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Achille Casale*

A revision of the genus *Atomopria* Kieffer, 1910
(Hymenoptera Diaprioidea Diapriidae)

Riassunto: *Revisione del genere* Atomopria *Kieffer, 1910 (Hymenoptera Diaprioidea Diapriidae).*
Il genere *Atomopria* Kieffer, 1911 include attualmente due sole specie descritte: *A. fulvicornis* Kieffer, 1911 (Italia nord-occidentale: Liguria) e *A. rufithorax* Kieffer, 1911 (Tunisia: Tunisi).
Nel presente lavoro sono descritte le seguenti dieci nuove specie del Nord Africa e delle Isole Canarie: *A. helenae* n. sp. (Algeria: Kabylia), *A. giachinoi* n. sp. (Algeria: Kabylia), *A. lisae* n. sp. (Algeria: Kabylia), *A. olmii* n. sp. (Isole Canarie: Gran Canaria), *A. ortegae* n. sp. (Isole Canarie: Tenerife), *A. boffai* n. sp. (Isole Canarie: Tenerife), *A. cavazzutii* n. sp. (Isole Canarie: Tenerife), *A. longicornis* n. sp. (Isole Canarie: Tenerife), *A. paglianoi* n. sp. (Isole Canarie: Tenerife), *A. scaramozzinoi* n. sp. (Isole Canarie: Tenerife). Sono descritti i caratteri diagnostici delle specie attribuite a questo genere e sono illustrati per la prima volta i genitali maschili di alcune specie. Viene ipotizzata, ma non proposta formalmente, la sinonimia del genere *Atomopria* con *Basalys* Westwood, 1832. Viene anche fornita una chiave per l'identificazione di tutte le specie, sia per le femmine, sia per i maschi. Infine, sono brevemente discusse alcune questioni relative alla tassonomia e alla biogeografia di questo genere.

Abstract: The genus *Atomopria* Kieffer, 1911 currently includes two only described species: *A. fulvicornis* Kieffer, 1911, from north-western Italy (Liguria) and *A. rufithorax* Kieffer, 1911, from Tunisia (Tunis).
The following ten new species are described from North Africa and Canary Islands: *A. helenae* n. sp. (Algeria, Kabylia), *A. giachinoi* n. sp. (Algeria, Kabylia), *A. lisae* n. sp. (Algeria, Kabylia), *A. olmii* n. sp. (Canary Islands, Gran Canaria), *A. ortegae* n. sp. (Canary Islands, Tenerife), *A. boffai* n. sp. (Canary Islands, Tenerife), *A. cavazzutii* n. sp. (Canary Islands, Tenerife), *A. longicornis* n. sp. (Canary Islands, Tenerife), *A. paglianoi* n. sp. (Canary Islands, Tenerife), *A. scaramozzinoi* n. sp. (Canary Islands, Tenerife). Diagnostic morphological features of representatives of this genus are described; male genitalia of some species are illustrated for the first time. The synonymy of the genus *Atomopria* with *Basalys* Westwood, 1832 is also hypothesized, but not proposed in this contribution. A key for identification of all species is provided, both for females and males. Finally, some taxonomic and biogeographic questions are briefly debated.

Key words: Hymenoptera; Diapriidae; *Atomopria*; revision; new species; Algeria; Canary Islands.

INTRODUCTION

The interest of the author of this contribution to Hymenoptera of the family Diapriidae arose from the regular occurrence of several representatives of this family in environments that he intensively explored in last decades: soil, humus, caves, upper hypogean zone and high altitude habitats. In these habitats, sifting soil or in pitfall traps, it is easy to meet diapriids (Decu *et al*., 1998; Casale & Focarile, 2009). For these reasons, the present contribution is dedicated to an interesting little known genus, the species of which are smallest in size, micropterous or apterous in both sexes, and seem to be exclusively forest soil-inhabiting in the Western Mediterranean and Macaronesian areas.

MATERIALS AND METHODS

The type material in MSNG of the species described so far (*A. fulvicornis* Kieffer, 1911 and *A. rufithorax* Kieffer, 1911) was examined. Type specimens of the new species here described were mostly collected by the author, colleagues and co-operators during two collecting travels to Algeria in 1981 and 1984, respectively, and to the Canary Islands in 1988. Further Canarian specimens were selected in the collections of the MCNT. For the new species here described, in some cases it was difficult to associate successfully males to females: this association was made only when males and females, from the same or close localities, showed agreeing morphological features. Diagnostic combinations and descriptions have been mostly based on characters of head, antennae, meso- and metasoma, and only secondly on colour and size, which in parasitoid Hymenoptera can be highly variable into the same species. In some cases, the scarceness of material made difficult to decide what

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differences are to be included in the range of specific variation: thus, some taxonomic information, concerning in particular the Canarian species, is not exhaustive, because or one of the sexes in some species is unknown, or is unrecognized. Male genitalia were dissected, washed in distilled water, cleared in cold KOH, dehydrated in ethanol, cleared in Xilene and examined and illustrated, using standard techniques before their definitive inclusion on microscope slides using Canada balsam mountant each attached to the respective specimen. Line drawings were made using a camera lucida attached to stereoscopic microscopes Wild M-3 and Wild M-5, and a microscope Leitz Orthoplan.

Acronyms

MCNT, Museo de Ciencias Naturales, Santa Cruz de Tenerife, Tenerife, Canary Islands.

MRSN, Museo Regionale di Scienze Naturali, Torino (provisionally deposited in the author's collection for study).

MSNG, Museo Civico di Storia Naturale "G. Doria", Genova, Italy.

A1, A2, A3, ..., antennal segments.

T2, second abdominal tergite, or large tergite of authors.

HT, Holotype

LT, PLT, Lectotype, Paralectotype

PT, PTT, Paratype, Paratypes

Atomopria Kieffer, 1910

Atomopria Kieffer, 1910: 695
Atomopria Kieffer, 1911: 875
Atomopria Kieffer, 1916: 28
Atomopria Johnson, 1992: 128
Atomopria Casale, 1995: 8.Type species: *Atomopria rufithorax* Kieffer, 1911 (by subsequent designation).

NOTE. Kieffer's work in Species des Hymenoptères d'Europe et d'Algérie was published in parts, with different dates: pp. 593-752 published on 1 March 1910, *Atomopria* was described without included species, this makes the name available and the date of *Atomopria* Kieffer, 1910; pp. 753-912 published on 1 March 1911, the generic description is continued, and *A. rufithorax* designated, and since the genus is made available in 1910, the type species designation in 1911 is not an original designation, but a subsequent designation.

DESCRIPTION. Female: Body smooth, shiny, scarcely pubescent. Wings vestigial or absent. Small size (body total length from 1 to 2 mm). Head elongate, markedly opisthognathous in lateral view; pubescence bordering back of head greyish or whitish, developed. Mandibles reduced. Palpi very short; palpal formula 5-3. Frons mostly with a distinct median tooth and lamelliform outgrowths. Malar space very wide, wider than the width of the eye. Eyes hairy, small, placed in anterior position; ocelli very small or vanished. Antennae 12-segmented, with abruptly differentiated, 3-segmented club. Mesosoma modified due to reduction of wings. Suture dividing prothorax from mesoscutum deep; mesoscutum flat, suture dividing mesoscutum from scutellum normally absent, slightly distinct only in *fulvicornis*. Notauli absent. Tegulae reduced; wings reduced, not reaching beyond the posterior margin of propodeum, or absent. Scutellum without basal pit (two smallest and superficial foveae are however hardly distinguishable in a male of *A. fulvicornis*). Propodeum medially glabrous, with low median keel. Femora dilated subapically; tarsi 5-segmented; protibial spur very long. Petiole often with rather long, whitish, scale-like hairs. T2 pubescent, occupying most of the length of metasoma, with front margin entire.

Male: Otherwise as in female. Body a little narrower and more elongate. Wings vestigial or absent. Antennae long, filiform, 14-segmented; flagellar segments with relatively short hairs; antennomere 4 without or with weak emargination, sometimes ending distally in a tooth (Figs. 9-18). Aedeagus as in Figs. 4, 29, particularly similar to those of *Spilomicrus* and *Basalys* (=*Loxotropa* Auct.) representatives (Teodorescu, 1970).

HOSTS AND ECOLOGY. Hosts unknown, but almost certainly puparia of Diptera. All specimens were collected sifting soil and rotting leaves in forest.

KEY TO SPECIES

Females (antennae 12-segmented)

1 - Frons with lateral projections and median tooth reduced or virtually missing (Figs.1-2) (species of the Mediterranean Area) 2

- Frons with lateral projection and median tooth very developed (Fig. 6) (species of the Canary Islands) 5

2 - Suture dividing mesoscutum from scutellum reduced but distinct; wings reduced to small stamps (Fig. 1) (Body reddish, head and metasoma brown or

piceous-black, mouth parts and antennae reddish yellow, legs testaceous) (Italy, Liguria)..........................
....1. ***fulvicornis*** **Kieffer, 1911**

- Suture dividing mesoscutum from scutellum fully absent; body apterous or brachypterous 3

3 - Antennal club blackish, as long as the rest of flagellum (Figs. 2, 5); petiole with dense, scale-like pubescence (body blackish, thorax and antennae, except the club, reddish) (Tunisia).......................................
....5. ***rufithorax*** **Kieffer, 1911**

- Antenna completely reddish or reddish yellow, at most with darkened apical club. Petiole almost glabrous on the dorsal side 4

4 - Smaller in size (body total length: mm 1.0); head (Fig. 23) from above with sides markedly constricted to the neck; eyes small, almost flat; antenna (Fig. 24) very short, antennal club large, wide, slightly shorter than the rest of flagellum; colour fully reddish yellow, only head and metasoma a little darkened (Algeria, Kabylia)..**4. *lisae* n. sp.**

- Larger in size (body total length: mm 1.51); head (Fig. 22) subquadrate, with almost parallel sides; eyes larger and very prominent; antenna (Fig. 19) long, antennal club less tickened, markedly shorter than the rest of flagellum; colour reddish, head and metasoma brownish (head and eyes with dense and long hairs) (Algeria, Kabylia)...........................**2. *helenae* n. sp.**

5 - Brachypterous; wings very reduced, reaching the middle of propodeum (antennal club, head and metasoma blackish; hairs of head and metasoma very long and decumbent) (Fig. 6) (Canary Islands: Gran Canaria) ....**6. *olmii* n. sp.**

- Wings absent 6

6 - Antennal club (Fig. 20) and metasoma reddish-brown, less contrasting in colour with flagellum, mesosoma and legs, which are yellow or reddish yellow; head from above short, subglobose (Fig. 21), brown or reddish-brown; small size (body total length: mm 1.00-1.03) (Canary Islands: Tenerife) ....
....**7. *ortegae* n.sp.**

- Antennal club and metasoma dark brown or blackish, more strongly contrasting in colour with flagellum and legs, which are yellow or reddish-yellow, and with the mesosoma, which is reddish-brown or ferrugineous. Head from above elongate, longer than wide, elongate or parallel sided, dark-brownish or black. Species larger in size (mm 1.50-1.87) 7

7 - Antennal club very large, globose; A 11 very transverse (Fig. 26); head strongly punctate-pubescent (Fig. 25) (Canary Islands: Tenerife)..................................
....**12. *scaramozzinoi* n. sp.**

- Antennal club smaller, with less transversal segments (Fig. 27) 8

8 - Metasoma very elongate; large T2 with gently arcuate sides (Fig. 7) (Canary Islands: Tenerife)..........
....**9. *cavazzutii* n. sp.**

- Metasoma shorter, egg shaped; large T2 very short and wide, with strongly arcuate sides (Fig. 8) (Canary Islands: Tenerife).........................**11. *paglianoi* n. sp.**

Males (antennae 14-segmented)

1. Suture dividing mesoscutum from scutellum distinct; alar stumps less reduced, reaching the apex of propodeum (Fig. 3); antennae long, segments from A5 to A13 about two times longer than wide (Fig. 4). Petiole with dense, long, whitish pubescence (relatively large sized species: body total length mm 1.84-2.00; head piceous black, mesosoma and metasoma brown, antennae and legs reddish) (Italy, Liguria) ....
....1. ***fulvicornis*** **Kieffer, 1911**

- Suture dividing mesoscutum from scutellum absent; alar stumps smallest, at least reaching the middle of the propodeum, or fully absent; antennae moniliform, segments from A5 to A13 as long as wide or a little longer than wide. Petiole with short pubescence, often reduced to the lateral sides.......................................2

2 - Frons with median tooth reduced or absent (micropterous or apterous species from Northern Africa)
....3

- Frons with developed median tooth (species from Canary Islands)...5

3 - Larger in size (body total length: mm 1.66); head from above with almost parallel sides; eyes very prominent; wings fully absent (colour reddish, with head markedly darker, piceous-black, and metasoma brownish) (Algeria, Kabylia)...........**2. *helenae* n. sp.**

- Smaller in size (body total length: mm 1.05-1.33); head from above with oblique or curved sides (colour fully reddish, at least with head and metasoma slightly darker, piceous brown) 4

4 - A4 shorter and thickened, slightly longer than A5, with deep emargination, ending distally in a weak tooth (Fig. 29); head from above subpentagonal (Fig. 28); larger in size (body total length : mm 1.21-1.33) (Algeria, Kabylia) ....**3. *giachinoi* n. sp.**

- A4 longer, 1.5 times as long as A5, with weak emargination distally rounded (Fig. 31); head from above subglobose (Fig. 30); smaller in size (body total length: mm 1.05) (Algeria, Kabylia).....**4. *lisae* n. sp.**

5 - Head from above narrow and very elongate, almost parallel sided (Fig. 32); A4 with distinct emargiunation, ending distally in a distinct tooth (colour reddish yellow, head and metasoma darkened, piceous brown; antennal segments from A5 to A14 slightly darkened) (Canary Islands, Tenerife)...................**8. *boffai* n. sp.**

- Head from above wider and shorter (Figs. 35, 37, 39); A4 without or with very weak emargination.....6

6 - Head from above subglobose, reddish brown as the metasoma, slightly contrasting in colour with thorax, antennae and legs, which are yellow or reddish, the latter at least darkened from A5 to A13. A4 slightly or not emarginated (Fig. 34). Small size (mm 1.15-1.21) (Canary Islands, Tenerife) ....**7. *ortegae* n. sp.**

- Head from above markedly elongate, dark piceous or blackish as the metasoma, and markedly contrasting in colour with the reddish thorax and the yellow legs 7

7- Head from above almost parallel sided (Fig. 37); A4 with deep emargianation in the basal half (Fig. 38); metasoma elongate, markedly longer than mesosoma; larger size (mm 1.81) (Canary Islands, Tenerife) ....**12. *scaramozzinoi* n. sp.**

- Head from above distinctly constricted to the neck; A4 without or with weak, oblique emargination in the basal half; metasoma small sized, short, egg-shaped, not longer than mesosoma; smaller size (mm 1.30-1.42)...8

8- Head posteriorly with more markedly constricted sides (Fig. 35); antennae thin, elongate, as long or longer than body, with segments from 4 to 7 about twice as long as wide; A4 without distinct emargination (Fig. 36) (Canary Islands, Tenerife) ....**10. *longicornis* n. sp**.

- Head posteriorly with slightly constricted sides (Fig. 39); antennae markedly shorter and thicker, shorter than body, with segments from 5 to 8 moniliform, 1.30-1.50 times longer than wide; A4 with distinct, basal oblique emargination (Fig. 40).......................***cavazzutii* n. sp.**

1. *Atomopria fulvicornis* Kieffer, 1911

A. Fulvicornis Kieffer, 1911: 877
A. fulvicornis Kieffer, 1916: 28
A. fulvicornis Johnson, 1992: 129
A. fulvicornis Casale, 1995: 8

Loc. typ.: Italy, Liguria: Leivi.

Type material: LT female here designated (selected but not designated by Ghesquière, in litt.) “Leivi XII - [18]98 Solari” “Atomopria fulvicornis” [handwritten by Kieffer] “Holotypus ♀” “Atomopria fulvicornis Kieffer, J. Ghesquière rev., 1959”; PLTT here designated 2 males “Ruta, Liguria 14-XI-[1]902 A. Dodero” “Atomopria fulvicornis” [handwritten by Kieffer] “Allotypus ” (MSNG).

Further material examined (besides the type material): 1 male, 1 female: Liguria, “M. di Portofino (Genova) 19.V.1982 G. Bartoli”; 1 female “La Spezia, Villagrossa, m 600, 7.IV.1985, N. Sanfilippo”; 1 female “Liguria, Gattorna (GE) 26.01.1997 M.B. Invernici” (MSNG).

Description. Female: (Fig. 1) Body total length: mm 1.83. Brachypterous. Colour mostly dark-brown or blackish, shiny; thorax, antennae and mouth-parts reddish; legs yellow. Head globose, with gently rounded sides; frons glabrous, wide, sub-triangular, smooth, with prominent anterior angles; median tooth obsolete; ocelli not distinct. Suture dividing mesoscutum from scutellum superficial but distinct; wings very shortened, not reaching the posterior angles of propodeum. Metasoma narrow, elongate, tapered to apex; petiole with dense, whitish, scale-like pubescence; large 12 with scarce, long, decumbent hairs.

Male: Body total length: mm 1.84-2.00. Agreeing with female in general features, but differing in the following: body narrower and slender, pronotal pubescence with longer, decumbent hairs. Head larger and more globose; frons with a distinct tooth on the posterior angle of the triangular frontal depression. Antennae as in Fig. 4; A4 with weak but distinct, arcuate emargination. Suture dividing mesoscutum from scutellum deeper; wings as reduced as in female, but a little narrower, scale-like. In one specimen, there are two smallest foveae at the base of scutellum (Fig. 3).

Remarks. This species is very interesting both for having the most plesiomorphic characters in the genus (suture dividing mesoscutum from scutellum distinct, wings atrophic but evident) and for being the only species known from Europe, in NW Italy, apparently endemic to Liguria, in a relict area of the northern Tyrrhenian region.

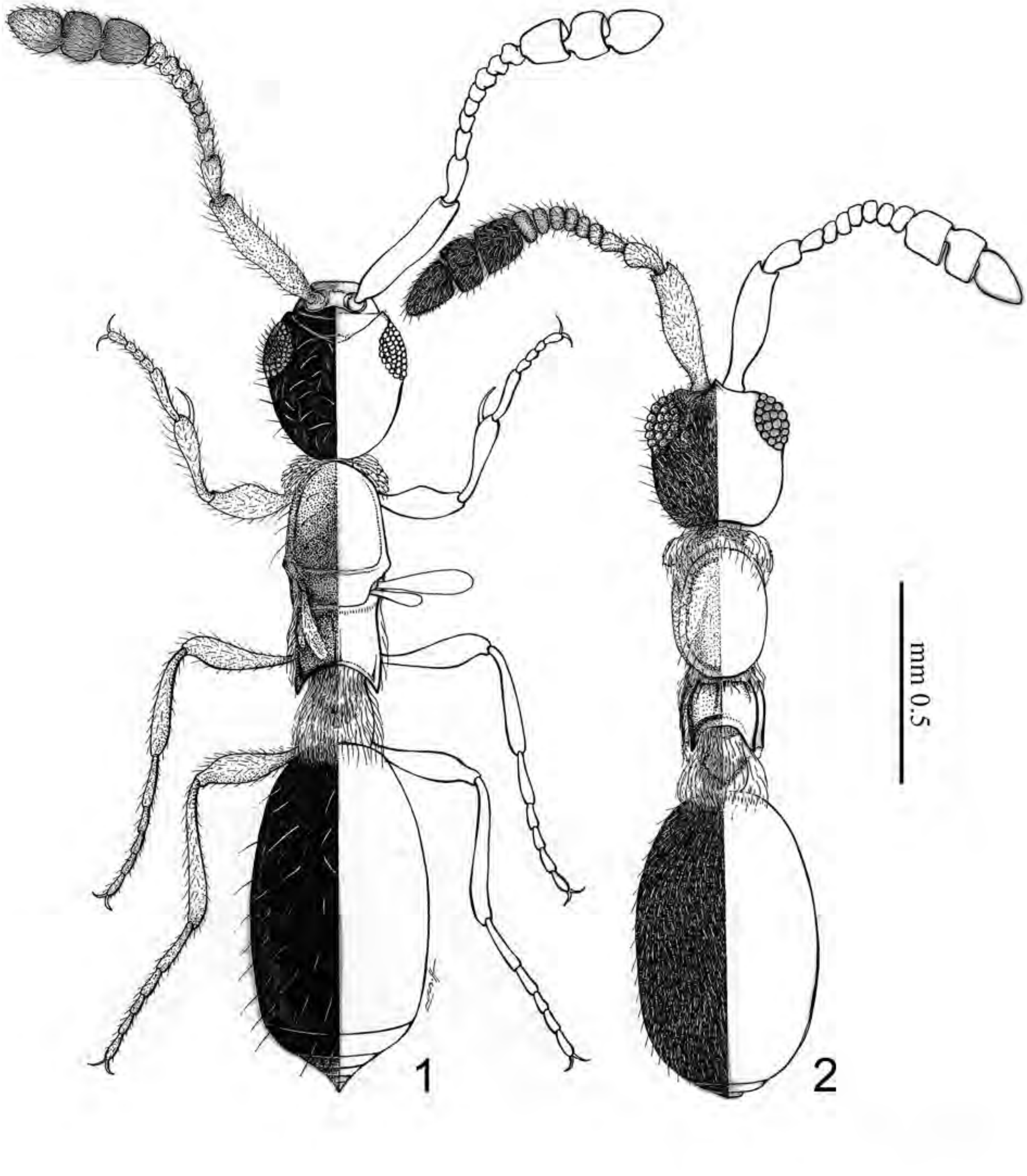
Distribution. Italy, Liguria.

All specimens were collected in woods, sifting soil and rotting leaves.

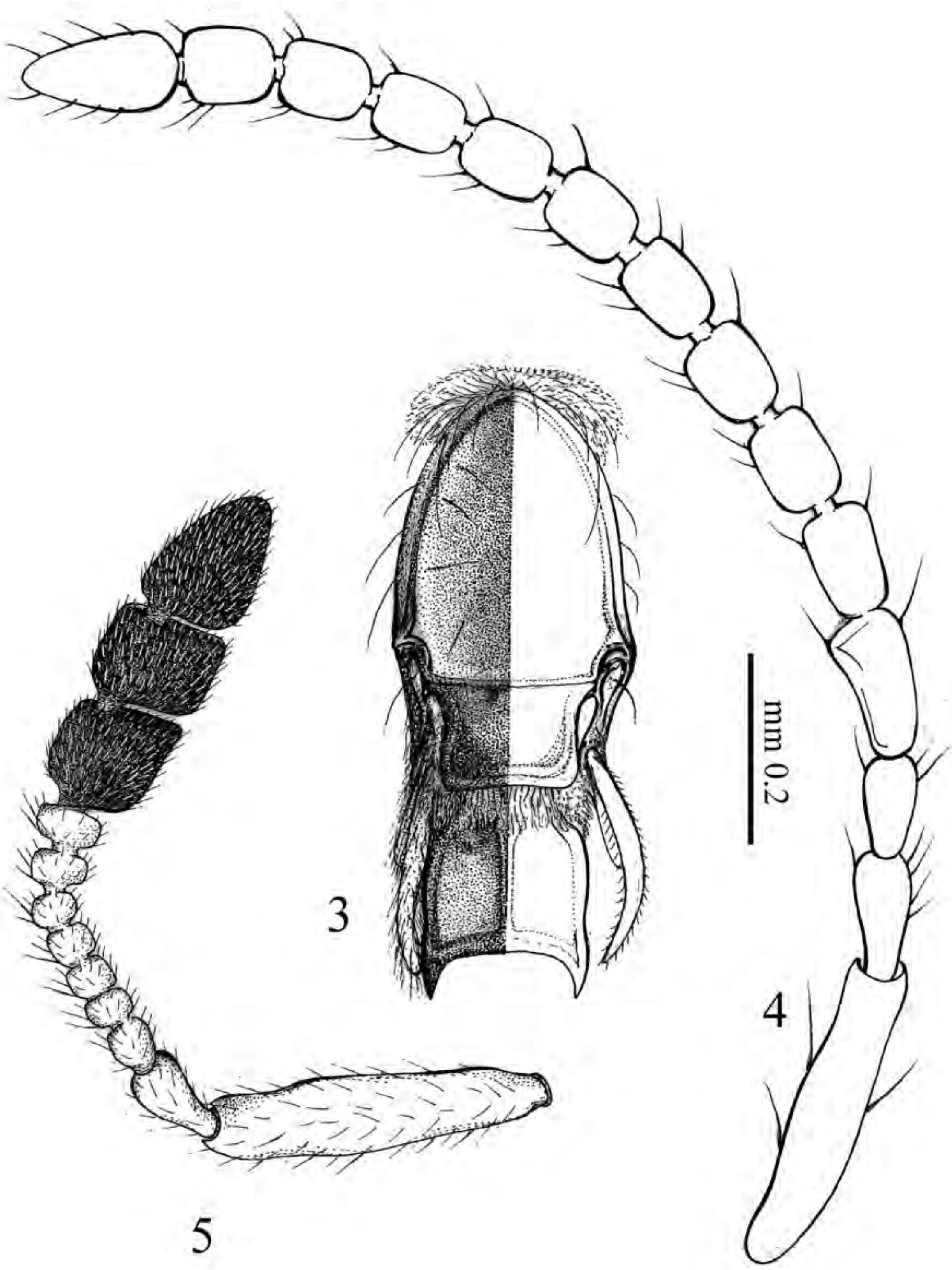
2. *Atomopria helenae* n. sp.

Loc. typ.: Algeria, Jijel, Forêt de Guerrouch.

Type material: HT female “Algeria, Jijel, Ft. de



Figs. 1-2. *Atomopria* spp., females, habitus in dorsal aspect. 1: *A. fulvicornis*, female holotype; 2: *A. rufithorax*, female holotype.



Figs. 3-5. *Atomopria* spp., males and females. 3: *A. fulvicornis*, male paralectotype, thorax in dorsal aspect; 4: idem, antenna; 5: *A. rufithorax*, female holotype, antenna.

Guerrouch m 1200, 4/10-XI-1984" (Algeria 1984. A. Casale leg.; 1 PT male "Algeria, Piccola Kabilia, Ft. d'Akfadou 12-XI-1984" (MRSN).

Specific epithet. I wish to dedicate this new species to Elena Gavetti (in Latin: *Helena*), Curator of zoological collections at the MRSN, for her support in collecting specimens in the mountains and forests of Algeria.

Description. Female: Body total length: mm 1.51. Wings fully absent. Colour mostly reddish, head and metasoma brownish; legs reddish-yellow. Head (Fig. 22) elongate, with almost parallel sides and long, sparse, decumbent hairs; frontal tooth small; eyes relatively large, prominent. Antennae long (Fig. 19): A1 as long as flagellum excluding the antennal club; joints from A4 to A8 each about as long as wide. Propodeum with well developed median carina. Petiole as long as the propodeum; metasoma elongate-oval. T2 with sparse, very long hairs.

Male: Body total length: mm 1.66. Agreeing with the female in the general characters, but differing in the following: head blackish, a little shorter and more globose. Antennae yellow, very elongate; A4 with distinct, deep emargination. Aedeagus as in Figs. 9-11.

Remarks. Well distinct among the North African species known so far for the relatively large size and the morphological characters described above and in the keys. The association of the male with the female is not sure, the different sexes coming from two different localities which are, however, close each to other and ecologically very similar. So, the accordance of the respective characters make this association very likely.

Distribution. Algeria, Lesser Kabylia: Jijel, Guerrouch Forest; El Kseur, Akfadou Forest.

Specimens were collected at 1000-1200 m, sifting soil in oak forest.

3. ***Atomopria giachinoi*** **n. sp.**

Loc. typ.: Algeria, Djurdjura, Tala Guilef.

Type material. HT male "Algeria, Djurdjura, Tala Guilef m 1100, 30/31-X -1/XI – 1984" (Algeria 1984, A. Casale leg.); 1 PT male (same as holotype) (MRSN).

Specific epithet. I wish to dedicate this new species to Pier Mauro Giachino, good friend and estimated entomologist, for his support in collecting specimens in the mountains and forests of Algeria and many other areas.

Description. Male: Body total length: mm 1.21-1.33. Micropterous. Colour mostly reddish yellow, with head and metasoma darkened, reddish brown. Head short, from above subpentagonal, with sides narrowed to the neck (Fig. 28); eyes prominent. Antennae long, joints from A5 to A13 about 1 time ½ longer than wide; A4 relatively short, hardly longer than A5, with distinct, curved emargination, ending distally in a weak tooth (Fig. 29). Wings reduced to small scales, not reaching the apex of the propodeum. Metasoma egg-shaped, relatively short, scarcely pubescent. Aedeagus as in Figs. 15-17.

Female: unknown.

Remarks. A well characterized species, easily distinguishable from the other North African species for the peculiar structure of head, antennae and aedeagus (see figures and key).

Distribution. Algeria, Djurdjura massif, Tala Guilef, 1100 m. The specimes were collected sifting soil in forest of *Cedrus atlantica*.

4. ***Atomopria lisae*** **n. sp.**

Loc. typ.: Algeria, Jijel, Guerrouch forest.

Type material. HT female "Algeria, Jijel, F.t. de Guerrouch m 1200. 4/10 - XI – 1984" (Algeria 1984. A. Casale leg.); 1PT male, same as holotype (MRSN).

Specific Epithet. I wish to dedicate this new species to my dear friend Lisa Levi, former Curator of zoological collections at the MRSN, for her support in collecting specimens in the mountains and forests of Algeria, and elsewhere.

Description. Female: Body total length: mm 1.00. Apterous. Colour yellow reddish; head and metasoma a little darkened, reddish; legs and antennae yellow, only the antennal club slightly darkened. Head from above elongate, with lateral sides narrowed to the neck (Fig. 23). Eyes very small, almost flat. Frontal tooth small but evident. Antennae (Fig. 24) very short; joints from A4 to A9 strongly transverse, about 3 times as wider as long. Propodeum with longitudinal carina and posterior angles very reduced. Petiole small, transverse. Metasoma egg-shaped; T2 with gently curved lateral sides.

Male: Body total length: mm 1.05. Agreeing with the female in the general characters, but differing in the following: body more slender. Head subglobose (Fig. 30). Eyes larger. Antennae moderately elongate, entirely yellow testaceous; A4 relatively long, 1,5 times as long as A5, with a weak, oblique emargination, not ending distally in a tooth (Fig. 31). Aedeagus as in Fig. 12.

Remarks. A well characterized species, markedly distinct from all other North African species by the smallest size, and other features stressed in key and description.

DISTRIBUTION. Algeria, Lesser Kabylia: Jijel, Guerrouch forest, m 1200 about. The specimens were collected sifting soil in oak-forest (*Quercus* spp.).

5. ***Atomopria rufithorax*** Kieffer, 1911

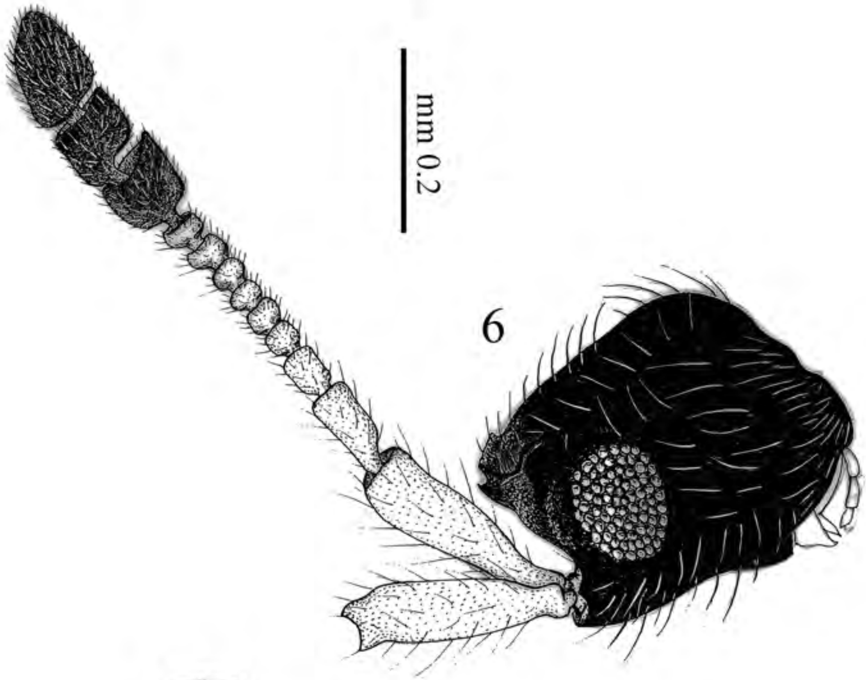
A. Rufithorax Kieffer, 1911: 877.
A. rufithorax Kieffer, 1916: 28
A. rufithorax Johnson, 1992: 129
LOC. TYP.: Tunisie
TYPE MATERIAL. HT female "Tunisi dint. 19-I-1883. Miceli" "Atomopria rufithorax K." "Typus", "Atomopria rufithorax Kieff. J. Ghesquière rev., 1959 (MSNG).
DESCRIPTION. Female: (Fig. 2) Body total length: mm 1.80 (HT). Apterous. Color mostly blackish; thorax, mouth parts and antennae (except the club) yellow reddish; antennal club black; legs yellow. Teguments shiny. Head relatively short and wide, with gently rounded sides; ocelli almost fully reduced; frontal tooth well distinct. Antennae short; antennal club very large, wide, about as long as the rest of flagellum (Fig. 5).
Propleurae and petiole with dense, greyish, scale-like pubescence. Metasoma short and wide, egg-shaped; T2 with slightly arcuate sides.
Male: unknown.
REMARKS. Relatively isolated among the North African species known so far, *A. rufithorax* seems to be related, for the general shape of body, antennae, and the colour pattern, to some Macaronesian species, as *A. scaramozzinoi* and *A. paglianoi*, both from Tenerife (Canary Islands).
DISTRIBUTION. Tunisia, near Tunis (MSNG).

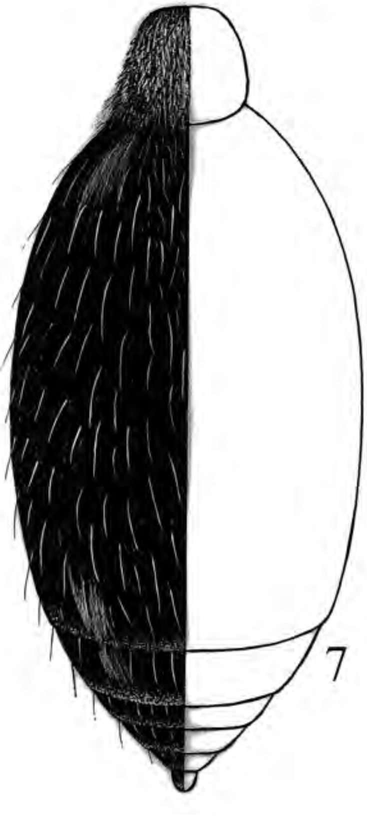
6. ***Atomopria olmii*** n. sp.

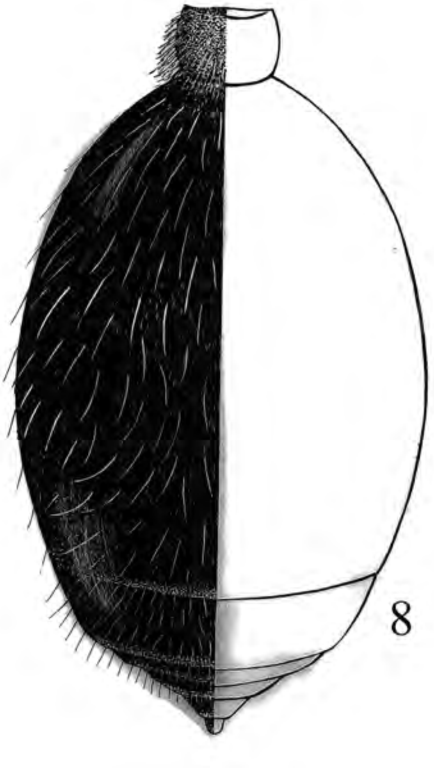
LOC. TYP.: Spain, Canary Isl., Gran Canaria: Pozo de la Nieve.
TYPE MATERIAL: HT female "Gran Canaria. Pozo de la Nieve m 1600. 11. III. 1988. A. Casale leg." (MRSN).
SPECIFIC EPITHET. I wish to dedicate this new species to my good friend Massimo Olmi, estimated entomologist and specialist of Hymenoptera Dryinidae of the world, for his support in collecting specimens in the Canary islands and other areas.
DESCRIPTION. Female: Body total length: mm 1.45 (HT). Wings reduced to small, narrow scales reaching the base of propodeum. Colour mostly brown reddish, with head and metasoma blackish and antennal club chestnut brown; legs and antennae (excl. joints from A10 to A12) yellow orange. Head (Fig. 6) large, elongate, with almost parallel sides; frons with median tooth and lateral projections very prominent; eyes small, a little prominent; ocelli evident. Antennal club shorter than flagellum; joints A10 and A11 about as longer as wide.
Mesoscutum relatively large, with five pairs of bristles; short, dense, whitish pubescence.
Metasoma very narrow and elongate, almost truncate at the apex; large T2 with almost parallel sides and with scarce, but long yellowish hairs.
Male: unknown.
REMARKS. This taxon is well characterised, amongst the other Canarian species (all from Tenerife), by the persistence of alar stumps in female.
DISTRIBUTION. *A. olmii* is so far the only known species from Gran Canaria. The HT was collected by pit traps in *Pinus* forest.

7. ***Atomopria ortegae*** n. sp.

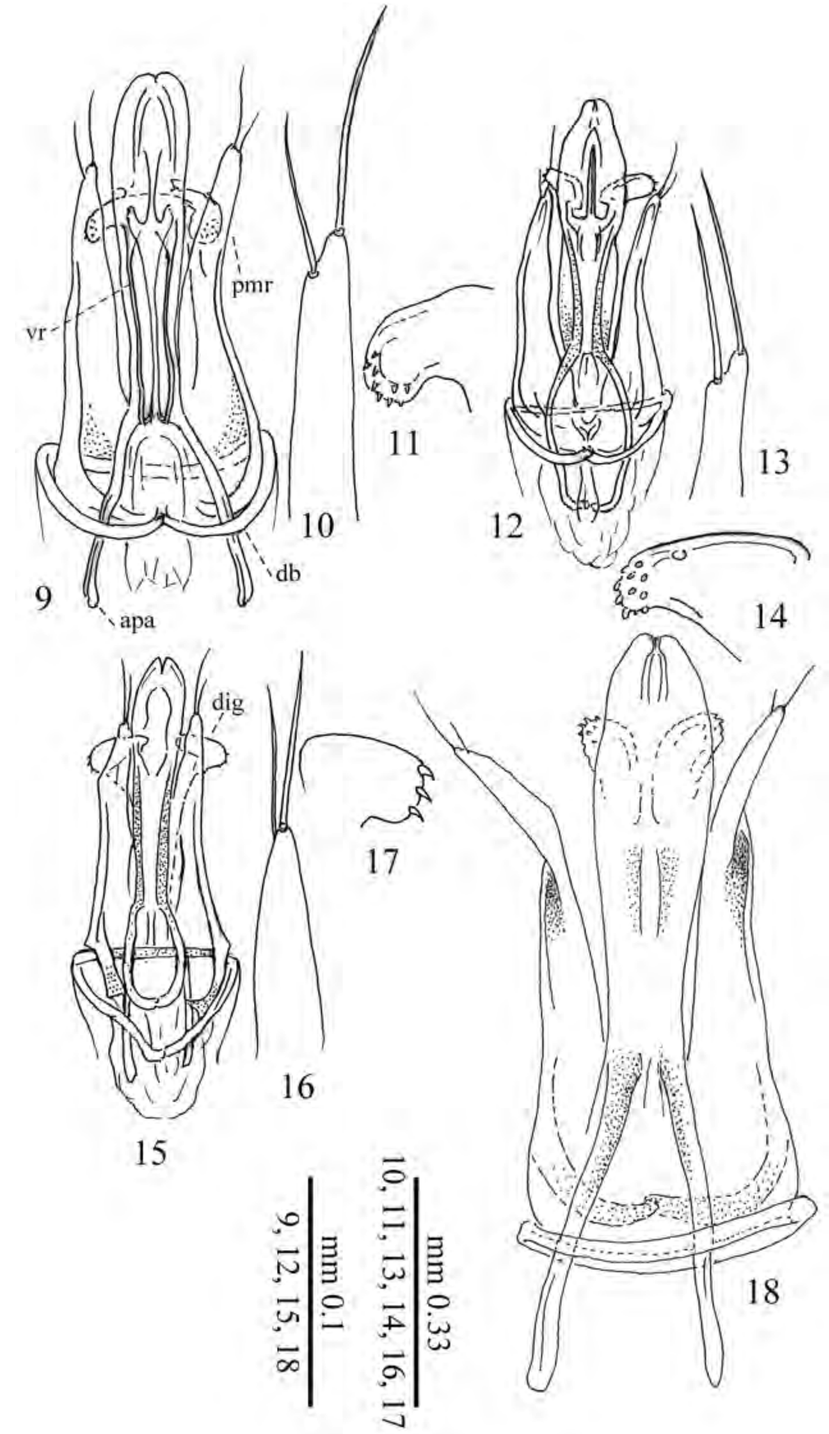
LOC. TYP.: Spain, Canary Isl., Tenerife, Mt. Los Silos
TYPE MATERIAL. HT female, Mt. Los Silos 12 - 3 - 1985. A. Aguiar » (MCNT); PTT: 2 females, Erjos, M. de l'Agua m 1200 23. III. 1988. A. Casale " (MRSN); 1 male "Bailadero 9. XII. 1962. R. Arozarena"; 1 male "M.te Aguirre. 6. VI. 1965. R. Arozarena" (MCNT); 1 male "Erjos, M. de l'Agua m 1200 23. III. 1988 A. Casale" (MRSN).
SPECIFIC EPITHET. I wish to dedicate this new species to Gloria Ortega, curator of the entomological collections at the MCNT, for having provided in 1988 important material and support in my investigations in Canary Islands.
DESCRIPTION. Female: Body total length: mm 1.00-1.03. Colour reddish yellow; head, metasoma and antennal club brownish, poorly contrasting in colour with the mesosoma. Head (Fig. 21) from above relatively short, subglobose, with gently rounded sides; eyes small, almost flat; ocelli very reduced, frontal tooth and lateral projection poorly developed. Antennal club less sharply widened than in the other Canarian species, about as long as A1 and shorter than the rest of flagellum (Fig. 20). Pronotum, propodeum and petiole only with scarce, short pubescence. Metasoma elongate oval; T2 with gently arcuate sides, and with long, scarce, decumbent hairs.
Male: Length mm 1.15-1.21. Agreeing with the female in the general characters, but differing in the following: antennae long, as long as the body or a little longer; A4 and A5 about as long as the pedicel; A6-







Figs. 6-8. *Atomopria* spp. 6: *A. olmii* n. sp., female holotype, head in lateral aspect; 7: *A. cavazzutii* n. sp., female holotype, gaster; 8: *A. paglianoi* n. sp., female holotype, gaster.



Figs. 9-18. *Atomopria* spp., male genitalia in dorsal aspect. 9: *A. helenae* n. sp., male paratype, aedeagus; 10: idem, apex of paramere; 11: digitus; 12: *A. lisae*, male paratype, aedeagus; 13: idem, apex of paramere; 14: idem, idem, digitus; 15: *A. giachinoi*, male paratype, aedeagus; 16: idem, apex of paramere; 17: idem, digitus; 18: *A. cavazzutii* n. sp., male paratype, aedeagus. Acronyms: apa, apodeme of aedeagus; db, dorsal bridge of basal ring; dig, digitus; pmr, paramere; vr, volsellar ridge.

A8 about two times as long as wide; A9-A13 one time and 1/2 as long as wide; A4 hardly or not emarginate in the basal half (Fig. 34).
REMARKS. This small sized, peculiar species seems to be very isolated among the other Canarian *Atomopria* species, and could be more closely related to the species from Algeria described above.
DISTRIBUTION. Canary Islands, Tenerife, rather largely distributed along the Laurisilva zone in the North of the island, from the NW (Teno massif) to the NE (Anaga massif): Mt. Agua, Mt. los Silos, Mt. Aguirre, Mt. Anaga: El Bailadero (MRSN, MCNT).

8. *Atomopria boffai* n. sp.
LOC. TYP.: Spain, Canary Isl., Tenerife: Mt. Agua.
TYPE MATERIAL. HT male "Canarie, TF, Erjos, Mt. Agua m 1200, 23. III. 1988. A. Casale leg." (MRSN)
SPECIFIC EPITHET. I wish to dedicate this new species to my friend Giovanni Boffa, painter and entomologist, former curator of entomological collections at the MRSN, for his support in collecting specimens in the mountains and forests of Algeria and in many other areas.
DESCRIPTION. Male: Body total length: mm 1.33. Colour mostly reddish yellow; head and metasoma blackish brown; antennae reddish yellow, a little darkened from A5 to A14. Integuments shiny, with fine but distinct granulose microsculpture, particularly evident on head and mesoscutum. Wings fully absent.
Head very narrow, elongate, longer than wide, with almost parallel sides (Fig. 32); eyes small, moved to anterior position, a little prominent; ocelli very reduced. Median tooth and lateral projections of frons very prominent. Antennae relatively short and thickened, with joints from A8 to A13 strongly transverse; A4 with a distinct emargination, ending distally in a weak tooth (Fig. 33). Mesoscutum about two times as longer as wide, convex. Metasoma relatively narrow, elongate oval; T2 with gently arcuate sides.
Female: unknown.
REMARKS. Apparently related to *A. scaramozzinoi* n. sp. described below, *A. boffai* n. sp. is however peculiar amongst the Canarian species for the strongly elongate, narrowed head and for the structure of antennae, with A4 deeply emarginate and apical joints very transverse. The only known male comes from the north-western part of Tenerife, where the species is sympatric with *A. scaramozzinoi, A. ortegae* and *A. cavazzutii.*
DISTRIBUTION. Canary Island: Erjos, Mt. Agua m 1200, in Laurisilva forest.

9. *Atomopria cavazzutii* n. sp.
Loc. typ.: Spain, Canary Isl., Tenerife: Mt. Agua.
TYPE MATERIAL. HT male " Canarie, TF, Erjos, Mt. Agua m 1200. 23.III: 1988. A. Casale leg. " (MRSN); PTT: 2 females , 3 males, same as holotype (MRSN, MCNT).
Specific epithet. I wish to dedicate this new species to my good friend Pierfranco Cavazzuti, estimated carabidologist, for his support in collecting specimens in both Algeria and Canary Islands, and in many other areas.
DESCRIPTION. Female: Body total length: mm 1.56-1.87. Wings fully reduced. Colour mostly reddish with abdominal T2 dark brown; head and antennal club blackish; rest of antenna and legs reddish yellow. Head from above elongate, with almost parallel sides; frons with median tooth and lateral projection very prominent; eyes small, in anterior position, a little prominent; ocelli very small but evident. Antennae relatively short; joints from A4 to A9 transverse, about 2 times as wider as long; antennal club less thickened than in *scaramozzinoi*, joints A10 and A11 about as long as wide. Mesoscutum narrow, about 2 times as longer as wide. Petiole with short, dense, whitish pubescence on lateral sides. Metasoma narrow and very elongate; T2 with its largest width about at middle, covered by relatively long, decumbent hairs (Fig. 7).
Male: Body total length: mm 1.30-1.36. Head as in Fig. 39. Agreeing to the female in the general characters, but differing in the following: antenna long, about as long as the body; joints from A1 to A3 yellow, from A4 to A13 a little darkened, reddish or reddish brown; joints from A5 to A8 moniliform, shorter than in *longicornis*, 1.30-1.50 times longer than wide; A4 with an oblique, very weak but distinct emargination in the basal half (Fig. 40). Aedeagus as in Fig. 18.
REMARKS. Closely related to *A. longicornis*, of which it seems to be the western substitute in Teno Massif (N.W. Tenerife).
DISTRIBUTION. Canary Islands, Tenerife, Mt. Agua. Sampled only in Laurisilva forest by pit-traps.

10. *Atomopria longicornis* n. sp.
LOC. TYP.: Spain, Canary Isl., Tenerife: Taganana.
TYPE MATERIAL. HT male "Vueltas Taganana 28. 2.

1989 A. Agular"; PT: 1 male, same as holotype, "26. 2. 1976, J.M. Fernandez" (MCNT).

SPECIFIC EPITHET. The name *longicornis* (= long-horned) stresses the main diagnostic feature of this new taxon in males.

DESCRIPTION. Male: Wings absent. Length mm 1.36-1.42. Mesosoma, legs and joints from 1 to 13 of antenna yellow; head dark brown or blackish, metasoma and antennal joints from A4 to A13 chestnut-brown or dark reddish. Head (Fig. 35) from above elongate, densely punctate-pubescent, about twice as long as wide, with narrowed sides to the neck constriction; antenna thin, long, as long or longer than body, with joints from A4 to A7 subcylindrical, about twice as long as wide (Fig. 36); A4 without or with almost indistinct emargination.

Scutellum, lateral sides of propodeum, and base of T2 at the sides with dense, short, scale-like whitish pubescence; T2 dorsally only with scarce, long, decumbent hairs.

Female: unknown.

REMARKS. A specific separation of *A. longicornis* n. sp. from *A. cavazzutii,* described above, is uncertain, the scarce material making difficult a correct evaluation of a possible intraspecific variation. Some of the morphological characters indicated in keys and description, as the shape of head and antennal joints, seem rather important to maintain at moment this separation. The discovering of females of *A. longicornis* could furnish new, important information about the taxonomic status of these two allopatric, closely allied taxa.

DISTRIBUTION. Tenerife, Taganana region.

11. *Atomopria paglianoi* n. sp.

LOC. TYP.: Spain, Canary Isl., Tenerife: Aguamansa.

TYPE MATERIAL. HT female "Canarie, Tenerife. Aguamansa. 22. III. 1988. A. Casale leg."; PT 1 female, same as holotype (MRSN).

SPECIFIC EPITHET. I wish to dedicate this new species to my good friend Guido Pagliano, well known and estimated specialist of Hymenoptera, for his support in collecting specimens in the forests of Algeria and in other localities.

DESCRIPTION. Female: Body total length: mm 1.50-1.68. Wings absent. Colour mostly reddish brown, with T2 chestnut brownish; head blackish, antennal club dark brown or blackish, legs and antennal joints from A1 to A9 yellow reddish. Head from above elongate, with almost parallel sides; eyes prominent; ocelli relatively large and distinct; median tooth and lateral projections of frons well developed. Antennal club relatively small (as in *cavazzutii*: see Fig. 27); A10 about as wide as long, A11 weakly transverse. Pronotum, lateral sides of propodeum and petiole with short, dense, whitish pubescence. T2 peculiarly short and wide, with very scarce, decumbent hairs (Fig. 8).

Male: unknown.

REMARKS. Probably close to *A. cavazzutii, A. paglianoi* is however markedly distinct from any other *Atomopria* species for the peculiar shape of abdominal T2 and for other characters made evident in both the key and description.

DISTRIBUTION. Canary Islands, Tenerife, Aguamansa. It is noticeable that the only two known females of this species were obtained from a relatively xeric *Pinus* forest, though the other congeneric species in Tenerife were collected in Laurisilva, or in other wet plant association.

12. *Atomopria scaramozzinoi* n. sp.

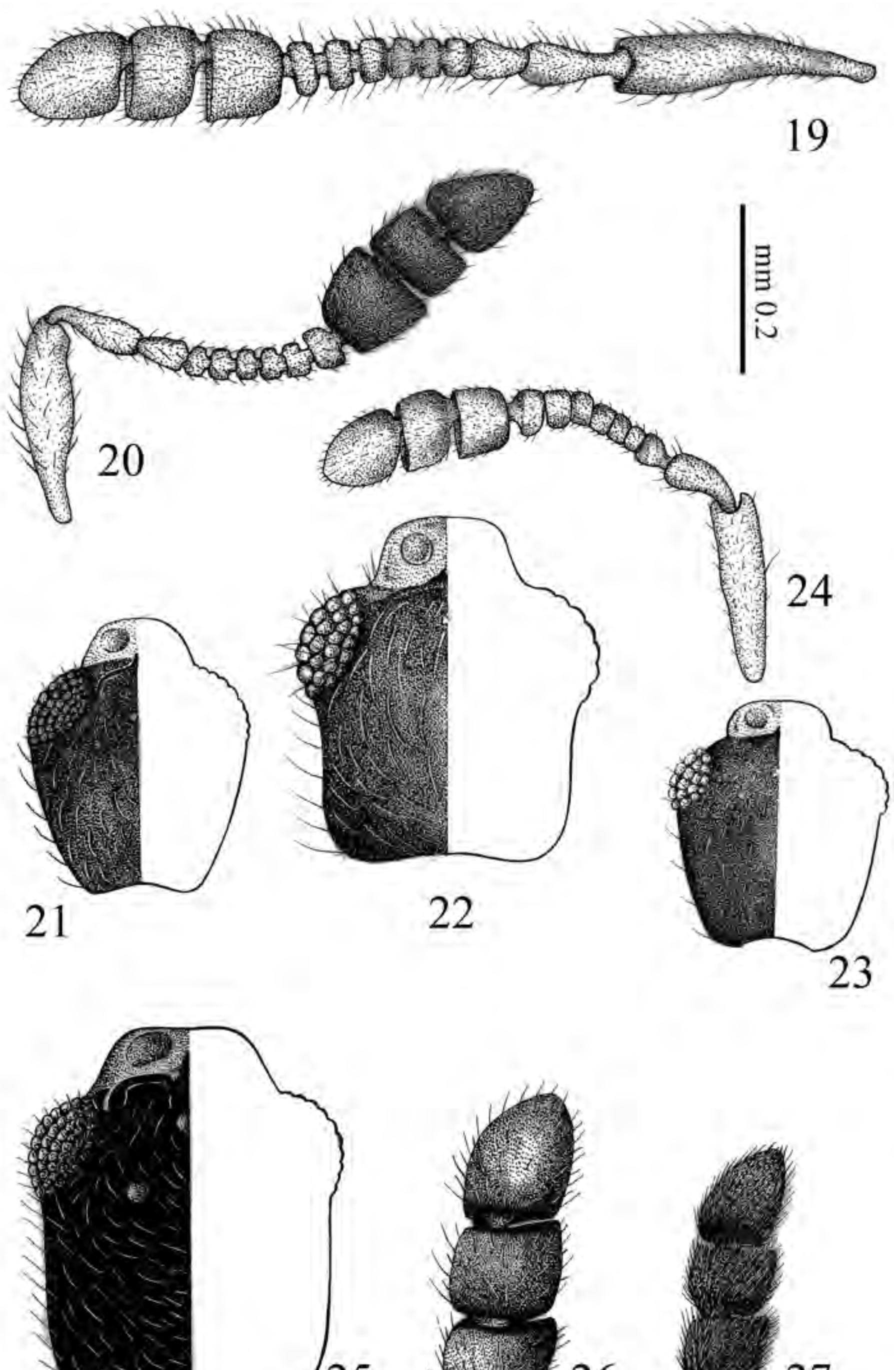
LOC. TYP.: Spain, Canary Isl., Tenerife: Mt. Aguirre.

TYPE MATERIAL. HT female "Tenerife Me Aguirre 6. VI. 1965 R. Arozarena" (MCNT); PT: 1 male "TF Erios.- M. Agua m 1200 23.III:1988. A. Casale leg." (MRSN).

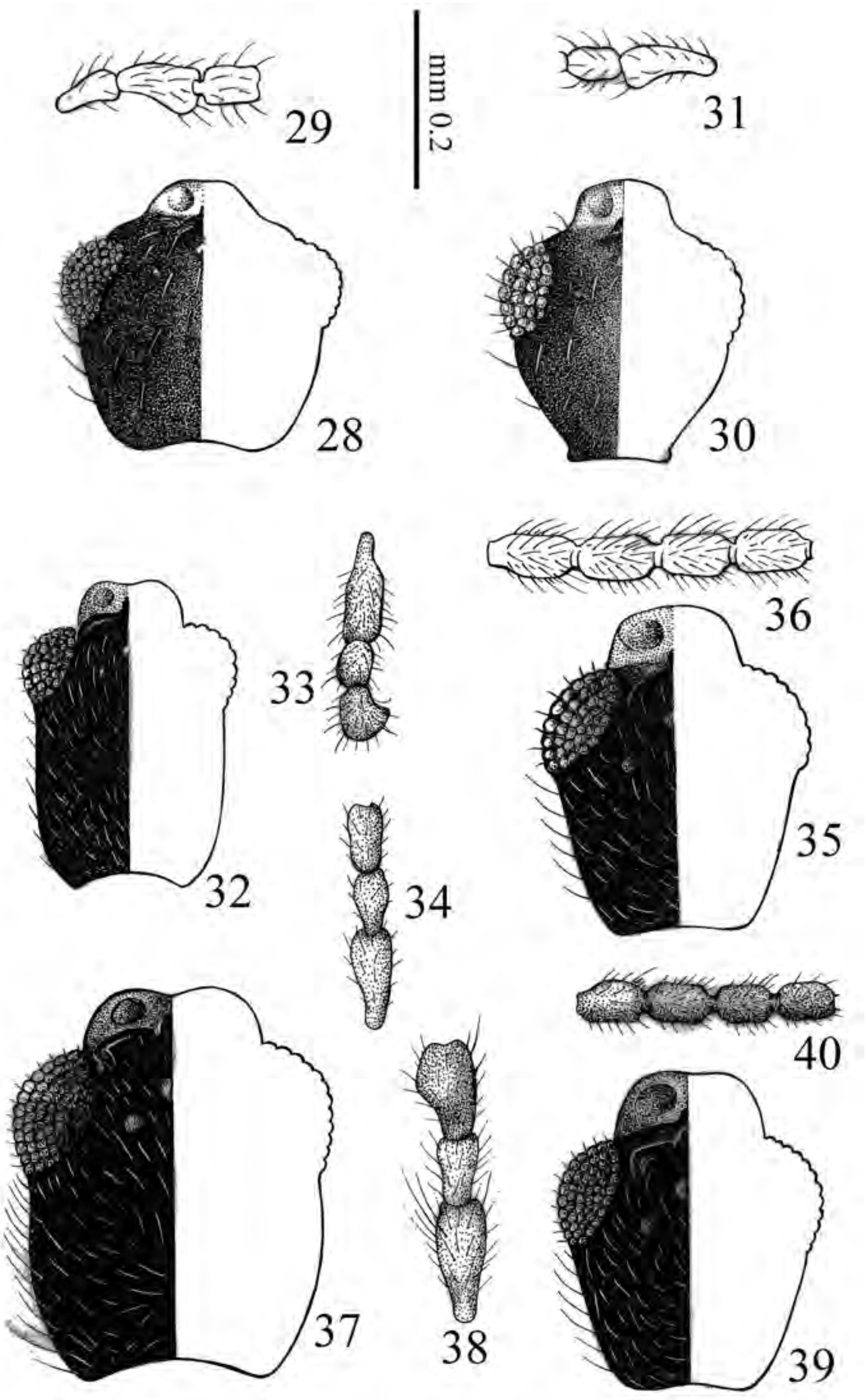
SPECIFIC EPITHET. I wish to dedicate this new species to Pierluigi Scaramozzino, specialist in Hymenoptara Ichneumonidae, former curator of entomological collections at the MRSN, for his support in collecting specimens in Algeria, Canary Islands and in other areas.

DESCRIPTION. Female: Body total length: mm 1.79. Wings absent. Colour mostly reddish, with head, abdominal T2 and antennal club dark brown; legs orange-yellow. Head (Fig. 25) relatively large, sub-rectangular, strongly punctuate-pubescent, with parallel lateral sides, bent to the neck constriction. Frons with well developed median tooth and lateral projections. Eyes prominent; ocelli distinct. Antennal club (Fig. 26) very large, subglobose; A11 strongly transverse. Pronotum, lateral sides of propodeum and petiole with rather dense, short, whitish pubescence. Abdominal T2 very large, elongate ovoid, truncate at apex, with relatively long, decumbent hairs.

Male: Body total length: mm 1.81. Agreeing with female in the general characters. Head blackish (Fig. 37). Antennae relatively robust, reddish yellow at the base from A1 to A3, darkened from A4 to A14; A4 (Fig. 38) with a distinct emargination in the basal half.



Figs. 19-27. *Atomopria* spp., females, head in dorsal aspect and antennae. 19: *A. helenae* n. sp., female holotype, antenna; 20: *A. ortegae* n. sp., female holotype, antenna; 21: idem, head; 22: *A. helenae* n. sp., female holotype, head; 23: *A. lisae* n. sp., female holotype, head; 24: idem, antenna; 25: *A. scaramozzinoi*, female holotype, head; 26: idem, antennomeres 10-12; 27: *A. cavazzutii* n. sp., female holotype, antennomeres 10-12.



Figs. 28-40. *Atomopria* spp., males, head in dorsal aspect and antennomeres. 28: *A. giachinoi* n. sp., male paratype, head; 29: idem, antennomeres 3-5; 30: *A. lisae* n. sp., male paratype, head; 31: idem, antennomeres 4-5; 32: *A. boffai* n. sp., male holotype, head; 33: idem, antennomeres 2-4; 34: *A. ortegae*, male paratype, antennomeres 4-6; 35: *A. longicornis* n. sp., male holotype, head; 36: idem, antennomeres 4-7; 37: *A. scaramozzinoi* n. sp., male paratype, head; 38: idem, antennomeres 2-4; 39: *A. cavazzutii* n. sp., male paratype, head; 40: idem, antennomeres 4-7.

REMARKS. Though not collected together, the male and female described above are attributed, with a high degree of probability, to the same species: morphological characters of the two specimens are respectively according, and the localities of found are both located in Teno Massif (NW Tenerife).

DISTRIBUTION. Tenerife, in the north-western Teno massif, collected sifting soil and in pit-traps in Laurisilva forest.

TAXONOMY AND BIOGEOGRAPHIC NOTES

Owing to its morphological features, the genus *Atomopria* is obviously very close to genus *Basalys* Westwood, 1833 (=*Loxotropa* auct. nec Förster), of which it appears as a very apomorphic sister group, or a clade derived from within *Basalys,* i.e. a mere synonym of it.

As for *Basalys*, females of *Atomopria* species have a 12-segmented antennae, with a sharply differentiated club, and males have 14-segmented antennae, with short flagellar hairs.

Apparently, from most species of *Basalys* and related genera, *Atomopria* differs owing to markedly modified morphological characters: in fact, in the latter, the constant micropterous or apterous condition in both sexes has highly influenced some modifications in pterothorax, reducing or vanishing the suture dividing mesoscutum from scutellum; furthermore, in *Atomopria*, the latter is small and without or very reduced basal pit. The *Psilus*-shaped, opisthognathous head, with frontal tooth and lamelliform outgrowths, is very characteristic.

However, there is no satisfactory generic diagnosis for *Atomopria*: the armature of head also occurs in some species of *Basalys* (*e.g*. in *Acidopria* Kieffer, 1913, synonymized by Masner, 1964). The fact that the scutellum is fused with mesoscutum and the scutellar pit absent or very reduced in size may be due to advanced wing reduction, as observed by Masner (pers. comm.) among micropterous/apterous *Basalys* spp. from soil samples in the New World. Generally, apterism in diapriids results in correlated changes of the pterothorax.

Masner & García (2002) recognized *Basalys* primarily on the unique venation of fore wing, especially the position and the shape of the basal vein. In *Atomopria*, the examination of this character is impossible, owing to the reduction or absence of fore wings.

Therefore, very probably the taxa currently and here attributed to *Atomopria* represent a mere, very derived species group of *Basalys*, but the synonymy of *Atomopria* with *Basalys* (in the widest sense) is not yet proposed in the present contribution.

From the biogeographic point of view, the distribution pattern of these species merits however particular attention: they seem in fact localized each to small, scattered areas along the Western Mediterranean and in the Canary Islands. This should indicate a relict distribution of an ancient phyletic lineage, originally tied to Pliocene subtropical forests, presently limited to the Macaronesian Laurisilva (an evergreen plant association of endemic species as *Laurus novocanariensis*, *Ocotea foetens*, *Persea indica*, *Apollonias barbujana*, *Ilex perado*, and others) owing to the Pleistocene climatic deterioration.

ACKNOWLEDGEMENTS

For the friendly support in collecting specimens in areas not easy (or now impossible) to reach, the author is very indebted to his friends, colleagues and cooperators: in particular Giovanni Boffa, Pier Franco Cavazzuti, Elena Gavetti, Pier Mauro Giachino, Lisa Levi, Massimo Olmi, Guido Pagliano, Pier Luigi Scaramozzino.

For providing material or type specimens from the collections of their institutes and museums, a particular acknowledgement is due to Roberto Poggi (MSNG) and Gloria Ortega (MCNT), and for their support in researches in Canary Islands to Pedro Oromi Masoliver (University of La Laguna, Tenerife) and to Antonio Machado, author of an excellent monograph of the carabid beetles of these islands. Giovanni Boffa, well known Italian painter, merits a particular citation for his nice drawings illustrating the features of taxa treated in this contribution. For assistance in preparation of figures, I'm indebted to my friend and cooperator Enrico Busato (University of Torino)

A particular acknowledgement is due to Lubomír Masner (Canadian National Collection of Insects, Ottawa, Canada) and David Notton (Natural History Museum, London), excellent and well known specialists of Hymenoptera Diapriidae at world level, for their suggestions and corrections that highly improved the preliminary draft of this manuscript.

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Boll. Soc. Entomol. Ital., 148 (3): 115-119, ISSN 0373-3491 **15 dicembre 2016**

Arnaldo Bordoni[*]

New data on the Xantholinini from China. 27°. New species and new records in the collection of Tateo Ito, Kyoto
(Coleoptera, Staphylinidae)

265° contribution to the knowledge of the Staphylinidae

Riassunto: *Nuovi dati su Xantholinini di Cina. 27°. Nuove specie e nuovi dati presenti nella collezione di Tateo Ito, Kyoto (Coleoptera, Staphylinidae).*
Vengono descritte e illustrate le seguenti nuove specie: *Liotesba dayiensis* sp. n. (Sichuan), *Megalinus yuntai* sp. n. (Guizou), and *Atopolinus dayianus* sp. n. (Sichuan). Sono nuove per le province indicate le seguenti specie: *Thyreocephalus hongkongensis* (Redtenbacher) and *Nudobius mirificus* Bordoni (Hubei), *Yunnella spinosa* Bordoni (Gansu), *Megalinus ningxiaensis* Bordoni (Zhejiang), and *Megalinus hunanensis* Bordoni (Shaanxi).

Abstract: The following new species are described and illustrated for the listed provinces of China: *Liotesba dayiensis* sp. n. (Sichuan), *Megalinus yuntai* sp. n. (Guizou), and *Atopolinus dayianus* sp. n. (Sichuan). The following species are new records for the listed provinces: *Thyreocephalus hongkongensis* (Redtenbacher) and *Nudobius mirificus* Bordoni (Hubei), *Yunnella spinosa* Bordoni (Gansu), *Megalinus ningxiaensis* Bordoni (Zhejiang), and *Megalinus hunanensis* Bordoni (Shaanxi).

Key words: Coleoptera, Staphylinidae, Xantholinini, new species, new records, China.

Introduction

The colleague Tateo Ito (Kyoto) has recently sent me in study some Xantholinini from various regions. In this material I found some specimens from China. In this paper the results of their study are reported, with the description of three new species from Sichuan and Guizou. Five species are new records for some Chinese provinces. Data on a further species are taken from material conserved in the Hayashi's collection.

Acronyms

cB: coll. A. Bordoni, Firenze, Italy
cH: coll. Hayashi, Kawanishi, Japan
cI: coll. T. Ito, Kyoto, Japan

Taxonomy

Thyreocephalus hongkongensis (Redtenbacher, 1867)

Examined Material. NW Hubei, 15 km E Xianhshan pass to Huangliangping, leg. ? 6.VI.1998, 1 ex. (cI).

Distribution. The species is known from the Oriental Region (from Myanmar to Bali) and from China (Bordoni, 2002). New record for Hubei.

Liotesba dayiensis sp. n.

Examined Material. Holotype ♀: Sichuan, Shuanghe, Dayi Dafeishan Forest, 100 km W Chengu, 30.40N, 103.10E, M. Tryzna & Z. Jindra 22.VI.1993 (cI).

Description. Length of body 12 mm; from anterior margin of head to posterior margin of elytra: 7 mm. A big *Liotesba*; body shiny; head and pronotum black, elytra reddish with black scutellum; abdomen, antennae and legs reddish brown light. Head and pronotum and related punctuation as in Fig. 1. Labrum as in Fig. 2. Elytra sub-rectangular, very long and narrow, with subparallel and sub-rectilinear sides, longer than, and as wide as pronotum, with rounded humeral angles. Surface with fine, sparse punctuation, arranged in some spaced series. Abdomen with fine, dense, transverse micro-striation and fine but evident punctuation, arranged in some series.

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Male unknown.

ETYMOLOGY. The specific epithet refers to the type locality.

DISTRIBUTION. The species is known only from the type locality.

NOTE. This species differs from the congeners by the shape and punctuation of the head, by the structure of the labrum, and by the particular length of the elytra. In particular the setiferous punctuation of head is different from those of *L. ovaticeps* Zhou & Zhou, 2013, from Sichuan (Baoxing), *L. recticeps* Zhou & Zhou, 2013 from Sichuan (Wolong, Genda and Emei Shan), *L. fengyangshana* Zhou & Zhou, 2013 from Zhejiang (Fengyang Shan), and *L. expansipalpis* Zhou & Zhou, 2013 from Hubei (Muyu), recently described from China. *Liotesba* are mountains species, not common, probably with a restricted distribution.

Nudobius mirificus Bordoni, 2003b

EXAMINED MATERIAL. Holotype ♀: NW Hubei, Shipusa, 2300 m, Dashennongjia Mts, 2300 m, leg. ? 26.VI-1.VII.1998 (cI).

NOTE. This species was described (1 ♀) from the border Shaanxi-Sichaun (Daba Shan). This is the first record since its description. New record for Hubei. The species of this genus are normally sporadic, probably linked to particular stages of decay of plants.

Yunnella spinosa Bordoni**,** 2003b

EXAMINED MATERIAL. Gansu, Yin Shan, 2100 m, A. Gorodinski 1.V.1997, 1 ♂ (cI), 1 ♀ (cB).

NOTE. This very nice species was described from Shaanxi (Qinling Shan) and cited recently from N Sichuan (Juijaigow, Minshan Mts) (Bordoni, 2009) and also from Shaanxi (Foping) (Bordoni, 2013c). I propose the figure of the male genitalia because the parameres of the aedeagus in this specimen are very large (Figs. 3-5). New record for Gansu.

Phacophallus japonicus (Cameron, 1933)

EXAMINED MATERIAL. NW Hubei, 15 km E Xiangshan pass to Huangliangping, leg. ? 6.VI.1998, 1 ♂, 1 ♀ (cB).

DISTRIBUTION. The species is known from the Oriental Region (Thailand, Malaysia, Vietnam, China: Yunnan, Guanxi, Zhejiang, Hong Kong, Fujian (Bordoni, 2002). Recently it was cited also from Bejing, Henan, Sichuan (Bordoni, 2003a), and Jiangsu (Bordoni, 2013a).

Megalinus ningxiaensis Bordoni**,** 2013a

EXAMINED MATERIAL. (Zhejiang), Dinghai, Lajishan, 3500 m, A. Gorodinski 1.VII.1997, 2 ♂, 2 ♀ (cI), 2 ♂ (cB).

NOTE. This species was described from Ninxia (Sutai Forstry, 2200 m) and Qinghai (63 km ESE Men Yuan, 2558 m, and 23 km S Ledu, 2726 m). This is the first record since its description. New record for Zhejiang.

Megalinus hunanensis Bordoni, 2013a

EXAMINED MATERIAL. S Shaanxi, pass 15 km N Xunyangba, 1700 m, leg. ? 11-13.VII.1998, 1 ♂ (cI), 1 ♂ (cB).

NOTE. The species was described from Hunan (Wulingyuashan) and cited also from Guizhou (Zhou *et al*., 2013), and from Hubei (Yichang) (Bordoni, 2014). New record for Shaanxi.

Megalinus montanicus Bodoni, 2003b

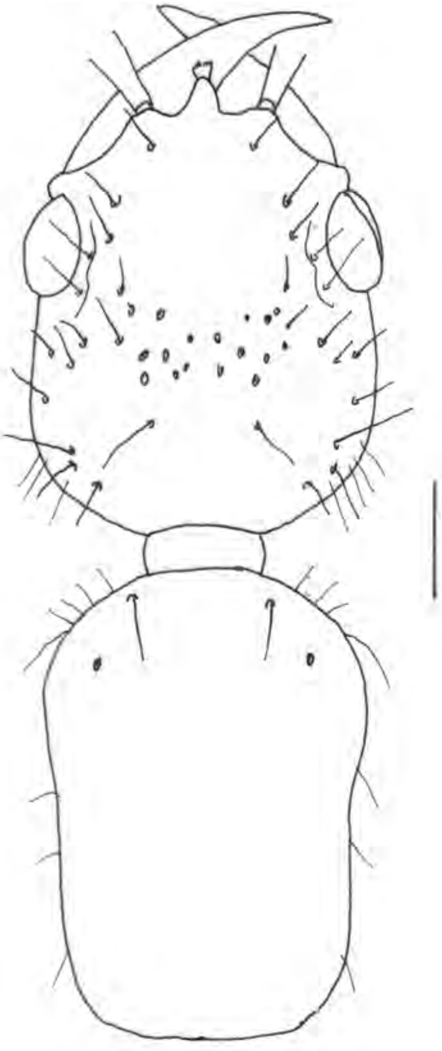
EXAMINED MATERIAL. Shaanxi, Qinling Mts, Xunyangba env., 1200 m, leg. ? 20.V-10.VI.2000, 1 ♂ (cH).

DISTRIBUTION. This species is actually known only from the Qinling mountains.

Megalinus yuntai sp. n.

EXAMINED MATERIAL. Holotype ♂: Guizou, 60 km N Kaiu, Shibing-Yunati Shan, E. Jemdek & O. Sausa 21-26.V.1995 (cI); paratype: same data, 1 ♂ (cB).

DESCRIPTION. Length of body 8.5 mm; from anterior margin of head to posterior margin of elytra: 4 mm. Body brown more or less light, with black head; antennae missing; legs testaceous light. Head sub-rectangular, narrowed forward, with sub-rectilinear sides and strictly rounded posterior angles. Eyes very small and almost flat. Surface of head shiny, with deep, dense punctuation, apart for a wide median stripe, partially elongated, finer and denser on clypeus. Pronotum as long as head, strongly broadened anteriad and here as wide as head, with oblique anterior margins, sub-rectilinear sides, and rounded anterior angles. Surface with dorsal series of 7 broad, superficial punctures and lateral series of 3-4 finer, spaced punctures; some punctures near anterior angles. Elytra large, much longer and wider than pronotum, broadened posteriad, with rounded humeral angles. Surface with superficial, fine punctuation, arranged in numerous series. Abdomen with traces of transverse micro-striation and fine puncturation on sides.



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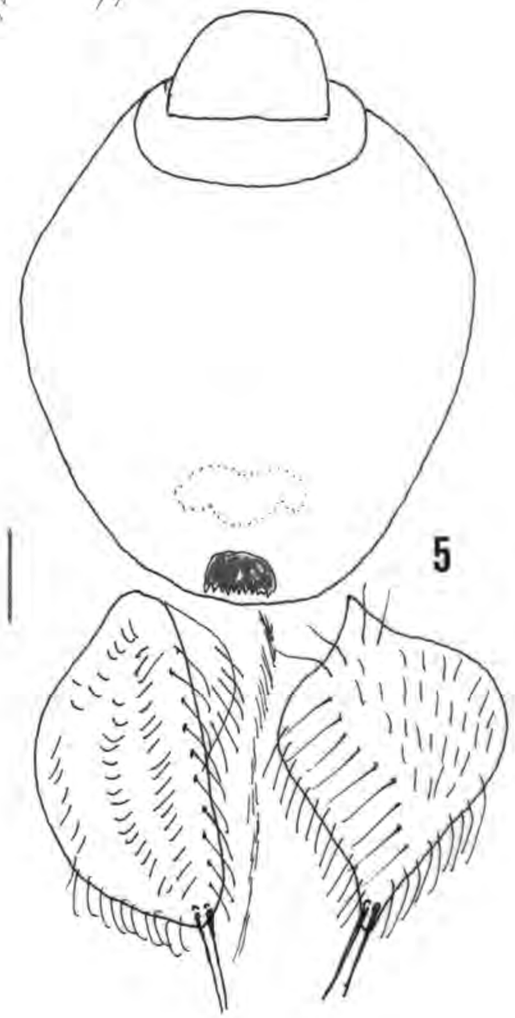

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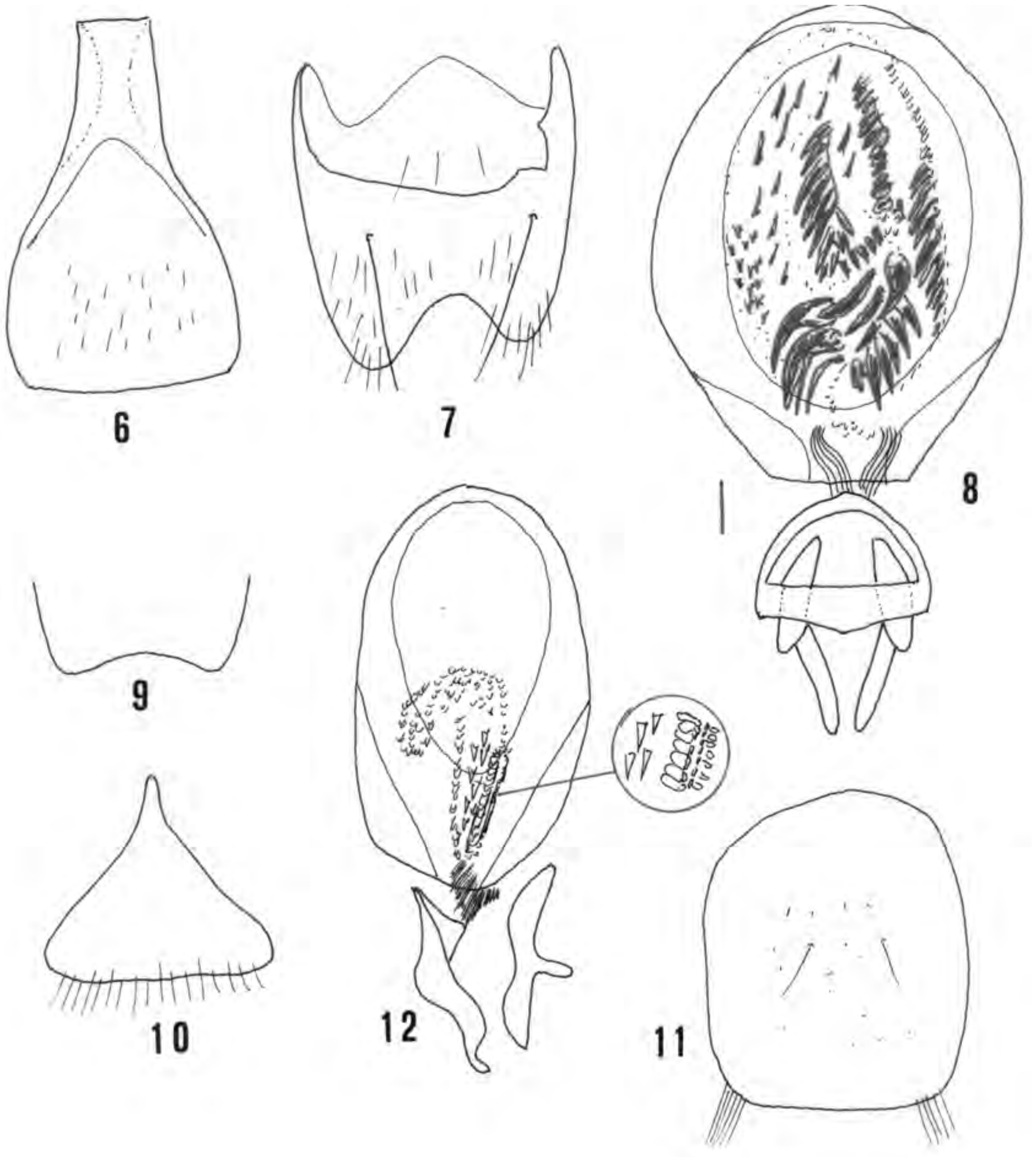
Figs. 1-5. *Liotesba dayiensis* sp. n.: 1 − head and pronotum (bar scale: 0.5 mm); 2 − labrum. *Yunnella spinosa* Bordoni: 3 − tergite and; 4 − sternite of the male genital segment; 5 − aedeagus. Bar scale: 0.1 mm.

Tergite and sternite of male genital segment as in Figs. 6-7. Aedeagus (Fig. 8) 1.35 mm long, sub-ovoidal; parameres short and narrow; inner sac with numerous series of spines.

ETYMOLOGY. The specific epithet refers to the type locality.

DISTRIBUTION. The species is known only from the type locality.



Figs. 6-12. *Megalinus yuntai* sp. n.: 6 − tergite and 7 − sternite of the male genital segment,; 8 − aedeagus. *Atopolinus dayianus* sp. n.: 9 − posterior margin of 6th visible male tergite; 10 − tergite and 11 − sternite of the male genital segment; 12 − aedeagus. Bar scale: 0.1 mm.

NOTE. This species differs from the congeners especially for the structure of the inner sac of the aedeagus.

Atopolinus dayianus sp. n.

EXAMINED MATERIAL. Holotype ♂: Sichuan, Dayi Dafeishan, M. Tryzna 21-27.VI.1993 (cI).

DESCRIPTION. Length of body 5.8 mm; from anterior margin of head to posterior margin of elytra: 3.2 mm. A little *Atopolinus*, reddish brown with darker head; antennae and legs brown. Body shiny. Head sub-rectangular, with largely rounded posterior angles. Eyes small and a little protruding. Surface of head with sparse, very fine punctuation, apart for a wide median stripe. Pronotum a little longer and narrower than head, with very oblique anterior margins, obsolete anterior angles, and sinuate sides. Surface with dorsal series of 7-8 punctures and lateral series of 5-6 punctures. Elytra large, longer and wider than pronotum, broadened posteriad, with marked humeral angles. Surface with fine, spaced punctuation, arranged in some series. Scutellum large, with fine, transverse micro-striation. Abdomen with fine punctuation on sides.

Sixth visible abdominal tergite as in Fig. 9. Tergite and sternite of male genital segment as in Figs. 10-11. Aedeagus (Fig. 12) 1.1 mm long, small, ovoidal, narrow; pseudoparameres asymmetrical; inner sac with numerous scales.

ETYMOLOGY. The specific epithet refers to the type locality.

DISTRIBUTION. The species is known only from the type locality.

NOTE. This species differs from the congeners for the small body, colouration, shape of tergite and sternite of the male genital segment, and especially for the structure of the aedeagus and its inner sac.

ACKNOWLEDGEMENTS

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Boll. Soc. Entomol. Ital., 148 (3): 121-140, ISSN 0373-3491 **15 dicembre 2016**

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Egg laying behaviour, host plants and larval survival of *Euphydryas aurinia provincialis* (Lepidoptera Nymphalidae) in a Mediterranean population (central Italy)

Riassunto: *Deposizione delle uova, scelta delle piante ospiti e sopravvivenza delle larve di* Euphydryas aurinia provincialis *(Lepidoptera Nymphalidae) nell'area Mediterranea (Italia centrale).*
In questo lavoro, sono riportati i risultati di uno studio di cinque anni sul campo finalizzato a individuare le piante nutrici delle larve e le loro preferenze alimentari e valutare quali segnali siano utilizzati dalle femmine per la deposizione delle uova in *Euphydryas aurinia provincialis* nell'area Mediterranea. Le femmine depongono su *Gentiana cruciata*, *Scabiosa columbaria* e *Cephalaria leucantha* e le larve si nutrono indifferentemente su tutte queste piante, ma anche su *Lonicera caprifolium* e, in laboratorio, su *Gentiana lutea*. Le femmine non mostrano alcuna preferenza per una specifica pianta ospite e le larve passano a nutrirsi dall'una all'altra pianta senza alcuna difficoltà. I fattori più importanti nel determinare la selezione della pianta ospite per l'ovideposizione sono la visibilità, l'accessibilità e l'esposizione solare delle piante. Lo stato vegetativo delle piante ospite è il fattore chiave che determina quale specie vegetale sia utilizzata dalle larve nei diversi stadi dello sviluppo durante il periodo pre- e post-diapausa. *G. cruciata* e *C. leucantha,* piante ospite di grandi dimensioni, sono fondamentali per la crescita e la sopravvivenza degli stadi larvali pre-diapausa (I-III instar), mentre sono del tutto inadeguate per nutrire le larve in primavera dopo la diapausa invernale a causa del loro ritardo nella ripresa vegetativa; invece le piante di *S. columbaria,* molto più abbondanti e in fase vegetativa sempre molto più avanzata rispetto a *G. cruciata* e *C. leucantha*, sono utilizzate in primavera dalle larve post-diapausa per completare lo sviluppo. *L. caprifolium,* seppur in misura minore per la minor diffusione e il relativo ritardo nello sviluppo dei germogli, svolge un ruolo analogo a *S. columbaria*. Il lavoro è completato da alcune considerazioni conclusive dedotte dalle osservazioni. Vivere in gruppo sembra essere evolutivamente selezionato sin dalla deposizione delle uova sulle piante più grandi; infatti, le femmine di *E. aurinia provincialis* se trovano uova deposte da un'altra femmina vi depongono a fianco o addirittura sopra. Nonostante la competizione trofica tra le larve, questo comportamento delle femmine risulta evidentemente vantaggioso ed aumenta il tasso di sopravvivenza dei nidi sulle piante più grandi. La vita gregaria di un numero maggiore di larve su una pianta di grandi dimensioni: nel periodo pre-diapausa, riduce i casi di *starvation*; durante la diapausa invernale, con nidi più robusti e più stabili permette una maggiore resistenza ai predatori e ai rigori invernali; nel periodo post-diapausa, permette una maggiore efficienza nella termoregolazione rendendo le larve indipendenti dalle basse temperature esterne.

Abstract: In this paper, we show the results of research that can inform conservation measures elsewhere in Europe for the endangered butterfly *Euphydryas aurinia.* A five year field study was undertaken to identify the host plant preference of larvae of *Euphydryas aurinia provincialis* in the Mediterranean and which signals are used by females to lay their eggs. The females oviposit on *Gentiana cruciata*, *Scabiosa columbaria* and *Cephalaria leucantha*; the larvae feed on all these plants and additionally on *Lonicera caprifolium* in the wild and on *Gentiana lutea* in the laboratory. The females do not show any preference for a specific host plant and the larvae move from one species of plant to another without any difficulty. The most important factors in determining the female oviposition are the visibility, accessibility and sun-exposure of the host plants. The vegetative state of host plants is the key factor in larval use of plants during the pre- and post-diapause period. The large-sized host plants, *G. cruciata* and *C. leucantha,* are optimal for the growth and survival of the pre-diapause I-III larval instar, while they are unavailable to the larvae in Spring because of their delayed vegetative growth. The post-diapause larvae preferentially feed on plants of *S. columbaria,* and to lesser degree *L. caprifolium,* as they provide and abundant food source compared with *G. cruciata* and *C. leucantha*. The results also suggest that, there is an evolutionary advantage in large numbers of caterpillars feeding together, with the females of *E. aurinia provincialis* preferring to lay their eggs nearby or above egg batches laid previously by another female, and selecting large plants for oviposition. Despite the competition for food among caterpillars, the oviposition behaviour of females is advantageous and increases the larval survival rate on large plants. The gregarious larval behaviour provides several benefits during both pre-diapause period (avoiding starvation) and post-diapause period (efficiency in thermoregulation).

Key words: *Euphydryas aurinia provincialis*, Female host plant choice, Larval host plant, Larval web survival, Larval aggregation behaviour.

Introduction

The Marsh Fritillary butterfly *Euphydryas aurinia* (Rottemburg, 1775) has suffered a severe decline in most European countries during the 20th Century (Van Swaay & Warren, 1999; Van Swaay *et al.*, 2010). For this reason *E. aurinia* is listed in Annex II of the

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European Community Habitats and Species Directive (92/43/EEC) and is also given protection through the Bern Convention.

In Italy the *Euphydryas aurinia* species complex is represented by three taxa that were alternatively considered as species or subspecies depending on authors (Verity, 1950; Hartig, 1968; Prola et *al.*, 1978; Balletto & Cassulo, 1995; Parenzan & Porcelli, 2006; Balletto *et al*., 2014a). These taxa are: i) *aurinia* (Rottemburg, 1775), occurring in wet meadows in the Po Plains, ii) *glaciegenita* (Verity, 1928), in alpine region of Northern Italy, and iii) *provincialis* (Boisduval, 1828), which is limited to the Maritime Alps and the Apennine Mountains (Balletto *et al*., 2014b). According to the most recent assessment (under Art. 17 of Habitat Directive) the conservation status of *E. aurinia* populations is judged to be "bad" in Central and Northern Europe, where suitable habitat has become strongly reduced in area and fragmented. In Italy, at least 12 populations of *E. a. aurinia* have become extinct because of habitat destruction (Bonelli *et al.*, 2011). On the contrary, the conservation status of the Mediterranean and Alpine populations is "favourable" (Balletto *et al*., 2014b).

Most of the available information on ecology and biology of the *E. aurinia* species complex comes from *E. a. aurinia* in Western and central Europe where it has been studied in some detail for over a century (Ford & Ford, 1930; Porter, 1981; Warren, 1993; 1994; 1996; Warren *et al*., 1994; Klemetti & Wahlberg, 1997; Wahlberg, 2001; Anthes *et al*., 2003; Hula *et al*., 2004; Saarinen *et al.*, 2005; Mazel, 2006; Peńuelas *et al*., 2006; Svitra & Sielezniew, 2010; Porter & Ellis, 2011). In contrast, very few observations on ecology and biology of this species have been carried out in the Mediterranean area. The first ecological observations on *E. aurinia* in the Mediterranean are reported by Verity (1950) and Jutzeler (1994) and only recently by Casacci *et al.* (2014). Verity describes *E. aurinia provincialis* as a butterfly that usually inhabits both marshy meadows in the forest glades and dry meadows. Jutzeler refers to his observations on caterpillars and their host plants from a Ligurian population. Casacci *et al.* (2014) reports the results on metapopulation dynamics and dispersal abilities of two populations of *E. (a.) glaciegenita* from NW Alps and *E. (a.) provincialis* from Northern Apennines, with mention of some larval food plants (Tab. 1).

The main purpose of this paper is to understand why the Mediterranean populations of *E. aurinia* in Central Italy are in a better state than elsewhere by looking at key aspects of its ecology and biology. In this research we looked at a population of *E. a. provincialis* in the Apennines of Central Italy with the aim of identifying: i) host plant preference by ovipositing females; ii) larval host plant preferences; iii) the interaction between larvae and host plants during their life cycle; and iv) the larval survival after winter diapause.

MATERIALS AND METHODS

Study animal. *E. aurinia* is univoltine butterfly with adults emerging from May and flying through June to July depending on altitude and microclimate. Eggs are laid in batches of 300 or more on the underside of the leaves of host plants (Kuussaari *et al*., 2004). The species has six larval instars (three pre-diapause instars and three post-diapause instars); in European populations, the first five instars are gregarious and the sixth instar is solitary. The first three instar larvae are pale-brown and then change colour during the moult from the third to the fourth instar, becoming jet-black. In the early stages, larvae feed gregariously within a communal silken web and move from a plant to plant as their host plants are consumed; fourth instar larvae do not feed prior to diapause and overwinter in a larval web (hibernaculum), usually close to the ground and incorporating a few dead leaves which are spun tightly together (Porter, 1981; 1982). When the fourth instar larvae emerge from the winter diapause they still show the gregarious behaviour and use basking behaviour as a way of thermo-regulating (Porter, 1981; 1982). Larvae start to disperse in their fifth instar and feed solitarily (Warren, 1996; Kuussaari *et al*., 2004). Finally they pupate close to the ground, usually on plant stems (Warren, 1996).

Study area. *E. a. provincialis* is a widespread species in the Central Apennines and in particular in Monti Reatini (data from Osservatorio per la Biodiversità del Lazio). The study population of *E. a. provincialis* in Central Apennines was discovered during previous survey work (Pinzari *et al*., 2010) on the Lepidoptera in the area surrounding Vallemare (Rieti, Lazio, Central Italy, Location WGS84: N42.4836°-E13.1148°). Here, the species occupies habitat patches in montane grassland and slopes, sometimes steep and rocky, within a mosaic of different habitats including wooded

Tab. 1. Status of knowledge on host plants and larval host use in *E. aurinia* subspecies.

E. aurinia subspecies	Egg laying	Pre-diapause I-III instar	Post-diapause IV-VI instar	Instar not specified
aurinia	*Succisa pratensis* (Porter, 1981; Porter & Ellis, 2011; Anthes *et al.*, 2003; Sardet & Betremieux, 2006; Eeles, 2014)	*Succisa pratensis* (Porter, 1981; Sardet & Betremieux, 2006; Porter & Ellis, 2011; Botham *et al.*, 2011; Masek, 1987, In: Konvicka *et al.*, 2003)	*Succisa pratensis* (Porter, 1981; Porter & Ellis, 2011)	*Succisa pratensis* (Luckens, 1978; Betzholtz *et al.*, 2007; Casacci *et al.*, 2014).
	Scabiosa columbaria (Sardet & Betremieux, 2006)	*Scabiosa columbaria* (Sardet & Betremieux, 2006; Mazel, 2006)	*Scabiosa columbaria* (Lobenstein, 2008)	*Scabiosa columbaria* (Porter, 1981; Warren, 1993; Mazel, 1984)
	Knautia arvensis (Sardet & Betremieux, 2006)	*Knautia arvensis* (Sardet & Betremieux, 2006; Mazel, 2006)	*Lonicera periclymenum* (Porter & Ellis, 2011)	*Scabiosa comosa* (Wahlberg *et al.*, 2001)
	Lonicera implexa (Stefanescu *et al.*, 2006)	*Lonicera periclymenum* (Warren, 1993)	*Gentiana cruciata* (Svitra & Sielezniew, 2010)	*Knautia arvensis* (Porter, 1981; Mazel, 1982, 1984; Mazel, 1977 In: Jutzeler, 1994)
	Gentiana cruciata (Sardet & Betremieux, 2006; Lobenstein, 2008)	*Gentiana cruciata* (Sardet & Betremieux, 2006; Svitra & Sielezniew, 2010; Lobenstein, 2008)	*Valeriana dioica* (Anthes, 2002)	*Gentiana cruciata* (Hafner, 2001 com. pers. In: Anthes, 2002; Perru & Sardet, 2005; Mazel & Lutran, In: Jutzeler, 1994)
	Gentiana asclepiadea (Anthes, 2002; Anthes *et al.*,	*Cephalaria leucantha* (Mazel, 2006)	*Valeriana sambucifolia* (Betzholtz *et al.*, 2007)	*Gentiana asclepiadea* (Ebert & Rennwald, 1991, 2003) In: Anthes, 2002)
			Menyanthes trifoliata (Anthes, 2002; Anthes *et al.*, 2003)	*Gentiana lutea* (Rey *et al.*, 2004 in Sardet & Betremieux, 2006)
				Cephalaria leucantha (Mazel, 1982, 1984; Mazel & Lutran, In: Jutzeler, 1994)
				Valeriana officinalis (Favretto 2009)
				Dipsacum fullonum (B. Gillam, com. Pers. In: Warren, 1993)
beckeri	*Lonicera implexa* (Penuelas *et al.*, 2006; Stefanescu *et al.*, 2006)	*Lonicera implexa* (Stefanescu *et al.*, 2006)	*Lonicera periclymenum* (Junker & Schmitt, 2010; Warren, 1993)	*Lonicera periclymenum* (Warren *et al.*, 1994)
			Lonicera implexa (Stefanescu *et al.*, 2006)	*Lonicera implexa* (Munguira, com. Pers; Templado, 1975, in Warren, 1993; Warren *et al.*, 1994)
				Lonicera etrusca (Warren, 1993; Warren *et al.*, 1994; Kankare *et al.*, 2005, in Stefanescu *et al.*, 2006)

Continua nella pagina seguente

areas, hedgerows, fields and less steep areas which are occasionally ploughed and cultivated. *E. a. provincialis* inhabits discrete habitat patches that differ in their larval host plants composition according to the following altitudinal zones: i) 1500-1300 m, *G. lutea* L.*, G. cruciata* L. and *S. columbaria* L.; ii) 1300-1000 m, *G. cruciata*, *S. columbaria* and *L. caprifolium* L.; iii) 1000-800 m, *S. columbaria* and *L. caprifolium* or *C. leucantha* (L.) Schrad. ex Roem. & Schult. We detected 13 habitat patches whose position, features and land use are indicated in Fig. 1; they are adjacent to each other and MRR sampling have shown (Pinzari M., unpublished data) that flying adults can be easily move between areas; in the study patches (Fig. 1) *C. leucantha* and *G. lutea* were absent. Additional observations were also carried out in habitat patches located outside the study area; they are at Monte Cagno and Villa Camponeschi, where the species and its host plants *G. lutea* and *C. leucantha* are recorded.

Adults of *E. a. provincialis* are regularly present within the habitat patches and absent in forests and scrub. They do disperse across other land parcels, such as agricultural areas and pastures, but these lack suitable host plants and offer little in the way of nectar sources. Caterpillars were observed only in patches of habitat with uncultivated steeply sloping rocky areas or road verges.

The field-work on adults of *E. a. provincialis* began in 2010 and has been continued up to 2015. Observations on larval stages started in 2012 and continued until 2015. A total of 77 days over three years were spent monitoring egg batches and larval webs, focusing on: eggs (from May to the end of June); pre-diapause gregarious phase (I-III instar on larval webs) (from May to September); diapause phase (IV instar in larval webs) (from September to mid-February); post-diapause gregarious phase (IV instar) (from mid-February to mid-March); and solitary caterpillars (V-VI instar) (from March to mid-April).

Laboratory observations on larval feeding behaviour were carried out in captivity in Rome in artificial rearing facilities indoors in February 2014 (19 February to 13 March) during eleven days and in April 2015.

Host plants. The biology of pre-imagined stages of *E. aurinia* complex has been studied by numerous scientists in Northern and Central Europe. There are far

Tab. 1. *Segue dalla pagina precedente*.

E. aurinia subspecies	Egg laying	Pre-diapause I-III instar	Post-diapause IV-VI instar	Instar not specified
glaciegenita				*Gentiana clusii* (Geiger, 1987 In: Warren, 1994)
				Gentiana acaulis (Geiger, 1987 In: Warren, 1994; Casacci *et al.*, 2014)
				Gentiana kochiana (Gerber, 1972, In: Anthes 2002; Warren, 1996; Gerber, 1972, In: Mazel, 1982)
				Gentiana alpina (Warren 1996)
provincialis		*Cephalaria leucantha* (Jutzeler, 1994)	*Lonicera etrusca* (Nel, 1983, in litt., In: Mazel, 2006)	*Knautia arvensis* (Casacci *et al.,* 2014)
			Cephalaria leucantha (Jutzeler, 1994)	*Cephalaria leucantha* (Casacci *et al.*, 2014)
			Centranthus ruber (Jutzeler, 1994)	*Centranthus ruber* (Bromilov In: Verity, 1950)

fewer observations on the species complex in the Mediterranean area and in particular in Italy. For synthesis, in Tab. 1, all known host plants of *E. aurinia* subspecies are presented, with an indication where possible the corresponding use by pre- and post-diapause pre-imaginal stages. *E. a. aurinia* is the most studied sub-species and the host plants used by ovipositing females and by larvae are known. Several authors suggest that larvae feed exclusively on a single, main host plant; others state that the species can utilize a wide spectrum of host plants. *Succisa pratensis* (Dipsacaceae) is the most important food plant of *E. a. aurinia* across the European species range and especially in the North; some other plants belonging to Dipsacaceae, Caprifoliaceae, and Gentianaceae families were also recorded for the species in Western and Southern Europe. *E. a. beckeri* is dependent to genus *Lonicera* for both oviposition and larval food plant. Prior to the current study, information on egg laying behaviour and female host plant preferences in *E. a. provincialis* was not clear*;* observations on caterpillars and host plants referred to populations in rocky

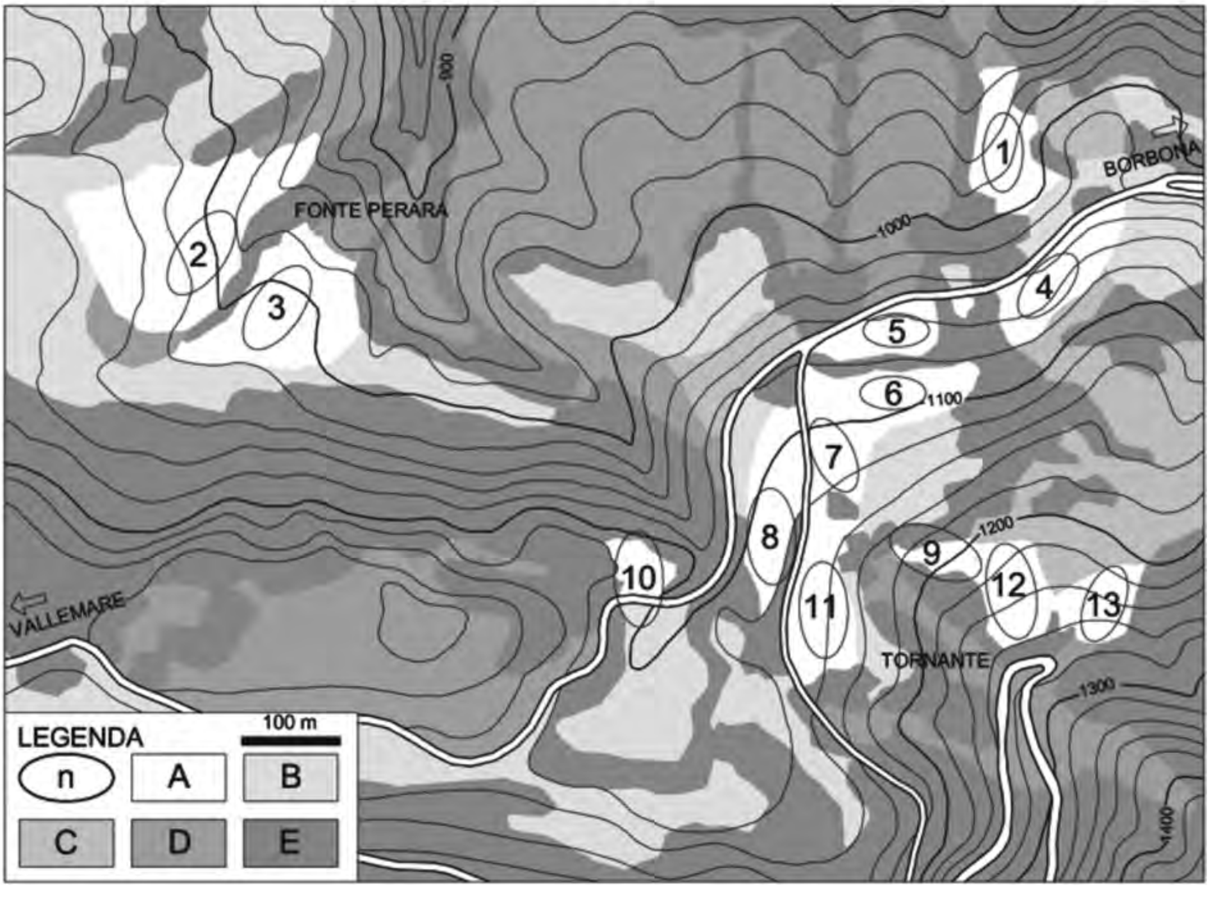

Fig. 1. Habitat and position of the habitat patches in the study area: 1, 4, Crossroads Santa Maria del Monte – Fonte Brignola; 2, 3, Fonte Perara; 5, 6, 7, 8, 11, along the path between the road to Santa Maria del Monte and Hairpin curve Mattano-Malepasso; 9, 12, 13, Hairpin curve Mattano-Malepasso; 10, Pian Mattano. The patch 14, Villa Camponeschi, is not included on this map due to its distance from the other localities (2 km from Fonte Perara). Features and land use of the study area: A) Semi-natural dry grasslands and scrubland facies on calcareous substrates, where adults of *E. a. provincialis* were recorded in past studies (Pinzari *et al.*, 2010); B) cultivated areas for intense pasture and hay harvesting areas; C) thick scrubs; D) mineralized areas, erosion or with very little vegetation cover; E) high trees oak and beech forests; where adults of *E. a. provincialis* were absent.

habitat in Southern France and in NW Italy (Liguria). Similarly, *E. a. glaciegenita* has been little studied and its biology is poorly known; existing observations suggest it uses species of Gentianaceae as food plants.

General. All study subjects (host plants, egg batches, larval webs) were marked by an alphanumeric code written on a stone that was positioned nearby. This enabled the relocation of plants at each sampling period and from year to year. All qualitative and quantitative observations have been documented with notes, photographs and short videos.

Female host plant choice. To identify the host plants of *E. a. provincialis*, we searched and quantified the target plant species, which were already known in literature for the *E. aurinia* complex species, and we examined these plants recording the presence of egg batches and larval webs with feeding caterpillars.

G. cruciata, *L. caprifolium* and *S. columbaria* were recorded in the study habitat patches, while *G. lutea* and *C. leucantha* were confirmed as host plants outside the study area. All individual plants of *G. cruciata* and *C. leucantha* were located across meadows and counted. *S. columbaria* was sampled along zigzag transects (70 m^2 area, 35 m in length, 2 m in width). For this purpose twenty-seven transects were assessed in all habitat patches.

The presence of egg batches on host plants was recorded during twenty-three, variable length, zigzag transects. The use of variable length transects was done to allow for the heterogeneity in the distribution of host plants, especially *S. columbaria* and differing areas of sample locations.

In each transect we counted the egg batches (original and derived from larval webs) on each host plant to assess the number of egg batches laid in the studied habitats patches. The original site of egg batches from larval webs were determined by following the tracks of the webs spun by the caterpillars during their transfers from one host plant to another as they fed. The egg batches were recorded and the age of each batch, as determined by difference in colour, used to distinguish the eggs of different females on the same host plant. The eggs laid at different times by different females were easily recognizable by their different colour (bright yellow, freshly laid and changing from orange to purplish-brown, after a few days, Fig. 2). A female can lay two separate egg batches on the same plant and to avoid over estimation we considered all eggs with same colour as laid by the same female.

Using the field data we calculated for the all earlier stages (from eggs to pre-diapause larval stages) the *plant occupancy rate*, as the ratio between the number of plants with egg batches (original and derived from larval webs), and the number of the host plants examined along any transect.

Larval web survival and host plant phenology. To detect the role of host plants in larval survival we monitored the larvae behaviour and the larval webs during pre-winter and spring phase for three generations, focusing our attention on the growth characteristics of the host plants in the study area. The vegetative status of the host plants and surrounding vegetation was systematically recorded with photos, short notes and videos; this was schematically shown in Fig. 3A-C. We want to emphasize that *C. leucantha*, reported in Fig. 3 together with the other host plants, does not exist in the same place with *G. cruciata*; *C. leucantha* is limited to a rocky slope in a small habitat patch nearby Villa Camponeschi.

The pre and post-diapause larval webs were counted at every visit in each locality recording the presence/absence and documenting location by photos. For the post-diapause phase we counted both larval webs (IV instar, gregarious stage) and solitary larvae (V-VI instar). We calculated the survival rate of the larval webs as the ratio between the number of larval webs surviving the winter and the number of larval webs recorded before winter diapause.

Post-diapause larval host plant choice. To detect the larval host plant affinity of *E. a. provincialis* and the use of each host plant by V and VI instar larvae, we observed and counted the larval webs that overwintered and survived and the activities of gregarious (without webs) and solitary caterpillars in the study area along zigzag transects in all study habitat patches. In spring we observed the larval webs marked before winter and gregarious caterpillars (IV instar) behaviour, we then looked at the activity of solitary caterpillars. The time for each activity was assessed in proportion to the percentage of solitary caterpillars found in a specific activity. The field data were recorded when the weather was dry and sunny as this was when larvae were active.

The behaviour of the solitary caterpillars was

Fig. 2. Eggs and larval stages of *E. a. provincialis* on host plants: A) double deposition on *G. cruciata*; B) single deposition on *C. leucantha*; C) double deposition on the same leaf of *S. columbaria*; D) pre-diapause nest (II instar larvae) on *G. cruciata*; E) pre-diapause nest (I instar larvae) on *C. leucantha*; F) pre-diapause (II instar larvae) on *S. columbaria*; G) pre-diapause nest (II instar larvae) during transfer from *S. columbaria* to prostrate stems of *L. caprifolium*; H) and I) behavior of gregarious larvae of IV instar after winter diapause: When it was sunny, larvae arranged more or less parallel and in a single layer closing ranks as possible (H); when there was no sun, larvae piled up on each other in a more compact manner possible (almost spherical) (I).

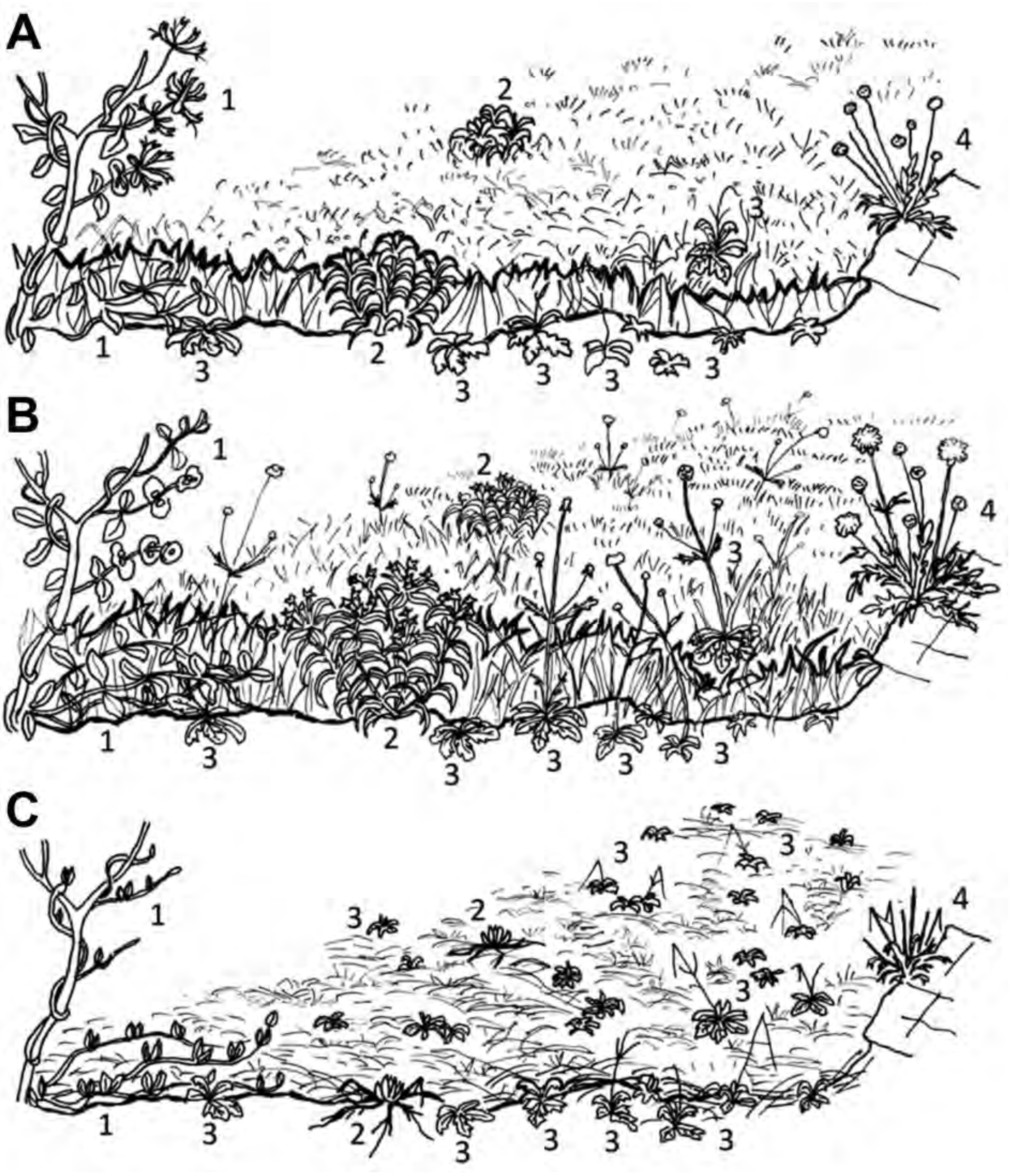

Fig. 3. Vegetation structure and host plants status during during larval stages in *E. a. provincialis*. A) Egg laying and pre-diapause period; B) diapause; C) post-diapause period. 1) *Lonicera caprifolium*; 2) *Gentiana cruciata*; 3) *Scabiosa columbaria*; 4) *Cephalaria leucantha*. This scheme reports all host plants present in the study area but *G. cruciata* and *C. leucantha* do not coexist in any patch.

recorded against three behavioural categories (feeding, moving and dorsal basking). In the feeding category we recorded which host plant larvae were using.

To assess how the larvae of *E. a. provincialis* can switch feeding between different host plants we carried out feeding tests in laboratory on larvae of each stage. The feeding tests were carried using 50 larvae from a larval web on *Gentiana cruciata* collected in February 2014. During these tests the host plants *S. columbaria*, *L. caprifolium*, *C. leucantha* and *G. lutea* were offered to caterpillars by random plant rotation. Additionally, *Plantago* sp., reported in literature as host plant of *E. a. aurinia,* and abundant in the study area, was also tested during feeding experiments.

Observations on larval stages in captivity. To distinguish the instar of solitary caterpillars of *E. a. provincialis* observed in the wild populations we collected a sample of 27 larvae from natural populations and their growth was monitored up to pupal stage in captivity.

RESULTS

Host plants. In the study area we recorded three species that were already cited as host plants for *E. aurinia* species complex in other countries. They were *S. columbaria, L. caprifolium* and *G. cruciata*. A few kilometres away from the study area *C. leucantha* and *G. lutea,* were also found (see below). The plants of *S. columbaria* were abundant in all habitat patches, but with a patchy distribution (Tabs. 2 and 3).

This is in contrast to the very low density of *S. columbaria* in the cultivated and recently ploughed areas. The plants of *G. cruciata* were located in both meadow and scrub in all habitats patches, but they were uncommon and sparsely distributed (Tab. 4). The

Tab. 2. Records on single and multiple egg depositions in the surveys 2012-2013, 2013-2014, 2014-2015 and 2015-2016.

	Patches	Egg batches per plant				Plants with eggs	Plants	Plant occupancy
		Single (N_s)	Double (N_d)	Triple (N_t)	Egg masses (N)	($D=N_s+N_d+N_t$)	(P)	(D/P) %
Gentiana cruciata	4	0	1	0	2	1	1	100
	5	1	2	0	5	3	7	43
	6	2	0	1	5	3	5	60
	7	10	2	1	17	13	14	93
	8	4	1	0	6	5	14	36
	9	2	1	0	4	3	5	60
	10	1	0	0	1	1	2	50
	11	2	2	1	9	5	6	83
	12	2	1	0	4	3	7	43
	13	2	3	0	8	5	9	55
	Tot. (%)	26 (43)	13 (22)	3 (15)	61 (100)	42	70	60
Scabiosa columbaria	1	9	0	0	9	9	203	4
	2	1	1	0	3	2	288	1
	Tot. (%)	10 (83)	1 (17)	0	12 (100)	11	491	2
Cephalaria leucantha	14	5	0	0	5	5	18	28
	Tot. (%)	5 (100)	0	0	5 (100)	5	18	28

Habitat patches: 1, 4, Crossroads Santa Maria del Monte – Fonte Brignola; 2, 3, Fonte Perara; 5, 6, 7, 8, 11, along the path between the road to Santa Maria del Monte and Hairpin curve Mattano-Malepasso; 10, Pian Mattano; 9, 12, 13, Hairpin curve Mattano-Malepasso; (Fig. 1); 14, Villa Camponeschi (see the location in Pinzari *et al.*, 2010).

robust growth from of *G. cruciata* meant that plants were clearly visible above the general herbaceous vegetation during butterfly flight period. In grazed meadows their visibility was increased due to their unpalatability for livestock (Fig. 3A). In the areas where adults of *E. a. provincialis* fly (Pinzari *et al*., 2010) *G. cruciata* was only present in south-faced meadows above an altitude of about 1000 m. *L. caprifolium* was usually observed as a climber on scrub, or prostrate on the ground in the edge of the meadows, and occurred across all habitat patches in the study area (Fig. 3). The plants of *C. leucantha* (thirty-two plants) were 2 km from the study area on very steep rocky slopes on the edge of a short segment of paved road between the built-up areas of Villa Camponeschi and Laculo (1000 m). In this xerothermic habitat, where *C. leucantha* typically grows, adults of *E. a. provincialis* do occasional find this host plant as they fly between habitat patches. Egg batches and/or larval webs were found on *G. cruciata*, *S. columbaria*, *L. caprifolium* and *C. leucantha* (Tabs. 2-4), whilst no eggs or larvae were observed on *G. lutea* in the wild.

Frequent mention is made of *Plantago* sp. as a host plant in the scientific and popular literature. In the study areas the genus *Plantago* is abundant and represented by several species. However, no egg batches or feeding larvae were found on any *Plantago* spp. To the untrained eye, confusion is possible with *Melitaea cinxia* (Nymphalidae) whose pre-diapause and post-diapause larval instar could be mistaken for *E. aurinia.* In laboratory, larvae of *E. a. provincialis* did not eat *Plantago spp*. plants offered during the feeding tests.

Eggs and host plant searching behaviour. The flight period of adults of *E. a. provincialis* extends from May to July in the study locality. Once mated, the females fly slowly through the meadows, nectaring and basking as well as searching for suitable oviposition sites. When searching for host plants, mated females performed very short flights, landing on plants and walking on the leaves as part of a meticulous and long inspection of the host plant (about 20 min on an area of not more than 9 cm in radius in one case). Once a plant is deemed suitable, the female stops on a selected leaf of the host plant, perches on the edge of the upper side of the leaf, and bends her abdomen to lay the eggs on the undersides of the lower and large outer leaves (Fig. 2A-C).

Over the period of the study we recorded sixty-one batches on *G. cruciata* (single 43%, double 22% and triple 15%), twelve on *S. columbaria* (single 83%, double 17%), and five on *C. leucantha* (all single batches) (Tab. 2). No egg batches were found on *L. caprifolium* and *G. lutea*. Many plants were without egg batches (40% *G. cruciata,* N=28; 98% *S. columbaria,* N=480; 72% *C. leucantha*, N=13) (Fig. 4). The *plant*

Tab. 3. Records of eggs (or larval webs) on *S. columbaria* in all localities during the pre and post-diapause period in the surveys 2012-2013, 2013-2014, 2014-2015 and 2015-2016.

Patches	Survey	Plants (N)	Plants with eggs or pre-diapause larval webs (N)	Plant occupancy (%)	Plants with post-diapause larval webs (N)	Larval web survival rate (%)
1	2013-14	66	1	1	1	100
1	2014-15	65	2	3	2	100
1	2015-16	385	9	2	*	*
2	2012-13	1000	20	2	0	0
3	2012-13	714	2	0.3	0	0
4	2013-14	50	1	2	0	0
4	2015-16	483	5	1	*	*
12	2012-13	929	1	0.1	0	0
Tot./Mean		3692	41	1	3	11**

Habitat patches (Fig. 1): 1, 4, Crossroads Santa Maria del Monte – Fonte Brignola; 2,3, Fonte Perara; 12, Hairpin curve Mattano - Malepasso. (*) The larval web survival rate was not calculated due to the 2015-2016 generation is yet in development. (**) The mean value was calculated excluding the larval webs of 2015-2016 generation.

occupancy rate by egg batches differs in value between the host plant species (Tab. 2); it was considerably higher on: *G. cruciata* (60%, Chi square test, N=561, χ^2=232.216; d.f.=1, P<0.0001) when compared with *S. columbaria* (2%) in the study areas; where *C. leucantha* and *S. columbaria* occur together in area 14, *C. leucantha* is used preferentially (28%, Chi square test, N=45, χ^2=5859; d.f.=1, P=0.0155) compared with *S. columbaria* (0%) in habitat patch 14 (Fig. 1).

Host plant use over three years. From 2013 to 2015 sixteen plants of *G. cruciata* (81%) were used for oviposition and out of these 31% were used in two or three consecutive years (Fig. 5). The data from the

Tab. 4. Records of eggs (or larval webs) on *G. cruciata* and *C. leucantha* in all localities during the pre and post-diapause period in the surveys 2012-2013, 2013-2014, 2014-2015 and 2015-2016.

	Patches	Survey	Plants (N)	Plants with eggs or pre-diapause larval webs (N)	Plant occupancy (%)	Plants with post-diapause larval webs (N)	Larval web survival rate (%)
Gentiana cruciata	2	2012-13	1	1	100	0	0
	3	2012-13	11	6	54	5	83
	3	2014-15	11	7	64	-	-
	4	2015-16	1	1	100		*
	5	2014-15	9	5	55	2	50
	5	2015-16	7	3	43		*
	6	2014-15	5	2	40	1	50
	6	2015-16	5	3	60		*
	7	2015-16	14	13	93		*
	8	2015-16	14	5	36		*
	9	2015-16	5	3	60		*
	10	2015-16	2	1	50		*
	11	2015-16	6	5	83		*
	12	2012-13	7	6	86	2	33
	12	2013-14	7	3	43	3	100
	12	2014-15	7	4	57	1	25
	12	2015-16	7	3	43		*
	13	2013-14	9	3	33	2	67
	13	2014-15	9	1	11	1	100
	13	2015-16	9	5	55		*
	Tot./Mean		146	80	55	17	45**
Cephalaria leucantha	14	2014-15	32	2	6	0	0
	14	2015-16	18	5	28		**
	Tot./Mean		50	7	14		

Habitat patches: 1, 4, Bivio Santa Maria del Monte – Fonte Brignola; 2, 3, Fonte Perara; 5, 6, 7, 8, 11, along the path between the road to Santa Maria del Monte and Hairpin curve Mattano-Malepasso; 9, 12, 13, Hairpin curve Mattano-Malepasso; 10, Pian Mattano (Fig. 1); 14, Villa Camponeschi. (-) Lack of data due to the stationing of livestock that blocked the access to locality3 during 2014-15 survey. (*) The larval web survival rate was not calculated due to the 2015-2016 generation is yet in development; out of eighty plants of *G. cruciata* with eggs (or pre-diapause larval webs), only thirty were used in the data analysis; (**) The larval webs survival rate could not be defined for the five cases on *C. leucantha* because the 2015-2016 generation is yet in development.

2012-2013 survey includes records of egg batches on the same two plants of *G. cruciata* for four successive years. The plants of *G. cruciata* without eggs were located in areas, which were in shadow or covered by vegetation and so not available for females.

Larval host plants during pre-diapause phase. Females of *E. a. provincialis* laid the eggs on their host plants when these plants were in full growth and flowering. After hatching, we recorded larvae mainly feeding on leaves of *G. cruciata,* rosette leaves and cortex of stems of *S. columbaria,* and leaves of *C. leucantha* and *L. caprifolium*.

The number of *S. columbaria* plants with egg batches, or used in summer by pre-diapause larval webs*,* was generally very low compared to the large number of plants recorded in all habitats patches and surveys (pre-diapause plant occupancy range: 0.1-3%, mean value, 1%, Tab. 3). In *G. cruciata,* virtually all the available plants carried egg batches (or pre-diapause larval webs), even if this plant was uncommon at a site (noting that all *G. cruciata* plants were sampled). There were far fewer plants of *G. cruciata* (range: 1-14 plants) compared to *S. columbaria* (range: 50-1000 plants) and the pre-diapause *G. cruciata* occupancy was on average higher (ranges from 11% to 100%, mean value: 55%, Tab. 4) than that on *S. columbaria* (mean value, 1.11%, Tab. 3) (Chi square test: χ^2=1308.134, d.f.=1, N=3838, P<0.0001). The same pattern is seen in *C. leucantha* (Tab. 4) (Chi square test: χ^2=2637, d.f.=1, N=77, P=0.1044).

Furthermore, whilst the larvae will eat any suitable host plant, even moving from one plant species to another when feeding (from *G. cruciata* to *S. columbaria*, from *G. cruciata* to *L. caprifolium*, from *S. columbaria* to *L. caprifolium)*, in the wild the change of host plant is a random event caused by the total consumption of the plant by caterpillars. Larvae from eggs laid on *G. cruciata* and *C. leucantha* almost always complete their development on the same plant. In the rare circumstances where the larvae did need to move this was usually to the more abundant *S. columbaria*. Egg batches that were laid on *S. columbaria* rapidly consume the host plant due to its small size and are forced to move in search for a new food source; this is usually another plant of *S. columbaria* due to the abundance of this host compared to *G. cruciata.* The use of different host plants and the fact that all can act as interchangeable resources for larvae of *E. a. provincialis* were confirmed by our feeding tests in laboratory. In fact, larvae (I-VI instar) fed on all host plants that were offered during trials without showing any preference for the host species.

Larval host plants during diapause phase. In the end of summer, when larvae of *E. aurinia provincialis* started the winter diapause inside larval webs, the host plants *G. cruciata* and *C. leucantha* dried out, while *L. caprifolium* began to lose their leaves as winter ap-

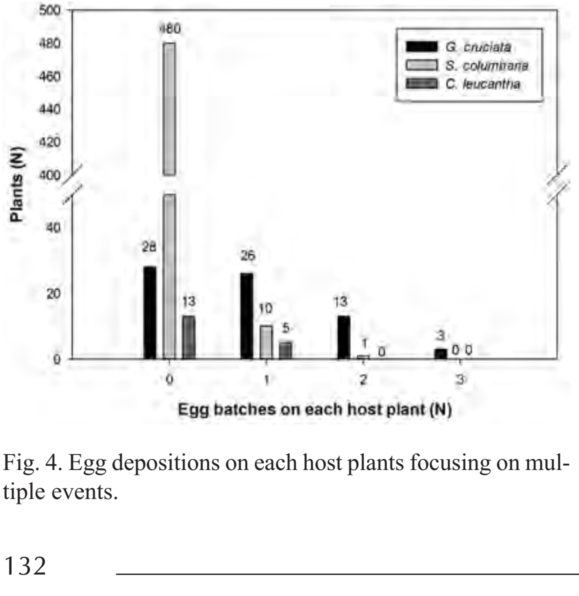

Fig. 4. Egg depositions on each host plants focusing on multiple events.

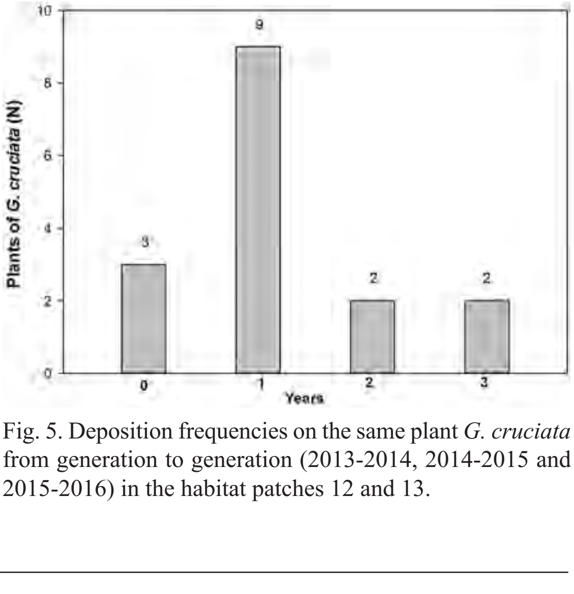

Fig. 5. Deposition frequencies on the same plant *G. cruciata* from generation to generation (2013-2014, 2014-2015 and 2015-2016) in the habitat patches 12 and 13.

proached. In contrast, *S. columbaria* retains a basal rosette of green leaves through the winter. In all habitats patches we observed overwintering larvae in large larval webs on *G. cruciata* and with small larval webs on other host plants. Additionally, larvae could enter diapause after spinning larval webs on other plants that were not host plants, *e.g.* leaves of grasses, *Carlina acaulis* L., *Eryngium* sp., *Prunus spinosa* L. and *Sanguisorba minor* Scop.

The larval webs on non-host plants were always recorded in two circumstances, i) during early larval stages, when larvae move from a host plant to another in search of new food and spin webs as part of dispersal, and ii) after moulting from III to IV instar when the larvae spin stronger webs in which to hibernate; these webs can be made on any adjacent vegetation. These observations suggest that the non-host plants may have been erroneously recorded as food sources in past studies.

Larval host plants during post-diapause phase. After the winter, the emergence of larvae from diapause is dependent upon climatic conditions and therefore altitude and sun exposure. By February the fourth instar larvae are actively basking and looking for food. Each species of host plant differs in when they begin to grow fresh leaves and develop sufficiently to provide a viable food source for the larvae of *E. a provincialis*. In February, *G. cruciata* and *C. leucantha* are still dormant and only beginning to sprout new leaves; *L. caprifolium* is still leafless, while *S. columbaria* has new shoots on small rosettes and an abundance of leaves. In early February the surviving larval groups of IV instar larvae on *G. cruciata* were still gregarious but they did not live inside a silk larval web.

From February to April, larvae abandoned the original larval webs and moved onto nearby plants, usually *S. columbaria* plants, that were abundant and had shoots and leaves that larvae can eat. The rarity of the small shoots of other host plants is such that we never found gregarious larvae (IV instar) feeding on plants other than *S. columbaria*. During these transfers the larvae follow silken "guide strands" spun by lead caterpillars without having to build a larval web.

After emergence from diapause, the larvae gradually disperse into small groups and can even feed as solitary larva in IV instar. In March, when *L. caprifolium* produces new leaves on prostrate branches, larvae in V instar (all solitary) also started to feed on this host plant. As growth develops on *G. cruciata*, the V and VI instar larvae used all three host plants as food source (*S. columbaria*, *L. caprifolium* and *G. cruciata*) in the study area, although the majority still used *S. columbaria*. *L. caprifolium* and *G. cruciata* were used less frequently (Chi square test: $\chi^2=22.231$, d.f.=2, $P<0.0001$). Out of forty-six larvae, 65% were recorded on *S. columbaria*, 24% on *L. caprifolium* and 11% on *G. cruciata* (Tab. 5).

During the journey from one plant to another, the caterpillars often stopped to bask in the sun on a silky "platform" which is spun on dry leaves on the ground. Basking enables larvae to metabolise food more rapidly than air temperatures would suggest they spend much of their time on non-feeding activities (z-score test: $z=-3.7976$, $P=0.00014$). We observed a total of one hundred and thirty nine solitary larvae during the three seasons 2012-2015: only 33% were involved with feeding behaviour and the rest in non-feeding types of behaviour (moving, 12% and dorsal basking, 55%) (Tab. 5).

When it was sunny, larvae arranged themselves in a single layer, more or less parallel to one another, on dead leaves (Fig. 2H), closing ranks when possible. When there was no sun (most of the day and night), larvae took shelter among the leaves and dried herbs and piled up on each other in a compact "ball" thus the contact surfaces between larvae increased as much as possible and reducing heat loss (Fig. 2I). This sec-

Tab. 5. Activities and host plants in solitary larvae (V e VI instar) of *E. a. provincialis*.

Activity	Larvae (n)	%	Feeding on host plant	Larvae (n)	%
Feeding	46	33	*S. columbaria*	30	65
Moving	16	12	*L. caprifolium*	11	24
Dorsal basking	77	55	*G. cruciata*	5	11
Tot.	139	100	Tot.	46	100

ond behaviour, unknown in literature, was displayed by all gregarious caterpillars of fourth instar.

Larval web survival. Not all larval webs survived winter diapause and many individuals probably died (Tabs. 3 and 4). Out of forty-one egg/larval webs on *S. columbaria* that were recorded during all surveys only three overwintered giving a mean larval web survival rate equal to 11% (Tab. 3). Conversely, the larval web survival rate on *G. cruciata* was usually high in value and varied from 25 to 100% (Tab. 3). We found a difference between the two host plants in larval survival rate approaching significance level (Chi square test: χ^2=2871, d.f.=1, N=121, P=0.09).

Gregarious and solitary larval stages. During our observations on larvae feeding behaviour in February we recorded groups of IV instar larvae simultaneously with solitary larvae nearby. In March, all larvae were solitary and according to Wahlberg (2000) would have to be already at VI stage, but surprisingly they were still quite small. By collecting some of these larvae (N=27) and monitoring their growth up to pupa in captivity we revealed that twenty-four individuals were at V instar.

DISCUSSION

Host plants. There are over twenty larval host plants reported in literature for the Marsh fritillary *Euphydryas aurinia* across its European range (Tab. 1). Among host plants, *Cephalaria leucantha* is mentioned as the host plant of the pre-imaginal stages in *E. a. provincialis* by Jutzeler (1994) and in *E. a. aurinia* by Mazel (1982, 1984); *Gentiana cruciata* is cited alone or together with *Scabiosa columbaria* or other plants by several authors (Mazel & Lutran In: Jutzeler, 1994; Hafner, 2001 com. pers. In: Anthes, 2002; Perru & Sardet, 2005; Sardet & Betremieux, 2006; Lobenstein, 2008; Svitra & Sielezniew, 2010). *Lonicera caprifolium* is reported as host plant of all subspecies of *E. aurinia*, except *provincialis* ssp., by Mazel (1977, in Jutzeler, 1994).

In Central Italy, our observations on *E. a. provincialis* show that four species of plant are used by larvae as host plants: *Gentiana cruciata*, *Scabiosa columbaria*, *Lonicera caprifolium* and *Cephalaria leucantha.* The larvae show no preference between these plants. These host plants are consumed by caterpillars from I to VI instar but the role played by each host plant in supporting larval growth is different and depends on vegetative status of each host plant species. The mean values of plant occupancy showed that: *G. cruciata* (55%) and *C. leucantha* (14%) prevail in the diet of the pre-diapause larval stages (Tab. 4), with *S. columbaria* providing the major food source for the post-diapause fourth instar 65% to the nourishment of the fifth and sixth instar. *L. caprifolium* provides a lesser contribution as a food source for the V-VI instars (24%, Tab. 5).

In laboratory larvae did eat *Gentiana lutea,* no eggs or larvae were found using this host plant in the wild.

Oviposition host species. Females laid their eggs on three plant species, *Gentiana cruciata*, *Scabiosa columbaria* and *Cephalaria leucantha* (Tabs. 2-4). Whenever *S. columbaria* and *G. cruciata* coexist, the pre-diapause plant occupancy on *G. cruciata* is on average higher than that on *S. columbaria* (Tab. 3) although *G. cruciata* is uncommon at a site (noting that all *G. cruciata* plants were sampled) and *S. columbaria* was very abundant. The same pattern was seen where *C. leucantha* is together with *S. columbaria.* Why do the females lay more egg batches on plants that are less frequent and numerically rare? In *E. aurinia,* the main stimulus that encourages females to alight on a plant is primarily visual, as observed in *E. editha* (Ehrlich & Hanski, 2004). Therefore, the visibility of plants is crucial in selecting oviposition sites and depends on local features of the soil morphology, the vegetation structure, and the physical size of the host plant present within a habitat patch. This topic has been studied by several authors and recognized as related to the presence of eggs (Porter, 1981; 1982; 1992; Anthes *et al*., 2003; Konvicka *et al*., 2003; Fowles & Smith, 2006; Liu *et al*., 2006; Stefanescu *et al*., 2006; Betzholtz *et al*., 2007; Botham *et al*., 2011; Pennekamp *et al*., 2013).

Our observations on *E. a. provincialis* have led us to the same conclusion and show that there was no preference in the choice of the host plant in this species and the egg deposition was determined only by host plants visibility and accessibility to females. Females of *E. a. provincialis* mainly laid their eggs on *G. cruciata* (and on *C. leucantha*) that are more easily accessible than *S. columbaria* (Fig. 3) although those plants were much less numerous than those of *S. columbaria* (about 1:100). Taking into account the egg batches alone, the plant occupancy rate were higher: 60%, *G. cruciata,* 28%, *C. leucantha,* 2%, *S. columbaria*, in each habitat patches (Tab. 2). This shows a distinct preference for the large, clearly accessible plants of *G. cruciata*. We want to emphasize that *C. leucantha* does not exist in the same place with *G. cruciata*; *C. leucantha* is limited to a rocky slope in a small habitat patch nearby Villa Camponeschi therefore it is not ecologically relevant to compare *cruciata* with *leucantha*.

Considering the presence of eggs and larval webs together, although different factors (*i.e.* mortality, starvation, etc.) can affect the conclusions above, a similar pattern in host plant use is observed (55%, *G. cruciata,* 14%, *C. leucantha,* 1%, *S. columbaria* (Tabs. 3 and 4). During the flight period of *E. a. provincialis* the vegetative status of the host plants and surrounding vegetation was systematically recorded. This could provide an approximate index of the visibility of the host plant.

In all altitudinal zones in the study area *G. cruciata* is represented by prominent, large-sized individuals that stand out clearly above the surrounding vegetation. The ground rosettes leaves of *S. columbaria* are almost always completely hidden, and therefore inaccessible to searching females. In north-facing and wet grassland patches, *S. columbaria* is very frequent but patchily distributed and completely hidden by the surrounding tall grasses, with the flower heads of *S. columbaria* concealed by vegetation (Fig. 3A). In these places there are neither webs nor eggs despite the local high host plant density. On contrast, the eggs batches are found on *S. columbaria* where slope, aspect, sun exposure, humidity and soil, do allow good visibility of host plants. In these situations the host plants may be larger in size, or more apparent due to grazing activity.

Some authors suggest that the presence of egg batches is linked to host plant density and other factors such as host plant size, morphology and growth habits, and vegetation structure of the habitat (Anthes *et al*., 2003; Fowles & Smith, 2006; Liu *et al*., 2006; Stefanescu *et al*., 2006; Betzholtz *et al*., 2007), or microclimatic predictors (sun exposure and topography, Botham *et al*., 2011; Pennekamp *et al*., 2013). Our observations are not inconsistent with those results. In fact, the egg and larval occupancy of *S. columbaria* is very low in all habitat patches, both where large and small host plants coexist, and where only small plants are present.

Some plants of *G. cruciata,* even if visible and accessible for females, occur in shady or dense vegetation cover. These plants were never used for egg laying in contrast to plants in open sunny conditions that held egg batches year after year (Fig. 5). These results show how the location (sun exposure, microclimate) of plants of the same species can influence the female choice of oviposition site. In addition, the exposure to sunlight within the habitat could shape the female choice for oviposition plant; for example, large, visible plants would not be considered for egg laying if they were in shadow. For this reason there were plants that were highly visible, but shaded, on which egg batches were never observed compared to “optimally” placed plants that were used for oviposition for consecutive seasons (Fig. 5). The observed pattern of host plant use is of great relevance to the conservation of the species *E. a. provincialis*, with the data showing selection of the same *G. cruciata* plants year after year. Accordingly to observations on *E. a. aurinia* (Porter, 1992; Anthes *et al*., 2003; Sardet & Betremieux, 2006; Singer, 2003 In: Stefanescu *et al*., 2006) females of *E. a. provincialis* also lay their eggs on the same plant where other females have previously laid. The multiple batch placements seem unrelated to host plant availability. In the study area there were many plants without egg batches (40%, *G. cruciata*, N=70; 97%, *S. columbaria*, N=396) (Fig. 4). In fact, females seemed to prefer the plants with egg batches rather than “empty” ones despite these being available. The presence of eggs as a stimulant for further egg batches being added is known in other butterflies (Ehrlich & Hanski, 2004). In *E. a. provincialis* the presence of multiple egg laying events on the same plant could not be random because during oviposition behaviour the females make a long and meticulous inspection of the host plant and then lay their eggs nearby or on the egg batches laid previously by a different female (Fig. 2C). If this inspection of host plants was aimed at preventing the competition for trophic sources, females would avoid laying on host plants that already held batches. The hypothesis that the multiple egg laying events on the same host plant can be due to the lack of host plants is unsupported. For example, excluding the plants located in non-optimal conditions for butterfly activity, a moderate percentage of Gentian plants were not used by females.

Given the above, why do females oviposit on small plants and not continue to search for large host plants? We think that females of *E. a. provincialis* do not use size in selecting host plants, but they oviposit on the first host plant found during their search; then, they check it, not to evaluate the plant (prerequisite for a choice whether or not to abandon it) rather to search for eggs laid by other females before adding their batch. Although this female behaviour is seemingly not favourable for larvae in terms of competition for food source, it provides benefits in terms of survival by creating large numbers within a feeding group during the post-diapause stages (see below).

Larval host plant choice. *Pre-diapause and diapause phase.* The young larvae (I-III instars) have a distinct behaviour and live in a group inside a silk larval web feeding on the four above-mentioned plants. The key point is that, accordingly to the data on egg batches, large plants were mostly occupied by the pre-diapausing stages. In the study area, the pre-diapause plant occupancy on *G. cruciata* was on average always higher than that on *S. columbaria* (respectively, 55% *vs.* 1%, Tabs. 3 and 4). This was also true in the habitat patches nearby Villa Camponeschi where *G. cruciata* is absent and *C. leucantha* takes over as large sized host plant; here, the plant occupancy on *C. leucantha* was 14% and higher than that on *S. columbaria* (on this plant no larval web was observed). This suggests that, when eggs laying occurred on large-sized plants, the young caterpillars remain aggregated, thanks to the abundance of food provided by plant. These larvae also built large, robust larval webs, spun around two or three stems of host plant, that easily withstood the ravages of winter (Fig. 2D,E). These larval webs may contain some hundreds of larvae. In contrast, if egg laying occurred on small host plants, such as the rosettes of *S. columbaria*, the larvae quickly consumed the whole plant and then were forced to move onto new food sources. In these cases, the original feeding group of larvae dispersed in the meadows and often divided into small groups, not all of which survived due to starvation (see below in *Larval survival* paragraph). The surviving larvae made small and less robust larval webs (Fig. 2F) and these contained a small numbers of individuals. Only two examples were found where this also occurred on *G. cruciata* where larvae consumed the original host plant and the original gregarious group dispersed as they searched for a new food source. The overwintering larval webs were recorded on the four host plants cited above and also on some *Graminacee and other plants as Carlina acaulis, Eryngium sp., Prunus spinose, Sanguisorba minor.*

Post-diapause phase. After the diapause period, in February, gregarious larvae (IV instar) became active; they moved on the ground in search of food, using a silk thread to guide the group of caterpillars. In February, available food consisted solely of small but abundant shoots of *S. columbaria,* with minimal contribution from small shoots of the few plants of *G. cruciata* and *C. leucantha* (Fig. 3). The plants of *L. caprifolium* are, at this time of year, without leaves and cannot be used as a food source. From March onwards, the fifth instar larvae were feeding as individuals with no gregarious behaviour and start to utilise *L. caprifolium* as it produces fresh leaves and shoots. In the study area all three host plants provided food source for *E. a. provincialis* caterpillars post-diapause, but with *S. columbaria* as main food source (Tab. 5).

Larval survival after winter diapause. It is clear that the larger host plants have an important role in the larval development during the pre-diapause period and reduce winter mortality during the early larval instars and a high survival through the winter (diapausing larvae).

The survival rate of overwintering larval webs on *G. cruciata* was on average higher than on *S. columbaria,* though not reaching significance. This result becomes more significant when the differences in web size are considered; although this rate was impossible to determine directly without causing irreparable damage to the larval webs, it was easily inferable as the larval webs on *G. cruciata* and *C. leucantha* contained many more larvae (150-200 larvae) than those on the *S. columbaria* (20-50 individuals). The better survival rate on *G. cruciata* can be related two points: the size and biomass of *G. cruciata* and the benefits of large overwintering webs. The large plant size and abundant leaves of *G. cruciata*, enable the first three larval instars to develop on a single host plant. This means that larvae do not need to disperse in search of food in contrast to larvae using small plants as *S. columbaria*. The high numbers of larvae on *G. cruciata* are able to construct large and robust larval webs (a larval web on gentian: 10-15 cm in length and 4-5 cm in diameter), which provide protection from climatic pressures (snow, rain, low temperatures) and predators. The predators includes true bugs (Hemiptera, Heteroptera) as *Deraeocoris schach* (Fabricius, 1781) (Pinzari, 2016) and *Picromerus bidens* (L., 1758) that attack the pre-diapause larvae, and flies *Erycia furibunda* (Zetterstedt, 1844) (Diptera, Tachinidae) that are parasitoid of the pre-diapause larvae (Pinzari, in press).

At this point, it is legitimate to ask why *E. a. provincialis* continues to egg lay on *S. columbaria* if it seems to be advantageous in terms of larval survival to oviposit on *G. cruciata* and large plants in general. Our results show that, on their own, large plants of *G. cruciata* do not ensure the survival of *E. a. provincialis* larvae as they are unavailable as a food source for post-diapause larvae. *S. columbaria* and *L. caprifolium* are key sources of food during the post-diapause period. Additionally, in patches where *G. cruciata* was absent, the larval webs survival of *E. a. provincialis* was exclusively dependent upon *S. columbaria* and *L. caprifolium,* although with low survivorship.

Post-diapause larval activities and thermoregulation. The fact the shoots of small plants were the main food source for larvae during the post-diapause period means that they need to move frequently to find food. This is facilitated by the high density of *S. columbaria* plants but also includes opportunities to bask. This matches Porter's studies (1982) where larvae need an optimum body temperature (not less than 30°C) to metabolize food efficiently. When they feed their body temperature decreases for the ingestion of cold food; consequently, they need to bask in sunshine to raise their body temperature above 30°C. In February, the temperatures reached as low as 0°C and never exceed 10-15°C until April. Consequently, it is easy to understand how, at low temperatures, it is difficult for caterpillars to maintain the optimum body temperature for rapid food digestion and how long periods of dorsal basking are needed to (especially in the fourth instar) to facilitate rapid digestion. The results of our observations on the fifth and sixth solitary caterpillars activities do show that around 55% of their time is devoted to body thermoregulation compared the time spent moving or feeding (Tab. 5).

In *E. a. aurinia,* larvae use dorsal basking behaviour to heat up in the sun and raising their body to temperatures above 30°C (35-37°C) (Porter, 1982). The change of larval habitus from pale-brown in post-diapause feeding stages to jet-black in post-diapause is presumably related to individual body thermoregulation. The colour helps both absorbing the solar radiation and limit heat losses. Porter (1982) showed that the larval body temperature decreases as they feed low down in the cooler parts of the plant and suggested that larvae move closer together to reduce the lateral dispersion of heat. This behaviour was also observed during our field work; when it was sunny, larvae arranged themselves more or less parallel in tightly aligned groups and in a single layer (Fig. 2H). Additionally, we observed another behaviour used by caterpillars for reducing heat loss from their body in absence of sun (in cloudy days or at sunset). At these times larvae took shelter among the leaves and dried herbs and piled up on each other in a tight, almost spherical cluster, thus the larvae are in close contact with all their neighbours and this will reduce heat loss from each larva (Fig. 2I). The basking and clustering behaviours are reinforced by the female behaviour of adding eggs to existing batches to create larger groups of larvae. This preference to lay eggs on a plant with existing egg batches will have evolutionary advantage. The aggregation of individuals is an effective way to promote warming, and the greater the number of larvae in a group the better. Hence, multiple egg deposition on the same host plant and large larval webs on large host plants give greatest advantage to survival of larvae.

As spring progresses, the climatic conditions change and temperatures rise. In these conditions gregarious behaviour is not needed as a way of maintaining the temperature body; the need to find new food sources is now more important than the need to keep warm by group basking. At this time the fresh shoots of host plants are soon exhausted as the larvae grow larger, and larval groups begin to split up to search for new food sources. By the fifth instar the gregarious behaviour ceases and larvae become solitary.

Conclusions

Females of *E. a. provincialis* oviposit on three host plants (*G. cruciata, S. columbaria, C. leucantha*) without any preference and locate them by using visual stimuli. More visible and accessible plants (*G. cruciata* and *C. leucantha*) show a higher number of egg laying events.

Female prefer to lay their eggs on the plants where other females have previously oviposited as in *E. aurinia aurinia* (Porter, 1992; Anthes *et al*., 2003; Sardet & Betremieux, 2006; Singer, 2003 In: Stefanescu *et al*., 2006). In *E aurinia*, living in larval groups seems to be evolutionary selected through laying egg batches. Double and triple egg laying events on the same plant contribute to form single, large groups of larvae. This female behaviour can be seen as disadvantageous because of the high competition for food sources among young larvae on the same host plant; however, gregarious behaviour can offer several benefits to larvae during both pre-diapause period and post-diapause period.

E. a. provincialis is a polyphagous species in the study area. The larvae feed on three plants *G. cruciata*, *L. caprifolium* and *S. columbaria*, and in other patches nearby our study area they also eat *C. leucantha*. A fifth species, *G. lutea* is eaten under laboratory conditions but needs further confirmation in the wild. The larvae show no preference for a specific host plant, readily moving from one to another one when feeding. All host plants are important for the larval survival in *E. a. provincialis,* supporting their growth and development during one or more of their larval stages.

The success of *E. a. provincialis* and its persistence over forty years in the study area may be helped by the larvae being polyphagous. The preferential use of different host plants by larvae at each growth stage ensures the survival of the species.

Larval survival is often the key determinant of population size and distribution, so understanding the sources and variation in larval mortality is essential to understanding and predicting butterfly population dynamics.

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Verity R., 1950 - Famiglie Apaturidae e Nymphalidae. In: Le Farfalle diurne d'Italia. Marzocco, Firenze, Vol. IV, Tav. 38-54, XV-XX, 380 pp.

Wahlberg N., 2001 - The phylogenetics and biochemistry of host-plant specialization in Melitaeine butterflies (Lepidoptera: Nymphalidae). Evolution, 55(3): 522-537.

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Warren M.S., 1994 - The UK status and suspected metapopulation structure of a threatened European butterfly, the marsh fritillary *Eurodryas aurinia*. Biological Conservation, 67: 239-249.

Warren M.S., 1996 - *Euphydryas aurinia*. In: Van Helsdingen P.J., Willemse L.P.M., Speight M.C.D. (eds.), Background information on invertebrates of the Habitats Directive and the Bern Convention. Part I - Crustacea, Coleoptera and Lepidoptera: 121-126. Council of Europe, Strasbourg, Nature and environment, No. 79.

Warren M.S., Munguira M.L., Ferrin J., 1994 - Notes on the distribution, habitats and conservation of *Eurodryas aurinia* (Rottemburg) (Lepidoptera: Nymphalidae) in Spain. Entomologist's Gazette, 45: 5-12.

SEGNALAZIONI FAUNISTICHE ITALIANE

607 - ***(Lamprodila) mirifica mirifica*** (Mulsant, 1855) (Coleoptera Buprestidae)

Curletti G., 1994 - I Buprestidi d'Italia. Catalogo geonemico, sinonimico, bibliografico, biologico. Mon. nat. Bresciana, 19, Brescia, ed. Vannini, 320 pp.

Curletti G., Rastelli M., Rastelli S., Tassi F., 2003. Coleotteri Buprestidi d'Italia. Museo Civico di Storia naturale di Carmagnola (Torino), Piccole Faune, Progetto Biodiversità (Roma), CD-ROM.

Prima segnalazione per la Lombardia di specie a corologia Turanico-Mediterranea, già nota per altre regioni Italiane.

Reperti. Lombardia: prov. Brescia, Montichiari, 30.VI.2015, Petruzziello L., det., leg. 1 ex. (coll. Petruzziello L.).

Osservazioni. Si tratta di un elemento stenofago a spese di *Ulmus* spp., con ciclo annuale. La larva scava gallerie trofiche tra la corteccia e il legno dei rami o dei tronchi di piante morte di recente o comunque senescenti. L'immagine, che sfarfalla da una celletta pupale costruita nella corteccia oppure poco sotto la superficie dell'alburno, a seconda dello spessore della scorza, si trasferisce immediatamente sulla chioma per cibarsi delle foglie tenere.

La specie è segnalata per l'Italia, di Trentino Alto Adige, Friuli Venezia Giulia, Emilia Romagna, Toscana, Marche, Abruzzo, Lazio, Campania, Molise, Basilicata, Puglia, Calabria e Sicilia (Curletti *et al*., 2003).

L'esemplare della pianura bresciana è stato raccolto in trappole aeree innescate con sostanze in fermentazione, collocate su di un colle, in un boschetto naturale di latifoglie con una forte presenza di olmi (*Ulmus minor*), quasi tutti morti o sofferenti perché infettati dal fungo *Ophiostoma ulmi* (Grafiosi dell'olmo). Sulle stesse essenze è stato osservato anche il cerambicide *Saperda punctata* che condivide, con la *Lamprodila*, gli stessi organi legnosi.

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608 - ***Harmonia axyridis*** (Pallas, 1773) (Coleoptera Coccinellidae)

Sasaji, H., 1971 - Fauna Japonica. Coccinellidae (Insecta: Coleoptera). Academic Press of Japan, Keigaku Publishing, Tokyo, 340 pp.

Iablokoff-Khnzorian S.M., 1982 - Les Coccinelles Coléoptères-Coccinellidae Tribu Coccinellini des régions Paléarctique et Orientale. Boubée. Paris, France, 568 pp.

Eizaguirre S., 2015 - Fauna Iberica Vol. 40 - Coleoptera Coccinellidae. CSIC, 514 pp.

Prima segnalazione per la Sicilia Orientale di specie est asiatica nota per altre regioni italiane.

Reperti. Sicilia-Mineo (Catania), 350 m s.l.m, 37.3516°N, 14.7013°E; 2 es. su piante di arancio (*Citrus sinensis*) 02.X.2014; Motta Sant'Anastasia (Catania). 300 m.l.m; 37.5261°N, 14.9827°E, 1 es. all'interno di civile abitazione 10.XII.2015. Tutti gli esemplari raccolti appartengono alla forma succinea, dotata di colorazione di fondo delle elitre rosso-arancio e macchie scure con formula elitrale ½ -2-3-3-1.

Osservazioni. Specie descritta originariamente da Pallas, nel 1773, come *Coccinella axyridis*, inserita da Jakobson, nel 1915, nel genere *Harmonia*. Originariamente distribuita in Cina, Giappone, Corea, Taiwan, Mongolia, Siberia meridionale, Kazakistan e Uzbekistan, è stata introdotta a più riprese per la lotta biologica negli Stati Uniti e in Canada tra il 1916 e il 1982, si è successivamente diffusa in varie parti del globo. In Europa *H. axyridis* è stata segnalata a partire dal 1995 e si è poi diffusa in vari stati (Francia, Belgio, Olanda, Germania, Svizzera, Repubblica Ceca, Spagna, Portogallo, Grecia, Austria, Gran Bretagna, Liechtenstein, Lussemburgo e Polonia). In Italia è stata segnalata per la prima volta nel 2006 in Piemonte e, successivamente, in altre regioni (Lombardia, Emilia Romagna, Friuli Venezia Giulia, Veneto, Liguria, Toscana, Abruzzo, Alto Adige e Calabria). Si tratta di una specie afidofaga ma che può predare anche uova e larve di altri Coccinellidi. Morfologicamente molto variabile (si conoscono circa 32 forme con differente colorazione) si è rivelata un pericoloso competitor ecologico nei confronti dei Coccinellidi europei. La specie, inoltre, può indurre problemi di ordine sanitario, poiché gli adulti in svernamento, penetrando spesso all'interno delle abitazioni civili possono rilasciare delle sostanze allergeniche contenute nell'emolinfa provocando, in soggetti sensibili, varie patologie (rinite, asma, congiuntivite e orticaria).

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ATTI SOCIALI

CONVOCAZIONE DI ASSEMBLEA GENERALE ORDINARIA

L'Assemblea Generale Ordinaria dei Soci della Società Entomologica Italiana è convocata presso la Sede di Corso Torino 19/4 scala A – Genova, venerdì 24 marzo 2017, alle ore 15:00 in prima convocazione e

sabato 25 marzo 2017 alle ore 15:00

in seconda convocazione, con il seguente

ORDINE DEL GIORNO

1) Convalida dei soci presentati dal Consiglio.
2) Comunicazioni della Presidenza.
3) Relazione dei membri del Consiglio.
4) Bilancio consuntivo esercizio 2016 e previsioni per il 2017.
5) Pubblicazioni sociali.
6) Varie ed eventuali.

I soci che non potessero intervenire possono farsi rappresentare da altri soci con delega scritta.

BOLLETTINO DELLA SOCIETÀ ENTOMOLOGICA ITALIANA
Vol. 148 (2016)

Indice dei nuovi taxa (*in corsivo*) e dei nuovi atti nomenclatoriali
Index of new taxa (*italic*) and of new nomenclatorial acts

Coleoptera

Hymenoptera

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