, very similar in habitus to the species of the alpine subg. *Hypsipezum* Alluaud, 1917 but easily distinguishable from these last by the elytral microsculpture, clearly isodiametric in the subgenus *Hypsipezum* and in irregular, moderately transverse sculpticells in *B. sjoestedti*.

TYPE LOCALITY. Mt. Kilimanjaro, Tanzania.

MATERIAL EXAMINED. Holotype, male, "Kiboscho / 3' - 4000 m. [printed] // Kilimandj / Sjöstedt [printed] // MUSEUM PARIS / Coll. Ch. ALLUAUD [blue, printed] // TYPE [red, printed] // *Bembidion / sjoestedti* / TYPE Alluaud [handwritten] / Alluaud, dét. 1934 [printed, in red, the whole label bordered in red]" (MNHN); 1 ex., "PARATYPE [red, printed] // MUSEE DU CONGO [printed] / Kilimandjaro: Kiboscho / 3'-4000m (Sjostedt) / (don Alluaud) [handwritten] // Kiboscho / 3'-4000 m [printed] // Kilimandj. / Sjöstedt [printed] // R. DET / 2457 [printed]" (MRAC); 4 exx., "PARATYPUS [red, printed] // Kilimandj. / Sjöstedt [printed] // Kiboscho / 3000-4000

m [printed] // Bärgs- / ängarne [printed] // COLL.MUS. CONGO / Col. P. Basilewsky [printed]" (MRAC); 7 exx., Kiboscho, 3' - 4000 m, Kilimandj., Sjöstedt, MUS. ROY. AFR. CENTR. (ex coll. Mus. Stockholm, Col. P. Basilewsky) (MRAC, CTVR); 3 exx., Camp 2 12,450 ft., Shira Plateau, Kilimanjaro, T.T., 29.XI.48 G. Salt, COLL.MUS. CONGO (don. G. Salt) (MRAC); 46 exx., COLL. MUS. CONGO, Tanganyika Terr.: Kilimanjaro, Vers. Sud., 4200/4600m., 18/20-VII-1957, prairie alpine, Mission Zoolog. I.R.S.A.C. en Afrique Orientale (P. Basilewsky et N. Leleup) (MRAC, CSCHM, CTVR, PB); 40 exx., I.R.S.A.C. - MUS. CONGO, Kilimanjaro, lim. sup. Ericetum, 4300/4450M., N. Leleup, 14.II.1956, base du Mawenzi, Mission Zoolog. I.R.S.A.C. en Afrique Orientale (P. Basilewsky et N. Leleup) (MRAC, CSCHM, CTVR, PB); 3 exx., I.R.S.A.C. - MUS. CONGO, Kilimanjaro, Versant Est, Ericetum, 3200/3700m., N. Leleup, 16.II.1956, Mission Zoolog. I.R.S.A.C. en Afrique Orientale (P. Basilewsky et N. Leleup) (MRAC, CTVR); 2 exx., Tanganika: / W Shore of L. Manyara. / June-Sept. 1935. / B. Cooper. / B.M. 1935-472 (NHMUK, CTVR); 11 exx., Zoologische Staatssammlung, Tanganjika, Kilimandjaro, Bismarckhütte, 4000m, 9.X.1952 leg. Lindemann und Pavlitzki, COLL.MUS. CONGO, Col. P. Basilewsky (MRAC, CTVR); 18 exx., Kibo S W Hang, 2500-3100m, lg.H. Franz, Kilimanjaro, Tanganyika (NHMW coll. Franz, CSCHM, CTVR, PB); 5 exx., Kibo S W Hang, 2500-3100m, lg.H. Franz, Kilimanjaro, Tanganyika COLL. MUS. CONGO, ex coll. Franz, Col. P. Basilewsky (MRAC); 1 ex., Kibo S W Hang, 3500-4600m, lg.H. Franz, Kilimanjaro, Tanganyika COLL. MUS. CONGO, ex coll. Franz, Col. P. Basilewsky (MRAC); 3 exx., Kilimandjaro, Horonbo 3200-3800m, 4. IX. 1983 leg. P. Beron (CTVR); 1 ex., Kilimandjaro, Sadelpatan 4400m, 25/6/48 A. Holm, MUS. ROY. AFR. CENTR. (ex coll. Mus. Stockholm, Col. P. Basilewsky) (MRAC); 1 ex., Kilimanjaro 12500, February 1942, Mrs P.R.O. Bally, COLL. MUS. CONGO, Col. P. Basilewsky (MRAC); 2 exx., Kilimanjaro, T.T., 14500 ft. 27.X.48 G. Salt [printed], under and beside stones on saddle [handwritten] // Brit. Mus. 1949-616 [printed] // 1016 [handwritten] // *Peryphus sjoestedti* All., P. Basilewsky det., 1949 [handwritten] (NHMUK); 7 exx., Kilimanjaro, T.T. 14500 ft. 27.X.48 G. Salt [printed], under and beside stones on saddle [handwritten] // 1045, COLL. MUS. CONGO (don. G. Salt) (MRAC); 2

exx., Kilimanjaro, T.T., 16000 ft., 25.X.48 G. Salt, under stones outside Kibo Hut, 1002, COLL. MUS. CONGO (don. G. Salt) (MRAC); 1 ex., Kilimanjoro 1500 Ft, COLL. MUS. CONGO, Col. P. Basilewsky (MRAC); 1 ex., Mrs P.R.O. Bally, Kilimanjoro 1600 Ft, February 1942, COLL. MUS. CONGO, Col. P. Basilewsky (MRAC); 1 ex., Mrs P.R.O. Bally, Kilimanjoro 1500 Ft, February 1942, COLL. MUS. CONGO, Col. P. Basilewsky (MRAC); 2 exx., Mrs P.R.O. Bally, Kilimanjoro 1600 Ft. February 1942 [printed] // Pres. by Com. Inst. Ent, B. M. 1948/83 [printed] // *Hypsipezum sjöstedti* All. [handwritten], P. Basilewsky det. [printed] (NHMUK); 6 exx., Tanzania: Mt. Kilimanjaro, -3.1391 37.4428, 3697m, 26.x.2014, under stone V. Grebennikov (CSCHM, OSAC: DNA5535).

REDESCRIPTION. Bl = 4.3 to 5.2 mm. Colour: dark brown to piceous-brown. Legs reddish brown, antennomeres 1, 2, base of 3 and sometimes base of 4 reddish-brown, rest of antennae darkened. Palps reddish-brown, last maxillary palpomere yellowish, sometimes penultimate maxillary palpomere darkened.

Head (Hw = 1.0 to 1.1 mm): frons smooth; frontal furrows parallel and rather deep; eyes flat and temples long; Al = 2.2 to 2.7. Microsculpture superficial but mostly visible, in very weakly transverse sculpticells on the frons and in the frontal furrows, isodiametric on neck.

Pronotum (Pl = 0.92 to 1.04 mm, Paw = 0.82 to 1.00 mm, Pw = 1.20 to 1.40 mm, Pbw = 0.84 to 1.00 mm, Pw/Pl = 1.30 to 1.35): strongly convex, transverse, cordate. Anterior transverse impression shallow, median line sharp and superficial; basal transverse impression narrow with some rugosities. Basal foveae very superficial, square, almost flat; laterobasal carina short but evident. Sides rounded, weakly sinuate before the slightly obtuse hind angles. Lateral gutter narrow. Microsculpture absent on disc, sometimes visible but superficial in weakly transverse sculpticells at sides.

Elytra (El = 2.64 to 3.12 mm, Ew = 1.70 to 2.04 mm, El/Ew = 1.53 to 1.55, Ew/Pw = 1.42 to 1.46): oval, rounded shoulders, apex somewhat pointed. Elytral striae finely punctured in the basal two thirds and sulcate in the apical third, superficial but visible almost up to the apex, stria 7 more superficial than the others, marked by a row of superficial, sharp punctures. Apical stria short and superficial, connected

with the end of stria 5 or 7, both sometimes very difficult to see at the extreme apex. Intervals flat. Microsculpture evident on the whole elytra consisting in irregular, weakly transverse sculpticells.

Micropterous species.

MALE GENITALIA (Fig. 17). Median lobe of the aedeagus gently arcuate, narrow, with oval central sclerite relatively small; flagellum short and basal end of the ostial flag more sclerotized than the rest of the flag.

COMPARATIVE NOTES. *B. sjöstedti* seems isolated from the other East African species of the subgenus, but very similar in the male genitalia to the European *Bembidion (Euperyphus) scapulare* Dejean, 1831.

DISTRIBUTION. The species is endemic to the Mt. Kilimanjaro in Tanzania.

HABITAT. Based on the information presented on the label data of the material studied, occurrence of this species seems not to be restricted to mountain streams as in the Ethiopian species of the subgenus *Peryphus*. Instead, it was found under and beside stones in the *Erica* forests of the high mountain zone and in the afroalpine zone. *Bembidion sjöstedti* occurs at elevations of about 2500 - 4500 m (based on label data).

***Bembidion* subgenus *Ocydromus* Clairville, 1806**

Type species: *Carabus modestus* Fabricius, 1801

***Bembidion (Ocydromus) basistriatum* Fairmaire, 1893 (Figs. 7, 18) new combination**

Bembidium basistriatum Fairmaire, 1893.

Bembidion (Testedium) basistriatum Fairmaire, 1893 (Csiki, 1928)

Bembidium (Testedium) basistriatum Fairmaire, 1893 (Lorenz 1998, 2005)

= *Bembidion muscicola* Basilewsky, 1953 (nec *Bembidion (Semicampa) muscicola* Hayward, 1897)

n. syn.

NOMENCLATORIAL NOTES. The name *muscicola* Basilewsky, 1953 is preoccupied by the North American *B. (Semicampa) muscicola* Hayward, 1897. During this study, thanks to the precious help of our friend Paolo Neri we were allowed to study the original description of *B. basistriatum* Fairmaire, 1893, described from Shoa Province, in Central Ethiopia, at present attributed to the subgenus *Testedium* Motschulsky, 1864 (Lorenz 1998, 2005). It is very unlikely that the boreo-montane subgenus *Testedium* is distributed in tropical Africa. The type of *B. basistriatum* is probably preserved at MNHN,

however, we were unable to study it due to the pandemic. Instead, we carefully compared the original description of *B. basistriatum* with the species dealt with here and we discovered that it could match *B. melanocerum* as well as *B. muscicola* Basilewsky 1953. However, some details indicate that *B. basistriatum* more likely refers to this last taxon. The following characters noted by Fairmaire (1893) match *B. muscicola* Basilewsky better than *B. melanocerum*: (i) body colouration bronze; (ii) head with punctures; (iii) elytral striae markedly punctate. Therefore, at least provisionally, in order to prevent the introduction of unnecessary names in nomenclature, we decided to state here the following synonymy, waiting for crucial evidence coming from the restudy of the type material of *B. basistriatum*:

***Bembidion muscicola* Basilewsky, 1953, n. syn. of *Bembidion basistriatum* Fairmaire, 1893.**

DIAGNOSIS. Shiny, piceous black species with bronze lustre from Ethiopia, with discal elytral pores in the third interval adjoining stria 3, few small punctures behind the frontal furrows or at their base, elytral striae 2 to 5 superficial, but present at the apical fifth, sharply punctate and not sulcate, lacking elytral microsculpture at 100x and with aedeagus as in Fig.18.

TYPE LOCALITY. "Choa" (= Shoa, former province of Shewa), Ethiopia.

TYPE MATERIAL EXAMINED. Type (NHMUK) seen (LT); 6 paratypes of *B. muscicola* Basilewsky, 1953, "Paratypus [red, printed] // ABYSSINIA: / Wolamo Prov., / Mt. Damota, / over 10,000 ft., / 5.xi.1948 [printed] // ETHIOPIA: / 1948-1949. / Hugh Scott. / B.M. 1949-184. [printed] // From moss on / wet rock-face / of spring. [printed] // COLL. MUS. CONGO / Col. P. Basilewsky [printed]" (MRAC); 2 paratypes of *B. muscicola* Basilewsky, 1953, "Paratypus [red, printed] // ABYSSINIA: / Wolamo Prov., / Mt. Damota, / over 10,000 ft., / 5.xi.1948 [printed] // ETHIOPIA: / 1948-1949. / Hugh Scott. / B.M. 1949-184. [printed] // From moss on / wet rock-face / of spring. [printed] // COLL. MUS. CONGO / Col. P. Basilewsky [printed]" (MRAC).

OTHER MATERIAL EXAMINED. 5 exx., Begemdir Prov.: Gimbar stream 5 km S. of Geech 3170m, 22-X-73 // Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke (MRAC, CTVR); 1 ex., Begemdir Prov.: Semiens Mts.; Jimbar stream 22-X-73 // Coll. Mus. Tervuren, Ethiopie, G.

de Rougemont (MRAC); 2 exx., Begemdir Prov.: Debarek: 1/2 km N. of Town 2840m 21-X-73 Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke (MRAC, CTVR); 3 exx., Begemdir Prov.: Semiens Mts. Nat. Park, Geech 8/9-IX-74, leg. Rob Bosmans // Coll. Mus. Tervuren, Ethiopie, leg. Rob Bosmans (MRAC, CTVR); 1 ex., Begemdir Prov.: / Geech area, 23/24-X.73 / 3250/3500 m // Coll. Mus. Tervuren / Ethiopie / G. de Rougemont (MRAC); 1 ex., Ethiopia: Simien, nr. Mindigabsa over 10,000 ft. 29.xii.1952. [printed] // N. Ethiopia: 1952-1953. Hugh Scott B.M. 1953-335 [printed] // *Peryphus muscicola* Basil. [handwritten], P. Basilewsky det., 195 [printed] 5 [handwritten] (NHMUK); 2 exx., Ethiopia: Simien, nr. Mindigabsa, over 10,000ft 16.xi.1952. // N. Ethiopia: 1952-1953. Hugh Scott B.M. 1953-335 // from dry soil in roots of tufted plants overhanging a stream (NHMUK); 1 ex., Ethiopie N. Wollo Col Abuna Yusef 4000m 6.1.2013 Leg. E. Queinnec (CTVR); 1 ex., Ethiopie N. Wollo S Dessie Amba farit 3500m 1.1.2013 Queinnec Leg. (CTVR); 1 ex., Gojjam Prov.: Mt. Choke 3200/3500m 15/18.XII.1972 Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke (MRAC, CTVR); 4 exx., ABYSSINIA: Wolamo Prov., Mt. Damota, over 10,000 ft., 5.xi.1948 [printed] // ETHIOPIA: 1948-1949. Hugh Scott. / B.M. 1949-184. [printed] // From moss on wet rock-face of spring. [printed] (NHMUK, CTVR); 2 exx., Coll. Mus. Tervuren, Ethiopie: Entoto Hills 5 km N Addis Abeba R.O.S. Clarke 17.IV.1971 (MRAC, CTVR); 28 exx., Arussi Prov.: Arussi Mts, c 8 km E of Dighellu 3000m 1972 Coll. Mus. Tervuren Ethiopie R.O.S. Clarke (MRAC, CTVR); 1 ex., Coll. Mus. Tervuren / Ethiopie; Addis Abeba / 1971 / G. de Rougemont (MRAC); 34 exx., Ethiopia Oromia 2.XII.16 Mt. Chillalo, SW slope 3000-3300m leg. Schmidt 07°54'01"N 39°11'26" E (CSCHM, CTVR, PB); 42 exx., Ethiopia Oromia 30.XI.16 Mt. Chillalo, SW slope 2985m leg. Schmidt 07°53'31"N 39°10'18" E (CDW, CSCHM, CTVR, OSAC: DNA5185, PB); 53 exx., ETHIOPIA Oromia, SE-slope of Mt. Chillalo, Dhaba village, 3200 m, 19.II.2020, 7.861644 39.27711, leg. J. Schmidt, C. Wirkner, Yeshitla M. (CSCHM, ZMAA, ZSM); 1 ex., ETHIOPIA Oromia, SE-slope of Mt. Chillalo, Damamelkeso Vall., 3500 m, 25.II.2020, 7.891089 39.256121, leg. J. Schmidt, C. Wirkner, Yeshitla M. (CSCHM); 3 exx., ETHIOPIA Oromia, Mt Enkuolo, NE-slope, 3100-3200m, 07°24'41"N 39°22'26"E, 5-7.XII.16, leg. J. Schmidt (CSCHM); 27 exx., ETHIOPIA Oromia, Mt Enkuolo,

N-slope, 3350-3600m, 07°22'48"N 39°21'07"E, 6-9.XII.16, leg. J. Schmidt (CSCHM); 1 ex., ETHIOPIA Oromia, western Bale Mts above Dodola, 2700-2850 m, 06°53'49"N 39°11'32"E, 10-11.XII.16, leg. J. Schmidt (CSCHM); 1 ex., ETHIOPIA Oromia, western Bale Mts above Dodola, 3400-3700 m, 06°51'N 39°14'E, 12-13.XII.16, leg. J. Schmidt (CSCHM); 9 exx., ETHIOPIA Oromia, Bale Mts., Sebsebe Washia Forest, Salgen Vall. 2720-2800 m, 07°01'N 39°34'E, 3.II.2019, leg. R. Emmerich, J. Schmidt, Yeshitla M. (CSCHM); 31 exx., ETHIOPIA Oromia, Bale Mts., Sebsebe Washia Forest, Salgen Vall. 3130 m, 07°02'08"N 39°36'06"E, 4.II.2019, leg. R. Emmerich, J. Schmidt, Yeshitla M. (CSCHM); 6 exx., ETHIOPIA Oromia, Bale Mts., Sebsebe Washia Forest, upp. Salgen Vall. 3340-3500 m, 07°03'N 39°37'E, 4.II.2019, leg. R. Emmerich, J. Schmidt, Yeshitla M. (CSCHM); 5 exx., ETHIOPIA Oromia, Bale Mts., Sebsebe Washia Forest, upp. Salgen Vall. 3630 m, 07°01'47"N 39°37'43"E, 6.II.2019, leg. R. Emmerich, J. Schmidt, Yeshitla M. (CSCHM); 1 ex., ETHIOPIA Oromia, N-slope Bale Mts above Goba, 3650 m, 06°54'43"N 39°55'6"E, 17.XII.16, leg. J. Schmidt (CSCHM); 4 exx., ETHIOPIA Oromia, S-slope Bale Mts., S of Rira, Katcha, 2380 m, 06°42'58"N 39°43'25"E, 3.III.2015, leg. J. Hagge *et al.* (CSCHM); 1 ex., ETHIOPIA Oromia, Bale Mts., Hareenna Forest W Rira, 3000 m, 06°45'57"N 39°41'47"E, 14.XII.2017, leg. D. Hauth, J. Schmidt, Yeshitla M. (CSCHM); 3 exx., ETHIOPIA Oromia, Bale Mts., Angeso Vall. S Goba, 3050 m, 6.932923, 39.951341, 5.II.2020, leg. J. Schmidt, C. Wirkner, Yeshitla M., Yitbarek W. (CSCHM); 1 ex., ETHIOPIA Oromia, Bale Mts., Shaya Vall. SW Goba, 3100-3150 m, 6.991843 39.884397, 6.II.2020, leg. J. Schmidt, C. Wirkner, Yeshitla M., Yitbarek W. (CSCHM); 18 exx., ETHIOPIA Oromia, Mt. Kaka, E-slope above Meraro, 3300-3420 m, 07°24'N 39°12'E (env.Camp 1), 23-28.II.2017, leg. D. Hauth, J. Schmidt, Yeshitla M. (CSCHM, ZMAA); 4 exx., ETHIOPIA Oromia, Mt. Kaka, E-slope above Meraro, 3350-3400 m, 07°23'30"N 39°11'41"E, 28.XI.2017, leg. D. Hauth, J. Schmidt, Yeshitla M. (CSCHM); 1 ex., ETHIOPIA Oromia, Mt. Kaka, E-slope above Meraro, 3370-3500 m, 07°22'57"N 39°11'27"E, 25.XI.2017, leg. D. Hauth, J. Schmidt, Yeshitla M. (CSCHM); 9 exx., ETHIOPIA Oromia, Mt. Kaka, NE-slope above Meraro, 3400-3670 m, 07°24'N 39°11'E, 27.XI.2017, leg. D. Hauth, J. Schmidt, Yeshitla M. (CSCHM,

ZMAA); 1 ex., ETHIOPIA Oromia, Mt. Kaka, SE of crater, 3700-4100 m, 07°21'54"N 39°09'48"E to 07°21'09"N 39°10'18"E, 1.XII.2017, leg. D. Hauth, J. Schmidt, Yeshitla M. (CSCHM); 34 exx., ETHIOPIA Sodo, Mt. Damot, 2800-2900 m, 06°54'24"N 37°47'07"E, 3.XII.2017, leg. D. Hauth, J. Schmidt, Yeshitla M. (CSCHM); 3 exx., ETHIOPIA Gughe Highlands, near Tola vill., 2950 m, 06°18'48"N 37°33'57"E, 5.XII.2017, leg. D. Hauth, J. Schmidt, Yeshitla M. (CSCHM); 1 ex., ETHIOPIA Gughe Highlands, near Mt. Gughe, 2880-2950 m, 06°12'00"N 37°20'19"E, 7.XII.2017, leg. D. Hauth, J. Schmidt, Yeshitla M. (CSCHM); 20 exx., ETHIOPIA Amhara, W-slope Mt. Choke, 3450 m, 10°38'09"N 37°46'06"E, 22.II.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM, ZMAA); 44 exx., ETHIOPIA Amhara, W-slope Mt. Choke, 3370 m, 10°38'07"N 37°45'51"E, 23.II.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM, CTVR, PB); 1 ex., ETHIOPIA Amhara, SW-slope Mt. Choke, 3630-3730 m, 10°38'02"N 37°50'08"E, 28.II.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM); 1 ex., Ethiopia IV 94 Gemu Gofa Prov. Ch'en'cha 2500m Werner leg. (CTVR).

REDESCRIPTION. Bl = 4.3 to 4.8 mm. Colour: piceous-black with bronze lustre. Legs brown, in some specimens with infuscated basal half of femora. Antennomere 1 and base of 2 to 4 reddish, rest of antennae darkened. Palps dark brown with penultimate palpomere darker and last palpomere yellowish.

Head (Hw = 0.88 to 1.00 mm): frons smooth with a few scattered punctures, a few also behind the parallel and uneven frontal furrows. Eyes normally protruding, with temples very short. Al = 2.0 to 2.1 mm. Microsculpture absent on the head, except for neck where it is superficial, in isodiametric sculpticells.

Pronotum (Pl = 0.76 to 0.96 mm, Paw = 0.76 to 0.92 mm, Pw = 1.04 to 1.32 mm, Pbw = 0.80 to 1.02 mm, Pw/Pl = 1.36 to 1.37): weakly convex, markedly transverse. Anterior transverse impression and median line superficial; basal transverse impression narrow, coarsely punctured. Basal foveae deep, square with irregular surface, laterally limited by an evident laterobasal carina. Sides rounded, moderately sinuate before the slightly obtuse hind angles. Pronotal microsculpture not visible.

Elytra (El = 2.76 to 2.88 mm, Ew = 1.60 to 1.92 mm, El/Ew = 1.50 to 1.72, Ew/Pw = 1.45 to 1.54): convex, subparallel, with marked shoulders; elytral stria 1 punctate-sulcate, 2 to 7 punctate and not sulcate. Striae 2 to 5 almost complete at apex even though very superficial, represented by rows of very small punctures. Intervals flat. Microsculpture absent on the whole elytra (magnification 100x).

Fully winged species.

MALE GENITALIA (Fig. 18). Median lobe of the aedeagus narrow, arcuate, with apex evidently bent ventrally. Central sclerite narrow and elongate, in diagonal orientation; flagellum long, almost reaching the ostial flag.

COMPARATIVE NOTES. *Bembidion basistriatum* is distinguishable from both the sympatric species *B. melanocerum* and *melanoceroides* by the elytral striae 2 to 5 punctate from the apical fifth to their apex (faintly sulcate, not punctate in *melanocerum* and *melanoceroides*).

DISTRIBUTION. The species is widely distributed in the highlands of northern and southern Ethiopia.

HABITAT. Based on our own field data (JS) the species occurs on the banks of different kind of mountain streams, and it was found in a wide elevational range (about 2380 - 4000 m). It occurs sympatric with *B. melanocerum* in northern and central Ethiopia, *B. melanoceroides* in southern Ethiopia, *B. scottustulatum* in northern and central Ethiopia, *B. damota* in southwestern Ethiopia, *B. baleense* in the Bale Mts., and with the following species of the *Bembidion* subgenus *Omotaphus*: *B. aethiopicum* Raffray, 1886, *B. tropicum* Chaudoir, 1876, and *B. scotti* Netolitzky, 1931.

***Bembidion (Ocydromus) melanocerum* Chaudoir, 1876 (Figs. 8, 19)**

Bembidion (Peryphus) melanocerum Chaudoir, 1876.

Bembidion (Peryphus) melanocerum Chaudoir, 1876 (Lorenz 1998, 2005)

REMARK. In the 2017 version of the online Global Database of Ground Beetles (Lorenz, 2020) this species is already listed within the subgenus *Ocydromus*.

DIAGNOSIS. Brown to piceous black species of the northern and central Ethiopian highlands, with elytral striae 2 to 5 superficial, but present and sulcate from the apical fifth to their apex, and with elytral microsculpture visible at 50x. A few small punctures

behind the frontal furrows or at their base, less evident than in *B. basistriatum*.

TYPE LOCALITY. Adowa, Ethiopia.

MATERIAL EXAMINED. Type (MNHN) seen (LT); 1 ex., Ethiopien: Prov. Gondar, Simien: Jinbar Wenz 3200-3400m 15.-19.4.1976 Leg. Löffler (CTVR); 20 exx., Ethiopia Simien, Mecana torrent, below Mecana Abbo, c. 10,000 ft., 9.xii.1952. // N. Ethiopia, 1952-1953. Hugh Scott, B.M. 1953-335 // Coll. Mus. Congo, Col. P. Basilewsky (MRAC, NHMUK, CTVR, PB); 2 exx., Ethiopia: Simien, nr. Mindigabsa, over 10,000ft 16.xi.1952. // N. Ethiopia: 1952-1953. Hugh Scott B.M. 1953-335 // from dry soil in roots of tufted plants overhanging / a stream (MRAC, NHMUK); 2 exx., Ethiopia: Simien, nr. Mindigabsa, over 10,000ft 16.xi.1952. // N. Ethiopia: 1952-1953. Hugh Scott B.M. 1953-335 // from stiff wet mud or under stones in bed of torrent. // Coll. Mus. Congo Col. P. Basilewsky (MRAC, NHMUK); 5 exx., Tigre Prov.: Geralta, 5.7.1976, Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke (MRAC, CTVR); 1 ex., Wollo Zeggin (?) Ambò Giag. (?) 2-45 [handwritten] // Coll. Mus. Congo, Don Cerruti handwritten, Col. P. Basilewsky (MRAC); 6 exx., Gojjam Prov.: 8 km W of Falega Birhan, Anguata river, 2820m, 18.XII.1972 // Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke (MRAC, CTVR); 8 exx., ETHIOPIA Amhara, Mt. Abuna Yosef, S-slope, 3700-3800 m, 12°09'10"N 39°09'35"E, 5.III.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM); 38 exx., ETHIOPIA Amhara, W-slope Mt. Choke, 2750-2900 m, 10°38'N 37°45'E, 1.III.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM, CTVR, OSAC: DNA5535, PB, ZMAA); 1 ex., ETHIOPIA Amhara, Mt. Choke, crater valley, 3700-3800 m, 10°41'14"N 37°50'07"E, 24.II.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM); 8 exx., ETHIOPIA Amhara, W-slope Mt. Choke, 3370 m, 10°38'07"N 37°45'51"E, 23.II.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM); 3 exx., ETHIOPIA Amhara, W-slope Mt. Choke, 3450 m, 10°38'09"N 37°46'06"E, 22.II.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM); 1 ex., Abyssinia, Addis Allem, circa 8,000 ft., 18.-19.ix.1926 Dr. H. Scott // Coll. Mus. Congo Col. P. Basilewsky // cultivated country // Box 7 // melanocerum det Netolitzky [handwritten] (NHMUK); 1 ex., Abyssinia, Addis Allem, circa 8,000 ft., 18.-19.ix.1926 Dr. H. Scott // Coll. Mus. Congo Col. P. Basilewsky // cultivated country // melanocerum det Netolitzky [handwritten]

(MRAC); 2 exx., Abyssinia, Addis Alleme, circa 8,000 ft., 18.-19.ix.1926 Dr. H. Scott // cultivated country // Box 7 // melanocerum det Netolitzky [handwritten] (NHMW); 1 ex., Abyssinia: Douber R. between Debra Libanos and Addis Abeba, circa 8,500 ft., 5.i.1927, Dr. H. Scott // Coll. Mus. Congo Col. P. Basilewsky // melanocerum det Netolitzky [handwritten] (MRAC); 20 exx., Ethiopia, Hang Jammatal b. Debra Libanos 2300mNN 9,746°N 38,815°O leg I. Harry 28.11.2012 (CH, CTVR, PB); 1 ex., Abyssinia; Entoto, circa 9,000 ft., 16.IX. 1926. Dr. H. Scott. [printed] // Brit. Mus. / 1927-127 [printed] // melanocerum Chd. det. Netolitzky [handwritten] (NHMUK); 1 ex., COMP. TYP. BASILEWSKY [red, printed] // Abyssinia; Entoto, circa 9,000 ft., 16.IX. 1926. Dr. H. Scott. Coll. Mus. Congo Col. P. Basilewsky // melanocerum det. Netolitzky [handwritten] // melanocerum Chd. [handwritten] P. Basilewsky det. 1967 (MRAC); 1 ex., Athiopien: Ambo 13.-17.10.1990 leg. Rybalov (CTVR); 3 exx., Etiopia - Shoa - Loc. 1 Tra Addis Abeba e Holetta / n. 2400 circa - 21-X-1973, A Vigna Leg. (AVT, PB); 1 ex., Shoa Prov.: 40 km of Addis Abeba (Old airport zone) 10.I.1973 // Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke (MRAC); 19 exx., Shoa Prov.: Top of Blue Nile, Gorge near Goha Tsion 5-V-74 Coll. Mus. Tervuren Ethiopie G. de Rougemont (MRAC, CTVR).

REDESCRIPTION. Bl = 4.7 to 4.8 mm. Colour: piceous-brown, legs testaceous-red, antennomere 1 and base of antennomeres 2, 3, 4 reddish, rest of antennae darkened. Palps brown, except for last maxillary palpomere, yellowish, and the penultimate maxillary palpomere, darkened.

Head (Hw = 1.00 to 1.04 mm): frons weakly rugose, frontal furrows very slightly convergent, uneven and rather deep. Eyes relatively small but convex, temples very short. Al = 2.4 to 2.5 mm. Microsculpture, at magnification of 100x, visible only on neck, isodiametric.

Pronotum (Pl = 0.90 to 0.92 mm, Paw = 0.88 to 0.96 mm, Pw = 1.20 to 1.26 mm, Pbw = 0.92 to 0.96 mm, Pw/Pl = 1.33 to 1.37): small, transverse; median line rather deep; anterior transverse impression superficial, with some scattered punctures in the central portion; basal transverse impression relatively wide, with coarse punctures; basal foveae small and rather deep, square, wrinkled and punctate; sides rounded, evidently sinuate before the square hind angles. Lateral gutter rather wide; laterobasal carina very thin,

sharp. Pronotal microsculpture not visible at magnification of 100x.

Elytra (El = 2.46 to 2.54 mm, Ew = 1.88 to 2.00 mm, El/Ew = 1.50 to 1.54, Ew/Pw = 1.57 to 1.59): subparallel, marked shoulders, apex rounded. Elytral striae 1 to 6 punctate-sulcate, 7 punctate. Apical stria short, ending in direction of the apical traces of stria 5. Elytral microsculpture visible at least at 50x, in transverse, irregular sculpticells.

Macropterous species.

MALE GENITALIA (Fig. 19). Median lobe of aedeagus short, narrow, evidently arcuate. Long flagellum, narrowing from base to apex, connected at base with the basal chitin platelet and ending at apex, in correspondance with the ostial flag, with a gently waved end. Central brush oblique; sclerotized stylet apically ending with a shortly enlarged, flat tip. Ventral sclerite narrow, at middle of the aedeagus, weakly sclerotized. INTRASPECIFIC VARIABILITY. In the examined specimens the elytral microsculpture is variable in depth, from superficial to evidently impressed, but it is in any event always visible at 50x magnification.

COMPARATIVE NOTES. *Bembidion melanocerum* is distinguishable from *B. basistriatum* by the elytral striae 2 to 5 sulcate at the apical fifth (sharply punctate, not sulcate in *basistriatum*), and from its sister species *melanoceroides* n.sp. by the elytral microsculpture visible at 50x (not visible at 50x in *melanoceroides* n.sp.) and the flagellum in the endophallus, longer and almost reaching the ostial flag in *melanocerum*, shorter in *melanoceroides* sp.n. For the endophallic structure the species is strikingly similar to *B. africanum* (see below).

DISTRIBUTION. The species is widely distributed in the highlands of northern and central Ethiopia.

HABITAT. As in *B. basistriatum*, see above.

***Bembidion (Ocydromus) melanoceroides* n.sp.** (Figs. 9, 20)

urn:lsid:zoobank.org:act:

F3DEA175-FC92-4D14-ACEB-699E03CE3FE7

DIAGNOSIS. Brown to piceous black species of southern Ethiopia with elytral striae 2 to 5 superficial, but present and sulcate at the apical fifth, and with elytral discal microsculpture very faintly engraved, not visible at 50x. A few small punctures behind the frontal furrows or at their base in some specimens, in some others frontal punctures absent.

TYPE LOCALITY. Oromia, Bale Mts., Ethiopia, Sebsebe

Washia Forest, Salgen Vall. 2720-2800 m, 07°01'N 39°34'E, 3.II.2019.

TYPE SERIES. Holotype, male, "ETHIOPIA Oromia, Bale Mts., Sebsebe Washia Forest, Salgen Vall. 2720-2800 m, 07°01'N 39°34'E, 3.II.2019, leg. R. Emmerich, J. Schmidt, Yeshitla M." (CSCHM). Paratypes: 114 exx., same collecting data as the holotype (CSCHM, CTVR, PB, ZMAA); 18 exx., "ETHIOPIA Oromia, Bale Mts., Sebsebe Washia Forest, Salgen Vall. 3130 m, 07°02'08"N 39°36'06"E, 4.II.2019, leg. R. Emmerich, J. Schmidt, Yeshitla M." (CSCHM); 1 ex., "ETHIOPIA Oromia, Bale Mts., Sebsebe Washia Forest, upp. Salgen Vall. 3340-3500 m, 07°03'N 39°37'E, 4.II.2019, leg. R. Emmerich, J. Schmidt, Yeshitla M." (CSCHM); 1 ex., "ETHIOPIA Oromia, Bale Mts., Angeso Vall. S Goba, 3050 m, 6.932923, 39.951341, 5.II.2020, leg. J. Schmidt, C. Wirkner, Yeshitla M., Yitbarek W." (CSCHM); 5 exx., "Bale Prov.: 20 km E de Adaba, 2500m 16.XII.1971 Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke" (MRAC, CTVR); 2 exx., "Bale prov.: 8 km W de Dinshu, 3050 m, 19.XII.1971 // Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke" (MRAC); 3 exx., "Etiopia - Bale - Loc. 44 A est di Abeba, m 2600 circa - 9-XI-1973 [printed], C. Consiglio [handwritten]" (AVT, PB); 10 exx., "Etiopia - Bale - Loc. 44, A est di Abeba, m 2600 circa - 9-XI-1973 [printed], Cottarelli [handwritten]" (AVT, CTVR, PB); 9 exx., "Etiopia - Bale - Loc. 44 A est di Abeba, m 2600 circa - 9-XI-1973 [printed], Vigna [handwritten]" (AVT, CTVR, PB); 20 exx., "Ethiopia Oromia 2.XII.16 Mt. Chillalo, SW slope 3000-3300m leg. Schmidt 07°54'01,"N 39°11'26" E" (CSCHM, CTVR); 136 exx., "ETHIOPIA Oromia, Mt Chillalo, SW-slope, 2985 m, 07°53'31"N 39°10'18"E, 30.XI.16, leg. J. Schmidt" (CDW, CSCHM, CTVR, PB, ZSM); 21 exx., ETHIOPIA Oromia, SE-slope of Mt. Chillalo, Dhaba village, 3200 m, 19.II.2020, 7.861644 39.27711, leg. J. Schmidt, C. Wirkner, Yeshitla M. (CSCHM, ZMAA); 1 ex., "Abyssinia, Mt. Chillalo, forest . circa 9,000ft., 15-16.xi.1926. Dr. H. Scott. // Brit. Mus. 1927-127. // box 101 // Under stones near stream // melanocerus det. Netolitzky" (NHMUK); 4 exx., "ETHIOPIA Oromia, Mt Chillalo, SW-slope, 3000-3300 m, 07°54'01"N 39°11'26"E, 2.XII.16, leg. J. Schmidt" (CSCHM); 2 exx., "ETHIOPIA Oromia, N-slope Bale Mts, river valley above Goba, 2990 m, 06°56'08"N 39°57'20"E, 7+18.II.17, leg. Berndt & Schmidt" (CSCHM); 17 exx., "ETHIOPIA Oromia,

western Bale Mts above Dodola, 2700-2850 m, 06°53'49"N 39°11'32"E, 10-11.XII.16, leg. J. Schmidt" (CSCHM, OSAC: DNA5183); 15 exx., "ETHIOPIA Oromia, Mt Enkuolo, NE-slope, 3100-3200m, 07°24'41"N 39°22'26"E, 5-7.XII.16, leg. J. Schmidt" (CSCHM); 9 exx., "ETHIOPIA Oromia, Mt Enkuolo, N-slope, 3350-3600m, 07°22'48"N 39°21'07"E, 6-9.XII.16, leg. J. Schmidt" (CSCHM); 6 exx., "ETHIOPIA Oromia, Mt. Kaka, E-slope above Meraro, 3300-3420 m, 07°24'N 39°12'E (env.Camp 1), 23-28.11.2017, leg. D. Hauth, J. Schmidt, Yeshitla M." (CSCHM); 1 ex., "ETHIOPIA Oromia, Mt. Kaka, E-slope above Meraro, 3350-3400 m, 07°23'30"N 39°11'41"E, 28.11.2017, leg. D. Hauth, J. Schmidt, Yeshitla M." (CSCHM); 3 exx., "ETHIOPIA Oromia, Mt. Kaka, E-slope above Meraro, 3370-3500 m, 07°22'57"N 39°11'27"E, 25.11.2017, leg. D. Hauth, J. Schmidt, Yeshitla M." (CSCHM); 2 exx., "ETHIOPIA Oromia, Mt. Kaka, NE-slope above Meraro, 3400-3670 m, 07°24'N 39°11'E, 27.11.2017, leg. D. Hauth, J. Schmidt, Yeshitla M." (CSCHM); 90 exx., "Arussi Prov.: Arussi, Mts. c. 4 km E of Dighellu, 2850m, 1972, Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke" (MRAC, CTVR); 1 ex., "Arussi Prov.: Asella, 2600m, 9-XII-73, Coll. Mus. Tervuren, Ethiopie, G. De Rougemont" (MRAC).

DESCRIPTION. BI = 4.2 to 5.0. Colour: piceous-brown, legs testaceous-red, antennomere 1 and base of antennomeres 2, 3, 4 reddish, rest of antennae darkened. Palps brown, except for last maxillary palpomere, yellowish, and the penultimate maxillary palpomere, darkened.

Head (Hw = 0.92 to 1.12 mm): frons weakly rugose, frontal furrows very slightly convergent, uneven and rather deep. Eyes relatively small but convex, temples very short. Al = 2.1 to 2.4 mm. Microsculpture visible only at neck, isodiametric.

Pronotum (Pl = 0.84 to 0.96 mm, Paw = 0.82 to 0.96 mm, Pw = 1.12 to 1.28 mm, Pbw = 0.86 to 1.00 mm, Pw/Pl = 1.33 to 1.40): small, transverse; median line rather deep; anterior transverse impression superficial, with some scattered punctures in the central portion; basal transverse impression relatively wide, with coarse punctures; basal foveae small and rather deep, square, wrinkled and punctate; sides rounded, sinuation before the hind angles slightly less marked than in *B. melanocerus*, thus hind angles very slightly obtuse. Lateral gutter rather wide, laterobasal carina very thin, sharp. No microsculpture visible.

Elytra (El = 2.56 to 3.08 mm, Ew = 1.72 to 2.00 mm, El/Ew = 1.49 to 1.55, Ew/Pw = 1.49 to 1.56): subparallel; marked shoulders, apex rounded. Elytral striae 1 to 6 punctate-sulcate, 7 punctate. Apical stria short, ending in direction of the apical traces of stria 5. Elytral discal microsculpture scarcely visible at magnification of 100x, not visible at 50x.

Macropterous species.

MALE GENITALIA (Fig. 20). Median lobe of aedeagus short, evidently arcuate, with flagellum almost anteriorly reaching the ostial flag.

INTRASPECIFIC VARIABILITY. In the examined specimens the elytral microsculpture may vary from absent to very superficial at magnification of 100x, but always invisible at 50x.

ETYMOLOGY. The name is an adjective that refers to the extreme similarity with *B. melanocerum*.

COMPARATIVE NOTES. *B. melanoceroides* is distinguishable from *B. basistriatum* by the elytral striae 2 to 5 sulcate at the apical fifth (sharply punctate, not sulcate in *basistriatum*), and from *melanocerum* by the elytral discal microsculpture not visible at 50x (visible at 50x in *melanocerum*). The species *melanocerum* and *melanoceroides* are certainly strictly related to one another, as also shown by the endophallic structure, where the first shows a longer flagellum, but the rest of the characters are shared by both species.

DISTRIBUTION. The species is known from the Arsi and Bale Mountains of southern Ethiopia.

HABITAT. As in *B. basistriatum* and *B. melanocerum*, see above.

Bembidion (Ocydromus) africanum Chaudoir, 1876 (Figs. 10, 21)

Bembidion (Peryphus) africanum Chaudoir, 1876.

Bembidion (Notaphomimus) africanum Chaudoir, 1876 (Netolitzky, 1937).

Bembidion (Peryphus) africanum Chaudoir, 1876 (Lorenz, 1998; 2005)

REMARK. In the 2017 version of the online Global Database of Ground Beetles (Lorenz, 2020) this species is already listed within the subgenus *Ocydromus*.

DIAGNOSIS. Brown, unspotted *Bembidion* species from Southern and Southwestern Ethiopia with wide pronotum, discal elytral pores near stria 3, convex, ovate elytra, evidently convex elytral intervals, and elytral microsculpture consisting of very sharp and transverse sculpticells.

TYPE LOCALITY. Edges of Tsana Lake, Ethiopia.

MATERIAL EXAMINED. Type (MNHN) seen (LT); 1 ex., Abyss. Raffray [blue, printed] // Coll. Netolitzky [printed] // in Coll. Putzeys, "P. africanus" Chaud bezettelt [handwritten] (NHMW); 1 ex., Abyssinia, Mt. Chillalo, forest. circa 9,000ft., 15-16.xi.1926., Dr. H. Scott. [printed] // Box 101, [printed] // Brit. Mus. 1927-127. [printed] // Under stones near stream [printed] // africanum [handwritten] det. Netolitzky [printed] (NHMUK); 1 ex., Abyssinia, Djem Djem Forest, from river bed. circa 8,000 ft. 2.x.1926, Dr. H. Scott. // Coll. Netolitzky [printed] // africanum det Netolitzky [printed] // Coll. Netolitzky [printed] (NHMW); 2 exx., Abyssinia, Djem Djem Forest, from river bed. circa 8,000 ft. 2.x.1926, Dr. H. Scott. // Coll. Netolitzky [printed] // africanum det Netolitzky [printed] // Coll. Netolitzky [printed] (NHMUK); 1 ex., ABYSSINIA: Gamo Prov, near Ezo, c. 9,600 ft. 20,21.xi.1948. [printed] // From bed of stream. [printed] // ETHIOPIA 1948-1949. Hugh Scott. B.M. 1949-184 (NHMUK); 1 ex., Addis Abeba Old Airport 25.XII.1970 Under rocks by river Coll. Mus. Tervuren Ethiopie R.O.S. Clarke (CTVR); 2 exx., Akaki River Old Airport, Addis Abeba, 27.XII.1970 [handwritten] // under stone by river [handwritten] // Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke (MRAC); 7 exx., Athiopien: Ambo 13.-17.10.1990 leg. Rybalov (CSCHM, CTVR, PB); 3 exx., Athiopien: Ambo, 1.-4.11.1990, leg. Rybalov (CTVR); 1 ex., Coll. Mus. Tervuren, Ethiopie: Munagaschia Forest 29km. W. Addis Abeba, R.O.S. Clarke (MRAC); 16 exx., Ethiopia, Hang Jammatal b. Debre Libanos 2300mNN 9,746°N 38,815°O leg I. Harry 28.11.2012 (CH, CSCHM, CTVR, PB); 6 exx., Ethiopia, Wald b. Wondo Gennet 2000mNN 7,099°N 38,641°O leg I. Harry 28.11.2012 (CH, CTVR); 1 ex., Ethiopia: Ghedo 7,500 ft. 20.v.46, K.M. Guichard, B.M. 1945-39 [printed] // Coll. Mus. Congo, Col. P. Basilewsky [printed] // COMP. TYP. / BASILEWSKY [red, bordered in black, printed] // africanus / Chd [handwritten] / P. Basilewzky det., 19 [printed] 67 [handwritten] (MRAC); 1 ex., Ethiopia: Ghedo 7,500 ft., 20.v.46, K.M. Guichard, B.M. 1945-39 [printed] // *Peryphus africanus* Chd. [handwritten] det. S.L. Straneo 1948 [printed] (NHMUK); 12 exx., Ethiopie - E. Gojam Amhara Gona: Ts'iyon Gorges du Nil 10.1.2013 Leg. E. Queinnec (CE, CSCHM, CTVR, PB); 6 exx., Etiopia - Shoa - Loc. 1, Tra Addis Abeba e Holetta, n. 2400 circa - 21-X-1973, A Vigna Leg. (AVT, CTVR, PB); 2 exx., Meta Ambo, 13 km west

of Addis Abeba, 27.XII.1970 [handwritten] // Under rock by waterfall // Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke (MRAC, CTVR); 2 exx., Shoa Prov.: Sabeta 23-XI-73 // Coll. Mus. Tervuren, Ethiopie, G. de Rougemont (MRAC, CTVR); 1 ex., Shoa Prov.: 40 km of Addis Abeba (old airport zone) 10.I.1973 // Coll. Mus. Tervuren, Ethiopie, R.O.S. Clarke (MRAC).

REDESCRIPTION. Bl = 5.3 to 6.2 mm. Colour: piceous-brown with metallic reflection. Legs testaceous, antennomeres 1 and 2 and base of 3 and 4 testaceous, rest of antennae darkened. Palps testaceous, except for last maxillary palpomere, yellowish, and the penultimate maxillary palpomere, darkened.

Head (Hw = 1.10 to 1.28 mm): frons with some scattered punctures, in some specimens also in the bottom of the frontal furrows and behind them. Frontal furrows almost parallel, uneven. Eyes normally convex but relatively small, with temples oblique, relatively long. Al = 3.0 to 3.5 mm. Microsculpture in a few specimens very superficial, hard to see, in weakly transverse sculpicells on the frons; isodiametric on neck.

Pronotum (Pl = 1.04 to 1.20 mm, Paw = 0.98 to 1.10 mm, Pw = 1.40 to 1.56 mm, Pbw = 1.00 to 1.16 mm, Pw/Pl = 1.30 to 1.35): cordate, convex, transverse; anterior transverse impression with some punctures, median line not deep; transverse basal impression rather wide, with coarse punctures; sides rounded, markedly sinuate before the right hind angles; subquadrate basal foveae rather superficial, rugose; laterobasal carina sometimes sharp, sometimes rudimentary, in some cases almost invisible. Pronotal microsculpture absent at magnification of 100x.

Elytra (El = 3.32 to 3.84 mm, Ew = 2.16 to 2.40 mm. El/Ew = 1.54 to 1.60, Ew/Pw = 1.53 to 1.54): evidently convex, with marked shoulders and sides gently rounded. Elytral striae 1 to 7 evidently impressed, punctate-sulcate, at apex striae 1 to 3 sulcate, outer striae only punctate and evanescent. Apical stria short, terminating at the end of stria 5 or 7. Elytral intervals very convex in the basal half, then progressively less convex. Two discal elytral pores in the third interval, adjoining stria 3. Elytral microsculpture well visible, in extremely transverse and sharp sculpicells.

Macropterous species.

MALE GENITALIA (Fig. 21). Median lobe of the aedeagus narrow, with ventral margin evidently arcuate. Long flagellum, evidently narrowing from

base to apex, connected at base with the basal chitin platelet, waved in its apical fourth and ending at the ostial flag. Well sclerotized stylet, arcuate with ventral concavity and apical tip abruptly enlarged and flat. Central brush oblique. Ventral sclerite narrow and arcuate, well sclerotized, with ventral concavity, at middle of the aedeagus.

INTRASPECIFIC VARIABILITY. The specimens from E. Gojam Amhara Gona, Ts'iyon Gorges du Nil show a shorter and less pointed apical fourth of the aedeagus.

COMPARATIVE NOTES. In spite of the external similarity, the endophallic characters of *B. africanum* reveal that the species is not related to *B. scottustulatum* and nearest relatives. From this perspective it seems to show marked affinities with *B. melanocerum*, since it shares the main layout of the sclerites. In particular, both species share a flagellum evidently narrowing from base to apex, apically ending with a wave, a strikingly identical basal chitin platelet at base of the flagellum (see Figs. 19 and 21) and a sclerotized stylet, at the apical second fourth, apically ending with an abruptly enlarged, flat tip. Also the ventral sclerite is similar, even though less sclerotized in *B. melanocerum*.

DISTRIBUTION. The species seems widely distributed in Ethiopia. It was collected from the Arsi Mountains (Mt. Chillalo) in the south to the Blue Nile Gorge in the north.

HABITAT. Based on label data, the species was found under stones and on river banks at elevations of about 2300 - 3000 m.

***Bembidion (Ocydromus) augustovignai* sp.n.** (Figs. 11, 22)

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DIAGNOSIS. Blue, shiny species from Anderaccia (Kaffa Province, Ethiopia) similar to *B. africanum* but distinguishable from this last by the narrower pronotum and the aedeagus as in Fig. 22.

TYPE LOCALITY. Anderaccia, Gurgutto natural bridge, Southern Nations Nationalities and people, Ethiopia.

TYPE SERIES. Holotype, male, "Etiopia - Kaffa - Loc. 18 / Anderaccia, / ponte naturale di Gurgutto / m. 1650 circa - 26-X-1973 [printed] / Vigna [handwritten]" (AVT); Paratype, female, same collecting data as the holotype (PB).

DESCRIPTION. Bl = 4.9 to 5.7 mm. Colour: black with blue, metallic reflections. Legs reddish-testaceous, antennomere 1 and base of 2 to 4 reddish, rest of

antennae darkened. Palps dark reddish, penultimate palpomere darkened, last palpomere yellowish.

Head (Hw = 0.96 to 1.16 mm): eyes moderately convex; temples oblique, relatively long; frons smooth showing a few scattered punctures between the slightly convergent, uneven frontal furrows. A few sharp punctures behind the frontal furrows. Microsculpture in slightly transverse sculpticells superficial on labrum and clypeus, almost invisible on the frons, isodiametric on neck. Al = 2.8 to 3.0 mm. Pronotum (Pl = 0.96 to 1.10 mm, Paw = 0.86 to 0.96 mm, Pw = 1.16 to 1.40 mm, Pbw = 0.88 to 1.04 mm, Pw/Pl = 1.21 to 1.27): relatively small, cordate, with rounded sides gently sinuate before the hind angles, square in the holotype, slightly obtuse in the paratype. Anterior transverse impression sulcate, evident, with some punctures in the median portion; median line evidently impressed; basal transverse impression rather wide, coarsely punctate. Basal foveae small, square, rugose, laterobasal carina present, very thin in the holotype, barely visible in the paratype. Lateral gutter narrow. Pronotal microsculpture absent.

Elytra (El = 3.00 to 3.60 mm, Ew = 2.00 to 2.26 mm, El/Ew = 1.54 to 1.59, Ew/Pw = 1.61 to 1.72): large, with shoulders somewhat rounded but evident. Sides subparallel, very gently rounded, apex wide. Elytral striae deeply punctate-sulcate; stria 7 evident, impressed like the inner ones. All striae visible, even though more superficial, at apex. Apical stria short, connected with the apical end of stria 5. Intervals strongly convex in the basal 3/5, then progressively more flat. Two discal elytral pores in the third interval, adjoining stria 3. Elytral microsculpture well visible, in extremely transverse and sharp sculpticells.

MALE GENITALIA (Fig. 22). Ventral margin of the median lobe of the aedeagus arcuate, with ventral concavity. Long and thick, waved flagellum, evidently narrowing from base to apex. A moderately sclerotized stylet about at the apical third, arcuate with ventral concavity and pointed at apex. Basal chitin platelet large and flat. Central brush moderately sclerotized, horizontally positioned at the basal second fourth. Ventral sclerite present, but very narrow, about at middle of the aedeagus.

ETYMOLOGY. The species is named in memory of our late friend Augusto Vigna Taglianti, specialist, among other countless skills, in Carabidae and Dermaptera, giant of Italian and international entomology, teacher of one of us (PB) and fundamental reference point for

Italian entomology during half century of scientific activity. This species was personally collected by Augusto himself, and he informed one of us (PB) that it was his favourite Ethiopian capture. The name is genitive.

COMPARATIVE NOTES. Except for the body colour (*B. augustovignai* is the sole Afrotropical *Bembidion* with blue, metallic integument), the species looks very similar to specimens of *B. africanum*. Many similarities in the layout of the sclerites within the endophallus appear to confirm that the two species are near relatives.

DISTRIBUTION. Currently, the species is only known from the type locality near Bonga in southwestern Ethiopia.

***Bembidion (Ocydromus) fontinale* Raffray, 1885 (Figs. 12, 23) new combination**

Bembidium (Peryphus) fontinale Raffray, 1885

Sinechostictus fontinalis (Raffray 1885) (Csiki, 1928)

Bembidion (Sinechostictus) fontinale Raffray 1885 (Lorenz, 1998; 2005)

DIAGNOSIS. A relatively large (5.0 to 5.6 mm) dark brown to piceous-brown Ethiopian *Bembidion* species with rounded shoulders and small punctures behind the frontal furrows.

SYSTEMATIC NOTES. In the original description this species was retained “très voisine du *rufipes*, var. *stomoides*” (Raffray 1885). Therefore, later it was listed under *Sinechostictus* Motschulsky, 1864 (Csiki 1928; Lorenz, 1998, 2005). We were allowed to examine the holotype, male, of *Bembidion fontinale* Raffray, 1885 and ascertain that the species actually belongs to the subgenus *Ocydromus* Clairville, 1806, as clearly shown by the armature of the endophallus.

TYPE LOCALITY. Mount Abuna Yousef, Amhara, Ethiopia.

TYPE SERIES. Holotype, male, “Abyssinie / A. Raffray / Voy. 1881. [printed, bordered in black] // Mt. Abuna / Yussef [handwritten] // *Bembidium / fontinale* Raffr. / Type! [handwritten] // TYPE [red, printed]”, MNHN).

NON TYPE MATERIAL EXAMINED. 8 exx., Ethiopia Amhara, Mt. Abuna Yosef, N-slope, 3800-3950 m, 12°07'52"N 39°11'39"E, 4.III.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM, OSAC: DNA5589); 144 exx., Ethiopia Amhara, Mt. Abuna Yosef, S-slope, 3850-3900 m, 12°07'29"N 39°11'21"E, 5.III.2019, leg. D. Hauth, J. Schmidt,

Yeshitla M., Yitbarek, W. (CSCHM, CTVR, OSAC: DNA5590, PB, ZMAA, ZSM); 19 exx., Ethiopia Amhara, Mt. Abuna Yosef, S-slope, 3700-3800 m, 12°09'10"N 39°09'35"E, 5.III.2019, leg. D. Hauth, J. Schmidt, Yeshitla M., Yitbarek, W. (CSCHM); 1 ex., Ethiopie, N. Wollo, Amhara, bord ruisseau, Col Abuna Youssef 3993m, 7.1.2013 leg. E. Queinnec (CTVR). REDESCRIPTION. BL = 5.2 to 5.6 mm. Colour: elytra dark brown to piceous brown, head and pronotum often lighter than elytra, often with a lighter longitudinal band at middle of the pronotum. Legs reddish, antennomere 1 and base of 2 to 4 reddish, rest of antennae darkened, palps yellowish-red, except for the penultimate maxillary palpomere, darkened.

Head (Hw = 1.04 to 1.16 mm): with convex eyes, frontal furrows parallel, uneven, frons smooth, with a few scattered punctures between the frontal furrows and behind them. Microsculpture in isodiametric sculpticells more or less visible, from evident to very superficial, sometimes barely visible on the frons and the clypeus, more evident on neck and even more marked on labrum. Al = 2.6 to 3.2 mm.

Pronotum (Pl = 1.00 to 1.12 mm, Paw = 0.90 to 1.02 mm, Pw = 1.26 to 1.44 mm, Pbw = 0.88 to 1.00 mm, Pw/Pl = 1.26 to 1.29): weakly convex, cordate, with rounded sides markedly sinuate before the square hind angles. Median line and anterior transverse impression rather superficial, this last sometimes with a few punctures or wrinkles at middle. Basal transverse impression rather wide, with many wrinkles, longitudinally oriented. Basal foveae superficial, wrinkled. Laterobasal carina absent. Lateral gutter narrow. Pronotal microsculpture in weakly transverse sculpticells, superficial, almost invisible on the disc, more marked on the sides.

Elytra (El = 3.08 to 3.44 mm, Ew = 2.00 to 2.24 mm, El/Ew = 1.53 to 1.54, Ew/Pw = 1.56 to 1.59): oval, with markedly rounded shoulders and sides. Elytral striae 1 to 7 evident, punctate-sulcate, with punctures not deep, easily visible up to the apex, apical stria connected with the apical end of stria 5. Elytral intervals flat. Elytral microsculpture evidently impressed, in polygonal, slightly transverse sculpticells.

Micropterous species.

MALE GENITALIA (Fig. 23). Median lobe of the aedeagus long, ventral margin evidently arcuate with ventral concavity, apex markedly pointed. Endophallus extremely similar to that of *B. siculum*

Dejean, 1831, with central brush near the basal opening, very long tubular flagellum extending from the basal opening to the extreme apex, ostial flag long, ending posteriorly with a pointed, well sclerotized tip. COMPARATIVE NOTES. The endophallic structure suggests that *B. fontinale* is close related to western Palearctic species of *Ocydromus* in the strict sense, being strikingly similar in this perspective to *B. siculum* and thus clearly differing from the other East African species dealt with in this study. The *atlanticum* species group is the only *Ocydromus* species group already reported for East Africa (*B. adowanum* Chaudoir, 1876).

DISTRIBUTION. This species is probably endemic to the Abuna Yousef Massif in northern Ethiopia.

HABITAT. The species was found at the banks of small sunny mountain streams at elevations of 3700 - 4000 m.

KEY TO THE EAST AFRICAN SPECIES OF
BEMBIDION LATREILLE, 1802 WITH SPECIAL REFERENCE
TO THE SUBGENERA *PERYPHUS* DEJEAN, 1821 AND
OCYDROMUS CLAIRVILLE, 1806

- 1 elytral shoulders finely saw-toothed
.....*Bembidion* subg. *Microserrullula*
Netolitzky, 1921
- elytral shoulders normal.....2
- 2 discal elytral pores situated almost in the middle
of third interval; species often with *Notaphus*-like
elytral spots or light apical elytral lunula.....
.....*Bembidion* subg. *Omotaphus* Netolitzky,
1914 and *Notaphocampa* Netolitzky, 1914
- discal elytral pores in the third interval adjoining
stria 3.....3
- 3 eyes markedly convex, protruding as a full
semicircle
.....*Bembidion* subg. *Ocydromus* Latreille,
1806 (*atlanticum* Wollaston, 1854 species group)
- eyes normally protruding4
- 4 elytral apical light lunula more or less developed
but visible.....5
- elytra unicolourous6
- 5 species from North, Central and South Ethiopia, in
southern Ethiopia east of Rift Valley with marked
elytral shoulders; endophallus (Fig. 13) with

- relatively small central sclerite and narrow flagellum ..*Bembidion (Peryphus) scottustulatum* Netolitzky, 1937
- species only from southern Ethiopia with rounded shoulders; endophallus (Fig. 14) with larger central sclerite and thicker flagellum.....
.....*Bembidion (Peryphus) damota* n.sp.
- 6 rounded elytral shoulders (Figs. 4-6, 12).....7
- square elytral shoulders (Figs. 1-3).....11
- 7 total body length > 5.5 mm, maximum elytral width beyond the middle.....8
- total body length < 5.5 mm, elytra more evenly ovate.....10
- 8 vertex with fine punctures near basal end of frontal furrows (Abuna Yousef Massif of northern Ethiopia).....
.....*B. (Ocydromus) fontinale* Raffray, 1885
- vertex smooth.....9
- 9 pronotum wider in respect to the elytra (ew/pw = 1.48 to 1.52), aedeagus as in Fig. 16, Kenya.....
.....*Bembidion (Peryphus) jeanneli* Alluaud, 1939
- pronotum narrower in respect to the elytra (ew/pw = 1.62 to 1.63), aedeagus as in Fig. 15, Southern Ethiopia.....*Bembidion (Peryphus) baleense* sp.n.
- 10 elytral microsculpture distinctly isodiametric.....
.....*Bembidion* subgg. *Acropezum* Alluaud, 1917 and *Hypsipezum* Alluaud, 1917
- elytral microsculpture in irregular, moderately transverse sculpticells, aedeagus as in Fig. 17.....
.....*Bembidion (Peryphus) sjoestedti* Alluaud, 1926
- 11 relatively small species (total length 4.3 to 5.0 mm), piceous black, mostly with bronze lustre, elytral microsculpture absent (magnification 100x) or superficial, in moderately transverse sculpticells12
- on average larger species (total length 5.0 to 6.2 mm), dorsal surface dark brown or blueish, elytral microsculpture evident, in very transverse and sharp sculpticells.....14
- 12 dorsal surface very shiny, black with metallic bronze lustre, a few small punctures behind the frontal furrows or at their base, elytral striae 2 to 5 more superficial at apex, but visible in rows of sharp punctures, legs dark brown, aedeagus as in Fig. 18
.....*Bembidion (Ocydromus) basistriatum* Fairmaire, 1893
- elytral striae 2 to 5 more superficial at apex but always sulcate, not in rows of punctures, small punctures behind the frontal furrows very scarce or absent.....13
- 13 Elytral microsculpture evident at 50x, aedeagus as in Fig. 19, northern and central Ethiopia
.....*Bembidion (Ocydromus) melanocerum* Chaudoir, 1876
- Elytral microsculpture absent or not visible at 50x, aedeagus as in Fig. 20, Arsi and Bale Mountains of southern Ethiopia.....
.....*Bembidion (Ocydromus) melanoceroides* n.sp.
- 14 dorsal surface shiny blue, pronotum less cordate and narrower in respect to the elytra (ew/pw = 1.61 to 1.72), aedeagus as in Fig. 22.....
.....*Bembidion (Ocydromus) augustovignai* n.sp.
- dorsal surface brownish, pronotum more cordate and wider in respect to the elytra (ew/pw = 1.53 to 1.54), aedeagus as in Fig. 21.....
.....*Bembidion (Ocydromus) africanum* Chaudoir, 1876

CONCLUSIONS

The subgenus *Peryphus* Dejean, 1831, formerly was reported to be present in East Africa with six species. Of these, based on the results of this study, four species have to be transferred to the subgenus *Ocydromus* Clairville, 1806. However, we identified two new *Peryphus* species so that this subgenus is now present in the area with four species all occurring in Ethiopia.

Based on our results, the genus *Sinechostictus* Motschulsky, 1864 is not part of the East African fauna. The only species of that area formerly attributed to this genus actually belongs to *Bembidion* subgenus *Ocydromus*. The same applies for the *Bembidion* subgenus *Testedium* Motschulsky, 1864. The only species formerly attributed to this taxon we likewise identified as belonging to *Ocydromus*.

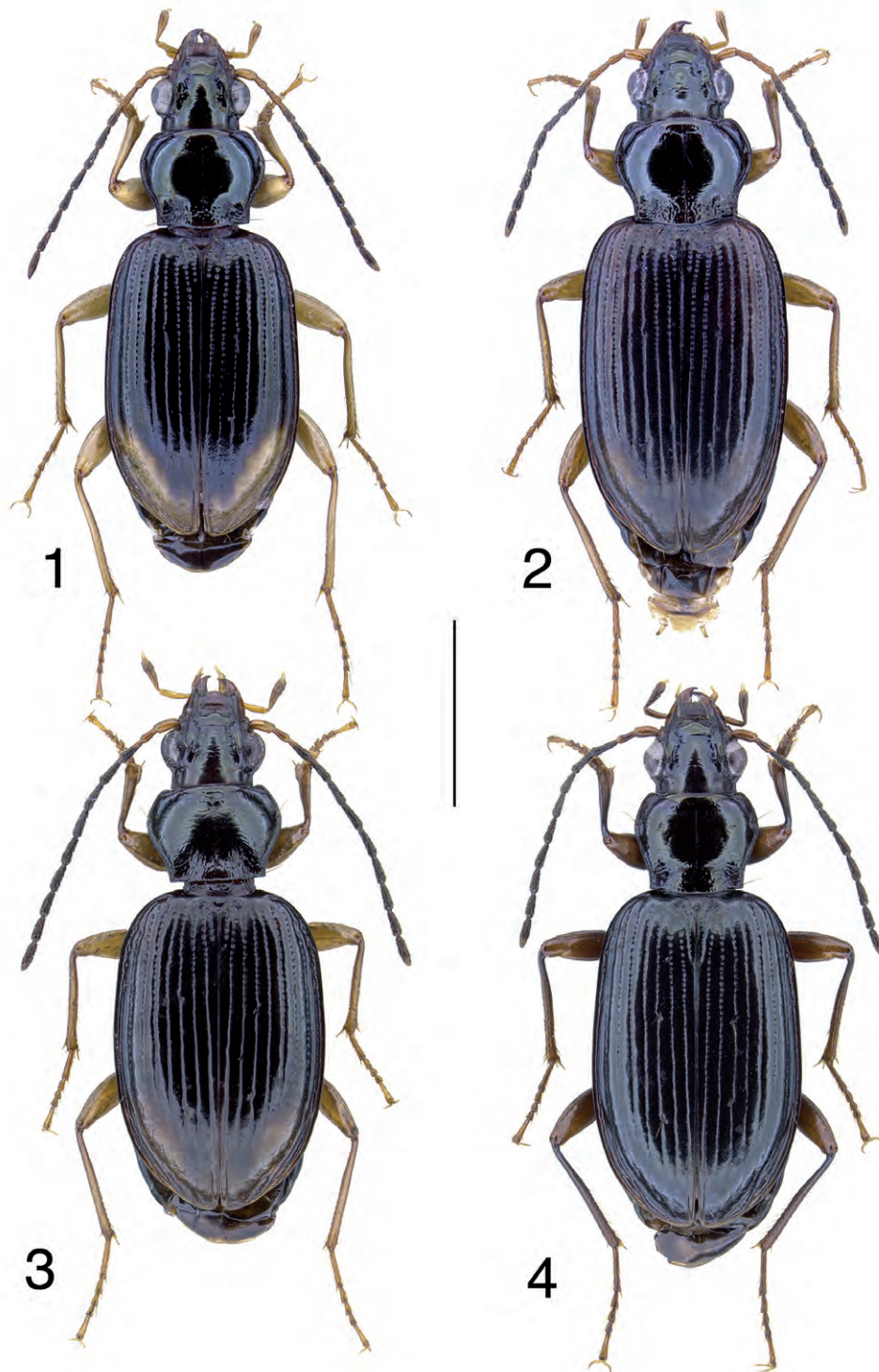
Presence of the subgenus *Ocydromus* in East Africa is not surprising but a well-known fact since

representatives of the *atlanticum* Wollaston, 1854 species group are known to occur in different areas from North to South Africa: *B. atlanticum* Wollaston, 1854, (North Africa), *B. adowanum* Chaudoir, 1876 (Ethiopia), *B. leleupi* Basilewsky, 1954 (Kenya), *B. ortsi* Netolitzky, 1938 (Congo), *B. meruanum* Basilewsky, 1962 (Tanzania), *B. drago* Basilewsky, 1958 (Lesotho, South Africa). Together with *B. adowanum*, the taxonomic changes noted above, and the two species newly described in the present paper, ten *Ocydromus* species are now known to occur in East Africa, seven of which seem to be endemic to Ethiopia. Therefore, Ethiopia harbours a particularly rich *Bembidion* fauna, which is very probably a result of the diversity of the local climates and the remarkable geomorphology with several of the many high mountains of the country reaching up to the afroalpine zone.

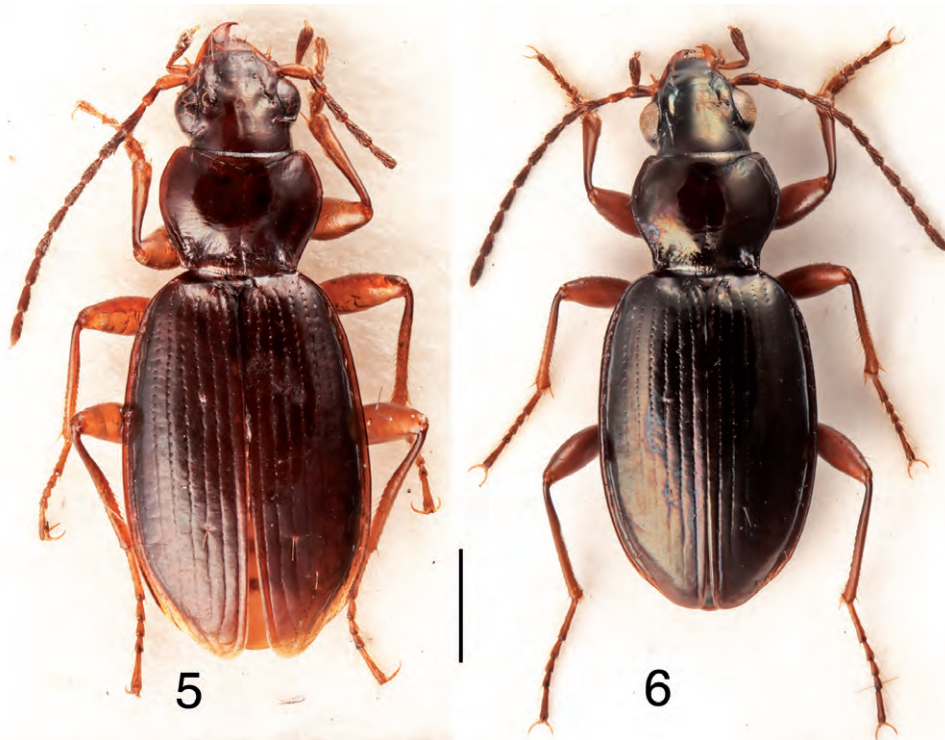
ACKNOWLEDGEMENTS

We wish to thank all the friends that helped us by providing material in study or in other ways: Max Barclay (NHMUK), Marc De Meyer (MRAC), Thierry Deuve (MNHN), Dominique Echaroux

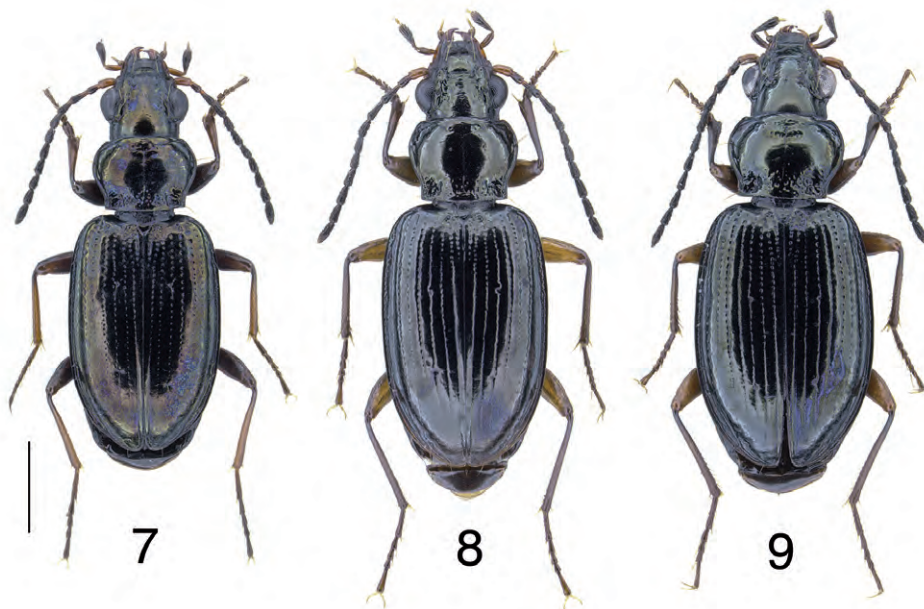
(Etrechy, France), Sergio Facchini (Piacenza, Italy), Beulah Garner (NHMUK), Stéphane Hanot (MRAC), Ingmar Harry (Freiburg, Germany), Manfred Jäch (NHMW), Wolfgang Lorenz (Tutzing, Germany), David Maddison (Corvallis, Oregon), Paolo Neri (Forlì, Italy), Roberto Poggi (MSNG), Harald Schillhammer (NHMW), Heinrich Schönmann (NHMW), Azadeh Taghavian (MNHN), Didier Van den Spiegel (MRAC) and David Wrase (Gusow Platkov). JS thanks the Ethiopian Wildlife Conservation Authority, the Ethiopian Biodiversity Institute, the College of Natural and Computational Sciences and the Department of Plant Biology and Biodiversity Management, Addis Ababa University, the Bale Mountains National Park and the Arsi Mountain National Park for their cooperation and kind permission to conduct field work. Particular thanks are due to David Hauth (Munich), Katinka Thielsen, Mekbib Fekadu and Yeshitla Merene (Marburg), Ralph Emerich (Rostock) and Yitbarek Wolde-Hawariat (Addis Ababa) for supporting or organising fieldwork of JS. We wish to thank David Maddison for the review which markedly improved the manuscript, Paolo Neri for providing useful information and bibliographic material, and Jon Cooter (Oxford) for the linguistic revision of the text.



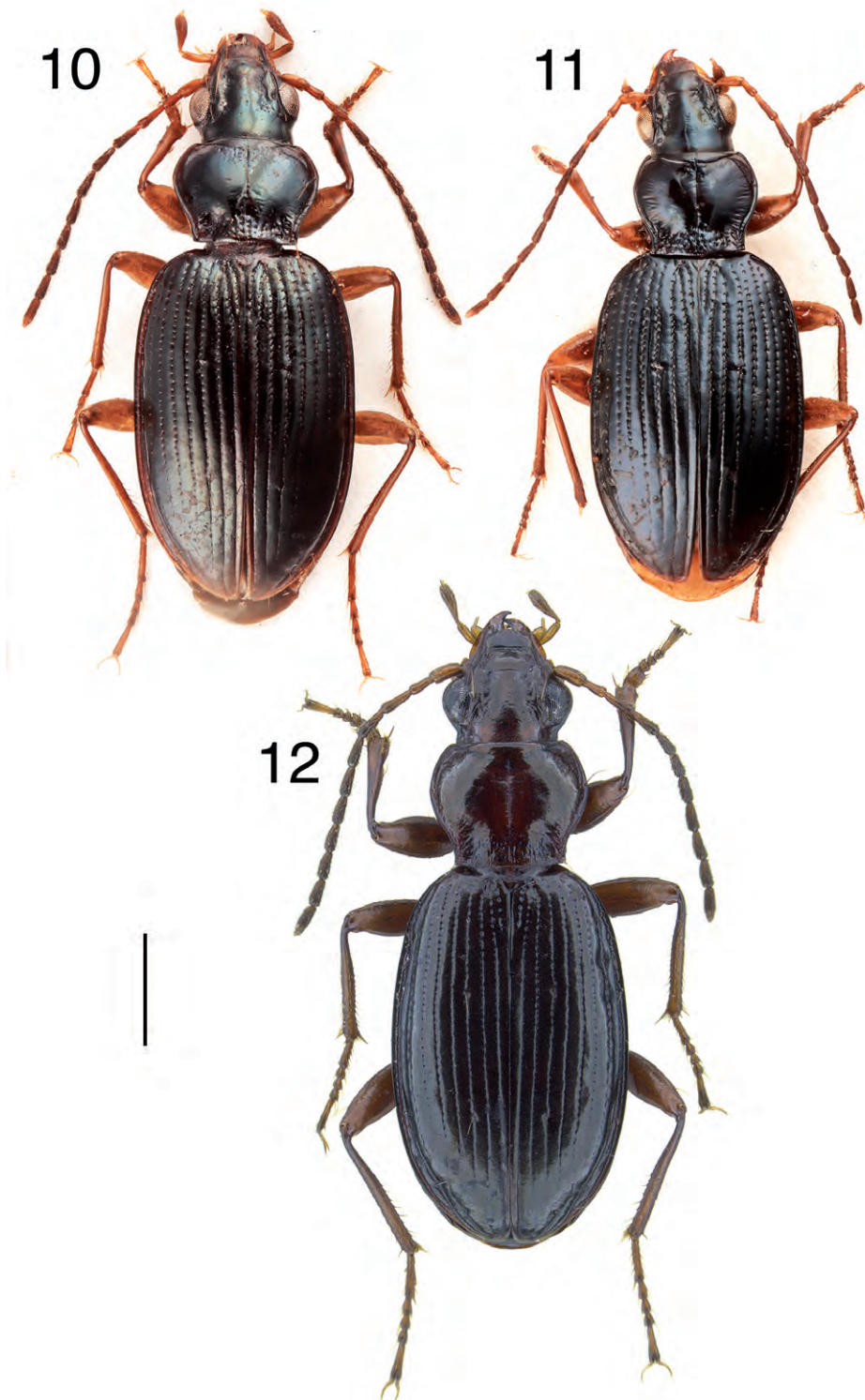
Figs. 1-4. habitus of: 1. *Bembidion scottustulatum* Netolitzky, 1937, specimen from Mt. Choke (CSCHM); 2. *Bembidion scottustulatum* Netolitzky, 1937, specimen from Abuna Yousef (CSCHM); 3. *Bembidion damota* n.sp., holotype (CSCHM); 4. *Bembidion baleense* n.sp., holotype (CSCHM); scale: 2 mm.



Figs. 5-6. habitus of: 5. *Bembidion jeanneli* Alluaud, 1939, paratype (MNHN); 6. *Bembidion sjoestedti* Alluaud, 1926, specimen from Mt. Kilimanjaro (CTVR); scale: 1 mm.



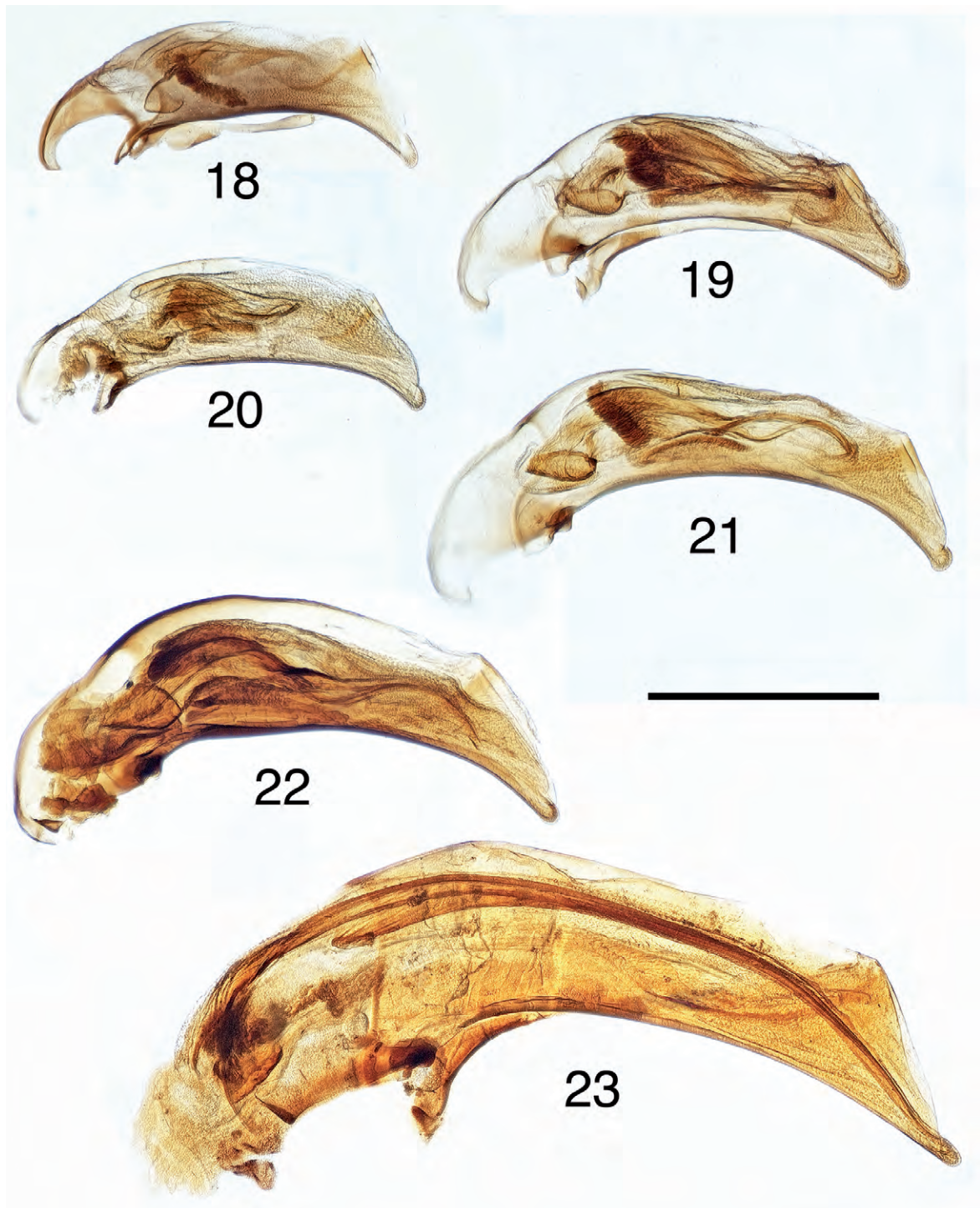
Figs. 7-9. habitus of: 7. *Bembidion basistriatum* Fairmaire, 1893, specimen from Enkuolo (CSCHM); 8. *Bembidion melanocerum* Chaudoir, 1876, specimen from Mt. Choke (CSCHM); 9. *Bembidion melanoceroides* n.sp., paratype from Enkuolo (CSCHM); scale: 1 mm.



Figs. 10-12. habitus of: 10. *Bembidion africanum* Chaudoir, 1876, specimen from Debre Libanos (CTVR); 11. *Bembidion augustovignai* n.sp., Holotype (AVT); 12. *Bembidion fontinale* Raffray, 1885, specimen from Abuna Yousef (CSCHM); scale: 1 mm.



Figs. 13-17: Median lobe of aedeagus of: 13. *Bembidion scottustulatum* Netolitzky, 1937, paratype from Djem Djem Forest (NHMW); 14. *Bembidion damota* n.sp., paratype from Mt. Chillalo (NHMUK); 15. *Bembidion baleense* n.sp., paratype from Dodola (CTVR); 16. *Bembidion jeanneli* Alluaud, 1939, Holotype (MNHN); 17. *Bembidion sjoestedti* Alluaud, 1926, specimen from Horonbo, Mt. Kilimanjaro (CTVR); scale: 0.5 mm.



Figs. 18-23. Median lobe of aedeagus of: 18. *Bembidion basistriatum* Fairmaire, 1893, specimen from Mt. Chillalo (CTVR); 19. *Bembidion melanocerum* Chaudoir, 1876, specimen from Holetta (AVT); 20. *Bembidion melanoceroides* n.sp., paratype from "Bale, a Est di Abeba" (AVT); 21. *Bembidion africanum* Chaudoir, 1876, specimen from Ghedo (MRAC); 22. *Bembidion augustovignai* n.sp., Holotype (AVT); 23. *Bembidion fontinale* Raffray, 1885, Holotype (MNHN); scale: 0.5 mm.

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Erminio PIVA*

**Inaspettata scoperta di *Cimbrodytes heterognathus*, eccezionale nuovo genere
e nuova specie di Trechino troglobio dell'Altopiano di Asiago
(Prealpi vicentine, Veneto)
(Coleoptera Carabidae Trechinae)**

Riassunto: Viene descritto *Cimbrodytes heterognathus*, nuovo genere e nuova specie di Trechino troglobio scoperto in una grotta dell'Altopiano di Asiago, nelle Prealpi vicentine, Veneto (Coleoptera Carabidae Trechinae). Il nuovo taxon, per il primo protarsomero dilatato nel maschio, si colloca nella linea filetica di *Neotrechus* (sensu Jeannel, 1928) e si avvicina particolarmente al genere *Orotrechus* Müller, 1913, con il quale condivide alcuni caratteri morfologici (labium saldato al prebasilare, gruppo omerale di setole ombelicate disaggregate, tibie e tarsi pubescenti, edeago piccolo e semplice, con lobo mediano privo di bulbo basale distinto, lamella copulatrice ritorta, in posizione anisotopa, parameri brevi, lamellari, con alcune setole all'apice in numero variabile). La particolare conformazione mandibolare risulta essere l'unico caso, per ciò eccezionale, fra tutti i Trechini noti.

Abstract: *Unexpected discovery of Cimbrodytes heterognathus, exceptional new genus and new species of troglitic Trechinae from the Asiago plateau (Vicenza Prealps, Veneto) (Coleoptera Carabidae Trechinae).*

Cimbrodytes heterognathus, a new genus and a new species of troglitic Trechinae discovered in a cave on the Asiago plateau, in the Vicenza Prealps, Veneto (Coleoptera Carabidae Trechinae) is described. The new taxon, for the first protarsomere dilated in the male, belongs to the phyletic lineage of *Neotrechus* (sensu Jeannel, 1928) and it is particularly close to the genus *Orotrechus* Müller, 1913, with which it shares some morphological characters (labium fused with the submentum, humeral group of umbilicated pores disaggregated, pubescent tibiae and tarsi, small and simple aedeagus, with median lobe without a distinct basal bulb, twisted copulatory piece, in anisotropic position, short and lamellar parameres with some apical setae in variable number). The particular mandibular conformation turns out to be the only case, exceptional for this reason, among all the known Trechini.

Key words: Carabidae, Trechinae, Trechini, *Cimbrodytes heterognathus* n. gen. n. sp., Altopiano di Asiago, Prealpi vicentine, Veneto.

To meet the requirements by the International Code of Zoological Nomenclature (ICZN), this article was registered at ZooBank (31 March 2021) under the ZooBank Life Science Identifier (LSID): 2E513886-7739-400F-A9ED-F9912B25C9BE.

Published: 23 April 2021.

INTRODUZIONE

L'Altopiano dei Sette Comuni, più noto come Altopiano di Asiago, si estende per più di 600 Km² nel settore prealpino situato a nord di Vicenza; è delimitato a ovest dalla Valle dell'Astico, a nord e a est dalla Valle del Brenta (o Valsugana) e a sud dal pedemonte (Mietto & Sauro, 1989). Data l'impostazione prettamente tassonomica del presente lavoro, rimando al citato volume per notizie sull'assetto territoriale, sull'idrologia, la litologia e altro.

Limitandoci solamente ai coleotteri possiamo far risalire all'anno 1879 le prime ricerche faunistiche nell'Altopiano, quando il principe Della Torre scopre, nelle Grotte di Oliero, un Carabide troglobio, che lui stesso descrive come *Anophthalmus Targionii* (oggi *Orotrechus targionii targionii*) (Della Torre, 1880).

Del medesimo sito vengono poi descritti il Leptodirino *Neobathyscia antrorum antrorum* (Doderò,

1900) e gli Pselafini *Bryaxis troglodytes troglodytes* (Fiori, 1900) e *Bryaxis vicinus* (Doderò, 1919).

Su materiale proveniente dalla cima del Monte Manderiolo, in sede endogea, Ganglbauer (1911) descrive *Trechus (Anophthalmus) Mandriolae*, divenuto *Orotrechus mandriolae* (Ganglbauer, 1911).

Nella Grotta di Costalta (Conci, 1950) vengono scoperti il Trechino *Orotrechus stephani stephani* (Müller, 1913) e i Leptodirini *Aphaotus jureceki* Breit, 1914, e *Halbherria stefani* (Breit, 1914); su questi due ultimi taxa vi fu un clamoroso caso nomenclatoriale, conseguenza di un errore, chiarito in seguito da Conci & Tamanini (1951, 1952, 1954).

Su due reperti endogei del Monte Barco viene descritto *Orotrechus targionii alticola* Jeannel, 1928.

Nel 1953 Tamanini descrive due Trechini provenienti dalla Grotta della Bigonda (Galvagni, 1952), *Orotrechus Ganglbaueri Galvagnii*, in seguito

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da egli stesso elevato a specie distinta (Tamanini, 1957) e *Orotrechus Stephani Perinii*, messo in sinonimia di *Orotrechus stephani stephani* da Piva (2014).

Altre nuove specie di Leptodirini vengono descritte in seguito: *Neobathyscia isabelae* Piva, 1984, della Speluga della Ceresara; *Halbherria cimbrica* Piva, 1985, dell'Abisso di Busa del Ghiaccio; *Aphaotus granulatus* Piva, 1986, della Spaluga di Lusiana; tutti elementi raccolti successivamente in varie grotte dell'Altopiano.

Fu una gradita e inaspettata sorpresa quando il Sig. Bianco Dante, socio del Gruppo Grotte Valdagno CAI, mi affidò in studio il materiale raccolto da lui stesso e da altri soci in una cavità del territorio di Asiago: fra i taxa già noti potei individuare un Trechino, rivelatosi subito ignoto alla Scienza, con caratteristiche talmente peculiari da assegnarlo ad un genere nuovo, che più avanti descrivo.

MATERIALI E METODI

Tutti gli esemplari che compongono la serie tipica sono stati raccolti mediante l'impiego di trappole a caduta. Gli apparati genitali, quando estratti, sono stati inclusi in Euparal e posti su cartellini in plastica trasparente.

I disegni sono stati ottenuti alla camera lucida montata su microscopio Askania RME 5; le misurazioni rilevate con micrometro oculare. Le immagini fotografiche realizzate con fotocamera digitale CANON EOS 450D, corredata di obiettivo Sigma Zoom 18 mm-125 mm invertito, montata su colonna micrometrica dotata di illuminazione anulare a led.

Riguardo alle misurazioni, per lunghezza del corpo si intende la distanza dall'apice delle mandibole all'apice elitale, per lunghezza del capo la distanza dal margine anteriore del clipeo al restringimento collare, per lunghezza delle antenne la distanza tra la base del primo articolo (escludendo l'apofisi articolare) e l'estremità dell'undicesimo articolo, per lunghezza del protorace la distanza (lungo l'asse mediano) tra i margini anteriore e basale, per lunghezza delle elitre la distanza dal vertice del triangolo scutellare all'apice elitale, per larghezza delle elitre la loro misura massima considerandole assieme; la lunghezza dell'edeago è data dalla distanza tra la base del bulbo e l'apice del lobo mediano.

L'Holotypus, dopo il disegno in toto, è stato dissezionato e le varie parti anatomiche incluse in Euparal e montate su cartellini in plastica trasparente.

I reperti sono conservati nelle seguenti collezioni: CBI (coll. Dante Bianco, Santorso, Vicenza), CCA (coll. Casale, Torino), CFA (coll. Paolo Falsirollo, Nogara, Verona), CPI (coll. Erminio Piva, Vicenza), GGV (coll. Gruppo Grotte Valdagno CAI, Valdagno, Vicenza).

Cimbrodytes n. gen.

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SPECIE TIPO: *Cimbrodytes heterognathus* n. sp.

DIAGNOSI. Genere di Trechini anisotopi di medie dimensioni, a facies afenopsiana, immediatamente riconoscibile da tutti i Trechini attualmente noti per la diversa conformazione di mandibole e mascelle.

DESCRIZIONE. Genere di Trechini di aspetto afenopsiano, depigmentato, attero, di dimensioni medie. Capo ingrossato, privo di cicatrici oculari, con due setole sopraorbitali per lato, solchi frontali incompleti, labium saldato al submento e con dente labiale unificato, mandibole particolarmente modificate, brevi e all'apice bruscamente ripiegate, mascelle ugualmente ricurve all'apice. Antenne allungatissime e densamente pubescenti.

Pronoto piccolo, cordiforme, privo di setole basali e a superficie glabra.

Elitre ellittiche allungate, pedunculato, con omeri appena evidenti, a tegumenti glabri, strie molto superficiali, solo le interne parzialmente visibili.

Chetotassi: gruppo omerale di setole della serie ombelicata disaggregato, due pori discali su ogni elitra.

Zampe gracili, allungate.

Edeago semplice, in visione laterale poco incurvato, con bulbo basale indistinto, parameri muniti di poche setole apicali; lamella copulatrice in posizione anisotopa, in visione dorsale subtriangolare, con vertice arrotondato e angolo prossimale sinistro ritorto dorsalmente.

DERIVATIO NOMINIS. Il nome del genere è formato da *Cimbro-*, che prende origine da un contingente del popolo nordico dei Cimbri che si insediò, verso la metà del X secolo, sull'Altopiano dei Sette Comuni, dove si trova la località tipica del nuovo taxon, e *-dytes*, da Dite (= Plutone), il dio degli Inferi nella mitologia latina. Il nome del genere è maschile.

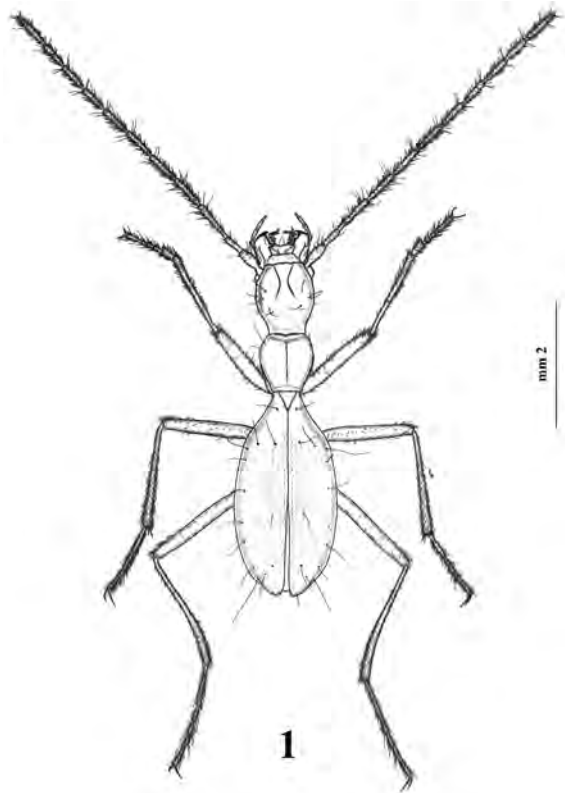


Fig. 1. *Cimbrodytes heterognathus* n. gen. n. sp., Holotypus ♂: habitus.

***Cimbrodytes heterognathus* n. sp.**

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LOCALITÀ TIPICA: Veneto, Altopiano dei Sette Comuni. Asiago (VI); località Busa della Vedova, Grotta Lago Bianco (8673 V VI), 1367 m.

SERIE TIPICA. Holotypus ♂: Veneto, Altopiano dei Sette Comuni. Asiago (VI); località Busa della Vedova, Grotta Lago Bianco (8673 V VI), 1367 m, 12.VI.2011, M. Cocco, D. Sbicego, M. Tomasi, F. e P. Urbani & G. Zarantonello leg. (CBI). Paratipi: Veneto, Altopiano dei Sette Comuni, Asiago (VI), località Busa della Vedova, Grotta Lago Bianco (8673 V VI), 1367 m, 12.VI.2011, M. Cocco, D. Sbicego, M. Tomasi, F. e P. Urbani & G. Zarantonello leg., 1 ♂ (CBI) 1 ♀ (GGV); ibidem, 9.VII.2011, L. Dalle Tezze & P. Falsirollo leg., 1 ♂ (CFA); ibidem, 17.VI.2012, D. Bianco, L. Dalle Tezze, P. Falsirollo, E. Piva, P. Urbani & altri soci del Gruppo

Grotte Valdagno CAI leg., 2 ♀♀ (CPI); ibidem, 6.X.2013, M. Cocco, L. Dalle Tezze & P. Falsirollo leg., 1 ♀ (CFA); ibidem, 15.VII.2019, P. Falsirollo & E. Piva leg., 2 ♂♂ (CCA, CPI).

DERIVATIO NOMINIS. L'epiteto *heterognathus*, letteralmente, dal greco, "dalle mandibole diverse", sta ad indicare la più evidente caratteristica del nuovo taxon, unica tra tutti i Trechini attualmente noti.

DESCRIZIONE DELL'HOLOTYPE ♂. Corpo a facies afenopsiana (Fig. 1), con appendici snelle ma non gracili, lungo 5.76 mm, di colore giallo pallido (per incompleta sclerificazione), tranne le mandibole, rossastre; tegumenti con fitta e finissima microscultura a maglie poligonali irregolari.

Capo grande, più largo del pronoto (Figg. 3, 4), privo di vestigia oculari, lungo 1.11 mm e largo 0.91 mm (rapporto lunghezza/larghezza = 1.22). Tempie fortemente convesse, con poche setole; collo evidente. Solchi frontali incompleti, bene incisi, divergenti sia in avanti sia all'indietro, svaniti prima della setola sopraorbitale posteriore. Due setole sopraorbitali maggiori per lato, inserite su due linee appena convergenti in addietro, più altre due setole accessorie minori per lato. Epistoma (Fig. 3) con quattro setole; labrum (Fig. 9) trasverso, con margine anteriore incavato, munito di sei setole. Antenne (Fig. 8) lunghe 5.50 mm (il rapporto lunghezza antenne/lunghezza corpo è 0.95), densamente pubescenti dal III articolo: I antennumero ingrossato e più lungo del II, III appena più lungo del doppio del II, IV più breve del III ma più lungo dei sei seguenti (V-X), XI fortemente assottigliato nel terzo apicale, poco più breve del III.

Mandibole (Figg. 12, 13, 16 e 17) brevi e larghe, uncinato all'apice, con una setola inserita lateralmente alla carena superiore. Mascelle (Figg. 20 e 21) con lacinia armata di numerose e forti spine, bruscamente ripiegata all'apice. Labium (Fig. 4) saldato allo sclerite prebasilare, con dente labiale semplice; sono presenti due setole e due fossette sensoriali. Prebasilare con cinque setole; maggiori le due esterne, una per lato. Palpi labiali (Fig. 11) con quattro setole sul penultimo articolo; ligula (Fig. 10) con otto setole. Una macrocheta è inserita su ambo i lati della gola (in Fig. 4 se ne osservano i relativi pori).

Protorace piccolo, cordiforme (Fig. 5), con proepisterni parzialmente visibili dall'alto. Pronoto

lungo 0.90 mm e largo 0.85 mm (rapporto lunghezza/larghezza = 1.06), con massima larghezza nei due quinti anteriori; lati ampiamente arrotondati, ristretti poco prima degli angoli posteriori, che sono ottusi e smussati; doccia laterale strettissima, margine anteriore concavo nel mezzo e angoli anteriori non prominenti in avanti. Setole basali assenti, le anteriori in posizione molto avanzata, a circa un quinto dal margine anteriore, su livelli diversi, la sinistra un po' più avanti; in posizione arretrata rispetto a quest'ultima è presente una terza setola accessoria, meno sviluppata.

Elitre (Fig. 6) ellittiche allungate, moderatamente convesse, con la massima larghezza oltre la metà della lunghezza e con rapporto lunghezza/larghezza = 1.80, omeri appena riconoscibili, doccia marginale stretta e uniforme, carena apicale delimitante un lobo sporgente oltre la regolare curvatura

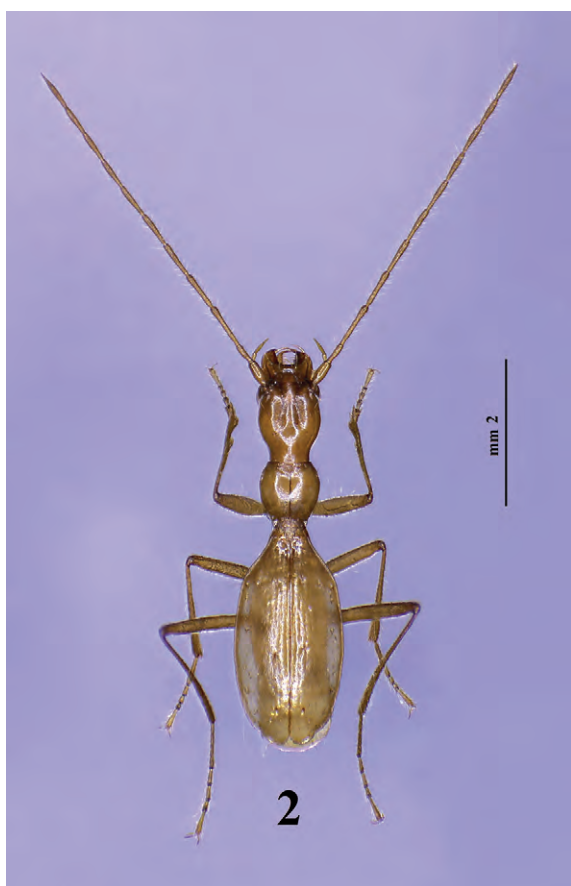


Fig. 2. *Cimbrodytes heterognathus* n. gen. n. sp., paratypus ♂: habitus.

preapicale dell'elitra; strie svanite, tranne le tre interne, poco incise ma distinguibili. Chetotassi: setola basale presente, a lato del vertice dello scutello; serie discale di due setole, inserite sulla terza interstria; gruppo omerale della serie ombelicata disaggregato, con la seconda setola equidistante dalla prima e dalla terza, mentre tra quest'ultima e la quarta la distanza è più del doppio di quella tra la seconda e la terza sull'elitra sinistra, circa il doppio sull'elitra destra; distanza tra le setole quinta e sesta circa 1.5 volte quella tra la seconda e la terza, mentre tra la settima e l'ottava la distanza è uguale a quella tra la seconda e la terza sulle rispettive elitre; triangolo apicale completo.

Sterniti addominali (Fig. 7) con microscultura finissima, a maglie poligonali trasverse, IV-VII recanti due setole per lato in posizione paramediana.

Zampe molto allungate, pubescenti. Femori con serie longitudinali di rade setole, progressivamente ridotte su mesofemori e metafemori, apici con un numero maggiore di setole. Tibie (tranne il tratto prossimale) e tarsi densamente pubescenti. Protarsi con il primo articolo dilatato e dentato internamente (Fig. 24) e con il quarto articolo munito inferiormente di un tubercolo recante lunghi faneri (Fig. 25); quarto articolo dei mesotarsi con analoga struttura del quarto protarsomero (Fig. 27) e un abbozzo di essa è rilevabile anche sul quarto metatarsomero (Fig. 29).

Edeago piccolo, lungo 0.70 mm (rapporto lunghezza edeago/lunghezza corpo = 0.12); il lobo mediano, in visione laterale (Fig. 31), è poco incurvato, presenta un bulbo basale indistinto ed è privo di carena sagittale mentre l'apice è arrotondato e provvisto di numerosissimi pori sensoriali; in visione dorsale (Fig. 32) risulta piuttosto stretto, a lati subparalleli e ad apice ampiamente arrotondato. Parameri (Figg. 33 e 34) brevi e subtroncati obliquamente, recanti entrambi cinque setole apicali, una delle quali, la dorsale, più breve e meno robusta; superficie esterna con alcuni pori irregolarmente distribuiti. Endofallo con lamella copulatrice grande (Fig. 35), in posizione anisotopa, in visione dorsale subtriangolare, con vertice arrotondato e con angolo sinistro ritorto dorsalmente.

DESCRIZIONE DEI PARATIPI E VARIABILITÀ. Lunghezza del corpo: 5.29-5.57 mm nei ♂♂ (media: 5.45 mm),

5.66-5.69 mm nelle ♀♀ (media: 5.67 mm); il rapporto lunghezza antenne/lunghezza corpo è di 0.87-0.97 nei ♂♂ (media: 0.93), di 0.88-0.95 nelle ♀♀ (media: 0.92). Capo con rapporto lunghezza/larghezza di 1.22-1.26 nei ♂♂ (media: 1.24), di 1.20-1.24 nelle ♀♀ (media: 1.21). Pronoto con rapporto lunghezza/larghezza di 1.05-1.11 nei ♂♂ (media: 1.07), di 1.02-1.09 nelle ♀♀ (media: 1.07). Il rapporto lunghezza/larghezza delle elitre è di 1.78-1.83 nei ♂♂ (media: 1.81), di 1.80-1.84 nelle ♀♀ (media: 1.82). Chetotassi variabile: sul capo mancano le setole sopraorbitali accessorie minori e, inferiormente, il prebasilare può recare 4 o 5 setole; alcuni sterniti addominali presentano talvolta una o tre setole in luogo di due, sia su uno dei lati, ovvero su entrambi i lati dello stesso sternite. Pronoto sempre con le sole due setole anteriori. Elitre con il primo poro discale generalmente in posizione avanzata (verso la base elitrale) rispetto al livello del primo poro del gruppo omerale della serie ombelicata, mentre a volte si trova al medesimo livello di quest'ultimo e in due casi vi si trova in posizione arretrata.

Nei paratipi ♂♂ l'apparato copulatore presenta il lobo mediano conforme a quello dell'Holotypus, ma i parameri possono recare da quattro a sette setole apicali e in due casi sono arrotondati all'apice, anziché subtroncati obliquamente.

Paratipi ♀♀ con protarsi semplici, armatura genitale con gonostili (Figg. 36 e 37) arrotondati all'apice e muniti di tre setole tergalì maggiori e 2-4 setole minori; fossetta preapicale ampia, con due esili setole e 2-3 bastoncelli sensoriali.

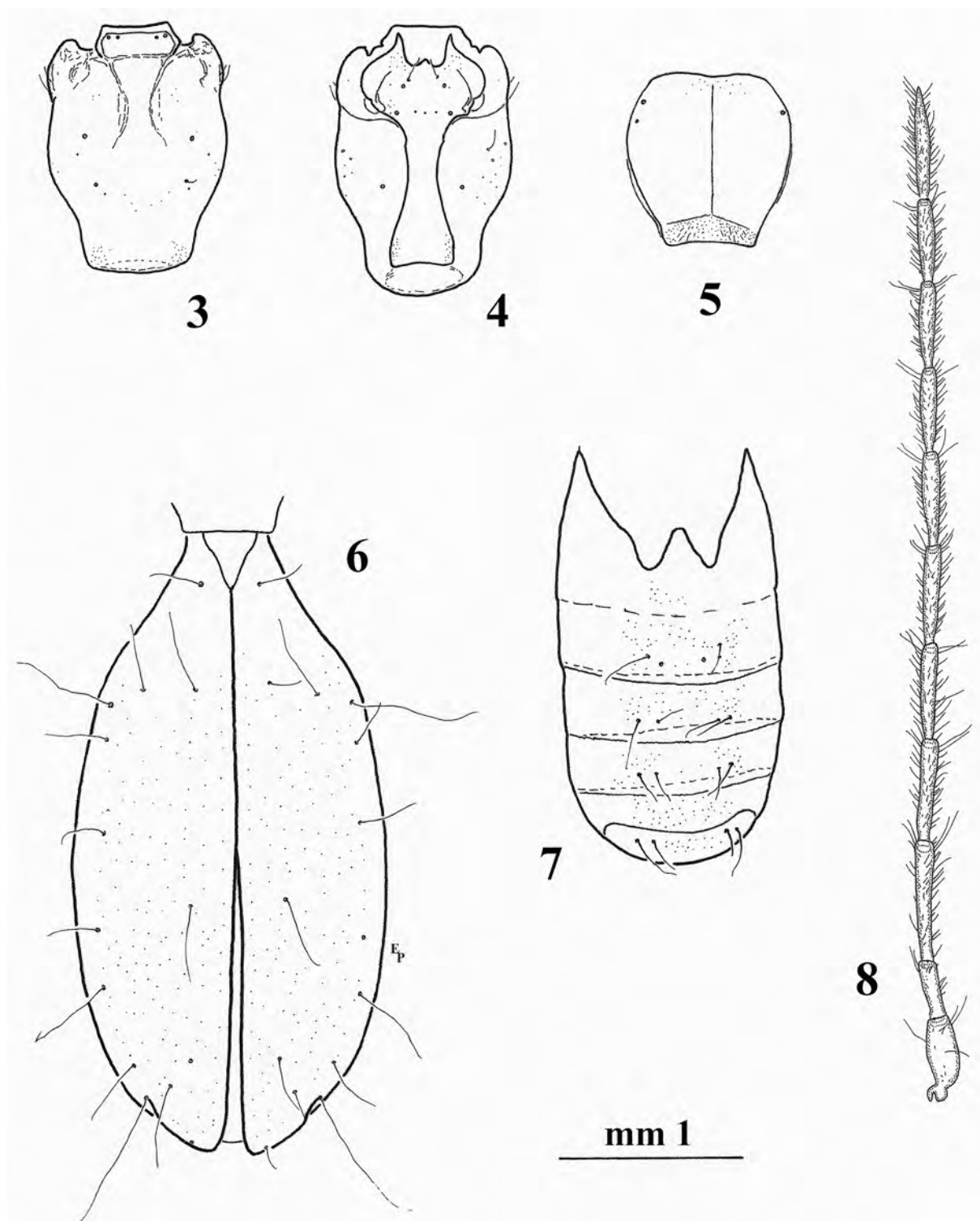
DISTRIBUZIONE E NOTE ECOLOGICHE. La zona in cui si apre la Grotta Lago Bianco, denominata Busa della Vedova, è situata a nord-ovest della Piana di Marcesina e presenta una copertura morenica risalente al Würmiano che maschera gli affioramenti in roccia sottostanti; la cavità si sviluppa nei Calcarei Grigi liassici, di età geologica riferibile al Giurassico Inferiore (Mietto & Sauro, 1989; Barbieri & Grandesso, 2007). Dalla base di un modesto pozzo iniziale parte un tortuoso e angusto meandro ad andamento debolmente discendente, che a circa metà percorso interseca un laghetto, poco profondo in condizioni idrologiche normali; superato il bacino, attraverso un passaggio superiore, il meandro continua incontrando alcune salette con pavimento fangoso, quindi oltrepassa uno

sprofondamento interessato da un abbondante deposito di latte di monte e va, infine, a esaurirsi in fessure fangose impraticabili. Lo sviluppo totale della grotta è di 237 metri, con un dislivello di -37 metri; si è notato, nel corso di ogni visita, un netto cambiamento del microclima interno, a partire dal laghetto, oltre il quale si percepisce una temperatura decisamente inferiore rispetto alla prima metà del meandro.

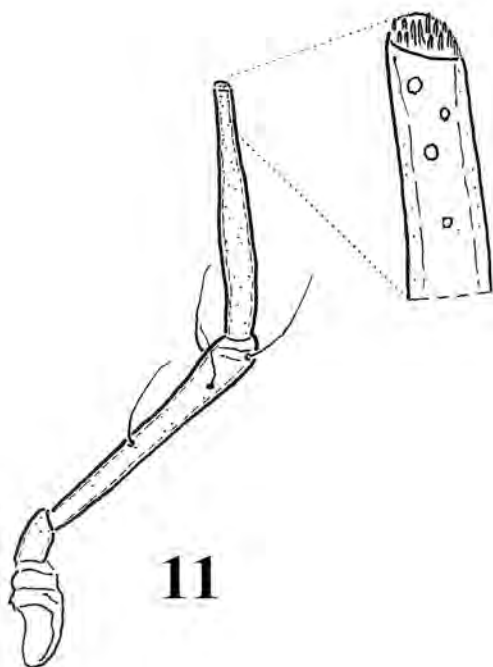
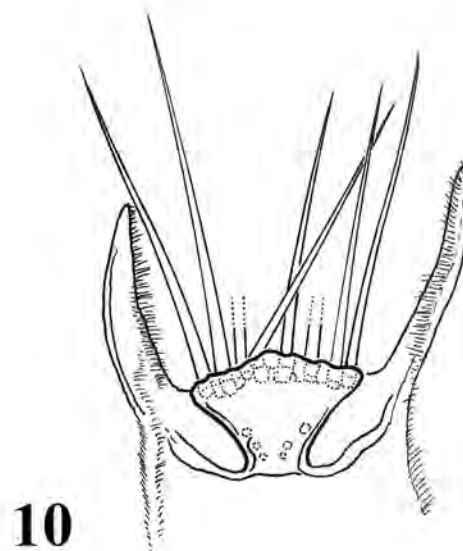
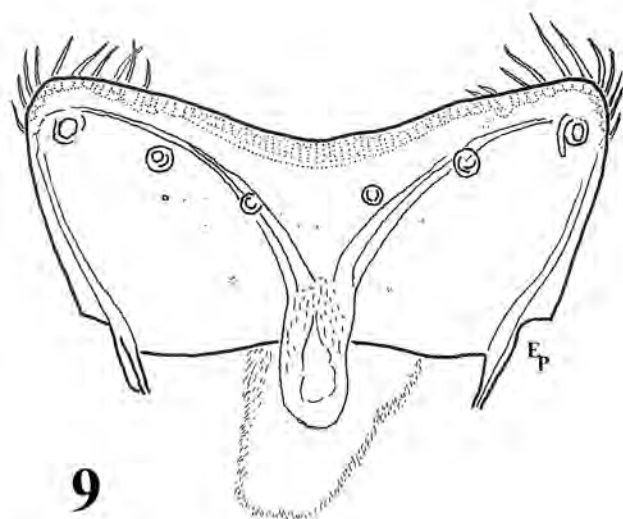
La grotta, di tipo oligotrofico freddo (Sbordoni *et al.*, 1977), ospita numerosi elementi, sia ipogei, sia occasionali: tra i Carabidae, i Trechini *Orotrechus stephani stephani*, oltre al nuovo taxon descritto più sopra e il Pterostichino *Speluncarius stefani* (Jureček, 1910); tra i Leiodidae Cholevinae, i Leptodirini *Aphaotus granulatus*, *Halbherria cimbrica* e *Neobathyscia antrorum antrorum*, il Catopino *Catops subfuscus* Kellner, 1846. Tra il materiale non determinato figurano Ditteri, Collemboli, Opilioni del genere *Ischyropsalis* Koch, 1839, Acari, Pseudoscorpioni della famiglia Neobisiidae e del genere *Chthonius* Koch, 1843.

Speluncarius stefani e *Catops subfuscus* sono stati reperiti solamente prima del laghetto, mentre oltre a questo sono stati rinvenuti tutti i reperti del nuovo taxon; inoltre, sempre oltre il laghetto sono state numericamente maggiori le catture di *Orotrechus s. stephani* e di *Aphaotus granulatus*.

OSSERVAZIONI. L'evidentissima caratteristica del nuovo taxon (Fig. 2) si osserva immediatamente passando in rassegna i vari generi di Trechini attualmente noti (Jeannel, 1928; Casale & Laneyrie, 1982; Deuve, 1993; Monguzzi, 1993; Deuve, 2002; Belousov & Kabak, 2003; Quéinnec, 2008; Lohaj & Lakota, 2010; Townsend, 2010; Eberhard & Giachino, 2011; Tian *et al.*, 2014; Casale & Giachino, 2016; Deuve *et al.*, 2016; Lohaj *et al.*, 2016; Ortuño *et al.*, 2017; Tian, 2017; Tian *et al.*, 2017; Ćurčić *et al.*, 2018, 2018a; Delić *et al.*, 2019; Pavićević *et al.*, 2020; Tian & He, 2020); a titolo di esempio ho scelto un individuo di sesso maschile del Trechino sintopico *Orotrechus stephani stephani* comparando alcune sue parti anatomiche con quelle omologhe dell'Holotypus di *Cimbrodytes heterognathus* n. gen. n. sp. Con l'*Orotrechus* preso a modello intendo limitarmi alla morfologia tipica dei Trechini noti senza alcun riferimento a questioni filogenetiche, per le quali si renderebbe necessaria un'indagine molecolare, con esame del DNA.



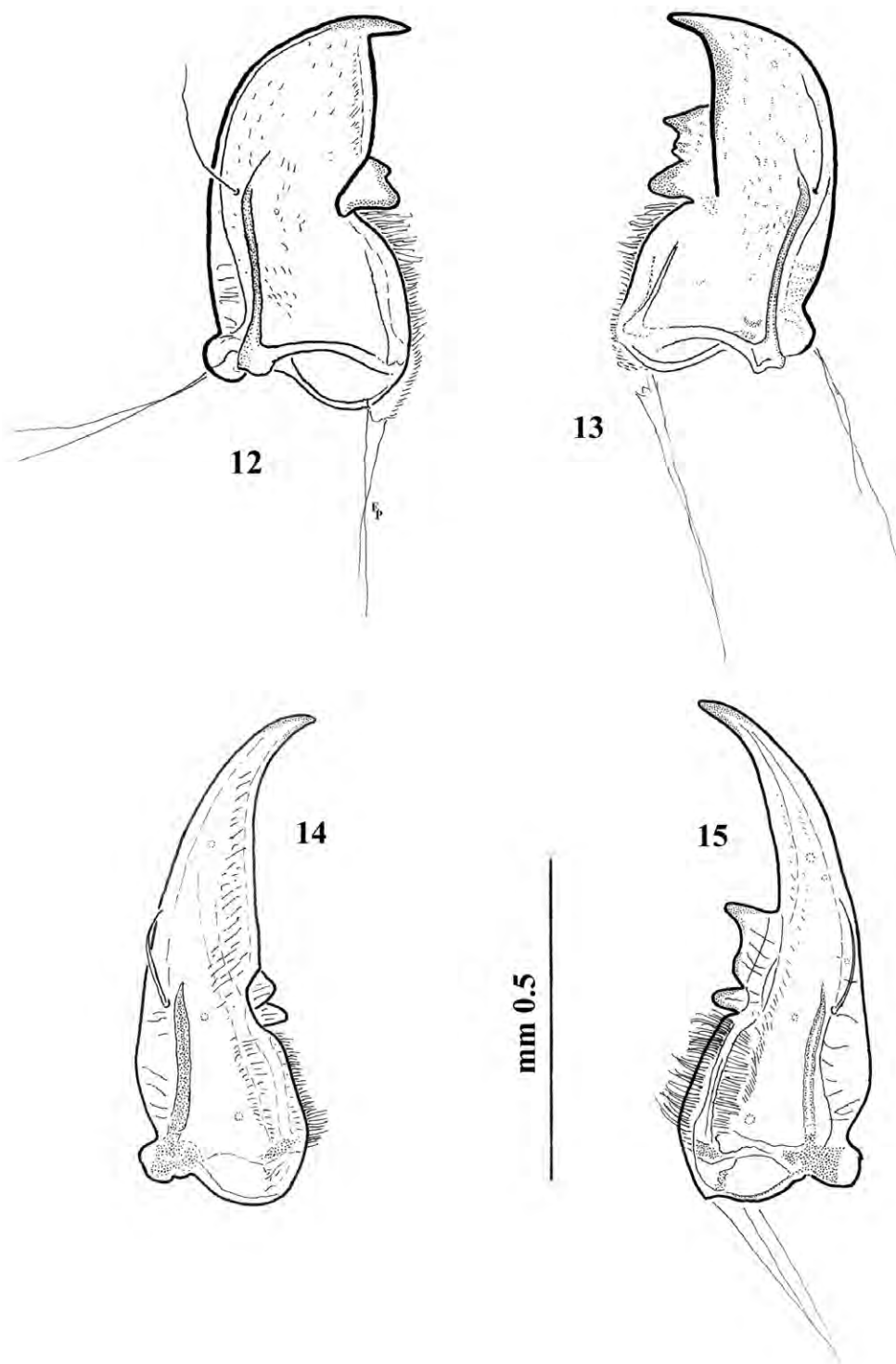
Figg. 3-8. *Cimbrodytes heterognathus* n. gen. n. sp., Holotypus ♂: 3 – cranio in visione dorsale; 4 – idem, in visione ventrale; 5 – protorace; 6 – elitre; 7 – sterniti addominali; 8 – antenna sinistra.



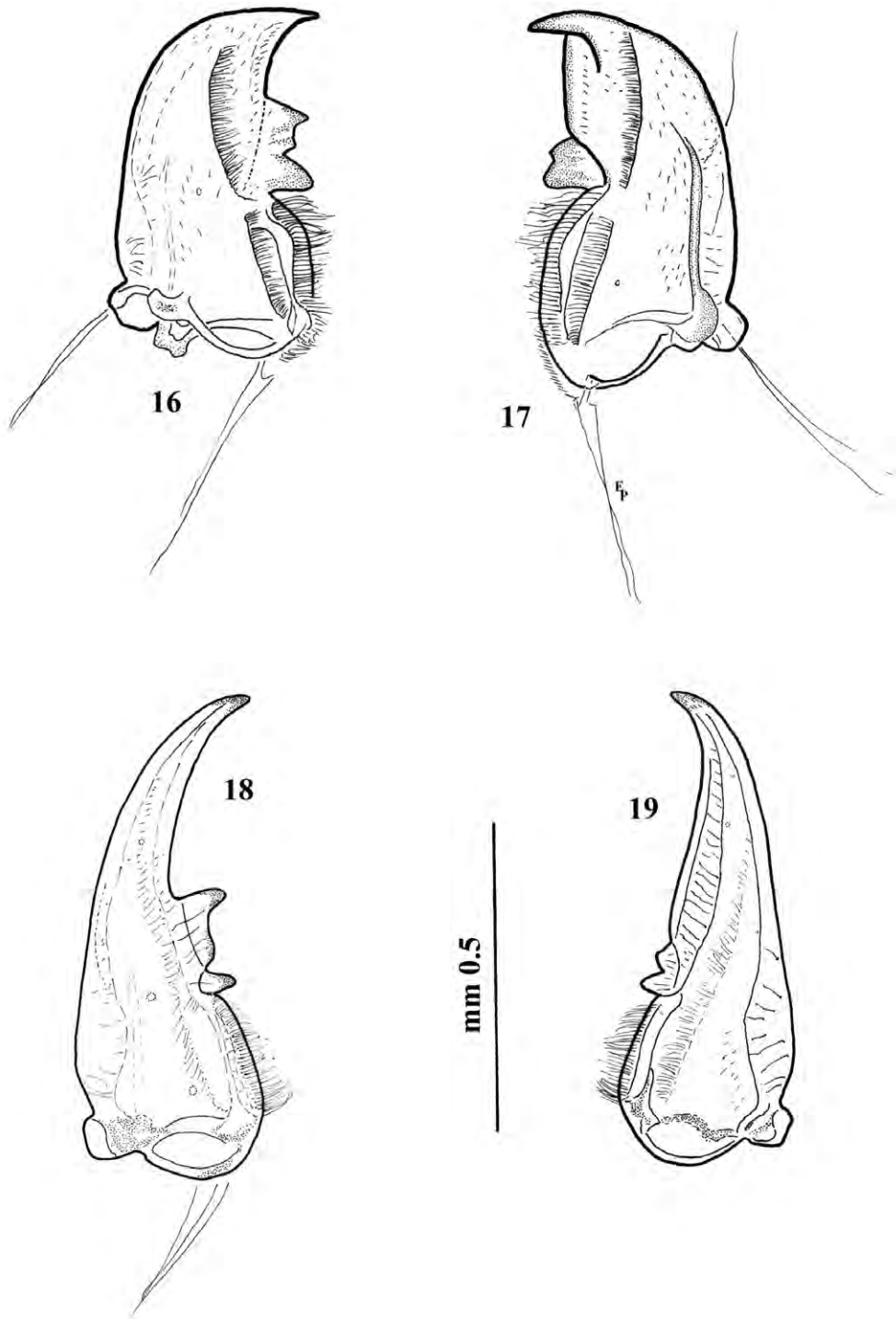
0.5 mm: fig. 11

0.3 mm: figg. 9, 10

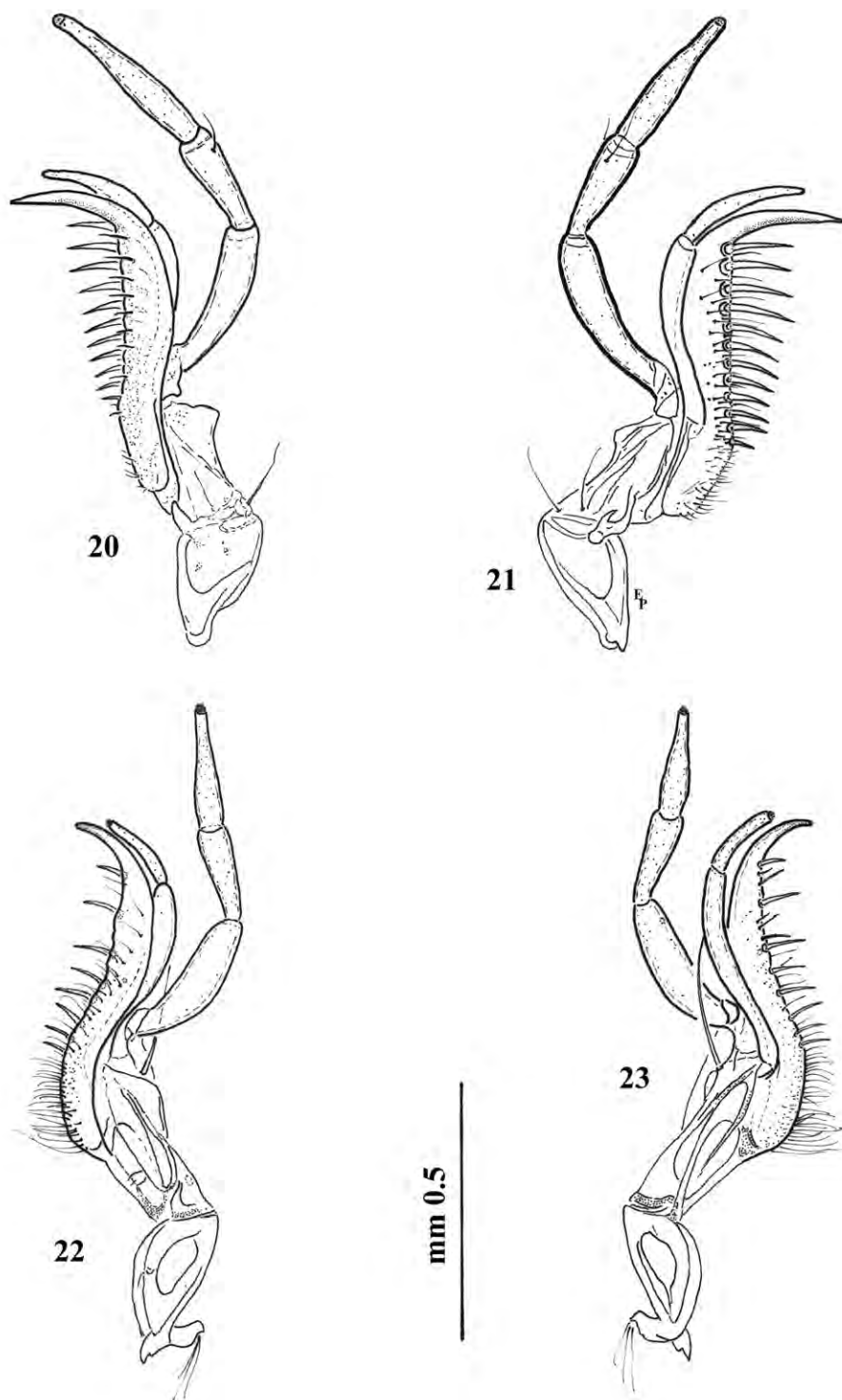
Figg. 9-11. *Cimbrodytes heterognathus* n. gen. n. sp., Holotypus ♂: 9 – labrum; 10 – ligula e paraglosse; 11 – palpo labiale sinistro in visione inferiore.



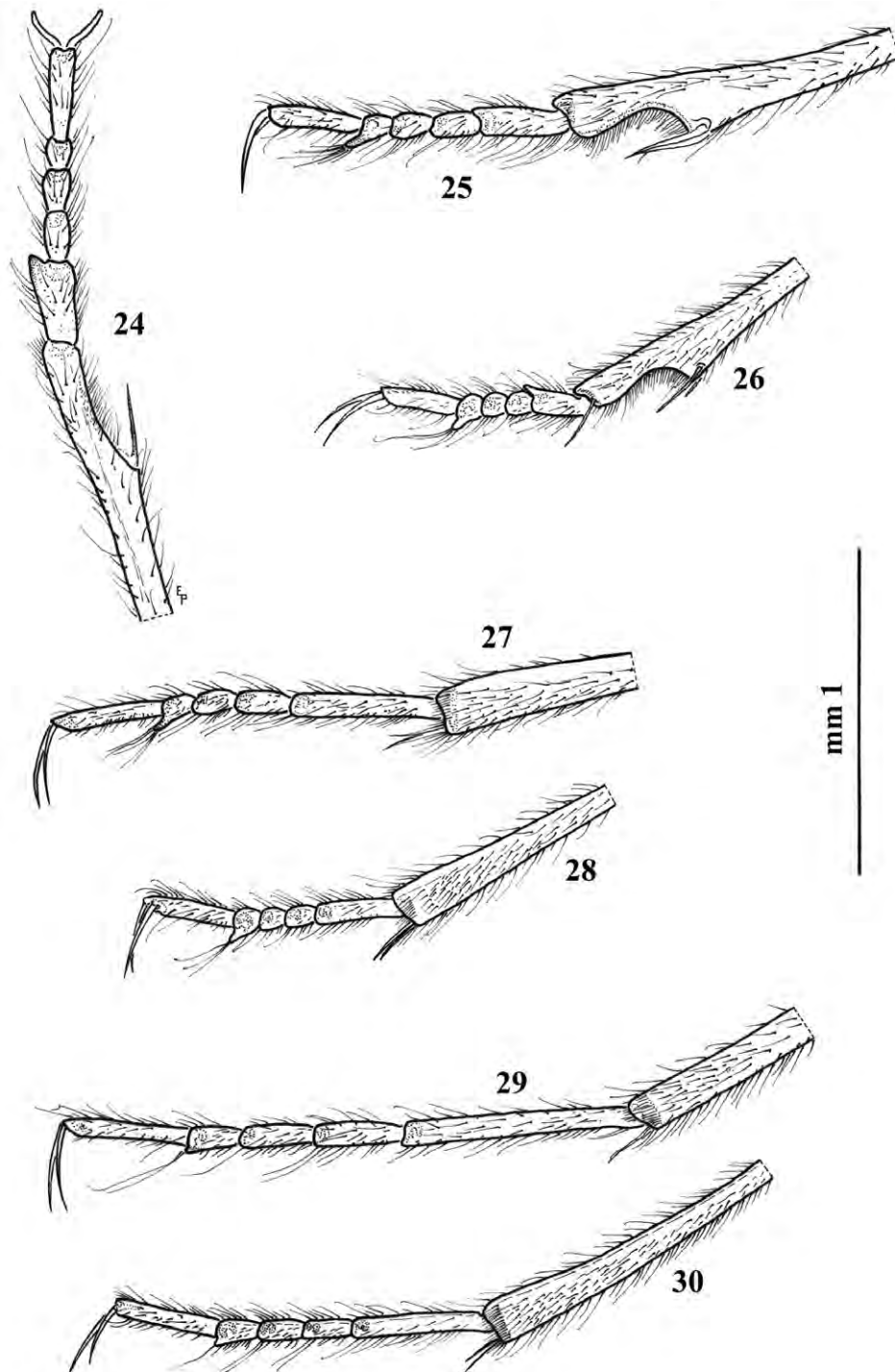
Figg. 12-15. *Cimbrodytes heterognathus* n. gen. n. sp., Holotypus ♂: 12 – mandibola sinistra in visione dorsale; 13 – mandibola destra in visione dorsale. *Orotrechus stephani stephani* (♂, Grotta Lago Bianco): 14 – mandibola sinistra in visione dorsale; 15 – mandibola destra in visione dorsale.



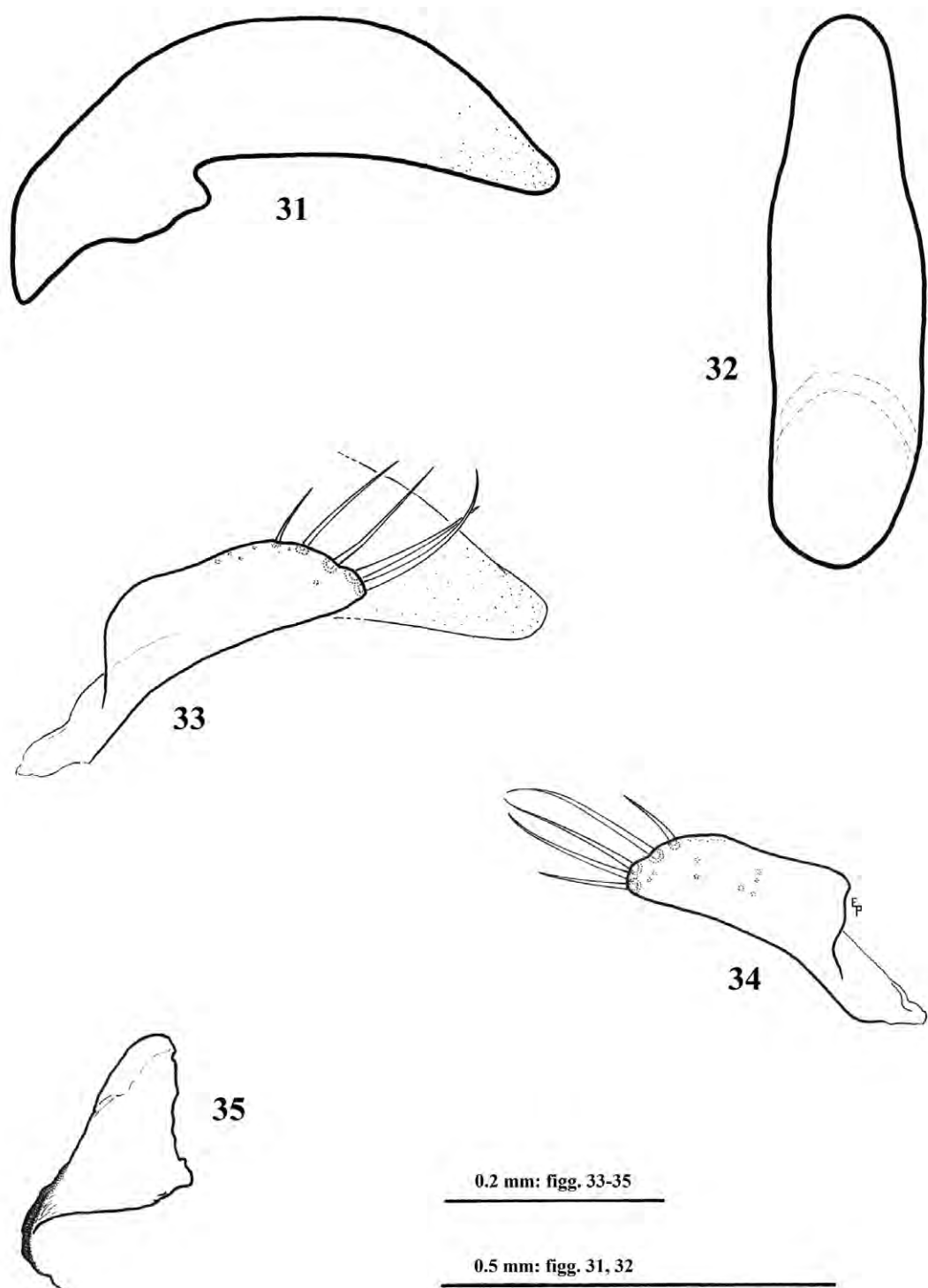
Figg. 16-19. *Cimbrodytes heterognathus* n. gen. n. sp., Holotypus ♂: 16 – mandibola destra in visione ventrale; 17 – mandibola sinistra in visione ventrale. *Orotrechus stephani stephani* (♂, Grotta Lago Bianco): 18 – mandibola destra in visione ventrale; 19 – mandibola sinistra in visione ventrale.



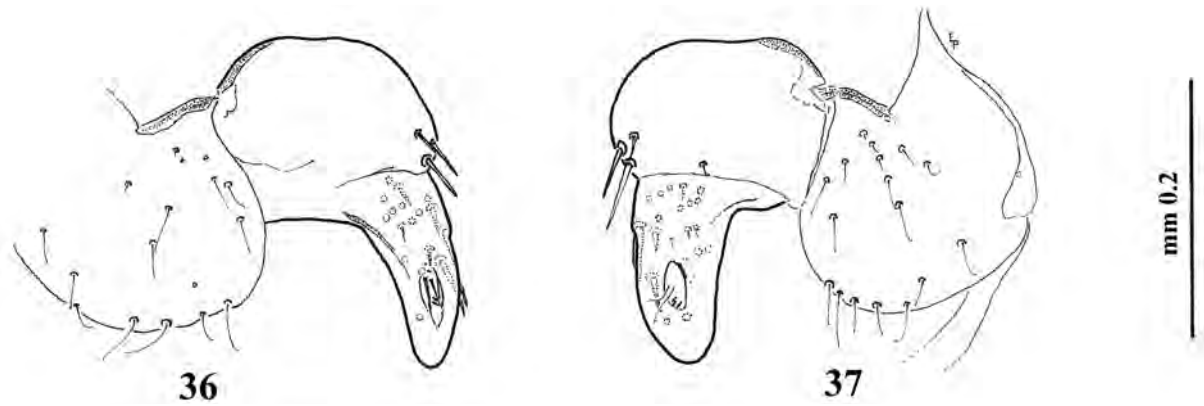
Figg. 20-23. *Cimbrodytes heterognathus* n. gen. n. sp., Holotypus ♂: 20 – mascella destra in visione dorsale; 21 – idem, in visione ventrale. *Orotrechus stephani stephani* (♂, Grotta Lago Bianco): 22 – mascella destra in visione dorsale; 23 – idem, in visione ventrale.



Figg. 24-30. *Cimbrodytes heterognathus* n. gen. n. sp., Holotypus ♂: 24 – apice protibia e protarso destri in visione dorsale; 25 – idem, in visione laterale; 27 – apice mesotibia e mesotarso destri in visione laterale; 29 – apice metatibia e metatarso destri in visione laterale. *Orotrechus stephani stephani* (♂, Grotta Lago Bianco): 26 – apice protibia e protarso destri in visione laterale; 28 – apice mesotibia e mesotarso destri in visione laterale; 30 – apice metatibia e metatarso destri in visione laterale.



Figg. 31-35. *Cimbrodytes heterognathus* n. gen. n. sp., Holotypus ♂: 31 – lobo mediano dell'edeago in visione laterale; 32 – idem, in visione dorsale; 33 – paramero sinistro in visione laterale; 34 – paramero destro in visione laterale; 35 – lamella copulatrice in visione dorsale.



Figg. 36-37. *Cimbrodytes heterognathus* n. gen. n. sp., paratypus ♀: 36 – gonostilo destro in visione ventrale; 37 – gonostilo sinistro in visione ventrale.



Figg. 38-44. Capo di: 38 – *Aphaenopidius kamnikensis kamnikensis* Drovenik, 1987 (♀, Kamniška jama, Slovenia); 39 – *Aphaenops leschenaulti* Bonvouloir, 1861 (♀, Grotte de Castel-Mouly, France); 40 – *Italaphaenops dimaioi* Ghidini, 1964 (♀, Abisso San Nazzaro, Italia); 41 – *Orotrechus schwienbacheri* Grottole & Martinelli, 1991 (♀, Grotte Vecchia Diga, Italia); 42 – *Pheggomisetes buresi* (Knirsch, 1923) (♀, Ledenika cave, Bulgaria); 43 – *Pheggomisetes globiceps breiti* Mandl, 1942 (♂, Cave Dinevata peshtera, Bulgaria); 44 – *Cimbrodytes heterognathus* n. gen. n. sp. (♂, paratypus).



Figg. 45-48. *Cimbrodytes heterognathus* n. gen. n. sp., paratypus ♂: 45 – capo in visione dorsale; 46 – idem, in visione ventrale. *Orotrechus stephani stephani* (♂, Grotta Lago Bianco): 47 – capo in visione dorsale; 48 – idem, in visione ventrale.

Ho messo a confronto le mandibole, la mascella destra, gli apici tibiali e i tarsi dell'Holotypus di *Cimbrodytes heterognathus* n. gen. n. sp. (rispettivamente Figg. 12-13, 16-17, 20-21, 24-25, 27 e 29) con le corrispondenti parti anatomiche di *Orotrechus stephani stephani* (rispettivamente Figg. 14-15, 18-19, 22-23, 26, 28 e 30). Non reputo necessario commentare in dettaglio le differenze tra le varie parti del corpo dei due reperti, essendo più che sufficiente osservarne i disegni; un particolare, tuttavia, merita di essere evidenziato: il tubercolo esistente sul lato inferiore del quarto articolo dei pro- e mesotarsi si ritrova, allo stato di abbozzo, anche sul lato inferiore del quarto metatarsomero (cfr. Figg. 29 e 30).

Nemmeno in Trechini macrocefali lo sviluppo e la forma delle mandibole varia sensibilmente in relazione all'ipertrofia del capo, come negli esempi illustrati nelle Figg. 38-43, mentre la situazione è ben diversa nel nuovo taxon (Fig. 44). Ulteriori esempi su questo tema figurano in letteratura (Casale & Vigna Taglianti, 1975; Monguzzi, 2011; Casale *et al.*, 2012; Tian *et al.*, 2016; Luo *et al.*, 2018).

Nell'ambito della famiglia Carabidae esistono numerosissime specie che presentano modificazioni nella struttura delle mandibole e ciò in relazione a modalità predatorie o specializzazioni alimentari particolari. Potrei menzionare alcuni rappresentanti del genere *Licinus* Latreille, 1802, a regime alimentare elicofago, dotati di mandibole brevi, robustissime e asimmetriche, atte ad incidere e aprire i gusci dei molluschi di cui si cibano (Brandmayr & Zetto Brandmayr, 1986; Brandmayr *et al.*, 2005).

Nel genere *Leistus* Frölich, 1799, predatore specializzato di Collemboli, le mandibole sono notevolmente ampie e concave inferiormente, mentre mascelle e gola presentano lunghe e robuste spine: l'azione combinata delle mandibole e delle spine formano ciò che viene definito "cestello di cattura", con il quale la preda viene ingabbiata ed immobilizzata (Brandmayr *et al.*, 2005).

Numerosi Carabidae elicofagi presentano un allungamento delle mandibole e un restringimento dell'avancorpo, definito dagli Autori "cicrizzazione", i cui tipici rappresentanti sono i Cychrini (Brandmayr *et al.*, 2005). Anche le specie del genere *Stomis* Clairville, 1806, non soggette a particolari specializzazioni predatorie note, possiedono mandibole allungatissime.

Infine vorrei ricordare, tra i Bembidiini Anillina (Jeannel, 1937), le ipertrofie mandibolari dei

generi *Anillus* Duval, 1851, *Scotodipnus* Schaum, 1860 e *Binaghites* Jeannel, 1937.

Tornando al nuovo taxon, si potrebbe ipotizzare che la modificazione mandibolare rappresenti un carattere adattativo a un regime alimentare sconosciuto, ma non lo si può asserire con certezza; presumo che la sola interpretazione possibile sia di considerare l'esclusività di quel carattere unico come un'autoapomorfia del nuovo genere, l'esito attuale di un processo evolutivo la cui genesi rimane del tutto ignota ed enigmatica. Un dato certo è che questa particolarità è priva di significato filogenetico.

La presenza del solo primo pro-tarsomero dilatato negli individui maschi colloca *Cimbrodytes heterognathus* nella linea filetica di *Neotrechus* (sensu Jeannel, 1928), mentre la combinazione di altri caratteri (labium saldato al prebasilare, gruppo omerale della serie di setole ombelicate disaggregato, tibie e tarsi pubescenti, edeago piccolo, semplice, con lobo mediano privo di bulbo basale distinto, lamella copulatrice ritorta, in posizione anisotopa, parameri brevi, lamellari, con alcune setole apicali in numero variabile) lo avvicina particolarmente al genere *Orotrechus* Müller, 1913; tale affermazione, inoltre, è avvalorata da puntuali considerazioni biogeografiche (Casale & Vigna Taglianti, 2005).

Le continue scoperte, in varie parti del mondo, di nuovi generi e nuove specie a molteplici gradi di troglomorfia, dovute principalmente a prospezioni capillari in territori nuovi o già indagati e a nuove tecniche di ricerca da parte di biospeleologi, hanno prodotto una tale ricchezza di dati che solo un'indagine molecolare ne può interpretare correttamente la filogenesi; molti studi condotti in quest'ottica (Faille *et al.*, 2010, 2011, 2013, per rimanere in ambito europeo) hanno permesso di confermare alcune importanti questioni, come l'origine monofiletica dei tre generi pirenaici *Aphaenops* Bonvouloir, 1861, *Hydrapphaenops* Jeannel, 1926 e *Geotrechus* Jeannel, 1919, e di conseguenza hanno prospettato l'esigenza di trasferire in altri contesti i molti generi attribuiti da vari autori alla linea filetica di *Aphaenops*, assegnazioni talvolta basate su una fuorviante somiglianza morfologica. A proposito dell'ampia gamma di tipologie morfologiche con le quali vengono definiti i generi ad elevato grado di troglomorfia concordo con quanto suggerito da Quéinnec (2008), che le raggruppa in un unico ed onnicomprensivo tipo afenopsiano.

Ai sorprendenti risultati degli studi su base molecolare citati più sopra, posso aggiungere che un ulteriore recentissimo lavoro (Faille *et al.*, 2019), rivela anche altre insospettabili realtà, come ad esempio le relazioni filetiche fra alcuni Trechini delle Alpi Dinariche ed elementi del Mediterraneo occidentale; sicuramente gli studi futuri sulla filogenesi di questi organismi ipogei contribuiranno a risolvere molti degli interrogativi che da sempre hanno impegnato gli studiosi e probabilmente non mancheranno sorprese.

Per ciò che riguarda gli stadi larvali, la forma del margine anteriore dell'epistoma (nasale) può offrire ottimi spunti nel riconoscere reali affinità filetiche, purché sia molto caratteristico, come nel caso di *Allegrettia* Jeannel, 1928 e *Italaphaenops* Ghidini, 1964: le larve dei due generi, infatti, presentano il nasale con un'apofisi pressoché identica, rivelandone l'indiscutibile parentela (Monguzzi, 2011). In moltissime altre larve di Trechini, invece, il nasale è molto simile e non possiede particolari conformazioni rendendo così problematica una chiara

attribuzione; a questo, infine, si aggiunge la difficoltà di reperimento di tali larve che ne avvalorano l'oggettiva impossibilità di utilizzo a scopi filogenetici.

RINGRAZIAMENTI

Ringrazio tutti coloro che in varia misura hanno contribuito alla stesura di questo lavoro: i soci del Gruppo Grotte Valdagno CAI Bianco Dante, Cocco Moreno, Dalle Tezze Luca, Falsirollo Paolo, Sbicego Daniela, Tomasi Michele, Urbani Francesco, Urbani Paolo, Viola Tiziano e Zarantonello Giuseppe, per le ricerche sul campo; Casale Achille (Università di Sassari), per i validi suggerimenti; Poggi Roberto (Museo Civico di Storia Naturale "G. Doria", Genova) per i consigli avuti; Paolo Mietto (responsabile del Catasto Speleologico Veneto) per le preziose informazioni; il Club Speleologico Proteo di Vicenza, per il parziale contributo finanziario destinato alle ricerche biospeleologiche; i due anonimi revisori che pazientemente hanno revisionato criticamente il manoscritto.

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**Il genere *Duvalius* nell'isola di Creta,
con descrizione di *Duvalius (Duvalius) augusti* specie nuova
(Coleoptera Carabidae Trechinae)¹**

Riassunto: Gli Autori descrivono *Duvalius (Duvalius) augusti* nuova specie, con località tipica e unica nota finora: la grotta Spilia Kronio (=Trapeza Cave), sita a 940 m s.l.m. (Lassithi, Tzermiadio), nel massiccio orientale del Dikti nell'isola di Creta (Grecia). Il nuovo taxon è attribuibile al gruppo di *Duvalius sbordonii* Vigna Taglianti, Genest & Sciaky, 1980 come definito dagli Autori in precedenti contributi sul genere *Duvalius* in Grecia, e presenta in particolare affinità nei confronti di *D. passaueri* Lebenbauer, 2005, presente nel medesimo massiccio.

Da tutte le specie del gruppo è marcatamente distinta per numerosi caratteri esterni e per la diversa struttura dell'edeago e della lamella copulatrice. Tali caratteri sono descritti e illustrati in dettaglio nel presente contributo, con note sul livello di specializzazione delle differenti specie nei confronti dell'ambiente sotterraneo.

Alcuni dati sulla paleogeografia e la zoogeografia di Creta sono riportati, che confermano un'origine nord-occidentale di tale gruppo di specie, che trova apparenti affinità nei confronti di *D. taygetanus* Casale, 1979, specie isolata e localizzata nel massiccio del Taygeto in Peloponneso.

Abstract: *The genus Duvalius in Crete, with description of Duvalius (Duvalius) augusti sp. n. (Coleoptera Carabidae Trechinae).*

Duvalius (Duvalius) augusti new species is described from the type locality and the only so far known locality: the Spilia Kronio cave (=Trapeza Cave), located at 940 m a.s.l. (Lassithi, Tzermiadio), in the eastern Dikti massif in Crete island (Greece). The new taxon belongs to the *Duvalius sbordonii* Vigna Taglianti, Genest & Sciaky, 1980 species group, in the sense of the authors as defined in previous contributions on *Duvalius* from Greece. In particular, it is close to *D. passaueri* Lebenbauer, 2005, living in the same massif.

From all other species of this group it is markedly distinct both by several external morphological features and the different shape of aedeagus and copulatory piece. All these features are described and illustrated in detail in this contribution, with notes on the different degrees of specialisation to the subterranean environment of the different species.

Some data on the paleogeography and zoogeography of Crete are also reported, which confirm a north-western origin of this species group, apparently related to *D. taygetanus* Casale, 1979, an isolated species endemic to the Taygetos massif in Peloponnesos.

Key words: Coleoptera, Carabidae, Trechinae, *Duvalius augusti* new species.

To meet the requirements by the International Code of Zoological Nomenclature (ICZN), this article was registered at ZooBank (31 March 2021) under the ZooBank Life Science Identifier (LSID): CA8BB08C-DCEB-48EF-B3B9-E312132F7C74.
Published: 23 April 2021.

INTRODUZIONE

La straordinaria diversità del genere *Duvalius* Delarouzée, 1859 (Coleoptera Carabidae Trechinae) in Grecia è ben nota da tempo grazie ad un'ampia letteratura (cfr. fra gli altri Jeannel, 1928, 1929; Scheibel, 1937, e per una sintesi recente, successivamente incrementata, Casale, 2011).

Ciononostante, la scoperta della presenza di specie del genere *Duvalius* nell'isola di Creta ha una storia relativamente recente. Fino all'inizio degli anni '80 del secolo corso, infatti, non era descritta per l'isola alcuna specie appartenente a questo genere, malgrado lo stesso

Jeannel (1929) citasse un paio di elitre rinvenute da H. Wichmann a Creta nella grande "Katavothra" (= inghiottitoio) dell'altipiano di Omalos.

La conferma della presenza nell'isola di *Duvalius* si deve a Valerio Sbordoni, che visitò Creta nel 1974, nell'ambito delle indagini sulle faune ipogee del Vicino Oriente promosse dall'Università di Roma "La Sapienza" in collaborazione con il Circolo Speleologico Romano. Sbordoni affidò in studio l'unico esemplare raccolto, una femmina, al compianto Augusto Vigna Taglianti, che attese la disponibilità di altri materiali prima di procedere alla sua descrizione.

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¹ Results of the program "Research Missions in the Mediterranean Basin" sponsored by the World Biodiversity Association onlus. XLVI contribution.

Altri materiali furono successivamente raccolti, verso la fine dello stesso anno, dai biospeleologi bulgari P. Beron e V. Beskov e anche, nel 1979, da R. Sciaky. Lo studio di questi materiali portò alla descrizione di *Duvalius sbordonii* Vigna Taglianti, Genest & Sciaky, 1980 con località tipica Omalos, Inghiottoio di Tzani, nel massiccio montuoso del Lefka Ori.

Passarono diversi anni prima che, nel 1991, Harald Mixanig scoprisse la seconda specie, *D. mixanigi* Daffner, 1993 nella Grotta Mithia Kabathura sita sull'Oros Ídi. La presenza di due specie di *Duvalius* su due dei tre massicci montuosi più elevati dell'isola orientò le successive ricerche – svolte in particolare dagli entomologi austriaci Harald Mixanig, Uwe Passauer e Thomas Lebenbauer – verso il terzo massiccio più elevato, quello dell'Oros Díkti. Su questo massiccio, in un piccolo inghiottitoio sul margine NW del polje di Lassithi, Harald Mixanig raccolse infine, nel 2004, una terza specie, *D. passaueri* Lebenbauer, 2005.

Nel giugno 2016 due degli autori (PMG e DV), con lo scopo di estendere all'isola di Creta le tecniche di raccolta in ambiente sotterraneo già applicate in Grecia continentale (Giachino & Vailati, 2010), visitarono l'isola posizionando circa 400 trappole sia in MSS sia in grotta. Nel tentativo di reperire *D. passaueri*, cercato invano il piccolo inghiottitoio che costituisce la località tipica, posizionarono una serie di trappole in una piccola cavità presso l'abitato di Tzermiadi. La cavità, indicata in loco da cartelli turistici col nome di Trapeza Cave (= Grotta della Banca), è indicata sulle carte anche con il nome di Chronio Cave (= Grotta di Chronos, il padre di Zeus).

Queste trappole, recuperate nel 2018, hanno permesso il reperimento di un esemplare di sesso maschile di *Duvalius*, attribuito in prima istanza a *D. passaueri*, la cui località tipica dista solo 4 km in linea d'aria. Grande è stata la sorpresa quando il successivo esame in laboratorio ha rivelato che l'unico esemplare raccolto apparteneva ad una specie diversa e inedita, la cui descrizione costituisce uno degli scopi del presente contributo. La descrizione della nuova specie fornisce anche l'occasione per rivedere e uniformare descrizioni e iconografie di tutte le specie di *Duvalius* attualmente note dell'isola.

MATERIALI E METODI

I genitali maschili sono stati dissezionati, disidratati in etanolo, chiarificati in KOH al 5% a freddo e montati in Balsamo del Canada su supporto di ace-

tato con l'utilizzo di uno stereomicroscopio Wild M3. Successivamente, muniti di numero di riferimento ai disegni originali conservati nell'archivio di uno degli autori (DV), i preparati sono stati spillati direttamente sotto all'esemplare di riferimento.

I disegni al tratto degli esemplari e dei preparati microscopici sono stati realizzati rispettivamente con un microscopio stereoscopico Wild M3 munito di oculare con reticolo micrometrico e con un microscopio ottico Leitz Dialux equipaggiato con camera lucida.

Acronimi

CCa:	Collezione Achille Casale, Torino (Italia).
CGi:	Collezione Pier Mauro Giachino, San Martino Canavese (TO) (Italia).
CVa:	Collezione Dante Vailati, Brescia (Italia).
HT:	holotypus
PT:	paratypus
L:	lunghezza dall'apice delle mandibole all'apice delle elitre.
TL:	lunghezza dal clipeo all'apice delle elitre.
LA:	lunghezza antenna
PL/PMW:	rapporto lunghezza/larghezza del pronoto
EL/EW:	rapporto lunghezza/larghezza delle elitre

RISULTATI

Duvalius sbordonii Vigna Taglianti, Genest & Sciaky, 1980

(Figg. 1, 2, 9, 13)

LOC. TYP.: Creta, Omalos, inghiottitoio di Tzani, m 1040.

MATERIALE ESAMINATO. 1 ♀, Graecia, Kreta, nomos Chanion, Lefka Ori, Omalos, Tripa Tzani, m 1040, 21.5.1991, leg. H. Mixanig, *Duvalius sbordonii* V.G.S. det. Daffner 1992 (CGi); 4 ♂♂ 3 ♀♀ + resti di 3 ♂♂ e 6 ♀♀, Grecia, Creta, Chania, Omalos, Tripa Tzani, N35°20'57.3" E23°54'27.8", 1040 m, 1.VI.2016/12.VI.2018, Giachino & Vailati leg. (CGi, CVa); 1 ♂, Kreta, nomos Chanion, Lefka Ori, Omalos, Tripa Vroules, 1200 m, 20.5.1991, leg. H. Mixanig (CCa).

NOTE. L'esemplare di *D. sbordonii* in CCa è etichettato come proveniente dalla "Tripa Vroules", sita a 1200 m di quota, che corrisponde al dato riportato nel contributo di Lebenbauer (2005). Non è chiaro se si tratti di un secondo nome della Tripa Tzani o di un'altra grotta: in merito, non siamo riusciti a trovare indicazioni. Stando ai dati riportati da

Mixanig, fra le due grotte ci sarebbe una differenza di quota di 160 metri.

La descrizione originale di Vigna Taglianti *et al.* (1980) appare molto accurata e non riteniamo necessario procedere, in questa sede, ad una ridescrizione. Consideriamo sufficiente, per uniformità di trattamento e confronto con le altre specie, fornire i disegni di habitus e genitali maschili.

***Duvalius mixanigi* Daffner, 1993**

(Figg. 3, 4, 10, 14)

LOC. TYP.: Graecia, Kreta, Nomós Rethimnou, Oros Idhi, Nidha Hochfläche, Tripa Mithia Kabathura, 1320 m.

MATERIALE ESAMINATO. 1 ♂, Graecia, Kreta, nomos Rethimnou, Oros Idhi, Nidha, Tripa Mithia Kabathura, 1320 m, 23.5.1993, leg. H. Mixanig, *Duvalius mixanigi* Daffn., det. Daffner 1993 (CCa); 1 ♂, Graecia, Kreta, Nomós Rethimnou, Oros Idhi, Nidha, Tripa Mithia Kabathura, 1320 m, 4.8.2000, leg. H. Mixanig, *Duvalius mixanigi* det. A. Gitzen (CGi).

NOTA. La descrizione originale di Daffner (1993) è sufficientemente accurata e non riteniamo necessario procedere, in questa sede, ad una ridescrizione: riteniamo sufficiente fornire i disegni di habitus e genitali maschili che nella descrizione originale appaiono eccessivamente schematici.

È opportuno precisare che, a differenza di quanto dichiarato nella descrizione originale, la grotta "Tripa Mithia Kabathura" non si trova sull'altopiano di Nidha, ma a una decina di chilometri a WNW da questo, sul versante W dell'Oros Ídi (= Psiloritis).

***Duvalius passaueri* Lebenbauer, 2005**

(Figg. 5, 6, 11, 15)

LOC. TYP.: Griechenland, Kreta, Prov. Iráklío, Oroseira Dikti, Lasithiou, Kleine Schwinde, 820 m.

MATERIALE ESAMINATO. 1 PT ♂, GR., Kreta, Prov. Iráklío, Oroseira Dikti, Lasithiou, kleine Schwinde, 820 m, 16 u 17.VII.04, leg. H. Mixanig. Paratypus, *Duvalius (Duvalius) passaueri* sp. nov., det. T. Lebenbauer 2004 (CCa); 1 ♂, Graecia, Kreta, Oros Dikti, Lasithi, 820 m, Nebenschwunde, 23.7.1997, leg. H. Mixanig, *Duvalius passaueri* Coll./det. A. Gitzen (CGi).

NOTA. La descrizione originale di Lebenbauer (2005) è sufficientemente accurata e non riteniamo necessario procedere, in questa sede, ad una ridescrizione: riteniamo sufficiente fornire i disegni di habitus e genitali maschili che nella descrizione originale appaiono eccessivamente schematici.

***Duvalius (Duvalius) augusti* n. sp.**

(Figg. 7, 8, 12, 16)

urn:lsid:zoobank.org:act:

AD7F45E6-2B45-44CD-B532-81F273972D3D

LOC. TYP.: Grecia, Creta, Lassithi, Tzermiado, Spilia Kronio, N35°11'48.9" E25°29'47.4", 940 m.

MATERIALE TIPICO: HT ♂, Grecia, Creta, Lassithi, Tzermiado, Spilia Kronio, N35°11'48.9" E25°29'47.4", 940 m, 4.V.2016/13.VI.2018, Giachino & Vailati leg. (CGi).

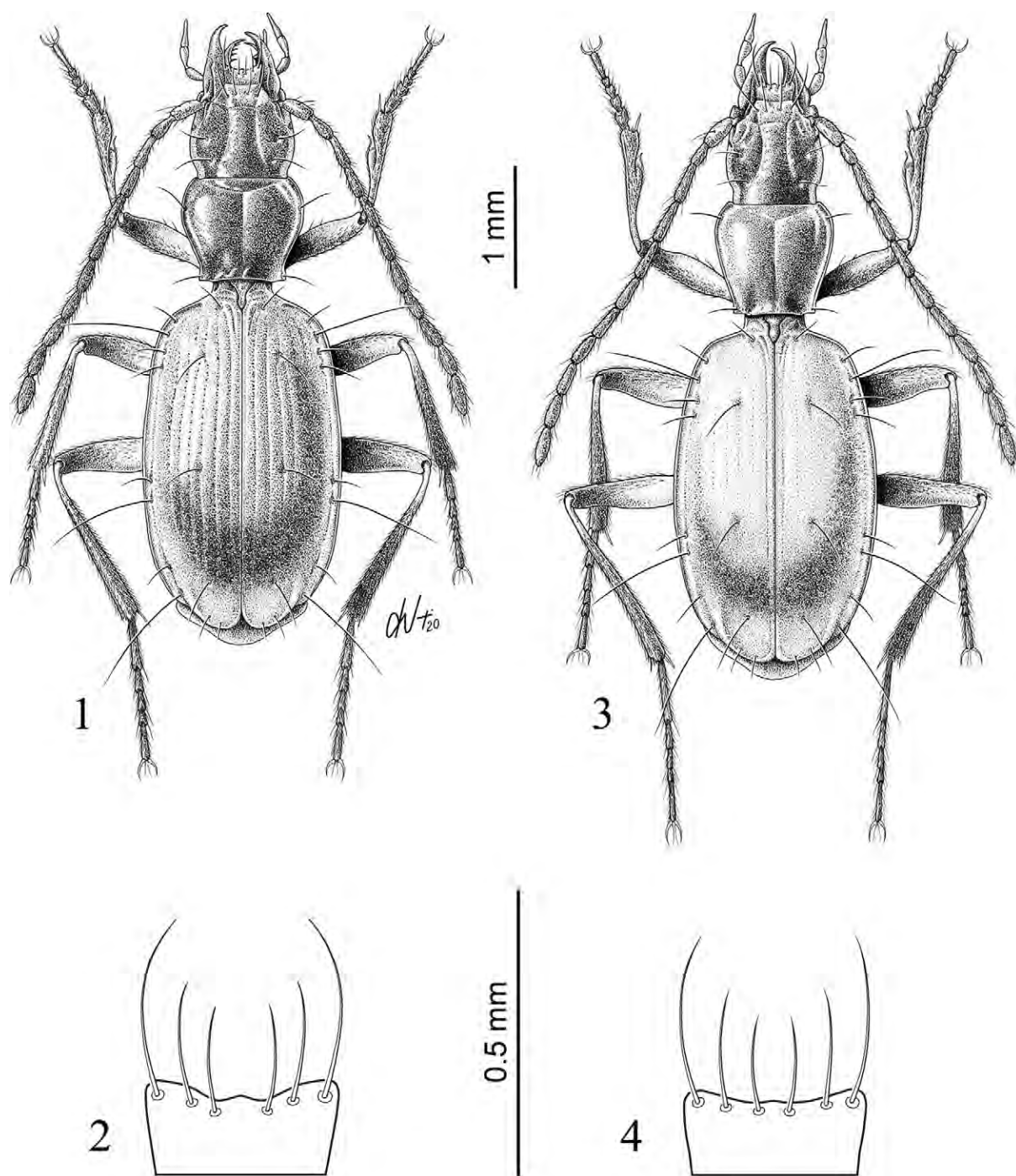
DIAGNOSI. Un Trechino anoftalmo, depigmentato, di colore fulvo uniforme, con tegumenti lucidi, glabri senza tracce di micro-setole sugli intervalli elitrali, ascrivibile a *Duvalius* del Subgen. *Duvalius* (nel senso di Jeannel, 1928) per lo stato complessivo dei caratteri: protibie pubescenti, pori 1-4 del gruppo omerale della serie ombelicata delle elitre allineati lungo la doccia marginale e circa equidistanti, tarsi anteriori nel maschio con due primi articoli dilatati e dentati sul lato interno, lamella copulatrice "isotopa", uniloba all'apice.

Pronoto a lati lungamente e regolarmente arcuati, appena sinuati prima degli angoli posteriori che sono retti, vivi ma non salienti all'esterno. Elitre strette e allungate, sub-convexe, con strie interne 1-4 evidenti, molto profonde e punteggiate; strie esterne meno impresse ma evidenti.

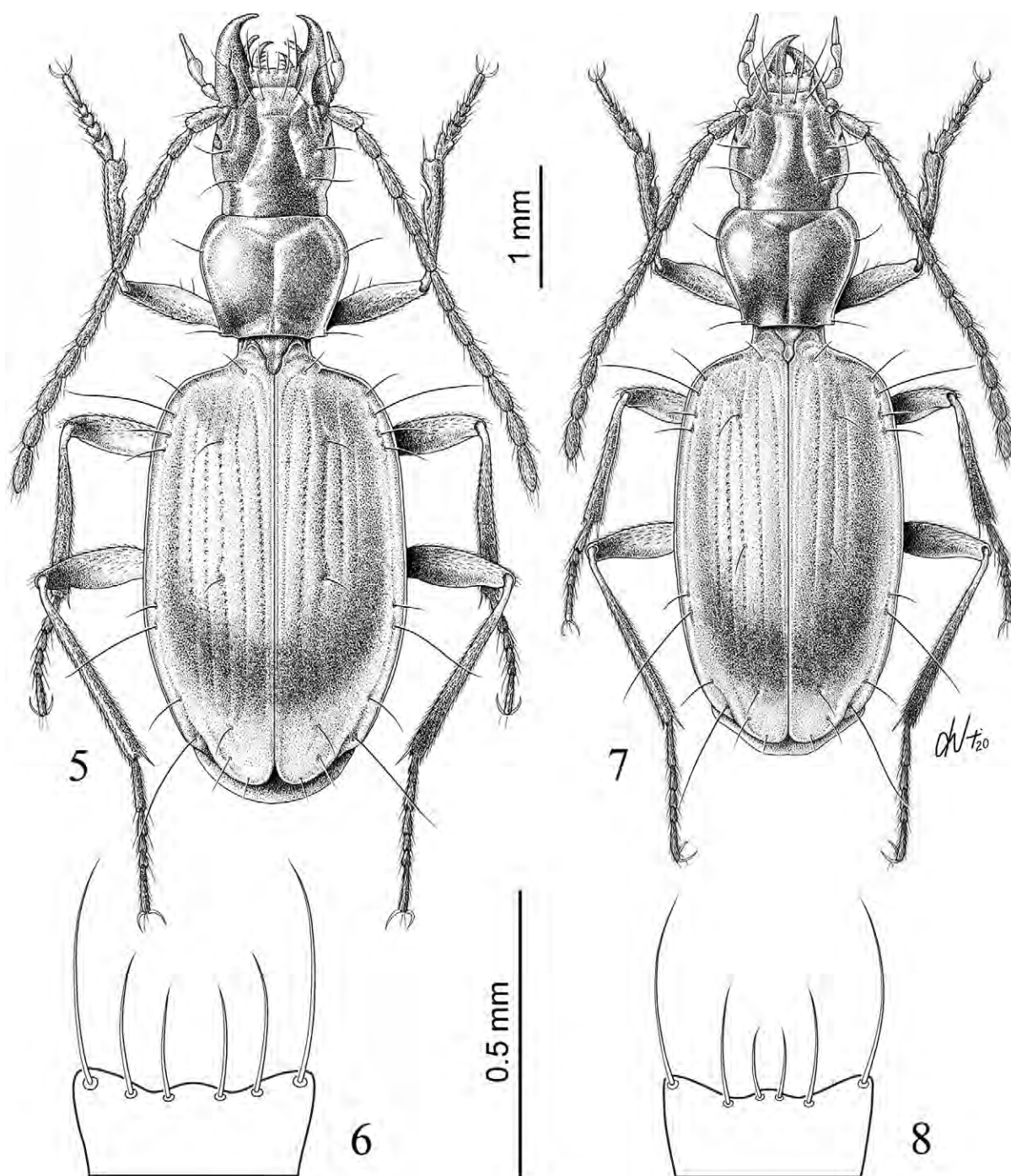
Genitali maschili come in Figg. 12 e 16.

Genitali femminili sconosciuti.

Chiaramente attribuibile al gruppo di *D. sbordonii* proprio di Creta come definito da Casale *et al.* (1996), e simile nella morfologia esterna a *D. passaueri* (più vicina geograficamente) per le dimensioni relativamente grandi, le strie elitrali molto profonde e profondamente punteggiate e gli intervalli elitrali interni subconvessi, ma ben distinto da quest'ultima specie per le dimensioni minori (L mm 5.78 in *augusti* sp. n., 6.0-6.40 in *passaueri*), per la diversa disposizione delle setole sul margine anteriore del labrum, con le quattro mediane distintamente raggruppate (Figg. 6-8), per le elitre più brevi, con omeri più arrotondati, e per gli occhi totalmente svaniti (una macula oculare ellittica, bianca e traslucida, con bordo nettamente scuro, è ancora ben visibile in *D. passaueri*). Da tutte le specie di *Duvalius* note di Creta, è infine marcatamente distinta per la diversa conformazione del lobo mediano dell'edeago (Figg. 9-16) e della lamella copulatrice (Figg. 9-11). *D. augusti* n. sp. è inoltre facilmente distinguibile, per le maggiori dimensioni, sia da *D. sbordonii* (L mm 4.1-4.9) sia da *D. mixanigi* (L mm 5.0-5.1).



Figg. 1-4. *Duvalius sbordonii* Vigna Taglianti, Genest & Sciaky, 1980: 1 – habitus, 2 – labbro; *Duvalius mixanigi* Daffner, 1993: 3 – habitus, 4 – labbro.



Figg. 5-8. *Duvalius passaueri* Lebenbauer, 2005: 5 – habitus, 6 – labbro; *Duvalius augusti* n. sp: 7 – habitus, 8 – labbro.

DESCRIZIONE DELL'HT ♂. Habitus come in Fig. 8. L: 5.78 mm; TL: 5.36 mm.

Colore fulvo uniforme. Tegumenti lucidi. Microscultura evidente, in maglie reticolari fitte, sulla fronte, sul collo e sulla parte anteriore del pronoto; appena percettibile, in maglie trasversali, sul disco del pronoto e svanita sulle interstrie delle elitre.

Corpo allungato, convesso, glabro con tempie glabre, privo di tracce di micro-pubescentia allineata sugli intervalli elitrati.

Capo allungato ma robusto; tempie convesse, arcuate, bruscamente ristrette sul collo. Margine anteriore dell'epistoma e solco clipeo frontale rettilinei. Solchi frontali completi, più profondi nel tratto compreso fra il clipeo e l'inserzione della setola sopraorbitale posteriore, con rughe superficiali estese sul lato esterno della fronte. Setole sopraorbitali disposte su due linee lievemente convergenti all'indietro. Cicatrici oculari molto ridotte ma distinte, sotto forma di bande oblique biancastre al centro. Antenne moderatamente allungate, non gracili (LA: 3.21 mm), raggiungenti distese all'indietro l'apice del terzo basale delle elitre. Mandibole allungate; labbro superiore con margine anteriore bisinuato, trilobo, munito di 6 setole, con le 4 centrali distintamente raggruppate (Fig. 8).

Pronoto trasverso (PL/PMW: 0.81), con massima larghezza circa al quarto anteriore, con margini laterali poco rilevati, lungamente arcuati nella metà anteriore, subrettilinei nella metà posteriore, bruscamente sinuati appena prima degli angoli posteriori che sono retti, vivi e non salienti all'esterno. Angoli anteriori arrotondati, appena prominenti; margine anteriore sub-rettilineo e margine basale distintamente smarginato lateralmente. Doccia laterale stretta ma evidente; disco moderatamente convesso, superficialmente rugoso; solco mediano profondo, completo; solco basale superficiale. Area basale priva di rugosità longitudinali; fossette basali piccole ma profonde, aperte anteriormente sul disco del pronoto. Setole marginali anteriori inserite nel punto di massima larghezza, latero-basali anteriormente agli angoli basali.

Elitre strette e moderatamente allungate (EL/EW: 1.12), sub-convesse, appena allargate al centro; doccia laterale ampia; omeri arrotondati ma angolosamente indicati. Strie tutte visibili, punteggiate, più distinte e profonde le interne 1-4; tutte risultano svanite nella regione distale dell'elitra,

posteriormente al poro preapicale. Striola basale profonda; stria ricorrente apicale arcuata, diretta verso il prolungamento ideale della 5° stria. Intervalli elitrati più interni subconvessi, piani quelli più esterni. Carena apicale sviluppata. Chetotassi: gruppo omerale di quattro pori setigeri circa equidistanti, addossati alla doccia marginale; 5° e 6° poro ravvicinati fra loro, addossati alla doccia laterale, e inseriti posteriormente al punto di massima larghezza delle elitre. Tre pori discali sulla stria 3 (due, più poro preapicale), il secondo inserito circa a metà della lunghezza dell'elitra. Triangolo apicale senza particolari caratteristiche, come da Fig. 7.

Zampe allungate ma robuste; tibie anteriori pubescenti, solcate. Due primi articoli dei protarsi nei maschi regolarmente dilatati e dentati sul margine interno.

Sterni addominali IV-VII ciascuno con una setola posteriore per lato.

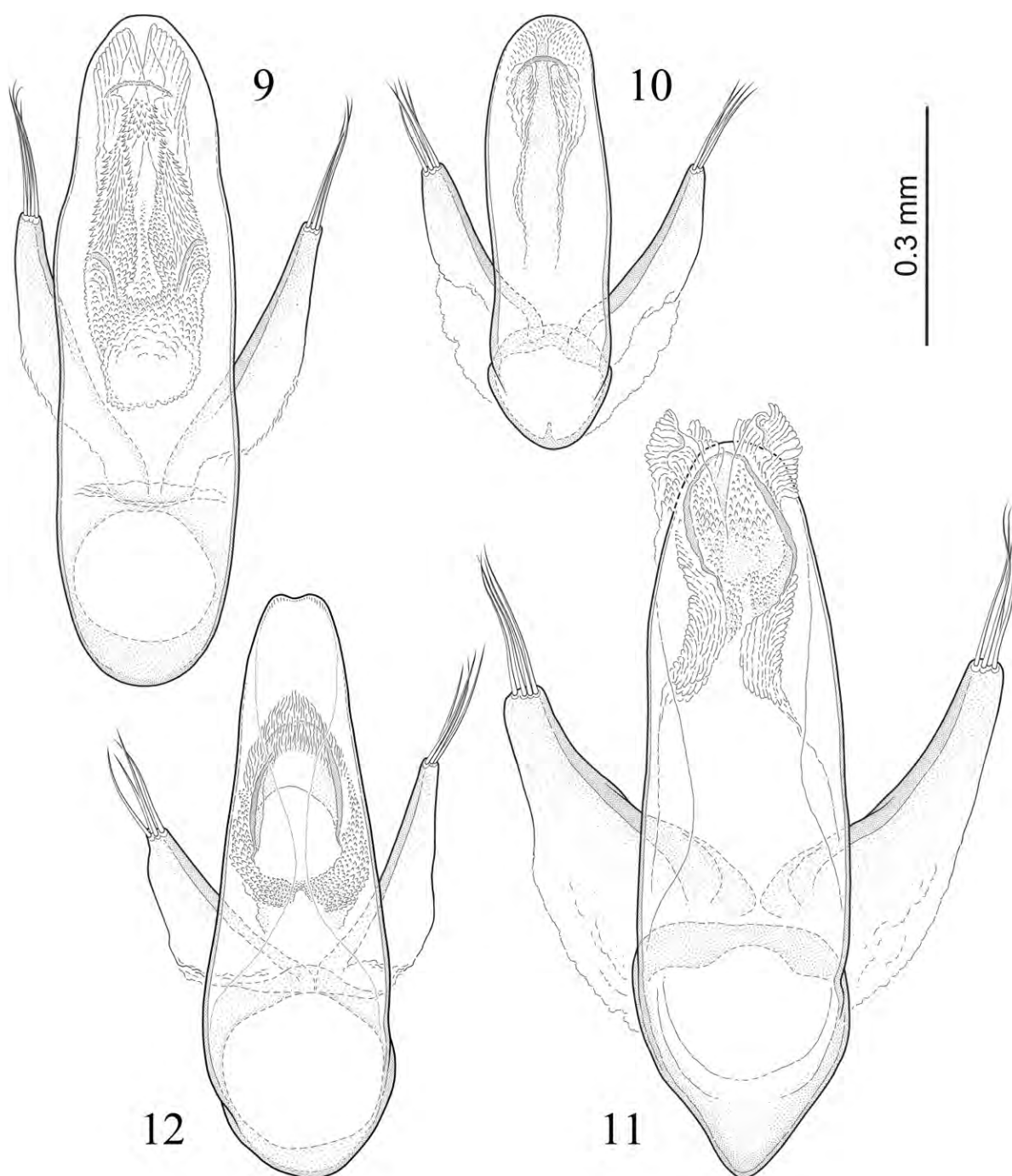
Genitali maschili come in Figg. 12 e 16. Lobo mediano dell'edeago relativamente piccolo, tozzo, con margine ventrale poco arcuato e apice non flesso sul lato ventrale in visione laterale; in visione dorsale subtruncato e lievemente inciso a U; bulbo basale poco sviluppato, caudato, privo di carena sagittale, con lati dell'orifizio basale arcuati, non smarginati. L'orifizio apicale presenta un'ampia apertura distale, prolungata nella regione mediana. Parameri moderatamente allungati, ciascuno con 4 setole apicali.

Endofallo con armatura costituita da una lamella copulatrice grande, ogivale, non bilobata, circondata da tutti i lati da estesi fasci di scaglie spinose (Fig. 12).

Femmina sconosciuta.

DERIVATIO NOMINIS. Dal latino *Augustus* – *i*, genitivo singolare di Augusto, dedicato alla memoria dell'amico e maestro Augusto Vigna Taglianti che dedicò, fra le altre attività, molte energie allo studio dei carabidi sotterranei del Mediterraneo orientale, Creta e Vicino Oriente compresi. Augusto fu, fra l'altro, uno dei descrittori di *D. sbordonii*, prima specie nota di *Duvalius* dell'isola di Creta.

DISTRIBUZIONE ED ECOLOGIA. *D. augustii* n. sp. è nota finora della sola località tipica, la grotta Kronio (=Trapeza Cave), sita a 940 m s.l.m. presso Tzermiadi, sull'altopiano di Lassithi (Creta), dove è



Figg. 9-12. Edeago in visione dorsale di 9 – *Duvalius sbordonii*, 10 – *D. mixanigi*, 11 – *D. passaueri*, 12 – *D. augusti* n. sp.

stata scoperta mediante trappole innescate con formaggio lasciate in sito per due anni. Si tratta di una piccola cavità fossile, relativamente secca, con sviluppo complessivo di circa 50 m. L'unico altro coleottero presente nella cavità è risultato essere l'interessante Carabide Pterostichino *Speluncarius pasquinii* Cerruti, 1973.

AFFINITÀ. Come evidenziato nella diagnosi, la nuova specie qui descritta si inserisce nel gruppo di specie di *Duvalius sbordonii* come definito da Casale *et al.* (1996) e Casale (2011), caratterizzate da corpo glabro con tempie glabre, da *labrum* trilobo (con margine anteriore prominente al centro, carattere condiviso peraltro da altre specie della Grecia continentale, quali *D. milenae* Casale, 1983, del gruppo *krueperi*), da lobo mediano dell'edeago semplice, tozzo, privo di carena sagittale, moderatamente arcuato, arrotondato o subtroncato all'apice, da parameri ciascuno con quattro setole apicali, e da lamella copulatrice poco sclerificata, biloba alla base, uniloba all'apice, avvolta da fasci di squame spinose diversamente distribuite nell'endofallo (Figg. 9-12, 13-16).

I dati sulla paleogeografia e la zoogeografia di Creta confermano l'ipotesi di un'origine nord-occidentale di tale gruppo di specie, che trova apparenti affinità nei confronti di *D. taygetanus* Casale, 1979, specie isolata e localizzata nel massiccio del Taigeto in Peloponneso (Casale *et al.*, 1996).

All'interno del gruppo risulta relativamente affine a *D. passaueri*, specie prossima geograficamente, per le dimensioni relativamente grandi, per le strie elitrali molto profonde e profondamente punteggiate, per i margini laterali del pronoto lungamente arrotondati, appena sinuati anteriormente agli angoli basali, ma da quest'ultima risulta marcatamente distinta per i caratteri morfologici evidenziati nella diagnosi, nella descrizione e nelle illustrazioni riportate.

Vale ancora la pena evidenziare i diversi gradi di specializzazione all'ambiente sotterraneo all'interno del gruppo considerato. *D. mixanigi* risulta essere l'entità più specializzata, caratterizzata da capo, pronoto ed elitre più stretti e allungati, strie elitrali molto superficiali (tutte profonde ed evidenti nelle rimanenti specie) e zampe molto allungate e gracili (Fig. 3); il capo non presenta tracce di macchie oculari, ma solo una cicatrice pre-oculare obliqua sulle tempie. *D. sbordonii* appare invece come l'entità

meno specializzata per le piccole dimensioni, le appendici più brevi e la presenza di macule oculari biancastre ben visibili (Fig. 1).

In *D. passaueri* è ancora presente un'evidente macula oculare, ellittica con bordo scuro, traslucida ma priva di ommatidi all'interno (Fig. 5), mentre in *D. augusti* sp. n. le cicatrici oculari sono rappresentate da fessure oblique nerastre evidenti, con all'interno una piccola area biancastra priva di ommatidi (Fig. 7).

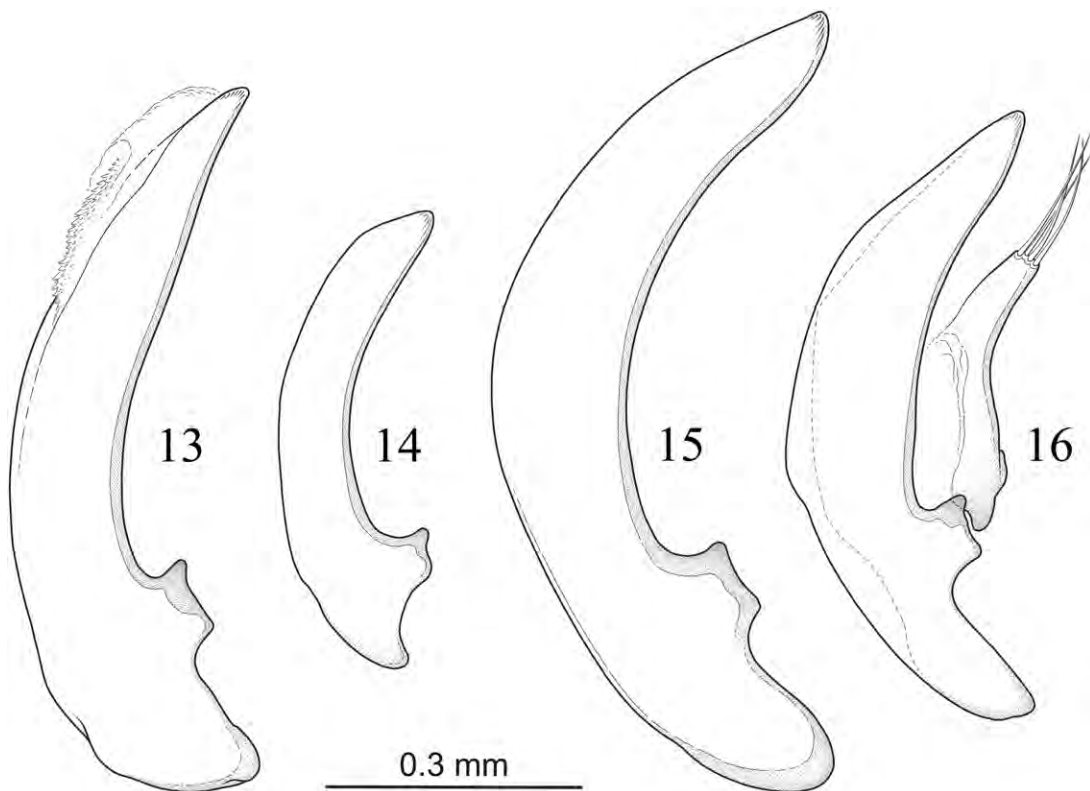
CONCLUSIONI

La scoperta di una seconda specie di *Duvalius* nel massiccio orientale del Dikti a Creta è indubbiamente interessante, ma non particolarmente sorprendente. La straordinaria diversità del genere in Grecia è ben nota, pure con la presenza di un genere molto affine nell'Eubea (Casale & Giachino, 2016), e la presenza di due, tre e pure quattro specie simpatriche e talora sintopiche nel medesimo massiccio della Grecia continentale e peninsulare (Peloponneso) è ben nota (Casale, 1979; Casale & Lebenbauer, 2011; Casale *et al.*, 2017, 2018).

Una particolare attenzione merita tuttavia il popolamento dell'Isola di Creta.

Creta, con un'estensione attuale di 260 km in lunghezza da ovest a est e una larghezza di 12 – 60 km, presenta una storia geologica e paleogeografica lunga e molto complessa (Le Pichion & Angelier, 1979; Higgins & Higgins, 1996; Ten Veen & Postma, 1999). L'isola è parte dell'arco geologico che dalle Alpi Dinariche, attraverso la Grecia da nord a sud e passando da Creta, Karpathos e Rodi, giunge in Asia Minore. Come tale, fa parte del cosiddetto Arco Ellenico esterno, ed è completamente emersa dal Mare di Tethys da circa 20 milioni di anni, a seguito della collisione della Placca Africana con la Placca Asiatica. Non casualmente, tutta l'area coinvolta è ancora oggi altamente sismica. Tuttavia, in Creta non sono presenti vulcani attivi.

Sino al Miocene superiore l'isola di Creta è collegata alle altre isole ed emersa: un'area continentale soggetta a sollevamento e a intensa erosione collega la Grecia alla Turchia, come indicano i depositi clastici pre-messiniani di Creta con provenienze da Nord e le superfici erosive coeve presenti nell'Egeo meridionale. Tra 13 e 10 MA, l'area viene interessata da tettonica distensiva, con faglie dirette e sprofondamenti differenziali.



Figg. 13-16. Edeago in visione laterale di 13 – *Duvalius sbordonii*, 14 – *D. mixanigi*, 15 – *D. passaueri*, 16 – *D. augusti* n. sp.

Nel Tortoniano si individua il Bacino cretese e a Nord il Bacino di Saros. Contemporaneamente, in Grecia si sviluppano numerosi bacini continentali e si interrompe il collegamento di terre emerse tra Grecia e Turchia.

Dopo la generale regressione marina dovuta alla crisi di salinità, una nuova ingressione culmina nel Pliocene superiore e il mare copre le zone costiere della Grecia e gran parte delle isole, comprese le aree costiere e di bassa quota di Creta, dove si isolano i massicci montuosi che oggi caratterizzano l'isola.

Attualmente, Creta è caratterizzata dalla presenza di tre principali massicci montuosi, in gran parte costituiti da calcari grigi e notevolmente elevati. Da Ovest a Est, rispettivamente (Fig. 17): 1. Il Lefka Ori (= Monti Bianchi), con una massima altezza nel Pachnes a 2453 m. Il massiccio è caratterizzato da profonde gole (la più nota è la gola di Samaria) e dal vasto plateau di Omalos. 2. Lo Psiloritis (= in Greco, "il più alto"), con la vetta a 2456 m, conosciuto anche

come Monte Ida. 3. Il Dikti, che raggiunge i 2148 m. Il massiccio è ben noto nella mitologia greca per la presenza di un'ampia grotta, il Dikteon Andron, dove, secondo una delle due versioni accreditate sull'isola (l'altra si riferisce alla grotta Idéon Andron, sita sul Monte Ida) sarebbe nato Zeus poi amorevolmente nutrito dalla capra Amalthea.

La storia paleogeografica di Creta avvalorava l'ipotesi di un popolamento nord-occidentale dell'isola da parte di una linea di *Duvalius* presente nella Grecia continentale, che ha lasciato tracce in *Duvalius taygetanus* Casale, 1979 (non casualmente in un massiccio del Peloponneso ricchissimo di elementi isolati e relitti), mentre nessuna affinità del "gruppo *sbordonii*" è attualmente riconoscibile nei confronti delle poche specie del genere attualmente note nella Penisola Anatolica (cfr. Casale & Vigna Taglianti, 1999).

Le quattro specie di *Duvalius* nell'isola sarebbero pertanto l'esito attuale di una speciazione

allopatrica, per isolamento in massicci montuosi isolati l'uno dall'altro in una situazione insulare, da un contingente monofiletico penetrato a Creta dalla Grecia continentale anteriormente a un periodo compreso fra 11 e 7 milioni di anni fa (Tortoniano). Tale linea sarebbe andata incontro a una radiazione adattativa in un'area all'epoca peninsulare o insulare, con fenomeni di speciazione che avrebbero lasciato tracce in poche entità sopravvissute e isolate in ambiente sotterraneo a seguito del deterioramento climatico plio-pleistocenico.

RINGRAZIAMENTI

Desideriamo ringraziare il Ministero per l'Ambiente e l'Energia della Repubblica Ellenica per la concessione dei permessi n° 138098/698 del 31/3/2016 e n° 166238/248 del 25/4/2018, nell'ambito dei quali sono state eseguite le ricerche a Creta durante le quali la nuova specie è stata censita.

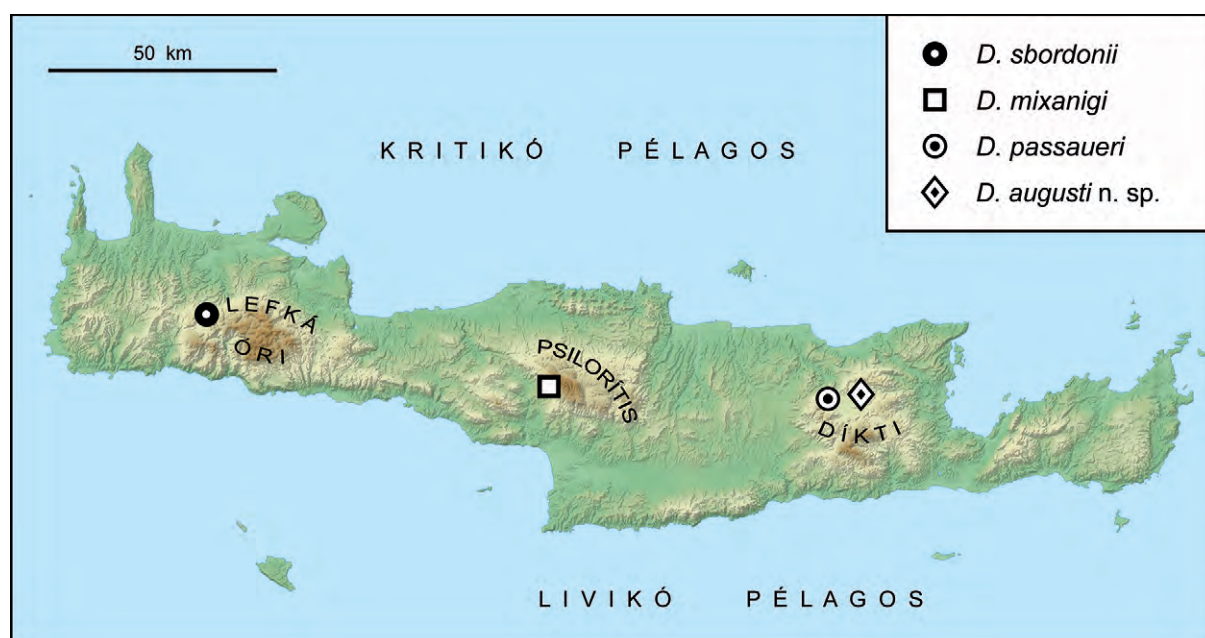


Fig. 17. Distribuzione delle specie del genere *Duvalius* note fino ad oggi dell'isola di Creta.

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Graphipterus vignai new species from Zambia (Coleoptera Carabidae, Cyclosomini)

Abstract: *Graphipterus vignai* n. sp. from Kafue River, Lusaka, Zambia, is described. This new species belongs to the “*Graphipteri diversitarsi*” section (sensu Basilewsky, 1977) and seems closely related to *G. lineolatus* (Boheman, 1848), sharing part of its distribution area. It can be distinguished by the dorsal side of pygidium completely pubescent and the structure of the aedeagus.

Riassunto: *Graphipterus vignai* nuova specie dello Zambia (Coleoptera Carabidae, Cyclosomini).

Gli autori descrivono *Graphipterus vignai* n. sp. proveniente da Kafue River, Lusaka, Zambia. La nuova specie appartiene alla sezione dei ‘*Graphipteri diversitarsi*’ (sensu Basilewsky, 1977) ed è apparentemente vicina a *G. lineolatus* (Boheman, 1848), con il quale condivide parte dell’areale. Da questo si distingue per il lato superiore del pigidio completamente pubescente e per la forma dell’edeago.

Key words: new species, *Graphipterus vignai* n. sp., Africa, Zambia, Kafue river.

To meet the requirements by the International Code of Zoological Nomenclature (ICZN), this article was registered at ZooBank (31 March 2021) under the ZooBank Life Science Identifier (LSID): 2F26E57F-1A83-4D76-85CF-6E8D93A25BAE.

Published: 23 April 2021.

INTRODUCTION

After the first monograph devoted to the genus *Graphipterus* Latreille, 1802 by Chaudoir (1870), where 56 species were recognized, we had to wait more than 50 years before the genus was monographically treated again (Burgeon, 1929) and then almost 50 more (Basilewsky, 1977). After that, only a few contributions were devoted to these beautiful ground beetles. Indeed, Basilewsky himself successively published two additional papers, describing four other taxa (one species and three subspecies) from Zaire (now Democratic Republic of Congo) and Somalia (Basilewsky, 1981), as well as seven further new species from South Africa (Basilewsky, 1986). After Basilewsky, few other authors carried out taxonomic research concerning this genus: Werner (2003) described a new species from Kenya, then (2007) described three new species from Zambia; Mawdsley (2012) reviewed the group of *G. ancora* Dejean, 1831 (sensu Basilewsky, 1977), but without describing any new taxa; Maquet & Bouyer (2013) dealt with the distribution of *G. dymorphus dymorphus* Burgeon 1928 and the morphological differences distinguishing the

subspecies of *G. ellipticus* Burgeon, 1928; eventually Renan *et al.* (2018) reviewed the group of *G. serrator* (Forskål, 1775) (sensu Basilewsky, 1977), describing five new species and proposing to raise many subspecies or synonyms, many of which are sympatric, to the rank of valid species.

Among the entomological materials collected in Zambia during 1986 by Franco Ferrero from Turin, one of the authors (PMG) identified a probable new species of *Graphipterus* from Kafue River, Zambia. Discussing this discovery with the late Augusto Vigna Taglianti, PMG became aware of the fact that, in a similar batch of material from the collections of Franco Ferrero, he had also identified the presence of the same probable new species. This information halted PMG’s intention to proceed with the research, while awaiting the description by Vigna Taglianti, which unfortunately never appeared. Now, more than thirty years after these events, the availability of the materials of the Vigna Taglianti Collection, now donated to MCSNG, makes the description of this new species possible, also thanks to the courtesy of the Honorary Curator Roberto Poggi.

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MATERIALS AND METHODS

Morphological analysis was carried out through the examination of habitus with a stereomicroscope Wild M3. Dried male genitalia were glued on a card fixed to the same pin as the adult specimen.

The images of habitus and male genitalia were made using a Leica DFC295 camera mounted on a Leica M205 C Stereomicroscope, using the software Leica Application System V4.0.

The material studied is deposited in the following Museums and private collections:

- MCSNG: Museo Civico di Storia Naturale “Giacomo Doria”, Genova, Italy
 CAI: Gianni Allegro Collection, Moncalvo (Asti), Italy
 CCa: Achille Casale Collection, Torino, Italy
 CFa: Leonardo Falletti Collection, Buttigliera Alta (Torino), Italy
 CGi: Pier Mauro Giachino Collection, San Martino Canavese (Torino), Italy
 CMa: Niccolò Massimo Collection, Manerbio (Brescia), Italy
 CSc: Riccardo Sciaky Collection, Milano, Italy
 CVi: Augusto Vigna Taglianti Collection, now in MCSNG

***Graphipterus vignai* n. sp.**

(Figs. 1, 2, 4, 8)

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842C7DE9-04FB-494D-B0CE-C6CFC00D8923

LOC. TYP.: Zambia, Lusaka, Kafue River, m 1300.

TYPE SERIES: HT♂ Zambia, Lusaka, Kafue River, I.1998, F. Ferrero legit (CGi). PTT: 5 ♂♂ 6 ♀♀ same data as HT (CAI, CVi); 6 ♂♂ 5 ♀♀, Zambia, Kafue, I.1998, F. Ferrero leg. (CGi); 14 ♂♂ 7 ♀♀ Zambia, Lusaka, Kafue, Kafue River, m 1200, XII.1986, F. Ferrero legit (CVi); 2 ♂♂ 6 ♀♀ Zambia, Lusaka, Kafue, Kafue River, XII.1986, F. Ferrero legit (CGi, CVT); 50 ♂♂ 44 ♀♀ Zambia, Lusaka, Kafue River, m 1300, XII.1986, F. Ferrero legit (CAI, CCa, CFa, CGi, CSc, CMa); 1 ♀, Zambia, Kafue River, XII.1986 (CGi); 8 ♂♂ 7 ♀♀ Zambia, Lusaka, Kafue City, Kafue River, m 1200, 22.XI-2.XII.1987, R. Mourglia legit (CGi, CSc, CVi); 2 ♂♂ Zambia, Kafue, XII.1989, F. Ferrero legit (CVi); 2 ♂♂ Zambia, Lusaka, Kafue City, Kafue River, m 1200, 21.XII.1989, F. Ferrero legit (CVi); 1 ♀ Zambia, Lusaka, Kafue City, Kafue River, m 1200, I.1996, F. Ferrero legit (CVi); 2 ♀♀ Zambia, Lusaka, Kafue City, Kafue River, m 1200, 4.I.1996, F. Ferrero

legit (CVi); 2 ♂♂ 1 ♀ Zambia, Lusaka, Kafue City, Kafue River, m 1200, 5.I.1996, F. Ferrero legit (CVi); 4 ♂♂ Zambia, Lusaka, Kafue City, Kafue River, m 1200, 6.I.1996, F. Ferrero legit (CVi); 2 ♀♀ Zambia, Lusaka, Kafue City, Kafue River, m 1200, 7.I.1996, F. Ferrero legit (CVi); 3 ♂♂ 2 ♀♀, Zambia, Kafue River, I.2000, F. Ferrero leg. (CGi); 7 ♂♂ 11 ♀♀, Zambia, Lusaka, Mazabuka, m 1400, XII.1986, F. Ferrero leg. (CFa, CGi, CMa, CSc).

DIAGNOSIS. A species of the “*Graphipteri diversitarsi*” section (sensu Basilewsky, 1977), belonging to the “*G. circumcinctus* species-group”, and in particular close to *G. lineolatus* (Boheman, 1848) (Fig. 9) on account of the general body morphology and of the elytral vestiture, consisting of seven complete longitudinal bands of pale scaly pubescence and a wider lateral pale band, as well as on account of the vestiture of pronotum, showing a disk sparsely covered by blackish



Fig. 1. *Graphipterus vignai* n. sp.: habitus of HT.

scales and two wide lateral bands of pale scales. It differs from *G. lineolatus*, however, in the dorsal side of pygidium completely covered by pale pubescence (Fig. 2) (only two pale lateral triangular bands in *G. lineolatus*) (Fig. 3), in the vertex of head with distinct longitudinal wrinkles (usually simply punctate in *G. lineolatus*), as well as in the morphology of the median lobe of the aedeagus: in particular, in lateral view it shows a different shape and appears completely smooth at sides and underneath, while it is wrinkled in all the specimens of *G. lineolatus* we examined; in dorsal view, it shows a broadly rounded apex with very narrow apical lamella (Fig. 4) (more or less pointed and triangular in *G. lineolatus*) (Figs. 5-7).

DESCRIPTION. Body entirely black with head, pronotum and elytra showing pale bands of scaly pubescence (Fig. 1). Total body length (from apex of labrum to apex of elytra): ♂♂ 9.7-14.4 mm, ♀♀ 9.0-14.0 mm.

Head black, with two wide curved longitudinal bands of white-yellowish scales; eyes large but hardly bulging; mandibles elongate. Clypeus anteriorly bor-

dered and with a setigerous pore on each side placed well before anterior angles; anterior margin hardly concave; labrum subquadrate, provided with 6 setae at anterior margin; tempora and frons densely punctate. Supraorbital area depressed and distinctly longitudinally striolate (such as vertex). Neck not narrowed. Antennae long, reaching the basal fourth of elytra, pubescent, flattened and strongly elongated from 4th antennomere; the second and third antennomeres flattened and glabrous; the second 1/3 as long as the third; the first 1.5 times as long as the second, not flattened but dorsally depressed; antennomeres 2-11 keeled on inner side.

Pronotum black, cordiform, with obtuse and widely rounded basal angles; fore angles with prominent subtriangular lobes; anterior margin bordered; base slightly concave and unbordered; sides regularly rounded forward and delicately sinuated before basal angles; disk wholly punctate, almost pockmarked, sparsely covered with blackish scales on centre of disk, and with two wide pale lateral bands formed by dense whitish scales, occupying the entire lateral groove and the external part of the disk. Lateral groove closely joined with basal impressions, which seamlessly extend over the entire base, so that the whole basal edge appears raised. Pro-, meso- and metasterna brownish-black. Prosternum, front of mesosternum and metepimera provided with sparse whitish pubescence.

Legs black; pro-, meso- and metatibiae externally furrowed; external metatibial spur spoon-shaped; protarsomeres of males not dilated, but inferiorly with dense yellowish pubescence.

Elytra ovoid and convex, coarctate (brachypterous species), almost gibbous at base of elytral suture, with completely obliterated shoulders, slightly truncate in preapical area and separately rounded. Elytral disk entirely, strongly and irregularly punctate, with striae relatively distinct and depressed; disk completely covered by white-yellowish and brownish scales, alternating so as to form seven complete and biseriate pale longitudinal bands, plus an eighth much wider external band occupying the elytral edge. The general appearance of the pale bands can vary, especially in old specimens, due to wear and tear with relative loss of scales, both pale and dark. Pygidium blackish brown, dorsally entirely covered by dense yellowish-white pubescence and provided with a distinct median keel in both sexes. Sternites glabrous, blackish brown; last sternite without keel and equipped with two pairs of apical setae in both sexes.



Figs. 2-3. Pygidium of *Graphipterus vignai* n. sp. from Kafue River, Zambia (2) and of *G. lineolatus lineolatus* from Maun, Botswana (3).

Median lobe of aedeagus small, regularly curved and dorsally completely open, totally smooth at sides and underneath; in lateral view stocky, with a blunt apex; in dorsal view the apex is broadly rounded, asymmetrical, with very short apical lamella (Fig. 4); parameres stout, slightly elongated, the right one truncate at apex, the left one rounded.

ETYMOLOGY. It is a pleasure for us to dedicate this new species to our late friend and colleague Augusto Vigna Taglianti, who had already many years ago suspected it was a new species, as a token of our esteem and friendship and with deep regret for his untimely death.

ECOLOGY AND GEOGRAPHICAL DISTRIBUTION. *G. vignai* n. sp. is currently known only from a restricted area along Kafue River (Lusaka, Mid-Southern Zambia), where it was collected at 1,200-1,300 m a.s.l (Fig. 8). Most specimens were collected at night, attracted to light in a savannah habitat at about 1 km from the banks of the Kafue River.

REMARKS. Following the key provided by Basilewsky (1977) to the *Graphipterus* species-groups, *G. vignai* n. sp. would key out to the group of '*G. michaelsoni*', mainly because of the character of the complete (instead of incomplete) pale pubescence of pygidium (Figs. 2-3), (couplet n. 22 at page 22). On the other hand, not considering this character, this species easily fits in the group of '*G. circumcinctus*', which includes *G. lineolatus* (externally almost indistinguishable) and 6 more species morphologically very similar to *G. vignai* n. sp. Among these, the new species appears particularly close to *G. lineolatus* in the external morphology and elytral vestiture, being distinguished mainly by the feature of the pygidial pubescence and by the morphology of aedeagus.

For these reasons, we consider the character 'complete/incomplete pygidial pubescence' as not significant to discriminate among species-groups, at least in this case. This consideration opens the discussion regarding the lack of use by Basilewsky (1977, 1981, 1986) and other authors (Mawdsley, 2012; Werner, 2003, 2007) of the morphological characters of the aedeagus, which was considered extremely homogeneous and therefore inadequate for

taxonomic purposes (Basilewsky, 1977, p. 12). It is true that the features presented by this organ are rather subtle and maybe less evident than in other carabid groups, mainly compared to other very evident diagnostic external characters like those concerning the colour of the vestiture, but they are anyway useful for a specific distinction. Actually, as highlighted by Renan *et al.* (2018) within the group of '*G. serrator*', the aedeagi of different species, although rather homogeneous, are very suitable for taxonomic purposes. In the case of the taxon described here, the morphology of the aedeagus is decisive for its attribution to a new species.

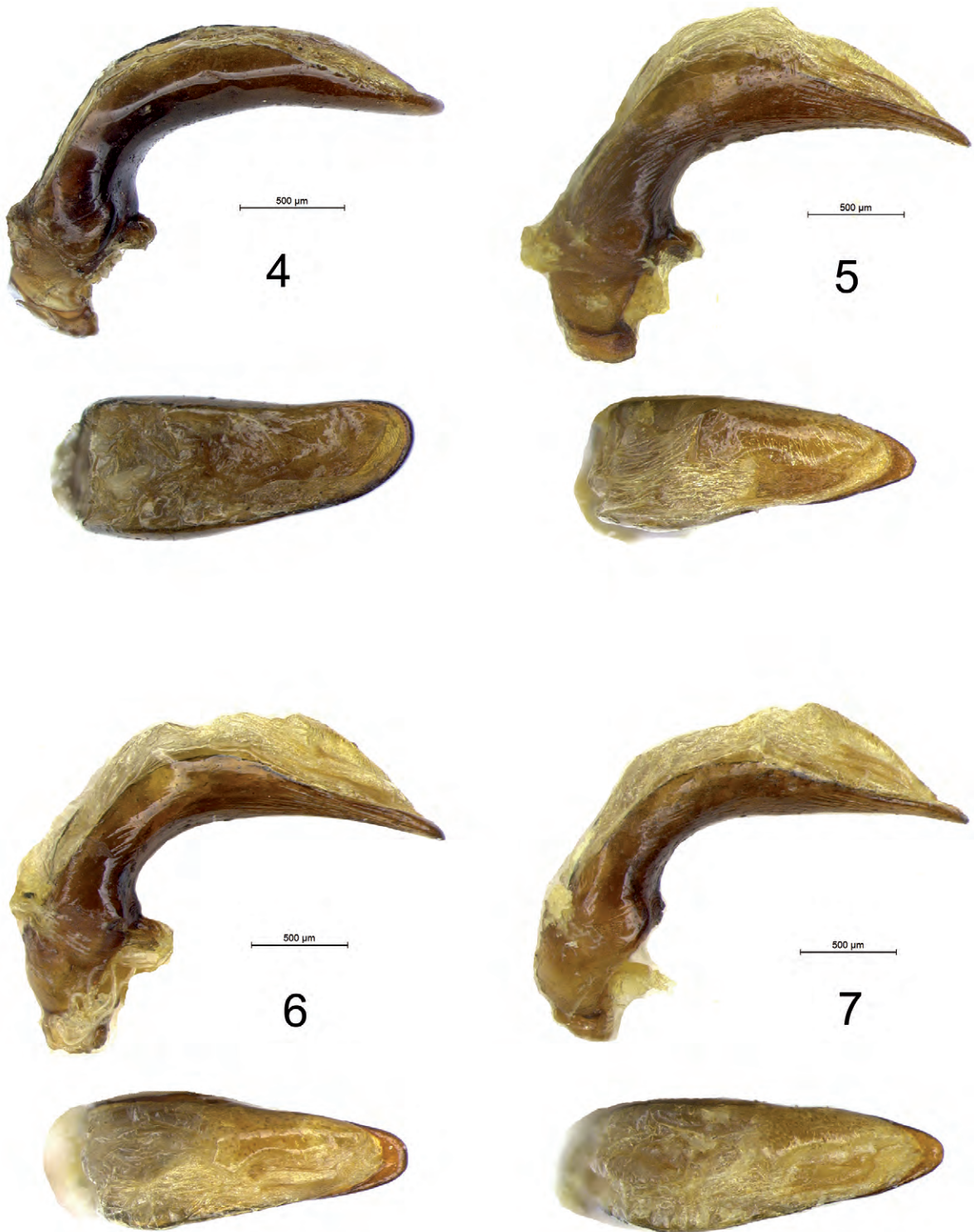
Graphipterus lineolatus (Boheman, 1848)
(Figs. 3, 5-9)

This species was described with the type-locality "Ad Montes Makkalienses". Its distribution has been extensively studied by Basilewsky (1977), who found that it occupies Namibia, Botswana, Zimbabwe, Zambia and the Republic of South Africa. Within this large distribution area Peringuey (1896) described a "var. *geminatus*" from "Salisbury (Zambezia)" and "Zambeze River". The original description described this variety as follows: "Shape, size and colouring of *G. lineolatus*, but the seven white lines on the elytra, instead of being equidistant, have three sets of duplicate lines set close to each other, with the intervals, of course, broader between the duplicated line". Later, Burgeon (1929) treated this form as a "var. or ssp.", while Basilewsky (1977) definitely accepted it as a valid subspecies, but limited its distribution to the region of Zimbabwe around Harare and Umvuma. We think that probably it is a variety occurring together with the nominotypical subspecies but prevalent in some zones, but only the direct study of material from different areas will shed light on this matter.

G. lineolatus, except for this particular form, is not very variable, considering the extension of its distribution area; only the size can vary from 9 to 14 mm. The aedeagal shape can vary slightly, as can be observed in the illustrations 5-7, but the fundamental characters (thickness of apex in lateral view, shape of apical lamella, etc.) remain constantly different from those of *G. vignai* n. sp.

ZOOGEOGRAPHIC NOTES

In Zambia many species of *Graphipterus* are known, but probably many other species remain to be



Figs. 4-7. Aedeagus in lateral and dorsal view of *Graphipterus vignai* n. sp. (HT) (4); *G. lineolatus lineolatus* from Bulawayo, Zimbabwe (5); *G. lineolatus lineolatus* from Maun, Botswana (6, 7).

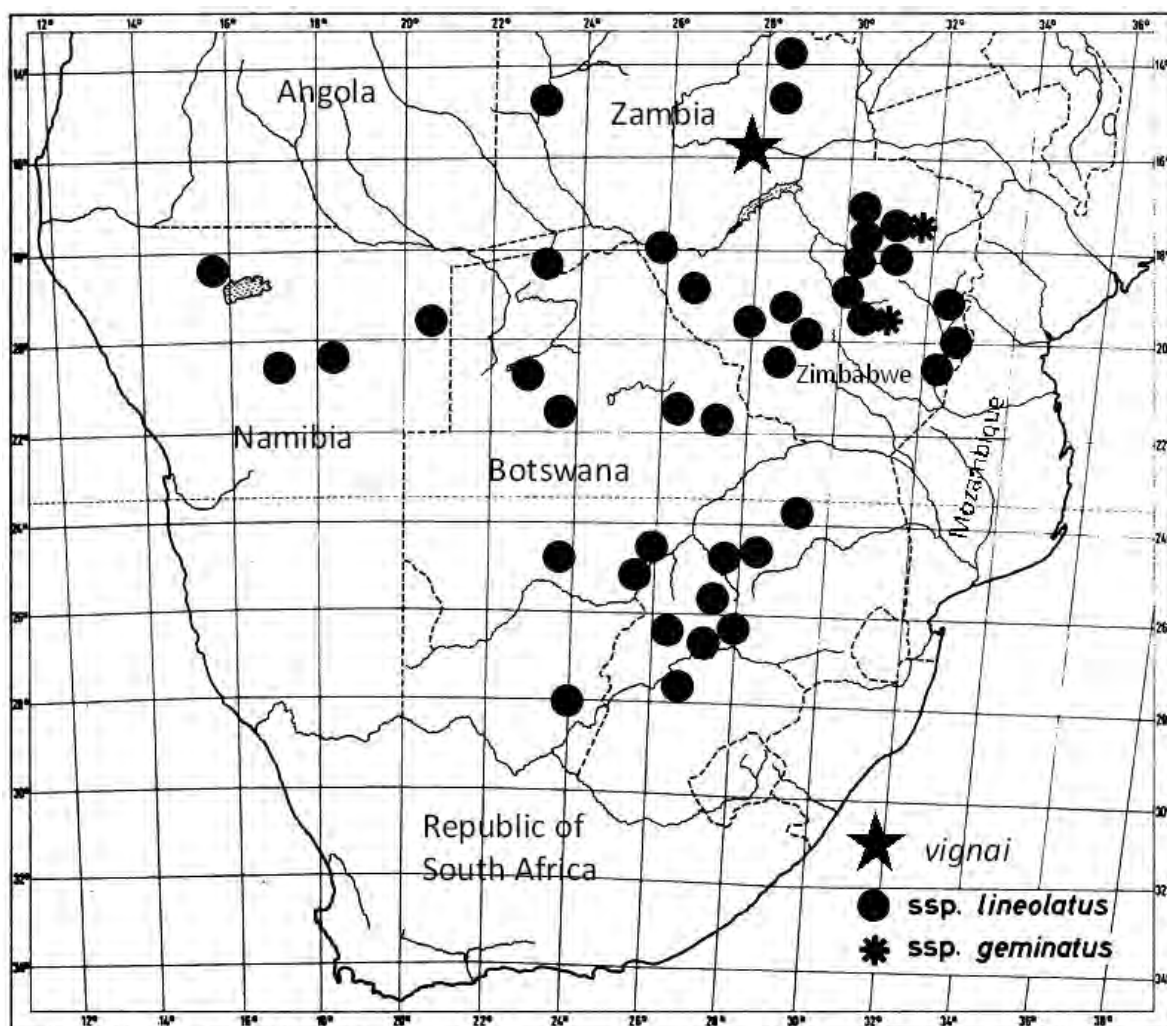


Fig. 8. Distribution map of *Graphipterus vignai* n. sp., *G. lineolatus lineolatus* and *G. lineolatus geminatus* (modified from Basilewsky, 1977).

reported for the country. Among the “*Graphipteri similatarsi*” we know from this country: *G. amabilis* Boheman, 1860, *G. cordiger* ssp. *zambeziensis* Peringuey, 1892, *G. ornatus* ssp. *dollmani* Burgeon, 1829, *G. salinae* ssp. *paratibialis* Basilewsky, 1977, *G. vittiger* Peringuey, 1888, while among the “*Graphipteri diversitarsi*” there are: *G. albolineatus* (Wallengren, 1881), *G. atrimediis* Chaudoir, 1870, *G. basilewskyi* Werner, 2003, *G. duvivieri* Burgeon, 1929, *G. ellipticus* Burgeon, 1928, *G. katangae* Burgeon, 1929, *G. limbatus* Castelnau, 1840, *G. lineolatus*

(Boheman, 1848), *G. lorenzi* Werner, 2007, *G. marshalli* Burgeon, 1928, *G. nanniscus* Peringuey, 1896, *G. neavei* Burgeon, 1928, *G. nyassicus* ssp. *zambiensis* Basilewsky, 1977, *G. rhodesianus* Burgeon, 1928, *G. snizeki* Werner, 2007, *G. tichyi* Werner, 2007, *G. tristis* Klug, 1855, *G. upembanus* Basilewsky, 1953. Therefore, there are 22 species known for this country so far, three of which belong to the same group as *G. vignai*. This seems to show a pattern of distribution of this genus extremely complicated and difficult to reconstruct.



Fig. 9. Habitus of *Graphipterus lineolatus lineolatus* from Maun, Botswana.

CONCLUSIONS

The fact that the distribution area of *G. vignai* n. sp. is entirely within that of *G. lineolatus* suggests that it is a valid species and cannot be a subspecies (see fig. 8, from Basilewsky, 1977, modified). A doubt can arise concerning *G. lineolatus* ssp. *geminatus*, another taxon whose distribution area is completely within that of *G. lineolatus*; after more complete studies this taxon may either prove to be a good species, or a variety with no nomenclatorial value.

Moreover, by examining some (unfortunately still too few) specimens of *G. lineolatus* from different localities of its wide distribution area, we noticed a certain variability in male genitalia (Figs. 5-7). Therefore, we suspect that a study of the numerous populations of *G. lineolatus*, also taking into account the formerly neglected characters of the median lobe of aedeagus as well as of the parameres, may lead to discover that it is a complex of various species.

We can only confirm the statement of Mawdsley (2012): "The results of the study presented here suggest that it may be time for a broader re-evaluation of the genus *Graphipterus*, starting in particular with a review of the taxa recognized as subspecies by Burgeon (1929) and Basilewsky (1977). It is possible that many of these taxa will prove to be separate species ... or synonyms of a single species".

ACKNOWLEDGEMENTS

We are very grateful to Roberto Poggi (Honorary Entomological Curator at MCSNG) for the loan of the specimens of the new species from CVI; to Achille Casale as well as to the referees for critical revision of the manuscript and useful suggestions; to Franco Ferrero for the specimens donated to one of the authors (PMG) and for the data regarding the habitat of the new species; to Pier Giuseppe Chiadò Fiorio (Librarian at Museo Regionale di Scienze Naturali in Turin) for help with finding some difficult literature. A special thank to Maxwell Barclay (BMNH) for linguistic revision of the manuscript.

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Luigi BISIO* - Piero GIUNTELLI**

I Carabidi dell'alta Val Brembana (Alpi e Prealpi Orobie): una sintesi (Coleoptera Carabidae)

Riassunto: Dopo avere brevemente illustrato i principali caratteri geologici, climatici e vegetazionali dell'alta Val Brembana, gli autori propongono una sintesi delle ricerche carabidologiche condotte sino a oggi in quest'area. Viene presentato un catalogo topografico delle 143 specie di Carabidi (Cicindelinae incluse) segnalate in questo territorio, con note riguardanti la loro ecologia e la loro corologia. Infine, sono descritte le principali carabidocenosi osservate.

Parole chiave: Coleoptera Carabidae, fauna alpina, Alpi centrali, Lombardia, Bergamo.

Abstract: *Carabid beetles of the high Brembana Valley (Orobian Alps and Prealps, Lombardy, Bergamo, Italy) (Coleoptera Carabidae).*

After a short illustration of the main geological as well as climatic and vegetational features of the high Brembana Valley, a synthesis of the carabidological researches carried out so far in this area is provided. A topographic catalogue of the 143 Carabid species (Cicindelinae included) recorded from this territory is given, with notes regarding their ecology and distribution. Furthermore, the main observed carabid assemblages are described.

Key words: Coleoptera Carabidae, Alpine fauna, central Alps, Lombardy, Bergamo.

PREMESSA

Lo studio dettagliato della coleotterofauna che popola le diverse valli alpine lombarde è stato recentemente iniziato da Grottolo & Pedersoli (2015) (che si sono occupati dei Cerambycidae della Valle Camonica), da Grottolo *et al.* (2016) (che si sono dedicati ai Carabidi del bacino superiore del Fiume Oglio) e da Toledo & Grottolo (2019) (che hanno censito i Coleotteri acquatici della Provincia di Brescia). Il presente lavoro dedicato ai Carabidi (Cicindelinae comprese) dell'alta Val Brembana viene presentato in un ideale proseguimento dei contributi di questi autori ed è in parte il risultato di una serie di campagne di ricerca condotte dagli scriventi tra gli anni ottanta e novanta del secolo scorso. Tali ricerche hanno consentito di radunare una discreta quantità di dati faunistici che vanno a integrare i numerosi dati messi a disposizioni da diversi colleghi e le segnalazioni desumibili dalla letteratura che sono altrettanto numerose. La Val Brembana è stata infatti al centro di importanti flussi turistici sin dal primo Novecento quando, nel corso della *Belle Époque*, il boom del turismo termale, incentrato sullo stabilimento di San Pellegrino Terme, iniziava ad attirare ospiti da tutta Europa. La fama internazionale sempre maggiore della

stazione contribuì indirettamente a promuovere a poco a poco lo sviluppo turistico anche delle località brembane più periferiche, diventate oltretutto sempre più facilmente raggiungibili anche grazie all'inaugurazione nel 1906 della ferrovia che collegava Bergamo con la località termale, prolungata poi nel corso del primo dopoguerra sino a Piazza Brembana (cfr. Riceputi, 2006; Bottani, 2015). Ciò favorì di riflesso anche l'inizio dell'esplorazione entomologica della valle, che è stata poi portata avanti per tutto il Novecento e sino ai giorni nostri da generazioni di carabidologi. Le prime ricerche documentate sono di marca mitteleuropea. Tra i pionieri delle ricerche in valle sono infatti da citare il tedesco Karl Daniel di Monaco di Baviera e l'austro-ungarico Gustav Bernau di Tolmino; a questi due autori si devono le prime segnalazioni di Carabidi rinvenuti in questo territorio (K. Daniel, 1908; Bernau, 1914). Dopo queste segnalazioni, molte altre ne seguirono dagli anni venti del secolo scorso per merito di Bari (1950), Bina-ghi (1937, 1939, 1951), Breuning (1932-1936), De Monte (1947), Focarile (1949, 1950), Ghidini (1957), Holdhaus (1954), Jeannel (1926, 1927, 1928), Luigioni (1929), Marcuzzi (1953), Müller (1951), Schatzmayr (1930, 1942-1943, 1944), Schauburger (1927, 1936) e

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Weissmandl (1935). Questo già corposo nucleo di dati fu però arricchito notevolmente da Magistretti (1965, 1968) che, grazie al lungo elenco di Carabidi e di stazioni da lui citati nel suo Catalogo topografico-sinonimico e nel successivo supplemento, pose di fatto le basi di un'approfondita conoscenza faunistica di questo territorio. Poi, dopo le segnalazioni di Casale *et al.* (1982, 2006), Comotti (1983, 1986), Donabauer & Lebenbauer (2003), Focarile (1976), Franz (1971), Magrini (1998), Monguzzi (1982), Monzini & Pesarini (1986) e Sciaky (1985, 1991), si è avuto in tempi recenti il contributo di Monzini (2008) che, in un corposo elenco faunistico di sintesi dedicato ai Carabidi della Lombardia, ha ripreso molti dati forniti dagli autori precedenti integrandoli con numerose segnalazioni inedite, fra le quali diverse relative all'alta Val Brembana. Sono invece più recenti le segnalazioni di Bonavita & Vigna Taglianti (2010), De Giovanni & Magrini, (2016, 2019), Gobbi *et al.* (2018), Magrini *et al.* (2020), Monzini (2013b, 2015), Szallies & Huber (2014) e Zanella (2016).

Questo lavoro vuole riassumere in una sintesi le conoscenze a tutt'oggi disponibili sulla fauna dei Carabidi che popola questo territorio.

DESCRIZIONE DEL TERRITORIO

In questo lavoro viene preso in considerazione il territorio dell'alta Val Brembana (Fig. 1) intesa come l'alto bacino idrografico del Torrente Brembo a monte dell'abitato di San Pellegrino Terme, comprendendo la Val Taleggio e la zona di Dossena, Serina e Oltre il Colle. Si tratta del territorio nel quale gli scriventi hanno compiuto diverse escursioni a carattere entomologico, culminate poi in un trekking in alta quota effettuato allo stesso scopo da uno degli autori (L.B.).

Il territorio in oggetto fa parte delle Alpi e Prealpi Orobie ed è addossato al tratto dello spartiacque che separa la Valtellina dalle valli bergamasche compreso tra il Pizzo dei Tre Signori e il Pizzo del Diavolo di Tenda (cresta Pizzo dei Tre Signori-Monte Ponteranica-Monte Verobbio-Passo di San Marco-Monte Azzaredo-Monte Tartano-Monte Valegino-Cima Cadelle-Passo Dordona-Corno Stella-Monte Masoni-Pizzo del Diavolo di Tenda). Dal Pizzo dei Tre Signori, lungo la destra orografica, si sviluppa la dorsale (cresta Zuc di Valbona-Monte Foppabona-Zuccone Campelli-Cima di Piazza-Monte Sodadura-Piani d'Artavaggio-Zucco di Maesimo-Culmine di San Pietro-Cima di Muschiada-Resegone di Lecco)

che forma il versante destro e divide l'alta valle dalla Valsassina. A formare invece il versante opposto, si snoda dal Pizzo del Diavolo di Tenda lo spartiacque (cresta Pizzo del Diavolo di Tenda-Passo Valsecca-Monte Grabiasca-Passo della Portula-Monte Madonnino-Monte Cabianca-Monte Valrossa-Monte dei Frati-Passo d'Aviasco-Monte Pradella-Pizzo Farno-Passo dei Laghi Gemelli-Monte delle Galline-Passo Branchino-Monte Corna Piana-Pizzo Arera-Passo di Zambra-Monte Alben) che separa il territorio in oggetto dalla Val Seriana. Il reticolo idrografico dell'alto corso del Brembo è suddiviso in diversi rami. Nell'accezione comune il ramo principale (denominato semplicemente "Brembo", senza nessun altro riferimento geografico) è quello che ha origine alle pendici del Pizzo del Diavolo di Tenda e che solca la valle di Carona. Lungo il suo percorso esso riceve le acque dal Brembo di Valleve nei pressi di Branzi, dal Torrente Valsecca (discendente dalla valle di Roncobello) poco a monte di Moio dei Calvi, dal Brembo di Mezzoldo poco a monte di Lenna, dal Torrente Parina poco a monte di Camerata Cornello e il Torrente Enna (discendente dalla Val Taleggio). Il bacino del Brembo di Mezzoldo è il tributario più esteso; esso è alimentato dal Torrente Mora (che solca la Valmoresca) e dal Torrente Stabina (che scorre nella Valtorta).

Dall'esame della Carta geologica d'Italia 1:100.000 (Foglio n°18 Sondrio e Foglio n°33 Bergamo) e dalla letteratura più recente (Dal Piaz, 1990, 1998; AA.VV. 2010) si può desumere il seguente quadro litologico:

1. **Formazioni sedimentarie calcareo-dolomitiche:** deposte a partire dal Triassico, rappresentano la grande maggioranza della copertura sedimentaria presente nel territorio in oggetto e costituiscono i grandi massicci prealpini: Zuccone Campelli-Monte Corna Grande, Monte Venturosa-Monte Cancervo, Pizzo Arera-Monte Corna Piana (Fig. 2) e Monte Pegherolo-Monte Cavallo.
2. **Formazioni sedimentarie terrigene:** affiorano nel massiccio Pizzo dei Tre Signori-Monte Ponteranica (Fig. 3) e lungo la fascia nord-orientale del territorio in oggetto (tra i Laghi Gemelli e il Pizzo del Diavolo di Tenda) e sono rappresentate da conglomerati, arenarie e argilloscisti.
3. **Basamento cristallino:** rappresentato da ortogneiss di origine granitica affioranti sui monti di Foppolo.

L'alta Val Brembana è dominata dalle morfologie di esarazione e di deposito create dal glacialismo pleistocenico (cfr. AA.VV., 2010; Bini, 2012). In corrispondenza dell'ultima glaciazione, due grandi ghiacciai occupavano rispettivamente la Valle di Carona e quella di Mezzoldo. Il primo occupava l'intera valle e si spingeva a Sud di Lenna. Il secondo si arrestava nei pressi di Frola (poco a valle di Olmo al Brembo) senza congiungersi con l'altro ghiacciaio che dalla piana di Lenna si affacciava verso Piazza Brembana. In entrambi i bacini, i ghiacciai hanno modellato il profilo delle due valli attuali che oggi si presenta tipicamente a "U"

soprattutto nell'alta valle di Carona. Di origine glaciale sono anche le valli sospese (come la valle di Carisole), i grandi circhi glaciali spesso ospitanti laghetti alpini (come il circo di Cadelle e il circo della Val Sambuzza), le rocce montonate (come quelle osservabili nella conca dei Laghi Gemelli) e i depositi morenici (come quelli della Valtorta, esito dell'azione dei ghiacciai che scendevano dallo Zuccone Campelli e dal Monte Corna Grande). La morfologia glaciale originaria è stata in seguito modificata in parte dall'azione disagregatrice dei fenomeni crioclastici, delle acque superficiali e della gravità, azione testimoniata dalla presenza di conoidi

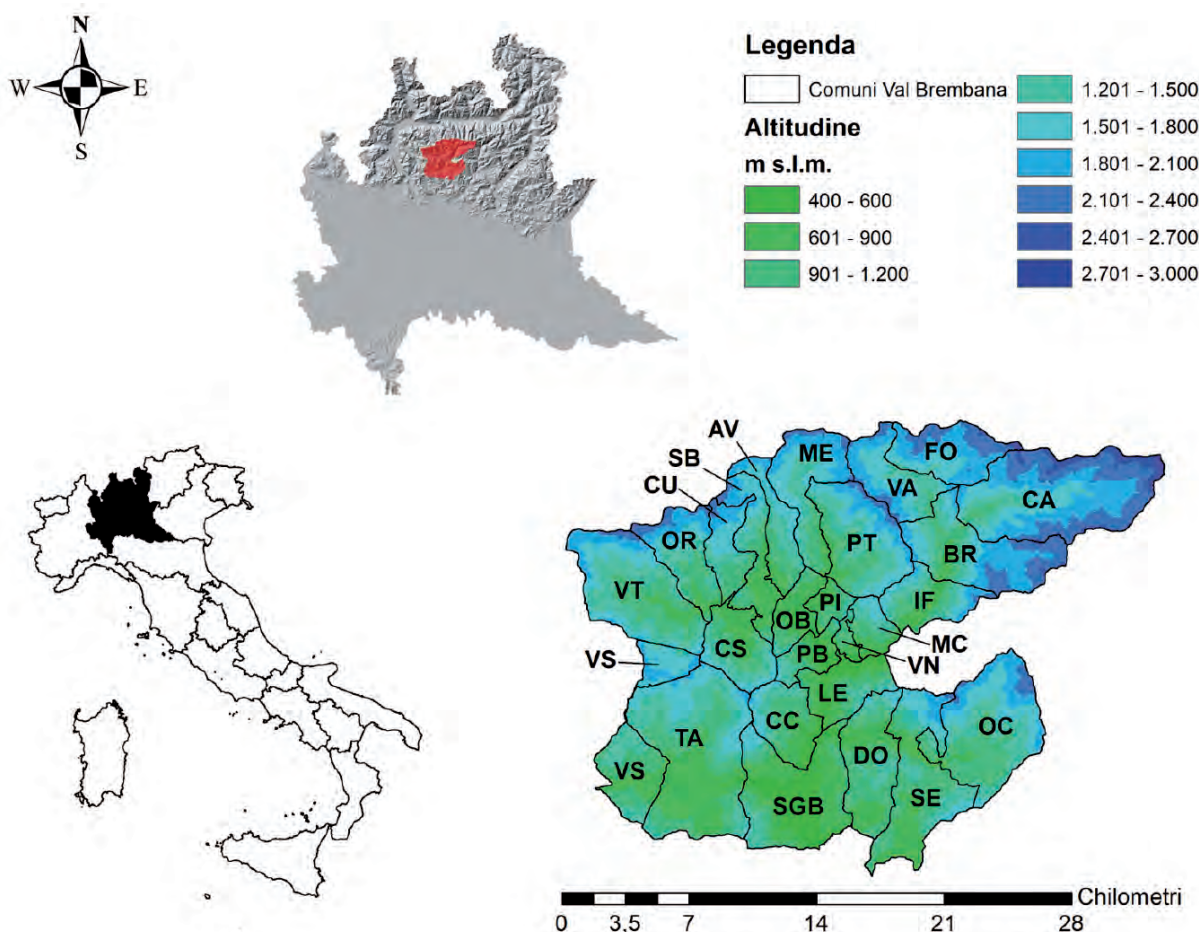


Fig. 1. L'alta Val Brembana (tavola redatta da Matteo Negro): Le sigle presenti sulla mappa indicano i comuni interessati dal SIC: Averara (AV), Branzi (BR), Camerata Cornello (CC), Carona (Ca), Cassiglio (CS), Cusio (CU), Dossena (DO), Foppolo (FO), Isola di Fondra (IF), Lenna (LE), Mezzoldo (ME), Mojo dei Calvi (MC), Olmo al Brembo (OB), Oltre il Colle (OC), Ornica (OR), Piazza Brembana (PB), Piazzatorre (PT), Piazzolo (PI), San Giovanni Bianco (SGB), Santa Brigida (SB), Serina (SE), Taleggio (TA), Valleve (VA), Valnegrà (VN), Valtorta (VT) e Veduggio (VS).

detritiche a grandi blocchi (esito di paleofrane di crollo) e dai depositi fluvioglaciali che si osservano in alcuni punti lungo i fondivalle.

Come si può desumere dalla “Carta delle precipitazioni medie annue del territorio alpino della Regione Lombardia” (Ceriani & Carelli, 2000), l’alta Val Brembana è un territorio interessato da apporti meteorici molto elevati. Dai già consistenti 1300-1400 mm medi annui di precipitazioni che si registrano lungo il fondovalle nella parte centrale della vallata (Valle di Mezzoldo e dintorni di Roncobello), si passa ai 1700-1800 mm lungo i fondivalle della Valtorta e della Valle di Carona, ai 1900-1950 mm in corrispondenza del Pizzo dei Tre Signori e della zona dei Laghi Gemelli e del Lago di Sardegnana e ai 2100 lungo i contrafforti del Pizzo Arera. Dai dati pluviometrici medi mensili disponibili per la stazione di Carona (1096 m) forniti da Belloni & Pelfini (1993) si evince che il regime pluvio-

metrico (Fig. 4) è caratterizzato da un massimo assoluto nel mese di maggio. È interessante notare (Tab. 1) tuttavia che il tasso complessivo di precipitazioni del trimestre primaverile, sebbene sia piuttosto elevato (456 mm nei mesi di marzo, aprile e maggio), è comunque inferiore ai tassi molto elevati che si registrano rispettivamente nel trimestre estivo (557 mm nei mesi di giugno, luglio e agosto) e in quello autunnale (525 mm nei mesi di settembre, ottobre e novembre). Solo il trimestre invernale (dicembre-gennaio-febbraio) è contraddistinto da apporti meteorici notevolmente più ridotti (249 mm).

Il regime termico dell’alta Val Brembana è molto differenziato, perché influenzato dai notevoli dislivelli altitudinali (dai circa 500 m di San Giovanni Bianco si sale agli oltre 2900 m del Pizzo del Diavolo di Tenda, la cima più elevata del territorio), dalla già evidenziata diversa esposizione delle valli in cui si di-



Fig. 2. Nevai alla base del Monte Corna Piana (versante di Roncobello) (15.VI.1991). Lungo i pendii sono presenti popolazioni di *Carabus castanopterus*, *C. creutzeri*, *Cychrus cylindricollis*, *Nebria lombarda*, *Pterostichus lombardus*, *P. multipunctatus*, *Abax arerae*, *Amara alpestris* e *Platynus teriolensis*.



Fig. 3. Il Pizzo dei Tre Signori (14.VI.1992) le cui pendici sono sede di molti Carabidi citati nel testo.

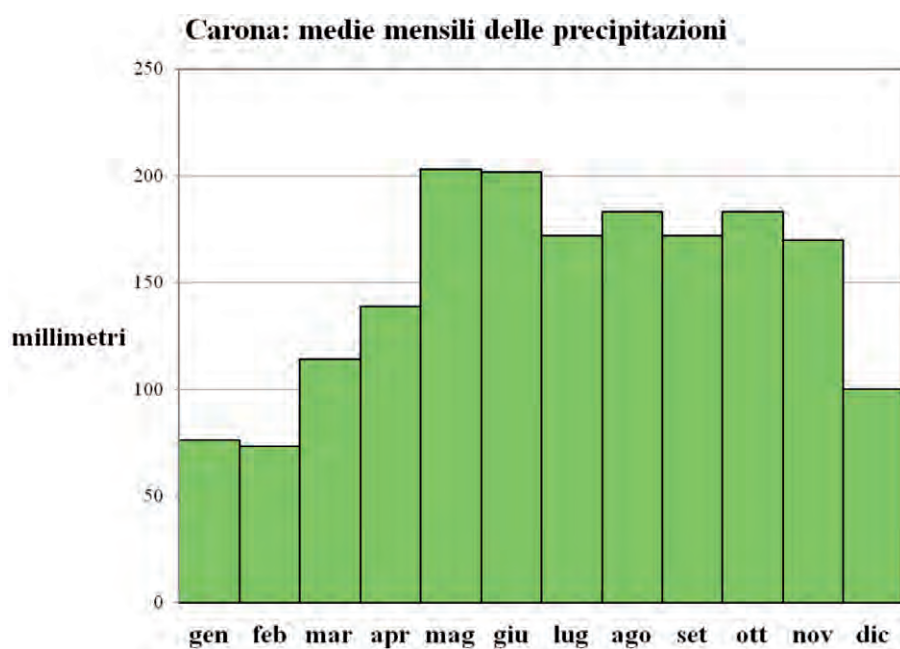


Fig. 4. Regime pluviometrico della stazione di Carona negli anni 1955-1984.

vide il territorio in oggetto e dal loro più o meno accentuato infossamento, fattore quest'ultimo che riduce alquanto la durata giornaliera del soleggiamento durante i mesi invernali. L'esame della "Carta delle isoterme annue della Provincia di Bergamo" (Belloni & Pelfini, 1994) permette di valutare gli effetti di questi fattori in alcune zone del territorio e di distinguere le seguenti situazioni:

1. **Valle di Mezzoldo:** orientata da Nord verso Sud, è in esposizione tendenzialmente meridionale ed è quindi caratterizzata da una maggiore durata giornaliera della radiazione solare. La temperatura media annua è perciò più elevata rispetto alla valle di Carona: si attesta infatti sugli 8°C nella parte bassa della valle e, nonostante l'aumento della quota, è superiore agli 8°C nella parte alta.
2. **Tratto della valle di Carona compreso tra Lenna e Branzi:** ha un orientamento da Nord-Est verso Sud-Ovest ed è intersecata trasversalmente dalle isoterme degli 8°C nei pressi di Lenna, mentre quella dei 7°C la attraversa longitudinalmente tra Branzi e Moio dei Calvi. La diminuzione di temperatura in questo tratto è probabilmente da imputare in gran parte all'incremento della quota.
3. **Tratto della Valle di Carona nei pressi dell'abitato omonimo:** orientato da Est verso Ovest, presenta il versante sinistro esposto a Nord ed è sotto il cono d'ombra della catena che sovrasta i Laghi Gemelli. La temperatura media annua della stazione di Carona è di 6,8°C, con temperature medie mensili invernali sotto lo zero (mesi di dicembre, gennaio e febbraio) (cfr. Belloni & Pelfini, 1994).

Come è avvenuto in altre valli alpine, diversi comuni dell'alta Val Brembana, in concomitanza del boom economico che ha caratterizzato il secondo do-

poguerra, hanno subito un marcato spopolamento (cfr. dati dei censimenti del 1921 e del 2011 in Arrigoni, 2015: 42-43) che ha avuto come conseguenza il progressivo abbandono di molti dei pascoli e dei prati da sfalcio più impervi, un tempo sfruttati per un'agricoltura di sussistenza. Tali formazioni aperte hanno subito un consequenziale continuo arretramento a causa della ricolonizzazione da parte della vegetazione arbustiva e forestale, favorita anche dal clima molto umido che caratterizza la valle. Nel territorio in oggetto, quindi, le formazioni boschive occupano attualmente superfici molto vaste.

La distribuzione della copertura forestale rispecchia il classico schema delle zone altitudinali elaborato da Giacomini & Fenaroli (1958). Si distinguono infatti:

1. un orizzonte submontano delle querce caducifoglie e del castagno;
2. un orizzonte montano inferiore rappresentato dal *Fagetum*;
3. un orizzonte montano superiore delle conifere rappresentato prevalentemente da abete rosso (*Picea excelsa*) e larice (*Larix decidua*);
4. un orizzonte subalpino degli arbusti contorti occupato da ontaneti ad *Alnus viridis*, boscaglie di *Pinus mugo*, rodoreti a *Rhododendron hirsutum* (su substrati carbonatici) o a *Rhododendron ferrugineum* (su substrati silicei);
5. un orizzonte alpino dei pascoli;
6. un orizzonte alto alpino.

CATALOGO TOPOGRAFICO

Per la nomenclatura di quasi tutte le specie e per l'attribuzione del corotipo di competenza a ciascuna di esse si è fatto riferimento alla Checklist dei Carabidi italiani elaborata da Vigna Taglianti (2005), apportando peraltro alcune variazioni che sono di volta in volta giustificate con nota a piè di pagina. Invece, per quanto riguarda la nomenclatura dei Bembidiini, si è assunta come base la Checklist nel contributo più recente di Neri *et al.* (2011). Per ogni località segnalata viene indicata la citazione bibliografica o il raccogliatore (GA=Gianni Allegro; LBi=Luigi Bisio; LBo=Luca Bodei; PG=Piero Giuntelli; MG=Mario Grottolio; RM=Riccardo Monguzzi; PN=Paolo Neri; DP=Davide Pedersoli; AVT= Augusto Vigna Taglianti; FZ=Francesco Zaccheo).

1. *Cicindela (Cicindela) campestris campestris* Linné, 1758

Tab. 1. Dati pluviometrici stagionali relativi per la stazione pluviometrica di Carona.

Stazione pluviometrica di Carona m 1096	
Precipitazioni medie trimestre invernale mm	249
Precipitazioni medie trimestre primaverile mm	456
Precipitazioni medie trimestre estivo mm	557
Precipitazioni medie trimestre autunnale mm	525
Precipitazioni medie annue mm	1787

Pizzo dei Tre Signori (Franz, 1971); Rifugio Ca' d'Arera (Oltre il Colle) m 1450 (MG).

C. campestris si rinviene frequentemente in radure soleggiate o lungo i sentieri soprattutto nei piani submontano e montano (Pesarini & Monzini, 2011a). Più raramente si osserva anche in quello alpino.

Corotipo: Paleartico (PAL).

2. *Cicindela (Cicindela) gallica* Brullé, 1834

Pizzo dei Tre Signori (Magistretti, 1965; Monzini, 2008); Foppolo (Magistretti, 1965; Monzini, 2008); Corno Stella (Magistretti, 1965; Monzini, 2008); Rifugio Longo (ex Calvi) m 2000 (RM); Passo della Portula (Carona) m 2250 (LBI).

Diffusa in tutto l'arco alpino, *C. gallica*, a differenza di altre Cicindelinae, si rinviene quasi esclusivamente nei pascoli alpini, a quote superiori ai 1.500 m (Pesarini & Monzini, 2011a). Molto comune.

Corotipo: Centroeuropeo (CEU).

3. *Calosoma sycophanta* (Linné, 1758)

Zambla (Monzini, 2008).

C. sycophanta è un'entità diffusa dalla pianura sino al piano montano, dove può raggiungere i 1600 m di quota (Casale *et al.*, 1982). Talora si rinviene anche a quote ben superiori, ma, come osservato da Magistretti (1965) e da Casale *et al.* (1982), gli esemplari rinvenuti in alta montagna sono alloctoni, portati in quota dal vento. Presente soprattutto nei boschi, essa è una grande predatrice di bruchi e crisalidi di Lepidotteri, particolarmente Limantriidi e Taumetopeidi (Casale *et al.*, 1982).

Corotipo: Paleartico (PAL).

4. *Carabus (Eucarabus) italicus italicus* Dejean, 1826

Zambla (Monzini, 2008); Monte Alben (Monzini, 2008).

Specie endemica italiana, *C. italicus* è un'entità legata ai prati umidi, diffusa dalla pianura alla collina e ai monti sino a 1000-1500 m di quota (Casale *et al.*, 1982). Secondo Casale (1991) e Brandmayr *et al.* (2005), la specie è da considerarsi un indicatore biologico di buona conservazione dei biotopi.

Corotipo: Alpino-Appenninico (ALAP).

5. *Carabus (Tachypus) cancellatus emarginatus* Duftschmid, 1812

Dossena (Monzini, 2008); Serina (Magistretti, 1965;

Monzini, 2008); Oltre il Colle (Casale *et al.*, 2006); Zambla (Monzini, 2008); Colle di Zambla (Val Parina, Oltre il Colle) m 1200 (RM).

C. cancellatus è una specie dotata di ampia valenza ecologica che predilige soprattutto le formazioni aperte (prati, pascoli, coltivi e radure dei boschi) e che si rinviene dalla pianura sino a 2.000 m (Casale *et al.*, 1982).

Corotipo: Sibirico-Europeo (SIE).

6. *Carabus (Orinocarabus) castanopterus* A. Villa & G.B. Villa, 1833

Piani di Bobbio e Zuccone Campelli (Franz, 1971); Pizzo dei Tre Signori (Breuning, 1932-1936; Magistretti, 1965; Franz, 1971; Monzini, 2008); Pizzo di Giacomo (Valle di Ornica, Valle Stabina) m 2000, Peregò *legit* (RM); Passo di Verrobbio (Alta Val Mora) m 2000 (RM); Passo di San Marco (Monzini, 2008); Passo di San Marco (Mezzoldo) m 2000 (Busato, 2004); Passo di San Marco (Mezzoldo) m 1900 (LBI); Passo di San Marco (Mezzoldo) m 2000 (RM); San Simone (Monzini, 2008); Passo di San Simone (Magistretti, 1965; Casale *et al.*, 2006); Passo di San Simone (Mezzoldo) m 2000 (LBI); Bocchetta di San Simone m 2000 (LBo; MG); Corno Stella (Magistretti, 1965); Foppolo m 2000, Dacatra *leg.* (LBI); Monte Cadelle (Foppolo) m 1800, R. Rossi *leg.* (RM); Passo Venina (Foppolo) m 2400 (RM); Val Sambuzza (Carona) (Magistretti, 1965); Pizzo del Diavolo di Tenda (Carona) m 2000 (LBI); sentiero per la Bocchetta Podavit (Pizzo del Diavolo di Tenda, Carona) m 2350 (DP); Rifugio Calvi (Carona) (Monzini, 2008); Rifugio Calvi (Carona) m 2200 (FZ); Rifugio Calvi (Carona) m 2000 (RM); Passo della Portula (Carona) m 2250 (LBI); Laghi Gemelli (Monzini, 2008); Laghi Gemelli (Carona) m 2000 (LBI); Passo d'Aviasco (Carona) m 2200 (LBI); Baite di Mezzeno (Roncobello) m 1500 (LBI); Monte Corna Piana (Pizzo Arera, Roncobello) m 1900 (LBI & PG); Pizzo Arera (Bernau, 1914: sub *alpestris* var. *montisarerae*; Breuning, 1932-1936; Magistretti, 1965); Pian Cansaccio (Pizzo Arera, versante Val Parina) m 1800 (RM); Mandrone (Pizzo Arera, versante Val Parina) m 2000 (RM); dintorni Rifugio Capanna 2000 (Oltre il Colle) m 1970 (DP); Monte Alben (Monzini, 2008).

Endemita noto del Canton Ticino, delle Alpi e Prealpi Bergamasche e della Valtellina, *C. castanopterus* è una specie montana, diffusa particolarmente in massicci calcarei, dove si rinviene (tra i 1500 m sin oltre

i 2500 m di quota) come sublapidicola nei pascoli, lungo le morene, le doline e presso i nevai (Casale *et al.*, 1982).

Corotipo: Centro-S-Alpino (ALPC).

7. ***Carabus (Tomocarabus) convexus convexus*** Fabricius, 1775

Branzi m 900 (LBi).

C. convexus è una specie diffusa dalle coste fino a oltre i 2.000 m. Generalmente silvicola, è più comune nei boschi di latifoglie, lungo i sentieri o nelle radure, ma si rinviene talora anche nel pascolo alpino (Casale *et al.*, 1982).

Corotipo: Sibirico-Europeo (SIE).

8. ***Carabus (Platycarabus) creutzeri kircheri*** (Germar, 1824)

Monte Venturosa m 1900 (RM); Zuccone Campelli m 2200 (Franz, 1971); Vallone dei Camosci, (Zuccone Campelli) m 2100 (RM); dintorni di Foppolo m 1400 (RM); San Simone (Monzini, 2008); Bocchetta di San Simone m 2000 (RM); Carona m 1200 (LBi); Monte Menna (Lemma) (Magistretti, 1968); Monte Corna Piana (Pizzo Arera, Roncobello) m 1900 (LBi & PG); Pizzo Arera (Bernau, 1914: sub *creutzeri grignensis*; Breuning, 1932-1936; Magistretti, 1965); Costa di Serina (Val Serina) (RM); dintorni Zambra Alta (Oltre il Colle) m 1140 (DP).

C. creutzeri è un elemento proprio delle Alpi e Prealpi centrali ed orientali, dal Lago di Lugano e di Como alla Carinzia, alla Carniolia ed alla Liburnia (Casale *et al.*, 1982). L'areale della ssp *kircheri* si sovrappone parzialmente a quello di *C. depressus* (Dolomiti, Alpi e Prealpi Orobiche) che sostituisce nei massicci calcarei (cfr. Brandmayr & Zetto Brandmayr, 1979; Brandmayr *et al.*, 1988; Casale & Vigna Taglianti, 2005). È un'entità prevalentemente silvicola che, comune particolarmente nei boschi e nelle foreste, raggiunge i 2000-2500 m in molte località montane (Casale *et al.*, 1982).

Corotipo: E-Alpino (ALPE).

9. ***Carabus (Platycarabus) depressus depressus*** Bonelli, 1810

Pizzo dei Tre Signori (Franz, 1971); Vallone dei Camosci, (Zuccone Campelli) m 2100 (RM); Mezzoldo m 1300 (LBi); dintorni di Mezzoldo m 1500 (RM); Passo di San Marco (Mezzoldo) m 1900-2000 (LBi); Passo di San Simone (Mezzoldo) m 2000 (LBi); Bocchetta di San Simone m 2000 (LBo; MG; RM); Passo

Venina (Foppolo) m 2300 (RM); Passo Dordona (Magistretti, 1965; Monzini, 2008); Val Sambuzza (Magistretti, 1965); Pizzo del Diavolo di Tenda (Carona) m 2000 (LBi); Rifugio Calvi (Carona) m 2200 (F. Zaccaro com. pers. 2018); Laghi Gemelli (Magistretti, 1965; Monzini, 2008).

C. depressus è un elemento diffuso in gran parte della catena alpina sui due versanti, dalle Alpi Marittime all'Austria. Eualpino nelle Alpi Marittime, nelle aree più settentrionali, più fresche e assai piovose scende fino a 800-900 m di quota (Casale *et al.*, 1982). In Val Brembana, dove è molto comune, viene sostituito dall'affine *C. creutzeri* su substrati carbonatici. Monzuzzi (com. pers., 2019) ha peraltro rinvenuto le due specie sintopiche sotto la stessa pietra su substrato calcareo nel Vallone dei Camosci. Un altro caso di sintopia tra le due specie osservato da Monzini è stato recentemente segnalato da Casale & Rapuzzi (2015). Corotipo: Centroeuropeo (CEU).

10. ***Carabus (Megodontus) germarii germarii*** Sturm, 1815

Bocchetta di San Simone m 2000 (LBo); Pizzo Arera (Monzini, 2008); Serina (Monzini, 2008); Oltre il Colle (Monzini, 2008);

C. germarii è un elemento Alpino-Balcanico, distribuito dalle Alpi Occidentali all'Ungheria, attraverso la Pianura Padana e marginalmente lungo l'Appennino Settentrionale. La ssp. nominale è diffusa dalle Alpi Giulie alle Orobiche e al Canton Ticino. È un'entità eurica, comune tanto in boschi e foreste, quanto nell'alto pascolo alpino, nei prati, nei campi e nei coltivi di pianura (Casale *et al.*, 1982).

Corotipo: S-Europeo (SEU).

11. ***Cychrus angustatus*** Hoppe & Hornschuch, 1825
Carona, F. Bosi *legit* (RM); Bocchetta di San Simone m 2000 (MG); Passo Branchino (Roncobello) m 1700 (LBi & PG); Pizzo Arera (Casale *et al.*, 2006); Oltre il Colle (Magistretti, 1965; Monzini, 2008); Piazza dei Muffi (Oltre il Colle) m 1850 (DP); Val Parina, Oltre il Colle m 1100 (RM); Monte Alben (Magistretti, 1965; Monzini, 2008; MG).

C. angustatus è diffuso lungo tutta la catena alpina e prealpina, ma risulta molto più frequente nelle Alpi e Prealpi centro-orientali. Specie montana, la si rinviene dal *Fagetum* (1000-1700 m) fino ai pascoli alpini oltre i 2.200 m (Casale *et al.*, 1982).

Corotipo: Centroeuropeo (CEU).

12. ***Cychrus caraboides caraboides*** (Linné, 1758)
Passo Branchino (Roncobello) m 1700 (LBi).

C. caraboides è una specie che dalla pianura sale oltre i 2000-2400 m. Predilige le foreste di latifoglie, mentre risulta meno frequente nei pascoli alpini (Casale *et al.*, 1982).

Corotipo: Europeo (EUR).

13. ***Cychrus cylindricollis*** Pini, 1871

Pizzo dei Tre Signori (K. Daniel, 1908; Holdhaus 1954; Magistretti, 1965; Casale *et al.*, 1982; Monzini, 2008); Monte Ponteranica (Casale *et al.*, 1982); Passo di San Simone (Casale *et al.*, 2006); Bocchetta di San Simone m 2000 (LBo; MG); Monte Pegherolo (Magistretti, 1965; Casale *et al.*, 1982; Monzini, 2008); Monte Cadelle (Foppolo) m 1800, R. Rossi *leg.* (RM); Laghi Gemelli (Magistretti, 1965; Casale *et al.*, 1982; Monzini, 2008); Passo di Aviasco m 2000 (LBi); Monte Corna Piana (Pizzo Arera, Roncobello) m 1900 (LBi & PG); Pizzo Arera (Holdhaus, 1954; Magistretti, 1965; Casale *et al.*, 1982); Pizzo Arera m 2000-2200 (Casale *et al.*, 2006); Pizzo Arera (versante Val Parina) m 2000 (RM); sentiero dei Fiori (Pizzo Arera) m 2000 (Casale *et al.*, 2006).

Cychrus cylindricollis è un endemita diffuso dalle Alpi e Prealpi Bergamasche al Monte Baldo e ai Monti Lessini che popola, con colonie piuttosto localizzate, alcuni distretti di rifugio carbonatici. La specie, che si rinviene sotto grandi massi e tra la ghiaia di conche umide interessate da innevamento prolungato, è strettamente legata alla presenza di *Helix frigida* De Cristofori & Jan, 1832, di cui si nutre (Casale *et al.*, 1982; Grottole *et al.*, 2016). Casale & Vigna Taglianti (1992) ne hanno descritto la morfologia larvale.

Corotipo: Centro-S-Alpino (ALPC).

14. ***Cychrus italicus*** Bonelli, 1810

Piazzatorre (Magistretti, 1965); San Martino dei Calvi (Magistretti, 1965); Oltre il Colle (Magistretti, 1965). Specie endemica italiana, diffusa in tutta l'Italia continentale ad eccezione del Veneto, del Friuli Venezia Giulia e della parte meridionale della Puglia, *C. italicus* popola ambienti molto diversi dalla pianura fino ai 1.500 m di quota (raramente si spinge fino ai 2.000 m) (Casale *et al.*, 1982).

Corotipo: Alpino-Appenninico (ALAP).

15. ***Cychrus attenuatus attenuatus*** (Fabricius, 1792)
Bocchetta di S. Simone (Foppolo) m 2000 (RM).

C. attenuatus è specie per lo più montana, ma non strettamente alticola, che si rinviene da poche centinaia di metri sul livello del mare a 2000-2400 m. È più frequente in boschi e foreste, particolarmente di faggio o conifere, pur essendo comunque presente anche negli alti pascoli, presso i nevai e tra gli sfasciumi (Casale *et al.*, 1982).

Corotipo: Centroeuropeo (CEU).

16. ***Leistus (Leistus) nitidus*** (Duftschmid, 1812)

Piani di Bobbio m 1600 (Franz, 1971); Piazzo (Piazzatorre) m 1100 (LBi); Rifugio Madonna delle Nevi (Mezzoldo) m 1300 (LBi); Bocchetta di San Simone (Monzini, 2008).

Moderatamente igrofilo, *L. nitidus* è una specie montana, prevalentemente silvicola e raramente ripicola, che tende talora a spingersi trasgressivamente ben al di sopra del limite superiore della vegetazione arborea (Bisio *et al.*, 2017).

Corotipo: Centroeuropeo (CEU).

17. ***Leistus (Pogonophorus) rufomarginatus*** (Duftschmid, 1812)

Mezzoldo (Magistretti, 1965; Monzini, 2008).

Elemento prevalentemente silvicolo e montano (Magistretti, 1965), *L. rufomarginatus* è una specie diffusa in tutta Italia.

Corotipo: Europeo (EUR).

18. ***Leistus (Pogonophorus) spinibarbis spinibarbis*** (Fabricius, 1775)

Vetta del Monte Alben m 2020 (DP).

L. spinibarbis è un'entità silvicola moderatamente igrofila che si rinviene in primavera e in autunno nelle aree forestali più fresche (Bisio *et al.*, 2017).

Corotipo: Europeo (EUR).

19. ***Leistus (Pogonophorus) montanus rhaeticus*** Heer, 1837

Bocchetta di San Simone (Monzini, 2008); Bocchetta di San Simone m 2100 (RM).

La distribuzione in Italia di *L. montanus* è ancora poco conosciuta, sia perché, almeno apparentemente, la specie risulta molto rara, sia perché essa viene forse confusa con *L. spinibarbis*. A causa della scarsità di esemplari nelle collezioni è attualmente difficile dimostrare la validità della ssp. *rhaeticus* che viene considerata un semplice sinonimo junior da Coulon *et al.* (2011). Secondo Fritze &

Hannig (2010), la specie sembra presentare un excursus altitudinale molto ampio, compreso tra 300 e 2170 m.

Corotipo: Europeo (EUR).

20. *Nebria (Nebriola) fontinalis fontinalis* K. Daniel & J. Daniel, 1890

Rifugio Ca' del Sul (Ornica) m 1700 (LBi & PG); Val d'Inferno (Pizzo dei Tre Signori) (Magistretti, 1965); Monte Avaro (Cusio) m 2000 (RM); Monte Ponteranica (Magistretti, 1965; Monzini, 2008); Monte Ponteranica m 2000 (RM); Passo di San Marco (Monzini, 2008); Bocchetta di San Simone (Magistretti, 1965; Monzini, 2008); Bocchetta di San Simone m 2000 (RM); Passo di San Simone (Mezzoldo) m 1900-2000 (LBi); Val Sambuzza (Magistretti, 1965; Monzini, 2008); sentiero per la Bocchetta Podavit (Pizzo del Diavolo di Tenda, Carona) m 2400 (DP); Rifugio Calvi (Monzini, 2008); Rifugio Calvi (Carona) m 2200 (FZ); Laghi Gemelli (Binaghi, 1951; Magistretti, 1965; Monzini, 2008); Laghi Gemelli (Carona) m 2000 (LBi); dintorni del Rifugio Laghi Gemelli (Branzi) m 1970 (DP); Passo di Aviasco (Magistretti, 1965); Passo d'Aviasco (Carona) m 2200 (LBi); Passo di Mezzeno (Roncobello) m 2100 (LBi); Passo Branchino (Roncobello) m 1700 (LBi & PG).

Specie diffusa nelle Alpi Bergamasche, Bresciane, Giudicarie e Ticinesi, (Magistretti, 1965; Pesarini & Monzini, 2011a), *N. fontinalis* è un elemento ripiccolo stenotermo, legato ad acque fredde, che si rinviene lungo i ruscelli convoglianti acque sorgive e di fusione. Focarile (1973) considera questo taxon come una delle specie guida del suo *Nebrietum fontinale*, coleotterocenosi che occupa i bordi e il letto dei rigagnoli e torrentelli convoglianti acque sorgive e/o di fusione a bassa temperatura.

Corotipo: Centro-S-Alpino (ALPC).

21. *Nebria (Boreonebria) rufescens* (Stroem, 1768) Mezzoldo (Magistretti, 1965: sub *gyllenhali*; Monzini, 2008); Passo di San Marco (Magistretti, 1965: sub *gyllenhali*; Monzini, 2008); Valleve m 1100 (LBi); Lago Arale (San Simone) m 1700 (LBi & PG); Bocchetta di San Simone (Magistretti, 1968; Monzini, 2008); Bocchetta di San Simone m 2000 (MG; RM); Carona (Magistretti, 1965: sub *gyllenhali*; Monzini, 2008); Foppolo m 1500 (LBi); sentiero per la Bocchetta Podavit (Pizzo del Diavolo di Tenda, Carona) m 2400 (DP); Oltre il Colle (Magistretti, 1965; Monzini, 2008).

N. rufescens è un'entità ripiccola molto comune che popola le sponde dei torrenti montani.

Corotipo: Oloartico (OLA).

22. *Nebria (Eunebria) jockischii* Sturm, 1815

Rifugio Ca' del Sul (Ornica) m 1700 (LBi & PG); Mezzoldo m 1300 (LBi); Pizzo (Piazzatorre) m 1100 (LBi); Foppolo (Magistretti, 1965; Monzini, 2008); versante W del Pizzo Farno (Branzi) m 2000 (DP); Laghi Gemelli (Magistretti, 1965); Baite di Mezzeno (Roncobello) m 1500 (LBi); Pizzo Arera (Monzini, 2008); Monte Alben (Monzini, 2008).

Elemento eualpino e montano, *N. jockischii* è un'entità tendenzialmente ripiccola e igrofila (Magistretti, 1965). Generalmente molto comune.

Corotipo: Centroeuropeo (CEU).

23. *Nebria¹ (Oreonebria) castanea brunnea* (Duftschmid, 1812)

Monte Ponteranica (Magistretti, 1965); Monte Ponteranica m 2000 (RM); Passo di San Marco m 2000 (RM); Bocchetta di San Simone (Magistretti, 1965); Bocchetta di San Simone m 2000 (MG; RM); Passo Dordona (Foppolo) (Magistretti, 1965); Corno Stella (Magistretti, 1965).

Secondo Focarile & Casale (1978), *N. castanea* è un'entità perinivale in senso stretto, cioè un predatore/necrofago di *pabulum* alloctono in grado di muoversi sulla neve per cibarsi degli insetti portati in quota dalle correnti ascensionale ricaduti sul nevaio stesso. Focarile (1973) la considera una delle specie guida del suo *Nebrietum nivale*, coleotterocenosi che popola i margini dei nevai temporanei e semipermanenti su substrati già parzialmente evoluti e colonizzati almeno in parte dalla prateria alpina.

Corotipo: Centroeuropeo (CEU).

24. *Nebria (Oreonebria) picea picea* (Dejean, 1826)

Monte Ponteranica (Monzini, 2008); Monte Ponteranica m 2000-2200 (Monzini, 2008; AVT: sub *picea lanceolata*); Passo di San Marco m 2000 (LBi); Bocchetta di San Simone m 2000 (MG); Passo di San Simone (Mezzoldo) m 2000 (LBi); Lago Arale (San Simone) m 1700 (LBi & PG); Rifugio Calvi (AVT: sub *picea lanceolata*); Rifugio Calvi (Carona) m 2200 (FZ); Pizzo del Diavolo di Tenda (Carona) m 2000

¹ Sensu Ledoux & Roux (2005).

(LBi); Laghi Gemelli (Magistretti, 1965: sub *castanea brunnea*; Monzini, 2008; AVT: sub *picea lanceolata*); Laghi Gemelli (Carona) m 2000 (LBi); Passo Brachino (Roncobello) m 1700 (LBi & PG).

Secondo Vigna Taglianti (com. pers., 2007), gli esemplari di *N. picea* della Val Brembana appartenerebbero alla ssp. *lanceolata* Meggiolaro, 1960, il cui areale complessivo occuperebbe le Alpi Retiche, le Orobiche e il Monte Grappa. In attesa di una revisione della specie, continuiamo a considerare gli esemplari della valle come appartenenti alla ssp. nominale. La specie è un elemento silvicolo criofilo, tipico delle grandi foreste fredde e umide del piano montano e subalpino, che raggiunge anche quote elevate in concomitanza di microclimi adatti quale elemento relitto delle foreste post-würmiane (Focarile & Casale, 1978). La specie, a differenza di *N. castanea*, *N. lombarda* e *N. soror*, è probabilmente un predatore di *pabulum* autoctono. Corotipo: S-Alpino (ALPS).

25. ***Nebria (Oreonebria) lombarda*** (K. Daniel & J. Daniel, 1890)

Monte Corna Grande, Vallone dei Mugoffi (Valtorta) m 1900 (LBi & PG); Pizzo dei Tre Signori (Holdhaus, 1954; Magistretti, 1965; Franz, 1971; Monzini, 2008); Foppolo (Magistretti, 1968); Bocchetta di San Simone (Magistretti, 1965; Monzini, 2008); Bocchetta di San Simone m 2000 (MG); Passo di San Simone (Mezzoldo) m 1800, Gudenzi leg. (LBi); Pizzo del Diavolo di Tenda (Carona) m 2000 (LBi); sentiero per la Bocchetta Podavit (Pizzo del Diavolo di Tenda, Carona) m 2450 (DP); Rifugio Calvi (Carona) m 2020 (MG); Passo della Portula (Carona) m 2250 (LBi); Passo d'Aviasco (Carona) m 2200 (LBi); Passo dei Laghi Gemelli (Branzi) m 2140 (DP); Monte Corna Piana (Pizzo Arera, Roncobello) m 1900 (LBi & PG); Pizzo Arera (Holdhaus, 1954; Magistretti, 1965); versante S del Pizzo Arera (Oltre il Colle) m 2200 (DP); miniera lungo il versante W del Pizzo Arera (Oltre il Colle) m 2070 (DP); miniera presso Rifugio Capanna 2000 (Oltre il Colle) m 1950 (DP); Monte Alben (Magistretti, 1965; Monzini, 2008); Colle Brassamonti (Monte Alben) m 1755 (DP; MG).

Endemita delle Alpi e Prealpi Orobiche, *N. lombarda* è una specie orofila che popola conche fredde e nevose sopra i 1700-1800 m di quota. Come *N. castanea*, è probabilmente un elemento perinivale in senso stretto (sensu Focarile & Casale, 1978), cioè un predatore/necrofago di *pabulum* alloctono che si muove nottetempo

sulla superficie dei nevai per nutrirsi della microfauna portata in quota dalle correnti ascensionali.

Corotipo: Centro-S-Alpino (ALPC).

26. ***Nebria (Oreonebria) soror tresignore*** Szallies & Huber, 2014

Pizzo dei Tre Signori (Monzini, 2008: sub *angustata*); Pizzo dei Tre Signori, Valle dell'Inferno m 2200 (Szallies & Huber, 2014; Gobbi *et al.*, 2018); Pizzo del Diavolo di Tenda m 2640 (Gobbi *et al.*, 2018).

N. soror (Daniel, 1903) s.l. è presente sulle Alpi con due sottospecie: la nominale, che è diffusa principalmente sul gruppo montuoso Adamello-Presanella e Monte Baldo (Ledoux & Roux, 2005), e la ssp. *tresignore*, che è propria invece del crinale orobico dove è presente con distribuzione puntiforme delle sue popolazioni (cfr. cartina corologica in Gobbi *et al.*, 2018). La specie è spiccatamente criofila e vive in alta quota come elemento perinivale e periglaciale in habitat estremi, quali *rock glaciers*, glacionevati, fronti glaciali, falde detritiche e morene, non ancora o scarsamente colonizzati dalla vegetazione pioniera, quindi poveri di sostanza organica (cfr. Gobbi *et al.*, 2014, 2018; Pivetti *et al.*, 2016; Szallies & Huber, 2014; Tampucci *et al.*, 2015). Come rilevato da Gobbi *et al.* (2018: 6), anche *N. soror* è una specie in grado di deambulare sulla neve e sul ghiaccio, dove, secondo quanto già ipotizzato da Focarile (1973) per le affini *N. angustata* (Dejean & Boisduval, 1830) e *N. angusticollis* (Bonelli, 1810), va alla ricerca di insetti trasportati in quota dalle correnti ascensionali. Si tratta pertanto di un elemento predatore/necrofago di *pabulum* alloctono dei piani altoalpino e nivale che popola substrati ai primi stadi evolutivi (litosuoli). Assieme a *N. angustata* e a *N. angusticollis*, è pertanto da annoverare tra le specie che caratterizzano l'*Oreonebrietum* (sensu Focarile, 1973), coleotterocenosi che, secondo la definizione dell'autore stesso, è la più elevata associazione perinivale rinvenibile sulle Alpi (dai 2000 ai 3400 m e oltre) che occupa le alte quote del deserto alpino, dove dominano ormai solo pareti di roccia, ghiacciai e nevai permanenti con rare isole scoperte. Gobbi *et al.* (2018) evidenziano l'estremo interesse biogeografico e conservazionistico della ssp. *tresignore* a causa dell'alto rischio di una sua estinzione, essendo la sua sorte legata in modo indissolubile alle masse glaciali o ai nevai permanenti che nelle Alpi Orobiche (anche a causa delle quote non molto elevate del crinale orobico) sono ormai di estensione vera-

mente ridotta e prossimi alla scomparsa a causa dei cambiamenti climatici in atto.

Corotipo: Centro-S-Alpino (ALPC).

27. *Notiophilus aquaticus* (Linné, 1758)

Pizzo dei tre Signori (Magistretti, 1965); Mezzoldo (Magistretti, 1965; Monzini, 2008); Passo di San Marco m 2000 (RM); Rifugio Calvi (Carona) m 2200 (FZ).

Eualpino e montano secondo Magistretti (1965), *N. aquaticus* si rinviene soprattutto nei pascoli della fascia alpina, spesso sopra i 2.000 m.

Corotipo: Oloartico (OLA).

28. *Notiophilus palustris* (Duftschmid, 1812)

Monte i Canti (Val Taleggio) (Monzini, 2008); Branzi (Magistretti, 1968); Branzi m 900 (LBi); Monte Ponteranica (Magistretti, 1965; Monzini, 2008).

Diffuso soprattutto nei piani submontano e montano, *N. palustris* è una specie che si rinviene in biotopi umidi e mediamente umidi, sia in foresta, sia nelle formazioni aperte.

Corotipo: Sibirico-Europeo (SIE).

29. *Notiophilus biguttatus* (Fabricius, 1779)

Piazzo (Piazzatorre) m 1100 (LBi); Monte Venturosa m 1900 (RM); Bocchetta di San Simone (Magistretti, 1965); Bocchetta di San Simone m 2000 (MG; RM); Branzi m 900 (LBi); Corno Stella (Magistretti, 1965); Oltre il Colle m 1100 (RM); Colle Brassamonti (Monte Alben) m 1755 (DP; MG).

N. biguttatus è un elemento prevalentemente silvicolo che frequenta soprattutto aree umide e fresche dei piani montano e submontano.

Corotipo: Oloartico (OLA).

30. *Alpiodytes ravizzai* Sciaky, 1985

Bocchetta di San Simone m 2000, 2 es. (RM); Zambla (Oltre il Colle, Val Serina) m 1000 (Sciaky, 1985).

Il genere *Alpiodytes* è l'unico rappresentante alpino di una linea di piccoli Scaritinae Clivinini endogei (Reicheiina) ampiamente distribuiti nell'area mediterranea e nell'Africa a Sud del Sahara (Casale & VignaTaglianti, 1993). Di esso si conoscono solo due specie i cui areali sono nettamente separati: *A. penninus* (Binaghi, 1936), noto di località puntiformi delle Prealpi Biellesi e del Canavese, e *A. ravizzai*, endemita delle Prealpi Bergamasche. Di quest'ultima specie sono noti solo sei esemplari: i tre della serie tipica, raccolti nel

greto di un torrente a Zambla, i due della Bocchetta di San Simone e un individuo trovato da Monguzzi (com. pers., 2019) a 900 m di quota presso Orezzo (Gazzaniga, media Val Seriana). La sua ecologia è del tutto sconosciuta.

Corotipo: E-Alpino (ALPE).

31. *Reicheiodes schatzmayri* Bari, 1950

Pizzo Arera (Bari, 1950; Magistretti, 1965; Monzini, 2008); versante S del Pizzo Arera (Oltre il Colle) m 2200 (DP).

R. schatzmayri è uno stenoendemita delle Alpi Orobie, noto solo del Pizzo Arera. La specie è anche nota del versante serianese del Pizzo Arera (Monguzzi com. pers., 2019).

Corotipo: E-Alpino (ALPE).

32. *Broskosoma relictum* Weissmandl, 1935

Monte Ponteranica (Magistretti, 1965; Monzini, 2008); Monte Ponteranica m 2000 (RM); Bocchetta di San Simone (Luigioni, 1929: sub *baldense*; Weissmandl, 1935); Holdhaus, 1954; Magistretti, 1965; Monzini, 2008); Passo di San Simone (Mezzoldo) m 2000, Gudenzi leg. (LBi); Bocchetta di San Simone m 2000 (MG; RM); Monte Pegherolo (Magistretti, 1965; Monzini, 2008); Pizzo Arera (Monzini, 2008); Monte Alben (Weissmandl, 1935; Magistretti, 1965; Monzini, 2008); Monte Alben m 2000 (versante di Val Parina, Oltre il Colle) (RM); Colle Brassamonti (Monte Alben) m 1755 (DP; MG).

Il genere *Broskosoma* ha una distribuzione disgiunta alpino-asiatica (cfr. cartine di distribuzione del genere *Broskosoma* in Giachino & Vailati, 1993 e in Casale & Vigna Taglianti, 2005) ed è presente in Italia con due sole specie: *B. relictum*, endemita delle Alpi Orobie, e *B. baldense* Rosenhauer, 1846, diffuso nelle Prealpi Bresciane e dalle Giudicarie al Monte Baldo e al Pasubio (Pesarini & Monzini, 2011a; Grottole *et al.*, 2016). *B. relictum* è una specie predatrice che si rinviene principalmente presso ghiaioni, morene e scarpate sassose (Monzini, 2008).

Corotipo: Centro-S-Alpino (ALPC).

33. *Thalassophilus longicornis* (Sturm, 1825)

Branzi (Magistretti, 1965; Monzini, 2008).

T. longicornis è un'entità ripicola diffusa dalla pianura al piano alpino che si rinviene nei greti dei corsi d'acqua.

Corotipo: Europeo (EUR).

34. ***Trechus (Trechus) rubens*** (Schränk, 1781)

Passo di San Marco (Monzini, 2008).

T. rubens è un'entità presente in Italia dalle Alpi lombarde alle Tridentine (Degiovanni & Magrini, 2019).
Corotipo: Oloartico (OLA).

35. ***Trechus (Trechus) obtusus obtusus*** Erichson, 1837

Monte Alben (Magistretti, 1965; Monzini, 2008).

T. obtusus è una specie ad ampia distribuzione la cui sottospecie nominale è nota di tutta Italia con l'esclusione della Sardegna (Degiovanni & Magrini, 2019).
Corotipo: Europeo-Mediterraneo (EUM).

36. ***Trechus (Trechus) binotatus*** Putzeys, 1870

Piani di Bobbio m 1600 (Franz, 1971: sub *fairmairei*); Zuccone Campelli m 1600-1700 (Donabauer & Lebenbauer, 2003: sub *kahleni*); Mezzoldo (Magistretti, 1965: sub *fairmairei*); Pizzo (Piazzatorre) m 1100 (LBi); Passo di San Marco (Magistretti, 1965: sub *fairmairei*); Passo di San Marco m 2000 (Donabauer & Lebenbauer, 2003: sub *kahleni*; RM); Bocchetta di San Simone (versante di Mezzoldo) m 2000 (RM); Passo San Simone m 2000 (De Giovanni & Magrini, 2016; MG); Valleve m 1350 (De Giovanni & Magrini, 2016); Foppolo (Magistretti, 1968: sub *fairmairei*); Monte Pegherolo m 2250 (De Giovanni & Magrini, 2016); Pizzo Arera (MG); dintorni di Dossena (RM); Oltre il Colle (Jeannel, 1927: sub *fairmairei*; Magistretti, 1965: sub *fairmairei*); dintorni Rifugio Ca' d'Arera (Oltre il Colle) m 1450 e 1580 (DP); dintorni Rifugio Capanna 2000 (Oltre il Colle) m 1950 (DP); Val Parina (Oltre il Colle) m 1100 (RM); Valpiana (Val Parina, Oltre il Colle) m 1000 (RM).

Considerato per lungo tempo sinonimo di *T. fairmairei* Pandellé, 1867, *T. binotatus* è stato recentemente riportato al rango di specie distinta da Degiovanni & Magrini (2016). La specie è un endemita italiano che occupa buona parte dell'Italia continentale. Verso Sud è noto sino alla linea Monte Cairo-Matese (Degiovanni & Magrini, 2019).

Corotipo: Alpino-Appenninico (ALAP)

37. ***Trechus (Trechus) schaumii*** Pandellé, 1877²

Monte Venturosa m 1900 (Casale *et al.*, 2006: sub *ma-*

rianii; RM); Monte Corna Grande, Vallone dei Mugoffi (Valtorta) m 1900 (LBi & PG); Zuccone Campelli (Magistretti, 1965: sub *marianii*; Monzini, 2008: sub *marianii*); Piani di Bobbio, Diotti leg. (GA); Pizzo dei Tre Signori m 2200-2300 (Franz, 1971: sub *longobardus*); Passo di Verrobio (Alta Val Mora) m 2000 (RM); Laghi di Ponteranica (Focarile, 1949: *brembanus*; Magistretti, 1965: *brembanus*; Monzini, 2008: *brembanus*); Laghi di Ponteranica m 2150 (RM); Monte Ponteranica, Diotti leg. (MG); Passo di San Marco (Monzini, 2008: *brembanus*); Passo di San Marco m 1900-2000 (Casale *et al.*, 2006: *brembanus*; MG); Passo di San Marco m 2000 (Degiovanni & Magrini, 2019; RM); Passo di San Marco, Diotti leg. (GA); Bocchetta di San Simone (Monzini, 2008: *brembanus*); Bocchetta di San Simone (versante di Mezzoldo) m 2000 (RM); Passo di Lemma (San Simone) (Focarile, 1950: sub *intrusus*; Magistretti, 1965: sub *intrusus*); Passo Dordona (Magistretti, 1965: sub *intrusus*; Monzini, 2008: *brembanus*); Passo Dordona m 2000 (Degiovanni & Magrini, 2019); Passo Dordona (Foppolo) m 2200 (RM); Lago Rotondo (Carona) (Monzini, 2008: *brembanus*); Rifugio Calvi (Carona) m 2000 (RM).

Trechus marianii Focarile, 1949, *T. longobardus* Putzeys, 1870, *T. brembanus* Focarile, 1950 e *T. intrusus* Focarile 1950 sono stati recentemente messi in sinonimia con *T. schaumii* da Donabauer (2017). La specie è uno stenoendemita delle Alpi Lepontine orientali e Retiche (Degiovanni & Magrini, 2019).

Corotipo: Centro-S-Alpino (ALPC).

38. ***Trechus (Trechus) bergamasculus*** Jeannel, 1927 (= *T. orobicus* Monguzzi, 2015)

Monte Alben m 1800 (Degiovanni & Magrini, 2019); Monte Alben m 2000 (versante di Val Parina, Oltre il Colle) m 1900 (RM); Colle Brassamonti (Monte Alben) m 1730-1755 (DP; MG).

T. bergamasculus è un endemita delle Prealpi Bresciane, delle Prealpi Bergamasche e del Monte Alben (Degiovanni & Magrini, 2019).

Corotipo: Centro-S-Alpino (ALPC).

39. ***Trechus (Trechus) montisarerae*** Focarile, 1950
Dintorni Passo Monte Corna Piana m 1950 (DP); Pizzo Arera (Focarile, 1950; Magistretti, 1965; Monzini, 2008); Pizzo Arera (Oltre il Colle) (MG); Monte Arera (Luigioni, 1929: sub *insubricus*); Monte Arera m 2200 (Degiovanni & Magrini, 2019); Monte Alben

² Sensu Donabauer (2017).

(Magistretti, 1965; Monzini, 2008; Pesarini & Monzini, 2011a).

T. montisarerae è uno stenoendemita delle Prealpi Bergamasche, localizzato sui monti della Val Serina e sul Monte Arera (Degiovanni & Magrini, 2019). Secondo Degiovanni & Magrini (2019) le citazioni relative al Monte Alben sarebbero da riferire a *T. bergamascus*.

Corotipo: Centro-S-Alpino (ALPC).

40. ***Trechus (Trechus) insubricus*** K. Daniel & J. Daniel, 1898

Bocchetta di San Simone (Focarile, 1950; Holdhaus, 1954; Magistretti, 1965; Monzini, 2008; MG); Corno Stella (Focarile, 1950; Magistretti, 1965; Monzini, 2008); Val Sambuzza (Focarile, 1950; Magistretti, 1965; Monzini, 2008); Lago Moro (Foppolo) (Monzini, 2008); sentiero per la Bocchetta Podavit (Pizzo del Diavolo di Tenda, Carona) m 2450 (DP); Rifugio Calvi (Focarile, 1950; Magistretti, 1965; Monzini, 2008); Lago Rotondo (Carona) m 2000 (Casale *et al.*, 2006); Laghi Gemelli (Focarile, 1950; Magistretti, 1965; Monzini, 2008); Laghi Gemelli (Carona) m 2000 (LBi); Passo dei Laghi Gemelli (Branzi), m 2140 (DP); Monte Corte (Luigioni, 1929); Passo di Aviasco (Luigioni, 1929; Focarile, 1950; Magistretti, 1965; Monzini, 2008); Passo d'Aviasco (Carona) m 2200 (LBi); Passo della Portula (Carona) m 2250 (LBi); Passo di Mezzeno (Carona) m 2150 (LBi).

T. insubricus è uno stenoendemita che occupa il crinale orobico bergamasco tra il Passo di San Simone e la Val Seriana (Degiovanni & Magrini, 2019).

Corotipo: Centro-S-Alpino (ALPC).

41. ***Boldoriella (Boldoriella) carminatii*** (Dodero, 1917)

La specie è presente in alta Val Brembana con due sottospecie:

ssp. carminatii (Dodero, 1917)

Peghera (Val Taleggio) m 900 (MSS), V. Rosa *legit* (Monguzzi, 1982); Culmine San Pietro (Val Taleggio) m 1300 (MSS) (Monguzzi, 1982); Monte i Canti (Val Taleggio) (Monzini, 2008); 1057 LoBG Bùs del Magro (Olmo al Brembo) m 700 (Comotti, 1983); 1253 LoBG Bùs de la Volp (Roncabello) m 1080 (Comotti, 1983);

ssp. bucciarelli Monguzzi, 1982

Dossena (faggeta) m 900 (MG); Miniere di Monte Pe-

drozio (Dossena, Val Serina) m 1200 (RM); miniera sul versante Sud del Monte Valcareggio (Dossena) m 1300 (MG); miniera sul versante Ovest del Monte Valcareggio (Dossena) m 1250 (MG); Oltre il Colle (faggeta) m 1100 (MG); 1284 LoBG Laca del Merlas (Oltre il Colle) m 1425 (Comotti, 1983); 3529 LoBG Bùs de la Rasga (Oltre il Colle) m 1260 (Comotti, 1986); miniera lungo il versante W del Pizzo Arera (Oltre il Colle) m 2070 (DP); miniera del Pizzo Arera (Oltre il Colle) m 1500 (MG); Val Parina (Oltre il Colle) (MSS) m 1100 (Monguzzi, 1982); miniera a valle del rifugio Cà d'Arera (Oltre il Colle) m 1450 e 1500 (DP).

B. carminatii s.l. è uno stenoendemita che popola le grotte e l'ambiente sotterraneo superficiale tra la Valsassina e la Val Seriana (cfr. cartina corologica in Monzini, 2013a). La *ssp. nominale* è diffusa lungo la dorsale che separa la Valsassina dalla Val Brembana e nella bassa Val Seriana, mentre la *ssp. bucciarelli* occupa i massicci dell'Alben e del Pizzo Arera. La *ssp. silvanae* diffusa sui monti dell'alta Brianza, tra i fiumi Adda e Lambro, descritta da Monzini (1995) è stata recentemente elevata al rango specifico dall'autore stesso (Monzini, 2013a).

Corotipo: Centro-S-Alpino (ALPC).

42. ***Boldoriella (Boldoriella) concii*** Monguzzi, 1982

La specie è presente in valle con due sottospecie:

ssp. culminicola Monguzzi, 1982

Morterone (Monzini, 2008); Morterone (Val Taleggio) m 1000 (MSS) (Monguzzi, 1982); Culmine San Pietro (Monzini, 2008); Culmine San Pietro (Val Taleggio) m 1300 (MSS) (Monguzzi, 1982);

ssp. folinii Monguzzi, 1982

Dossena (Monzini, 2008); Dossena (faggeta) m 900 (MG); miniera del Monte Valcareggio (Dossena) m 1300 (MG); Miniere di Monte Pedrozio (Dossena, Val Serina) m 1200 (RM); Serina (Monzini, 2008); Serina (Monzini, 2008); Serina (Val Serina) m 900 (MSS) (RM); Oltre il Colle (Monzini, 2008); Monte Alben, versante Nord, in faggeta (MSS) (Val Parina, Valpiana) m 1000 (Monguzzi, 1982); Val Parina (Monzini, 2008); *B. concii* Monguzzi, 1982 s.l. è uno stenoendemita presente in Val Seriana (*ssp. nominale*), in Val Serina (*ssp. folinii*) e lungo la dorsale che divide la Val Brembana dalla Valsassina (*ssp. culminicola*) (Pesarini & Monzini, 2011a). La specie popola le cavità naturali e

l'ambiente sotterraneo superficiale (cfr. Monguzzi, 1982).

Corotipo: Centro-S-Alpino (ALPC).

43. ***Boldoriella (Insubrites) binaghii*** Bucciarelli, 1978

La specie è presente in valle con due sottospecie:

ssp. binaghii Bucciarelli, 1978

Pizzo Arera (Binaghi, 1937: sub *Speotrechus knauthi*; Magistretti, 1965: sub *Speotrechus knauthi*); Oltre il Colle (Monzini, 2008); Oltre il Colle (Val Parina) m 1100 (MSS) (RM); Monte Alben (Jeannel, 1928: sub *Speotrechus knauthi*; Magistretti, 1965: sub *Speotrechus knauthi*; Monzini, 2008); Colle dei Brassamonti (Monte Alben) m 1700 (MG).

ssp. leonardii Monguzzi, 1982

Monte Venturosa m 1990 (Monguzzi, 1982; Monzini, 2008); Monte Cancervo (Monguzzi, 1982; Monzini, 2008); Zuccone Campelli (Monguzzi, 1982).

B. binaghii s.l. è uno stenoendemita diffuso nelle Alpi Orobiche che occupa i massicci del Pizzo Arera, del Monte Alben e Pizzo della Presolana (*ssp. nominale*) e la destra orografica dell'alta Val Brembana (*ssp. leonardii*) (Pesarini & Monzini, 2011a). È un elemento microclasiobionte alticolo dalla spiccata criofilia. La *ssp. leonardii* è vicariante stagionale di *B. focarilei venturosae* Monguzzi, 1982 nelle stazioni nelle quali i due taxa sono simpatrici e, rispetto a questo taxon, presenta una fenologia molto più precoce (Monguzzi, 1982).

Corotipo: Centro-S-Alpino (ALPC).

44. ***Boldoriella (Insubrites) brembana*** (Binaghi, 1937)

Monte Pegherolo (Binaghi, 1937: sub *Speotrechus*); Bocchetta di San Simone (Magistretti, 1965: sub *Speotrechus*; Monzini, 2008); Bocchetta di San Simone m 2000 (LBo; MG).

Elemento criofilo perinivale, *B. brembana* è uno stenoendemita microclasiobionte alticolo noto di poche stazioni lungo il tratto di crinale orobico che divide l'alta Val Brembana dalla Valtellina.

Corotipo: Centro-S-Alpino (ALPC).

45. ***Boldoriella (Insubrites) focarilei*** (R. Rossi, 1965)

La specie è presente in valle con due sottospecie:

ssp. focarilei (R. Rossi, 1965)

Monte Serrada (=Monte Resegone), versante Val Taleggio sopra Morterone, presso sorgente Forbesette, m 1700 (RM);

ssp. venturosae Monguzzi, 1982

Monte Venturosa m 1990 (Monguzzi, 1982; Monzini, 2008); Monte Cancervo, Passo di Grialetto m 1700 (Monguzzi, 1982) Monte Cancervo (Monzini, 2008); Zuccone Campelli m 1900 (RM).

B. focarilei (R. Rossi, 1965) s.l. è uno stenoendemita diffuso sul M. Resegone (*ssp. nominale*), sui monti dell'alta Valsassina e sul Monte Venturosa, lungo il versante occidentale della Val Brembana (*ssp. venturosae*) (Pesarini & Monzini, 2011a). Elemento criofilo e perinivale, in quasi tutte le località note la specie è stata rinvenuta all'interno di crepacci e spaccature a cielo aperto di origine carsica, tranne che in alcune popolazioni del Monte Resegone, dove si trova ai margini di nevai. La *ssp. venturosae* è vicariante stagionale di *B. binaghii leonardii* nelle stazioni nelle quali i due taxa sono simpatrici e, rispetto a questo taxon, presenta una fenologia molto più tardiva (Monguzzi, 1982).

Centro-S-Alpino (ALPC).

46. ***Allegrettia pavani*** C. Bari & R. Rossi, 1965

La specie è presente in valle con due sottospecie:

ssp. castionii Monzini, 2013

Monte i Canti (Val Taleggio) (Monzini, 2008: sub *pavani*); Lo/CO 2654 Grotta "La Maddalena" (Alta Val Taleggio) (Monguzzi, 2011: sub *pavani pavani*; Monzini, 2013b).

ssp. orobensis Monzini, 2015

Complesso minerario di Dossena (Monzini, 2015); Oltre il Colle (Monzini, 2008: sub *pavani*); Oltre il Colle (Val Parina) m 1100 (MSS) (RM); miniera del Pizzo Arera (Oltre il Colle) (MG); miniera del Monte Arera (Monzini, 2015); miniera a valle del Rifugio Ca' d'Arera (Oltre il Colle) m 1450 (DP); Monte Alben (Monzini, 2008: sub *pavani*); Monte Alben (faggeta) m 1100 (Monguzzi, 2011: sub *pavani pavani*).

A. pavani è uno stenoendemita noto di diverse cavità naturali delle Prealpi Orobiche. Della specie sono attualmente note quattro sottospecie (cfr. Monguzzi, 2011; Monzini, 2013b; 2015): la nominale (diffusa tra la Val Seriana e il corso del Fiume Oglio), la *ssp. rossii* Mon-

guzzi, 2011 (che occupa un contrafforte montuoso tra la Val Seriana e la Val Cavallina), la ssp. *orobiensis* Monzini, 2015 (nota del massiccio Monte Grem-Monte Secco-Pizzo Arera, della piana di Clusone e del versante Nord del Monte Alben) e la ssp. *castionii* Monzini, 2013 (diffusa sui monti della Val Taleggio e della Val Imagna).

Corotipo: Centro-S-Alpino (ALPC).

47. *Allegrettia comottii* Monguzzi 2011

Miniera a valle del Rifugio Ca' d'Arera (Oltre il Colle) m 1450 (DP); miniera presso Piazza dei Muffi (Oltre il Colle) m 1810 (DP).

Stenoendemita delle Prealpi Bergamasche, *A. comottii* è una specie ipogea localizzata in alcune miniere dismesse e grotte del massiccio Monte Alben-Pizzo Arera-Monte Secco (Monguzzi, 2011).

Corotipo: Centro-S-Alpino (ALPC).

48. *Duvalius winklerianus* Jeannel, 1936

La specie è presente in alta Val Brembana con due sottospecie:

ssp. *winklerianus* Jeannel, 1926

Laghi Gemelli (Binaghi, 1951; Holdhaus, 1954; Magistretti, 1965; Magrini, 1998; Monzini, 2008); versante W del Pizzo Farno (Branzi) m 2000 (DP); Pizzo Arera (Luigioni, 1929; Holdhaus, 1954; Magistretti, 1965; Magrini, 1998); Dossena (Monzini, 2008); Dossena m 900 (MG); Oltre il Colle (Luigioni, 1929; Magistretti, 1965; Magrini, 1998; Monzini, 2008; MG); miniera a valle del Rifugio Ca' d'Arera (Oltre il Colle) m 1450 (DP; MG); miniera presso Baita Pessel in bassa Val Vedra (Oltre il Colle) m 1320 (DP); Monte Alben (Jeannel, 1926; Luigioni, 1929; Magistretti, 1965; Magrini, 1998; Monzini, 2008); Monte Alben m 1600 (MG); Monte Alben (versante Val Parina, Oltre il Colle) m 2000 (RM); Colle Brassamonti (Monte Alben) m 1755 (DP); Monte Alben, versante Nord, in faggeta (Val Parina, Valpiana) m 1000 (Monguzzi, 1982);

ssp. *magistrettii* Binaghi, 1939

Morterone (Val Taleggio) m 1000 (Monguzzi, 1982; Magrini, 1998); Culmine San Pietro (Val Taleggio) m 1300 (RM); Corno Stella (Binaghi, 1939; Holdhaus, 1954; Magistretti, 1965; Magrini, 1998; Monzini, 2008); Rifugio Calvi (Casale *et al.*, 2006).

Endemita delle Prealpi Bergamasche, *D. winklerianus* si rinviene, come elemento ripiccolo, presso il greto dei

torrenti e come specie ipogea in grotta e nell'ambiente sotterraneo superficiale (MSS) (Pesarini & Monzini, 2011a; Grottolo *et al.*, 2016).

Corotipo: Centro-S-Alpino (ALPC).

49. *Duvalius longhii longhii* (Comolli, 1837)

Passo di San Marco m 2000 (RM); Bocchetta di San Simone m 2000 (Casale *et al.*, 2006; LBo; MG); Bocchetta di San Simone, Sciaky leg. (GA); Bocchetta di San Simone (Mezzoldo) m 2000 (RM).

Endemita delle Prealpi Comasche, delle Alpi e Prealpi Orobic e della Valtellina, *D. longhii* è un'entità ealpina e montana che popola, come elemento ipogeo, gli ambienti sotterranei, ma che si rinviene talora anche all'esterno (Magistretti, 1965).

Corotipo: Centro-S-Alpino (ALPC).

50. *Tachyura (Tachyura) parvula* (Dejean, 1831)

San Giovanni Bianco (Magistretti, 1965; sub *Tachys*; Monzini, 2008).

Segnalato come specie ripiccola e igrofila da Koch (1989), agli scriventi *T. parvula* pare invece un'entità che si rinviene con maggior frequenza su terreni xerici e ben soleggiati, rimaneggiati di recente, come osservato da Hurka (1996).

Corotipo: Oloartico (OLA).

51. *Ocys monzinii* Magrini & Vigna Taglianti, 2006

Colle Brassamonti (Monte Alben) m 1750 (Magrini *et al.*, 2020).
O. monzinii è una specie orofila che vive su suoli sabbiosi autoctoni, originati dalla disgregazione delle roccia e quasi del tutto privi di vegetazione erbacea. Si rinviene soprattutto lungo i pochi tratti colonizzati da *Dryas octopetala* (cfr. Magrini *et al.*, 2020). La specie è nota del versante lecchese del Monte Resegone (loc. typ.) e potrebbe essere presente anche su quello brembano.

Corotipo: Centro-S-Alpino (ALPC).

52. *Asaphidion austriacum* Schweiger, 1975

Valtorta (Monzini, 2008); Roncobello (Monzini, 2008).

A. austriacum è una specie ripiccola legata soprattutto a greti sabbiosi.

Corotipo: Centroeuropeo (CEU).

53. *Bembidion (Metallina) lampros* (Herbst, 1784)

Mezzoldo (Magistretti, 1965); Bocchetta di San Simone (Magistretti, 1965); Foppolo (Magistretti,

1965); Oltre il Colle (Magistretti, 1965); Piazza dei Muffi (Oltre il Colle) m 1700 (DP).

B. lampros è un elemento ubiquitario molto frequente nelle formazioni aperte. Sempre molto comune.

Corotipo: Paleartico (PAL).

54. ***Bembidion (Bembidion) quadrimaculatum*** (Linné, 1761)

Bocchetta di San Simone (Mezzoldo) m 1700 (RM).

B. quadrimaculatus è una specie igrofila molto comune che si rinviene spesso su suoli fangosi.

Corotipo: Oloartico (OLA).

55. ***Bembidion (Testedium) bipunctatum bipunctatum*** (Linné, 1761)³

Passo San Marco (Mezzoldo) m 1990 (PN); Bocchetta di San Simone (Magistretti, 1965: sub *bipunctatum nivale*; Monzini, 2008: sub *Principidium*); Bocchetta di San Simone m 2000 (MG); Passo San Simone (Mezzoldo) m 1900 (PN); Foppolo (Magistretti, 1965: sub *bipunctatum nivale*; Monzini, 2008: sub *Principidium*); sentiero per la Bocchetta Podavit (Pizzo del Diavolo di Tenda, Carona) m 2450 (DP); Rifugio Calvi (Carona) m 2020 (MG).

B. bipunctatum è un'entità igrofila che popola i piani subalpino, alpino e altoalpino da 1800 a oltre 3000 m. Elemento perinivale spesso sintopico con le specie di *Bembidion* del subg. *Testediolum* ai margini dei nevai, rispetto a queste manifesta una maggior scelta igrofila; si rinviene infatti anche come elemento ripiccolo lungo le rive dei laghi alpini e nelle torbiere d'alta quota (Bisio, 2009b).

Corotipo: W-Paleartico (WPA)⁴.

56. ***Bembidion (Bembidionetolitzkya) varicolor*** (Fabricius, 1803)

Mezzoldo (Magistretti, 1965: sub *tricolor*; Monzini, 2008: sub *Ocydromus*); Rifugio Calvi (Carona) m 2000 (RM).

B. varicolor è un elemento ripiccolo prevalentemente montano e submontano, diffuso nell'Italia continentale. Corotipo: Europeo (EUR).

57. ***Bembidion (Bembidionetolitzkya) conforme*** Dejean, 1831

Mezzoldo (Magistretti, 1965; Monzini, 2008: sub *Ocydromus*); Val Terzera (Mezzoldo) m 1650 (PN); Carona, F. Bosi *legit* (RM); Rifugio Calvi (Carona) m 2000 (RM); Serina (Monzini, 2008: sub *Ocydromus*). *B. conforme* è un'entità ripiccola, prevalentemente montana, diffusa lungo la catena alpina e l'Appennino Settentrionale.

Corotipo: Centroeuropeo (CEU).

58. ***Bembidion (Bembidionetolitzkya) ascendens*** K. Daniel, 1902

Olmo al Brembo (Magistretti, 1965; Monzini, 2008: sub *Ocydromus*); Valtorta (Monzini, 2008: sub *Ocydromus*); Mezzoldo (Magistretti, 1965: sub *egregium*; Monzini, 2008: sub *Ocydromus*); Serina (Monzini, 2008: sub *Ocydromus*); Torrente Serina (Monzini, 2008: sub *Ocydromus*).

Elemento ripiccolo montano e submontano, *B. ascendens* è diffuso in Italia lungo l'arco alpino e nell'Appennino Settentrionale e Centrale.

Corotipo: Centroeuropeo (CEU).

59. ***Bembidion (Bembidionetolitzkya) longipes*** K. Daniel, 1902

Val Brembana m 1200 (PN).

B. longipes è un elemento ripiccolo, del tratto montano e subalpino di fiumi e torrenti. È diffuso lungo l'intero versante italiano delle Alpi (cfr. cartina corologica in Bonavita & Vigna Taglianti, 2005), ma nella maggior parte dei casi i reperti sono poco numerosi, ottenuti di solito solo con copiose raccolte di Bembidiini (a tale proposito anche cfr. Ravizza, 1972, Bisio, 2009a). È noto di diverse stazioni lombarde (Magistretti, 1965; Monzini, 2008; Grottolo *et al.*, 2016).

Corotipo: Centroeuropeo (CEU).

60. ***Bembidion (Bembidionetolitzkya) catharinae*** Netolitzky, 1943

Monte Avaro (Cusio) m 2000 (RM); Monte Ponteranica (De Monte, 1947; Magistretti, 1965; Monzini, 2008: sub *Ocydromus*); Monte Ponteranica m 2000 (RM); Val Terzera (Mezzoldo) m 1650 (PN); Bocchetta di San Simone (De Monte, 1947; Magistretti, 1965; Monzini, 2008: sub *Ocydromus*); Bocchetta di San Simone (Mezzoldo) m 1900 (PN; RM); sentiero per il Passo San Simone (Mezzoldo) m 1700 (PN); Passo di San Simone, Sciaky *leg.* (GA).

B. catharinae è un endemita localizzato in un'area molto ristretta delle Alpi Orobie occidentali a quote superiori

³ Sensus Neri *et al.* (2013).

⁴ Sensus Vigna Taglianti (com. pers., 2011).

ai 2000 m (Pesarini & Monzini, 2011a). È un'entità perinivale a fenologia precoce e di durata ristretta.
Corotipo: Centro-S-Alpino (ALPC).

61. ***Bembidion (Bembidionetolitzky) geniculatum geniculatum*** Heer, 1837

Monte Avaro (Cusio) m 2000 (RM); Val Terzera (Mezzoldo) m 1650 (PN); Passo di San Marco (Magistretti, 1965; Monzini, 2008: sub *Ocydromus*); Passo di San Marco m 2000 (RM); Bocchetta di San Simone (versante di Mezzoldo) m 2000 (RM); Foppolo (Magistretti, 1965; Monzini, 2008: sub *Ocydromus*); Bocchetta di San Simone, Sciaky leg. (GA); Bocchetta di San Simone m 2000 (MG); sentiero per la Bocchetta Podavit (Pizzo del Diavolo di Tenda, Carona) m 2350 (DP); Oltre il Colle (Magistretti, 1965; Monzini, 2008: sub *Ocydromus*); Val Parina (Oltre il Colle) m 1100 (RM).

Specie ripicola tra le più comuni lungo i corsi d'acqua montani, *B. geniculatum* è un'entità diffusa in Italia nella parte continentale.

Corotipo: Europeo (EUR).

62. ***Bembidion (Bembidionetolitzky) tibiale*** (Duftschmid, 1812)

Mezzoldo (Magistretti, 1965; Monzini, 2008: sub *Ocydromus*); dintorni di Mezzoldo (RM); Val Terzera (Mezzoldo) m 1650 (PN); Foppolo (Magistretti, 1965; Monzini, 2008: sub *Ocydromus*); Rifugio Calvi (Carona) m 2000 (RM); dintorni di Serina (Val Serina) (RM).

B. tibiale è un elemento ripicolo comune lungo tutto l'arco alpino.

Corotipo: Europeo (EUR).

63. ***Bembidion (Peryphiolus) monticola*** Sturm, 1825

Serina (Monzini, 2008: sub *Ocydromus*).

B. monticola è un elemento montano e submontano tipico degli ambienti ripari dei torrenti di fondovalle (Grottolo *et al.*, 2016). Presente nell'Italia settentrionale e centrale, è noto di poche stazioni perché è un'entità che in molte valli alpine risulta oggettivamente sporadica (Bisio, 2009a). Le località lombarde attualmente note sono state segnalate da Monzini (2008) e da Grottolo *et al.* (2016).

Corotipo: Europeo (EUR).

64. ***Bembidion (Nepha) genei illigeri*** Netolitzky, 1914

Carona (Bonavita & Vigna Taglianti, 2010); Monte

Alben (Monzini, 2008: sub *Ocydromus tetragrammus illigeri*).

Diffuso in tutta Italia, *B. genei* è specie igrofila eurizonale, raramente ripariale, con alta capacità di colonizzare substrati, sia limosi che sabbiosi, ad elevata umidità e privi di vegetazione, come anche pozze temporanee o aree irrigate in aree coltivate (Bonavita & Vigna Taglianti, 2010).

Corotipo: Europeo-Mediterraneo (EUM).

65. ***Bembidion (Testediolum) rhaeticum*** Heer, 1837

Passo San Marco (Mezzoldo) m 1990 (PN); Passo di San Marco m 2000 (RM); Bocchetta di San Simone (De Monte, 1947: sub *orobicum*; Magistretti, 1965: sub *orobicum*; Monzini, 2008: sub *Ocydromus*); Bocchetta di San Simone (Mezzoldo) m 1800 (PN); Bocchetta di San Simone (versante di Mezzoldo) m 2000 (PN); Corno Stella (De Monte, 1947: sub *orobicum*; Magistretti, 1965: sub *orobicum*; Monzini, 2008: sub *Ocydromus*); Passo Dordona (De Monte, 1947: sub *orobicum*; Magistretti, 1965: sub *orobicum*; Monzini, 2008: sub *Ocydromus*); Rifugio Calvi (Carona) m 2200 (FZ); sentiero per la Bocchetta Podavit (Carona) m 2450 (DP); Passo della Portula (Carona) m 2250 (LBI); versante W del Pizzo Farno (Branzi) m 2000 (DP); Laghi Gemelli (De Monte, 1947; Magistretti, 1965: sub *orobicum*; Monzini, 2008: sub *Ocydromus*); Pizzo Arera (De Monte, 1947: sub *orobicum*; Magistretti, 1965: sub *orobicum*; MG); Pizzo Arera (versante Val Parina) m 2000 (RM).

B. rhaeticum è un elemento orofilo perinivale che, presente marginalmente in Valle d'Aosta (Valle di Gressoney), è diffuso lungo il versante italiano dell'arco alpino tra il Biellese e il Trentino. Di norma occupa quote inferiori rispetto alla specie seguente (Bisio, 2009b).

Corotipo: S-Europeo (SEU).

66. ***Bembidion (Testediolum) glaciale*** Heer, 1837

Corno Stella (Magistretti, 1965: sub *glaciale intracabile*; Monzini, 2008: sub *Ocydromus*).

Elemento perinivale, *B. glaciale* manifesta un *praeferendum* termico più frigofilo rispetto alla specie precedente che lo porta a insediarsi a quote più elevate e, prevalentemente, lungo i versanti meno esposti (Bisio, 2009b).

Corotipo: Centroeuropeo (CEU).

67. ***Bembidion (Ocydromus) decorum decorum*** (Zenker in Panzer, 1799)

San Giovanni Bianco (Magistretti, 1965); Mezzoldo (Magistretti, 1965); Pizzo Arera (Magistretti, 1965); Oltre il Colle (Magistretti, 1965).

Elemento ripiccolo eurizonale, *B. decorum* è una specie molto comune e diffusa.

Corotipo: Centroasiatico-Europeo (CAE).

68. ***Bembidion (Peryphus) tetracolum*** Say, 1823
Dintorni di Mezzoldo (RM); Rifugio Madonna delle Nevi (Mezzoldo) m 1300 (PN); Branzi m 900 (LBI); Carona (Magistretti, 1965: sub *ustulatum*).

B. tetracolum è specie igrofila molto comune che popola soprattutto rive dei corsi d'acqua. La rinviene anche nei boschi, nei campi e nei prati umidi ed è molto frequente su suoli rimaneggiati e compattati (depositi di macerie o di materiali da costruzione).

Corotipo: Palearctico (PAL).

69. ***Bembidion (Peryphus) incognitum*** G. Müller, 1931

Val Terzera (Mezzoldo) m 1650 (PN); Passo San Marco m 2000 (MG); Bocchetta di San Simone (Magistretti, 1965); Bocchetta di San Simone, Sciaky leg. (GA); Bocchetta di San Simone m 2000 (MG); sentiero per il Passo San Simone (Mezzoldo) m 1700 (PN); Foppolo (Magistretti, 1965; Monzini, 2008: sub *Ocydromus*); Rifugio Calvi (Carona) m 2000 (MG); Lago Rotondo (Rifugio Calvi, Carona) m 1972 (DP); Pizzo Arera (versante Val Parina) m 2000 (RM).

B. incognitum è un elemento ripiccolo dei tratti montani, subalpini e alpini di corsi d'acqua, ma anche diffuso in habitat umidi d'alta quota, come bordi di laghetti, nevai e ghiacciai, o anche in ghiaioni con substrato umido (Bonavita & Vigna Taglianti, 2005).

Corotipo: Centroeuropeo (CEU).

70. ***Bembidion (Peryphanes) deletum*** Audinet-Serville, 1821

Monte Avaro (Cusio) m 2000 (RM); Passo di San Marco (Magistretti, 1965: sub *nitidulum*); dintorni di Mezzoldo (RM); Val Terzera (Mezzoldo) m 1650-1750 (PN); Bocchetta di San Simone (versante di Mezzoldo) m 2000 (RM); Branzi m 900 (LBI); Foppolo (Magistretti, 1965: sub *nitidulum*); Dossena (MG); Oltre il Colle (Magistretti, 1965; MG); Piazza dei Muffi (Oltre il Colle) m 1700 (DP); Monte Alben (Magistretti, 1965); Colle Brassamonti (Monte Alben) m 1750 (MG).

B. deletum è un elemento ripiccolo che si rinviene talvolta lungo le scarpate ancora instabili e prive di vegetazione a monte o a valle di strade, di piste forestali o di piste silvo-pastorali, analogamente alla specie seguente con la quale è spesso sintopico.

Corotipo: Europeo (EUR).

71. ***Bembidion (Peryphanes) italicum*** De Monte, 1943

Val Brembana (Monzini, 2008: sub *Ocydromus*).

Specie appartenente al gruppo di *Bembidion (Peryphanes) brunnicornis* Dejean, 1831, *B. italicum* è un taxon diffuso in gran parte dell'Italia continentale e in Sicilia (Neri *et al.*, 2011). Esso pare occupare prevalentemente substrati argillosi denudati o quasi del tutto privi di vegetazione per intervento antropico o per cause naturali. È raramente ripiccolo: si rinviene più spesso lungo le scarpate ancora instabili e prive di vegetazione a monte o a valle di strade, di piste forestali o di piste silvo-pastorali (Bisio, 2019). In Lombardia è noto di diverse stazioni (Magistretti, 1965; Monzini, 2008; Grottolo *et al.*, 2016).

Corotipo: Sud-Europeo (SEU).

72. ***Sinechostictus (Sinechostictus) decoratus*** (Duftschmid, 1812)

Valtorta (Monzini, 2008); Piazza Brembana (Monzini, 2008).

S. decoratus è un elemento ripiccolo psammofilo, che popola i corsi d'acqua nei piani montano e submontano.

Corotipo: Centroeuropeo (CEU).

73. ***Sinechostictus (Sinechostictus) ruficornis*** (Sturm, 1825)

Piazzatorre (Magistretti, 1965: sub *Bembidion*; Monzini, 2008); Rifugio Madonna delle Nevi (Mezzoldo) m 1300 (PN); Foppolo (Magistretti, 1965: sub *Bembidion*; Monzini, 2008); Pizzo Arera (versante Val Parina) m 2000 (RM).

S. ruficornis è un elemento ripiccolo, eualpino e montano, che popola i torrenti in tutto l'arco alpino (Magistretti, 1965).

Corotipo: Centroeuropeo (CEU).

74. ***Sinechostictus (Pseudolimnaeum) doderoi*** (Ganglbauer, 1891)

Serina (Monzini, 2008); Torrente Serina (Monzini, 2008: sub *Ocydromus*).

Specie non comune diffusa su Alpi e Appennino set-

tentrionale, *S. doderoi* è un elemento ripiccolo che si rinviene lungo i torrenti in ambienti forestali dei piani submontano e montano (Pesarini & Monzini, 2011a). Noto in Italia di poche stazioni, in Lombardia è conosciuto di diverse località (Monzini, 2008; Grottolo *et al.*, 2016).

Corotipo: Centroeuropeo (CEU).

75. ***Stomis (Stomis) rostratus schatzmayri*** Monzini & Pesarini, 1986

Peghera (Val Taleggio) (Monzini & Pesarini, 1986; Monzini, 2008); Piazza (Piazzatorre) m 1100 (LBi); Mezzoldo (Monzini & Pesarini, 1986; Monzini, 2008); Rifugio Madonna delle Nevi (Mezzoldo) m 1300 e 1500 (LBi); Ponte dell'Acqua (Mezzoldo) (RM); Branzi (Ghidini, 1957; Magistretti, 1965; Monzini, 2008); Valleve (Monzini & Pesarini, 1986; Monzini, 2008); Carona m 1200 (LBi); Rifugio Calvi (Monzini, 2008); Pizzo Arera (Ghidini, 1957; Magistretti, 1965; Monzini, 2008); Serina (Monzini, 2008); Serina (Val Serina) m 900 (RM); Oltre il Colle (Marcuzzi, 1953; Pizzo Arera (versante Val Parina) m 1600 (RM); Magistretti, 1965; Monzini & Pesarini, 1986; Monzini, 2008); 1284 LoBG Laca del Merlas (Oltre il Colle) m 1425 (Comotti, 1983).

Monzini & Pesarini (1986) hanno articolato *Stomis rostratus* (Sturm in Duftschmid, 1812) in tre sottospecie: la ssp. nominale presente in Carinzia e nel Friuli Venezia Giulia a est del Tagliamento, la ssp. *ceresae* dei Massici del Monte Baldo e dei Monti Lessini e la ssp. *schatzmayri* che occupa le zone montuose comprese tra l'Adda e il Tagliamento. Diffusa dall'orizzonte montano a quello subalpino, è un'entità silvicola caratterizzata da una marcata igrofilia. Secondo Grottolo *et al.* (2016), si rinviene, localmente frequente, nelle forre o lungo torrenti nei tratti ombrosi in ambito forestale, dove mostra una certa troglofilia, mentre a quote più elevate si rinviene presso i nevai.

Corotipo: S-Alpino (ALPS).

76. ***Poecilus (Poecilus) versicolor*** (Sturm, 1824)

Bocchetta di San Simone (Magistretti, 1968: sub *coeruleescens*); Carona (Magistretti, 1965: sub *coeruleescens*); Foppolo (Magistretti, 1965: sub *coeruleescens*); Baite di Mezzeno (Roncobello) m 1500 (LBi).

P. versicolor è un'entità molto comune che popola le formazioni aperte del piano montano.

Corotipo: Asiatico-Europeo (ASE).

77. ***Poecilus (Macropoecilus) lepidus gressorius*** (Dejean, 1828)

Piani di Bobbio (Franz, 1971); Mezzoldo (Magistretti, 1965: sub *Pterostichus*; Monzini, 2008); Branzi (Magistretti, 1965: sub *Pterostichus*; Monzini, 2008); Branzi m 900 (LBi); Baite di Mezzeno (Roncobello) m 1500 (LBi); Serina (Magistretti, 1965; Monzini, 2008); Oltre il Colle (Magistretti, 1965; Monzini, 2008).

Specie legata alla fascia montana, *P. lepidus* si rinviene soprattutto su suoli a granulometria grossolana. È molto diffuso lungo le rive ghiaiose dei corsi d'acqua (Pesarini & Monzini, 2011b).

Corotipo: Sibirico-Europeo (SIE).

78. ***Pterostichus (Phonias) strenuus*** (Panzer, 1796)

Branzi (Magistretti, 1965); Foppolo (Magistretti, 1965); Foppolo m 1500 (LBi); Carona (Magistretti, 1965).

P. strenuus è un'entità presente in Italia continentale come relitto igrofilo e frigofilo (Vigna Taglianti, 2009) che popola i prati umidi e i biotopi paludosi. Risulta presente anche negli ambienti di torbiera dove pare occupare soprattutto le zone più marginali, mentre viene sostituito nelle aree maggiormente intrise d'acqua dall'affine *P. diligens* (Sturm, 1824).

Corotipo: Asiatico-Europeo (ASE).

79. ***Pterostichus (Morphnosoma) melanarius*** (Illiger, 1798)

Piazzatorre (Magistretti, 1965: *vulgaris*; Monzini, 2008).

Euricio secondo Magistretti (1965), *P. melanarius* popola soprattutto le formazioni aperte dell'orizzonte montano. È diffuso nell'Italia settentrionale e centrale.

Corotipo: Oloartico (OLA).

80. ***Pterostichus (Pseudomaseus) nigrita*** (Paykull, 1790)

Carona (Magistretti, 1965); Passo di San Marco (Magistretti, 1965); Oltre il Colle (Magistretti, 1965).

Specie fortemente igrofila, frequente negli ambienti umidi, *P. nigrita* è diffuso in tutta l'Italia ma rara al Nord, dove in genere la sostituisce l'affine *P. rhaeticus* (Pesarini & Monzini, 2011b). È probabile peraltro che queste segnalazioni siano da riferire alla specie seguente.

Corotipo: Paleartico (PAL).

81. *Pterostichus (Pseudomaseus) rhaeticus* Heer, 1837

Foppolo m 1500 (LBi); Carona (Monzini, 2008); Rifugio Calvi (Carona) m 2000 (MG); Pizzo Arera (Oltre il Colle) m 2000 (MG).

Magistretti (1965) riteneva che *rhaeticus* non fosse nemmeno una sottospecie di *P. nigrita*, ma un semplice insieme di forme locali, di statura minore, proprie delle Alpi. Attualmente *P. rhaeticus* è invece considerato una specie distinta. Si tratta di una specie igrofila che si rinviene nei boschi e nei prati umidi, negli ambienti paludosi e lungo le rive dei corsi d'acqua.

Corotipo: Europeo (EUR).

82. *Pterostichus (Haptoderus) unctulatus* (Duftschmid, 1812)

Valtorta m 1600 (LBi & PG); Passo Branchino (Roncobello) m 1700 (LBi & PG); Monte Alben m 1400 (MG).

Presente in Italia nelle Alpi centro-orientali (dalle Retiche fino alla Venezia Giulia) (Magistretti, 1965; Pesarini & Monzini, 2011b), *P. unctulatus* è un'entità silvicola che popola i boschi del piano montano spingendosi frequentemente a colonizzare i pascoli alpini. Comune in buona parte dell'areale (cfr. Magistretti, 1965; Pesarini & Monzini, 2011b; Grottolo *et al.*, 2016), in Val Brembana pare meno frequente.

Corotipo: Alpino-Appenninico (ALAP).

83. *Pterostichus (Cheropus) dissimilis* (A. Villa & G.B. Villa, 1833)

Piani di Bobbio (Valtorta) (Monzini, 2008); Ornica (Magistretti, 1965); Piazzatorre (Casale *et al.*, 2006); Pizzo (Piazzatorre) m 1100 (LBi); Mezzoldo (Magistretti, 1965; Monzini, 2008); Branzi m 900 (LBi); Valleve m 1100 (LBi); San Simone (Monzini, 2008); Lago Arale (San Simone) m 1700 (LBi & PG); Bocchetta di San Simone (Magistretti, 1965); Monte Pegherolo (Magistretti, 1965); Corno Stella (Magistretti, 1965); Carona (Casale *et al.*, 2006); Carona m 1300 (LBi); Foppolo (Casale *et al.*, 2006); Foppolo m 1500 (LBi); Baite di Mezzeno (Roncobello) m 1500 (LBi); Pizzo Arera (Magistretti, 1965; Monzini, 2008); miniera di Paglio Pignolino (Dossena) m 1200 (MG); Oltre il Colle (Magistretti, 1965; Monzini, 2008); Oltre il Colle m 1100 (LBi); Monte Alben (Monzini, 2008); Colle Brassamonti (Monte Alben) m 1755 (DP).

P. dissimilis è un endemita diffuso nelle Alpi e Prealpi Bergamasche e in Valle Camonica. Secondo Grottolo *et al.* (2016), si tratta di una specie brachittera localmente comune nelle faggete e nelle peccete umide che si spinge talvolta oltre il limite superiore delle foreste. In Val Brembana è molto comune e diffuso.

Corotipo: Centro-S-Alpino (ALPC).

84. *Pterostichus (Platypterus) lombardus* K. Daniel, 1901

Piani di Bobbio (Franz, 1971); Monte Ponteranica (Monzini, 2008); Corno Stella (Magistretti, 1965); Pizzo del Diavolo di Tenda (Carona) m 2000 (LBi); sentiero per la Bocchetta Podavit (Pizzo del Diavolo di Tenda, Carona) m 2450 (DP); Rifugio Calvi (Carona) m 2200 (FZ); Passo della Portula (Carona) m 2250 (LBi); Passo dei Laghi Gemelli (Branzi) m 2140 (DP); Passo d'Aviasco (Luigioni, 1929; Schatzmayr, 1930; Magistretti, 1965); Passo d'Aviasco (Carona) m 2200 (LBi); Monte Corna Piana (Pizzo Arera, Roncobello) m 1900 (LBi & PG); versante W Monte Corna Piana (Roncobello) m 1950 (DP); Pizzo Arera (Schatzmayr, 1942-1943; Magistretti, 1965; Monzini, 2008); Pizzo Arera (Oltre il Colle) m 2000 (MG); alta Valle d'Arera (Oltre il Colle) m 2050-2100 (DP); Monte Alben m 1500 (MG).

Noto delle Alpi e Prealpi Bergamasche, della Valtellina (lungo il versante sinistro) e della Valcamonica, *P. lombardus* è un'entità orofila che si rinviene esclusivamente al di sopra dei 2000 m. Presenta una fenologia precoce e molto breve, legata al primo fondere delle nevi e popola soprattutto substrati a prevalente granulometria grossolana in gran parte denudati o appena colonizzati da chiazze di vegetazione pioniera specializzata, quali substrati ricchi di ciottoli e pietrame, ghiaioni, falde detritiche e *rock glaciers* (cfr. anche Pivetti *et al.*, 2016). L'habitat è quindi del tutto simile a quelli spesso frequentati da altre specie congeneri, quali *Pterostichus (Parapterostichus) schaschli* (Marseul, 1880) nelle Alpi Orientali (cfr. Brandmayr *et al.*, 1988; Brandmayr & Pizzolotto, 1989), *Pterostichus (Pterostichus) honnoratii* Dejean, 1828 nelle Alpi occidentali piemontesi (cfr. Bisio, 2012) e *Pterostichus (Pterostichus) focarilei* Casale & Giachino, 1985, endemico del Monte Sirino in Basilicata (cfr. Casale & Giachino, 1985). In alta Val Brembana è relativamente comune al Passo di Aviasco (LBi).

Corotipo: Centro-S-Alpino (ALPC).

85. ***Pterostichus (Pterostichus) micans*** Heer, 1841
Piazzatorre (Casale *et al.*, 2006); Pizzo (Piazzatorre) m 1100 (LBi); Mezzoldo m 1300 (LBi); Passo di San Simone, versante W (Mezzoldo) m 2000 (LBi); Branzi m 800 (LBi); Foppolo (Magistretti, 1965); Foppolo m 1500 (LBi); Carona (Magistretti, 1965; Casale *et al.*, 2006); Carona m 1300 (LBi); Laghi Gemelli (Magistretti, 1965); Laghi Gemelli (Carona) m 2000 (LBi); Oltre il Colle (Magistretti, 1965); Oltre il Colle m 1100 (LBi).

Presente in Svizzera e in Italia dove è diffuso dalle Alpi Lepontine alle Venete e nell'Appennino fino alla Sila (Grottolo *et al.*, 2016), *P. micans* è una specie silvicola molto comune in Val Brembana.

Corotipo: Alpino-Appenninico (ALAP).

86. ***Pterostichus (Oreophilus) multipunctatus*** (Dejean, 1828)

Zuccone Campelli (Franz, 1971); Pizzo dei Tre Signori (Franz, 1971); Monte Ponteranica (Magistretti, 1965); Piazzatorre (Casale *et al.*, 2006); Rifugio Ca' del Sul (Ornica) m 1700 (LBi & PG); Pizzo (Piazzatorre) m 1100 (LBi); Mezzoldo m 1300 (LBi); Passo di San Marco (Mezzoldo) m 1900-2000 (LBi); Bocchetta di San Simone (Magistretti, 1965); Bocchetta di San Simone m 2000 (MG); Passo di San Simone (Mezzoldo) m 2100 (LBi); Lago Arale (San Simone) m 1700 (LBi); Corno Stella (Magistretti, 1965); Foppolo (Magistretti, 1965); Foppolo m 1500 (LBi); Carona (Casale *et al.*, 2006); Carona m 1300 (LBi); Pizzo del Diavolo di Tenda (Carona) m 2000 (LBi); Rifugio Calvi (Carona) m 2200 (FZ); Rifugio Calvi (Carona) m 2020 (MG); Laghi Gemelli (Magistretti, 1965); Laghi Gemelli (Carona) m 2000 (LBi); Baite di Mezzeno (Roncobello) m 1500 (LBi); Monte Corna Piana (Pizzo Arera, Roncobello) m 1900 (LBi & PG); Serina (Magistretti, 1965); Pizzo Arera (Magistretti, 1965); Pizzo Arera (Oltre il Colle) (MG); alta Valle d'Arera (Oltre il Colle) m 2050-2100 (DP); Monte Alben (Oltre il Colle) m 1600 (MG).

P. multipunctatus è una specie molto comune nelle foreste di conifere dell'orizzonte montano superiore, negli arbusteti dell'orizzonte subalpino e nei pascoli alpini (dove supera spesso i 2000 m di quota). Mentre le popolazioni delle Alpi occidentali presentano una pressoché costante colorazione rosso-rameica, quelle lombarde sono caratterizzate da diverse varianti cromatiche.

Corotipo: S-Alpino (ALPS).

87. ***Tanythrix edura*** (Dejean, 1828)

Zuccone Campelli m 1600 (Franz, 1971); Monte Corna Grande, Vallone dei Mugoffi (Valtorta) m 1900 (LBi & PG); Pizzo (Piazzatorre) m 1100 (LBi); Branzi m 800 (LBi & PG); Foppolo (Magistretti, 1965: sub *Molops*; Monzini, 2008); Pizzo Arera (Luigioni, 1929: sub *Molops*; Holdhaus, 1954: sub *Molops*; Magistretti, 1965: sub *Molops*; Monzini, 2008); Oltre il Colle (Magistretti, 1965: sub *Molops*; Monzini, 2008); Monte Alben (Oltre il Colle) m 1600 (MG).

Il genere *Tanythrix* consta di tre specie endemiche italiane (cfr. cartina corologica in Audisio & De Biase, 1993): *T. senilis* (Schaum, 1859), stenoendemita delle Alpi Biellesi, *T. marginepunctata* (Dejean, 1831), diffusa dalle Giudicarie al massiccio del Monte Grappa, e *T. edura*, diffusa dalle Prealpi lombarde al Trentino (Pesarini & Monzini, 2011b). Come le specie congeneri, *T. edura* è un'entità prevalentemente silvicola.

Corotipo: Centro-S-Alpino (ALPC).

88. ***Abax (Abax) parallelepipedus lombardus*** A. Fiori, 1896

Monte Venturosa (Monzini, 2008); Piani di Bobbio (Valtorta) (Monzini, 2008; Zanella, 2016); Piazzatorre (Zanella, 2016); Pizzo (Piazzatorre) m 1100 (LBi); Branzi m 800 (LBi & PG); Pizzo Arera (Marcuzzi, 1953; Magistretti, 1965; Monzini, 2008; Zanella, 2016); Serina (Schatzmayr, 1944; Magistretti, 1965); Oltre il Colle (Magistretti, 1965; Monzini, 2008); Oltre il Colle m 1100 (LBi).

A. parallelepipedus è presente in Italia lungo l'arco alpino e l'Appennino sino alla Calabria con diverse sottospecie (cfr. Zanella, 2016). La ssp. *lombardus* è diffusa dal Lago Maggiore alle Alpi Giudicarie (Grottolo *et al.*, 2016). È una specie silvicola molto comune nei boschi dell'orizzonte montano della Val Brembana.

Corotipo: Centro-S-Alpino (ALPC).

89. ***Abax (Abax) fiorii*** Jakobson, 1907

Oltre il Colle (Marcuzzi, 1953; Magistretti, 1965: sub *angustatus*; Monzini, 2008); Zambla Alta m 1140 (DP).

A. fiorii è una specie affine alla precedente, localizzata nella fascia boschiva prealpina compresa fra i Laghi Maggiore e d'Iseo (Pesarini & Monzini, 2011b).

Corotipo: Centro-S-Alpino (ALPC).

90. ***Abax (Abax) baenningeri*** Schaubberger, 1927

Rifugio Ca' del Sul (Ornica) m 1700 (LBi & PG);

Piani di Bobbio (Valtorta) (Monzini, 2008); Piazzo (Piazzatorre) m 1100 (LBi); Mezzoldo m 1300 (LBi); Passo di San Marco (Magistretti, 1965; Monzini, 2008); Branzi m 800 (LBi & PG); Valleve m 1100 (LBi); Baite di Mezzeno (Roncobello) m 1500 (LBi); Passo Branchino (Roncobello) m 1700 (LBi & PG); Pizzo Arera m 2000 (Casale *et al.*, 2006); Oltre il Colle (Magistretti, 1965; Monzini, 2008); Oltre il Colle m 1100 (LBi); Monte Alben (MG).

A. baenningeri è un endemita diffuso dalle Alpi Lepontine alla Val Trompia (Pesarini & Monzini, 2011b). La specie, che popola i boschi, gli arbusteti e i pascoli fino a circa 2.000 m, è molto comune in Val Brembana.

Corotipo: Centro-S-Alpino (ALPC).

91. *Abax (Abax) arerae* Schauburger, 1927

Monte Corna Grande, Vallone dei Mugoffi (Valtorta) m 1900 (LBi & PG); Zuccone Campelli (Monzini, 2008); Piazzatorre (Magistretti, 1965; Monzini, 2008); Lago Arale (San Simone) m 1700 (LBi & PG); Bocchetta di San Simone (Magistretti, 1965; Monzini, 2008); Bocchetta di San Simone, Sciaky leg. (GA); Passo di San Simone (Mezzoldo) m 2100 (LBi); Passo Dordona (Schatzmayer, 1944; Monzini, 2008); Corno Stella (Schatzmayer, 1944); Lago Sargednana (Carona) (Magistretti, 1968); Laghi Gemelli (Magistretti, 1965; Monzini, 2008); Laghi Gemelli (Carona) m 2000 (LBi); Passo dei Laghi Gemelli (Branzi) m 2140 (DP); Passo Branchino (Roncobello) m 1700 (LBi & PG); Lago Branchino (Roncobello) m 1820 (DP); Monte Corna Piana (Pizzo Arera, Roncobello) m 1900 (LBi & PG); Pizzo Arera (Schauburger, 1927; Magistretti, 1965; Monzini, 2008); alta Valle d'Arera (Oltre il Colle) m 2050 (DP); Passo della Crocetta (Oltre il Colle) m 1340 (DP); Zambla Alta m 1140 (DP); Monte Alben (Magistretti, 1965; Monzini, 2008; MG).

Endemita delle Alpi e Prealpi Orobie (Pesarini & Monzini, 2011b), *A. arerae* si rinviene prevalentemente negli orizzonti subalpino e alpino dove popola gli arbusteti e la prateria alpina.

Corotipo: Centro-S-Alpino (ALPC).

92. *Abax (Abax) contractus* (Heer, 1841)⁵

San Giovanni Bianco (Magistretti, 1965: sub *continuus*; Monzini, 2008: sub *continuus*); Branzi m 800 (LBi & PG); Oltre il Colle (Magistretti, 1965: sub *continuus*; Monzini, 2008: sub *continuus*).

Endemita dell'Italia settentrionale, *A. contractus* è un'entità silvicola prevalentemente diffusa nell'orizzonte submontano. Corotipo: S-Alpino (ALPS).

93. *Amara (Amara) aenea* (De Geer, 1774)

Rifugio Madonna delle Nevi (Mezzoldo) m 1400 (LBi); Branzi m 800 (LBi & PG); Carona (Magistretti, 1968); Oltre il Colle (Monzini, 2008).

A. aenea è una specie molto comune ad ampia valenza ecologica che popola le formazioni aperte dalla pianura a oltre 2.000 m. Come le specie congeneri è un'entità granivora. È diffusa in tutta Italia.

Corotipo: Palearctico (PAL).

94. *Amara (Amara) convexior* Stephens, 1828

Monte Alben (Monzini, 2008).

Specie comune legata agli orizzonti submontano e montano, *A. convexior* è tendenzialmente mesofila. È diffusa nell'Italia settentrionale e centrale (Magistretti, 1965).

Corotipo: Sibirico-Europeo (SIE).

95. *Amara (Amara) curta* Dejean, 1828

Rifugio Madonna delle Nevi (Mezzoldo) m 1400 (LBi); Monte Ponteranica (Magistretti, 1965; Monzini, 2008); Branzi m 800 (LBi & PG); dintorni Rifugio Ca' d'Arera (Oltre il Colle) m 1450 (DP).

Secondo Magistretti (1965), *A. curta* è un'entità legata ai terreni umidi. In realtà è una specie xero-termofila più frequente lungo i pendii ben esposti. Si rinviene nei pascoli e nei prati dell'orizzonte montano dell'Italia continentale.

Corotipo: Sibirico-Europeo (SIE).

96. *Amara (Amara) familiaris* (Duftschmid, 1812)

Rifugio Madonna delle Nevi (Mezzoldo) m 1400 (LBi).

A. familiaris è un'entità diffusa dalla pianura ai 2000 m. Specie granivora polifaga (cfr. Lundgren, 2009), si rinviene, spesso molto abbondante, soprattutto nei prati.

Corotipo: Sibirico-Europeo (SIE).

97. *Amara (Amara) lunicollis* Schiödte, 1837

Bocchetta di San Simone (Mezzoldo) m 2000 (RM).

⁵ Sensu Zanella (2017).

Specie prevalentemente montana, *A. lunicollis* popola prati moderatamente umidi e poco esposti. È diffusa nell'Italia continentale (Magistretti, 1965).

Corotipo: Oloartico (OLA).

98. *Amara (Amara) nitida* Sturm, 1825

Piazzo (Piazzatorre) m 1100 (LBI); Mezzoldo m 1300 (LBI); Rifugio Madonna delle Nevi (Mezzoldo) m 1400 (LBI); Lago Arale (San Simone) m 1700 (LBI & PG); Piazza dei Muffi (Oltre il Colle) m 1670 e m 1800 (DP); Cima della Croce dell'Alben (Oltre il Colle) m 1975 (DP).

Entità montana, *A. nitida* ha abitudini del tutto simili alla specie precedente con la quale è spesso sintopica. Corotipo: Asiatico-Europeo (ASE).

99. *Amara (Amara) montivaga* Sturm, 1825

Monte i Canti (Val Taleggio) (Monzini, 2008); Laghi Gemelli (Hieke, 1976); Pizzo Arera (Hieke, 1976); Oltre il Colle (Hieke, 1976).

Specie montana ad areale molto ampio, *A. montivaga* risulta presente in buona parte dell'Italia settentrionale, anche se in Piemonte pare decisamente più localizzata rispetto alle regioni centro-orientali (cfr. Magistretti, 1965; Bisio & Giuntelli, 2014). Secondo Honek *et al.* (2005), gli adulti si nutrono degli acheni di *Taraxacum officinale*, per poi passare in giugno-luglio a quelli di *Crepis biennis*, a spese dei quali si sviluppano anche le larve.

Corotipo: Asiatico-Europeo (ASE).

100. *Amara (Amara) ovata* (Fabricius, 1792)

Piazzo (Piazzatorre) m 1100 (LBI); Mezzoldo m 1300 (LBI); Rifugio Madonna delle Nevi (Mezzoldo) m 1400 (LBI); Bocchetta di San Simone (Monzini, 2008); Bocchetta di San Simone (Mezzoldo) m 2000 (RM); Laghi Gemelli (Monzini, 2008); Baite di Mezzeno (Roncobello) m 1500 (LBI); Passo di Zambla m 1250 (DP).

Entità frequente soprattutto in ambienti collinari e montani, *A. ovata* è una specie che predilige terreni ben drenati. Magistretti (1965) la segnala delle cave di ghiaia; si rinviene comunque con una certa frequenza su suoli rimaneggiati di recente.

Corotipo: Asiatico-Europeo (ASE).

101. *Amara (Amara) similata* (Gyllenhal, 1810)

Branzi m 800 (LBI & PG); Foppolo (Magistretti, 1965; Monzini, 2008); Laghi Gemelli (Magistretti, 1965).

Diffusa in pianura e nelle zone montuose (Magistretti,

1965), *A. similata* è una specie granivora polifaga (cfr. Lundgren, 2009) che si rinviene nei campi e nei prati. Corotipo: Asiatico-Europeo (ASE).

102. *Amara (Celia) erratica* (Duftschmid, 1812)

Pizzo dei Tre Signori (Franz, 1971); Mezzoldo (Magistretti, 1965; Monzini, 2008); Monte Ponteranica (Magistretti, 1965; Monzini, 2008); Passo di San Marco (Magistretti, 1965; Monzini, 2008); Passo di San Marco m 1950 (RM); Bocchetta di San Simone (Magistretti, 1965; Monzini, 2008); Bocchetta di San Simone, Sciaky leg. (GA); Bocchetta di San Simone (Mezzoldo) m 2000 (RM); Lago Arale (San Simone) m 1700 (LBI & PG); Foppolo (Magistretti, 1965; Monzini, 2008); Foppolo m 1500 (LBI); Passo Venina (Foppolo) m 2300 (RM); Carona (Magistretti, 1965; Monzini, 2008); sentiero per la Bocchetta Podavit (Pizzo del Diavolo di Tenda, Carona) m 2350 (DP); Lago Sardegnana (Carona) (Magistretti, 1968); Laghi Gemelli (Magistretti, 1965; Monzini, 2008); dintorni del Rifugio Laghi Gemelli (Branzi) m 1970 (DP); Piazza dei Muffi (Oltre il Colle) m 1800 (DP); Monte Alben (Monzini, 2008).

A. erratica popola le praterie alpine di alta e media quota (Pesarini & Monzini, 2011b), dove è molto abbondante al primo fondere delle nevi.

Corotipo: Oloartico (OLA).

103. *Amara (Celia) praetermissa* (Gyllenhal, 1810)

Monte Ponteranica (Monzini, 2008; sub *pallens*); Passo San Marco m 2000 (RM); Ca' San Marco (Mezzoldo) (Monzini, 2008; sub *pallens*); Pizzo del Diavolo di Tenda (Carona) m 2000 (LBI).

A. praetermissa è un'entità xerofila eualpina diffusa sui monti di tutta l'Italia continentale (cfr. Magistretti, 1965).

Corotipo: Sibirico-Europeo (SIE).

104. *Amara (Celia) brunnea* (C.R. Sahlberg, 1827)

Val Sambuzza (Carona) (Magistretti, 1965; Monzini, 2008); Val Sambuzza (Carona) m 2200 (Focarile, 1976).

Specie affine alla precedente, *A. brunnea* è un'entità montana marginale per il nostro paese, nota solo di pochissime stazioni di Valle d'Aosta, Lombardia e Alto Adige (Focarile, 1976; Magistretti, 1965).

Corotipo: Oloartico (OLA).

105. *Amara (Paracelia) quenseli* (Schönherr, 1806)

Pizzo del Diavolo di Tenda (Carona) m 2000 (LBI);

sentiero per la Bocchetta Podavit (Pizzo del Diavolo di Tenda, Carona) m 2350 (DP).

A. quenseli è una specie comune sulle Alpi dai 2000 ai 3000 m di quota. È stata più volte osservata come colonizzatrice primaria delle aree di recente deglaciazione (Gobbi & Brandmayr, 2005; Bisio & Allegro, 2018).
Corotipo: Oloartico (OLA).

106. *Amara (Percosia) equestris equestris* (Duftschmid, 1812)

Dintorni Casera di Menna (Oltre il Colle) m 1480 (DP).

Legata agli orizzonti montano, subalpino e alpino, *A. equestris* è una specie insediata prevalentemente su substrati ben drenati e lungo i versanti più esposti dove si rinviene in sede ipolitica o deambulante in pieno giorno lungo i sentieri o nei prati tra i ciuffi d'erba soprattutto dopo lo sfalcio (Bisio, 2009c).

Corotipo: Asiatico-Europeo (ASE).

107. *Amara (Curtonotus) aulica* (Panzer, 1796)

Monte Alben (Monzini, 2008).

A. aulica è una specie montana frequente nei prati umidi di fondovalle. Secondo Lundgren (2009) è granivora polifaga.

Corotipo: Oloartico (OLA).

108. *Amara (Leirides) alpestris alpestris* A. Villa & G.B. Villa, 1833

Zuccone Campelli (Franz, 1971); Monte Corna Grande, Vallone dei Mugoffi (Valtorta) m 1900 (LBi & PG); Pizzo dei Tre Signori (Franz, 1971); Monte Ponteranica (Magistretti, 1965; Monzini, 2008); Passo di San Marco (Monzini, 2008); Passo di San Marco (Mezzoldo) m 1900-2000 (LBi); Bocchetta di San Simone (Magistretti, 1965; Monzini, 2008); Bocchetta di San Simone (Mezzoldo) m 2100 (LBi); Bocchetta di San Simone (Mezzoldo) m 2000 (RM); Lago Arale (San Simone) m 1700 (LBi & PG); Foppolo (Magistretti, 1965; Monzini, 2008); Passo Dordona (Magistretti, 1965; Monzini, 2008); Corno Stella (Magistretti, 1965; Monzini, 2008); Passo di Tartano (Holdhaus, 1954; Magistretti, 1965); Pizzo del Diavolo di Tenda (Carona) m 2000 (LBi); Rifugio Calvi (Carona) m 2200 (FZ); Laghi Gemelli (Magistretti, 1965; Monzini, 2008); Laghi Gemelli (Carona) m 2000 (LBi); Passo di Mezzeno (Roncobello) m 2150 (LBi); Passo Branchino (Roncobello) m 1700 (LBi & PG); Monte Corna Piana (Pizzo Arera, Roncobello) m

1900 (LBi & PG); Pizzo Arera (Holdhaus, 1954; Magistretti, 1965; Monzini, 2008); alta Valle d'Arera (Oltre il Colle) m 2050 (DP); Monte Alben (Monzini, 2008; MG).

Endemita delle Alpi lombarde, venete e tridentine, *A. alpestris* è articolata in quattro sottospecie: la ssp. nominale (propria delle Alpi lombarde e delle Giudicarie), la ssp. *baldensis* K. Daniel & J. Daniel, 1898 (del Monte Baldo), la ssp. *pasubiana* K. Daniel & J. Daniel, 1898 (del Monte Pasubio) e la ssp. *dolomitana* K. Daniel & J. Daniel, 1898 (che è diffusa nelle Alpi venete e nelle Dolomiti) (Pesarini & Monzini, 2011b). È una specie eualpina molto comune nei pascoli di alta quota.

Corotipo: E-Alpino (ALPE).

109. *Licinus (Neorescius) hoffmannseggii* (Panzer, 1803)

Pizzo Arera (Magistretti, 1965; Monzini, 2008).

Elemento prevalentemente montano e submontano (Grottolo *et al.*, 2016), *L. hoffmannseggii* è una specie silvicola che si rinviene nei luoghi più freschi e ombrosi (Jeannel, 1942).

Corotipo: Centroeuropeo (CEU).

110. *Anisodactylus (Anisodactylus) binotatus* (Fabricius, 1787)

Branzi m 900 (LBi & PG).

Comune in ambienti umidi sia in pianura sia sui monti, *A. binotatus* è la specie più diffusa del genere (Pesarini & Monzini, 2011b). È più frequente nelle formazioni aperte.

Corotipo: Asiatico-Europeo (ASE).

111. *Anisodactylus (Anisodactylus) nemorivagus* (Duftschmid, 1812)

Carona (Magistretti, 1968).

Diffuso in pianura e nelle zone montuose (Magistretti, 1965), *A. nemorivagus* è un'entità caratterizzata da un'ampia valenza ecologica.

Corotipo: Europeo (EUR).

112. *Ophonus (Metoponus) laticollis* Mannerheim, 1825

Foppolo, m 1400-1600 (RM); Baite di Mezzeno (Roncobello) m 1500 (LBi).

O. laticollis è una specie con ampio excursus altitudinale, frequente nei prati delle valli alpine.

Corotipo: Sibirico-Europeo (SIE).

113. *Pseudoophonus (Pseudoophonus) rufipes* (De Geer, 1774)

Branzi m 900 (LBi & PG).

Secondo Brandmayr & Zetto (1994), *P. rufipes*, come entità onnivora, è una delle specie più opportuniste fra i Carabidi europei, tendendo infatti ad addensarsi su terreni ruderali e di riporto, discariche di macerie, coltivi. In ciò è forse favorita dal fatto che, essendo anche spermofaga, si nutre dei semi di quelle essenze vegetali pioniere che colonizzano per prime tali ambienti (*Chenopodium album*, *Senecio vulgaris*, *Papaver rhoeas*, ecc.) (cfr. Lundgren, 2009). È uno dei Carabidi più comuni in Italia; in Val Brembana è certamente più diffuso di quanto non appaia dall'unico dato attualmente disponibile.

Corotipo: Paleartico (PAL).

114. *Harpalus (Harpalus) affinis* (Schränk, 1781)

Baite di Mezzeno (Roncobello) m 1500 (LBi).

Specie dalle abitudini alimentari molto simili alla precedente (cfr. Lundgren, 2009), *H. affinis* è anch'esso in grado di popolare ambienti fortemente antropizzati. Corotipo: Asiatico-Europeo (ASE).

115. *Harpalus (Harpalus) distinguendus* (Duftschmid, 1812)

Branzi m 800 (LBi & PG); Dintorni Rifugio Ca' d'Arera (Oltre il Colle) m 1450 (DP).

Anche *H. distinguendus* presenta abitudini del tutto simili alle due specie precedenti.

Corotipo: Paleartico (PAL).

116. *Harpalus (Harpalus) rubripes* (Duftschmid, 1812)

Baite di Mezzeno (Roncobello) m 1500 (LBi); Dintorni Rifugio Ca' d'Arera (Oltre il Colle) m 1450 (DP); Piazza dei Muffi (Oltre il Colle) m 1850 (DP).

H. rubripes è un'entità granivora molto comune diffusa soprattutto nelle aree agricole (Pesarini & Monzini, 2011b).

Corotipo: Asiatico-Europeo (ASE).

117. *Harpalus (Harpalus) marginellus* Dejean, 1829

Piani di Bobbio (Valtorta) (Monzini, 2008); Pizzo Arera (Oltre il Colle) m 2000 (MG).

H. marginellus è una specie che si rinviene nei pascoli montani e alpini, anche in ambienti alterati dall'uomo (Pesarini & Monzini, 2011b).

Corotipo: Centroeuropeo (CEU).

118. *Harpalus (Harpalus) atratus* Latreille, 1804

Mezzoldo (Magistretti, 1965; Monzini, 2008).

H. atratus è una specie mesofila e forestale (Vigna Taglianti *et al.*, 1999) che, come rileva giustamente anche Jeannel (1942), si rinviene spesso anche su terreni rimaneggiati, in depositi di macerie e nei dintorni dei luoghi abitati.

Corotipo: Europeo (EUR).

119. *Harpalus (Harpalus) solitarius* Dejean, 1829

Passo della Portula (Carona) m 2250 (LBi).

Taxon xerofilo e microtermo, *H. solitarius* è una specie diffusa esclusivamente nel pascolo alpino, caratterizzata da una fenologia tardiva e prolungata.

Corotipo: Oloartico (OLA).

120. *Harpalus (Harpalus) honestus* (Duftschmid, 1812)

Carona (Magistretti, 1968); Baite di Mezzeno (Roncobello) m 1500 (LBi).

H. honestus è una specie xerofila a fenologia tardiva e prolungata, propria di terreni ben esposti e caratterizzati da una marcata xericità dovuta alla scarsa capacità di ritenuta idrica del substrato e alla profondità della falda (Grottolo *et al.*, 2016).

Corotipo: Sibirico-Europeo (SIE).

121. *Parophonus (Parophonus) maculicornis* (Duftschmid, 1812)

Carona (Magistretti, 1968).

P. maculicornis è un'entità che popola le formazioni aperte su suoli mediamente umidi.

Corotipo: S-Europeo (SEU).

122. *Trichotichnus (Trichotichnus) laevicollis* (Duftschmid, 1812)

San Simone (Monzini, 2008); Bocchetta di San Simone (Magistretti, 1965); Passo Dordona (Magistretti, 1965; Monzini, 2008); Foppolo (Magistretti, 1965; Monzini, 2008); Lago Sardegnana (Carona) (Magistretti, 1968); Pizzo del Diavolo di Tenda (Schauberger, 1936; Magistretti, 1965); Laghi Gemelli (Magistretti, 1965; Monzini, 2008); Roncobello (Magistretti, 1965; Monzini, 2008); Baite di Mezzeno (Roncobello) m 1500 (LBi); Passo Branchino (Roncobello) m 1700 (LBi & PG); Pizzo Arera (Monzini, 2008); Piazza dei Muffi (Oltre il Colle) m 1800 (DP); Monte Alben (Magistretti, 1965; Monzini, 2008).

T. laevicollis è un'entità eualpina e montana, silvicola,

presente lungo tutta la catena delle Alpi e delle Prealpi (Magistretti, 1965).

Corotipo: Centroeuropeo (CEU).

123. *Calathus (Neocalathus) melanocephalus* (Linné, 1758)

Pizzo dei Tre Signori (Franz, 1971); Branzi m 800 (LBi & PG); Lago Sardegnana (Carona) (Magistretti, 1968); Pizzo Arera (Magistretti, 1965).

Specie molto comune e diffusa dalla pianura alla fascia alpina, *C. melanocephalus* è un'entità che si rinviene soprattutto nelle formazioni aperte.

Corotipo: Palearctico (PAL).

124. *Calathus (Neocalathus) micropterus* (Duftschmid, 1812)

Passo Dordona (Foppolo) (Magistretti, 1965; Monzini, 2008).

C. micropterus è una specie legata a suoli ricchi di sostanza organica che, secondo Brandmayr *et al.* (1988), è tipica della taiga delle regioni settentrionali. Si rinviene soprattutto nelle formazioni forestali della fascia subalpina e montana (in particolare nei boschi di conifere). È presente talora anche nei pascoli al di sopra del limite superiore delle foreste, dove tende a concentrarsi sui suoli ammoniacali nei dintorni degli alpeggi. Queste popolazioni d'alta quota potrebbero essere le vestigia di una fauna silvicola sopravvissuta all'abbassamento del limite superiore delle foreste alle quote attuali.

Corotipo: Oloartico (OLA).

125. *Laemostenus (Laemostenus) janthinus coeruleus* (Dejean, 1828)

Piani di Bobbio (Franz, 1971); Bocchetta di San Simone (Magistretti, 1965; Monzini, 2008); Bocchetta di San Simone m 2000 (MG); dintorni Rifugio Ca' d'Arera (Oltre il Colle) m 1560 (DP); Monte Alben m 1500 e 1700 (MG); Colle Brassamonti (Monte Alben) m 1755 (DP).

Presente lungo l'intera catena alpina., *Laemostenus janthinus* è specie tendenzialmente eualpina e montana, frequente soprattutto in ambienti aperti, anche xerici (Casale, 1988).

Corotipo: S-Alpino (ALPS).

126. *Laemostenus (Actenipus) macropus* (Chaudoir, 1861)

Passo della Crocetta (Oltre il Colle) m 1340 (DP); mi-

niera del Pizzo Arera (Oltre il Colle) m 1450 (MG); miniera nei pressi del Rifugio Ca' d'Arera (Oltre il Colle) m 1530 (DP); Monte Alben m 1400 (MG).

Stenoendemita lombardo diffuso dal Lago di Como alla Val Camonica, *L. macropus* è un'entità microtermofila e silvicola non troglifila e non spiccatamente orofila (Casale, 1988).

Corotipo: Centro-S-Alpino (ALPC).

127. *Laemostenus (Antisphodrus) insubricus* Ganglbauer, 1903

1057 LoBG Bùs del Magro (Olmo al Brembo) m 700 (Magistretti, 1965; Comotti, 1983); Dossena (faggeta) m 1000 (MG); miniera di Paglio Pignolino (Dossena) m 1200 (MG); miniera lungo il versante Sud del Monte Valcareggio (Dossena) m 1300 (MG); miniera lungo il versante Ovest del Monte Valcareggio (Dossena) m 1300 (MG); Pizzo Arera (Müller, 1951); Oltre il Colle (faggeta) m 1000 (MG); miniera del Pizzo Arera (Oltre il Colle) m 1450 (MG); miniera lungo il versante W del Pizzo Arera (Oltre il Colle) m 2070 (DP); grotta non catastata presso Zorzone (Oltre il Colle) m 1170 (Comotti, 1986); Buco della Volpe (grotta non catastata presso Zorzone, Oltre il Colle) m 1200 (Comotti, 1986); miniera nei pressi del Rifugio Capanna 2000 (Oltre il Colle) m 1950 (DP); miniera presso la Baita Pessel in bassa Val Vedra (Oltre il Colle) m 1950 (DP); Monte Alben (MG); grotta presso il Bivacco Nembrini (Monte Alben) m 1800 (DP).

Stenoendemita lombardo diffuso dal Lago di Como al Fiume Oglio, *L. insubricus* è una specie ipogeobia (sensu Giachino & Vailati, 2016), presente negli orizzonti forestali.

Corotipo: Centro-S-Alpino (ALPC).

128. *Agonum (Agonum) muelleri muelleri* (Herbst, 1784)

Carona (Monzini, 2008); Foppolo (Monzini, 2008); Foppolo m 1500 (LBi).

Specie igrofila che popola ambienti umidi e paludosi e le rive dei corsi d'acqua, diffusa dalla pianura fino a oltre 2000 m.

Corotipo: Sibirico-Europeo (SIE).

129. *Agonum (Agonum) antennarium* (Duftschmid, 1812)

Serina (Monzini, 2008); Zambala (Monzini, 2008).

A. antennarium è una specie montana diffusa negli ambienti umidi montani delle Alpi e più limitatamente

dell'Appennino settentrionale (Pesarini & Monzini, 2011b).

Corotipo: Europeo (EUR).

130. *Agonum (Melanagonum) viduum* (Panzer, 1796)

Foppolo m 1500 (LBi).

A. viduum è un'entità igrofila e ripicola che si rinviene su terreni umidi e paludosi e lungo le rive dei corsi d'acqua. È diffusa dalla pianura all'orizzonte montano.

Corotipo: Sibirico-Europeo (SIE).

131. *Agonum (Punctagonum) sexpunctatum* (Linné, 1758)

Branzi (Magistretti, 1965; Monzini, 2008); Foppolo (Magistretti, 1965; Monzini, 2008).

A. sexpunctatus è una specie euriecia, che si rinviene soprattutto su terreni argillosi. Prevalentemente montano, ma anche in pianura (Magistretti, 1965).

Corotipo: Sibirico-Europeo (SIE).

132. *Anchomenus (Anchomenus) dorsalis* (Pontopidan, 1763)

Passo di Zambla m 1250 (DP).

Specie estremamente comune e diffusa, *A. dorsalis* è una specie euriecia che si rinviene dalla pianura al piano montano.

Corotipo: Palearctico (PAL).

133. *Anchomenus (Anchodemus) cyaneus* Dejean, 1828

Torrente Serina (Monzini, 2008); Serina (Monzini, 2008).

A. cyaneus è una specie ripicola diffusa principalmente lungo i corsi d'acqua di media montagna, soprattutto nel Nord Italia (Magistretti, 1965; Pesarini & Monzini, 2011b).

Corotipo: W-Europeo (WEU).

134. *Platynus teriolensis* K. Daniel & J. Daniel, 1898
Zuccone Campelli (Franz, 1971); Pizzo dei Tre Signori (Franz, 1971); Passo di San Marco (Mezzoldo) m 1900-2000 (LBi); Piazzo (Piazzatorre) m 1100 (LBi); Bocchetta di San Simone (Magistretti, 1965; Monzini, 2008; MG); Passo di San Simone (Mezzoldo) m 2100 (LBi); Lago Arale (San Simone) m 1700 (LBi & PG); Passo Dordona (Magistretti, 1965; Monzini, 2008); Corno Stella (Magistretti, 1965;

Monzini, 2008); Foppolo m 1500 (LBi); Carona m 1200-1300 (LBi); Pizzo del Diavolo di Tenda (Carona) m 2000 (LBi); sentiero per la Bocchetta Podavit (Pizzo del Diavolo di Tenda, Carona) m 2450 (DP); Rifugio Calvi (Carona) m 2100, Tombesi leg. (LBi); Rifugio Calvi (Carona) m 2200 (FZ); Rifugio Calvi (Carona) m 2020 (MG); Passo della Portula (Carona) m 2200 (LBi); Passo d'Aviasco (Carona) m 2200 (LBi); Laghi Gemelli (Magistretti, 1965; Monzini, 2008); Passo di Mezzeno (Carona) m 2150 (LBi); Baite di Mezzeno (Roncobello) m 1500 (LBi); Passo Branchino (Roncobello) m 1700 (LBi & PG); Monte Corna Piana (Pizzo Arera, Roncobello) m 1900 (LBi & PG); versante W Monte Corna Piana (Roncobello) m 2000 (DP); Pizzo Arera (Holdhaus, 1954; Magistretti, 1965; Monzini, 2008); Pizzo Arera (Oltre il Colle) m 2000 (MG); dintorni Rifugio Capanna 2000 (Oltre il Colle) m 1950 (DP); Monte Alben (Oltre il Colle) (MG); Colle Brassamonti (Monte Alben) m 1755 (DP).

Endemita diffuso nelle Alpi centrali dal Lago di Como ai Monti Lessini, *P. teriolensis* è una specie che si rinviene soprattutto nei pascoli alpini. È tuttavia presente talora anche in foresta.

Corotipo: Centro-S-Alpino (ALPC).

135. *Limodromus assimilis* (Paykull, 1790)

Branzi (Magistretti, 1968); Foppolo m 1500 (LBi).

L. assimilis è un'entità igrofila molto comune che si rinviene nei boschi umidi e, come elemento ripicolo, lungo le rive dei corsi d'acqua più ombrosi dalla pianura sino al limite superiore delle foreste. Anche in Val Brembana ha certamente una diffusione maggiore di quanto non appaia dai pochi dati disponibili.

Corotipo: Sibirico-Europeo (SIE).

136. *Cymindis (Cymindis) humeralis* (Geoffroy in Fourcroy, 1785)

Corno Stella (Magistretti, 1965; Monzini, 2008); Bocchetta di San Simone m 2000 (MG).

Come le congeneri, *C. humeralis* è una specie xerotermofila a fenologia tardiva e prolungata che popola soprattutto le formazioni aperte dal piano montano a quello alpino. È ampiamente diffusa sulle Alpi e sull'Appennino centro settentrionale.

Corotipo: Europeo (EUR).

137. *Cymindis (Cymindis) cingulata* Dejean, 1825
Mezzoldo (Magistretti, 1965; Monzini, 2008); Boc-

chetta di San Simone (Monzini, 2008); Foppolo (Magistretti, 1965; Monzini, 2008); Foppolo m 1500 (LBI); Colle Brassamonti (Monte Alben) m 1755 (DP).

Xero-termofila, *C. cingulata* si rinviene frequentemente nelle formazioni aperte del piano montano.

Corotipo: Centroeuropeo (CEU).

138. *Cymindis (Tarulus) vaporariorum* (Linné, 1758) Pizzo dei Tre Signori (Magistretti, 1965; Monzini, 2008); Corno Stella (Magistretti, 1965; Monzini, 2008); Pizzo del Diavolo di Tenda (Carona) m 2000 (LBI); Rifugio Calvi (Carona) m 2200 (FZ).

Specie molto comune e diffusa nelle valli alpine e appenniniche, che popola le praterie alpine sopra i 2000 m di quota, *C. vaporariorum* è un'entità xero-termofila, caratterizzata da una fenologia tardiva e prolungata. Corotipo: Sibirico-Europeo (SIE).

139. *Apristus europaeus* Mateu, 1980

San Giovanni Bianco (Magistretti, 1965: sub *subaeus*; Monzini, 2008).

A. europaeus è un'entità legata a substrati umidi e sabiosi, frequente negli ambienti perifluviali (Pesarini & Monzini, 2011b; Grottolo *et al.*, 2016).

Corotipo: S-Europeo (SEU).

140. *Paradromius (Manodromius) linearis* (Olivier, 1795)

Serina (Magistretti, 1965; Monzini, 2008).

Specie molto comune, *P. linearis* si rinviene soprattutto sotto detriti vegetali e alla base degli alberi. È diffuso dalla pianura alla fascia montana.

Corotipo: Europeo-Mediterraneo (EUM).

141. *Dromius (Dromius) agilis* (Fabricius, 1787)

Zambla (Monzini, 2008).

D. agilis è un'entità arboricola che, attiva in estate sulla chioma degli alberi, nella stagione invernale si sposta verso la base del fusto per svernare negli intestizi della corteccia, dove si rinviene più frequentemente. È la specie più comune del genere *Dromius* e presenta un excursus altitudinale molto ampio, dalla pianura fino a quasi 2.000 m (cfr. Bisio, 1996).

Corotipo: Sibirico-Europeo (SIE).

142. *Dromius (Dromius) fenestratus* (Fabricius, 1794)

Zambla (Monzini, 2008).

D. fenestratus è un'entità arboricola che ha abitudini simili alla specie precedente. Anch'esso molto comune, pare maggiormente legato al piano montano.

Corotipo: Europeo (EUR).

143. *Philorhizus melanocephalus* (Dejean, 1825)

Branzi (Sciaky, 1991; Monzini, 2008).

P. melanocephalus è una specie che si rinviene frequentemente sotto detriti vegetali.

Corotipo: Turanico-Europeo-Mediterraneo (TEM).

PRINCIPALI CARABIDOCENOSI RILEVATE

Carabidocenosi silvicole degli orizzonti submontano e montano. Le foreste dell'alta Val Brembana sono popolate da carabidocenosi silvicole molto ricche come numero di specie nelle quali l'elemento numericamente dominante quasi ovunque è *Abax parallelepipedus*.

Nell'orizzonte submontano, in sintopia con questa specie, si osservano spesso popolazioni numerose di *A. contractus* (che, ampiamente diffuso in quest'orizzonte, sconfina marginalmente in quello superiore), *A. baennigeri* (più comune nell'orizzonte montano, ma presente talora ai margini superiori di quello submontano) e *Pterostichus micans* (comune in entrambi gli orizzonti). Tra le altre specie che sono note di questa fascia forestale, sono da annoverare *Carabus convexus*, *Notiophilus palustris*, *Stomis rostratus*, *Pterostichus dissimilis*, *Tanythrix edura* e *Limodromus assimilis*.

Nella fascia montana (Fig. 5) le carabidocenosi tendono a modificarsi per la comparsa di taxa maggiormente legati al *Fagetum* e alle foreste di conifere e per la rarefazione di alcune entità che, pur presenti, sono confinate solo ai margini inferiori dell'orizzonte. All'aumentare della quota, si osserva la graduale scomparsa di *Abax contractus*, mentre, in sintopia con *Abax parallelepipedus*, *A. baennigeri* e *Pterostichus micans* (molto comuni anche in questa fascia), iniziano a comparire popolazioni via via più numerose (soprattutto nelle foreste di conifere) di *Pterostichus multipunctatus*. Queste specie sono accompagnate da un corteggio di Carabidi silvicoli molto numeroso formato da *Carabus creutzeri*, *C. depressus*, *C. germarii*, *Cychrus angustatus*, *C. caraboides*, *C. italicus*, *Notiophilus palustris*, *N. biguttatus*, *Stomis rostratus*, *Pterostichus rhaeticus*, *P. unctulatus*, *P. dissimilis*,

Tanythrix edura, *Trichotichnus laevicollis*, *Laemostenus macropus*, *Platynus teriolensis*, *Limodromus assimilis* e *Cymindis cingulata*. Ben rappresentato in questa fascia è anche il genere *Trechus* (*T. obtusus*, *T. binotatus* e *T. bergamascus*). Completano l'elenco delle entità note dell'orizzonte montano alcuni taxa silvicoli che paiono invece molto meno comuni quali *Leistus nitidus*, *L. rufomarginatus* e *Licinus hoffmannseggii*.

Carabidocenosi pratiche delle fasce forestali.

Anche la composizione delle carabidocenosi che popolano le formazioni aperte negli orizzonti submontano e montano è molto ricca come numero di specie (Fig. 5), anche se occorre rilevare che, essendo composte in buona parte da entità molto comuni, le indagini sulla loro composizione tendono a essere un po' trascurate dagli entomologi, soprattutto se, come nel caso degli scriventi, si effettuano campagne di ricerca

da condurre in tempi ristretti lontano dalle località di residenza. Ricerche specializzate in valle dedicate alle specie delle formazioni aperte potrebbero incrementare notevolmente il numero dei taxa noti, già comunque molto numerosi. A tale proposito è da rilevare ad esempio che nel territorio in oggetto mancano del tutto notizie su un'eventuale presenza di qualche specie del genere *Brachinus*. Si tratta di taxa che si rinvenivano in elevato numero di esemplari soprattutto nella stagione invernale, ai quali occorrerebbe pertanto dedicare apposite ricerche specializzate. In Val Brembana ne sono note solo due specie, segnalate da Monzini, (2008) della Val Imagna, che per ragioni di brevità non è stata considerata in questo lavoro: *B. crepitans* (Linné, 1758) e *B. explodens* Duftschmid, 1812. Non è da escludere che questi due taxa possano essere presenti anche lungo il fondovalle dell'alta valle, sino ai margini inferiori dell'orizzonte montano, come dimostrano i risultati ottenuti dagli scriventi in diverse valli



Fig. 5. La conca delle Baite di Mezzeno (7.V.1989) popolata da *Carabus castanopterus*, *Nebria jockischii*, *Poecilus versicolor*, *P. lepidus*, *Pterostichus dissimilis*, *P. multipunctatus*, *Abax baenningeri*, *Amara ovata*, *Ophonus laticollis*, *Harpalus affinis*, *H. rubripes*, *H. honestus*, *Trichotichnus laevicollis* e *Platynus teriolensis*.

alpine piemontesi (cfr. Bisio, 2011).

Tra i taxa segnalati sino a oggi, prevalgono le specie del genere *Amara* (*A. aenea*, *A. convexior*, *A. curta*, *A. familiaris*, *A. lunicollis*, *A. nitida*, *A. montivaga*, *A. ovata*, *A. similata*, *A. equestris* e *A. aulica*) e le Harpalinae (*Anisodactylus binotatus*, *Ophonus laticollis*, *Pseudoophonus rufipes*, *Harpalus affinis*, *H. distinguendus*, *H. rubripes*, *H. marginellus*, *H. atratus*, *H. honestus* e *Parophonus maculicornis*). Sono inoltre noti di questi ambienti *Cicindela campestris*, *Carabus italicus*, *C. cancellatus*, *Bembidion lampros*, *Poecilus versicolor*, *P. lepidus*, *Pterostichus strenuus*, *P. melanarius*, *Calathus melanocephalus*, *Laemostenus janthinus*, *Agonum muelleri*, *A. antennarium*, *A. viduum*, *A. sexpunctatum*, *Anchomenus dorsalis*, *Anchomenus cyaneus*, *Cymindis humeralis*, *C. cingulata*, *Apristus europaeus*, *Paradromius linearis* e *Philorhizus melanocephalus*.

Carabidocenosi cripticole. La carabidofauna criptica dell'alta Val Brembana è di fatto il fiore all'occhiello di questo territorio, contribuendo a elevarne notevolmente il pregio faunistico. I massicci di composizione carbonatica ivi presenti, costituiti da rocce sedimentarie carsificate e fessurate, ospitano infatti, nel loro vasto complesso di cavità naturali (grotte, pozzi, ecc.) e nell'ambiente sotterraneo superficiale (M.S.S.), un gruppo di stenoendemiti ipogei specializzati dei quali i Trechini sono la componente più numerosa e importante. In tale gruppo sono da annoverare due specie del genere *Boldoriella* (*B. carminatii* e *B. concii*), due del genere *Allegretta* (*A. pavani* e *A. comottii*), i *Duvalius* (*D. winklerianus* e *D. longhii*) e, come rappresentante degli Sphodrina, *Laemostenus insubricus*.

Carabidocenosi degli orizzonti alpino e alto-alpino.

Gli orizzonti alpino e alto-alpino sono popolati da diverse carabidocenosi orofile la cui fenologia, come descritto da Focarile (1987) per la Valle d'Aosta, è influenzata, in funzione dei rispettivi *praeferenda* igrotermici, dal variare del tasso di umidità che si registra al suolo nel corso dell'estate (Figg. 6 e 7).

Al primo fondere delle nevi compaiono gli elementi perinivali in senso stretto (sensu Focarile, 1987) che nel territorio in oggetto sono *Nebria soror*, *N. lombarda* e, presente marginalmente, *N. castanea*. Si tratta di entità che occupano durante le ore diurne i suoli saturi di acqua di fusione ai margini dei nevai e si spo-

stano nottetempo sulla superficie degli stessi per nutrirsi del *pabulum* alloctono rappresentato dalla microfauna viva o morta portata in quota dalle correnti ascensionali. La prima specie popola (cfr. Gobbi *et al.*, 2018), spesso come unico Carabide presente, suoli poco evoluti del tutto denudati o quasi privi di vegetazione (come aree di recente deglaciazione, *rock glaciers*, ghiaioni). *N. lombarda* e *N. castanea*, pur presenti anche nei ghiaioni, colonizzano anche substrati più evoluti almeno parzialmente colonizzati dalle fitocenosi erbacee pioniere, dove si osservano spesso in sintopia con un corteggio di altre entità attratte al margine dei nevai dall'elevato tasso di umidità. Tale corteggio comprende *Carabus depressus*, *Cychrus cylindricollis*, *Nebria picea*, *Brososoma relictum*, gli stenoendemiti del genere *Trechus* (*T. schaumii*, *T. montisarerae* e *T. insubricus*), i *Bembidion* perinivali (*B. catharinae*, *B. glaciale*, *B. rhaeticum* e *B. bipunctatum*), *Pterostichus lombardus*, *Amara erratica* e *Platynus teriolensis*. Legate allo stillicidio della fusione sono anche le *Boldoriella* del subg. *Insubrites* (*Boldoriella binaghii*, *B. brembana* e *B. focarilei*), elementi microclasibionti perinivali.

Con l'avanzare dell'estate, i taxa sin qui citati vengono gradualmente sostituiti da altri relativamente meno esigenti in fatto di basse temperature e umidità, caratterizzati di conseguenza da una fenologia più prolungata, favorita probabilmente anche dall'elevata piovosità estiva, che tende a coprire l'intera stagione. Tra queste specie sono da annoverare *Carabus castanopterus*, *Pterostichus multipunctatus*, *Abax arerae*.

Infine, con la scomparsa degli ultimi nevai, sui terreni che progressivamente sono sempre più interessati da una maggiore xericità superficiale, compare il contingente di entità più xerofile che, limitatamente ai taxa più comuni, comprende *Amara praetermissa*, *A. brunnea*, *A. quenseli*, *A. alpestris*, *Calathus melanocephalus*, *Cymindis humeralis*, *C. vaporariorum* e *Harpalus solitaris*.

Carabidocenosi ripicole. La composizione delle carabidocenosi popolanti il reticolo idrografico dell'alta Val Brembana subisce una graduale evoluzione a causa delle variazioni della temperatura delle acque, delle caratteristiche degli alvei (quantità e dimensioni dei sedimenti), delle portate e della velocità della corrente. In particolare si registrano situazioni di vicarianza tra alcune specie e un graduale arricchimento come numero di taxa al diminuire della quota. A



Fig. 6. Pendii a valle del Passo di Aviasco (24.VII.1992), habitat di una carabidocenosi orofila formata da *Carabus castanopterus*, *Cychrus cylindricollis*, *Nebria fontinalis*, *N. lombarda*, *Trechus insubricus*, *Pterostichus lombardus* e *Platynus teriolensis*.



Fig. 7. Nevaio nei pressi del Colle della Portula (23.VII.1992). Nei dintorni dello stesso è stata rilevata la presenza di una carabidocenosi formata da *Cicindela gallica*, *Carabus castanopterus*, *Nebria lombarda*, *Trechus insubricus*, *Bembidion rhaeticum*, *Pterostichus lombardus*, *Harpalus solitaris* e *Platynus teriolensis*.

grandi linee si possono individuare le situazioni ambientali qui di seguito descritte.

Gli ambienti sorgivi in quota sono popolati da *Nebria fontinalis*, elemento frigofilo stenotermo la cui presenza è condizionata dalla bassa temperatura delle acque. Più a valle, lungo le rive dei torrentelli che convogliano acque meno fredde, la specie viene sostituita da *N. rufescens* e *N. jockischii* e iniziano a comparire i primi Bembidiina (*Bembidion geniculatum* e *B. incognitum*).

Il Torrente Brembo e i suoi affluenti ospitano invece una carabidofauna più ricca come numero di taxa, costituita soprattutto da Bembidiina molto co-

muni e ad ampia diffusione, quali *Asaphidion austriacum*, *Bembidion varicolor*, *B. conforme*, *B. ascendens*, *B. geniculatum*, *B. tibiale*, *B. genei*, *B. decorum*, *B. tetracolum*, *Sinechostictus decoratus* e *S. ruficornis*. Accanto a queste specie, si registra peraltro la presenza di Bembidiina tendenzialmente più rari quali *Bembidion longipes*, *B. monticola* e *Sinechostictus doderoi*.

CONCLUSIONI

In totale, le specie di Carabidae attualmente note dell'alta Val Brembana sono 143. Accanto alla compagine degli elementi a più vasta distribuzione, tra i quali prevalgono (38% del totale) quelli a gravitazione più settentrionale (oloartici) rispetto a quelli a corotipo europeo (31%) (Tab. 2 e Fig. 8), spicca l'elevato numero di specie endemiche (ben 45, pari al 31%), rappresentate soprattutto da elementi Centro-Alpini (31 pari a circa il 22%) che sono in gran parte stenoendemiti ad areale alquanto ristretto, legati in molti casi ad habitat peculiari. Per la ricchezza faunistica e per l'elevato tasso di endemicità, l'alta Val Brembana si dimostra quindi, come del resto altre valli lombarde (cfr. Grottole *et al.*, 2016), un territorio di pregio faunistico molto elevato, meritevole di opportune misure di tutela volte alla conservazione dei taxa e dei biotopi da essi popolati.

RINGRAZIAMENTI

Desideriamo ringraziare gli amici Achille Casale e Gianni Allegro per la lettura critica del testo, per i preziosi suggerimenti e per la comunicazione di alcuni dati corologici, così come Matteo Negro che ha redatto la tavola riguardante la valle in oggetto. Ringraziamo inoltre i numerosi colleghi (Gianni Allegro, Luca Bodei, Mario Grottole, Riccardo Monguzzi, Paolo Neri, Davide Pedersoli e Francesco Zaccheo) che ci hanno messo a disposizione i dati corologici in loro possesso. Un ringraziamento particolare va infine alla moglie di uno di noi (L.B.), Anna Maria, che l'ha accompagnato nel corso di diverse escursioni.

DEDICA

Desideriamo dedicare questo lavoro alla memoria dell'amico e maestro Augusto Vigna Taglianti. Sempre prodigo di consigli, egli fu per noi una fonte inesauribile di dati corologici, messi generosamente a disposizione per i nostri lavori sui Carabidi delle valli piemontesi. Anche in questo lavoro abbiamo avuto, grazie a lui, la possibilità di utilizzarne alcuni.

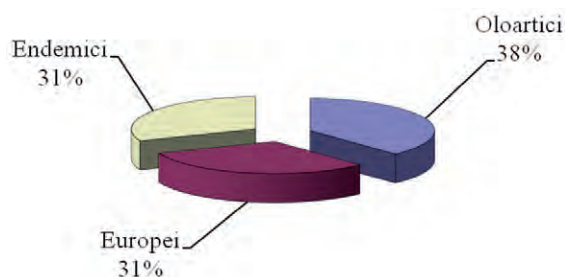


Fig. 8. Distribuzione percentuale dei corotipi nelle principali categorie corologiche.

Tab. 2. Distribuzione percentuale dei corotipi.

	Corotipi	N	%
Oloartici	OLA	14	9,79
	PAL	10	6,99
	WPA	1	0,70
	ASE	10	6,99
	SIE	16	11,19
	CAE	1	0,70
	TEM	1	0,70
Europei	EUM	3	2,10
	EUR	16	11,19
	CEU	20	13,99
	SEU	5	3,50
	WEU	1	0,70
Endemici	ALPC	31	21,68
	ALPE	4	2,80
	ALPS	5	3,50
	ALAP	5	3,50
Totale		143	100,00

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Risultati di trent'anni di ricerche in Piemonte e in Valle d'Aosta sui Dromiini arboricoli: una sintesi (Coleoptera Carabidae)

Riassunto: Vengono esposti i risultati di trent'anni di ricerche sui Carabidi arboricoli dei generi *Dromius*, *Philorhizus* e *Calodromius* in Piemonte e Valle d'Aosta. Nel corso di tali ricerche sono stati raccolti numerosi esemplari lungo il tronco di alcune essenze arboree. Il maggior numero di individui è stato rinvenuto nella stagione invernale soprattutto sugli aceri (*Acer* sp.) e su alcune conifere. Viene esaminata la distribuzione in queste due regioni di *Dromius (Dromius) agilis* (Fabricius, 1787), *Dromius (Dromius) angustus angustus* Brullé, 1834, *Dromius (Dromius) meridionalis* Dejean, 1825, *Dromius (Dromius) fenestratus* (Fabricius, 1794), *Dromius (Dromius) quadrimaculatus* (Linné, 1758), *Philorhizus quadrisignatus* (Dejean, 1825) e *Calodromius spilotus* (Illiger, 1798). Inoltre, vengono illustrati alcuni aspetti dell'ecologia di queste specie.

Abstract: Results of thirty years of researches on arboreal Dromiini in Piedmont and Aosta Valley: a synthesis (Coleoptera Carabidae).

The results of thirty years of researches dedicated to arboreal Carabidae of genera *Dromius*, *Philorhizus* and *Calodromius* in Piedmont and in Aosta Valley are reported. Many specimens have been sampled in winter along the trunks of a few tree species: most specimens have been found mostly on maples (*Acer* sp.) and on conifers. The Distributions in the two concerned regions of *Dromius (Dromius) agilis* (Fabricius, 1787), *Dromius (Dromius) angustus angustus* Brullé, 1834, *Dromius (Dromius) meridionalis* Dejean, 1825, *Dromius (Dromius) fenestratus* (Fabricius, 1794), *Dromius (Dromius) quadrimaculatus* (Linné, 1758), *Philorhizus quadrisignatus* (Dejean, 1825) and *Calodromius spilotus* (Illiger, 1798) is examined. Moreover, some aspects of ecology of these species are illustrated too.

Key words: Dromiini, chorology, ecology, Piedmont, Aosta Valley.

*In memoria dell'amico e maestro
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INTRODUZIONE

La gran parte dei Dromiini paleartici costituisce tra i Carabidae un gruppo ecologicamente molto isolato. Infatti, mentre la maggioranza dei taxa di questa famiglia di Coleotteri vive prevalentemente sul suolo o nei suoi strati più superficiali e si rinviene soprattutto sotto pietre, tronchi abbattuti, cortecce marcescenti e tra i detriti vegetali, è ormai ben noto che i *Dromius*, i *Calodromius* e alcuni *Philorhizus*¹ sono invece entità arboricole (cfr. Habu, 1967; Trautner, 1984; Bisio, 1996; Casale *et al.*, 1996; Scheffler, 1997; Luff, 1998; Simon, 2001; Felix & van Wielink, 2008, 2011; Hannig, 2011). Durante l'estate queste entità conducono una vita attiva sulla chioma degli alberi, dove predano larve di microlepidotteri defogliatori (Bin, 1980; Casale *et al.*, 1996), di Curculionidi o di Scolitidi xilofagi (Burmeister, 1939; Jeannel, 1942); poi, in autunno, più

o meno in corrispondenza della caduta delle foglie (unico periodo nel corso del quale talora si trovano individui anche tra le foglie già cadute al suolo), esse migrano lungo il tronco per andare a svernare nelle fessure della corteccia e/o sotto i muschi che ricoprono il ritidoma nella zona del tronco meno esposta al sole. A causa di queste abitudini, i Dromiini arboricoli non entrano a far parte (se non accidentalmente e, nel caso, sempre in numero alquanto ristretto di individui) del

¹ Non vengono qui presi in considerazione i *Philorhizus* brachitteri che vivono sul suolo e si rinvencono prevalentemente tra i detriti vegetali, rappresentati in Piemonte e Valle d'Aosta da *P. liguricus* Sciaky, 1991, *P. notatus* (Stephens, 1827), *P. occitanus* Allegro, 2015 e *P. crucifer confusus* Sciaky, 1991. Analogamente, non viene considerato *P. melanocephalus* (Dejean, 1825) che, pur essendo un'entità che si osserva talora come elemento corticicolo sul tronco degli alberi (Bisio, 1996; Allegro, com. pers. 2020), non può ritenersi una specie arboricola in senso stretto come i *Dromius* e i *Calodromius*, dato che si trova spesso sul suolo come gli altri *Philorhizus* sopra citati.

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materiale raccolto normalmente da un carabidologo che stia effettuando generiche ricerche a vista. Questo fatto ha contribuito in passato a creare per queste entità una fama di specie rare², che, per alcune di esse, è invece del tutto immeritata (cfr. Bisio, 1996; Casale *et al.*, 1996; Scheffler, 1997; Luff, 1998; Simon, 2001; Felix & van Wielink, 2008, 2011; Hannig, 2011). Numerose indagini condotte pressoché ininterrottamente dallo scrivente per quasi trent'anni in Piemonte e Valle d'Aosta hanno permesso di ottenere una consistente mole di dati e di informazioni su questi taxa. La presente nota intende proporre una sintesi delle attuali conoscenze riguardanti la corologia e l'ecologia nelle due regioni considerate di tutte le specie arboricole di *Dromius*, di *Philorhizus* e di *Calodromius* delle quali sia nota la presenza.

MATERIALI E METODI

Le abitudini arboricole di molte specie di *Dromiini* hanno rappresentato per lungo tempo una delle maggiori difficoltà nel reperirle. Infatti, durante l'estate, queste specie frequentano soprattutto le zone più alte della chioma degli alberi e, solo in rare occasioni, capita di imbattersi in individui che, spostandosi in volo da un albero all'altro, cadono accidentalmente al suolo. Anche la ricerca a vista degli esemplari ibernanti è un'operazione piuttosto complessa. Questi, infatti, non svernano alla base degli alberi nella zona del colletto come la maggioranza dei Carabidi (che, occupando quella zona, sono facilmente snidabili smuovendo il terriccio intorno al colletto); essi vanno invece a occupare, nella corteccia del tronco, le fessure del ritidoma, anche a diversi metri dal suolo. Dalle loro sedi di ibernazione si potrebbero snidare procedendo al distacco manuale delle placche di ritidoma dalla corteccia, ma queste, nella maggior parte delle essenze arboree, sono molto lignificate e non si possono di conseguenza staccare facilmente, a meno che le parti suberificate della corteccia non siano state intaccate dall'azione di microorganismi saprofiti. Per superare questo problema sono state messe a punto

metodologie particolari efficaci che consentono di ottenere campioni rappresentativi della carabidofauna arboricola eventualmente presente su di un albero. Tra queste sono da ricordare: l'impiego di fasce di cartone ondulato avvolte intorno al tronco (gli interstizi fungono da sede di ibernazione per gli adulti e gli stadi preimmaginali che possono quindi essere facilmente raccolti: cfr. Casale *et al.*, 1996; Felix & van Wielink, 2008, 2011), di bande di nastro adesivo anch'esse avvolte intorno al tronco (gli insetti restano invischiati e se ne può rilevare la presenza: cfr. Allegro, 2014; Allegro & Cersosimo, 2004; Allegro & Chiarabaglio, 2016; Allegro *et al.*, 2002, 2004) o di appositi anelli che fanno cadere gli insetti in appositi recipienti di raccolta (Felix & van Wielink, 2008, 2011). Il principale limite di tali tecniche è che le strutture impiegate sono ben visibili da lontano e, a meno di utilizzarle in aree poco accessibili, c'è il rischio concreto che vengano



Fig. 1. Val Chisone, Colle Las Arà (Pramollo), 24.II.2020. Vecchio esemplare di acero montano (*Acer pseudoplatanus*) a fine inverno. Le ricerche lungo il tronco hanno consentito il rinvenimento di numerosi individui in ibernazione di *Dromius agilis*, *D. fenestratus* e *D. quadrimaculatus*.

² Non così la pensavano però Sella (1864), che segnalava *Dromius quadrimaculatus* come specie comune nel Biellese, e Baudi di Selve (1890), che considerava *D. agilis* non raro d'inverno presso Torino, sotto le cortecce di platano e, a proposito di *D. fenestratus*, scriveva di aver raccolto numerosi esemplari sugli abeti nelle Alpi Marittime.

smantellate da estranei di passaggio. Lo scrivente, dopo alcuni tentativi con il cartone ondulato, falliti per la scomparsa dello stesso, ha poi preferito continuare con le ricerche a vista degli individui ibernanti (già iniziate negli anni novanta del secolo scorso), operando su essenze arboree la cui corteccia tende a sfaldarsi spontaneamente, quali le specie del genere *Acer* (Figg. 1 e 2) e alcune conifere, in particolare l'abete rosso (*Picea abies*). Su tali essenze le placche di ritidoma si possono rimuovere manualmente senza particolari difficoltà ed è quindi possibile ispezionare una miriade di fessure, potenziali sedi di ibernazione di questi taxa arboricoli, spesso con buoni risultati (per maggiori dettagli cfr. Bisio, 1996). Una volta snidati, gli insetti possono essere catturati direttamente sul tronco o, nel caso che si lascino cadere al suolo, raccolti su di un supporto appositamente predisposto alla base dell'albero (lo scrivente ha di norma utilizzato un telo di nylon e, quando questo non era disponibile, la propria giacca a vento, come è accaduto durante alcune escursioni in montagna). In Piemonte e Valle d'Aosta, il periodo migliore per utilizzare questo metodo di ricerca è risultato quello compreso tra la fine di ottobre (in corrispondenza della caduta delle foglie) e il mese di marzo (nei mesi estremi gli individui rinvenuti risultano essere comunque molto meno numerosi rispetto a quelli centrali), peraltro con variazioni locali, molto dipendenti dalla quota e dall'esposizione³. È da notare che i lunghi periodi di assenza di neve al suolo (anche nel piano montano), che caratte-



Fig. 2. Particolare della corteccia dello stesso albero: le placche parzialmente sollevate del ritidoma sono la sede di ibernazione di numerosi esemplari di *Dromius*.

rizzano ormai gli inverni piemontesi da diversi anni, hanno alquanto agevolato questo tipo di ricerche, che erano molto più difficoltose e, in alcuni inverni particolarmente nevosi, pressoché impossibili una trentina di anni fa. Sebbene questo metodo di ricerca consenta di individuare la presenza di alcune entità arboricole in un determinato territorio, occorre comunque riconoscere che, essendo considerate solo alcune essenze arboree, esso non permette un censimento oggettivo di questi taxa, perché, come ha dimostrato Scheffler (1997), alcune specie arboricole sembrano essere maggiormente presenti e numerose su alcune essenze arboree piuttosto che su altre.

RISULTATI E DISCUSSIONE

Per la nomenclatura delle specie in oggetto e per l'attribuzione del corotipo di competenza a ciascuna di esse, si è fatto riferimento alla Checklist dei Carabidi italiani elaborata da Vigna Taglianti (2005). Per ogni stazione segnalata sono riportati la citazione bibliografica, il raccoglitore o la collezione in cui il materiale è conservato (LB=Luigi Bisio; AC=Achille Casale; GDB=Giuseppe Della Beffa; RM=Riccardo Monguzzi).

Dromius (Dromius) agilis (Fabricius, 1787)

In Piemonte e Valle d'Aosta la specie è nota delle seguenti località:

Piemonte TO: Torino (Baudi di Selve, 1890); Carignano (Bisio, 1996); Busano m 300 (Bisio, 1996); Bienca Canavese (Chiaverano) m 450 (Malaise trap, AC) (Bisio, 1996); **Val Pellice:** Comba dei Carbonieri m 900 (Bisio, 1996); Culubrusa (Villanova, Bobbio Pellice) m 1460 (Bisio, 1996); Serre Sarsenà (Bobbio Pellice) m 1350 (Bisio, 2004); Vallone Subiasco m 1350 (Bisio, 1996); Gardetta (Vallone Rospard, Villar Pellice) m 1240 (Bisio, 1996); Sap (Valle Angrogna) m 1400 (Bisio, 2001); Chiot (Valle Angrogna) m 1225 (Bisio, 1996); Ciaudet (Valle Angrogna) m 1380 (Bisio, 1996); Criulira (Valle Angrogna) m 1590 (Bisio, 1996);

³ Lo scrivente ha avuto l'occasione di catturare ancora 35 esemplari di *Dromius agilis* verso la fine di aprile in un bosco in esposizione Nord a 1620 m di quota, a Pian Benot (Valli di Lanzo) (cfr. Bisio, 1996), quando, a quote inferiori, non si trovavano più esemplari in ibernazione.

Colle della Vaccera (Valle Angrogna) m 1500 (Bisio, 1996); **Val Germanasca**: Ghigo (Praly) m 1450 (Bisio, 2007); **Val Chisone**: Colle Las Arà (Pramollo) m 1550 (Bisio, 1996); Fenestrelle m 1160 (Bisio, 2013a); Pragelato (Bisio, 1996); Balboutet (Usseaux) m 1570 (LB); Traverses (Pragelato) m 1550 (Bisio, 1996); Serre Moretto (Vallone del Gran Dubbione, Pinasca) m 1000-1200 (Bisio, 2013a); **Val Sangone**: Alpe Colombino (seggiovie dell'Aquila, Giaveno) m 1200 (Bisio & Allegro, 2014); **Val di Susa**: Mompellato (Rubiana) m 1100 (LB); Bardonecchia m 1300 (LB); **Valli di Lanzo**: Germagnano m 450 (Bisio, 1996); Forno (Lemie) m 840 (Bisio, 1996); Pian Benot (Usseglio) m 1620 (Bisio, 1996); Margone m 1420 (Bisio, 1996); Villaretto (Usseglio) m 1270 (Bisio, 1996); Vallone d'Ovarda (Lemie) m 1500 (Bisio, 1996); Forno Alpi Graie m 1220 (Bisio, 1996); Pialpetta m 1070 (Bisio, 1996); Candiela (Chialamberto) m 1150 (Bisio, 1996); San Giacomo (Cantoira) m 1420 (Bisio, 1996); Curchiatto (Chiaves) m 1090 (Bisio, 1996); **Valle Orco**: Ceresole Reale m 1550-1560 (Bisio, 1996); Talosio (Vallone di Ribordone) m 1250 (Bisio, 1996); Cappella Belice (Chiesanuova, Valle Sacra) m 950 (Bisio, 1996); Santuario di Santa Elisabetta (Colletterto Castelnuovo, Valle Sacra) m 1150, 1350 e 1450 (Bisio, 1996); Santuario di Santa Elisabetta (AC): Vallone Piova (Castelnuovo Nigra, Valle Sacra) m 1420 (Bisio, 1996); Monte Calvo (Castelnuovo Nigra, Valle Sacra) m 1100 (Bisio, 1996); **Val Soana**: Punta Arbella (Pont Canavese) m 1100 (Bisio, 1996); Reverso (Ingria) m 1100 (Bisio, 1996); Servino (Ronco Canavese) m 1200 (Bisio, 2003); Punta Quinzeina (Frassinetto) m 1200 (Bisio, 1996); **Val Chiusella**: Trausella m 600 (Bisio, 2012); Succinto (Traversella) m 1150 (Bisio, 1996); Novareglia (Vico Canavese) m 700 (Bisio, 1996). **AL**: "Bosco Palli" (Casale Monferrato) (Allegro & Chiarabaglio, 2016). **AT**: Bric Puschera (Serole) m 800-850 (Allegro, 2014); Oasi WWF "Forteto della Luja" (Loazzolo) (Allegro, 2014); Parco regionale di Rocchetta Tanaro (Allegro & Cersosimo, 2004); Oasi WWF Bosco del Lago di Castello di Annone (Allegro *et al.*, 2002); Asti, frazione Valmanera (Allegro, 2019); Alneto del Mulino (Villanova d'Asti, frazione Savi) (Allegro, 2015). **BI**: **Valle Elvo**: Bagneri m 1000-1100 (Bisio, 2018); Raja di Graglia m 1100-1135 (Bisio, 2018); Alpetto Inferiore m 1250 (Bisio, 2018); **Valle Cervo**: Piedicavallo m 1000-1100 (Bisio *et al.*, 2017); Golzio (Monticchio) m 1200 (Bisio *et al.*, 2017); **Val Ponzone**: Regione Bellavista (Trivero) m 900-1000

(LB); **Val Sessera**: Alpe Artignaga m 1390 (LB). **CN**: Bossolasco (AC); **Val Tanaro**: Viozene m 1245 (Bisio & Giuntelli, 2019a); **Val Casotto**: Valcasotto m 1000 (Bisio & Giuntelli, 2019b); **Val Ellero**: Norea m 669 (Bisio *et al.*, 2015a); **Val Pesio**: Val Pesio (Magistretti, 1965); Chiusa Pesio m 600 (Bisio *et al.*, 2013); **Val Vermenagna**: Palanfrè m 1300 (Bisio *et al.*, 2018); **Valle Stura di Demonte**: Aisone m 800 (LB); **Val Grana**: Ougie-Piebruno (Monterosso Grana) m 1200 (Bisio & Giuntelli, 2014a); Santa Lucia di Coumboscuro (Monterosso Grana) m 1000-1100 (Bisio & Giuntelli, 2014a); **Val Maira**: Canosio (Marmora) m 1300 (Bisio & Giuntelli, 2011); Preit (Marmora) m 1600 (Bisio & Giuntelli, 2011); **Val Varaita**: Vallone di Gilba (Brossasco) m 1200 (Bisio & Giuntelli, 2008); **Valle Po**: Bertolini (Crissolo) m 1400 (Bisio, 2010); Martino (Ostana) m 1400 (Bisio, 1996). **NO**: Oleggio (RM); Romagnano Sesia (NO) (RM). **VB**: **Val Cairasca**: Alpe Veglia (IPLA, 1991); **Val Formazza**: Val Formazza (Pescarolo, 1998); **Val Antigorio**: Piani di Aleccio (Val Bondolero) m 900-1400 (Pescarolo, 1998). **VC**: **Val Sesia**: Val Sesia (Pescarolo, 1998); Morondo (Varallo Sesia) m 900 (RM); Campertogno m 800-1000 (RM). **Valle d'Aosta (AO)**: **Valle di Champorcher**: Petit-Mont-Blanc (Champorcher) m 1700 (Bisio & Allegro, 2019); **Valle di Cogne**: Aymavilles m 700 (Bisio *et al.*, 2016); Ozein m 1350 (Bisio *et al.*, 2016); Ozein m 1000, V. Rosa *legit* (RM); Epinel m 1450 (Bisio *et al.*, 2016); **Valsavaranche**: Rovenaud m 1450 (Bisio & Allegro, 2018); **Val di Rhêmes**: Sarral (Rhêmes-Saint-Georges) m 1200 (Bisio & Allegro, 2017); Chanavey (Rhêmes-Notre-Dame) m 1700 (Bisio & Allegro, 2017); **Valgrisenche**: Chamençon m 1250 (Bisio & Giuntelli, 2014b); Planaval m 1500 (Bisio & Giuntelli, 2014b); **Valle di La Thuile**: Pont Serrand m 1600 (LB); **Valle del Gran San Bernardo**: Saint-Oyen m 1350 (LB); **Val Peline**: Chez-Collet (Ollomont) m 1280 (Bisio, 2015); **Valle di Saint Barthélemy**: Val Dessus (Blavy) m 1300 (Bisio, 2013b); Issologne (Saint-Barthélemy) m 1550 (Bisio, 2013b); **Valtournanche**: Buisson (Antey-Saint-André) m 1108 (Bisio *et al.*, 2015b); Lago di Loz (Valtournanche) m 1700 (Bisio *et al.*, 2015b); **Val d'Ayas**: Arcesaz (Challant St. Anselme) m 1100 (Bisio, 2006); Extrepièraz (Brusson) m 1400 (Bisio, 2006); Bosco di Pesse (Col de Joux) m. 1700 (Quarello com. pers., 2020); **Valle di Gressoney**: San Grato (Issime) m 1500-1600 (Bisio *et al.*, 2012); Gressoney Saint Jean m 1400 (Bisio *et al.*, 2012).
COROTIPO: Sibirico-Europeo (SIE).

Secondo Pesarini & Monzini (2011), *D. agilis* è diffuso nell'Italia settentrionale, in gran parte dell'Italia centrale e in Basilicata. Occorre peraltro evidenziare che, in molte regioni, le segnalazioni sono attualmente ancora molto scarse e frammentarie, anche se probabilmente solo per difetto di ricerche specializzate dato che, in Piemonte e Valle d'Aosta (cfr. Bisio, 1996; Pescarolo, 1998), risulta essere un taxon molto comune. La specie presenta un excursus altitudinale relativamene ampio che si estende dalla pianura al piano montano, sino a una quota massima rilevata di 1620 m. Spesso fortemente gregario, *D. agilis* si osserva frequentemente in numerosi individui concentrati in pochi punti dell'albero (lo scrivente ha contato ben 16 esemplari sotto un'unica placca del ritidoma di un acero montano). Jeannel (1942), Magistretti (1965), Pescarolo (1998) e Coulon *et al.* (2000) lo segnalano come più frequente sulle conifere, mentre Scheffler (1997) e Felix & van Wielink (2008, 2011) ne dimostrano la presenza numerosa anche sulle latifoglie (in particolare su pioppo e quercia). Alla luce delle attuali conoscenze, esso si rinviene indifferentemente su entrambi i gruppi di essenze arboree (cfr. Bonadona, 1971; Bisio, 1996; Luff, 1998). Come altre specie alate, *D. agilis* è attratto nelle trappole luminose a luce di Wood (cfr. Allegro, 2015). Si tratta di una specie monotipica, caratterizzata peraltro da una certa variabilità di colorazione delle elitre: la forma ad elitre concolori è più comune, ma sono tutt'altro che infrequenti individui che presentano una macchia discale pallida sull'elitra (aberrazione *bimaculatus* Dejean, 1825).

***Dromius (Dromius) angustus angustus* Brullé, 1834**

La specie è nota in Piemonte delle seguenti stazioni: **AL:** Vargo, «pl. es., XII.88» (Monzini, 1991). **AT:** Oasi WWF "Forteto della Luja" (Loazzolo), 1 es. (banda adesiva sul tronco) (Allegro, 2014); **CN:** **Alpi Marittime** (Casale & Vigna Taglianti, 1993). **VB:** **Val d'Ossola** (Pescarolo, 1998).

COROTIPO: Europeo (EUR).

D. angustus è una specie arboricola nota in Italia di pochissime stazioni. Porta (1923) lo cita di Toscana e Sardegna; le segnalazioni più recenti riguardano invece Emilia, Liguria e Piemonte (Sciaky & Pavesi, 1986; Monzini, 1991; Fabbri & Degiovanni, 1997; Pescarolo, 1998; Allegro, 2014). In quest'ultima regione questa entità è attualmente nota di due sole

località (Monzini, 1991; Allegro, 2014), oltre che per le generiche citazioni per le Alpi Marittime (Casale & Vigna Taglianti, 1993) e per l'Ossolano (Pescarolo, 1998), fatto che fa pensare a un'oggettiva sua maggiore sporadicità, che pare comprovata anche dalla totale assenza di reperti registrata dallo scrivente nel corso delle ripetute ricerche condotte nelle valli alpine occidentali, così come dal numero molto ridotto di esemplari segnalati per il Piemonte da quasi tutti autori, con la sola eccezione di Monzini (1991). *D. angustus* sembra anche raro nel resto d'Europa: Jeannel (1942) lo riteneva tale in Francia, mentre Scheffler (1997) e Felix & van Wielink (2008, 2011), nel corso delle loro ricerche condotte rispettivamente in Germania e Olanda, ne hanno censito un numero trascurabile di individui, a fronte di una quantità molto consistente di esemplari di altre specie di *Dromius*. Come nel caso della specie precedente, *D. angustus* è noto in Italia grazie a reperti ottenuti durante la stagione invernale (cfr. date di cattura in Monzini, 1991; Fabbri & Degiovanni, 1997) in ibernazione come elemento «corticicolo» (Fabbri & Degiovanni, 1997). Secondo Jeannel (1942), esso si rinviene su meli e platani, mentre, secondo Bonadona, 1971; Scheffler (1997), Luff (1998) e Pescarolo (1998), predilige invece le conifere. Luff (1998) lo considera un riproduttore estivo (*summer breeder*).

***Dromius (Dromius) meridionalis* Dejean, 1825**

La specie è nota delle seguenti stazioni piemontesi e valdostane:

Piemonte: **TO:** **Val Soana:** Ronco Canavese (Magistretti, 1968); **Valle d'Aosta (AO):** **Valle di Cogne:** Piano di Sylvenoire (Cogne) (Carret, 1905); **Valsavarenche** (Magistretti, 1965; Focarile, 1975); **media Valle d'Aosta:** Saint-Nicolas (Sarriod) m 1400 (Focarile, 1975).

COROTIPO: Sibirico-Europeo (EUR).

Elemento xerotermofilo, *D. meridionalis* è diffuso nell'Italia centrale e meridionale, nelle isole e, con areale disgiunto, in Valle d'Aosta (cfr. cartina-areale in Focarile, 1974), dove la sua presenza è certamente favorita dal clima xerico che caratterizza il territorio (cfr. Focarile, 1974). Occorre però evidenziare che in quest'ultima regione pare poco comune, come sembrano dimostrare gli esiti negativi delle ricerche ivi condotte per diversi anni dallo scrivente. Secondo

Casale *et al.* (1996), che ne hanno descritto gli stadi preimmaginali e il ciclo biologico, *D. meridionalis* è un'entità arboricola, predatrice oligofaga di microlepidotteri, che sverna negli fessure della corteccia sia come larva, sia come adulto. Secondo Lindroth (1985), Casale *et al.* (1996) e Luff (1998) si tratta di un riproduttore estivo (*summer breeder*). La specie è stata osservata soprattutto su latifoglie (Bonadona, 1971; Casale *et al.*, 1996; Luff, 1998; Magrini & Degiovanni, 2010).

Dromius (Dromius) fenestratus (Fabricius, 1794)

Conosco la specie delle seguenti località:

Piemonte TO: **Val Pellice:** Chiot (Valle Angrogna) m 1225 (Bisio, 1996); Ciaudet (Valle Angrogna) m 1380 (Bisio, 1996); Criulira (Valle Angrogna) m 1590 (Bisio, 1996); Arcia (Valle Angrogna) m 1250 (Bisio, 1996); Colle della Vaccera (Valle Angrogna) m 1500 (Bisio, 1996); **Val Germanasca:** Ghigo (Praly) m 1450 (Bisio, 2007); **Val Chisone:** Colle Las Arà (Pramollo) m 1550 (Bisio, 1996); **Val Sangone:** Alpe Colombino (seggiovie dell'Aquila, Giaveno) m 1200 (Bisio & Allegro, 2014); **Val di Susa:** Gran Bosco di Salbertrand (GDB); **Valli di Lanzo:** Margone m 1420 (Bisio, 1996); Villaretto (Usseglio) m 1270 (Bisio, 1996); Vallone d'Ovarda (Lemie) m 1500 (Bisio, 1996); Tornetti (Viù) m 1300 (Bisio, 1996); Cornetti (Balme) m 1500 (Bisio, 1996); Forno Alpi Graie m 1220 (Bisio, 1996); San Giacomo (Cantoira) m 1420 (Bisio, 1996); **Valle del Malone:** Pian Audi (Corio) m 950 (Bisio, 1996); **Valle Orco:** Nero (Alpette) m 1200 (Bisio, 1996); Trione (Alpette) m 1180 (Bisio, 1996); Monte La Cialma (Locana) m 1300 (Bisio, 1996); Ceresole Reale m 1550-1560 (Bisio, 1996); Talosio (Vallone di Ribordone) m 1250 (Bisio, 1996); Santuario di Santa Elisabetta (Colleretto Castelnuovo, Valle Sacra) m 1150, 1350 e 1450 (Bisio, 1996); Monte Calvo (Castelnuovo Nigra, Valle Sacra) m 1100 e 1250 (Bisio, 1996); **Val Soana:** Reverso (Ingria) m 1100 (Bisio, 1996); **Val Chiusella:** Vallone di Bossola (Trausella) m 1200 (Bisio, 2012); Fondo m 1020 (Bisio, 1996); **Anfiteatro morenico di Ivrea:** San Giacomo di Andrate m 1000 (AC) (Bisio, 1996). **BI:** **Valle di Oropa:** Santuario di Oropa (Bisio, 1996; Giachino & Giachino, 2009); **Valle Cervo:** Rosazza (RM); Golzio (Monticchio) m 1200 (Bisio *et al.*, 2017); **Val Sessera:** Alpe Artignaga m 1.390 (LB). **CN:** **Alpi Marittime** (Baudi di Selve, 1890); **Val Tanaro:**

Viozene m 1245 (Bisio & Giuntelli, 2019); **Val Pesio:** Pian delle Gorre m 1100 (Bisio, 1996); **Val Vermentagna:** Palanfrè m 1300-1379 (Bisio *et al.*, 2018); **Val Maira:** Canosio (Marmora) m 1300 (Bisio & Giuntelli, 2011); Preit (Marmora) m 1600 (Bisio & Giuntelli, 2011); **Val Varaita:** Vallone di Gilba (Brossasco) m 1200 (Bisio & Giuntelli, 2008); **Valle Po:** Bertolini (Crissolo) m 1400 (Bisio, 2010); Martino (Ostana) m 1400 (Bisio, 1996). **VB:** **Valle Antigorio:** Piani di Aleccio (Val Bondolero) m 900-1400 (Pescarolo, 1998). **VC:** **Val Sesia:** Morondo (Varallo Sesia) m 900 (RM); Camasco (Varallo Sesia) m 900 (RM); Alpe di Mera (Scopello) m 1500 (RM); Campertogno m 1000 (RM); Alpe Cangello (Campertogno) m 1400 (RM); Mollia m 900 (RM); Alagna (Magistretti, 1965). **Valle d'Aosta (AO):** **Valle di Champorcher:** Petit-Mont-Blanc (Champorcher) m 1700 (Bisio & Allegro, 2019); **Valle di Cogne:** Epinel m 1450 (Bisio *et al.*, 2016); **Val di Rhêmes:** Chanavey (Rhêmes-Notre-Dame) m 1700 (Bisio & Allegro, 2017); **Valle di La Thuile:** Pont Serrand m 1600 (LB); **Valle del Gran San Bernardo:** Saint-Oyen m 1350 (LB); Saint-Léonard m 1500 (LB); **Val Pelline:** Chez-Collet (Ollomont) m 1280 (Bisio, 2015); **Valle di Saint Barthélemy:** Issologne (Saint-Barthélemy) m 1550 (Bisio, 2013b); Alpage Chaleby (Lignan, Saint-Barthélemy) m 1940 (Bisio, 2013b); **Valtournanche:** Buisson (Antey-Saint-André) m 1108 (Bisio *et al.*, 2015b); Lago di Loz (Valtournanche) m 1700 (Bisio *et al.*, 2015b); **Valle di Gressoney:** San Grato (Issime) m 1500-1600 (Bisio *et al.*, 2012); Gressoney-Saint-Jean m 1400 (Bisio *et al.*, 2012).

COROTIPO: Europeo (EUR)

D. fenestratus è un elemento arboricolo noto dell'Italia settentrionale e di Toscana, Lazio e Calabria (Pesarini & Monzini, 2011). In Piemonte e Valle d'Aosta la specie si rinviene quasi esclusivamente nel piano montano (900 m è la quota minima nota). È anch'esso un elemento arboricolo che lo scrivente ha rinvenuto prevalentemente durante la stagione invernale, in ibernazione nelle fessure della corteccia lungo il tronco sia di conifere, sia di latifoglie (per maggiori dettagli sulla presenza della specie sulle diverse essenze arboree cfr. Bisio, 1996). Come già segnalato da Baudi di Selve (1890) e da Pescarolo (1998), è molto comune, anche se le sue popolazioni risultano quasi sempre meno numerose rispetto a quelle di *D. agilis* con il quale è spesso sintopico.

***Dromius (Dromius) quadrimaculatus* (Linné, 1758)**

La specie mi è nota in Piemonte e in Valle d'Aosta delle seguenti stazioni:

Piemonte TO: Mirafiori (Torino), 30.XI.1941, reperto ottenuto in una zona attualmente antropizzata dove la specie è senza dubbio scomparsa (AC) (Bisio, 1996); Colline Torinesi (Magistretti, 1965); Colline di Torino (Bisio, 1996); Torino, Colle della Maddalena (AC); Ciriè (Magistretti, 1965); San Carlo Canavese m 350 (Bisio, 1996); Burolo (AC); Busano m 300 (Bisio, 1996); Valperga m 370 (Bisio, 1996); Cuorgnè, Rio Gallenca m 420 (Bisio, 1996); **Val Pellice:** Villar Pellice m 650 (Bisio, 1996); Serre Sarsenà (Bobbio Pellice) m 1350 (Bisio, 2004); Torre Pellice m 550 (Bisio, 1996); Ciaudet (Valle Angrogna) m 1380 (Bisio, 1996); Criulira (Valle Angrogna) m 1590 (Bisio, 1996); Arcia (Valle Angrogna) m 1250 (Bisio, 1996); Colle della Vaccera (Valle Angrogna) m 1500 (Bisio, 1996); **Val Chisone:** Colle Las Arà (Pramollo) m 1550 (Bisio, 1996); **Val Sangone:** Alpe Colombino (seggiovie dell'Aquila, Giaveno) m 1200 (Bisio & Allegro, 2014); **Val di Susa:** Fenils (Cesana Torinese) m 1350 (LB); Bardonecchia m 1300 (LB); **Val della Torre:** Laghi di Caselette m 350 (LB); **Valli di Lanzo:** Villaretto (Usseglio) m 1270 (Bisio, 1996); Forno (Lemie) m 840 (Bisio, 1996); Vallone d'Ovarda (Lemie) m 1500 (Bisio, 1996); Tornetti (Viù) m 1300 (Bisio, 1996); Cornetti (Balme) m 1500 (Bisio, 1996); Forno Alpi Graie m 1220 (Bisio, 1996); Pialpetta m 1070 (Bisio, 1996); Candiela (Chialamberto) m 1150 (Bisio, 1996); San Giacomo (Cantoira) m 1420 (Bisio, 1996); **Valle del Malone:** Front Canavese m 310 (Bisio, 1996); Vauda Canavese m 360 (Bisio, 1996); Pian Audi (Corio) m 950 (Bisio, 1996); **Valle Orco:** Salto (Cuorgnè) m 420 (Bisio, 1996); Nero (Alpette) m 1100-1200 (Bisio, 1996); Praie (Locana) m 550 (Bisio, 1996); Monte La Cialma (Locana) m 1300 (Bisio, 1996); Rosone (Locana) m 715 (Bisio, 1996); Vasario (Sparone) m 1020 (Bisio, 1996); Cappella Belice (Chiesanuova, Valle Sacra) m 950 (Bisio, 1996); Santuario di Santa Elisabetta (Colleretto Castelnuovo, Valle Sacra) m 1150, 1350 e 1450 (Bisio, 1996); Monte Calvo (Castelnuovo Nigra, Valle Sacra) m 1100 e 1250 (Bisio, 1996); **Val Soana:** Monte Arbella (Pont Canavese) m 1100 (Bisio, 1996); Berchiotto (Frassinetto) m 1170 (Bisio, 1996); Frassinetto m 980 (Bisio, 1996); **Val Chiusella:** Trausella m 600 (Bisio, 2012); Fondo m 1080 (Bisio, 1996); Succinto (Traversella)

m 1150 (Bisio, 1996). **AL:** Piovera (Magistretti, 1965); Riserva Naturale Speciale del Torrente Orba (Allegro *et al.*, 2004); Casale Monferrato (Allegro & Sciaky, 2001); Riserva naturale integrale della Garzaia di Valenza (Allegro & Sciaky, 2001); Riserva Naturale "Ghiaia Grande" (Morano sul PO) (Allegro, 2007). **AT:** Bric Puschera (Serole) m 800-850 (Allegro, 2014); Oasi WWF "Forteto della Luja" (Loazzolo) (Allegro, 2014); Parco regionale di Rocchetta Tanaro (Allegro & Cersosimo, 2004); Oasi WWF Il Verneto di Rocchetta Tanaro (Allegro, 2001); Oasi WWF Bosco del Lago di Castello di Annone (Allegro *et al.*, 2002); Moncalvo, frazione Patro (Allegro, 2019); Asti, frazione Valmanera (Allegro, 2019). **BI:** «**Provincia di Biella**» (Sella, 1864); **Valle Elvo:** Occhieppo Inferiore m 400 (Bisio, 2018); Bagneri m 1000-1100 (Bisio, 2018); Raja di Graglia m 1100-1135 (Bisio, 2018); Alpetto Inferiore m 1250 (Bisio, 2018); **Valle Strona di Mosso:** Bianco (Camandona) m 800 (LB). **CN:** Cuneo (Bisio, 1996); Pezzolo Val Uzzone (Magistretti, 1965); **Val Pesio:** Val Pesio (Bisio, 1996); Val Pesio, Pian delle Gorre m 1100 (AC); Meschie (Monte Besimauda versante NE, Pradeboni) m 1000-1200 (Bisio *et al.*, 2013); **Val Vermenagna:** Palanfrè m 1379 (Bisio *et al.*, 2018); **Val Gesso:** Valdieri (AC); **Valle Stura di Demonte:** Beguda (Borgo San Dalmazzo) m 650 (LB); **Val Grana:** Ougie-Piebruno (Monterosso) m 1200 (Bisio & Giuntelli, 2014a); Santa Lucia di Coumboscuro (Monterosso Grana) m 1000-1100 (Bisio & Giuntelli, 2014a); Campomolino m 1150 (Bisio & Giuntelli, 2014a); **Val Maira:** Canosio (Marmora) m 1300 (Bisio & Giuntelli, 2011); **Val Varaita:** Val Varaita (Magistretti, 1965); Vallone di Gilba (Brossasco) m 1200 (Bisio & Giuntelli, 2008). **NO:** **Valle del Ticino** (Pescarolo, 1991). **VC:** Bosco delle Sorti della Partecipanza (Trino) (Allegro *et al.*, 2016); "Fontana Gigante" Di Tricerro (Allegro, 2005); **Val Sesia:** Val Sesia (Magistretti, 1965); Chioso (Scoppello) m 600 (RM); Campertogno m 800-1000 (RM). **Valle d'Aosta (AO):** **Valle di Cogne:** Aymavilles m 700 (Bisio *et al.*, 2016); **Val Pelline:** Chez-Collet (Ollomont) m 1280 (Bisio, 2015).

COROTIPO: Europeo (EUR).

Specie diffusa in buona parte d'Italia (Pesarini & Monzini, 2011), *D. quadrimaculatus* è molto comune in pianura e nell'orizzonte submontano, mentre, nel piano montano, pare limitare la sua presenza alle quote inferiori e ai versanti più esposti. È un'entità arboricola

presente soprattutto sulle latifoglie (Bonadona, 1971; Bisio, 1996; Luff, 1998), anche se non mancano reperti, peraltro molto meno frequenti, sulle conifere (per maggiori dettagli sulla presenza della specie sulle diverse essenze arboree cfr. Bisio, 1996; Scheffler, 1997). Tutti gli esemplari raccolti dallo scrivente sono stati rinvenuti durante la stagione invernale, in ibernazione nelle fessure della corteccia. spesso in sintopia con *D. agilis* (meno frequentemente con *D. fenestratus*). Come *D. agilis*, anche *D. quadrimaculatus* è attratto dalle trappole luminose a luce di Wood (Allegro, com. pers. 2020). Secondo Luff (1998), si tratta di un riproduttore estivo (*summer breeder*).

***Philorhizus quadrisignatus* (Dejean, 1825)**

La specie è nota delle seguenti stazioni piemontesi: **Piemonte TO: Valle Orco:** Santuario di Santa Elisabetta (Valle Sacra) m 1350 (Bisio, 1996). **AL:** Gavi (Magistretti, 1965: sub *Dromius*). **AT:** Oasi WWF Bosco del Lago di Castello di Annone (Allegro *et al.*, 2002). **VC:** Bosco delle Sorti della Partecipanza (Trino) (Casale, 1983; Allegro *et al.*, 2016).

COROTIPO: Europeo-Mediterraneo (EUM).

P. quadrisignatus è noto in Italia di quasi tutta la penisola, di Sardegna e di Corsica, ma pare sempre raro e localizzato (Sciaky, 1991), in particolare in Piemonte, come sembrano confermare il ridotto numero di segnalazioni desumibili dalla letteratura e la scarsità di reperti ottenuti dallo scrivente nel corso nei diversi anni di ricerche nelle valli alpine occidentali. La specie è spesso corticicola (Magistretti, 1965; Bisio, 1996; Allegro *et al.*, 2002), ma la sua biologia è ancora poco nota. Secondo Luff, (1998), vive sulle latifoglie, ma si rinviene anche sotto detriti vegetali. Casale (1983) ne ha segnalato un individuo trovato nel detrito accumulato all'interno del nido di un picchio.

***Calodromius spilotus* (Illiger, 1798)**

La specie è nota delle seguenti stazioni piemontesi e valdostane:

Piemonte TO: Val Chisone: Traverses (Pragelato) m 1550, 4 es. (Bisio, 1996). **VB:** Val d'Ossola

(Pescarolo, 1998). **Valle d'Aosta (AO): Valpelline:** Chez Collet (Ollomont) m 1280, 1 es. (Bisio, 2015).

COROTIPO: Europeo-Mediterraneo (EUM).

C. spilotus è una specie arboricola nota in Italia di buona parte della penisola e di Sardegna (cfr. Magistretti, 1965; Pesarini & Monzini, 2011), dove sembrerebbe tutt'altro che comune, considerando il numero estremamente ridotto di esemplari rinvenuti dall'autore nel corso di molti anni di indagini nelle valli piemontesi e valdostane. In realtà, come attestano i numerosi reperti ottenuti nel corso di ricerche specializzate sia da Scheffler (1997), sia da Felix & van Wielink (2008, 2011), è probabile che questa entità sia meno rara di quanto non appaia. Non è da escludere infatti che la maggior o minor consistenza delle popolazione di volta in volta censite sia, almeno in parte, da collegare al praefendum altitudinale di *C. spilotus*. Lo scrivente ha quasi sempre operato a quote comprese tra 500 e 1800 m, mentre sia Scheffler, sia Felix & van Wielink hanno invece rinvenuto numerosi esemplari in zone situate poco al di sopra del livello del mare. Bisogna inoltre considerare che gli esiti delle ricerche potrebbero anche essere fortemente condizionati dalla specie arborea sulla quale queste vengono effettuate, come si evince dai dati forniti da Scheffler (1997) che, operando su una rosa di dieci generi di essenze arboree, ha rilevato la presenza di 340 esemplari di *C. spilotus* su *Populus*, a fronte di pochi individui o addirittura nessuno su altre essenze. Allo stato attuale delle conoscenze, la specie comunque sembra presente indifferentemente sia su conifere, sia su latifoglie (cfr. Bisio, 1996, 2015; Felix & van Wielink, 2008, 2011; Magistretti, 1965; Magrini & Degiovanni, 2010; Pesarini & Monzini, 2011; Pescarolo, 1998). Secondo Luff (1998), si tratterebbe di un riproduttore estivo (*summer breeder*).

RINGRAZIAMENTI

Desidero ringraziare vivamente gli amici Achille Casale e Gianni Allegro per la lettura critica del testo, per la comunicazione di dati corologici e per i preziosi suggerimenti. Un ulteriore ringraziamento va inoltre a Giuseppe Della Beffa e Riccardo Monguzzi per la comunicazione di dati corologici.

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Updated knowledge on Italian Dermaptera with the report of a new alien species: *Forficula smyrnensis* Audinet-Serville, 1838

Abstract: The Dermaptera species number reported for the Italian fauna (27 species) is the most conspicuous among the European Union. The knowledge on Italian Dermaptera is among the most accurate in Europe, above all thanks to the large number of well-known entomologists who, over two centuries, have dedicated themselves to it in depth. Half of the species of Dermaptera known for Italy have indeed been described by Italian entomologists. Four species are alien and some of which have long been acclimatized in Italy. Among these, *Forficula smyrnensis* Audinet-Serville, 1838, is reported here for the first time from Italy, found in the Marche, Veneto and Emilia Romagna Regions in 2011, 2018 and 2020 respectively. The last record could suggest an acclimatization of this species in Italy. The knowledge of Italian Dermaptera was already very wide and accurate in 1994 when the 36th issue of the Checklist of the Italian fauna was published and even more so after the revision of 2005. The recent revision of the genus *Chelidurella* Verhoeff, 1902 on a molecular basis has substantially confirmed the great complexity for this genus in Italy and the ongoing research on the genus *Chelidura* Latreille, 1825 in the central-western Alps could unveil a similar complexity.

Riassunto: Le attuali conoscenze sui Dermaptera italiani con segnalazione di una nuova specie aliena: *Forficula smyrnensis* Audinet-Serville, 1838.

Il contingente dei Dermatteri segnalati per la fauna italiana è il più cospicuo tra i paesi dell'Unione Europea. Le specie segnalate per l'Italia sono 27, poco meno delle 29 note per la Penisola Iberica; 21 sono i Dermatteri della Francia e 16 quelli della Grecia. Le conoscenze sui Dermatteri italiani sono tra le più accurate in Europa, soprattutto grazie al grande numero di acclarati entomologi che vi si sono dedicati in modo approfondito nell'arco di due secoli. La metà delle specie di Dermatteri note per l'Italia è stata infatti descritta da entomologi italiani. Oltre un quarto delle specie italiane (6) risultano essere endemiche mentre ben 4 sono aliene, alcune delle quali sono da lungo tempo acclimate in Italia. Tra queste specie aliene viene qui segnalata *Forficula smyrnensis* Audinet-Serville, 1838, rinvenuta nel 2011 nelle Marche, nel 2018 in Veneto e nel 2020 in Emilia Romagna e quest'ultimo dato potrebbe suggerire per questa specie la sua acclimatazione in Italia. Le conoscenze dei dermatteri italiani erano già molto ampie ed accurate nel 1994 quando venne pubblicato il fascicolo 36 della Checklist della fauna italiana e ancor di più dopo la revisione del 2005. La recente revisione del genere *Chelidurella* Verhoeff, 1902 su base molecolare ha sostanzialmente confermato la grande complessità per questo genere in Italia e le ricerche in corso sul genere *Chelidura* Latreille, 1825 nelle Alpi centro-occidentali potrebbero svelare una situazione analoga.

Key words: Dermaptera, Forficulidae, earwig, *Forficula smyrnensis*, distribution, Italy, Europe.

INTRODUCTION

The Dermaptera of the Italian fauna constitute the largest contingent among the countries of the European Union. Italy with 27 species is the second in Europe, only the Iberian Peninsula (Spain and Portugal) counts 29 species, while the political territory of Spain (with Canary Islands and Madeira) counts 45 species. Other countries with a significant number of species are France with 22 species and Greece with 16. The species known in the European

continent, including also the Canary Islands and Madeira, are in total 87 and among the countries not belonging to the European Union, the Dermaptera known for Russia are 34 and those of Ukraine are 14 (Tab. 1 and Fig. 1).

One of the reasons why the Italian Dermaptera are so well known derives largely from the extensive group of Italian scholars who have dedicated themselves to this order of insects: Franco Andrea Bonelli (1784-1830), Giuseppe Genè (1836-1890),

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Tab. 1. The number of species of Dermaptera known for European countries obtained from available Checklists and updated literature.

Country/geographic area	Species
Europe (with Canary Is. and Madeira)	87
Russia	34
Italy	27
Spain and Portugal	29
Spain (with Canary Is. and Madeira)	45
France	22
Turkey	20
Greece	16
Ukraine	14
Austria	11
Romania	10
Germany	9
Switzerland	9
Croatia	9
Bosnia And Herzegovina	9
Slovenia	8
Czech Republic	7
Slovakia	7
Hungary	7
Serbia	7
Bulgaria	7
Sweden	6
United Kingdom	6
Poland	6
Denmark	6
Lithuania	5
Belarus	5
Albania	5
Belgium	4
Norway	3
Ireland	3
Finland	2
Macedonia	2

Achille Costa (1823-1898), Alfredo Borelli (1857-1943), Felice Capra (1896-1991), Teresita Paulucci Maccagno (1900-1999), Antonio Galvagni (1924-2015) and Augusto Vigna Taglianti (1943-2019). Among them (Fig. 2) many have contributed by describing new species or by delineating the geographical distribution of Italian species. Teresita Paulucci Maccagno deserves a particular mention as she was a true pioneer in the study of the taxonomic value of the male genitalia of Dermaptera (Maccagno, 1933). Alfredo Borelli was one of the greatest specialists of Dermaptera worldwide. There are 165 taxa nowadays attributed to him and another 35 of the taxa he described have been put into synonymy, at least according to the Dermaptera Species File online (<http://dermaptera.speciesfile.org/>), which to tell the truth it is not very well updated. Antonio Galvagni carried out very in-depth research on the genus *Chelidurella* Verhoeff, 1902 and contributed to the interpretation of its vast morphological variability, as we will see. The great Italian zoologist and biogeographer Augusto Vigna Taglianti, in addition to having studied and described new species of Italian and foreign Dermaptera (Vigna Taglianti, 1993 and 1999), has studied these insects in depth from a biogeographical point of view (Vigna Taglianti, 1994) as well as having compiled and updated the Checklist of the Italian fauna (Failla *et al.*, 1994; Vigna Taglianti, 2001 and 2005). Vigna Taglianti has studied in particular the Dermaptera of the Apennines (Vigna Taglianti, 1999 and Fontana *et al.*, 2004) and of the Western Alps (Vigna Taglianti, 2009), having in mind to revise the genus *Chelidura* Latreille, 1825 (in collaboration with Paolo Fontana) but unfortunately this remained an uncompleted purpose. His clear vision on the taxonomic structure and on the biogeographical aspects of the genus *Chelidura* (Chemini & Vigna Taglianti, 2002) are in fact today amply confirmed by the first molecular analyzes (Fontana *et al.*, in press).

If the knowledge on Italian Dermaptera is very deep, an adequate synthesis of such knowledge is still lacking and, above all, tools for their identification are lacking. Unfortunately (but probably fortunately), the volume of the Fauna of Italy relating to Dermaptera has not yet been written, but it is planned to carry out it as soon as the taxonomic situation of the genus *Chelidura* will be clarified. The only key available for the Italian Dermaptera, even if mainly focused on northern Italian species, as well as a clear exposition of the techniques related to the study of this order of

(Fig. 3). Then all endemic Italian taxa of Dermaptera belong to these three genera, namely *Chelidurella caprai* Vigna Taglianti, 1993, *Chelidurella poggii* Capra, 1982, *Pseudochelidura orsinii* (Gené, 1833), *Pseudochelidura galvagnii* Vigna Taglianti, 1999, *Forficula apennina* Costa, 1881 and *Forficula silana* Costa, 1881 (Fig. 4).

Following a new research based on molecular as well morphological analyses and relating to the most widespread species of Dermaptera in Europe and Italy, *Forficula auricularia* Linnaeus, 1758 resulted presently belonging to at least 4 different species: the morphologically diagnosable *Forficula aeolica* González-Miguéns & García-París, 2020, the cryptic taxa *Forficula mediterranea* González-Miguéns & García-París 2020, *Forficula dentata* Fabricius, 1775 and *Forficula auricularia* Linnaeus, 1758 sensu stricto (González-Miguéns *et al.*, 2020).

According to González-Miguéns *et al.* (2020), *Forficula auricularia* Linnaeus, 1758 is present in Czech Republic, Hungary, Italy, Romania, Sweden, France (in sympatry with *F. dentata*), Turkey, Canada, USA and Australia; *Forficula aeolica* González-Miguéns & García-París, 2020 is present in Spain and Morocco, *Forficula dentata* Fabricius, 1775 in Portugal, Spain Andorra, Great Britain, France (in sympatry with *Forficula auricularia*), Chile and USA, and *Forficula mediterranea* González-Miguéns & García-París, 2020 in Iberian Peninsula and Morocco. Therefore, only the true *Forficula auricularia* would be present in Italy but it is clear that the Italian *Forficula auricularia* complex should be deeply investigated in Italy and its islands too.

The recent revision of the genus *Chelidurella* (Kirstová *et al.*, 2020) has practically confirmed the

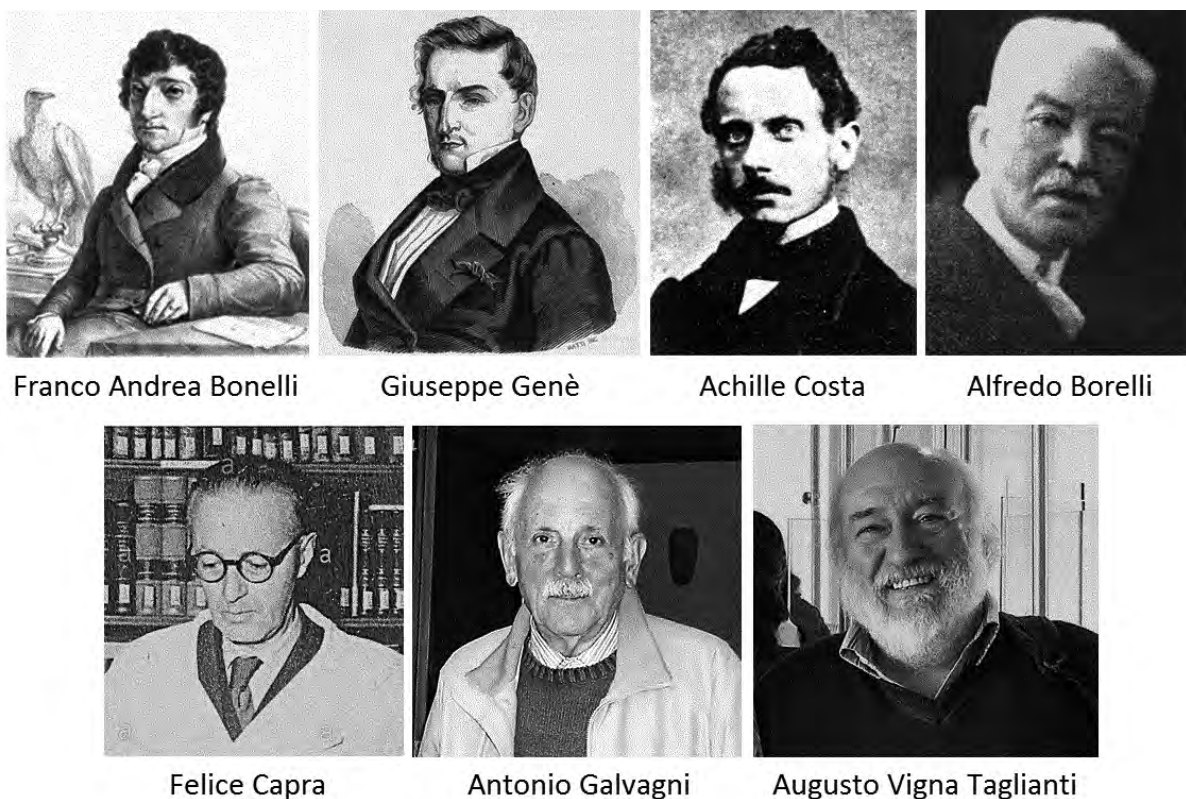


Fig. 2. Portraits of the Italian Dermapeterologists: Franco Andrea Bonelli (1784-1830), Giuseppe Gené (1836-1890), Achille Costa (1823-1898), Alfredo Borelli (1857-1943), Felice Capra (1896-1991), Antonio Galvagni (1924-2015) and Augusto Vigna Taglianti (1943-2019). Unfortunately, any portrait of Teresita Paulucci Maccagno (1900-1999) is known.

structure of this complex genus outlined by Antonio Galvagni in the course of his wide and accurate studies on this genus (Galvagni, 1994, 1995, 1996 and 1997). Kirstová *et al.* (2020), with their careful investigation, have confirmed on a molecular basis the identity of three genera in recent times joined under the genus *Chelidura* Latreille, 1825, namely *Chelidura* latreille, 1825, *Chelidurella* Verhoeff, 1902 and *Mesochelidura* Verhoeff, 1902. The study has brought to the synonymy of *Chelidurella guentheri* Galvagni, 1994 with *C. acanthopygia* (Gené, 1832) and of *C. tatrica* Chládek, 2017 with *C. thaleri* Harz, 1980 and to the description of two new species, *Chelidurella galvagnii* Kirstová & Kočárek, 2020, until now known only from Austria, and of *C. pseudovignai* Kočárek & Kirstová, 2020, known from northeastern Italy (Friuli Venezia Giulia), Austria and Slovenia. The approach used by Kirstová *et al.* (2020) was applied for the revision of the genus *Chelidura* which, as mentioned, Augusto Vigna Taglianti had been planning to carry out for many years and it is now on going (Fig. 5).



Fig. 3. (a) The most common species of the genus *Chelidurella*, *C. acanthopygia*, Italy, Colli Euganei, Veneto (Padua), photo by Andrea Cogo. (b) *Pseudochelidura orsinii*, Italy, Abruzzo (l'Aquila), Gran Sasso, Monte Aquila, photo by P. Fontana.



Fig. 4. (a) *Forficula apennina*, Italy, Abruzzo (l'Aquila), Gran Sasso, Monte Aquila, photo by P. Fontana. (b) *Forficula silana*, Italy, Abruzzo (L'Aquila), Civitella Alfedena, photo by P. Fontana.



Fig. 5. *Chelidura aptera* lago del Mucrone. Photo by P. Fontana.

***Forficula smyrnensis* Audinet-Serville, 1838
new for the Italian fauna**

At least three allochthonous species, with a wide subcosmopolitan, intertropical diffusion, up to date appear to have been introduced in Italy with crops: *Euborellia annulipes* (Lucas, 1847), known in Italy since 1837, but after 1930 widespread also in smaller Tuscan islands, *Nala lividipes* (Dufour, 1820), known since 1915 in Sicily and Sardinia and since 1977 on the Lazio coast and *Euborellia annulata* (Fabricius, 1787), previously known as *Euborellia stali* (Dohrn, 1864), found since 2002 in Lombard nurseries (Vigna Taglianti, 2005). To these three alien species now we add *Forficula smyrnensis* Audinet-Serville, 1838, found in Italy in single specimens, both females, the first time in the Marche in 2011 and more recently in Veneto in 2018. A new record (2020) from Emilia Romagna is concerning several specimens (5-6 females and 1 male) under the bark of an oak and this could suggest an areal acclimatization in Italy of the species.

Forficula smyrnensis is widespread in the eastern Mediterranean basin (from Yugoslavia to the Caucasus and to Israel), and was reported from Corsica without further details by Brunner von Wattenwyl (1882); the Corsican specimen is still in the Naturhistorisches Museum in Vienna. This same record is reported by

Chopard (1923), by Albouy & Caussanel (1990) and by Braud *et al.* (2002). Any new catches seem to have confirmed this report from Corsica. On the basis of the consolidated distribution of this species, the Corsica report seems reasonably to be framed in a phenomenon of passive introduction, as it is also probable for the three Italian records (Fig. 6). However, given the presence of this species in the Balkans, the finding of *Forficula smyrnensis* on the Adriatic side of Italy could also be interpreted as an example of trans-Adriatic fauna (Gridelli, 1950).

Forficula smyrnensis is a medium-large species for the genus and is characterized by lively coloring. The head is often orange, the pronotum is yellowish and the tegmina are of a blackish-brown with two clear and pale-yellow oval spots. The portion of the wings protruding from the short tegmina is quite long and very clear, sometimes white. The abdomen is dark brown and the cerci are blackish-brown. Antennae brown, paler in the basal segments and the legs are yellowish. The cerci of the female are very long for the genus and those of the male are generally more or less as long as the tegmina and the protruding part of the wings together. The shape of the cerci is simple, slightly arched and without teeth in the median portion; they are instead dilated in a sort of denticulation at their base (Fig. 7).

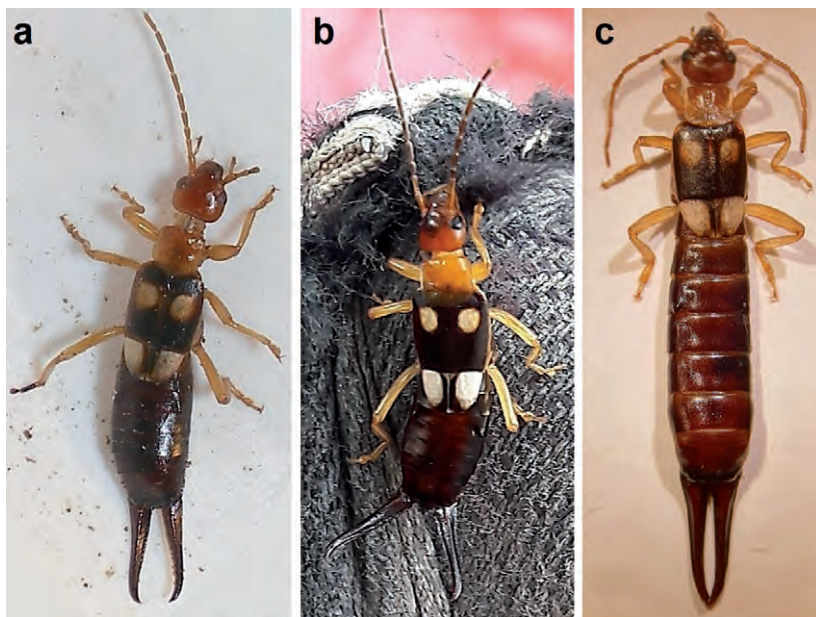
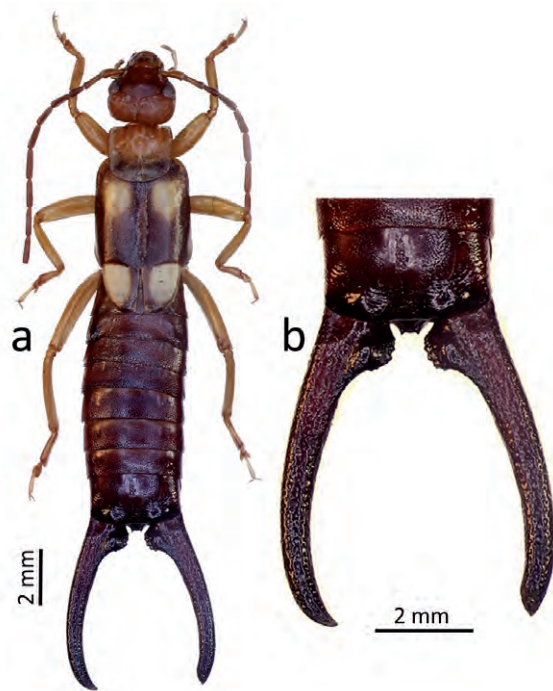


Fig. 6. The females specimens of *Forficula smyrnensis* collected in Italy. (a) Italy, Marche (Ancona), Offagna, 12.XI.2011, photo by G. Giovagnoli. (b) Italy, Veneto (Treviso), Montebelluna, 29.V.2018, photo by P. Tirello. (c) Italy, Emilia Romagna (Bologna), Zola Predosa, Gessi, 21.XI.2020, photo by Loris Colacurcio.



EXAMINED MATERIAL (Fig. 8): Italy, Veneto (Treviso), Montebelluna, Via Calmaggione, 29.V.2018, leg. P. Tirello, 1 female (P. Tirello private collection); Italy, Emilia Romagna (Bologna), Zola Predosa, Gessi, 3 females, 21.XI.2020, leg. L. Colacurcio (L. Colacurcio private collection); Italy, Marche (Ancona), Offagna, 12.XI.2011, leg. G. Giovagnoli, 1 female (G. Giovagnoli private collection); Italy, Marche (Ancona), Osimo, Monte Cerno (Monte della Crescia), 340 m, 45°30'49" N, 13°25'57" E, 6.II.2011, leg. G. Giovagnoli, 1 female (ex coll. E. Ruzzier, now in the coll. of the Fondazione Museo Civico di Rovereto).

Fig. 7. *Forficula smyrnensis* male, Bulgaria, Primorsko env., 19.VI.1997, J. Simandl leg., coll. P. Kočárek. (a) overall view of the male and (b) detail of the cerci, photo Petr Kočárek.

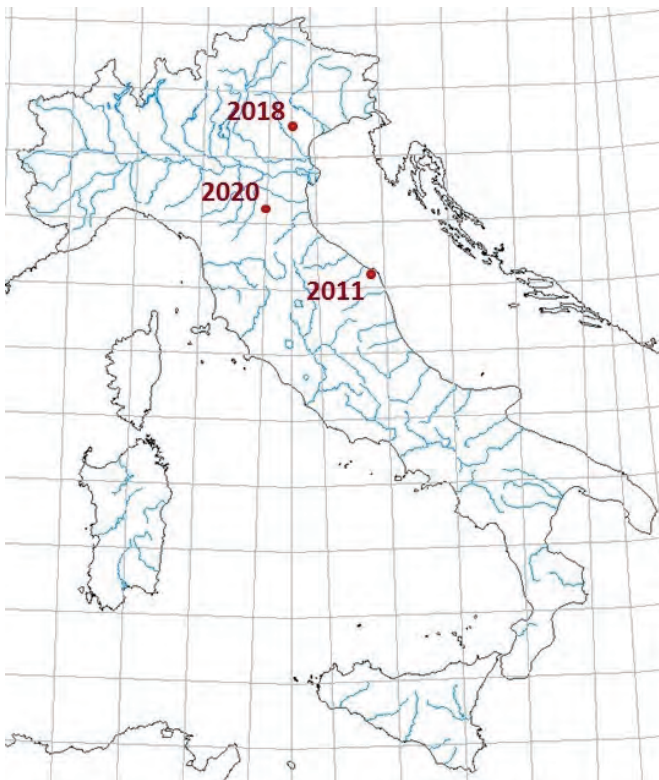


Fig. 8. The three Italian locations where *Forficula smyrnensis* was collected (the two sites in the Marche region are only a few kilometers away from each other).

UPDATED DERMAPTERA CHECKLIST
OF THE ITALIAN FAUNA WITH REGIONAL DISTRIBUTION

Family **Anisolabididae**

Anisolabis Fieber, 1853

Anisolabis maritima (Bonelli in Gené, 1832) (N, S, Si, Sa)

ITALIAN REGIONAL DISTRIBUTION: Friuli Venezia Giulia, Veneto, Liguria, Tuscany, Abruzzo, Lazio, Campania, Calabria, Sicily, Sardinia

Euborellia Burr, 1910

Euborellia annulipes (Lucas, 1847) (N, S, Si, Sa)

ITALIAN REGIONAL DISTRIBUTION: Friuli Venezia Giulia, Veneto, Piedmont, Liguria, Emilia Romagna, Tuscany, Abruzzo, Lazio, Campania, Calabria, Sicily, Sardinia.

Euborellia moesta (Gené, 1837) (N, S, Sa)

ITALIAN REGIONAL DISTRIBUTION: Friuli Venezia Giulia, Veneto, Lombardy, Piedmont, Liguria, Emilia Romagna, Tuscany, Umbria, Marche, Lazio, Abruzzo, Campania, Sardinia.

Euborellia annulata (Fabricius, 1787) (N)

ITALIAN REGIONAL DISTRIBUTION: Lombardy

Family **Labiduridae**

Nala Zacher, 1910

Nala lividipes (Dufour, 1820) (S, Si, Sa)

ITALIAN REGIONAL DISTRIBUTION: Lazio, Sicily, Sardinia.

Labidura Leach, 1815

Labidura riparia (Pallas, 1773) (N, S, Si, Sa)

ITALIAN REGIONAL DISTRIBUTION: Friuli Venezia Giulia, Veneto, Lombardy, Piedmont, Liguria, Emilia Romagna, Tuscany, Marche, Umbria, Abruzzo, Lazio, Campania, Apulia, Basilicata, Calabria, Sicily, Sardinia.

Family **Spongiphoridae**

Labia Leach, 1815

Labia minor (Linnaeus, 1758) (N, S, Si)

ITALIAN REGIONAL DISTRIBUTION: Trentino-South Tyrol, Veneto, Lombardy, Piedmont, Liguria, Emilia Romagna, Tuscany, Marche, Lazio, Abruzzo, Molise, Campania, Apulia, Basilicata, Calabria, Sicily, Sardinia

Family **Forficulidae**

Anechura Scudder, 1876

Anechura bipunctata (Fabricius, 1781) (N, S)

ITALIAN REGIONAL DISTRIBUTION: Lombardy, Piedmont, Aosta Valley, Abruzzo.

Chelidura Latreille, 1825

Chelidura aptera (Megerle in Charpentier, 1825) (N)

ITALIAN REGIONAL DISTRIBUTION: Piedmont.

Chelidurella Verhoeff, 1902

Chelidurella acanthopygia (Gené, 1832) (N, S)

ITALIAN REGIONAL DISTRIBUTION: Friuli Venezia Giulia, Trentino-South Tyrol, Veneto, Lombardy, Piedmont, Emilia Romagna, Tuscany.

Chelidurella caprai Vigna Taglianti, 1993 (S) [E]

ITALIAN REGIONAL DISTRIBUTION: Campania, Basilicata, Calabria.

Chelidurella mutica (Krauss, 1886) (N) [E]

ITALIAN REGIONAL DISTRIBUTION: Trentino-South Tyrol, Veneto, Lombardy.

Chelidurella poggii Capra, 1982 (N) [E]

ITALIAN REGIONAL DISTRIBUTION: Friuli Venezia Giulia, Trentino-South Tyrol.

Chelidurella thaleri Harz, 1980 (N)

ITALIAN REGIONAL DISTRIBUTION: Friuli Venezia Giulia, Trentino-South Tyrol, Veneto, Lombardy.

Chelidurella vignai Galvagni, 1995 (N)

ITALIAN REGIONAL DISTRIBUTION: Friuli Venezia Giulia, Trentino-South Tyrol, Veneto.

Chelidurella fontanai Galvagni, 1996 (N)

ITALIAN REGIONAL DISTRIBUTION: Aosta Valley, Piedmont, Liguria, Emilia Romagna.

Chelidurella pseudovignai Kočárek & Kirstová, 2020 (N)

ITALIAN REGIONAL DISTRIBUTION: Friuli Venezia Giulia.

Pseudochelidura Verhoeff, 1902

Pseudochelidura orsinii (Gené, 1833) (N, S) [E]

ITALIAN REGIONAL DISTRIBUTION: Piedmont, Liguria, Tuscany, Marche, Umbria, Abruzzo, Lazio, Molise, Campania.

Pseudochelidura galvagnii Vigna Taglianti, 1999 (S) [E]

ITALIAN REGIONAL DISTRIBUTION: Marche, Lazio, Abruzzo.

Apterygida Westwood, 1840

Apterygida albipennis (Megerle in Charpentier, 1825) (N, S)

ITALIAN REGIONAL DISTRIBUTION: Trentino-South Tyrol, Veneto, Lombardy, Piedmont, Aosta Valley, Liguria, Emilia Romagna, Tuscany, Marche, Umbria, Abruzzo, Lazio, Molise, Apulia, Calabria.

***Forficula* Linnaeus, 1758**

***Forficula apennina* Costa, 1881 (S) [E]**

ITALIAN REGIONAL DISTRIBUTION: Lazio, Abruzzo, Calabria.

***Forficula auricularia* Linnaeus, 1758 (N, S, Si, Sa)**

ITALIAN REGIONAL DISTRIBUTION: Friuli Venezia Giulia, Trentino-South Tyrol, Veneto, Lombardy, Piedmont, Aosta Valley, Liguria, Emilia Romagna, Tuscany, Marche, Umbria, Lazio, Abruzzo, Molise, Campania, Apulia, Basilicata, Calabria, Sicily, Sardinia.

***Forficula decipiens* Gené, 1832 (N, S, Si, Sa)**

ITALIAN REGIONAL DISTRIBUTION: Friuli Venezia Giulia, Veneto, Lombardy, Piedmont, Liguria, Emilia Romagna, Tuscany, Marche, Lazio, Abruzzo, Campania, Molise, Apulia, Basilicata, Calabria, Sicily, Sardinia.

***Forficula silana* Costa, 1881 (S, Si) [E]**

ITALIAN REGIONAL DISTRIBUTION: Abruzzo, Molise, Lazio, Basilicata, Calabria, Sicily.

***Forficula smyrnensis* Audinet-Serville, 1839 (N, S)**

ITALIAN REGIONAL DISTRIBUTION: Veneto, Emilia, Romagna, Marche

***Guanchia* Burr, 1911**

***Guanchia obtusangula* (Krauss, 1904) (N, S, Si)**

ITALIAN REGIONAL DISTRIBUTION: Veneto, Tuscany, Umbria, Lazio, Abruzzo, Molise, Campania, Apulia, Basilicata, Calabria, Sicily.

***Guanchia pubescens* (Gené, 1837) (N, S, Si, Sa)**

ITALIAN REGIONAL DISTRIBUTION: Veneto, Lombardy, Piedmont Liguria, Emilia Romagna, Tuscany, Marche, Lazio, Abruzzo, Campania, Calabria, Sicily, Sardinia.

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Petr KOČÁREK*

***Epilandex vignai* sp. nov. from Sulawesi**
(Dermaptera: Anisolabididae)

Abstract: A new species of the genus *Epilandex* Hebard, 1927, *Epilandex vignai* sp. nov., is described based on material from Sulawesi, Indonesia. The habitus and diagnostic characteristics are illustrated, and the taxonomic position is discussed. An identification key for all recognised *Epilandex* species is provided.

Riassunto: *Epilandex vignai* sp. nov. di Sulawesi (Dermaptera: Anisolabididae).

Una nuova specie del genere *Epilandex* Hebard, 1927, *Epilandex vignai* sp. nov., è descritta sulla base di materiale proveniente da Sulawesi, Indonesia. Vengono illustrati l'habitus e i caratteri diagnostici, discussa la posizione tassonomica della nuova specie e fornita una chiave di identificazione delle specie note di *Epilandex*.

Key words: Dermaptera, Anisolabididae, Anisolabidinae, taxonomy, Oriental region.

To meet the requirements by the International Code of Zoological Nomenclature (ICZN), this article was registered at ZooBank (15 March 2021) under the ZooBank Life Science Identifier (LSID): 3CD96768-7F52-463F-B50D-2DB5358E6114.

Published: 23 April 2021.

INTRODUCTION

The genus *Epilandex* Hebard, 1927, comprises 8 species of Anisolabididae. Anisolabidinae earwigs distributed in Oriental, Australian and Oceanian regions (sensu Holt *et al.*, 2012), from India in the north to the Solomon Islands and Australia in the south (Steinmann, 1989; Srivastava, 1976a, 2003a, 2003b). *Epilandex* includes relatively small species with body lengths of 7-14 mm, reddish brown or dark in colour, shining, generally glabrous, and the genus is well defined by male genitalia with very long and thin parameres, which are characteristically attenuating and asymmetrical male forceps (Steinmann, 1989). Tegmina and wings are fully developed, wings could be concealed, or both tegmina and wings are absent.

A new species, *Epilandex vignai* sp. nov., is described here from Sulawesi, based on holotype male deposited in the National Museum, Praha, Czech Republic.

MATERIALS AND METHODS

Nomenclature and morphological terminology that were used by STEINMANN (1986) follow. The studied specimen of *Epilandex vignai* sp. nov. was dry-mounted, examined, and photographed with an

Olympus SZ61 stereomicroscope equipped with an ocular grid and a CANON D1000 camera. Genitalia were studied and photographed with an Olympus CX41 microscope equipped with a CANON D1000 camera. Microphotographs of 10 to 40 focal layers of the same specimen were combined with Quick Photo Camera 2.3 software and finally processed with Adobe Photoshop CS6 Extended (version 13). The type specimen was mounted on a label, and dissected body parts (penultimate sternite) were mounted with methylcellulose glue on the same board as the specimen. A genital armature was mounted in dimethyl hydantoin formaldehyde resin (DMHF, a water-soluble mounting medium) on the same label as the specimen. Nomenclatural and morphological terminology follows that used by Steinmann (1993); terminology for the terminalia and genitalia follows Kamimura (2014). The type specimen is deposited in the National Museum, Praha, Czech Republic (NMPC).

COMPARATIVE MATERIAL STUDIED. *Epilandex solomonensis* Brindle, 1970: Solomon Is., Guadalcanal, Mt. Austen, Jan. 1966, P. Greenslade (2 males/2 females paratypes, coll. Bernice Pauahi Bishop Museum, Honolulu, Hawaii, USA - BPBM); *Epilandex serrata* Srivastava, 1976: P.I.: Luzon, Camarines Sur, Mt. Isarog, Pili, 600 m, 6.IV.1965; H.M. Torre Villas, Light

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Trap, Bishop (male holotype, coll. BPBM); *Epilandex peterseni* Ramamurthi, 1967: Philippines, Palawan, Mantalingajan, Tagenbung 1150 metres, 19. Sept. 1961, Noona Dan Exp. 61-62, caught by mercury-light 18.30-06.00 (female paratype, coll. Zoological Museum, University of Copenhagen - ZMUC); Philippines, Palawan, Mantalingajan, Pinigisan 600 metre, 10. Sept. 1961, Noona Dan Exp. 61-62, Caught by mercury-light 19.00-06.00 (female paratype, coll. ZMUC); Brunei Darussalam, Ulu Temburong NP, 130 m a.s.l., 4°32'49''S 115°09'25''E, 02.-19.ii.2013, P. Kočárek leg. (2 males coll. P. Kočárek, Ostrava, Czech Republic); *Epilandex handschini* Hincks, 1954: W. Sumba, near Pogobina, 550 m, 12.-15.IX.1949, W.D. Hincks leg. (Holotype, Naturhistorisches Museum Basel); Papua New Guinea, Madang prov., Hapurpi village near Halopa mission, 700 m a.s.l., S 5°05' E 145°41', primary rainforest, April 2001, Aman, Novotný leg. (Malaise trap) (7 males/1 female, coll. P. Kočárek, Ostrava, Czech Republic); *Epilandex burri* (Borelli, 1921): W Malaysia, Kuala Lumpur, Lake Gardens, 40 m, 3°8'39.1''N, 101°41'3.2''E, 18.9.1999, P. Kočárek leg. (1 male/1 female, coll. P. Kočárek, Ostrava, Czech Republic).

TAXONOMY

***Epilandex vignai* sp. nov. (Figs. 1-5)**

urn:lsid:zoobank.org:act:

218FC780-C56B-40B9-A910-3492A6587AD8

TYPE LOCALITY. Indonesia: S Sulawesi, Tana Toraja, Rantepao env., Tilanga village, 930 m, 03°01'27.31'' S, 119°53'29.49''E.

MATERIAL EXAMINED. HOLOTYPE: male, Indonesia: S Sulawesi, Rantepao env., Tilanga, 930 m, 03°01'27.31''S, 119°53'29.49''E, 21.-24.01.2010, Řehoř Fafejt leg. (NMPC). The specimen is provided with an additional printed red label: HOLOTYPE / *Epilandex vignai* sp. nov., det. P. Kočárek 2020'.

DESCRIPTION. General colour blackish brown; head, pronotum and tegmina darker; antennae and legs yellowish brown. Length without forceps 10.1 mm, length of forceps 1.6 mm.

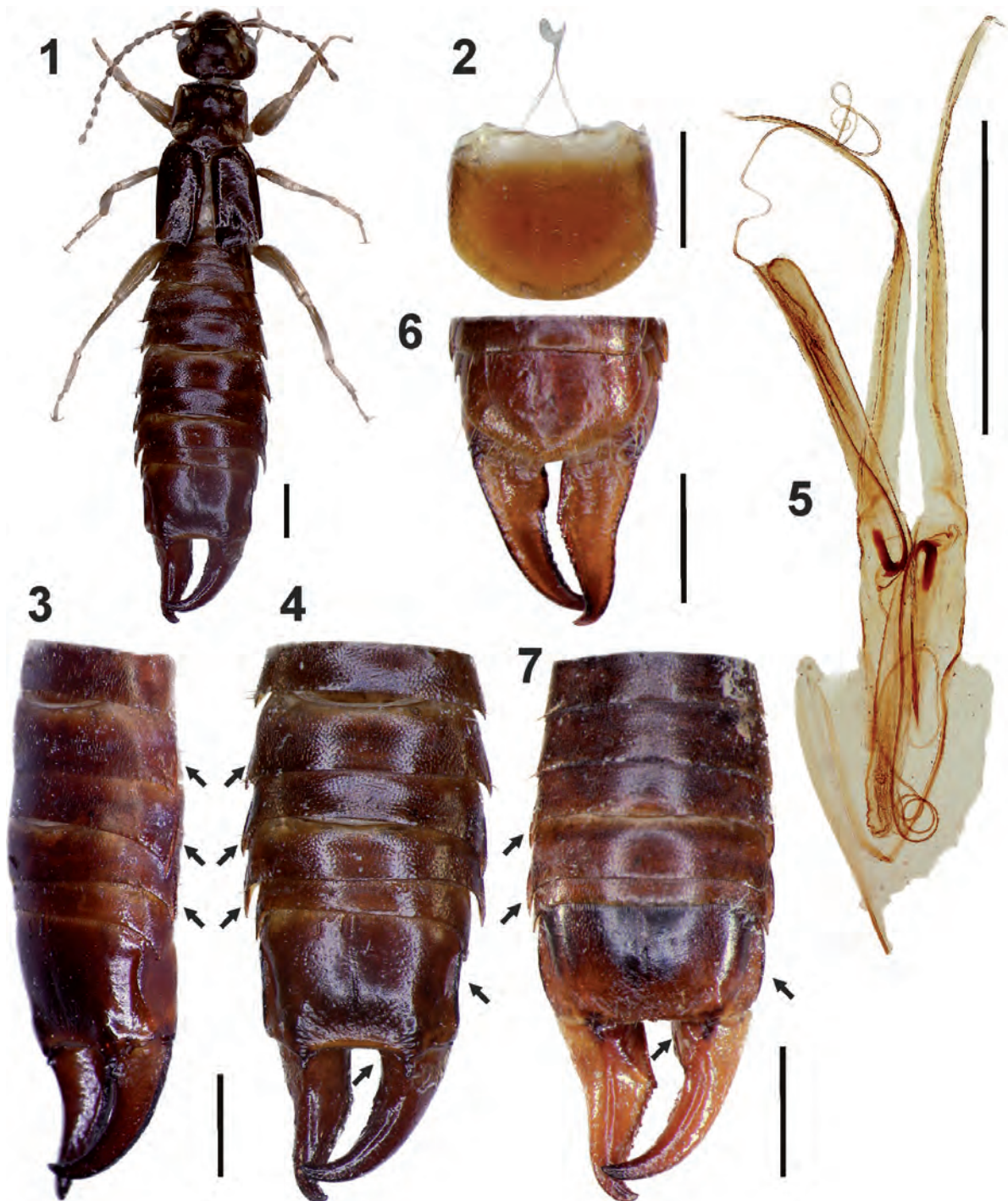
Head (Fig. 1) slightly broader than long; frons moderately convex, smooth, and impunctate; sutures

shallow, but visible. Eyes small, only slightly protruding, shorter than the postocular area, and as long as the basal antenna. Antennae (partly broken) 13-segmented, pyriform; basal segment stout, gently narrowed at base, shorter as the distance between antenna bases; 2nd short, broader than long; 3rd long and slender, shorter than 4th and 5th combined.

Pronotum (Fig. 1) transverse, anteriorly straight, gently diverging posteriorly, hind angles and margin broadly rounded, median sulcus faintly marked; prozona gently raised and metazona depressed. Prosternum longer than broad, slightly narrowed posteriorly; mesosternum approximately as long as broad, hind margin convex and metasternum transverse, projecting as a narrow lobe between hind coxae with hind margin truncate. Tegmina well developed, smooth and glabrous, wings absent. Legs typical for genus, hind tarsi with 1st segment longer than the combined length of 2nd and 3rd segments.

Abdomen (Figs. 1-4) spindle shaped, convex, punctulate, finely pubescent, sides with long sparse pubescence, sides of segment 6th to 8th acute angled with a sharp carina, from above looking incurved (Fig. 2). Penultimate (9th) sternite transverse (Fig. 4), broader than long, smooth, laterally parallel-sided, hind margin broadly rounded, without emargination; manubrium approximately as long as the sternite and gently dilated apically. Ultimate tergite (10th) transverse (Figs. 2-3), broader than long, obscurely punctulate, sloping backwards, sides with a sharp carina, median sulcus faintly marked; the area in middle posteriorly depressed, with fine striations; hind margin trisinate, laterally oblique, above the bases of forceps projecting into minute triangular lobe. Pygidium not visible from above, vertical, narrowed in middle, apically emarginate in middle. Forceps with branches subremote at base, trigonal above in basal one third, then depressed, tapering; left branch almost straight, incurved only in distal fifth; right branch gradually incurved from base and crossing over the left near apices, tip pointed and hooked, internal branches emarginate at base, then finely serrated.

Male genitalia (Fig. 5) with parameres approximately 15 times longer than broad, narrowed apically with tip pointed; penis lobes parallel-sided, obtuse at tip, 3/4 long as parameres and as long as penis base; virga at base incurved, long and thin.



Figs. 1-7. *Epilandex vignai* sp. nov., holotype ♂ 1: habitus from dorsal view; 2: penultimate sternite, ventral view; 3: lateral view on abdomen; 4: dorsal view on abdomen; 5: genital armature. Figs. 6-7. *Epilandex solomonensis* Brindle, 1970, paratype ♂; 6: dorsal view on abdomen; 7: ventral view on penultimate sternite and forceps. Arrows indicate differential characteristics between *E. vignai* sp. nov. and *E. solomonensis* (see differential diagnosis in the main text). Scale bars = 1.0 mm.

DIFFERENTIAL DIAGNOSIS. *Epilandex vignai* sp. nov. differs from other species of *Epilandex* based on its characteristic male genitalia with very long parameres (15 times longer than wide) and long genital lobes reaching 3/4 of the paramere length. *E. vignai* sp. nov. have developed three sharp lateral longitudinal carina on abdominal tergites 6th – 8th. The same arrangement of carina only on *E. acuminata* Srivastava, 2003a from Hong Kong, which is significantly smaller (7.1-8.7 vs. 11.7), has posteriorly subtruncate and usually slightly emarginated penultimate sternite, and all known specimens are fully winged. *E. burri* (Borelli, 1921) has also developed carina on three abdominal tergites, but these are on the 7th to 9th. The remaining species have fewer or more carinate tergites, while *E. wagneri* Srivastava, 1990; *E. handschini* Hincks, 1954; and *E. petterseni* Ramamurthi, 1967, have developed median carina on four distal abdominal tergites (6th to 9th), and two species, *E. serrata* Srivastava, 1976, and *E. solomonensis* Brindle, 1970, have developed median longitudinal carina on only two tergites (on 8th and 9th or 7th and 8th tergites, respectively). *Epilandex gressitti* Srivastava, 1976, has ecarinate abdominal tergites. Newly described species is similar to *E. solomonensis* in general appearance, including size and undeveloped wings in typical form (but winged specimens are also recorded). *E. solomonensis* and *E. vignai* sp. nov. are the only two species with small, not prominent eyes, which are noticeably shorter than the postocular area. Eyes of the remaining species have eyes longer, as long as, or only slightly shorter than the postocular area. In addition to the abovementioned characteristics, the differential characteristics for these two species are different shapes of the penultimate sternite (broadly rounded in *E. vignai* sp. nov. vs. widely triangular posteriorly in *E. solomonensis*), lateral sides of ultimate tergite concave vs. convex, and inner basal part of right cercus continuously rounded vs. widened to sharp ridge (differential characters are marked on Figs. 3, 4 and 7).

ETYMOLOGY. This species is named in honour of deceased Professor Augusto Vigna Taglianti from Rome, who had a significant impact on the knowledge of (not only) European earwigs.

BIONOMY. Unknown.

DISTRIBUTION. Indonesia, Sulawesi, Tana Toraja (Fig. 8).

List of *Epilandex* Hebart, 1927 species and their known distribution

Epilandex acuminata Srivastava, 2003

Distribution: Hong Kong (Srivastava 2003b)

Epilandex burri (Borelli, 1921)

syn. *Epilandex undulata* Ramamurthi, 1963 (synonymized by Srivastava, 1982)

syn. *Epilandex bazyuki* Steinmann, 1979 (synonymized by Srivastava, 2003b)

Distribution: India, Sri Lanka, Thailand, Indonesia: Sumatra, Kalimantan, Philippines: Luzon, Australia (Hebart, 1927, Boseman, 1954, Ramamurthi, 1963, Kapoor, 1968, Brindle, 1970, Srivastava, 1976a,b, 1987, Steinmann, 1979), Malaysia (this study).

Epilandex gressitti Srivastava, 1976

Distribution: Philippines: Mindanao (Srivastava, 1976b)

Epilandex handschini Hincks, 1954

Distribution: Indonesia: West Sumba (Hincks, 1954, Srivastava, 1976a); Papua New Guinea (this study).

Epilandex petterseni Ramamurthi, 1967

Distribution: Philippines: Tawi Tawi, Palawan, Mindanao; Bismarck Islands: New Britain, New Ireland (Ramamurthi, 1967, Srivastava, 1976a, 1978), Brunei (this study).

Epilandex serrata Srivastava, 1976

Distribution: Philippines: Luzon (Srivastava, 1976a)

Epilandex solomonensis Brindle, 1970

Distribution: Solomon Islands (Brindle, 1970)

Epilandex vignai Kočárek, sp. nov.

Distribution: Indonesia: Sulawesi

Epilandex wagneri Srivastava, 1990

Distribution: Indonesia: Moluccas (Srivastava, 1990)

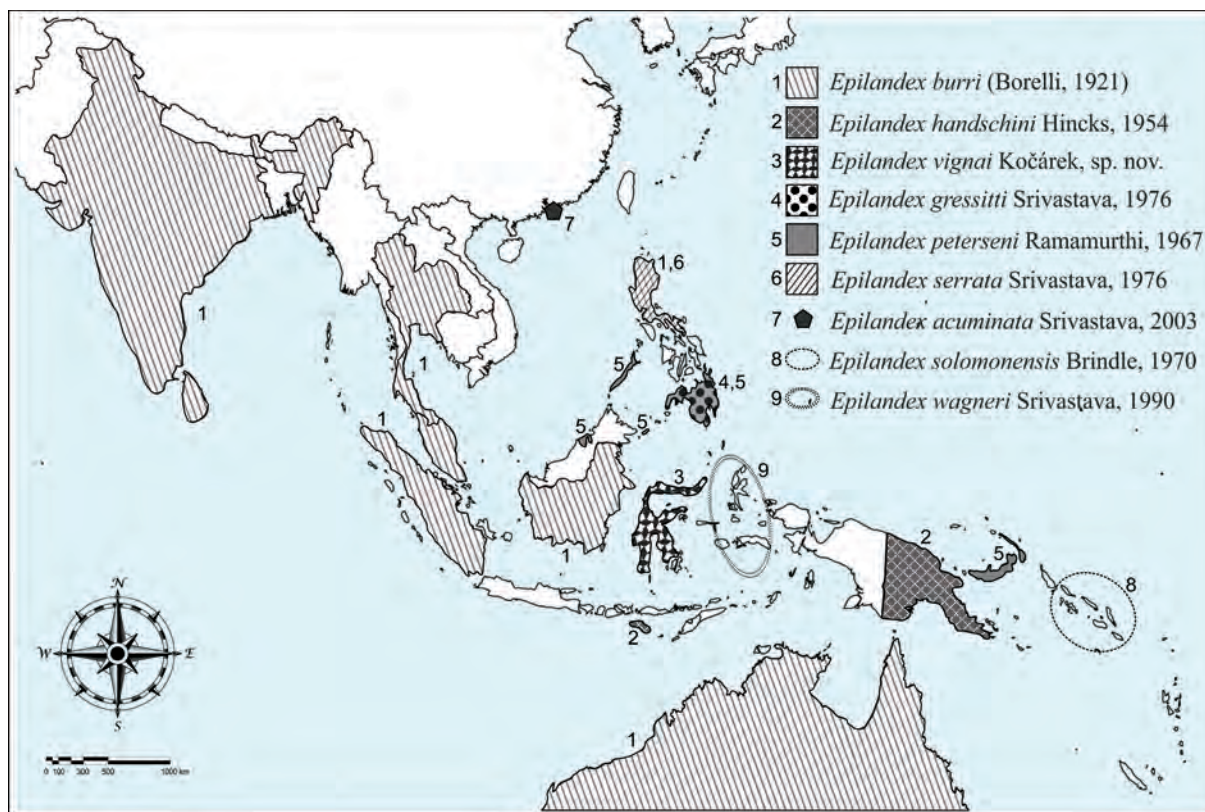


Fig. 8. Map showing known distribution of individual *Epilandex* species based on published records and a new faunistic data presented in this study.

KEY TO *EPILANDEX* SPECIES (BASED ON MALES)

- 1 (6) Penultimate sternite with a short median ridge on the distal part, visible at least as a feeble rudiment of it at the extreme apex.
- 2 (3) Sides of abdominal tergites 7-9 with well visible median longitudinal carina; eyes slightly longer than postocular area.....
.....*E. burri* (Borelli)
- 3 (2) Sides of abdominal tergites 6-9 with highly visible median longitudinal carina; eyes as long as or slightly shorter than postocular area.
- 4 (5) Left cercus with inner margin entire, not concave; pronotum noticeably widened posteriorly*E. peterseni* Ramamurthi

- 5 (4) Left cercus strongly concave from the base to distal third, with a tooth at approximately the middle, finely serrated; pronotum parallel-sided or only slightly widened posteriorly
.....*E. handschini* Hincks
- 6 (1) Penultimate sternite without any median ridge or rudiment.
- 7 (8) Apterous, tegmina and wings not developed.
.....*E. wagneri* Srivastava
- 8 (7) Tegmina always fully developed, wings developed or concealed (absent).
- 9 (10) Sides of abdominal tergites without lateral carina; penultimate sternite with a deep emargination in the middle posteriorly
.....*E. gressitti* Srivastava

- 10 (9) Sides of certain abdominal tergites carinate; penultimate sternite entire posteriorly.
- 11 (14) Sides of three distal abdominal tergites (6th to 8th) with a sharp median carina.
- 12 (13) Penultimate sternite posteriorly subtruncate in the middle or faintly emarginated in the middle; smaller species <9 mm (incl. forceps)*E. acuminata* Srivastava
- 13 (12) Penultimate sternite wide, broadly rounded posteriorly; larger species >10 mm (incl. forceps).....*E. vignai* sp. nov.
- 14 (13) Sides of only two abdominal tergites with highly visible median longitudinal carina.
- 15 (16) Sides of 8th and 9th abdominal tergites with a median longitudinal carina; penultimate sternite pointed in the middle posteriorly.....*E. serrata* Srivastava
- 16 (15) Sides of 7th and 8th abdominal tergites with highly visible longitudinal carina; penultimate sternite rounded, widely triangular posteriorly*E. solomonensis* Brindle

DISCUSSION

Anisolabididae is subdivided into 13 subfamilies (sensu Srivastava, 1999) and contains approximately 393 species in 31 genera (Srivastava, 1999; Haas, 2018). The subfamily Anisolabidinae, to which *Epilandex* belongs, contains 278 species in 13 genera (Anisutkin, 1998a,b, 2004, Srivastava, 1990, 1993, 1999, 2003a,b, Nishikawa, 2008, Kočárek, 2011a,b; Matzke & Kočárek, 2015). *Epilandex* is a less numerous genus with only 9 recognised species. With the exclusion of widely distributed *E. burri* (Borelli, 1921) and *E. peterseni* Ramamurthi, 1967 (Steinmann, 1989, Srivastava, 2003a), the remaining species are restricted to one island (or archipelago), and the majority of them seem to be endemic.

Individual species of *Epilandex* are very similar to each other in terms of external morphology, and many characteristics (including those commonly

used for differential diagnoses) are more or less variable. Characteristics used for species delimitations include tegmina and wing development, carination on the lateral sides of abdominal tergites, shape of penultimate sternite and ultimate tergite, shape of male forceps, and structure of male genitals (Steinmann, 1989, Srivastava, 2003a,b). Only one species is apterous (*E. wagneri*), and the remaining species have developed at least the tegmina. However, some species, such as *E. burri* and *E. solomonensis*, show macropterous and brachypterous (or wingless) forms (Ramamurthi, 1963, Steinmann, 1989, Srivastava, 2003b); therefore, the development of wings cannot be generally used as an identification characteristic. A relatively useful characteristic seems to be lateral carination of several abdominal segments, which is stable among species but only in normally developed males. Less developed males (minor form), which resemble females in superficial view (the forceps are less developed, nearly symmetrical), sometimes occur together with fully developed males in the same population (Brindle, 1970), and these males usually have reduced lateral carina (Srivastava, 2003b). Therefore, this characteristic could be applicable only for normally developed males (with strongly asymmetric forceps). Usable indicators occur on terminal abdominal segments (penultimate sternite, ultimate tergite) and forceps, although there is slight variability as well, especially in the less developed minor forms.

Rigorous phylogenetic analysis of the genus supported by molecular evidence is necessary in the future, including clarification of the phylogenetic position and relationships of the genus with other Anisolabidinae genera.

ACKNOWLEDGEMENTS

We thank Daniel Burckhardt (Naturhistorisches Museum Basel, Switzerland) and Shepherd Myers (Bernice Pauahi Bishop Museum, Honolulu, Hawaii, USA) for kindly loaning *Epilandex* material from the collections under their care. We thank Universiti Brunei Darussalam for permission to conduct the research at the Kuala Belalong Field Studies Centre. This study was supported by project CZ.1.07/2.2.00/28.0149, financed by the Structural Funds of the European Union.

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Toward a revision of the genus *Chelidura* Latreille, 1825: designation of the Neotype for *Chelidura aptera* (Megerle in Charpentier, 1825) (Dermaptera: Forficulidae)

Abstract: Since it is not possible, after several years of research, to locate the type material of *Chelidura aptera* (Megerle in Charpentier, 1825), type species of the genus *Chelidura* Latreille, 1825, and not being able to define in any way, even vaguely, the *terra typica*, it was decided to fix a neotype. This neotype is here selected on the basis of its matching with the original description and with the support of molecular data. Three Alpine populations, two Italian and one Swiss, of what is actually considered *C. aptera* were sampled and sequenced; COI sequences were then compared with *Chelidura pyrenaica arverna* David & Van Herrewege, 1973 from the Massif Central in France, and other species of the genera *Chelidurella*, *Mesochelidura* and *Forficula*. The separation between *C. aptera* and *C. pyrenaica* is strongly supported by DNA barcodes and substantial differences among the three Alpine populations have been detected. The genetically intermediate among the Alpine populations (Italy, Piedmont (Biella), Pennine Alps, Lago del Muçrone) is chosen as neotype of *Chelidura aptera*, furthermore largely matching the original description. Further genetic and morphological investigations will clarify the relations among the Alpine populations and in the early future we expect to extend the analyzes to the majority of the Alpine and non-Alpine populations of *Chelidura*. In addition, the updated view about the taxonomy and distribution of *Chelidura* and the first illustration of male genitalia of *Chelidura pyrenaica arverna* David & Van Herrewege, 1973 are provided.

Riassunto: Verso una revisione del genere *Chelidura* Latreille, 1825: designazione del Neotipus di *Chelidura aptera* (Megerle in Charpentier, 1825) (Dermaptera: Forficulidae.)

Non essendo possibile, dopo molti anni di ricerche, reperire materiale tipico della specie *Chelidura aptera* (Megerle in Charpentier, 1825), specie tipo del genere *Chelidura* Latreille, 1825, e non potendo definire in alcun modo, anche vago, la località di provenienza del materiale usato per la descrizione, si è deciso di fissare un neotipo per la specie e di sceglierlo sulla base della conformità alla descrizione originale e di alcune analisi molecolari. Sono state campionate e sequenziate tre popolazioni alpine, due italiane e una svizzera, di quella che attualmente è considerata *C. aptera*; le sequenze COI sono state quindi confrontate con *Chelidura pyrenaica arverna* David & Van Herrewege, 1973 dal Massiccio Centrale in Francia, e altre specie dei generi *Chelidurella*, *Mesochelidura* e *Forficula*. La separazione tra *C. aptera* e *C. pyrenaica* è fortemente supportata dal DNA barcoding e sono state rilevate differenze sostanziali tra le tre popolazioni alpine. Come neotipo di *Chelidura aptera* si è scelto un esemplare proveniente dalla popolazione alpina geneticamente intermedia e cioè quella italiana del lago Muçrone, nelle Alpi Pennine in Piemonte (Biella), che corrisponde inoltre ampiamente alla descrizione originale. Ulteriori indagini morfologiche e molecolari permetteranno di definire le differenze rilevate tra le popolazioni alpine e nei prossimi anni le stesse analisi saranno estese al maggior numero possibile di popolazioni alpine e non. Viene fatto inoltre il punto sulla distribuzione del genere *Chelidura* e sulla sua attuale tassonomia e si fornisce la prima illustrazione dei genitali maschili di *Chelidura pyrenaica arverna* David & Van Herrewege, 1973.

Key words: Dermaptera, earwig, *Chelidura*, *Chelidura aptera*, phylogeny, molecular systematics, distribution, Europe.

To meet the requirements by the International Code of Zoological Nomenclature (ICZN), this article was registered at ZooBank (31 March 2021) under the ZooBank Life Science Identifier (LSID): F4CFB38A-7D4E-406E-97EA-431D65AF5A9A.
 Published: 23 April 2021.

INTRODUCTION

Twenty-five years ago, the late Augusto Vigna Taglianti (1943-2019) and the first author proposed to carry out a systematic revision of the genus *Chelidura* Latreille, 1825 (Fig. 1). Augusto Vigna

Taglianti, in love with his Piedmont mountains, intensively collected material of this genus (now in the Museo Civico di Storia Naturale Giacomo Doria in Genoa, Italy) and, as a very learned zoologist and biogeographer, he deeply studied the few species of

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the genus from a biogeographical and phylogenetic point of view, considering *C. aptera* (Megerle in Charpentier, 1825) probably shifted into different taxa (Chemini & Vigna Taglianti, 2002). However, the revision of the *Chelidura* genus had never carried out, although it was always among the wishes of the great entomologist. The beginning of this same revision now, after his death, wants therefore to be an ongoing tribute to Augusto Vigna Taglianti, who will be in this way our travel companion in the coming years of study.

Regrettably, the type material of *Chelidura aptera*, type species of the genus, has been lost. Furthermore, at that time it was not possible to trace down the type locality, vaguely indicated in the original description as *Europa indigena* (Europe). Consequently, the only result was the discovery and redescription of the types (Fig. 2) of *Chelidura*

alpina (Bonelli in Gené, 1832), *Chelidura montana* (Bonelli in Gené, 1832), both considered synonyms of *C. aptera*, and of *Chelidura pyrenaica* (Bonelli in Gené, 1832) (Fontana, 1999). The careful revision of biography of Megerle De Muehlfeld, the collector and true describer of *C. aptera*, led to the impossibility to reconstruct the fate of the typical material and at the same time did not provide any further relevant information useful to trace back to the geographical origin of the material on which the species was described. Therefore, in order to proceed with the revision, a priority was to try to establish and designate the neotype for *Chelidura aptera*. However, the selection of the population within which to identify the neotype must be made carefully, basing the decision with the support of molecular data and not invalidating any other species (such as those of Bonelli) that could, in the light of the revision, be in some case resurrected at a specific or subspecific level. The recent confirmation of the validity of genus *Chelidura* and its clear separation from the genera that had been previously synonymized with it (*Chelidurella* Verhoeff, 1902 and *Mesochelidura* Verhoeff, 1902), obtained through molecular analysis (Kirstová *et al.*, 2020), gave new impetus to the study. On the basis of the large data collected by the first author, including images of specimens preserved in various museums and the extensive bibliography on the topic and thanks to the preliminary results of the review of the related genus *Chelidurella* Verhoeff, 1902 (Kirstová *et al.*, 2020) it was decided to start the approach on *Chelidura* with the support of DNA barcoding, starting from the Alpine populations so far recognized as *C. aptera*. The results of this preliminary investigation and the designation of the neotype are here presented.

MATERIALS AND METHODS

In September 2019 a field expedition across Italy, Switzerland and France was organized in Western Alps (Paolo Fontana and Federico Marangoni) to collect fresh specimens in localities known from collection labels or from literature. Given the not suitable season, individuals of *Chelidura* were found in only two of the over 15 localities visited, namely on Lago del Mucrone (Pennine Alps, Biella) and in the precise location from which Bonelli's *Forficula montana* was described, namely the Col du Grand



Fig. 1. a) Male of *Chelidura aptera*, Italy, Piedmont (Biella), Pennine Alps, Lago del Mucrone, Oropa, 1910 m (45°37'43.54" N, 7°56'38.24" E), 18.IX.2019, photo by Federico Marangoni; b) male of *Chelidura aptera* (type locality of *F. montana*) Switzerland, Valais, Col du Grand Saint-Bernard, Liddes, 2160 m, 18.IX.2019, photo by Federico Marangoni.

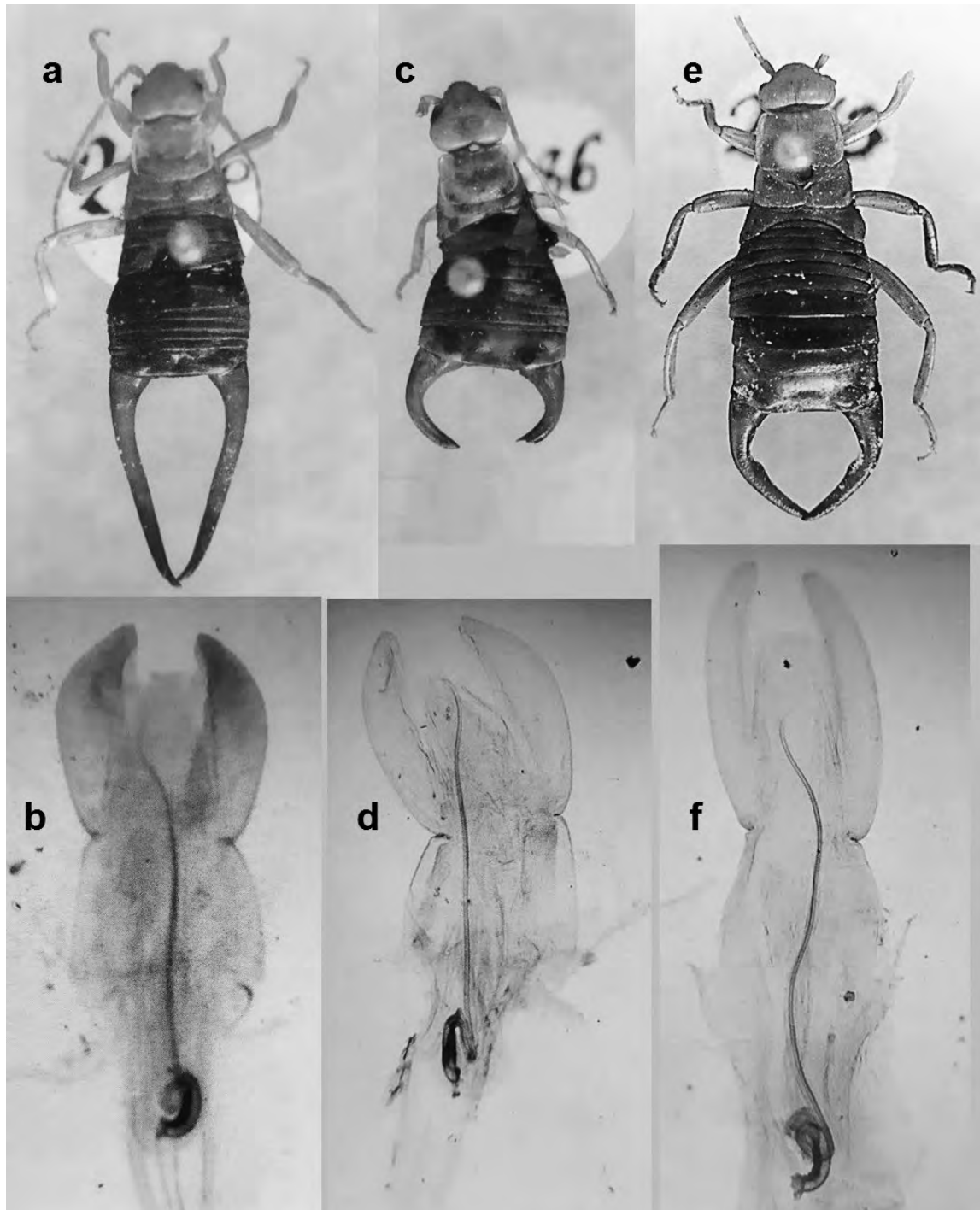


Fig. 2. The *Chelidura* specimens described by Genè (1832) preserved in the Museo Regionale di Scienze Naturali di Torino, Italy. a) Dorsal overview and b) genitalia of the male Lectotype of *F. montana*, Gran S. Bernardo, tra Lyde e l'Ospizio, (Switzerland, Valais). c) Dorsal overview and d) genitalia of the male Lectotype of *Forficula alpina*, Moncenisio, tra la Croce e l'Ospizio, dal lato che guarda settentrione (Italy, Piedmont). e) Dorsal overview and f) genitalia of the male Lectotype of *Forficula pyrenaica*, Pirenei. Original illustrations from Fontana (1999).

Saint-Bernard: *tra Lyde e l'Ospizio* and so *between Lyde and the Hospice* (Liddes, Valais, Switzerland). To these specimens were then added those provided by Petr Kočárek, namely the material relating to *C. pyrenaica arverna* David & Van Herrewege, 1973 and some specimens of a population, coming from the Western Rhaetian Alps (Sondrio). This last population is outside the current distribution of the genus *Chelidura* in Italy. Specimens for molecular studies were immediately stored in 90% ethanol as soon they have been collected in the field. Male genitalia of dry and in alcohol specimens have been mounted following the standard protocol provided by Fontana *et al.* (2002): they were removed, cleared immersing them for 20 minutes in 10% KOH solution at room-temperature; they were dehydrated by passages in alcohols of increasing concentration and in xylene and finally mounted in Canadian Balm on a microscope slide or on a transparent holder. The specimens and the male genitalia were measured with a micrometric lens (Meopta H 8 × 10 m) using a stereomicroscope (Optech). Nomenclatural and morphological terminology follows that used by Steinmann (1993) for general morphology and for the male terminalia and genitalia follows Kamimura (2014).

MOLECULAR ANALYSIS EXAMINED MATERIAL LOCALITIES

Chelidura aptera (Megerle in Charpentier, 1825)
Italy, Piedmont (Biella), Pennine Alps, Lago del Mucrone, Oropa, 1910 m (45°37'43.54" N, 7°56'38.24" E), 18.IX.2019, Paolo Fontana and Federico Marangoni leg.

Italy, Lombardy (Sondrio), Western Rhaetian Alps, Frascaia, Lanzada, 1480 m, (46°17'21.4" N, 9°54'41.14" E), 22.VII.2019, Mario Grosser leg.

Switzerland, Valais, Col du Grand Saint-Bernard, Liddes, 2160 m, (45°53'11.24" N, 7°11'24.35" E), 18.IX.2019, Paolo Fontana and Federico Marangoni leg.

Chelidura pyrenaica arverna David & Van Herrewege, 1973
France, Loire, Station de Chalmazel, Chalmazel, 1137 m, (45°40'33"N, 03°49'32"E), 31.VIII.2016, Christophe Girod leg.

LABORATORY METHODS. Each insect specimen was dissected, and the six legs were used for DNA extraction. After lyophilization, the total DNA was isolated using a commercial kit (NucleoSpin® Tissue; Macherey-Nagel, Düren, Germany). The cytochrome oxidase subunit I (COI) gene was amplified with the primer pair LCO1490 (5'-GGTCAACAAAT CATAAAGATATTGG-3') and HCO2198 (5'-TAAA CTTTCAGGGTGACCAAAAAATCA-3') (Folmer *et al.* 1994). Polymerase chain reaction (PCR) conditions were as reported in ("PM 7/129 (1) DNA barcoding as an identification tool for a number of regulated pests," 2016, p. 12). PCR products, after purification with illustra ExoProStar1-Step (GE Healthcare, Little Chalfont, UK), were sequenced with the Big Dye Terminator v3.1 cycle sequencing kit (Applied Biosystems, Foster City, CA, USA) on an Applied Biosystems 3130 xl Genetic Analyzer (Carlsbad, CA, USA). Sequences were manually checked using BIOEDIT (Hall 1999).

PHYLOGENETIC ANALYSIS. In order to have a COI dataset as much exhaustive as possible the barcodes obtained have been integrated with the complete sequences freely available in BOLD (Ratnasingham and Hebert 2007) namely: ARTNO058-17, GBMNB59325-20, GBMNB59325-20, NOORT128-13, NOORT074-12, NOORT131-13, NOORT130-13 and NOORT132-13 for *Chelidurella acanthopygia*; GBMNB59324-20 for *Chelidurella thaleri*; IBIDR004-20 for *Mesochelidura occidentalis* and AGMPN014-18, AGMPN015-18, AGMPP013-18 for *Forficula auricularia*. The COI sequence of *Chelidura pyrenaica arverna* was mined out of GENE BANK (GenBank: MH853428.1). Evolutionary analysis was conducted in MEGAX (Kumar *et al.* 2018) and the phylogeny was inferred by using the Maximum Likelihood method and Tamura-Nei model. The pairwise genetic distances between sequences were calculated using MEGA X software, under default settings.

THE GENUS *CHELIDURA* LATREILLE, 1825 AND ITS TYPE SPECIES

The genus *Chelidura* is attributed to the French entomologist Pierre André Latreille (1762-1833) who in 1825 divided the Dermaptera (*Forficulaires*) into two main groups specifying that "*Quelque espèces sont*

aptères” (“some species are wingless”). He gave the name of *Forficule* / *Forficésile* to the winged species and named *Chélidoure* the wingless group (Latreille, 1825). Two years later, in the German edition of Latreille’s work edited with notes by the German naturalist Arnold Adolph Berthold (1803-1861), the group (g.) *Chélidoure* of Latreille (1825) became the genus (*Geschl.*, abbreviation of *Geschlecht* that is genus in English) *Chelidura* (Berthold, 1827). Even in Berthold there is no further information except that the genus *Chelidura* is simply characterized by being wingless: “*Nicht mit flügeln versehene*” (not provided with wings). No species is attributed to *Chelidura* until 1831, when the French entomologist Jean Guillaume Audinet-Serville (1775-1858) assigned *Forficula aptera* of von Charpentier (von Charpentier, 1825) to the genus *Chelidura*. Unfortunately, in this taxonomic change Audinet-Serville refers to *F. aptera* as originating from the Pyrenees (Audinet-Serville, 1831). Audinet-Serville reports the genus with the name *Chelidoura* (SIC!) adopting a sort of intermediate name between the typically French one of *Chélidoure* of Latreille and the Latin one used by Berthold, *Chelidura*, which will have priority and will be maintained in future. In addition to assigning the first species to the genus, Audinet-Serville added some anatomical details by giving a sort of brief description of the genus; from this description it is evident that he could examine some wingless earwig quite matching von Charpentier’s description:

“Point de pelote entre les crochets des tarsi. Corps aptère, allant en s’élargissant sensiblement de la base à l’extrémité. Yeux très-petits, point saillants, placés au milieu du bord latéral de la tête. Abdomen ayant le dessus de son avant-dernier segment étroit, transversal, coupé droit postérieurement; le dessous prolongé, semi-circulaire, recouvrant en partie le dernier segment.”

“No sphere between the hooks of the tarsus. Wingless body, which widens considerably from base to tip [actually the males of the genus *Chelidura* have a body that gradually dilates proceeding from the head towards the back of the body]. Eyes very small, not protruding, placed in the center of the lateral edge of the head. Abdomen having the upper part of its penultimate segment narrow,

transverse, cut straight posteriorly; the extended lower part, semicircular, partially covering the last segment.”

Audinet-Serville (1831) established as type species of the genus, von Charpentier’s *Forficula aptera*, which was described the same year in which Latreille (1825) had described the group of wingless Dermaptera (*Chélidoure*) later transferred by Berthold (1827) into the genus *Chelidura*.

The Audinet-Serville’s indication of *C. aptera* for the Pyrenees, made Giuseppe Genè (1800-1847) doubt on the validity of the description of *F. pyrenaica* by Franco Andrea Bonelli (1784-1830), that Genè had published after Bonelli’s death (Genè, 1832), on the basis of his hand notes given in the general catalog of the collection at the Zoological Museum of the University of Turin and probably following other Bonelli’s documents (Fontana, 1999). In a subsequent publication on Dermaptera, Genè (1837) declared to be convinced that the two species are synonymous but to maintain the specific name *pyrenaica* of Bonelli because the specific name *aptera* would be too generic and misleading, due to the fact that there are several species presenting the same characteristics as the five species reported by Genè himself: *Forficula maritima* (now *Anisolabis maritima* Bonelli in Genè, 1832), *Forficula acanthopygia* (now *Chelidurella acanthopygia* Genè, 1832) and the three *Forficula* (*montana*, *alpina* and *pyrenaica*) now assigned to *Chelidura*. Actually, the description of Megerle (*F. aptera*) and that of Bonelli (*F. pyrenaica*) cannot refer to the same species, for the strongly characteristic internal tooth in the male cerci of the last one, and Bonelli, who was working on a monograph on Dermaptera (Fontana, 1999), must have immediately understood that the specimens he had received from a French entomologist (specimens collected in the Pyrenees by Mister Moncarel and sent to Bonelli by Mister Dupare of Paris) could not correspond to the *Forficula aptera* of Megerle.

We come therefore to the description of the *Forficula aptera*, which the German geologist and entomologist Toussaint von Charpentier (1779-1847) published in 1825 in his *Horae Entomologicae* (von Charpentier, 1825). This is a very detailed description for the time, which von Charpentier received from Johann Carl Megerle von Mühlfeld (1765-1840), a zoologist who worked extensively at the Naturhistorisches Museum

in Vienna. Megerle von Mühlfeld had become the curator of the museum in 1797 until 1835) and organized the natural history collection. In 1806 the museum acquired its collection of European insects and Megerle von Mühlfeld became the first curator of the entomology section. Tragically, the old collections of the Vienna Museum, including Megerle von Mühlfeld's specimens, were destroyed in October 1848 during a fire in the Hofburg palace. The extensive Latin description of *Forficula aptera* appears in the IV chapter (*De Orthopteris Europaeis*) and precisely on page 69 of von Charpentier's book:

Forficula aptera
(Meg. De Muehlfeld)

F. ferruginea, aptera, abdomine postico lato: forcipes valido, incurvo, inermi. A carissimo de Muehlfeld mecum communicata, Europae indigena. Absque omni elytrorum alarumque vestigio: F. biguttata paullo longior et multo latior, praecipue versus abdominis finem. Caput rufescens, macula inter antennis nigra: hae pallidae, duodecim articulorum, quorum tertius a basi reliquis paullo minor est. Thorax quadratus, lateribus paullulum reflexis, lucidioribus. Elytra nulla: eorum loco segmentum abdominale in medio nonnihil impressum, ita ut quodammodo suturam aemuletur; in segmento tertio puncta duo elevata; omnia segmenta punctis parvis impressis obsita. Ultimum segmentum fossulam habet parvam in medio et tuberculum ad latus utrumque. Forcispis (maris?) crura valida, non dentate, valde incurvata, fere semicircularia. Unum tantumodo insect hujus tam insignis vidi specimen.

Forficula aptera
(Meg. De Muehlfeld)

Forficula brown, wingless, with abdomen posteriorly wide and forceps sturdy, curved and unarmed. Received by dear Muehlfeld, European native. Any vestiges of elytra as well as wings are missing; much wider and a little longer than *Forficula biguttata*, especially towards the end of the abdomen. The head is reddish, with a black stain between the

antennae: these shall be pale, composed by twelve articles, of which the third form the base is a little less short of the other. Thorax is a square, with sides a little incurved and more lucid. Elytra are absent; in the abdominal segment of their usual position, there is a small impression, so that somehow mimics a suture; in the third segment there are two elevated signs; all segments are covered with small impressed points. The last segment with a small dimple in the middle and a tubercle on each side. The forceps (of male?) branches are stout, unarmed, strongly incurvated and almost semicircular. I observed only one specimen of this showy insect.

Megerle von Mühlfeld's description permits to restrict the number of candidate species to a few. The description reflects the anatomical features of the species now belonging to *Chelidura sensu* Kirstová *et al.* (2020), furthermore the detailed description of the cerci allows the exclusions of both *C. pyrenaica pyrenaica* (Bonelli in Gené, 1832) and *C. pyrenaica arverna* David & Van Herrewwege, 1973. These two taxa are so different from each other that they could be treated as two distinct species; overall they do not match with what Megerle von Mühlfeld described as *Forficula aptera*, an earwig characterized by male cerci almost semicircular and toothless. The male cerci of *C. p. pyrenaica* has a distinct obtuse tooth in the middle of the inner margin of male cerci (of the cyclolabia form) while *C. pyrenaica arverna* has cerci toothless but only slightly curved. As for the two species described by Gené (1832) and later synonymized with *C. aptera*, *Forficula montana* from Col du Grand Saint-Bernard, has cerci very different from those described by Megerle von Mühlfeld, while as regards *Forficula alpina* from Moncenisio Pass, the similarity is very evident even if Gené described a small tubercle at the base of the cerci of his species.

Forficula aptera [original text and translation from von Charpentier (1825)]

Forcispis (maris?) crura valida, non dentate, valde incurvata, fere semicircularia.

The forceps (of male?) branches are stout, unarmed, strongly incurvated and almost semicircular.

Forficula montana [original text and translation from Genè (1832)]

...*forficibus maris abdominis longitudinem aequantibus, validis, teretibus, subrectis, edentulis, basi supra obsolete unituberculatis...*

...*una robusta pinzetta, le cui branche nel maschio eguagliano in lunghezza l'addome. Queste sono quasi diritte, cilindriche, senza denti, fornite soltanto di un tubercolo poco elevato sul dorso della base...*

... male cerci as long as abdomen, stout, smooth, almost straight, toothless, with a small tubercle on the upper part of their basis...

... a sturdy tweezers, whose branches in the male equal the abdomen in length. These are almost straight, cylindrical, without teeth, provided only with a little high tubercle on the back of the base...

Forficula alpina [original text and translation from Genè (1832)]

... *forficibus maris breviusculis, validis, lunatis, basi supra obsolete unidentatis...*

... *Le branche della pinzetta eguagliano appena in lunghezza la metà dell'addome, e sono perfettamente semilunari nel maschio, forti, riquadrate al lato interno, fornite di una dente piccolo e ottuso sul dorso della base, e propriamente sull'angolo superiore della riquadratura...*

... male cerci shorter, stout, lunate, with a small tubercle on the upper part of their basis...

... The branches of the tweezers barely equal half of the abdomen in length, and are perfectly semilunar in the male, strong, squared on the inside, equipped with a small and obtuse tooth on the back of the base, and properly on the upper corner of the squared side...

Forficula pyrenaica [original text and translation from Genè (1832)]

... *forficibus maris, arcuatis, validis, medio intus obtuse dentatis...*

... *Le pinzette di questa bella forficula sono grosse nel maschio, robuste, arcuate, fornite di un dente ottuso alla metà del lato interno, e*

lunghe quando la metà, quando due terzi del corpo...

... male cerci, curved, stout, with an obtuse tooth in the middle of the inner side.

... The tweezers of this beautiful earwig are large in the male, robust, arched, provided with a dull tooth in the middle of the inner side, and long when half, when two thirds of the body ...

Chelidura p. arverna [original text and translation from David & Van Herrewege (1973)]

Le meilleur critère distinctif est constitué par la forme des cerques. Ceux-ci sont plus robustes, relativement plus larges, plus courts, moins aequés chez les individus du Mont Mézenc [...] On doit ajouter que le bord interne des cerques présente toujours, chez les individus pyrénéens, une sorte de dent très émoussée. Cette caractéristique est absente dans la population du Mont Mézenc.

The best distinctive feature is the shape of the cerci. Those are more robust, relatively wider, shorter, less tight in the specimens of Mont Mézenc [...] We must add that the internal margin of the cerci always presents, in Pyrenean individuals, a kind of very blunt tooth. This characteristic is absent in the population of Mont Mézenc.

Although the original descriptions and types of the species presently preserved can be of great use, however, it must be considered that in Dermaptera the shape and size variability of male cerci is a very common phenomenon, so that for many species two cerci extreme forms are considered. The form with very developed cerci is called *macrolabia*, and that with small cerci is called *cyclolabia*. Between these two forms, several intermediate forms are normally present (Fig. 3). Examining specimens of *Chelidura* from different locations, however, it seems that not all populations are present with true macrolabia forms that seem to be missing in those with very arched and semicircular cerci (as in the original description of *F. aptera*).

In the same species, in addition to the shape of the cerci, even their possible indentation can be variable, as well as the shape of the pygidium, as can easily be observed in the related genus *Chelidurella* (Galvagni,

1994, 1995, 1996, 1997 and Kirstová *et al.*, 2020). This does not mean that the morphology, if studied on an adequate number of specimens, cannot be interpreted correctly, as demonstrated by the recent molecular analysis of the species of the genus *Chelidurella* (Kirstová *et al.* 2020) which has largely confirmed the studies on the morphological basis by Antonio Galvagni (1924-2015). As far as the genus *Chelidura* is concerned, exactly this great variability in the shape of the cerci, sometimes between populations not far away but often also within the same population (although apparently not always), created a certain confusion.

The variability within the genus *Chelidura* is not only restricted to cerci size and shape but it also involves the structure of male genitalia. While within the genus *Chelidurella*, this character is scarcely useful for species classification (Galvagni, 1994, 1995, 1996, 1997), except to separate *C. acanthopygia* (Gené, 1832) and *C. thaleri* Harz, 1980 (Kirstová *et al.* 2020), the few data concerning male genitalia of the known species of the genus *Chelidura* suggest that this anatomical character, and in particular the shape and size of the parameres, can be used to separate species or groups of species from each other. In the

redescription of the typical material of the *Chelidura* species described by Gené (1832), Fontana (1999) managed to extract, clarify, mount and illustrate the male genitalia of specimens that are almost two centuries old. Parameres of the type of *F. pyrenaica* are clearly more elongated and thinner than those of *F. alpina* and *F. montana*, which also show some differences between them (Fig. 2). The study of the male genitalia of other *Chelidura* males from the Pyrenees, the Central Massif and the Alps, has shown that the slender and gently curved shape and almost parallel margins of the parameres, would be typical of *C. pyrenaica pyrenaica* but also of *C. pyrenaica arverna* (Fig. 4). Alpine specimens, on the other hand, would be characterized by shorter and stockier parameres, with an arched external margin; this conformation could be useful to better define the Alpine populations, today prudently all assignable to *C. aptera* (Fig. 5).

This clear division between *C. aptera* and *C. pyrenaica* on the basis of the shape of the male genitalia's parameres, was already been clearly formulated by the Italian entomologist Teresita Maccagno (1900-1999) who was a pioneer in the study of this anatomical structure in Dermaptera

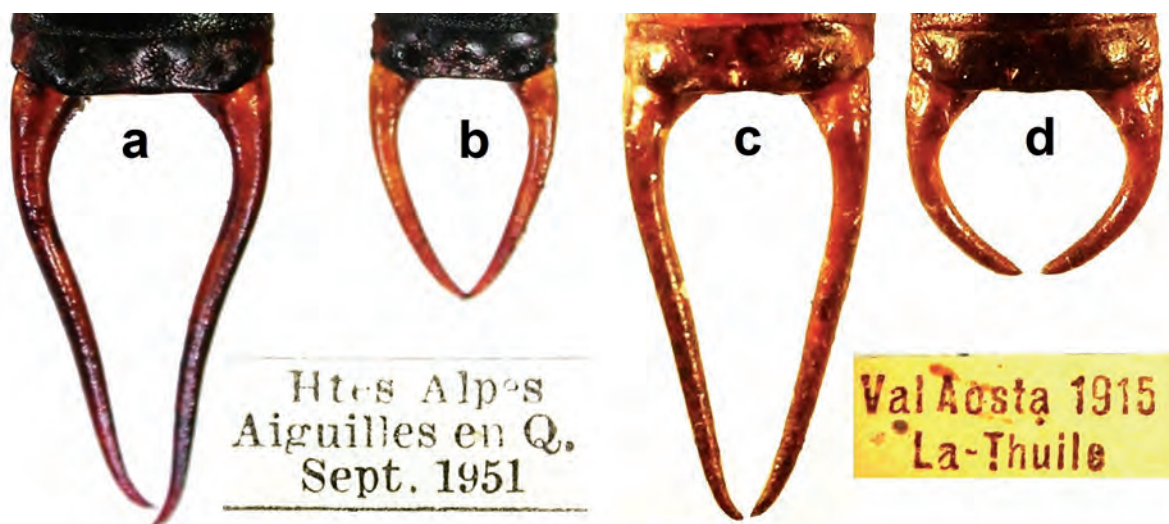


Fig. 3. a) Male cerci of the macrolabia and b) of the cyclolabia forms of two males of *Chelidura aptera* collected in the same locality and in the same date; France, Hautes Alpes, Aiguille, IX. 1951 (collection Museum National d'Histoire Naturelle of Paris), photo by Paolo Fontana. c) male cerci of the macrolabia and d) of the cyclolabia forms of two males of *Chelidura aptera* collected in the same locality and in the same date; Italy, Aosta Valley, La Thuile, 1915 (collection Museum National d'Histoire Naturelle of Paris), photo by Paolo Fontana.

(Maccagno, 1933). In the discussion on *C. aptera*, that she considered present only in the Alps, Teresita Maccagno (1933) writes in a footnote at page 276:

(1) *La forma ciclolabia corrisponde alla specie F. alpina Genè; la macrolabia alla F. montana Genè (loc.cit. pag. 14, 15). Della 2^a si tentò di fare una varietà ma ne mancano gli elementi. La forficula simplex Lafresnaye (apud Germar), che Burr (Genera Ins. P. 69) mette in sinonimia con la Ch. aptera Meg., è invece la forma macrolabia della specie Ch. pyrenaica Bon.: l'apparato copulatore maschile offre un carattere diagnostico inequivocabile.*

(1) The cyclolabia form corresponds to the

species *F. alpina* Genè; the macrolabia to *F. montana* Genè (loc.cit. pages 14, 15). An attempt was made to make a variety of the 2nd but the elements are not strong enough. The *Forficula simplex* Lafresnaye (apud Germar), which Burr (Genera Ins. p. 69) puts in synonym with *Ch. aptera* Meg., is instead the macrolabia form of the species *Ch. pyrenaica* Bon.: the male copulatory apparatus offers a unambiguous diagnostic character.

The approach of Teresita Maccagno (1933) is also confirmed with great evidence by two apparently identical males of *Chelidura*, both of the macrolabia form, preserved in the collections of the Museum National d'Histoire Naturelle of Paris. The two specimens were both identified on the basis of the genitalia, mounted in a small slide attached to each of the two specimens, by the distinguished Italian entomologist Felice Capra (1896-1991), a great researcher on Dermaptera. The first specimen comes from the Alps and precisely from the Aosta Valley (Gressoney la Tr., 1600 m, 1935) and it has been iden-

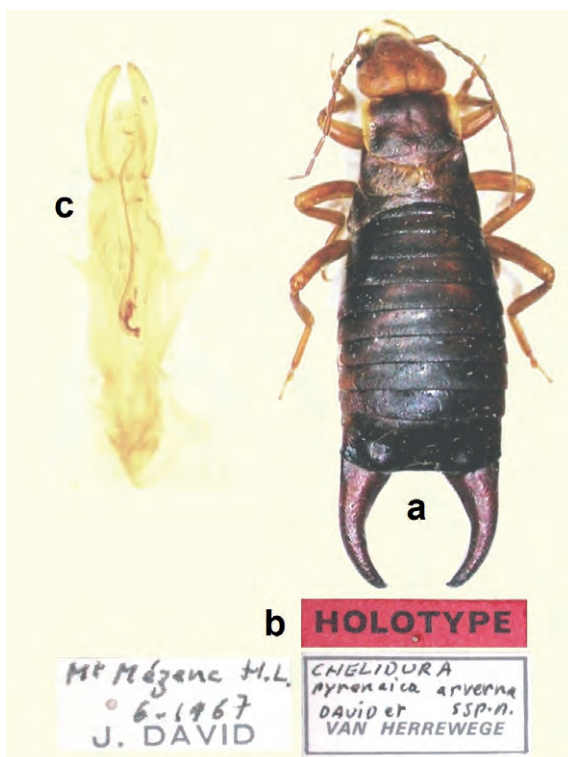


Fig. 4. a) Male Holotype of *Chelidura pyrenaica arverna* and relative labels (b); France, Massif Central, Mt. Mézenc H. L., VI.1967, J. David (collection of the Museum National d'Histoire Naturelle of Paris, France), photo by Paolo Fontana. c) Male genitalia of a specimen of *Chelidura pyrenaica arverna*, France, Ardeche, Sattleu surr., 1000 m, 13.VI.1994, leg. Andrei V. Gourov (collection Fontana at the Museo Civico di Rovereto, Italy), photo by Paolo Fontana.

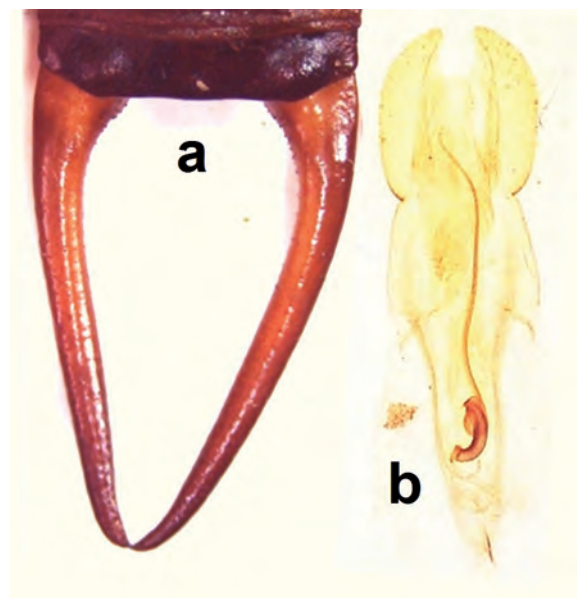


Fig. 5. a) Terminalia of a male of the form macrolabia and b) genitalia of the same specimen; *Chelidura aptera*, Italy, Piedmont (Torino), Val d'Ala di Lanzo, Balme, 1400 m, 10.VIII.1995, leg. Beppe Osella (collection Fontana at the Museo Civico di Rovereto, Italy), photo by Paolo Fontana.

tified by Capra as “*C. aptera* Charp. f. *macrolabia*”. The second specimen, coming from the Massif Central (Mt. Doré), has been identified as “*C. pyrenaica* Genè subsp. nova *arvernica* David *et al.*, f. *macrolabia*”. The shape and size of the parameres of the two specimens, examined directly by the first author, leave no doubt as to their attribution (Fig. 6).

For the moment, it is quite useless to chase after all the taxa described and synonymized within the genus *Chelidura*; this will be done in the future when it will

be possible to have molecular analyses on a greater number of populations. Remaining to the species nowadays universally accepted, namely *C. aptera* and *C. pyrenaica*, it should be noted that their identity and distribution are commonly misinterpreted. For example, in the 56th volume of the *Faune de France*, dedicated to the Orthopteroïdes (Chopard, 1951) but also later, in the 75th volume of the *Faune de France*, exclusively dedicated to the Dermaptera (Albouy & Caussanel, 1990), the two species are confused both

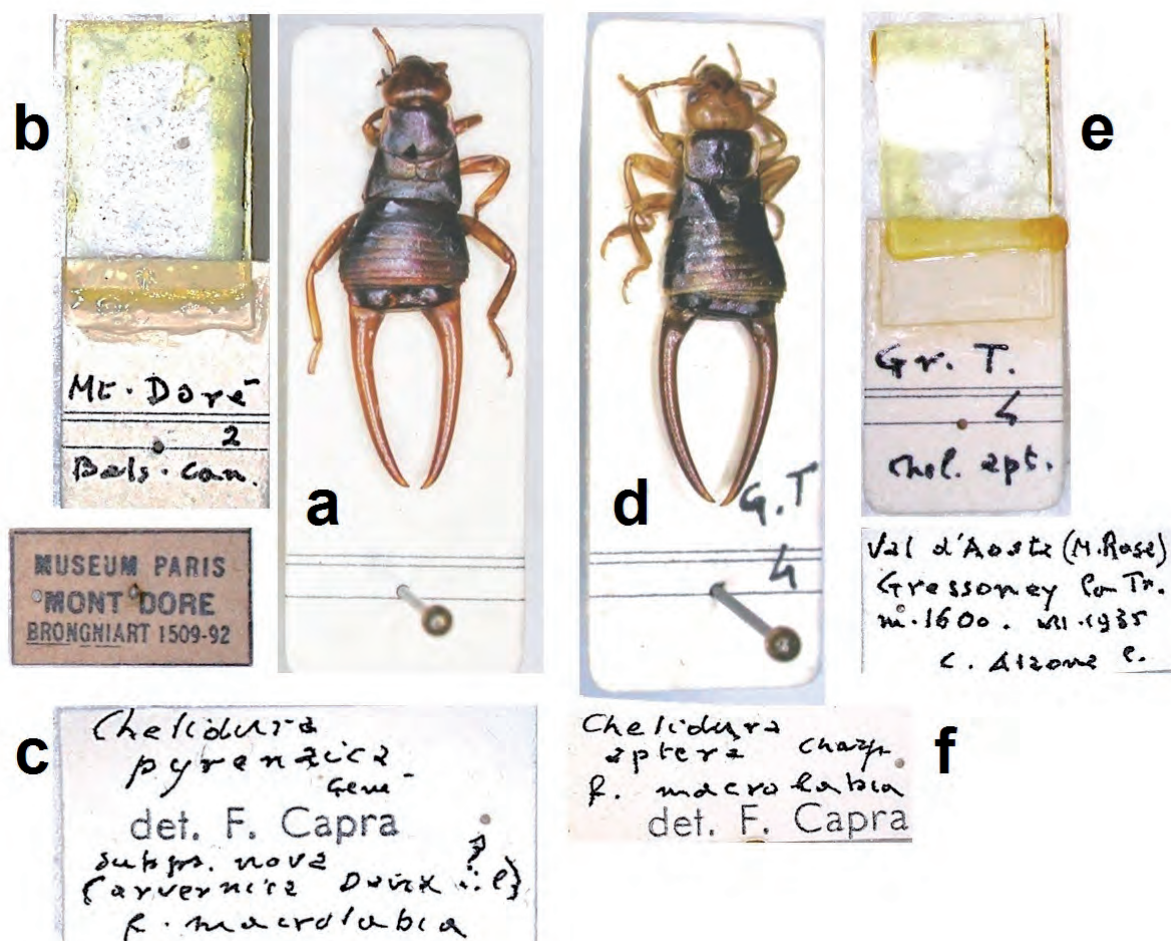


Fig. 6. Two *Chelidura* males identified by Felice Capra: a) mounted specimen, b) genitalia mounted on a small slide and c) original locality and identification labels of a male of *Chelidura pyrenaica arvernica* of the *macrolabia* form, France, Massif Central, Mt. Doré (collection of the Museum National d'Histoire Naturelle of Paris, France), photo by Paolo Fontana. d) Mounted specimen, e) genitalia mounted on a small slide and f) original locality and identification labels of a male of *Chelidura aptera* of the *macrolabia* form, Italy, Aosta valley, M. Rose, Gressoney la Tr., 1600 m, VII. 1935, C. Arzone Legit (collection Fontana at the Museum National d'Histoire Naturelle of Paris, France), photo by Paolo Fontana.

taxonomically as well in their distribution. In the last volume (Albouy & Caussanel, 1990), even the two subspecies of *C. pyrenaica*, namely *C. pyrenaica pyrenaica* and *C. pyrenaica arverna*, are both considered to be present in the Massif Central. In fact, David & Van Herrewege (1973), had considered only the material of one locality of the Massif Central (Mt. Mezenc) for the description of their new subspecies of *C. pyrenaica* and they seem not to have taken into consideration the existence of *C. aptera*. They suppose the presence of another subspecies of *C. pyrenaica* in the Alps, on the basis of specimens from Val d'Isère (Savoie) recorded by Amiet (1961) and of some others collected by one of the two authors (David) in Mont Cenis (Hautes Alpes). David & Van Herrewege (1973) specify that both the specimens of Amiet (1961) as those collected by David, do not have, in the middle of the inner side of the cerci, the obtuse tooth characteristic of the typical form of *C. pyrenaica* (which therefore they delimit only to the Pyrenees); however, they forget that Mont Cenis is the Locus typicus of the *Forficula alpina* of Genè, which is synonymous with *C. aptera*. An interesting aspect of the work of David & Van Herrewege (1973), is their morphometric approach, which could easily be applied to all populations of *Chelidura*. Also in the *Catálogo de los Dermapteros de España* (Herrera Mesa, 1999) *C. aptera* and *C. pyrenaica* are confused and both are recorded for the Spanish side of the Pyrenees. On the contrary, what was reported in the third volume of *The Orthoptera of Europe* (Harz & Kaltenbach, 1976) is much more convincing and the distribution that will be presented in this article in some way will confirm this approach.

From what has been briefly explained so far, it was considered fundamental, in order to undertake the revision of the genus *Chelidura*, to establish the geographical area of *Chelidura aptera* and later to fix the neotype for the species; thus, we need to begin from some molecular analyses and add some morphological considerations, on the basis of which to base the choice of the neotype and program subsequent studies.

CHELIDURA BARCODE AND PHYLOGENETIC ANALYSIS

The DNA barcoding performed on three Alpine populations (Fig. 7) resulted in eighteen sequences of COI gene fragment (Appendix 1). The genetic dis-

tances clearly show three different groups, representatives of the different localities sampled (*i.e.* Col du Grand Saint-Bernard, Lago del Mucrone, and Franscia). The population of the Col du Grand Saint-Bernard shows a mean genetic distance with Lago del Mucrone (8.2%) clearly higher than that between Lago del Mucrone and Franscia (mean distance 3.3%), despite the first two being the geographically closest to each other. The phylogenetic reconstruction, inclusive of the genera *Chelidura*, *Chelidurella*, *Mesochelidura* and *Forficula*, resulted in a consensus tree in which Alpine *Chelidura* monophyly is highly supported (99 bootstrap) with *C. pyrenaica arverna* recovering as sister taxon (84 bootstrap). The genus *Chelidurella* is confirmed as a sister group of the clade Alpine *Chelidura* + *C. pyrenaica arverna*, with *Mesochelidura* and *Forficula* clustering as a separate lineage (Fig. 8). The Alpine cluster presents a genetic divergence from *C. pyrenaica arverna* of 25%, while the latter species differs from *Chelidurella* of about 30%.

DESIGNATION AND DESCRIPTION OF THE NEOTYPE OF *C. APTERA* (MEGERLE IN CHARPENTIER, 1825)

On the basis of the genetic divergence among the three Alpine populations, considered prior to this contribution as belonging to *C. aptera* sensu lato, and their distance from *C. pyrenaica arverna*, it is now possible to clarify the separation among the Massif Central and the Alpine populations. Despite the genetic distances between at least a couple of populations, given the limited data available it is premature to propose any taxonomic separation among Central and Occidental alpine *Chelidura*; however, our preliminary results allow us to select the most suitable population from which to designate the neotype of *C. aptera*.

In order to designate the neotype of *C. aptera*, we decided to follow compliance with the original description as the first criterion and, secondly, to choose no population from the locality from which one of the species now synonymous with *C. aptera* has been described in the past. We then wanted to characterize the population from which the neotype was identified also according to the modern techniques of molecular biology. So, we identify in Monte Mucrone and Lago del Mucrone in the Pennine Alps (Biella), Piedmont, Italy, the best candidate for

the neotype designation. In fact, the male specimens of this population matches almost perfectly Megerle's description of *Chelidura aptera* and they are geographically and genetically separated from *C. pyrenaica arverna* (Massif Central, France) and from *Chelidura* sp. (Col du Grand Saint Bernard, type locality of Bonelli's *Forficula montana*). Monte Mucrone (2335 m) is a mountain in the Pennine Alps, lying between Italy (Piedmont and Valle d'Aosta) and Switzerland (Valais, Ticino and other Swiss cantons). In the geological conformation of Monte Mucrone there is a massive presence of jadeite meta-granite (called Mucronites). Its characteristic shape and its advanced position compared to the rest of the Alpine chain make it easily recognizable from the plain. On the north-western side of Mount Mucrone, at an altitude of about 1900 m, there is the alpine lake "Lago

Mucrone" from which the Oropa stream springs (Fig. 9).

The neotype (male) (Fig. 10) have been designated among those preserved in the Paolo Fontana collection now at the Museo di Scienze e Archeologia - Fondazione Museo Civico di Rovereto (Trento, Italy):

Italy, Piedmont (Biella), M. Mucrone, 30.VIII.1971, leg. Pace R., 1 male (Neotype) and 1 female.

Italy, Piedmont (Biella), Alpi Pennine, Lago Mucrone, 1902 m, VII.1911, leg. Burlini, 1 male.

Italy, Piedmont (Biella), Monte Mucrone, Lago Mucrone, 1903 m, 24.IX.2003, leg. Fontana P., Buzzetti F. M. & Tirello P., 1 male and 1 female.

The specimens collected in September 2019 have been used only for molecular analyzes:

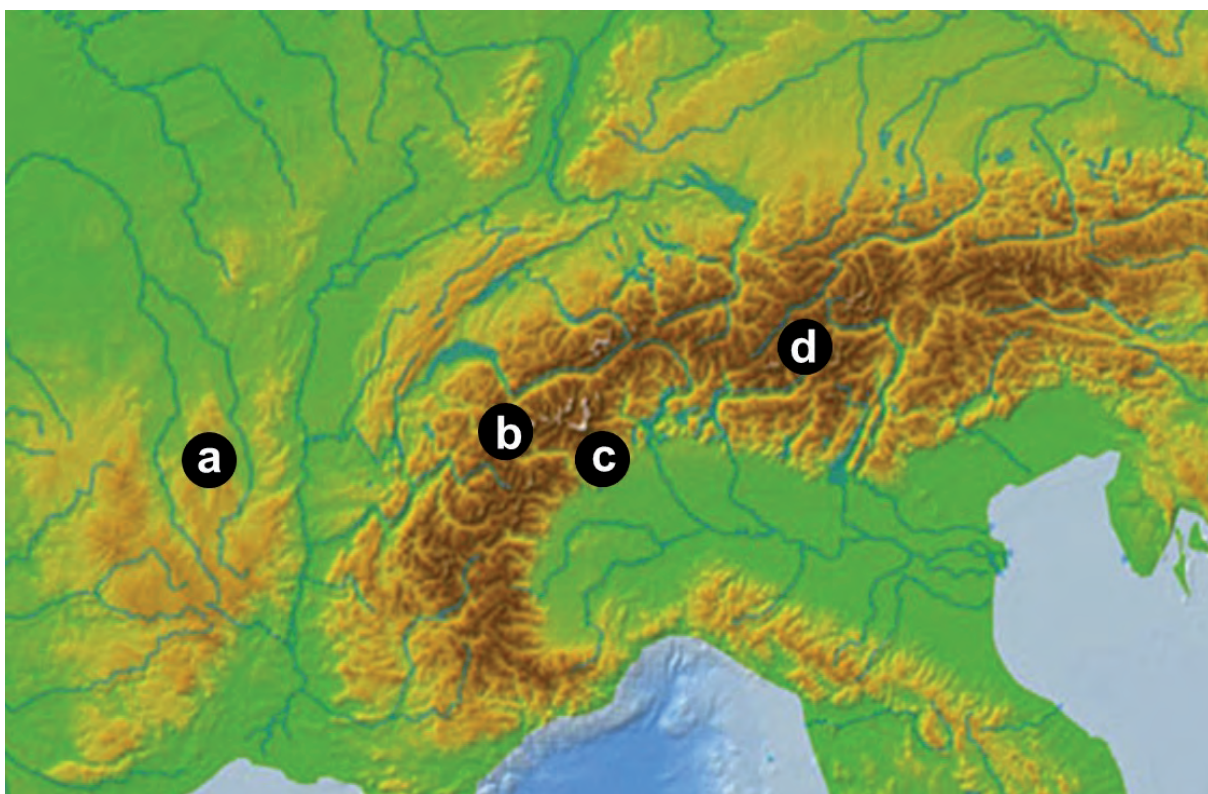


Fig. 7. Geographical positioning of the 4 populations of *Chelidura* used for molecular analyzes: a) *Chelidura pyrenaica arverna*, France, Loire, Station de Chalmazel, Chalmazel, 1137 m, (45°40'33" N, 03°49'32" E). b) *Chelidura aptera*, Switzerland, Valais, Col du Grand Saint-Bernard, Liddes, 2160 m, (45°53'11.24" N, 7°11'24.35" E). c) *Chelidura aptera*, Lago del Mucrone, 1910 m, Oropa (Biella), Pennine Alps, Italy (45°37'43.54" N, 7°56'38.24" E). d) *Chelidura aptera*, Franscia, 1480 m, Lanzada (Sondrio), Western Rhaetian Alps, Italy (46°17'21.4" N, 9°54'41.14" E).

Italy, Piedmont (Biella), Alpi Pennine, Lago del Mucrone, Oropa, 1910 m (45°37'43.54" N, 7°56'38.24" E), 18.IX.2019, Paolo Fontana and Federico Marangoni leg., 2 males and 1 female.

DESCRIPTION OF THE NEOTYPE OF *CHELIDURA APTERA* (MEGERLE IN CHARPENTIER, 1825)

MALE. General colour dark brown; head, legs and antennae light brown. Total length without forceps

(from head apex to ultimate tergite end) 18.66 mm; maximum length of the forceps (Fig. 10) 4.74 mm. Head broader than long; frons moderately convex, smooth; sutures shallow but visible. Eyes very small, only slightly protruding and just over half the length of the first antennomere. Antennae (partly missing); basal segment stouter, gently narrowed at base, shorter as the distance between antenna bases; 2nd short, a little longer than broad; 3rd long and slender, shorter than 4th and 5th combined. Pronotum transverse (ratio

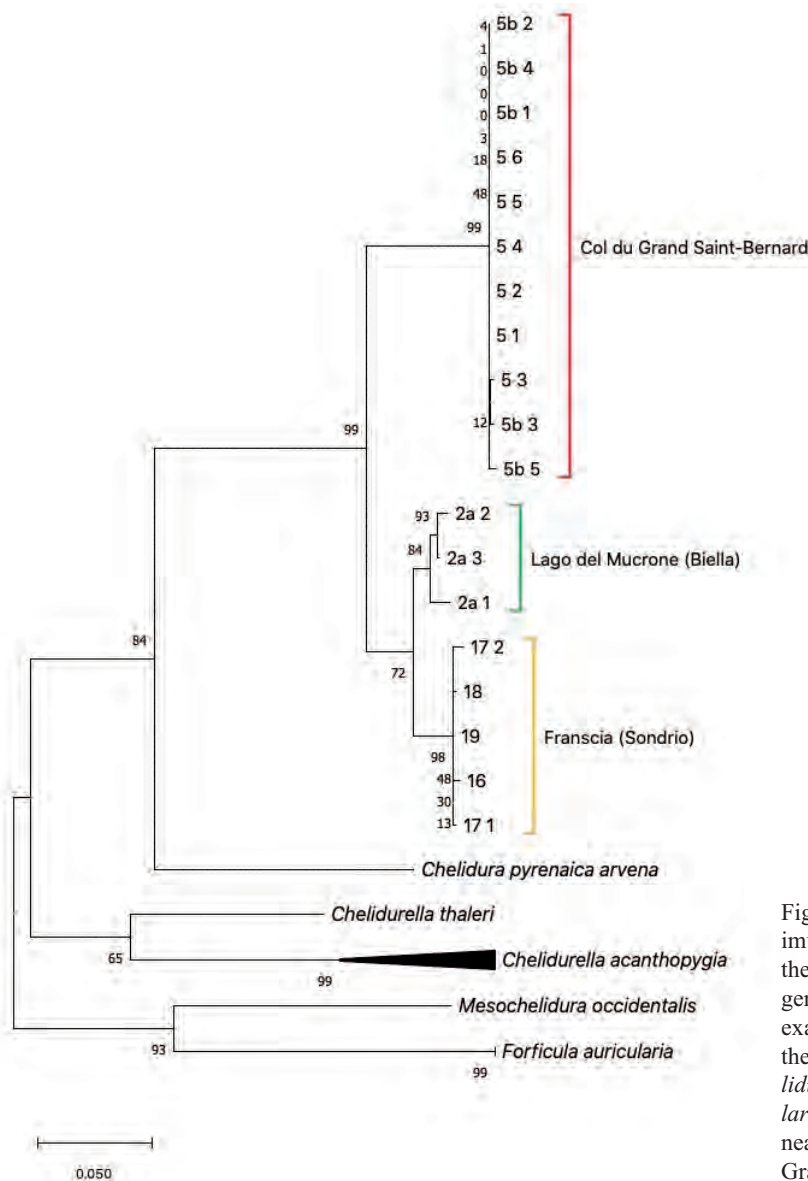


Fig. 8. Phylogenetic tree inferred by maximum likelihood (ML) method based on the cytochrome c oxidase subunit I (COI) gene fragment for *Chelidura* populations examined together with some species of the related genus *Chelidurella*. *Mesochelidura occidentalis* and *Forficula auricularia* were added as an outgroup. Numbers near the nodes represent bootstrap values. Graphic by Enrico Ruzzier.

pronotum width/length is 0.48), anteriorly straight, gently diverging posteriorly; hind angles and margin of the pronotum broadly rounded; median sulcus faintly marked; prozona almost smooth and metazona dotted. Scutellum not visible. Apparently apterous being tegmina rudimentary, dotted, touching each other medially; distal and internal edges of the temina broadly rounded. Wings absent. Femora slightly enlarged; tibiae thin. Abdomen dilated proceeding towards the terminalia; ratio between pronotum width and ultimate tergite width: 0.48. Posterior part of the abdominal tergites rugose, except in the last (10th), which is completely smooth. Ultimate tergite (10th) transverse, 3.8 times broader than long. Pygidium not visible from above, 3.09 mm wide, rugose, almost flat and with one shallow horizontal depression almost at middle. Cerci semicircular, stout and symmetrical, sparsely dotted; cerci enlarged at their base (2.45 mm), gradually tapering to the pointed apex. Total length of the cerci: 4.74 mm; maximum inner curvature of the cerci is 1.99 mm (Fig. 10). Cerci without any tooth in

the inner margin, while bearing a small tubercle in the inner upper part, in the proximity of the base (Tab. 1 and Fig. 11).

MALE GENITALIA. Parameres approximately 4.6 times longer than wide, crescent shaped, with an almost straight inner margin and a curved outer margin. Virga s-shaped, about twice as long as the parameres.

CURRENT KNOWLEDGE ON THE DISTRIBUTION AND ECOLOGY OF THE SPECIES OF THE GENUS *CHELIDURA*

Following the analysis on the four populations from Italy, Switzerland and France, an updated, albeit provisional, taxonomic arrangement of the genus *Chelidura* and its distribution on the basis of published and unpublished data are here proposed.

From a biogeographical point of view, *Chelidura* may be considered one of the oldest genera within the European Dermaptera fauna, possibly with Angarian origin (Vigna Taglianti, 1994). *C. aptera* and *C. p. pyrenaica* inhabit sub- and alpine environments,

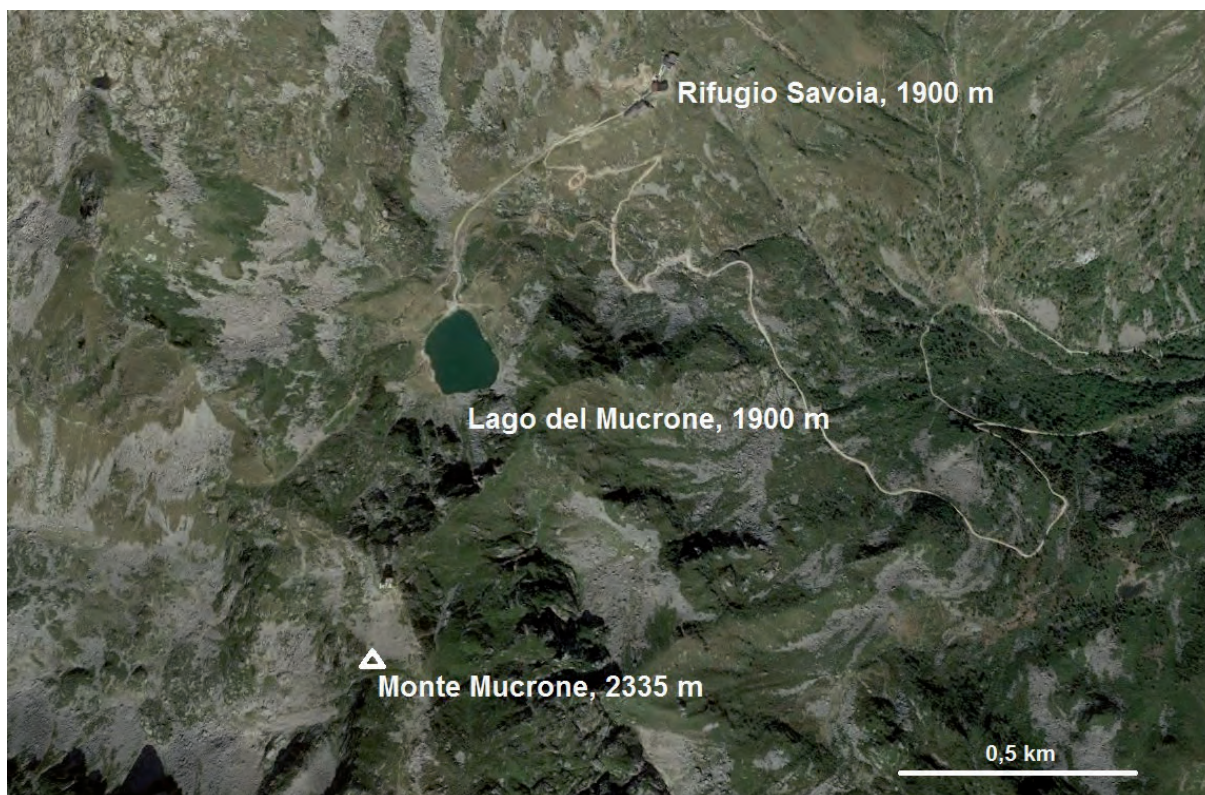


Fig. 9. Orthophoto of the Monte Mucrone area (Italy, Piedmont, Pennine Alps). Graphic elaboration by Paolo Fontana.

normally between 1400 m and 2000 m asl and in some cases, as on Mount Canigou (eastern Pyrenees), these earwigs live up to 2300 m asl of altitude. According to Chemini & Vigna Taglianti (2002), *C. aptera* is typical of the upper mountain and alpine plains, where it lives among raspberry bushes and the rocky substrate. In general, the species of the genus live in typical alpine grasslands with rocky outcrops where the individuals frequently recover under stones (Fig. 12). As for *C. p. arverna*, which probably lives on the Massif Central up to its highest peaks, populations are known even at an altitude of only 1000 m asl and living in forest environments.

On the basis of the present state of knowledge, the three taxa nowadays assignable to the genus *Chelidura*

Tab. 1. Main measures and ratios of the male neotype of *Chelidura aptera* from Monte Mucrone (Biella), 30.VIII.1971, leg. R. Pace. For male cerci measures see Fig. 11.

Total body length (no cerci)	18.66 mm
Head width	7.65 mm
Pronotum width in the middle	3.67 mm
Pronotum length	2.29 mm
Ratio pronotum length/width	0.62
Ultimate tergite width	7.65 mm
Ultimate tergite length	1.99 mm
Ratio pronotum width/ultimate tergite width	0.48
Cerci total length	4.74 mm
Cerci basal width	2.45 mm
Cerci width at maximum curvature	0.92 mm
Maximum curvature of the cerci	1.99 mm
Pygidium width	3.09 mm
Paremeres length	0.22 mm
Parameres maxim width	1.02 mm

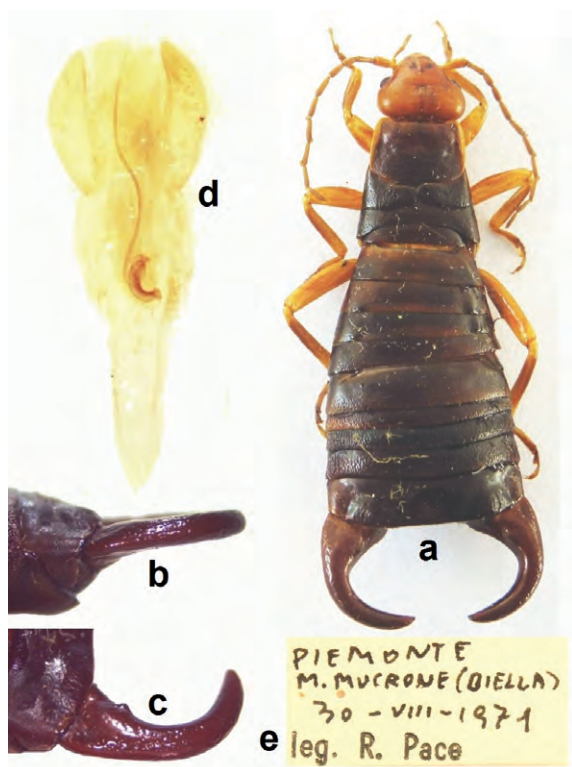


Fig. 10. Male neotype of *Chelidura aptera*, Italy, Piedmont (Biella), M. Mucrone, 30.08.1971, leg. Pace R. (collection Fontana at the Museo Civico di Rovereto, Italy), photo by Paolo Fontana. (a) Male dorsal overview, (b) terminalia form left lateral view, (c) three-quarter view from the left of left cercus and its small sub-basal small tubercle, (d) male terminalia, (e) original label. Photo by Paolo Fontana.

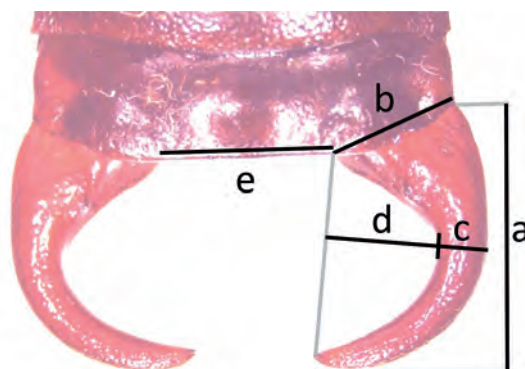


Fig. 11. Indication of the exact detection positions of the measurements of the terminalia of the Neotype of *Chelidura aptera*, according to David & Herrewége (1973). a) Cerci total length, b) cerci basal width, c) cerci width at maximum curvature, d) cerci maximum curvature and e) pygidium width. Graphic elaboration by Paolo Fontana.

sensu Kirstová *et al.* (2020), can be ecologically characterized and geographically distributed as follows:

***C. aptera*:** exclusively alpine species, present on the Western and Central Alps. The Central Alps population, collected only in 2019 by M. Grosser,

substantially extends the distribution of the species towards the east. As previously shown in this paper, the alpine populations present a certain degree of genetic divergence, suggesting the existence of cryptic taxa under the present *C. aptera*. Chemini & Vigna Taglianti (2002) underline the presence of at least



Fig. 12. a) Habitat of *Chelidura aptera*, Italy, Piedmont (Biella), Pennine Alps, Lago del Mucrone, Oropa, 1910 m, 18.IX.2019, photo by Federico Marangoni; b) habitat of *Chelidura aptera* (type locality of *F. montana*) Switzerland, Valais, Col du Grand Saint-Bernard, Liddes, 2160 m, 18.IX.2019, photo by Federico Marangoni.

some very distinct populations and in particular in the Ligurian, Maritime and Cottian Alps.

***C. pyrenaica pyrenaica*:** species recorded to date from the eastern Pyrenees, across France and Spain. In the collections of the Muséum national d'Histoire Naturelle (Paris, France) there is a male specimen from the Picacho de Veleta (Sierra Nevada) morphologically matching with the typical form (Fig. 13). Picacho de Veleta may refer to Pico del Veleta, a mountain in the Sierra Nevada (Spain). Pico del Veleta is the third highest mountain in the Iberian Peninsula (3392 m). This specimen, if really collected in the Sierra Nevada and not mislabelled, could considerably extend the range of the genus *Chelidura* to the south. The specimen of the Museum of Paris and any other specimens of this population outside its known distribution, definitely need to be re-examined (genitalia and barcoding) in order to dispel any doubts about their identity or the possibility of their accidental introduction from the Pyrenees.

***C. pyrenaica arverna*:** subspecies endemic from the Massif Central in France. DNA barcoding states it is a distinct entity from the alpine populations (*C. aptera*), however we still do not know its relations with *C. pyrenaica pyrenaica* from the eastern Pyrenees.

CONCLUSIONS

The analysis on the four populations of *Chelidura*, together with the historical reconstruction and the morphological examination of a vast series of samples of very wide origin, allow us to further confirm, after the careful analysis carried out on the genus *Chelidurella* by Kirstová *et al.* (2020), the clear separation between the genera *Chelidura* Latreille, 1825, *Chelidurella* Verhoeff, 1902 and *Mesochelidura* Verhoeff, 1902. The genetic distance detected between the alpine populations of *Chelidura*, currently assigned to *C. aptera*, and those from the Massif Central resemble the divergence among the different genera mentioned above. Despite such genetic separation in two relatively close populations may suggest their separation in two genera, the establishment of any new name is premature. According to current knowledge it can therefore be concluded that the Alpine populations of *Chelidura* are clearly separated from those of the Massif Central, both as regards the molecular aspects and the morphology of the male genitalia. For now, only on a morphological basis, but entirely sufficient to support this distinction, even the populations from the Pyrenees can be considered clearly distinct from those of the Alps while further investigations are

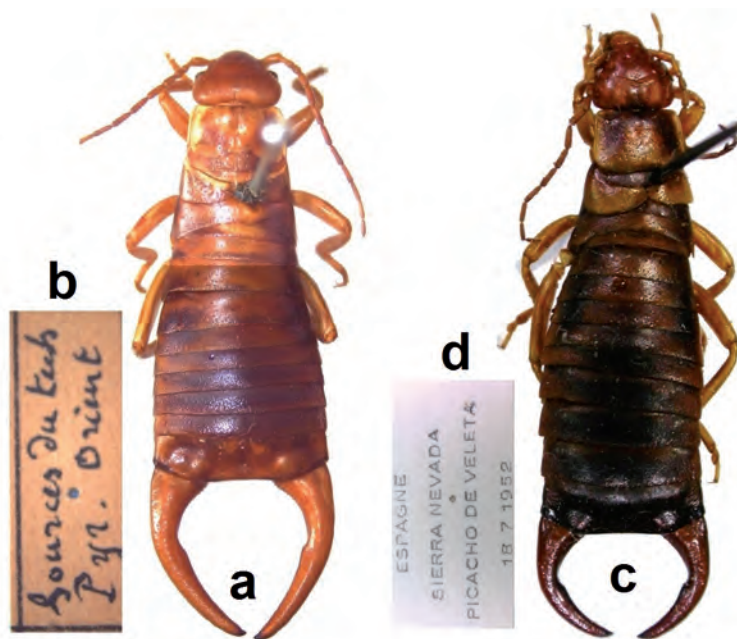


Fig. 13. a) Overview of a male and b) its relative label of *Chelidura pyrenaica*, cyclolabia form, France, Pyrenees Orientals, Sources du Tech (= Vallée superior du Tech), VII. 1904, leg. A. Borelli (collection Fontana at the Museo Civico di Rovereto, Italy), photo by Paolo Fontana. For locality and data see Borelli (1905). c) Overview of a male and d) its relative label of a specimen probably belonging to *Chelidura pyrenaica*, cyclolabia form, Spain, Sierra Nevada, Picacho de Veleta (= Pico de veleta), (collection of the Museum National d'Histoire Naturelle of Paris, France), photo Paolo Fontana.

needed in order to establish their affinity with the Pyrenean populations. DNA barcodes suggest that the Alpine *Chelidura* may be a species complex; for this reason, an integrated approach between fine morphology and DNA markers is strongly recommended in order to clarify what diversity hides under the name *C. aptera*.

We can therefore propose a distribution map of the genus *Chelidura* in relation to *Chelidurella* and *Mesochelidura* distributions (Fig. 14).

ACKNOWLEDGEMENTS

We are obliged to Christophe Girod (Échalas, France) and Mario Grosser (Opava, Czech Republic), who kindly collected the *Chelidura* material for us. We thank the Fondazione Museo Civico di Rovereto for helping us to examine the museum collection despite the difficult time of the Covid pandemic. We thank our friend and distinguished entomologist Beppe Osella for having donated to the first author most of the *Chelidura* specimens now preserved at the Civic Museum of Rovereto. We also thank Alberto Grassi of the Edmund Mach Foundation for his collaboration in the realization of some stereomicroscope images.

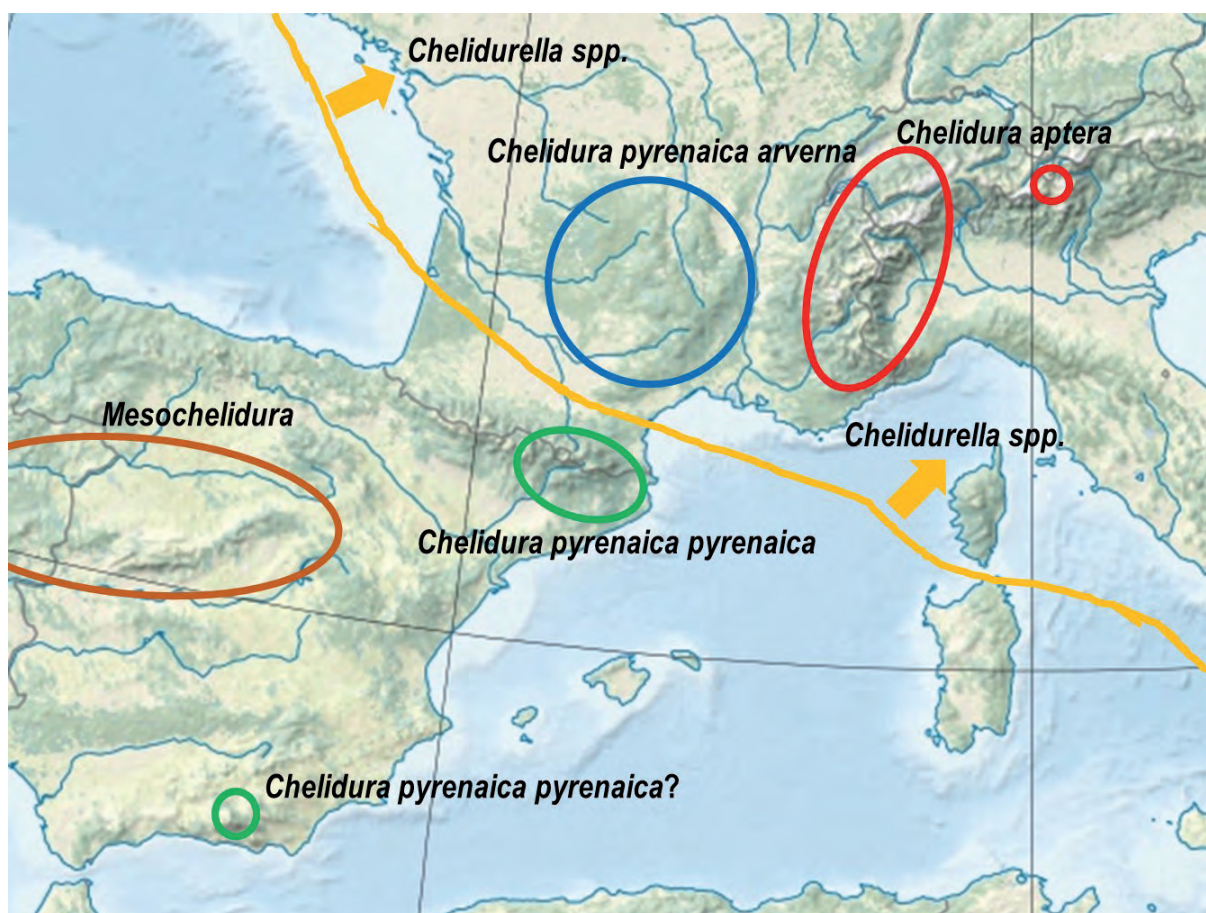


Fig. 14. Actual distribution map of the genus *Chelidura*, the genus *Mesochelidura* and the southwestern border of the known distribution of the genus *Chelidurella*, graphic by Paolo Fontana.

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APPENDIX 1

Code	Locality	Barcode
2a-1	Italy, Piedmont (Biella), Pennine Alps, Lago del Mucrone, Oropa, 1910 m (45°37'43,54" N, 7°56'38,24" E), 18.IX.2019, Paolo Fontana and Federico Marangoni leg.	GGACTTTGTATTTTTGTTTGGGGCATGATCCGGAATGATTGGTACCTCT CTTAGAATATTAATTCGAGCTGAGTTAGGTACACCCGGAGCTTTAATTG GGGATGACCAAATTTATAATGTAATTGTAACAGCCCACGCTTTTGTAAT GATTTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTGACT TGTGCCCTTGATACTAAGAGCCCCGGATATAGCTTTCCACGTTTAAAT AACATGAGATTCTGACTTCTCCCCCTTCGTTATTATTGTTACTATCTGG GAGTATGGTAGATAGCGGGGCAGGAACAGGGTGAACAGTCTATCCTCC TTTGGCAGGATAATAGCTCATGCAGGTGCTTCGGTAGATTAAAGAATTT TTTCTCTTCACTTGGCGGGGTATCATCAATTTAGGGGCTGTAACTT TATTACTACTGTAATAAACATGCGTCCAGCAGGCCTAAGACTAGAACGA ATTCCACTATTTGTATGGTCCGTGGCAATTACAGCTTTATTGTTGTTGTT GTCTCTTCCCGTGTTGGCAGGGGCCATTACCATGTATTAAGTATCGA AATTTAAATACATCGTTCTTTGACCCTGCTGGAGGGGGTGATCCTATCT ATACCAACATTTGCTT
2a-2	Italy, Piedmont (Biella), Pennine Alps, Lago del Mucrone, Oropa, 1910 m (45°37'43,54" N, 7°56'38,24" E), 18.IX.2019, Paolo Fontana and Federico Marangoni leg.	GACTTTGTATTTTTGTTTGGGGCATGATCCGGAATGATTGGTACCTCT CTTAGAATATTAATTCGAGCTGAGTTAGGTACACCCGGAGCTTTAATT GGGGATGACCAAATTTATAATGTAATTGTAACAGCCCACGCTTTTGTA ATGATTTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTG ACTTGTGCCCTTGATACTAAGAGCCCCGGATATAGCTTTCCACGTTTA AATAACATGAGATTCTGACTTCTCCCCCTTCGTTATTGTTGTTACTAT CTGGGAGTATGGTGGATAGCGGGGCAGGAACAGGGTGAACAGTCTAT CCTCCTTTGGCAGGATCCATAGCCCATGCGGGTGCTTCGGTAGATTTA AGAATTTTTTCTCTTCACTTGGCGGGGGTATCATCAATTTTAGGGGCT GTAAACTTTATTACTACTGTAATAAACATGCGTCCAGCAGGCCTAAGA CTAGAACGAATCCACTATTTGTATGGTCCGTGGCAATTACAGCTTTAT TGTTGTTGTTGTCTCTTCCCGTGTTGGCAGGGGCCATTACCATATTAT AACTGATCGAAATTTAAATACATCGTTCTTTGACCCTGCTGGAGGGGG TGATCCTATCTATACCAACACTTTGTTTT
2a-3	Italy, Piedmont (Biella), Pennine Alps, Lago del Mucrone, Oropa, 1910 m (45°37'43,54" N, 7°56'38,24" E), 18.IX.2019, Paolo Fontana and Federico Marangoni leg.	GGACTTTGTATTTTTGTTTGGGGCATGATCCGGAATGATTGGTACCTC TCTTAGAATATTAATTCGAGCTGAGTTAGGTACACCCGGAGCTTTAATT GGGGATGACCAAATTTATAATGTAATTGTAACAGCCCACGCTTTTGTA ATGATTTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTG ACTTGTGCCCTTGATACTAAGAGCCCCGGATATAGCTTTCCACGTTTA AATAACATGAGATTCTGACTTCTCCCCCTTCGTTATTGTTGTTACTAT CTGGGAGTATGGTGGATAGCGGGGCAGGAACAGGGTGAACAGTCTAT CCTCCTTTGGCAGGATCCATAGCCCATGCGGGTGCTTCGGTAGATTTA AGAATTTTTTCTCTTCACTTGGCGGGGGTATCATCAATTTTAGGGGCT GTAAACTTTATTACTACTGTAATAAACATGCGTCCAGCAGGCCTAAGA CTAGAACGAATCCACTATTTGTATGGTCCGTGGCAATTACAGCTTTAT TGTTGTTGTTGTCTCTTCCCGTGTTGGCAGGGGCCATTACCATATTAT AACTGATCGAAATTTAAATACATCGTTCTTTGACCCTGCTGGAGGGGG TGATCCTATTCTATACCAACACTTTGTTTT

Code	Locality	Barcode
5-1	Switzerland, Valais, Col du Grand Saint-Bernard, Liddes, 2160 m, (45°53'11,24" N, 7°11'24,35" E), 18.IX.2019, Paolo Fontana and Federico Marangoni leg	GACTTTATATTTTTGTTTGGAGCATGATCCGGAATGATCGGCACCTCT CTGAGAATATTAATTCGAGCTGAGTTAGGCCACCCCGAGCTTTAATT GGAGATGACCAAATTTATAATGTAATTGTAACAGCCCACGCTTTCGTA ATAATTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTGA CTTGTAACCTTGATATTAAGAGCCCCGGACATAGCTTTCCCACGTTTAA ATAATATGAGATTCTGACTTCTTCCTCCTTCACTGTTGTTGTTGCTATCT GGGAGAATGGTGGACAGCGGAGCAGGAACCGGGTGAACAGTTTACC CCCCTTTGGCAGGATCAATAGCTCATGCGGGCGCTTCGGTAGATTAA GAATTTTTTCTCTTCATTGGCAGGGGTGTCATCAATTTAGGGGCTGT AAACTTTATTACTACTGTAATGAACATGCGTCCAGTAGGTCTAAGGCT GGAGCGAATTCCCCTATTTGTGTGGTCCGTAGCAATTACAGCTTTATTG TTGTTGTGTCCCTTCCTGTCTTAGCAGGGGCTATTACCATATTATTAA CTGATCGAAATTTAAATACGTCATTCTTTGACCCTGCTGGAGGAGGTG ACCCTATTTGTACCAACATTGTTT
5-2		GACTTTATATTTTTGTTTGGAGCATGATCCGGAATGATCGGCACCTCT CTGAGAATATTAATTCGAGCTGAGTTAGGCCACCCCGAGCTTTAATT GGAGATGACCAAATTTATAATGTAATTGTAACAGCCCACGCTTTCGTA ATAATTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTGA CTTGTAACCTTGATATTAAGAGCCCCGGACATAGCTTTCCCACGTTTAA ATAATATGAGATTCTGACTTCTTCCTCCTTCACTGTTGTTGTTGCTATCT GGGAGAATGGTGGACAGCGGAGCAGGAACCGGGTGAACAGTTTACC CCCCTTTGGCAGGATCAATAGCTCATGCGGGCGCTTCGGTAGATTAA GAATTTTTTCTCTTCATTGGCAGGGGTGTCATCAATTTAGGGGCTGT AAACTTTATTACTACTGTAATGAACATGCGTCCAGTAGGTCTAAGGCT GGAGCGAATTCCCCTATTTGTGTGGTCCGTAGCAATTACAGCTTTATTG TTGTTGTGTGCCCTTCCTGTCTTAGCAGGGGCTATTACCATATTATTAA TGATCGAAATTTAAATACGTCATTCTTTGACCCTGCTGGAGGAGGTGA CCCTATTTGTACCAACATT
5-3		GACTTTATATTTTTGTTTGGAGCATGATCCGGAATGATCGGCACCTCT CTGAGAATATTAATTCGAGCTGAGTTAGGCCACCCCGAGCTTTAATT GGAGATGACCAAATTTATAATGTAATTGTAACAGCCCACGCTTTCGTA ATAATTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTGA CTTGTAACCTTGATATTAAGAGCCCCGGACATAGCTTTCCCACGTTTAA ATAATATGAGATTCTGACTGCTTCCTCCTTCACTGTTGTTGTTGCTATCT GGGAGAATGGTGGACAGCGGAGCAGGAACCGGGTGAACAGTTTACC CCCCTTTGGCAGGATCAATAGCTCATGCGGGCGCTTCGGTAGATTAA GAATTTTTTCTCTTCATTGGCAGGGGTGTCATCAATTTAGGGGCTGT AAACTTTATTACTACTGTAATGAACATGCGTCCAGTAGGTCTAAGGCT GGAGCGAATTCCCCTATTTGTGTGGTCCGTAGCAATTACAGCTTTATTG TTGTTGTGTGCCCTTCCTGTCTTAGCAGGGGCTATTACCATATTATTAA TGATCGAAATTTAAATACGTCATTCTTTGACCCTGCTGGAGGAGGTGA CCCTATTTGTACCAACATT
5-4		GACTTTATATTTTTGTTTGGAGCATGATCCGGAATGATCGGCACCTCT CTGAGAATATTAATTCGAGCTGAGTTAGGCCACCCCGAGCTTTAATT GGAGATGACCAAATTTATAATGTAATTGTAACAGCCCACGCTTTCGTA ATAATTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTGA CTTGTAACCTTGATATTAAGAGCCCCGGACATAGCTTTCCCACGTTTAA ATAATATGAGATTCTGACTTCTTCCTCCTTCACTGTTGTTGTTGCTATCT GGGAGAATGGTGGACAGCGGAGCAGGAACCGGGTGAACAGTTTACC CCCCTTTGGCAGGATCAATAGCTCATGCGGGCGCTTCGGTAGATTAA GAATTTTTTCTCTTCATTGGCAGGGGTGTCATCAATTTAGGGGCTGT AAACTTTATTACTACTGTAATGAACATGCGTCCAGTAGGTCTAAGGCT GGAGCGAATTCCCCTATTTGTGTGGTCCGTAGCAATTACAGCTTTATTG TTGTTGTGTGCCCTTCCTGTCTTAGCAGGGGCTATTACCATATTATTAA TGATCGAAATTTAAATACGTCATTCTTTGACCCTGCTGGAGGAGGTGA CCCTATTTGTACCAACA

Code	Locality	Barcode
5-5		GACTTTATATTTTTGTTTGGAGCATGATCCGGAATGATCGGCACCTCT CTGAGAATATTAATTCGAGCTGAGTTAGGCCACCCCGGAGCTTTAATT GGAGATGACCAAATTATAATGTAATTGTAACAGCCCACGCTTTCGTA ATAATTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTGA CTTGTAACCTTGATATTAAGAGCCCCGGACATAGCTTTCCCACGTTTAA ATAATATGAGATTCTGACTTCTTCCTCCTCACTGTTGTTGTTGCTATCT GGGAGAATGGTGGACAGCGGAGCAGGAACCGGGTGAACAGTTTACC CCCCTTTGGCAGGATCAATAGCTCATGCGGGCGCTTCGGTAGATTAA GAATTTTTTCTCTTCATTGGCAGGGGTGTCATCAATTTAGGGGCTGT AAACTTTATTACTACTGTAATGAACATGCGTCCAGTAGGTCTAAGGCT GGAGCGAATTCCCCTATTTGTGTGGTCCGTAGCAATTACAGCTTTATTG TTGTTGTTGTCCCTTCCTGTCTTAGCAGGGGCTATTACCATATTATTAAC TGATCGAAATTTAAATACGTCATTCTTTGACCCTGCTGGAGGAGGTGA CCCTATTTTGTACCAACATT
5-6		GACTTTATATTTTTGTTTGGAGCATGATCCGGAATGATCGGCACCTCT CTGAGAATATTAATTCGAGCTGAGTTAGGCCACCCCGGAGCTTTAATT GGAGATGACCAAATTATAATGTAATTGTAACAGCCCACGCTTTCGTA ATAATTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTGA CTTGTAACCTTGATATTAAGAGCCCCGGACATAGCTTTCCCACGTTTAA ATAATATGAGATTCTGACTTCTTCCTCCTCACTGTTGTTGTTGCTATCT GGGAGAATGGTGGACAGCGGAGCAGGAACCGGGTGAACAGTTTACC CCCCTTTGGCAGGATCAATAGCTCATGCGGGCGCTTCGGTAGATTAA GAATTTTTTCTCTTCATTGGCAGGGGTGTCATCAATTTAGGGGCTGT AAACTTTATTACTACTGTAATGAACATGCGTCCAGTAGGTCTAAGGCT GGAGCGAATTCCCCTATTTGTGTGGTCCGTAGCAATTACAGCTTTATTG TTGTTGTTGTCCCTTCCTGTCTTAGCAGGGGCTATTACCATATTATTAAC TGATCGAAATTTAAATACGTCATTCTTTGACCCTGCTGGAGGAGGTGA CCCTATTTTGTACCAACATT
5b-1		GACTTTATATTTTTGTTTGGAGCATGATCCGGAATGATCGGCACCTCT CTGAGAATATTAATTCGAGCTGAGTTAGGCCACCCCGGAGCTTTAATT GGAGATGACCAAATTATAATGTAATTGTAACAGCCCACGCTTTCGTA ATAATTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTGA CTTGTAACCTTGATATTAAGAGCCCCGGACATAGCTTTCCCACGTTTAA ATAATATGAGATTCTGACTTCTTCCTCCTCACTGTTGTTGTTGCTATCT GGGAGAATGGTGGACAGCGGAGCAGGAACCGGGTGAACAGTTTACC CCCCTTTGGCAGGATCAATAGCTCATGCGGGCGCTTCGGTAGATTAA GAATTTTTTCTCTTCATTGGCAGGGGTGTCATCAATTTAGGGGCTGT AAACTTTATTACTACTGTAATGAACATGCGTCCAGTAGGTCTAAGGCT GGAGCGAATTCCCCTATTTGTGTGGTCCGTAGCAATTACAGCTTTATTG TTGTTGTTGTCCCTTCCTGTCTTAGCAGGGGCTATTACCATATTATTAAC TGATCGAAATTTAAATACGTCATTCTTTGACCCTGCTGGAGGAGGTGA CCCTATTTTGTACCAACATT
5b-2		GACTTTATATTTTTGTTTGGAGCATGATCCGGAATGATCGGCACCTC TCTGAGAATATTAATTCGAGCTGAGTTAGGCCACCCCGGAGCTTTAAT TGGAGATGACCAAATTATAATGTAATTGTAACAGCCCACGCTTTCGTA ATAATTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTGA CTTGTAACCTTGATATTAAGAGCCCCGGACATAGCTTTCCCACGTTTAA ATAATATGAGATTCTGACTTCTTCCTCCTCACTGTTGTTGTTGCTATCT GGGAGAATGGTGGACAGCGGAGCAGGAACCGGGTGAACAGTTTACC CCCCTTTGGCAGGATCAATAGCTCATGCGGGCGCTTCGGTAGATTAA GAATTTTTTCTCTTCATTGGCAGGGGTGTCATCAATTTAGGGGCTGT AAACTTTATTACTACTGTAATGAACATGCGTCCAGTAGGTCTAAGGCT GGAGCGAATTCCCCTATTTGTGTGGTCCGTAGCAATTACAGCTTTATTG TTGTTGTTGTCCCTTCCTGTCTTAGCAGGGGCTATTACCATATTATTAAC TGATCGAAATTTAAATACGTCATTCTTTGACCCTGCTGGAGGAGGTGA CCCTATTTTGTACCAACATT

Code	Locality	Barcode
5b-3		GAC TTTATAT TTTT TGT TTTGGAGCATGATCCGGAATGATCGGCACCTCT CTGAGAATATTAATTCGAGCTGAGTTAGGCCACCCCGGAGCTTTAATT GGAGATGACCAAATTTATAATGTAATTGTAACAGCCCACGCTTTCGTA ATAATTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTGA CTTG TACCCTTGATATTAAGAGCCCCGGACATAGCTTTCCACGTTTAA ATAATATGAGATTCTGACTTCTTCTCTTCACTGTTGTTGTGTCTATCT GGGAGAATGGTGGACAGCGGAGCAGGAACCGGGTGAACAGTTTACC CCCCTTTGGCAGGATCAATAGCTCATGCGGGCGCTTCGGTAGATTAA GAATTTTTTCTCTTCATTTGGCAGGGGTGTCATCAATTTAGGGGCTGT AAACTTTATTACTACTGTAATGAACATGCGTCCAGTAGGTCTAAGGCT GGAGCGAATTCCCCTATTTGTGTGGTCCGTAGCAATTACAGCTTTATTG TTGTGTTGTCCCTTCTGTCTTAGCAGGGGCTATTACCATATGATTAA CTGATCGAAATTTAAATACGTCATTCTTTGACCCTGCTGGAGGAGGTG ACCCTATTTTGTACCAACATT
5b-4		GAC TTTATAT TTTT TGT TTTGGAGCATGATCCGGAATGATCGGCACCTCT CTGAGAATATTAATTCGAGCTGAGTTAGGCCACCCCGGAGCTTTAATT GGAGATGACCAAATTTATAATGTAATTGTAACAGCCCACGCTTTCGTA ATAATTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTGA CTTG TACCCTTGATATTAAGAGCCCCGGACATAGCTTTCCACGTTTAA ATAATATGAGATTCTGACTTCTTCTCTTCACTGTTGTTGTGTCTATCT GGGAGAATGGTGGACAGCGGAGCAGGAACCGGGTGAACAGTTTACC CCCCTTTGGCAGGATCAATAGCTCATGCGGGCGCTTCGGTAGATTAA GAATTTTTTCTCTTCATTTGGCAGGGGTGTCATCAATTTAGGGGCTGT AAACTTTATTACTACTGTAATGAACATGCGTCCAGTAGGTCTAAGGCT GGAGCGAATTCCCCTATTTGTGTGGTCCGTAGCAATTACAGCTTTATTG TTGTGTTGTCCCTTCTGTCTTAGCAGGGGCTATTACCATATTATTAAC TGATCGAAATTTAAATACGTCATTCTTTGACCCTGCTGGAGGAGGTGA CCCTATTTTGTACCAACATT
5b-5		GCTTTATAT TTTT TGT TTTGGAGCATGATCCGGAATGATCGGCACCTCT TGAGAATATTAATTCGAGCTGAGTTAGGCCACCCCGGAGCTTTAATTG GAGATGACCAAATTTATAATGTAATTGTAACAGCCCACGCTTTCGTAAT AATTTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTGACT TGTACCCTTGATATTAAGAGCCCCGGACATAGCTTTCCACGTTTAAAT AATATGAGATTCTGACTTCTTCTCTTCACTGTTGTTGTGTCTATCTG GGAGAATGGTGGACAGCGGAGCAGGAACCGGGTGAACAGTTTACCC CCCTTTGGCAGGATCAATAGCTCATGCGGGCGCTTCGGTAGATTAAAG AATTTTTTCTCTTCATTTGGCAGGGGTGTCATCAATTTAGGGGCTGTA AACTTTATTACTACTGTAATGAACATGCGTCCAGTAGGTCTAAGGCTG GAGCGAATTCCCCTATTTGTGTGGTCCGTAGCAATTACAGCTTTATTGT TGTTGTTGTCCCTTCTGTCTTAGCAGGGGCTATTACCATCTTATTAAC GATCGAAATTTAAATACGTCATTCTTTGACCCTGCTGGAGGAGGTGAC CCTATTTTGTACCAACATT
16	Italy, Lombardy (Sondrio), Western Rhaetian Alps, Franschia, Lanzada, 1480 m, (46°17'21,4" N, 9°54'41,14" E), 22.VII.2019, Mario Grosser leg.	GAC TTTGTAT TTTT TGT TTTGGGGCATGATCTGGGATGATTGGTACCTCT CTTAGAATATTAATTCGAGCTGAGTTAGGTACCCCGGAGCTTTAATT GGGGATGACCAAATTTATAATGTAATTGTAACAGCCCACGCTTTTGTA ATGATTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTG ACTTGTGCCCTTGATACTAAGAGCCCCGGATATGGCTTTCCACGTTT AAATAACATGAGATTCTGACTTCTTCTCTTCTCGTTACTGTTGTACTA TCTGGAAGTATGGTGGATAGCGGGGCAGGAACAGGGTGAACAGTTTA TCCTCTTTGGCAGGATCAATAGCTCATGCGGGGTGCTTCAGTAGATTT AAGAATTTTTTCTTCACTTAGCAGGAGTATCATCAATTTAGGGGCT GTAAACTTTATTACTACTGTAATAAATGCGTCCAGCAGGCCTAAGA CTAGAACGAATTCCTACTATTTGTATGGTCCGTGGCAATTACAGCATTAT TGTTGTTGTGTCTCTCCCCGTGTTAGCAGGGGCCATTACCATTGTATT AACTGATCGAAATTTAAATACATCGTTCTTTGACCCTGCTGGAGGGGG TGATCTATTTTATACCAACATT

Code	Locality	Barcode
17-1	Italy, Lombardy (Sondrio), Western Rhaetian Alps, Franscia, Lanzada, 1480 m, (46°17'21,4" N, 9°54'41,14" E), 22.VII.2019, Mario Grosser leg.	GACTTTGTATTTTTGTTTGGGGCATGATCTGGGATGATTGGTACCTCTCTTAGAATATTAATTCGAGCTGAGTTAGGTCACCCCGGAGCTTTAATTGGGGATGACCAAATTTATAATGTAATTGTAACAGCCACGCTTTTGTAATGATTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTGACTTGTGCCCTTGATACTAAGAGCCCCGGATATGGCTTTCCACGTTTAAATAACATGAGATTCTGACTTCTTCTCCTTCGTTACTGTTGTTACTATCTGGAAGTATGGTGGATAGCGGGGCAGGAACAGGGTGAACAGTTTATCCTCCTTTGGCAGGATCAATGGCTCATGCGGGTGCTTCAGTAGATTTAAGAATTTTTCTCTTCACTTAGCAGGAGTATCATCAATTTAGGGGCTGTAAACTTTATTACTACTGTAATAAACATGCGTCCAGCAGGCCAAGACTAGAACGAATTCACATTTTGTATGGTCCGTGGCAATTACAGCATTATGTTGTTGTTGTCTCTCCCGTGTTAGCAGGGGCCATTACCATATTATTAAGTATCGAAATTTAAATACATCGTTCTTTGACCCTGCTGGAGGGGGTGATCCTATTTTATACCAACATTT
17-2	Italy, Lombardy (Sondrio), Western Rhaetian Alps, Franscia, Lanzada, 1480 m, (46°17'21,4" N, 9°54'41,14" E), 22.VII.2019, Mario Grosser leg.	GACTTTGTATTTTTGTTTGGGGCATGATCTGGGATGATTGGTACCTCTCTTAGAATATTAATTCGAGCTGAGTTAGGTCACCCCGGAGCTTTAATTGGGGATGACCAAATTTATAATGTAATTGTAACAGCCACGCTTTTGTAATGATTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTGACTTGTGCCCTTGATACTAAGAGCCCCGGATATGGCTTTCCACGTTTAAATAACATGAGATTCTGACTTCTTCTCCTTCGTTACTGTTGTTACTATCTGGAAGTATGGTGGATAGCGGGGCAGGAACAGGGTGAACAGTTTATCCTCCTTTGGCAGGATCAATAGCTCATGCGGGTGCTTCCGTAGATTTAAGAATTTTTCTCTTCACTTAGCAGGAGTATCATCAATTTAGGGGCTGTAAACTTTATTACTACTGTAATAAACATGCGTCCAGCAGGCCAAGACTAGAACGAATTCACATTTTGTATGGTCCGTGGCAATTACAGCATTATGTTGTTGTTGTCTCTCCCGTGTTAGCAGGGGCCATTACCATATTCTTAAGTATCGAAATTTAAATACATCGTTCTTTGACCCTGCTGGAGGGGGTGATCCTATTTTATACCAACAAT
18	Italy, Lombardy (Sondrio), Western Rhaetian Alps, Franscia, Lanzada, 1480 m, (46°17'21,4" N, 9°54'41,14" E), 22.VII.2019, Mario Grosser leg.	GACTTTGTATTTTTGTTTGGGGCATGATCTGGGATGATTGGTACCTCTCTTAGAATATTAATTCGAGCTGAGTTAGGTCACCCCGGAGCTTTAATTGGGGATGACCAAATTTATAATGTAATTGTAACAGCCACGCTTTTGTAATGATTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTGACTTGTGCCCTTGATACTAAGAGCCCCGGATATGGCTTTCCACGTTTAAATAACATGAGATTCTGACTTCTTCTCCTTCGTTACTGTTGTTACTATCTGGAAGTATGGTGGATAGCGGGGCAGGAACAGGGTGAACAGTTTATCCTCCTTTGGCAGGATCCATAGCTCATGCGGGTGCTTCAGTAGATTTAAGAATTTTTCTCTTCACTTAGCAGGAGTATCATCAATTTAGGGGCTGTAAACTTTATTACTACTGTAATAAACATGCGTCCAGCAGGCCAAGACTAGAACGAATTCACATTTTGTATGGTCCGTGGCAATTACAGCATTATGTTGTTGTTGTCTCTCCCGTGTTAGCAGGGGCCATTACCATATTATTAAGTATCGAAATTTAAATACATCGTTCTTTGACCCTGCTGGAGGGGGTGATCCTATTTTATACCAACATTTGTTT
19	Italy, Lombardy (Sondrio), Western Rhaetian Alps, Franscia, Lanzada, 1480 m, (46°17'21,4" N, 9°54'41,14" E), 22.VII.2019, Mario Grosser leg.	GACTTTGTATTTTTGTTTGGGGCATGATCTGGGATGATTGGTACCTCTCTTAGAATATTAATTCGAGCTGAGTTAGGTCACCCCGGAGCTTTAATTGGGGATGACCAAATTTATAATGTAATTGTAACAGCCACGCTTTTGTAATGATTTTTTTATGGTTATACCTATTATAATTGGTGGTTTTGGTAATTGACTTGTGCCCTTGATACTAAGAGCCCCGGATATGGCTTTCCACGTTTAAATAACATGAGATTCTGACTTCTTCTCCTTCGTTACTGTTGTTACTATCTGGAAGTATGGTGGATAGCGGGGCAGGAACAGGGTGAACAGTTTATCCTCCTTTGGCAGGATCAATAGCTCATGCGGGTGCTTCAGTAGATTTAAGAATTTTTCTCTTCACTTAGCAGGAGTATCATCAATTTAGGGGCTGTAAACTTTATTACTACTGTAATAAACATGCGTCCAGCAGGCCAAGACTAGAACGAATTCACATTTTGTATGGTCCGTGGCAATTACAGCATTATGTTGTTGTTGTCTCTCCCGTGTTAGCAGGGGCCATTACCATATTATTAAGTATCGAAATTTAAATACATCGTTCTTTGACCCTGCTGGAGGGGGTGATCCTATTTTATACCAACATTTGTTT

Roberto BATTISTON* - Andrea MAURICI** - Paolo FONTANA***

New data on the distribution and ecology of the earwigs (Insecta, Dermaptera) of Kyrgyzstan

Abstract: An update on the dermapterofauna of Kyrgyzstan is presented. The distribution and ecology of *Oreasiobia fedtschenkoi* have been revised and the presence of *Anechura bipunctata* and *Labidura riparia* is reported for the first time in this country. The habitat, ecology and conservation of these species are discussed in the context of the Kyrgyz area and an identification key for the earwigs of Kyrgyzstan is included.

Riassunto: Nuovi dati sulla distribuzione ed ecologia delle Forficule (Insecta, Dermaptera) del Kyrgyzstan.

Viene presentato un aggiornamento sulla dermatterofauna del Kirghizistan. La distribuzione e l'ecologia di *Oreasiobia fedtschenkoi* sono state riviste e la presenza di *Anechura bipunctata* e *Labidura riparia* vengono segnalate per la prima volta in questo Paese. L'habitat, l'ecologia e la conservazione di queste specie sono discussi nel contesto dell'area del Kirghizistan e viene inclusa una chiave di identificazione per i dermatteri del Kirghizistan.

Key words: Dermaptera, taxonomy, ecology, distribution, conservation.

INTRODUCTION

Kyrgyzstan is a complex and diverse Country in its natural ecosystems, within the Central-Asian area, but still poorly known in its fauna and flora. About 94% of this Country is covered by mountains over 1000 m, and 40% of these peaks are 3000 m above sea level, with many glaciers, covering about 4% of the territory. Kyrgyzstan is however very rich in term of environments, ranging from semi-arid barelands to steppe foothills, mountain forests, sub-alpine and alpine meadows.

In this landscape earwigs are a neglected group of insects among the Kyrgyzstan fauna. At present only one species, *Oreasiobia fedtschenkoi* (de Saussure, 1874), is reported to be present in this country, though other species are reported for "Central Asia" or "Turkestan", a neighboring country with documented earwig diversity (Steinmann, 1989; Haas, 2019). Semenov-Tjan-Shanskij (1935) is the first to report the presence of earwigs in this area (*O. fedtschenkoi* cited for the "kirghis steppe"). Mistshenko (1937) presented the collecting records of

O. fedtschenkoi in Kyrgyzstan in the Osh region and in the valley of the river Gultsha (Alai range). One further record is from the valley of the river Kyzylsuu attributed at the time to the Kashgaria region, now inside the borders of Kyrgyzstan. Later, Sakai (1973) cites this species for Afghanistan, Dzungaria, Kyrgyzstan and Turkestan. *Oreasiobia fedtschenkoi* has subsequently been reported from the Alai valley and the Issik-Kul basin, as the only earwig species of this country in the modern catalogs and atlases of the fauna of Kyrgyzstan (Chelpakova *et al.*, 2011; Lazkov *et al.*, 2016). This information is supported by the main world catalogs of Dermaptera (Steinmann, 1989; Haas, 2019). It must be noted that a second species, *Forficula tomis* (Kolenati, 1846) has been historically reported for Northern Kyrgyzstan, in Tokmok and supposed to be present in the Tien-Shan mountains (Bey-Bienko, 1936) and it is generally reported for Transcaucasia in Steinmann (1989). This species is however not reported in more recent reports and its presence in Kyrgyzstan at present time should be confirmed.

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To date, there are no published specific investigations on this group of insects in Kyrgyzstan.

In the last two years two scientific expeditions: OS-Tianshanica-2018 and 2019, organized by the World Biodiversity Association and composed by different specialists and students, collected and produced new earwig material and information that increase our knowledge base and understanding of these insects.

This contribution is dedicated to Augusto Vigna Taglianti, extraordinary entomologist who extensively studied and improved the knowledge on Dermaptera, especially on high altitude populations, even in the most remote localities.

MATERIALS AND METHODS

During two scientific expedition in Kyrgyzstan (OS-Tianshanica 2018 and 2019) a total of fifteen earwig specimens were collected from different Kyrgyzstan localities, later mounted and examined following Fontana *et al.* (2002) and preserved in the entomological collections of the Museo di Archeologia e Scienze Naturali 'G. Zannato' (MCZ). The expeditions were conducted by car and horseback between the end of April and the beginning of May of both 2018 and 2019. Twenty collecting sites, representing differing environments and altitudes, were utilized to collect three species and update their distribution and male genital anatomy.

RESULTS

Labidura riparia (Pallas, 1773)

Forficula riparia Pallas, 1773

Forficula dentata Fabricius, 1775

Forficula pallipes Fabricius, 1775

Forficula maxima Villiers, 1780

Forficula bilineata Herbst, 1786

Forficula gigantea Fabricius, 1787

Forficula bidens Olivier, 1791

Forficula crenata Olivier, 1791

Forficula erythrocephala Fabricius, 1793

Forficula flavipes Fabricius, 1793

Forficula gigantea Fabricius, 1793

Forficula rufescens Palisot, 1805

Psalis morbida Audinet-Serville, 1831

Forficesila affinis Guérin-Méneville, 1836

Forficesila gigantea Burmeister, 1838

Forficesila suturalis Burmeister, 1838

Forficula bivittata Klug, 1838

Forficesila icterica Audinet-Serville, 1839

Forficesila terminalis Audinet-Serville, 1839

Forficula marginella Costa, 1839

Forficesila riparia Fischer, 1846

Forficula bicolor Motschulsky, 1846

Forficula fischeri Motschulsky, 1846

Forficula amurensis Motschulsky, 1858

Labidura bengalensis Dohrn, 1863

Labidura servillei Dohrn, 1863

Labidura auditor Scudder, 1878

Labidura clarki Kirby, 1891

Labidura granulosa Kirby, 1891

Labidura pluvialis Kirby, 1891

Labidura distincta Rodzianko, 1897

Labidura erythrocephala Bormans, 1900

Apterygida huseine Rehn, 1901

Labidura truncata Kirby, 1903

Labidura dubronyi Borg, 1904

Labidura karschi Borg, 1904

Tomopygia sinensis Burr, 1904

Labidura mongolica Rehn, 1905

Labidura confusa Capra, 1929

TYPE LOCALITY: Irtysh river.

DISTRIBUTION. Cosmopolitan. In Kyrgyzstan this species can be found on the shores of the lake Orto Tokoy in the Kochkor district.

SPECIMENS EXAMINED: Orto Tokoy (42°17'44" N, 75°56'36" E) 1729 m, 23.IV.2019, leg. OS-Tianshanica Team, Coll. MCZ, 3 males, 3 females. Several other specimens were observed in the area, with a high density and gregarious attitude, both as nesting couples or as single individuals, all adults (Figs. 1 and 2).

TAXONOMICAL AND ECOLOGICAL NOTES. This species was found in large numbers only on the shores of the Orto Tokoy, an artificial reservoir on the Chu River in an almost complete bare land (Fig. 3). Adult couples were found actively guarding their nests, often gregarious with other couples or singles. The gregariousness of this species is known to be low in laboratory conditions, if compared to other Dermaptera (Sauphanor & Sureau, 1993; Shepard *et al.*, 1973), and even lower during the adult and reproductive stage (Gomez & Kolliker, 2013) and it is practically unknown in nature. This species has been here observed to aggregate in high numbers

especially under abandoned tires (about 20 individuals were observed under the same tire; Fig. 1), a rather common waste along the roadside verges of Kyrgyzstan. The rubber of the tires may provide some thermal insulation to the extreme climate of this Country and promote aggregation, which may be lower in more temperate areas. Some groups of individuals have been however observed to occasionally aggregate also under wood and beach debris in other warmer regions (*e.g.* Southern Sicily, B. Massa pers. comm.) and this behavior may be more common than expected. This species has indeed a global distribution but is locally uncommon with fragmented populations.

Anechura bipunctata (Fabricius, 1781)

Forficula bipunctata Fabricius, 1781

Chelidura anthracina (Kolenati, 1846)

Anechura asiatica Semenov, 1903

Forficula biguttata (Fabricius, 1793)

Forficula fabricii (Fieber, 1853)

Anechura orientalis Krauss, 1900

TYPE LOCALITY: Italy

DISTRIBUTION. Central and East Europe; West and Central Asia. In Kyrgyzstan this species can be found in At-Bašy valley

SPECIMENS EXAMINED: At-Bašy valley (41°12'13"N; 75°45'28"E) 2018 m a.s.l., 28.IV.2019, leg. OS-Tianshanica Team, Coll. MCZ, 2 females, 2 juveniles (Fig. 4).

TAXONOMICAL AND ECOLOGICAL NOTES. This species was found in a single valley with a semi-desert environment (Figs. 3-8) and appears to prefer a warmer environment than other species in the Country. It must be noted that all the specimens collected have a black head and this character is usually referred to *Anechura asiatica* Semenov, 1903 (now in synonymy with *bipunctata*), in contrary to true *A. bipunctata* usually reported with a reddish head. While we respected here the synonymy, further investigations on these populations need to be done to confirm this taxonomy.

Oreasiobia fedtschenkoi (de Saussure, 1874)

Forficula fedtschenkoi de Saussure, 1874

Anechura fedtschenkoi Bormans & Krauss, 1900



Fig. 1. Male and female of *Labidura riparia* guarding their nest in early spring (left) and a single male resting under an abandoned tire in Orto Tokoy (right). Photo R. Battiston.

TYPE LOCALITY: Turkestan

DISTRIBUTION. Central Asia. In Kyrgyzstan this species is present in the Issyk-Kul area, the Alai Valley, in the Smaller Naryn River Valley, and near Kol Ukok lake. SPECIMENS EXAMINED: Kol Ukok lake (42°05'58.0"N 75°53'43.3"E) 3038 m, leg. R. Battiston, Coll. MCZ, 1 male; Smaller Naryn River (41°37'13"N, 76°26'35"E) 2429 m, 24.IV.2019, leg. OS-Tianshanica Team, Coll. MCZ, 2 males 2 females (Figs. 4 and 5).

TAXONOMICAL AND ECOLOGICAL NOTES. Adults of *Oreasiobia fedtschenkoi*, were found during the first OS-Tianshanica expedition in April, near Kol Ukok lake at 3,038 m above sea level in a typical high mountain environment (Fig. 3), with snow still present on the surrounding peaks. Other specimens were located in the Smaller Naryn valley along a riverbank in a snow-covered forest (Fig. 3). We presume this species has a large distribution in Kyrgyzstan. From a morphological point of view, it is interesting

to note that the peculiar shape in the apex of the central parameral plate of *Oreasiobia fedtschenkoi*, depicted



Fig. 2. Male terminalia of *Labidura riparia* from Orto Tokoy: genitalia (left) and supra genital plate (right). Scale bars: 1 mm.

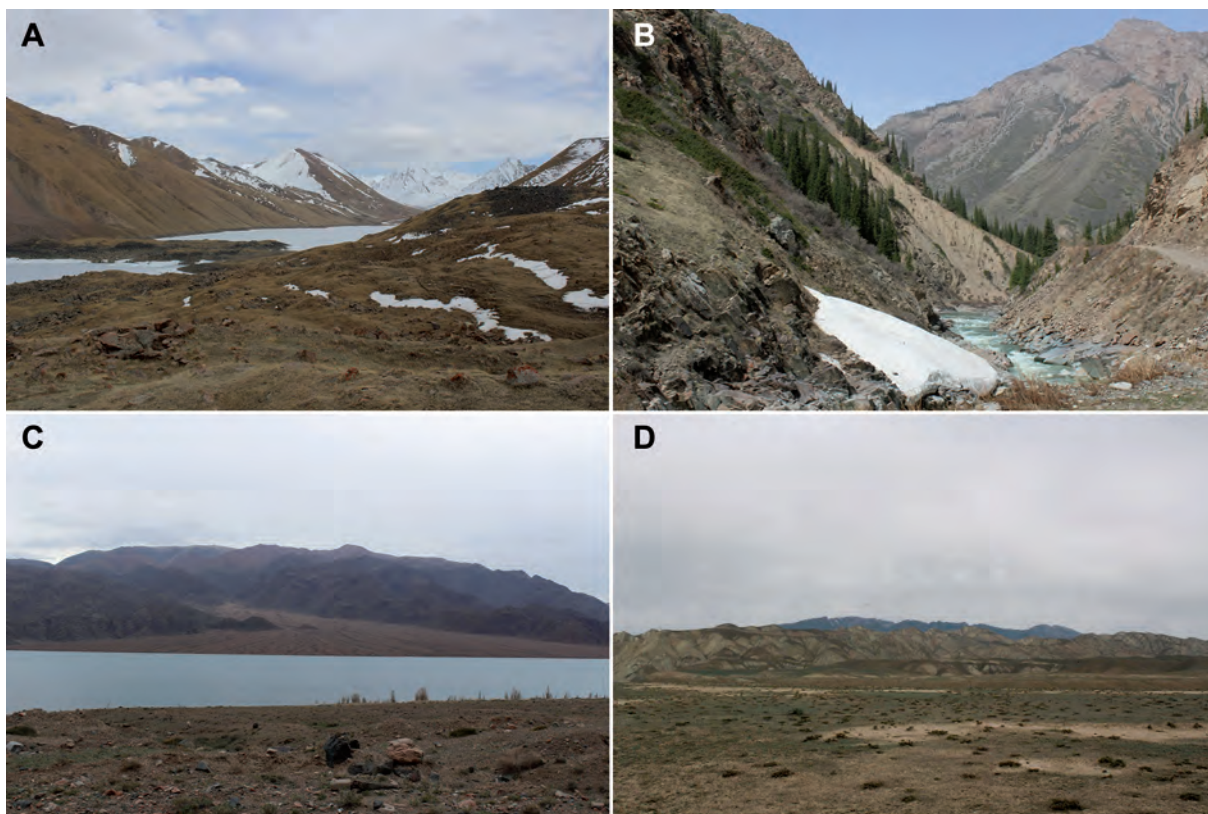


Fig. 3. Habitat of *Oreasiobia fedtschenkoi* (A - Kol Ukok: high mountain, B - Naryn: riverbank), *Labidura riparia* (C - Orto Tokoy: reservoir shores) and *Anechura bipunctata* (D - At-Bašy: semi-desert, bare-land). Photo R. Battiston.

by Steinmann (1989) is variable and can be both triangular or square (Fig. 6). At present, the genus *Oreasiobia* is composed by 6 different species (Hopkins *et al.*, 2021) and this variability should be considered in future taxonomical revisions and updates.

KEY TO THE DERMAPTERA OF KYRGYZSTAN

- 1 Antennae with more than 20 segments
.....*Labidura riparia*
- Antennae with less than 16 segments.....2
- 2 Presence of a white spot on each tegmina and each wing*Anechura bipunctata*
- Presence of a white spot only on each tegmina, wings not or barely visible when folded3



Fig. 4. Female of *Anechura bipunctata* over dry soil in the bare-land of the At-Bašy valley. Photo A. Maurici.

- 3 Proximal-inner side of the male cerci curved and smooth*Oreasiobia fedtschenkoi*
- Proximal-inner side of the male cerci straight and crenulated.....*Forficula tomis*

DISCUSSION

With an extreme continental climate and discontinuous presence of water, this Country is challenging for many species of insects. Despite the historical lack of knowledge, earwigs seem to survive well in this country with a number of species much greater than what previously reported but probably still reduced if compared to other warmer regions. As earwigs in Kyrgyzstan appear resistant to environmental extremes, their distribution may be wider than previously thought (Fig. 7) and historical records need to



Fig. 5. Male of *Oreasiobia fedtschenkoi* wandering over humid soil in the river banks of the Smaller Naryn River. Photo R. Battiston.

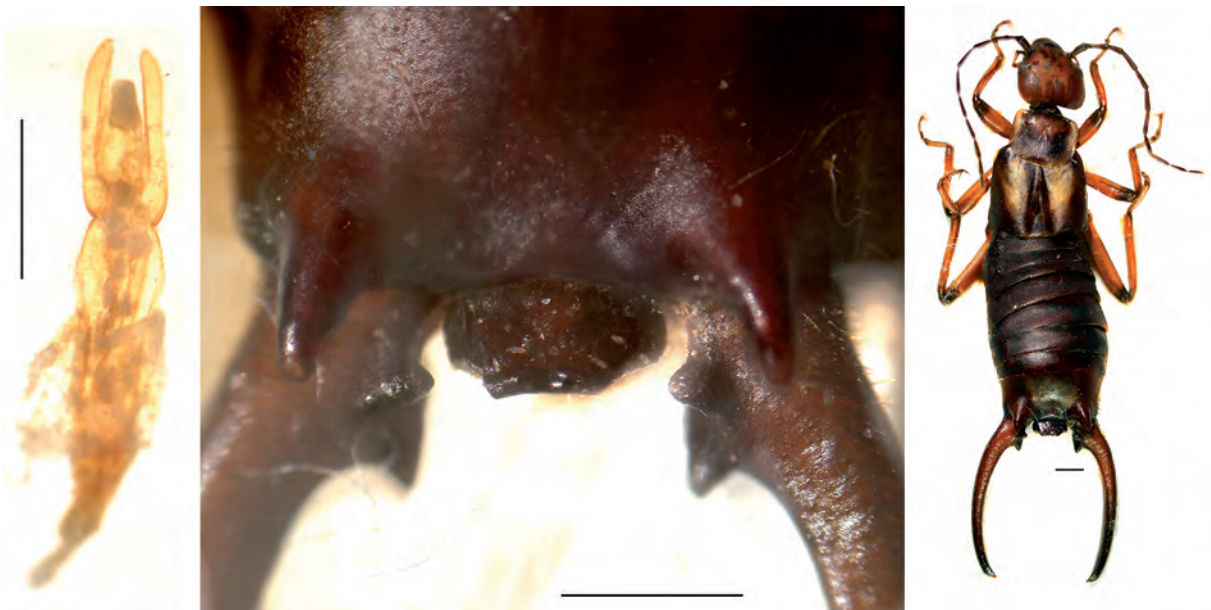


Fig. 6. Male terminalia of *Oreasiobia fedtschenkoi* from Naryn: genitalia (left), supra genital plate (center) and adult male habitus (right). Scale bars: 1 mm.



Fig. 7. Variability in the apex of the male genitalia of *Oreasiobia fedtschenkoi* in two Smaller Naryn River specimens from the same population (left and center), compared to Steinman, 1989 on the right. Scale bar: 1 mm.

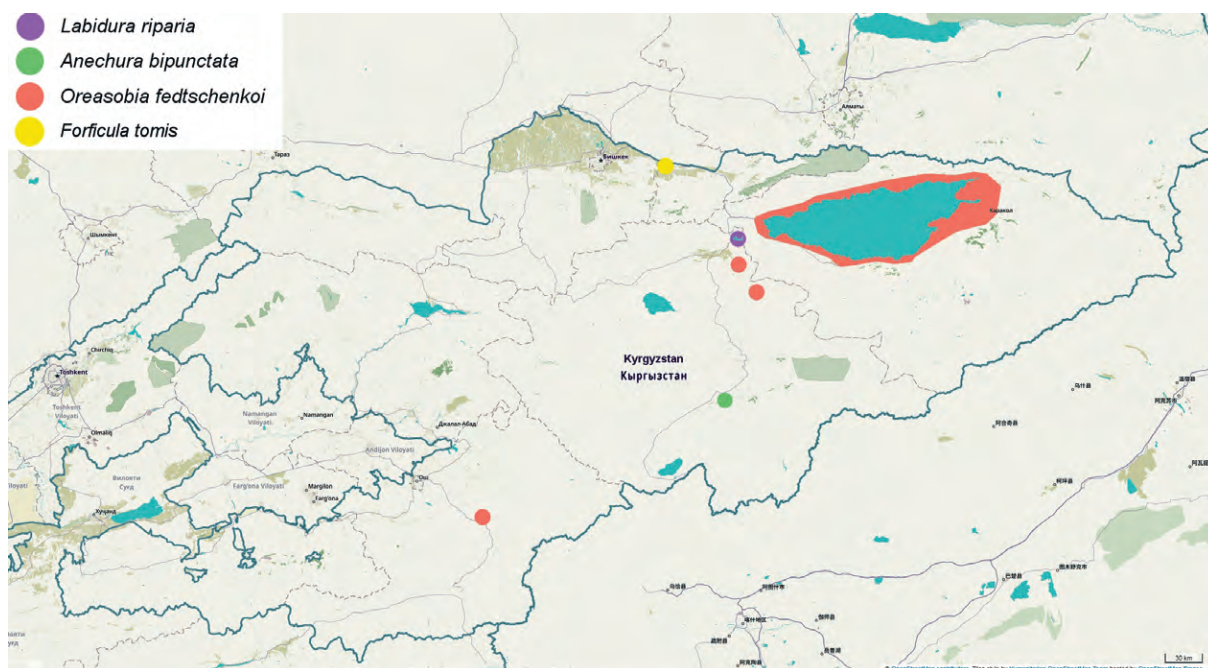


Fig. 8. Updated distribution of the earwig species in Kyrgyzstan with historical and new records. Base-map from the Humanitarian OpenStreetMap Team.

be confirmed, especially for *F. tomis* never encountered during these recent expeditions, but previously reported as abundant and wide spread (Bey-Bienko, 1936). Moreover, the apparent absence of *F. auricularia* Linnaeus, 1758 from Kyrgyzstan, a cosmopolit and adaptable species, usually common and already reported for Central Asia, need to be investigated. Further investigations are encouraged to better define the taxonomy, ecology and conservation of the dermapterofauna of Kyrgyzstan.

ACKNOWLEDGMENTS

This research is a result of the OS Tianshanica expeditions organized with the support of the World

Biodiversity Association. We would like to thank all its staff and in particular the leaders and members of the expedition: Rachele Amerini, Flavia Cerasti, Jennifer Pradelli, Luigi Quesada, Alberto Risato, Margherita Ruggeri, Angelo Todescan, Anna Todescan, Fosca Zannone, for their active help in the field surveys and collecting. We thank Tilek Zhetigenov and Baias Bakytbekov for their professional and kind logistical support in Kyrgyzstan, Evgeny Shcherbakov for his help with the Russian language and Gregory Lewbart for his linguistic revision, comments and advice on this manuscript. We are also grateful to Bruno Massa and Petr Kočárek for their valuable comments and contributions to this study.

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Fabio STOCH*

The legacy of Augusto Vigna Taglianti in amphipod taxonomy and biogeography

Abstract: The contribution to groundwater amphipod taxonomy and biogeography given by Augusto Vigna Taglianti is illustrated. Starting from his master thesis presented in Rome on the genus *Niphargus* under the supervision of prof. Sandro Ruffo, his passion for groundwater amphipods led him to publish several papers, describing 3 genera and 19 species new to Science. His hypothesis on the ancient origin of transadriatic distribution of niphargid amphipods were recently confirmed by sophisticated molecular methods and statistical historical biogeography. The paper is a tribute to Vigna Taglianti's memory and emphasizes his deep knowledge of our fauna, demonstrating the importance of his contribution to the development of current research activities on groundwater amphipod diversity.

Riassunto: *L'eredità di Augusto Vigna Taglianti nella tassonomia e biogeografia degli anfipodi.*

Viene illustrato il contributo fornito da Augusto Vigna Taglianti alla tassonomia e biogeografia degli anfipodi delle acque sotterranee. A partire dalla sua tesi presentata a Roma sul genere *Niphargus*, sotto la supervisione del prof. Sandro Ruffo, la sua passione per gli anfipodi sotterranei lo ha stimolato a scrivere numerosi articoli, descrivendo 3 generi e 19 specie nuove per la Scienza. La sua ipotesi sull'antica origine degli anfipodi Niphargidae a distribuzione transadriatica è stata di recente confermata con l'uso di sofisticate tecniche di biologia molecolare e di statistica applicate alla biogeografia storica. Il lavoro costituisce un omaggio alla memoria di Vigna Taglianti che mette in evidenza la sua profonda conoscenza della nostra fauna e dimostra l'importanza del suo contributo per lo sviluppo degli attuali filoni di ricerca sulla diversità degli anfipodi delle acque sotterranee.

Key words: Amphipoda, morphotaxonomy, biogeography, groundwater, transadriatic.

INTRODUCTION

The study of groundwater fauna has attracted the attention of zoologists during the past two centuries. Long considered devoid of life, groundwaters are now increasingly recognized for their unique and surprisingly biodiverse fauna. "Why did some taxa colonize the subterranean waters?" has been the main question since the mid-nineteenth century (Agassiz, 1851; see also Danielopol & Rouch, 1991). Groundwaters have long been considered a special, unfavourable environment, where few, highly specialized species took refuge, prisoners of their habitat (Danielopol, 1992). The answers to Agassiz's (1851) question gave rise to many debates (Stoch, 1995) and are still an object of active research using modern molecular techniques (Perez Moreno *et al.*, 2016).

The obligate groundwater dwelling organisms are named 'stygobionts' (from the mythical Styx, a river that forms the boundary between Earth and the Underworld), and their unusual adaptations and appearance has attracted the attention of zoologists and simple naturalists or observers. As pointed out by

Vigna Taglianti (1972a), the first citation of a groundwater, cave-dwelling animal is reported in an old book named "Descrittione di Tutta Italia", literally "Description of whole Italy" (Alberti, 1588) where the author, the friar Leandro Alberti, reported a letter, dated 5 March 1584 and written by Gian Giacomo Trissino from Vicenza, where some... "gambaretti picciolini simili a li gambarelli marini, chi si vendeno in Venetia" (i.e. "tiny shrimps similar to the marine shrimps sold in Venice") were reported for the groundwaters of the "Covale di Costozza" (i.e. the well known limestone quarry - 'covolo' - near Costozza, Berici Hills, Vicenza). Now the species (4 cm long) is known to be an amphipod crustacean, *Niphargus costozzae* (Schellenberg, 1935) (Fig. 1). It is not surprising this was the first subterranean organism that was observed.

Nowadays, it is well known that the groundwater-dwelling fauna is quite rich - see Botosaneanu's (1986) Stygofauna Mundi - and crustaceans represent by far the most diversified stygobitic taxon. Among them Amphipoda contribute about 21% of the overall groundwater species richness

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in European freshwaters with nearly 500 species (Zagmajster *et al.*, 2014); over 425 described species belong to the genus *Niphargus* (Horton *et al.*, 2019), distributed in the Western Palearctic. In Italy, Ruffo & Stoch (2007) reported 11 families, 17 genera and 94 morphospecies, and the genus *Niphargus* makes up for over 90% of all Italian groundwater amphipods.

Most of the taxonomic knowledge of groundwater amphipods of Italy is due to the work of Sandro Ruffo (1915-2010), who pointed out the extraordinary complexity in defining species and their relationships, especially in the rich genus *Niphargus*. For this reason, it is not surprising that Augusto Vigna Taglianti (1943-2019), one of his students (as he liked to call himself for a lifetime) was attracted by the morphology, taxonomy and biogeography of this taxon. Vigna Taglianti, generally remembered for his entomological papers (see Carpaneto *et al.*, 2019 for a complete bibliography), graduated in Natural Sciences in 1966 at the University of Rome 'La Sapienza' discussing a thesis on "Systematics, zoogeography and ecology of the genus *Niphargus* (Crustacea,

Amphipoda)". The passion for groundwater amphipods accompanied Vigna Taglianti for the rest of his career. Since he was young, he was interested in speleology and later in biospeleology, participating to the activities of the speleological societies in Italy, and exploring later the karstic areas of Slovenia, Dalmatia, and Herzegovina (in 1968, defined "a wonderful journey of about a month, through immense caves rich in fauna": Vigna Taglianti, 2011). From the Dinaric Karst he came back with a rich and extraordinary collection of niphargids. The biospeleological research, intensive in the Apennines and in Sardinia, was extended later especially to other Mediterranean countries and the Near East. After his thesis, he published 19 papers dealing with the taxonomy and biogeography of amphipods, in addition to the numerous faunal data present in his biospeleological publications, especially the monumental work of the cave fauna of the Ligurian Alps (Bologna & Vigna Taglianti, 1985).

Given the important contribution to the knowledge of groundwater amphipods of Vigna Taglianti, it is not surprising that his ideas have shaped



Fig. 1. The cover of the volume by Alberti (1588) where the first citation of a groundwater animal is reported, and the habitus of *Niphargus costozzae* from Berici Hills, Vicenza (photo F. Stoch).

our taxonomic, faunal and biogeographical vision of this interesting taxon, especially in Italy and the Mediterranean areas. Some of the hypothesis conceived by Vigna Taglianti with traditional morpho-taxonomical methods deserve attention, considering they were recently tested using modern molecular techniques (Delić *et al.*, 2019; Stoch *et al.*, 2020). In this paper, which aims to be a tribute to his stimulating ideas, two main topics will be discussed: (i) the taxonomic relationships between morphospecies in the context of Italian fauna and its origin, and (ii) the problem of the existence of transadriatic clades and their biogeographical explanation.

MORPHOTAXONOMY

The thesis of Augusto Vigna Taglianti on niphargid amphipods (1966) began as a simple proposal to study the groundwater fauna of Latium. As Vigna Taglianti (2011) himself wrote, when he went to the Natural History Museum in Verona, he was then an internal student at the Institute of Zoology of the University of Rome, and he was holding a letter of introduction for “the Professor” [Sandro Ruffo] prepared by Emilia Stella, a well-known hydrobiologist specialized in copepods, supervisor of his degree thesis. The subject of the thesis was the groundwater fauna of Latium, but after the meeting with Ruffo the target was transformed into the study of a difficult genus of groundwater amphipods, the genus *Niphargus*, in an attempt to solve some taxonomic and biogeographical problems he soon encountered. Sandro Ruffo helped him to write his first papers, which Ruffo immediately wanted to be published with Augusto as the single author: the collaborative papers came later, when he had achieved a certain autonomy of research on groundwater amphipods (Vigna Taglianti, 2011).

Some years later, in 1969, he compiled an extensive catalogue (unpublished) of the *Niphargus* collection (‘pompously’, as he said, named Ruffo-Vigna *Niphargus* collection: Vigna Taglianti, 2011) entitled [English translation] “List of the material of the genera of the *Niphargus* group existing in the Ruffo - Vigna Taglianti collection in the Civic Museum of Natural History of Verona” (Appendix 1). This catalogue was the basis for the extensive checklist and the distributional database of the Italian amphipods of the genus *Niphargus* (Ruffo & Stoch, 2007).

Successively, he participated to the “1er

Colloque international sur le genre *Niphargus*”, held in Verona in 1969, presenting a communication (Vigna Taglianti, 1972a) entitled [English translation] “Current knowledge on the genus *Niphargus* in Italy”, which was the first attempt to attribute the species known from Italy to the “species groups” following the awesome work by Straškraba (1972). The paper is still a useful overview of the complexity of the *Niphargus* fauna from Italy; unfortunately, the difficulties in establishing species affinities based on variable morphological characters prevented him to create monophyletic groups, albeit some of these are now recognized as important clades. The problems of exhaustively reviewing the taxonomy of the genus in Italy were partly due to the scarcity of material collected and the incompleteness of the knowledge of actual species richness. Most *Niphargus* species have restricted distribution ranges (Trontelj *et al.*, 2009), sometimes known from single or few localities, and caves and other subterranean habitats are difficult to explore. Moreover, the use of morphological characters in *Niphargus* is unsatisfactory and misleading (Fišer *et al.*, 2008): morphocharacters are highly homoplastic (Fišer *et al.*, 2008, 2010), and pedomorphosis is a widespread phenomenon; moreover, differences between species are quite weak, while intraspecific variation sometimes is high or unknown. These problems, already pointed out in the monograph by D’Ancona (1942), are still a problem in niphargid taxonomy. Some results of the study are still valid, some other questionable, but several affinities remain unknown. For example, Vigna Taglianti (1972a) pointed out some affinities (the group *pedemontanus* Ruffo, 1937 - *speziae* Schellenberg, 1936 - *romuleus* Vigna Taglianti, 1968) which in part still holds, being widely distributed along the Apennines, the Tuscan Archipelago, and Latium, albeit the supposed affinities with *Niphargus tatrensis* Wrzesniowski, 1888 and *N. stygius* (Schjødte, 1849) were discarded using molecular techniques (Stoch *et al.*, 2020).

The difficulties of nomenclature allowed successively the splitting and clumping of species in a chaotic way. Karaman (1993), in his volume of “Fauna d’Italia” on freshwater amphipods, clumped together several species described by Vigna Taglianti in a way that he defined “irrational” (Vigna Taglianti, pers. comm., 1994). For example, Karaman considered under the name of *Niphargus stygius*, described from Slovenian caves, all Italian Pre-Alpine and Apenninic species (including *N.*

romuleus described by Vigna Taglianti, 1968), completely upsetting the biogeographical picture assembled with meticulousness by Vigna Taglianti (1972a). A further questionable point was the division of another well-defined species, *N. pasquinii* Vigna Taglianti, 1966 described from karstic springs (Peschiera, San Vittorino) in Latium, attributing part of the specimens of its populations to the Central European *Niphargus puteanus* (Koch, 1836), which is a biogeographical puzzle. More recent papers based both on morphotaxonomy (Stoch, 1998) and on molecular markers (Stoch *et al.*, 2020) challenged these ideas, allowing these authors to raise back to species rank the taxa of the *Niphargus stygius* complex, including those described by Vigna Taglianti (1966b, 1968).

In his papers published during his long career,

Vigna Taglianti did not only deal with the taxonomy of *Niphargus*; a paper is dedicated to the relictual distribution of a surface gammarid amphipod in Alpine and Apenninic lakes (Iannilli *et al.*, 2005), while several papers are important faunal lists of Italian niphargids in central Italy (Vigna Taglianti, 1966a, 1976; Pesce & Vigna Taglianti, 1975; Ruffo & Vigna Taglianti, 1967). In his taxonomic papers he described (Tab. 1) three new genera (*Ilvanella* from Italy: Vigna Taglianti, 1972b; *Gammaropisa* and *Parhadzia* from Anatolia: Ruffo & Vigna Taglianti, 1988; Vigna Taglianti, 1988) and 19 new species (9 Bogidiellidae, 1 Gammaridae, 2 Hadziidae, 6 Niphargidae, and 1 Ingolfiellidae - now considered a member of the order Ingolfiellida: Lowry & Myers, 2017). Eleven stemmed from the Mediterranean countries (Fig. 2), while eight species of

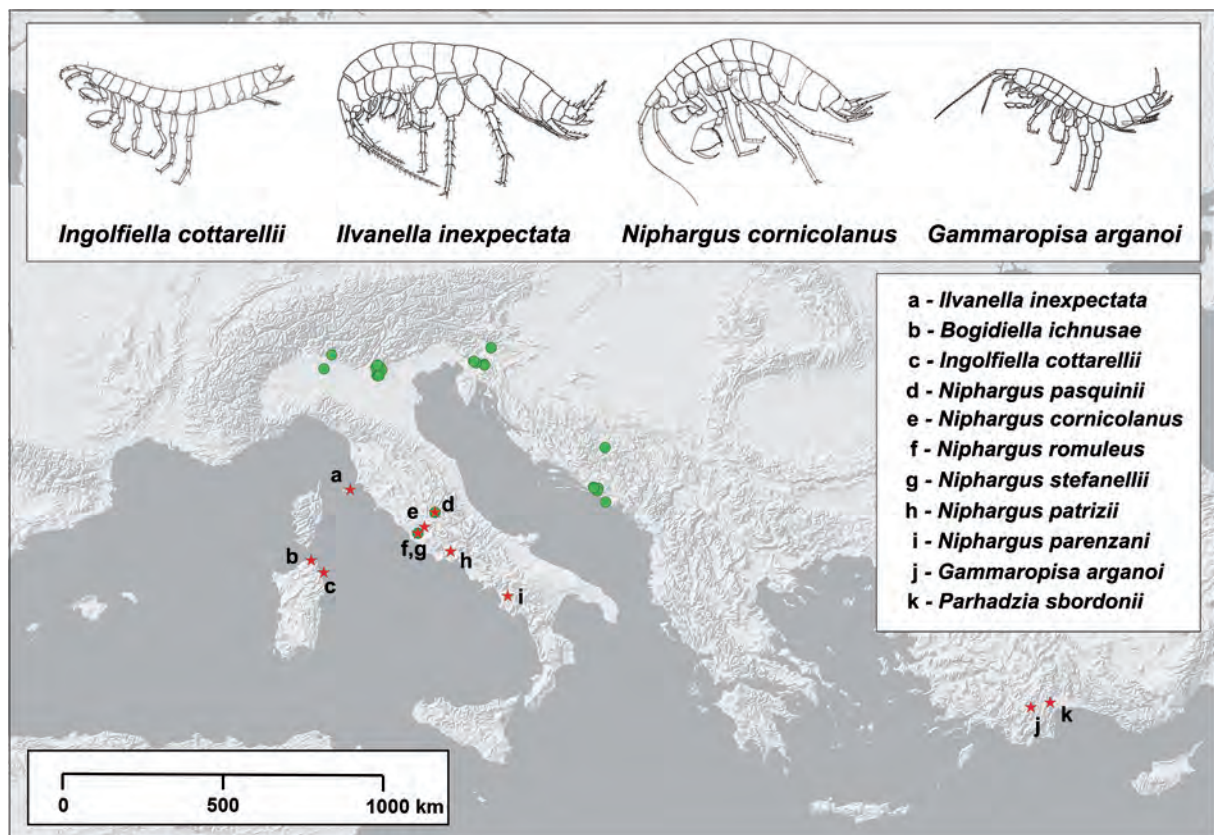


Fig. 2. Map of the sites where Augusto Vigna Taglianti collected amphipods (dots) or described new species (stars). Samples of *Niphargus* were collected in the period 1966-1969 in Italy and in 1968 in Slovenia and Bosnia Hercegovina (only a single further sample was collected in Grotta dei Damati near Verona in 1978). The described species (the habitus of some of them is reported in the upper part of the map) belong to different families (see Tab.1).

Tab. 1. Species of Amphipoda (including the recently established order Ingolfiellida) described by Augusto Vigna Taglianti. For each species the current binomial, the name used in the description, the type locality (country, site and habitat of origin), and the reference are reported. (*) The subspecies described up to now deserve species rank; (**) the family allocation of *Gammaropisa* is still uncertain, and no DNA sequences are available, considering it was never recollected.

Species	Synonym	Country	Type locality	Reference
Order AMPHIPODA				
Family Bogidiellidae				
<i>Arganogidiella arganoi</i>	<i>Bogidiella arganoi</i>	Mexico	Veracruz, Cordoba, Paraje Nuevo (well)	Ruffo & Vigna Taglianti, 1973
<i>Bogidiella ichnusae</i> (*)		Italy	Sardinia, Sassari, River Liscia (interstitial)	Ruffo & Vigna Taglianti, 1975
<i>Bogidiella michaelae</i>		Mexico	Oaxaca, Etla (well)	Ruffo & Vigna Taglianti, 1977
<i>Bogidiella niphargoides</i>		Mexico	Oaxaca, Etla (well)	Ruffo & Vigna Taglianti, 1977
<i>Bogidiella vomeroi</i>		Mexico	Chiapas, Sitalà, Cueva de Chanchanaptic	Ruffo & Vigna Taglianti, 1977
<i>Guagidiella holsingeri</i>	<i>Bogidiella holsingeri</i>	Guatemala	Alta Verapaz, Senahu, Cueva Seamay	Ruffo & Vigna Taglianti, 1973
<i>Guagidiella pasquinii</i>	<i>Bogidiella pasquinii</i>	Guatemala	Huehuetenango, S. Eulalia, Cueva de los Resadores	Ruffo & Vigna Taglianti, 1977
<i>Mexigidiella sbordonii</i>	<i>Bogidiella sbordonii</i>	Mexico	Chiapas, Ocozocautla, Cueva de Cerro Brujo	Ruffo & Vigna Taglianti, 1973
<i>Orchestigidiella orchestipes</i>	<i>Bogidiella orchestipes</i>	Mexico	Chiapas, San Cristobal de las Casas (well)	Ruffo & Vigna Taglianti, 1977
Family Gammaridae				
<i>Ilvanella inexpectata</i>		Italy	Tuscany, Elba Island, Bagnaia (interstitial)	Vigna Taglianti, 1972b
Family Hadziidae				
<i>Gammaropisa arganoi</i> (**)		Turkey	Antalya, Kizilcadağ (well)	Ruffo & Vigna Taglianti, 1988
<i>Parhadzia shordonii</i>		Turkey	Antalya, Doşemealti, Mustan Ini cave	Vigna Taglianti, 1988
Family Niphargidae				
<i>Niphargus cornicolanus</i>		Italy	Latium, Sant'Angelo Romano, Pozzo del Merro	Iannilli & Vigna Taglianti, 2005
<i>Niphargus parenzani</i>	<i>Niphargus orcinus parenzani</i>	Italy	Campania, Alburni Mountains, Cave of Castelvica	Ruffo & Vigna Taglianti, 1968
<i>Niphargus pasquinii</i> (*)	<i>Niphargus elegans pasquinii</i>	Italy	Latium, Cittaducale, Spring of San Vittorino	Vigna Taglianti, 1966b
<i>Niphargus patrizii</i>	<i>Niphargus orcinus patrizii</i>	Italy	Latium, Ausoni Mountains, Cave of Pastena	Ruffo & Vigna Taglianti, 1968
<i>Niphargus romuleus</i>		Italy	Latium, Roma, Foro Romano (wells)	Vigna Taglianti, 1968
<i>Niphargus stefanellii</i>		Italy	Latium, Roma, Foro Romano (wells)	Ruffo & Vigna Taglianti, 1968
Order INGOLFIELLIDA				
Family Ingolfiellidae				
<i>Ingolfiella cottarellii</i>		Italy	Sardinia, Tavolara Island, Grotta del Papa	Ruffo & Vigna Taglianti, 1989

Bogidiellidae were described on material collected by his friends from Mexico and Guatemala (Ruffo & Vigna Taglianti, 1973, 1977).

BIOGEOGRAPHY

Although the biogeographical interest of Vigna Taglianti concentrated on the definition of chorotypes (Vigna Taglianti *et al.*, 1993, 1999), from a point of view of amphipod research the most important studies were dedicated to the problem of the so called ‘transadriatic’ species.

Species distributed on both sides of the Adriatic Sea are well known and quite well documented especially in the entomological literature. Gridelli (1950) published the first revisory work, entitled [English translation] “The problem of species with current transadriatic distribution with particular reference to Coleoptera”. The main explanation of this pattern was found in the level fluctuations of the Adriatic Sea during Pleistocene glaciations. However, Gridelli admitted that some disjunct distribution patterns required a more ancient, Miocenic, sea regression, and due to the ancient name of the ‘Aegean plate’, these more ancient species were called ‘paleo-Aegean’.

However, the discovery of the presence of morphologically similar, obligate subterranean amphipods along the Dinaric Karst as well as along peninsular Italy is quite surprising due to their low dispersal ability. This was noticed by Ruffo & Vigna Taglianti (1967, 1968) for the “*Niphargus* (*Orniphargus*) *orcinus*” complex (*Niphargus orcinus* Joseph, 1869 is a stout species inhabiting caves in the Dinaric Karst in Slovenia and northeastern Italy). Ruffo & Vigna Taglianti (1968) described two subspecies of *N. orcinus* from Italy, namely *N. orcinus patrizii* (from a cave on Ausoni Mts., Latium) and *N. orcinus parenzani* (from Alburni karstic massif, Campania) and considered *N. orcinus* as a ‘paleo-Aegean’ transadriatic species sensu Gridelli (1950). Moreover, they described a third representative of the same group from the groundwaters of Rome, *N. stefanellii*, remarking its affinities with other Dinaric species, especially with *N. hebereri* Schellenberg, 1933. More recently, Iannilli & Vigna Taglianti (2005) described a further member of the same group (reported dubitatively as *N. orcinus parenzani* in the previous paper), *N. cornicolanus*, from the deep sinkhole named Pozzo del Merro (Cornicolani Mts.,

near Rome). It is quite surprising that all these taxa with Dinaric affinities are distributed near the Thyrrhenian coast, and not along the Adriatic coast, where only a further species of the same group (i.e., *N. ictus* Karaman, 1985) was described from Frasassi caves (Marche region) (Fig. 3).

Members of the obsolete sugenus *Orniphargus* S. Karaman, 1950 are specialized dwellers inhabiting the phreatic karstic zones, usually with small distribution ranges both in the Dinaric and in the Apenninic karst, which implies their poor dispersal abilities. How these ecologically specialized species live on both sides of the Adriatic Sea and along the Thyrrhenian coast is an intriguing question that can be framed within at least three testable scenarios: (i) convergence (i.e. Dinaric and Italic species are phylogenetically unrelated and attained their morphological similarity convergently); (ii) vicariance (Italo-Dinaric species share widespread ancestors which broad areal was split by the Adriatic Sea), and (iii) dispersal (the clades originated on only one peninsula and dispersed across the Adriatic basin during marine regressions, from Messinian to later Pleistocene glaciations).

In a recent paper dedicated to the memory of Augusto Vigna Taglianti (Delić *et al.*, 2019), we tested the above-mentioned hypotheses. The taxonomic structure of the species group was revised using unilocus species delimitation methods using several molecular markers, and the timeframe of cladogenetic events was inferred using a multi-locus time-calibrated phylogeny. The geographical origin of the studied clade as well as dispersal and vicariance events were assessed through sophisticated statistical models of historical biogeography. The results of this study may be summarized as follows: (i) the transadriatic species of *Niphargus* form a monophyletic unit which does not include *N. orcinus* (i.e. the species *N. orcinus* sensu Ruffo & Vigna Taglianti, 1968, is paraphyletic); (ii) the reconstructions of ancestral ranges suggest that the clade emerged in the Balkan Peninsula, dispersed three times independently to the Apennine Peninsula and once back to the Balkans; (iii) the dispersal–vicariance events correspond to historical regression–transgression cycles during Miocene.

Already Flot & Stoch (2011) suggested that the large species aggregate *N. hebereri*–*N. ictus*–*N. stefanellii* is composed of several cryptic species.

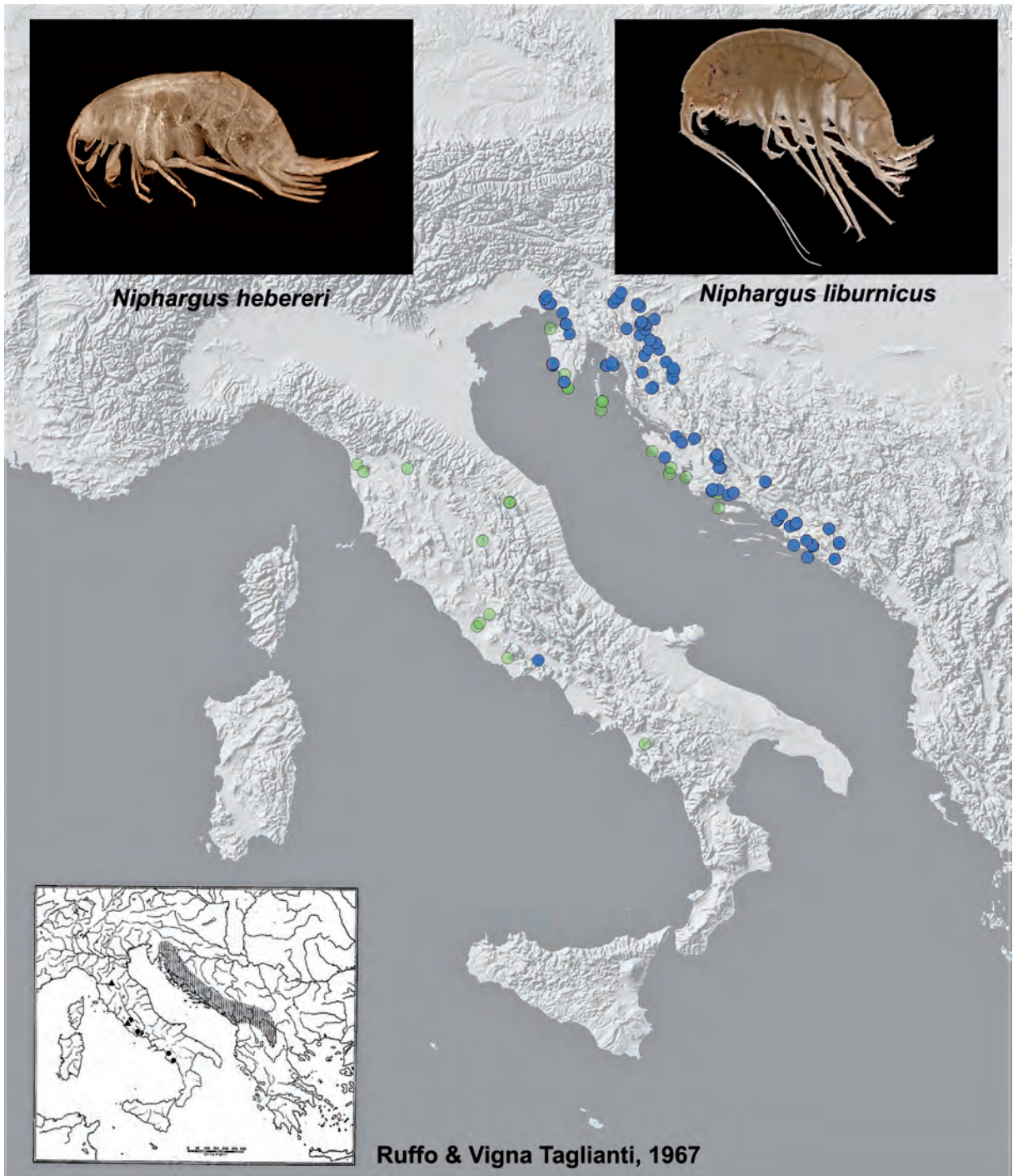


Fig. 3. The transadriatic distribution in two clades of the genus *Niphargus*, the *N. hebereri* clade (green dots) and the *Niphargus steueri* clade (blue dots); the habitus of two representatives of these clades is illustrated (photos F. Stoch). The small map in the lower left corner reports the reconstruction of the species ranges known in 1967, which allowed Ruffo and Vigna Taglianti to develop the theory of the paleo-Aegean Italian endemics.

More recent molecular research revealed that further species in peninsular Italy (*N. cornicolanus* from Latium and *N. parenzani* from Campania) belong to this species aggregate. On the Dinaric side, this clade includes also several species of the *N. steueri* complex: *N. patrizii* is the only Italian species that belongs to the *N. steueri* subclade.

The first two hypotheses, viz. convergence and vicariance, were thus definitively rejected. The age of the common ancestor of the transadriatic clade was dated to the late Oligocene – early Miocene, with a mean estimate of 24 Ma, and the earliest splits took place between 10 and 20 Ma. The ancestor of the *N. hebereri* – *N. ictus* clade split from its Dinaric relatives approximately 14 Ma. Somewhat younger (11 Ma) was the split between the *N. steueri* complex and *N. patrizii*. Later on, during the Messinian Salinity Crisis, the *N. hebereri* clade split from *N. ictus*.

During Pleistocene glaciations, several times the sea level lowered over 100 m, and the Adriatic coast moved southwards favouring faunal exchanges. However, Delić *et al.* (2019) definitively ruled out the recent origin of the Italian transadriatic elements, favouring the hypothesis proposed by Ruffo & Vigna Taglianti (1967). Although Ruffo & Vigna Taglianti (1967) were not able to separate clearly the Italian species from the Balkan ones on a morphological basis, their hypothesis received a strong support: the actual distribution of transadriatic niphargid faunas apparently reflects old biogeographical event, and our endemics correspond to their old-fashioned definition of ‘paleo-Aegean’ species.

CONCLUSIONS

As Augusto Vigna Taglianti wrote in a recent tribute to Sandro Ruffo (Vigna Taglianti, 2011), he was all the life very proud of those periods in which he worked side by side with his mentor in the Verona museum and on “their” collection, starting with the synthesis of the fauna of Italian *Niphargus*, and then studying other groundwater amphipods, but occasionally

coming back to the beloved *Niphargus*. However, he was left with the impression that Ruffo, while pushing him to continue the study of carabid beetles, basically never forgave him for having “betrayed” the amphipods, neglecting their study in favor of the most diversified insects (Vigna Taglianti, 2011).

Most of Vigna Taglianti’s papers are dedicated to carabid beetles or are contributions to the knowledge of Italian Dermaptera and mammals (see the exhaustive list in Carpaneto *et al.*, 2019), nevertheless his minor production with Ruffo on taxonomy and biogeography of Amphipods represents a groundwork for modern research and depicts a scenario which is now being tested using the advanced molecular techniques currently available.

After his thesis, (i) the huge amount of new amphipod species described, (ii) the first attempt of a coarse subdivision of Italian niphargids in species groups, and (iii) the biogeographical hypotheses postulated in his papers make his contribution to amphipodology of paramount importance for current research. In an era where molecular barcoding and ‘big questions’ are becoming the only important fields of study (the so-called era of ‘speleogenomics’: Perez Moreno *et al.*, 2016), and taxonomy is losing its importance as a ‘Science’ (Hopkins & Freckleton, 2002), I cannot forget that all the research I am currently carrying out was made possible by the studies of this old-fashioned naturalist, by his teachings and the discussions during my visits to his laboratory or the collaboration in systematising the chorotypes of the Italian fauna (Stoch & Vigna Taglianti, 2007). The present paper is a tribute to his knowledge of groundwater amphipods, but, especially, to his deep fondness for our fauna and of what we call today, in a much more resounding way, biodiversity.

ACKNOWLEDGEMENTS

The author is indebted to dr. Pier Mauro Giachino for his help, encouragement and support in writing this article.

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APPENDIX 1

LISTA DEL MATERIALE DEI GENERI DEL GRUPPO NIPHARGUS ESISTENTE NELLA COLLEZIONE
RUFFO - VIGNA TAGLIANTI NEL MUSEO CIVICO DI STORIA NATURALE DI VERONA. IX.1969

- Niphargellus arndti (Schellenberg). - Cecoslovacchia. Praga. Straskraba leg. 9 es.
- Cecoslovacchia. Kralický Sněžník, spring. 7.1961. Straskraba. 6 es.
- Niphargus angelieri Ruffo. - Le Boulou (Pyr. Or.) 23.XI.1950. E. Angelier leg. 7 es. (cotypi)
prep. 9-12
- Baillaurie (Banyuls sur Mer). 23.XI.1950. E. Angelier leg. 1 es.
- La Raillère (Amélie-les-Bains). 20.X.1950. E. Angelier leg. 2 es.
- Pont du Boulou (Pyr. or.). 5.III.1952. C. Delamare leg. prep. 13+14
- apuanus Ruffo. - Grotta Ventaiola. C. Mancini leg. 1 es. parz. dissez. (Typus)
- aguilex Schiötte. - Cecoslovacchia. Praga. pozzi. 7.2.1953. Straskraba. 9 es.
- Southampton a Bornemonth. Ober water, u silnise mezi
9.7.1964. Straskraba. 7 es.
- balcanicus (Absolon). - Popovo Polje. Zavala. Pečina Vjetrenica. ramo inf.
25.X.1968. A.e G. Vigna leg. 1 es.
- Popovo Polje. Strujici. Baba pečina. 23.X.1968. A.e G. Vigna. 3 es.
- boskovici Karaman. - Popovo Polje. Zavala. Pečina Bjelusica.
22.X.1968. A.e G. Vigna leg. 50 es.
- brixianus Ruffo. - Grotta di Val Mala 141 Lo. 1 es. (Typus)
- Brescia. Val Trompia. Caja di Valmala. 25.VI.1960. 5 es.
- Caja di Val Mala 141 Lo. 21.2.1939. M. Pavan leg. 1 es.
- costozzae Schellenberg. - Lumignano. IX.1941. Benedetti leg. (?) ex coll. D'Ancona. moltissimi
- Covoio della Guerra. 9.X.1938. Anelli leg. " 2 es.
- Grotta della Guerra. 30.X.1914. C. Menozzi leg. " 3 es.
- Covoio della Guerra. 22.XII.1967. L. Boscolo leg. 20 es.
- Covoio della Guerra. 23.II.1965. L. Boscolo leg. 11 es.

- costozzae Schellenberg. -Covolo della Guerra.14.V.1953.S.Ruffo leg. molti es.
 -Covolo della Guerra.16.X.1955.E.Busulini leg. 10 es.
 -Covolo della Guerra.22.V.1937.L.Boldori leg. 3 es.
 -Covolo della Guerra.17.IV.1937 molti es.
 -Grotta della Guerra.G.G.Trevisiol (Vicenza) leg. 19 es.
 -Grotta della Guerra.BS/II.G.G.Trevisiol leg. 1 es.
 -Covolo di Costozza. prep.250-251
 -Grotta Mulini di Alonte.24.IX.1961.Bartolomei leg. 3 es.
 -Grotta del Subiolo.Vicenza.16.VI.1938.Trevisiol leg. 1 es.
 -I Buso de Sarcedo.Vicenza.3.VII.1966.M.Paoletti leg. 4 es.
 • d'anconae Karaman. -Gerchia(UD).Mainarie dal Puint.28.IX.1955.E.Busulini leg. 2 es.
 (omonimo. probabilmente -Tarcento(UD).Grotta Nuova di Villanova.
=dolenianensis Lorenzi) 11.XI.1949.E.Busulini leg. molti
 id. 6.VII.1952.Dell'Oca leg. vari
 - id. 15.I.1950.E.Busulini leg. molti
d'anconai Benedetti. -(Verona)Duomo.1940-41.ex coll.D'Ancona vari es.
 -(Verona)Via Pigna.1940-41. " vari es.
 -(Verona)Poli.Guarienti.1940 " 1 es.
delamarei Ruffo. +Baillaurie.Banyuls sur Mer.10.XI.1950.Angelier. 9 es.(cotypi)
 prep.1-4
 -Baillaurie.Banyuls.(Pyr.or.).23.XI.1950.Angelier. 3 es.
 -La Raillère.Amélie-les-Bains.20.X.1950.E.Angelier. 1 es.
 -Pont du Boulou(Pyr.or.).5.III.1953.C.Delamare. prep.5-7
elegans Garbini. -Brusegana III.XI.1939.Benedetti leg.(?).ex Coll.D'Ancona 29 es.
 -Ponte S.Niccolò.IV.1940. " " 8 es.
 -Montà.II.1940. " " 12 + 8 + 3 es.
 -Abano T. IV.1941. " " 30 + 11 + 11 es.
-
- elegans Garbini. -Brusegana I-II.XI.1939.Benedetti leg.(?).ex Coll.D'Ancona. 17 es.
 -Brusegana I. XI.1939. " " 2 + 25 es.
 -S.Maria di Zevio.VIII.1940. " " 14 es.
 -Tegghi PD. VII.1941. " " 11 es.
 -Altichiero Padova.II.1940. " " 7 es.
 -S.Michele.S.Giov.Sup.VIII.1940 " " 11 es.
 -Guaina(S.Martino B.A.).VIII.1940. " " 19 es.
 -Brusegana III. II.1940. " " 43 es.
 -Tre Ponti,Luvigliano.(Fontana .VII.1941 " " 32 es.
 -Asigliano.S.Andrea di Cologna Vn.VII.1941. " " 1 es.
 -Contrada dei disturbi.Agugliano.VII.1941. " " 27 es.
 -Brusegana II. II.1940. " " 44 es.
 -Mandriola Pd.IV.1940. " " 8 es.
 -S.Michele Extra.VIII.1940. " " 38 es.
 -Fontana in Torreglia.VIII.1941. " " 58 es.
 -Altichiero.II.1940. " " 18 es.
 -S.Lazzaro.IV.1940. " " 4 es.
 -I fontana in Torreglia.VIII.1941. " " 33 es.
 -Fontana in Sorza.VII.1941. " " 17 es.
 -Pozzo S.Quirico.VII.1941. " " 8 es.
 -Sile. VII.1941. " " 18 es.
 -II Pozzo di Caldogno.IX.1941. " " 13 es.
 -S.Martino B.A. VIII.1940. " " 41 es.
 -Fontana sotto S.Giorgio in Salici.VII.1941 " " 72 es.
 -Sandrigo.VII.1941. " " 15 es.
 -Nogarole.Villafraanca.VII.1941. " " 15 es.
 -Porto Mant.Castelbelforte.VII.1941. " " 5 es.

<u>elegans</u> Garbini.	-Bovolone.VII.1941. Benedetti leg.(?).ex Coll.D'Ancona.	2 es.
	-Albaro.S.Maria di Zevio.VII.1941. "	8 es.
	-Ronco all'A.Pozza.VII.1941. "	19 es.
	-Carpi.Spinimbecco.VII.1941. "	2 es.
	-Bovolone.Oppeano.VII.1941. "	1 + 11 es.
	-3 scalini Vic.VII.1941. "	9 es.
	-Marmirolo.VII.1941. "	22 es.
	-Porto Mantovano.VII.1941. "	12 es.
	-Oppeano.VII.1941. "	4 es.
	-Roverbella.Mantova.VII.1941. "	15 es.
	-Erbè Vr.VII.1941. "	4 es.
	-Cicogne.S.Andrea Colonia Ven.VII.1941 "	6 es.
	-Bionde Vr.VII.1941. "	2 es.
	-Albaro Vr.VII.1941. "	6 es.
	-Cerea.S.Pietro Morubio.VII.1941. "	30 es.
	-Novaledo Vicentino. "	20 es.
	-Gossano.Albettone.VII.1941. "	19 es.
	-Motta Vic.VII.1941. "	52 es.
	-Morgano Vic.VII.1941. "	20 es.
	-Arzergrande Pd.VII.1941. "	9 es.
	-S.Pietro Mor.Borravicina.VII.1941. "	39 es.
	-Monselice.VII.1941. "	109 es.
	-Caselle.Minerbe.VII.1941. "	74 es.
	-Brescia città.Stab.Ittiogenico.30.I.1937.M.Pavan "	2 es.
	-Fiume Adigetto di S.Pancrazio.Verona.VII.1936.Ruffo "	7 es.
	-Brescia città.Stab.Ittiogenico.6.2.1937.M.Pavan "	29 + 22 es.
	-Sorgente presso Bornata.6.I.1937.M.Pavan "	9 + 7 es.
<u>elegans</u> Garbini.	-Treviso.Fiume Sile.16.X.1963.A.Minelli leg.	1 es.
	-Treviso.Ponzano.10.IV.1967.A.Minelli leg.	6 es.
	-Riva del Garda.ruscelli.16.IX.1936.	7 es.
	-Mincio a Borghetto(Verona).26.IV.1964.	1 es.
	-Fiume Tramigna.Soave.VIII.1936.	vari es.
	-Fossati N S.Michele.Verona. VIII.1964.R.Palminteri.	vari es.
	-Bosco Fontana(Mantova).presso la sorgente.24.V.1951.	vari es.
	-Castellaro (Mantova).26.IV.1964.	4 es.
	-S.Pancrazio(Verona).14.V.1936.	molti es.
	-Verona.vasche del Museo.8.III.1950.S.Ruffo leg.	24 es.
	-Museo di Verona.scoli dell'acquedotto.VIII.1948.	4 es.
	-Padova.dintorni.IV.1936.	3 es.
	-Sorgente Zugna(Nave Brescia).20.II.1938.M.Pavan leg.	2 es.
	-Dintorni di Milano.X.1936.	vari es.
	-Milano.Pr.S.Donato.Fontanile Borraccina.23.II.1958.N.Sanfilippo leg.	vari es.
	-Pavia.cunicolo di scaricò dell'Acquario dell'Ist.di Zoologia.	
	30.IV.1930.Pomini.	vari es.
	-Ciurlina,Ghisalba(Bergamo).9.IX.1964.Pezzoli leg.	vari es.
	-Fontanile Ciurlina,Ghisalba (Bergamo).27.IV.1964.	molti es.
	-Ghisalba(BG).Ciurlina.2.III.1964.A.Valle leg.	molti es.
	-Affluente delle Paludi di Pozzolengo(Mantova).8.IV.1969.F.Giusti.	1 es.
	-Torrente presso Numana Bassa (Ancona).23.VII.1965.C.Baroni.	4 es.
	-Camerano(Ancona).Grotta del Diavolo e torrente defluente	
	dalla grotta.14.V.1961.C.Baroni leg.	6 es. prep.181
gruppo <u>elegans</u> (?)	-Lago delle Lame 1043 m,Alta Val d'Aveto.2.X.1950.F.Capra leg.	1 es.

- foreli Humbert. -Lago Maggiore.-300.24.II.1954.Ist.Idrob.Pallanza. 2 es.
 -Lago Maggiore.-200.15.VI.1954.Ist.Idrob.Pallanza. 4 es.
 -Lago Maggiore.1954. 45 prep.(dissez.e in toto) non numer.ex Taramelli
 -Lago di Como.-100.7.IX.1953. 5 es.
 -Bodensee. 3 es.
- gruppo foreli. -Königsee.-1.21.IV.1951.Engelhart. 1 es.
 -Königsee.-2. 9.IX.1955.Engelhart. vari es.
 -Königsee.-20. 13.X.1952.Engelhart. 3 es.
 -Trentino.Val di Tovel.2°emissario fiume Tresenga.
 5.VIII.1966.Tomasi leg. 10 es.
 -Val di Tovel.Risorgente della Tresenga.loc.Capriolo.
 VII.1968.Vettori leg. molti es.
 -Lago di Tovel.X.1968.Vettori leg. 2 tubi molti es.
- gallicus Schellenberg.-La Raillère.Amélie-les-Bains.20.X.1950.E.Angelier. 5 es. prep.8
- galvagnii Ruffo. -Trentino.Val Sugana.Grotta di Castel Tesino.18 V.T.
 2.VIII.1952.Tamanini leg. 16 es. (cotypi)
 " " " 26.27.VIII.1952.Conci e Galvagni leg.
 10 es. (cotypi). prep.18-22
 " " " 20.XII.1953. 16 es.
- grandii Ruffo. -Pozzo in Verona.I.1937.Ruffo leg. 19 +8 es.(cotypi) prep.225-233
 -Pozzo in Verona.II.1937. 16 es.
 -Pozzo in Verona.(n.1).Via Muro Padri.XI.1938.Ruffo leg.16+11 es.
 -Pozzo in Casa Biondani.S.Lucia.Verona.3.XII.1938. 21 es.
 -Pozzo in casa Dolci.Verona.4.I.1939.S.Ruffo leg. 11 es.
 -Pozzo Rossi Giosué.Ponzano Veneto.Treviso.28.VIII.1949. 1 es.
 -Pozzo Musella.S.Martino B.A.Verona.II.1952.S.Ruffo leg. 4 es.
 -Dueville.IX.1941.Benedetti leg.(?).ex Coll.D'Ancona. 5 es.
- grandii Ruffo. -Poli.Guarienti.(Verona).1940.Benedetti leg.(?).ex Coll.D'Ancona.
 5 es.
 -(Verona).Via Pigna.1940-41. " " 6 es.
 -S.Paolo.VIII.1941. " " 13 es.
 -Pozzi di Verona.VIII.1941. " " 1 es.
 -(Verona?).Duomo.1940-41. " " 2 tubi.134 es.
 -(Verona).Giardino Giusti.Muro Padri.VIII.1941. " " 12 es.
 -Verona.Pozzo Lazzaretto.30.IX.1969.Ruffo e Vigna leg. 1 es.
- hebereri Schellenberg. -Pozzo in Rovigno,Istria.R.Riedl leg. 21 es. prep.66-69
- hercegovinensis Karaman. -Popovo Polje.Ploča gumna.Žira Jama.24.X.1968.A.e G.Vigna leg.
 11 tubi. 263 es.
 -Popovo Polje.Turkovići.Ponor Crnulje.24.X.1968.A.Vigna leg. 1 es.
 -Popovo Polje.Strujići.Baba pećina.23.X.1968.A.e G.Vigna leg.2 es.
- hrabei Karaman. -Čičov.Súd-Slowakei.2.VII.1952.Straskraba. 5 es.
- illidzensis Schaffner. -Bosna.Sarajevo.Ilidža.Vrelo Bosne.19.X.1968.A.e G.Vigna leg.
 2 tubi. 103 es.
 -Bosnia,Ilidža.sorgenti del Bosnia.10.VII.1969.F.Papi leg. 6 es.
- inopinatus Schellenberg. -Kagran,from a well.Austria.8.IX.1962.Vornatscher leg. 2 es.
- gruppo jovanovici. -Grotte du Presbitère ou de la Giraldassee.Soulatgè.(Aude).
 Delamare leg. 1 es.
- kochianus Bate. -Hermalle-sous-Argentau. 8 es.
- gruppo kochianus. -Grotte de la Giraldassee.(Aude).Soulatgè.Delamare leg. 16 es.
 prep.15-17
- kolombatovici Karaman. -Popovo Polje.Zavala.Pećina Gladnica.25.X.1968.A.e G.Vigna leg.
 13 es.
 -Popovo Polje.Čvaljina.Baba pećina.23.X.1968.A.e G.Vigna leg. 3 es.
- longicaudatus(Costa). -Napoli.sotterranei Staz.Biol.Sperim.11.X.1960.P.Parenzan leg.6 es.

- longicaudatus (Costa). -Matese.Campitello.1500.29.VI.1967.Osella e Riggio leg. vari es.
 -Matese.M.te Gallinola.25.VI.1967.B.Osella leg. 6 es.
 -Gargano.S.Egidio.VI.1940.F.Pomini leg. 2 tubi. 41 es.
 -Gargano.Alveo S.Egidio.27.IV.1940.F.Pomini leg. 36 es.
 -Gargano.pozzi S.Egidio.18.VIII.1934.Ghigi leg. 2 es.
 -Gargano.Lago di Lesina.Sorgente di Lauro.14.III.1967.R.Argano.leg.9 es.
 -Grotta del Lete.Letino.Caserta.X.1960. 2 tubi. 4 es.
 -Sorgente di Capodifiume.Piana del Sele.Salerno.10.V.1965.Ruffo. 1 es.
 -Grotta del Caliendo.I Staz.9.XI.1958.B.Davide leg. 3 es.
 -Aspromonte.Gambarie.Piani di Pilima.1300.25.VII.1957.C.Conci leg.2 es.
 -Sorgenti di Capo d'acqua.1500.Matese.14.VI.1962.Ruffo. 5 es.
 -Monti Picentini.Verteglia.20.VI.1956.Ruffo. molti es.
 -"Niphargus anticolanus.Fiuggi" ex coll.D'Ancona. 2 tubi. 14 es.
 -Bosco Ponte Briganti.Terminillo.1600.7.VII.1949.M.Pavan leg. 7 es.
 -Grotta di S.Luca 13 La.13.II.1955.Cerruti,Patrizi,Callori leg.5 es.
 -Sasso.cisterna cortile.31.VIII.1948. 2 es. prep.256-260
 -Pozzo del Merro 32 La.centro,in profondit .19.V.1954.S.Patrizi. 4 es.
 -Pozzo Sventatore 33 La;22.XI.1964.V.Sbordoni leg. 1 juv.es.
 -Grotta di Verrecchie 2 A.Tagliacozzo.30.III.1952.S.Patrizi leg.13 es.
 -Verrecchie,Grotta Beatrice Cenci 3 A.12.XI.1967.V.Sbordoni leg.22 es.
 " " " M.Cobolli leg. 2 es.
 -Poggio Moiano.sorg.1.IV.1967.Cottarelli e Castagnolo leg. vari es.
 -Pescorocchiano.Risorgenza di Civitella.22.X.1967.V.Sbordoni leg.
 2 tubi. 17 es.+juv.
 -Licenza.Villa d'Orazio.ruscello.5.II.1965.Sbordoni e Vigna. 1es.
 " " " " prep.70-72
 -Fontanella di Licenza.19.IV.1956.Stella leg. 1 es.
- longicaudatus (Costa). -Grotta degli Ausi 342 La;Prossedi.27.II.1964.V.Sbordoni leg. 1 es.
 -Pozzo della Creta Rossa.Jenne.27.XI.1966.V.Sbordoni leg. 3 es.
 -Inghiottoio di Camposecco 311 La.31.X.1965.V.Sbordoni leg. 4 es.
 -Pozzo del Faggeto(P.Cerasole)343 La.Supino.10.VII.1966.Sbordoni.11 es.
 " " " 16.IV.1967.V.Sbordoni leg.6 es.
 " " " 26.XI.1967. " 23 es.
 " " " 28.IV.1968.A.Vigna leg. 5+2 es.
 -Grotta del Pertuso.(Pastena). prep.247
 -Ouso del Pozzo Comune 274 La.Monti Lepini.24.VII.1954.E.Callori. 3 es.
 " " " 20.XI.1966.V.Sbordoni. 2 es.
 " " " 10.XI.1963.Di Domenico. 2 es.
 " " " 10.XI.63.V.Sbordoni. 3 es.
 prep.100-101
 " " " 17.XI.1963.V.Sbordoni leg.
 2+1+3 es. prep.94-97
 " " " 17.XI.1963.N.Di Domenico leg.
 2 es. prep.39-43 e 93
 " " " 8.II.1965.V.Sbordoni leg.
 4 es. prep.98-99
 " " " 12.II.1965.Di Domenico.7 es.
 prep.102
 " " " 18.V.1965.A.Vigna leg.
 4+4+7+2 es. prep.103-110
 -Sorgente presso Le Pantane.Bellegra.12.III.1964.A.Vigna leg. 1 es.
 prep.59-60
 " " " 25.II.1966.A.Vigna leg. 2 es.
 -Sorgenti lungo la strada Olevano-Bellegra.25.II.1966.Vigna. 10 es.
 -Grotta dell'Arco 5 La.Bellegra.7.IV.1932.S.Patrizi leg. 2 es.

- longicaudatus* (Costa). -Grotta dell'Arco 5 La.Bellegra.7.IV.1932.S.Patrizi. Prep.221-222
- " " " 26.VII.1953.S.Patrizi leg. 6 es.
- " " " 17.III.1964.A.Vigna leg. 1 es.
- " " " 11.XI.1964.A.Vigna leg. 1 es.
- " " " 25.II.1966.A.Vigna leg. 6 es.
- " " " 22.VII.1964.A.Vigna leg. resti di 3 es.
- " " " (17.III.64)ex allev.24.III.64 2 es.
- " " " 10.X.1968.V.Sbordoni leg. 1 es.
- " " " 10.X.1968.R.Argano leg. 1 es.
- Grotta A Male.L'Aquila.Assergi.4.XI.1968.V.Sbordoni leg. 11+4 es.
- " " " 4.XI.1968.R.Argano leg. 4 es.
- Sorgente Acqua ferrosa.Circeo.30.XI.1968.Argano e Cottarelli.10 es.
- letto fiume Melfa.Roccasecca 28.V.1969.Argano e Vigna. 6 juv.es.
- Isola Ponza,Formale della Cantina.4.XI.1965.V.Sbordoni e A.Vigna leg. 6 tubi. 29 es. prep.92
- " 23.I.1966.V.Cottarelli leg. 1 es.
- Formale di Cala d'Inferno.23.I.1966.V.Cottarelli;V.Sbordoni e A.Vigna leg. 7 es.
- " Cisterna presso Campo Inglese.4.IV.1966.Cottarelli.1 es.
- Valletta di Giancos.16.V.1966.R.Argano leg. 7 es.
- " " " 24.V.1966.A.Vigna leg. 2 es.
- " " " 10.XI.1966.R.Argano leg. 7+17 es.
- " " " 8.III.1967.V.Sbordoni leg. 13 es.
- " "Grotta del Castagno".18.I.1967.V.Sbordoni leg. 3 es.
- " Sorgente Cala Cantina.24.II.1968.R.Argano leg. 2 es.
- " Piana d'Incenso.24.II.1968.R.Argano leg. 3+2 es.
- " 12.XI.1966.V.Cottarelli leg. 2 es.
- " Ruscello a E di M.te Beppe Antonio.9.III.67.Cottarelli.2 es.
- longicaudatus* (Costa).-Isola Palmarola."Grotta dell'Acqua".3.IV.1966.V.Cottarelli leg. 3 es.
- Isola Zannone,Sorgente costa E.19.V.1966.A.Vigna leg. 7 es.
- " " 27.II.1966.Argano e Sbordoni. 1 es.
- " " 28.I.1966.Argano e Vigna leg. 23 es.
- " Cisterna costa NW.21.V.1966.Sbordoni e Vigna leg.26 es.
- " fossetta nel fango secco sotto sasso interrato alla "pozza del Varo".28.VI.1966.A.Vigna leg. 1 es.
- " "pozza del Varo".17.I.1967.R.Argano leg. 1 es.
- " sorgente littoranea.IX.1949.S.Patrizi leg. 17+21 es.
- " sorgente 2 A.27.IV/2.V.1931. 14 es.
- Dintorni di Bologna.abbeveratoio.10.IV.1960.C.Moscardini leg.molti es.
- Grotta di Rio delle Vene.Grosseto.17.X.1954.B.Lanza leg. 1 es.
- Sardegna.torrente presso Budoni.NU.19.IV.1964.V.Sbordoni leg. 1 es.
- " Grotta Su Coloru.Laerru.6.V.1952.S.Patrizi leg. 10 es.
- " Isola di Tavolara. C 13. 40 es.
- " " Pozzo n.3. 27.II.1966. 3 es.
- " Isola di Molara. A 2. 2 es.
- gruppo *longicaudatus*. -Acquedotto Colleoni.BG.Castagnetta.10.III.1957. 1 es.
- Premeno.10.IX.1960. 8 es.
- Pallanza.sorgenti.VII.1964.E.Stella e Fox leg. 11 es.
- Tanna da Basua 55 Li.Toirano.2.VI.1950.N.Sanfilippo leg. 8 es.
- Garbo de Cunche 93 Li.17.VI.1954.Biancheri leg. 8 es.
- Oropa. prep.242-243
- Buco della Bondaccia.M.te Fenera.8.XII.1967.CAI-GSB Biella 2 es.
- Ciutaron.M.Fenera.13.II.1954.S.Dell'Oca leg. 5 es.
- Grotta Chiara 2507 Pi.M.Fenera.10.V.1969.A.Casale leg. 1 es.
- Buco della Bocca.Lombardia. prep.240-241
- Padova.Via S.Francesco 42.VIII.1941.Benedetti leg. 10 es.

- gruppo longicaudatus. -Padova.Via S.Francesco 42.VIII.1941.Benedetti leg.(?).
ex Coll.D'Ancona. molti es.
-Venezia.Campo S.Maria del Giglio.20.I.1942.ex Coll.D'Ancona
molti es.
-Vicenza.Pozzo S.Croce.IX.1941.Benedetti leg.(?). " molti es.
-Canonica S.Lazzaro.XI.1940. " " molti es.
-Pozzi S.Lazzaro.1940.II.V. " " 10+83 es.
-Gr.Garzeniko.Kandhila.Accadie.15.IV.1962.Henrot leg. 1 es.
-Gr.di Katafinghi.Peloponneso.28.VIII.1956.S.Patrizi leg. 1 es.
-Attique.Mt.Parnés.Spilia Panon.5.IV.1959.H.Coiffait leg. 14 es.
-Caverne de Pan.Montagne Parnes.14.V.?.Petrochilos leg. 3 es.
-Burgaz.VII.1947. ? 1 es.
-Vrlovka Spilja.Brlog Grad.Croatie.30.VIII.1953.Coiffait. 3 es.
-Cuevas de Landarbaso.San Sebastian.Santander.España.
E.Dresco 1952-J.Balazuc-Ruffo 2 es.
longidactylus Ruffo. -(Verona).Poli.Guarienti.1940.Benedetti leg.(?).ex Coll.D'Ancona.5 es
-Pozzi di Verona.VIII.1941. " " 11 es.
-Via S.Paolo.VIII.1941. " " molti es
con grandii
-S.Paolo.VIII.1941. " " 52 es.
-(Verona).Duomo.1940-41. " " vari es. con
danconai
-(Verona).Via Pigna.1940-41. " " vari es. con
danconai
-Pozzo in Verona.Via Muro Padri.XI.1938.S.Ruffo leg. 28 es.
-(Verona).Pozzo in casa Dolci.4.I.1939.S.Ruffo leg. vari es.
-Pozzo Musella.S.Martino B.A.II.1952.S.Ruffo leg. vari es.
" " 30.IX.1969.Ruffo e Vigna leg. 2 es.
longidactylus Ruffo. -Pozzo in casa Zanetti.(Verona).15.V.1953. prep.194
-Pozzo in casa Gambaro.(S.Martino B.A.).29.V.1953. prep.195
longiflagellum Karaman-Slovenia.Videm.Podpeška Jama.23.IV.1968.V.Sbordoni leg. 3 tubi.16 es.
" " " " R.Argano leg. 2 tubi. 14 es.
" " " " ex allevamenti 2 tubi. 2 es.
miljeticus Straskraba.-Isola Meleda.Bobino Polje.Grotta Woslascevitza. 2 es.
ohridanus Karaman. -Macedonia.Lago di Ohrid.spediz.olandese (1954?) 2 es.
orcinus Joseph. -Postumia.Tartaro basso.15.X.1934.F.Anelli leg.ex Coll.D'Ancona 1 es.
orcinus juv. ? -Slovenia.Lož.Mrzla Jama.16.X.1968.A.Vigna leg. 1 es.
-Slovenia.Postojna.Postojnska Jama.Tartarus.14.X.1968.A.e G.Vigna.2 es.
gruppo orcinus. -Lazio.Pozzo del Merro 32 La.19.V.1954.S.Patrizi leg. 1 es. prep.138,148
parenzani Ruffo e Vigna.-Grotta di Castelcivita.20.XII.1953.P.Parenzan leg.
1 es. (Typus). prep.149-153
-Grotta di Castelcivita.20.XII.1953.P.Parenzan leg. 3 es.(paratypi)
prep.136
-Grotta del Bussento.19.X.1950.S.Patrizi leg. 2 tubi.3 es. prep.137
-Grotta di Pertosa.17.VIII.1968.V.Vomero leg. 4 es.
pasquini Vigna. -Lazio.Rieti.Sorg.S.Vittorino.11.III.1965. 1 es.(Typus) prep.83,172
A.Vigna leg.
" " " 11.III.1965.A.Vigna leg. 13 tubi.28 es.
(paratypi).prep.73-82,84,168,177,
178.
" " " 7.V.1965.A.Vigna leg. 12 tubi.28 es.
(paratypi).prep.85-91,167,169,170
" " " 29.I.1957.E.Stella leg. 4 es.(paratypi)
prep.47-49,171
" " " 4.VII.1967.A.Vigna leg. 1 es.

- pasquinii Vigna. -Lazio.Rieti.Sorg.S.Vittorino.31.III.1968.A.Vigna leg. 4 es.
 " " Sorg.del Peschiera. 1956.E.Stella leg.(?). 1 es.prep.176
 " " " 25.III.1965.R.Argano leg. 4 tubi.
 7 es.prep.173-175
 " " " 10.XI.1958. 6 es.
 " " " IX.1955.S.Ruffo leg. 1 es.
 -Campania.Polla.sorg.8.X.1967.V.Sbordoni leg. 5 es.
 -Matese.Sorg.del Biferno.Boiano.12.VI.1962.S.Ruffo leg. 2 es.
 prep.179-180
- patrizii Ruffo e Vigna.-Grotta di Pastena 28 La.19.XI.1967.V.Sbordoni leg. 1 es.(Typus)
 prep.128-131
 " " " " 3 tubi. 8 es.(paratypi)
 prep.132-133,146
 " " 4.II.1932.S.Patrizi leg. 7 es. (paratypi)
 -Grotta del Formale 39 La.7.XI.1954.Cerruti e Patrizi leg. 6 es.
 prep.134-135
- pedemontanus Ruffo. -Oropa.VI.1928.A.Dodero leg. 3 es.(paratypi) prep.244-246
 -Sorgenti della Val di Lanzo.Pasa leg. 5 es.
 - pedemontanus s.l. vedi gruppo spetiae
plateau Chevreux. -S.et O.Louvres(env.de Paris).20.III.1949.J.de Bauffremont 20 es.
 -Lectoure.Gers.Pozzo.Barbé leg. 2 tubi. 14 es.
 - podpecanus Karaman. -Slovenia.Videm.Podpeška Jama.23.IV.1968.V.Sbordoni leg. 1 es.
 - rhonorhodanensis Schellenberg.-Isère.Grotte de la Balme.13.V.1950.R.Ginet leg. 8 es.
 -Hérault.Minerve.Aven de la Couronelle.28.III.1953.Coiffait.3 es.
 " " " ex.mortes en élevage.Coiffait. vari es.
 - robustus Chevreux. -Lot.rivière souterraine de Padirac.1903. 12 es.
 -Ariège.Cazayet.Aven de Salège.X.1958.Bouillon;Coiffait;Rouch. 6 es.
 - romuleus Vigna. -Roma.Foro Romano.4.XII.1965.A.Vigna leg. 1 es.(Typus) prep.127
 " " " " 15 tubi.30 es.(paratypi)
 prep.117-125
 " " 19.XI.1963.A.Vigna leg. 1 es.(paratypus).prep.115
 " " 23.XI.1963.A.Vigna leg. 2 tubi.2 es.(paratypi).
 prep.113,116
 " " 9.XII.1965.A.Vigna leg.3 tubi.18 es.(paratypi)
 " " 19.XI.1963.A.Vigna leg. 6 es.
 " " 1964.A.Vigna leg. 1 es. prep.112
 " 4.XII.1963(23.XI.67)A.Vigna. 1 es. prep.111
 " " 10.XI.1964.A.Vigna leg. prep.114
 -Roma.Palazzo Cancellaria.27.I.1954.S.Patrizi leg. 2 tubi.5 es.
 -Firenze.Pozzo della Specola.12.I.1967.S.Carfi e B.Lanza leg. 12 es.
 " " " 4.I.1968.Chelazzi e Messina leg. 35 es.
 - romuleus s.l. vedi gruppo spetiae (materiale appenninico non determinato)
salonitanus Karaman. -Dalmacjia.Cavtat.Šipun pećina.21.X.1968.A.e G.Vigna leg. 1 es.
schellenbergi Karaman.-Grotte En Brixot,La Preste.Haute Vallespir.Fyr.or.24.IV.1954.14 es.
 -Lovaine(Nancy).Husson leg. 2 tubi. 20 es.
 -Grotte de Han-sur-Lesse,Belgique.26.V.1952.Anciaux leg. 14 es.
 - setiferus Schellenberg.-Suisse.Grotte de Vers-chez-le-Brand,Verrières,Neuchâtel,
 5.VIII.1968.C.Pleşa leg. 1 es.
 - speziae Schellenberg.-Grotta Bocca Lupara. prep.270
 -Grotta Grande di Pignone 36 Li.20.V.1951.C.Conci leg. 1 es.
 " " " " 9.III.1952.N.Sanfilippo leg. 2 es.
 " " " " 22.XI.1966.A.Vigna leg. 1 es.
 " " " " 22.XI.1967.A.Vigna leg. 11 es.
 -Grotta di Acquasanta 71 Li.8.VIII.1948.N.Sanfilippo leg. 1 es.prep.304

- gruppo *spetiae*. (materiale appenninico e alpino occidentale non determinato appartenente a forme simili a *pedemontanus*, *spetiae*, *apuanus*, *romuleus*; in corso di studio)
 - Tanone di Torano 179 T. Carrara, nel lago. 5.III.1961. F. De Sio leg. 2 es.
 - Massa, loc. Madielle, acqua potabile. VIII.1967. C. Ceccarelli leg. 2 es.
 - Tana delle Volte, Alpi Apuane. 26.III.1951. B. Lanza leg. 6 es.
 - Strada per il Passo del Vestito. 1000 m c.a. 2 es.
 - Buca dei Gracchi del Passo del Vestito. 26.XII.1964. F. Utili leg. 2 es.
 - Borgo a Buggiano, PT. N. 20. 24.III.1968. L. Chelazzi leg. 1 es.
 - S. Martino a Terenzano. N. 8. (Firenze). 26.XII.1967. L. Chelazzi leg. 2 tubi. 12 es.
 - Agnano Pisano, Grotta del Leone. 17.XII.1967. B. Lanza e L. Chelazzi leg. 3 tubi. 200 es.
 - Monti d. Calvana. Grotta delle Pile (1 T.). 20.IV.1927. Razzauti leg. ex Coll. D'Ancona 1 es.
 - " Spelonca delle Pille 1 T. 27.VII.1960. Prelovsek leg. 1 es.
 - " " " 31.XII.1960. B. e U. Lanza leg. 2 es.
 - " " " 21.VII.1943. B. Lanza leg. 3 es.
 - " " " 27.I.1946. B. Lanza leg. 3 es.
 - " " " 14.IV.1946. B. Lanza leg. 5 es.
 - " Buca di Case Castello. 19.IV.1952. G. Porri leg. 5 es.
 - " " " 5.XII.1954. G. Porri leg. 7 es.
 - " (Grotta di) Fonte Buia (5 T.). N. 15. 3.III.1968. L. Chelazzi. 19 es.
 - Grotta dell'Anemone Bianco (Bolognese). 1.III.1959. 7 es.
 - Grotta di Gaibola. Bologna. ex Coll. D'Ancona 5 es.
 - Tana della Mussina. (Reggio E.). 20.X.1932. Menozzi leg. 7 es.
 - " " " 2.X.1932. Menozzi leg. 9 es.
 - " " " 25.VII.1965. C. Moscardini leg. 9 es.
 - Grotta di Monterosso. Alta Valle del Secchia. VIII.1947. 1 es.
- gruppo *spetiae*. (materiale appenninico e alpino occidentale non determinato appartenente a forme simili a *pedemontanus*, *spetiae*, *apuanus*, *romuleus*; in corso di studio)
 - Appennino Tosco-Emiliano. Val Sestaione. 1500 m. 13.VII.1964. S. Ruffo leg. molti es.
 - Grotta delle Tassare. M. Nerone. Urbino. 2.VIII.1952. C. Conci leg. 5 es.
 - Sasso, bottino del fontanile Fumarolo. 2.IX.1948. Cerruti e Patrizi. molti es.
prep. 261-269
 - Monti Sibillini. Ambiente igropetrico centrale Aso. 7.VIII.1955. Tomasi. 1 es.
 - " Sorgente Aso. 7.VII.1955. Tomasi. 5 es.
 - " Fonte del Fargno. 30.VII.1955. Tomasi. molti es.
 - " Sorgente laghetto Foce. 7.VII.1955. Tomasi. molti es.
 - " Sorgente di Panico. 28.VII.1955. Tomasi leg. 4 es.
 - Prom. Argentario. Grotta di S. Liberata. 1.V.1951. molti es. prep. 252-255
 - " Grotta di Punta degli Stretti 250 T. Lago Egiziano. 7.V.1963. V. Sbordoni leg. 1 es.
 - " " " " " 11.XII.1965. A. Vigna leg. 3 tubi. 4 es. prep. 163-166
 - Isola di Capraia. III.1966 vari es.
 - Isola di Capraia. laghetto NE. 13.III.1966. C. Baroni leg. vari es.
 - Isola d'Elba. Bagnaia. P. Ferraio. pozzo N. 17. 18.III.1968. L. Chelazzi leg. 26 es.
 - " " " pozzo N. 16. 18.III.1968. L. Chelazzi leg. 7 es.
 - " " Torrente Valle. N. 18. 18.III.1968. L. Chelazzi leg. 4 es.
 - " Uviale di Marciana. q. 300. 6.I.1969. N. Sanfilippo leg. 3 es.
 - Sorgente a Punta Chiappa. Portofino. GE. 17.VI.1962. N. Sanfilippo leg. 2 es.
 - Genova. Acquisanta. Rio Bujardetta. 20.VI.1957. N. Sanfilippo leg. 1 es.
 - Tanna da Scaggia 15 Li. 16.I.1949. N. Sanfilippo leg. prep. 289-297 1 es.
 - " 30.I.1949. N. Sanfilippo leg. vari es.
 - " 1.I.1948. N. Sanfilippo leg. 1 es.
 - Ruscello dei prati di Bavari. 17.IV.1949. N. Sanfilippo leg. vari es.

gruppo spetiae. (materiale appenninico e alpino occidentale non determinato appartenente a forme simili a pedemontanus, spetiae, apuanus, romuleus; in corso di studio)

- Grotta della Scaggia 15 Li. prep.286-288 2 es.
- " " " 30.I.1957.C.Conci e N.Sanfilippo leg. vari es.
- Torrente S.Ilario.9.II.1947.N.Sanfilippo e C.Conci leg. 2 es.
- Grotta S.Ilario 63 Li.15.XII.1943.N.Sanfilippo e C.Conci leg. 1 es.
- " " " 9.II.1947. " vari es.
- prep.285
- Grotta del Padino 8 Li.18.VII.1948.N.Sanfilippo leg. vari es.
- Andora.T.Merula.3.IV.1955.N.Sanfilippo leg. vari es.
- Genova.S.Siro Struppa.Passo dell'Alpensa.ruscello.1.XI.1952.Sanfilippo. 2 es.
- Genova Voltri.Cascina Stellin.pozza d'acqua sorg.24.VIII.1947.Sanfilippo. vari
- Genova;Nervi.24.IV.1968.F.Capra leg. 2 es.
- Genova.Prato.Torr.Fontanegli.sotto sorg.17.IV.1949.N.Sanfilippo leg. 4 es.
- Grotta della Suja.F.Capra leg. prep.271-274 2 es.
- Grotta delle Fate.24.VIII.1946.N.Sanfilippo leg. prep.298-299 1 es.
- " " Franciscolo leg. prep.300-303
- Grotta Dragonara 6 Li.28.XI.1948.N.Sanfilippo leg. 10 es.
- " " " 8.XII.1948. " 2 es.
- " " " 21.XI.1948. " 1 es.
- " " " ? " prep.279-281
- " " " ? Franciscolo leg. prep.275-278
- Galleria orientale Acquedotto di Camogli.23.V.1948.Sanfilippo-Cappello 3 es. (1)
- Grotta Cavassola 125 Li.30.I.1949.N.Sanfilippo leg. vari es.
- " " " 16.I.1949 " 3 es.
- " " " 9.I.1949 " vari es.
- " " " ? " prep.309-313
- (1) prep.305-308

• gruppo spetiae. (materiale appenninico e alpino occidentale non determinato appartenente a forme simili a pedemontanus, spetiae, apuanus, romuleus; in corso di studio)

- Caverna Valdettaro.Rapallo.18.X.1929.F.Capra leg. 2 es.
- Grotta del Cantè 7 Li.15.II.1948.Franciscolo leg. prep.282-284 1 es.
- Genova.Acquedotto 7 fratelli.all'est.2.V.1952.N.Sanfilippo leg. vari es.
- Molini di Triora.Grotta Melosa 263 Li.16.VI.1957.N.Sanfilippo leg. 1 es.
- Finale.Passo del Melogno.ruscello.21.VI.1962.N.Sanfilippo leg. vari es.
- Melogno.SV.rio Franchetta.2.3.VI.1952.M.Franciscolo leg. vari es.
- Pigna.Caverna di Ruglio 19 Li.1.XI.1953.N.Sanfilippo leg. vari es.
- Bardineto.Buranco.26.VIII.1967.A.Vigna leg. 1 es.
- Millesimo.Grotta della Volpe 248 Li.22.III.1952.C.Conci leg. 1 es.
- Pieve di Teco.1966.G.M.Ghidini. 2 tubi. 2 es.
- Pieve di Teco.loc.Ligassorio.Pozzo.Durand leg. 1 es.
- Arma Pollera.24 Li.27.XI.1967.A.Vigna leg. 9 es.
- Arma Pollera 24 Li. ? .Franciscolo. prep.314-316
- Ponte di Nava.Grotta dell'Orso 118 Pi.Franciscolo leg. prep.190-193
- Val Sabbia.Varallo.2.V.1953.C.Moscardini leg. 11 es.
- Alpi Liguri.M.te Mondolè.VII.1950.S.Ruffo leg. molti es.
- Grotta di Viozene (?).XI.1953.S.Ruffo leg. 7 es.
- Barma della Fascia.Limone 1700.2.VII.1958.A.Vigna leg. 8 es.+ prep.54-55
- " " " 24.IV.1963.A.Vigna leg. 1 es.
- " " " 6.IX.1963.A.Vigna leg. 6 es.+ prep.27-35,44-46
- Val Pesio.Grotta del Camosciere 105 Pi.1.X.1948.A.e H.Henrot leg. vari es.
- prep.201-205
- " " " " 28.VIII.1968.A.Vigna leg. 3 es.
- " " " " 28.VI.1969.A.Vigna e R.Argano leg. 11 es.

- snoeckeri Schellenberg. -vario materiale sloveno frammisto a stygius s.l.
vedi gruppo stygius
- stefanellii Ruffo e Vigna. -Roma, Foro Romano, acque freatiche. 4.XII.1965. A. Vigna leg.
1 es. (Typus). prep. 139-141, 147
- " " " 4.XII.1965. A. Vigna leg. 6 es. (paratypi)
- " " " 4.XII.1963. A. Vigna leg. 2 es. (paratypi)
- " " " 9.XII.1965. A. Vigna leg.
9 tubi. 141 es. (paratypi). prep. 142-143
- " " " 19.XI.1963. A. Vigna leg. 21 es. (paratypi)
- Roma, Palazzo Cancellaria. 27.I.1954. S. Patrizi leg. 2 tubi. 161 es.
- Firenze, Pozzo della Specola. 25.II.1966. B. Lanza leg. 19 es.
- " " " 12.I.1967. S. Carfi e B. Lanza leg.
2 tubi. 90 es. prep. 144
- " " " 4.I.1968. L. Chelazzi leg. 448 es.
- Marche, Grotta del Fiume 8 MA/AN. 6 es. prep. 145
- stygius Schiöde. -Slovenia, Postojna, Postojnska Jama, Gr. Tricolore. 12.X.1968.
A. Vigna leg. 4 es.
- " " " Tartarus inf. 12.X.68. Vigna. 2 es.
- " " " Tartarus. 14.X.1968. A. e G. Vigna
6 es.
- Postumia, bivio Tricolore. VIII.1936. ex Coll. D'Ancona. 19 es.
- Postumia, grotta Ticolore. 13.VI.1935. Anelli. ex Coll. D'Ancona. 2 es.
- " " " D'Ancona. ex Coll. D'Ancona. 2 es.
- Postumia. ex Coll. D'Ancona. 27 es.
- Postumia, Anelli. ex Coll. D'Ancona. 14 es.
- Postumia, falde del Grande Calvario. V.1936. ex Coll. D'Ancona. 41 es.
- Postumia. VIII.1936. 10 es.
- stygius Schiöde. -Postumia, bivio Sepolcro. 17.VIII.1934. D'Ancona leg. ex Coll. D'Ancona. 4 es.
- " Calvario. 17.VIII.1934. " 20 es.
- " Tartaro basso. 17.VIII.1936. " 3 es.
- " Tartaro basso. 8.I.1936. " 6 es.
- " Il gnomo. 10.XII.1934. Anelli. " 6 es.
- " Il gnomo. 25.II.1937. Anelli. " 1 es.
- " Brillante. 10.XII.1934. Anelli. " 2 es.
- " Il Brillante. 7.XII.1935. Anelli. " 8 es.
- " Grotta senza nome. 18.XI.1935. Anelli. " 5 es.
- " " 16.XI.1935. Anelli. " 4 es.
- " Grotta Cristalli. 2.IV.1935. " 2 es.
- " " 25.II.1937. " 8 es.
- gruppo stygius -Postojna, Galleria artificiale tra Postojnska e Crna Jama. 14.X.1968.
A. e G. Vigna leg. 10 es.
- Predjama, Grotta di Castel Luegg. 11.X.1968. A. e G. Vigna leg. 32 es.
- Grotta Castello di Lueghi 107 V.G. 26.II.1937. Anelli. ex Coll. D'Ancona. 8 es.
- Grotta Ottocco. 6.VIII.1937. Anelli. " 1 es.
- Grotta a W di Bucuie 1615 V.G. 12.VI.1935. Anelli. " 2 es.
- Grotta del Torrente. 2286 V.G. 27.IX.1935. Anelli. " 5 es.
- Grotta del Maestro 1355 V.G. 15.X.1935. Anelli. " 12 es.
- Iaze, Jama Mačkovica. 10.X.1968. A. e G. Vigna leg. 13 es.
- Postojna, Crna Jama. 14.X.1968. A. e G. Vigna leg. 12 es.
- Most na Soči, Lom, Jama Smoganica. 15.X.1968. A. e G. Vigna leg. 2 tubi. 48 es.
- " " Sorgente presso Smoganica. 15.X.1968. A. e G. Vigna leg. 2 es.
- Grotta M. Milesni 1342 V.G. 4.XII.1936. Anelli. Ex Coll. D'Ancona. 1 es.
- Postumia, Grotta Nera. 10.XII.1934. Anelli. " 1 es.
- " " 8.VI.1936. " 3 es.

• gruppo <u>stygius</u> .	-Postumia.Grotta Nera.24.VIII.1936.Anelli. ex Coll.D'Ancona.	4 es.
	-Caverna Planina.ramo Piuca.23.VII.1936.Anelli. "	1 es.
	" " ramo occidentale.31.VII.1935.Anelli. "	3 es.
	" " ramo sud-occidentale.26.II.1937.Anelli. "	3 es.
	" " 7.VIII.1938.Anelli. "	9 es.
	" " (Gvigvta).10.III.1938.Anelli. "	9 es.
	" " ramo occidentale.19.VIII.1936.D'Ancona. "	13 es.
	-Planina.Planinska Jama.16.X.1968.A.e G.Vigna leg. 7 tubi.	206 es.
	" " " 17.X.1968.A.e G.Vigna leg. 9 tubi.	177 es.
	-Grotta Zidanica 1658 V.G.8.VIII.1935.Anelli. ex Coll.D'Ancona.	1 es.
	-Grotta di Trebiciano.21.VIII.1936.D'Ancona. "	2 es.
	" 21.VIII.1936.D'Ancona. "	7 es.
	-Grotta dell'Orso.19.VII.1938.Anelli. "	7 es.
	-Caverna presso Samatorza.257 V.G.19.VII.1938.Anelli. "	4 es.
	-Cisterna recinto Palazzo Schrabsc (?).28.VIII.1936.Anelli. "	15 es.
	-Grotta di Permani 736 V.G.X.1936.Anelli. "	1 es.
	-Denizza(Chersano).25.VI.1933.Anelli. "	4 es.
	-Preluca. Depoli. "	1 es.
	-Preluca. Goidanich. "	6 tubi.3 es.+resti
	-Trentino.Grotta del Calgeron 244 V.T.22.VIII.1952.C.Conci leg.	3 es.
	" Grotta della Bigonda 243 V.T.1.VIII.1952.	8 es.
	" " " " 1.VIII.1952.L.Tamanini leg.	vari es.
	" " " " 1.VIII.1952.A.Galvagni leg.	2 es.
	(ramo del Grillo)	
	" " " " 20.III.1952.Galvagni,Perna,Tomasi leg.	
	(a 1200-1300 m dall'ingr.)	vari es.
	" " " " 21.III.1952.Tomasi,Perini leg.	
	(a 600-1000 m dall'ingr.)	vari es.
gruppo <u>stygius</u> .	-Trentino.Grotta della Bigonda 243 V.T.20.VIII.1952.C.Conci leg.	1 es.
	" " " " 20.III.1952.Tomasi,Galvagni,Perna leg	
	(a 1200 m dall'ingr.)	vari es.
	" " " " 21.III.1952.Tomasi e Perini leg.	
	(a 700-1000 m dall'ingr.)	vari es.
	" " " " 24.III.1952.Perini leg.	
	(Galleria del Drago)	vari es.
	" " " " Galleria.22.III.1953.	vari es.
	" Bus de le Guane 106 V.T. 18.X.1941.C.Conci leg.	2 es.
	" Bus del Bilbom 211 V.T.28.VII.1952.C.Conci e L.Tamanini leg.	3 es.
	" " " " 31.VIII.1953.C.Conci leg.	1 es.
	-Veneto.Verona.Il Busetto.IX.1949.	prep.198-200 vari es.
	" " " 7.XII.1945.S.Ruffo leg.	prep.197 2 es.
	" Grotta di Veja.9.IX.1939.Benedetti leg.(?).ex Coll.D'Ancona.	13 es.
	" " " 19.IX.1939. "	42 es.
	" " " 23.IX.1939. "	23 es.
	" " " 1940-41 "	182 es.
	" " " 16.VI.1946.S.Ruffo leg.	9 es.
	" " " 19.VIII.1964.R.Palminteri leg.(Grotta Nord Ponte Veja)	vari es.
	" " " (nelle pozze d'acqua).3.XII.1933.S.Ruffo leg.	4 es.
	" " " VIII.1963.	vari es.
	" " " 4.VI.1933.S.Ruffo leg.	vari es.
	" " " 9.I.1936.S.Ruffo leg.	vari es.
	" " " 13.I.1946.Battisti leg.	vari es.
	" Cave di lignite Vajo dell'Anguilla.Verona.29.VII.67.F.Krapp leg.	2 tubi.vari
	" " " " 18.VII.1968.Ruffo e Vigna leg.	2 tubi.36
	" VII Presa del Montello.VII.1941.Benedetti leg.(?).ex Coll.D'Ancona.	1+14 es.

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- gruppo stygius.-Lombardia.Grotta Bus del Mescapel 1147 Lo.Albenza.BG.27.VI.1943.L.Malachini.5 es.
 " " " " " " " 19.V.1944.Malachini e
 L.Mazzocchi leg. 2 es.
 " Taberna de la Bresana 1110 Lo.Fonteno.BG.22.VI.1941.R.Scossioli leg.3 es.
 " " " " " " 7.VII.1940. " vari es.
 " " " " " " 18.X.1940. " vari es.
 " Buco del Piombo.2208 Lo.Erba.Como.26.X.1941.M.Pavan leg. vari es.
 " Trona di Val di Bäre 2008 Lo.13.II.1955.Dell'Oca leg. vari es.
 " Tanone 2156 Lo.V.Cosis.Dell'Oca leg. vari es.
 " Il Fus 2009 Lo.Como.1.IX.1954.S.Dell'Oca leg. vari es.
 " Caja di Brutine 194 Lo.D.Fontanazzo.BS.10.XI.1940.M.Pavan leg. 8 es.
 " (?)Risorgenza dei Ronchi. 9.IV.1946. vari es.
 " Buco del Corno 1004 Lo.Entratico.BG.16.VI.2 e 16.VII.1955.N.Bonino. 1 es.
 " " " " " 16.VI.2 e 9.VII.1955.L.Bonino. 7 es.
 " " " " " 27.II.1955.L.Malachini leg. 1 es.
 " " " " " 5.VIII.1945.L.Malachini leg. 2 es.
 " Bus de le Bedole 221 Lo.28.II.1960. 11 es.
 " Nord di Dardama Corna q.1950.13.VIII.1968. (?) 6 es.
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REGISTRATO PRESSO IL TRIBUNALE DI GENOVA AL N. 76 (4 LUGLIO 1949)

Prof. Achille Casale - Direttore Responsabile

Pubblicazione a cura di PAGEPress - Via A. Cavagna Sangiuliani 5, 27100 Pavia

Stampa: Press Up s.r.l., via E.Q. Visconti 90, 00193 Roma, Italy



SOCIETÀ ENTOMOLOGICA ITALIANA via Brigata Liguria 9 Genova