Leucopodoptera eumundii, a new genus and species of katydid from the tropical rainforests of North Queensland, Australia (Orthoptera: Tettigoniidae: Phaneropterinae: Holochlorini)

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Leucopodoptera eumundii, a new genus and species of katydid from the tropical rainforests of North Queensland, Australia (Orthoptera: Tettigoniidae: Phaneropterinae: Holochlorini)

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Abstract

A new katydid from the tropical rainforests of northern Australia, *Leucopodoptera eumundii gen. et sp. nov.*, is described. Morphological examination, scanning electron microscopy imaging and cytological preparations were used to establish defining characteristics. Principal taxonomic characters include the stridulatory file of the male and the ovipositor of the female. Laboratory and field-based observations give insight into the distribution, ecology and life-history of the species.

Key words

Orthoptera, Holochlorini, *Leucopodoptera eumundii*, cytology, aposematic coloration, *Ryparosa*, cyanide, cyanogenesis, Achariaceae, Flacourtiaceae

Introduction

Tropical rainforests are known for their high tettigoniid species diversity (Rentz 1996) and Australian rainforests are no exception. The family Tettigoniidae is thought to include around 1000 Australian species, most of which remain unnamed. 'Mostly unnamed' is certainly true for the subfamily Phaneropterinae, which are the most diverse of the Australian Tettigoniidae, yet are largely unstudied as a group. The unknown species described in this paper was first collected in 1967, but has remained undescribed until now.

Originally thought to be in the genus *Psyrana* Uvarov, a small genus with Asian affinities, this katydid species has previously been found across a wide range of rainfall gradients and altitudes in the tropical rainforests of northern Australia. Interest was generated in the species when it was found feeding on a rainforest tree known to be highly cyanogenic and toxic to generalist herbivores (Webber 1999). In this paper we describe the katydid from collection material, field-based observations and laboratory-raised stock.

Materials and methods

Measurements.— Anatomical measurements were taken under a light microscope. Acoustic recordings were made with a Nagra IV reel to reel tape recorder (tape speed 38.1cm s^{-1}) and a Brüel & Kjaer half-inch directional microphone (frequency range 0 to 22.5 kHz) situated approximately 10 cm from the subject. Singing males were caged in 1-l preserving jars with screen inserts and recordings were made at night in laboratory conditions (27°C). Katydid calls were digitized (sampling rate 44.1 kHz) using Canary 1.2.4 software (Cornell Lab of Ornithology, Ithaca, USA) and were not filtered post-capture. Sound analysis was accomplished with Raven 1.0 acoustic analysis software (Cornell Laboratory of Ornithology, Ithaca, USA) and visualized as oscillograms and sonagrams.

Imaging.— Morphological details of the katydid exterior anatomy and egg surfaces were examined by scanning electron microscopy (SEM). Specimens were prepared for SEM by dehydration in an ethanol series, critical-point dried and sputter-coated with gold, before being examined and digitally imaged on a Phillips XL30 FEG scanning electron microscope. Additional macroimages were taken of live katydids using a Nikon F801 camera, fitted with an AF Micro Nikkor 105 mm 1:2.8 D lens and Nikon SB24 flash unit.

Cytological component.— The cytological material was fixed in Carnoy's fluid and prepared utilizing the techniques and protocols described in Rentz (1987). Karyotype analysis was performed on squash preparations of testis follicles, allowing for cytogenetic observations and plate preparation.

Results and discussion

Generic diagnosis.—This new genus is a member of the Holochlorini, owing to the tibial auditory organ being open on both sides (Fig. 1) and the forecoxa armed with a long spine. It differs from *Phaulula* I. Bolivar in having a very short ovipositor, as opposed to elongate, and from *Psyrana* Uvarov in not having the pronotum convex dorsally. In addition, *Psyrana* has a distinctive ovipositor that may or may not be serrate on the dorsal and ventral margins. *Leucopodoptera* also differs from *Holochlora* Stål which has a differently shaped ovipositor without any serrations. *Arnobia* Stål is much more distantly related and is distinctive in having hairy legs. *Liotrachela* Brunner is also distantly related and distinctive in having marked pronotal carinae. Table 1 lists some of these characteristics.

It appears that *Leucopodoptera* shares more characters with *Holochlora* than with any other genus in the Holochlorini that we have seen. It differs from all of these genera in having a single apical spine on the outer margin of the dorsal surface of the foretibia as opposed to two in all of the genera mentioned above, except *Phalula*, which is unarmed.

Table 1. Comparison of morphological characters differentiating genera of the Holochlorini closely related to *Leucopodoptera*.

Character	*Phaulula*	*Psyrana*	*Holochlora*	*Liotrachela*	*Arnobia*	*Leucopodoptera*
Fore tibia with dorsal spines (+) or without (-)	-	+	+	+	+	-
Radius with branches (+) or without (-)	+	-	-	-	-	+
Costa developed (+) or not (-)	-	+	+	+	+	-
Pronotum convex dorsally (+) or not (-)	-	+	+	+	+	+
Pronotum with flange (+) or without (-)	-	+	-	-	-	-
Ovipositor	Very short	Elongate, laterally serrate	Short, laterally rough, with groove, serrate	Short, broad, serrate	Elongate to weakly upcurved, smooth	Short, without serrations

## *Leucopodoptera*[*], **Rentz & Webber**, *gen. nov*.

Australian National Insect Collection (ANIC) number, Gen. Nov. 23
Type species: *Leucopodoptera eumundii* Rentz & Webber by original designation (Fig. 2).

Diagnosis.— ♂/♀. Size moderate for tribe, form elongate, delicate, both sexes fully winged. Head with fastigium of vertex broadly conical, surface without sulcus dorsally but with minute sulcus on anterior surface; frons feebly oblique in profile. Eye round, bulging, positioned high on head. Antenna with scape elongate, about one and one half times as long as pedicel; flagellum very thin, extending slightly beyond apex of tegmina. Pronotum elongate, cephalic margin feebly indented, caudal margin evenly obtuse, with feeble rim; surface of disk smooth, not polished, cut by weak anterior sulcus, indicated only on humeral angles; posterior sulcus sinuate, present on middle of disk, absent from lateral lobes; lateral lobes deep, anterior margin straight, posterior margin obtuse, surface as described for disk but with depressions; ventral margin obtuse, somewhat produced in middle. Prosternum simple, unarmed; mesosternum with broad lobes, angulate on caudal external margin; metasternum with lobes large, caudal external margin not angulate. Thoracic auditory structure large, directed forward, completely hidden by caudal pronotal lobe.

Legs elongate, slender, without modifications, surface not especially setaceous. Both tibial auditory tympana exposed. Foreleg with femur cylindrical, evenly tapering from base, surface smooth, ventral surface grooved, anterior margin of ventral surface with row of 8 to 9 teeth; tibia expanded in region of tympanum, cylindrical, then greatly narrowing evenly to apex; dorsal surface armed only on posterior margin with 4 spines, ventral surface with scattered spines along entire margin. Middle leg with femur subcylindrical, slightly bowed, ventral surface grooved, armed only on anterior margin with a number of minute spines along entire length; tibia feebly expanded at base and apex, cylindrical to slightly quadrate in cross section, dorsal surface armed on anterior margin with a single spine near base, posterior margin with several spines along its entire length. Hind leg with femur laterally compressed, expanded in basal third, external surface wrinkled, shining, ventral surface

Fig. 1. *L. eumundii* exhibiting an open tibial auditory structure on the fore tibia.
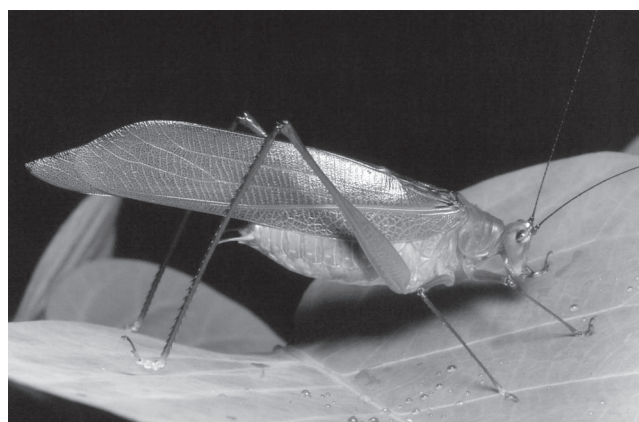
Fig. 2. *L. eumundii* is a "normal" green in color with dark brown antennae and white tarsi (adult male pictured).

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[*] The generic name refers to the uniformly white tarsi of the genus.

grooved, with minute teeth along external margin for entire apical two-thirds, internal margin with few minute teeth near apex; tibia quadrate in cross section, dorsal surface armed with many spines of similar length along entire surface of both margins, ventral surface with smaller number of spines on internal and external margins. Apex of fore and middle tibiae armed with a single spine on anterior margin of dorsal surface, ventral surface with single spine on both margins; hind tibia armed dorsally at apex with single spine on each side, spine on internal margin much longer than internal spine, ventral surface with 4 apical spines. Genicular lobes of fore and middle femora armed with a single tooth on anterior margin, posterior margin with 2 teeth; hind tibia with single spine on external margin, internal margin with 2 spines. Fore coxa with elongate spine externally, internal margin with small tooth or knob.

Tegmina surpassing abdomen apex, in outline relatively broad, even, apex subacute on anterior margin; costa short but prominent, curving anterior well before anterior fifth of tegmen; subcosta and radius close-set, flaring slightly apically, radial sector forked in apical quarter of tegmen, media without any major branches but with large number of parallel veins extending to posterior margin of tegmen; wing simple, without modification. Stridulatory region relatively well sclerotized, mirror with major transverse vein in cephalic quarter, mesal area with net-like pattern of cells, otherwise membranous; stridulatory vein arching, somewhat swollen at internal margin; stridulatory file simple, file teeth broad, positioned in an unbroken, arching series. Male abdomen with 10th tergite not modified, apex truncate, extending slightly over supra-anal plate; supra-anal plate simple, broadly triangular, surface without tubercles or ridges, margins relatively densely hirsute; paraprocts simple, unmodified; subgenital plate broad basally, tapering to narrow apex, styles absent, represented as minute knobs, apex with narrow, shallow V-shaped median incision; cercus very elongate, slender, incurved, apex with minute sclerotized tooth; concealed genitalia simple, without sclerotized parts. Female abdomen with 10th tergite unmodified; supra-anal plate minute, triangular; subgenital plate minute, short, broadly triangular, without ridges or sulci, cercus short, weakly directed inwards. Ovipositor short, laterally compressed, of uniform width throughout, without teeth or modification.

Overall color "normal" green, as common in Phaneropterinae. Antennae dark brown, with light rings; caudal margin of tegmen brown, stridulatory region brown; wing colorless except exposed tip coriaceous, green; all tarsi white; dorsal surface of abdomen reddish brown, somewhat darker in males; ovipositor pallid green.

Leucopodoptera eumundii[*], **Rentz & Webber**, *sp. nov.*

ANIC number, Gen. Nov. 23, sp. 1.

Holotype.— ♂. 1. "lat 17°17' S, long 145° 34' E Curtain Fig, 2km SSW of Yungaburra, Atherton Tableland, Qld. 7 March 1988 D. C. F. Rentz Stop A-2". 2. "D. C. F. Rentz Cytol. Prep. 88-189". 3. "Song recorded S-614". Holotype in ANIC.

The following characters are in addition to those listed above. Stridulatory file with 88 teeth (Fig. 3a), distal portion of file on raised swelling (Fig. 3b), teeth broadest at this point. Teeth not flanged but minutely serrate or grooved apically (Figs 3c to 3f). Apex of cercus with single minute tooth (Fig. 4).

♀. Cercus extending nearly to midpoint of ovipositor, then abruptly tapering in apical one-third. Ovipositor with a small elongate "blister" at base on each side; dorsal surface with a low arching carina (Fig. 5b, c).

Color.— (♂/♀) Overall color as above with following additions: antenna with ventral surface yellow; compound eye ventrally creamy-white grading to light yellow, dorsally a uniform bright green somewhat darker than body, two halves separated by thin yet distinct, dark brown dorsoventral band, pseudopupil black; ocelli uniformly white (eye color based on live specimens; Figs 1, 6). Legs with fore and middle tibiae light brown in distal portion adjacent to tarsus; fore and middle femora green, apex light brown on posterior surface, anterior surface with distinct black spot on flange on lower surface at apex. Light blue coloration concentrated on distal carinae of meta- and mesosternal lobes, extending onto middle and hind coxe, the prosternal and ventral surface of the abdomen between fore and hind coxae. Ventral surface of abdomen exhibiting inducible aposematic coloration: each abdominal segment displays a central pink region outlined by yellow with a purple dot in the inter-segmental regions; all 3 colors darkening rapidly upon disturbance.

Specimens examined.—

Paratypes.— Queensland: lat 15°47'S, long 145°14'E, Shiptons Flat, nr Cooktown, 16-18 May 1981 (D. C. F. Rentz, stop 38, vine forest, 2 ♂♂, Cytol. Prep 81-141, 1 ♂, ANIC). Lat 15°50'S, long 145°20'E, Gap Ck, 5 km ESE of Mt Finnigan, nr Cooktown, 13-16 May 1981 (D. C. F. Rentz, Stop 37, rainforest, 1 ♀, ANIC). Lat 16°07'S, long 145°27'E, Crystal Ck, Cape Tribulation Nat. Pk, 12 Nov 2001 (B. L. Webber and A. M. Shirley, Site 1, on understory vegetation and saplings in vine forest canopy gaps, 9 nymphs, matured in laboratory Dec 2001, ANIC). Lat 16°08'S, long 145°26'E, Noah Ck, Cape Tribulation Nat. Pk, 9 Nov 2001 (B. L. Webber and A. M. Shirley, Site 6, on saplings in vine forest canopy gaps, 4 nymphs, matured in laboratory Dec 2001, ANIC). Lat 16°10'S, long 145°24'E, Little Cooper Ck, Cape Tribulation Nat. Pk, 7 Nov 2001 (B. L. Webber and A. M. Shirley, Site 5, on saplings in vine forest canopy gap, 9 nymphs, matured in laboratory Dec. 2001, ANIC); same locality, 14 Nov 2001 (B. L. Webber and R. Chetley, Site 5, on saplings in vine forest canopy gap, 14 nymphs, matured in laboratory Dec 2001, ANIC). Lat 16°49'S, long 145°39'E, nr Barron Falls, Kuranda, 15 Mar 1988 (D. C. F. Rentz, stop A-34, 1 ♀, ANIC). Lat 16°51'S, long 145°39'E, Barron River Gorge, 14 km NW by W of Cairns, 29 Feb 1988 (D. C. F. Rentz, stop A-24, 1 ♀, ANIC). *ca* Lat 16°55'S, long 145°43'E, Whitfield Range Forest Reserve, Cairns, 19 Apr 1967 (D. H. Colless, 1 ♀ ANIC). Lat 17°02'S, long 145°37'E, Davies Ck, 15 rd-km from Kennedy Hwy, 22 km E by S of Mareeba, 24 Mar 1988 (D. C. F. Rentz, stop A-28b, 1 ♂, ANIC). Lat 17°10'S, long 145°39'E, Cathedral Fig, Danbulla Forestry Res., 13 km NE of Yungaburra, 25 Mar 1988 (D. C. F. Rentz, stop A-19a, 1 ♂, Cytol. prep. 88-217; Song recorded S-627, ANIC); same locality, 9 Dec 1985 (J. Balderson, 1 ♀, collected as nymph, matured in laboratory 29 Dec 1985, ANIC). Lat 17°12'S, long 145°40'E, Gillies Range, 1.2 km S of Cathedral Fig, 12 km NE of Yungaburra, 9 Mar 1988 (D. C. F. Rentz, stop A-33, 1 ♂, Cytol. prep. 88-192; song recorded S-612, ANIC). Lat 17°15'S, long 145°38'E, Lake Barrine, Atherton Tableland, 15 Feb 1988 (D. C. F. Rentz, stop A-8, 1 ♂, Cytol. Prep. 88-116; song recorded S- 552, ANIC); same locality, 28 Jan 1988 (D. C. F. Rentz, stop A-8, 1 ♀ collected as nymph, matured

[*] The species name is in honor of a fearless Aboriginal warrior, and also a thirst-quenching Queensland lager!
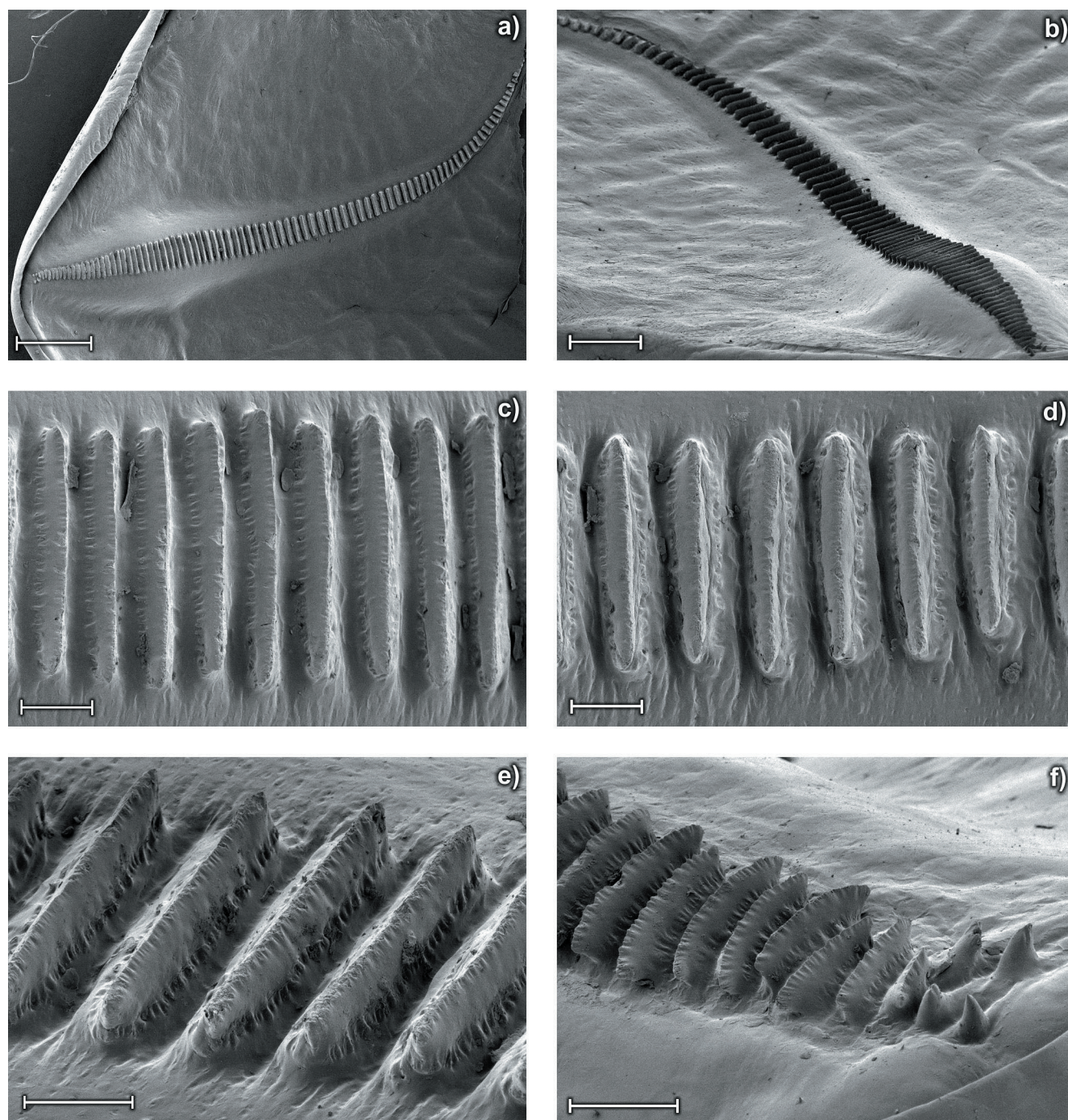
Fig. 3. The stridulatory file of *L. eumundii* is simple and arching a) with the distal portion on a raised swelling a),b). File teeth are broad c) to f) and comprise one unbroken series. Scale bars: 500 μm a), 250 μm b), 50 μm c) to f).

in laboratory 7 Feb 1988). Lat 17°17′S, long 145° 34′E, Curtain Fig, 2 km SSW of Yungaburra, Atherton Tableland, 21 Jan 1988 (D. C. F. Rentz, A-2, 1 ♂, Cytol prep. 88-19; song recorded S-484, 1♀, ANIC); same locality, 7 Mar 1988 (D. C. F. Rentz, 1♂, Cytol. Prep. 88-189; song recorded S-614, 1♂, ANIC). Lat 17°25′S, long 145°52′E, Josephine Falls, Nat. Pk, 8 Feb 1995 (L. Ring, 1♀, ANIC). 17°35′S 145°42′E, Palmerston Nat. Pk, 12 km SE Millaa Millaa, 15 Dec 1985 (J. Balderson, 1♀, collected as nymph, matured in laboratory 13 Dec 1985, ANIC).

Anatomical Measurements.— Adult individuals of *L. eumundii* (n = 13) averaged 51.4 ± 0.4 mm ($\pm s_{\overline{x}}$) in total length and had a tegmen length of 40.3 ± 0.3 mm ($\pm s_{\overline{x}}$; Table 2). Protonum dimensions ($\pm s_{\overline{x}}$) averaged 5.6 ± 0.1 mm in length by 4.3 ± 0.1mm in width, while fore, middle and hind-femur lengths averaged 7.6 ± 0.1, 10.6 ± 0.2 and 22.6 ± 0.5 (mm $\pm s_{\overline{x}}$) respectively (Table 2). The ovipositor of female specimens was 5.7 ± 0.2 mm ($\pm s_{\overline{x}}$, n = 7) in length. Although all anatomical features measured in female specimens were on average larger than in males (Table 2), differences between the sexes were small and only statistically significant in femur lengths (95% confidence level).
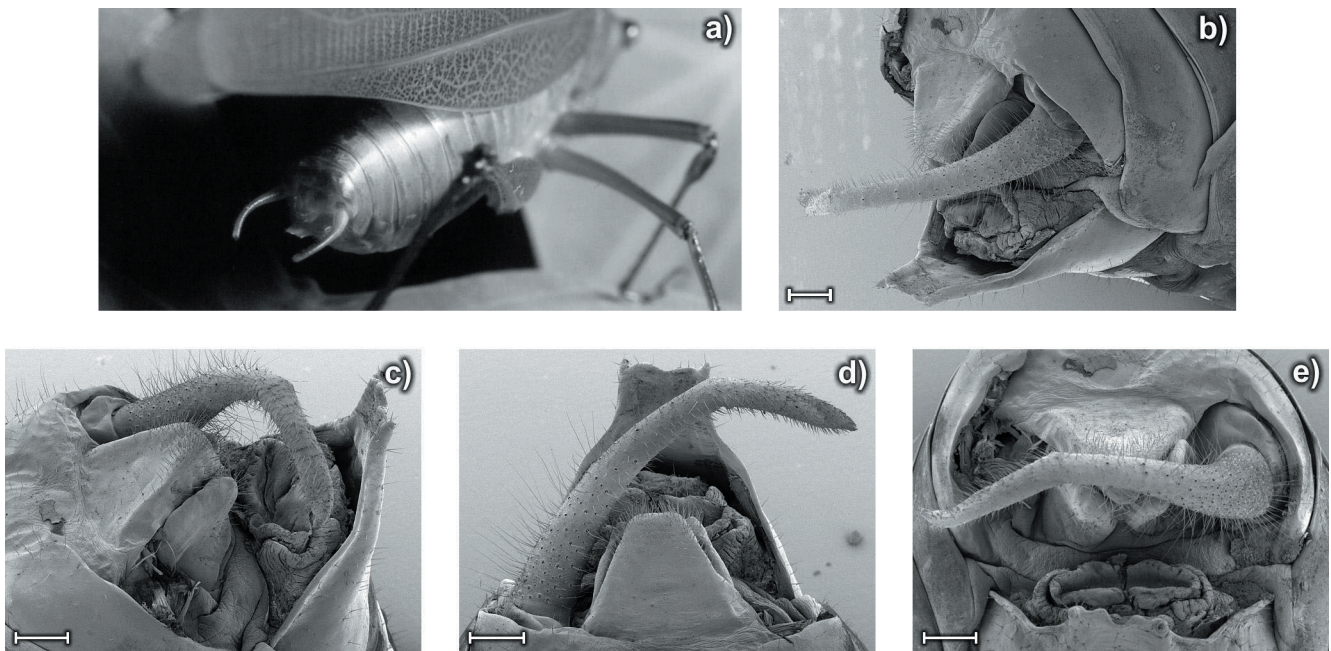
Fig. 4. Diagnostic structures of the male abdomen of *L. eumundii*. Male abdomen posterior view a); with one cercus removed, side view b), c); dorsal view d) and posterior view e). All scale bars: 500 µm.
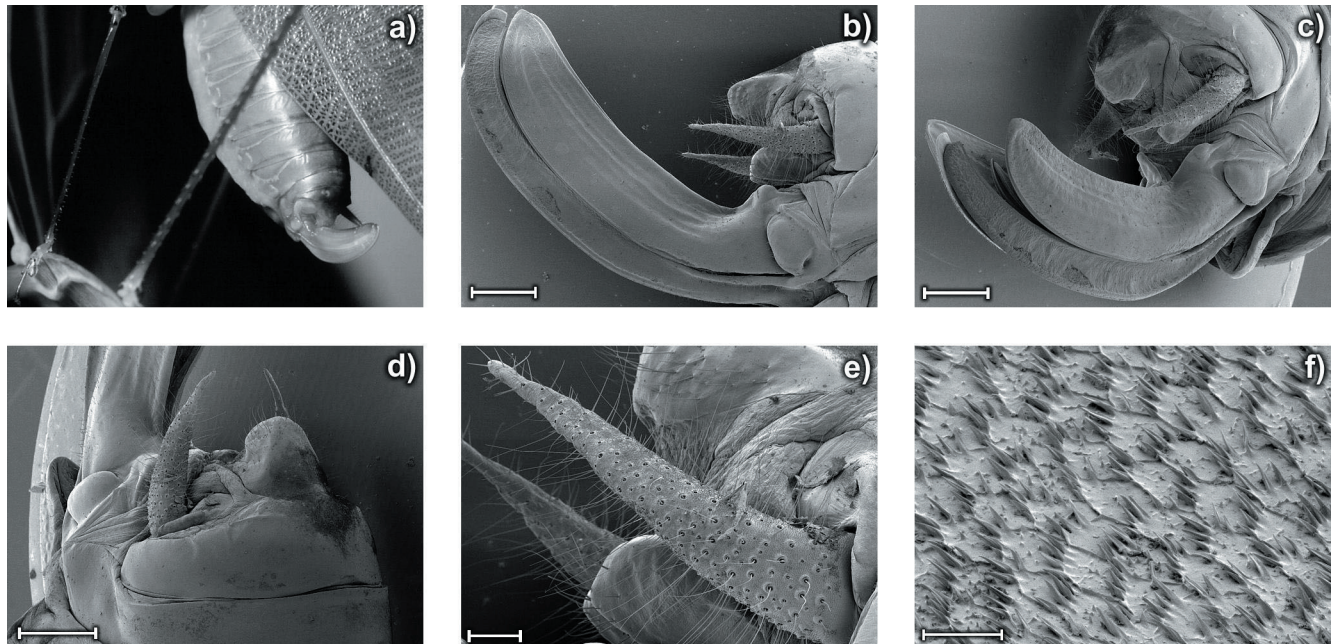

Fig. 5. Diagnostic structures of the female abdomen of *L. eumundii*. Side view a), b); posterior view c); dorsal view d). Cerci are short and directed inwards e). Exterior surface of abdomen tergum f). Scale bars: 1000 µm b) to d), 250 µm e) 20 µm f).

Song description.— The song of *L. eumundii* is comprised of short lisps emitted at night and is rather typical of phaneropterines. In the field, calling has been observed to start just on dusk, a pattern also observed in captive males once accustomed to glasshouse conditions. Lisps (Fig. 7a) are performed in groups averaging 4 with a regular period of 350 ± 5 ms ($\pm s_{\bar{x}}$; n = 15) between each lisp (Figs 7b, 7c). Bursts of 3 and 5 are not uncommon. Each burst of lisps is separated by a time interval of several seconds (Fig. 7c), varying according to the activity of the calling males. On average, each lisp covers the entire frequency range captured by the recording equipment used (0 to 22.5kHz), with peak intensity between 10 to 12 kHz and 15 to 17kHz, midway through each lisp (Fig. 7b). Reverberation introduced by the glass walls of the container obscured the AM Pattern of the lisp. It has not been determined whether females respond acoustically to the calls of males.

Ecological notes.—*L. eumundii* is known from a range of tropical rainforest sites in northern Queensland (Fig. 8). From Mt Bartle Frere in the south to Cooktown in the north, the species has been found in coastal lowland vine forest through to mesophyll and notophyll vine forest in the cooler regions of the Atherton Tablelands (alt. 800 m). Nymphs have usually been observed in the months of November to January, where they seem to be more active on a variety of plant species with low foliage in canopy gaps. This period of time corresponds with the start of the wet season in tropical north Queensland. Adults have been observed towards the end of the wet season, during the months of February to May.

  L. eumundii seem to be wholly vegetative feeders. Extensive leaf lamina consumption in adults and nymphs was observed in field and laboratory conditions, while adults were also observed ingesting the bark of young stems on glasshouse seedlings. Nymphs showed no preference for nocturnal activity and were readily observed feed-

Fig. 6. Head of *L. eumundii* with bulging eyes positioned high on the head (adult male pictured). Scale bar: 1000 μm.

Table 2. Anatomical measurements (mm) of *L. eumundii*. Average values for male (n = 6) and female (n = 7) specimens (mean $\pm s_{\bar{x}}$) are summarized at the bottom of the table. Differences between the sexes were only significant in femur lengths (95% confidence interval).

| Locality	Sex	Total Length	Pronotum Length	Pronotum Width	Fore Femur Length	Middle Femur Length	Hind Femur Length	Tegmen Length	Ovipositor Length
Shiptons	♂	50.0	5.3	4.1	7.4	10.2	21.2	38.0	
Shiptons	♀	54.0	5.8	4.7	8.3	11.6	25.0	42.0	6.2
Gap Ck	♀	52.0	5.7	4.3	7.8	10.9	22.7	39.0	6.2
Palmer NP	♀	49.0	5.4	4.1	7.5	9.9	21.1	40.0	4.7
Curtain Fig	♀	50.3	5.4	4.3	8.1	11.4	23.1	40.2	5.3
Curtain Fig	♂	50.1	5.5	4.1	7.0	9.8	20.7	39.0	
Curtain Fig	♂	52.0	5.5	4.1	7.0	9.8	20.4	40.1	
Gillies R.	♂	52.0	5.7	4.3	7.5	10.3	22.7	41.0	
Holotype	♂	51.0	5.4	4.0	7.1	9.7	21.0	40.0	
Barron Falls	♀	52.0	5.5	4.4	7.7	10.9	23.6	40.5	6.1
Davies Ck	♂	52.0	5.6	4.4	7.4	10.6	22.6	41.0	
Josephine	♀	50.0	5.8	4.4	8.3	11.3	24.0	41.0	5.3
Barron R.	♀	54.0	6.1	4.6	8.2	11.5	25.5	42.5	6.2
Male (n=6)		51.2 ± 0.4	5.5 ± 0.1	4.2 ± 0.1	7.2 ± 0.1	10.1 ± 0.1	21.4 ± 0.4	39.9 ± 0.5	
Female (n=7)		51.6 ± 0.7	5.7 ± 0.1	4.4 ± 0.1	8.0 ± 0.1	11.1 ± 0.2	23.6 ± 0.6	40.7 ± 0.5	5.7 ± 0.2
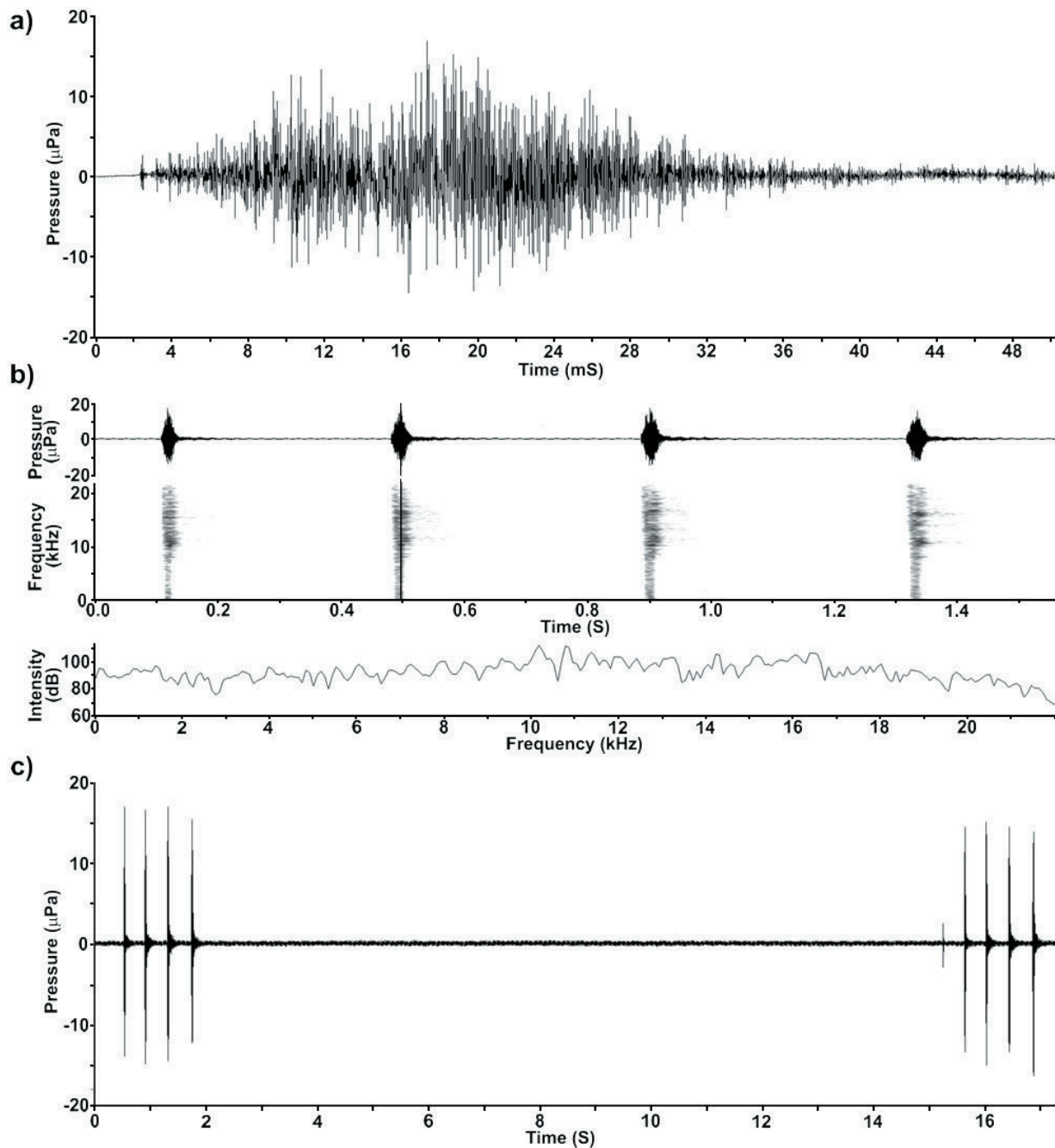
Fig. 7. Oscillograms and sonagram of the song of *L. eumundii* (♂). Each song comprises a short lisp a) performed in groups averaging 4 b), with bursts of 3 and 5 not uncommon. Each burst of 4 lisps is separated by a time interval of several seconds, varying according to the activity of the calling males c). The line through lisp 2 (b at 0.5 s) indicates the point at which the spectrogram slice is taken.

ing during daylight hours (Fig. 9). In contrast, laboratory raised adults fed only at night, and spent daylight hours concealed in the upper leaves of their host plants. When resting, nymphs pressed their bodies close against the foliage and extended their hind legs out well behind their abdomen. This posture is common amongst leaf-mimicking members of the Phaneropterinae and the Pseudophyllinae and serves to camouflage the legs while emphasizing the abdomen (Belwood 1990). A powerful leap at the sign of any disturbance seems to be their best defence against predation. Interestingly, both nymphs and adults display inducible aposematic coloration on the ventral surface of their abdomen when disturbed

in laboratory conditions. Particular posturing to reveal this warning display has not been observed, although this may relate to the fact that disturbance events resulting in induced coloration have always been caused by human handlers — a threat not representative of typical field predators!

In a week of collecting during November 2001, the subcanopy tree *Ryparosa javanica* (Blume) Kurz *ex* Koord. & Valeton (Achariaceae syn. Flacourtiaceae) comprised >30% of host plants on which the nymphs were feeding when caught, despite the low abundance (<5%) of this tree species at collection sites. Interestingly, *R. javanica*

Fig. 8. The known distribution of *L. eumundii* covers a range of tropical rainforest sites in northern Australia. Extending from Mt Bartle Frere in the south to Cooktown in the north, the distribution covers an altitudinal gradient of 800 m.
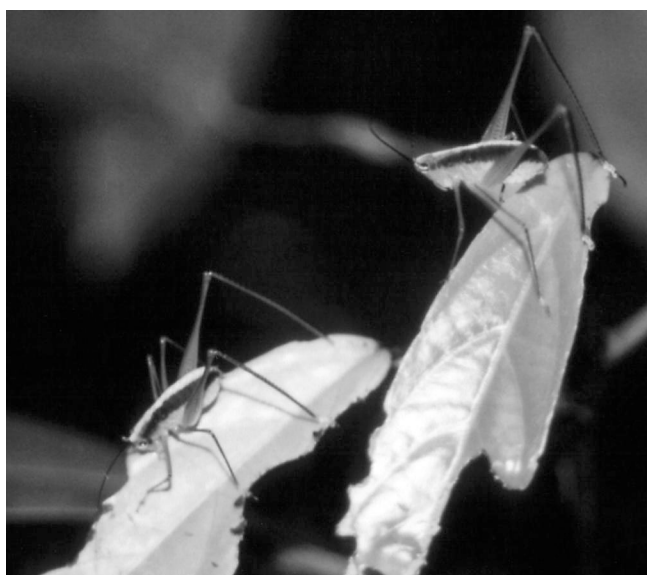

Fig. 9. An early nymph stage of *L. eumundii* browsing on *Ryparosa javanica* (Blume) Kurz *ex*. Koord. & Valeton. The distinct black and white stripes on the dorsal surface of the abdomen are clearly visible.

is known to contain high concentrations of foliar cyanogenic glycosides (Webber 1999), a proven deterrent to generalist herbivores (Gleadow & Woodrow 2002). When taken into the laboratory, both nymphs and adults of the species browsed on a range of vegetation provided to them and showed a noticeable preference for young, unexpanded leaves. The one exception was seen in nymphs browsing on young foliage of *Schefflera actinophylla* (Endl.) Harms (Araliaceae). Very little material was eaten out of these leaves; however, it seemed to result in the direct death of 4 of the younger instars, which started to "stagger" around their cage before dying 4 to 12 h after *S. actinophylla* foliage was introduced. The Araliaceae are known to contain oxalates, a group of toxic chemicals that can cause fatalities due to internal formation of calcium oxalate crystals after ingestion (Frohne & Pfänder 1983). While the recent interest in *L. eumundii* relates largely to its habit of feeding on toxic plant species, as yet no controlled feeding trials have been carried out.

As young instars, *L. eumundii* nymphs closely resemble bird droppings, with a white stripe, highlighted on each side by black stripes down the entire length of the dorsal surface of the body (Fig. 9). In later instars, and by the stage of first wing development, the stripe has faded to a single central dark-grey mark found only on the dorsal surface of the abdomen. It is not known how many instar stages there are; however, it is at least 4 and probably in the order of 6 or 7.

The spermatophore of *L. eumundii* is quite large, averaging 8.5 mm in length by 6.5 mm wide (Fig. 10a). Two almost intact spermatophores were observed already attached to captive females. When attached to the female, the posterior end of the spermatophore comprises 2 large globose lobes, 3 mm in diameter, which contain the sperm (Fig. 10c). The spermatophylax, positioned anteriorly to the two lobes, is partially segmented by a groove running parallel with the abdomen of the katydid (Fig. 10b). Spermatophore coloration is somewhat translucent and creamy-yellow in the lobes, with a gradual change to an opaque milky-white at the anterior end.

Oviposition in *L. eumundii* is unknown from natural populations. Eggs are small, ovoid in shape and have an irregularly shaped micropyle zone on their margin (Fig. 11). Their broad ovipositor seems suitably adapted for splitting thickened leaf laminas for oviposition within leaf tissue or inside cracks in the outer bark of tree trunks. Two female adults were killed and dissected for internal investigation before oviposition, revealing 36 and 41 eggs within their abdomens. Adults that had matured in captive conditions were offered a range of oviposition media in an effort to determine preference. A captive population of 14 females produced over 300 eggs in cages with a choice of damp newspaper, "paper booklets", distressed balsa wood and potted seedlings of the rainforest pioneer species *Omalanthus novo-guineensis* (Warb.) K. Schum (Euphorbiaceae). Approximately 65% of eggs laid were deposited between the sheets of paper in booklets wedged against the base of seedlings. A further 28% of eggs were laid in the damp newspaper on the bottom of the cage while the remaining eggs were either laid on the soil surface in the seedling pot or between leaves that were stuck together. No eggs were laid in the distressed balsa wood, despite it's similarity to tree-trunk oviposition sites. Egg diapause is unknown from natural populations and is currently being investigated in controlled laboratory conditions (Webber, unpub.).

Cytological determination.—

Material examined.— Cytol. Preps 81-41, 88-19, -116, -189, -192, -217. 2n male= 24 (Fig. 12)

Spermatogonial metaphases show chromosomes with a neo-XY system (Figs 12a, b). It comprises one pair of large and 10 pairs of small telocentrics, gradually decreasing in size, and the neo-XY, a large telocentric neo-X and a small telocentric neo-Y.

At first metaphase there are 11 autosomal bivalents and then a neo-XY bivalent (Fig. 12c). During the first anaphase, the X moves to one pole and the Y moves to the other pole, as is usual (Fig. 12d). As a result of the first division, 2 types of second metaphases occur, one with 11 autosomes and the X, the other with 11 autosomes and the Y. They divide in the usual manner (Figs 12e and f).

The chromosomes of the known Australian Phaneropterinae range, in males, from 2n = 12 to 29 (Ueshima, unpub.). However, the 2n = 24 (22 autosomes and the neo-XY) karyotype is only found in *Leucopodoptera*. Morphologically this genus may be close to another holochlorine phaneropterine, *Psyrana*; however, the chromosome system is quite different from *Psyrana* which is known to have 2n = 21 (20 autosomes and the X) in the male. Based on previous work, 2n = 21 chromosomes is thought to be the modal number in the Phaneropterinae (Ueshima, unpub.).

Concluding remarks

Leucopodoptera is one of about 35 undescribed phaneropterine genera in the ANIC. These genera run the gamut of the "recognized" tribes but are certain to include species with characters so different that new tribes will be needed to accommodate them. A generic review of the Phaneropterinae, as currently understood, is sorely needed as there has been no major overview of it in more than a century. Since that time dozens of genera from all parts of the world have been described and many have not been properly assigned to tribes. There is indication that the Phaneropterinae will be divided into a number of related subfamilies.
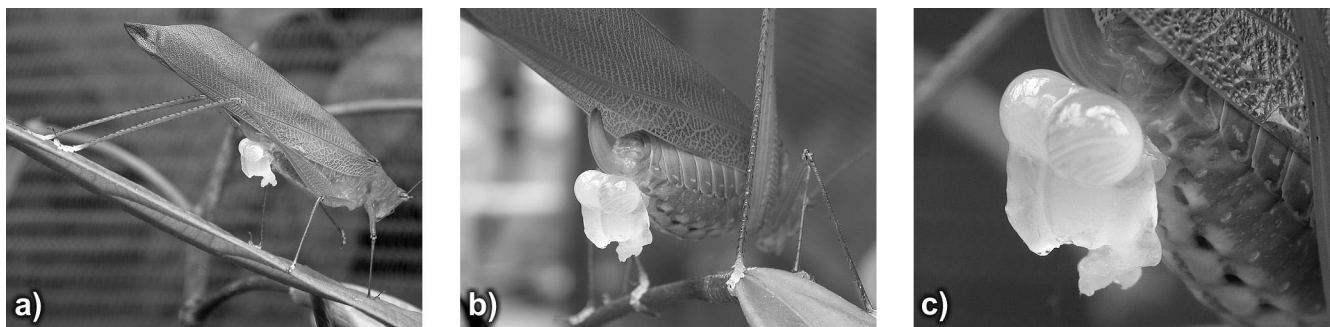

Fig. 10. Spermatophore of *L. eumundii* attached to a female indicating its relatively large size (a); the partially segmented spermatophylax (b); and the globose lobes containing sperm, positioned posteriorly to the spermatophylax when attached on the female (c).
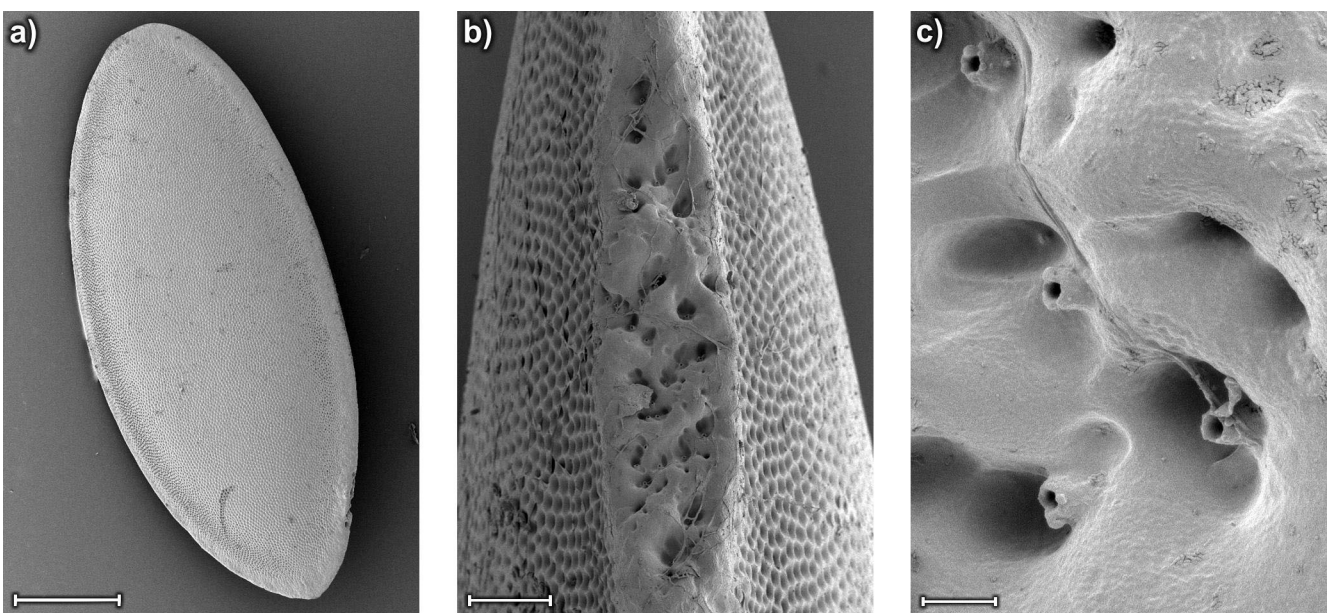

Fig. 11. Surface structures on the egg of *L. eumundii*, indicating it's ovoid shape (a), micropyle zone situated on the rim of the egg (b) and micropyles (c). Scale bar: 1000 μm (a), 100 μm (b), 10 μm (c).
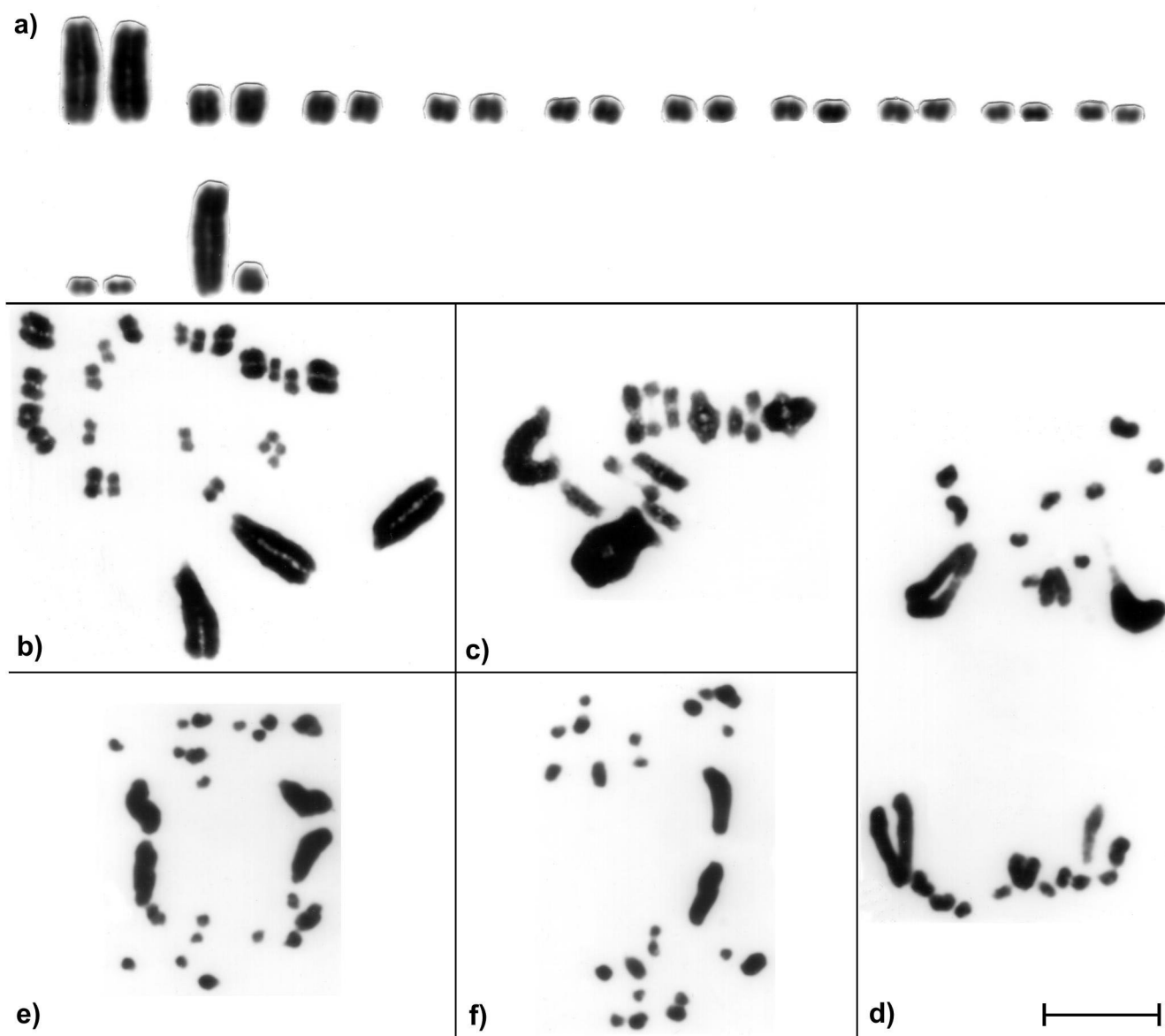
Fig. 12. Chromosome complement of *L. eumundii* indicating karotype (a), spermatogonial metaphase (b), first metaphase (c), first anaphase (d), second anaphase with the X (e) and second anaphase with the Y (f). Scale bar: 10 µm.

Acknowledgements

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