

RESEARCH PAPER

Tarehylava, a new planthopper genus from Madagascar (Hemiptera: Fulgoromorpha: Ricaniidae)

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Abstract. A new monotypic genus of ricaniid planthoppers (Hemiptera: Fulgoromorpha: Ricaniidae), *Tarehylava* gen. nov., is described for *T. avymaina* sp. nov. (type species), based on four females collected in the spiny forest ecoregion of south-western Madagascar. Habitus, as well as external and internal female genital structures of the new genus and species are described and illustrated.

Key words. Hemiptera, Fulgoroidea, Ricaniidae, morphology, taxonomy, spiny forest, Madagascar, Afrotropical Region

Zoobank: <http://zoobank.org/urn:lsid:zoobank.org:pub:1FA06A95-4F5D-4C7F-BAEA-42852D915D69>

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Introduction

The Ricaniidae Amyot & Audinet-Serville, 1843 constitute a family of planthoppers (Hemiptera: Fulgoromorpha) distributed throughout the warm temperate and tropical regions of the world. These phytophagous insects are associated with herbaceous and woody plants and have adapted to various habitats ranging from rainforests to semideserts. Despite being fairly diverse, the taxonomy, morphology and biology of the family have remained poorly studied. Currently, it consists of 67 genera (2.7% of Fulgoromorpha) and 437 species (3.2%) (BOURGOIN 2021).

Sixty species of Ricaniidae, belonging to 15 genera, have been recorded from Madagascar so far (METCALF 1955; SYNAVE 1956, 1966; STROŃSKI et al. 2011; STROŃSKI 2020a; BOURGOIN 2021). However, currently available material indicates that the biodiversity of Ricaniidae in Madagascar is much higher than previously estimated. After STROŃSKI et al. (2011) and STROŃSKI (2020a), the present paper is the third contribution from a long-term project on the Ricaniidae of Madagascar. The project aims to review: 1) the taxonomy of the group, including redescriptions of all Madagascan Ricaniidae based on their type specimens, revisions of their possible synonymies, descriptions of new species, identification keys for genera and species; 2) the great regional disparity of the family with morphological analyses of peculiar characters, and 3) its biodiversity, particularly in relation to the local endemism of ricaniid taxa in

link with the type of environment and distinguishing taxa characteristic for particular habitats or biomes. Ultimately, the project will provide a taxonomic catalogue of the Ricaniidae of Madagascar, a review of characters used for the identification of species and diagnosis of higher taxa (e.g., tegmen venation, male and female genital structures), and a characterization of Madagascan biomes from a taxonomic perspective through their specific ricaniid taxa. It will not only contribute to our knowledge of the invertebrate fauna of Madagascar, but also towards a sounder base for the identification of local biodiversity hotspots, the designation of areas of endemism, and ultimately, in the development of conservation strategies in the country.

The present publication describes a new ricaniid taxon from south-eastern Madagascar, which is associated with the spiny forest ecoregion.

Material and methods

Material. The taxonomic description is based on dry-pinned specimens deposited in the following collections:

CAS California Academy of Sciences, Department of Entomology, San Francisco, USA;
MZPW Museum and Institute of Zoology, Polish Academy of Sciences, Warsaw, Poland.

Label information from all specimens examined is provided verbatim with each line separated by a slash (/) and each label given in square brackets.



Terminology. The nomenclature of the fore wing (tegmen) follows the interpretation proposed by BOURGOIN et al. (2015) and STROIŃSKI (2020b). Antennal structures are named in accordance with STROIŃSKI et al. (2011). The terminology of the female genitalia follows BOURGOIN (1993). The administrative division of Madagascar follows the results of the Malagasy constitutional referendum in 2007.

Methods. The abdomen of one of the specimens examined was cut off and cleared for 30 min in a warm (50 °C) 10% KOH solution with a few drops of chlorazol black (CAS No. 1937-37-7), in order to stain ectodermal genital structures, based on the method introduced by CARAYON (1969). Dissections and cleaning of the genital structures were carried out in distilled water. Final observations were made in glycerol using an Olympus stereoscopic microscope (SZH10). The photographs of the habitus and internal structures were taken using a stereoscopic microscope Leica MZ 16 with a IC3D camera. Final images were adjusted using the Helicon 5.0 software and Adobe Photoshop. The scanning electron micrographs (SEM) of uncoated specimens were taken at the Laboratory of Scanning Microscopy, Museum and Institute of Zoology, Polish Academy of Sciences (Warsaw), using a scanning electron microscope HITACHI S-3400N under low vacuum conditions.

The distribution map of the species was created using SimpleMapp (SHORTHOUSE 2010). Ecoregions were defined after climatic and vegetation criteria (CORNET 1974, BURGESS et al. 2004).

Measurements and abbreviations. Measurements were made with an ocular micrometer. Total length was measured from the head apex to the apex of tegmina in dorsal view. The following measurements, ratios and their abbreviations were used in this study:

Ap/B	width of vertex measured at posterior margin / length of vertex measured at midline;
C/E	width of frons at upper margin / length of frons at midline;
D/E	maximum width of frons / length of frons at midline;
F/B	length of pronotum at midline / length of vertex at midline;
G/F	length of mesonotum / length of pronotum at midline;
G/B+F	length of mesonotum / cumulative length of vertex and pronotum at midline;
G/H	length of mesonotum at midline / width of mesonotum between lateral angles;
I/J	length of tegmen measured from the base to the apical margin in median portion / width of tegmen measured at the widest part.

Taxonomy

Tarehylava gen. nov.

(Figs 1–7, 11–63)

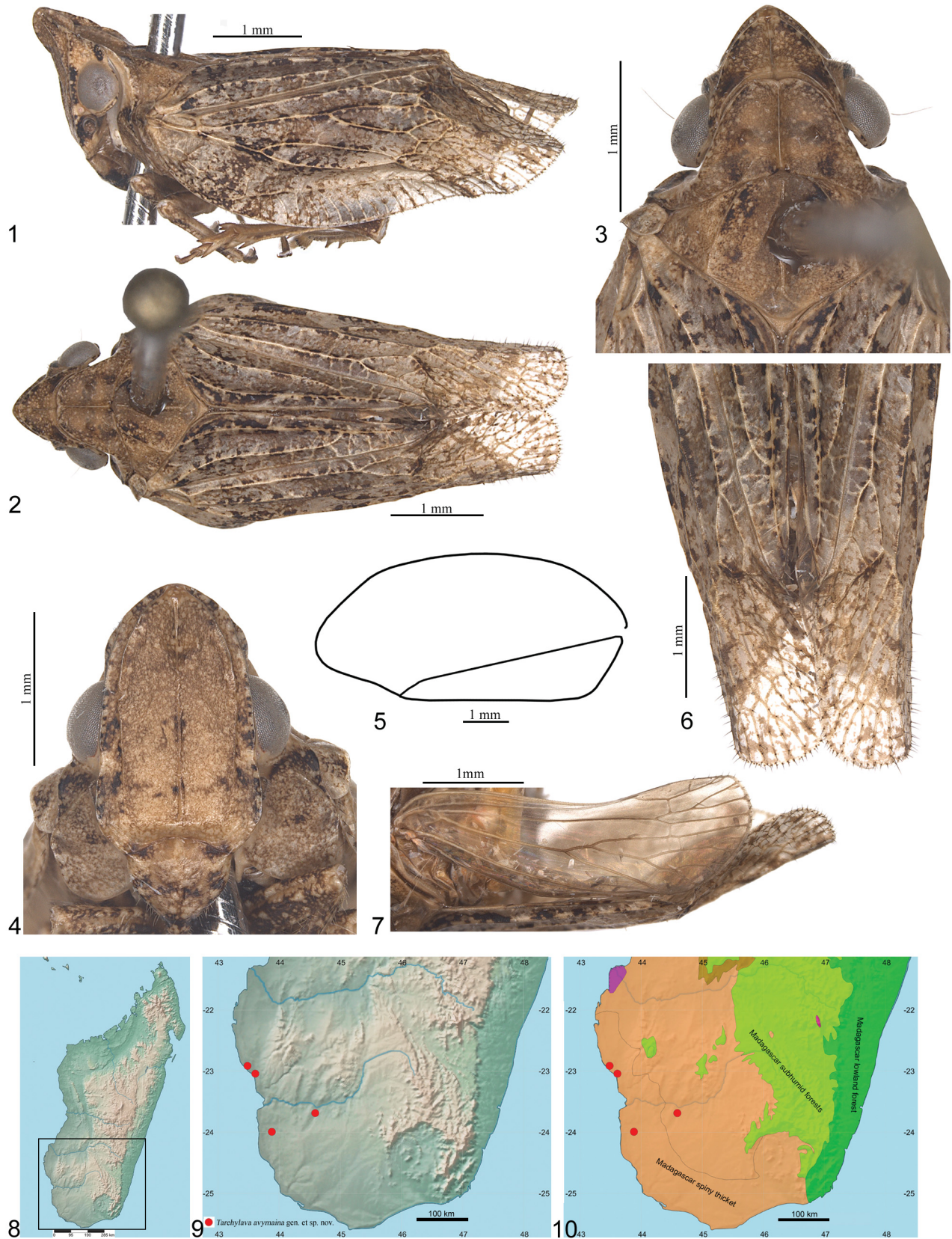
Type species. *Tarehylava avymaina* sp. nov. (here designated).

Diagnosis. *Tarehylava* gen. nov. differs from all other known Madagascan genera of Ricaniidae by the following characters: vertex arrowhead-shaped, frons elongate, lateral carinae of frons connected with median carina below upper margin and forming extension; lateral lobes of pronotum with transverse carina; tegmen divided in two parts, venation of posterior part swelling and flattened, with

setae and sensory structures; costal margin of hind wing without precostal cell.

Description. **Head** with compound eyes (in dorsal view) slightly narrower than thorax. Vertex (Figs 2–3, 11–13) distinctly wider at the level of posterior angles than long at midline, arrowhead-shaped, posterior angles placed about the level of midlength of compound eyes; median portion of posterior margin placed before anterior margin of compound eyes; posterior margin strongly elevated medially. Disc of vertex with keel-shape median carina. Frons (Figs 1, 4, 15–19) with all margins well carinated; frons at upper margin distinctly shorter than high at midline, widest at the lower part; lateral margins covering base of pedicel, incised at the level of ocelli. Frontal disc tricarinate, lateral carinae connected with median carina below upper margin of frons and forming extension; area between connection of frontal carinae and upper margin distinctly swollen; all carinae distinctly surpassing half of disc; median carina straight, lateral carinae in a form of horseshoe almost reaching fronto-clypeal suture, lateral carinae of same length or slightly shorter than median carina, all carinae around point of their connection distinctly elevated, keel-shaped. Disc of frons strongly wrinkled. Compound eyes with a very small callus at postero-ventral margin, elongate in dorsal view. Ocelli present. Antenna (Figs 22–24): pedicel barrel-shaped with a slightly wider tip, with functional area (trichoid sensilla type 1 and antennal plate organs) reaching half of segment length on the dorsal and ventral surfaces, small on the lateral surface; plate organs of crenellated type, surrounded by a ring of elevated spines. Clypeus (Figs 4, 15, 20) distinctly narrower than frons, with median carina well visible in lower part. Rostrum with apical segment slightly shorter than subapical one, reaching hind coxae.

Thorax. Pronotum (Figs 1–3, 11–13) distinctly longer than vertex at midline; disc of pronotum with elevated median carina and two lateral impressions; lateral lobes of pronotum with fully developed postocular transverse carinae, reaching both margins; anterior margin of pronotum placed before the line of anterior margin of compound eyes. Mesonotum (Figs 1–3, 11, 30) about as long as combined length of vertex and pronotum at midline and wider in lateral angles than long at midline; disc of mesonotum tricarinate with median carina and lateral carinae present; antero-lateral carinae absent; median carina and lateral carinae separated basally, subparallel; median carina reaching scutellum, lateral carinae reaching posterior margin; lateral angles placed before midlength. Hind legs (Figs 25–28). Metatibia distinctly longer than metafemur, not widened at distal part; metatibia in basal half with two remnants of lateral spines weakly visible in some specimens, two well-developed lateral spines placed distally to each other in distal half, and apical row of well-developed teeth (2+5, 7), different in size and forming irregular line; lateral spines of equal size, larger than internal. Metatarsus with basitarsomere about as long as cumulative length of second and third tarsomeres, with asymmetrical V-shaped row of 9–10 teeth: two lateral teeth different in size, external lateral spine larger than internal lateral one which is similar in size to intermediary spines; each internal tooth

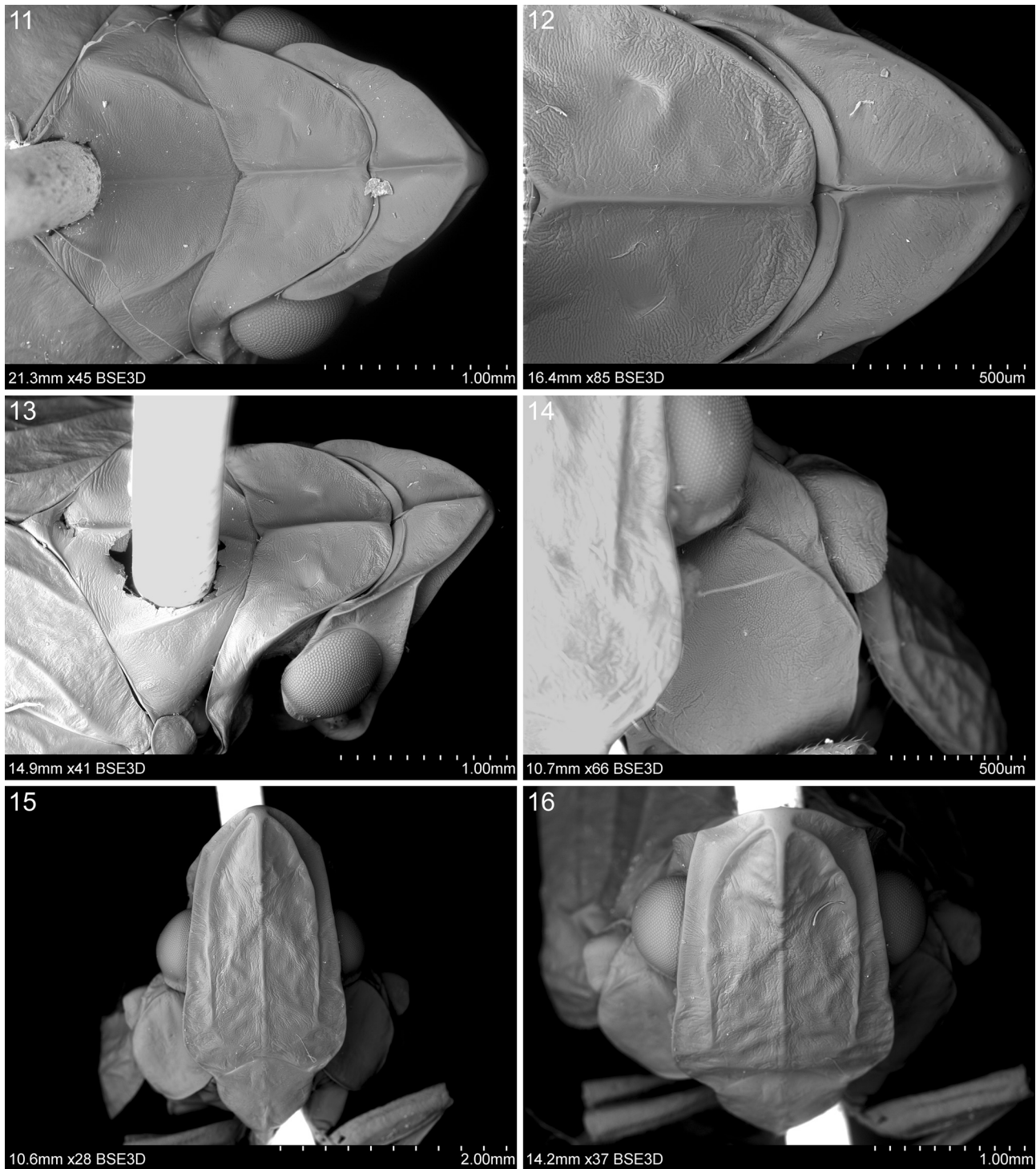


Figs 1–10. *Tarehylava avymaina* gen. & sp. nov. 1 – habitus, lateral view; 2 – same, dorsal view; 3 – anterior part of body, dorsal view; 4 – same, ventral view; 5 – tegmen, outline; 6 – posterior part of tegmina, dorsal view; 7 – hind wing; 8 – Madagascar, physical map, with area enclosed by the black square enlarged in Figs 9 and 10; 9 – distribution of *T. avymaina* gen. & sp. nov. in Madagascar (red points); 10 – same, ecoregions.

bearing strong seta; mesotarsomere with pad of strong setae on ventral side.

Tegmina (Figs 1–2, 6, 29–40) elongate, semi-convex in basal part, partly coriaceous basally to the level of clavus apex, posterior part of tegmen from the level of clavus apex membranous, partially flexible; tegmina with distinct venation and transverse veinlets, venation of posterior part swelling and flattened, with setae and sensory structures. Costal margin arcuate, apical angle broadly rounded, posterior margin tapered with rounded tip (Fig. 5); tornus

(postclaval margin) present and weakly concave. Costal area with dense transverse veinlets, ending at the level of clavus apex; very narrow basally (to 1/3 of length), distinctly wider (also wider than costal cell) more posteriorly. Costal cell with irregular net of transverse veinlets in basal part. Basal cell elongate, narrow, distinctly longer than wide (about 3 times). Longitudinal veins ScP+RA, MP and CuA leaving basal cell separated; all first forks of longitudinal veins placed distinctly before half of tegmen; veins ScRA and RP arising as long common stem from

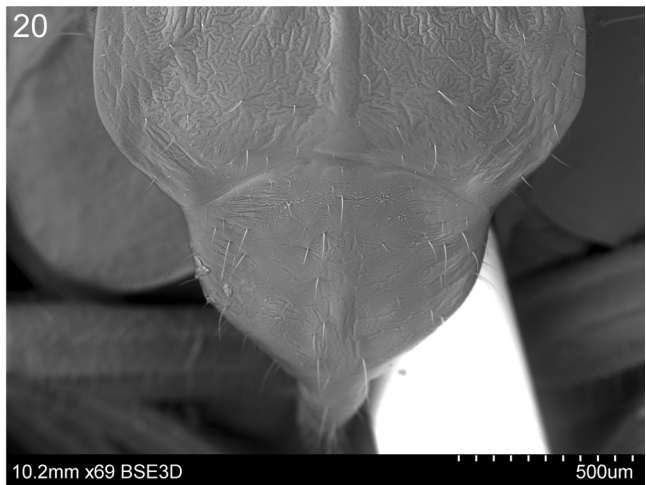
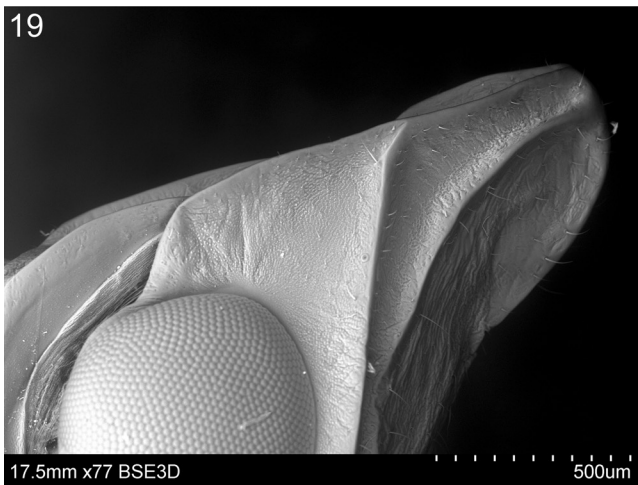
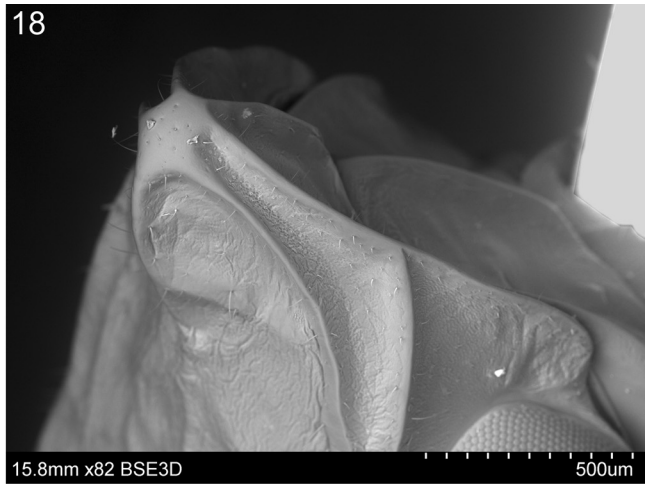
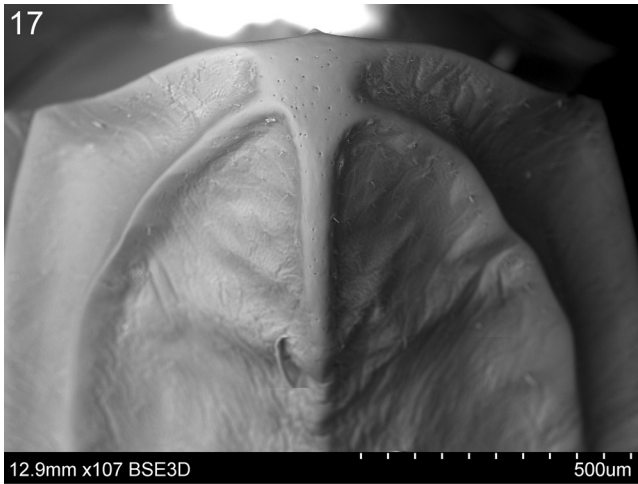


Figs 11–16. *Tarehylava avymaina* gen. & sp. nov., SEM micrographs. 11 – anterior part of body, dorsal view; 12 – vertex and pronotum, dorsal view; 13 – anterior part of body, dorso-lateral view; 14 – lateral lobes of pronotum, frontal view; 15 – frons and clypeus, frontal view; 16 – same, oblique dorso-frontal view.

basal cell; first fork placed before first fork of MP; first fork of MP placed before or almost at claval connection (never extending beyond this level); Cu stem always longer than MP stem with first fork at the level of claval connection or more posteriorly. Nodal line absent. Cubital cell with transverse veinlets (weakly visible in some specimens). Clavus closed; CuP ending at margin, claval veins (Pcu and A1) fused distinctly after midlength of CuP; posterocubital cell (basal and posterior parts), postcubital and anal cells

with transverse veinlets, transverse veinlets of postcubital and anal cells weakly visible in some specimens.

Hind wing (Fig. 7) shorter than tegmina, with posterior margin reaching midlength of the area between tip of clavus and posterior margin of tegmina; anterior margin without precostal cell; ScRA and MP forking distinctly after midlength of wing in distal part, first fork of MP slightly more distad than ScRA but both close each other, CuA forking approximately at wing midlength; ScRA with

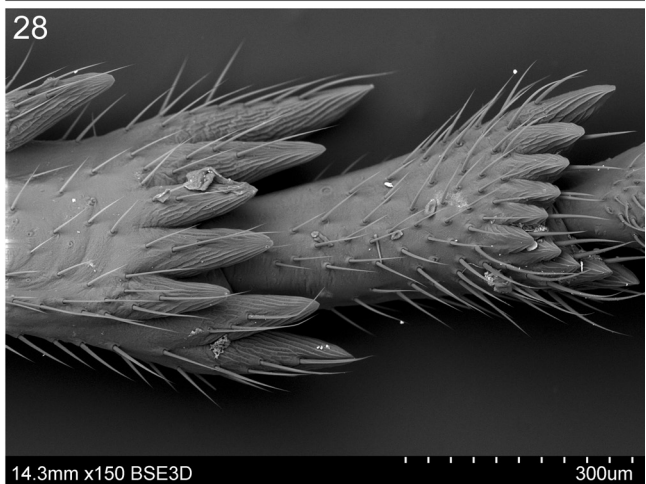
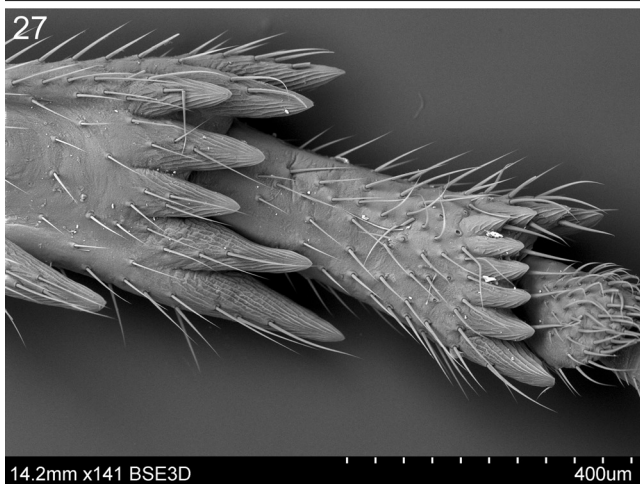
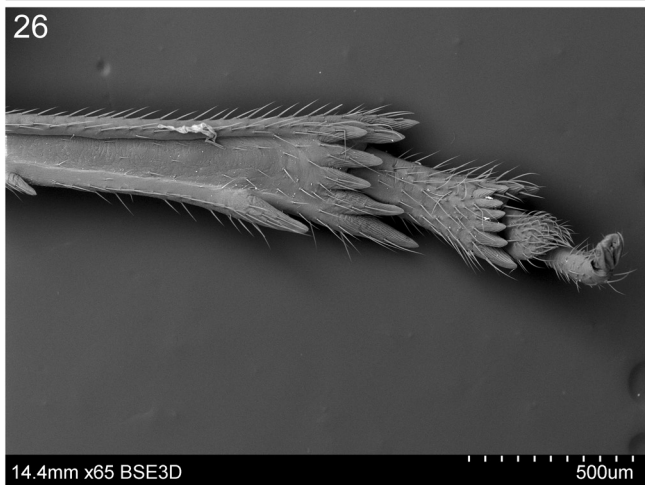
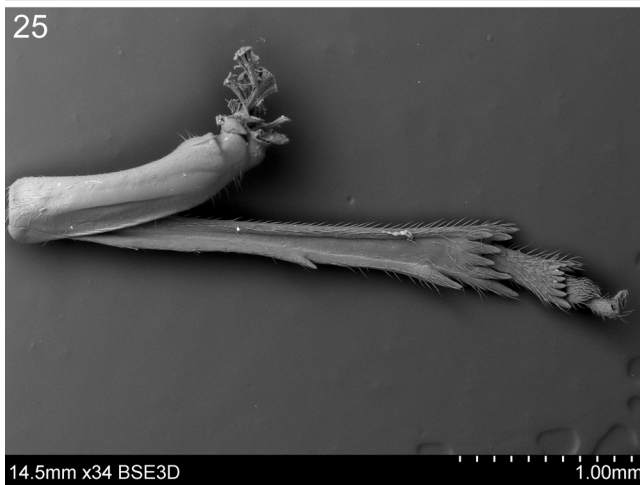
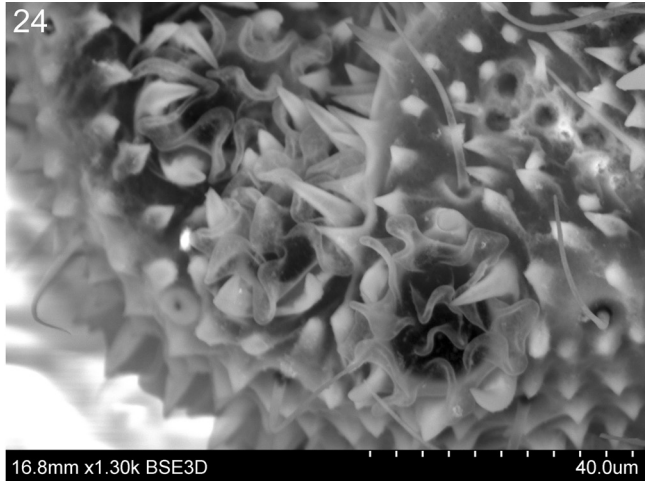


Figs 17–22. *Tarehylava avymaina* gen. & sp. nov., SEM micrographs. 17 – connection of frontal carinae, frontal view; 18 – same, fronto-lateral view; 19 – upper part of head, lateral view; 20 – lower part of frons and clypeus, frontal view; 21 – lower parts of head and pronotum, lateral view; 22 – antenna, dorso-frontal view.

single terminal, RP with 2–3, MP with 3–4, CuA with 6–7 terminals; *rp-m*, *m-cua* (1–2) and *icu* (1–4, variable character) transverse veinlets present in distal part of wing.

Female terminalia (Figs 41–63). Pregenital sternite (Figs 46–48, 54, 58) with well-developed, elongate-oval and distinctly separated lateral lobes; median part of pregenital sternite narrow, anterior and posterior margins almost straight medially; posterior margin without any process. Anal tube in lateral view (Figs 41–42, 55, 57), elongate, not extending beyond the midlength of upper margin of gonoplac; basal part of anal tube distinctly wider than posterior one; anal

opening, in dorsal and lateral views, placed before midlength; anal tube, in dorsal view (Figs 44–45, 53), elongate ovoid, wider at midlength; anal style (paraproct) and anal segment (epiproct) short, not extending beyond posterior margin of anal tube. Gonoplac (Figs 41–43, 46, 49–52, 55, 59) well developed, unilobate, laterally flattened; posterior margin of the gonoplac with single row of well-developed teeth placed alongside apical part of dorsal margin and upper half of posterior margin; membranous parts of gonoplac in two parts: first part narrow, weakly sclerotized, placed on lower part of posterior margin below teeth, second part large,



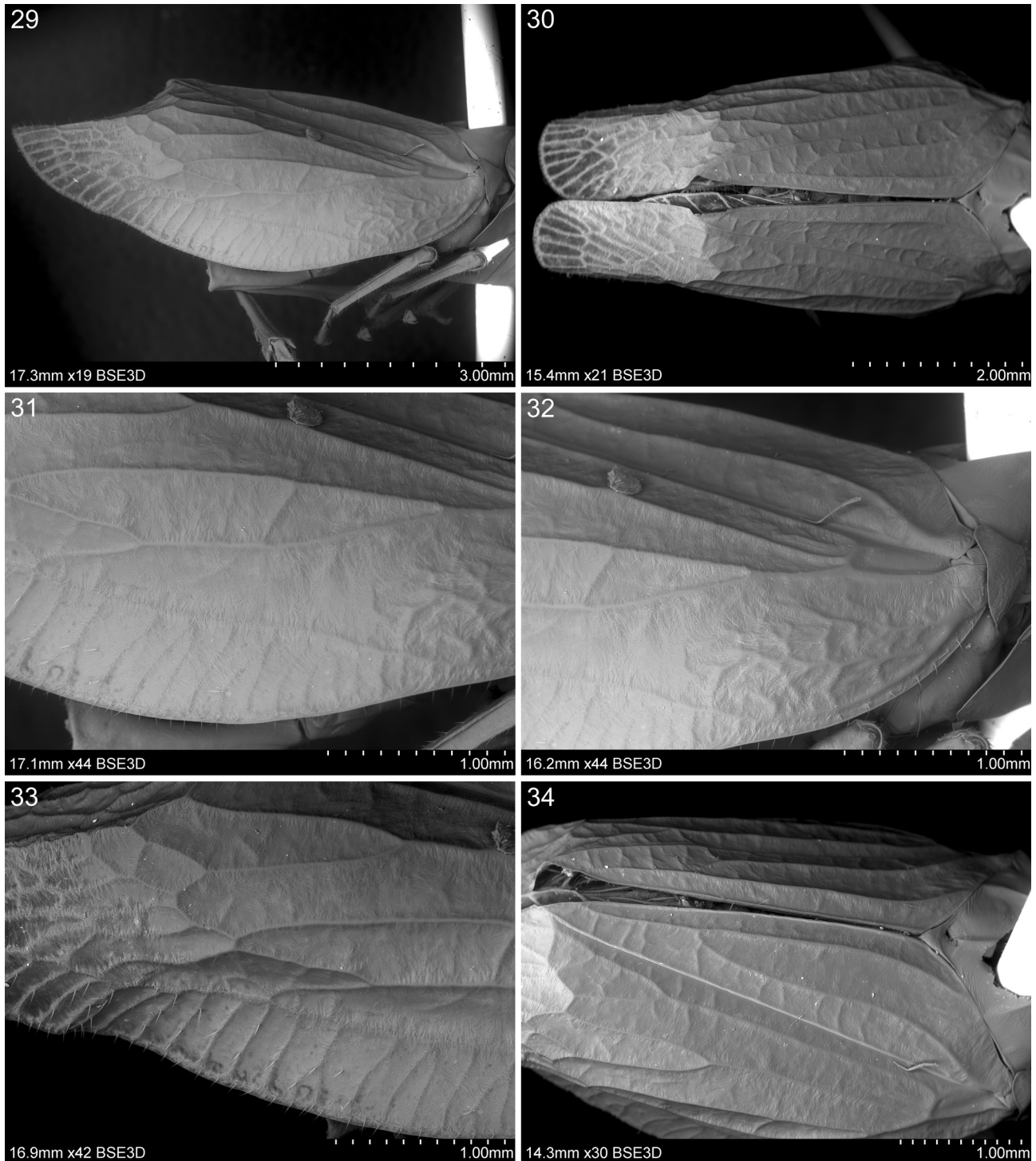
Figs 23–28. *Tarehylvava avymaina* gen. & sp. nov., SEM micrographs. 23 – apex of antenna; 24 – antennal plate organs; 25 – hing leg, ventral view; 26 – distal part of hind tibia and tarsus, ventral view; 27–28 – apical part of hind tibia and basimetatarsomere, ventral view.

fully membranous, placed ventro-basad of the gonoploc. Gonapophysis VIII (Fig. 60) elongate, sabre-like, V-shaped in cross section, with teeth at posterior part of dorsal margin; endogonocoxal process tapering apicad, slightly shorter than gonapophysis VIII, with median sclerotized belt surrounded by membranous part. Gonapophyses IX and gonospiculum bridge well developed as in Figs 61–62. Bursa copulatrix with two pouches connected with short ductus; first pouch elongate, with cells and sclerotized ornamentation (except dorsal part), with sclerotized plate with very large median sclerite and 5–8 small petals around; second pouch elonga-

te-oval, smaller than first one, without cell but with sclerotized plates. Spermatheca (Fig. 63) well-developed; ductus receptaculi elongate and narrow, ribbed; diverticulum ductus with two parts (about the same length), distinctly longer (about twice) than ductus receptaculi, with long, narrow, smooth basal ductus, and long, smooth, wider apical ductus.

Male. Unknown.

Etymology. The generic name *Tarehylava* is a combination of two Malagasy words: “tarehy” (= face) and “lava” (= long), which refers to the characteristic prolongation of the frons. Gender feminine.



Figs 29–34. *Tarehylava avymaina* gen. & sp. nov., tegmen, SEM micrographs. 29 – lateral view; 30 – tegmina, dorsal view; 31 – median part of tegmen; 32 – basal part of tegmen; 33 – apical part of costal area and costal cell; 34 – clavus.

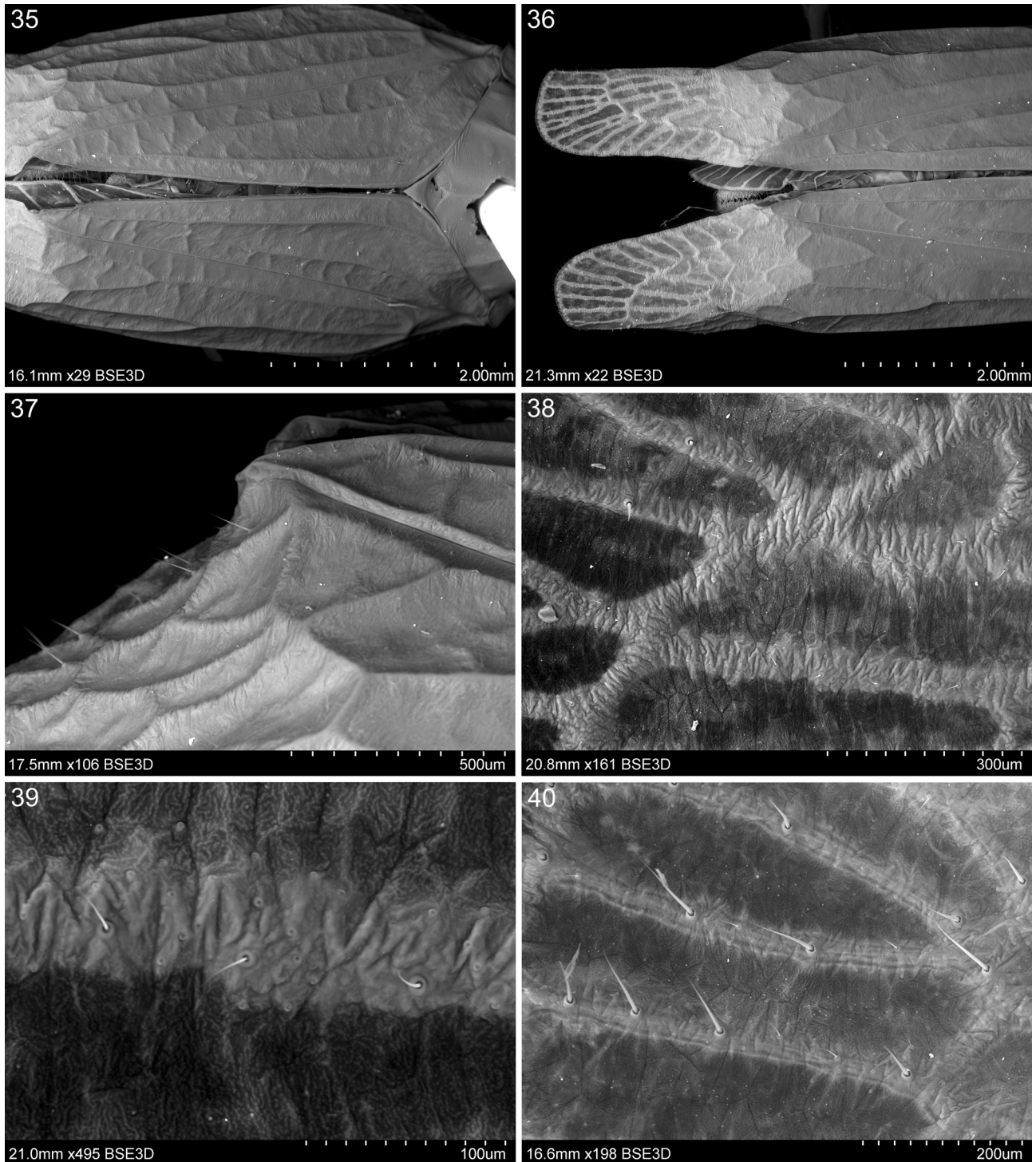
Distribution. South-western Madagascar: Atsimo-Andrefana region (Figs 8–10).

***Tarehylava avymaina* sp. nov.**

(Figs 1–7, 11–63)

Type material. HOLOTYPE: ♀, [MADAGASCAR: Toliara / Prov, Lake Ranobe, / 23°02.468' S, 43°36.607' E / elev 30 m, 25–31 April 2003 / California Acad. of Sciences], [colls: Frontier Wilderness / Project, malaise trap, spiny/forest/ tamarind forest near / lake edge code: MGF066], [CASENT 3008293] (CAS). PARATYPES: 1 ♀, [MADAGASCAR: Toliara Prov. / Parc National de Tsimanampetsotsa, / Forêt de Bemanateza, 20.7

km / 81° E Efoetse, 23.0 km 131°SE / Beheloka, 22–26 March 2002], [23°59'32"S 43°52'50" E / Fisher, Griswold et al. / California Acad of Sciences / malaise trap - in spiny forest / thicket, elev 90 m BLF6257], [CASENT / 8078826] (CAS); 1 ♀, [MADAGASCAR: Tulear / Province, Mikea Forest, / NW of Manombo, elev. 37 m, / 22°54.80 S 43°28.93'E / 6–19 August 2002], [coll: M. Irwin, R. Harin'Hala / California Acad of Sciences / malaise trap, spiny forest MA-02-18B-30], [CASENT / 8108670] (CAS); 1 ♀, [MADAGASCAR: Tulear / Province, Beza Mahafaly / Reserve, Parcelle 1 near / research station / 10 March – 21 April 2003, 23°41.19'S 44°35.46'E], [California Acad of Sciences / coll. R. Harin'Hala, malaise / trap in dry deciduous forest / elev 165m, MA-02-14A-56], [CASLOT 038523] (MZPW).



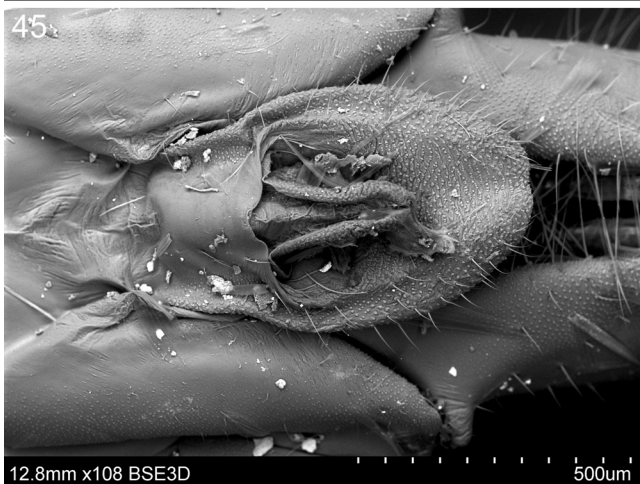
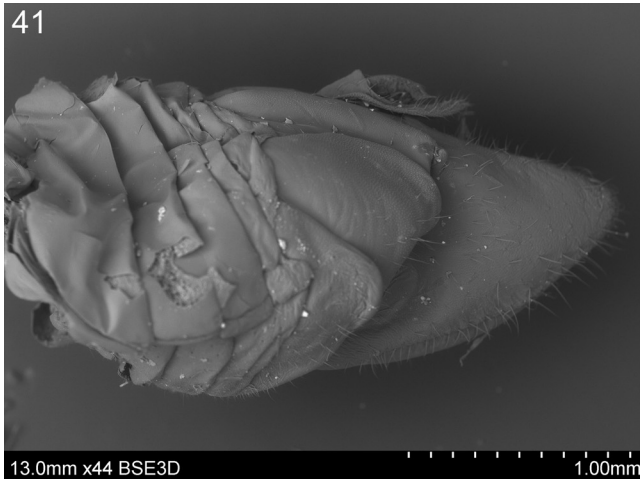
Figs 35–40. *Tarehylava avymaina* gen. & sp. nov., tegmen, SEM micrographs. 35 – clavus, dorsal view; 36 – apical part of tegmina, dorsal view; 37 – apex of clavus and margin between coriaceous and membranous parts of tegmen; 38–40 – details of venation of membranous part.

Diagnosis. See Diagnosis for the genus.

Description. Measurements and shapes. Total length 0.84–0.90 cm. Vertex: $A_p/B = 0.48\text{--}0.51$; anterior margin strongly arcuate; posterior margin weakly arcuate. Frons: $C/E = 0.41\text{--}0.47$; $D/E = 0.64\text{--}0.67$. Pronotum: $F/B = 1.20\text{--}1.47$; anterior margin strongly arcuate, in median portion flattened with small concavity medially; posterior margin weakly concave (Fig. 12). Mesonotum: $G/F+B = 0.98\text{--}1.03$, $G/F = 1.64\text{--}1.87$, proportion $G/H = 0.68\text{--}0.71$. Tegmina: $I/J = 2.77\text{--}2.90$.

Female terminalia. Anal tube: apical margin (in dorsal view, Figs 45, 56) arcuate with small concavity medially; ventral margin (in lateral view, Figs 42, 57) almost straight.

Coloration (specimens originally preserved in alcohol). General coloration from light brown to brown with irregular dark patches. Female abdominal tergites, pregenital sternite and anal tube all light brown. Sternites brown with light narrow band alongside posterior margin; gonoplac dark brown with brown-yellow posterior margin.



Figs 41–46. *Tarehylava avymaina* gen. & sp. nov., female abdomen and terminalia, SEM micrographs. 41 – lateral view; 42 – anal tube, lateral view; 43 – gonoplac, lateral view; 44 – dorsal view; 45 – anal tube, dorsal view; 46 – ventral view.

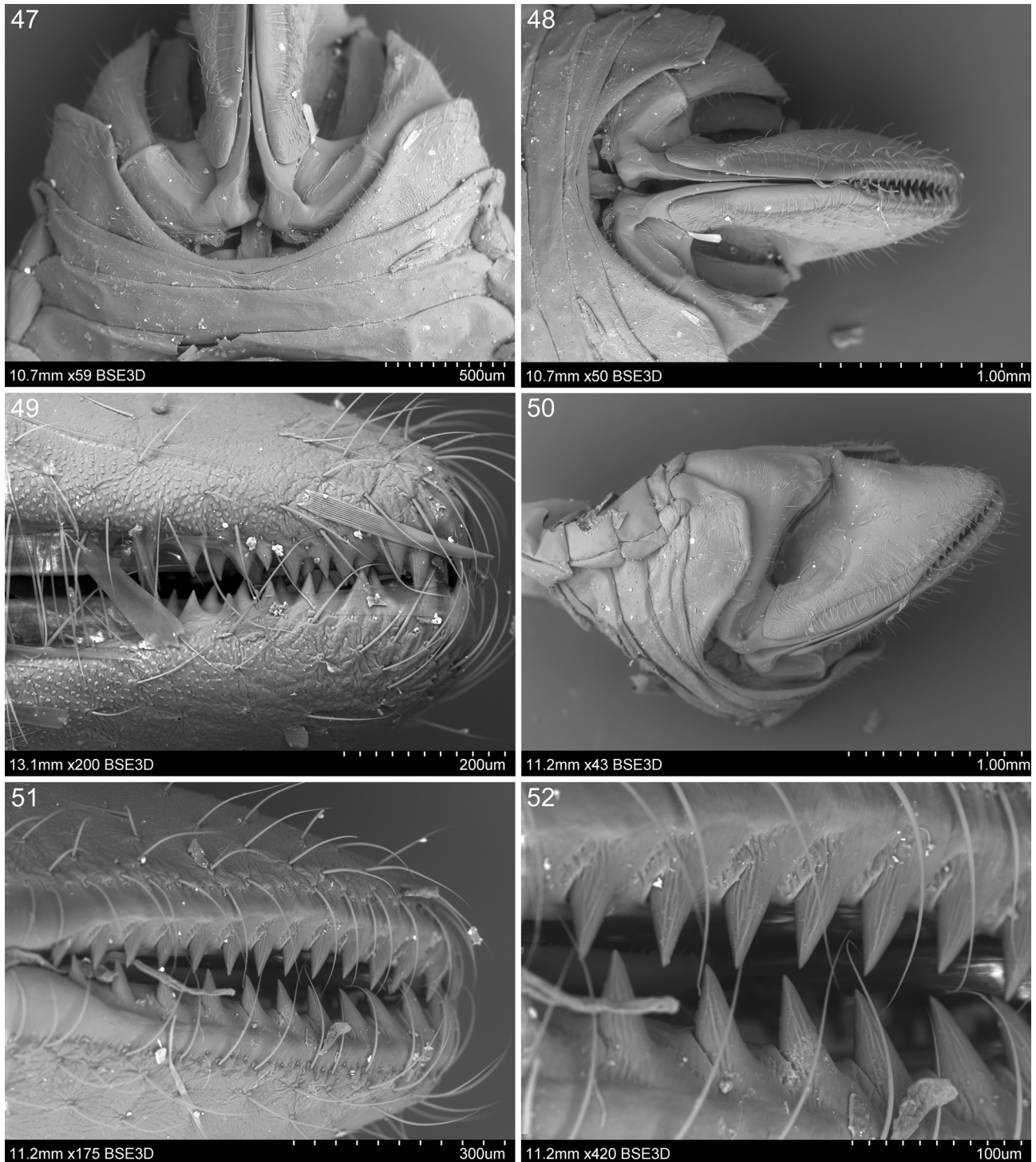
Etymology. The specific name *avymaina* is a combination of two Malagasy words: “avy” (= from) and “maina” (= dry). It refers to the distribution of the species in a dry region of southwestern part of Madagascar, covered with spiny forests.

Distribution. Madagascar, Atsimo-Andrefana region: Toliara I, Toliara II and Betioky-Atsimo districts (Figs 8–10).

Discussion

The new genus displays numerous morphological character states, so far unknown among the Ricaniidae, such as

the head with an arrow-shaped vertex, elongate frons and the connection of frontal carinae below the upper margin of frons. Furthermore, characters of the pronotum (lateral lobes with a transverse carina) and the tegmen (divided in two parts: a basal, coriaceous part and an apical, membranous part, with swelling and flattened veins bearing setae and sensory structures) also indicate its uniqueness within the family. The usual diagnostic characters for the Ricaniidae include the following: vertex transverse (subrectangular); frons about as long as wide, with frontal carinae separated at base or connected basally; tegmen

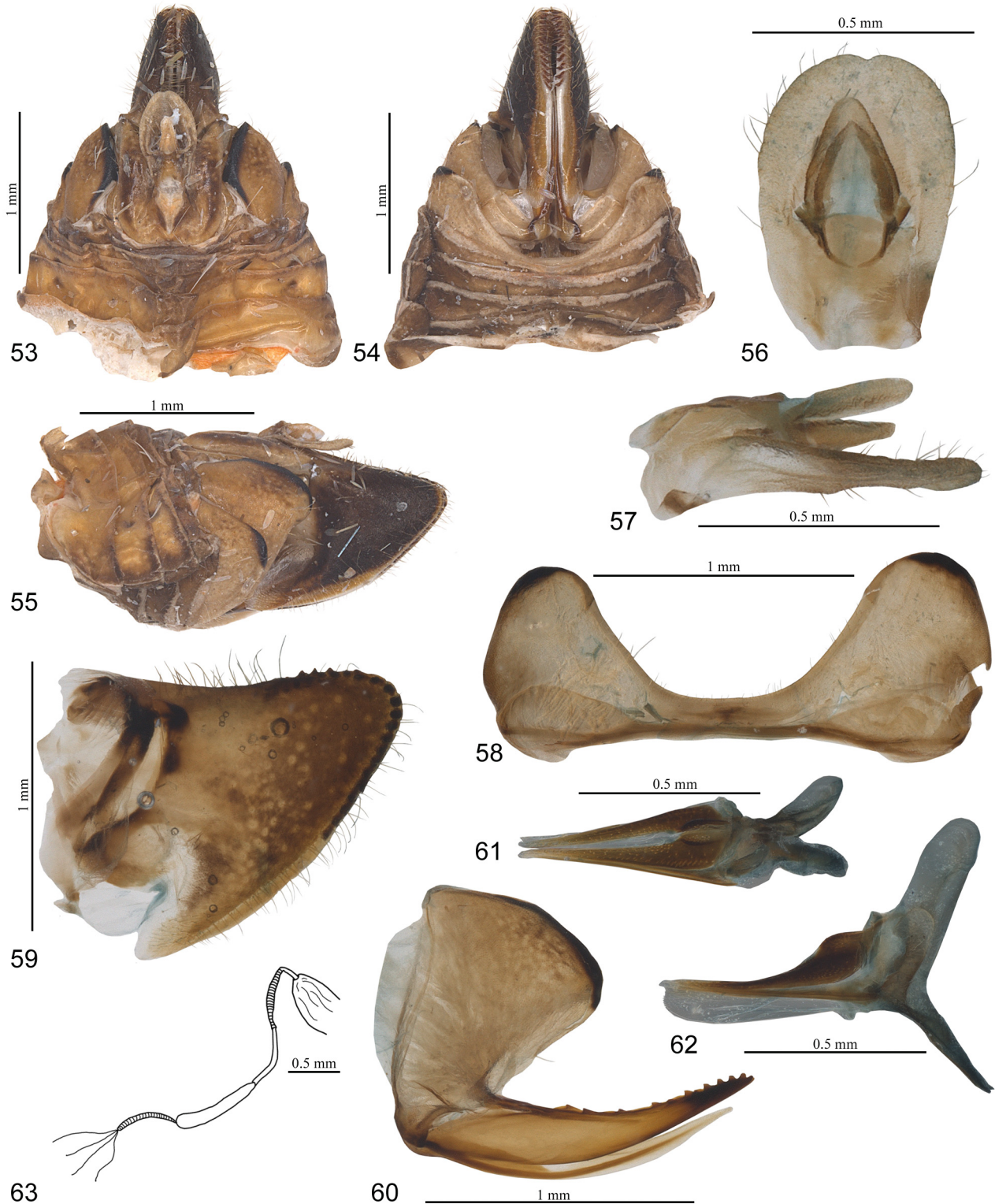


Figs 47–52. *Tarehylava avymaina* gen. & sp. nov., female terminalia, SEM micrographs. 47 – pregenital sternite, ventral view; 48 – terminalia, ventral view; 49 – apex of gonoplac, dorsal view; 50 – terminalia, dorso-lateral view; 51 – posterior margin of gonoplac; 52 – teeth on posterior margin of gonoplac.

membranous (in most genera) or coriaceous (in some Madagascan taxa: STROIŃSKI et al. 2011) but never divided in two parts; and tegmen veins without sensory structures. An irregular net of veinlets in postcostal cell and irregular costal area present in *Tarehylava* gen. nov. could suggest some relationship with the genus *Pochazoides* Signoret,

1860 but a much deeper study is necessary to confirm this.

Despite its unusual morphological characters and intensive explorations of Madagascar over the period of the last few decades, *Tarehylava avymaina* gen. & sp. nov. is known only from four female specimens collected in 2002 and 2003. This may be the result of cryptic behavior



Figs 53–63. *Tarehylava avymaina* gen. & sp. nov., female abdomen and terminalia. 53 – abdomen, dorsal view; 54 – same, ventral view; 55 – same, lateral view; 56 – anal tube, dorsal view; 57 – same, lateral view; 58 – pregenital sternite; 59 – gonoplac, lateral view; 60 – gonapophysis VIII and endogonocoxal process, lateral view; 61 – gonapophyses IX and gonospiculum bridge, dorsal view; 62 – same, lateral view; 63 – spermatheca. Figs 53 – 55 were taken of the dry abdomen, Figs 56–62 after its maceration in KOH.

or *T. avymaina* gen. & sp. nov. may represent a rare species. The considerable distance between the four known localities may be indicative of a relatively large area of distribution, which further reflects our weak knowledge on the Madagascan planthopper fauna in general. All records of *T. avymaina* gen. & sp. nov. are located within the spiny forest ecoregion (also known as the Madagascar spiny thickets: CROWLEY 2004). Some information on this area was presented by ŚWIERCZEWSKI & STROIŃSKI (2019), who also described a new taxon of Flatidae, *Lembakaria saintemarieae* Świerczewski & Stroiński, 2019, from the same region. Two of the localities (Mikea Forest and Parcelle 1) are shared by both taxa. This further indicates how important it is to intensify field and taxonomic work in the extremely endangered ecosystems of Madagascar.

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