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Review of Cape Verde *Aphanommata* Wollaston, 1873 (Coleoptera: Curculionidae: Cossoninae) with Description of New Species, Larva and Notes on Biology and Distributional Patterns

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Abstract: The genus *Aphanommata* in the Old World is reviewed. *Aphanommata kuscheli* sp. nov. from São Nicolau and *A. strakai* sp. nov. from Fogo (both Cape Verde islands) are described. *Aphanommata euphorbiarum* (Wollaston, 1867) from Santo Antão in the Cape Verde islands is redescribed and its lectotype is designated. All three *Aphanommata* species from the Cape Verde islands as well as *A. filum* (Mulsant and Rey, 1859) from Old World are diagnosed, illustrated, and keyed. Mature larva of *A. kuscheli* sp. nov. is described, larval morphology is discussed and the current state of knowledge about immature stages of Cossoninae is summarized. Vertical and inter-insular distributional pattern of Cape Verde *Aphanommata* and *Pselactus* is reviewed and discussed.

Keywords: Curculionidae; Cossoninae; Rhyncolini; Rhyncolina; taxonomy; new species; mature larva; morphology; host plant; Cape Verde; biogeography; microclimate; species competition

1. Introduction

Islands and archipelagos are particularly important for biodiversity not only because they host many threatened species but also because they are biodiversity hotspots due to their high levels of endemism [1,2]. The Cape Verde Archipelago consists of ten main islands and several islets located between 550 and 800 km west of the Senegal coast, all the islands are volcanic in origin. The geographical isolation of this archipelago exhibited a specific area with many endemic plants, and animals including beetles.

Research on Cape Verde Coleoptera started 150 years ago with a remarkable monograph by Thomas V. Wollaston [3]. However, since that time, only limited data were accumulated about biology, larvae, evolution, distribution and the phylogenetical relationship of beetle taxa endemic to the archipelago [4–9]. Weevils are not an exception and recent field research produced a significant amount of undescribed endemic species which can shed light on the history of this group within the archipelago [8,9]. Historically, the genera *Dinas* Wollaston, 1867 and *Pselactus* Broun, 1886 were the only weevil genera with more than one species within the archipelago. Biological notes based on original observations are limited to the collecting notes for several genera made by Wollaston [3] and for the endemic genus *Dinas* made by Skuhrovec and Batelka [8]. With six genera now recorded the diversity of the Cossoninae endemic to the Cape Verde archipelago is considerably higher than previously realised.

The aim of this paper is to review the Cape Verde members of the genus *Aphanommata*. The genus was described by Wollaston for a single species *A. euphorbiarum* (Wollaston, 1873) from the island Santo Antão (Cape Verde) and all other species currently assigned to *Aphanommata* were described in different genera. *Aphanommata* Wollaston, 1873 is a small genus currently placed in the tribe Rhyncolini, subtribe Rhyncolina [10]. This genus includes five described species [7], but only two species are currently known from the Old World. *Aphanommata filum* (Mulsant & Rey, 1858) is a west Palaearctic species so far known from Albania, Bulgaria, Croatia, France (including Corsica), Italy, Spain and Algeria; and *A. euphorbiarum* is known only from Cape Verde (Santo Antão). The inclusion of three New World species, *A. corrosa* (Champion, 1909) from Panama, *A. perlonga* (Champion, 1909) from Belize and Guatemala and *A. tenuis* (Casey, 1892) from the USA to the genus *Aphanommata* is only due to the inclusion of three American genera, *Rhamphocolus* Casey, 1892, *Macrancyloides* Champion, 1909 and *Oocorynus* Champion, 1909 in *Aphanommata* by Kuschel in Wibmer and O'Brien [11] and should be verified in the future.

In this paper, we describe two new *Aphanommata* species from São Nicolau and Fogo and provide a description of the larva of new species from São Nicolau and some details on biology and biogeography of the genus. It seems that with three species, the Cape Verde archipelago is a center of the diversity of the genus.

2. Materials and Methods

2.1. Field Survey

Larvae and adults of both *Aphanommata* species were obtained from dead woody parts of various native and introduced plants (see Collection circumstances for particular species). The collectors identified the plants. The larvae of *Aphanommata* were preserved in fixation liquid directly at the locality.

2.2. Morphological Descriptions of Adults

The adult specimens were examined with a Leica S8APO stereomicroscope with diffuse lighting at magnifications up to ×128. Dry mounted specimens were relaxed in the warm water and dissected; male and female terminalia were macerated in KOH solution, embedded in Euparal and illustrated; all dissected parts were mounted on plastic labels and pinned together with the respective specimen. Illustrated structures were studied using a ZEISS stereoscopic microscope and figured using the camera lucida. Photos of adults were taken with Canon EOS 700D cameras with an MP-E 65 mm macro lens and combined using Zerene Stacker and GIMP2 software. Details of adults were taken and corrected with HIROX (RH-2000, digital microscope).

The terminology of the rostrum and the genitalia follows Oberprieler et al. [12]. The head length was measured from the anterior margin of pronotum (base of head) to the anterior margin of the frontal rostrum; head width was measured across the eyes; the elytral length was measured along the suture; the width refers to the maximum width of pronotum. The body length is a combined length of the head, pronotum and elytra, measured separately.

Label data are cited verbatim. All labels of the studied material are printed; '/' separates different labels; (p) denotes printed labels, (h) denotes handwritten labels. All type specimens were provided with the following red printed label: HOLOTYPE, PARATYPE, LECTOTYPE or PARALECTOTYPE generic and specific name of the taxon, J. Skuhrovec, P. Hlaváč and J. Batelka det., 2018.

2.3. Deposition of Material

The material is deposited in the following collections:
BMNH—Natural History Museum, London, United Kingdom (formerly British Museum of Natural History) (Michael Geiser);
CJB—private collection of Jan Batelka, Prague, Czech Republic;

CJS—private collection of Jiří Skuhrovec, Prague, Czech Republic;
CPH—private collection of Peter Hlaváč, Prague, Czech Republic;
NMPC—National Museum, Prague, Czech Republic (Jiří Hájek);
OUMNH—Hope Entomological Collections, Oxford University Museum of Natural History, United Kingdom (Amoret Spooner);
SMNS—Staatliches Museum für Naturkunde, Stuttgart, Germany (Wolfgang Schawaller).

2.4. Morphological Descriptions of Larvae

A few larvae were fixed individually in Pampel fixation liquid (see [13]). These specimens are now deposited in CJS. To prepare the slides, we followed May [14]: a larva was decapitated, and the head was cleaned with a 10% potassium hydroxide (KOH) solution and then rinsed with distilled water. After cleaning, the mouthparts were separated from the head capsule, and the head capsule and all mouthparts were mounted on permanent microscope slides in Euparal. All other body parts were mounted on temporary microscope slides in 10% glycerine.

The observations and measurements were conducted using a light microscope with calibrated oculars (BX 40, Olympus, Tokyo, Japan and Eclipse 80i, Nikon, Tokyo, Japan). The following characteristics were measured for each larva: head width, length of the body laterally (larvae fixed in a C-shape were measured in segments), and width of the body in the widest place (i.e., metathorax or abdominal segments I–IV). The thorax and abdomen were not sclerotized, and it is unlikely that the fixation process altered the proportions of the weevils; measurements of these parts are provided for comparison purposes only.

Drawings were created with a drawing tablet (Intuos Pro S, Wacom, Saitama Prefecture, Japan) and the digital images subsequently processed with Adobe Photoshop, Corel Photo-Paint 11 and/or GIMP 2. The numbers of setae on bilateral structures were given for one side only.

We used the terms and abbreviations for the setae of the mature larvae found in Scherf [15], May [14,16], Marvaldi [17,18], Trnka et al. [19] and Skuhrovec et al. [20].

3. Results

***Aphanommata* Wollaston, 1873**

Aphanommata Wollaston, 1873: 463. Type species *Rhyncolus euphorbiarum* Wollaston, 1868.
Brachytemnoides Folwaczny, 1973: 155. Type species: *Rhyncolus filum* Mulsant and Rey, 1859, synonymy in Alonso-Zarazaga, 1989: 325.
Macrancyloides Champion, 1909: 75. Type species: *Macrancyloides perlongus* Champion, 1909, synonymy by Kuschel in Wibmer and O'Brien, 1986: 5.
Oocorynus Champion, 1909: 76. Type species: *Oocorynus corrosus* Champion, 1909, synonymy by Kuschel in Wibmer and O'Brien, 1986: 5.
Rhamphocolus Casey, 1892: 702. Type species: *Rhamphocolus tenuis* Casey, 1892, synonymy by Kuschel in Wibmer and O'Brien, 1986: 5.
Aphanommata Wollaston: Alonso-Zarazaga, 1989: 325 (review).

The genus *Aphanommata* is readily distinguishable from other genera of the tribe Rhyncolini by the combination of following character states: (1) body in cross section circular; (2) head narrow, conical, tapered anteriad, rostrum longer than wide; (3) eyes not prominent; (4) antennae short and stout, funicule with seven antennomeres; (5) basal margin of pronotum straight; (6) humeri well-defined, elytra parallel-sided; (7) scutellum visible and (8) apical tarsomere expanded to apex.

***Aphanommata euphorbiarum* (Wollaston, 1867)**

(Figure 1a,b, Figures 4e,f, 6c and 8a)

Rhyncolus euphorbiarum Wollaston, 1867: 119. Type locality: interior of Santo Antão, 4 syntypes in the Ribeira Fria and 1 syntypus in Ribeira da Babosa.

Aphanommata euphorbiarum: Alonso-Zarazaga, 1989: 327 (redescription, illustration of habitus, lateral view of head and aedeagus).

Type material studied: Lectotype, sex not determined, here designated: (h) *euphorbia*/round label with red margin (p) Type/(p) T. V. Wollaston Coll., B. M. 1867-82, CAPE VERDE IS./original white label with a green corner. BMNH. Paralectotype, ♂, hardly damaged specimen, aedeagus and some other parts mounted in Euparal: (p) T. V. Wollaston Coll., B. M. 1867-82, CAPE VERDE IS. BMNH.

Remark I. *Green corner on the original label is a mark of Wollaston and means that the specimen was collected on the island Santo Antão.*

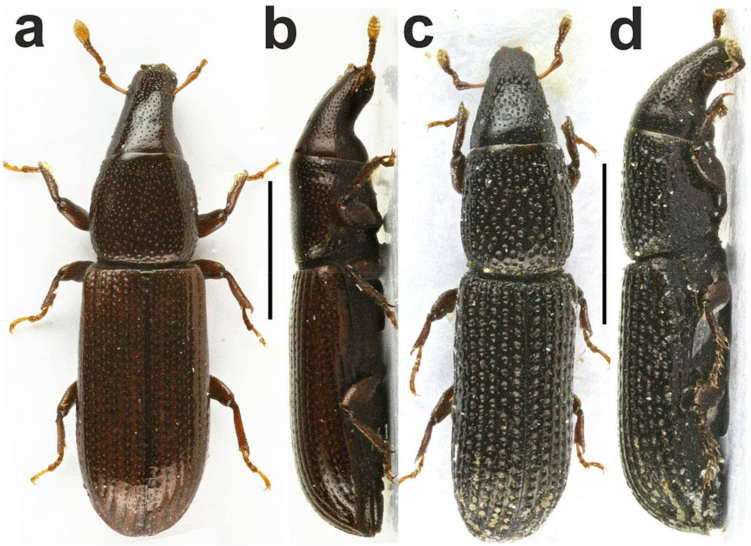

Figure 1. *Aphanommata euphorbiarum*, habitus, (**a**) Dorsal view; (**b**) Lateral view; *A. filum*, habitus; (**c**) Dorsal view; (**d**) Lateral view. Scale bars: 1 mm.

Diagnosis: Smaller species with body length under 3.5 mm, maximum width of elytra 0.96 mm, colour reddish-brown. Antennal scape slightly pedunculate at apex, short, shorter than funicule, funicule with 7 antennomeres; funicular antennomere I slightly longer than wide, about 1.5 times as long as II; antennal club about 1.4 times as long as wide; head and pronotum shiny, finely shagreened, evenly punctate with fine punctures; anterior margin of pronotum slightly narrower than base; eyes oval, flat, about 1.7 times higher than wide, temples short, width of eye equal to distance from margin of eye to pronotal margin (Figure 4f); pronotum widest in posterior third; elytra with 15 rows of punctures of different size, in sutural region cross-cracked, elytral intervals flat.
Differential diagnosis. *Aphanommata euphorbiarum* is distinguishable from its Old World congeners by the combination of the following character states: (1) body large, more than 3 mm but less than 3.5 mm long (Figure 1a); (2) pronotum with fine punctures, distance between punctures always superior to diameter of punctures (Figure 6c); (3) sides of pronotum evenly rounded (Figure 6c); (4) pronotum smooth (Figure 6c); (5) apex of elytra with very small erect setae (Figure 8a); (6) funicular antennomere I parallel-sided (Figure 1a) and (7) different shape of apex of aedeagus (Alonso-Zarazaga, 1989: 328, Figures 3 and 4). *Aphanommata euphorbiarum* is readily separated from *A. kuscheli* sp. nov. and *A. strakai* sp. nov. by different size, the absence of setae on the apex of elytra and the shape of aedeagus.

Remark II. *The species A. euphorbiarum has been redescribed by Alonso-Zarazaga [7] according to one male from the syntype series and distinguished in the key from A. filum (Mulsant and Rey, 1858) which were in the same work transferred in this genus due to the synonymy of the genus Brachytemnoides Folwaczny, 1973 to Aphanommata. One of the main diagnostic characters cited for A. euphorbiarum was the rostrum with the shallow median sulcus. We have examined 2 syntypes deposited in BMNH and did not find such a sulcus on the*

rostrum. The rostrum of both specimens examined by us is simple, lacking any trace of the sulcus, with only the sparse puncturation (Figure 4e,f). As the aedeagus illustrated by Alonso-Zarazaga [7] well corresponds with the aedeagus studied by us, we believe that the sulcus on the rostrum could be more an artefact than the case of interspecific variability, but more material will be needed to definitely solve this question.

Remark III. *A. euphorbiarum has been described according to five specimens sifted by V. Wollaston on two localities in the interior of the island Santo Antão [3:120]. We were searching all syntypes, but it seems that the specimen studied by Alonso-Zarazaga [7] as well as other two syntypes were lost, they are neither in BMNH (Max Barclay, per. comm.) nor in OUMNH (Amoret Spooner, per. comm.) where Wollaston's collection is deposited.*

Biology: Syntype series were collected from the decayed stem of the *Euphorbia tuckeyana*.
Distribution: Cape Verde (Santo Antão).

***Aphanommata kuscheli* sp. nov.**

(Figure 2a–c, Figure 3a–f, Figure 4a,b, Figure 5a, Figure 6a, Figures 7a, 9a–f and 10a–d)

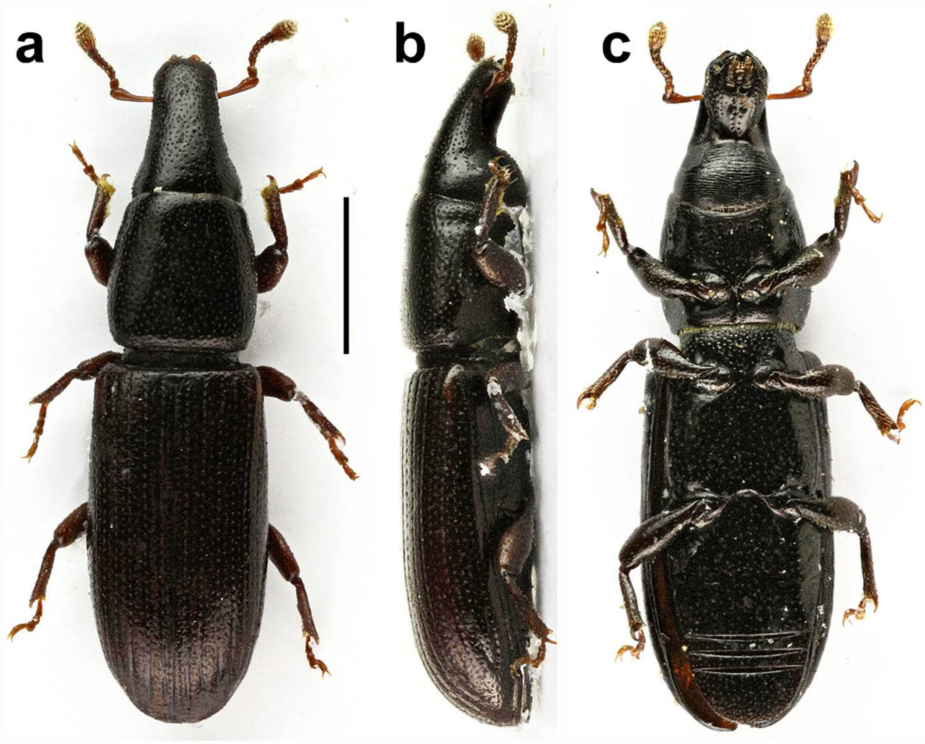

Figure 2. *Aphanommata kuscheli* **sp. nov.**, habitus, male, holotype: (**a**) Dorsal view; (**b**) Lateral view; (**c**) Ventral view.Scale bar: 1 mm.

Adult material studied

Type material. HOLOTYPE, ♂: CAPE VERDE Isl., 10.X.2013, SAO NICOLAU, W, Mt. Gordo summit, 16.625089, -24.350854, J. Straka and J. Batelka lgt. (p)/windward slopes in rotten wood of *Euphorbia tuckeyana* (p) (SMNS). **PARATYPES:** 47 ex.: the same data as holotype. SMNS (18), BMNH (3), OUMNH (2), NMPC (2), CJS (10), CPH (10), CJB (2). **Non-type material**. 3♀: SAO NICOLAU, W.-S of Cachaco, 13.XI.2011, 16°37′ N, 24°21′ W, J. Straka and J. Batelka lgt., in rotten wood of *Agave sisalana*. CJS, CPH, CJB.

Remark IV. *Specimens from São Nicolau, W-S of Cachaco are not included in the type series due to the lack of a male.*

Diagnosis. Antennal scape slightly pedunculate at apex, short, shorter than funicule, funicule with 7 antennomeres; funicular antennomere I slightly longer than wide, about 1.75 times as long as II; antennal club about 1.7 times as long as wide; head and pronotum shiny, finely shagreened, evenly puncturate with fine punctures; anterior margin of pronotum slightly narrower than base; pronotum widest in posterior fourth; elytra with 14–16 rows of punctures of different size, in anterior half cross-cracked, elytral intervals flat.

Description (Figure 2a–c). Body convex, shiny, pitch-black, sometimes elytra brownish, tarsi and antennae brownish (Figure 2a). Length 3.60–4.45 mm, maximum width of elytra 1.08–1.30 mm.

Head 1.15–1.25 times as long as wide, with sparse, fine punctures. Rostrum slightly convex, more than three times as long as head behind eyes (Figure 4a,b). Antennal scrobe lateral, not visible in dorsal view, short, deep, curved downward before eye, the point of antennal insertion located on anterior third of head (Figure 4a,b). Antennae (Figure 5a) stout, with long, sparse setae, antennal club with dense, golden pubescence on apical margin of first and second antennomeres of club; antennal scape short, pedunculate at apex, about 4.20–4.60 times as long as funicular antennomere I and shorter than funicule; funicule with seven antennomeres, funicular antennomere I expanded to apex, 1.40 times as long as wide, slightly longer and wider than II, later about 1.60 times as long as III, III–VII transverse, V–VII subequal, slightly longer than III and IV, antennal club with three antennomeres, first clearly longest, club apically pointed, 1.50–1.60 times as long as wide. Eyes oval, flat, about 1.50 times higher than wide, temples long, width of eye inferior, about 1.5 times, to distance from margin of eye to pronotal margin (Figure 4b).

Pronotum (Figure 6a) with dense, fine, even punctures, pronotal punctures equal in size to punctures on head but puncturation denser, distance between punctures considerably superior to diameter of punctures. Pronotum 1.00–1.05 times as long as wide, 1.15–1.30 times as long as head, widest in posterior fourth, basal margin straight. Scutellum well-defined, oval, wider than long.

Elytra (Figure 7a) 1.80–1.95 times as long as wide, 2.10–2.30 times as long as pronotum, convex, fused, surface smooth and shiny, with about 14–16 striae formed by rows of punctures of different size, distance between punctures varies but always superior to diameter of puncture, in anterior half cross-cracked, elytral intervals flat, humeri prominent, humeral calli well-defined. Hind wings absent.

Prosternum at the same level as meso and metaventrite, finely shagreened, with very few uneven punctures, long, disc depressed in anterior part, depression with transverse furrow, anterior margin finely dentate; procoxae separated by narrow isthmus, hypomerae fused with median part of prosternum; mesoventrite short, about 2.50 times shorter than metaventrite, both finely shagreened, shiny, mesoventrite roughly punctured mainly in anterior part, anterior margin with golden setae, mesoventral process long, wide, truncate, shagreened and punctured, metaventrite evenly punctured, mesocoxae separated, isthmus about as wide as half of coxa, metacoxae strongly separated by large process of first ventrite, puncturation on metaventrite denser than on ventrite I and II, ventrite I about 1.35 times as long as ventrite II, all ventrites shagreened and punctured, posterior part of ventrite I and anterior part of ventrite II medially depressed, ventrites III and IV subequal in length, ventrite V semicircular in shape, more than three times as long as ventrite IV.

Legs (Figure 2a–c) brownish, finely shagreened, tibiae with strongly arcuate uncus and well-defined mucro, fore tibiae with dense, golden setation on inner part of apical half of tibia, apex of mid and hind tibiae decent setae, tarsi with four tarsomeres, tarsomere I long, about as long as II–III combined, III bilobed in apical half, onychium long, about as long as I–III combined, with two free, divaricate, tarsal claws equal.

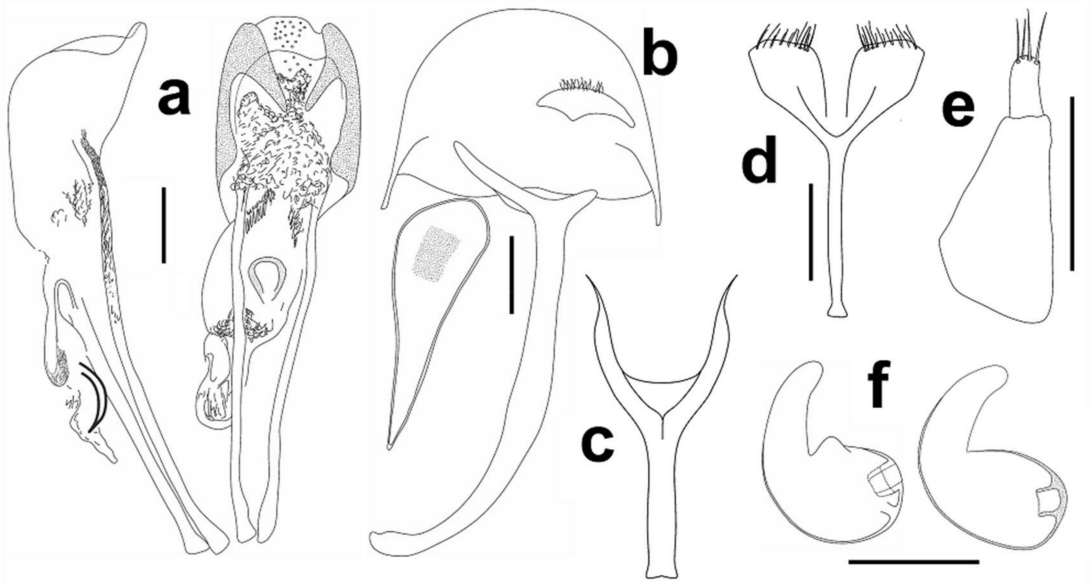

Figure 3. *Aphanommata kuscheli* **sp. nov.**, male genitalia: (**a**) Aedeagus, lateral and dorsal view; (**b**) Male sternite 9 (spiculum gastrale), hemisternite, and rectal loop; (**c**) Tegmen; and female genitals: (**d**) Female sternite 8 (spiculum ventrale); (**e**) Gonocoxite; (**f**) Spermatheca, dorsal and ventral view. Scale bars: 0.2 mm.

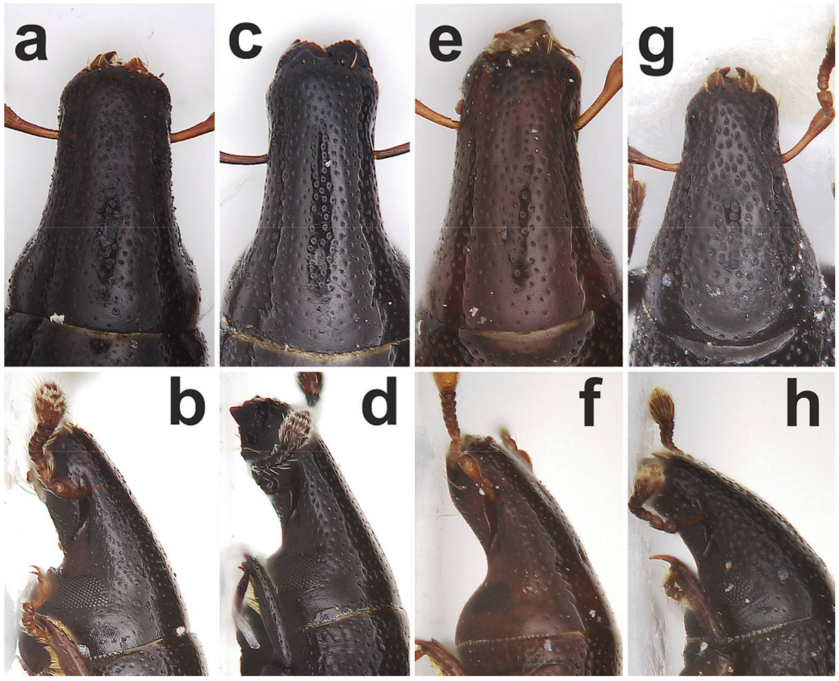

Figure 4. *Aphanommata kuscheli* **sp. nov.**, rostrum, male, holotype: (**a**) Dorsal view; (**b**) Lateral view. *A. strakai* **sp. nov.**, rostrum, male, holotype: (**c**) Dorsal view; (**d**) Lateral view. *A. euphorbiae*, rostrum, male: (**e**) Dorsal view; (**f**) Lateral view. *A. filum*, rostrum, male: (**g**) Dorsal view; (**h**) Lateral view.

Male genitalia. Aedeagus (Figure 3a), male sternite 9 (spiculum gastrale), hemisternite and rectal loop (Figure 3b).

Female genitalia. Spermatheca (Figure 3f), female sternite 8 (spiculum ventral) (Figure 3d), gonocoxite (Figure 3e).

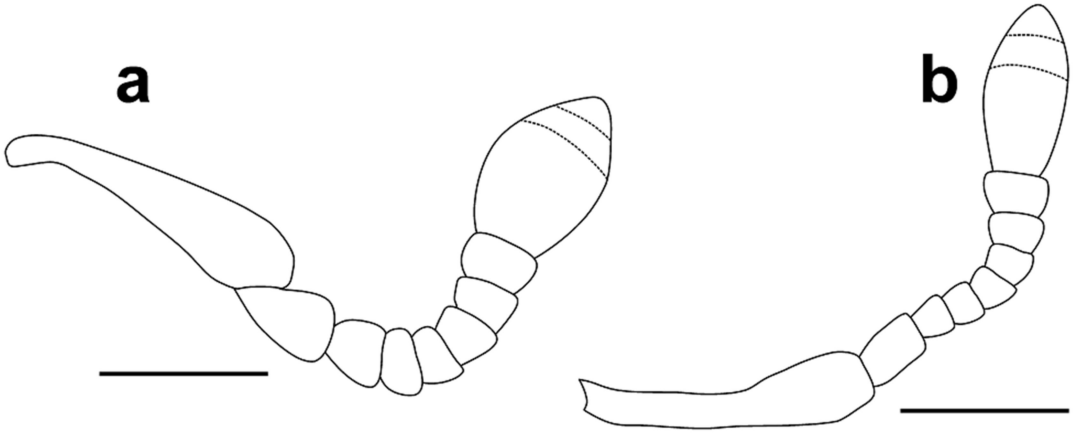

Figure 5. Antenna of *Aphanommata* species: (**a**) *A. kuscheli* **sp. nov.**, holotype; (**b**) *A. strakai* **sp. nov.**, holotype. Scale bars: 0.2 mm.

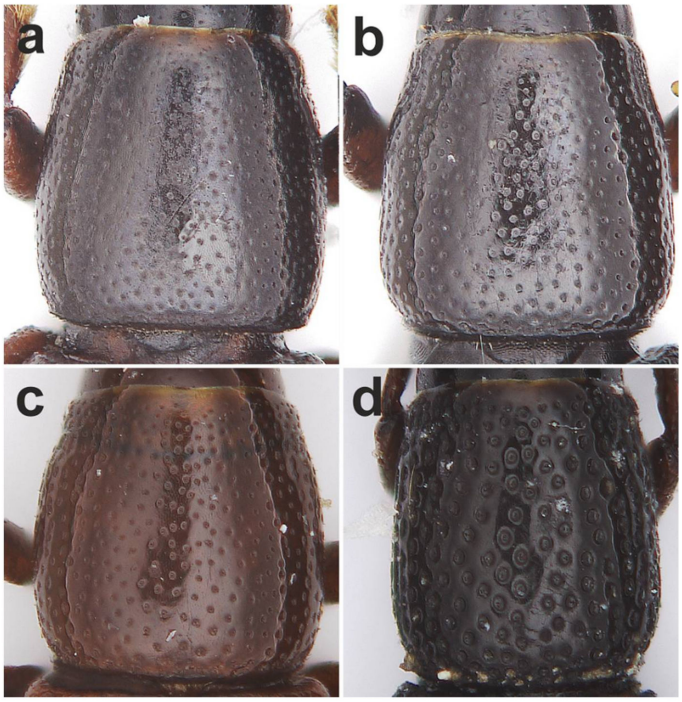

Figure 6. Pronota of *Aphanommata* species, males: (**a**) *A. kuscheli* **sp. nov.**, holotype; (**b**) *A. strakai* **sp. nov.**, holotype; (**c**) *A. euphorbiae*; (**d**) *A. filum*.

Sexual dimorphism. Ventrites I and II in females simple, lacking median depression.

Differential diagnosis. *Aphanommata kuscheli* sp. nov. is distinguishable from its Old World congeners by the combination of the following character states: (1) body large, more than 4 mm long; (2) pronotum with fine punctures, distance between punctures always superior to diameter of punctures (Figure 6a); (3) sides of pronotum evenly rounded (Figure 6a); (4) pronotum shagreened (Figure 6a); (5) apex of elytra with any erect setae (Figure 7a); (6) funicular antennomere I expanded to apex (Figure 5a); (7) different shape of apex of aedeagus (Figure 3a); and (8) apex of cornu on spermatheca slightly bent (Figure 3f). *Aphanommata kuscheli* sp. nov. is readily separated from *A. strakai* sp. nov. by the different surface of pronotum, the shape of antenna, aedeagus and spermatheca; and from *A. euphorbiarum* by different size, the absence of setae on the apex of elytra and the shape of aedeagus.

Etymology. Patronymic, named after Guillermo Kuschel, an eminent Curculionidae worker who has also contributed significantly to knowledge of the subfamily Cossoninae.

Figure 7. Elytra of *Aphanommata* species, males: (**a**) *A. kuscheli* **sp. nov.**, holotype; (**b**) *A. strakai* **sp. nov.**, holotype.

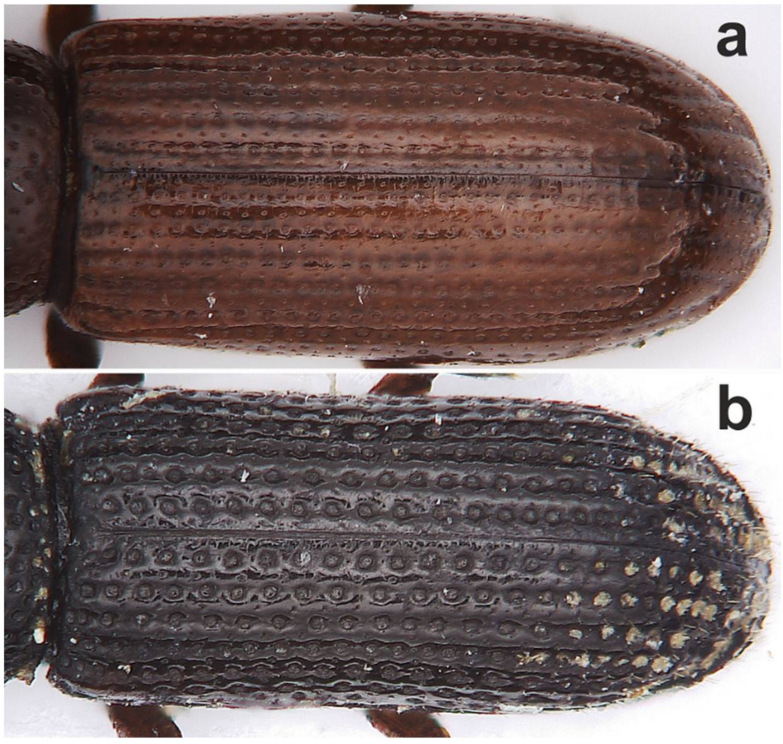

Figure 8. Elytra of *Aphanommata* species, males: (**a**) *A. euphorbiae*; (**b**) *A. filum*.

Description of mature larva

Material examined. 2 mature larvae: Cape Verde Isl., São Nicolau W—Mt. Gordo Summit, 10.x.2013, 16.625089 N, 24.35084 W, J. Straka and J. Batelka lgt., windward slopes, in rotten wood of *Euphorbia tuckeyana* Steud. (Euphorbiaceae).

Measurements (in mm). Body length: 5.48–6.15. The widest body part (abdominal segments II–VI) 1.47. Head width: 0.87–0.96.

General. Body elongate, slightly curved, rounded in cross section (Figure 10a).

Colouration. Dark yellow to pale brown head around suture white (Figure 10a). All thoracic and abdominal segments white and dorsum with fine speckling (Figure 10a).

Vestiture. Setae on body very long to very short, orange and clearly visible.

Head capsule (Figure 9a). Head suboval and distinctly rounded laterally, endocarinal line absent. Frontal sutures on head very broad and well visible, extended to antennae. One stemmata (st) feebly visible, in the form of a minute pigmented spot with convex cornea, located on each side anterolaterally, behind antenna. Setae on head piliform, varying in length, from very long to short. Des_1 and des_2 located behind the middle part of the central part of epicranium, very long des_1 near to the middle part of epicranium, and medium des_2 near to side of epicranium, very long des_3 located anteriorly on epicranium in or very close to frontal suture, medium des_4 close to des_3, very long des_5 located anterolaterally (Figure 9a); des_2 and des_4 as long as third of length of remaining three *des*. Dorsal part of epicranium with 2 sensilla; one between des_1 and des_2, and next one close to des_4. Fs_1 of medium length located posteriomedially, and almost in the frontal suture, fs_2 located medially, fs_3 and fs_4 located anterolaterally; and fs_5 close to antennae; fs_1, fs_2 and fs_4 as long as des_4, and fs_3 and fs_5 very long as long as des_5 (Figure 9a). Les_1 and les_2 as long as des_1; both *ves* short, as long as third length of *les*. Epicranial area with 3–4 *pes*.

Antennae located at the end of the frontal suture on each side, membranous and conical basal article bearing one conical triangular sensorium located centrally; basal membranous article with 2(3) very short basiconic sensillae (Figure 9d).

Clypeus (Figure 9e) slightly trapezium-shaped, anterior margin of clypeus slightly concave; approximately 2 times as wide as long; cls_1 very long, placed posteromedially, cls_2 of medium length to long, localized posterolaterally; 1 sensillum *clss* placed between cls_1 and cls_2.

Mouth parts. Labrum (Figure 9e) also slightly trapezium-shaped, approximately twice as wide as long, with 3 piliform *lms*, of different lengths; lms_1 very long, lms_2 and lms_3 as long as two third of length of lms_1; all *lms* protrudes well over the anterior margin of labrum; lms_1 placed medially in the central part of labrum, lms_2 located anteromedially and lms_3 located anterolaterally; anterior margin bi-sinuate. Epipharynx (Figure 9f) with 3 finger-like *als*, als_1 more than twice as long as als_2 and als_3, all in line to labral rods; with 3 *ams* piliform, ams_1 as long as als_1, ams_2 as long as half or one third length of ams_1, and ams_3 very short as als_2 and als_3; and with 2 very short to minute, finger-like *mes*; labral rods (lr) narrow, elongate, parallel. Mandibles (Figure 9c) slightly curved, distinctly broad, with divided apex; bifid, teeth of unequal length; slightly truncate; mds_1 very long, and mds_2 long, piliform, located in distinct holes. Maxilla (Figure 9b) stipes with 1 *stps*, 2 *pfs* and 1 *mbs* with one sensillum close to *mbs*, *stps* and $pfs_{1–2}$ very long, *mbs* minute to very short; mala with 7 finger-like *dms*; 4 *vms*, different in length, one very short seta, one short and two as long as *dms*; 2 *vms* distinctly shorter than *dms*. Maxillary palpi with two palpomeres; basal palpomere with 1 relatively long *mxps* and two sensilla; length ratio of basal and distal palpomeres: 1:1; distal palpomere with one sensillum and a group of conical, cuticular apical processes. Prelabium (Figure 9b) oval-shaped and feebly elongate, with 1 long *prms*; ligula with sinuate margin, 2 relatively long to short *ligs*, and one sensillum; premental sclerite feebly visible. Labial palpi with two palpomeres; length ratio of basal and distal palpomeres, basal palpomere much wider than distal: 1:1.3; distal palpomere elongate, with one sensillum and short, cuticular apical processes; basal palpomere with 1 dorsal sensillum.

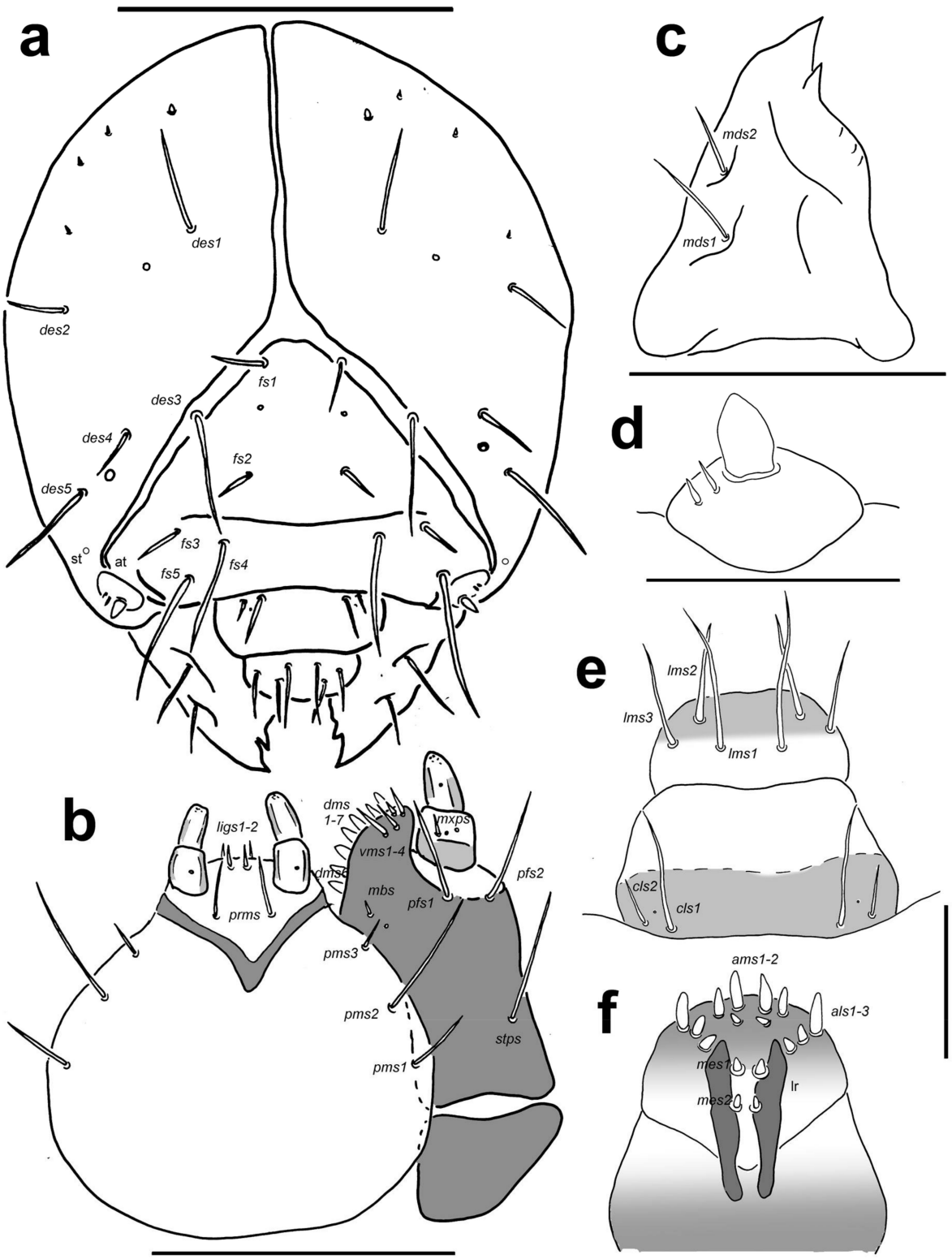

Figure 9. *Aphanommata kuscheli* **sp. nov.**, mature larva: (**a**) Head, frontal view (*des*—dorsal epicranial seta; *fs*—frontal epicranial s.; *les*—lateral epicranial s.; at—antenna); (**b**) Maxillolabial complex consisting of left maxilla (*dms*—dorsal malar s.; *vms*—ventral malar s.; *mpxs*—maxillary palps s.; *mbs*—basioventral s.; *pfs*—palpiferal s.; *stps*—stipital s.), prementum and postmentum, ventral view (*prms*—premental s.; *pms*—postmental s.; *ligs*—ligular s.); (**c**) Right mandible (*mds*—mandible dorsal s.), ventral view; (**d**) Antenna; (**e**) Labrum and clypeus (*lms*—labral s., *cls*—clypeal s.), dorsal view; (**f**) Epipharynx (*ams*—anteromedial s.; *als*—anteriolateral s.; *mes*—median s.; lr—labral rods), ventral view. Scale bars: (**a**) 0.5 mm; (**b**,**c**) 0.25 mm; (**d**) 0.05 mm; (**e**,**f**) 0.1 mm.

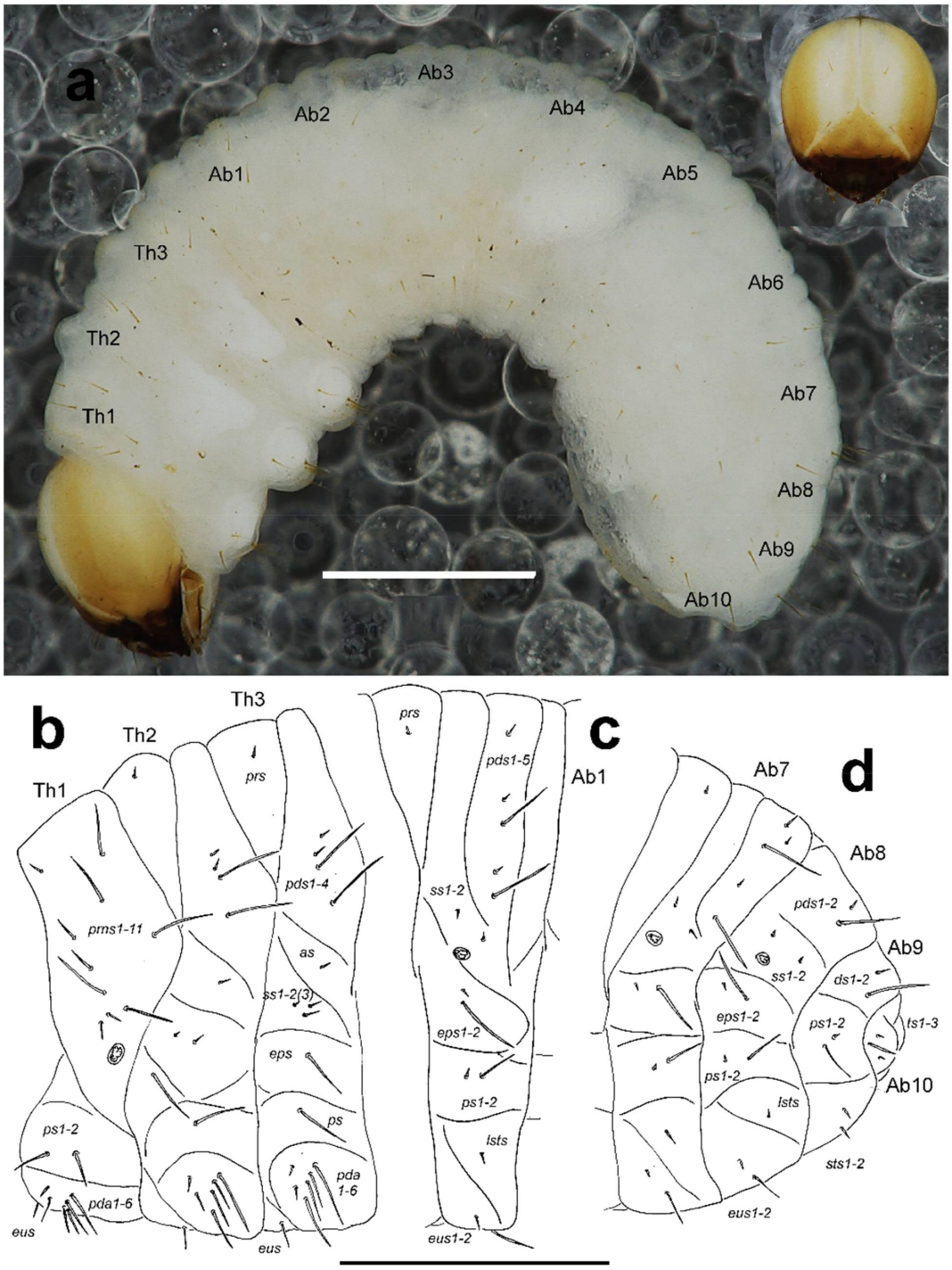

Figure 10. *Aphanommata kuscheli* **sp. nov.**, mature larva: (**a**) Habitus, left lateral view; (**b**) Left lateral view of thoracic segments; (**c**) Left lateral view of abdominal segment I; (**d**) Left lateral view of abdominal segments VII-X (*prns*—pronotal s.; *prs*—prodorsal s.; *pds*—postdorsal s.; *as*—alar s.; *ss*—spiracular s.; *eps*—epipleural s.; *ps*—pleural s.; *pda*—pedal s.; *lsts*—laterosternal s.; *eus*—eusternal s.; *ds*—dorsal s.; *sts*—sternal s.; Th1-3—number of thoracic segments; Ab1-10—number of abdominal seg.). Scale bars: 1 mm.

Postlabium (Figure 9b) with 3 *pms*, all *pms* located laterally; pms_1 and pms_2 very long, but pms_1 as long as two third of pms_2, pms_3 long, more than 2 times shorter than pms_1.

Thorax. Prothorax smaller than meso- and metathorax. Spiracle bicameral, placed between the pro- and mesothorax (see Skuhrovec et al. [9]). Prothorax (Figure 10b) with 10 short to very long *prns* (3 placed apically (one short and 2 very long); 1 or 2 very long and 2 relatively long medially; 4 form a group close to spiracle, 2 very long, and 2 short); 2 very long to long *ps*; and 1 relatively long *eus*. Mesothorax (Figure 10b) with 1 short to very short *prs*, 4 *pds* different in length (order: very short, very short, very long, very long); 1 short to very short *as*; 1 very short and 1–2 short to relatively long *ss*; 1 very long *eps*; 1 very long *ps*; and 1 long to very long *eus*. Chaetotaxy of metathorax (Figure 10b) almost identical to that of mesothorax. Each pedal area of thoracic segments well separated, with 4 very long and 2 relatively long to short *pda*.

Abdomen. Abdominal segments I–VI of almost equal length, remaining abdominal segments decreasing in width gradually posterad. Abdominal segment X reduced to four anal lobes of unequal size, the dorsal being distinctly the largest, the lateral pair equal in size, and the ventral lobe very small. Anus located terminally; ambulatory ampullae bilobate to circular. Spiracles bicameral, the eight abdominal spiracles located medially, close to the anterior margin of abdominal segments I–VIII. Abdominal segments I–VII (Figure 10c) with 1 very short to short *prs*; 5 *pds* different in length (order: short, very short, very long, very short, very long); 2 short *ss*; 1 very short and 1 very long *eps*; 1 very short and 1 very long *ps*; 1 relatively long *lsts*; and 1 relatively long and 1 very long *eus*. Abdominal segment VIII (Figure 10d) with 2 *pds* different in length (order: short, very long); 2 short *ss*; 1 very short and 1 very long *eps*; 1 very short and 1 very long *ps*; 1 relatively long *lsts*; and 1 relatively long and 1 very long *eus*. Abdominal segment IX (Figure 10d) with 1 short to relatively long and 1 very long *ds*, located close to posterior margin of segment; 1 very long and 1 very short *ps*; and 2 relatively long to short *sts*. Abdominal segment X (Figure 10d) with 3 *ts*, 1 long and 2 very short to minute.

Collection circumstances. Imagines and larva collected in 2011 south-west of Cachaco were extracted from the outer layer of the rotten stem of *Agave sisalana*, growing by the mountain trail circa 1050 m a.s.l. More specimens of the species were obtained in 2013 from the rotten stem of *Euphorbia tuckeyana* on the northern slope of Monte Gordo, not far from the summit, some 1200 m a.s.l. The stem of *Euphorbia* was much eaten by larvae of the species, imagines were in the larval galleries and pupal chambers.

Distribution: Cape Verde (São Nicolau)

***Aphanommata strakai* sp. nov.**

(Figures 4c,d, 5b, 6b, 7b, 11a–c and 12a–f)

Type material studied. HOLOTYPE, ♂: CAPE VERDE Isl., FOGO—Chã des Caldeiras 8.–9.X.2009, J. Straka and J. Batelka lgt. (p) (SMNS). **PARATYPES:** 9 ex.: the same data as holotype. SMNS (1), BMNH (1), OUMNH (1), NMPC (1), CJS (2), CPH (2), CJB (1).

Diagnosis. Antennal scape slightly pedunculate at apex, short, shorter than funicule, funicule with seven antennomeres; funicular antennomere I about 1.60 times as long as wide, almost parallel-sided, about 1.75 times as long as II; antennal club about twice as long as wide; head and pronotum shiny, head finely shagreened, pronotom not shagreened, evenly puncturate with fine punctures, punctures on pronotum bigger; elytra with 14–15 rows of punctures of different size, finely cross-cracked in anterior half only close to sutura, elytral intervals flat; anterior margin of pronotum slightly narrower than base; pronotum widest in posterior fourth.

Description (Figure 11a–c)**.** Body convex, shiny, reddish-brown to dark reddish-brown, tarsi and antennae of the same colour (Figure 11a–c). Length 4.00–4.25 mm, maximal width of elytra 1.10–1.20 mm.

Head 1.15–1.20 times as long as wide, with sparse, fine punctures. Rostrum slightly convex, more than three times as long as head behind eyes (Figure 4c,d). Antennal scrobe lateral, not visible in dorsal view, short, deep, curved downward before eye, the point of antennal insertion located on anterior third of head (Figure 4c,d). Antennae (Figure 5b) stout, with long, sparse setae, antennal club with dense, golden pubescence on apical margin of first and second antennomeres of club; antennal

scape short, pedunculate at apex, about 4.65–4.75 times as long as funicular antennomere I and shorter than funicule; funicule with seven antennomeres, funicular antennomere I parallel-sided, 1.60 times as long as wide and 1.75 times as long as II, later about 1.30 times as long as III, III–VII transverse, V–VI subequal, VII about 1.2 times as wide as VI, antennal club with three antennomeres, first clearly longest, club apically pointed, 1.40–1.50 times as long as wide. Eyes oval, flat, about 1.2–1.3 times higher than wide, temples long, width of eye inferior, about 1.33 times, to distance from margin of eye to pronotal margin (Figure 4d).

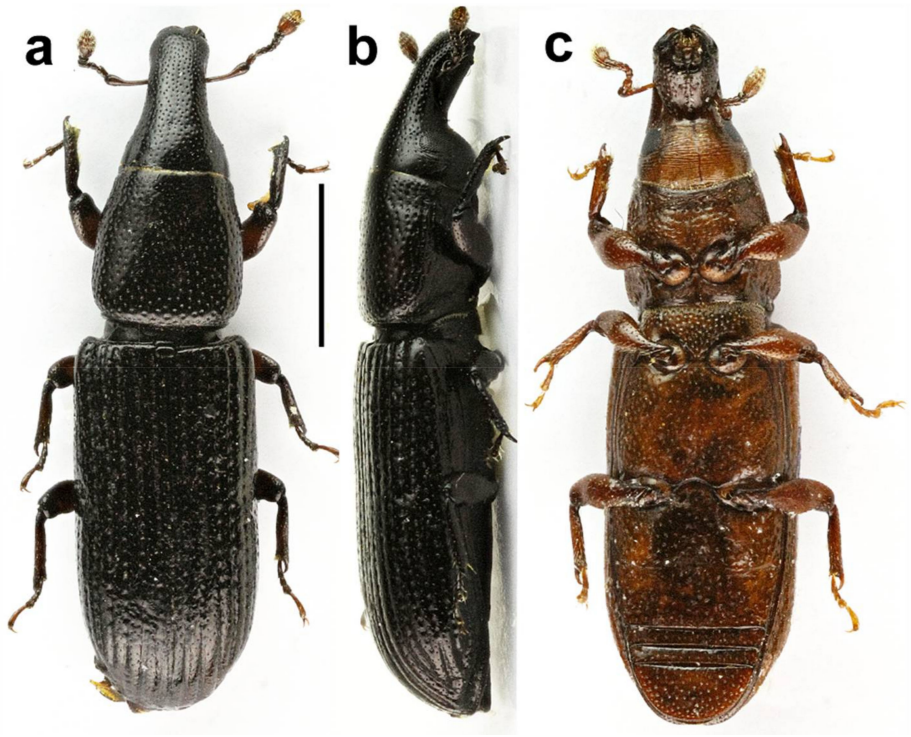

Figure 11. *Aphanommata strakai*, **sp. nov.**, habitus, male, holotype: (**a**) Dorsal view; (**b**) Lateral view; paratype: (**c**) Ventral view.

Pronotum (Figure 6b) with dense, fine, even punctures, pronotal punctures larger and denser than punctures on head, distance between punctures varies considerably, from inferior, equal to clearly superior to diameter of punctures, pronotum 1.00–1.05 times as long as wide, 1.10–1.25 times as long as head, widest in posterior fourth, basal margin straight. Scutellum well-defined, oval, wider than long.

Elytra (Figure 7b) 1.95–2.05 times as long as wide, 2.30–2.45 times as long as pronotum, convex, fused, surface smooth and shiny, with about 14–16 striae formed by punctures of different size, distance between punctures varies but always superior to diameter of puncture, in anterior half cross-cracked only close to suture, elytral intervals flat, humeri prominent, humeral calli well-defined. Hind wings absent.

Prosternum at the same level as meso and metaventrite, finely shagreened, with uneven punctures, long, disc depressed in anterior part, depression with transverse furrow, anterior margin finely dentate; procoxae separated by narrow isthmus, hypomerae fused with median part of prosternum; mesoventrite long, about 1.75 times shorter than metaventrite, both finely shagreened, shiny, mesoventrite roughly punctured mainly in anterior part, anterior margin with golden setae, mesoventral process long, wide, truncate, shagreened and punctured, metaventrite sparsely unevenly punctured, mesocoxae separated, isthmus about as wide as half of coxa, metacoxae strongly separated by large process of first ventrite, puncturation on metaventrite about as dense as on ventrite I and II, ventrite I about 1.30 times as long as ventrite II, all ventrites shagreened and punctured, posterior part

of ventrite I and anterior part of ventrite II medially depressed, ventrites III and IV subequal in length, ventrite V semicircular in shape, more than three times as long as ventrite IV.

Legs (Figure 11a–c) brownish, finely shagreened, tibiae with strongly arcuate uncus and well-defined mucro, fore tibiae with dense, golden setation on inner part of apical half of tibia, apex of mid and hind tibiae decent setae, tarsi with four tarsomeres, tarsomere I long, about as long as II–III combined, III bilobed in apical half, onychium long, about as long as I–III combined, with two free, divaricate, tarsal claws equal.

Male genitalia. Aedeagus (Figure 12a), male sternite 9 (spiculum gastrale) (Figure 12b).

Female genitalia. Spermatheca (Figure 12f), female sternite 8 (spiculum ventral) (Figure 12d), gonocoxite (Figure 12e).

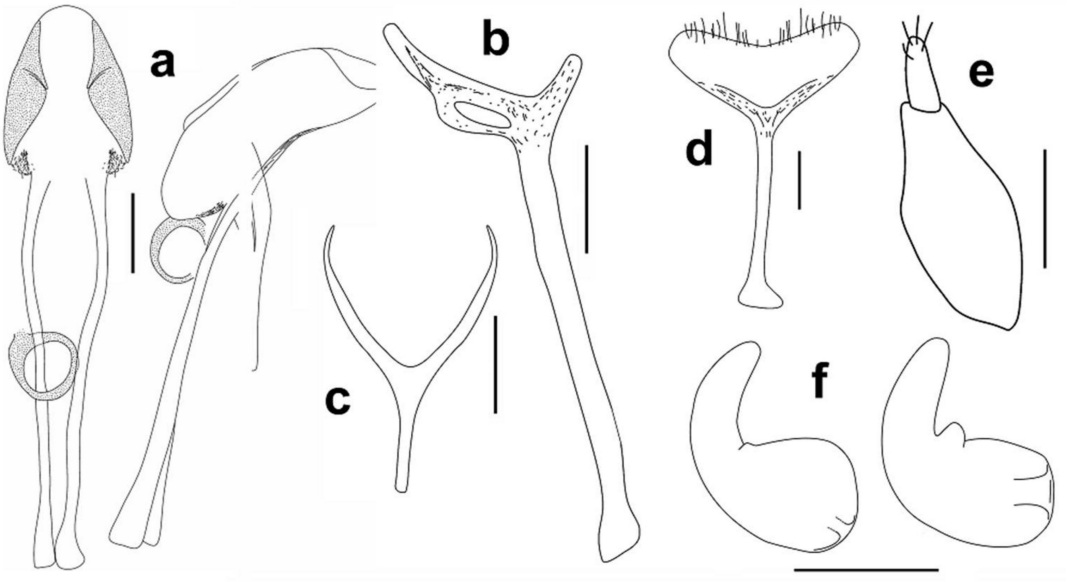

Figure 12. *Aphanommata strakai* **sp. nov.**, male genitalia: (**a**) Aedeagus, dorsal and lateral view; (**b**) Male sternite 9 (spiculum gastrale); (**c**) Tegmen; and female genitals: (**d**) Female sternite 8 (spiculum ventrale); (**e**) Gonocoxite; (**f**) Spermatheca, dorsal and ventral view. Scale bars: 0.2 mm.

Sexual dimorphism. Ventrites I and II in females simple, lacking median depression.

Differential diagnosis. *Aphanommata strakai* sp. nov. is distinguishable from its Old World congeners by the combination of the following character states: (1) body large, more than 4 mm long; (2) pronotum with fine punctures, distance between punctures always superior to diameter of punctures (Figure 6b); (3) sides of pronotum evenly rounded (Figure 6b); (4) pronotum smooth (Figure 6b); (5) apex of elytra with any erect setae (Figure 7b); (6) funicular antennomere I parallel-side (Figure 5b); (7) different shape of apex of aedeagus (Figure 12a); and (8) apex of cornu on spermatheca straight (Figure 12f). *Aphanommata strakai* sp. nov. is readily separated from *A. kuscheli* sp. nov. by the different surface of pronotum, the shape of antenna, aedeagus and spermatheca; and from *A. euphorbiarum* by the different size, the absence of setae on the apex of elytra and the shape of aedeagus.

Etymology. The species name is dedicated to the Czech entomologist Jakub Straka (Praha, Charles University) in appreciation of his friendship and his energetic field research on the Cape Verde Curculionidae.

Collection circumstances. All adults were collected under the bark of dead *Euphorbia tuckeyana* on the floor of the caldera of the Fogo volcano, about 2 km SW of Portela village, circa 1710 m a.s.l.

Distribution. Cape Verde (Fogo).

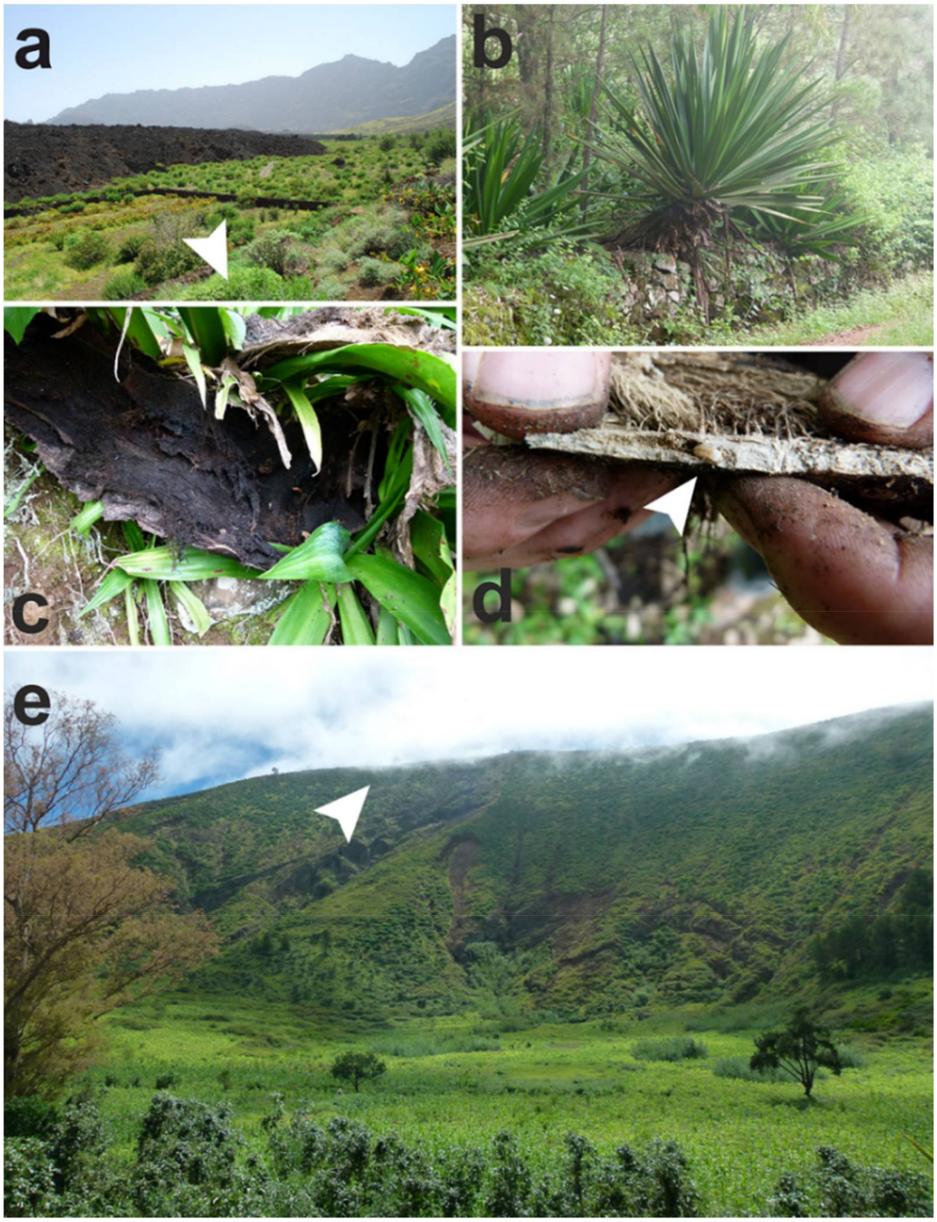

Figure 13. Images of habitat of *Aphanommata* species: (**a**) The type locality of *Aphanommata strakai* sp. nov. (indicated by arrowhead): FOGO, Chã des Caldeiras, ca. 1710 m, the (Photo 8.–9.X.2009 J. Batelka); (**b**–**e**) localities and habitats of *Aphanommata kuscheli* sp. nov.; (**b**–**d**) rotten wood of *Agave sisalana* (Agavaceae) with larva of the new species: SAO NICOLAU, W, S of Cachaco, 16°37′ N, 24°21′ W (Photos 13.XI.2011 J. Straka); (**e**) windward (north) slope with *Euphorbia tuckeyana* (Euphorbiaceae), the locality is indicated by arrowhead: SAO NICOLAU, W, Mt. Gordo, (Photo 10.X.2013 J. Straka).

Key to *Aphanommata* species of Old World

1 Small species, body length 2.30–2.80 mm (Figure 1c,d). Pronotum with rough, dense punctures, the distance between punctures inferior to the diameter of punctures (Figure 6d). Sides of pronotum parallel (Figure 6d). Distribution: known from southern Europe, and Algeria. . . . . ***A. filum*** **(Mulsant and Rey)**

- Larger species, body length more than 3 mm (Figure 1a,b; Figure 2a–c; Figure 11a–c). Pronotum with fine punctures, distance between punctures always superior to the diameter of punctures

(Figure 6a–c). Sides of pronotum evenly rounded (Figure 6a–c). Distribution: only on the Cape Verde islands. **2**

2 Smaller species, body length less than 3.5 mm (Figure 1a,b). The apex of elytra with small erect setae (Figure 8a). . . . . ***A. euphorbiarum* (Wollaston)**

\- Larger species, body length more than 4.0 mm (Figure 2a–c; Figure 11a–c). The apex of elytra lacking erect setae (Figure 7a,b). **3**

3 Pronotum shagreened (Figure 6a). Funicular antennomere I expanded to apex, 1.40 times as long as wide, slightly longer and wider than II, later about 1.60 times as long as III (Figure 5a). The apex of cornu on spermatheca slightly bent (Figure 3f). . . . . ***A. kuscheli* sp. nov.**

\- Pronotum smooth, not shagreened (Figure 6b). Funicular antennomere I parallel-sided, 1.60 times as long as wide and 1.75 times as long as II, later about 1.30 times as long as III (Figure 5b). The apex of cornu on spermatheca straight (Figure 12f). . . . . ***A. strakai* sp. nov.**

4. Discussion

4.1. Comparison with Larvae of Other Cossoninae Species

The larvae of 54 Cossoninae taxa in 31 genera have been previously described [9,15,16,21–23]. The larva we report on here was compared with the majority of the species described or drawn by Anderson [21] and May [14,23]. Their illustrations are all of high or sufficient quality and are, therefore, useful; however, the described characteristics are useful only for differential diagnoses.

The precise general description of larvae of the subfamily Cossoninae, which is summarized by 10 character sets, was first published by May [23]: (1) labral lateral setae as long as anterior setae; (2) epipharyngeal lining with 2 groups of sensilla (3) tormae strong, separate (with a few exceptions); (4) spiracle on abdominal segment VIII lateral; (5) mandibular setae (two) aligned longitudinally; (6) spiracles bicameral; (7) rectal bracon forms a pigmented loop; (8) head with 4 *fs* (fs_1 absent); (9) abdominal segments II–VI with 4 dorsal folds (except Cotasterini Voss, 1953 (in [21]; recently synonym of Dryotribini LeConte, 1876)); and finally (10) each abdominal segment with 2 dorsal setae. May [23] commented in detail the state of these characters for each of specific Cossoninae groups. All these characters with one main exception (character 8) fit well with *Aphanommata* larva described here. Larva of *Aphanommata* species have five frontal setae (Figure 9a), but normally Cossoninae larvae have only four setae. This character state is also shared with some other genera, such as *Pselactus* Broun, 1886; *Hexarthrum* Wollaston, 1860; *Stenoscelis* Wollaston, 1861; *Nyssonotus* Casey, 1892; *Catolethrus* Boheman, 1838; *Pseudopentaarthrum* Wollaston, 1873 (in [21] as *Pentarthrinus* Casey, 1892) and also tribes Acamptini LeConte, 1876 and Anchonini Imhoff, 1856 (in [21]; both recently assigned to Molytinae). This situation is not exceptional for Cossoninae. For example, *Eiratus suavis* T. Broun, 1885 from the tribe Cotasterini has only one mandibular seta, not two as it is typical for this subfamily [23].

Anderson [21] published the most comprehensive review of the morphology of larvae of Cossoninae including data on 25 genera. In his tribal key, the genus *Aphanommata* was assigned to the tribe Cossonini Schoenherr, 1825 based on the following characters; (1) labial palpi two-segmented (Figure 9b); (2) pedal area of thoracial segments with six or more setae (Figure 10a,b); (3) spiracles on abdominal segment VIII lateral in position, and not larger than on previous segments (Figure 10a,d); (4) epipharynx with 2 *mes* (Figure 9f); and finally (5) epipharynx without discernible asperities (Figure 9f).

In the key of the tribe Cossonini [21], the genus *Aphanommata* is located close to the genera *Catolethrus* and *Nyssonotus* or genera *Rhyncolus* Germar, 1817 and *Phloeophagus* Schoenherr, 1837, where *Catolethrus* is placed in the tribe Dryotribini LeConte, 1876 and *Nyssonotus*, *Rhyncolus* and *Phloeophagus* are probably closed genera together with *Aphanommata* actually placed in the tribe Rhyncolini Gistel, 1856 [10]. These seven morphological larval characters are common for these three genera; (1) epipharynx with three *als* (Figure 9f); (2) meso- and metathorax with 4 or 5 *pds* (Figure 10b); (3) sternum of thoracic segments with one seta (Figure 10b); (4) spiracles on abdominal

segments bicameral (Figure 10c,d); (5) anterolateral setae on epipharynx not in a straight, longitudinal row (Figure 9f); (6) anteromedian setae on epipharynx arranged transversely (Figure 9f), and finally (7) typical abdominal segments with four or five dorsal folds (Figure 10a). Larval morphology of *Aphanommata* species suggests a close relationship with *Nyssonotus*, *Rhyncolus* and *Phloeophagus*, but the classification of these four genera within the tribe Rhyncolini needs further verification (as discussed above).

Larvae of *Aphanommata* are easily separated from those of *Rhyncolus* and *Phloeophagus* by the former having (1) five frontal setae (vs. four frontal setae) (Figure 9a); from *Nyssonotus* by having (1) mala with seven dorsal setae (vs. mala with six dorsal setae) (Figure 9b); and (2) eusternum on typical abdominal segments with the more lateral seta short, the more ventral seta long (vs. eusternum on typical abdominal segments with the setae short to moderately long, subequal) (Figure 10c,d), and finally from *Catolethrus* by having (1) clypeal setae 1 very long and cls_2 long (Figure 9e) (vs. clypeal seta very short, and cls_2 short), and (2) five postdorsal setae of which 3 and 5 are very long, 1, 2 and 4 short to very short (Figure 10c) (vs. five postdorsal setae of which 1, 3 and 5 are long, 2 and 4 short to very short).

4.2. Biology and Distribution

The humid environment caused by mist is the most influential factor contributing to the vertical distribution of Cape Verde endemic plants [24]. This phenomenon plays the most important role also in distribution of endemic animals, notably insects depending on these plants as herbivores (e.g., Curculionidae), or predaceous insects feeding on these endemic insect groups. The scarce water source, in otherwise arid to semiarid archipelago with infrequent rain, is limited to the highest slopes of each island, although the absolute height margin between dry and wet conditions varies significantly among islands and mountain ranges [24].

This pattern of vertical distribution is notably apparent in some endemic genera of beetles with more species, e.g., *Melanocoma* (Tenebrionidae) [25] and *Dinas* (Curculionidae: Entiminae) [8], or in endemic radiations of the genus *Cymindis* (Carabidae) [26] and genera *Aphanommata* and *Pselactus* (Curculioniae: Cossoninae) ([9], and this study), which all are restricted to wet slopes and summits all over the archipelago. The genera *Dinas*, *Aphanommata* and *Pselactus* are also of interest as a model organisms for studying speciation and evolutionary history in the Cape Verde islands, because they are at present the only weevil genera with more than one species within the archipelago and because all species of these three genera so far known are flightless single island endemics occurring several hundred meters above sea level. All three genera, however, differ significantly in their horizontal inter- and intra-insular distribution. *Dinas*, with 14 taxa and two subgenera is widespread all over the archipelago (except Sal and small islets) with distributional pattern influenced likely by geological history of the archipelago and each particular island and by the wind currents [8]. Intra-generic habitat-shift with morphological adaptations exists between nominotypical subgenus and subgenus *Microspina* Skuhrovec & Batelka 2014, which both are sharing the same localities in São Vicente and São Nicolau, but differ in niches inhabited by adults [8].

Available records of *Aphanommata* and *Pselactus* provide however a different picture of their distribution within the archipelago. Larvae of both genera primarily develop in dead wood stems of the endemic shrub *Euphorbia tuckeyana*, but both are also capable of developing in rotten above-ground parts of some introduced plants, i.e., *Aphanommata* in *Agave* (Agavaceae) (this study) (Figure 13b–d) and *Pselactus* in *Jatropha* (Euphorbiaceae) [9]. So far, larvae of both genera have not been observed in underground parts of any plant. Interestingly, they also have not yet been collected in the same locality. From Fogo only *Aphanommata strakai* sp. nov. is known (Figure 13a), from Santo Antão only *A. euphorbiarum* (Wollaston, 1867), and from São Vicente only *Pselactus obesulus* (Wollaston, 1867). São Nicolau is the only island where both genera are known (*Aphanommata kuscheli* sp. nov., and *Pselactus strakai* Skuhrovec, Hlaváč and Batelka, 2017) (Figure 13b–e). Available data indicate the possibility that both lastly mentioned species do not overlap in their distribution on the island with the respect to the

vertical gradient of the locality. *Pselactus strakai* was collected at localities 580 and 800 m high [9], while *Aphanommata kuscheli* sp. nov. is so far known from 1050 and 1200 m.

Field results suggest that an altitude between 800 and 1000 limits the vertical distribution of both genera across the archipelago. The species *Aphanommata euphorbiarum* is reported from Ribeira Fria and Ribeira Baboso situated in the western part of Santo Antão without altitude details, but both valleys comprise localities between 600 and 1000 m, and the highest summits of respective mountain ranges reach slightly above 1800 m. *Aphanommata* species have not been so far collected in São Vicente (with its highest point Monte Verde, 750 m) and the eastern part of São Nicolau (i.e., *Former Eastern Island* sensu Skuhrovec and Batelka [8], with its highest point Alto das Cabaças, 687 m), maybe because localities with suitable microclimate are absent, and this factor may impede members of the genus to colonize or to survive on these islands or, on proto-islands, because of competition with *Pselactus*.

Available data for both cossonine genera may be currently interpreted as a habitat shift because of competition for the same larval niche (exposed rotten wood) and subsequent adaptation for slightly different microclimatic conditions. More research, however, has to be done to test this hypothesis, e.g., whether *Aphanommata* is capable of developing at lower altitudes in islands where *Pselactus* is absent or where microclimatic conditions of altitudes below 1000 m are similar to those characteristic for this genus (e.g., climatic inversion in the valley) (Figure 13a,e).

Author Contributions: Jiří Skuhrovec drafted the manuscript and described the immature stages. Peter Hlaváč described the new species and wrote all the taxonomic part, and Jan Batelka carried out field research and described the biological and biogeographic part of the manuscript. All authors read and approved the final manuscript.

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