



First record of *Cyrtogenius* Strohmeier in Europe, with a key to the European genera of the tribe *Dryocoetini* (Coleoptera: Curculionidae, Scolytinae)

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Abstract

The genus *Cyrtogenius* Strohmeier, represented by the species *C. luteus* (Blandford, 1894), is reported for the first time in Europe. Many adults were collected for four consecutive years (2009–2012) in various localities of northern Italy in both multifunnel and cross-vane traps baited with multilure blends. A diagnosis of the species and a revised key to the European genera of tribe *Dryocoetini* Lindemann is also reported. An explanation is suggested for the increasing number of recent introductions of exotic scolytids into Europe.

Key words: exotic bark beetles, invasive species, Asian species, climatic change

Introduction

In the summer of 2009, specimens of *Cyrtogenius* Strohmeier were found in both multifunnel and cross-vane traps baited with various multilure blends (Tab. 1) set up in the international harbours of Venice (Marghera, 45° 27' N, 12° 15' E) and Chioggia (45° 22' N, 12° 28' E) (NE Italy). In summer 2010 and 2012, many other specimens were caught in the same harbours (Tab. 1). Lately, in summer 2011, the same species was found also in traps set up in semi-urban areas in Martellago (45° 55' N, 12° 16' E) and San Biagio di Callalta (45° 69' N, 12° 37' E) (Tab. 1), respectively at about 15 km and 40 km from the closest harbour (Marghera). Subsequent morphological and genetic analyses ascribed the collected specimens to the species *Cyrtogenius luteus* (Blandford, 1894), a bark beetle of subtropical origin. The specimens were collected only in traps and no dying or recently dead trees were found to be infested by the species.

TABLE 1. Number of *C. luteus* adults trapped in Northern Italy in 2009–2012. Different letters indicate different type of lures used to bait the traps (see notes).

Localities	2009		2010		2011		2012	
	blend	captures	blend	captures	blend	captures	blend	captures
Chioggia	A	1	B	10	C and D	0	-	-
Marghera	A	1	B and C	13	C and D	0	B	97
San Biagio di Callalta	-	-	-	-	C	9	-	-
Martellago	-	-	-	-	C and D	14	-	-
Total	-	2	-	23	-	23	-	97

Type of lures:

- A) Multilure blend composed by ethanol, α -pinene, ipsenol and ipsdienol
- B) Multilure blend composed by ethanol, α -pinene, ipsenol, ispdienol and methyl-butenol
- C) Pheromone for *Monochamus galloprovincialis* (SEDQ[®]) added with ethanol, ipsenol and methyl-butenol
- D) Multilure blend composed by ethanol, α -pinene, ipsenol and methyl-butenol

Cyrtogenius Strohmeier, 1910

The genus *Cyrtogenius* includes about 90 species, mainly from Oceania and Micronesia (about 49), 25 from Africa and about 16 from Asia (Wood & Bright 1992). *Cyrtogenius* species are largely tropical in their distribution, and some breed in seeds or in the pith of twigs, rather than in phloem. The majority of the species are, however, true bark beetles (phloeophagous). Very few of them (*C. luteus* and *C. philippinensis*) are associated with conifers, with a strong preference for pines, whereas all other species develop in tropical broadleaf trees and lianas. For the majority of *Cyrtogenius* species (about 65%) the host plant is still unknown (Wood & Bright 1992). Some *Cyrtogenius* species are known to be heterosanguineously polygynous (Wood 1986).

Cyrtogenius luteus (Blandford, 1894)

Dryocoetes luteus Blandford

Carposinus pini Hopkins

Oriosotes formosanus Schedl

General features. *Cyrtogenius luteus* (Fig. 1), the only *Cyrtogenius* species so far known to Europe, is similar to the European species belonging to the genus *Dryocoetes* from which is easily distinguished by the 4-segmented antennal funicle (Fig. 2), and the slightly elevated ventro-lateral margin of the declivity which is armed by small granules (Figs. 1 and 3). Other features concern the antennal club, which has a basal corneous portion (segment 1) always procurved, and sutures visible only on the anterior face (Fig. 2). Compared to the other Dryocoetini genera, *Cyrtogenius luteus* is a stout species with the elytrae 1.4 times longer than the pronotum (Fig. 1).

Diagnosis. *Female.* Body cylindrical and shiny, brown (Fig. 1). Body length 2.28 ± 0.045 mm (mean \pm SEM, $n = 10$); 2.74 ± 0.041 longer than wide. Frons weakly convex, transversely impressed just above the epistoma; surface closely granulate-punctate with abundant short vestiture (Fig. 5). Eyes broadly emarginated. Antennal funicle 4-segmented (Fig. 2). Pronotum 1.09 ± 0.081 times longer than wide (Fig. 4); sides straight and sub-parallel on basal half; anterior margin broadly rounded; apical half finely and closely asperate; posterior half shiny with coarse and deep punctures, spaced by three times the diameter of a puncture; summit indistinct; hair-like setae mostly on asperate surface as well as on the posterolateral part (Fig. 4); lateral margins on basal two-thirds acutely margined. Elytra shiny, 1.57 ± 0.026 longer than wide, 1.4 ± 0.055 times longer than pronotum, sides straight and sub-parallel on basal three-fourths, posteriorly terminating broadly rounded, almost squared (Fig. 1); discal striae indistinctly impressed; striae 1 and 2 impressed near declivity, marked by large and deep punctures; interstriae slightly wider than striae with close punctures of smaller size. Declivity very steep with convex face; striae 1, 2 and 3 sulcate; stria 1 more strongly impressed than on disc, interstria 1 moderately elevated; interstriae 1, 2 and 3 wider than on disc, each bearing an uniseriate row of widely spaced pointed granules; interstriae 4–7 bearing granules, those on 7 larger. Vestiture of fine hairs both on elytra and declivity; disc devoid of hairs.

Male. Similar to female in all morphological characters, except in having frons with finer punctures on smooth surface and with inconspicuous hairs (Fig. 6).

Distribution. The species is so far known from different parts of the Oriental, Papuan and Oceanian regions, including India, Burma, China (Fujian, Guangdong, Guangxi, Henan, Hunan, Jiangsu, Jiangxi, Shanxi, Sichuan, Yunnan), Japan, Korea, Thailand, Myanmar, Taiwan, Malaysia, Indonesia (Java), Philippines, Micronesia, Bismarck Islands, Caroline Islands, Gilbert Islands, Mariana Islands, Samoa and New Guinea (Wood & Bright 1992; Beaver & Liu 2010).

Host trees. Species usually breeding in the phloem of conifers, especially *Pinus* (*P. densata*, *P. khasya*, *P. massoniana*, *P. tabulaeformis*, and *P. yunnanensis*), but also recorded from other Pinaceae (*Larix* and *Picea*) (Wood & Bright 1992; Beaver & Liu 2010). In Italy it has been found only in traps.

Genetic analysis. *Cyrtogenius luteus* and *C. brevior* are very similar species and there are no keys available for distinguishing them morphologically. *C. luteus* has been recorded from coniferous hosts and it has a more northerly distribution, whereas *C. brevior* is known from angiosperm hosts and has a southerly distribution (Beaver, pers. comm.). To separate these two sibling species, since we did not know the host trees, we performed a genetic analysis of the adults found in the traps. Some individuals freshly collected from traps were singly stored in 90% ethanol until DNA extraction. Nucleic acid extraction was performed on single specimens following a salting



FIGURE 1. Adult of *Cyrtogenius luteus*, dorsal view.

out protocol (Patwary *et al.* 1994). A segment of the mitochondrial COI gene was amplified using the universal primers HCO1490 and LCO2198 (Folmer *et al.* 1994). DNA sequencing was performed by dideoxy chain termination method at BMR Genomics sequencing service (BMR Genomics srl, Padova, Italy). Sequences were then deposited in GenBank (accession numbers JQ417240, JQ417241, JQ417242, JQ621833, JQ621834). Using MEGA version 5 (Tamura *et al.* 2011) sequences were then aligned with all the COI sequences in GenBank obtained from specimens belonging to the genus *Cyrtogenius*: a sequence isolated from *C. brevior* – collected in Papua New Guinea (Cognato *et al.* 2011), GenBank #s HM064152 – and two sequences of *C. chirindaensis* (GenBank #s AF187118 and AF438511). Moreover, a phylogenetic tree was reconstructed with the NJ method (Kimura-two parameters distance) using *Dryocoetes autographus* as outgroup (GenBank ID: AF444054). Node support was assessed by performing 1000 bootstrap replicates.

The comparison of the sequences obtained from our samples with the sequences of the other two *Cyrtogenius* species clearly shows that our samples belong to a species different from *C. brevior* although closely related to it (Fig. 7). In addition, the analysed samples show five different haplotypes between years and localities (Tab. 2); the consistent number of haplotypes may suggest a large single introduction.

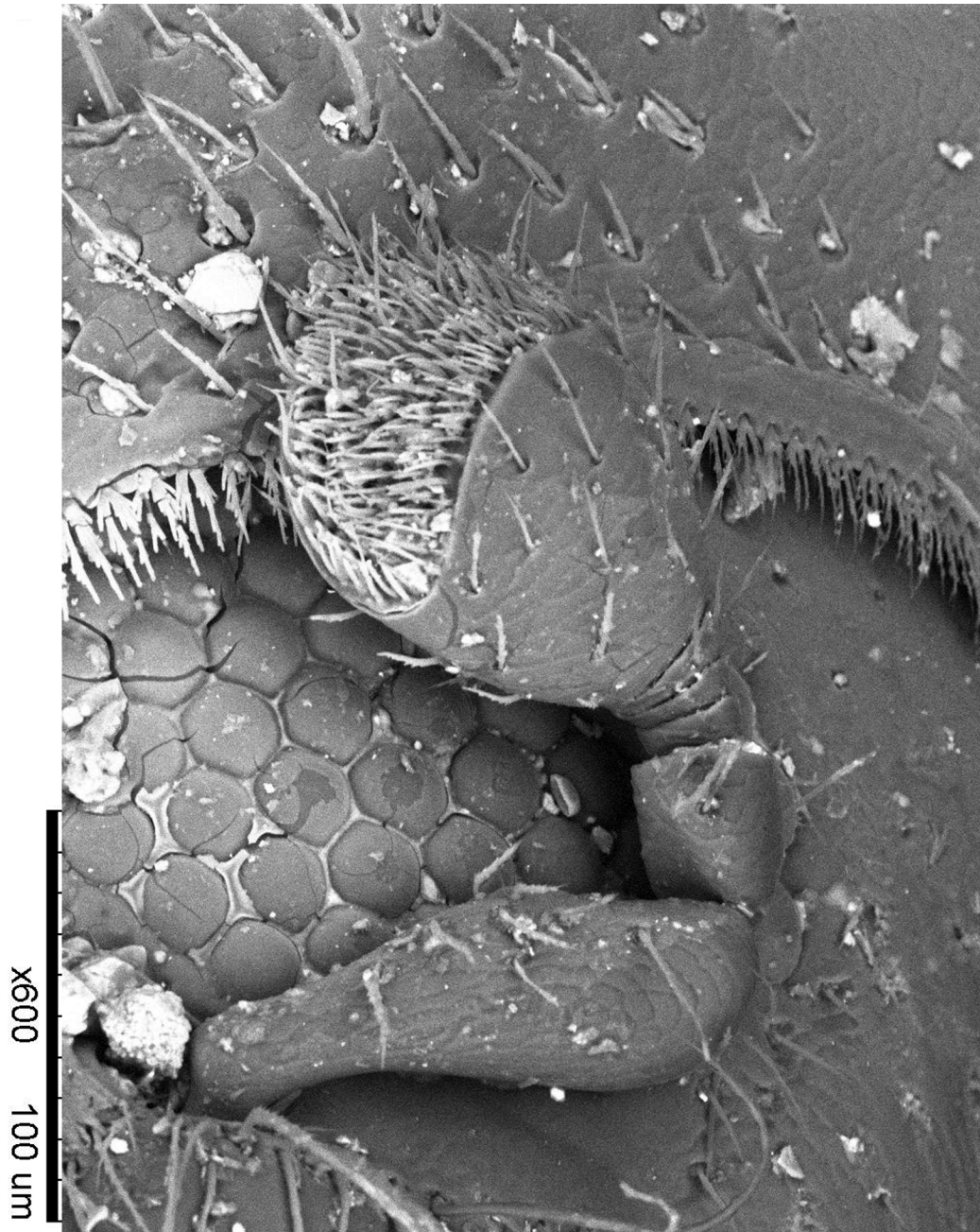


FIGURE 2. Antennal funicle 4-segmented of *Cyrtogenius luteus*. Note also the antennal club obliquely truncated with a basal corneous portion and sutures visible only on the anterior face.

TABLE 2. Haplotype table with all polymorphic sites with the position in base pairs from the start of the COI fragment nucleotide sequence analyzed in this study.

GenBank ID	Locality and date	Position			
		21	33	432	531
JQ417240	Chioggia, 2009	A	A	G	G
JQ417241	Chioggia, 2010	A	A	A	A
JQ417242	S. Biagio di Callalta, 2011	G	A	A	G
JQ621833	Martellago, 2011	A	A	A	G
JQ621834	Marghera, 2009	A	G	A	G

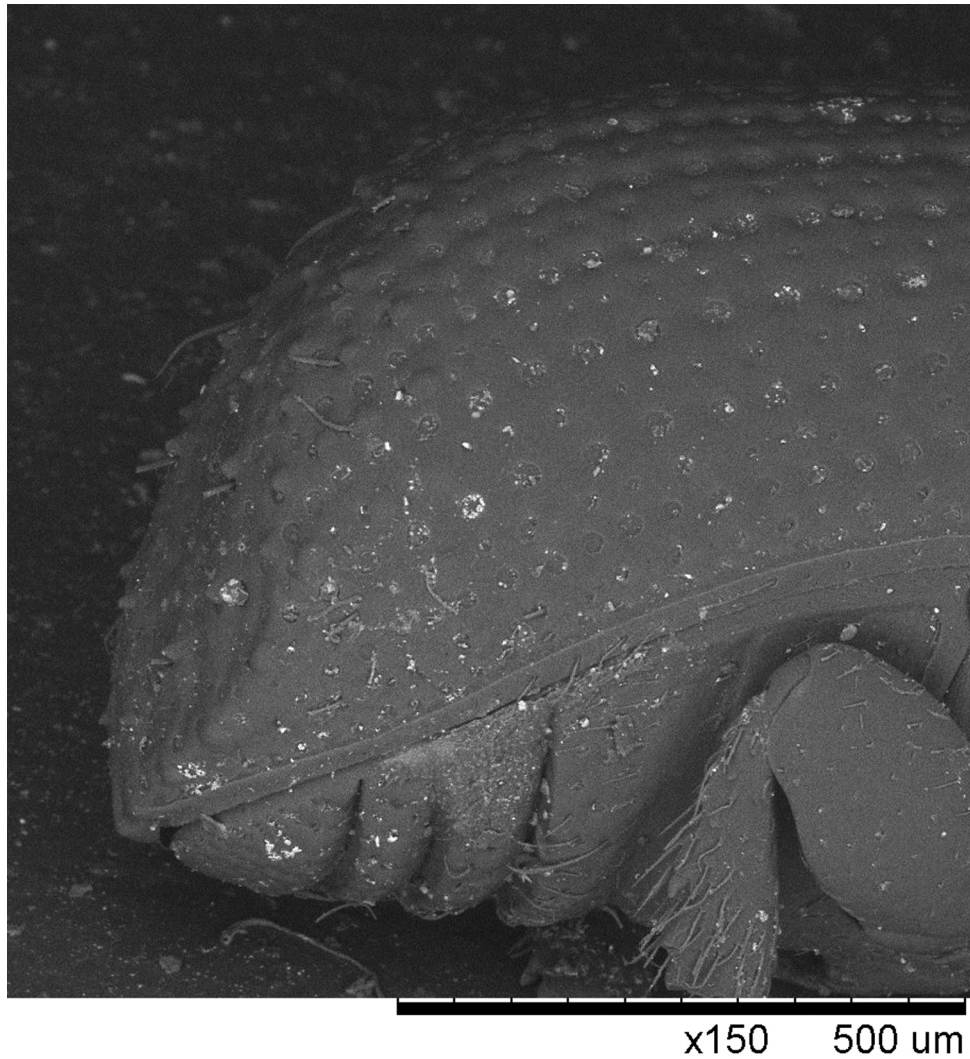


FIGURE 3. Ventro-lateral margin of the declivity of *Cyrtogenius luteus* slightly elevated and armed of small granules.

Discussion

We can infer from the mitochondrial data that the new species introduced in Europe and acclimatized in Italy is *C. luteus*. In this respect, as adults of *C. luteus* were found for four consecutive years (2009–2012) in four different localities separated by several dozens of km, it is probable that the species is established in Italy, as recently recorded for other sub-tropical species (Faccoli 2008; Faccoli *et al.* 2009; Faccoli 2010; Kirkendall & Faccoli 2010; Sauvard *et al.* 2010). *Cyrtogenius* are usually infesting tropical broadleaves that do not occur in European forests and in natural areas. Nevertheless, *C. luteus* is associated with conifers, mainly pines but recorded also on larch and spruce, and this could explain its naturalisation in Europe, where pine is widely spread. Further specific investigations will be carried out to establish the distribution of *C. luteus* in Italy and its occurrence in conifer forests.

In Europe, a coordinated program of monitoring of the ports of entry is still missing and it is urgently required (Marini *et al.* 2011). In addition, currently there are no effective and quick methods to identify scolytids from Asia or Oceania, and phytosanitary efforts to monitor or control new invasive species will fail without correct taxonomic and biogeographic information. A way out of this impasse is the development of inexpensive molecular methods for separating species that are hardly identifiable morphologically (Kirkendall & Faccoli 2010).

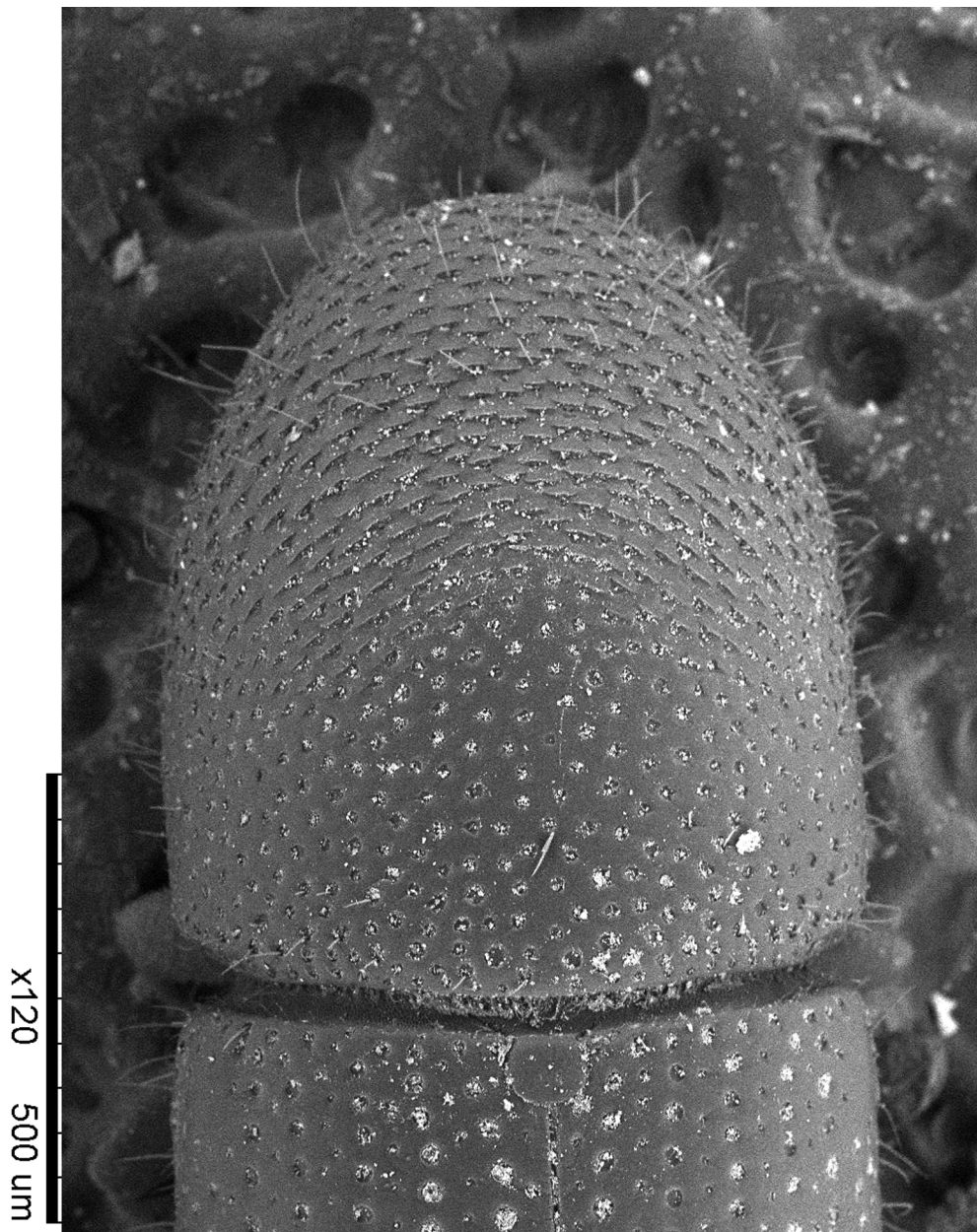


FIGURE 4. Pronotum of *Cyrtogenius luteus*. Note also the elytral punctures larger and more deeply impressed along striae than interstriae.

Meantime, it is unfortunately impossible to determine when *C. luteus* began to spread (before 2009, harbour monitoring by pheromone traps was not active) and how it reached Europe. Moreover, data concerning trapping of *Cyrtogenius* species were not available so far for Europe, not even as simple interceptions. By contrast, from 1984 to 2008 the genus *Cyrtogenius* was intercepted in the ports of entry of 9 American states at least 20 times in 11 years (Haack & Rabaglia 2011). Of these interceptions, 10 refer to *C. luteus* – the only identified species – which has been found in the harbours of 6 US states in commodities coming from China, South Korea, Singapore and Vietnam (Haack & Rabaglia 2011). Other *Cyrtogenius* species (*C. brevior* and *C. dimorphus*) were trapped in Australian harbours (Brisbane port, summer 2007) by panel traps (flight interception) baited with frontalin, or Ipsenol, or a blend of α -pinene and ethanol (Wylie *et al.* 2008).



FIGURE 5. Frons of *Cyrtogenius luteus* female. Note the abundant vestiture missing on the frons of the males.

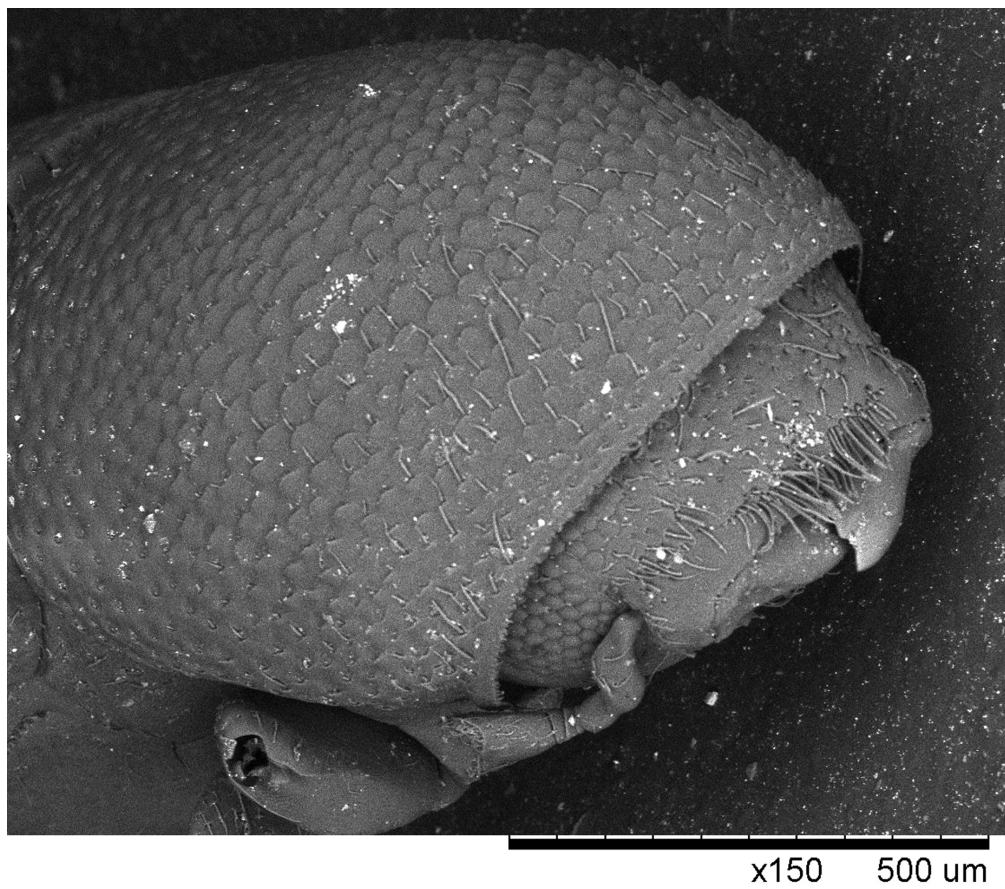


FIGURE 6. Frons of *Cyrtogenius luteus* male with inconspicuous hairs.

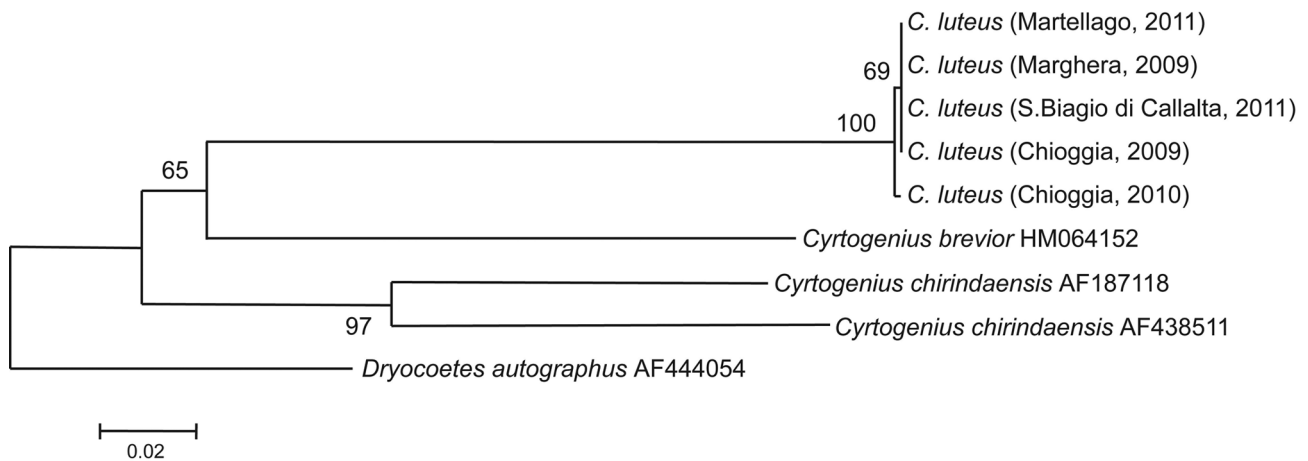


FIGURE 7. NJ tree based on a 390 bp fragment of cytochrome c oxidase subunit I barcode region from 5 samples of *C. luteus* plus the other sequences of the same mtDNA region for the genus *Cyrtogenius* retrieved from GenBank. Bootstrap percent values (1000 replicates) higher than 50 are reported on nodes.

Key to the European genera of the tribe *Dryocoetini*

This key is intended to facilitate the identification of *Cyrtogenius* and the other *Dryocoetini* genera occurring in Europe. The key is modified from Wood (1986) considering only the European genera of the *Dryocoetini* tribe. The arrangement of the genera in the key is not phylogenetic.

- 1 Anterior half of pronotum armed by asperities or granules of different sizes randomly distributed or arranged in concentric lines 4
- Anterior half of pronotum unarmed by asperities or granules, with punctures on the whole surface 2
- 2 Male mandibles with horn-like processes. Antennal funicle 4-segmented. Smaller species (< 1.2 mm). Male frons deeply impressed. In shrubs of *Cactus* or *Euphorbia*..... *Triotemnus* Wollaston
- Male mandible unadorned. Antennal funicle 5-segmented. Larger species (> 1.4 mm). Male frons either deeply impressed or flat 3
- 3 Frons of males and females flat or convex, usually with a prominent central ridge. Lateral margin of protibiae linear and armed by 4–5 large socketed teeth. In *Euphorbiaceae* *Thamnurgus* Eichhoff
- Male frons deeply impressed. Lateral margin of protibiae curved and armed by 5–8 small socketed teeth. In phloem of broadleaves..... *Pseudothamnurgus* Egger
- 4 Elytrae > 2x longer than pronotum. Antennal club flat, lenticular, without basal corneous portion, with procurved sutures visible on both faces of the club 5
- Elytrae < 2x longer than pronotum length (Fig. 1). Antennal club either obliquely truncated with a basal corneous portion and sutures visible only on the anterior face (Fig. 2), or globular with straight sutures 6
- 5 Antennal funicle 4-segmented. Antennal club with sutures obsolete or hardly visible. Lateral margin of protibiae armed by 5 small socketed teeth. Male frons convex. Scutellum rather large, flat. Mainly in phloem of *Corylus* or *Acer* *Lymanator* Lowendal
- Antennal funicle 5-segmented. Antennal club very strongly procurved, clearly visible on both faces. Lateral margin of protibiae armed by 7 or more small socketed teeth. Male frons impressed. Scutellum very small, not flat. Only in phloem of *Clematis* *Xylocleptes* Ferrari
- 6 Elytral punctures similar on striae and interstriae. In seeds of palm or *Dracaena*. 7
- Elytral punctures larger and more deeply impressed on striae than interstriae (Fig. 4). In phloem of European conifers and broadleaves 8
- 7 Lateral margin of protibiae armed by 2–4 large socketed teeth. Antennal funicle 5-segmented. Scutellum flat, rather large. Males smaller than females, dwarfed, different in shape. In Europe only in palm seeds *Coccotrypes* Eichhoff
- Lateral margin of protibiae armed by 7 or more small socketed teeth. Antennal funicle 4-segmented. Scutellum very small, not flat, reduced to a narrow lamella hardly visible. Males and females similar in size. Both in palm seeds and *Dracaena* *Dactylotrypes* Eggers
- 8 Antennal funicle 5-segmented. Anterior margin of segment 1 in the club acutely raised and recurved or transverse. Ventrolateral margin of the declivity never elevated or specially armed. *Dryocoetes* Eichhoff
- Antennal funicle 4-segmented (Fig. 2). Segment 1 in the club distinctly procurved. Ventrolateral margin of the declivity slightly elevated, with small granules (Fig. 1) *Cyrtogenius* Strohmeyer

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