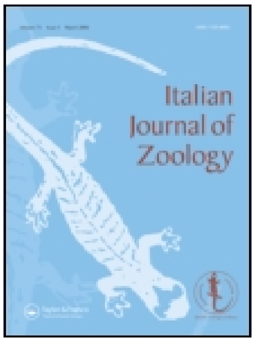

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Revision of first instar larvae of *Meloe*, subgenera *Eurymeloe* and *Coelomeloe*, with new descriptions and a key to the species (Coleoptera: Meloidae)

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Abstract
In this paper the larval morphology of the Palaearctic *Meloe* subgenera *Eurymeloe* and *Coelomeloe* is revised. We describe the first instar larva of *Meloe* (*Eurymeloe*) *apenninicus,* endemic to the Italian peninsula and, comparatively, triungulins of three more species of the subgenus *Eurymeloe*: *M. apivorus*, *M. ganglbaueri*, misidentified in literature, and of *M. mediterraneus*, incompletely described. Descriptions are accompanied by scanning electron microscope (SEM) photos of diagnostic characters and by a table reporting the size of the morphological details of 11 Euro-Mediterranean species and of *M.* (*Coelomeloe*) *tuccius*. The taxonomic position of the subgenus *Coelomeloe* and its distinction from *Eurymeloe* are discussed on the basis of larval morphology. Taxonomical problems concerning some *Eurymeloe* species are also discussed. A key to first instar larvae of all known *Eurymeloe* and *Coelomeloe* triungulins is provided.

Keywords: *Larval morphology, taxonomy, Meloini, SEM, key*

Introduction

Family Meloidae (Insecta: Coleoptera) is well known in the biological and medical literature due to its unusual larval development related to its parasitic habits on Hymenoptera Aculeata and Orthoptera Caelifera, and the cantharidin production, a natural terpenoid with several pharmacological applications (see Bologna 1991; Bologna et al. 2010). Phylogenetic relationships of blister beetles were recently clarified by Bologna et al. (2008). The presence of a peculiar modality of larval development, called hypermetamorphosis or hypermetaboly, is common to all Meloidae from subfamilies Nemognathinae and Meloinae, with the probable exception of the basal subfamily Eleticinae, that may have predator rather than parasitoid larvae (Pinto et al. 1996; Bologna et al. 2001, 2008; Bologna & Di Giulio 2011). The development of the most derived subfamilies includes seven distinct larval instars, often divided into five morphologically and biologically distinct phases (Paoli 1932; Selander & Mathieu 1964); the first one, usually called triungulin, locates the host (or eventually the prey), walking actively onthe ground (most Meloinae) or is phoretic on wildbees or other insects (most Nemognathinae and someMeloinae) (see Bologna 1991; Di Giulio et al. 2003;Bologna & Di Giulio 2011 for reviews).

The morphology of the first instar larva was largely used in the systematics of this family to evidence phylogenetic relationships at different taxonomic levels (Bologna & Pinto 2001; Bologna et al. 2008). Phoretic behaviour and relative morpho-functional adaptations are common to both Nemognathinae and Meloinae, and the hypothesis of convergent evolution was advanced and supported (Bologna & Pinto 2001; Bologna & Di Giulio 2011). In particular, according to molecular and morphological evidence, phoresy evolved multiple times in different tribes of the subfamily Meloinae (Bologna & Pinto 2001; Bologna et al. 2008).

The meloine genus *Meloe* Linnaeus, 1758 (tribe Meloini) includes some 150 Holarctic and Afrotropical species. The first larval instars of all of them are adapted to phoresy on bees, with different

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degrees of specialization at the level of antennal sensorium, head setation, mandibles, femurs, claws, etc. (Bologna & Pinto 1992, 1995, 1998, 2001; Pinto & Bologna 1993; Di Giulio et al. 2002; Bologna & Di Giulio 2011). In particular, the antennal sensorium, a chemoreceptive structure that in Coleoptera larvae seems to be involved in prey/host finding (Giglio et al. 2008), is reduced in species that are highly adapted to phoresy, since they do not look for the host species (Pinto & Bologna 1993).

The first instar larvae of about 30 species belonging to 11 of the 16 subgenera have been described, and the first instar larvae of the subgenera are identifiable (reviews in Bologna & Pinto 1998; Di Giulio et al. 2002). Larval studies were relevant for the systematics of some genera; e.g., triungulin morphology suggested moving some genera, such as *Physomeloe* Reitter, 1911, *Berberomeloe* Bologna, 1989, and *Trichomeloe* Reitter, 1911 out of the genus *Meloe*, and confirmed the subgeneric division of the genus, in most cases based on adult morphology (Bologna 1989; Bologna & Aloisi 1994; Bologna & Di Giulio 2008).

Eurymeloe Reitter, 1911 is the most speciose subgenus of *Meloe*, with ca. 50 mostly Palaearctic species (exceptions from northern Somalia and from the Aleutinian islands; Bologna 1988). Two distinct groups of species, namely the "*brevicollis*" and "*rugosus*" groups, have been identified on adult morphology (Bologna 1988), but here we question the validity of these groups and the possible inclusion of the monotypic subgenus *Coelomeloe* Reitter, 1911 in *Eurymeloe,* as a third group, based on larval morphology (Selander 1985; Bologna et al. 1989; Bologna & Pinto 2001). Larvae of few species of *Eurymeloe* have been described so far, some of these after unreliable identification (reviews in Bologna 1988, and Bologna et al. 1989).

A larval synopsis of the subgenus *Eurymeloe* is the main object of this contribution. In detail, the aims of this study are to: (i) describe the triungulin of *Meloe apenninicus* Bologna, 1988, endemic to the Italian peninsula; (ii) describe comparatively the triungulin of *M. apivorus* Reitter, 1895, a controversial taxon, endemic to High Atlas (Morocco) and previously referred as subspecies to *M. affinis* Lucas, 1847; (iii) compare the triungulin of *apivorus* Reitter, 1895 against that of *affinis* Lucas, 1847 (var. *setosus* Escherich, 1890); (iv) describe comparatively the first instar larvae of two Euro-Mediterranean species, *M. ganglbaueri* Apfelbeck, 1905 and *M. mediterraneus* G. Müller, 1925, both poorly described; (v) assess the taxonomic status of *Coelomeloe* and the proposed synonymy with *Eurymeloe*; (vi) provide a key to all known first instar larvae of *Eurymeloe* and *Coelomeloe* (12 Euro-Mediterranean species) and a comparative table with the main measures of body and appendices of these species.

Materials and methods

The description of triungulins and the key of identification are based on the following material preserved in 70% ethanol and/or mounted on slides, if not differently indicated larvae and adults are kept at Roma Tre University, Rome, Italy, in the M. A. Bologna collection. Sampled localities are ordered by country, from north to south and from west to east. The key was built basing both on direct study of specimens and on descriptions available in the literature (Bologna 1988; Bologna et al. 1989; Lückmann & Kuhlmann 1997; Di Giulio et al. 2002; Lückmann & Scharf 2004); when contrasting characters were found, direct observation was considered more reliable.

(i) *Meloe (Eurymeloe) affinis* Lucas, 1847 (var. *setosus* Escherich, 1890)
  - Slide from Natural History Museum of London (UK), collection van Emden, "ex ovo 10.5.1935 Dr. A. Cros" (40 triungulins).

(ii) *Meloe (Eurymeloe) apenninicus* Bologna, 1988
  - Vial 610 (ca. 100 triungulins), slides M462/M463; adults from Italy, Abruzzo, Ovindoli (AQ), loc. Piani di Pezza, ca. 1400 m. 16.x.2010 A. Di Giulio leg.; oviposition 10.xi.2010, hatch 3–4.xii.2010.
  - Slide M75 (1 triungulin); netting on flowers, Italy, Calabria, Sila Mts. (CS), Lorica, ca. 1300 m, 23.vi.1988 J.D. Pinto leg.
  - Vials 150, 152/154 (9 triungulins), slide M171/ M172; on undetermined bees, Italy, Sicily, Nebrodi Mts., near Cesarò (ME), ca. 1400 m, 9.vi.1992, J.D. Pinto leg.
  - Slides M196, M197, M459 (4 triungulins); netting on flowers, Italy, Sicily, Nebrodi Mts., Cesarò, Portella di Femmina morta (ME), ca. 1540 m, 9.vi.1992, J.D. Pinto leg.

(iii) *Meloe (Eurymeloe) apivorus* Reitter, 1895
  - Vial 617 (about 300 triungulins), slides M465 (4 triungulins), M466 (4 triungulins), M467 (4 triungulins), M468 (3 triungulins); adult from Morocco, Tizi-n-Test, about 2 Km Nto pass, 1933 m a.s.l., 30,87479° N-8,37739° W, 04.v.2009, A.Di Giulio & E. Maurizi leg.

(iv) *Meloe (Eurymeloe) brevicollis* Panzer, 1773
- Vials 78/79, 83/84 (ca. 150 triungulins), slide M68 (2 triungulin); adult from Spain, Salamanca prov., Candelario, ca. 1200 m, 10.v.1989, M.A. Bologna leg.; oviposition 12.v.1989; hatch 13.6.1989.
- Vials 3/4 (about 200 triungulins), slides M19, M20; adult from Italy, Abruzzo, Civitella del Tronto (TE), Val Salinello, Laghetto di San Sisto, ca. 1000 m, 20.iv.1983 M.A. Bologna leg.; oviposition 25.iv.1983, hatch 20.v.1983.
- Slides M67, M74 (3 triungulins) by netting on flowers, Italy, Calabria, Sila Mts. (CS), Lorica, ca. 1300 m, 23.vi.1988 J.D. Pinto leg.

(v) *Meloe (Eurymeloe) corvinus* Marseul, 1876
- Vial 88 (ca. 5 triungulins), slide M69 (2 triungulins); adult from Japan, Honshu, Hyogo prefecture, Santŏ-chŏ, 1982, T. Kifune leg.

(vi) *Meloe (Eurymeloe) flavicomus* Wollaston, 1854
- Vials 17/18 (ca 50 triungulins), slides M25, M26, M27 (10 triungulins); adults from Spain, Canary Islands, La Gomera Island, El Cedro, 20.iii.1985, A. Vigna Taglianti leg.; oviposition 1/5.iv.1985, hatch ca. 25.iv.1985.

(vii) *Meloe (Eurymeloe) ganglbaueri* Apfelbeck, 1905
- Vials 249, 250, 402, 403 (ca. 500 triungulins) slides M213 (2 triungulins); adult from Italy, Latium, Canale Monterano (RM), 12.ii.1994, M.A. Bologna leg.; oviposition 21.ii.1994, hatch 30.iii.1994.

(viii) *Meloe (Eurymeloe) glazunovi* Pliginskji, 1910
- Vials 9/10 (ca. 50 triungulins) and slides M24, M38 (4 triungulins); adults from Turkey, Akseki, ca. 900 m, 28.iv.1992 M.A. Bologna leg.; oviposition 1.v.1992, hatch 15.v.1992.

(ix) *Meloe (Eurymeloe) mediterraneus* G. Müller, 1925
- Vial 618 (10 triungulins), slide M469 (1 triungulin); on mouthparts of Syrphidae (Diptera), Spain, Salamanca, Campanarios de Azaba, 9.vii.2011, Garcia Ramirez and Cortés leg. (see Marcos-García & Moreno Fresneda 2012).
- Vial 435 (1 triungulin); on *Macquartia praefica* (Meigen, 1824) (Diptera, Tachinidae), Italy, Latium, Castelporziano Presidential estate (RM), loc. Ponte Ruffo, 12–25.v.1998, P. Cerretti leg.
- Vial 436 (2 triungulin); on *Leucostoma turonicum* Depuis, 1964 (Diptera, Tachinidae), Italy, Latium, Castelporziano Presidential estate (RM), loc. Grotta Romagnola, 12–25.v.1998, P. Cerretti leg.
- Slide M115 (1 triungulin); netting on vegetation, Italy, Sicily, Egadi islands, Favignana Island, western slope of Santa Caterina Mt., 2.v.1991, M. Mei leg.
- Slide M199 (3 triungulins); netting on flowers, Italy, Sicily,10 km NW of Geraci (PA), 9.vi.1992, J.D. Pinto leg.
- Slide M54 (1 triungulin); on mandibular setae of *Lagorina scutellata* (Laporte de Castelnau) (Coleoptera, Meloidae), Algeria, Hammam Righa, 5.1954, Stattermayer leg.
- Slide M198 (1 triungulin); on *Anthophora plagiata* (Illiger, 1806) (Hymenoptera, Anthophoridae), western Bulgaria, Kurilu Iskan, 19.vi.1955 D. Brčák leg.

(x) *Meloe (Eurymeloe) rugosus* Marsham, 1802
- Vials 460, 482 (ca. 150 triungulins), slide M460/461; adult from Germany, Magdeburg, 8–9.x.2001, J. Lückmann leg.; oviposition x.2001, hatch xi.2001.

(xi) *Meloe (Eurymeloe) scabriusculus* Brandt and Ericshon, 1832
- Vial 430 (ca. 10 triungulins), slide M361 (2 triungulins); adult from Austria, Neusiedlersee, iv. 1998 J. Lückmann leg.; oviposition 4.v.1998, hatch 30.v.1998.

(xii) *Meloe (Coelomeloe) tuccius,* Rossi, 1792
- Vial 141/143 (ca. 100 triungulins), slides M121/M124, M130/M132 (10 triungulins); adults from Spain, Canary islands, La Palma Island, Tijorafe, ca. 600 m, 30.iii.1992, T. Altea and B. Osella leg.; oviposition 1.v.1992, hatch 1.vi.1992.
- Vial 140 (ca. 100 triungulins); adult from Italy, Sardinia, Giara di Gesturi (CA), 2.v.1992 G.M. Carpaneto leg.; oviposition 3.v.1992, hatch 1.vi.1992.
- Vial 616 (ca. 200 triungulins); adult from Italy, Sardinia, Quartucciu (CA), 4.iv.2011, P.F. Murgia leg.; oviposition, 8.iv.2011, hatch ca. v.2011.
- Vial 228 (9 triungulins), slide M104 (1 triungulin); on *Anthophora* sp., Italy, Sicily, Lampedusa Island (AG), between

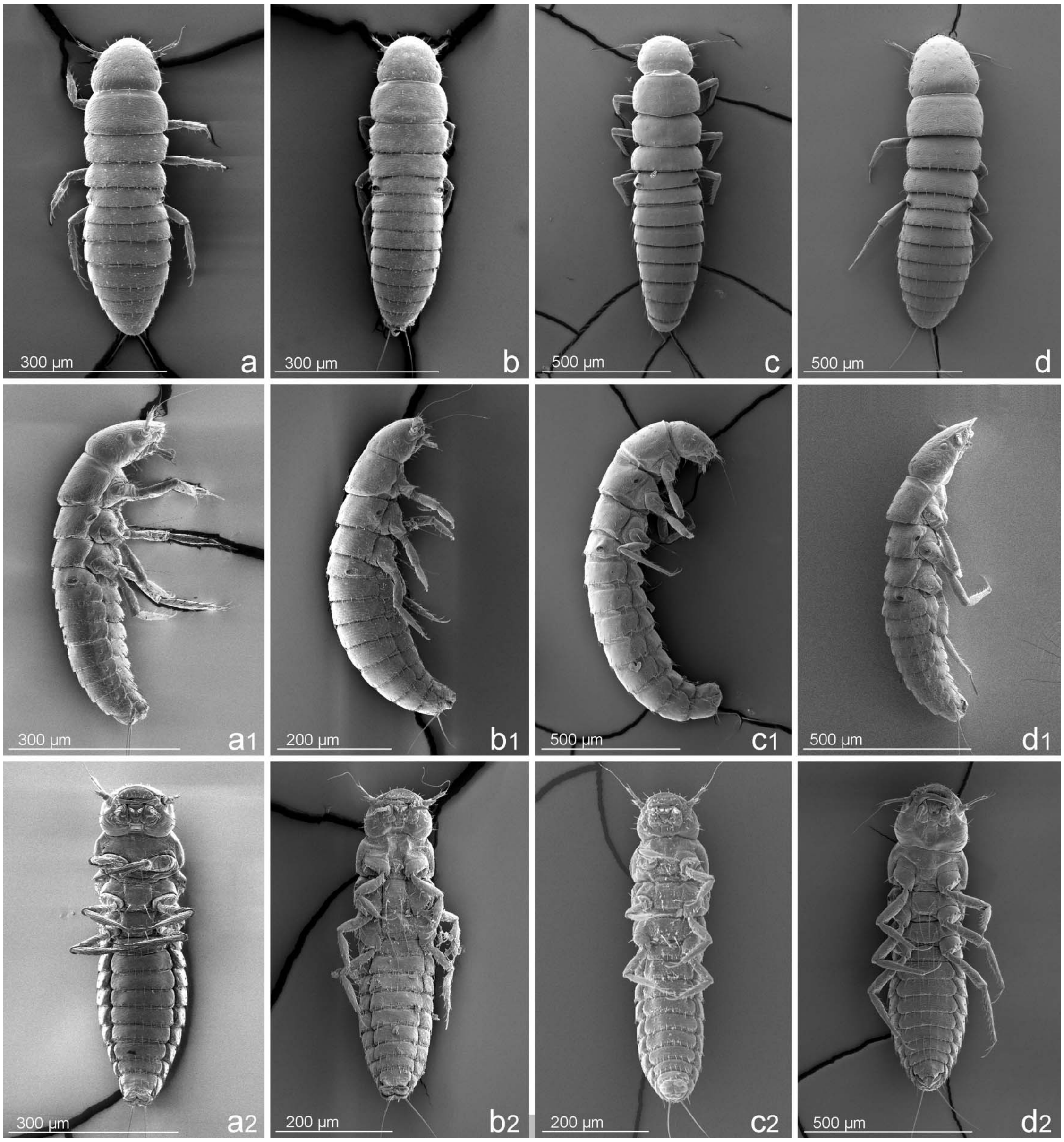

Figure 1. First instar larvae of *Meloe (Eurymeloe)* (a) *apenninicus*, (b) *apivorus*, (c) *ganglbaueri* and (d) *mediterraneus*: habitus in (a–d) dorsal, (a1–d1) right lateral and (a2–d2) ventral view.

> Lampedusa and Cala Galera, Sanctuary of Madonna di Lampedusa, 1.iv.1990 M. Mei and M. A. Bologna leg.

Adults were reared at 24–25°C in a thermostatic chamber with photoperiod control; females oviposited in sand provided as a substrate in rearing boxes, and their eggs were kept till hatching.

Morphological analysis was performed under an Olympus BX51 light microscope equipped with Colorview II camera (SIS) and Cell*D image analysis software (SIS) to examine and photograph the cleared specimens mounted on slides in Canada balsam, and a FEI dualbeam FIB/SEM Helios Nanolab as SEM for material mounted on stubs after critical point dehydration and gold sputtering.

Terminology of larval structures follows MacSwain (1956), Lawrence (1991), and Bologna & Pinto (2001). For some traits of larval chaetotaxy we followed notational conventions as suggested by Selander (1990).

Results

Description of the first instar larva of Meloe (Eurymeloe) apenninicus. Measurements in Table I. Triungulin campodeiform (Figures 1a–a2, 4e); body elongate, fusiform, about 3.8 times as long as

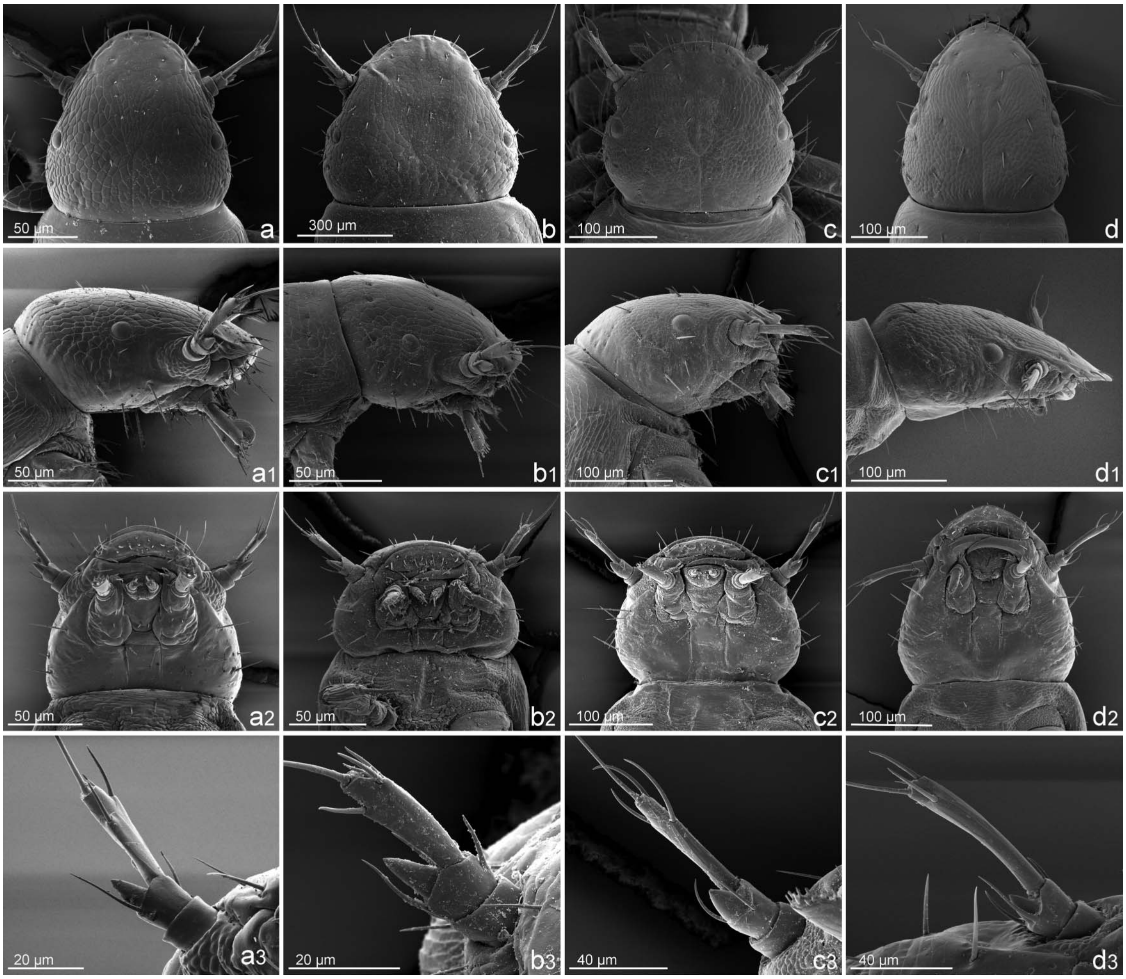

Figure 2. First instar larvae of *Meloe (Eurymeloe)* (a) *apenninicus*, (b) *apivorus*, (c) *ganglbaueri* and (d) *mediterraneus*: head in (a–d) dorsal, (a1–d1) right lateral and (a2–d2) ventral view; (a3–d3) right antenna in anterior view.

maximum width (on mesothorax). Colour light brown; head and legs brown, with distinctly irregular reticulate microsculpture (Figures 2a–a2); mandibles and area surrounding stemmata strongly sclerotized, dark brown (Figure 4e). Tergites and sternites of thorax and abdomen well sclerotized with reticulate microsculpture with transversely imbricated polygonal mesh (Figures 3a–a1); posterior meshes of sterna and laterotergites with short, spine-like backward prolongations that provide a microserrate aspect to posterior margins.

Head (Figures 2a–a2) subtriangular, slightly transverse (L/W = 0.9), widest just behind the posterior margin of stemmata; sides broadly curved from stemmata to occipital foramen, straight and convergent anteriorly (Figure 2a); basal elevation absent; anterior margin of head rounded. Epicranial suture Y shaped; frontal arms straight, slightly diverging at base (angle about 35°), markedly curved laterally to antennae at distal third; epicranial stem short (0.04 mm). One stemma on each side (Figure 2a1); stemmata round, distinctly convex, dorsolaterally placed (Figures 2a, 4e). Frontoclypeal region with 14 setae (Figure 2a); apex of frontoclypeus with one transverse row (frontoclypeal row, FCR_{1-3}) of three pairs of setae, FCR_3 longer than others; one sensory pit between FCR_1 and FCR_2; one medial sensory pit between pair of setae FCR_1; four pairs of setae posterior to FCR, one directly behind FCR_2 and three following a curved line paralleling the arms of the epicranial suture (from posterior to anterior setae 1–3); one sensory pit present between setae 1 and 2. Each epicranial plate dorsally with a basal group of four minute setae, eight longer setae mostly placed laterally around the stemma and three sensory pits (one medial, one lateral and one ocular distinctly anterior to stemma). Labrum (Figure 2a2) directed ventrally, transverse, anteriorly rounded and posteriorly straight, with nine pairs of setae of varying length (two lateral very

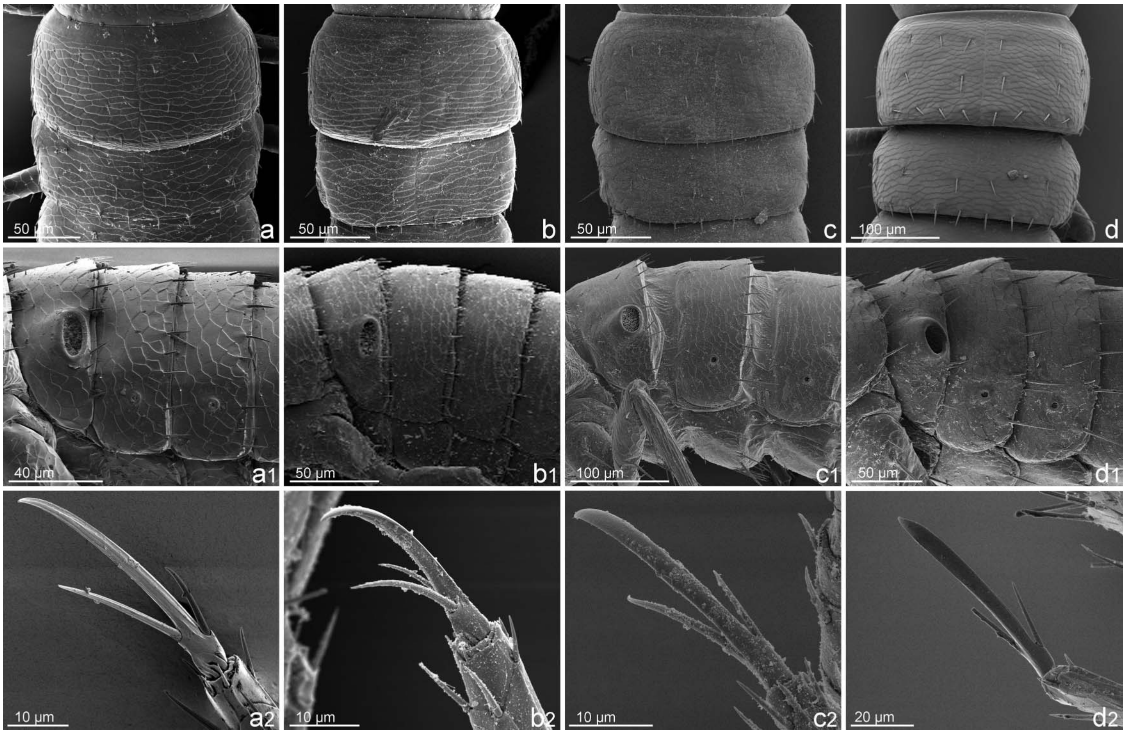

Figure 3. First instar larvae of *Meloe (Eurymeloe)* (a) *apenninicus*, (b) *apivorus*, (c) *gangbaueri* and (d) *mediterraneus*: (a–d) pro- and mesonotum (dorsal view), (a1–d1) abdominal tergites I–III (left lateral view) and (a2–d2) claws (midlegs).

long), one single medial seta and one pair of pits. Antennae anterolaterally directed (Figures 2a, a3); antennomere I short, ring-like, slightly asymmetrical with one dorsal sensory pit; segment II slightly longer than I, with three long apical setae (one dorsal, one lateral, one ventral), one minute seta (outer side) near sensory appendix and one dorsolateral pit; sensory appendix on antennomere II well developed, conical, lateroventral (outer side), as long as antennomere I (Figure 2a3); antennomere III slender and long, straight, sub-clavate, compressed laterally, about 1.8 times longer than II, with a long apical seta, three long subapical setae, two lateral (one on outer and one on inner sides) and one dorsal in position, one minute seta near the base of apical seta; one lateral and one sub-basal pit. Mandibles with broad and prominent base, apical half narrowing and abruptly bending inward, ental surface smooth; partially covered by labrum in the resting position (Figure 2a2); outer margin of mandible with two setae, one sensory pit between them and one pit mesodorsally. Maxillae with stipes rectangular with four setae; mala simple, lobiform, slightly protruding, with four to five spiniform setae, one longer than the others; cardo transverse, small, with minute seta; maxillary palpi with joints as follows: I extremely short, with one ventral pit; II slightly longer than I, with two ventrolateral subequal setae, one on the external and one on the internal side; III with the external side widened from base to apex, about three times the length of I and II together, asymmetrical (lateral side longer than medial side), with one dorsolateral seta (inner side); apex of segment III obliquely truncate, with a large, sensorial area composed of one apical, stick-like sensory appendix and surrounded about 10 shorter papillae; outer side with one slender digitiform sensillum. Gulamentum weakly sclerotized with two elongate anterior setae. Prementum fused with mentum with one pair of basal setae lined by one pair of external sensory pits; one pair of ligular setae present between insertion of palpi; labial palpi (Figure 2a2) small, with segment I short, II cylindrical, twice longer than I, with one moderately long, stick-like, apical sensory appendix, inserted in a prominent base and surrounded by five to seven shorter subapical papillae.

Thorax (Figure 3a) with segments transverse and subrectangular, broader than head; prothorax as wide as meso- and metathorax; margins of pronotum convergent anteriorly, margins of meso- and metanotum slightly rounded. Ecdysial line well marked, complete on pro- and mesonotum, vestigial on metanotum. Pronotum about 2.3 times wider than long, each half of notum with 13 setae and five pits symmetrically placed along three transverse, subparallel rows; anterior row (AR) with five setae and two pits; medial row (MR) with three setae; posterior row (PR) with five setae and two to three pits; prosternum with three pairs of medial setae the two anterior pairs similar in length, posterior pair much longer than others. Mesonotum slightly shorter than pronotum; AR with two setae grouped with one pit mesodorsally, two setae laterally, anterior to the spiracle. MR with three to four setae and one shorter seta near the spiracle; PR with five setae and two pits; three pairs of medial setae on mesosternum, the anterior pair extremely short. Setae of metathorax similar in number, position and relative dimensions to those of mesothorax.

Legs elongate (Figure 4e): coxa short and broad, with four elongate setae, transversally arranged, four to five minute basal setae and one pit; trochanter with two moderately long setae and four to six pits; femur with six setae and one pit, the longest ventral femoral seta, much shorter than femur; tibiae and claws increasing in length from pro- to metathorax; tibiae stout, tapered at apex and with four longitudinal rows of five to six moderately long setae; claw (Figure 3a2) conicofalcate, thin, acute and slightly curved at apex, with two long setae of slightly different length inserted almost at the same level near base.

Spiracles. Marginal ring (peritreme) of mesothoracic and I abdominal distinctly protruding. Mesothoracic spiracle elliptical, obliquely placed on laterotergite. Abdominal spiracle I (Figure 3a1) dorsally placed on laterotergite, transversely elliptical; abdominal spiracles II–VIII small, round, subequal and scarcely protruding, laterally positioned, placed on laterotergites.

Abdomen (Figures 1a, 4e) fusiform with transverse, rectangular tergites; maximum width at segment III; sternites entire (Figure 1a2). Mediotergites with two transverse rows (MR posteriorly displaced) of setae – their arrangement on each half of tergites as follows: AR with two minute setae (four on tergite I, two medial and two lateral) and one pit, MR + PR with nine elongate setae and one pit; tergite IX with one elongate pair of setae on PR (caudal setae) which are less long then the last four abdominal segments combined. AR of each sternite with one pair of minute seta, MR absent and PR with eight elongate setae, each slightly different in length. Sternite IX with two small seta on AR; six long setae and one pit on PR. Abdominal apex (segment X or pygopod) apically membranous, transversally divided in two parts: dorsal part semicircular with six extremely small setae transversally arranged, ventral part longitudinally divided in two lobes (Figure 1a2), moderately produced, with two pairs of setae along posterior margin.

Comparative description of the first instar larva of Meloe (Eurymeloe) apivorus. Measurements in Table I. Figures 1b–b2, 2b–b3, 3b–b2, 4f. Body slender, about 4.8 times as long as maximum width (on mesonotum), subparallel sided, with abdomen elongate, only slightly fusiform in dorsal view (Figures 1b, 4f) but very thick in lateral view (Figure 1b1). Head short, much wider than long (L/W = 0.8) with subbasal maximum width. Antennomere III 2.6 times longer than II. Abdomen maximum width at segment IV.

Comparative description of the first instar larva of Meloe (Eurymeloe) ganglbaueri. Measurements in Table I. Figures 1c–c2, 2c–c3, 3c–c2, 4h. Body about four times as long as maximum width (on mesothorax). Head globose, suboval (Figures 2c, c2), much wider than long (W/L = 0.87), with sides protruding just behind the stemmata (Figures 2c, 4h). Antennomere III about 1.9 times longer than II. Prosternum with three pairs of medial setae increasing in length from anterior to posterior, anterior pair much shorter than medial pair. Legs distinctly short (Figures 1c, c1, 4h). Abdomen maximum width at segment V (Figures 1c, 4h).

Comparative description of the first instar larva of Meloe (Eurymeloe) mediterraneus. Measurements in Table I. Figures 1d–d2, 2d–d3, 3d–d2, 4c. Body about 4.7 times as long as maximum width (on abdominal segments III–IV). Colour yellow, slightly darker on head and legs. Head deeply sculptured (Figures 2d–d1) with subhexagonal meshes, suboval (Figures 2d, 4c), longer than wide (L/W = 1.14), widest just behind stemmata, at middle head side; sides slightly curved from stemmata to occipital foramen. Frontal arms of the epicranial suture bisinuate, widely diverging at base (angle about 60°); epicranial stem very long (average of four specimens = 0.086 mm), about as long as the antenna. Stemmata extremely convex and protruding (Figures 2d–d1). One pair of sensory pits at the level of setae FCR2; one medial seta between FCR1. Ocular setae at the level of anterior margin of stemmata. Antenna (Figure 2d3) with sensory appendix on segment II small; antennomere III very long, cylindrical, about 3.6 times longer than II, slightly curved posteriorly. Maxillae with stipes bearing five setae and one pit; maxillary palpomeres I and II short, ring-like, subequal in length, III about two times the length of I and II together. Legs elongate (Figure 4c). Abdominal spiracle I suboval, distinctly protruding (Figure 3d). Abdominal tergites with three transverse rows of setae, their arrangement on each half of tergites as follows: AR with two minute setae (four on tergite I) and one pit, MR with two setae, PR with seven setae. Caudal

Table I. Main sizes (in mm) of the *Meloe (Eurymeloe)* first instar larvae mounted on slides and examined with a light microscope. Abbreviations: A1–A3 = length of antennomeres I–III; ABL = length of abdomen; ASL = length of apical antennal seta on A3; BL = body length; ESL = epicranial stem length; HL = head length; HW = head width; N. = number of examined specimens; SD = diameter of stemmata; PL = prothorax length; PW = prothorax width; SPA = abdominal spiracle maximum width; SPM = mesothoracic spiracle maximum width; TSL = length of terminal abdominal setae.

	affinis	*apenninicus*	*apivorus*	*brevicollis*	*corvinus*	*flavicomus*	*ganglbaueri*	*glazunovi*	*mediterran*	*rugosus*	*scabriusc*	*tuccius*
N.	3	2	3	1	2	2	2	2	4	1	2	2
BL	0.985–1.062 (1.021)	0.692–0.708 (0.700)	1.292–1.415 (1.369)	1.031	0.954–0.969 (0.962)	0.692–0.692 (0.692)	0.646–0.662 (0.654)	0.985–1.031 (1.008)	1.025–1.385 (1.237)	0.523	0.908–1.046 (0.977)	0.938–0.954 (0.946)
HL	0.198–0.210 (0.203)	0.119–0.137 (0.128)	0.183–0.189 (0.185)	0.207	0.201–0.220 (0.210)	0.128–0.137 (0.133)	0.110–0.113 (0.111)	0.186–0.192 (0.189)	0.244–0.271 (0.257)	0.113	0.155–0.155 (0.155)	0.204–0.207 (0.206)
HW	0.220–0.235 (0.228)	0.137–0.146 (0.141)	0.229–0.235 (0.232)	0.174	0.177–0.189 (0.183)	0.131–0.134 (0.133)	0.128–0.128 (0.128)	0.207–0.210 (0.209)	0.213–0.235 (0.226)	0.116	0.189–0.198 (0.194)	0.198–0.204 (0.201)
SD	0.021–0.027 (0.024)	0.015–0.015 (0.0152)	0.018–0.021 (0.020)	0.021	0.011–0.020 (0.015)	0.006–0.008 (0.007)	0.011–0.011 (0.011)	0.017–0.018 (0.018)	0.020–0.027 (0.023)	0.014	0.009–0.009 (0.009)	0.015–0.018 (0.017)
ESL	0.046–0.072 (0.063)	0.037–0.038 (0.038)	0.049–0.065 (0.058)	0.068	0.065–0.075 (0.070)	0.040–0.075 (0.058)	0.026–0.032 (0.029)	0.060–0.063 (0.062)	0.077–0.089 (0.086)	0.031	0.046–0.048 (0.047)	0.054–0.055 (0.055)
A1	0.009–0.015 (0.011)	0.006–0.008 (0.0069)	0.012–0.015 (0.014)	0.008	0.009–0.011 (0.010)	0.006–0.009 (0.008)	0.006–0.009 (0.008)	0.011–0.011 (0.011)	0.008–0.017 (0.014)	0.009	0.006–0.009 (0.008)	0.009–0.011 (0.010)
A2	0.026–0.029 (0.027)	0.014–0.015 (0.015)	0.018–0.022 (0.020)	0.017	0.015–0.015 (0.015)	0.014–0.022 (0.018)	0.011–0.012 (0.012)	0.014–0.018 (0.016)	0.017–0.022 (0.018)	0.011	0.017–0.018 (0.018)	0.012–0.014 (0.013)
A3	0.049–0.052 (0.051)	0.025–0.029 (0.027)	0.049–0.055 (0.052)	0.051	0.046–0.051 (0.048)	0.031–0.037 (0.034)	0.020–0.026 (0.023)	0.054–0.057 (0.055)	0.060–0.072 (0.066)	0.029	0.049–0.051 (0.050)	0.046–0.054 (0.050)
ASL	0.149–0.160 (0.153)	0.105–0.128 (0.116)	0.123–0.169 (0.147)	0.172	0.208–0.217 (0.212)	0.043–0.043 (0.043)	0.054–0.054 (0.054)	0.112–0.117 (0.155)	0.063–0.143 (0.091)	0.077	0.126–0.143 (0.135)	0.109–0.166 (0.138)
PL	0.177–0.192 (0.185)	0.078–0.080 (0.079)	0.160–0.186 (0.173)	0.122	0.118–0.120 (0.119)	0.078–0.080 (0.079)	0.074–0.086 (0.080)	0.118–0.122 (0.120)	0.122–0.138 (0.130)	0.065	0.122–0.123 (0.122)	0.091–0.097 (0.094)
PW	0.235–0.249 (0.243)	0.180–0.191 (0.185)	0.280–0.286 (0.284)	0.198	0.203–0.215 (0.209)	0.1177–0.185 (0.181)	0.158–0.171 (0.165)	0.220–0.223 (0.222)	0.246–0.275 (0.262)	0.136	0.223–0.226 (0.225)	0.223–0.235 (0.229)
ABL	0.463–1.123 (0.697)	0.360–0.363 (0.361)	0.642–0.790 (0.716)	0.543	0.457–0.479 (0.468)	0.369–0.430 (0.399)	0.345–0.366 (0.355)	0.549–0.555 (0.552)	0.432–0.741 (0.630)	0.473	0.497–0.561 (0.529)	0.488–0.491 (0.489)
TSL	0.142–0.157 (0.147)	0.103–0.106 (0.105)	0.228–0.254 (0.239)	0.154	0.146–0.166 (0.156)	0.092–0.106 (0.019)	0.086–0.086 (0.086)	0.145–0.154 (0.149)	0.192–0.223 (0.208)	0.092	0.163–0.169 (0.166)	0.190–0.194 (0.192)
SPM	0.028–0.031 (0.029)	0.023–0.025 (0.024)	0.018–0.031 (0.026)	0.031	0.017–0.023 (0.020)	0.018–0.020 (0.019)	0.018–0.020 (0.019)	0.018–0.023 (0.021)	0.028–0.034 (0.032)	0.015	0.017–0.028 (0.022)	0.026–0.029 (0.028)
SPA	0.029–0.035 (0.031)	0.022–0.023 (0.022)	0.034–0.038 (0.036)	0.025	0.017–0.029 (0.023)	0.023–0.028 (0.025)	0.020–0.025 (0.022)	0.031–0.034 (0.032)	0.031–0.037 (0.034)	0.018	0.031–0.032 (0.032)	0.055–0.055 (0.055)

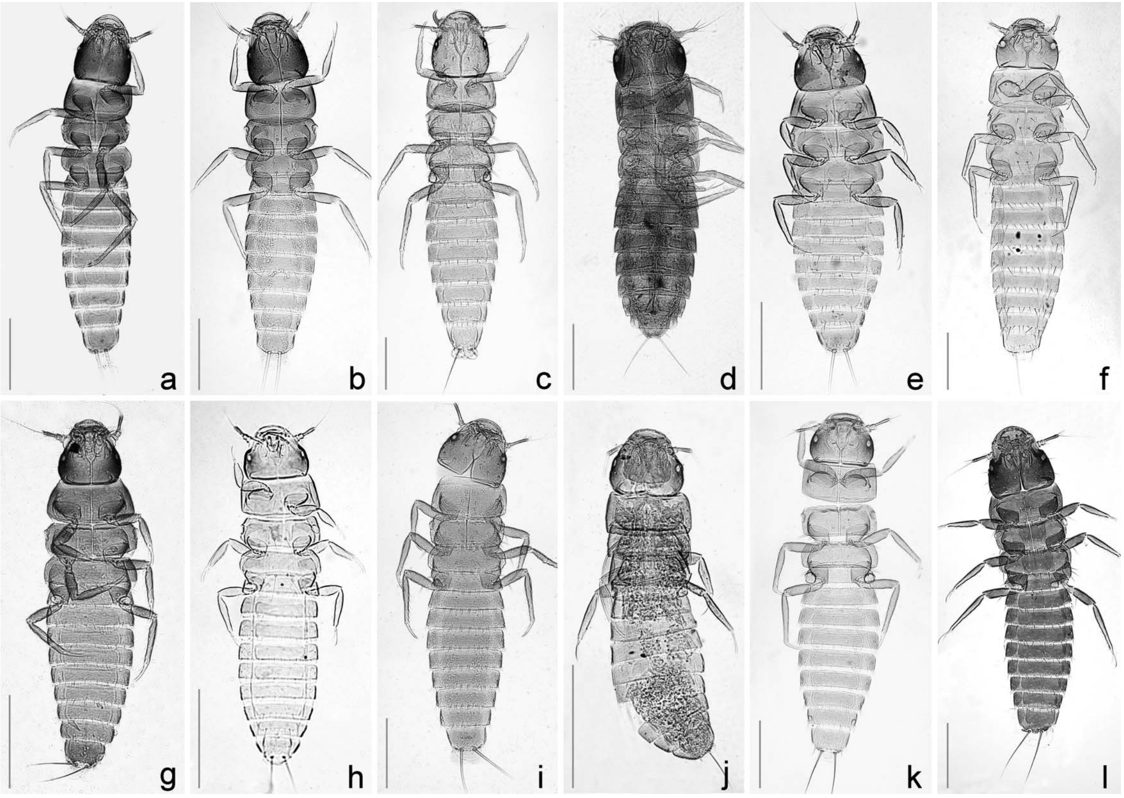

Figure 4. Images of slide-mounted first instar larvae of the following *Meloe (Eurymeloe)* species: (a) *brevicollis*, (b) *corvinus*, (c) *mediterraneus*, (d) *affinis*, (e) *apenninicus*, (f) *apivorus*, (g) *flavicomus*, (h) *ganglbaueri*, (i) *glazunovi*, (j) *rugosus*, (k) *scabriusculus*; and (l) *Meloe (Coelomeloe) tuccius*. Scale bar: 0.2 mm.

setae slightly longer than the last two abdominal segments.

Key to the first instar larvae of Eurymeloe *and* Coelomeloe *species*.

The following key to the species is based on the careful observation of all available larvae (see material and method), except *M. (E.) murinus*, for which we refer to the descriptions of Cros (1912, 1917, 1919, 1929).

1. Abdominal spiracle VIII (Figure 4d) ca. four times greather than II–VII, slightly wider than I. Periocular area black (Figure 4d), the remaining head surface, prothorax and urites II–V dark brown; meso-methatorax and urites VI–IX light brown. . . . . ***M. (E.) affinis* (var. *setosus*)**
– Abdominal spiracle VIII small, similar in size (or just slightly wider) to others, except I. Body colouration not as above 2
2. Head evidently longer than wide (L/W > 1.1); templa subparallel or only slightly widened . . 3
– Head slightly longer or about as long as wide (< 1.1); templa evidently rounded and widened. 4
3. Abdominal spiracle I transverse; greatest width of head sub-basal. . . . . ***M.(E.) brevicollis* and *M.(E.) corvinus***
– Abdominal spiracle I suboval; greatest width of head at middle. . . . . . . ***M. (E.) mediterraneus***
4. Abdominal spiracle I very large and transverse, about 1/3 the entire tergite width . . . . ***M. (C.) tuccius***
– Abdominal spiracle I suboval, only slightly transverse. 5
5. Abdominal spiracle VIII larger than II–VI (Figure 4e), VI just slightly larger. . . . . ***M. (E.) scabriusculus***
– Abdominal spiracle VIII as large as II–VII. . . . 6
6. Prothorax campaniform (Figure 4e), sides roundly converging in front, fore width clearly shorter than posterior 7
– Prothorax subrectangular, sides subparallel, fore width subequal or slightly shorter than posterior 9
7. Ratio L/W of head = 0.9. Abdominal spiracle I subequal in size to mesothoracic one. Maximal abdominal width on urite III. . . . . ***M. (E.) apenninicus***

- Ratio L/W of head ≥ 1.0. Abdominal spiracle I similar or wider than mesothoracic one. Abdominal width not as above 8

8. Maximal abdominal width on urite II. Abdominal spiracle I evidently wider than mesothoracic one . . . . ***M. (E.) flavicomus***

- Maximal abdominal width on urite IV. Abdominal spiracle I evidently similar to mesothoracic one . . . . ***M. (E.) murinus*** (from description)

9. Head very short (L/W ratio: 0.80–0.87) 10

- Head more elongate (L/W ratio: 0.90–0.97) 11

10. Maximal abdominal width on urite V, abdomen swollen in lateral view (Figure 1b1) . . . . ***M. (E.) ganglbaueri***

- Maximal abdominal width on urite IV, abdomen slender in lateral view (Figure 1c1) . . . . ***M. (E.) apivorus***

11. Maximal width of head at base (Figure 4j). Setae on all body short and thin . . . . ***M. (E.) rugosus***

- Maximal width of head at middle of templa (Figure 4i). Setae on all body robust and spiniform . . . . ***M. (E.) glazunovi***

A relevant incongruence exists between our description of *M. (C.) tuccius* first instar larva and that of Cros (1929), both based on specimens hatched from eggs oviposited by reared females. The shape of the abdominal spiracle I was considered as rounded as the others by Cros (1929), while in all triungulins we examined (Canary islands, Sardinia, and Lampedusa, an Italian island part of the Maghrebian platform) it is clearly wide and transverse (Figure 4l).

Remarks concerning *M. affinis, M. ganglbaueri* and *M. mediterraneus* were discussed above.

Discussion

The present study, based on the comparison of rich material of different taxa, clarifies some taxonomical problems of this complex subgenus of *Meloe*.

a. Selander (1985) elevated *Eurymeloe* to genus level and considered *Coelomeloe* and *Meloegonius* Reitter, 1911 as synonyms. Bologna (1988), Bologna et al. (1989), and Bologna & Pinto (2001) considered the three taxa as subgenera of *Meloe*, emphasizing the close similarity between *Eurymeloe* and *Coelomeloe*, and questioned their synonymy. According to present analysis of the larvae of all available species of *Eurymeloe* and *Coelomeloe*, the differences of *Coelomeloe* suggest to keep these subgenera separate. Actually, the subgenera are characterized only by plesiomorphic traits of antennae (with conical antennal sensorium), unmodified claws, legs and larvae. In detail, the first instar larvae of *M. (C.) tuccius* differ from *Eurymeloe* because of: (i) head strongly sclerotized, large compared to body size; (ii) basal part of frontal sclerite extremely thin, frontal sutures not sinuate, only slightly diverging at base; (iii) stemmata large; (iv) mandibles ventral, subtriangular, extremely short, with wide base; (v) thoracic tergites distinctly decreasing in width and length from pro- to metathorax; (vi) mesothoracic spiracle clearly protruding; (vii) abdomen short compared to body size; (viii) abdominal spiracle I very large and transverse, about as wide as one third of the tergite; (ix) setae of body strong and spiniform. It is worth noting, however, that spiracles modified as in *M. (C.) tuccius* (vi, viii), though at a much lesser degree, are present also in *M. (E.) brevicollis* and *M. (E.) corvinus*, suggesting parallel biological adaptations.

b. Selander (1985) excluded *affinis, ganglbaueri* and *mediterraneus* from *Eurymeloe* as "atypical *Meloe*", because of their widened head. Actually, from Bologna and Pinto (2001) and from present data, these three species belong to *Eurymeloe* and the shape of the head of this subgenus is remarkably variable.
In particular, *M. (E.) affinis* var. *setosus* appears to be clearly distinct because of the apomorphic condition of abdominal spiracle VIII, extremely widened and transverse (about four times the size of II–VII) and not small as in all *Eurymeloe* (only in *scabriusculus* it is slightly wider than II–VII). Moreover, this triungulin is the only *Meloe* with a bicoloured abdomen, similarly to some apterous and brachypterous Lyttini genera (*Berberomeloe* Bologna, 1989; *Trichomeloe* Reitter, 1911: see Bologna 1989; Bologna & Di Giulio 2008), or to several Mylabrini (MacSwain 1956; Di Giulio & Bologna, unpublished). According to Cros (1936: 192) this triungulin is not phoretic but probably fossorial, but this hypothesis needs confirmation. The possibility to define the exact identification of the studied species (see below), and to study larval behaviour and molecular traits, could permit to better clarify the taxonomic position of this meloid beetle.
The variety *setosus* was separated because of the presence of light yellow isolated setae along the posterior margin of abdominal tergites, the presence of a constant frontal furrow, the distinct elytral sculpture and the smaller size. Escherich (1890: 90, note 5) considered the possibility to ascribe it to a different species. Actually, this taxon

was never revised and it could represent a distinct species, also suggested by Peyehrimhoff (in Cros 1934), who observed the specimens from western Algeria (Sidi Bel Abbès, Bonnier) studied by Cros (1934, 1936).

The possibility to compare triungulins of *affinis* var. *setosus* (studied by Cros (1934, 1936), with those of *apivorus*, both obtained by eggs, permits us to resolve partially the taxonomic problem of the *affinis*-complex. In fact, Bologna (1988) considered *affinis* as polytypic, including four subspecies: *apivorus* (High Atlas; described as distinct species), *schatzmayri* Bologna, 1988 (Tripolitania), *simillimus* Escalera, 1914 (Middle Atlas; described as distinct species), and the nominate subpecies (northern Tunisia, Algeria and Morocco). The differences among subspecies are evident in adults (Bologna 1988, 1991), except between *apivorus* and *simillimus*, which probably represent a single species (Bologna 1988). The great differences between the first instar larvae of *affinis* var. *setosus* and *apivorus* do support the specific value of *apivorus*.

The great difference of the spiracle VIII of *affinis* var. *setosus* vs. that of all other *Eurymeloe* probably represents an automorphy of this taxon, versus all *Meloe* and other meloine larvae. According to Cros (1936: 189–190), this spiracle is adapted to emerge from the liquid honey, similarly to most Nemognathinae first instar larvae with differently conically modified abdominal spiracle VIII (Bologna 1991). Like all other *Eurymeloe* of the *rugosus* group (*sensu* Bologna 1988), adults of this species are mostly nocturnal and were collected only under stones (Cros 1934, 1936; Bologna 1988).

c. According to larval morphology, taxonomical distinction between *rugosus* and *apenninicus* is confirmed. The latter species is endemic to the Italian peninsula and is geographically vicariant to former species. Adults of the two species are very similar and the possibility of co-specificity was supposed (Bologna 1988), but triungulins differ primarily because of the head size and by some morphometric features (Table I).

d. In this paper we describe and figure the first instar larva of *ganglbaueri* for the first time. In fact, the description made by Cros (1943) is based on triungulins from Oujda (eastern Morocco), but *ganglbaueri* is not distributed in North Africa (Bologna 2008). In the Oujda area, the only species of *Eurymeloe* with well visible dorsal setae is *otini* Peyerimhoff, 1949, which was recently synonymized with *saharensis* Chobaut, 1898 (Ruiz et al. 2010). The triungulin from Oujda could belong to *saharensis* or to another undescribed species.

Also the re-description of *mediterraneus*, supported by figures, allows us to recognize definitively this species, previously inadequately described (Cros 1922, 1935, 1943).

e. Another taxonomic inference emerging from the present study concerns the definition of groups of species among *Eurymeloe*. Bologna (1988), studying adult morphology, tried to divide this subgenus into two groups, the *brevicollis* and the *rugosus* groups, the latter split in two subgroups (*rugosus* and *murinus*). Actually, this division is not supported by larval morphology. In fact, *mediterraneus*, previously included in the *rugosus* group, shows some similarities with species of the *brevicollis* group such as *brevicollis* and *corvinus* (see Figures 4a–c). On the contrary, *scabriusculus* (Figure 4k), previously ascribed to the *brevicollis* group, seems more similar to *glazunovi* (Figure 4i) and other species close to *rugosus*. Of course, *affinis*, referred to the *rugosus* group, must be ascribed to a separate group.

f. Finally, from our analysis, the first instar larvae of *brevicollis* (Figure 4a) and *corvinus* (Figure 4b) appear to be almost identical and we suspect a co-specificity of these two taxa. The *brevicollis*-complex, as evidenced by Bologna (1988, 1991) includes several species, such as *corvinus, algiricus* Escherich, 1890, *austrinus* Wollaston, 1854*, curticornis* Escalera, 1914, *ibericus* Reitter, 1895, and others that could represent only subspecies of *brevicollis*, distinct by phenetic features of colour and body sculpture.

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