ZooKeys 3: 1-10 (2008)
doi: 10.3897/zookeys.3.19
www.pensoftonline.net/zookeys

RESEARCH ARTICLE

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A new species of *Philorhizus* Hope, 1838 from Greece (Coleoptera, Carabidae, Lebiini)

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Academic editor: *Achille Casale* | Received 1 August 2008 | Accepted 2 September 2008 | Published 16 September 2008

urn:lsid:zoobank.org:pub:73199974-13A9-4F0D-9E28-8D897B4EAF6B

Citation: Wrase DW, Assmann T (2008) A new species of *Philorhizus* Hope, 1838 from Greece (Coleoptera, Carabidae, Lebiini). ZooKeys 3: 1-10. doi: 10.3897/zookeys.3.19

Abstract

Philorhizus marggii **n. sp.** is described from Greece (southern Peloponnese). Type locality: Taygetos Massif, Profitis Illias, N 36°58'/E 022°21', 2000-2400 m asl. Members of this micropterous species are distinguished from the other *Philorhizus* species occurring on the Balkans by habitus, the special colouration pattern of the elytra and the special construction of the internal sac of the median lobe. Illustrations of the habitus, the median lobe and its internal sac and a description of the habitat of the new species are presented. A key to all *Philorhizus* species known from Greece is given. Biogeographic notes on the distribution of micropterous *Philorhizus* species in the western Palaearctic realm are given. *Philorhizus paulo* Wrase, 1995 is recorded from France for the first time (East Pyrenees).

Keywords

Coleoptera, Carabidae, Lebiini, *Philorhizus*, new species, Greece, Taygetos Mts., France, Pyrenees, identification key

Introduction

In a previous paper (Wrase, 2005) brief mention was made of a striking, wingless species from the Taygetos Massif, obviously unknown to science. Unfortunately, as only a female representative was found, it was not described.

In an expedition to a locality in the Taygetos Massif close to the site where the female specimen was collected, one of us (Th.A.) was able to find three males which match perfectly with the original female specimen; thus, we are now able to describe this species, increasing the number of *Philorhizus* (urn:lsid:zoobank.org:act:EF8BB370-B48A-4618-99D3-5975C715D18D) species known from Greece to seven. To simplify the recognition and identification of *Philorhizus* species from Greece we present an identification key to all known species from that country.

Material

The material examined is housed in the collections listed below:

cASSM	Collection Th. Assmann, Bleckede, Germany (type material will be given to Zoologische Staatssammlung München)
cMA	Collection W.A. Marggi, Thun, Switzerland
cST	Collection W. Starke, Warendorf, Germany
cWR	Collection D.W. Wrase, Berlin, Germany

Methods

Total body length (BL) is measured from the tip of the mandibles to the apex of the right elytron as the maximum linear distance; the width of the head (HW) as the maximum linear distance across the head, including the compound eyes; the length of the pronotum (PL) from the anterior to the posterior margin along the midline; the length of the elytra (EL) from the basal margin to the apex of the right elytron as the maximum linear distance; the width of the pronotum (PW) and elytra (EW) at their broadest point; the width of the pronotal base (PBaW) between the tip of the hind angles at insertion of seta.

These measurements, made at a magnification of 32X (body length) and 50X, respectively, and using an ocular micrometer in a Leica MZ 16 stereobinocular microscope, were combined as ratios and/or added as follows:

BL: total body length;
PW/PL: width /length of pronotum;
PW/HW: width of pronotum /width of head;
PW/PBaW: width of pronotum/width of the pronotal base;
EL/EW: length/width of elytra;
EW/PW: width of elytra/width of pronotum.

Microsculpture was examined at a magnification of 100X.

Line drawings were prepared using an ocular grid (15 X 15 squares) attached to a Leica MZ 16 stereobinocular microscope. Dissections were made using standard techniques; genitalia were preserved in Euparal on acetate labels, and pinned beneath the specimens from which they had been removed. The habitus photograph was taken with an Olympus E-330 digital camera in combination with a Leitz MZ 95. Post-processing was done in Adobe Acrobat Professional 7.0. To achieve sufficient depth of focus, 17 planes were captured which were copied to separate layers, and the out-of-focus planes are masked by a stacking programme (Combine Z5).

Description

Philorhizus marggii Wrase et Assmann, new species

urn:lsid:zoobank.org:act:C9BA8153-E92C-4256-9D45-F5168DE60F78

Type material Holotype male: „S-Greece: Peloponnese/Taygetos: Profitis Illias subalpine, 16.V.2007, N 36°58' E 022°21', 2000-2400m asl, 226, leg. Th. Aßmann" (cWR, later in the Zoologische Staatssammlung München). Paratypes: 2 males, same as holotype (cASSM, cST). 1 female: „GR Pelop. /Taygetos Profitis Illias, 1200m, 23.IV.1997, W. Marggi & Ch. Huber leg." (cMA).

Diagnosis A micropterous species of average size for *Philorhizus*, with wide infuscated head, narrow pronotum, long-oval elytra yellowish with a wide dark transverse fascia at apical half and completely rounded humeri. Habitus, see Fig. 1.

Description Body length 3.3-3.7 mm; width 1.38-1.56 mm (holotype 3.6 mm and 1.48 mm, respectively).

Colour: Head (with exception of lighter clypeus) dark or light reddish piceous, mandibles, mouthparts, pronotum and appendages yellowish. Elytral basal half, apical margins and a large semicircular or almost square area around sutural angle testaceous, the remainder infuscated, forming a reddish piceous, wide, transverse, somewhat jagged fascia. The dark area bordering the suture extends slightly towards base of elytra.

Head (Fig. 1) large, almost as wide as pronotum (ratio PW/HW in males: 1.03-1.06, Ø 1.05, holotype 1.05; in female: 1.06). Eyes fairly large and flat, eye diameter about 2.3 to 3.0 times as long as rectilinearly narrowed tempora (seen in dorsal view). Antennae of medium length, slender, antennomeres 4-11 with dense and fairly fine setae except obligatory long apical setae (about as half as long as the latter).

Pronotum (Fig. 1) almost square (ratio PW/PL in males: 1.21-1.27, Ø 1.23, holotype 1.27; in female: 1.36), widest at about end of anterior fourth (at insertion of lateral seta). Anterior margin moderately emarginate, anterior angles rounded, projecting slightly forward, from there slightly curved laterally till insertion of lateral seta (here somewhat angulate), from there basad almost rectangularly narrowed and weakly sinuate before posterior angles which are obtuse and angled strongly forward (at about length of antennomere 2), at insertion of seta weakly angulate. Base medially slightly emarginate, laterally to insertion of seta strongly curved (ratio PW/PBaW in males: 1.21-1.27, Ø 1.24, holotype 1.27, in female: 1.25). Lateral furrows at anterior angles narrow, becoming explanate toward base and continuing into

Fig. 1. *Philorhizus marggii* n. sp., habitus, holotype.

large basal impression. Medial longitudinal impression deep, terminated at anterior and posterior transverse impression. Anterior transverse impression distinct, posterior transverse impression shallow and connecting both basal impressions.

Elytra (Fig. 1) long-oval (ratio EL/EW in males: 1.38-1.41, holotype 1.38; in female: 1.36; ratio EW/PW in males: 1.94-2.03, Ø 1.97, holotype 1.94; in female: 2.05) with completely rounded humeri, widest approximately at beginning of posterior fifth. Striae only suggested, becoming evanescent laterally. Hindwings reduced to small relicts.

Microsculpture mesh pattern on head in males consisting of weakly engraved isodiametric meshes on disc (somewhat more marked in the female), hence surface fairly shiny, on pronotum transverse and on elytra almost isodiametric in both sexes, moderately impressed, surface somewhat shiny.

Median lobe and internal sac structure (Fig. 2): Relatively stout, with apical lamella small, evenly narrowed and apically rounded. Internal sac (in inverted condition) with a long winding, wide band of scales and thorns, which appears in lateral view in the middle part of the median lobe, reaching the apical part, and a short band of thorns, situated ventrally before the apical part.

Comparisons In habitus and other characteristics (shiny head with weakly developed microreticulation, slender antennae, head wide with almost rectilinearly narrowed long tempora, pronotum very narrow, with posterior angles obtuse and angled strongly forward, micropterous, elytra with completely rounded humeri) similar to *Ph. alpinus* (Meschnigg, 1934), described from the Aroania Mountains (Greece). The new species can be distinguished from *Ph. alpinus* by its piceous head, by the elytra with a distinct, wide, dark transverse fascia at apical half which extends forward along the suture, omitting a large, testaceous semicircular or square area around the sutural angle, and by somewhat shorter tempora (while *Ph. alpinus* is unicolorous, tempora almost as long as eye diameter). A comparison of the male genitalia cannot be given here, as the only specimen of *Ph. alpinus* we were able to study was a female (see Wrase 2005).

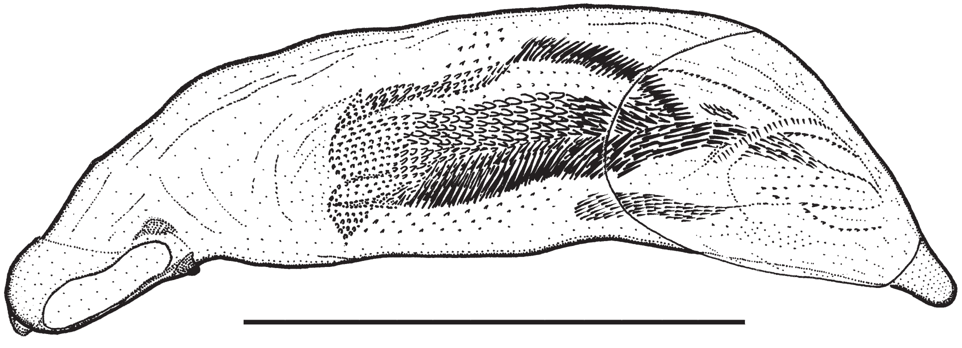

Fig. 2. *Philorhizus marggii* n. sp. male genitalia, median lobe, lateral view, holotype. Scale bar 0.5 mm.

The new species can be differentiated from the other species occurring in the Balkan Peninsula [*Ph. crucifer crucifer* (Lucas, 1846), *Ph. lompei* Wrase, 2005, *Ph. melanocephalus* (Dejean, 1825), *Ph. notatus* (Stephens, 1827), *Ph. quadrisignatus* (Dejean, 1825) and *Ph. sigma sigma* (P.Rossi, 1790)], and also from *Ph. dacicus* Sciaky, 1991 (Romania, Ukraine) by its characteristic colouration (see figures in Sciaky, 1991, and Wrase, 2005), the almost rectilinearly narrowed long tempora, the characteristic form of the pronotum with its obtuse posterior angles angled strongly forward (at about the length of antennomere 2), and therefore its base laterally strongly rounded toward the posterior angles, and by the different construction of its median lobe and the striking structure of its internal sac (compare figures in Sciaky, 1991, and Wrase, 2005). For better distinction we present an identification key (see below).

Etymology It gives us great pleasure to be able to dedicate this new species to our colleague and friend Dr. Werner A. Marggi (Thun), well-known specialist in Carabidae, who collected (together with Dr. Charles Huber, Bern) the first known specimen of the new species.

Distribution Up to now only known from the type locality in the Taygetos Massif and most likely an endemic species.

Habitat The specimens from 2007 were collected from low down on stones in subalpine meadows at altitudes of 2000 to 2400 m (Fig. 3). The stones were well embedded in the ground and surrounded by grass, which was taller than in the meadow grazed by goats and sheep. Beetles' activity on the plants is therefore likely to be typical for many other lebiine carabids (cf. Stork 1980). The specimen from 1997 was collected in the montane zone close to a small pond. These records indicate that the species probably occurs in the middle and higher altitudes of Mount Taygetos.

Biogeographic notes on the unwinged *Philorhizus* species from the West Palaearctic realm

Philorhizus marggii n. sp. belongs to a group of species of the genus *Philorhizus* which is characterized by microptery (or brachyptery) and by the fact of its distribution in mountainous regions. As far as is known at present, these species occur in the western part of the Palaearctic realm from the Macaronesian Islands (Canary Islands, Madeira), the Iberian, Apennine and southern Balkan Peninsulas, up to the Caucasus. The northern limit is marked by populations in the Ukraine, the southern by those in the Sierra Nevada, northern Sicily, Turkey and by the population(s) of *Ph. marggii* n. sp. from southern Greece (cf. Sciaky 1991; Wrase 2005). *Philorhizus tinauti* Anichtchenko, 2005, a sister species of *Ph. mendizabali* Mateu et Colas, 1954), is known from low altitudes in eastern Andalucia (Almería, Anichtchenko 2005). At least most, if not all, of these species live in southern glacial refuge areas of the western Palaearctic. Distribution pattern and low power of dispersal resulting from microptery (or brachyptery) in combination

Fig. 3. Habitat of *Philorhizus marggii* n. sp.

with small body size suggest that these taxa survived the glacial periods within or close to the recent/present-day distribution areas (cf. Holdhaus 1954). Moreover, we believe that these endemic *Philorhizus* species are relicts because in many cases not only one, but several massifs are colonized (cf. Habel and Assmann 2008). In contrast to some extreme endemics, such as numerous *Trechus* species or cave dwelling carabids, it is highly probable that these *Philorhizus* species had a wider distribution in the past. Otherwise it is difficult to explain the existence of some isolated populations of the same species such as *Ph. dacicus* Sciaky, 1991 known from Romania and Ukraine (Kabak 2003), *Ph. brandmayri* Sciaky, 1991 recorded from Sicily and the Aspromonte Mountains in Calabria and *Ph. paulo* Wrase, 1995 distributed in northern Spain and the Pyrenees. A new record from a locality in the East Pyrenees, about 5 kilometres southwest from Prades-de-Mollo-la-Preste, close to the Spanish border, enlarges the known distribution area of *Ph. paulo* to southern France (first record for France: "France, Collado de Ares, 27.V.1978, Hozman lgt." (Dept. Pyrénnées-Orientales); 1 male in cWR).

Key to the species of *Philorhizus* Hope from Greece

1. Pronotum very narrow (ratio width/length 1.21-.36), with posterior angles obtuse and angled strongly forward (at about the length of antennomere 2), and therefore its base laterally strongly rounded toward posterior angles. Tempora long, almost as long as eye diameter, or somewhat shorter, almost rectilinearly narrowed, distinctly set off against neck (see Figs 2, 3 in Wrase, 2005). Two species from the Peloponnese (Aroania and Taygetos Mts., with strongly reduced hindwings, elytra with completely rounded humeri 2

– Pronotum wider (ratio width/length <1.21), with posterior angles less obtuse and only weakly angled forward, its base weakly rounded laterally toward posterior angles (see Figs 2, 15, 16, 17 in Sciaky, 1991). Tempora short, ± distinctly curved to the neck. Macropterus or micropterous species with a wider distribution 3

2. Unicolorous pale yellowish red, only dorsal side of head and an indistinct macula in posterior half of elytra rusty red. Tempora almost as long as eye diameter. Alpine regions of northern mountains in Peloponnese .... ***Ph. alpinus* (Meschnigg, 1934)**

– Head (more or less dark reddish) piceous, elytra with a distinct, wide, dark transverse fascia at apical half extending forward along suture, omitting a large, testaceous semicircular or square area around sutural angle, abdomen dark. Tempora somewhat shorter. Alpine regions of Taygetos Mountains in Peloponnese .... ***Ph. marggii* nov. sp.**

3. Strongly brachypterous, elytra very short (ratio length/width 1.22-1.30), with completely rounded humeri. Elytral basal third testaceous. Small species (2.8-3.4 mm). Southern Greek mainland (Parnassos) and northern mountains in Peloponnese .... ***Ph. lompei* Wrase, 2005**

– Macropterus or micropterous species, elytra long (ratio length/width >1.40), in both cases elytral humeri distinctly developed 4

4. Large species (3.7-4.7 mm). Macropterous, elytral humeri dark brown. From the Canaries to the Near East .... ***Ph. quadrisignatus* (Dejean, 1825)**

– Smaller species (2.5-3.5 mm). Macropterous to micropterous, elytral humeri always light 5

5. Elytra pale yellowish, as a rule with darkened suture. From western Mediterranean area to Asia Minor and Caucasus .... ***Ph. melanocephalus* (Dejean, 1825)**

– Elytra always with dark pattern: dark transverse fascia in middle or at least a wide band along parts of suture and posterior part of lateral margin 6

6. Elytra on average more slender (ratio length/width 1.51-1.57, Ø 1.54), almost parallel-sided, with narrow transverse dark fascia, dark pattern more cross-like, the central square-like macula often without connection to the lateral longitudinal darkenings. Pronotum usually darkened in middle. Internal sac of median lobe of aedeagus with tubular, long-winding

structure, apically darkened by longer and denser microspines. Median lobe with longer apex (see Fig. 22 in Sciaky, 1991). From western Mediterranean area, Asia Minor, Middle East to Middle Asia. On the Balkan Peninsula with ssp. *crucifer* ....***Ph. crucifer*** **(Lucas, 1846)**

– Elytra on average wider (ratio length/width 1.41-1.54, Ø 1.46) and slightly widened apically, with very variable colour pattern, transverse dark fascia usually very wide, but sometimes not distinct, disappearing. Pronotum rusty red, often darkened on disc. Internal sac of median lobe of aedeagus with 2 subparallel fields of denticles. Apex of median lobe shorter and rounded (see Fig. 21 in Sciaky, 1991). Whole of Europe to Near East ....***Ph. notatus*** **(Stephens, 1827)**

Acknowledgements

We appreciate the support of Jon Cooter (Hereford, England) for reading a previous draft of the manuscript on which this paper is based. Moreover we thank our colleagues Werner Marggi (Thun, Switzerland) and Charles Huber (Bern, Switzerland) for the information about the collecting circumstances of the specimen of the new species, collected at first.

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ZooKeys 3: 11-21 (2008)
doi: 10.3897/zookeys.3.21
www.pensoftonline.net/zookeys

RESEARCH ARTICLE

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Redescription of *Inglisia vitrea* Cockerell (Hemiptera, Coccidae) and its transfer to the genus *Pseudokermes* Cockerell

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Academic editor: *Michael Wilson* | Received 19 August 2008 | Accepted 7 September 2008 | Published 16 September 2008

Citation: Kondo T, Hardy N (2008) Redescription of *Inglisia vitrea* Cockerell (Hemiptera, Coccidae) and its transfer to the genus *Pseudokermes* Cockerell. ZooKeys 3: 11-21. doi: 10.3897/zookeys.3.21

Abstract

The soft scale insect *Inglisia vitrea* Cockerell is transferred to the genus *Pseudokermes* as *P. vitreus* (Cockerell) **comb. nov.** The adult female is redescribed and illustrated. A lectotype is designated based on newly slide-mounted dry type material. New host-plant records and an updated geographical distribution for *P. vitreus* are given. *Pseudokermes correntinus* Granara de Willink is recognized as **syn. nov.** of *I. vitrea*.

Keywords

Coccoidea, Cardiococcinae, Cardiococcini, soft scale, new combination, new synonym

Introduction

The coccid genus *Inglisia* Maskell was originally erected for a New Zealand species, *I. patella* Maskell. As discussed by Morrison and Morrison (1922), Hodgson (1994) and Hodgson and Henderson (2000), very few if any of the species currently included in the genus *Inglisia* are likely to be congeneric. Indeed, many changes have been made in the taxonomy of this genus in recent years. Prior to 1993, there were nineteen species included in *Inglisia* (Ben-Dov 1993). Hodgson (1994) erected the genus *Vitrococcus* to accommodate *I. conchiniformis* Newstead as *V. conchiniformis* (Newstead). Ben-Dov et al. (1997) transferred *I. foraminifer major* Maskell to the genus *Cardiococcus* Cockerell as *C. major* (Maskell). Later Hodgson and Henderson (2000) distributed many New Zealand species previously included in *Inglisia* into two genera, transferring *I. fagi* Maskell, *I. leptospermi* Maskell and *I. ornata* to their newly erected genus *Crystal-*

lotesta as *C. fagi* (Maskell), *C. leptospermi* (Maskell) and *C. ornata* (Maskell), respectively, and transferred *I. inconspicua* Maskell to their newly erected genus *Aphenochiton* as *A. inconspicuus* (Maskell). Ben-Dov (1993) treated *Cryptinglisia zizyphi* (Brain) and *C. elytropappi* (Brain) as *I. zizyphi* [misspelled in Ben-Dov (1993) as *I. zizyphy*] and *I. elytropappi*. Hodgson (1994), in his identification manual to genera of Coccidae, followed De Lotto's (1978) recombination in his discussion of the genus *Cryptinglisia*, and the two species are currently treated as *C. zizyphi* and *C. elytropappi* respectively by the scale insect database, ScaleNet (Ben-Dov et al. 2006).

Currently, the genus *Inglisia* includes nine species (Ben-Dov et al. 2006): (1) *I. australis* Hempel, from Brazil, (2) *I. chelonioides* Green, from India, Sri Lanka, and China, (3) *I. grevilleae* Hall, from Zimbawe, (4) *I. malvacearum* Cockerell, from Mexico and Texas, U.S.A., (5) *I. patella* Maskell, from New Zealand, (6) *I. pluvialis* Hodgson, from Zimbabwe, (7) *I. speciosa* Takahashi, from Indonesia, (8) *I. theobromae* Newstead, from Cameroon, Uganda and Zambia, and (9) *I. vitrea* Cockerell, from Brazil, Cuba, Puerto Rico and Vieques Island, U.S.A. (Florida), and Trinidad and Tobago. Although not listed by Ben-Dov et al. (2006), *I. vitrea* has also been recorded from Colombia (Kondo 2001), California (U.S.A.) (Gaimari 2005), and from Jamaica (Cockerell 1895a). Cockerell's (1894) original description of *I. vitrea* had no accompanying illustrations and his description of the adult female emphasized external features of the glassy test. The species was redescribed by Hamon and Williams (1984) based on both the live appearance and on cuticular morphology of slide-mounted specimens of non-type material.

The genus *Pseudokermes* Cockerell has a New World distribution. According to the scale insect database, ScaleNet (Ben-Dov et al. 2006), there are currently 8 included species: one Nearctic species plus 7 Neotropical species. These species are: *P. armatus* (Cockerell) from Mexico [Nearctic region], *P. correntinus* Granara de Willink, *P. eugenium* Granara de Willink, *P. geoffroeum* Granara de Willink, from Argentina, *P. marginatus* Newstead, from Guyana, *P. nitens* (Cockerell) from Argentina and Brazil, and *P. palmae* Hempel from Brazil.

Both *Inglisia* and *Pseudokermes* belong to the tribe Cardiococcini (Coccidae: Cardiococcinae) (Hodgson 1994). *Inglisia patella*, the type species of *Inglisia* differs from *P. nitens*, the type species of *Pseudokermes*, mainly by the following combination of features (features of *P. nitens* in parentheses): (1) Legs developed, with most segments present, although the tibia and tarsus are fused (legs reduced to small areas of sclerotization, occasionally with a claw with small digitules); (2) cribriform-like plates present on dorsum, at level of metathoracic legs (cribriform-like plates absent); (3) marginal setae of two types which alternate around margin: (i) a club-shape spine, blunt apically and narrowing abruptly at base, and (ii) a sharply spinose seta (marginal setae all spinose); (4) stigmatic spines not differentiated from marginal spines (with one large stigmatic spine, tapering to a blunt point or with a slightly flattened apex); and (5) dorsum without bi- or trilocular pores (bi- or trilocular pores frequent along mid-dorsal line and in a narrow band just dorsad to marginal spines) (character states taken from Hodgson 1994). *Inglisia vitrea* does not share any of the five characteristics listed above for *I. patella* but, on the other hand, it does share all the features listed for *P. nitens*. Clearly, *Inglisia vitrea* is not congeneric with *I. patella* and would appear to be congeneric with *Pseudokermes nitens* Cockerell. Based on these morphological affinities of *I. vitrea* with *P. nitens*, we here transfer *I. vitrea* to *Pseudokermes*, as *P. vitreus* (Cockerell) comb. nov. and redescribe the species based on type and non-type material. We include additional features that were not described previously, e.g., distribution of dorsal microducts and simple pores, and the presence of vestigial legs represented by a pair of very short setae. We illustrate the adult female, designate a lectotype, and provide new host-plant and distribution data. In addition, we determine that *Pseudokermes correntinus* Granara de Willink, described from Argentina (Granara de Willink 1999), is morphologically indistinguishable from *P. vitreus* and thus it is here synonymized with the latter.

Materials and methods

Specimens were slide-mounted using the method described by Williams and Granara de Willink (1992), except that xylene was used instead of clove oil. Photographs of the dry type specimens and original labels (Figs 1A and B) were taken with a Nikon COOLPIX 3100 digital camera; Fig. 1C was taken with an Olympus OM4 camera, and were processed using the computer program Adobe Photoshop® 5.0. Afterwards, most of the dry type specimens were slide-mounted by T. Kondo. The illustration of the adult female (Fig. 2) shows the dorsum on the left and the venter on the right. The redescription of *I. vitrea* [now *P. vitreus*] is based on measurements and observations on the type material and other specimens, as listed. The terms for external morphology is taken from Cockerell's (1894) original description of the species, with some additional observations. Only specimens of *P. vitreus* were available in the present study, and material of other species of *Inglisia* and *Pseudokermes* were not seen, and so comparisons to other species mentioned in this manuscript were made using published literature.

Measurements of the lectotype are given in parentheses. The material studied is deposited at the Auburn University Coccoidea Collection, Auburn, Alabama, U.S.A. (AUCC); the National Museum of Natural History Entomological Collection, Washington, DC., U.S.A., Coccoidea collection held at USDA, Beltsville, Maryland (USNM); and the Bohart Museum of Entomology, University of California, Davis, U.S.A. (BME).

Results and discussion

Inglisia vitrea Cockerell, 1894: 308.
Pseudokermes correntinus Granara de Willink, 1999: 137. **Syn. nov.**

Common names.
English: Glassy scale (Hamon and Williams 1984). Proposed Spanish common name: Escama blanda vidriosa.

Type material studied. The type material consisted of one slide of 2 third-instar nymphs, one uncleared, with label "6409 / Inglisia / vitrea Ckll. / Acacia sp. / Port of Spain, / Trinidad / F.W. Urich #16 / TYPE", plus dry syntype coccids on two small pieces of twig, housed in a small cardboard box with two original labels inside, as follows: "Ckll. Coccidae 25. TYPE / Inglisia vitrea, Ckll / on Acacia sp. Port of Spain, Trinidad / Coll. F.W. Urich. (no. 16)" and "6049 / on / Acacia / Port of Spain / Trinidad / W.I.". These data exactly match those given in Cockerell's (1894) original description. In order to preserve stability and the nomenclatural status of this species, a lectotype is here designated from the syntypes. The examined type material is as follows: Adult female, lectotype of *Inglisia vitrea* Cockerell; paralectotypes: 4 adult females on 4 slides, 3 third-instar nymphs on 2 slides, 1 second-instar nymph on 1 slide, plus several dry specimens still in box (USNM).

Other material studied. Neotropical Region: Barbados: 10.VIII.1985, coll. K. Eng, JKF 100284, 88-04128, ex *Annona* sp. leaf, 1 slide, 4 specimens (USNM). **Brazil:** 9.VIII.1962, coll. Kunishi and Hidalgo, ex leaves of Thymelaeaceae, JFKIA, 66-495, 1 slide, 2 specimens (USNM); Sao Paulo, received 7.VI.1945, coll. H. L. Parker, 1003-61, 1 slide, 1 specimen (USNM); Sao Paulo, IX.1998, coll. T. Kondo, ex leaf of Araliaceae, 1 slide, 1 specimen (AUCC). **Colombia:** Valle del Cauca, Cali, Unicentro, 03°20'50"N, 76°34'15"W, 975 mts asl, 22.XII.2005, coll. Takumasa Kondo, ex *Pithecellobium dulce* (Roxb.) Benth. (Fabaceae), 1 slide, 1 specimen, No. TK0188 (BME). **Costa Rica:** 13.VIII.1981, coll. K. Niedzwiadek, ex orchid leaf, Miami quarantine intercept, 28981, 1 slide, 1 specimen (USNM). **Dominican Republic:** San Juan, 25.I.1974, coll. F. Rodriguez, ex leaf of undetermined tree, 5187, 1 slide, 1 specimen (USNM). **Jamaica:** Ocho Rios, 5.IX.2003, coll. Takumasa Kondo, ex undetermined tree, 1 slide, 1 specimen, No. TK0057 (BME). **U.S.A.:** Florida, Naples, 15.II.1972, coll. W. A. Padgett, ex *Calliandra* sp., 1 slide, 1 specimen (USNM). **Venezuela:** Las Delicias, Edo. Araqua, 13.X.1943, coll. Sr C. H. Ballou, Q. Vivas B, ex *Cajanus indicus*, BFQ, 1 slide, 4 specimens (USNM).

Description. Adult female (measurements based on n=21).

Unmounted material (Fig. 1). Cockerell (1894) wrote of the adult female in life: "On *Acacia* sp., Port-of-Spain (Urich). 3 mm. long, 1½ wide, oval, moderately convex. Glassy scale white, with a conspicuous median longitudinal ridge; posterior cleft large,

Fig. 1. A. Dry insects and twigs with original labels; B. Close-up of one dry adult female showing half of glassy covering removed; C. *I. vitrea* on leaf of greenhouse plant (Araliaceae), Brazil. (A and B: Type material of *I. vitrea* Cockerell, housed in USNM; photos by T. Kondo).

about one-third total length of scale. Surface of scale strongly but finely striate radiately on sides; the apparent striations, highly magnified, resolve themselves into rows of small dots (air cells?). The dorsal portion of this scale is divided into testudinoid plates; there are apparently six series of such plates, three along each side, but the two middle series are the sides of a single median row, divided only by the keel or ridge. Beyond these the broad margin is not divided into plates. The plates are concentrically striate, with a granular patch in the middle of each. The median row of plates consists of two large dorsal ones, and two smaller posterior ones. The second row consists of three plates on each side, and the third row of seven on each side. Margin with a fringe of rods at rather distant intervals. The subtransparent scale removed leaves the insect shiny red-brown, looking like a *Lecanium*. Derm with large gland pits near the margin; margin with simple spines, varying in size." The insects are commonly flat and almost round when infesting the leaves [Fig. 1C; see also round-shaped specimen (rshs), upper right of Fig. 2, small inset drawing after Hamon and Williams (1984)], but are more convex and generally longer than broad when infesting twigs (pers. obs.).

Slide-mounted material. Body 1.72-4.70 mm long, 1.28-4.84 mm wide. Lectotype damaged, 2.04 mm long, approximately 1.30 mm wide. **Note.** The lectotype and adult female paralectotypes are much smaller than the rest of the adult specimens studied (except for the Florida specimen) because the types (and the Florida specimen) are young adult females.

Dorsum. Derm membranous, becoming entirely sclerotized on older adult females. Dorsal setae completely absent. Dorsal microducts (dmic) oval, bilocular, each about 5 µm wide, with a long terminal filament; present marginally, along inner margins of anal lobes and longitudinally in a mid-dorsal line; absent elsewhere. Simple pores (sp) each 2 µm wide, closely associated with dorsal microducts and showing a similar distribution; outline of simple pores and dorsal microducts on mid-dorsal line, especially anterior to anal plates, becoming sclerotized and thus resembling preopercular pores. Dorsal tubular ducts, preopercular pores, dorsal tubercles and pocket-like sclerotizations absent. Anal plates (aplt) together quadrate, with smooth rounded outer angles, plates located at about 1/4 to 1/3 of body length from posterior margin, each plate 133-160 (155) µm long, 70-95 (90) µm wide, anterolateral margin 93-113 (113) µm long, posterolateral margin 90-113 (110) µm long, with 6-10 setae on dorsal surface, plus 1 pair of fringe setae anteriorly and about 3 ventral subapical setae; hypopygial setae not detected. Anal ring (ar) with 6 setae. A narrow sclerotic area present around anal plates, in a narrow mid-dorsal line beginning on area anterior to anal plates and extending anteriorly to level of mouthparts along mid-dorsal line of microducts; on more mature specimens, sclerotizated area on mid-dorsum may be broader but generally confined to mid-dorsal areas (as illustrated in Hamon and Williams, 1984), and in older specimens the whole dorsum may become sclerotized.

Margin. Marginal setae (mset) sharply spinose, straight, each 20-60 µm long, arranged in a single row, with 8-12 (11) on each side between anterior and posterior stigmatic areas. Stigmatic clefts very shallow or absent, each with 1 stigmatic spine (stgsp) per stigmatic area, each sharply spinose and 68-90 µm long. Eyes not detected.

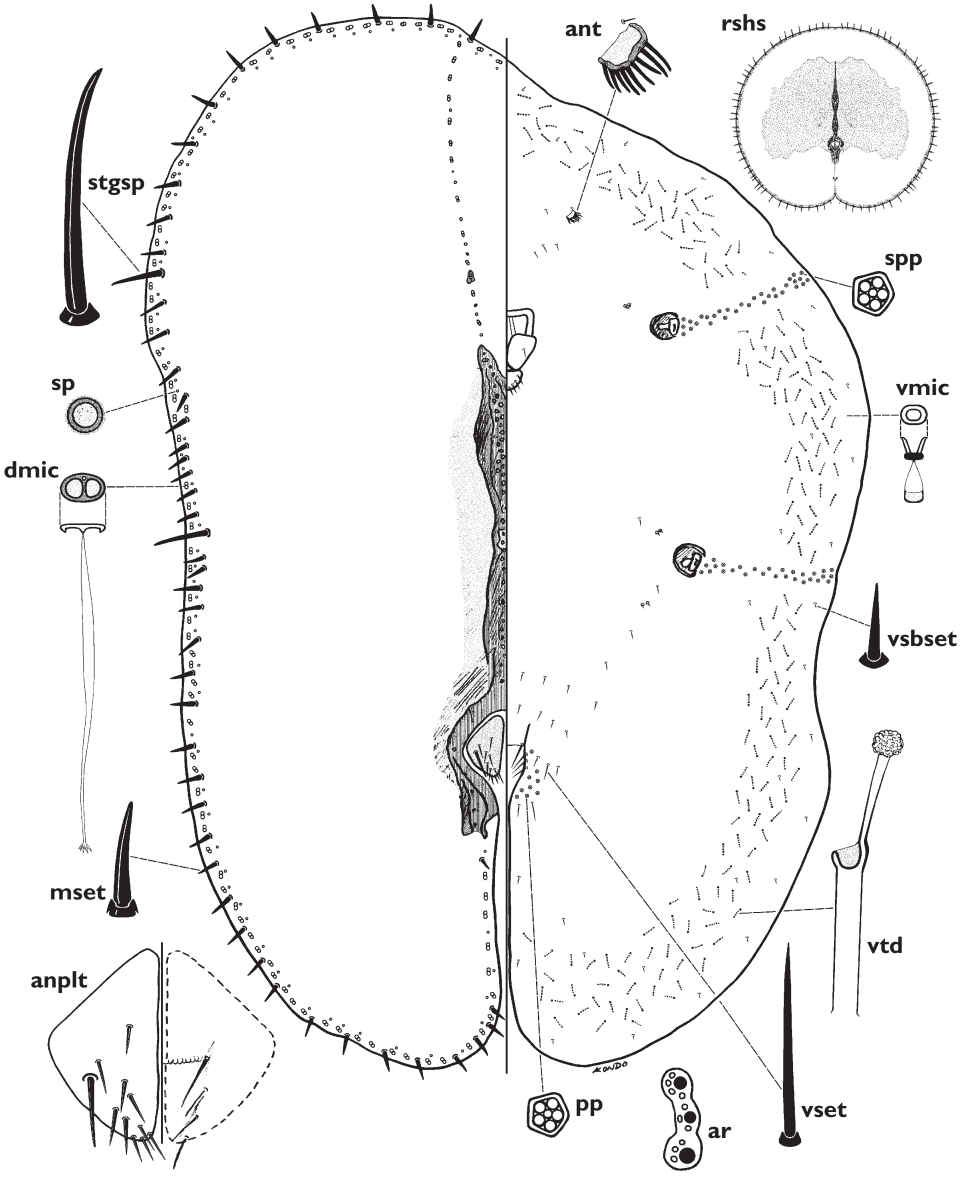

Fig. 2. *Pseudokermes vitreus* (Cockerell), adult female. Abbreviations of enlargements: anplt = anal plate; ant = antenna; ar = anal ring; dmic = dorsal microduct; mset = marginal setae; rshs = round-shaped specimen; sp = simple pore; pp = perivulvar pore; spp = spiracular pore; stgsp = stigmatic spine; vmic = ventral microduct; vset = ventral setae; vsbset = ventral submarginal setae; vtd = ventral tubular duct.

Venter. Derm entirely membranous. Perivulvar pores (pp) each 3-5 µm wide, with 5 loculi, restricted to a small area on either side of anal opening. Spiracular pores (spp) each 3-5 (4) µm wide, with 5 loculi, present in a narrow band as wide as peritreme (about 1 or 3 pores wide), extending laterally from each spiracle to body margin. Ventral microducts (vmic) scarce, scattered evenly throughout, each about 2 µm wide. Ventral tubular ducts present submarginally around body, absent elsewhere; each tubular duct with a terminal filament ending in a small flower-shaped gland. Ventral setae slender, scarce, straight or slightly bent, each 5-35 µm long, longest setae present just anterior of the vulva. Spiracles rather small, anterior spiracular peritremes each 28-43 (40) µm wide, posterior peritremes each 30-45 (45) µm wide, with a conspicuous sclerotization around each spiracle. Legs vestigial, represented by a pair of short setae, each seta about 3 µm long, hard to detect. Antennae (ant) very small, each 8-15 (13) µm long, 1 segmented, with about 9 setae. With about 6 interantennal setae, each interantennal setae 7-10 µm long. Mouthparts relatively small, clypeolabral shield 100-120 (120) µm wide; labium 1 segmented, with 4 pairs of labial setae.

Diagnosis. The adult female of *P. vitreus* can be diagnosed by the combination of the following features: (1) insect in life covered in a glassy wax cover; (2) mid-dorsal line becoming sclerotized, often with margins also becoming sclerotized; (3) dorsal setae completely absent; (4) dorsal tubercles and dorsal tubular ducts absent; (5) stigmatic setae sharply spinose, one per stigmatic cleft; (6) antennae greatly reduced, one segmented; (7) legs vestigial, represented by a pair of very short setae; (8) ventral tubular ducts in a submarginal band, absent elsewhere; (9) spiracular pores in a narrow band, present in a line from each stigmatic margin towards each spiracular peritreme; and (10) perivulvar pores present in a small group around vulva.

Morphological variation. The specimens from Costa Rica and Florida had longer marginal setae (around 55 µm on specimens from those locations versus approximately 30 µm on specimens from elsewhere). Compared to the type material, in the specimens from Barbados, Brazil, and the Dominican Republic, the spiracular pore band becomes broader near the margin. This is, no doubt, in part due to the large size of the latter specimens. On the lectotype, a tight band of ca. 30 spiracular pores extends from each spiracle to the body margin. The Florida specimen has ca. 15 spiracular pores in a band from spiracle to margin. The margins of the insect are often as sclerotic as its midline. According to Dr Chris Hodgson (pers. comm.), specimens found on the leaves are often wider than long; older specimens can be entirely sclerotized dorsally, and often have a wide submarginal band of quite large areolations. Specimens found on twigs, including, the type material, are generally longer than wide (pers. obs.).

Biology. The insects can be found on twigs and on leaves, with specimens on twigs being often associated with tending ants (T. Kondo, personal observation). Cockerell (1894) reported a specimen infested by a hymenopterous parasite.

Distribution [adapted from Ben-Dov et al. 2006; new host records indicated by an asterisk, see material studied or notes within parentheses "( )"].*Argentina (as *P. correntinus* in Granara de Willink 1999), *Barbados, *Costa Rica, Brazil, Colombia, Cuba, Dominican Republic, *Jamaica, Panama, Puerto Rico, Trinidad, U.S.A. (California, Florida) and *Venezuela. Also known from the Galapagos Island (C. Hodgson, pers. comm.).

Host plants [adapted from Ben-Dov et al. 2006; new host records indicated by double asterisk, see material studied or notes within parentheses "( )"]. **Annonaceae:** **Annona* sp., *Rollinia mucosa*; **Lauraceae:** *Laurus nobilis*, *Persea borbonia*; **Fabaceae:** *Acacia* sp., ***Cajanus indicus*, *Calliandra* sp., ***Pithecellobium dulce*; **Myricaceae:** *Myrica cerifera*; ****Orchidaceae;** ****Thymelaeaceae; Vitaceae:** *Vitis vinifera* (for *P. correntinus* in Granara de Willink 1999). In the Galapagos Island, the insect has been collected on *Annona cherimola* (Annonaceae), and on *Inga* sp. (Fabaceae) (C. Hodgson, personal communication).

Taxonomic notes. The specific epithet "*vitrea*" is amended to "*vitreus*" in order to match the gender of the genus "*Pseudokermes*".

In the descriptions of *Pseudokermes* spp. by Hodgson (1994) and Granara de Willink (1999), all species are described as having preopercular pores. In younger specimens of *P. vitreus*, the area anterior to the anal plates clearly shows no preopercular pores, but instead there is a mid-dorsal line of bilocular microducts associated with simple pores in the same way that they are present around the body margin. In older specimens, a linear area anterior to the anal plates becomes sclerotized up to level dorsad to mouthparts, and at this point, the structure of the bilocular microducts and simple pores become unrecognizable. Thicker areolations are formed on this sclerotized area (Fig. 2), giving the dorsal microducts and simple pores the appearance of preopercular pores. It is possible that this may be the same situation observed in other species of *Pseudokermes*. However, this will only be confirmed by observing teneral adult females, and further studies are needed to test whether this may be the case in species of *Pseudokermes* in general.

Pseudokermes vitreus appears similar to *P. nitens* (as described by Hodgson 1994), but the two differ in the following features (character states of *P. nitens* in parentheses): (1) spiracular pores present in a line extending from stigmatic areas to spiracles (spiracular pores present in a small group around stigmatic area only and not extending towards spiracle); (2) ventral tubular ducts restricted to a submarginal band (ventral tubular ducts present in a submarginal band with a few present also around mouthparts); and (3) perivulvar pores restricted to a small group around vulva (perivulvar pores present around vulva with some pores also present posteriorly on submedial areas of posterior abdominal segments).

The morphological features of *P. correntinus* Granara de Willink are almost identical to those of *P. vitreus* and thus *P. correntinus* is considered here to be junior synonym. All measurements and morphological features of *P. correntinus* agree with the description of *P. vitreus*, including the distribution of the spiracular pores, absence of ventral tubular ducts around the mouthparts, number of setae in the anal plates, and the length of marginal and stigmatic setae. Granara de Willink (1999) considered the antennae of *P. correntinus* to be composed of two segments, however, she also counted two segments in *P. eugenium* [Hodgson's (1994) *P. nitens* according to Granara de Willink (1999)] for which species Hodgson (1994) only counted one antennal segment. Furthermore, in *P. vitreus* there exists a single seta at the base of the one-segmented antennae and, in *P. correntinus,* Granara de Willink (1999) counted this seta as part of the first segment. The apparent difference in the number of antennal segments may be due to differences in interpretation. The legs in *P. vitreus* are vestigial, and represented by a pair of very short setae (each 3 µm long) and are not easy to detect. Indeed, Hamon and Williams (1984) in their redescription of the species considered the legs to be absent, but in their illustration showed a seta at the position of each leg.

Discussion

The type species of *Pseudokermes*, *P. nitens* was redescribed by Hodgson (1994) based on non-type material from Argentina and Brazil. Hodgson (1994) considered the material he studied to be conspecific with the type material and gave the following differences between his redescription and the original description of Cockerell (1895b): (1) Cockerell (1895b) considered that the antennae and legs in *P. nitens* were absent but they were present though minute, and (2) the length of the posterior margin of the anal plates was longer than that of the anterior margin in his redescription (*vice versa* in Cockerell's description). Hodgson (1994) also indicated that the material he studied from San Paulo, Brazil, differed from the original description in having more spiracular pores.

Granara de Willink (1999) described three new species from Argentina and considered that Hodgson's (1994) redescription of *P. nitens*, based on material collected in Misiones, Argentina, corresponded to her newly described species, *P. eugenium*. Granara de Willink (1999) did not examine the type material of *P. nitens* and based her decisions entirely on the original description by Cockerell (1985b) and a redescription of the species by Hempel (1900). Granara de Willink (1999) stated that, because Cockerell and Hempel had not mentioned the presence of differentiated stigmatic spines in their descriptions of *P. nitens* which are present on the species from Argentina, she assumed that *P. nitens* does not have differentiated stigmatic spines, and thus decided that none of the Argentinean species where conspecific with *P. nitens*. Granara de Willink (1999) also indicated that *P. nitens* does not occur in Argentina because all the material she studied from Argentina has reduced antennae, traces of legs and undifferentiated stigmatic setae (antennae and legs described as absent, and stigmatic spines not mentioned by either Cockerell (1895b) or Hempel (1900)). Microscopes in the early 1900's were not as powerful as those available at present, and on many occasions reduced morphological features were not observed by earlier coccidologists, including T. D. A. Cockerell. The legs in all species studied by Granara de Willink (1999) are greatly reduced and are represented by either a small sclerotization or a tiny claw with digitules. With the microscopes available in the late 1800's and early 1900's, it would have been very difficult to see such reduced features, which may have gone undetected. For example, Cockerell (1902) describes *Akermes colimae* Cockerell [now *Aztecalecanium colimae* (Cockerell)] as having no antennae and legs; however, a recent redescription by Kondo and Williams (2004) of this species clearly shows a pair of reduced antennae and small legs with all their segments (coxa, trochanter, femur, tibia, tarsus and claw). Thus, it is critical to compare the type material of *P. nitens* and *P. eugenium* in order to determine if they are conspecific.

As a result of this study, the composition of the genus *Pseudokermes* is changed to include 8 species: *P. armatus*, *P cooleyi*, *P. eugenium*, *P. geoffroeum*, *P. marginatus*, *P. nitens*, *P. palmae* and *P. vitreus*. *Pseudokermes* may include more synonyms because of the lack of studies based on type material. Furthermore, it is doubtful whether all species currently included in *Pseudokermes* are congeneric with the type species of the genus, *P. nitens*, and further studies are needed in order to elucidate their relationships.

Acknowledgements

The authors thank Dr Douglass R. Miller for the loan of specimens. Thanks also to Dr Penny Gullan and Dr Chris Hodgson for reviewing this manuscript. Special thanks to Dr Lyubomir Penev for making possible the publication of this study. This work was supported in part by grant DEB-0118718 from the National Science Foundation (Partnerships in Enhancing Expertise in Taxonomy program) to Penny Gullan.

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ZooKeys 3: 23-28 (2008)
doi: 10.3897/zookeys.3.24
www.pensoftonline.net/zookeys

RESEARCH ARTICLE

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A taxonomic study on the genus *Japananus* Ball (Hemiptera, Cicadellidae, Deltocephalinae), with description of one new species from China

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Academic editor: *Michael Wilson* | Received 6 September 2008 | Accepted 22 October 2008 | Published 27 October 2008

urn:lsid:zoobank.org:pub:5E7A9396-5294-4047-94FE-375DABA938DC

Citation: Xing J, Dai R, Li Z (2008) A taxonomic study on the genus *Japananus* Ball (Hemiptera, Cicadellidae, Deltocephalinae), with description of one new species from China. ZooKeys 3: 23-28. doi: 10.3897/zookeys.3.24

Abstract

The paper deals with four species of the genus *Japananus* Ball, 1931 (Hemiptera, Cicadellidae, Deltocephalinae), including one new species from Sichuan Province, China, *Japananus bicurvatus* **sp. nov.** A key is given to distinguish all species of the genus, and illustrations of genitalia are provided. The type specimens of the new species are deposited in the Institute of Entomology, Guizhou University (IEGU).

Keywords

Hemiptera, Deltocephalinae, Scaphytopiini, *Japananus*, new species, taxonomy, China

Introduction

The leafhopper genus *Japananus* (Hemiptera, Cicadellidae, Deltocephalinae, Scaphytopiini), was established by Ball (1931) for a single species, *Platymetopius hyalinus* Osborn, 1900. Later, Oman (1931) placed *Platymetopius cinctus* Matsumura as a junior synonym of *Platymetopius hyalinus* and Ball (1931) proposed the new combination *Japananus aceri* (Matsumura). Recently Viraktamath and Anantha Murthy (1999) described a third species, *Japananus nepalicus*, from Nepal.

In this paper, a new species is described and illustrated from Sichuan Province, China. The type specimens of new species are deposited in the Institute of Entomology, Guizhou University, Guiyang, Guizhou (IEGU). The genus *Japananus* now contains four species. A key is given to separate all species.

Japananus Ball

urn:lsid:zoobank.org:act:D338AE42-A083-4E5C-AEEE-7397F5BD1C98
Japananus Ball, 1931: 218. Type species: *Platymetopius hyalinus* Osborn, 1900.
urn:lsid:zoobank.org:author:D2163044-9C2C-43EF-A348-FA1F2F4818EA
urn:lsid:zoobank.org:pub:6B44547E-8C0E-4915-9832-ABDD969D844A

Description. Light green species, often with transverse brown bands on hyaline fore wings. Head conically produced in front, narrower than pronotum. Vertex medially depressed, transition between face and vertex angular, carinate, at least apically, disc shagreened. Face shagreened, frontoclypeus widened posteriorly, about twice as wide at bases of antennae as at apex, coronal sulci laterally divergent abruptly slightly beyond bases of antennae. Clypellus widened apically, extending beyond normal curve of genae. Fore wings hyaline, 3.0-3.4 times as long as wide, claval veins either fused in middle or connected by a cross vein; outer anteapical cell quadrangular, smaller than median anteapical cell, costal area without reflexed veins. Hind basitarsus with four platellae.

Male pygophore slightly longer than high, devoid of processes, with a few stout setae along ventro-caudal margin, ventral margin rather expanded. Tenth segment short, without processes. Subgenital plate with a caudal attenuated process, without stout setae. Style slender, elongate, with short finger-like apophysis, apex curved laterally. Connective slender, elongate, Y-shaped. Aedeagus with paired shafts, U-shaped in ventral view, each shaft with a subapical process. Gonopore opening adjacent base of subapical processes.

Size. Length (including tegmen): 4.3-5.5 mm.

Remarks. *Japananus* resembles *Afrascius*, Linnavuori, 1969 from the Afrotropical region. Both share a rather modified Y-shaped connective and similar subapical process on the paired shafts. However, *Japananus* lacks the anal collar process possessed by *Afrascius*, and the subgenital plates in *Japananus* have a caudal attenuated process while *Afrascius* has caudally truncate subgenital plates (Viraktamath and Anantha Murthy, 1999).

Distribution. Australian Region, Nearctic Region, Palaearctic Region, Oriental Region.

Key to species (♂) of *Japananus*

1. Subapical process of aedeagal shafts forked (Fig. 3) .... *nepalicus*
– Subapical process of aedeagal shafts not forked (Figs 1, 2, 8, 9) 2
2. Subapical process of aedeagal shafts straight and robust, with apices directed mediad (Fig. 2) .... *aceri*
– Subapical process of aedeagal shafts sinuate and delicate (Figs 1, 8, 9) 3
3. Apices of aedeagal shafts strongly developed, straight (Fig. 1) .... *hyalinus*
– Apices of aedeagal shafts weakly developed, curved (Figs 8, 9) .... *bicurvatus* sp. nov.

Japananus hyalinus (Osborn)

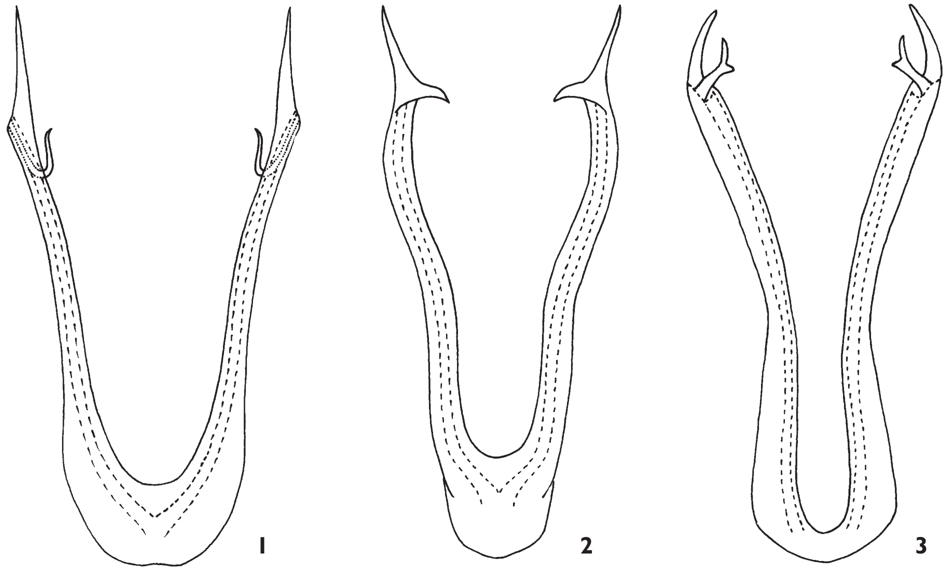
Platymetopius hyalinus Osborn, 1900: 501.
Platymetopius cinctus Matsumura, 1914: 215, synonymized by Oman 1931: 430.
Japananus hyalinus (Osborn), Ball 1931: 218.
Fig. 1

Distribution. Japan, China, India, Korea, Australia, Columbia, NSW, USA, Hokkaido, Honshu, Tokyo, Satsuma, New Zealand, Europe, Transcaucasia.

Material examined. China: 4♂♂,3♀♀, Guizhou Prov., Guiyang City, Huaxi, 2 June 2008, coll. Jichun Xing (IEGU); 1♂, Liaoning Prov., Dalian City, Ganjingzi Park, 9 August 2008, coll. Lin Ni (IEGU).

Discussion. The distribution of this species in the Oriental Region, Australian Region, Nearctic Region and Palaearctic Region. This species, first described from the USA (Osborn, 1900), is apparently native to Japan (Sanders and DeLong, 1920), from which it was introduced to North America with nursery stock of Japanese maples. It was subsequently (Matsumura, 1914) also described from Japan. It's a known host plants are maples, other plants have not collected this specimen. This species in western Europe seems to be confined to parks where 'Japanese maples' (*Acer palmatum*) are planted. The distribution of this species may be related to its host plants.

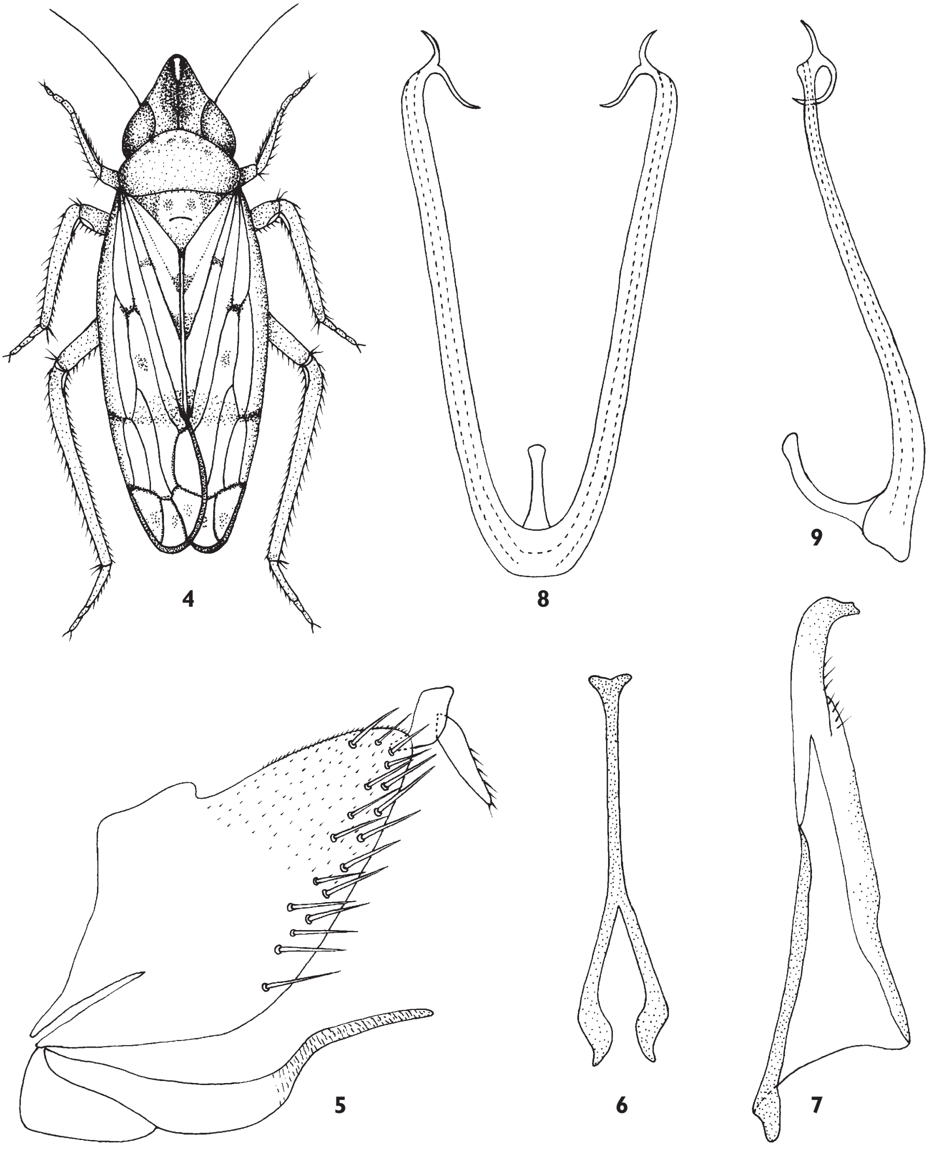
Known hosts. Maple, Aceraceae (*Acer palmatum*, *Acer buergerianum*, *Acer truncatum*).



Figs 1-3. Aedeagus of *Japananus* species, ventral view. 1. ***Japananus hyalinus*** (Osborn); 2. ***Japananus aceri*** (Matsumura) (after Anufriev and Emeljanov, 1988); 3. ***Japananus nepalicus*** Viraktamath and Anantha Murthy (after Viraktamath and Anantha Murthy, 1999).

***Japananus aceri* (Matsumura)**
Platymetopius aceri Matsumura, 1914: 216.
Japananus aceri (Matsumura), Ball 1931: 218.
Fig. 2

Distribution. Japan, Korea, China.
Known hosts. Maple.



Figs 4-9. ***Japananus bicurvatus* sp. nov.** 4. Adult, dorsal view; 5. Male pygofer side, Valve and subgenital plate, lateral view; 6. Connective; 7. Style, dorsal view; 8. Aedeagus, ventral view; 9. Aedeagus, lateral view.

Japananus nepalicus **Viraktamath & Anantha Murthy**

Japananus nepalicus Viraktamath & Anantha Murthy, 1999: 44
Fig. 3

Distribution. Nepal.
Known hosts. Unknown.

Japananus bicurvatus **Xing, Dai et Li, new species**

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Figs 4-9

Description. Color and external features as in generic description. Male genitalia: pygophore lobe with a few stout setae along ventro-caudal margin (Fig. 5). Valve large, subtriangular Subgenital plate with a caudal attenuated process. Style long, with strongly laterally curved caudal apex of apophysis (Fig. 7). Connective Y-shaped with arms shorter than stem (Fig. 6). Aedeagus shafts U-shaped in ventral view, shafts with a delicate sinuate subapical processes (Figs 8, 9); gonopore apical.

Measurement. Length (including tegmen): ♂, 4.5-4.7 mm; ♀, 4.7-4.9 mm.

Type Material. Holotype ♂, China: Sichuan Prov., Shuimogou (32° 52' N, 105° 59' E), 17 August 2008, coll. Jichun Xing (IEGU). Paratypes: 2♂♂3♀♀, same data as holotype.

Known hosts. *Acer palmatum*.

Remarks. This species is similar to *Japananus hyalinus* (Osborn) but can be distinguished by the the shape of the aedeagal shafts in ventral view and shape of their processes.

Etymology. The species name is derived from the Latin words *bi* and *curvatus*, indicating that the apical and subapical processes of aedeagal shafts are curved.

Acknowledgements

We thanks two anonymous reviewers and the editors of ZooKeys for reading the manuscript and making some suggestions.The project was supported by the Natural Science Foundation of China (30270176).

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ZooKeys 3: 29-50 (2008)
doi: 10.3897/zookeys.3.26
www.pensoftonline.net/zookeys

RESEARCH ARTICLE

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On two closely related species of the *Xiphinema americanum*-group: *X. simile* Lamberti, Choleva et Agostinelli, 1983 and *X. parasimile* Barsi et Lamberti, 2004 (Longidoridae), with a description of the male of *X. parasimile*

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Academic editor: *Sergei Subbotin* | Received 12 September 2008 | Accepted 21 October 2008 | Published 27 October 2008

Citation: Lazarova SS, De Luca F, Peneva VK (2008) On two closely related species of the *Xiphinema americanum*-group: *X. simile* Lamberti, Choleva et Agostinelli, 1983 and *X. parasimile* Barsi et Lamberti, 2004 (Longidoridae), with a description of the male of *X. parasimile*. ZooKeys 3: 29-50. doi: 10.3897/zookeys.3.26

Abstract

Several populations of *Xiphinema simile* Lamberti, Choleva et Agostinelli, 1983 and two of *X. parasimile* Barsi et Lamberti, 2004, originating from various habitats – natural and man-made, have been studied. *Xiphinema simile* was associated both with cultivated and naturally growing plants, while *X. parasimile* was recovered from soil around grapevine. Data on the morphological and biometrical characteristics (including juvenile stages) are presented and variations discussed. Pharyngeal bulbus and glandularium length, vaginal and uterine characteristics were shown to be good differentiating characters. This report of *X. parasimile* is a new record for Bulgaria as well as a new plant association for the species. The description of its male is provided for the first time. The Bulgarian population of *X. parasimile* showed the same pattern as the Serbian population revealed by the RFLP analyses of D1-D2 region.

Keywords

Bulgaria, Longidoridae, male description, morphology, new record, RFLP, D1-D2 region

Introduction

The present study is focused on the morphology and distribution of two closely related species of the *Xiphinema americanum* lineage from Bulgaria – *Xiphinema simile*

Lamberti, Choleva et Agostinelli, 1983 and *X. parasimile* Barsi et Lamberti, 2004. *Xiphinema simile* has been originally described from Bulgaria in association with poplar, grapevine, fruit-trees, black current (Lamberti et al. 1983), and subsequently has been reported from forest nurseries (Peneva and Choleva 1992). In Europe, the species has been found in various habitats: forests and grasslands in former Yugoslavia (Barsi 1994, Barsi and Lamberti 2002), hornbeam tree, maize and field maple in Serbia, and dogwood shrubs in Bosnia and Herzegovina (Barsi and Lamberti 2004, Barsi and De Luca 2008); grapevine, fruit and nut trees, and raspberries in Slovakia (Lišková et al. 1993, Lišková 1995, Lišková and Brown 1996, Lamberti et al. 1999); orchards in Czech Republic (Kumari 2006); various plants in Hungary (fruit trees, grapevine, birch, wild rose and Elsbeere tree) (Repasi et al. 2008). Outside Europe *X. simile* has been reported from Kenya in the rhizosphere of pepper and baobab trees, and riverine forest (Coomans and Heyns 1997).

Xiphinema parasimile was described from forest habitats in Serbia, in association with woody plants (*Quercus* sp. and *Carpinus betulus* L., Barsi and Lamberti 2004). In morphology and morphometrics it showed highest similarity to populations of *X. simile*, with differences in lip region and tail shape, however the authors underlined that both species can be thoroughly differentiated by the number of juvenile stages (four *vs* three).

Materials and methods

Soil samples were collected from different habitats representing various ecosystem types in Bulgaria. Nematodes were extracted from 200 cm^3 soil by a sieving and decanting technique, heat killed at 60°C for two minutes and fixed in a 4% formaldehyde solution. For morphological studies nematodes were processed to anhydrous glycerol and mounted on permanent microscopic glass slides (Seinhorst 1959). Additionally, live specimens were fixed in 1M NaCl for molecular studies. PCR amplification of *X. parasimile* D1-D2 domains of the 26S rDNA was carried out by using the primers FOR and REV as described in De Luca et al. (2004). The RFLP analyses of the D1-D2 region were performed using the following enzymes *Alu* I, *Ava* II, *Dde* I, *Nde* II, *Pst* I and *Rsa* I according to De Luca et al. (2004).

Drawings and photographs were taken using an Olympus BX51 compound microscope powered with differential interference contrast (DIC). Images were taken with a ColorView IIIu camera and cell^P software (Olympus Soft Imaging Solutions Gmbh). Measurements were made using an Olympus BX 41 light microscope, a digitising tablet (CalComp Drawing Board III, GTCO CalCom Peripherals, Scottsdale, AZ, USA), and computer Digitrak 1.0f programme, (Philip Smith, Scottish Crop Research Institute, Dundee, UK).

Results

Xiphinema parasimile represents the first record since its original description (Barsi and Lamberti 2004) and were recovered from two locations: 1) in North-Central (near village of Orlyane (**Or**)) and 2) in South-Central (near village of Vinogradets (**Vi**)) Bulgaria. Both populations were found in the rhizosphere of grapevine which is a new plant association. *Xiphinema simile* was recovered from five locations of North Bulgaria in association with different plants: cherry plum grove (*Prunus cerasifera* Ehrh., Kalimok – Brashlen (**KB**) protected area, along Danube river), abandoned vineyard (*Vitis vinifera* L.*,* near village of Orlyane (**Or**)), around oak trees in a mixed broadleaved forest (*Quercus pedunculiflora* C. Koch, Srebarna Reserve (**SR**) along Danube river) and in the rhizosphere of grasses (Kamen bryag (**Kb**), and Kaliakra areas (**Ka**), Black Sea Coast).

Xiphinema parasimile Barsi et Lamberti, 2004

(Figs 1; 2A, D, F, I-K, N, P, T; 3A-C; 4A-E; 5A-C; 6-8)

Measurements. See Tables 1-3;

Description. *Females.* Body C to spiral shaped. Labial region 4-5 µm high, set-off from the rest of the body. Amphids hardly visible, its opening 4 µm in a paratype specimen (40 % of the corresponding body width); 5-5.5 µm wide in specimens from Vinogradets and Orlyane (50-64 %). Odontostyle with poorly developed basal collar. Pharyngeal characters presented in Table 2. Reproductive system amphidelphic, symbiont bacteria present in the ovaries. Uteri short, ovejector and separate uteri present (Table 3); vagina 41.5 -52.2% of the corresponding body width (averages 48.4±1.4, n=5, paratype material; 46.4±3.4, n=17, **Vi**; 46.8±1.4, n=7, **Or**). Sperm cells observed in some of the females from Vinogradets. Tail conical, dorsally convex, ventrally almost straight or slightly concave with pointed terminus.

Male. One specimen was found in Vinogradets population. Male similar to the female with posterior region more strongly curved. Lip region and tail shape as in females, a difference was observed within anal body width, which reflect the lower **c'** value. Spicules slightly curved, lateral guiding piece 4 µm long. Adanal supplement pair preceded by a row of five irregularly spaced supplements. Tail conoid, ventrally straight, dorsally convex with pointed terminus.

Juveniles. The scatter diagram based on functional and replacement odontostyle, and body length revealed presence of four juvenile stages (Fig. 7).

PCR-RFLP analysis. The amplification of the D1-D2 expansion domains of *X. parasimile* generated a unique band of about 0.8 kb. The restriction fragments of the amplified region of *X. parasimile* population from Vinogradets locality using several enzymes are presented in Fig. 8.

Remarks. Metric data are within the ranges reported in the original description, with slightly lower average values for the female body length (1.78-1.82 *vs* 1.93-1.99

Table 1. Morphometrics of *Xiphinema parasimile* from two localities in Bulgaria. All measurements in micrometres, except body length and ratios, and in form: mean ± standard deviation (range).

Locality Host plant	Orlyane *Vitis vinifera*	Vinogradets *Vitis vinifera*					
	Females	Females	Male	J1	J2	J3	J4
Character	n=11	n=18	n=1	n=4	n=6	n=8	n=10
L (mm)	1.78 ± 0.11 (1.56 - 1.94)	1.82 ± 0.11 (1.66 - 2.04)	1.84	0.68 ± 0.01 (0.67 – 0.70)	0.89 ± 0.09 (0.83 – 1.07)	1.09 ± 0.09 (0.96 – 1.23)	1.45 ± 0.07 (1.35 – 1.54)
a	65.7 ± 2.71 (61.0 - 69.2)	68.8 ± 3.04 (64.0 - 75.9)	71.8	40.8 ± 2.18 (39.0 – 43.7)	47.7 ± 3.08 (45.6 – 53.6)	53.2 ± 2.02 (50.8 – 57.2)	61.9 ± 2.65 (57.8 – 65.5)
b	6.6 ± 0.76 (5.4 - 7.5)	7.3 ± 0.76 (5.3 - 8.3)	6.2	4.5 ± 0.42 (4.1 – 4.9)	5.1 ± 0.48 (4.7 – 5.9)	5.1 ± 0.44 (4.4 – 5.7)	6.4 ± 0.59 (5.1 – 7.0)
c	56.7 ± 2.32 (53.0 - 58.9)	60.5 ± 5.74 (52.3 - 71.2)	64.0	25.3	28.3 ± 1.59 (25.9 – 30.1)	35.7 ± 3.08 (31.9 – 40.4)	46.2 ± 3.31 (40.2 – 52.8)
c’	2.0 ± 0.05 (2.0 - 2.1)	2.0 ± 0.15 (1.7 - 2.3)	1.6	2.54	2.4 ± 0.48 (1.5 – 2.6)	2.4 ± 0.20 (2.1 – 2.6)	2.1 ± 0.11 (2.0 – 2.3)
V (%)	55.4 ± 1.38 (53 - 58)	54.5 ± 1.61 (50.5 – 56)	-	-	-	-	-
Odontostyle	68.9 ± 2.51 (63 - 72)	69.6 ± 1.91 (66 - 74)	72	35.9 ± 0.66 (35 – 37)	42.5 ± 2.47 (40 – 49)	52.2 ± 1.72 (50 – 55)	59.3 ± 1.95 (55 – 62)
Odontophore	38.0 ± 1.31 (36 - 40.5)	37.5 ± 0.87 (36 - 39)	37.5	23.0 ± 1.27 (22 – 24)	30.2 ± 1.52 (28 – 32.5)	31.9 ± 1.39 (30 – 34)	36.2 ± 1.55 (34 – 38.5)
Replacement odontostyle	-	-	-	41.1 ± 2.41 (38.5 – 44)	52.3 ± 1.71 (50 – 55)	60.8 ± 1.42 (59 – 64)	69.2 ± 2.19 (65 – 73)

Locality Host plant	Orlyane *Vitis vinifera*	Vinogradets *Vitis vinifera*					
	Females	Females	Male	J1	J2	J3	J4
Character	n=11	n=18	n=1	n=4	n=6	n=8	n=10
Oral aperture to guide ring	61.6 ± 1.37 (60 - 63.5)	59.8 ± 2.78 (55.5 - 62)	63	30.1 ± 0.47 (30 – 30.5)	35.9 ± 1.75 (33 – 38)	44.1 ± 2.41 (40 – 48)	52.4 ± 1.38 (51 – 55)
Tail	32.2 ± 1.8 (30 – 35	30.3 ± 1.63 (27 – 34)	29	26.7	29.8 ± 1.64 (28 – 33)	30.1 ± 2.03 (28 – 33)	31.4 ± 1.68 (29 – 34)
h (hyaline portion of tail)	7.9 ± 0.46 (7 - 8)	6.9 ± 0.85 (6 - 9)	7	3.2 ± 0.35 (3 – 4)	4.6 ± 0.83 (4 – 6)	4.4 ± 0.50 (4 – 5)	5.3 ± 0.54 (4 – 6)
Body diameter at lip region	8.8 ± 0.35 (8 - 9)	8.7 ± 0.38 (8 – 9)	8.5	6.8 ± 0.25 (6.6 – 7.2)	7.4 ± 0.48 (7 – 8)	7.7 ± 0.37 (7 – 8.5)	8.3 ± 0.21 (8 – 8.5)
Body diameter at guide ring	18.8 ± 0.82 (17 - 20)	19.3 ± 0.64 (18 - 20)	20	12.1 ± 0.97 (11 – 13)	13.9 ± 0.69 (13 – 15	15.1 ± 0.88 (14 – 16)	17.4 ± 0.50 (16 – 18)
Body diameter at pharyngeal base	24.1 ± 1.03 (22 - 26)	23.3 ± 0.80 (22 - 24)	24	15.3 ± 0.30 (15 – 16)	17.3 ± 1.23 (15.5 – 19)	19.0 ± 1.34 (17 – 20.5)	21.7 ± 0.94 (20 – 23)
Body diameter at mid-body	27.1 ± 1.52 (25 – 30)	26.5 ± 1.27 (23 - 29)	26	16.7 ± 1.03 (15.5 – 18)	18.5 ± 0.73 (18 – 20)	20.4 ± 1.56 (18 – 22)	23.4 ± 1.45 (21 – 26)
Body diameter at anus	15.5 ± 0.81 (15 - 17)	15.3 ± 0.63 (14 - 17)	18	10.5	13.2 ± 3.27 (11 – 19)	12.7 ± 0.83 (12 – 14)	14.7 ± 0.80 (13.5 – 16)
Spicules	-	-	30	-	-	-	-

Table 2. Pharyngeal characters of *Xipinema parasimile* and *X. simile* females from different localities.

	Xipinema parasimile				*Xiphinema simile*	
Locality Character	Orlyane	Vinogradets	Ralja, Serbia Paratypes	Srebarna Reserve	Kalimok-Brashlen	Orlyane
	n=6	n=14	n=5	n=8	n=12	n=11
Pharynx length (µm)	266.7±28.9 (245-288)	250.5±21.0 (233-311) n=11	282.2±2.1 (260-310)	303.1±9.6 (293-320)	289.9±10.4 (273-310)	293.9±15.5 (273-316)
Bulbus length (µm)	62.0±2.1 (58-65)	59.8±3.5 (55.5-68)	61.6±4.8 (56-63)	80.2±1.3 (78-82)	83.0±3.4 (78-92)	84.2±5.7 (76-92)
Bulbus width (µm)	11.75±0.4 (11-12)	12.0±0.6 (11-13)	14.4±0.5 (14-15)	13.1±0.4 (12-14)	13.3±1.1 (12-15)	13.1±0.8 (12-14)
Bulbus length/ Pharynx length (%)	23.4±1.9 (20.3-25.6)	24.2±2.3 (19-28) n=11	21.8±0.7 (20.7-22.6)	27.5±1.1 (24.3-28.0)	28.6±1.4 (27.1-31.4)	28.9±1.1 (27.7-30.5)
DN* (%)	11.9, 12.5, 12.2	16.7±3.3 (13.6-18.6) n=8	16.5-17.7	15.6, 13.2, 15.8	15.4±1.9 (11.6-17.7) n=9	16.6±1.6 (13.4-18.4) n=7
DO* (%)		11.1, 13.6	11.6-14.6	?	9.6±1.7 (7.9-11.1), n=5	10.8±1.5 (7.7-12.1), n=7
SVN1* (%)	?	?	55.3-59.7	61.3	61.1	61.8, 59.2, 61.2
SVN2* (%)	?	?	57.3-60.1	64.1	62.2	61.8, 64.1
Glandularium** (µm)	55, 54, 51	49.9±1.4 (48-52) n=11	52.6±2.2 (52-56)	68.2±1.5 (67-71) n=6	71.4±3.0 (68-78)	71.9±4.4 (63-75) n=8
D** (%)	80.9, 78.2, 79.2	80.1±1.7 (77.4-83.6) n=8	81.3± 0.8 (80.0-82.1)	77.7±0.5 (77.2-78.2) n=6	75.5±1.2 (73.4-77.96)	75.5± 0.7 (74.3-76.6) n=7
AS1** (%)	?	?	47.1-51.2, n=4	39.3	53.5, 53.9	52.1, 51.9, 55.3
AS2** (%)	?	?	48.9-53.7, n=4	42.7	54.4, 55.3	52.1, 57.7

Terminology adopted by Loof and Coomans, 1972 * and Andrássy, 1998**

Table 3. Measurements of uteri, ovejector and vaginal parts. All measurements in micrometres presented as mean ± standard deviation (range).

	Characters Locality	Anterior uterus	Posterior uterus	Ovejector	Vagina length	*Pars distalis vaginae*	*Pars proximalis vaginae*
Xiphinema parasimile	Ralja, Trešna Serbia, paratypes	40.0±11.3 (27-46) n=3	-	-	14.5±1.05 (13-16) n=5	7.8±0.8 (7-8.5) n=3	8.75±0.3 (8.5-9) n=4
	Vinogradets	33.1±0.4 (30-38) n=13	31.2±0.7 (24-39) n=13	29.4±4.3 (26-33.5) n=10	14.5±1.7 (13-15) n=17	7.4±0.5 (7-8) n=15	7.4±0.5 (7-9) n=19
	Orlyane	32.3±4.2 (24-43) n=6	30.5±5.7 (24-38) n=6	26.8±2.1 (23-30) n=4	13.9±0.9 (13-15) n=7	7.0±1.4 (6-8) n=6	7.6±1.4 (7-8.5) n=7
Xiphinema simile	Srebarna	18.8±2.8 (14-21) n=6	18.5±2.4 (15-20) n=6	36.3±6.4 (29-41) n=3	14.8±1.3 (13-16) n=5	5.8±0.4 (5.5-6) n=8	9.5±0.9 (8.5-11) n=7
	Kalimok- Brashlen	21.8±1.9 (16.5-24) n=14	21.5±1.8 (19-24) n=14	43.1±3.1 (36.5-48) n=12	16.8±0.8 (15-18) n=15	6.4±0.65 (5.5-7) n=17	8.6±0.5 (8-10) n=17
	Orlyane	21.75±2.2 (17-24) n=7	22.1±2.3 (19-26) n=7	43.8±4.2 (36-50) n=7	16.9±1.1 (15-18) n=8	6.05±0.6 (5.5-7) n=11	9.05±0.8 (8-10) n=10
	Kamen bryag	23.0±4.8 (18-30) n=5	24.2±4.15 (19-30) n=5	47.2±8.9 (37-60) n=5	15.9±1.8 (13-17) n=5	6.4±0.6 (6-7) n=5	9.8±0.8 (9-10) n=5

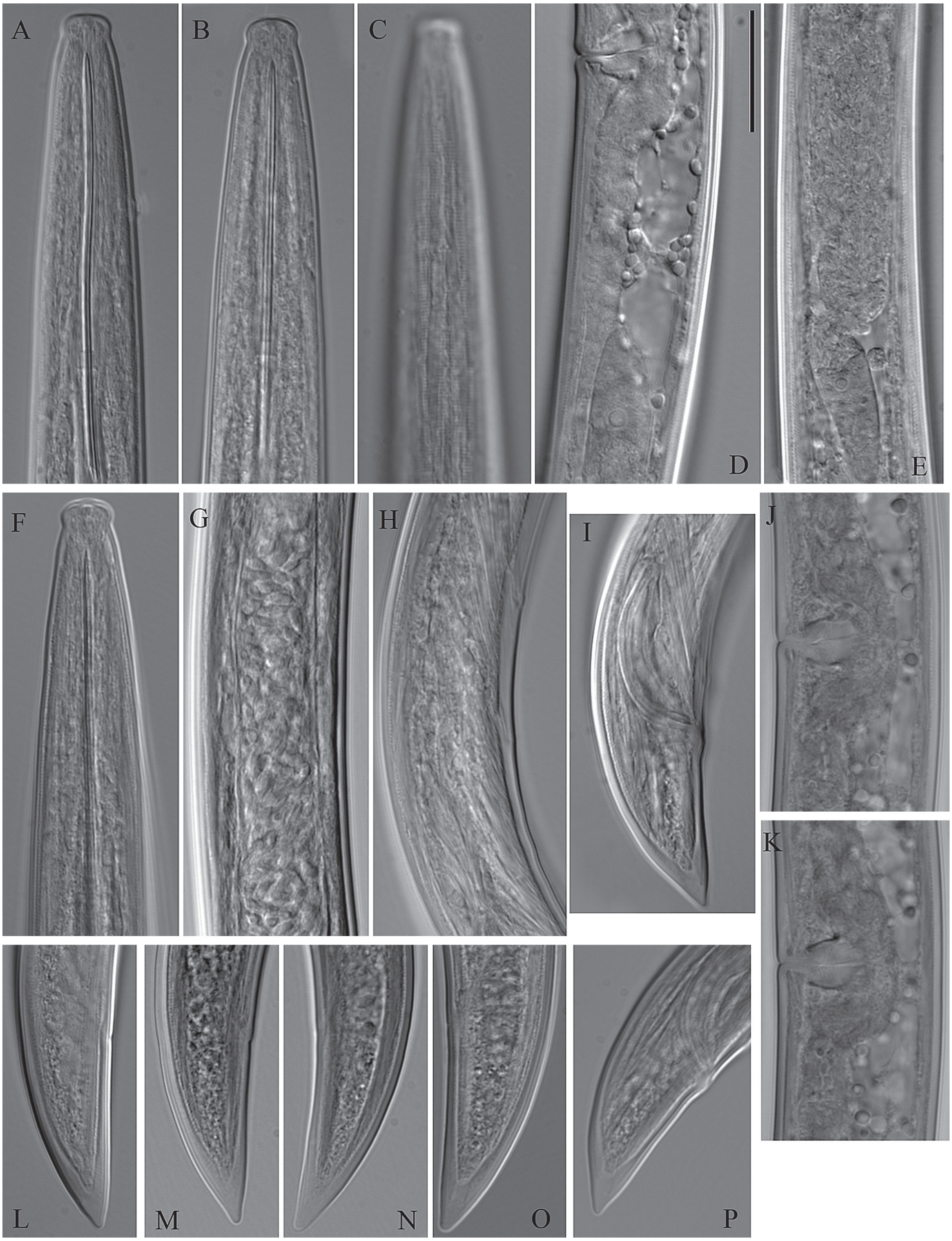

Fig. 1. *Xiphinema parasimile* Barsi et Lamberti, 2004. *Female*: A-C, Anterior region; D, Part of posterior genital branch; E, Posterior ovary; J, K, Vaginal region – different optical sections; L-O, Variation in tail shape; *Male*: F, Anterior end; G, Testis with sperm; H, Posterior end – muscles and supplements; I, Tail and copulatory apparatus; P, Tail. *Scale bar*: 20 μm.

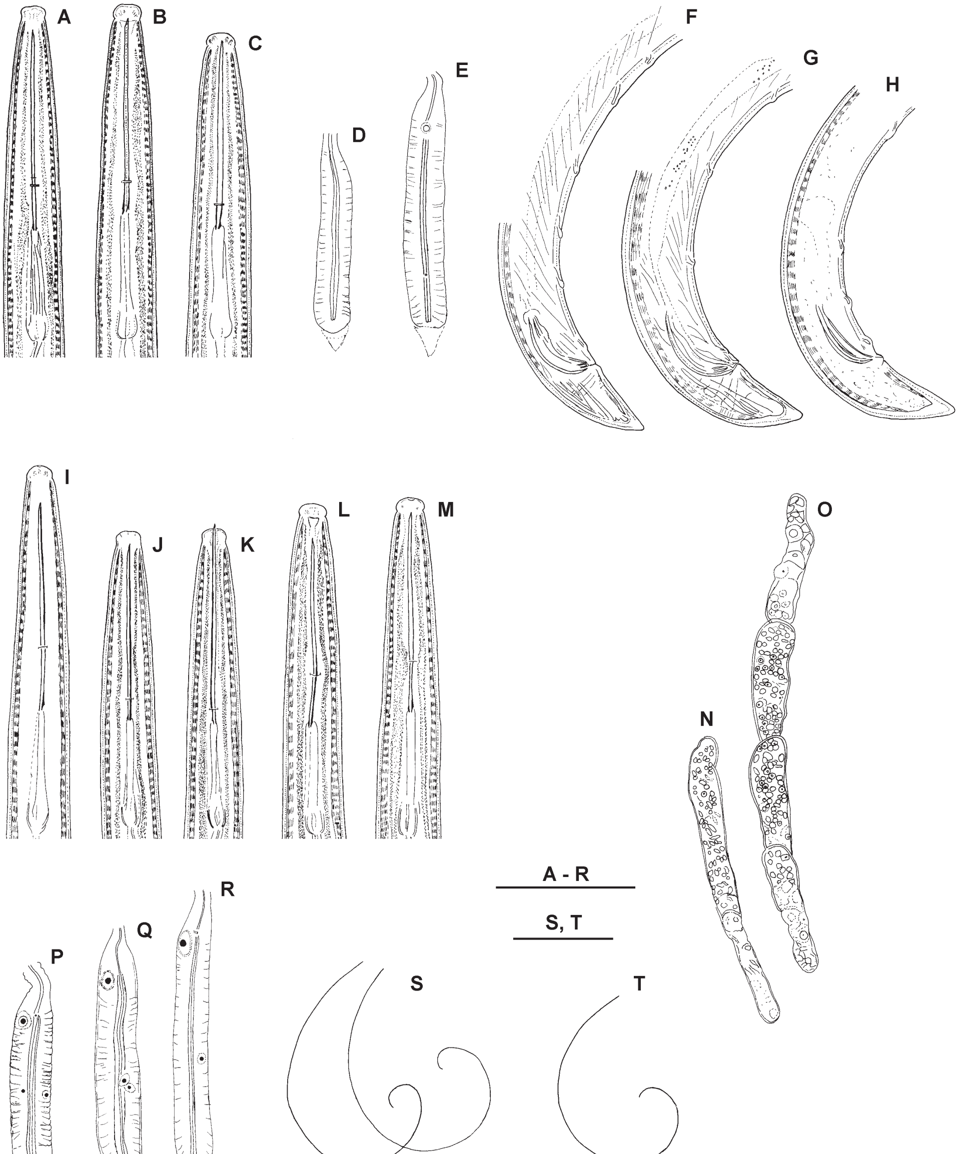

Fig. 2. *Xiphinema parasimile*. A, D, F, N, T: Male. A: Anterior end; D: Pharyngeal bulb; F: Posterior end; N: Posterior testis; T: Habitus; I-K, P: Females. I: Anterior end, paratype specimen; J: Anterior end, **Or**; K: Anterior end, **Vi**; P: Pharyngeal bulb; *Xiphinema simile*; B, C, E, G, H, O, S: Males. B – Anterior end, **SR**; C: Anterior end, **KB**; E: Pharyngeal bulb, **KB**; G: Posterior end, **KB**; H: Posterior end, **SR**; O: Genital system, **KB**; S: Habitus; L, M, Q, R: Females. L: Anterior end, **SR**; M: Anterior end, **KB**; Q, R: Pharyngeal bulb, **SR**; R: Pharyngeal bulb, **KB**. Scale bars: A-R=50 µm; S, T=500 µm.

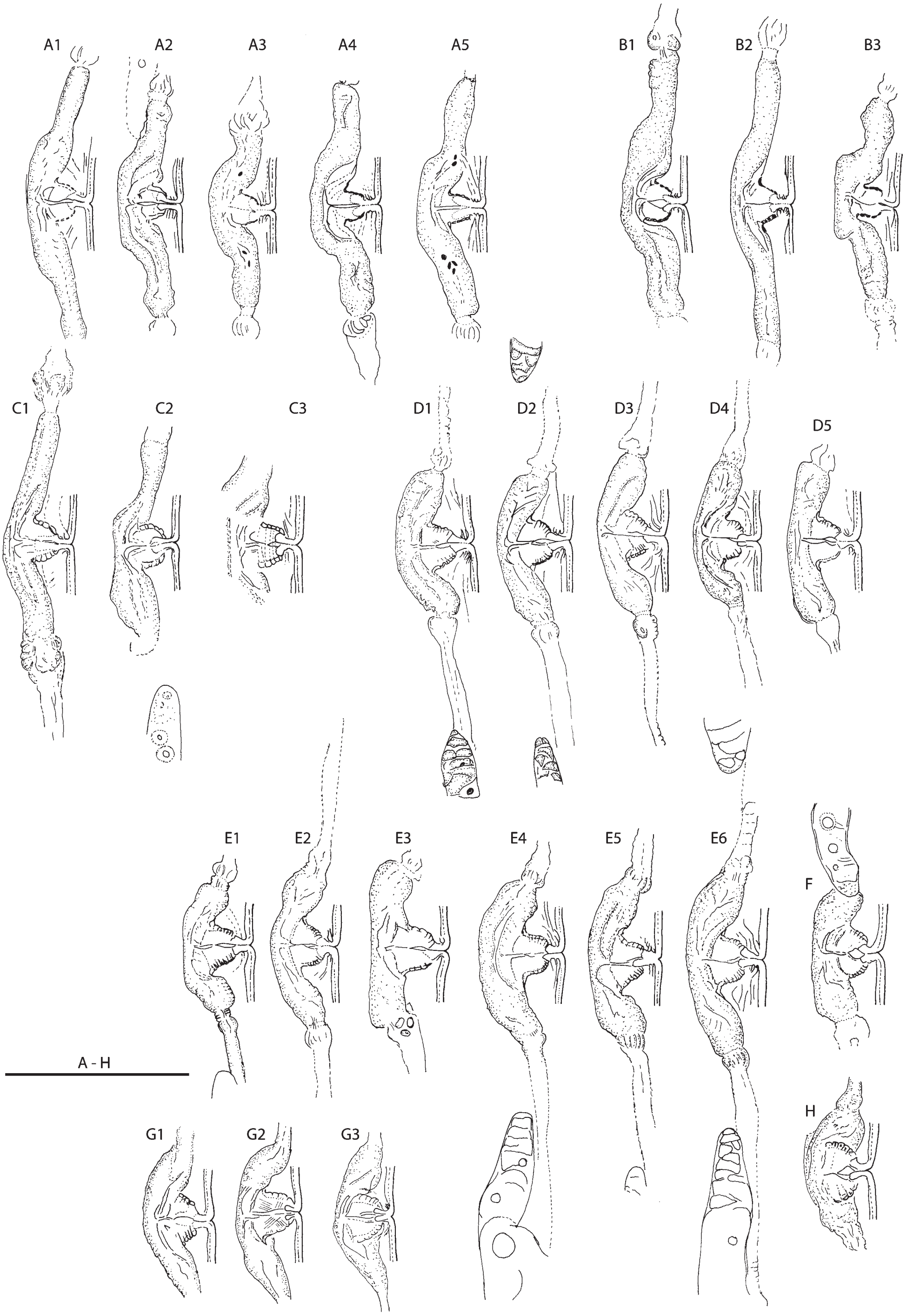

Fig. 3. Variability of vulval region. A-C: *Xiphinema parasimile*, A1-A5: **Vi**; B1-B3: **Or**; C1-C3: paratypes; D-H: *Xiphinema simile*, D1-D5: **KB**; E1-E6: **Or**; F: **Ka**; G1-G3: **SR**; H: **Kb**. Scale bar: A-H=50 µm.

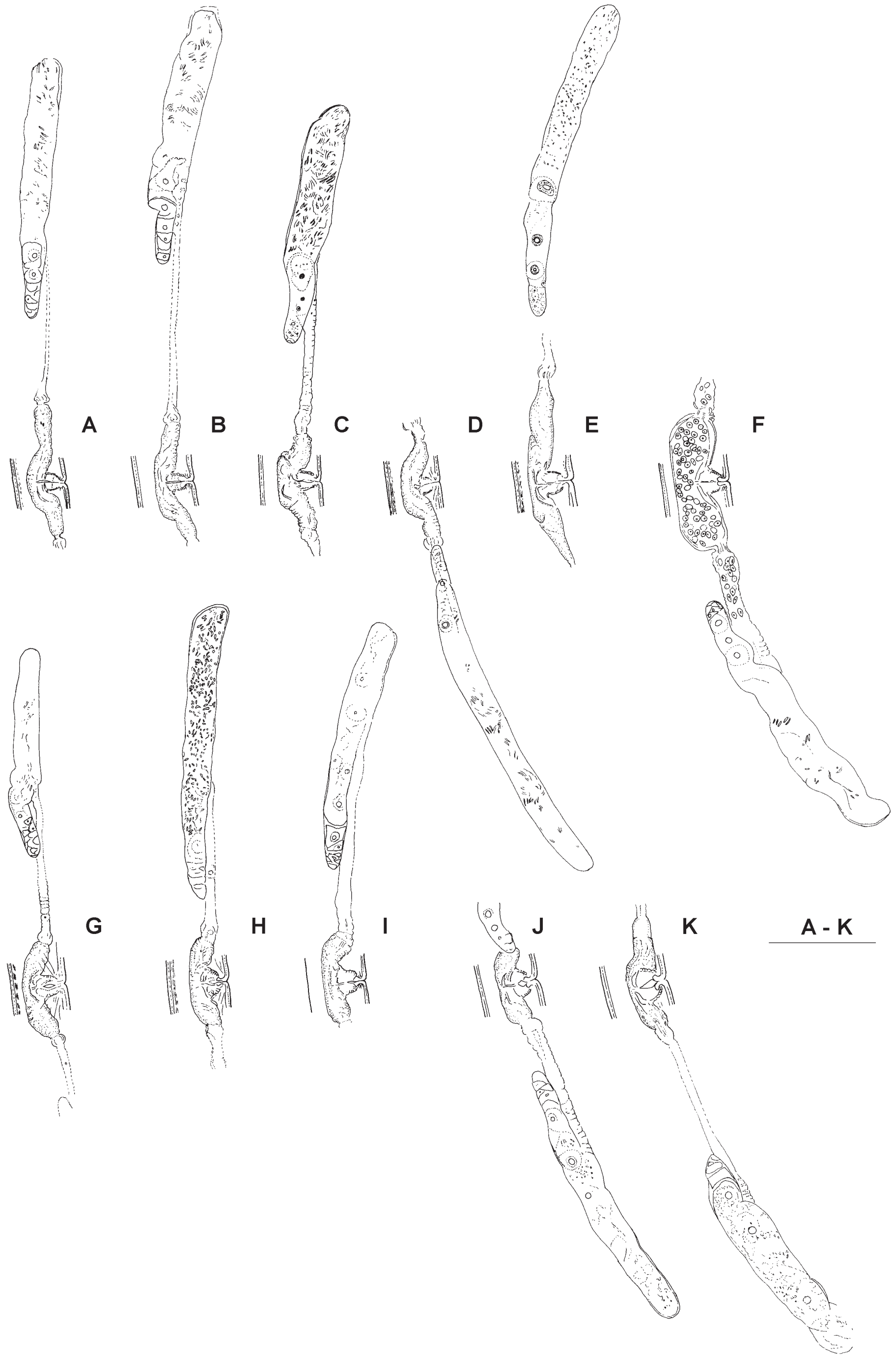

Fig. 4. *Xiphinema parasimile.* A-E: Females. A, B: Anterior genital branch, **Vi**: C: Anterior genital branch, **Or**; D: Posterior genital branch, **Or**; E: Posterior genital branch, paratype; *Xiphinema simile*. F-K. Females. Posterior genital branches. F: **Or**; J: **Ka**; K: **Ka;** Anterior genital branches. G: **Or**; H: **SR**; I: **KB**; Scale bar: A-K=50 µm.

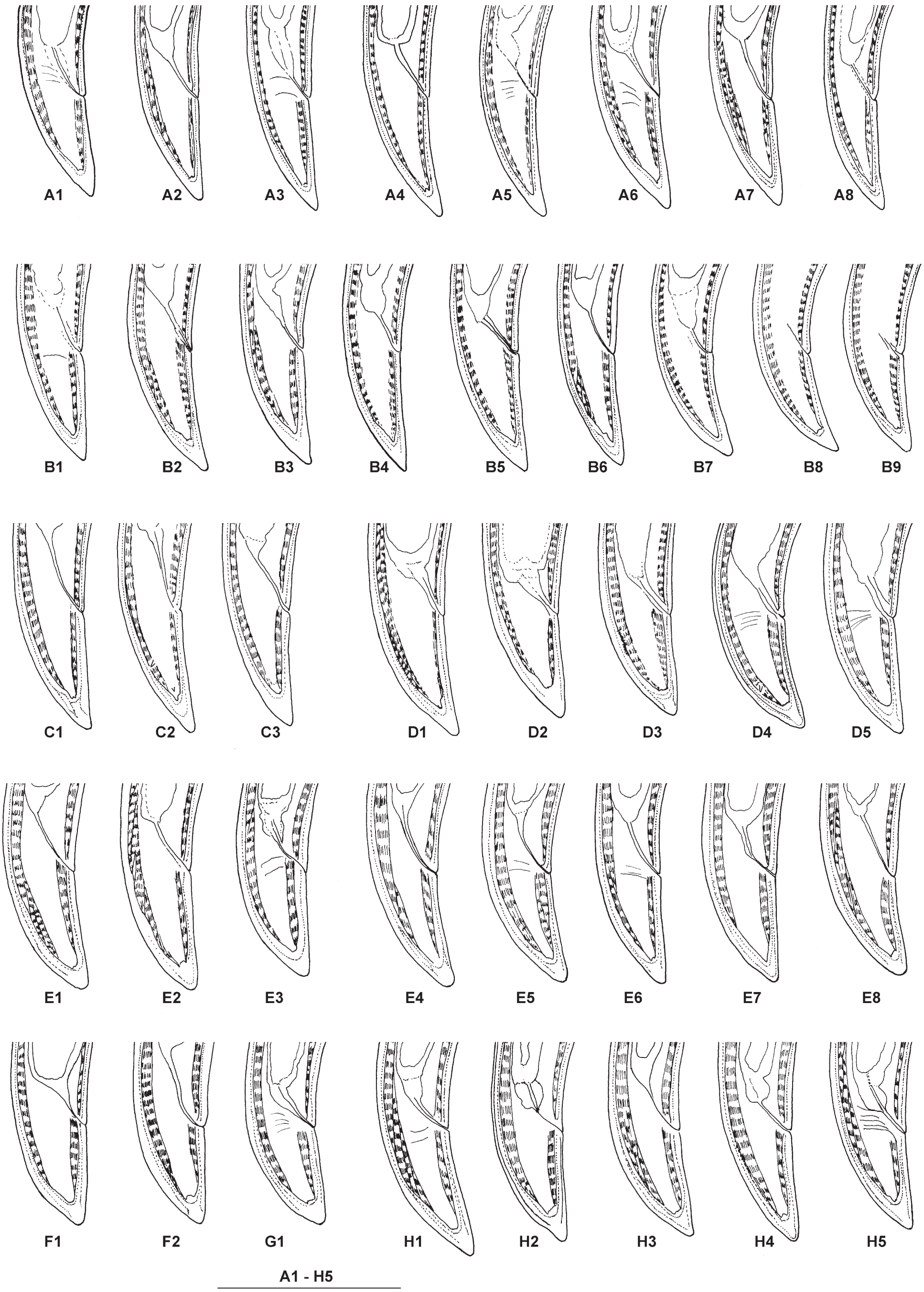

Fig. 5. Variability of female tale shape in studied populations. A-C: *Xiphinema parasimile*, A1-A8: **Vi**; B1-B9: **Or**; C1-C3: paratypes; D-H: *Xiphinema simile*, D1-D5: **SR**; E1-E8: **Or**; F1-F2: **Kb**; G1: **Ka**; H1-H5: **KB**. Scale bar: A-H=50µm.

mm). odontophore length (37.5-38.0 *vs* 40.7-41.6 µm), and body width (26.5-27.1 *vs* 27.9-28.3 µm) for the Bulgarian populations.

Male of *X. parasimile* compared to *X. simile* males from Serbia and Bulgaria had posterior part of the body less curved and a shorter body (1.84 *vs* 1.98-2.13 mm), narrower lip region (8.5 *vs* 10-10.5 µm), longer odontostyle (72 *vs* 63-69 µm) and shorter lateral guiding piece (4 *vs* 6 µm).

The RFLP results showed that the Bulgarian population of *X. parasimile* has the same restriction profiles as that from Serbia (Barsi and De Luca 2008). The enzyme *Ava* II produced in the Bulgarian population two extra bands that were absent in *X. parasimile* from Serbia, suggesting the existence of differences in restriction sites in D1-D2 sequences. Furthermore, the enzyme *Alu* I always showed a band of 0.8 kb, corresponding to the undigested product, along with the expected restriction fragments suggesting microheterogeneity of the D1-D2 region of Bulgarian materials of *X. parasimile* (Powers et al. 1997, Hugall et al. 1999, Hung et al. 1999, Subbotin et al. 2000, Morales-Hojas et al. 2001, Elbadri et al. 2002, Otranto et al. 2003, De Luca et al. 2004).

Xiphinema simile **Lamberti, Choleva et Agostinelli, 1983**

(Figures 2B, C, E, G, H, L, M, O, Q-S; 3D-H; 4F-K; 5D-H; 9–11)

Measurements. See Tables 2-4

Description. *Females.* Body slender, slightly tapering towards both ends; C- to spiral-shaped. Thickness of the cuticle at postlabial region 1 µm; at dorsal side of the tail cuticle thickness increases gradually from 2 to 3.6 (3-4) µm towards tail end. Lip region expanded, flatly rounded, 4 (4-5) µm high. Amphidial opening 4-5 µm wide, occupying 44-50% of the corresponding body width (n=4), located just below the demarcation line. Odontostyle with moderately developed basal collar, guiding ring not appearing single. Pharyngeal characters presented at Table 2. Genital system with two almost equally developed branches, uteri short (Table 3); vagina 13–16 µm long or 46–56 % of the corresponding body diameter. Sperm cells observed in females from Kalimok and Orlyane populations. Ovaries contain symbiotic bacteria. Rectum 20.1 (18-22) µm long. Tail conoid, dorsally convex, terminus rounded, in some specimens pointed; presence of slight dorsal constriction at the level of hyaline part.

Males. Similar to female apart from body more curved at the posterior end and higher lip region (5-5.5 µm). Spicules slightly curved, one adanal pair and 3 ventromedian supplements present, lateral guiding piece 6 µm long The spicules of the specimen from Srebarna Reserve were not well developed and the testes were not observed while the specimen from Kalimok-Brashlen locality was apperantly functional with well developed testes filled with sperm. Tail longer than in female, especially in the specimen from Srebarna, conoid, dorsally convex with rounded terminus.

Juveniles. The scatter diagram based on functional and replacement odontostyle, and body length reveal presence of three juvenile stages (Fig. 11A & B).

Table 3. Morphometrics of *Xiphinema simile* from different localities in Bulgaria. All measurements in micrometres, except body length and ratios, and in form: mean ± standard deviation (range).

Locality	Srebarna Reserve		Kalimok-Brashlen, Protected area		Kamen bryag area	Orlyane
Host plant	*Quercus pedunculiflora*		*Prunus cerasifera*		Poaceae	*Vitis vinifera*
Character	Female	Male	Female	Male	Female	Female
	n=8	n=1	n=10	n=1	n=5	n=13
L (mm)	2.17 ± 0.18 (1.93 - 2.50)	2.13	2.19 ± 0.10 (2.05 - 2.35)	2.10	2.04 ± 0.61 (1.95 - 2.11)	2.16 ± 0.15 (2.03 - 2.50)
a	70.7 ± 4.45 (63.9 - 78.6)	83.6	75.9 ± 4.55 (69.9 - 85.1)	70.8	67.4 ± 3.03 (64.1 - 70.2)	73.2 ± 4.23 (65.0 - 79.2)
b	7.2 ± 0.55 (6.2 - 7.9)	6.7	7.4 ± 0.41 (6.81-8.2)	7.03	6.8, 7.1	7.3 ± 0.35 (6.8 - 8.0)
c	70.2 ± 4.01 (64.1 - 75.7)	59.2	69.3 ± 9.36 (52.5 - 82.5)	67.7	77.0 ± 2.34 (74.4 - 79.6)	69.6 ± 5.44 (58.9 - 76.4)
c’	1.7 ± 0.07 (1.6 - 1.8)	1.8	1.7 ± 0.10 (1.5 - 1.9)	1.53	1.5 ± 0.04 (1.4 - 1.5)	1.7 ± 0.11 (1.6 - 1.9)
V (%)	55.5 ± 0.82 (53.7 - 56.4)	-	55.7 ± 1.22 (53.9 - 57.6)	-	54.8 ± 0.68 (54.2 - 55.9)	56.3 ± 0.79 (55.2 - 58.0)
Odontostyle	68.5 ± 1.61 (66 - 71)	69	69.6 ± 1.89 (66 - 72)	65.8	69.7 ± 1.97 (67 - 72.5)	69.6 ± 1.82 (66 - 72)
Odontophore	40.7 ± 1.87 (38 - 44)	46	42.5 ± 1.32 (40 - 45)	41.0	43.9 ± 1.13 (42 - 45)	41.8 ± 1.59 (40 - 45)

Locality	Srebarna Reserve		Kalimok-Brashlen, Protected area		Kamen bryag area	Orlyane
Host plant	*Quercus pedunculiflora*		*Prunus cerasifera*		Poaceae	*Vitis vinifera*
Character	Female	Male	Female	Male	Female	Female
	n=8	n=1	n=10	n=1	n=5	n=13
Oral aperture to guide ring	60.3 ± 1.82 (56.5 - 62)	62	59.3 ± 3.51 (50 - 61)	60.0	57.0 ± 0.66 (56.5 - 58)	58.1 ± 2.07 (56 - 60)
Tail	31.2 ± 1.29 (29.5 - 33)	36	29.2 ± 1.66 (26 - 31)	31.0	26.5 ± 0.33 (26 - 27)	30.5 ± 2.43 (27 - 35)
h (hyaline portion of tail)	7.2 ± 0.85 (6 - 8)	9	7.9 ± 0.42 (7.5 - 9)	7.9	6.7 ± 083 (6 - 8)	7.0 ± 1.46 (5 - 9)
Body diameter at lip region	10.3 ± 0.49 (10 - 11)	10	9.8 ± 0.29 (9 - 10)	10.1	9.9 ± 0.41 (10 - 10.5)	10.0 ± 0.37 (9 - 10.5)
Body diameter at guide ring	20.3 ± 0.81 (19 - 21.5)	19	20.2 ± 0.70 (19 - 21)	21.7	19.9 ± 0.16 (19.8 - 20.1)	19.5 ± 0.35 (19 - 20)
Body diameter at pharyngeal base	25.9 ± 1.07 (24.5 - 28)	24	26.0 ± 0.82 (25 - 27)	26.7	26.5 ± 0.89 (25 - 27)	25.4 ± 1.20 (23 - 27)
Body diameter at mid-body	30.8 ± 1.52 (28 - 33)	25.5	28.9 ± 1.06 (27 - 30)	29.7	30.3 ± 1.61 (28 - 32)	29.6 ± 1.69 (27 - 32)
Body diameter at anus	18.3 ± 0.35 (18 - 19)	21	17.5 ± 0.72 (16.5 - 18)	20.2	18.2 ± 0.50 (17.5 - 19)	17.5 ± 0.87 (16-19)
Spicules	-	30.5	-	36.0	-	-

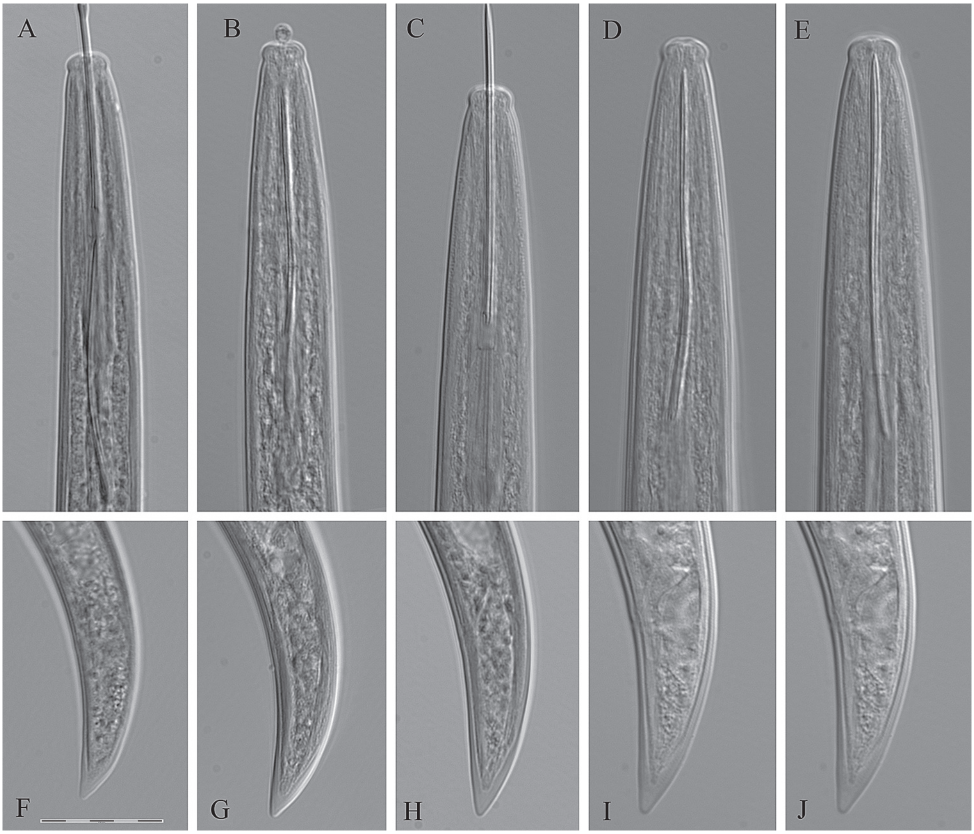

Fig. 6. *Xiphinema parasimile*. A-D, Anterior region of first, second, third and forth juvenile stages; E, Female anterior end; F-I, Tail of first, second, third and forth juvenile stages; J, Female tail. *Scale bar*: A-J, 20 µm.

Remarks. According to Barsi and Lamberti (2002) the populations of *X. simile* found in different localities have shown a broad range of variability in body length with populations with more southern distribution being shorter. This study revealed one population of *X. simile* from Kamen brayg area with lower mean values for body and tail length, **a**- and **c'**-ratios and higher **c**-ratio, as compared to other three populations. The comparisons with populations from different localities, showed that this population has similar body length with other Bulgarian (Lamberti et al. 1983, Peneva and Choleva 1992) and the Kenyan populations (Coomans and Heyns 1997), but still nematodes of this population had shorter tail length, higher **c**-ratios, and smaller **c'**-ratios. The other populations studied were within the range of those reported from northern localities of the range (Barsi 1994, Lišková and Brown 1996, Lamberti et al. 1999, Barsi and Lamberti 2002, Barsi and Lamberti 2004, Kumari 2006, Repasi et al. 2008).

Measurements of juvenile stages and male specimens are presented for the first time for Bulgarian populations. The obtained values were equal or close to those reported by Barsi and Lamberti (2002) and Barsi and De Luca (2008). The frequency distribution graphs of functional and replacement odontostyle lengths represent four

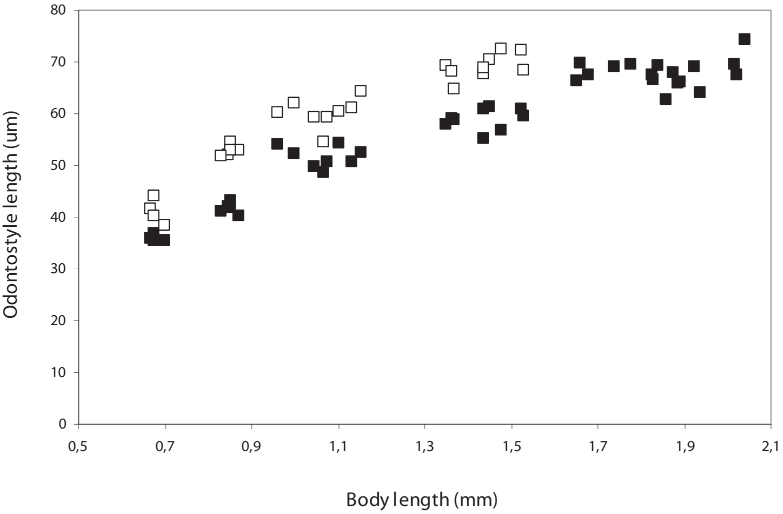

Fig. 7. Scatter plot of odontostyle (■) and replacement odontostyle (□) against body length of *Xiphinema parasimile* juveniles and females from Vinogradets population.

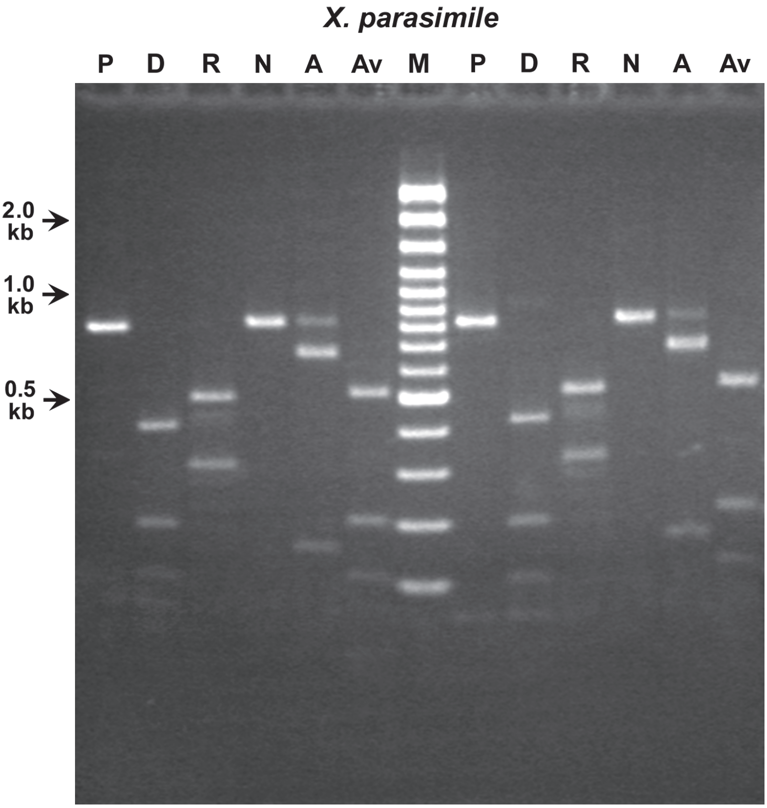

Fig. 8. Restriction fragments of amplified D1-D2 expansion domains of *Xiphinema parasimile.* A: *Alu* I, Av: *Ava* II, D: *Dde* I, N: *Nde* II, P: *Pst* I, R: *Rsa* I and M: 100bp ladder.

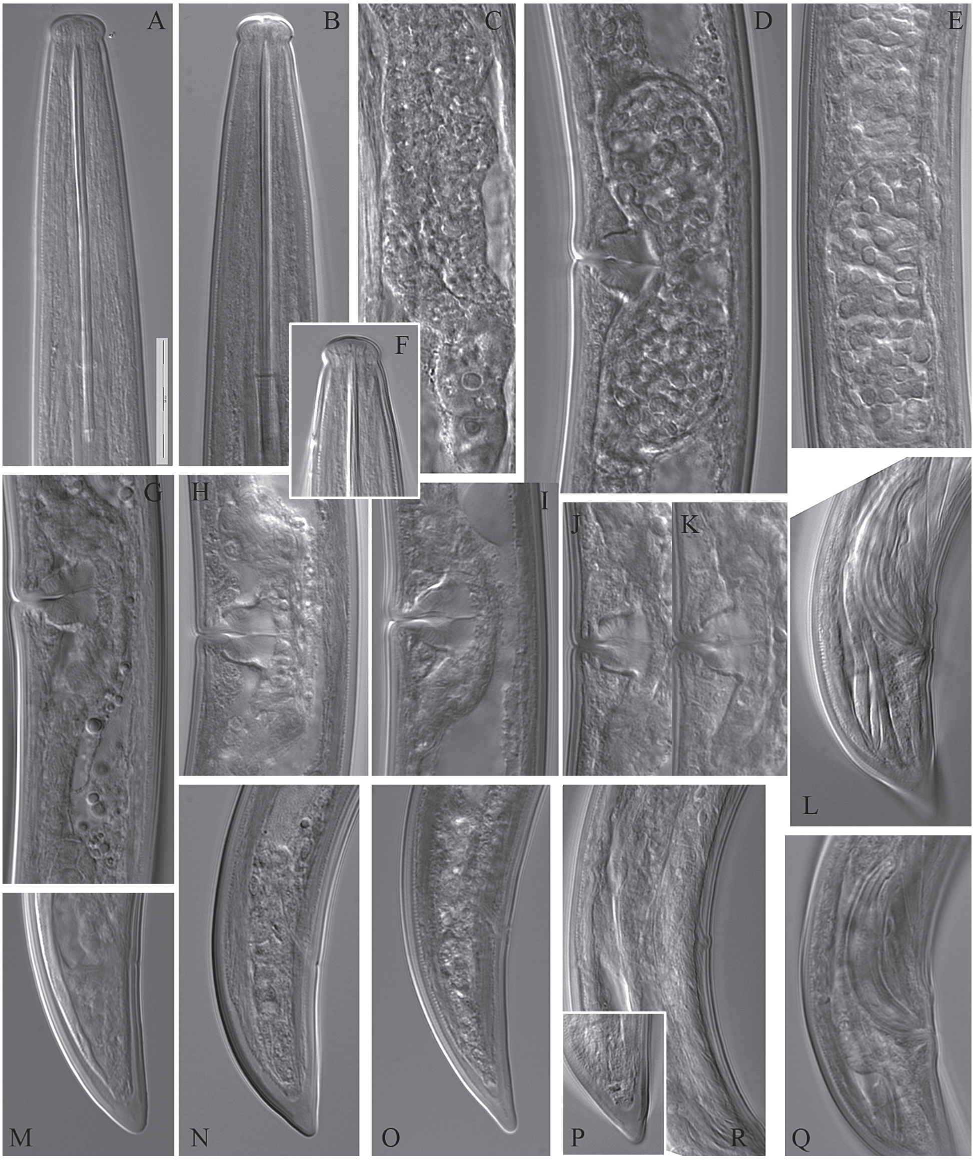

Fig. 9. *Xiphinema simile* Lamberti, Choleva et Agostinelli, 1983. *Female*: A-B, Anterior region; C, Ovarium with endosymbionts; D, Vagina and uteri with sperm; G, Vaginal region and part of the posterior genital branch; H-K, Vaginal region variation; M-O, Variation in tail shape; *Male*: E, Testis with sperm; F, Head end; L, Q, Spicules; P, Tail tip; R, Posterior end – copulatory muscles and midventral precloacal supplements. *Scale bar*: 20 µm.

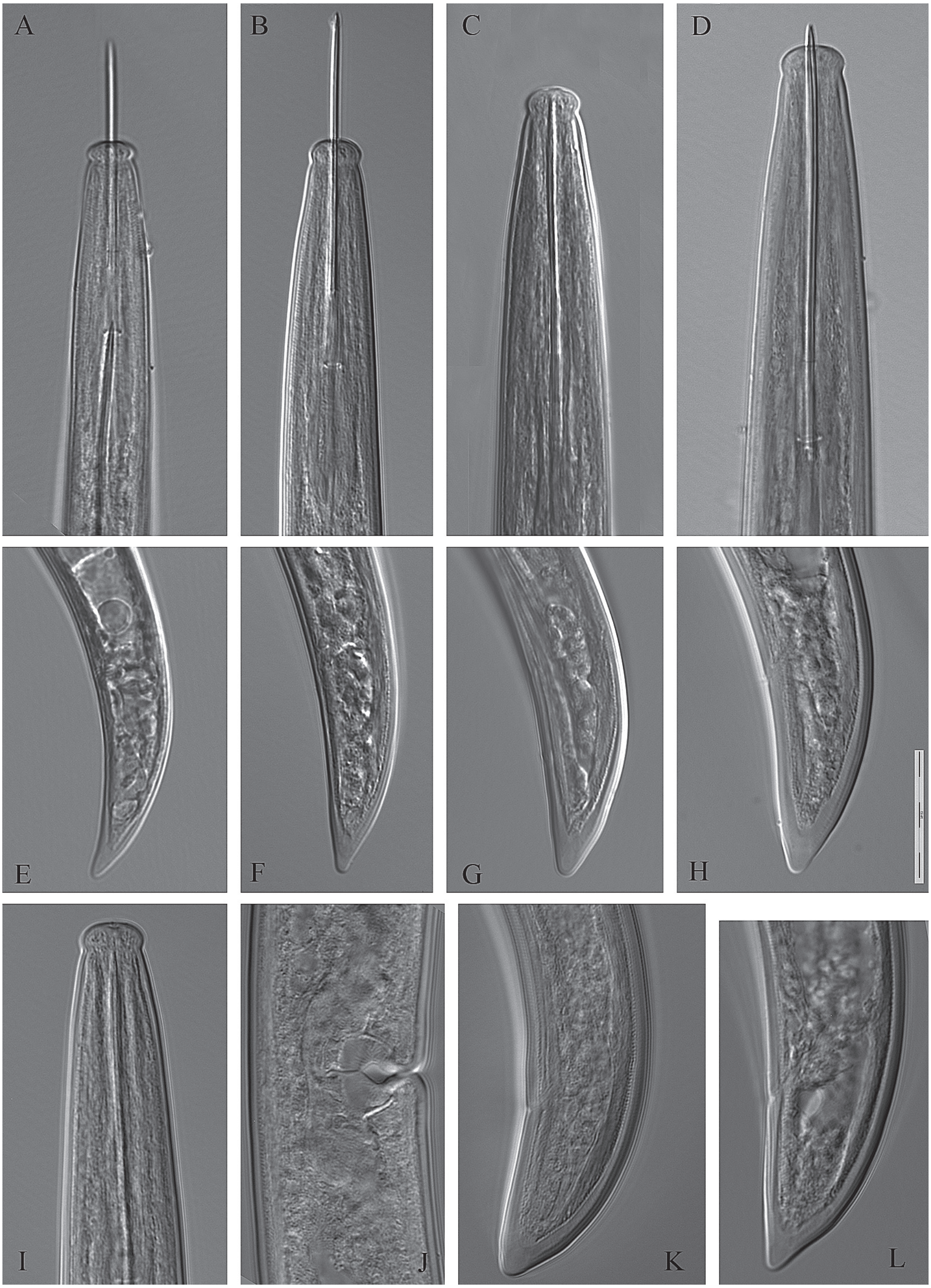

Fig. 10. *Xiphinema simile*. *Juveniles*: A-C, Anterior region of first, second and third juvenile stages; D, Female anterior end; E-G, Tail of first, second and third juvenile stages; H, Female tail. I-L *X. simile*: I, Female anterior end, J, Vaginal region, K, L, Tail. *Scale bar*: 20 µm.

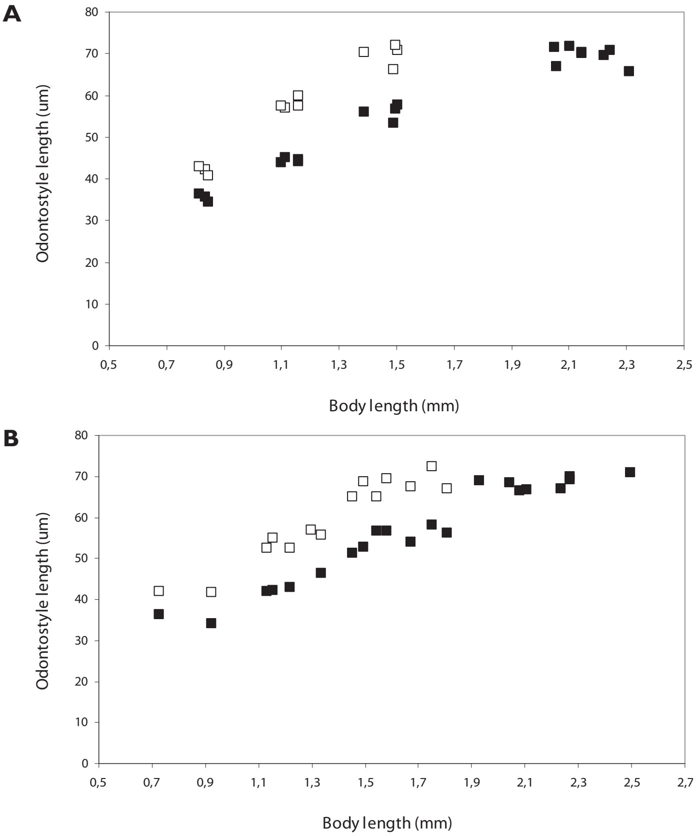

Fig. 11. Scatter plot of odontostyle (■) and replacement odontostyle (□) against body length of *Xiphinema simile* juveniles and females: A, Kalimok-Brashlen and B, Srebarna populations.

groups, corresponding to three juvenile stages and an adult stage and confirm the findings of other authors (Coomans and Heyns 1997, Barsi and Lamberti 2002, Barsi and Lamberti 2004, Kumari 2006) for the developmental pattern of *X. simile*.

Xiphinema simile was found to occur together with *X. parasimile* (Orlyane locality) and *X. pachtaicum* (Tulaganov, 1938) Kirjanova, 1951 (Kalimok-Brashlen protected area).

Conclusions

Apparently, *X. simile* has a wider geographical range and has been found in association of numerous plant species in natural habitats and arable lands compared to *X. parasimile* which is so far recorded only from the Balkan Peninsula. The males of both species regarded here, although quite rare, may play an important role in genetic variability and hence contribute to the phenotypic plasticity within and among their populations. The overlapping of the metric characteristics, especially when combining data from many different populations of these species has been widely discussed by Barsi and De Luca (2008). Yet, some qualitative characters can be used to separate *X. simile* and *X. parasimile* such as the shape of lip region and tail (Barsi and Lamberti 2004). We have found that the length of pharyngeal bulbus and glandularium are good characters allowing discrimination of both species, no overlapping of the ranges reported. Comparison between the Bulgarian populations of *X. simile* and *X. parasimile* studied showed that the uteri and the *pars distalis vaginae* of the first species are shorter. Uteri in *X. simile* were represented only by ovejector, while in *X. parasimile* ovejector and separate uteri were observed. Thus, the structure of the uteri can also be used as another differentiating character. Our study confirms the results by Barsi and De Luca (2008) concerning the validity of both species adding new information about their morphology, distribution, plant associations, genetic variability and male characteristics of *X. parasimile*.

Acknowledgements

The study was supported by the National Science Fund grants: No MU-B-1406/04, BioCORE project (INI 03/01.08.2005), B-1405/04. Mutual visits of authors have been supported by a mobility program between Bulgarian Academy of Sciences and Consiglio Nazionale delle Ricerca (Bilateral Collaboration Project between BAS and CNR). The authors kindly thank Dr László Barsi, Department of Biology and Ecology, Novi Sad (Serbia) for the loan of the paratype slides of *Xiphinema parasimile*.

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RESEARCH ARTICLE

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A new genus, *Smilirhexia*, of Smiliini (Hemiptera, Membracidae) from Costa Rica

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Guest editor: *Lewis Deitz* | Received 17 September 2008 | Accepted 6 October 2008 | Published 31 October 2008

urn:lsid:zoobank.org:pub:45774FDF-CF37-4A92-A63F-8A0BFC15B5A9

Citation: McKamey SH (2008) A new genus, *Smilirhexia*, of Smiliini (Hemiptera, Membracidae) from Costa Rica. ZooKeys 3: 51-55. doi: 10.3897/zookeys.3.29

Abstract

Smilirhexia naranja, **gen. n.** and **sp. n.**, is described from Central America, the southern limit of the tribe Smiliini, and represents a strong divergence from the morphology of the oak-feeding genera prevalent in North America.

Keywords

Membracoidea, Homoptera, Auchenorrhyncha, new genus, new species

Introduction

The tribe Smiliini is the nominotypical tribe of Smiliinae, one of the largest subfamilies of treehoppers (McKamey 1998). The subfamily is native to the New World, being most speciose in the tropics. In contrast to this subfamilial pattern, the species of Smiliini are primarily North American, with the great majority of species oligophagous on oaks (*Quercus* spp., Fagaceae) and the southernmost species recorded from Panama (R. Cocroft, pers. comm.). Excluding the odd smiliine genus *Antianthe* Fowler, the tribe's southern limit is even more restricted than that of oaks, which extend southward to Colombia.

The mostly recently described species is *Telamona archiboldi* Froeschner (1968), from Florida. There have been only three recent taxonomic works on Smiliini (McKamey and Deitz 1991, Wood and Pesek 1992, Wallace and Deitz 2003). The other recent papers consist of local or regional checklists (Kopp and Yonke 1973, 1974; Johnson and Freytag 1997; Wallace et al. 2003; Flynn et al. 2003; Wallace and Troyano 2006). Quisenberry et al. (1978) described the immatures of most genera of Smiliini.

Morphological terminology follows Deitz (1975).

Smilirhexia McKamey, gen. n.

urn:lsid:zoobank.org:act:AD148098-EBFC-46EA-BF5D-B74F697FD853
Type species: *Smilirhexia naranja*, sp. n.

Diagnosis. The new genus differs from all other genera of the tribe in having a smooth and shining pronotum, which is broad, almost completely convex, and brightly colored.

Description of male. Head (Fig. 3) glabrous, subtriangular in anterior view, ocelli equidistant from each other and from eyes. Pronotum (Figs 1-3) entirely concealing scutellum, convex, dorsal carina elevated only in posterior half, and weakly, otherwise delineated by absence of punctures; surface shining, punctures shallow and lacking setae; humeral angles not projected laterally beyond wing bases; posterior pronotal process ending at apex of forewing cell M_{3+4} (last apical cell). Forewing (Fig. 1) free, in repose not concealed wholly or in part by pronotum; without r-m crossveins, with veins R and M adjacent basally, weakly divergent soon after, R_{4+5} and M_{1+2} confluent for a short distance before apex, and strongly divergent at wing apex; R_{2+3} present as distinct branch of R; R_4 and R_5 separately joined to vein M, creating a small cell R_4 near center of wing. Hind wing with short r-m crossvein (holotype right wing) or veins R and M fused at single point (holotype left wing). Femora, tibiae, and tarsomeres lacking cucullate setae except metathoracic femur with two apically, metathoracic tibia with three rows (row 2 double), and metathoracic tarsomere I with 4 cucullate setae at apex. Metathoracic coxa and trochanter without apposed processes. Abdomen lacking fenestrae or mid-dorsal protuberances.

Female. Unknown.

Distribution. Costa Rica, Puntarenas Prov.

Material Examined. Holotype male of *Smilirhexia naranja*, sp. n.

Etymology. The new genus name is feminine and combines the name of its apparent tribe and the name of an unrelated genus, *Rhexia* Stål, which it resembles superficially [e.g., *Rhexia viridicollis* (Fowler), illustrated by Deitz (1983)].

Discussion. The distally confluent radial and medial veins, which diverge before the forewing apex, and the lack of processes on the metathoracic coxa and trochanter place the new genus firmly in the subfamily Smiliinae. In Deitz's key to the higher classification, the genus keys to the tribe Smiliini due to the presence of 2 m-cu crossveins. The only discrepancy is that in the new genus, the forewing is completely exposed rather than partially concealed. Most genera of the tribe are morphologically similar and authentic records of only a few species exist for Central America, the tribe's southern limit. The notable exception is the genus *Antianthe* Fowler, which is laterally compressed, strongly crested, and with pronounced humeral angles, and which occurs from the southern

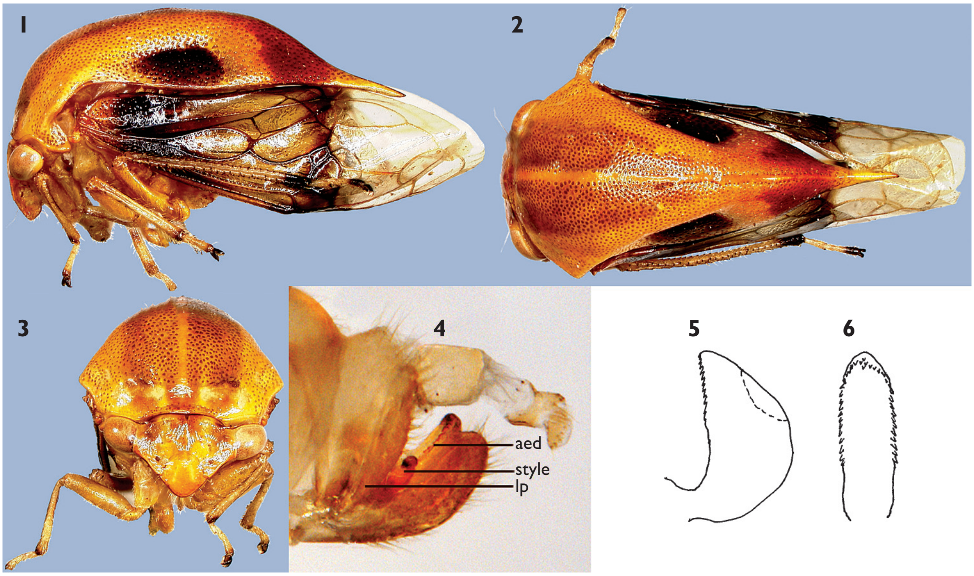
USA to South America. *Smilirhexia* appears to represent another distinct morphological form for Smiliini that may help to elucidate the evolutionary origin of this tribe.

Species of the subfamily Darninae, which appears to be a close relative of Smiliinae, also have the forewing with two r-m crossveins, as in Smiliini. Interestingly, *Cymbomorpha* Stål (Cymbomorphini, Darninae) occasionally have the characteristic forewing venation of Smiliinae, with veins R and M confluent for a short distance before the apex, and double setation in metathoracic tibial row II. Both *Cymbomorpha* and *Eumela* Stål, the other cymbomorphine genus, and *Smilidarnis* Andrade, 1989 (a Neotropical, unplaced genus with characters of both Darninae – especially Cymbomorphini – and Smiliinae), exhibit the shining pronotal surface and completely exposed forewings of the new genus *Smilirhexia*.

Smilirhexia naranja **McKamey, sp. n.**

urn:lsid:zoobank.org:act:F473B88C-4AF2-45CF-9F7D-964FBCDF7B3F

Description of male. Length including forewings in repose 8.0 mm, width between humeral angles 4.6 mm. Color. Head yellow-orange. Pronotum yellow-orange dorsally and posteriorly, yellow laterally except with large lateral indentation at mid-length black. Forewing fuscous at coriaceous base and transversally at distal crossveins, cells tinted yellow basally, hyaline distally. Male terminalia (Figs 4-6): lateral plate distinct,



Figs 1-6. *Smilirhexia naranja*, sp. n. 1-3, Lateral, dorsal, and anterior views of head, pronotum, wings, and legs (forewing anterior apices presumably rolled inward as a preservative side-effect). 4, Lateral view, cleared terminalia before dissection. 5-6. Aedeagus in lateral and anterior views, respectively. *aed*, aedeagus; *lp*, unarmed lateral plate.

long, lacking protuberances. Aedeagus narrow in anterior view, in lateral view U-shaped and widest at mid-length, anterior margin with many denticulae of increasing size ventrally; styles simple, distally recurved (Fig. 4), apex acute.

Female. Unknown.

Distribution. COSTA RICA: Puntarenas Prov.: Coto Brus, nr. San Vito, Estación Biológica Las Alturas, 8° 57'N, 82°50'W.

Material Examined. Holotype male, pinned, dissected, with labels "Est. Biol. Las Alturas, / 1500m., Coto Brus, Prov. / Puntarenas. Costa Rica, / F. Araya, 23 mar a 2 may / 1992, L-S 322500,591300", "COSTA RICA INBIO / CR1000 / 777014", and "HOLOTYPE / *Smilirhexia / naranja* McKamey". Deposited at the Instituto Nacional de Biodiversidad (INBio), Santo Domingo de Heredia, Costa Rica.

Etymology. The species epithet is a Spanish adjective for orange, the predominant pronotal color of the species.

Notes. In Costa Rica, most oaks occur in submontane and montane forests (1500-3200m) (Kappelle et al. 1992). In the Cordillera de Talamanca, which contains the type locality, there are at least eight oak species, with at least three reported from Coto Brus itself: *Quercus seemannii* Liebm., *Q. oocarpa* Liebm., and *Q. rapurahuensis* Pittier ex Trel. (Giddy 2008), and another (*Q. insignis* M. Martens & Gal.) at 1300m on the trail to Las Alturas (Instituto Nacional de Biodiversidad 2008). In short, it is easily possible that this new treehopper genus, like others in the tribe, feeds on *Quercus*.

Acknowledgments

I thank Carolina Godoy, formerly of the Instituto Nacional de Biodiversidad, for access to the collection and loan of the type specimen. L. L. Deitz, C.-P. Lin, N. Vandenberg, and M. Pogue provided helpful comments on an earlier draft of the manuscript.

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ZooKeys 3: 57-76 (2008)
doi: 10.3897/zookeys.3.45
www.pensoftonline.net/zookeys

RESEARCH ARTICLE

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A new genus and two new species of soft scale insect (Sternorrhyncha, Coccoidea, Coccidae) from Africa

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Academic editor: *Michael Wilson* | Received 29 September 2008 | Accepted 4 November 2008 | Published 9 November 2008

urn:lsid:zoobank.org:pub:CBCD770C-79A0-4A53-9C35-DCD7A1A32A14

Citation: Hodgson C (2008) A new genus and two new species of soft scale insect (Sternorrhyncha, Coccoidea, Coccidae) from Africa. ZooKeys 3: 57-76. doi: 10.3897/zookeys.3.45

Abstract

A new soft scale insect genus, *Sterculicoccus* Hodgson, **gen. n.**, is introduced to take a new species, *Sterculicoccus tafoensis* Hodgson, **sp. n.**, off *Triplochiton* from Ghana. *Sterculicoccus* belongs to the Myzolecaniinae and is close to *Alecanium* Morrison. In addition, a new species of *Hemilecanium* Newstead, *H. cedrelus* Hodgson, **sp. n.**, is also described off *Cedrela toona* from Zambia. *Hemilecanium cedrelus* is close to *H. coriaceum* Hall and *H. uesatoi* Kondo & Hardy (Saissetiinae). The adult females of these two species are described, along with the 1st-instar and the 2nd- and 3rd-instar females of *H. cedrelus*.

Keywords

Sternorrhyncha, Coccoidea, Coccidae, Africa, Zambia, Ghana, new species, new genus, Sterculiaceae, Meliaceae

Introduction

Whilst the Coccidae of some areas of Africa are quite well known [e.g. South Africa and Zimbabwe – both with more than 80 species (Scalenet, 2008)], others have had very little attention. Two such countries are Ghana (with 24 known species of Coccidae) and Zambia (with 16 species). The present paper describes a new species from each of the latter two countries, one of them in a new genus.

Materials, methods, and conventions

Several specimens were already mounted but others were mounted especially for this study in the usual way (Hodgson and Henderson, 2000), using acid fuchsin stain, except that the specimens were left in unheated KOH for about 72 h for clearing. The figures are typical scale insect diagrams, with the dorsal surface forming the left of the main drawing and the ventral surface forming the right; important structures within these central drawings are enlarged around the margins; these are not drawn to the same scale. Terminology follows that of Hodgson (1994). Specimens of both species will be deposited in The Natural History Museum, Cromwell Road, London (BMNH) and in the Coccoidea Collection of the Smithsonian Museum, Washington (USNM), kept in the US Department of Agriculture, Beltsville, Maryland.

Sterculicoccus Hodgson, gen. n.

urn:lsid:zoobank.org:act:DBD73214-1639-45E6-8F3C-6618B8CDD3E0
Type species: *Sterculicoccus tafoensis* Hodgson, sp. n.
urn:lsid:zoobank.org:act:E30D4191-C87F-472A-A2FF-B745A2954F05

Generic diagnosis. Body broadly oval. Anal cleft deep, about 1/3rd-1/4th total-body length, with parallel margins; with a narrow sclerotisation around anterior margin of cleft and sclerotisations ventrally in each stigmatic cleft. Dorsal derm otherwise membranous with numerous areolations, those anterior to anal plates and dorsal to mouthparts much larger than elsewhere. Dorsal setae mainly short, but with a few long. Anal plates together oval, with polygonal reticulations on dorsal surface. Outer anal opening with an O-shaped sclerotised band. Marginal setae apparently ventral, short and spinose, in a band 2-3 setae wide; stigmatic clefts absent but with stigmatic sclerotisations in each stigmatic area. Venter with a marginal band of large tubular ducts plus a broad submarginal band of much smaller tubular ducts. Pregenital disc-pores each with mainly 5 loculi, in a small group beneath posterior end of anal plates. Antennae small, 6 segmented. Clypeolabral shield proportionately large. Spiracles very large. Legs much reduced.

Relationships. *Sterculicoccus*, gen. n., is clearly a member of the subfamily Myzolecaniinae as defined by Hodgson (1994) – absence of dorsal tubular ducts; absence of eyespots; rather large spiracles; pregenital setae represented by bands of setae rather than pairs of larger setae; legs and antennae reduced in size, and anal tube short. However, it is unusual within this group in having (i) 2 types of ventral tubular ducts (usually only of one type) and (ii) each anal plate with only 4 setae, all near the apex (typically with many setae). In the Key to Myzolecaniinae in Hodgson (1994, p. 91), *Sterculicoccus* keys out at *Alecanium* Morrison. *Alecanium* and *Sterculicoccus* are clearly closely related and share the following character states: (i) stigmatic clefts very shallow or absent, without stigmatic spines; (ii) each stigmatic area with a small sclerotisation enclosing some spiracular disc-pores; (iii) marginal setae spinose, in a marginal band several setae wide;

(iv) some dorsal setae long and flagellate; (v) anal plates elongate oval; (vi) pregenital disc-pores with mainly 5 loculi; (vi) legs very reduced; (vii) antennae reduced; (viii) spiracles large; (ix) ventral tubular ducts in a wide submarginal band and in transverse bands medially on meso- and metathorax; (x) ventral setae with a similar distribution (i.e. with a band across metathorax), and (xi) outer end of anal tube with an O-shaped sclerotisation. *Sterculicoccus* differs from *Alecanium* in having (character-states on *Alecanium* in brackets): (i) two types of ventral tubular ducts (only 1 type); (ii) only one type of marginal seta (two types); (iii) dorsal surface of anal plates with a polygonal reticulate pattern of microridges (absent); (iv) anal plates each with only four setae near apex (each with many setae distributed over most of dorsal surface), and (v) long dorsal setae restricted to dorsad to mouthparts (throughout dorsal surface).

The key in Hodgson (1994) can be modified to accommodate *Sterculicoccus* as follows:

3. Stigmatic spines present; pregenital disc-pores each with 10 loculi ....*Richardiella* Matile-Ferrero & Le Ruyet
– Stigmatic spines absent; pregenital disc-pores each mainly with 5 loculi............ 3a
3a. Dorsal surface of anal plates with a reticulate pattern of micro-ridges; ventral tubular ducts of two types, a larger type along margin and a smaller type submarginally; marginal setae of one type only ....*Sterculicoccus* gen. n.
– Dorsal surface of anal plates without a reticulate pattern of micro-ridges; ventral tubular ducts of one type; marginal setae of two types, one spinose and the other flagellate...*Alecanium* Morrison

Etymology. The name *Sterculicoccus* is composed of the main part of the plant family (Sterculiaceae) on which this species was collected, plus *coccus*, from the Latin *Coccum*, a word commonly used to describe scale insects.

Distribution. *Sterculicoccus* is a monotypic genus currently only known from West Africa.

Sterculicoccus tafoensis Hodgson, sp. n.

urn:lsid:zoobank.org:act:E30D4191-C87F-472A-A2FF-B745A2954F05

Material studied. Holotype female: Ghana (Gold Coast), Tafo, on *Triplochiton scleroxylon* K. Schum. (Sterculiaceae), 5.XI.1945, E.O. Boafo (BMNH): 1/1 ad♀ in good condition.

Paratype ♀. As for holotype: 5/5 ad♀ in fair to good condition (BMNH, USNM).

Adult female (Fig. 1)

Unmounted material. Not seen.

Mounted material. Broadly oval, body length 2.4-5.4 mm; width 2.0-4.5 mm. Basic structure as in generic diagnosis.

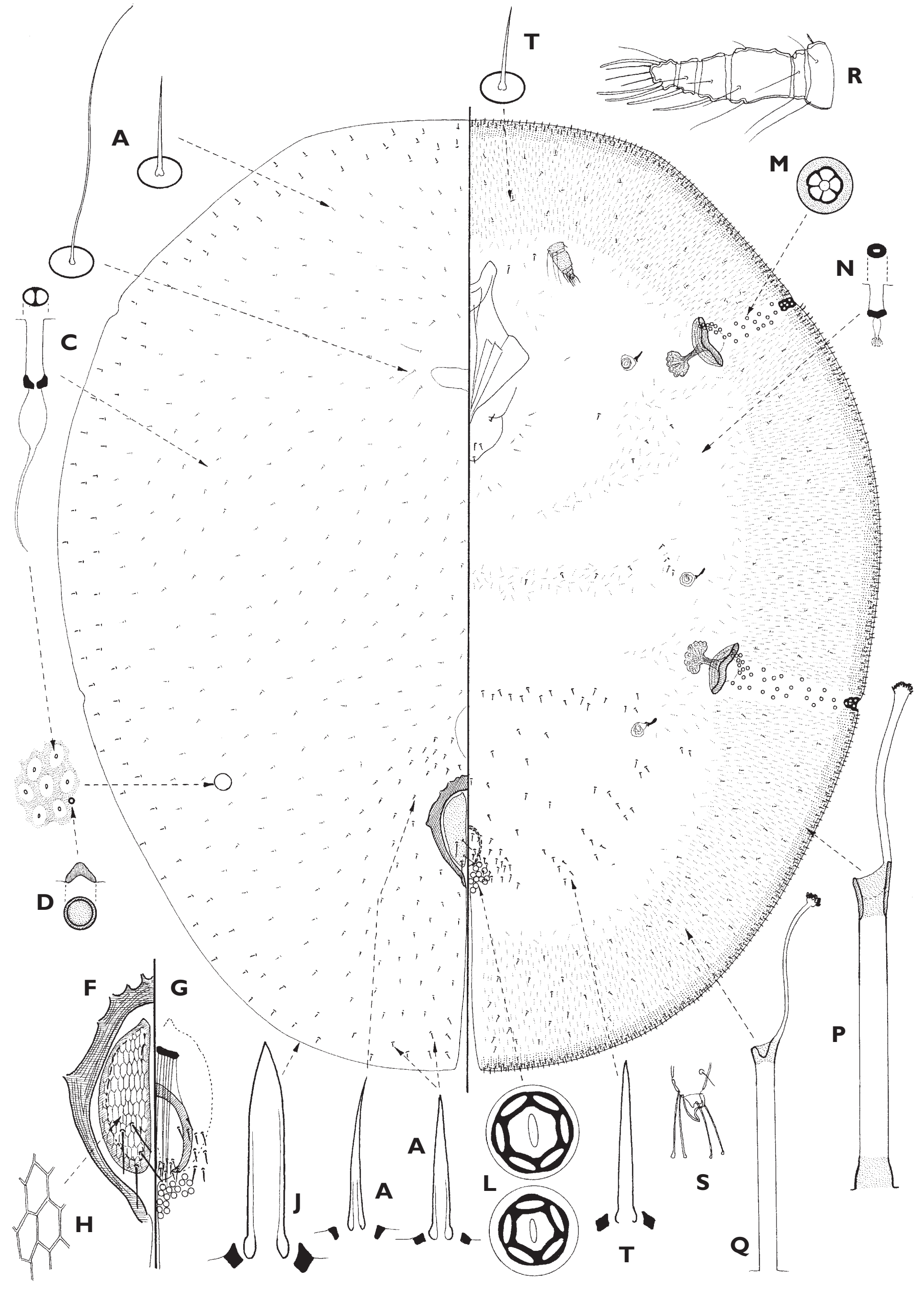

Fig. 1. *Sterculicoccus tafoensis* Hodgson, sp. n., adult female. Where: A = dorsal setae; C = dorsal microductule; D = dorsal simple porte; F = dorsal view of anal plates; G = ventral view of anal plates; H = microridges on dorsal surface of anal plate; J = marginal seta; L = pregenital disc-pore; M = spiracular disc-pore; N = ventral microduct; P = larger ventral tubular duct; Q = smaller ventral tubular duct; R = antenna; S = claw, and T = ventral setae.

Dorsum. Derm membranous, apart from a narrow crescentic sclerotisation around anterior margin of anal cleft. Derm with abundant small areolations, each polygonal in shape, with a central dorsal microductule. Dorsal setae variable: (i) a larger slightly spinose seta with a sharp apex and well-developed basal socket; each 16-18 µm long; apparently restricted to a broad submarginal band, plus a few occasionally up margins of anal cleft; (ii) a slightly smaller, more setose seta, each 12-16 µm long, in a broad area around anal plates, and (iii) a short, fine seta, each about 8-15 µm long, frequent throughout rest of dorsum, but also with 0-3 setae up to 100 µm long on either side of large areolation dorsad to mouthparts. Dorsal pores of 2 types: (i) a small convex, closed pore, each about 3 µm wide, frequent throughout; and (ii) a small microductule with a narrow outer ductule about 5 µm long, with sclerotised pore about 1.0-1.5 µm wide and an inner ductule quite long and swollen at proximal end; abundant throughout with one in each areolation. Dorsal tubular ducts, dorsal tubercles and preopercular pores absent. Anal plates together approximately oval, each plate with a rounded outer angle and with dorsal surface covered in micro-ridges arranged in a polygonal pattern; without a small additional triangular anal plate between lateral plates anteriorly; each plate 185-210 µm long, combined width 140-165 µm; each plate with 4 setae; 2 along inner margin, 1 near apex (each 33-38 µm long) and one dorso-laterally 45-50 µm long. Ano-genital fold possibly absent; posterior opening of anal tube apparently with a sclerotised O-shaped margin, with a group of 10-18 short setae, each 25-35 µm long, medially between ventral arms of anal ring posteriorly. Anal plates without strong inner apodemes. Anal ring with 3 pairs of anal ring setae, each about 125 µm long, all setae attached to ventral half of anal ring; anal ring apparently without anal ring pores; anal tube quite short, anal ring lying beneath anal plates. Eyespots not detected.

Margin. Marginal setae all short and spinose with parallel margins, each 11-17 µm long, in a marginal band 2-3 setae wide; basal socket broad; with several hundred around margin, appearing to be on ventral surface; setae on margins of anal lobe not differentiated. Stigmatic clefts absent or extremely shallow, each with a small area of sclerotisation on venter which encloses outermost spiracular disc-pores; without stigmatic spines.

Venter. Derm entirely membranous. Pregenital disc-pores quite large, each 8-10 µm wide, with mainly 5 or 6 loculi; restricted to a small group of 18-30 (total) apparently posterior to anal opening, probably with 8-20 on each side. Spiracular disc-pores each mainly with 5 loculi, present in a wide band between spiracles and margin, with perhaps 45-55 in anterior band and 50-70 in posterior band. Ventral microducts, each with ductule about 5 µm long and pore perhaps 2 µm widest; abundant throughout but perhaps least frequent medially on abdomen. Other ventral pores, including preantennal pores, absent. Ventral tubular ducts of 2 types: (i) ducts with a long, narrow outer ductule (each about 25 µm long and 2 µm wide), with a narrow, much shorter inner ductule about 14 µm long, and with a fairly small glandular end; in a fairly broad submarginal band, which extends medially past spiracles; also with a few on either side of mouthparts; absent medially on thorax and abdomen; (ii) much larger ducts, each with a long, narrow outer ductule about 33-40 µm long and 3 µm wide, with a sclerotised outer orifice, and a narrow, much shorter inner ductule about 20-28 µm long, and a fairly small glandular end; present in a dense marginal band about 2-3 ducts wide, intermingled with marginal setae. Ventral setae abundant, particularly submarginally, where quite fine, each 7-9 µm long, with a wide basal socket; some medially rather longer, longest about 27 µm long; pregenital setae not differentiated; with 2 pairs of interantennal setae, these similar to ventral submarginal setae, each 16-28 µm long.

Antennae greatly reduced, each about 80-105 µm long; with 6 ring-like segments; scape with 3 setae, 1 long and flagellate (about 40 µm long); pedicel with 2 setae, both long and flagellate + a campaniform sensilla; segment III with 3 setae, IV & V with 1 fleshy seta + 1 hair-like seta, and VI with 3 fleshy setae, 2 hair-like setae and 3 stiff setae. Mouthparts proportionately rather large; clypeolabral shield about 365-410 µm long; labium with 4 pairs of setae. Spiracles large, each with a large apodeme; each anterior peritreme 130-150 µm wide, posterior peritreme 140-165 µm wide; length of apodemes about 88-100 µm. Legs extremely reduced but with large coxal apodemes; segmentation difficult to discern but each coxa with long, flagellate setae (each 58-65 µm long), trochanter + femur with 1 long flagellate seta and, on each side, 2 campaniform sensilla; tibia + tarsus very short, with one short seta; tarsal digitules parallel-sided and about 33 µm long; claw digitules similar but shorter, each 26-28 µm long; claw about 13 µm long, without a denticle. Vulva probably located between segments VII and VIII.

Comment. *S. tafoensis* new species is the only species currently known in this genus but is readily separated from other possibly similar species by the presence of: (i) a reticulate pattern of microridges on the dorsal surface of the anal plates, (ii) the presence of two types of ventral tubular ducts, the larger ducts forming a marginal band and the smaller ducts in a broad submarginal band, and (iii) marginal setae of one type only, all spinose, in a band 2 to 3 setae wide around the entire margin, and not differentiated into stigmatic spines at each stigmatic area.

Etymology. The specific name *tafoensis* is composed of *Tafo*, the name of the site in Ghana where this species was collected, and *-ensis* (Latin), a suffix denoting place or locality.

Hemilecanium Newstead

urn:lsid:zoobank.org:author:2DEA755F-A46A-4203-B3B8-893324D22FAF
urn:lsid:zoobank.org:pub:7FB67D8F-AAA7-427B-AF54-53D64A52B87A

The genus *Hemilecanium* was introduced by Newstead (1908) to take *H. theobromae*, collected off cacao in Cameroon. Prior to 2005, *Hemilecanium* contained 4 species: *H. coriaceum* Hall, *H. imbricans* (Green), *H. recurvatum* Newstead and the type species. Since then however, there have been major changes in the species composition of *Hemilecanium,* most notably when Kondo and Hardy recently (2008) synonymised *Etiennea* Matile-Ferrero (type species *E. villiersi* Matile-Ferrero) with *Hemilecanium*, based on a comparative morphological study of the adult females, adult males and 1st-instar nymphs of 4 species of *Hemilecanium* and 6 species of *Etiennea*. The study also included a phylogenetic analysis based on adult female and 1st-instar nymphal characters. These changes brought the total number of species in *Hemilecanium* to 26. Earlier, Hodgson

(1994) had drawn attention to the morphological similarities of *Etiennea* and *Hemilecanium* (both genera having dorsal tubular ducts with funnel-like apertures and both with two centres of sclerotisation on the dorsum) but had considered that they could be easily separated due to the presence of cribriform plates on *Hemilecanium* (absent on *Etiennea* species). However, Kondo and Williams (2005) showed that 4 cribriform plates were present on the dorsum of the 1st-instar nymphs of several *Hemilecanium* species so that the 1st-instar nymphs of *E. villiersi* and *H. theobromae* were very similar.

Despite these changes, the species within the new concept of *Hemilecanium* can be divided into two groups based on the structure of the 1st-instar nymphs. These are referred to as the *petasus* and *thoebromae* groups by Kondo and Hardy (2008). The 1st-instar nymphs are only known for nine of the species now included in *Hemilecanium* but these can be separated as follows: the *petasus* group is diagnosed by the presence of: (i) the dorsum without clusters of 4-locular pores; (ii) each spiracular pore band with 2-4 spiracular disc-pores; (iii) each femur with a very long seta near apex (only on the prothoracic leg of *H. uesatoi*), and (iv) each stigmatic cleft with 3 well-developed stigmatic spines. The *petasus* group includes *H. ferox* (Newstead), *H. montricardiae* (Newstead), *H. multituberculatum* (Hodgson), *H. petasus* (Hodgson), *H. sinetuberculum* (Hodgson) and *H. uesatoi* Kondo & Hardy. The *theobromae* group, on the other hand, has the following combination of characters: (i) dorsum with 4 clusters of 4-locular pores; (ii) each spiracular pore band with 1 spiracular disc-pore; (iii) very long setae absent from all femora, and (iv) stigmatic spines absent. It includes *H. imbricans*, *H. mangiferae* Kondo & Williams, *H. theobromae* and *H. villiersi*. As pointed out by Kondo and Hardy, these two groups are also supported by a single adult female character, with those in the *theobromae* group lacking stigmatic spines while those in the *petasus* group have well-developed stigmatic spines. This suggests that the present composition of *Hemilecanium* may be paraphyletic. This was understood by Kondo and Hardy who go on to say (2008, p. 212) “We need data on first-instar nymphs of additional species to determine whether these two crawler types and their associated adult females will correspond to reciprocally monophyletic groups”.

Below is described a further species which is here being tentatively placed in *Hemilecanium*. Although the 1st-instar nymphs fulfil the 4 character-states for the *petasus* group discussed above, they also have an apparently unique character – 1-4 cone-shaped or flap-like triangular structures medially on most segments.

***Hemilecanium cedrelus* Hodgson, sp. n.**

urn:lsid:zoobank.org:act:422B8F25-F836-43A3-B878-27DC51E0DE90

Material studied. Holotype female: Zambia, Luanshya, 26.VII.1955, on *Cedrela toona* (spelt *tuna*), G.G. Robinson (BMNH): ad♀ in good condition.

Paratype ♀. Data as for holotype ♀:14/14 ad♀ (fair to good) (BMNH, USNM); also 3/27 1st-instar nymphs (fair to good (BMNH, USNM)) plus 1/1 3rd-instar ♀ (good) + 1 2nd-instar ♀ (with pharate 3rd-instar ♀; fair, with inner hyphae (BMNH)).

Adult female (Fig. 2).

Described from 5 specimens in good condition, and with reference to the remaining 10 specimens.

Instar diagnosis. *Dried material* with many clear, round, brown-ochre-coloured spots present throughout dorsum indicating position of dorsal tubercles. *Mounted material* oval to almost round. *Dorsum* membranous apart from a narrow sclerotisation around anterior margin of anal cleft; derm with a reticulate pattern of areolations; also with about 150-200 randomly distributed dorsal tubercles, distributed over entire dorsum, each without satellite tubular ducts; also "scars" (see discussion below) in position of dorsal tubercles of 3rd-instar. Conical preopercular pores and dorsal setae present. Anal plates roughly quadrate with 4 setae near apex. *Margin* with a single line of sharply spinose setae; with 3 stigmatic spines each clearly differentiated from marginal spinose setae, median stigmatic spines much longer than lateral spines. *Venter* with abundant 10-locular disc-pores on all abdominal and thoracic segments. Ventral microducts abundant throughout. Tubular ducts of probably 1 type, present in a wide submarginal band. Antennae 6 segmented. Limbs fully developed but relatively small; tibio-tarsal articulation without a sclerosis; claw digitules different; claw with a small denticle. Spiracles proportionately very large, width of peritreme much wider than width of coxae. Mouthparts relatively large.

Unmounted material. Dried material quite dark brown; younger specimens with a distinct shallow longitudinal dorsal ridge and a clear, shelf-like margin; older specimens becoming strongly convex with two strong shoulders medially; venter becoming highly concave, forming an inner egg chamber. Positions of dorsal tubercles indicated by clear round areas of more brown-ochre-coloured derm scattered over dorsum.

Mounted material. Oval to almost round, 2.8-6.0 mm long and 2.25-5.00 mm wide; anal cleft about 1/4th-1/5th body length. Basic structure as for diagnosis.

Dorsum. Derm mainly membranous but with a heavy sclerotised band around anterior margin of anal cleft, which expands anteriorly with age. Derm of available specimens with polygonal reticulations throughout, each reticulation with an inner areolation and a dorsal microductule; perhaps becoming sclerotised at maturity. Dorsal setae all rather spinose, quite sharply pointed, with parallel sides; frequent laterally and anteriorly to anal plates, but absent submarginally; those anterior to anal plates each 33-36 µm long, those more anteriorly and laterally smaller, down to 16-24 µm long. Preopercular pores present in an elongate triangular group anterior to anal plates, each pore conical and 8-11 µm wide; each group with 85-140 pores, extending anteriorly to about metathorax. Dorsal microductules oval, appearing bilocular but with single inner ductule arising medially, each about 2.5-3.0 µm widest, most ductules swollen proximally; abundant, present in each dorsal reticulation. Other dorsal pores absent. Dorsal tubercles large and convex, but sunken into derm; each 16-26 µm wide, with a heavily sclerotised outer cone plus 2 inner chimney-like tubes (one inside other); outermost tube with a ring of about 10-12 vertical ridges (see Discussion below adult female); innermost tube long, extending some way above tubercle; dorsum with a total of about 140-200 tubercles, randomly distributed throughout; also with about 16 submarginal "scars" and 2 pairs of submedial "scars" (in approximate positions of dorsal tubercles of 3rd instar). Anal plates each about 275-330

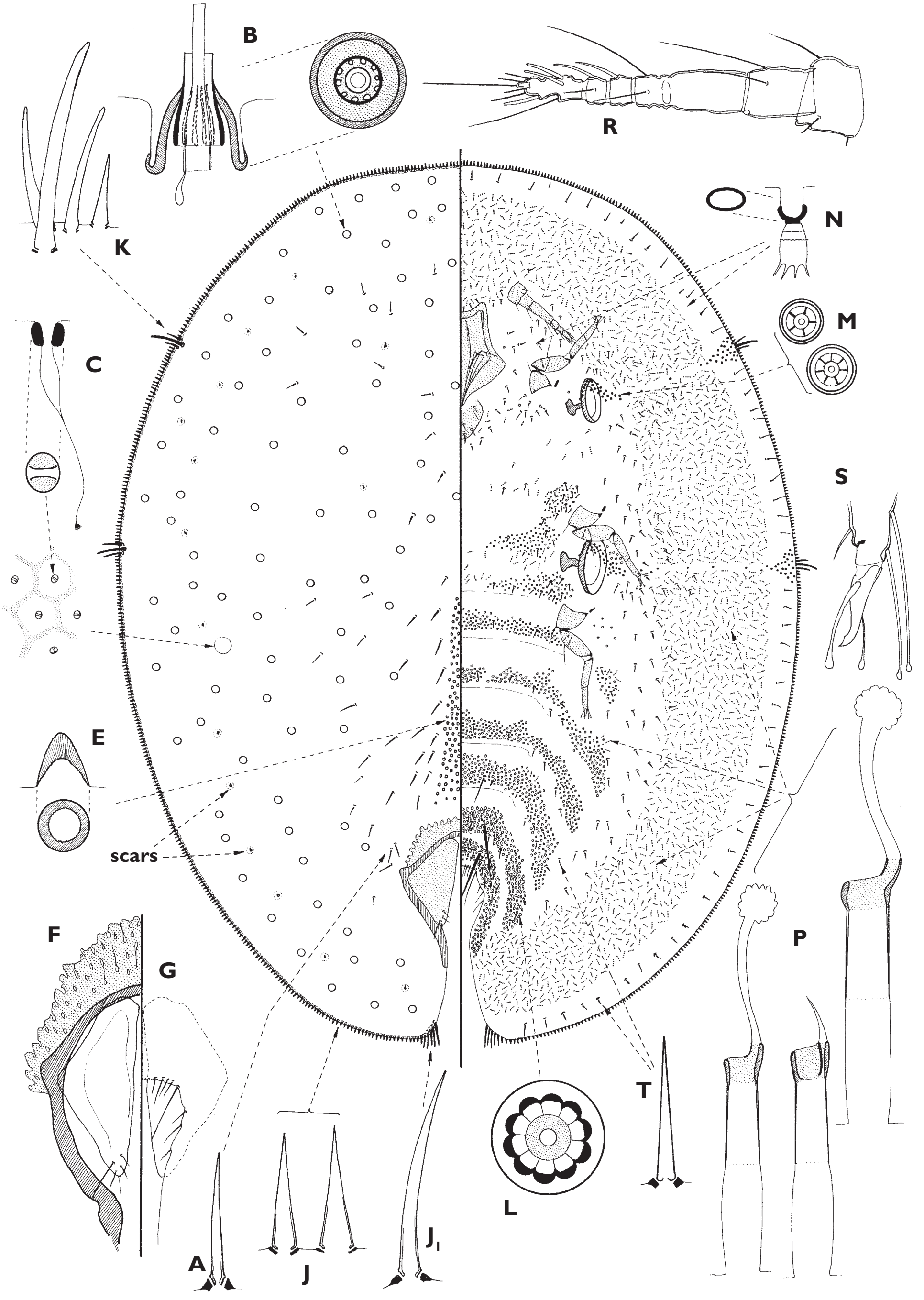

Fig. 2. *Hemilecanium cedrelus* Hodgson, sp. n., adult female. For lettering, see Fig. 1, but also where B = dorsal tubercle; E = preopercular pore; J = marginal seta and J_1 = marginal seta on anal lobe; K = stigmatic spines; P = tubular ducts; and scars = scars showing position of dorsal tubercles of 3rd-instar nymph.

µm long, width of single plate 115-170 µm; each plate triangular, with 4 apical setae, both inner margin setae and subapical seta 25-30 µm long, other seta appearing dorsal, about 60-72 µm long. Anogenital fold with a line of 6-8 setae along anterior margin, each fairly short but with a long seta at each corner, latter about 60-75 µm long; each lateral margin with 3 setose setae. Anal ring well developed, with many pores and probably 5 pairs of setae, each 270-360 µm long; anal tube about as long as anal plates. Eyespots not detected.

Margin. Marginal setae all sharply spinose, each 16-45 µm long, with a broad base, straight sides and narrow basal sockets; abundant, with 175-240 anteriorly between anterior stigmatic areas, 54-62 laterally between stigmatic areas and 125-195 on each side of abdomen; each anal lobe with a group of 5 or 6 longer, slightly curved setae, longest 105-115 µm long. Stigmatic clefts absent. Stigmatic spines 3, clearly differentiated from marginal spines, slightly curved and with a less pointed apex than marginal setae; median spine longest, 75-85 µm long, each lateral spine 28-65 µm long.

Venter. Derm membranous. Spiracular disc-pores each mainly with 5 loculi, in broad groups near margin and each peritreme but very few or even sometimes absent in between; with about 45-50 in each anterior band and 60-85 in each posterior band, latter with a small group of multilocular pores near each spiracle. Multilocular disc-pores each about 8-10 µm wide, mainly with 10 loculi, abundant across all abdominal segments and across meso- and metathorax; scarce on prothorax and head. Ventral microducts each about 3 µm wide, abundant throughout, except marginally. Ventral tubular ducts slightly variable but probably all of one type, each with an outer ductule 17-30 µm long, inner ductule 13-20 µm long, with or without a glandular end; abundant in a broad submarginal band and rather less frequently in bands across each thoracic segment; with 1 or 2 present medially on abdomen among multilocular disc-pores. Other pores types absent. Ventral setae mainly rather spinose, most about 20-26 µm long, present across each abdominal and thoracic segment but most abundant in a submedial band just laterad to spiracles and legs; with about 5 pairs of rather short inter-antennal setae, longest 40 µm long; abdominal segments V, VI and VII each with a pair of longer setae, longest on VI and VII, each about 150 µm long; submarginal setae frequent, each about 25 µm long.

Antennae each 6 segmented, total length 250-350 µm; scape with 3 setae, pedicel with 2 setae, other segments: III with 2 setae, IV with 1 fleshy seta, V with 1 fleshy seta + 1 flagellate seta and VI with 3 fleshy setae, about 5 stiff apical setae + 1 flagellate seta; length of apical seta 66-90 µm long. Clypeolabral shield 270-350 µm long, labium probably with 4 pairs of setae. Spiracles large, width of peritremes: anterior 125-165 µm, posterior 155-210 µm; muscle plate much shorter than width of peritreme. Legs well developed but small; lengths (µm) of metathoracic legs: coxae 120-130 (width of coxal base 80-100 µm); trochanter + femur 145-153; tibia + tarsus 185-210; claw 28-31; tibio-tarsal articulation not always clear, with no sclerosis; longest coxal seta about 70 µm; longest trochanter seta about 85 µm; other setae very sparse; tarsal digitules about equal to length of claw digitules; claw digitules longer than claw, with one slightly narrower than other; claw with a small denticle. Vulva probably present between abdominal segments VII and VIII.

Comment. The adult females of this species are superficially similar to those of *Hemilecanium coriaceum* Hall and *H. uesatoi* Kondo & Hardy, which also have dorsal tubercles randomly distributed throughout the dorsum,. However, *H. cedrelus* differs from *H. coriaceum* as follows (characters-states on *H. coriaceum* in brackets): (i) presence of 3 clearly differentiated stigmatic spines (absent or 1 barely differentiated); (ii) multilocular disc-pores abundant across all abdominal segments and also across meso- and metathorax (many fewer, restricted to abdomen); (iii) preopercular pores in an elongate group anterior to anal plates (in a broad group incorporating some dorsal tubercles anterior to anal plates); and (iv) large size of spiracular peritremes (small). Adult female *H. cedrelus* are also similar to the newly described *H. uesatoi* from the Ryukyu Archipelago, Japan, but the latter differs in having normal-sized spiracles; pocket-like sclerotisations restricted to the submargin, preopercular pores extending anteriorly onto head; 8-segmented antennae, and no denticle on the claw. In addition, the 1st-instar nymphs are rather different (see under that stage below).

Initially it was assumed that the ring of sclerotised spots on each dorsal tubercle, which are clearly visible in dorsal views of each tubercle, were satellite tubular ducts similar to those on some *Hemilecanium* species. However, true satellite ducts have the structure of a small tubular duct, i.e. with a long outer ductule, a small cup-shaped invagination and sometimes an inner ductule, each duct opening onto the surface of the tubercle through an aperture some distance from the funnel-like central cone (see *Etiennea halli*, *E. kellyi*, *E. petasus* and *E. villiersi* in Hodgson, 1991 (now all in *Hemilecanium*)). This is quite different from what we see on *H. cedrelus* where, when seen from the side, these "sclerotised spots" appear to refer to vertical sclerotised ridges on the outer funnel-shaped tube; none of which have either an associated ductule or an outer aperture. It is therefore considered that these structures are not satellite tubular ducts.

Distribution. *Hemilecanium cedrelus* is currently only known from Zambia.

Third-instar female (Fig. 3)

Described from 1 specimen in good condition. (Note: the data in brackets for the number of dorsal tubercles are from the pharate 3rd-instar nymph – see discussion under 2nd-instar nymph below.)

Instar diagnosis. Oval and rather flat. Dorsum with a submarginal ring of large dorsal tubercles plus 2/3 submedially on thorax. Margin with a single line of sharply spinose setae; with 3 stigmatic spines clearly differentiated from marginal spinose setae. Venter with a small group of 5-locular disc-pores posterior to anal opening; also with a sparse submarginal band of tubular ducts. Antennae 5 or 6 segmented. Legs fully developed; claw digitules dissimilar; claw with a small denticle. Spiracles of normal proportions, width of peritreme smaller than width of coxae. Mouthparts relatively large.

Unmounted material. Dried material pale brown; oval, rather flat, with a few shallow, radial ridges. No sign of a wax test.

Mounted material. As in instar diagnosis. Body 1.33 mm long and 0.9 mm wide; anal cleft about 1/5th body length. Dorsum with a submarginal ring of about 30 large dorsal tubercles plus 2(3) submedially on thorax, plus "scars" left by the 12 dorsal tubercles of 2nd-instar nymph.

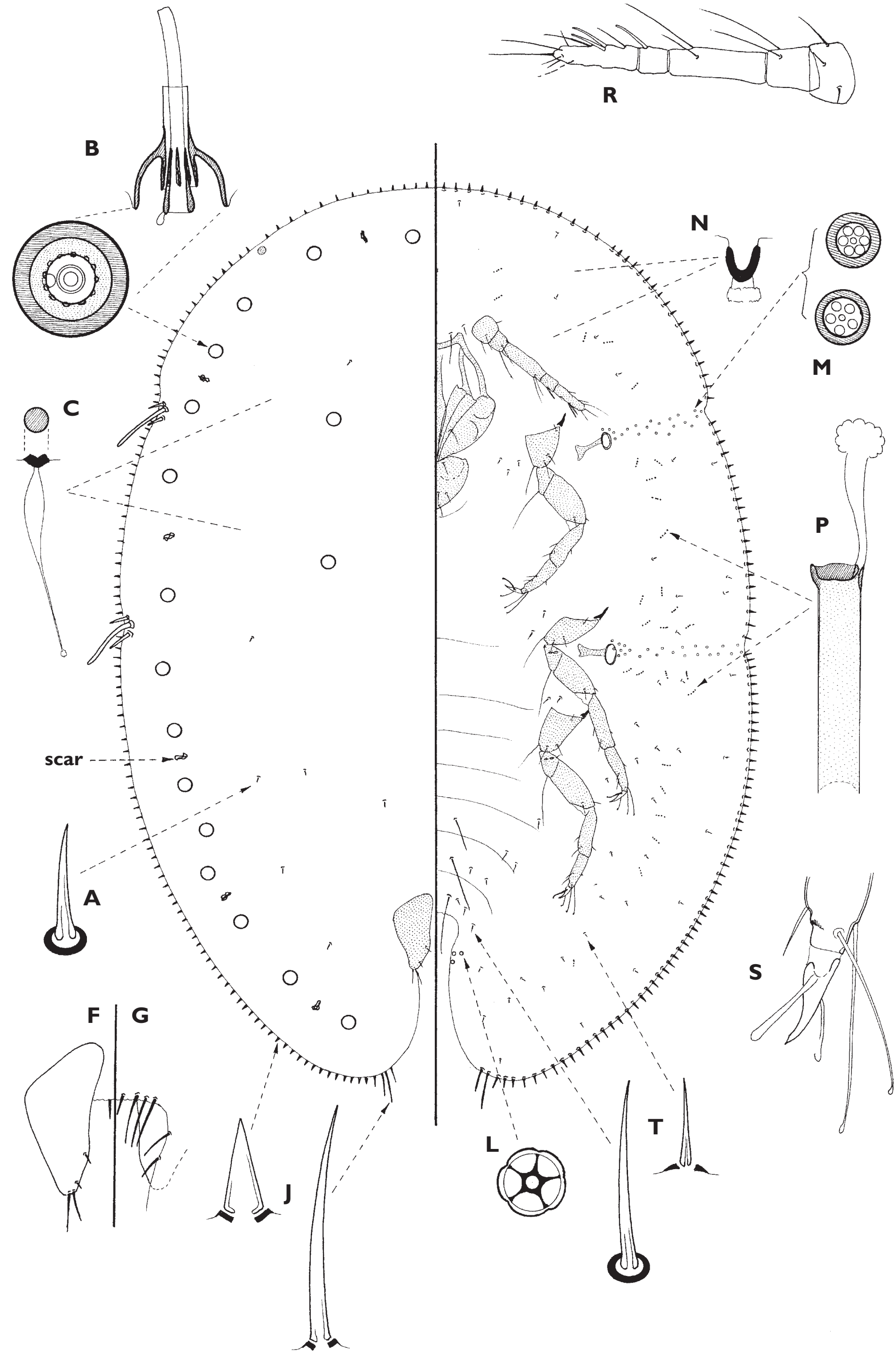

Fig. 3. *Hemilecanium cedrelus* Hodgson, sp. n., female 3rd- instar nymph. For lettering, see Figs 1 & 2, but where scar = position of scars left by dorsal tubercles of 2nd-instar nymph.

Dorsum. Derm mainly membranous, without a sclerotised band around anterior margin of anal cleft and without a reticulate pattern of areolations. Dorsal setae very few, each short and finely spinose, each about 10 µm long; distribution uncertain but very sparse. Preopercular pores absent. Dorsal microductules small, each about 1.5 µm wide, with an inner ductule about 8 µm long, most ductules swollen proximally; abundant. Other dorsal pores absent. Dorsal tubercles of more or less two types: (i) large and convex, each about 20-24 µm wide, basically similar to those on adult female; with (on each side in a submarginal ring) 5 (5-7) on abdomen; 2 (3) between stigmatic clefts, 2 (3) between anterior cleft and eyespot and 4 anteriorly between eyespots; and (ii) what are here considered to be remains of dorsal tubercles of 2nd-instar female, structure very unclear (but probably similar to "scars" on adult female); with 3 on each side of abdomen, 1 between stigmatic clefts, between anterior cleft and eyespot and 2 anteriorly between eyespots. Anal plates each about 110 µm long, width of single plate about 55 µm; each plate triangular, with 4 setae: 2 inner margin setae, both short, and two other apical setae, positions uncertain, each possibly 16-23 µm long. Anogenital fold with a line of perhaps 8 setae along anterior margin, each about 28 µm long; each lateral margin with 2 setae. Anal ring well developed, with 4 pairs of setae, each about 100 µm long; anal tube about twice length of anal plates. Eyespots oval, 21-23 µm widest.

Margin. Marginal setae all sharply spinose, each 12-16 µm long, with a broad base, rather straight sides and narrow basal sockets; with a total of 26 anteriorly between eyespots, and (on each side) 15-19 between eyespots and anterior stigmatic areas, 20-22 laterally between stigmatic areas and 58-64 on each side of abdomen; each anal lobe with a group of 2 or 3 longer, slightly curved setae, longest 53-66 µm long. Stigmatic clefts shallow, each with 3 stigmatic spines, clearly differentiated from marginal spines, slightly curved and with a less pointed apex than marginal setae; median spine longest, 70-90 µm long, each lateral spine 20-40 µm long.

Venter. Derm membranous. Spiracular disc-pores, each with a broad sclerotised margin and perhaps mainly with 5 or 6 loculi, in broad bands between margin and each peritreme; with 20 or 21 in each anterior band and 24-26 in each posterior band. Preanal multilocular disc-pores each about 5 µm wide with 5 loculi, in a small group of 3 each side beneath anal plates. Ventral microducts each about 3 µm wide, abundant throughout apart from marginally, where absent. Ventral tubular ducts of one type, each with an outer ductule 15 µm long, inner ductule 10-12 µm long, with a glandular end; in a mainly narrow submarginal band but tending to be most concentrated on either side of spiracular disc-pore bands, with 3 anteriorly on head, 1-3 between eyespots and anterior stigmatic clefts, 11-12 on each side between stigmatic clefts and 11-18 on each side of abdomen. Other pore types absent. Ventral setae perhaps slightly larger medially than laterally, most about 10-12 µm long; with one longer pair and one shorter pair of inter-antennal setae, longest about 60 µm; with long setae medially on abdominal segments V–VII, longest about 85 µm; with 2 or 3 short setae associated with each coxa; other setae fairly frequent in a broad submarginal band, most abundant on abdomen, each about 6-7 µm long.

Antennae each either 5 segmented or slightly deformed (i.e. really 6 segmented), total length 200-215 µm; scape with 3 setae, pedicel with 2 setae + campaniform sensillum, setae on other segments uncertain. Clypeolabral shield 185 µm long; labium with 4 pairs of setae. Spiracles of normal size, width of peritremes: anterior 25 µm, posterior 30-32 µm. Legs well developed; lengths (µm) of metathoracic legs: coxae 80-85; trochanter + femur 100-110; tibia + tarsus 122-140; claw 23-26; tibio-tarsal articulation poorly defined; longest coxal seta about 58-60 µm; longest trochanteral seta about 55 µm; femur with 2 setae; tibia with 3 setae; tarsus with 3 setae; tarsal digitules perhaps extending further than claw digitules, each 28 µm long; claw digitules longer than claw, with one narrower than other, length 28-32 µm; claw with a small denticle.

Comment. This is the only immature stage of any Coccidae known to the author with preanal multilocular disc-pores.

Second- instar female (Fig. 4)

Described from a single specimen containing a pharate 3rd-instar nymph.

Instar diagnosis. Oval. Similar to 3rd-instar but venter without disc-pores posterior to anal opening and without tubular ducts; marginal setae and spiracular disc-pores fewer.

Unmounted material. Dried material pale brown; oval, rather flat, with a few shallow, radial ridges. No sign of a wax test.

Mounted material. As for instar diagnosis. Body 1.5 mm long and 1.08 mm wide; anal cleft about 1/6th body length. Submarginal ring of 12 dorsal tubercles**.**

Dorsum. Derm mainly membranous, without a sclerotised band around anterior margin of anal cleft and without a reticulate pattern of areolations. Dorsal setae possibly absent. Dorsal microductules small, each about 1.5 µm wide, with or without an inner ductule, most ductules swollen proximally; sparse. Other dorsal pores absent. Dorsal tubercles of 1 type, each 11-15 µm wide**;** structure basically similar to those on adult female but smaller, each with about 6 vertical ridges on outer inner tube; with 1 pair of tubercles anteriorly, and (on each side) 1 between eyespots and anterior stigmatic cleft, 1 laterally between stigmatic clefts and 3 or 4 on abdomen (plus dorsal tubercles of pharate 3rd-instar nymph (as indicated in brackets in the description above). Anal plates each about 90 µm long, width of single plate about 42 µm; each plate triangular, with 4 setae, all broken. Anogenital fold with 2 pairs of setae anteriorly, longest setae about 33 µm long; each lateral margin with 1 seta. Anal ring well developed, with 3 pairs of setae, each about 110 µm long; anal tube about twice length of anal plates. Eyespots oval, 15 µm widest.

Margin. Marginal setae all sharply spinose, each 8-20 µm long, with a broad base, slightly curved sides and narrow basal sockets; with 12 anteriorly between eyespots, and (on each side) 6 between eyespots and anterior stigmatic areas, 6 or 7 laterally between stigmatic areas and 19-22 on each side of abdomen; each anal lobe probably with a group of 2 or 3 longer setae but all broken. Stigmatic clefts shallow, each with 3 stigmatic spines, clearly differentiated from marginal spines, slightly curved and with a less pointed apex than marginal setae; median spine longest, 60 µm long (only one present), each lateral spine 15-18 µm long.

Venter. Derm membranous. Spiracular disc-pores each with a broad sclerotised margin and perhaps mainly with 5 loculi, in narrow bands between margin and each peritreme; with 7 in each anterior band and 10-12 in each posterior band. Preanal multilocular disc-pores absent. Ventral microducts each about 3 µm wide, sparse in a broad submarginal band and also occasional medially on head, thorax and abdomen. Ventral tubular ducts absent. Other pores types absent. Ventral setae few, with two pairs of interantennal setae, longest 33+ µm; with long setae medially on abdominal segments V–VII, longest about 80+ µm; each coxa with 1 minute associated seta; other

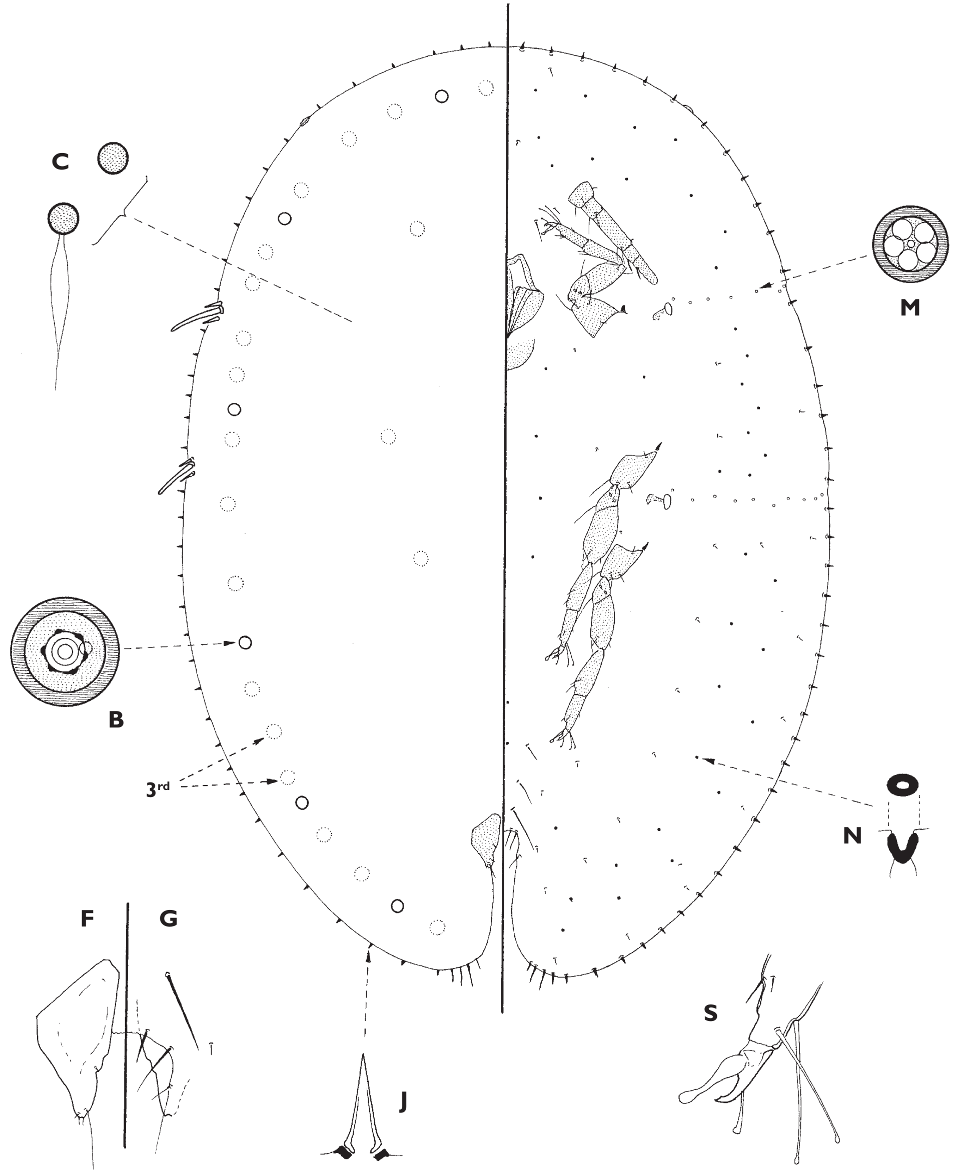

Fig. 4. *Hemilecanium cedrelus* Hodgson, sp. n., female 2nd-instyar nymph. For lettering, see Figs 1 & 2, but also where 3rd = position of dorsal tubercles on pharate 3rd-instar nymph.

setae in a submarginal line (1 laterally between stigmatic clefts), and an inner submarginal line on abdomen; each about 6-7 µm long.

Antennae both damaged but either 5 segmented or slightly deformed (i.e. really 6 segmented), total length perhaps 210 µm; scape with 3 setae, pedicel with 2 setae + campaniform sensillum; number on other segments uncertain. Clypeolabral shield 132 µm long; labium with 4 pairs of setae. Spiracles of normal size, all peritremes 17-19 µm wide. Legs well developed; lengths (µm) of metathoracic legs: coxae 78-80; trochanter + femur 116-120; tibia 80-85; tarsus 65-70; claw 20-22; tibio-tarsal articulation fairly clear; longest coxal seta about 60-66 µm; all long trochanter setae broken; femur 2 setae; tibia 3 setae; tarsus 3 setae; tarsal digitules perhaps extending further than claw digitules, each about 45 µm long; claw digitules longer than claw, with one clearly narrower than other, length 25-28 µm; claw with a small denticle.

Comment. Despite having a slightly larger body size than the 3rd-instar nymph described above, this is clearly a female 2nd-instar nymph. This is shown not only by the smaller limbs etc, smaller number of spiracular disc-pores and absence of preanal disc-pores, but also by the presence of the pharate 3rd-instar and the distribution of the latter's dorsal tubercles, which are clearly visible inside its cuticle.

Because this specimen had a pharate 3rd-instar nymph within, it was possible to study the number and distribution of the dorsal tubercles, which were well developed and these data are given in brackets in the description of the 3rd-instar nymph above. The number and distribution of the "scars" on the derm of the 3rd-instar nymph agree with the number and positions of the dorsal tubercles on the 2nd-instar nymph and therefore clearly refer to these (see also the Discussion beneath description of 1st-instar nymph of *H. cedrelus*).

First-instar (Fig. 5)

Instar diagnosis. Oval. Dorsum membranous but with a series of 1-4 large, triangular or cone-shaped protuberances medially on most segments. Dorsal setae absent. Margin with small spinose setae. Each stigmatic cleft with 3 stigmatic spines, median spine long. Venter with three pairs of long preanal setae. Ventral microducts in a sparse submarginal line. Legs well developed; each femur with an exceptionally long seta on anterior margin; long setae also present on tibia and tarsus; claw digitules different; claw with a small denticle.

Mounted material. As for instar diagnosis. Body 0.5-0.53 mm long and 0.26-0.30 mm wide; anal cleft very short.

Dorsum. Derm mainly membranous, but with large triangular or cone-shaped protuberances medially, each margin of protuberance about 33-35 µm long and each 20-22 µm wide at base**,** distributed as follows: none on abdominal segments V-VII, pairs on abdominal segments III & IV, singles on abdominal segments I & II, each thoracic segment plus a pair posteriorly on head and 2 pairs together more anteriorly on head. Dorsal setae absent. Dorsal microductules small, each about 1.5 µm wide with a long inner ductule, most ductules swollen proximally; mainly in 2 pairs of longitudinal lines, one pair of lines medially (with 5 pores on abdomen, probably 3 on thorax and 1 on head) and other lines submarginal (with 7 pores on abdomen, 2

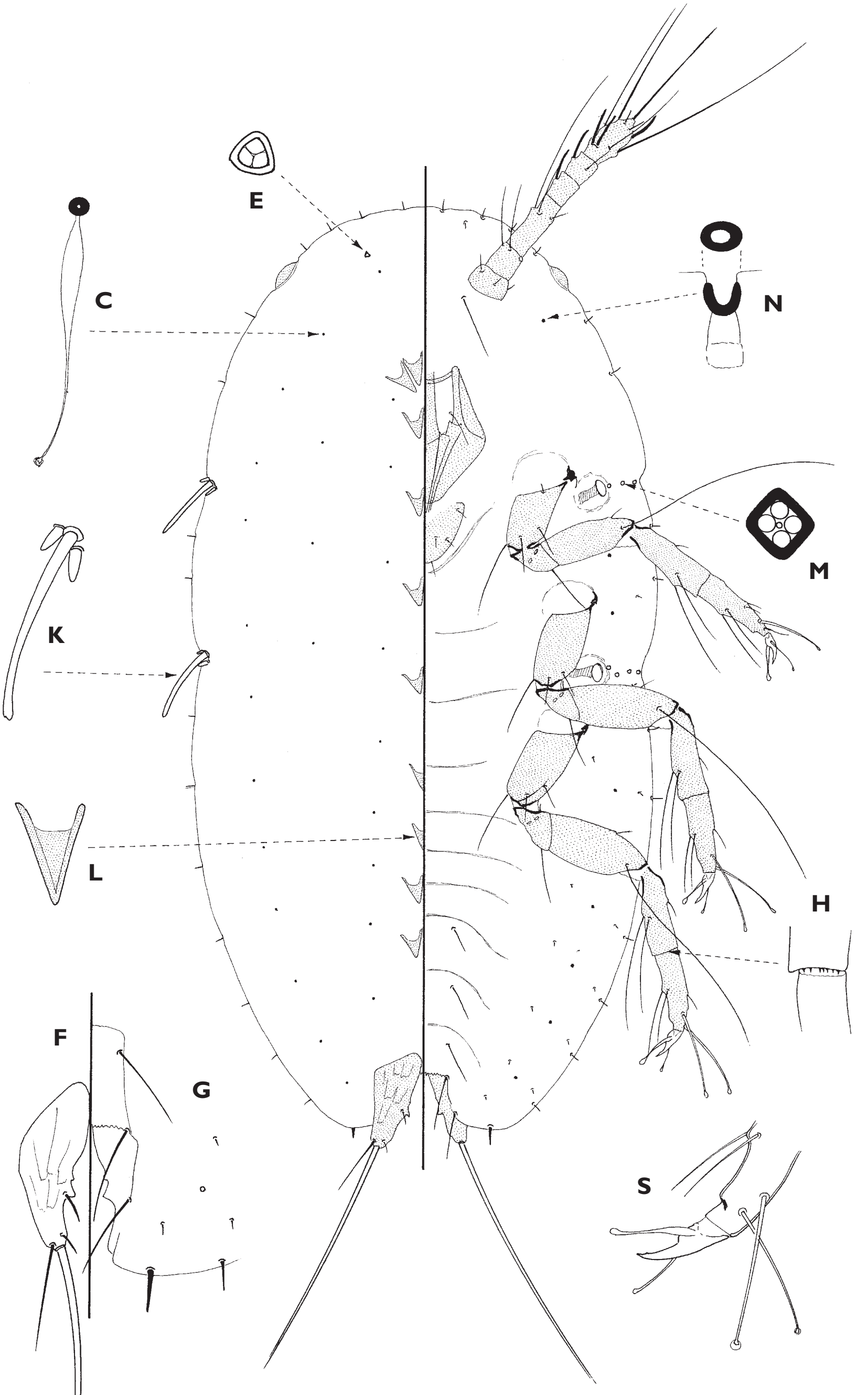

Fig. 5. *Hemilecanium cedrelus* Hodgson, sp. n., 1^{st}-instar nymph (sex unknown). For lettering, see Figs 1 & 2, but where E = dorsal trilocular pore; L =dorsal protuberances, and H = tibio-tarsal articulation with microspines.

between stigmatic clefts and 4 anteriorly); also with single pores submedially in each thoracic segment. A pair of trilocular pores present on head some distance from anterior margin, each about 3.0 µm wide. Other dorsal pores absent. Anal plates each quite elongate, about 60-65 µm long, with a few shallow longitudinal ridges; each with a small spine on inner margin, 2 short setae along inner margin, each about 8 µm long; a very long apical seta, each 260-310 µm long, and a single seta on posterior margin, about 36 µm long. Anogenital fold with a single long seta at each corner, each 26-28 µm long, and a single similar seta on each lateral margin, 23-28 µm long. Anal ring with 2 rows of pores, each with 5-7 pores, plus 6 anal ring setae, each about 80-85 µm long; anal tube extending anterior to anal plates. Eyespots each 15-18 µm wide.

Margin. Marginal setae all finely spinose, most 6-8 µm long (that on each anal lobe 13-15 µm long), with well-developed socket, distributed as follows: with 8 anteriorly between eyespots, and (on each side) 2 between eyespots and anterior stigmatic cleft, 2 laterally between stigmatic clefts and 8 on abdomen. Stigmatic clefts shallow, each with 3 stigmatic spines clearly differentiated from marginal setae; median spinose seta very long, rather parallel sided and possibly with a slightly flattened apex, each 40-45 µm long, with a broad basal socket; anterior lateral spine shortest, about 5 µm long, posterior spine about 6.5 µm long.

Venter. Derm membranous. Spiracular disc-pores each with very thick margins and perhaps with mainly 3 or 4 loculi (occasionally 5?), with 3 pores in each anterior pore band and 4 in each posterior band. Ventral microducts each about 1.5 µm wide, present in a submarginal line, with (on each side) 1 on head, 2 on thorax and probably 6 on abdomen. Ventral setae few; with 1 pair of interantennal setae, each about 40 µm long, and with pairs of long setae medially in abdominal segments V-VII, longest about 40-45 µm long; short setae in a submarginal line, with (on each side) 7 on abdomen, 1 on thorax and 1 anteriorly on head; also with an inner submarginal line of 7 setae on abdomen.

Antennae each 6 segmented, total length 150-175 µm; scape with 3 setae, pedicel with 2 quite long setae + campaniform sensillum segments: III with 3 setae, one very long, up to about 80-85 µm long, IV 1 fleshy seta, V 1 fleshy seta + 1 flagellate seta, and VI with 3 fleshy setae, about 4 stiff apical setae + 3 flagellate setae, longest at least 110 µm long; length of apical seta about 110 µm long. Clypeolabral shield 87-95 µm long; labium with 4 pairs of setae. Spiracles: all peritremes about 8 µm wide, in a shallow concavity. Legs well developed; lengths (µm) of metathoracic legs: coxae 60-66; trochanter + femur 83-85; tibia 55-60; tarsus 45-52; claw 20-23; longest coxal seta about 33-45 µm; longest trochanter seta about 40 µm; each femur with 3 setae, one exceptionally long seta on anterior margin, 140-150 µm long; tibia with 3 setae, 2 rather long, longest 75-80 µm long; tibia with a row of microspines along distal margin on each middle and hind leg; tarsus with 4 setae, 2 quite long, longest about 40 µm; tarsal digitules both capitate, offset, extending to about equal with claw digitules, each about 50 µm long; claw digitules longer than claw, with one distinctly narrower than other, each about 28 µm long; claw with a small denticle.

Comment. The 1st-instar nymph of *H. cedrelus* is distinctive due to the presence of the triangular or cone-shaped protuberances medially on the dorsum of most segments, unknown on any other 1st-instar nymphs as far as the author is aware, including those of *H. uesatoi.* However, Hodgson (1993), when describing the dorsum of *Etiennea (Hemilecanium) petasus* wrote "Derm entirely membranous, but thrown into small dermal nodules – in some specimens, these are rather pronounced and found throughout, in others they are few, but are always present around the margin and *in pairs medially,* probably one pair per segment" (my italics). In seems possible, therefore, that these "nodules" are just more pronounced on *H. cedrelus*. In addition, the presence of very long setae on each femoral segment of *H. cedrelus* is unusual, although similar setae are known on other species (Hodgson, 1993) in the *petasus* group as defined by Kondo and Hardy (2008). They are also known on *Protopulvinaria pyriformis* (Cockerell) (Ray & Williams, 1982) and *Kilifia* De Lotto (Ray & Williams, 1982). In addition to the triangular or cone-shaped protuberances medially, which are absent on the 1st-instar nymph of *H. uesatoi,* the 1st-instar nymphs of *H. cedrelus* differ from those of *H. uesatoi* in having (character-states on *H. uesatoi* (from Kondo & Hardy, 2008) in brackets): (i) long femoral setae on all femora (restricted to the metafemur only); and (ii) claw digitules dissimilar (similar).

Etymology. The specific name *cedrelus* is taken from the generic name of the host plant, *Cedrela toona* (Meliaceae).

A key to the adult females of *Hemilecanium* Newstead was included in Kondo and Hardy (2008, p. 195). This key can be modified to include *H. cedrelus* as follows:

6. Stigmatic spines not differentiated from marginal spines 7
– Stigmatic spines clearly differentiated from marginal setae 9a
9a Dorsum with dorsal tubercles present throughout dorsum; antennae 6-segmented; spiracles very large, posterior peritreme generally more than 1.7 times wider than basal width of metacoxa .... *H. cedrelus* new species
– Dorsum with dorsal tubercles generally restricted to a submarginal band (except *H. uesatoi*); antennae usually more than 6 segmented; spiracles smaller, width of peritremes of posterior spiracles usually less than basal width of metacoxa............ ....9b (9b is original couplet 9)

General discussion

Boratynski (1970), when describing the immature stages of *Parthenolecanium persicae* (Fabricius), showed that the positions of the dorsal tubercles (which he called marginal bicylindrical ducts) on immature instars was indicated in the following instar (i.e. the positions of the tubercles of the 2nd-instar nymphs on the derm of the 3rd-instar nymph) by atrophied ducts. This is a fairly common phenomenon in the Coccidae, where the term "pocket-like sclerotisations" has been frequently used to describe the atrophied tubercles. In *H. cedrelus*, the atrophied tubercles do not look like the pocket-like sclerotizations found on other Coccidae, although their exact structure is hard to determine, and so are referred to here simply as "scars". Thus, the position of the dorsal tubercles on the 2nd-instar nymph is shown by "scars" on the dorsum of the 3rd-instar nymph, and those of the 3rd-instar nymph by "scars" on the dorsum of the adult female. It appears that the "scars" on the 3rd-instar nymph (left from the tubercles of the 2nd-instar nymph) disappear at the last moult into the adult female as none could be detected.

Acknowledgements

I am extremely grateful to Dr. Jon Martin, Keeper of the Coccoidea collection in the Natural History Museum, London, for the loan of the specimens and for his general assistance, and to Drs Takumasa Kondo and Nathaniel Hardy for their helpful comments and criticisms of the manuscript. I am also most grateful to the National Museum of Wales for providing research facilities and for general encouragement.

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ZooKeys 3: 77-102 (2008)
doi: 10.3897/zookeys.3.51
www.pensoftonline.net/zookeys

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The scolopendromorph centipedes (Chilopoda, Scolopendromorpha) of Tunisia: taxonomy, distribution and habitats

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Academic editor: *Marzio Zapparoli* | Received 3 October 2008 | Accepted 4 November 2008 | Published 9 November 2008

Citation: Akkari N, Stoev P, Lewis JGE (2008) The scolopendromorph centipedes (Chilopoda, Scolopendromorpha) of Tunisia: taxonomy, distribution and habitats. ZooKeys 3: 77-102. doi: 10.3897/zookeys.3.51

Abstract

The present paper provides a review of the composition, distribution and habitat preferences of the scolopendromorph centipede fauna of Tunisia. Five (sub)genera and 8 (sub)species have hitherto been reported from the country, of which two are of uncertain status. After a study of significant amount of new material collected in the period 2003-2008, 6 species, namely *Scolopendra canidens* Newport, 1844, *S. morsitans* Linnaeus, 1758, *Cormocephalus gervaisianus* (C.L. Koch, 1841), *Otostigmus spinicaudus* (Newport, 1844), *Cryptops punicus* Silvestri, 1896 and *C. trisulcatus* Brölemann, 1902, were found in the country. New illustrations and, where appropriate, brief descriptions of the species are given, along with an identification key for the Tunisian scolopendromorphs. *Cryptops anomalans* Newport, 1844, *Scolopendra oraniensis* Lucas, 1846 and *S. cingulata* Latreille, 1829 are excluded from the country's list since all previous records are most likely based on misidentifications. *Cryptops trisulcatus* and *C. punicus* are recorded for the first time from Tunisia and Libya, respectively. The taxonomic position of *C. punicus* is discussed and the species is transferred from the subgenus *Trigonocryptops* to *Cryptops*. *Scolopendra morsitans scopoliana* is synonymised under *S. morsitans*. *S. canidens*, *O. spinicaudus* and *C. punicus* are well adapted to arid and semidesert biotopes and have much wider ranges compared to the other three species which are restricted to the northern, more humid parts of the country. *S. canidens* is the only myriapod in Tunisia found in a pure sandy desert.

Keywords

Scolopendra, *Cormocephalus*, *Otostigmus*, *Cryptops*, deserts, oases, identification key, Tunisia, Libya

Introduction

The scolopendromorph centipedes of Tunisia have never been studied intensively. Prior to Silvestri's (1896) paper "Una escursione in Tunisia…" only two species, *Scolopendra oraniensis* Lucas, 1846 and *Scolopendra mediterranea* var. *africana* Verhoeff, 1891 collected in the cities of Tunis and Gabes respectively [misspelled Ghades], had been recorded from the country (Pocock 1892, Verhoeff, 1891, Verhoeff 1893). After studying topotypic material of the latter, Silvestri (1896) proposed its synonymy with *S. oraniensis*. In the same publication he also recorded *Cupipes* (now *Cormocephalus*) *gervaisianus* (C.L. Koch, 1841) and *Cryptops anomalans* Newport, 1844 for Tunisia, and described a new variety, *punicus*, of *C. anomalans*. Verhoeff (1901) described *Otostigma tunetanum* from Tunis which Kraepelin (1903) later synonymized with *Otostigmus spinicaudus* (Newport, 1844). Kraepelin also reported *S. morsitans scopoliana* C.L. Koch, 1841 and *S. canidens* Newport, 1844, although he did not specify where exactly these species were collected. He disregarded the separate status of *punicus*. Attems (1902) reported *Scolopendra morsitans* Linnaeus, 1758 from Medjez-el-Bab in North Tunisia. A few years later, he (Attems 1908) also identified the myriapods amassed by Henri Gadeau de Kerville during his remarkable expedition to Kroumirie (NW Tunisia), confirming the occurrence in the area of *C. gervaisianus* and *C. anomalans*. Brölemann (1904) reported *Scolopendra morsitans* and *S. canidens* from several localities in Tunisia and was the first to summarize the information on the Myriapoda of North Africa, providing a checklist of all species known at that time (Brolemann 1921). He mentioned altogether 9 (sub)species of Scolopendromorpha for Tunisia, including *Scolopendra cingulata* Latreille, 1829, although, like Kraepelin, he did not mention any specific localities. In another paper (Brolemann 1928) he raised *Cryptops anomalans punicus* to full species rank and transferred it to the genus *Trigonocryptops* Verhoeff, 1906. In his monograph on Scolopendromorpha Attems (1930) excluded *S. oraniensis* and *S. cingulata* from the list of Tunisian species and probably being unaware of Brolemann's publication, regarded *C. punicus* as a synonym of *C. anomalans*. Studying a small collection of myriapods collected by Dr. Cloudsley-Thompson in Tunisia, Turk (1955) recorded *S. canidens* and *S. clavipes* C.L. Koch, 1847 from Jebel Cherchera, west of Kairouan. The same material was later referred to by Cloudsley-Thompson (1956). Dobroruka (1968) reported *S. morsitans*, *S. canidens* (incl. *S. c. cyrenaica* Verhoeff, 1908), and *C. gervaisianus* from several localities in Tunisia. Lewis (1969) recorded *Scolopendra amazonica* Bücherl, 1946, which is currently considered a junior synonym of *S. morsitans* (Würmli 1975, Koch 1983), from a mountain near Soukahas, Tunis, at 1000-1500 m elevation. This record from 1894 may refer to the Barbary state of Tunis rather than the city. This seems probable as there is no settlement with this name near Tunis, nor a mountain that high.

The taxonomic status and the distribution in the Mediterranean region of the species of *S. canidens* group were revised by Würmli (1980). Two of the subspecies, *S. canidens oraniensis* and *S. canidens cretica* Attems, 1902, were given full species rank, while some others including *S. c. cyrenaica* were synonymized. The author concluded that in Tunisia the group, which comprises also *S. clavipes* and *S. dalmatica* C.L. Koch, 1847, is represented only by *S. canidens*. Recently, Zapparoli (2002), Zapparoli et al. (2004), Simaiakis and Mylonas (2008) mentioned Tunisia in their overviews of the world range of *Scolopendra cingulata*. The centipede fauna of the Italian islands Lampedusa, Linosa and Pantelleria, which are situated close to Tunisian coast, was studied by Zapparoli (1995). On Pantelleria, which is located approx. 70 km off the Tunisian coast he recorded *C. punicus*, *C. trisulcatus* Brölemann, 1902, and *S. cingulata*, while on the Pelagic islands Lampedusa and Linosa lying ca. 120 km off the coast *S. canidens* and *C. punicus* were found. CHILOBASE, the world catalogue of Chilopoda (Minelli 2006) lists the following taxa: *C. anomalans*, *C. punicus*, *C. gervaisianus*, *S. oraniensis* and *O. spinicaudus* for Tunisia.

The Tunisian scolopendromorph fauna comprises 5 (sub)genera and 8 (sub)species, of which, the occurrence of *S. cingulata* and *C. anomalans* needs confirmation. Almost all the remaining species are known from single outdated records, mainly from the northern, generally better prospected parts of the country (e.g. Kroumirie and Mogods regions). The scolopendromorph fauna of the arid, semidesert and desert regions in the central and southern parts of the country (e.g. the Tunisian Ridge, the Sahel, the plain of Kasserine, the Grand Erg Oriental and the coastal plain of Jeffara) remained virtually unknown as had the biology and ecology of all Tunisian species.

In the last five years abundant material of Scolopendromorpha collected in each of the four main bioclimatic zones of the country: Humid (Kroumirie and Mogods regions), Subhumid (Cap Bon Peninsula), Semiarid–Arid (Central Tunisia), Arid (meridian Tunisia, south of 36th parallel) was accumulated and investigated. The aim of present paper is to put on record the results of the identification of this significant collection and to provide detailed information on the taxonomy, distribution, habitats and in some cases also the biology of scolopendromorphs in Tunisia. New illustrations based on the freshly collected material and a key are provided to facilitate the identification of the species.

Material and methods

Unless stated otherwise, the material treated herein has been collected by N.A. and P.S. during a month long collecting trip in Tunisia conducted in March 2008, and also in the course of individual excursions by the first author to different regions of the country in the period 2003-2008. Various types of habitats were prospected for scolopendromorphs: oak forests (*Quercus suber*, *Q. faginea*, *Q. ilex*), pine forest (*Pinus halepensis*), open habitats dominated by *Stipa tenacissima*, arid rocky planes with scattered palm trees, pure sandy and rocky deserts, coastal and mountainous oases dominated by palm trees (*Phoenix dactylifera*), etc. All the material was preserved in 70 or 96 % ethanol and was shared between the Field Museum of Natural History, Chicago, National Museum of Natural History, Sofia and University of Tunis El Manar. Close up photos were taken under an Olympus SZH 10 research microscope with an Olympus Altra-20 colour camera, and were processed using the program Adobe Photoshop CS2. A complete chronological list of citations related to species occurrence in Tunisia is also provided. Morphological terminology follows Lewis et al. (2005).

Abbreviations: ad. = adult, alt. = altitude, Distr. = District, ex. = exemplar/s, juv. = juvenile, N.P. = National Park, subad. = subadult.

Species account

Order Scolopendromorpha
Family Scolopendridae

Scolopendra canidens Newport, 1844

Figs 1-7

Scolopendra dalmatica var. *africana* Verhoeff, 1891, Berliner entomologische Zeitschrift, 36: 69.

Scolopendra mediterranea var. *africana*: Verhoeff 1893, Berliner entomologische Zeitschrift, 38: 319, fig. a.

Scolopendra oraniensis: Pocock 1892, Proceedings of the Zoological Society of London: 25.

Scolopendra oraniensis: Silvestri 1896, Naturalista Siciliano, An. I, (Nuova Serie), 8: 150.

Scolopendra canidens: Kraepelin 1903, Mitteilungen aus dem Naturhistorischen Museum in Hamburg, 20: 248, fig. 157.

Scolopendra canidens and *S. oraniensis*: Brölemann 1904, Bulletin du Muséum d'Histoire Naturelle 6: 318.

Scolopendra canidens and *S. oraniensis*: Brolemann 1921, Bulletin de la Société des Sciences Naturelles du Maroc, I (3-6): 104-105.

Scolopendra canidens canidens: Attems 1930, Das Tierreich, 54: 36.

Scolopendra canidens and *S. canidens oraniensis*: Brolemann 1932, Bulletin de la Société d'Histoire Naturelle d'Afrique du Nord, 23 (2): 52.

Scolopendra canidens canidens and *S. clavipes*: Turk 1955, Annals and Magazine of Natural History, ser. 12, vol. 8: 281.

Scolopendra canidens canidens and *S. clavipes*: Cloudsley-Thompson 1956, Annals and Magazine of Natural History, ser. 12, vol. 9: 328.

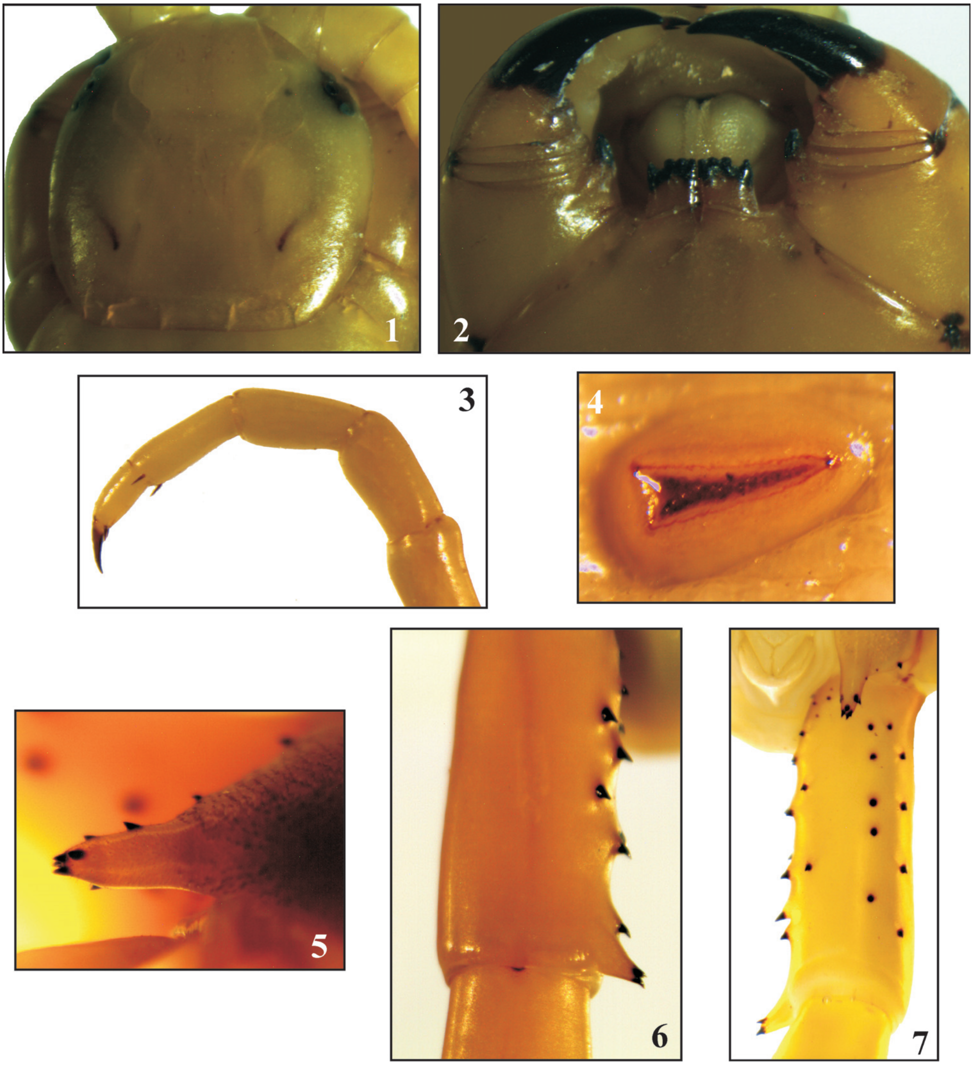
Scolopendra canidens canidens and *S. canidens cyrenaica*: Dobroruka 1968, Revue de Zoologie et de Botanique Africaines 78(3-4): 203.

Scolopendra canidens: Würmli 1980, Sitzungsberichte der Österreichischen Akademie der Wissenschaften, 189: 346, Abb. 10, 26.

Scolopendra canidens: Lewis 1985, Bijdragen tot de Dierkunde, 55 (1): 128, fig. 11, map 2.

Material examined. 1 juv., Sousse, N35°49.57/ E10°38.19, alt. 11 m, 17.2.2004; 1 ad., same locality, 22.3.2004; 1 juv., Le Kef, N36°11.44/ E08°44.39, alt. 623 m, 24.10.2003; 2 ex., Sfax, Agareb Steppe, N34°44.13/ E10°32.15, alt. 68 m, olive orchard, under stones, 25.11.2003; 1 juv., Mahdia Distr., Bekalta, N35°37.06/ E11°00.44, alt. 12 m, border of agricultural land, under stones, 30.10.2003; 1 ad., 3 juv., Sousse

Distr., Sidi Khalifa, N36°15.18/ E10°26.48, alt. 1 m, open area, 17.2.2004; 2 ex., Monastir, N35°46.43/ E10°49.48, alt. 6 m, 22.12.2004; 1 ex., Sousse Distr., Bou Ficha, N36°17.55/ E10°27.30, alt. 6 m, 22.3.2005; 1 ex., Hergla, N36°01.53/ E10°30.37, alt. 3 m, coast, 23.3.2005; 2 ad., 2 subad., Sidi Bouzid Distr., Bou Hedma N.P., N34°30.28/ E09°35.46, alt. 574 m, semi dry area dominated by *Acacia raddiana*, 20.3.2006; 1 subad., Nabeul Distr., Korba, N36°34.36/ E10°51.02, alt. 3 m, coast, 12.11.2006; 12 ex., Sfax Distr., Kerkennah Island, Chargui, N34°42.34/ E11°09.14, alt. 3 m, sandy open area, with scattered palm trees, under stones, 20.3.2007; 2 ad., Kebili, Fatnassa Oasis, May 2007; 1 ad., Zaouit El Hareth Oasis, 20.5.2007; 1 ad., Makthar, 12.5.2005; 2 juv.,



Figs 1-7. *Scolopendra canidens*: 1 – head plate; 2 – forcipular coxosternum and forcipules; 3 – leg 1; 4 – spiracle; 5 – coxopleural process, lateral view; 6-7 – prefemur of ultimate leg, dorsal and ventral views, respectively.

Kairouan Distr., Oueslatia, Aouinettes, 3.3.2005; 1 ex., Djerba Island, N33°52.09/ E10°50.42, alt. 10 m, 10.7.2003; 1 ex., Bizerta Distr., Ichkeul N.P., N37°09/ E9°5, maquis with *Olea europaea*, *Pistacia lentiscus* and *Smilax aspersa*, 8.2.2004; 6 juv., Kairouan Distr., 6 km of Oueslatia, N35°51.785/ E09°30.972, alt. 581 m, sparse olive trees, Roman ruins, bush, open area, stone debris, under stones, 6.3.2008; 1 ad., 1 juv., Sbeitla, 30 km NW Kasserine, inside the ruins of the ancient Roman town of Sifetoula, under stones, 7.3.2008; 4 ex., Kasserine Distr., Chambi N.P., surrounding of the park's guest house, N35°10.139/ E08°40.486, alt. 950 m, sparse trees, bush, *Pinus halepensis*, under stones, 7.3.2008; 1 ad., 3 juv., same locality, alt. 950-1000 m, *Pinus halepensis*, *Stipa tenacissima*, *Thuya*, under stones, logs and leaf litter of *Pinus halepensis*, 8.3.2008; 1 juv., inside Chambi N.P., N35°11.901/ E08°39.505, alt. 1291 m, *Pinus halepensis*, *Quercus ilex*, *Stipa tenacissima*, slope, under stones and leaf litter, 9.3.2008; 1 ad., Chambi peak and its surroundings, N35°12.285/ E08°40.653, alt. 1500-1540 m, *Pinus halepensis*, *Quercus ilex*, *Stipa tenacissima*, under stones and leaf litter, 9.3.2008; 1 ad., 1 juv., Gafsa Distr., Jebel Bou Ramli, N34°30.877/ E08°39.731, alt. 512 m, deserted rocky plain at the foot of the mountain, scattered trees, *Opuntia* and palm trees, under stones, 10.3.2008; 1 ad., Kebili Distr., Tombar, 6 km of Kebili, N33°43.463/ E08°54.349, alt. 14 m, oasis, palm trees, under stones, 12.3.2008; 2 ad., Kebili Distr., 10-20 km of Douz towards Matmata, N33°27.647/ E09°11.466, alt. 92, pure desert, sand, under stones, 12.3.2008; 5 ad., 3 juv., Gabes Distr., Matmata, N33°32.450/ E09°59.054, alt. 384 m, arid biotope, shrubs and stones, under stones, 12.3.2008; 2 ad., 1 juv., Gabes Distr., Matmata, N33°32.450/ E09°59.055, alt. 384 m, arid biotope, shrubs and stones, under stones, 13.3.2008; 2 ad., Tataouine Distr., surroundings of Tataouine city, N32°55.506/ E10°26.913, alt. 293 m, arid biotope, slope, stones, scattered trees of *Pinus* (planted), under stones, 13.3.2008; 3 ad., same district, Ksar Ouled Soltane, N32°47.281/ E10°30.784, alt. 453 m, arid biotope, rocks, stones, close to the village, under stones, 14.3.2008; 1 ad., Tataouine Distr., between Chenini and Douiret (mainly around Douiret), N32°51.090/ E10°16.900, alt. 425 m, arid biotope, close to the road, under stones, 14.3.2008; 1 juv., Mahdia Distr., Chebba (37 km south of Mahdia), N35°12.865/ E11°06.344, alt. 2 m, polluted suburban area close to the beach, under stones, 15.3.2008; 5 ad., Mahdia Distr., Mahdia City, Touristic area, N35°32.796/ E11°01.662, alt. 0 m, scattered palm trees and shrubs close to the road, polluted area not far from agricultural land, under stones, 16.3.2008; 1 ad., same locality, beach, sand, approx. 50-80 m from the water line, under stones, 16.3.2008; 4 ad., 2 juv., same district, surroundings of Ksour Essef (17 km of Mahdia), N35°24.824/ E10°58.026, alt. 59 m, olive trees (*Olea europaea*), grass, stones and shrubs, under stones, 16.3.2008; 2 ad., 3 juv., Siliana Distr., Jebel Bargou, 5 km of Bargou (road Bargou – Oueslatia), N36°05.775/ E09°37.347, alt. 571 m, *Quercus*, *Olea*, shrubs, under stones, 28.3.2008; 1 ad., 3 juv., same mountain, 50 km of Oueslatia (road Bargou – Oueslatia), N36°06.941/ E09°39.392, alt. 512 m, sparse olive trees, rocks, under stones, 28.3.2008; 8 ad., 6 juv., Zaghouan Distr., Jebel Mansour, close to Sidi Aouidet village, N36°12.307/ E09°45.588, alt. 514 m, Pine forest, *Rosmarinus*, under stones and leaf litter, 28.3.2008.

General distribution. Caucasus (Armenia, Azerbaijan), Italy (Lampedusa Island), Greece (Milos, Sifnos, Serifos, Gavdos?, Symi, Kastelorizo islands) Morocco, Algeria, Tunisia, Libya, Egypt, Turkey, Israel, Jordan, Lebanon, Syria, Iran, Saudi Arabia, Yemen, Turkmenistan, Uzbekistan, Tajikistan, Kazakhstan (Würmli 1980, Negrea 1997, Lewis and Wranik 1990, Simaiakis and Mylonas 2008).

Distribution in Tunisia (Map 1). A widespread and much more common species than *S. morsitans*, in particular in central and southern Tunisia. In the North it is known only from Korba on the Cap Bon Peninsula. In the central and southern regions of the country it occurs in the High tell (hills of Le Kef), virtually along the whole Tunisian Ridge (from Chambi to Zaghouan mountains), the eastern lowland plain (the so called Sahel) and the plain of Jeffara (Matmata Mts., Tataouine region), the islands Djerba and Kerkennah. In the West it is found from the High Steppes (Gafsa Mts.) down to the Sahara boundaries (Oriental Erg). In the past the species has been reported also from Adjel el Haioum, Arad, Sfax, Savoual, Makuassy, B. el Aalia, Jebel Cherchera, Gabes, Gabes-Mensel, Oasis Gafsa, Kairouan and Tunis (Verhoeff 1891, Pocock 1892, Silvestri 1896, Brölemann 1904, Turk 1955, Dobroruka 1968, Würmli 1980). We were unable to find some of the localities, e.g. Adjel el Haioum, Arad, Savoual, Makuassy, B. el Aalia, Gabes-Mensel, and they are not marked on the map.

Altitudinal range in Tunisia. From sea level up to 1500 m in the mountains (surroundings of Chambi Peak). In Saudi Arabia it is reported up to 2400 m alt. (Lewis 1986).

Habitats. Oak forests dominated by *Quercus ilex* or *Q. coccifera*; coniferous forests of *Pinus halepensis*; heterogeneous woods with *Q. ilex* and *P. halepensis*; semidry areas dominated by *Acacia raddiana*; coastal areas with sparse shrubs and semihumid grasslands; maquis with *Olea europaea*, *Pistacia lentiscus*; dry grasslands; dry rocky hills; sandy deserts; suburban areas; agricultural lands; *Olea europaea* stands; oases dominated by *Phoenix dactylifera*.

Remarks. The morphology of the specimens examined corresponds well to the species' description given by Attems (1930), Würmli (1980), Lewis (1986), Zalesskaja and Schileyko (1991). All records of the closely related *S. oraniensis* and *S. clavipes* from Tunisia (e.g. Pocock 1892, Silvestri 1896, Turk 1955) are erroneous and should be attributed to this species. While there are no reliable records of the latter in North Africa at all, *S. oraniensis* is known from few localities in Algeria and Morocco, as well as from the Maltese Archipelago (Würmli 1980, Zapparoli et al. 2004) and its occurrence in Tunisia is not improbable.

***Scolopendra morsitans* Linnaeus, 1758**

Figs 8-13

Scolopendra morsitans: Attems 1902, Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenshaftliche Classe 111 (I): 561.

Scolopendra morsitans scopoliana: Kraepelin 1903, Mitteilungen aus dem Naturhistorischen Museum in Hamburg, 20: 253.

Scolopendra morsitans and *S. morsitans scopoliana*: Brölemann 1904, Bulletin du Muséum d'Histoire Naturelle 6: 320-321.

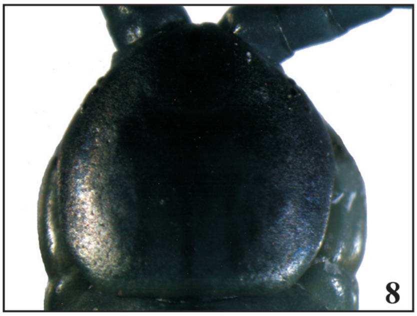
Scolopendra morsitans and *S. morsitans scopoliana*: Brolemann 1921, Bulletin de la Société des Sciences Naturelles du Maroc, I (3-6): 104.

Scolopendra morsitans and *S. morsitans scopoliana*: Attems 1930, Das Tierreich, 54: 23-25, figs 38-39.

Scolopendra morsitans and *S. morsitans scopoliana*: Brolemann 1932, Bulletin de la Société d'Histoire Naturelle d'Afrique du Nord, 23 (2): 51-52.

Scolopendra morsitans: Dobroruka 1968, Revue de Zoologie et de Botanique Africaines 78(3-4): 203.

Scolopendra amazonica: Lewis 1969, Zoological Journal of the Linnaean Society, 48 (1): 49-57.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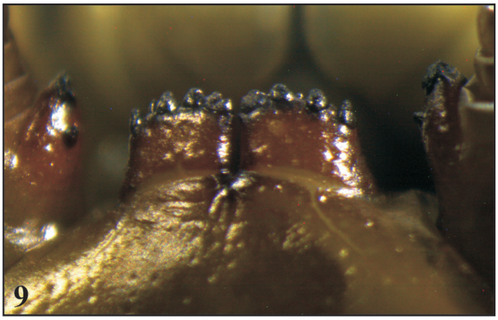
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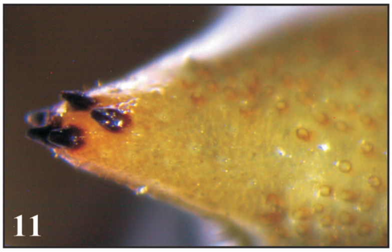
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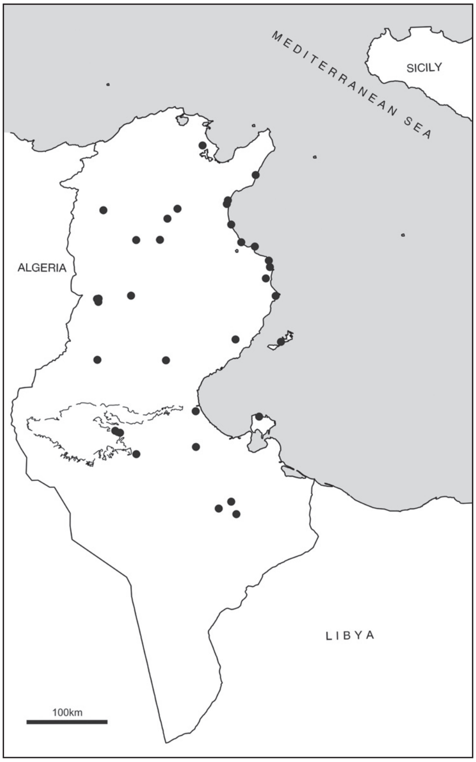
Figs 8-13. *Scolopendra morsitans*: 8 – head plate; 9 – forcipular coxosternal toothplate and trochantero-prefemoral process; 10 – leg 1; 11 – coxopleural process, ventral view; 12-13 – prefemur of ultimate leg, dorsal and ventral views, respectively.

Material examined. 2 ex., Nabeul Distr., Jebel Abderrahman, N36°41.31/ E10°40.20, alt. 168 m, garrigue with *Cistus monspeliensis*, *Pistacia lentiscus*, *Lavandula* sp., 24-28.11.2004; 1 ad., Siliana, N36°05.17/ E09°21.53, alt. 427 m, 7.6.2005; 1 ex., Zaghouan Distr., Jebel El Oust, N36°33.32/ E10°03.38, alt. 75 m, March 2006; 1 juv., Zaghouan Distr., Jebel El Fahs, N36°22.39/ E09°53.41, alt. 172 m, 20.3.2006; 1 ad., Cap Bon Peninsula, Nabeul Distr., El Haouaria, the ancient Roman quarry and surroundings, N37°03.448/ E10°59.869, alt. 51 m, slope facing the sea, under stones, 24.3.2008.

General distribution. North America (USA, Mexico); Caribbean Islands; South America; Atlantic Ocean Islands; Europe; Africa; Arabian Peninsula; Southeast Asia (incl. Indonesia, New Guinea, Philippines, Taiwan, and Japan); Indian Ocean Islands (Comoro Islands, Madagascar, Mascarene Islands, Seychelles); India; Australia; New Zealand; Pacific Islands (for more detailed information, see Shelley et al. 2005).

Distribution in Tunisia (Map 2). Known from the Subhumid and Semiarid bioclimatic zones. Comparatively rare species, found in northeastern Tunisia only – Cap Bon Peninsula, Jebel Zaghouan, Jebel El Fahs and near Siliana. The species has been reported also from Medjez-el-Bab (Attems 1902), Tunis and its surroundings (Brölemann 1904) and Jebel Serdj (Dobroruka 1968).

Altitudinal range in Tunisia. Known from sea level up to approx. 600 m.



Map 1. Distribution of *S. canidens* in Tunisia.

Map 2. Distribution of *S. morsitans* in Tunisia.

Habitats. Coniferous forests dominated by *P. halepensis*, mixed woods of *Q. coccifera* and *Rosmarinus officinalis*; garrigue with *Cistus monspeliensis*, *Pistacia lentiscus*, *Lavandula* sp.; also found in open coastal areas.

Remarks. All the specimens examined have olive green-blackish colouration, which is characteristic for *S. morsitans scopoliana* C.L. Koch, 1841. However, Lewis (1969, 1978) studied the variation of African scolopendrid centipedes, and particularly that of *S. amazonica* and stated that the colouration show a considerable degree of variation, thus being an unreliable taxonomic character. Koch (1982) observed the same variability in *S. laeta* in Australia, finding some correlation with the rainfall. The darkest forms of *S. laeta* occur mainly in areas with high mean annual rainfall (more than 750 mm), although sometimes they are also found in regions with low rainfall (up to 250 mm). Other characters used to characterize *S. m. scopoliana* are tergal margination starting on tergite 17, and coxopleural process bearing 5 spines (Brolemann 1932). As it has already been shown by Lewis (1969) these are also of little taxonomic value in *S. morsitans* and for this reason *S. morsitans scopoliana* is here considered a junior synonym of *S. morsitans*.

***Cormocephalus gervaisianus* (C.L. Koch, 1841)**

Figs 14-17

Cupipes gervaisianus: Silvestri 1896, Naturalista Siciliano, An. I, (Nuova Serie), 8: 151.

Cupipes gervaisianus: Kraepelin 1903, Mitteilungen aus dem Naturhistorischen Museum in Hamburg, 20: 179, fig. 120.

Cupipes gervaisianus: Attems 1908, Voyage zoologique en Khroumirie (Tunisie), Rouen: 104.

Cupipes gervaisianus: Brolemann 1921, Bulletin de la Société des Sciences Naturelles du Maroc, I (3-6): 104.

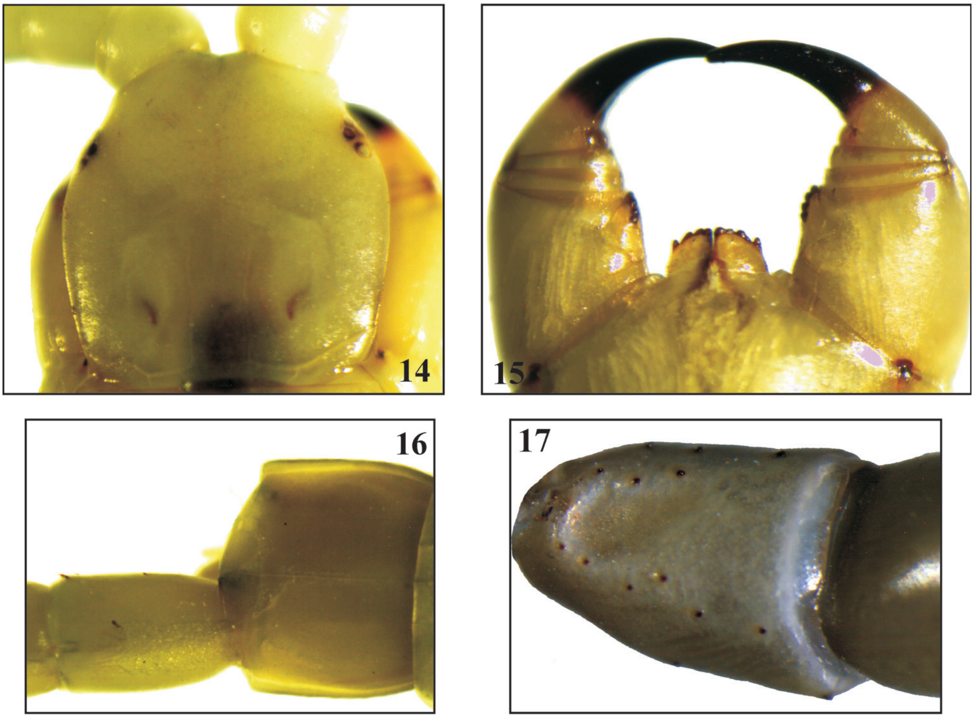
Cormocephalus gervaisianus: Attems 1930, Das Tierreich, 54: 102, figs 121-122.

Cupipes gervaisianus: Brolemann 1932, Bulletin de la Société d'Histoire Naturelle d'Afrique du Nord, 23 (2): 50.

Cormocephalus gervaisianus: Dobroruka 1968, Revue de Zoologie et de Botanique Africaines 78(3-4): 204.

Material examined. 1 ex., Tunis Distr., Faculty of Sciences of Tunis, N36°41.31/ E10°40.20, alt. 81 m, urban area with scattered trees of *Eucalyptus*, *Acacia mimosa* and *Nerium oleander*, 24.9.2003; 3 ex., same locality, 29.9.2003; 3 ex., same locality, 15.10.2003; 1 ex., same locality, January 2004; 2 ex., Beja Distr., Nefza, N36°88/ E9°03, garrigue with *Olea europaea*, *Pistacia lentiscus*, 27.2.2004; 2 juv., same locality, 18.4.2004; 1 juv., same locality, 3.10.2005; 2 ex., Jendouba Distr., Feidja N.P., N36°29.76/ E08°18.36, alt. 746 m, oak forest dominated by *Quercus faginea* with scattered *Q. suber* and a dense underwood of *Erica arborea*, *Phillyrea angustifolia*, *Cystus trifolia* and *Calycotome villosa*, 7.3.2004; 1 ex., Jendouba Distr., Col des Ruines Ain Draham, N36°47.24/ E08°41.02, alt. 799 m, oak forest dominated by *Q. faginea* associated with scattered *Q. suber*, 18.4.2004; 1 ex., Bizerta Distr., Ichkeul

N.P., N37°08.30/ E09°41, alt. 51 m, 7.1.2005; 6 ex., same locality, 8.2.2004; 2 juv., same locality, 24.9.2005; 1 ex., same locality, 3.12.2006; 2 ex., Sousse Distr., Bou Ficha, N36°17.55/ E10°27.30, alt. 6 m, open area with scattered shrubs, 22.3.2005; 1 ex., Ariana Distr., Jebel Ammar, Sidi Thabet, N36°55.05/ E10°04.54, alt. 70 m, maquis with scattered crops of *Olea europaea*, *Callitris articulata* and *Lavandula multifida*, 20.11.2003; 1 ex., same locality, 6.10.2006; 1 ex., Bizerta Distr., Zouaouine, N37°07.49/ E10°04.09, alt. 5 m, 11.1.2004; 1 juv., Tunis Distr., Jebel Rsas, N36°37.22/ E10°20.15, alt. 600 m, 21.9.2005; 1 ex., Le Kef, N36°11.44/ E08°44.39, alt. 831 m, 27.4.2005; 2 ex., Ariana Distr., El Ghazela, N36°53.32/ E10°10.62, alt. 14 m, houses' garden, 13.04.2007; 1 ex., Jendouba Distr., Beni Mtir, 19.2.2007, alt. 500 m; 1 juv., Tunis Distr., Jebel Bou Kornine, 17.2.2004; 3 juv., Zaghouan Distr., Jebel Zaghouan, N36°23.269/ E10°08.157, alt. 352 m, 25.2.2007; 1 ex., Ariana Distr., El Ghazela, house's garden, 20.3.2008; 4 ad., 2 juv., Tunis Distr., Bou Kournine N.P., N36°42.530/ E10°20.680, alt. 105-150 m, *Thuya*, *Eucalyptus*/ dry river bed, under stones and logs, 4.3.2008; 1 ad., 1 juv., Zaghouan Distr., Jebel Zaghouan, surroundings of the Gouffre du Courant d'Air (small limestone cave), N36°21.980/ E10°05.513, alt. 561 m, *Quercus ilex*, *Pistacia lentiscus*, *Jasminum fruticans*, under stones and leaf litter, 17.3.2008; 3 ad., same mountain, surroundings of the marabout Sidi Bou Gabrine, N36°22.423/ E10°06.328, alt. 642 m, meadows, scattered trees, under stones and



Figs 14-17. *Cormocephalus gervaisianus*: 14 – head plate; 15 – forcipular coxosternum and forcipules; 16 – terminal tergite and prefemur of ultimate leg, dorsal view; 17 – prefemur of ultimate leg, ventral view.

leaf litter, 17.3.2008; 1 juv., same locality, 29.3.2008; 1 ex., same mountain, collecting along the track between Gouffre Anti Prehistorique (N36°21.595/ E10°05.208) and Sidi Bou Gabrine (N36°22.423/ E10°06.328), 500-700 m, mixed forest, under stones and leaf litter, 18.3.2008; 3 ad., same mountain, collecting along the track Sidi Bou Gabrine (N36°22.423/ E10°06.328) – Sidi Abdel kader Cave (N36°22.419/ E10°06.371) – Saida Mannoubia (N36°22.650/ E10°06.332) – the asphalt road to Zaghouan (36°22.924/ E 10°06.789), alt. 650-780 m, mixed forest, under stones and leaf litter, 19.3.2008; 5 ad., 4 juv., Beja Distr., 7 km of Zahret Medine, N36°46.857/ E09°01.688, alt. 500 m, limestone hill, shrubs, under stones, 20.3.2008; 1 ad., 1 juv., same district, 13 km of Nefza (road Tabarka-Nefza), N36°57.610/ E08°56.507, alt. 150 m, Pine forest, under stones, 23.3.2008; 2 ad., 3 juv., Jendouba Distr., Tabarka, the Genoese fort and surroundings, N36°57.838/ E08°44.680, alt. 20-30 m, slope facing the sea, grass, rocks scattered trees, under stones and logs, 22.3.2008; 1 ad., same district, Hammam Bourguiba (west of Ain Draham), N36°45.926/ E08°35.084, alt. 158 m, meadow with scattered trees, under stones, 22.3.2008; 2 ad., Cap Bon Peninsula, Nabeul Distr., near Oued El Abid Dam, N36°49.901/ E10°42.378, alt. 42 m, grass, stones, under stones, 24.3.2008; 3 ad., Zaghouan Distr., Jebel Mansour, close to Sidi Aouidet Village, N36°12.307/ E09°45.588, alt. 514 m, Pine forest, *Rosmarinus*, under stones and leaf litter, 28.3.2008.

Description. Colour yellowish to olive-green. Maximal length, including ultimate legs, ca. 60 mm. Head plate with 2 paramedian sutures occupying the posterior half of head plate (Fig. 14). Antennae composed of 17 articles, the basal 6 glabrous. Tooth plate with 3+1 teeth, the lateralmost one well separated from the others. Trochanteroprefemoral process moderately expanded bearing 4 tubercles (Fig. 15). Legs 1-20 with two spurs on tarsus 2. Spiracles small and rounded. Tergites 1-20 with 2 paramedian sulci (those on first tergite not reaching anterior border), tergite 21 with a complete median suture. Sternites 2 to 20 with two complete paramedian sutures which are well separated anteriorly and posteriorly and narrowing in the middle of sternite. Sternite 21 trapeziform, broader anteriorly. Ultimate pair of legs: coxopleuron with one lateral spine and long and slender process bearing 2 terminal spines; pores not reaching posterior border of coxopleura. The length of coxopleural process varies considerably between specimens. Prefemur, femur and tibia strongly swollen with dorsal furrow, tarsus 1 wider than tarsus 2; prefemur with 2 ventrolateral rows of 3-5 spines, and 8-10 ventromedial and medial teeth and 2-6 dorsomedial ones (Figs 16-17). Pretarsus finely serrated ventrally, longer than tarsus 2.

General distribution. Spain, Algeria, Tunisia, Azerbaijan (Minelli 2006)

Distribution in Tunisia (Map 3). Widespread in North and Central Tunisia. The range covers the Mogods-Kroumirie Mts. in the west (Feidja, Beni Mtir) and spreads to the eastern part of the Tunisian Ridge (Jebel Mansour and Jebel Zaghouan) and the main coastal area of the Gulf of Tunis (Bizerta, Tunis, Ariana) including the Cap Bon Peninsula (Oued el Abid). Further south it has been found also in the Sahel (Bou Ficha in the district of Sousse). In the past recorded from Tunis, Souk el Arba, Babouch and Ain Draham (Silvestri 1896, Attems 1908). Dobroruka (1968) reported the species from Savoual (Zaghouan Region) but we were unable to find this locality on the map.

Altitudinal range in Tunisia. Known from sea level up to approx. 800 m.

Habitats. Mixed oak formations dominated by either *Quercus faginea* or *Q. suber*, coniferous forests dominated by *P. halepensis*, mixed forests of *Q. faginea* and *Q. suber*, *Q. faginea* and *Pinus pinaster*, *P. halepensis* and *Quercus ilex*, *Q. coccifera* and *P. halepensis*. It is also found in semidry open areas, garigue with *Olea europaea*, suburban habitats and coastal grasslands.

Remarks. The morphological characters of the specimens examined correspond well with the description of this species given by Attems (1930) which was the most recent description. *Cormocephalus*, which currently comprises about 70 species, was divided into three supergroups, each composed of several species-groups (Schileyko and Stagl 2004). In this tentative division, *C. gervaisianus* belongs to the *gervaisianus* species group of supergroup III, which is characterized by the presence of complete (rarely somewhat shortened) paramedian sulci on tergite 1; paramedian sulci complete from tergite 2; prefemur of ultimate leg-pair usually bearing ventrolateral spines; coxa of terminal legs with well developed coxopleural process; and pretarsus of ultimate legs longer than tarsus 2.

***Otostigmus spinicaudus* (Newport, 1844)**

Figs 18-25

Otostigma tunetanum Verhoeff, 1901, Nova Acta Leopoldina, 77: 433, Vergl. Taf. III Abb. 16.

Otostigmus spinicaudus: Kraepelin 1903, Mitteilungen aus dem Naturhistorischen Museum in Hamburg, 20: 107, fig. 49.

Otostigmus spinicauda: Brolemann 1921, Bulletin de la Société des Sciences Naturelles du Maroc, I (3-6): 104.

Otostigmus spinicaudus: Attems 1930, Das Tierreich, 54: 148, fig. 176.

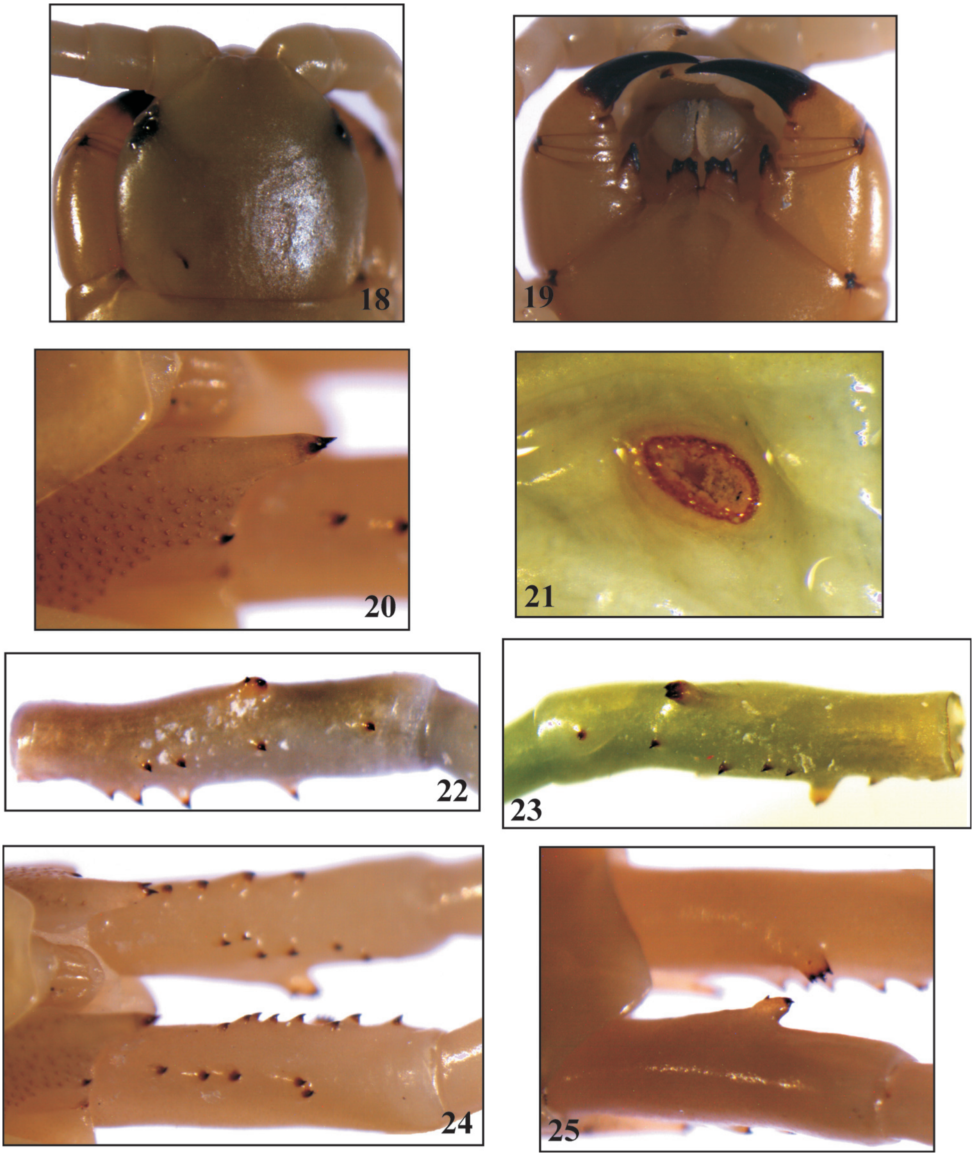
Otostigmus spinicaudus: Brolemann 1932, Bulletin de la Société d'Histoire Naturelle d'Afrique du Nord, 23 (2): 51.

Otostigmus spinicaudus: Lewis 2000, Journal of Natural History, 34: 434, figs 1-10.

Material examined. 1 ex., Sidi Bouzid Distr., Bou Hedma N.P., N34°30.28/ E09°35.46, alt. 574 m, 20.3.2006; 1 ex., Kasserine Distr., Chambi N.P., surrounding of the park's guest house, N35°10.139/ E08°40.486, alt. 950-1000 m, *Pinus halepensis*, *Stipa tenacissima*, *Thuya* sp., under stones, logs and leaf litter of *Pinus halepensis*, 8.3.2008; 1 ex., Gabes Distr., Matmata, N33°32.450/ E09°59.054, alt. 384 m, arid biotope, shrubs and stones, under stones, 13.3.2008.

General distribution. Known from Morocco, Algeria, Tunisia, Libya and the Spanish islands Fuerteventura and Lanzarote (Canary Isl.); *O. spinicaudus ghiblanus* Manfredi, 1935 and *O. spinicaudus latispinus* Manfredi, 1939 are known only from their type localities in Libya (Minelli 2006).

Distribution in Tunisia (Map 4). Known from Tunis (Verhoeff 1901), the mountains Bou Hedma and Chambi, and the surroundings of Matmata (new records); the specimen from Matmata may be another (sub)species (see below).



Figs 18-25. *Otostigmus spinicaudus*: 18 – head plate; 19 – forcipular coxosternum and forcipules; 20 – coxopleural process, lateral view; 21 – spiracle; 22-23 – prefemur of ultimate legs (specimen from Chambi): left leg, ventromesal view; right leg, mesal views, respectively; 24-25 – prefemora of ultimate legs (specimen from Matmata), ventral and dorsal views, respectively.

Altitudinal range in Tunisia. Known from 950-1000 m.

Habitats. Arid biotopes with *Acacia raddiana* or shrubs; sparse *P. halepensis* and *Thuya* forest grown with *Stipa tenacissima*.

Remarks. Lewis (2000) provided a detailed re-description of *O. spinicaudus* based on material from the Canary Islands. The specimens from Jebel Chambi (Figs 21-23) and Bou Hedma correspond well with the description given by Lewis, differing only in the number of ventromedial prefemoral spines on ultimate leg (4 vs. 3). In the specimen from Chambi two tarsal spurs are present on leg-pairs 1-9 the rest to 19 have one, while in the Bou Hedma specimen only legs 1-6 have two tarsal spurs. In the Canary Islands specimens there were usually two tarsal spurs on the first four pairs of legs but sometimes they occurred as far as leg-pair 8. Both specimens have coxopleural processes bearing 2 apical, one lateral and one dorsal spine. The dorsomedial conical protuberance bears a single apical spine in the specimen from Bou Hedma and two to four in the specimen from Jebel Chambi (Figs 22-23).

The specimen from Matmata is differing from the other two specimens and from the Lewis' (2000) redescription in that the prefemur of the ultimate leg bears 4-5 ventrolateral and 6-9 ventromedial spines (vs. 3/3 in Canary specimens and 4/4 in other Tunisian specimens), and the conical protuberance bears 4-5 spines (vs. usually 1-2) (Figs 24-25). In all other respects the specimen resembles *O. spinicaudus*.

Manfredi (1935, 1939) described two subspecies of *spinicaudus* from Libya – *O. s. ghiblanus* Manfredi, 1935 and *O. s. latispinus* Manfredi, 1939. The former was separated from nominate form by the presence of incomplete sternal sutures and only 2 apical spines on the coxopleural process, as well as by the different position of the

Map 3. Distribution of *C. gervaisianus* in Tunisia.

Map 4. Distribution of *O. spinicaudus* in Tunisia. The Matmata record is marked with an arrow.

dorsomedial spine on the prefemur of ultimate leg-pair (Manfredi 1935). The subspecies *latispinus*, was distinguished by the size, shape and the position of the dorsomedial prefemoral protuberance of the ultimate pair of legs, which is sited at mid-length of prefemur (big and emerging as a triangular appendix at the median side of the leg, sometimes bent distad, dorsally convex, ventrally concave with an apical spine). The prefemur also has strong longitudinal medial sulcus. Although not specified, the number of ventral prefemoral spines is higher than that in the type (Manfredi 1939). Having a larger number of prefemoral spines and well-developed conical protuberance on the dorsomedial side of the prefemur, the Matmata specimen resembles *O. spinicaudus latispinus*. However, it has 4-5 apical spines on the dorsomedial prefemoral protuberance instead of 1, and lacks a longitudinal sulcus. It could be a distinct (sub) species, although with only one specimen available it could represent an aberrant individual. The irregular arrangement of the prefemoral spines and their elevated number may indicate the ultimate legs are regenerated. Further Tunisian and other material is required in order to clarify the situation.

Family Cryptopidae

***Cryptops* (*Cryptops*) *trisulcatus* Brölemann, 1902**

Figs 26-27

Cryptops anomalans: Silvestri 1896, Naturalista Siciliano, An. I, (Nuova Serie), 8: 151. Misidentification?

Cryptops anomalans: Attems 1908, Voyage zoologique en Khroumirie (Tunisie), Rouen: 104. Misidentification?

Cryptops trisulcatus: Brolemann 1932, Bulletin de la Société d'Histoire Naturelle d'Afrique du Nord, 23 (2): 50.

Material examined. 1 ex., Jendouba Distr., Beni Mtir, N36°44.44/ E08°44.52, alt. 500 m, 19.2.2007, alt. 500 m; 1 ex., Nabeul Distr., Soliman, N36°42.54/ E10°21.15, alt. 98 m, 12.11.2006; 1 ex., Jendouba Distr., Ain Draham, Col des ruines, N36°47.24/ E08°41.02, alt. 799 m, 5.2.2004; 1 ex., same locality, 3.10.2005; 1 ex., Beja Distr., Jebel El Jouza Amdoun, N36°50.09/ E09°06.0, alt. 614 m, mixed oak forest, 19.11.2003; 3 ex., same locality, 4.11.2003; 1 ex., Beja Distr., Nefza, N36°45.42/ E09°11.41, alt. 176 m, 27.2.2004; 1 ex., same locality, 18.4.2004; 2 ex., Bizerta Distr., Ichkeul N.P., 8.2.2004; 1 ex., same locality, 7.1.2005; 1 ex., Ariana Distr., Nahli, N36°53.02/ E10°09.14, alt. 75 m, 6.12.2003; 1 ex., Kasserine Distr., inside Chambi N.P., N35°11.901/ E08°39.505, alt. 1291 m, *Pinus halepensis*, *Quercus ilex*, *Stipa tenacissima*, slope, under stones and leaf litter, 9.3.2008; 1 ex., inside Chambi N.P., N35°11.709/ E08°39.309, alt. 1286 m, *Pinus halepensis*, *Quercus ilex*, *Stipa tenacissima*, ruins, under stones and leaf litter, 9.3.2008; 2 ex., Zaghouan Distr., Jebel Zaghouan, surroundings of the marabout Sidi Bou Gabrine, N36°22.423/ E10°06.328, alt. 642 m, meadows, scattered trees, under stones and leaf litter, 17.3.2008; 1 ex., same locality, 29.3.2008; 1 ex., same mountain, collecting along the track between Gouffre Anti Prehistorique (N36°21.595/ E10°05.208) and Sidi Bou Gabrine (N36°22.423/ E10°06.328), 500-700 m, mixed forest, under stones and leaf litter, 18.3.2008; 1 ex., same mountain, collecting along the track Sidi Bou Gabrine (N36°22.423/ E10°06.328) – Sidi Abdel kader Cave (N36°22.419/ E10°06.371) – Saida Mannoubia (N36°22.650/ E10°06.332) – The asphalt road to Zaghouan (N36°22.924/ E10°06.789), alt. 650-780 m, mixed forest, under stones and leaf litter, 19.3.2008; 1 ex., Beja Distr., 7 km of Zahret Medine, N36°46.857/ E09°01.688, alt. 500 m, limestone hill, shrubs, under stones, 20.3.2008; 1 ex., Jendouba Distr., 4 km of Tabarka (direction of Malloula), N36°57.476/ E08°43.781, alt. 225 m, *Eucalyptus* and pine forest, under stones, 22.3.2008; 7 ex., Zaghouan Distr., Jebel Mansour, close to Sidi Aouidet Village, N36°12.307/ E09°45.588, alt. 514 m, Pine forest, *Rosmarinus*, under stones and leaf litter, 28.3.2008.

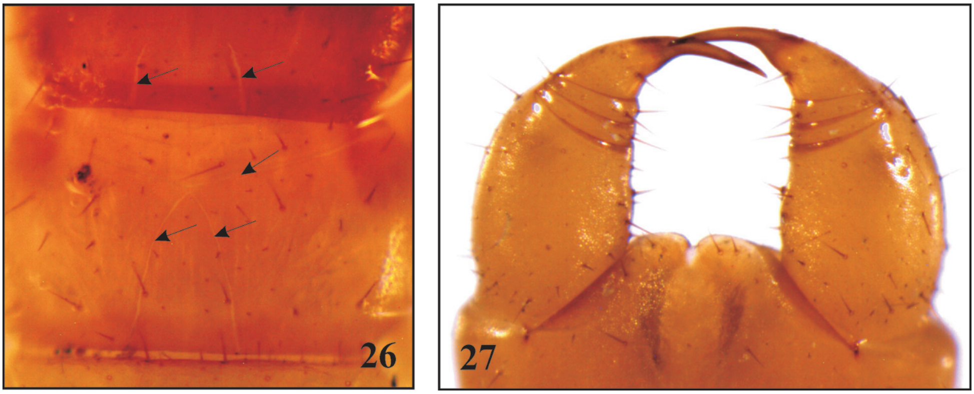
General distribution. Canary Islands, Algeria, Tunisia, Maltese Archipelago, Portugal, Spain (incl. Balearic Islands), South of France (incl. Corsica), Italy (incl. Sicily, Sardinia), Romania, Insular Greece (Ionian, Dodecanese islands and Crete), SE Turkey (Zapparoli 2002, Zapparoli et al. 2004).

Distribution in Tunisia (Map 5). Known from the Humid to Semiarid bioclimatic zones. The species range covers a vast area starting from the Mogods-Kroumirie region in the West and parts of the Tunisian Ridge chain further South (e.g. Chambi N.P.) and ending in Jebel Mansour, Jebel Zaghouan, the Gulf of Tunis and Cap Bon Peninsula (Soliman) area in the northeast. Known also from Ichkeul N.P.

Altitudinal range in Tunisia. Known from approx. 200 up to approx. 1300 m.

Habitats. Forests of *Quercus faginea*, mixed woods of *Q. faginea* and *Q. suber*, *Q. coccifera* and *P. halepensis*; *P. halepensis* and *Q. ilex*; found also in heterogenous *Eucalyptus* forest.

Remarks. Although this widespread Mediterranean species has already been recorded from Algeria (Ribaut 1915) and from the neighbouring Italian island of Pantelleria situated approx. 70 km off the Tunisian coast (Zapparoli 1995), these are the



Figs 26-27. *Cryptops trisulcatus*: 26 – posterior part of head plate and tergite 1; 27 – coxosternum.

first definite records of *C. trisulcatus* in Tunisia (see also under Discussion). Brolemann (1932) summarized the distribution of *C. trisulcatus* as "Littoral méditerranéen d'Afrique et d'Europe". It remains unclear whether this general statement was supported with original data from Tunisia. The species is also known from the Maltese Archipelago (Zapparoli et al. 2004). In several places, like Jebel Zaghouan, Jebel Mansour, Jebel Chambi, *C. trisulcatus* is fairly common and occurs syntopically with *C. punicus*.

***Cryptops* (*Cryptops*) *punicus* Silvestri, 1896**

Figs 28-30

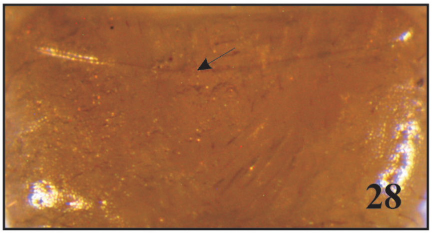
Cryptops anomalans Newport, v. n. *punicus* Silvestri, 1896, Naturalista Siciliano, An. I (Nuova Serie), 8: 151.

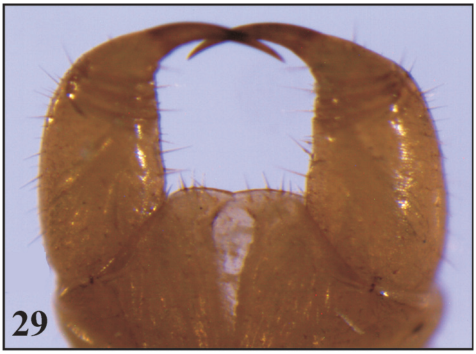
Cryptops anomalans punicus: Brolemann 1921, Bulletin de Société des Sciences Naturelles du Maroc, I (3-6): 104.

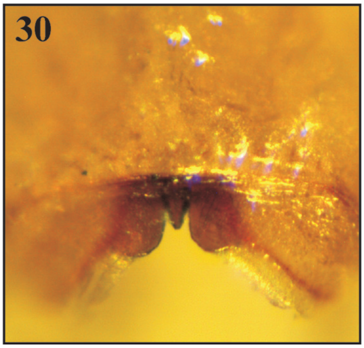
Trigonocryptops punicus: Brolemann 1928, Bulletin de la Société d'Histoire Naturelle de Toulouse, 57: 257, figs 10-18.

Trigonocryptops punicus: Brolemann 1932, Bulletin de la Société d'Histoire Naturelle d'Afrique du Nord, 23 (2): 48-49.

Material examined. TUNISIA: 3 ex., Nabeul Distr., Soliman, N 36°42.54/ E10°21.15, alt. 98 m, 12.11.2006; 2 ex., Ariana Distr., Sidi Thabet, N36°55.05/ E10°04.54, alt. 70 m, 20.11.2003; 1 ex. Mahdia Distr., Chebba, 20.3.2004; 1 ex., Le Kef, N36°11.44/ E08°44.39, alt. 623 m, 24.10.2003; 5 ex., Bizerta Distr., La Grotte Beach, N37°19.56/ E09°51.30, alt. 39 m, 12.2.2004; 1 ex., Sousse Distr., Bou Ficha, N36°17.55/ E10°27.30, alt. 6 m, 22.3.2005; 4 ex., Zaghouan Distr., Jebel Zaghouan, N36°23.269 / E10°08.157, alt. 352 m, 25.2.2007; 1 ex., Gabes Distr., Chenini Oasis, 22.3.2006; 1 ex., Ariana Distr., Sidi Thabet, 17.3.2004; 1 ex., Kasserine Distr., Chambi N.P., surrounding of the park's guest house, N35°10.139/ E08°40.486, alt. 950-1000 m, *Pinus halepensis*, *Stipa tenacissima*, *Thuya*, under stones, logs and leaf litter of *Pinus halepensis*, 8.3.2008; 2 ex., Gabes Distr., Matmata, N33°32.450/ E09°59.054, alt. 384 m, arid biotope, shrubs and stones, under stones, 12.3.2008; 2 ex., Mahdia Distr., Mahdia City, Touristic area, N35°32.796/ E11°01.662, alt. 0 m, scattered palm trees and shrubs close to the road, polluted area not far from agricultural land, under stones, 16.3.2008; 2 ex., Zaghouan Distr., Jebel Zaghouan, surroundings of the Gouffre du Courant d'Air (small limestone cave), N36°21.980/ E10°05.513, alt. 561 m, *Quercus ilex*, *Pistacia lentiscus*, *Jasminum fruticans*, under stones and leaf litter, 17.3.2008; 1 ex., same mountain, surroundings of the marabout Sidi Bou Gabrine, N36°22.423/ E10°06.328, alt. 642 m, meadows, scattered trees, under stones and leaf litter, 17.3.2008; 1 ex., Jendouba Distr., Tabarka, the Genoese fort and surroundings, N36°57.838/ E08°44.680, alt. 7 m, sea shore, 10-40 m from the water line, logs, grass, under stones, 22.3.2008; 1 ex., Nabeul Distr., Cap Bon Peninsula, Kelibia, the fort and surroundings, N36°50.337/ E11°06.841, alt. 10-40 m, slope, *Eucalyptus*, *Mimosa*, shrubs, under stones, 25.3.2008; 3 ex., same area, 7 km of Menzel Bou Zelfa, N36°40.268/ E10°40.677, alt. 236 m, *Pinus*, *Quercus*, shrubs,







Figs 28-31. *Cryptops punicus*: 28 – tergite 1; 29 – coxosternum; 30 – labral tooth; 31 – tibia and tarsus of ultimate leg. Arrows on figures 26 and 28 indicate the tergal sutures.

under stones, 25.3.2008; 1 ex., Siliana Distr., Jebel Bargou, 5 km of Bargou (road Bargou – Oueslatia), N36°05.775/ E09°37.347, alt. 571 m, *Quercus*, *Olea*, shrubs, under stones, 28.3.2008; 5 ex., Zaghouan Distr., Jebel Mansour, close to Sidi Aouidet Village, N36°12.307/ E09°45.588, alt. 514 m, Pine forest, *Rosmarinus*, under stones and leaf litter, 28.3.2008. LIBYA: 1 ex., Tripoli, 0-20 m, 28-30.11.1999, P. Beron leg.

Description. Light brown to tawny with dense punctuation, and extensive setation. Maximal length: 22-28 mm. Head as long as broad, with 2 short paramedian longitudinal sutures on the anterior and posterior borders of head plate. Antenna composed of 17 articles. Coxosternum rounded and slightly prominent (Fig. 29). Labrum with a single tooth (Fig. 30). First tergite with a complete curved anterior transverse suture only (Fig. 28). Paramedian sutures incomplete on the second tergite, becoming complete from the third. Lateral crescentic sulci starting on the 3rd or 4th tergite. From third leg-pair onwards tarsus 1 and tarsus 2 faintly separated. Ultimate pair of legs: coxopleura with pore field extending to but not touching the posterior margin of coxa. Many scattered setae among the pores and a tuft of 7-8 posterior to the pore field. Tibial saw with 11-13 sharp teeth. Tarsal saw with 5-7 teeth (Fig. 31).

General distribution. Algeria, Tunisia, Libya and Italy: Sicily, Sardinia, Tuscan Archipelago (Matic 1962, Minelli 1982, Zapparoli 1995).

Distribution in Tunisia (Map 6). One of the most common scolopendromorphs in Tunisia found in all bioclimatic zones. Originally described from Tunis (Silvestri 1896), it is currently known also from the littoral of Kroumirie (Tabarka), from the Gulf of Tunis area and along the eastern part of the Tunisian Ridge up to the Cap Bon Peninsula (Soliman, Mensel Bou Zelfa). Towards the centre, it is present in the western mountains of the Ridge (Chambi N.P.) and along the eastern coast of the Sahel (Sousse, Mahdia, Chebba) down to the plain of Jeffara in the southeast (Matmata, Gabes).

Altitudinal range in Tunisia. Known from sea level up to 1000 m in the mountains (Jebel Chambi).

Habitats. Forests dominated by *Q. coccifera* or *Pinus halepensis*, mixed woods of *Q. ilex* and *P. halepensis* or *Q. coccifera* and *P. halepensis*, mountain meadows, suburban areas, oases, arid rocky terrains with scattered shrubs.

Remarks. Silvestri (1896) described *Cryptops punicus* from Kroumirie as a variety of *C. punctatus* (now *anomalans*). It was synonymised with *C. anomalans* by Kraepelin (1903) and later revived by Brolemann (1928). Besides raising *punicus* to full species rank, Brolemann also transferred it to the genus *Trigonocryptops*, which is currently considered a subgenus of *Cryptops* Leach, 1815. *Trigonocryptops* is characterised by trigonal sutures in front of the endosternite, a transverse ridge on the sternites between the coxae, generally bipartite tarsi, head overlying tergite 1, a transverse suture on tergite

Map 5. Distribution of *C. trisulcatus* in Tunisia.

Map 6. Distribution of *C. punicus* in Tunisia.

1, a divided katopleure and mostly yellow or brown colour. Other characters shared by members of *Trigonocryptops* are an anterior setose area on the clypeus delimited by sutures, paired spinose process on the ultimate leg, slit-like spiracles, etc. (Edgecombe 2005). *C. punicus* shows some of the characters typical for *Trigonocryptops*, e.g. subdivided tarsi (very faint in most specimens), yellowish colouration, head overlying tergite 1, transverse suture on tergite 1 but these are shared with some species of the subgenus *Cryptops*. Instead of trigonal sutures at the base of endosternite there is just a curved transverse suture (see Brolemann 1928, fig. 14). With this possible exception *C. punicus* lacks the characters unique to the subgenus *Trigonocryptops* viz. the clypeus is devoid of sutures, and ultimate leg is devoid of processes. The spiracles are ovoid-shaped and the katopleure is single. For the above reasons, we prefer to place *C. punicus* in the subgenus *Cryptops* rather than in *Trigonocryptops* as suggested by Brolemann (1928). Nevertheless, until combined morphological and molecular phylogenetic analysis is undertaken in the genus *Cryptops*, the real position of *C. punicus* remains uncertain. The specimen from Tripoli represents the first formal record of the species from Libya.

Discussion

Remarks on the occurrence of *Scolopendra cingulata*, *S. oraniensis* and *C. anomalans* in Tunisia

Scolopendra cingulata, *S. oraniensis* and *C. anomalans* were reported for Tunisia in several old publications but were not found in the recently collected material. While those of *S. oraniensis* (e.g. Silvestri 1896, Brölemann, 1904) are most likely due to misidentification with the closely related *S. canidens* (see also Würmli 1980), the presence of the other two species requires further explanation in the light of the new study. *S. cingulata* was reported for all the countries of the Maghreb region in Brolemann's checklist of North African myriapods (1921). This publication still serves as a main source of information regarding the North African myriapod fauna, being cited even nowadays in papers outlining the world distribution of *S. cingulata* (e.g. Zapparoli 2002, Zapparoli et al. 2004, and Simaiakis and Mylonas 2008). It seems that Brolemann's data originated from Kraepelin's (1903) general statement that *S. cingulata* is distributed "durch ganz Nordafrika"[throughout northern Africa], though the author did not list exact localities to support this. There are numerous later records of *S. cingulata* from one or another country in the Maghreb (e.g. Verhoeff 1908, Manfredi 1939, Brolemann 1947), and the species was also reported to occur on the closely situated to Tunisia islands Pantelleria and Lampedusa (Zapparoli 1995). However, until new material becomes available to confirm its presence in Tunisia, we regard the old records as dubious. So far, the only reliable records of *S. cingulata* in North Africa come from the eastern part of Egypt (Lewis 1985, Minelli 2006).

Cryptops anomalans was recorded by Silvestri (1896) from Souk el Arba, Ain Draham and Babouch, and by Attems (1908) from Ain Draham. The recent intensive collecting in the region of Ain Draham where all these localities are situated did not confirm its presence there. Instead, another species, *C. trisulcatus*, appeared to be quite common in the area. Taking into account that *C. trisulcatus* superficially resembles *C. anomalans* (both having identical number of saw teeth on ultimate leg-pair and tergite 1 having obvious sutures), and the fact that at the time when Silvestri reported *anomalans*, *C. trisulcatus* had not been described, it is very probable that Silvestri misidentified his material. This may also holds true for Attems' later record of *anomalans*.

Distribution patterns

The scolopendromorph centipedes are widely distributed in Tunisia and occur in all the bioclimatic zones – from the humid and subhumid forests in the northwestern part of the country to the pure sandy deserts in the south. *Cryptops punicus* and *S. canidens* are the most common species, and except for the extreme south are virtually distributed throughout the country. The notable absence of *S. canidens* from the Kroumirie region and the core of Cap Bon Peninsula, could be explained by the higher humidity in those areas and possible competition with *S. morsitans*. The recent finds of *S. canidens* from Ksar Oued Soltane and Douiret (both situated south of Tatauine) constitute the southernmost point of distribution of Scolopendromorpha in Tunisia and together with still unidentified specimen of Lithobiidae represent the southernmost record of Myriapoda as a whole. The records from the Hoggar (Ahaggar Mts., Southern Algeria) represent the southernmost records of *S. canidens* in Africa (Würmli 1980).

S. morsitans has a restricted distribution in northeastern Tunisia from the extreme northern parts of Cap Bon Peninsula to the surroundings of Siliana. It seems that *S. canidens* and *S. morsitans* occur allopatrically in the country, the latter being generally restricted to more humid parts, the former to the rest of the country, including the harsh deserts in the south, southern coastal regions, and the islands of Djerba and Kerkennah. The eastern part of Tunisian Ridge is a possible contact zone where they may occur together. *Cryptops trisulcatus* and *Cormocephalus gervaisianus* show an almost identical distribution in north and central Tunisia, with the exception that the former goes farther south reaching the Chambi N.P. *Cryptops trisulcatus* is absent from the Cap Bon Peninsula although it is found along the coast to the west of that area. *O. spinicaudus* is the rarest of all the six species. Until now it was known only from Tunis, while the freshly collected material comes from three localities lying well apart from each other in the central and southeastern parts of the country.

Habitat preferences

In Tunisia, scolopendromorphs are known from virtually all the main types of vegetation, starting with the humid and subhumid oak forests of *Quercus faginea* and *Q. suber* in the Kroumirie-Mogods Mts., passing through the subhumid coniferous forests of the Tunisian Ridge and ending in the pure sandy desert of Sahara. They are also known in suburban and urban areas, in close proximity to the littoral zone and in agricultural stands. Caves are a largely unexplored biotope in terms of scolopendromorphs. It is not improbable that cave-dwelling species will be found in future in such a large limestone massifs as Jebel Zaghouan.

Cryptops punicus is a eurytopic species, which occurs in forests (oak, pine, eucalyptus, etc.), coastal areas, open grasslands, oases, agricultural stands and arid rocky areas with scattered shrubs. *S. canidens* is also quite euryecious, absent only in the oak forests of Kroumirie. It was found in oak forests dominated by *Q. ilex* (Jebel Bargou, Makthar) or *Q. coccifera* (Jebel Chambi); coniferous forests of *P. halepensis* (Le Kef) and heterogeneous woods with *Q. ilex* and *P. halepensis*; semidry areas dominated by *Acacia raddiana* (Bou Hedma N.P.); coastal areas with sparse shrubs and semihumid grasslands; dry grasslands; dry rocky hills (Jebel Bou Ramli, Gafsa); pure sandy deserts (Douz); suburban areas (e.g. Tataouine and Mahdia cities); agricultural lands; *Olea europaea* stands (the Sahel); oases dominated by *Phoenix dactylifera* (Kebili). *S. canidens* is the only myriapod species in Tunisia recorded in pure sandy desert. Having studied material from Israel, Negrea (1997) concluded that "*S. canidens* is a thermophilous, eurythermic and xerophilous species, occurring on low altitudes (-370 m at 'En Gedi)" and "come from sites…..Judean Hills, Judean Desert, Dead Sea, central Negev, and Arava Valley, the most arid parts within the investigated area".

Like the preceding species, *Otostigmus spinicaudus* is also a thermophilic species. It was found under stones in arid and semidesert biotopes with *Acacia raddiana* (Bou Hedma N.P.) and shrubs (Matmata). In Jebel Chambi it was collected in a sparse *P. halepensis* and *Thuya* forest grown with *Stipa tenacissima*. Lewis (2000) reported it from a crater on Lanzarote. *Scolopendra morsitans* has hitherto been registered only in coniferous forests of *Pinus halepensis*, mixed woods of *Quercus coccifera* and *Rosmarinus officicnalis* and in open coastal areas. *Cormocephalus gervaisianus* and *C. trisulcatus* show an affinity to the forest biotopes, being often present in old oak formations and different kinds of mixed heterogeneous woods.

Key for identification of the scolopendromorph centipedes of Tunisia

1(2) with 4 ocelli on each side of cephalic plate (Family Scolopendridae) 3
2(1) Head without ocelli. Ultimate legs with saw teeth on tibia and tarsus 1 (Family Cryptopidae) 9
3(4) Legs without tarsal spurs, pretarsus of ultimate leg longer than tarsus 2, spiracles very small.. *Cormocephalus gervaisianus*
4(3) Most legs with tarsal spurs, pretarsus of ultimate leg markedly shorter than tarsus 5
5(6) First spiracle (of leg-bearing segment 3) oval (Fig. 21), the rest round.............. .... *Otostigmus spinicaudus*
6(5) Spiracles triangular (Fig. 4), more or less parallel to body axis 7

7(8) Leg 1 with two tarsal spurs (Fig. 3); coxopleural process generally long, with at least six spines sited laterally as well as distally (Fig. 5); prefemur of ultimate leg with two rows of spines ventrolaterally and two ventromedially (Fig. 7) .... *S. canidens*

8(7) Leg 1 with one tarsal spur (Fig. 10); coxopleural process short, with at most five distal spines, none laterally (Fig. 11); prefemur of ultimate leg with, at most, three rows of three spines ventrally (Fig. 13); femur and sometimes tibia in males flattened with ridged lateral and median edges .... *S. morsitans*

9(10) Tergite 1 with anterior transverse suture from which run two diverging sutures to the posterior border of the tergite (Fig. 26) .... *C. trisulcatus*

10(9) Tergite 1 with anterior transverse suture only (Fig. 28)...................... *C. punicus*

Acknowledgements

The collecting trip in Tunisia in March 2008 was financially supported by the Field Museum Collection Fund. We are grateful to Petra Sierwald (Chicago, USA) for arranging the grant. N.A. is deeply obliged to Willi Xylander (Görlitz, Germany) for supporting her research visit to the SMNG in 2008, to Said Nouira and to Mohamed Hedi Ktari (Tunis, Tunisia) for their overall support. Henrik Enghoff (Copenhagen, Denmark) provided copies of some old papers. Atef Belkahla and Houda Belghagi (Tunis, Tunisia) kindly helped with the preparation of maps. Two anonymous referees provided valuable comments on the manuscript.

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