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## First records of Elachistinae from New Caledonia: evidence of repeated dispersal events with Australia (Lepidoptera, Gelechioidea, Elachistidae)

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### Abstract

The first records of Elachistinae (Lepidoptera, Elachistidae) are reported from New Caledonia. Eight species are recognized. *Elachista cynopa* Meyrick is reported outside Australia for the first time. All other species are described as new: *Elachista concubia* sp. nov., *E. achlyodes* sp. nov., *E. scoteina* sp. nov., *E. cardiaca* sp. nov., *E. dilobates* sp. nov., *E. vespertina* sp. nov. and *E. fugax* sp. nov. All the new species have sister-species level relatives in Australia. *E. fugax* is attributed to *Elachista* sg. *Elachista*. All other species are placed in *Elachista* sg. *Atachia*. Following Kaila's (2011) system *E. achlyodes* and *E. concubia* belong to the *E. catarata* section of the *E. gerasmia* group; *E. cardiaca*, *E. dilobates*, *E. scoteina* and *E. vespertina* belong to the *E. gerasmia* section of *E. gerasmia* group. Further, *E. cardiaca* is a member of the *E. paragauda* species complex, *E. scoteina* a member of the *E. gerasmia* species complex, and *E. dilobates*, *E. vespertina* of the *E. cynopa* species complex; *E. dilobates* is morphologically close to *E. toryna* Kaila. This pattern suggests at least six separate dispersal events between Australia and New Caledonia.

**Key words:** Biogeography, description, distribution, new species

### Introduction

Elachistinae (Gelechioidea: Elachistidae), as currently delimited (Kaila & Sugisima 2011, Heikkilä *et al.* 2014), is represented by about 700 recognized species (Kaila 2011) of generally small-sized moths. The prevailing hypothesis was that the species in the subfamily occurred predominantly in the Northern Hemisphere (see, e.g., Braun 1948; Traugott-Olsen & Nielsen 1977; Sinev & Sruoga 1995, Kaila 1996, 1997, 1999b, Sugisima 2005a,b, Kaila *et al.* 2015, Mutanen *et al.* 2013). This view, however, is challenged as a result of more targeted collecting and study of the fauna of the Southern Hemisphere. Recent studies and reviews of the elachistine fauna of Sub-Saharan Africa (De Prins & De Prins 2016, De Prins & Sruoga 2012, Sruoga & De Prins 2009, 2011); South America (Kaila 2000 and Sruoga 2010); New Zealand summarized by Dugdale (1988); and Australia by Kaila (2011) imply that the Southern Hemisphere hosts a large diversity of Elachistinae, in terms of supraspecific taxa, diverse morphologies and species number. The Southern fauna has already proven to provide crucial insight for the understanding of the phylogeny of the subfamily (Kaila & Sugisima 2011). However, there are still large geographic areas with few or no published records of Elachistinae, most notably China and Central America including Mexico. All this considered, the Southern Hemisphere is still quite fragmentarily explored in nearly every region as evidenced in the new species discovered in this work.

While New Caledonia hosts a rich endemic flora in species, generic and even higher ranks, associated with ultrabasic rocks (e.g. Balgooy 1971), observations on macroheteroceran groups such as Noctuoidea, Geometroidea and Bombycoidea (Holloway 1993), suggest a different biogeographic pattern. According to Holloway (1993), many moths found on New Caledonia also occur on other islands in the south Pacific, and the New Caledonian endemics have sister-group relationships with individual species in the Papuan subregion, Australia, or taxa more localized in the southwest Pacific. The published knowledge on New Caledonian Microlepidoptera is generally scanty with no systematic treatment available. Recent contributions, in addition to those mentioned above have been made by, e.g., Gaedike (1981), Tuck (1981), Adamski & Brown (2002), Dugdale (2005), Sobczyk (2013) and

Razowski (2013, 2014). These works do not discuss in detail the historical biogeography of the taxa treated. Micropterigidae, an old group of Lepidoptera, suggest a different pattern than the macroheterocarcan groups (Gibbs 2010, 2014; Gibbs & Lees 2014). These authors emphasize the presence of archaic elements present in New Caledonian Micropterigidae. Gibbs and Lees (2014) postulate the diverse Micropterigidae fauna of New Caledonia to be derived from taxa of New Zealand, both areas being remnants of the largely submerged continental plate Zealandia *sensu* Mortimer (2008) rather than another, predominantly Australian clade in this family. According to Gibbs and Lees (2014) the Zealandian group of Micropterigidae is thus supposed to be older than tectonic rifts of the area. Likewise, Horak (1984) postulates that *Williella* Horak, 1984 an endemic New Caledonian, fern-feeding genus of Tortricidae, to be of archaic origin.

The elachistine fauna is currently reasonably well documented in Australia (Kaila (2011) and New Zealand (Dugdale 1988), but other southeast parts of Asia and the Pacific are nearly unexplored. It is likely that the real elachistine diversity of New Caledonia will eventually prove to be much higher if focused collecting efforts, especially rearing of larvae, are undertaken (cf. Kaila 2011 on Australian fauna). Such studies are not expected in the foreseeable future. In this paper, the first records of Elachistinae are reported from New Caledonia. The present material, even though scarce, is deemed worth reporting, in particular due to its biogeographic implications. Specimens treated in the present publication have been collected as a result of several, separate trips targeting Lepidoptera in general.

## Material

The material comprises 13 specimens, representing eight species. Specimens treated here are housed in the National Museum of Natural History, Smithsonian Institution, Washington, U.S.A. (USNM). Some vouchers are preserved in the collection of the Finnish Museum of Natural History, University of Helsinki, Finland (MZH).

The systematic placement of species follows Kaila (2011), where the relevant species groups are also diagnosed. Terms for wing pattern and anatomical structures follow Traugott-Olsen & Nielsen (1977), Kaila (1999a) and Kaila & Sugisima (2011). The specific epithets of the new species are nouns in apposition.

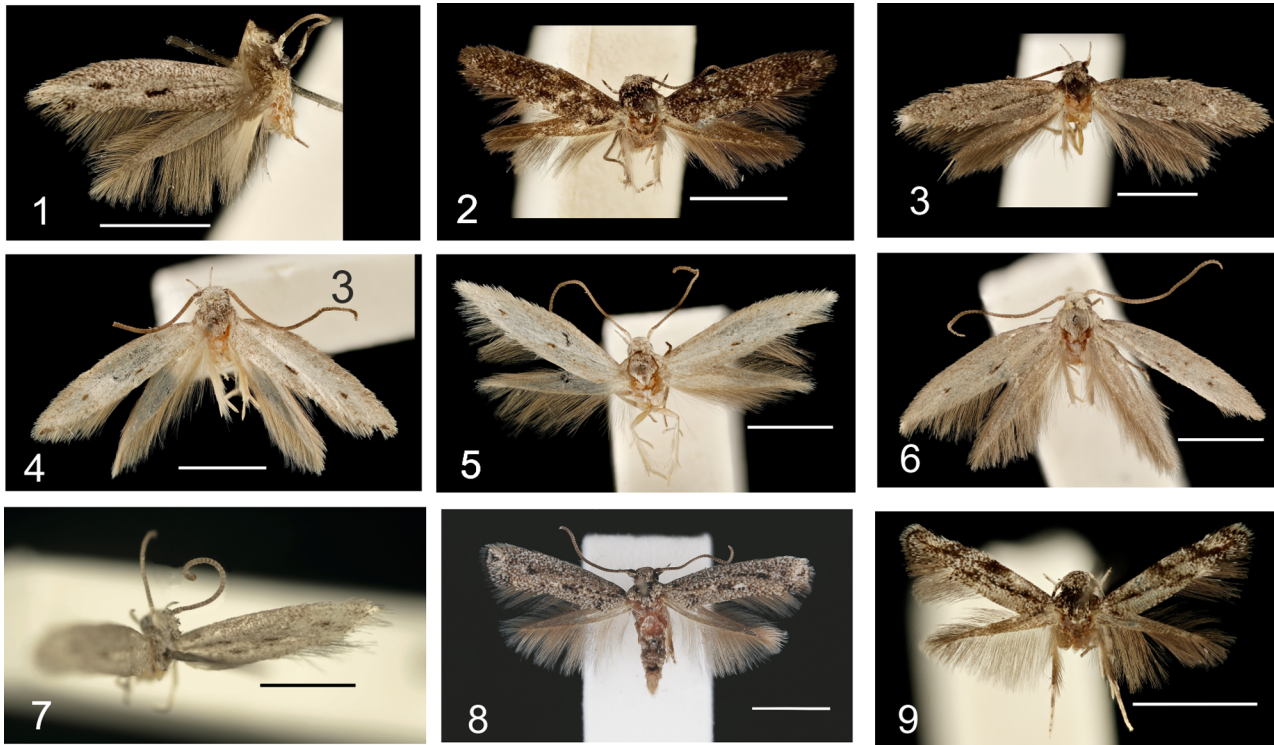
### *Elachista concubia* sp. nov.

Figs 1, 10

**Type material.** Holotype ♂: New Caledonia, 22°15'S 166°38'E Col de Mouirange, 225 m, 27.X.1986, UV trap, R. Brown & O. Pellmyr leg., Genitalia slide by L. Kaila, UNSM 142,821 (USNM).

**Diagnosis.** *Elachista concubia* has the forewing ground colour pale grey, mottled with brownish-grey tips of scales. The only wing pattern is formed of prominent, dark brownish-grey plical and discal spots, and strongly mottled fringe formed of dark brownish-grey -tipped scales. Externally it is close to *E. scoteina*, from which it differs by its paler forewing ground colour and the much more prominent plical and discal spots. The male genitalia are most similar to those of the externally entirely different, yellow Australian *E. ictera* Kaila, 2011, with a similar row of teeth in distal part of sacculus, and especially *E. crocospila* Kaila, 2011 and its relatives which are externally also different as having narrower, nearly black forewing with a pattern consisting of at most two small white spots. *E. concubia* shares a very characteristic apex of phallus with these species: its upper margin is distally strongly sclerotized and bent as a hook, and possesses a distally situated prominent, acute-tipped cornutus.

**Description.** Forewing length 4 mm. Labial palpus ascending, length 1.2 x diameter of head; basal half of second segment, and apex of distal segment grey, otherwise white above; underside of second segment and apex of third segment mottled, dark grey, otherwise white. Head, scape and pedicel, neck tuft, patagia and thorax dirty white, sparsely mottled with grey tips of scattered scales. Pecten consisting of a few narrow scales, pale grey. Flagellum unicolorous, dark grey. Foreleg leaden grey, apex of tibia and tarsomeres slightly paler grey [other legs missing in the specimen]. Forewing ground colour formed of basally bluish white and distally broadly grey scales; at middle of wing length at fold prominent, elongate plical spot; another similar spot at 2/3 of wing length; fold and area distad of discal spot paler than wing otherwise. Fringe concolorous with ground colour, at apex pale. Hindwing and underside of both wings grey.



**FIGURES 1–9.** External appearance of *Elachista* spp. Scale 2 mm. 1. *E. concubia* sp. nov., ♂ holotype. 2. *E. achlyodes* sp. nov., ♂ holotype. 3. *E. scoteina* sp. nov., ♂ holotype. 4. *E. cardiaca* sp. nov., ♂ holotype. 5. *E. dilobates* sp. nov., ♂ holotype. 6. *E. vespertina* sp. nov., ♂ holotype. 7. *E. cynopa* Meyrick (New Caledonia, Mt. Dzumac). 8. *E. cynopa* Meyrick (Australia; ACT, Black Mountain; a reared specimen). 9. *E. fugax* sp. nov., ♂ holotype.

**Male genitalia.** Uncus lobes medially separated by broad U-shaped indentation; lobe as long as wide, median margin straight, meeting distal margin at an obtuse angle; distal margin straight, lateral margin rounded; ventral surface distally and laterally broadly covered by cylindrical scales arising from erect pinaculae. Basal arms of gnathos twice as long as uncus lobe, distally separate. Spinose knob of gnathos oval, about 1.5 x as long as wide. Basal 3/4 of valva parallel-sided; basal fold of costa extended to 1/4 length of valva, distal fold long, narrow, extended to 4/5 length of valva where fades without distinct limit; cucullus narrower than rest of valva, rounded, bent towards costa; sacculus nearly straight, distally tapered and with two indistinct and three prominent teeth. Digitate process 1/5 length of valva, narrowest and bent medially, with a few setae. Median plate of juxta rounded, concave without lateral or posterior extensions. Juxta lobes small, laterally produced, medially distinctly separated from each other, without setae; median margin short and convex joining distal margin without an angle, distal margin straight, lateral margin concave. Vinculum large, U-shaped, without median ridge. Phallus as long as valva, straight, 6 x as long as its width medially; insertion of ductus ejaculatorius dorsally directed; caecum blunt, shorter than width of basal opening of phallus; distal opening extended to distal 2/3 of phallus; apex dorsally curved to form prominent strongly sclerotized hook and with triangular lobe; straight horn-shaped cornutus present at apex.

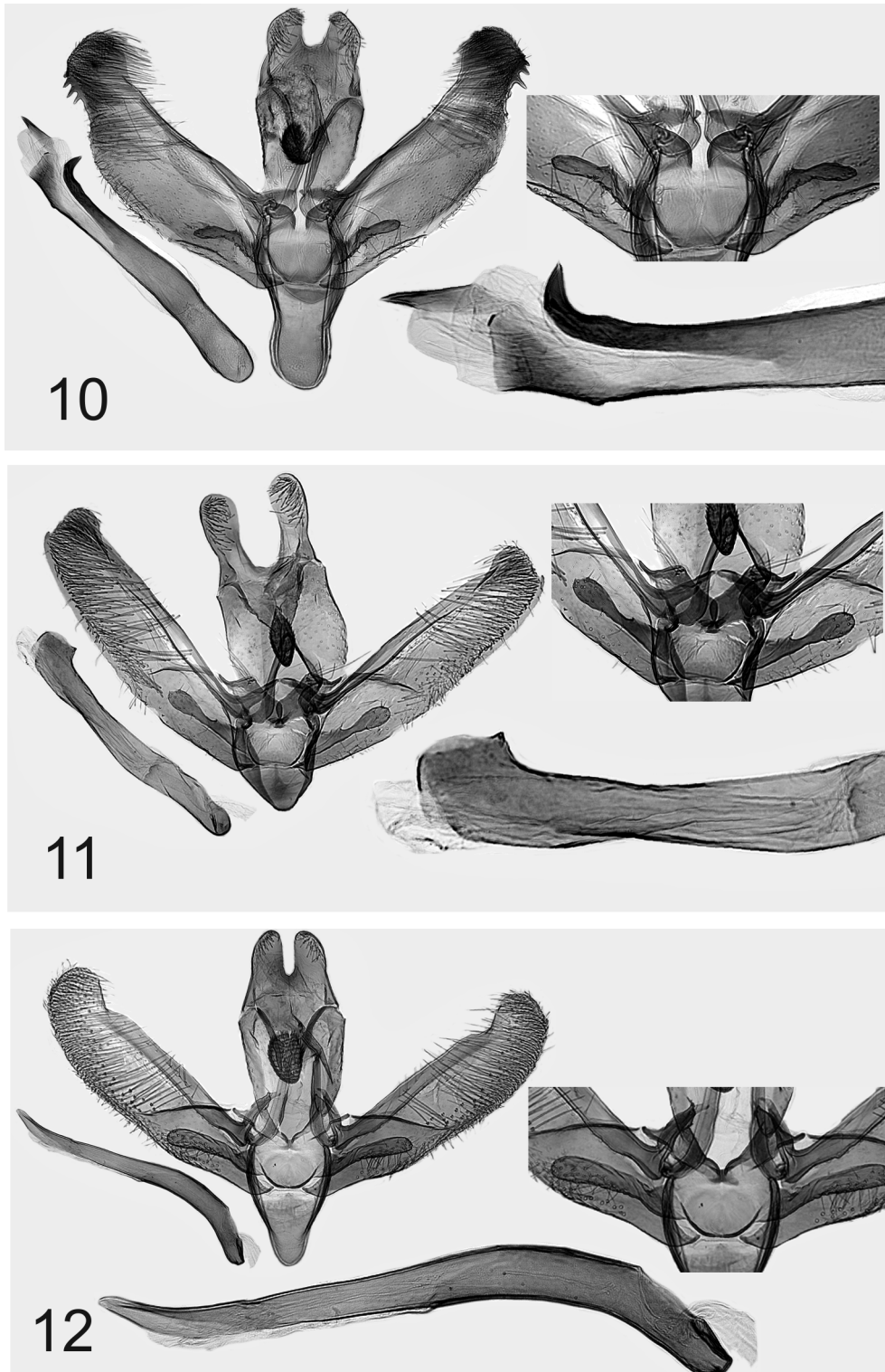
**Female genitalia.** Unknown.

**Biology.** The collecting site is characterized by Holloway (1979) as “mainly dry, bushy maquis with an area of *Gymnostoma* association in the valley bottom.”

**Distribution.** New Caledonia.

**Etymology.** The name is derived from the Latin word *concupium*, ‘the part of night covered by first sleep’, i.e. late dusk. This refers to the wing colour which is not bright as day but not dark as night, either.

**Remarks.** The overall similarity with the Australian *E. ictera* and *E. crocospila* with shared unique characters (see Diagnosis), both placed at the *E. catarata* section, suggests that *E. concubia* is also a representative of this species group.



**FIGURES 10–12.** Male genitalia of *Elachista* spp. 10. *E. concubia* sp. nov., ♂ holotype. Left: general image of genitalia, phallus in same scale. Right top: juxta and digitate processes. Right bottom: apex of phallus enlarged. 11. *E. achlyodes* sp. nov., ♂ holotype. Left: general image of genitalia, phallus in same scale. Right top: juxta and digitate processes. Right bottom: apex of phallus enlarged. 12. *E. scoteina* sp. nov., ♂ holotype. Left: general image of genitalia, phallus in same scale. Right top: juxta and digitate processes. Right bottom: phallus enlarged.

***Elachista achlyodes* sp. nov.**

Figs 2, 11

**Type material.** Holotype ♂: New Caledonia 20°24'S 160°11'E Mandjelia, 650 m, 20.–21.II.1984 M. Pogue & M. Epstein leg., Genitalia slide by L. Kaila, USNM 142,823 (USNM).

**Diagnosis.** *Elachista achlyodes* is a species with dark grey forewing ground colour. Its only pattern is formed of even darker, prominent discal and plical spots. It is darker than other New Caledonian species, and according to the shape of male genitalia close to the Australian *E. aluta* Kaila, 2011 and *E. sphaerella* Kaila, 2011. The characteristics in common with these species are the long and distally broadened uncus lobes, the narrow and elongate spinose knob of the gnathos and the very long and narrow digitate process. The phallus with its small dorsal tooth at apex, however, is more reminiscent to the Australian *E. flammula* Kaila, 2011. It is lacking in *E. aluta* and *E. sphaerella*. This character also distinguishes *E. achlyodes* from other New Caledonian species. The shape of the juxta lobes with a distinct angle at medial margin distinguishes *E. achlyodes* from all the related Australian species.

**Description.** Forewing length 3.8 mm. Labial palpus ascending, 1.2 x diameter of head; second segment and median part of third segment bluish white above, mottled dark grey below. Scales of head, neck tuft, patagia, thorax, scape and pedicel iridescent, bluish grey, dark grey tipped. Pecten formed of a few narrow scales at the base of scape. Flagellum dark grey, serrate in distal half. Scales of legs iridescent, bluish grey, dark grey-tipped, tibia and tarsomeres with pale distal rings; hind tibia basally broadly pale. Forewing ground colour consisting of basally blue, distally dark grey scales with bronzy sheen; plical spot black, elongate, at 1/2 wing length at fold, fold outward with a few black, raised scales; discal spot similar to plical spot, at 3/4 wing length in the middle of wing; fringe scales grey as forewing ground colour; underside dark grey. Hindwing and underside of both wings dark grey with concolorous fringe.

Male genitalia. Uncus lobes medially separated by deep drop-shaped indentation; lobe three times as long as wide, spoon-shaped, basally narrow, distally somewhat broadened and rounded; ventral surface distolaterally broadly covered by cylindrical scales arising from erect pinaculae. Basal arms of gnathos as long as uncus lobe, distally separate. Spinose knob of gnathos small, diamond-shaped, over twice as long as wide at its widest point. Valva 4 x as long as wide, parallel-sided; basal fold of costa straight, extended to 2/3 length of valva, distal fold broad triangular, extended to 6/7 length of valva where it fades and where cucullus is twisted on top of costa forming distinct hump; sacculus nearly straight, apically with curved horn-like spine; sacculus joining cucullus at an angle of 100°; cucullus small, produced towards costa. Digitate process 2/5 length of valva, straight, narrow medially, distally twice wider than in its narrowest point and blunt, sparsely covered with setae medially and distally. Median plate of juxta concave without lateral or posterior extensions, oval. Juxta lobe laterally produced, medial margin short and straight joining distal margin without angle; medial 2/3 of distal margin slightly concave, lateral part concave, with a group of setae at distal angle. Vinculum U-shaped. Phallus weakly bent, S-shaped, somewhat tapered towards apex, 8.8 x as long as wide in the middle of its length; length 7/8 x as long as valva; insertion of ductus ejaculatorius dorsoposteriorly directed; caecum blunt, as long as width of basal opening of phallus; distal opening of phallus extended to distal 2/3 of phallus; apex dorsally bent, tapered to tip; cornuti absent.

Female genitalia. Unknown.

**Biology.** Unknown.

**Distribution.** New Caledonia.

**Etymology.** The name is derived from the Greek word *achlys*, 'darkness'. This refers to the dark grey wing colour of *E. achlyodes*.

**Remarks.** The overall similarity of *E. achlyodes* to the Australian *E. aluta* and *E. sphaerella*, but in some respects, also to *E. flammula*, all placed in the *E. catarata* section, suggests that *E. achlyodes* is also a representative of this species group.

***Elachista scoteina* sp. nov.**

Figs 3, 12

**Type material.** Holotype ♂: New Caledonia 22°3'S 166°26'40"E Mt. Dzumac, 820 m, 25.Oct.1986 UV trap R.

Brown & O. Pellmyr leg. (USNM), genitalia slide by L. Kaila USNM 142.816. Paratypes: 3 ♂; 2 ♂ with the same collection data as in the holotype, 1 ♂ collected 2.Nov.1986; genitalia slides by L. Kaila USNM 142,817, 142,813, (USNM, 1 paratype with genitalia slide L. Kaila 6103 in MZH).

**Diagnosis.** *Elachista scoteina* is a medium-sized elachistine species with forewing ground colour mottled, leaden grey. The only wing pattern is formed by small plical and discal spots. The male genitalia are most similar to those of *E. physalodes* Kaila, 2011 that occurs in Australia and New Zealand. These species, as well as the closely related *E. gerasmia* Meyrick, 1889, are characterized particularly by their prolonged juxta lobes. *E. gerasmia* is readily distinguished by its larger size and forewing colour that varies from ochreous to dark chocolate brown. *E. physalodes* is more narrow-winged than *E. scoteina* and its forewing is not as mottled. The male genitalia of *E. scoteina* and *E. physalodes* differ as follows: the spinose knob of gnathos is rounded in *E. physalodes*, elongate with straight or slightly concave posterior margin in *E. scoteina*; the cucullus is more prolonged in *E. physalodes* than in *E. scoteina*; the digitate process is longer in *E. scoteina* than in *E. physalodes*; the juxta lobes are different in their form as follows: mesial margin is S-shaped in *E. physalodes*, straight or nearly evenly curved in *E. scoteina*; mesial margin joins distal margin in a right angle in *E. scoteina*, in acute angle in *E. physalodes*; distal margin has a straight, posteriorly directed extension that joins the valval process in *E. scoteina*; there is only short, laterally directed extension in *E. physalodes*.

**Description.** Forewing length 4.5–5.5 mm (n = 4 ♂). Labial palpus ascending, length 1.2 x diameter of head, white with apex of third segment grey above; below evenly fuscous grey except apex of second segment white. Head, scape, pedicel and neck tuft grey, mottled with darker tips of scales. Pecten formed of a few narrow, grey scales at the base of scape. Flagellum thick, leaden grey, annulated with dark grey rings. Foreleg varying from ochreous grey to dark, leaden grey, spurs ochreous; midleg ochreous grey with tibia and tarsomeres white distally. Hindleg ochreous grey, tarsomeres grey, distally pale. Forewing grey, densely mottled with darker grey tips of scales given the impression of forewing being leaden grey; plical spot dark grey, small and elongate, at middle of wing length at fold; discal spot similar, at 2/3 wing length in middle; fringe scales concolorous with forewing colour, shorter fringe scales distally dark grey forming indistinct fringe line along termen. Hindwing grey, fringe scales concolorous; underside of both wings grey with fringe scales concolorous.

Male genitalia. Uncus lobes medially separated by narrow, U-shaped incision; lobe twice as long as wide, somewhat tapered, distal margin rounded, ventral surface distolaterally with cylindrical scales arising from erect pinaculae. Basal arms of gnathos as long as uncus lobe, distally separate. Spinose knob of gnathos large, slightly tapered. Valva 3.5 x as long as wide, parallel-sided; basal fold of costa vestigial, distal fold narrow, extended to 5/6 length of valva; sacculus basally slightly concave, medially straight, distally slightly bent towards cucullus, without distal spine, joining cucullus without clear delimitation; cucullus rounded, bent towards costa. Digitate process 1/4 length of valva, straight, parallel-sided, distally blunt, with scales medially and setae distally. Median plate of juxta oval, concave without lateral or posterior extensions. Juxta lobe prolonged, medial margin basally curved, medially straight, distally with medially directed, acute-tipped lobe formed of medially extended distal margin distal margin straight, laterally extended; lateral margin straight, strongly sclerotized. Vinculum long, narrow U-shaped, without medial ridge. Phallus 8/9 length of valva, acute-tipped, broadest and evenly bent in basal half; insertion of ductus ejaculatorius dorsoposteriorly directed; caecum blunt, as long as width of basal opening of phallus; distal opening extended to distal 4/5 of phallus; in vesica no spinules or granules; cornuti absent.

Female genitalia. Unknown.

**Biology.** The collecting site is near an open maquis habitat (Holloway 1979). All other four species assigned to the *E. gerasmia* species complex by Kaila (2011) feed on *Juncus* spp. (Juncaceae), so this genus is a likely host candidate for *E. scoteina*.

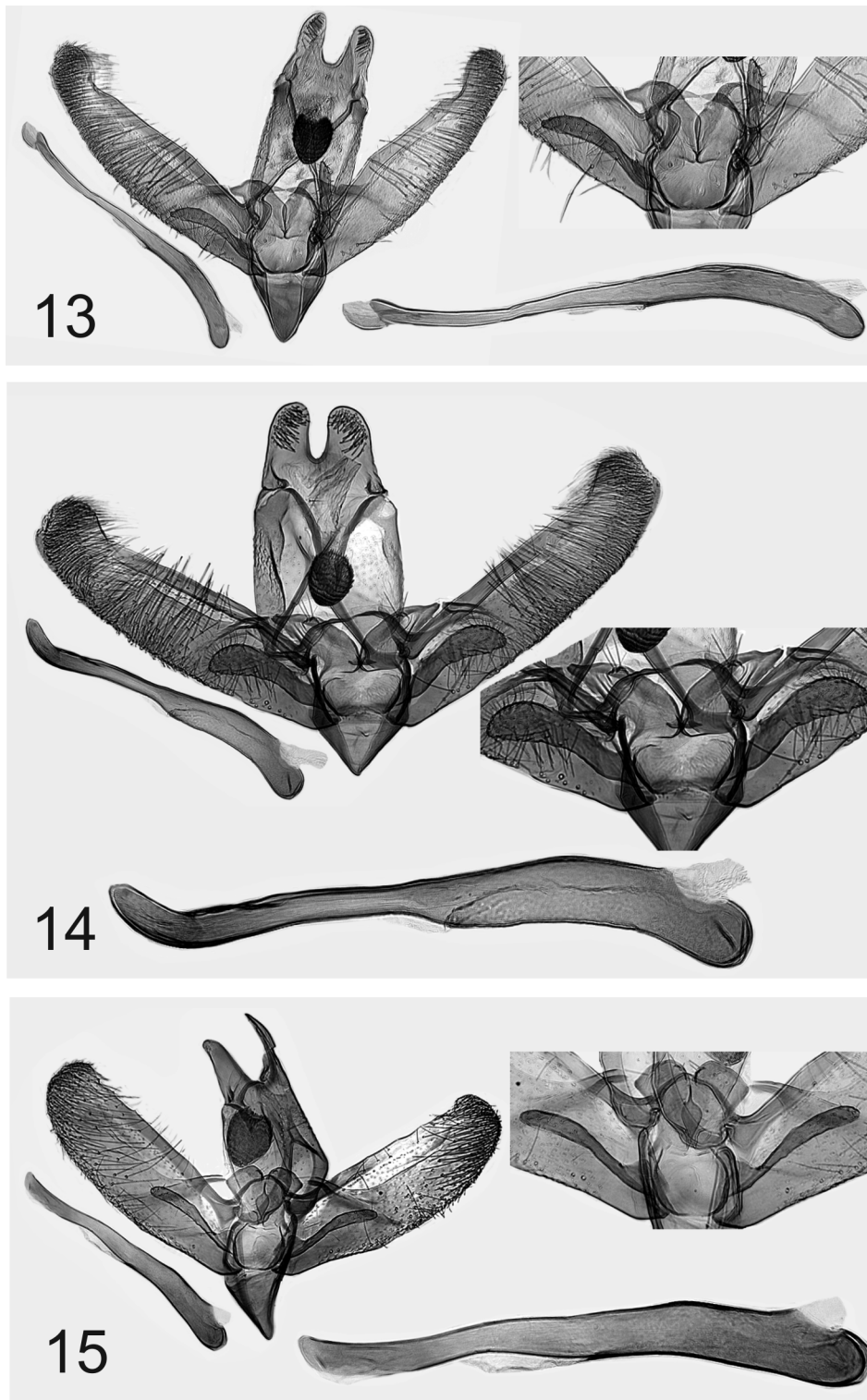
**Distribution.** New Caledonia.

**Etymology.** The name is derived from the Greek word *scoteinos*, 'darkness; gloom'. This refers to the wing colour of *E. scoteina*.

### ***Elachista cardiaca* sp. nov.**

Figs 4, 13

**Type material.** Holotype ♂: New Caledonia, 22°6'S 166°40'20"E Rivière Bleue 8.Nov.1986 R. Brown & O. Pellmyr leg. Genitalia slide by L. Kaila USNM 142,822 (USNM).



**FIGURES 13–15.** 13. *E. cardiaca* sp. nov., ♂ holotype. Left: general image of genitalia, phallus in same scale. Right top: juxta and digitate processes. Right bottom: phallus enlarged. 14. *E. dilobates* sp. nov., ♂ holotype. Left: general image of genitalia, phallus in same scale. Right top: juxta and digitate processes. Right bottom: phallus enlarged. 15. *E. vespertina* sp. nov., ♂ holotype. Left: general image of genitalia, phallus in same scale. Right top: juxta and digitate processes. Right bottom: phallus enlarged.

**Diagnosis.** *Elachista cardiaca* is a medium-sized species. Its forewing is pale grey with nearly black longitudinal plical spot at the middle of wing length at fold, and a small, rounded discal spot at 2/3 wing length in the middle of wing. As such, it externally resembles *E. vespertina* and *E. dilobates*. From *E. dilobates* *E. cardiaca* is readily distinguished by its heart-shaped spinose knob of gnathos, the narrower digitate process, the narrower

phallus and the narrow, distally tapered valva as compared to those of *E. dilobates*. *E. vespertina* also has broader phallus and valva than *E. cardiaca*. The uncus lobes of *E. vespertina* are narrower than in *E. cardiaca*. *E. cardiaca* is similar to the species of the Australian *E. paragauda* species complex. Externally it differs from other species of this complex by the paler and more unicolorous forewing (the single specimen known is somewhat worn and therefore this character should be considered with caution). It lacks the longitudinal, broad, nearly white median area making a contrast to otherwise darker, mottled grey colour, pattern typical of all known Australian relatives. The male genitalia of *E. cardiaca* differ from other species of the *E. paragauda* complex by the shorter and less curved apical lobe of the phallus and the somewhat more bent and distally more tapered digitate process.

**Description.** Forewing length 4.8 mm. Labial palpus ascending, length 1.2 x diameter of head, white above with apex of third segment grey; evenly fuscous grey below except apex of second segment white. Head, scape, pedicel and neck tuft grey, mottled with darker tips of scales. Pecten formed of row of narrow, grey scales. Flagellum thick, dark grey. Foreleg varying from ochreous grey to dark, leaden grey, spurs ochreous; midleg ochreous grey with tibia and tarsomeres white distally. Hindleg pale ochreous grey, tarsomeres grey, distally pale. Forewing pale grey, along margins sparsely mottled with brownish grey scales; plical spot dark grey, elongate, at middle of wing length at fold; discal spot small, rounded, at 2/3 wing length in middle, outwardly bound by small white area; fringe scales concolorous with forewing colour, shorter fringe scales distally dark grey forming indistinct fringe line along termen. Hindwing grey, fringe scales concolorous; underside of both wings grey with concolorous fringe scales.

Male genitalia. Uncus lobes medially separated by U-shaped incision; lobe 1.5 x as long as wide, distal margin rounded, ventral surface distolaterally with cylindrical scales arising from erect pinaculae. Basal arms of gnathos 1.5 x as long as uncus lobe, distally separate. Spinose knob of gnathos somewhat elongate, tapered distally, caudal margin distinctly concave. Valva 4 x as long as wide at its widest point, medially somewhat broadened and evenly tapered towards apex; basal fold of costa straight, indistinct, distal fold narrow, triangular, broadest distally, extended to 5/6 length of valva, where cucullus somewhat twisted on top of costa forming low hump, distal fold well defined; sacculus evenly curved, without distal spine and joining cucullus without clear delimitation; cucullus narrow and elongate, distally rounded, slightly bent towards costa. Digitate process 1/3 length of valva, narrow, sickle-shaped, narrowest at 1/3 length, with setae medially and distally. Median plate of juxta rectangular, concave without lateral or posterior extensions. Juxta lobe with two setae at distal third, laterally produced; medial margin straight joining distal margin at an obtuse angle; distal margin medially straight, laterally convex; lateral margin concave. Vinculum narrow, U-shaped, without medial ridge. Phallus narrow, over 20 x as long as its width in the middle of its length, almost as long as valva, evenly curved in basal 1/3, medially and distally bent, broadest in basal half; insertion of ductus ejaculatorius dorsoposteriorly directed; caecum blunt, shorter than width of basal opening of phallus; distal opening extended to distal 4/5 of phallus; along distal opening small folded lobe that is joined to vesica; vesica without spinules or granules; cornuti absent.

Female genitalia. Unknown.

**Biology.** The specimen has been caught with UV light trap. The habitat is lowland rainforest on ultramafic soils, with dominance of *Gymnostoma* (Casuarinaceae) vegetation (Holloway (1979).

**Distribution.** New Caledonia.

**Etymology.** The name is derived from the latinized form of the Greek word *kardia*, 'heart'. It denotes the heart-shaped gnathos of *E. cardiaca*.

**Remarks.** *E. cardiaca* is attributable to the *E. paragauda* complex on the basis of male genitalia; besides overall similarity, the apex of the phallus is similarly bent and shaped, and the spinose knob of the gnathos is heart-shaped. This complex of species has so far only been known from Australia. The *E. paragauda* complex consists of a number of cryptic sibling taxa there (Kaila & Ståhls 2006). The representative of this complex are characterised by their bizarre mine shape, and all constituent species have been found to feed on *Lepidosperma* spp. (Cyperaceae) (Kaila 2011). This plant genus is also present in New Caledonia.

### ***Elachista dilobates* sp. nov.**

Figs 5, 14

**Type material.** Holotype ♂: New Caledonia 22°02'S 166°28'E, Mt. Dzumac, 760 m, 16.–17.I.1984 M. Pogue & M. Epstein leg., Genitalia slide by L. Kaila, USNM 142,819 (USNM).



**Diagnosis.** *Elachista dilobates* closely resembles the Australian *E. toryna* Kaila. *E. dilobates* is externally paler than *E. toryna*, with its head and labial palpi fuscous white; the specimen known is somewhat worn so the forewing colour cannot be established with certainty, but appears to be markedly paler than in *E. toryna*. The wing pattern of *E. dilobates* solely consists of dark grey, elongate plical and discal spots. As compared to other New Caledonian species, the male genitalia are characteristic with the long and curved digitate process and the distally bent phallus. They also closely resemble those of *E. toryna*. They can be distinguished by the shorter uncus lobes, the broader digitate process and the larger spinose knob of the gnathos of *E. dilobates* as compared to *E. toryna*. The median plate of the juxta is wider in *E. dilobates* than in *E. toryna*.

**Description.** Forewing length 4.5 mm. Labial palpus ascending, length 1.2–1.3 x diameter of head; above fuscous white; below powdered with a few grey-tipped scales in middle of second segment. Head fuscous white, powdered with pale brown-tipped scales on vertex. Pecten absent. Scape and pedicel fuscous white below, grey above; flagellomeres unicolorous grey. Thorax pale grey and powdered with brown-tipped scales. Legs unicolorous ochreous white. Forewing ground colour not possible to establish with certainty as specimen is somewhat worn; apparently dorsal and costal margin broadly consisting of pale, distally pale brown scales; medial area pale fuscous, fold white (fold well protected from wearing so this pattern certainly real); plical spot small, elongate, dark grey, at 1/3 wing length on dorsal side of fold; discal spot small, dark grey, elongate, at 2/3 wing length in middle; fringe scales grey; underside dark grey with fringe scales paler grey. Hindwing grey with concolorous fringe scales; underside grey.

Male genitalia. Uncus lobes medially separated by narrow, U-shaped incision; lobe as wide as long, with rounded distal margin; ventral surface distolaterally broadly with cylindrical scales arising from erect pinaculae. Basal arms of gnathos 1.5 x as long as uncus lobe, distally separate. Spinose knob of gnathos almost rounded. Valva parallel-sided; basal fold of costa straight, extended to 1/4 length of valva, distal fold long, narrow, extended to 4/5 length of valva where cucullus somewhat twisted on top of costa forming low hump; sacculus straight with small and blunt spine distally; distal margin of cucullus straight, cucullus otherwise rounded and bent towards costa. Digitate process 1/3 length of valva, sickle-shaped; broadest beyond middle where its width 1/4 of the length of digitate process, distally blunt; densely covered by narrow and elongate scales medially and distally. Median plate of juxta kidney-shaped, concave without lateral or posterior extensions. Juxta lobe laterally markedly produced, with a few hair-like scales on a swelling near middle of distal margin, medial margin convex joining distal margin without an angle; distal margin convex and medially somewhat truncate; lateral margin concave. Vinculum broad, V-shaped. Phallus 11 x as long as its width in middle of its length; 5/6 length of valva, broadest in basal half; insertion of ductus ejaculatorius dorsally directed; caecum blunt, as long as width of basal opening of phallus; distal opening extended to middle of phallus; apex of phallus dorsally prolonged and bent; along distal opening longitudinal distally bent sclerotisation that is joined to vesica; cornuti absent.

Female genitalia. Unknown.

**Biology.** The single known specimen was collected with UV light trap placed under a large *Agathis* tree surrounded by open maquis habitat (R.L. Brown, pers. comm.).

**Distribution.** New Caledonia.

**Etymology.** The name is derived from the Greek word *deile*, ‘afternoon, evening’. This refers to the pale forewing colour.

### ***Elachista vespertina* sp. nov.**

Figs 6, 15

**Type material.** Holotype ♂: New Caledonia, 22°6’S 166°40’20’’E Rivière Bleue 8.Nov.1986 R. Brown & O. Pellmyr leg. Genitalia slide by L. Kaila USNM 142,815 (USNM). Paratypes: 2 ♂: New Caledonia 22°5’15’’S 166°26’40’’E Mt. Dzumac, 675 m, 2.Nov.1986 UV trap R. Brown & O. Pellmyr leg. (USNM), genitalia slides by L. Kaila USNM 142,814 (USNM), L. Kaila 6104 (MZH).

**Diagnosis.** *Elachista vespertina* is a nondescript pale grey species with plical and discal spots as the sole pattern on the forewing. As such, it externally resembles most *E. cardiaca* and *E. dilobates*. The genitalia with the very large spinose knob of gnathos and the narrow, tongue-shaped uncus lobes separate it from other New Caledonian species as well as all Australian species attributable to the *E. cynopa* group.

**Description.** Forewing length 4.5–5 mm. Labial palpus ascending, length 1.2–1.3 x diameter of head; fuscous white, second segment fuscous below. Head pale. Pecten formed of a few narrow scales at the base of scape. Scales of scape and pedicel pale grey, variably grey-tipped; flagellomeres unicolorous grey. Scales of neck tuft, tegula and thorax pale grey, dark grey-tipped. Fore femur and tibia grey; tarsomeres dark grey with pale grey distal rings; mid femur grey, tibia grey, mottled with dark grey-tipped scales, tarsomeres grey, distally pale; hind femur and tibia pale grey below, dark grey above, tarsomeres inwardly pale, outwardly grey and distally pale, spurs grey. Forewing ground colour pale grey, some scales distally brownish grey; fold broadly nearly white; plical spot elongate, dark grey, at 1/3 wing length on dorsal side of fold; discal spot small, grey, at 2/3 wing length in middle; fringe scales grey; underside grey with fringe scales concolorous. Hindwing grey, fringe scales concolorous; underside grey.

**Male genitalia.** Uncus lobes narrow, medially separated by U-shaped indentation; lobe 2 x as long as its width basally; gradually narrowed towards rounded apex; ventral surface distally with a few cylindrical scales arising from erect pinaculae. Basal arms of gnathos as long as uncus lobe, distally separate. Spinose knob of gnathos very large, slightly longer than wide, tapered distally, caudal margin concave. Valva 3 x as long as wide, costa straight, sacculus basally slightly convex; basal fold of costa extended to 1/5 length of valva, distal fold very narrow, extended to 3/4 length of valva; cucullus narrow, bent towards costa. Digitate process 1/3 length of valva, very narrow, weakly bent as S-shaped, sparsely covered with setae both medially and distally. Median plate of juxta rounded, concave without lateral or posterior extensions. Juxta lobe somewhat produced, with a few setae on a swelling on ventral surface; medial margin S-shaped, joining distal margin without an angle; distal margin weakly convex, joining the straight lateral margin at a right angle. Vinculum narrow, V-shaped, without medial ridge. Phallus 13 x as long as its width in the middle of its length, as long as valva; weakly bent at distal 2/3, somewhat tapered towards apex; insertion of ductus ejaculatorius dorsally directed; caecum blunt, longer than width of basal opening of phallus; distal opening extended to distal 5/6 of phallus; apex slightly upturned; along distal opening sclerotization attached to vesica; cornuti absent.

**Female genitalia.** Unknown.

**Biology.** All specimens were collected with UV light trap. The habitat of the holotype is rainforest on ultramafic soils, with dominance of *Gymnostoma* (Casuarinaceae) vegetation (Holloway (1979); habitat of paratypes is open maquis.

**Distribution.** New Caledonia.

**Etymology.** The name is derived from the Latin word *vesper*, 'evening'. This refers to the pale grey forewing colour.

### *Elachista cynopa* Meyrick

Figs 7, 8, 16

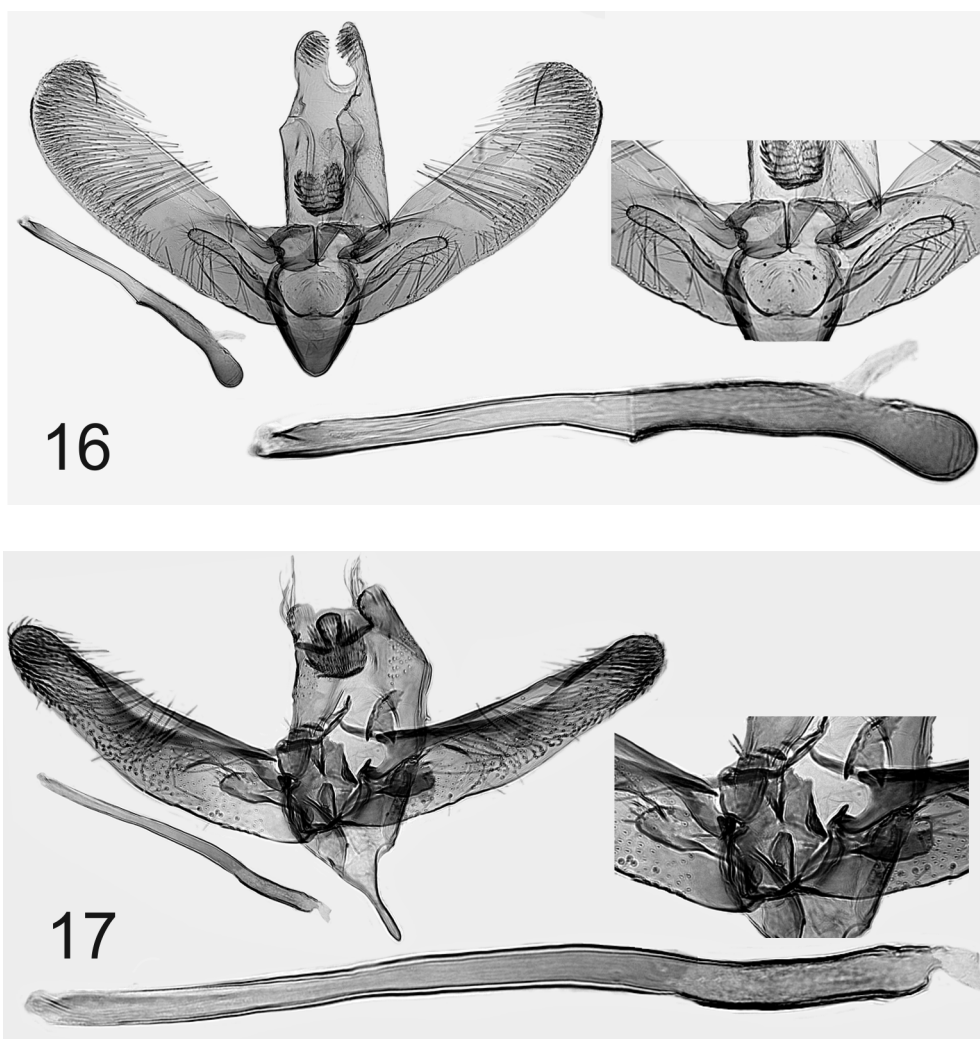
*Elachista cynopa* Meyrick, 1897: 334.

**Material examined from New Caledonia.** New Caledonia 22°5'15''S 166°26'30''E Mt. Dzumac, 625 m, 2.Nov.1986 1 ♂ UV trap R. Brown & O. Pellmyr leg., genitalia slide by M. Metz USNM 146.431 (USNM).

**Diagnosis.** *Elachista cynopa* is a stout-bodied species with thick male antennae and forewing colour grey with dark grey plical discal spots, with darker scales along fold and irregularly between the fold and dorsal margin. As such, it is particularly similar to *E. scoteina* among New Caledonian species. The male genitalia of *E. cynopa* are characteristic in having a bifurcate apex of the phallus and the small, basally incised spinose knob of the gnathos. A full description is given by Kaila (2011).

**Biology.** In Australia *E. cynopa* feeds on *Lepidosperma laterale* (Cyperaceae). It prefers shaded or semi-shaded microhabitats. The mine is a 4–5 cm long, swollen chamber near the leaf tip. The larva is characteristically ruby-coloured. For further details on morphology, see Kaila (2011).

**Remarks.** *E. cynopa* is a common species in eastern Australia in suitable habitats (Kaila 2011). It is the single elachistine species to date known to occur both in Australia and New Caledonia.



**FIGURES 16–17.** 16. *E. cynopa* Meyrick, genitalia of the New Caledonian specimen (USNM 146,431). Left: general image of genitalia, phallus in same scale. Right top: juxta and digitate processes. Right bottom: phallus enlarged. 17. *E. fugax* sp. nov., ♂ holotype. Left: general image of genitalia, phallus in same scale. Right top: juxta and digitate processes. Right bottom: phallus enlarged.

***Elachista fugax* sp. nov.**

Figs 9, 17

**Type material.** Holotype ♂: New Caledonia, Mt. Koghis, 400 m, 12.–14.XI.1996, UV trap R. Brown & O. Pellmyr leg. Genitalia slide by L. Kaila, USNM 142,824 (USNM).

**Diagnosis.** *Elachista fugax* is a small species that does not resemble any other species known from New Caledonia. It is characterized by the dorsoventrally flattened head, an unusual trait which is otherwise present in Elachistinae in the *E. saccharella* and *E. heteroplaca* groups *sensu* Sugisima & Kaila (2005). The forewing pattern consists of dark brown longitudinal stripes and indistinct dark brown oblique band on mottled bluish-grey ground colour. As such it does not resemble any Australian species either. The male genitalia are generally similar to the Australian *E. fucosa* Meyrick, 1922. They are characterized by the rounded, ventrally directed uncus lobes, the broad digitate process, the pair of dorsally directed lateral lobes in the median plate of the juxta, the narrow vinculum and the presence of a small lobe at apex of the phallus. Externally these species are quite different, *E. fucosa* being a very narrow-winged species. *E. fucosa* is characteristic with the extraordinarily long saccus and phallus, which is almost 1.5 x as long as the valva. The phallus is shorter than valva in *E. fugax*, and the vinculum + saccus is not nearly as long as in *E. fucosa* (cf. Fig. 282 in Kaila 2011).

**Description.** Forewing length 2.6 mm. Labial palpus ascending, length 1.2 x diameter of head, above bluish

white, below powdered with dark grey-tipped scales. Head somewhat dorsoventrally flattened, frontoclypeus white, vertex covered with grey, dark brown-tipped scales. Scape below white, above as well as pedicel, patagium and thorax covered with grey, dark brown-tipped scales. Pecten absent. Foreleg inwardly pale, outwardly leaden grey; mid- and hindlegs inwardly pale, outwardly white, tibia and tarsomeres distally grey; spurs pale. Forewing ground colour formed of basally bluish grey and distally darker brown scales giving a strongly mottled appearance, fold dark brown from base to middle of wing length; another similar streak at apical third of wing; indistinctly delimited group of dark grey scales near costa in middle of wing length, another, small group somewhat distad of the costal group at dorsal margin, these patches forming indistinct, oblique band; fringe scales grey, at apex partly white; shorter broad fringe scales dark brown-tipped forming dark brown fringe line along termen; hindwing dark grey. Underside of both wings dark grey, scales along termen of forewing with faint, dark fringe line and distally paler grey scales.

Male genitalia. Uncus lobes ventrally directed, widely separate from each other, rounded, ventrolateral surface with long hair-like scales. Tegumen dorsomedially incised, nearly meeting the margin of uncus. Spinose knob of gnathos large, rounded. Valva broadest basally, evenly tapered towards apex; length 4 x its width at base; basal fold of costa narrow, extended 3/5 length of valva, distal fold strongly sclerotised, extended to 4/5 length of valva where cucullus twisted on top; cucullus rounded; sacculus slightly bent medially, otherwise straight, without distal spine. Digitate process 1/4 length of valva, broad, parallel-sided, blunt distally, with setae. Median plate of juxta with pair of large, flat, dorsally directed pockets in lateral margin; juxta lobe parallel-sided, distal margin convex, with small group of setae in the middle; medial margin joining distal margin without an angle. Vinculum V-shaped, without median ridge, tapered to long and narrow saccus. Phallus 0.9 x the length of valva, narrow, basally slightly bent; caecum very short; apex with small sclerotized plate; vesica without cornuti or spine groups.

**Biology.** The single known specimen has been collected by UV trap. Otherwise biology is unknown.

**Distribution.** New Caledonia.

**Etymology.** The Latin word *fugax*, 'swift' refers to the typical habit of running fast, of moths of the *E. freyerella* group.

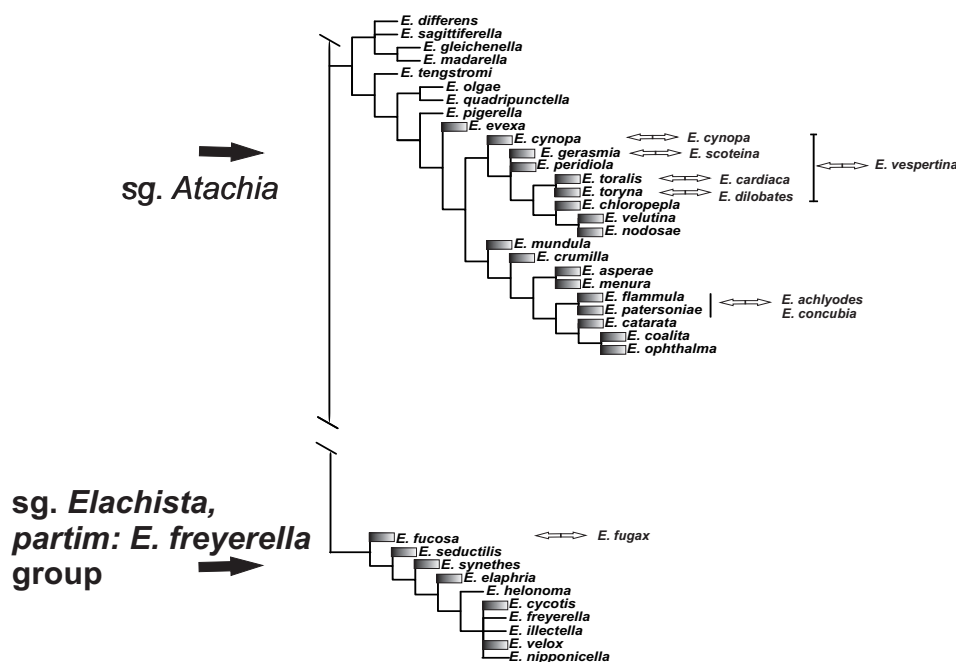
**Remarks.** *E. fugax* is in many respects similar to the Australian *E. fucosa* Meyrick, 1922. With *E. fucosa*, it shares the same character combination used in the phylogenetic analyses by Kaila (1999a): the tegumen is dorsally incised and medially meets the uncus; uncus lobes are ventrally directed; these characters are typical of the *E. freyerella* group. The presence of lateral, dorsally directed lateral lobe in the median plate of the juxta and the absence of lobe on caecum are plesiomorphic traits. The 'crown' species have the median plate of juxta formed as dorsally directed, inflated single lobe (Kaila 1999a,b, Kaila & Sugisima 2011). On the basis of this evidence this species is sister to the lineage has formerly been considered as the genus *Cosmiotes* Clemens, 1860.

## Discussion

The elachistine species from New Caledonia recorded here do not seem to form a monophyletic group, so speak little to vicariance in the south Pacific region or the age of taxa in the subfamily. Rather, individual New Caledonian species are more morphologically similar to individual Australian species putatively making the groups of species from each island paraphyletic in relation to each other. If indeed there is a sister-species level connection with Australian taxa, the distribution of *Elachista* is in line with Holloway's (1993) observations. Even so, there is only one species in common with both areas so far. This pattern is opposite to Gibbs's and Lees's (2014) results. There are no fully reliable dating analyses that include Gelechioidea available (but see Wahlberg *et al.* 2013). Nevertheless, by all evidence available Gelechioidea are much younger than the most ancient lepidopteran group, Micropterigidae. Gelechioidea is, according to the current hypothesis, a fairly recent group of Lepidoptera belonging to the clade Apoditrysia, possibly the first branch of the 'advanced' crown group of Lepidoptera, the Obtectomera (Mutanen *et al.* 2010, Bazinet *et al.* 2013, Heikkilä *et al.* 2015). It seems reasonable that the possible sister-species level link between New Caledonian and Australian elachistine taxa is a result of rather recent, repeated colonization events, while the biogeography of Micropterigidae, a truly old group, can better be explained by ancient tectonic events as postulated by Gibbs and Lees (2014).

Explicit reports of conspecific or sister-species-level connections between the microlepidopteran fauna of New Caledonia and Australia do not exist prior to the present report. Members of the nearly cosmopolitan *Elachista*

*freyerella* group (*sensu* Kaila 1999a,b and Kaila & Sugisima 2011) have an ability to colonize over long distances, as demonstrated by species present in the remote islands of New Zealand (Dugdale 1971). However, only one of the New Caledonian species, *E. fugax*, belongs to this species group in a broad sense.



**FIGURE 18.** A cladogram showing the putative sister/vicariant species relationships between Australia and New Caledonia. The cladogram is modified from Kaila & Sugisima (2011). Species occurring in Australia are indicated by a flag-like symbol.

There is some evidence that species in the *Elachista* sg. *Atachia* also have the ability to disperse over long distances. Australia and New Zealand share two species: *E. gerasmia* Meyrick and *E. physalodes* Kaila, and some species of this predominantly Australian clade of sg. *Atachia* are endemic to New Zealand. More than one of them belong to the *E. melanura* Meyrick species group, and at least three to the *E. cynopa* species group (R. Hoare and L. Kaila, unpublished). This evidence suggests that *Atachia* species have dispersed between Australia and New Zealand at least four times.

An intriguing pattern observed in the present, though limited, material is that nearly all New Caledonian species now reported seem to have a closer relative in Australia than among each other (Fig. 18). Based on character evidence, *E. fugax* belongs to the sg. *Elachista*, *freyerella* species group, and others to sg. *Atachia*. *E. achlyodes* and *E. concubia* putatively belong to the *catarata* section of the *E. gerasmia* group, and the remaining species to the *E. gerasmia* section of the *E. gerasmia* group. On the basis of very close likeness, *E. cardiaca* is a member of the *E. paragauda* species complex; *E. scoteina* belongs to the *E. gerasmia* species complex with two species occurring in both Australia and New Zealand. *E. dilobates* and *E. vespertina* display the typical characteristics of the *cynopa* species complex, with *E. dilobates* is very similar to the Australian *E. toryna* Kaila. *E. cynopa* is known from both Australia and New Caledonia. If these morphology-based assumptions eventually gain support from a cladistics analysis, this pattern implies an extreme picture of repeated colonization events between Australia and New Caledonia. Of the eight species now reported at least six, perhaps seven, seem to have their closest relative in Australia.

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