Species of *Cryptophagus* Herbst, 1792, belonging to the "*dentatus* group" (Coleopera: Cryptophagidae) from the Western Palearctic region

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Eight species of the genus *Cryptophagus* Herbst, 1792, belonging to the "*dentatus* group" from the Palearctic Region are revised. The opinions of different authors about the value of the characteristics of the external anatomy are contrasted, and an identification key and figures of the studied species are presented.

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1. Introduction

Coombs and Woodroffe wrote in 1955: "*...the* dentatus *group of sibling species has long caused confusion in the genus... It is possible that they may be hybrids among the other species...The dentatus group is obviously a complex of incipient species...*". Most of the authors that have studied this genus emphasize the high degree of variability of the species that form part of this genus. Coombs and Woodroffe (1955), Johnson (1988), and Otero (2011), express the difficulty to recognise the majority of the species by the characteristics of the external anatomy and point out the necessity to study the male genital organs. For instance, some species of the genus *Cryptophagus* (*C. punctipennis* Bris. and *C. reflexus* Rey = *C. pallidus* auctt. not Sturm) or those included in the genus *Telmatophilus* Heer are good examples of this. The study of a large number of specimens from different zoogeographical regions, together with sampling made systematically and periodically in different regions of the Iberian Peninsula, allow us to show natural interspecific variability for the species studied in this article, but we in no case detected specimens that made us suspect the existence of possible hybridisations. It is true that the variability manifests itself as frequent atypical shapes in the external anatomy, so it is necessary to study the male genital organs in most cases.

The following species are recognised in the group "*dentatus*": *C. dentatus* (Herbst), *C. denticulatus* Heer (= *C. pilosus* Gyllenhal, = *pseudodentatus* Bruce), *C. insulicola* Roubal (= *acuminatus* Coombs & Woodroffe), *C. puncticollis* P. H. Lucas (= *rotundatus* Coombs & Woodroffe), *C. intermedius* Bruce, *C. inaequalis* Reitter, *C. galilei* Otero and *C. aurelioi* Otero. Three of the species, *C. dentatus*, *C. denticulatus* and *C. intermedius*, can be recognised for their external anatomy, even if they show a certain degree of variability. For the other species, those characteristics

can be misleading, and it is necessary to study the male genital organs. Their study shows that among all the species of this group, there is a great similarity in the shape of the aedeagus and the internal sac and, in general, noticeable differences in the morphology of the parameres and the sclerotized spines of the aedeagus (Reška 1994, Lyubarsky 2002, Otero 2011).

2. Material and methods

Terminology and measurements follow Otero (1997, 2011). Structures were measured under a Leica M205C stereomicroscope equipped with an analysis system Application Suite.

The abbreviation WL is used for width/length ratio. The following acronyms are used to refer to the collections, in which the examined specimens are deposited:

CA: coll. F. Angelini, Francavilla Fontana, Italy
DA: coll. D. Agüin, Madeira
HNHM: Hungarian Natural History Museum, Budapest, Hungary
IZRCL: Museo Civico di Zoologia, coll. Luigioni, Rome, Italy
MHNG: Muséum d'Histoire Naturelle, Geneva
MNHU: Museum für Naturkunde der Humboldt-Universität, Berlin, Germany
NMW: Museo de Wien, Wien, Austria
MNCN: Museo Nacional Ciencias Naturales, Madrid, Spain
MZL: Museum of Zoology, Lund University, Lund, Sweden
UA: Entomological collection, Universidad de Alicante, Spain
USC: Universidad de Santiago de Compostela, Spain

3. Taxonomy (Figs 1–8)

The species of this group present the following characteristics: Side of the callosity poorly visible or not visible dorsally (Figs. 1a, 2a, 3a, 4a, 5a, 6a, 7a, 8a); weak dorsal margin, not surpassing the lateral margin of pronotum; aedeagus provided with a preputial sac with a structure finely granular and a well-defined cap in the apex.

3.1. Key to species

The key was created taking into account the works of Bruce (1936), Coombs and Woodroffe (1955), Dajoz (1959), Lohse (1967), Johnson (1988, 1992), Reška (1994), Lyubarsky (2002), Otero (2011) and Moncoutier (2002). All these works give valuable information about different aspects of the morphology and anatomy of the studied species.

1. Sides of pronotum (Figs. 1a, 4a, 7a) forming angles from callosity to lateral tooth, and from tooth to base 2
– Pronotum with parallel sides (Figs. 2a, 3a, 5a, 6a, 8a) 4
2. Straight apex of aedeagus (Fig. 7h); sclerotized rods linked in base (Fig. 7j) and endophallic orifice rounded and narrowed in apex. Narrow parameres (Fig. 7i), 2 times longer than wide in base, sinuated internal margin and straight external one. Basal nodules not covered by base of paramere. Area of pores without setae, equal to area with setae. 2 or 3 apical setae, 0.75 times longer than paramere. Length: 2.0–2.1 mm *C. intermedius* Bruce, 1934
– Rounded and undulate apex of aedeagus. Sclerotized rods not linked in base (Figs.1j, 4i) 3
3. Sclerotized rods (Fig. 1j); triangular parameres (Fig. 1i), 2 times longer than wide in base. Area of pores without setae larger than area of pores with setae; strongly sinuated internal margin and convex external margin. Apical setae shorter than paramere. Length: 2.2–2.5 *C. aurelioi* Otero & López, 2011
– Aedeageal apodeme with two sclerotized rods at apex (Fig. 4i). Parameres (Fig. 4h) extremely thin and with curved external edge. Two short apical setae and infrequent pores, latter ones either with or without bristles. Visible endophalic orifice (Fig. 4g). Length: 1.7–2.1 mm *C. galilei* Otero, 1997
4. Pronotum slightly narrower than base of elytra (Figs. 3b, 5b, 6b, 8b). Lateral tooth in middle of side. Long pubescence 5
– Pronotum (Fig. 2a,b) as wide as base of elytra, square or slightly transverse (WL= 1.4–1.6). Convergent sides in straight line from lateral

tooth to base. Punctation of pronotum (Fig. 2f) much stronger than punctation of elytra (Fig. 2g). Apex of aedeagus rounded outside and straight inside (Fig. 2h); preputial sac well defined and granulated, with "cap" in apex; simple sclerotized rods of same width in all their length, sharp in apex, and sometimes sinuated. Oval parameres (Fig. 2i), elongated and rounded in apical zone, while with bilateral nodule in base; area of pores without setae equal to area with setae. Numerous apical setae, 0.75 times longer than paramere. Length: 2.0–2.8 mm

C. dentatus (Herbst, 1793)

5. Convergent sides of pronotum in straight line from lateral tooth to base. Simple apex of aedeagus (Figs. 5h, 6g, 8h), rounded and without projections. Preputial sac readily visible, with granular aspect and 2 "caps" well marked in apex. Inconspicuous endophallic orifice; simple sclerotized rods of same width in all their length, sometimes sinuated and sharp in one of the ends (Figs. 5j, 6i, 8j) 6

– Rounded sides from lateral tooth to base, or slightly convergent (Fig. 3a,b). Apex of aedeagus (Fig. 3h) rounded externally and straight internally. Endophallic orifice rounded and narrowed in apical zone. Simple sclerotized rods of same width in all their length, sharp in apex, and sometimes sinuated and dilated in base (Fig. 3j). Oval parameres (Fig. 3i) elongated and rounded apically. Base with lateral nodule. Area of pores with setae larger than the area without them. 4 apical setae 0.75 times longer than paramere. Length: 2.0–2.8 mm

C. denticulatus Heer, 1841

6. Oval parameres (Fig. 8i), rounded in apex. Base with external nodule covered by base of paramere. Area of pores without setae larger than area with setae. 2 or 3 apical setae, 0.75 times shorter than paramere. Length: 2.3–2.8 mm *C. puncticollis* P. H. Lucas, 1846

– Triangular parameres (Figs. 5i, 6h). Area of pores with setae larger than area of pores without setae 7

7. Simple sclerotized (Fig. 6i) rods of same width in all their length. 3 or 4 apical setae shorter than length of paramere. Single external basal nodule of paramere (Fig. 6h) covering almost entirely the base of paramere, but internal nodule covering only lateral margin of paramere. Length: 2.0–3.0 mm

C. insulicola Roubal, 1919

– Simple sclerotized rods (Fig. 5j), dilated in base. 2 apical setae shorter than 0.75–0.8 × length of aedeagus. Base of paramere (Fig. 5i) with bilateral nodule. Both nodules covered by base of paramere. Length: 2.3–2.5 mm

C. inaequalis Reitter, 1878

3.2. Systematic list

3.2.1. *Cryptophagus aurelioi* Otero & López, 2011

Cryptophagus aurelii Otero & López, 2011. *The Coleop. Bull.*, 65 (2): 185 (original spelling incorrect)

Material examined. 5 ex, P. N. de Cabañeros, Ciudad Real, Spain (MNCN, UA, USC)

Important characteristics. Pronotum slightly transverse (WL= 1.5) (Fig. 1a,b). Anterior callosity small (1/5 the length of its side), projecting slightly from lateral edge, forming an obtuse angle at a 36.5° angle from body axis. Surface scarcely visible dorsally, glandular pore present, but not visible from above; lateral tooth in the middle of the edge; lateral border concave, from callosity to lateral tooth; sides converging from lateral tooth to base; basal groove present; well-defined punctation, punctures separated by a distance shoter than their diameter (Ø= 13–15 μm). Aedeagus in Fig. 1h, sclerotized rods in Fig. 1j and parameres in Fig. 1i.

Distribution. Spain (Otero & Lopez 2011).

3.2.2. *Cryptophagus dentatus* (Herbst, 1793)

Kateretes dentatus Herbst, 1793. En: Jablonsky, *Nat.syst. Bekannten Ausl. Insekten* (Käfer), 5: 15

Dermestes dentatus (Herbst): Panzer, 1795. *Dtschl. Insectenfaune*: 104

Corticaria fumata Marsham, 1802. *Entomol. Br.*, 1: 110

Cryptophagus quadridentatus Mannerheim, 1843. *Bull. Soc. Imp. Nat. Mosc.*, 16(2): 256

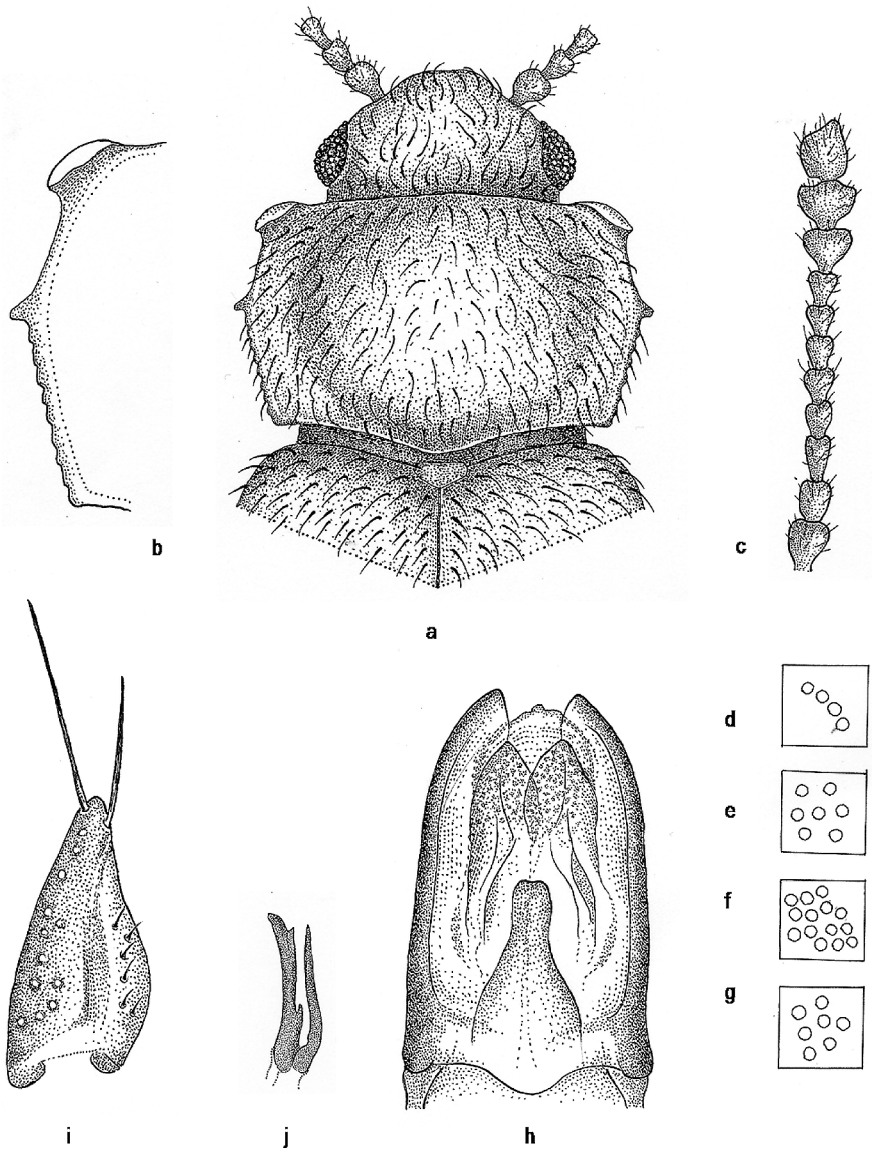

Fig. 1. *Cryptophagus aurelioi* Otero & López. – a. General view, male. – b. Pronotum. – c. Antenna. – d. Size and shape of ocular facets. – e–g. Comparison of punctation between head pronotum and elytra. – h. Dorsal view of aedeagus. – i. Paramere. – j. Sclerotized rods.

Cryptophagus dentatus (Herbst): Sturm, 1845. *Dtschl. Fauna Abbild., Insecten*, 16: 68

Cryptophagistes quadridentatus (Mannerheim): Crotch, 1873. *Check List Coleopt. Am.*: 44

Cryptophagus fortidens Rey, 1889. *Échange*, 5: 43

Material examined. 12 ex, Albania, Italy, Germany (IZRCL); 11 ex, Austria (NMW); 17 ex, Azores, France, Portugal (CA); 10 ex, Croatia, Denmark, Slovenia (HNHM); 23 ex, Germany (MNHU) (Otero 1986); 14 ex, Greece (CA) (Otero & Angelini 2008–2009); 23 ex, Italy (CA) (Otero & Angelini 1981, 1984); 10 ex, Italy, Spain (NMW); 7 ex, Iran, Slovenia (HNHM); 4 ex, Madeira (DA); 30 ex, Spain (Otero 1990, 2011); 2 ex, Turkey (Gillerfors & Otero 1993).

Important characteristics. Pronotum square or slightly transverse (WL= 1.4–1.6) (Fig. 2a,b), with straight and parallel sides, or forming an angle in lateral tooth. Lateral tooth in the middle of the side. Callosity of moderate size (1/5–1/6 the length of the side) usually with a strong dorsal edge, moderate or slightly prominent in sides.

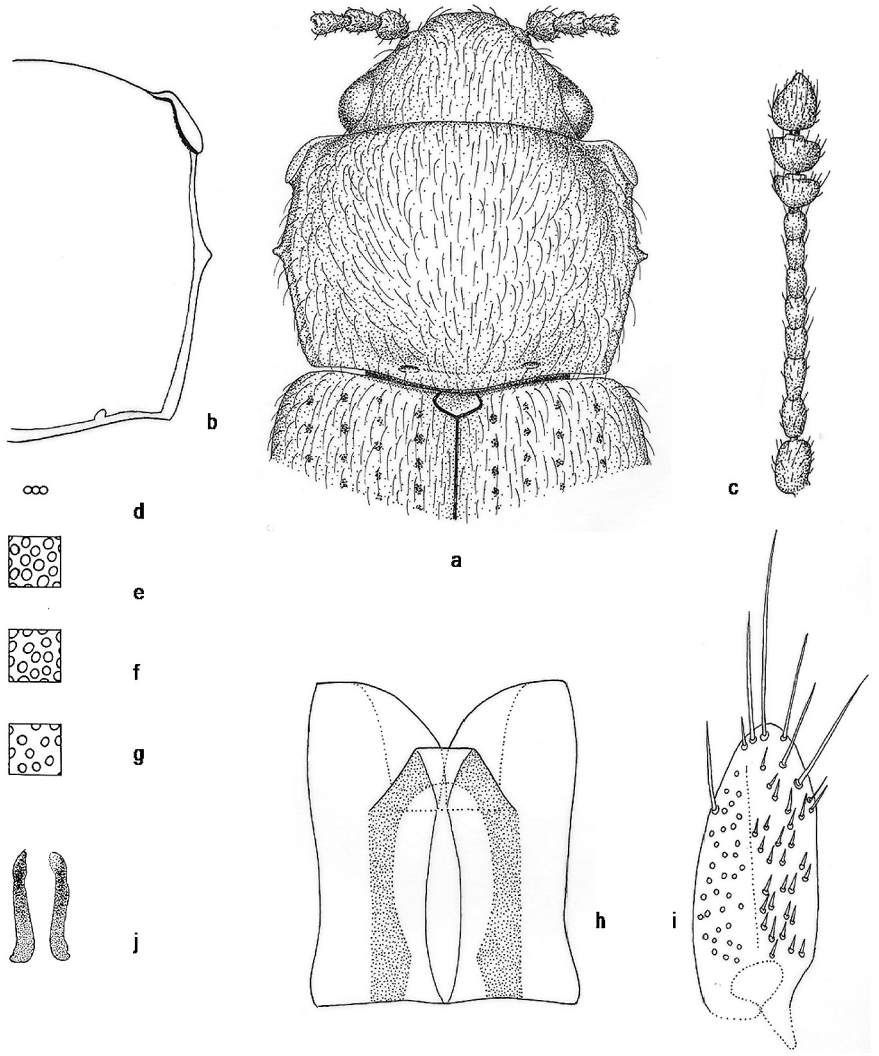

Fig. 2. *Cryptophagus dentatus* (Herbst). – a. General view, male. – b. Pronotum. – c. Antenna. – d. Size and shape of ocular facets. – e–g. Comparison of punctation between head pronotum and elytra. – h. Dorsal view of aedeagus. – i. Paramere. – j. Sclerotized rods.

Surface of callosity visible from above. Glandular pore visible. Callosities forming an angle of 35°–45° with axis of body. Posterior angles obtuse. Basal groove and foveae normal. Strong and dense punctation (Fig. 2f), punctures separated by 1/4 of their diameter (Ø = 20 µm). Aedeagus in Fig. 2h, sclerotized rods in Fig. 2j and parameres in Fig. 2i.

Distribution. Common through most of Europe, North Africa, Asia to the Far East, and the Nearctic region (Johnson *et al.* 2007).

3.2.3. *Cryptophagus denticulatus* Heer, 1841

Cryptophagus pilosus Gyllenhal, 1827. *Insecta Suec. Descr.,* 4: 287 (non Herbst, 1792)

Cryptophagus denticulatus Heer, 1841. *Fauna Coleopteror. Helv.*, 1(3): 426

Cryptophagus albipilus Rey, 1889. *Échange*, 5: 43

Cryptophagus corticum Rey, 1889. *Échange*, 5: 43

Cryptophagus obtusidens Rey, 1889. *Échange*, 5: 43

Cryptophagus substriatus Rey, 1889. *Échange*, 5: 43

Cryptophagus tamaricis Rey, 1889. *Échange*, 5: 43

Cryptophagus argenteus Joy, 1909. *Trans. Ent. Soc. Lond.* 1909–1910: lxv

Cryptophagus pseudodentatus Bruce, 1934. *Entomol. Tidskr.*, 55(2): 168

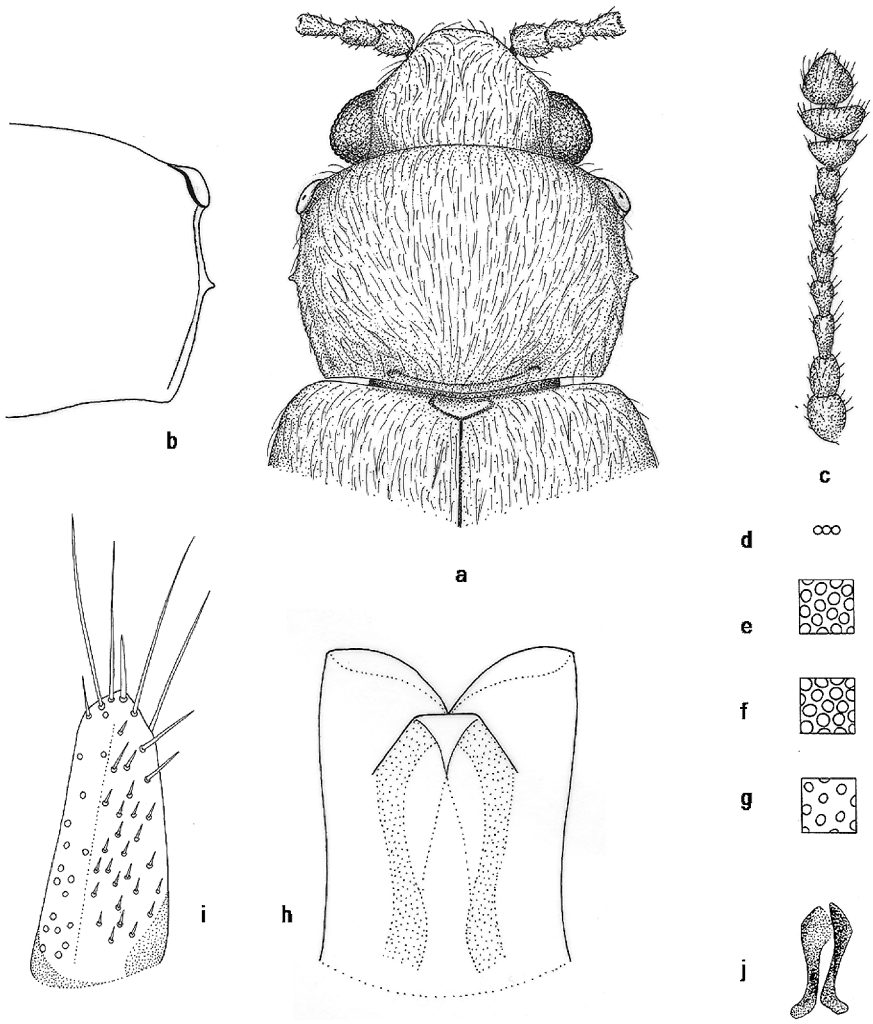

Fig. 3. *Cryptophagus denticulatus* Heer. – a. General view, male. – b. Pronotum. – c. Antenna. – d. Size and shape of ocular facets. – e–g. Comparison of punctation between head pronotum and elytra. – h. Dorsal view of aedeagus. – i. Paramere. – j. Sclerotized rods.

Material examined. 181 ex, Albania, Bosnia, Croatia, Italy, Moravia (NMW); 4 ex, Austria (CA, NMW); 44 ex, Austria, Bosnia, Bulgaria, Germany (Otero 1986); 1 ex, Czech Republic (MNHU); 2 ex, Germany (MNHU); 4 ex, Greece (Otero & Angelini 2008–2009); 2 ex, Greece (CA); 56 ex, Iran, Hungary, Mongolia (HNHM); 19 ex, Israel (Otero 1997); 30 ex, Italy (Otero & Angelini 1984); 3 ex, Madeira (DA); 7 ex, Portugal (USC); 3 ex, Turkey (Gillerfors & Otero 1993).

Important characteristics. Pronotum (Fig. 3a,b) narrower in its base than that of elytra and slightly transverse (WL= 1.6). Anterior callosity small (1/6 of length of side). Surface of callosity visible from above. Glandular pore visible. Callosities forming an angle of 35°–45° with axis of body. Lateral tooth situated before the middle of the side. Sides eventually rounded from callosity to base, or slightly retracted from lateral tooth. Posterior angles obtuse. Basal groove and foveae normal. Punctation variable (Fig. 3f) but stronger and denser than that of elytra: punctures separated by a distance longer than their diameter (Ø = 12 µm). Aedeagus in Fig. 3h, sclerotized rods in Fig. 3j and parameres in Fig. 3i.

Distribution. Common through most of Europe, Atlantic Islands: Madeira and Asia to the Far East, also Afrotropical, Australasian and Nearctic regions (Johnson *et al.* 2007).

Comments. Cryptophagus pilosus Gyllenhal, 1827 is a primary homonym of *Kryptophagus*

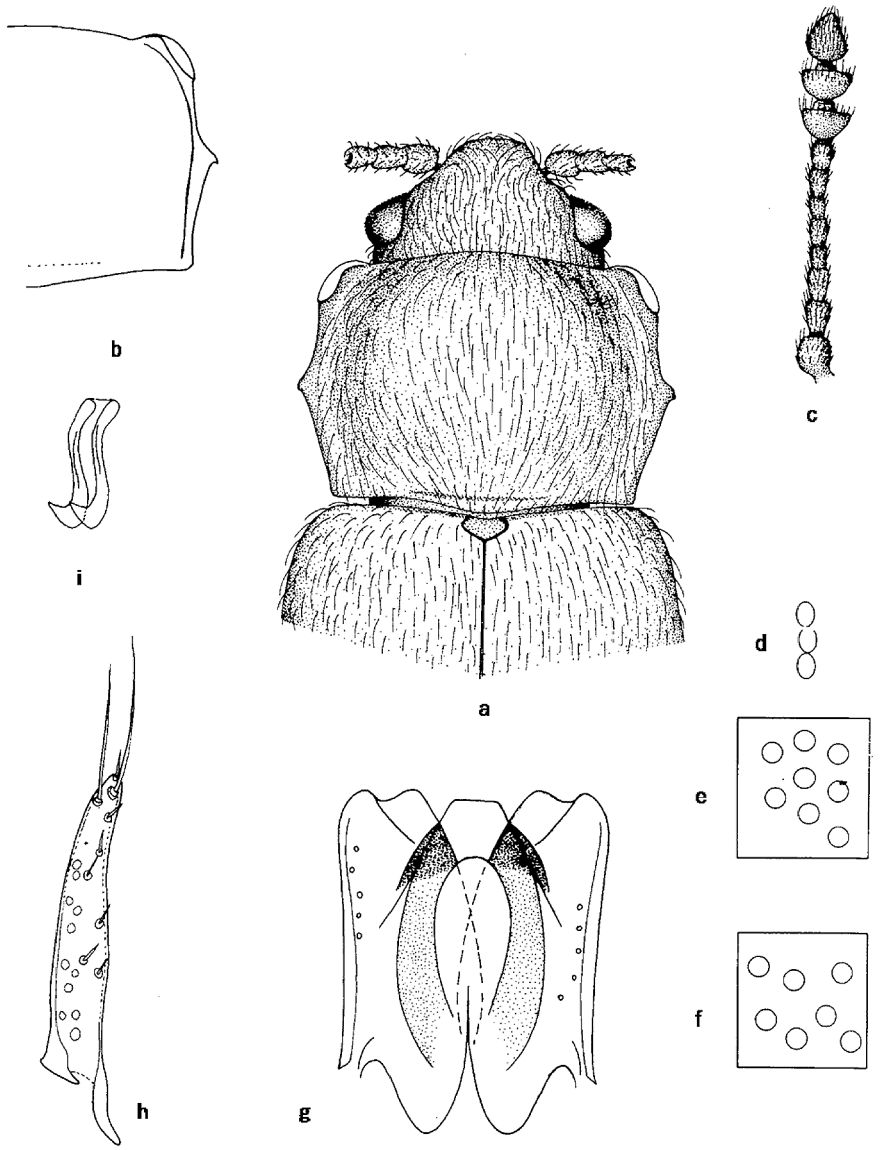

Fig. 4. *Cryptophagus galilei* Otero. – a. General view, male. – b. Pronotum. – c. Antenna. – d. Size and shape of ocular facets. – e–g. Comparison of punctation between pronotum and elytra. – h. Dorsal view of aedeagus. – i. Paramere. – j. Sclerotized rods.

pilosus Herbst, 1792. *Kryptophagus* is an incorrect original spelling (Opinion 1810, 1955), so to all intents and purposes, both names are identical and the most recent one is invalid (ICNZ 1999, Art. 57.2). The name was later corrected to *denticulatus* Heer (Johnson 2008).

3.2.4. *Cryptophagus galilei* Otero, 1997

Cryptophagus galilei Otero, 1997. *Revue Suisse Zool.*, 104 (1): 208

Material examined. 24 ex, Galilée, Israël (MHNG).

Important characteristics. Pronotum transverse (Fig. 4a,b) (WL= 1.6–1.7), as wide at its base as at its apex. Anterior callosities long (1/4 of the length of pronotum) in dorsal view projecting beyond anterior edge of pronotum but not prominent laterally; angle between posterior edge of callosity and lateral wall of pronotum obtuse. Angle between bare surface callosity and longitudinal axis of body 35°–45°. Surface of callosity scarcely visible in dorsal view, and not prominent

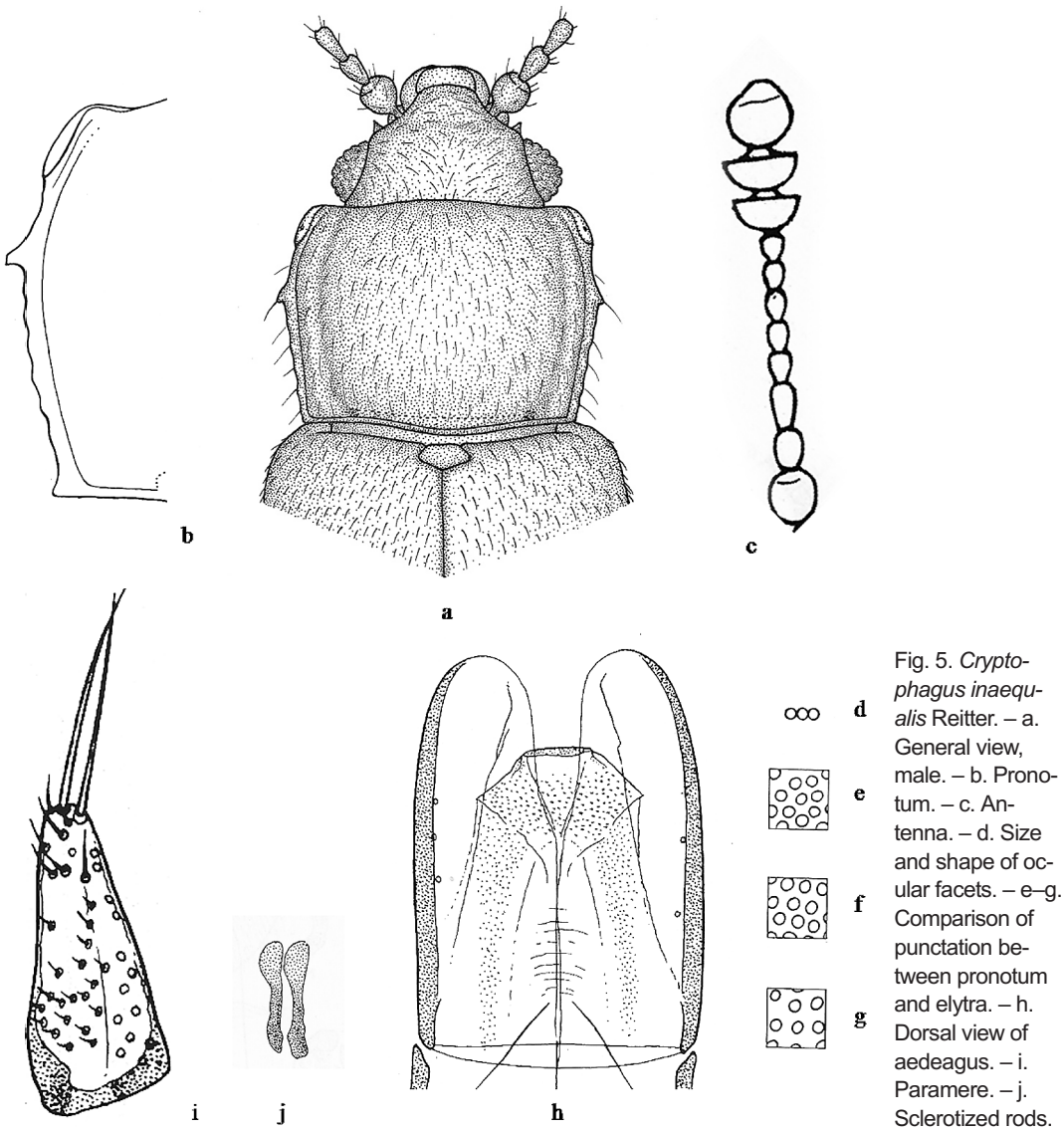

Fig. 5. *Cryptophagus inaequalis* Reitter. – a. General view, male. – b. Pronotum. – c. Antenna. – d. Size and shape of ocular facets. – e–g. Comparison of punctation between pronotum and elytra. – h. Dorsal view of aedeagus. – i. Paramere. – j. Sclerotized rods.

edge. Position of lateral tooth before the middle of the lateral margin. Lateral margin of pronotum bearing tooth just posterior to anterior-posterior midpoint; straight margin between tooth and base. Pronotal punctation pronounced; distance between punctures less than or equal to puncture diameter (Ø = 12 µm) (Fig. 4e). Aedeagus in Fig. 4g, sclerotized rods in Fig. 4i and parameres in Fig. 4h.

Distribution. Israel (Otero 1997), Greece (Otero & Angelini 2008–2009).

3.2.5. *Cryptophagus inaequalis* Reitter, 1878

Cryptophagus inaequalis Reitter 1878. *Deut. Ent. Zeit.,* 22: 53

Material examined. 12 ex, Velebit, Croatia; Herkulesbad, Romania; Gottschee, Slovakia (NMW).

Important characteristics. Pronotum slightly transverse (WL = 1.4) (Fig. 5a,b). Callosity small (1/5–1/6 of lateral margin), elongate-oval patch of bare surface visible from above. Glandular

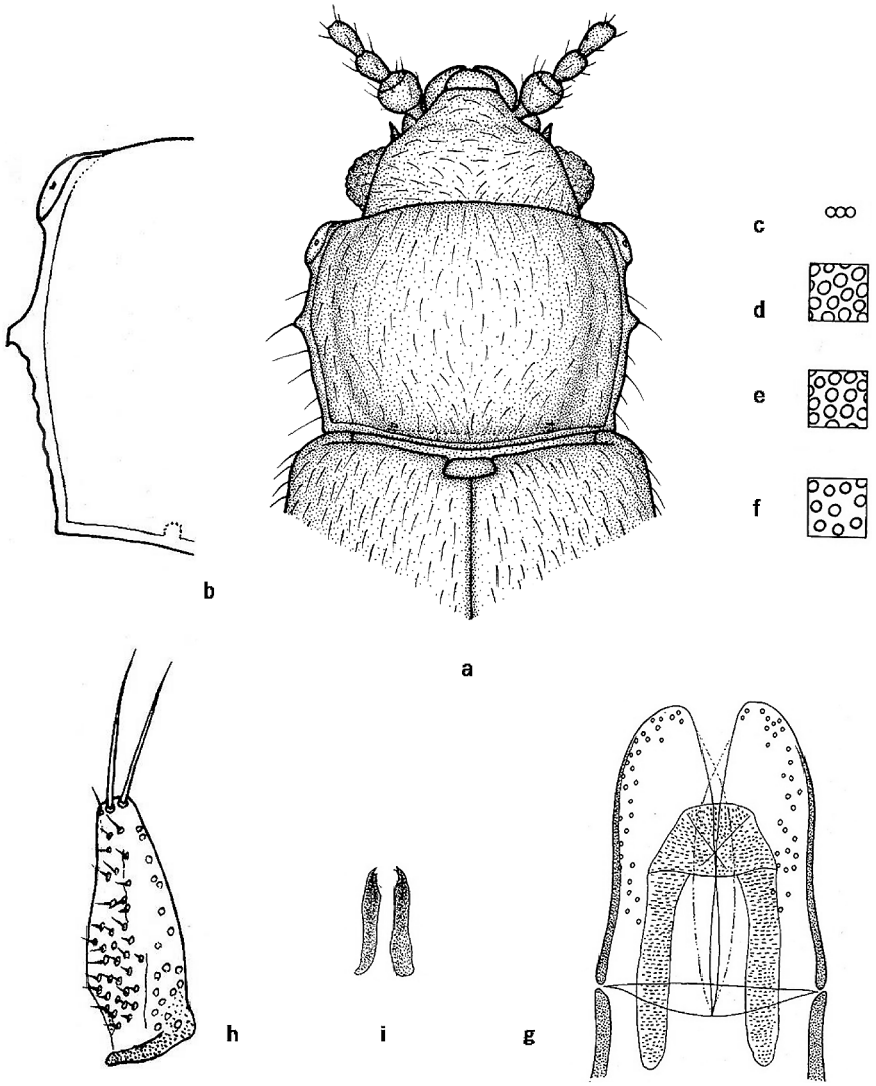

Fig. 6. *Cryptophagus insulicola* Roubal. – a. General view, male. – b. Pronotum. – c. Size and shape of ocular facets. – d–f. Comparison of punctation between head pronotum and elytra. – g. Dorsal view of aedeagus. – h. Paramere. – i. Sclerotized rods.

duct invisible. Point of callosity absent. Angle between bare surface of callosity and longitudinal axis of body 25°–35°. Lateral tooth in the middle of the side. General shape of lateral margin parallel. Posterior angles from right to acute. Basal pits slight or reduced. Puntures (Fig. 5f) separated by a distance shorter than their diameter (Ø = 12–13 µm). Aedeagus in Fig. 5h, sclerotized rods in Fig. 5j and parameres in Fig. 5i.

Distribution. Very rare in central and south eastern Europe: Austria, Bosnia Herzegovina, Greece, Romania, Slovakia, Ukraine (Johnson *et al.* 2007).

3.2.6. *Cryptophagus insulicola* Roubal, 1919

Cryptophagus acuminatus Coombs & Woodroffe, 1955. *Trans. Soc. ent. Lond.,* 106 (6): 257

Cryptophagus vagus Bruce, 1938. *Ann. Hist-nat. Mus. Nat. Hung. Pars Zool.*, 31: 6

Material examined. 8 ex, Germany, Ukraine (coll. NHMW); 2 ex, Greece (Johnson 2012); 1 ex, Italy (CA).

Important characteristics. Pronotum slightly transverse, almost subquadrate (WL= 1.5–1.6 or more) (Fig. 6a,b). Callosity small (1/6–1/5 of lat-

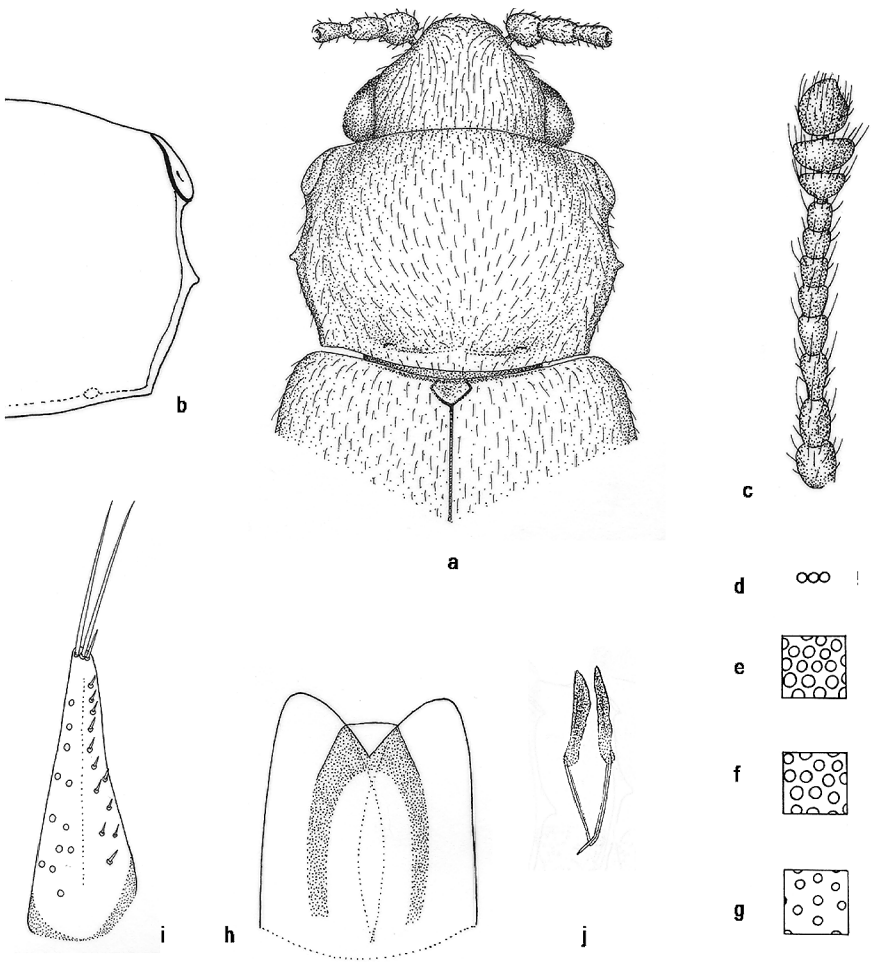

Fig. 7. *Cryptophagus intermedius* Bruce. – a. General view, male. – b. Pronotum. – c. Antenna. – d. Size and shape of ocular facets. – e–g. Comparison of punctation between head pronotum and elytra. – h. Dorsal view of aedeagus. – i. Paramere. – j. Sclerotized rods.

eral margin), elongate-oval patch of bare surface visible from above. Point of callosity absent. Caudolateral angle obtuse. Angle between bare surface of callosity and longitudinal axis of body 25°–35°. Position of lateral tooth at middle of lateral margin. General shape of lateral margin rounded or angular. Straight shape of lateral margin between lateral tooth and posterior angles. Posterior angles from rectangular to acute or obtuse. Basal groove slight, narrow or reduced. Basal pits normal. Aedeagus in Fig. 6g, sclerotized rods in Fig. 6i and parameres in Fig. 6h.

Distribution. Very rare in Europe: Great Britain, Germany, Greece, Switzerland and western Asia: Afghanistan, Iran, Tajikistan, Turkmenistan, Uzbekistan (Johnson *et al.* 2007).

3.2.7. *Cryptophagus intermedius* Bruce, 1934

Cryptophagus intermedius Bruce, 1934. *Entomol. Tidskr.,* 55(2): 179

Material examined. 3 ex, Italy (CA); 2 ex, Iran (HNHM); 2 ex, Spain (MZL).

Important characteristics. Pronotum convex, moderately transverse (WL= 1.5–1.6) (Fig. 7a,b). Callosity with a variable size (1/4–1/5 of the length of the side); forming a right angle backward; surface of callosity visible dorsally and with a strong edge. Glandular pore not visible. Callosities forming an angle of less than 25° with axis of body. Lateral tooth in the middle or behind the middle of the lateral margin. Posterior angles from right to acute. Basal groove normal. Basal foveae reduced. Punctation moderately diffuse;

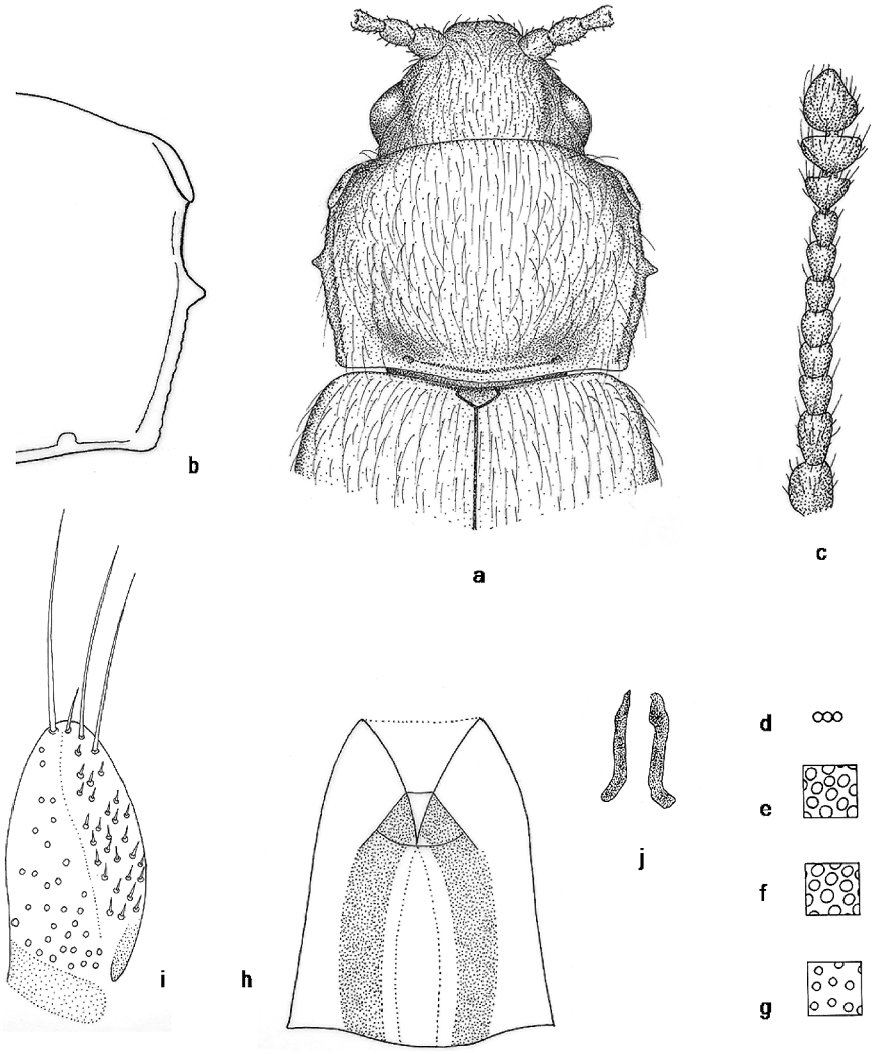

Fig. 8. *Cryptophagus puncticollis* P. H. Lucas. – a. General view, male. – b. Pronotum. – c. Antenna. – d. Size and shape of ocular facets. – e–g. Comparison of punctation between head pronotum and elytra. – h. Dorsal view of aedeagus. – i. Paramere. – j. Sclerotized rods.

punctures (Fig. 6f) separated by a distance shorter than their diameter (Ø = 10 µm). Aedeagus in Fig. 6h, sclerotized rods in Fig. 7j and parameres in Fig. 7i.

Distribution. Rare but widely in Europe: Azerbaijan, Armenia, Austria, Denmark, Estonia, France, Great Britain, Germany, Georgia, Italy, Norway, Poland, Romania, Slovakia, South of Russia, Sweden, Switzerland (Johnson *et al.* 2007).

3.2.8. *Cryptophagus puncticollis*
P. H. Lucas, 1846

Cryptophagus puncticollis P. H. Lucas, 1846. *Explor. Sci. Algér., Zool.*, 2: 221

Cryptophagus subelongatus Rey, 1889. *Échange*, 5: 43

Cryptophagus rotundatus Coombs & Woodroffe, 1955. *Trans. R. Entomol. Soc. Lond.*, 106: 258

Material examined. 16 ex, Italy (Otero & Angelini 1981, 1984); 10 ex, Spain (Otero & González 1985).

Important characteristics. Pronotum square or slightly transverse (WL= 1.4–1.5) (Fig. 8a,b), a little bit narrower in the base than that of the elytra. Callosity large (1/4 of the length of the side), forming an obtuse angle backward; surface of callosity visible dorsally; dorsal edge strong. Glandular pore visible. Callosities forming an an-

gle of 25°–35° with the axis of the body. Lateral tooth in the middle of the side. Sides slightly retracted from the lateral tooth to the base. Posterior angles from right to acute or obtuse. Basal groove and foveae normal. Punctures (Fig. 8f) separated by a distance smaller than their diameter (Ø = 10 µm). Aedeagus in Fig. 8h, sclerotized rods in Fig. 8j and parameres in Fig. 8i.

Distribution. Rare, mostly in central and southern Europe: Bosnia Herzegovina, Croatia, France, Great Britain, Germany, Hungary, Italy, The Netherlands, Spain, Switzerland, Serbia & Montenegro, and in North Africa: Algeria (Johnson *et al.* 2007).

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