



The American species of the genus *Glaucolepis* Braun, 1917 (*Neotrifurcula* van Nieukerken, syn. nov.) (Lepidoptera: Nepticulidae)

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Abstract

We provide diagnostic characters for the genus *Glaucolepis* Braun, re-examine the type series of the type species of the North American *G. saccharella* Braun, describe two new species from Chile and Argentina (*G. flagellata* Remeikis & Stonis, **sp. nov.** and *G. pseudoflagellata* Remeikis & Stonis, **sp. nov.**), and provide the first photographic documentation of the central Andean *G. aerifica* (Meyrick). We synonymize *Neotrifurcula* van Nieukerken, 2016, **syn. nov.** with *Glaucolepis* and provide one new combination for the south Andean *G. gielisorum* (van Nieukerken, 2016), **comb. nov.** All species treated in the paper are illustrated with drawings and (or) photographs of the adults and genitalia.

Key words: American fauna, Argentina, Chile, *Glaucolepis* Braun, *Glaucolepis aerifica*, *Neotrifurcula*, Nepticulidae, new species

Introduction

Glaucolepis Braun is probably among the most distinctive, easily recognizable, and best defined genera of the Nepticulidae family. It was described by Annette F. Braun in 1917 as a monotypic genus with a single species *Glaucolepis saccharella* feeding on maple. Thus, this is the 100-year anniversary of the genus. In some of the literature *Glaucolepis* (= *Fedalmia* Beirne, 1945, synonymized by Puplesis 1985) has been recognized and presented as a separate, “good” genus (ie. not as a subgenus), e.g. by Wilkinson & Scoble (1979); Puplesis (1985, 1992, 1994); Puplesis *et al.* (1996); Puplesis & Robinson (2000); Puplesis & Diškus (2003); Diškus & Puplesis (2003); Navickaitė *et al.* (2011, 2014a, b); Stonis *et al.* (2016, 2017); Remeikis (2017). In some other publications *Glaucolepis* (= *Fedalmia* Beirne) was treated as a subgenus of *Trifurcula* Zeller, 1848 (e.g., Scoble 1983; van Nieukerken 1986a, b; Johansson *et al.* 1990; Laštůvka & Laštůvka, 2000; van Nieukerken *et al.* 2004; Laštůvka *et al.* 2007, 2013; Ivinskis *et al.* 2012). Recently, *Neotrifurcula* van Nieukerken, 2016, was erected (van Nieukerken *et al.* 2016b) based on the species *N. gielisorum*. This species possesses identical wing venation to *Glaucolepis* species and also shares the most important diagnostic characters of the genitalia of *Glaucolepis*. The simultaneously published molecular research (Doorenweerd *et al.* 2016) did not provide clarity with respect to the newly erected *Neotrifurcula* (see Discussion).

Currently, *Glaucolepis* comprises 42 named species worldwide: from the Americas, ie. the Western Hemisphere (Braun 1917; Wilkinson & Scoble 1979; Puplesis & Robinson 2000; Puplesis *et al.* 2002; Stonis *et al.* 2016, 2017); Europe, reaching the highest diversity in the Mediterranean (e.g. Chrétien 1904, 1907, 1914; Parenti 1963; Klimesh 1975, 1978, 1979; Johansson *et al.* 1990; van Nieukerken & Puplesis 1991; Puplesis 1994; Laštůvka & Laštůvka 1997, 1998, 2007; van Nieukerken *et al.* 2004, 2013; Laštůvka *et al.* 2013; Navickaitė *et al.* 2014a, b); North Africa (Chrétien 1914, 1915); Asia (Puplesis 1985; van Nieukerken & Puplesis 1991; Puplesis 1994; Puplesis *et al.* 1996; Diškus & Puplesis 2003), including one species from southwestern India (Diškus &

Puplesis 2003); and South America (Puplesis & Robinson 2000; Puplesis *et al.*, 2002; van Nieuwerkerken *et al.* 2016a; Stonis *et al.* 2016, 2017), including two new species described from Argentina and Chile in this paper. Doorenweerd *et al.* (2016) stated that more new species could possibly occur in East Asia and other regions.

One *Glaucolepis* species, *argentosa* Puplesis & Robinson, 2000, is excluded from the genus in this paper, and will be discussed in a separate publication (Stonis *et al.*, *in prep.*) with novel morphological characters.

Material and methods

The majority of the material used for this study are deposited in the Zoological Museum, Natural History Museum of Denmark, Copenhagen, and the National Museum of Natural History, Smithsonian Institution, Washington D.C., U.S.A., collected from 1978 to 1981 in Argentina by E. S. Nielsen and O. Karsholt, and in Chile by Donald and Mignon Davis, B. Akerbergs, and L. Peña. Additionally, the type series of *G. saccharella* was received and studied from The Academy of Natural Sciences, Philadelphia, USA.

Methods and protocols for species identification and description are outlined in Puplesis (1994), Puplesis & Robinson (2000), Puplesis & Diškus (2003), and Stonis *et al.* (2016).

High intensity, daylight illumination was used and specimens were rotated under this light to ascertain the ground color and reflection of the adult scaling.

Preparation of temporary and permanent micro-mounts of genital structures were undertaken following the method according to Stonis *et al.* (2014). After maceration of the abdomen in 10% KOH and subsequent cleaning, abdominal pelts and female genitalia were stained with Chlorazol Black (Direct Black 38/Azo Black), and male genitalia were left unstained. The male genital capsules were removed from the abdomen and mounted ventral side uppermost. The phallus was severed from the genital capsule. Both male and female genitalia were mounted in Euparal.

Permanent slides were photographed and studied using a Leica DM2500 microscope and Leica DFC420 digital camera.

The descriptive terminology of morphological structures follows Johansson *et al.* (1990) and Puplesis & Robinson (2000), except for the term "aedeagus", which is referred here as "phallus" and the term "cilia", which is referred here as "fringe".

Institutional abbreviations used in the text:

ANSP—The Academy of Natural Sciences of Drexel University, Philadelphia, U.S.A.;

BMNH—The Natural History Museum, London, United Kingdom;

RMNH—Naturalis Biodiversity Center, Leiden, The Netherlands;

USNM—United States National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.;

ZMUC—Zoological Museum, University of Copenhagen, Denmark.

Diagnostics of *Glaucolepis* Braun, 1917 and the *flagellata* species group

Glaucolepis Braun, 1917: 201.

Type species: *Nepticula saccharella* Braun, 1912: 97.

Fedalmia Beirne, 1945: 207. The synonymy suggested by R. Johansson (unpublished), discussed in Scoble (1983) and provided by Puplesis 1985: 11.

Type species: *Nepticula headleyella* Stainton, 1854: 298.

Sinopticala Yang, 1989: 79, 81. The synonymy by van Nieuwerkerken & Puplesis 1991: 202.

Type species: *Sinopticala sinica* Yang, 1989: 80, 82.

Neotrifurcula van Nieuwerkerken, 2016; in van Nieuwerkerken *et al.* 2016b: 36, 37, **syn. nov.**

Type species: *Neotrifurcula gielisorum* van Nieuwerkerken, 2016; in van Nieuwerkerken *et al.* 2016b: 38, 39.

There are many shared characters that support the status of *Glaucolepis* as a well-defined, monophyletic genus. A revised list of diagnostic characters for *Glaucolepis* is given in Fig. 1; many of these characters are hypothesized to be apomorphic. Like other genera of Nepticulidae, the genus cannot be recognized by external characters such as forewing pattern, which in this genus is variable across species. In the genitalia, the most distinctive characters are

the long, rod-like sclerite of the phallus (which is expressed differently in various species, from an elongated cornutus to a flagellum-like sclerite) (Figs 25–34), the apical spines near the phallotrema (possibly reduced in the *raikhonae* group), and the coiled ductus spermathecae (Fig. 1), a structure that appears to be of diagnostic value in the Nepticulidae. The combination of characters listed in Figure 1 distinguishes this genus from all other genera of Nepticulidae. As is common in the Nepticulidae, morphology of head and leg structures (Figs 2–7) do not exhibit anything with taxonomic value. However, the wing venation (Figs 8–18) appears to contribute a strong diagnostic character: a trifurcate Rs+M in the hindwing venation is shared with the closely related *Trifurcula* Zeller, while Rs+M is bifurcate in all other Nepticulidae.

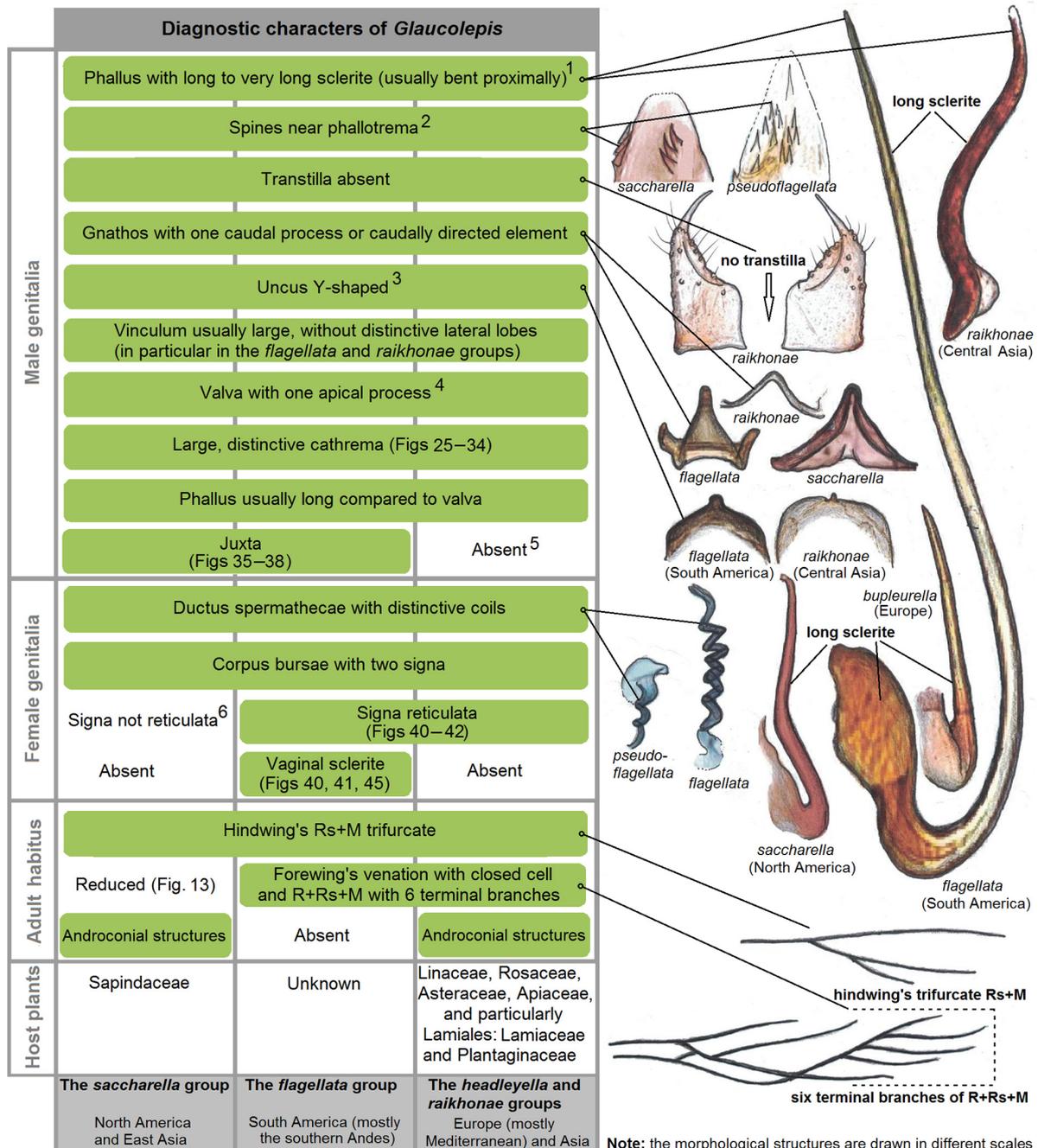


FIGURE 1. Diagnostics of *Glaucolepis* Braun (Notes: 1—it represents a cornutus, only a very few species have an additional cornutus and additional tiny, spine-like cornuti; 2—apical spines absent only in the Asian *raikhonae* group (see Discussion), possibly reduced; 3—uncus varied but in general always Y-shaped, particularly extended laterally in the *raikhonae* group; 4—only occasionally the apical process is partially reduced, usually very distinctive; 5—juxta absent or indistinctive in the *headleyella* group but present in the *raikhonae* group (see Discussion); 6—signa in the *saccharella* group are still comparable to some degree to signa in some other *Glaucolepis* (see Discussion).

Larvae are leaf or stem miners. Some European species from the *G. headleyella* group use more than one leaf, which is very unusual for Nepticulidae, and continue the mine from one leaf to another by moving through the petiole or stem (Johansson *et al.* 1990). Trophic relationships are still unknown for a third of the fauna, including all American *Glaucolepis*, except for *G. saccharella*; however, the known host-plant preferences are rather peculiar (listed in Figure 1 and briefly discussed in Dooreneewerd *et al.* 2016). Lamiaceae feeders prevail.

Annette F. Braun described *Glaucolepis* mainly on the basis of external coloration and wing venation (Braun 1917) and did not use genital characters during her early studies (Solis 1990). Sixty-seven years later the genus was illustrated and characterized using genitalia features by Wilkinson & Scoble (1979). However, the most comprehensive characterization of *Glaucolepis*, including numerous European species then assigned to *Fedalmia*, was provided by van Nieukerken (1986a) and Johansson *et al.* (1990), and later only briefly discussed by Puplesis (1994) and Puplesis & Robinson (2000).

The genus consists of at least four distinguishable entities, each with its own diagnostic characters, and referred to as species groups: the *headleyella* group (designated by Puplesis 1994), the *raikhonae* group (designated by van Nieukerken & Puplesis 1991), the *saccharella* group (designated by van Nieukerken *et al.* 2016a), and the *flagellata* group. The *flagellata* group is designated here for the first time.

The diagnostics of the *Glaucolepis flagellata* group are based on male and female genitalia characters. From all other *Glaucolepis*, the group can be distinguished by the presence of a characteristically elaborated vaginal sclerite in the female genitalia. It also differs from all the *Glaucolepis* (including the *saccharella* group and the majority of the *headleyella* group) by the extremely long semi-external rod-like sclerite (cornutus) of the phallus and the absence of androconial structures on wings. From the *headleyella* group, the *flagellata* group differs by the presence of a distinctive juxta in the male genitalia; from most species of the *headleyella* group, usually by a larger vinculum and the absence of the so called “velvet patch” of raised androconial scales on the underside of male hindwing. From the *raikhonae* group, the *flagellata* group differs by the apical spines near the phallotreme of the phallus in the male genitalia; from the *saccharella* group it differs by the presence of CuA vein of the forewing, very elaborated bifid juxta in the male genitalia and reticulate signa in the female genitalia. So far the *flagellata* group is known only from the southern (Patagonian) Andes.

Re-examination of the type series of the type species, *Glaucolepis saccharella* (Braun, 1912)

(Figs 2, 4, 5, 12–16, 19–25, 35, 39)

Nepticula saccharella Braun, 1912: 97.

Glaucolepis saccharella (Braun), in Braun 1917: 201.

Glaucolepis saccharella (Braun), in Wilkinson & Scoble 1979: 105–107.

Material examined. 1 ♀ (lectotype), USA, Ohio, Cincinnati, on *Acer saccharum*, B 406, “Cotype”, collection of Annette F. Braun, female genitalia slide no. 17357 (ANSP); 1 ♂, 2 ♀ (paralectotypes), same locality as lectotype, male genitalia slide no. USNM 16711 by DRD [Donald R. Davis], wing venation slide no. USNM 17127 by DRD (ANSP).

Diagnosis. In the male genitalia, *Glaucolepis saccharella* differs from all other described congeneric species in the combination of a slender apical process of the valva and a bifid gnathos (Figs 22, 35). In the female genitalia, *G. saccharella* differs from all other species by the combination of a spiny ductus spermathecae with 3.5 wide coils and distinct signa (see Fig. 39). Additionally, the host plant, *Acer* spp., and the peculiar androconia on the male adult forewing and hindwing (Figs 47, 48) make this species very distinctive.

Male (Figs 46–48). Forewing length about 2.0 mm; wingspan about 4.4 mm. Hindwing widened (ovate) (for description see Wilkinson & Scoble 1979). In contrast to Wilkinson & Scoble (1979), additionally hindwing with long fuscous brown androconia overlapping the fringe on basal third of the hindwing (Fig. 48); on underside, forewing speckled with dark brown scales over apical half, less distinctive and less abundant pale brown scales over proximal half, and with a large, fuscous brown tuft along dorsum (Fig. 47); hindwing underside brownish cream.

Female (Figs 20, 49, 50). Forewing length 1.8–2.0 mm; wingspan 4.2–4.4. Antenna shorter than half the length of forewing; flagellum dark grey-brown on upper side, brownish cream on underside. Forewing underside brown over apical third, very pale brown over basal two thirds to pale brown over entire length. Hindwing not

ovate, pale brownish grey. Abdomen dark grey-brown on upper side, brownish cream with some golden gloss on underside; genital segments cream on underside; tufts rubbed or absent. Otherwise as in the description by Wilkinson & Scoble 1979.

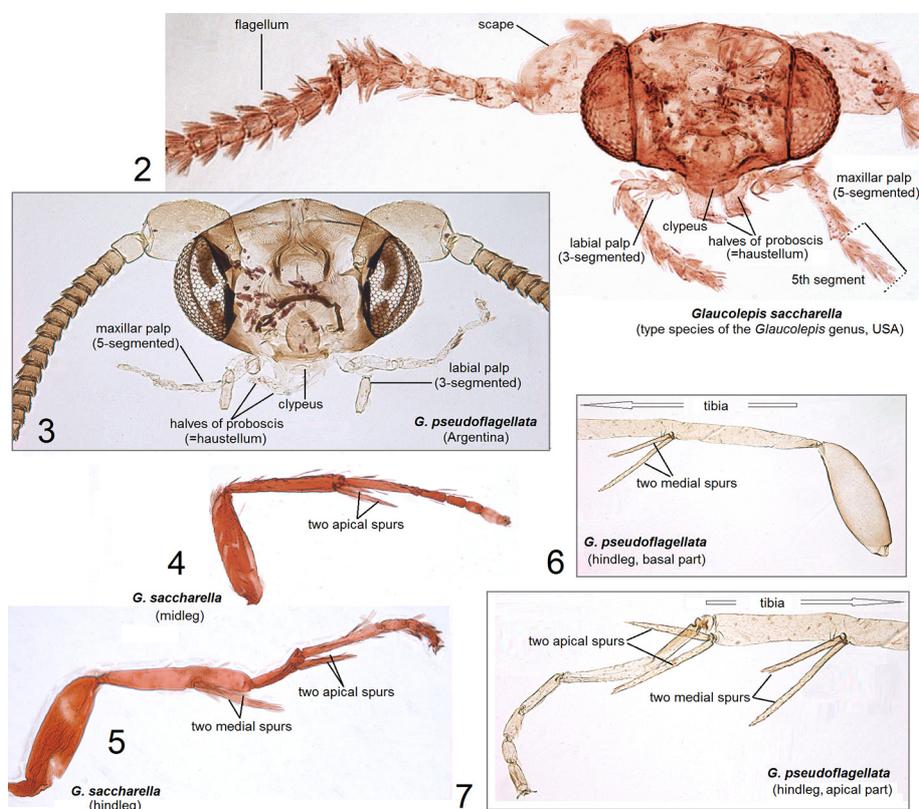
Male genitalia (Figs 22–25, 35). Capsule about 195–200 µm long, 165–170 µm wide. Phallus about 295 µm long, 70–100 µm wide.

Female genitalia (Figs 21, 39). Total length about 880 µm. Without vaginal sclerite. Ductus spermathecae with 3.5 wide coils.

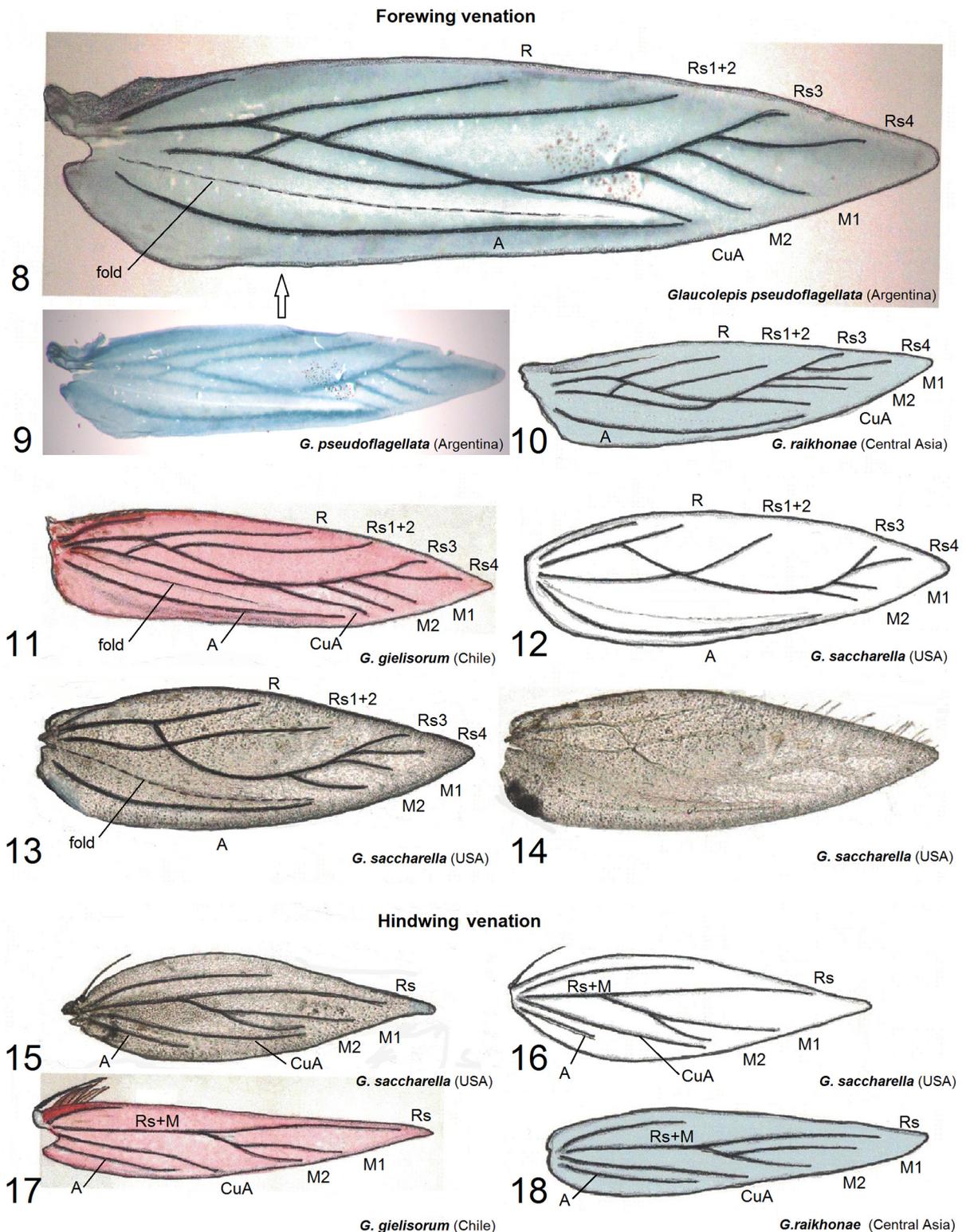
Bionomics. *Glaucolepis saccharella* is a leaf miner producing very long slender (linear) leaf mines (Fig. 19) on *Acer saccharum* Marshall and *A. rubrum* L.; the reference reporting *Quercus rubra* L. (Wilkinson & Scoble 1979) as a host plant appears to be incorrect. Larva pale green; feeds in late September–October; the larva often crosses the mid-rib of the leaf; black frass is deposited at first as a dense but interrupted line and later it is more dispersed (Wilkinson & Scoble 1979). Cocoon ochreous, with a projecting rim around the main body of the cocoon.

Distribution. This species occurs in Northeastern U.S.A., and Ontario, Canada.

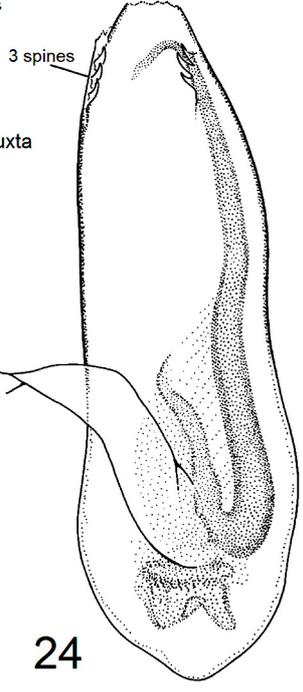
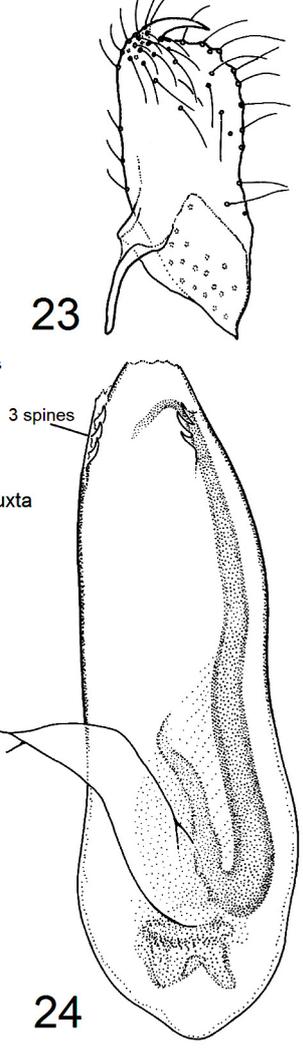
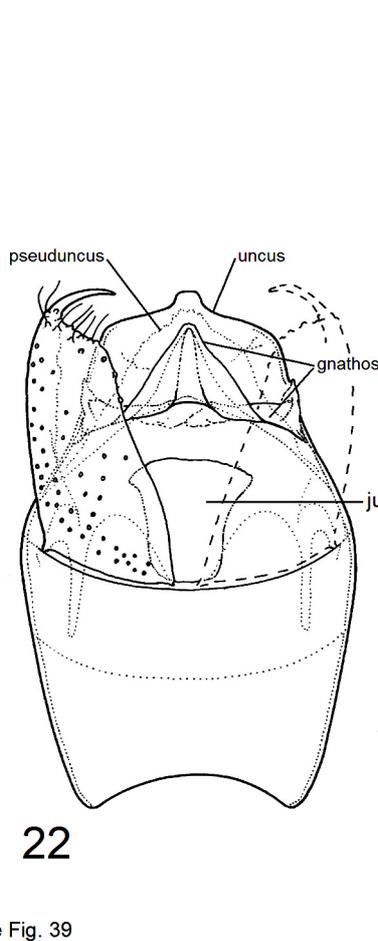
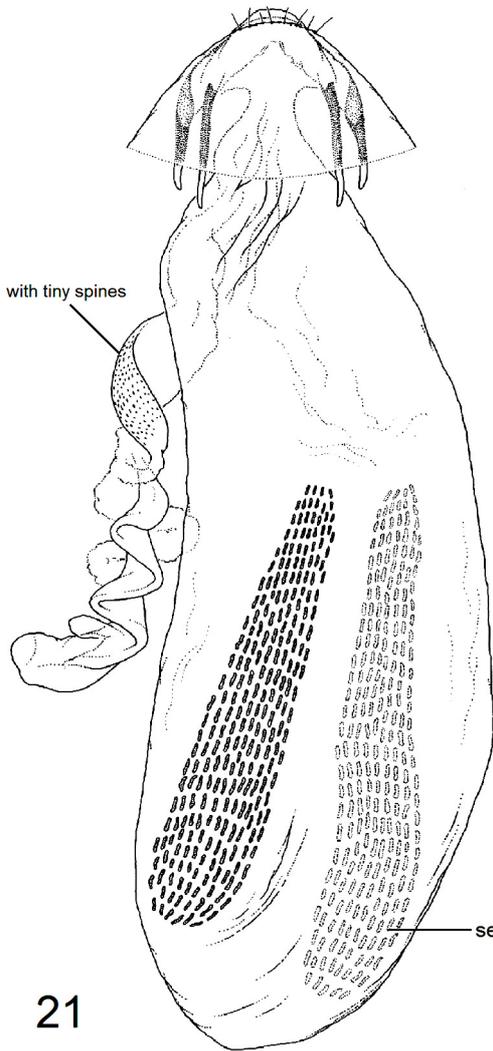
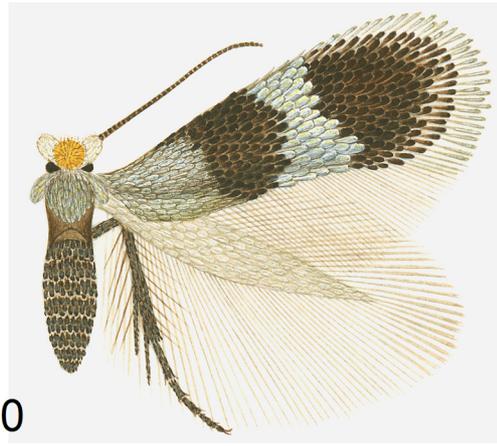
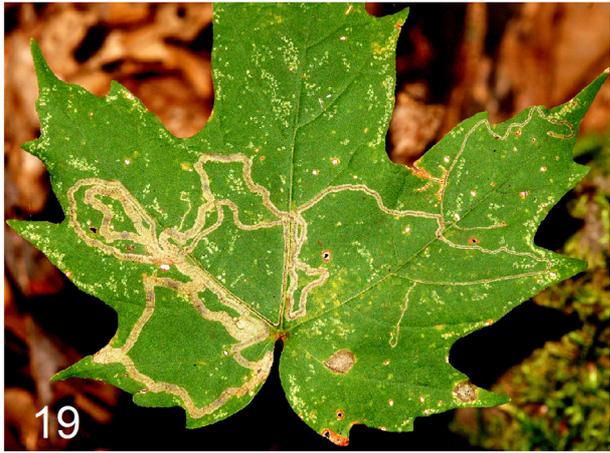
Remarks. Results of the first re-examination of the type series of *G. saccharella* from the collection of the ANSP was published by Wilkinson & Scoble (1979). The illustrations provided by the latter authors are good, though not very detailed. Prior to our research, Vichai Malikul (USNM) illustrated *Glaucolepis saccharella* (Figs 20–24) for D. Davis. We carefully re-examined the type series. We were able to confirm the presence of minute spines on the female ductus spermathecae, non-reticulate state of the signa, and absence of a vaginal sclerite (Figs 21, 39), as well as to document the male genitalia in more detail (Fig. 22, 35), including the juxta which was missing in Fig. 60 by Wilkinson & Scoble (1979). Our recent examination of the morphology of the adult head and legs (Figs 2, 4, 5) and re-examination of the wing scaling (Figs 46–50) revealed elaborate androconial structures on the male hindwing (Fig. 48) and especially on the forewing underside (Fig. 47); these structures are missing in the description by Wilkinson & Scoble (1979). We also re-examined the wing venation (Figs 13–15) and it appeared to be similar to those provided by other authors (see Figs 12, 16).



FIGURES 2–7. Details of *Glaucolepis* morphology. 2, descaled head of *G. saccharella* (Braun), slide no. 17127 (ANSP, currently USNM); 3, same, *G. pseudoflagellata* Remeikis & Stonis, slide no. RA583 (ZMUC); 4, 5, midleg and hindleg of *G. saccharella*, slide no. 17127 (ANSP, currently USNM); 6, 7, hindleg of *G. pseudoflagellata*, slide no. RA583 (ZMUC).



FIGURES 8–18. Wing venation of *Glaucolepis*. 8, 9, *G. pseudoflagellata* Remeikis & Stonis, forewing, enhanced and not enhanced photograph of slide no. RA583 (ZMUC); 10, *G. raikhonae* Puplesis, forewing, after Puplesis 1994, modified; 11, *G. gielisorum* (van Nieukerken), forewing, after van Nieukerken *et al.* 2016b, modified; 12, *G. saccharella* (Braun), forewing, line drawing after Wilkinson & Scoble 1979; 13, 14, same, enhanced and not enhanced photograph of slide no. 17127, paralectotype (ANSP, currently USNM); 15, *G. saccharella*, hindwing, photograph of slide no. 17127, paralectotype (ANSP, currently USNM); 16, same, line drawing after Wilkinson & Scoble 1979; 17, *G. gielisorum*, hindwing, after van Nieukerken *et al.* 2016b, modified; 18, *G. raikhonae*, hindwing, after Puplesis 1994, modified. Note that the venation in Figures 8–11 and Figures 15–18 are practically identical.



FIGURES 19–24. Leaf mine and details of *Glaucolepis saccharella* morphology. Leaf mine on *Acer saccharum* Marshall by Charles Eiseman (Northfield MA, USA); 20, female adult; 21, female genitalia; 22, male genitalia, capsule; 23, same, valva; 24, same, phallus (20–24, the artwork by Vichai Malikul, USNM).

Description of *Glaucolepis flagellata* Remeikis & Stonis, sp. nov.
(Figs 27, 38, 41, 51)

Neotrifurcula specimen RH2; in van Nieukerken *et al.* 2016b: 44, Figs 111–114.

Type material. Holotype: ♂, CHILE, Valdivia, 20 km S Valdivia, Rincon de la Piedra, caught around *Podocarpus salignus* D. Don, elevation ca. 180 m, 15.xi.1981, E. S. Nielsen & O. Karsholt, genitalia slide no. RA370♂ (ZMUC).

Paratypes: 5 ♂, 3 ♀, same label data as holotype, caught around *Podocarpus salignus*, genitalia slide nos RA322♂, RA326♂, RA327♀, RA591♀ (ZMUC).

Diagnosis. The combination of a uniform grey-brown forewing, large cluster of spines near phallosome in the male genitalia, and 6.5 coils of the ductus spermathecae in the female genitalia distinguishes *G. flagellata* **sp. nov.** from all congeneric species, including the most similar *G. pseudoflagella* **sp. nov.** The species belongs to the *Glaucolepis flagellata* group.

Male (Fig. 51). Forewing length 2.7–3.1 mm; wingspan 5.9–6.8 mm. Head: palpi cream to brownish cream; frontal tuft pale, yellowish orange; collar comprised of piliform scales, yellowish orange; scape golden cream to silvery shiny; antenna as half the length of forewing or slightly longer; flagellum with 42–44 segments, glossy, pale brownish grey to brownish cream on upper side and underside. Thorax and tegula glossy, dark grey-brown proximally, pale grey distally. Forewing glossy, densely speckled with dark brown (in other angle of view, grey-brown) scales, without fascia but with distinctive bluish iridescence (only sometimes iridescence is weak); fringe dark grey to pale brownish grey; underside of forewing grey-brown or grey, without spots or androconia. Hindwing relatively wide, brown-grey to brownish cream on upper side and underside, without androconia; fringe brownish cream. Legs brownish cream, glossy on upper side and underside, except for fuscous grey forelegs on upper side. Abdomen fuscous grey on upper side, grey, shiny on underside; anal tufts cream to grey, very short, indistinctive; genital plates cream.

Female. Flagellum with about 38 segments. Otherwise as in male.

Male genitalia (Figs 27, 38). Capsule 390–470 µm long, 250–260 µm wide. Valva (Fig. 38) 220–225 µm long. Juxta thickened, bifid (Fig. 38). Phallus (Fig. 27) 270–400 µm long, 100–130 µm wide; spines form a distinctive cluster near phallosome (Fig. 27); rod-like sclerite (“flagellum” which actually represents an enlarged cornutus) about 270 µm long.

Female genitalia (Fig. 41). Total length about 1175 µm. Anterior apophyses very short. Vestibulum with a complex vaginal sclerite (Fig. 41). Corpus bursae with two reticulate signa but without pectinations. Accessory sac absent; ductus spermathecae with 6.5 coils.

Bionomics. Host plant: Unknown. Adults fly in November.

Distribution. This species occurs in the southern Andes (Chile) in the Valdivian forest habitat at an altitude of about 180 m.

Etymology. The species name is derived from Latin *flagellatus* (flagellated) in reference to the long sclerite (“flagellum”) in the male genitalia.

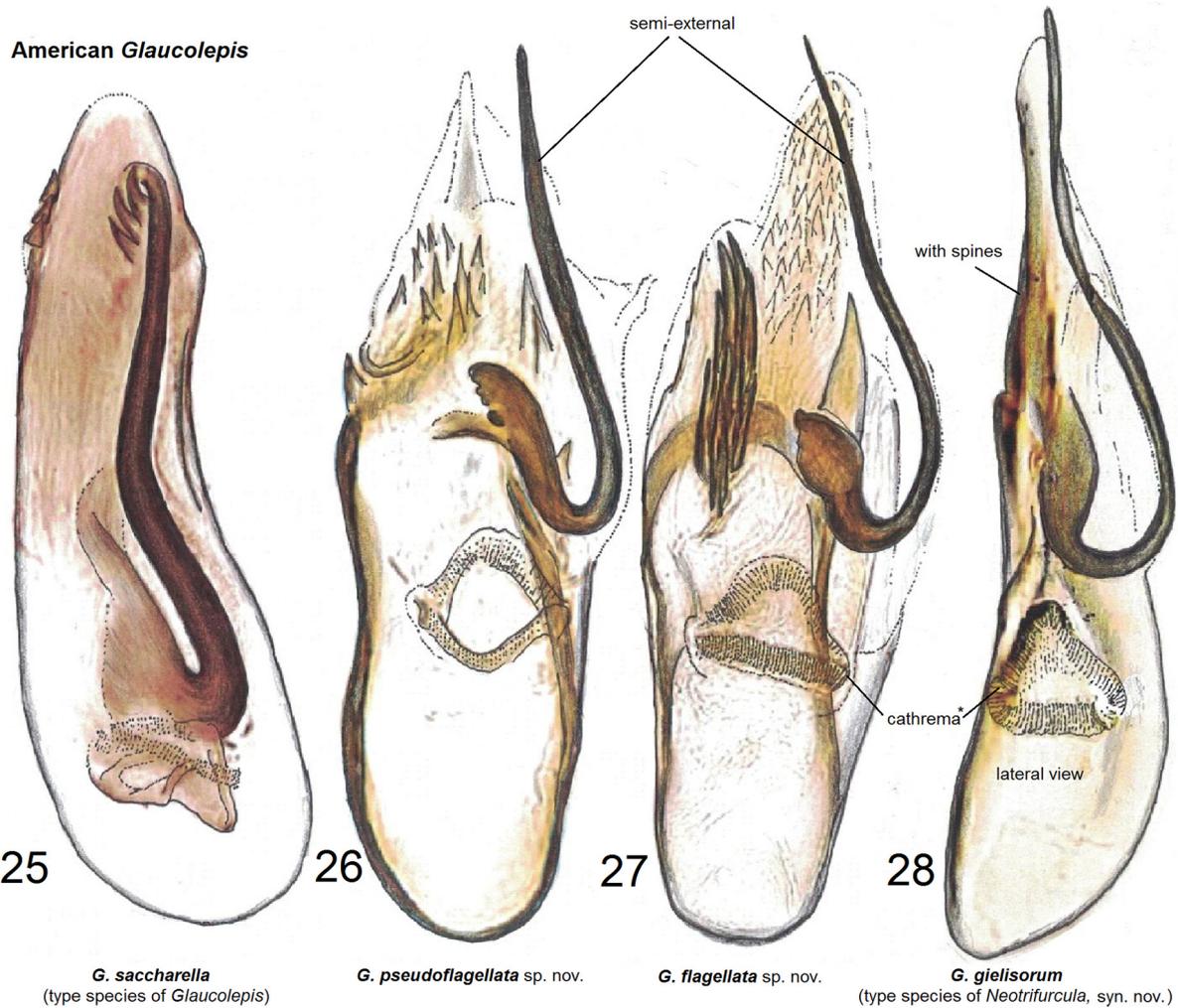
Description of *Glaucolepis pseudoflagellata* Remeikis & Stonis, sp. nov.

(Figs 3, 6–9, 26, 37, 40, 52)

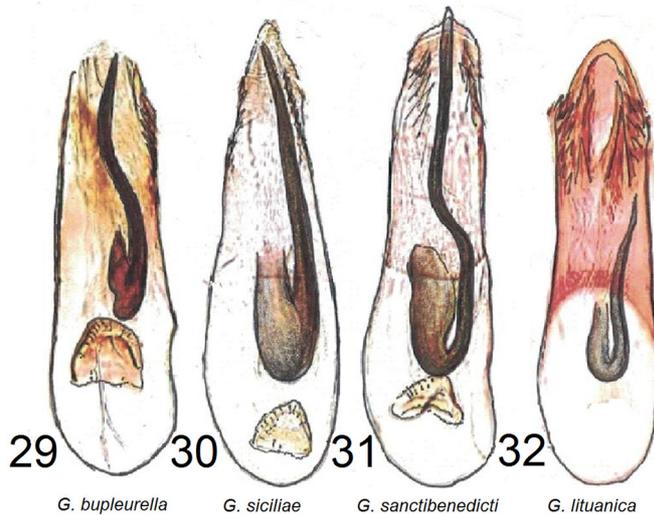
Type material. Holotype: ♂, ARGENTINA, Neuquen, Lago Lacar, Pucará, elevation ca. 650 m, 28.xi–27.xii.1981, E. S. Nielsen & O. Karsholt, genitalia slide no. RA587♂ (ZMUC).

Paratypes: ARGENTINA, 3 ♂, 3 ♀, same label data as holotype, genitalia slide nos RA583 (head, forewing & hindleg, ♂), RA593♂, RA624♀ (ZMUC); 1 ♂, same area, 5 km E of Hua-Hum, 26–27.xii.1981, E. S. Nielsen & O. Karsholt, genitalia slide no. RA524♂ (ZMUC); 1 ♂, Rio Negro, S. C. de Bariloche, Colonia Suiza, elevation ca. 800 m, 23.xii.1981, E. S. Nielsen & O. Karsholt, genitalia slide no. Diškus190♂ (ZMUC); 1 ♂, same locality, 5–7.i.1982, E. S. Nielsen & O. Karsholt (ZMUC); 1 ♂, same locality, elevation ca. 810 m, 9.xii.1978, *Mision Científica Danesa* (ZMUC).

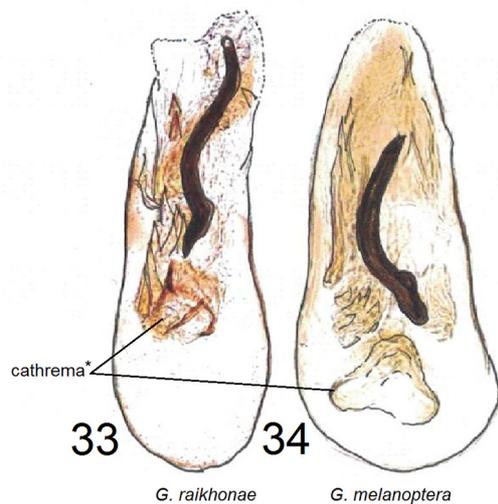
CHILE: 2 ♂, 3 ♀, Cabreria, Cord. Nahuelbuta, elevation ca. 1100 m, 15–20.i.1977, L. Peña (USNM); 2 ♂, 1 ♀, Temuco Province, Fundo La Selva, 48 km NW Nueva Imperial, elevation ca. 700 m, 9–11.xii.1981, D. R. Davis, genitalia slide no. RA586♂ (USNM); 1 ♂, 2 ♀, Chiloe Id., Hueque Trumao, 22 km N. Quellon, elevation ca. 50 m, 26–27.xii.1981, D. R. Davis (USNM); 2 ♀, Cautin, Pucon Peninsula, 19.xii.1982, R. L. Brown (USNM); 1 ♀, Nuble Province, Shangrila, SW side of volcan Chillan, elevation ca. 1600 m, 19–21.i.1979, D. & M. Davis & B. Akerbergs (USNM); 1 ♀, same province, Las Trancas, 21 km E Recinto, near high waterfall, elevation ca. 1300 m, 17.i.1979, M. & D. Davis & B. Akerbergs (USNM).



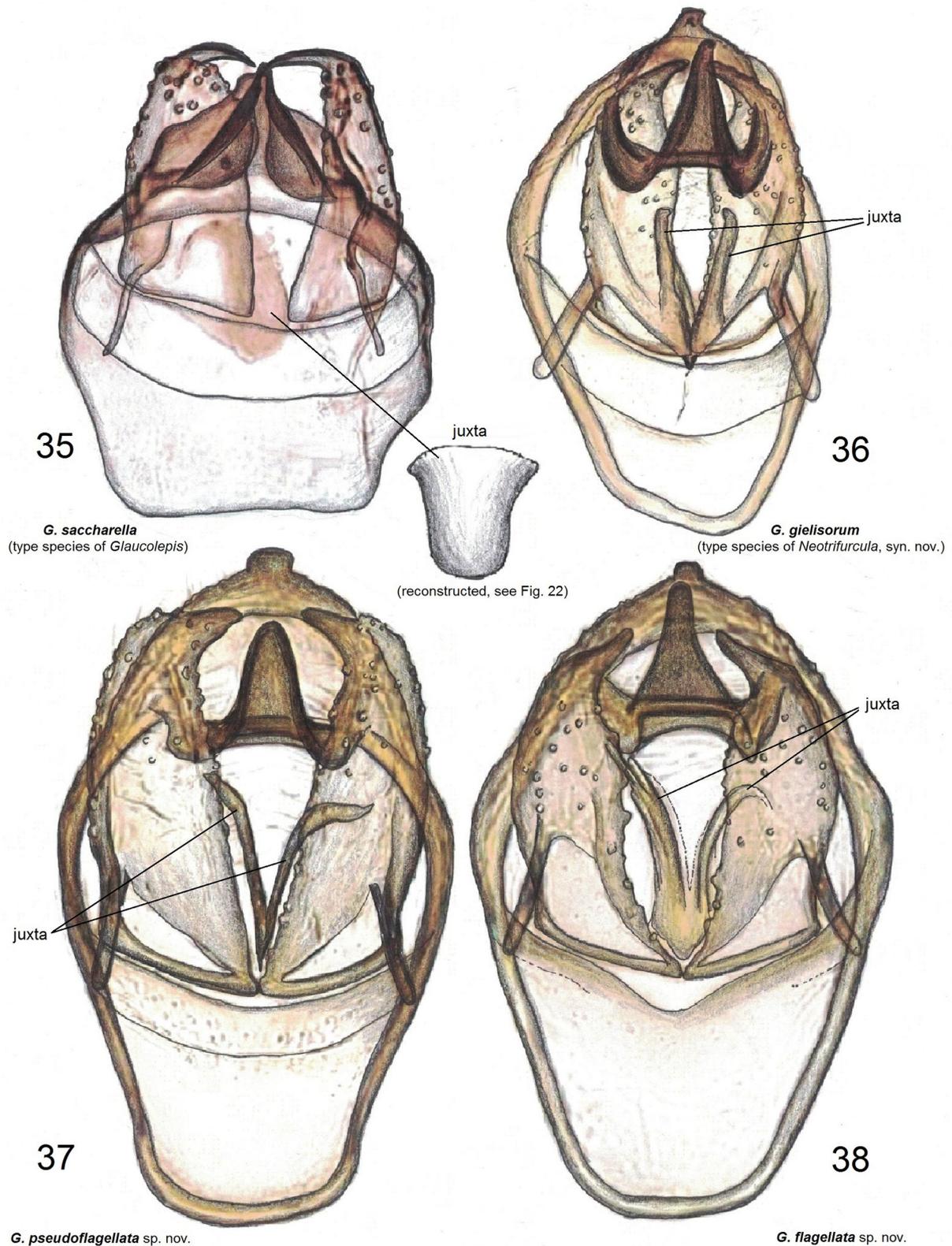
Selected species of *Glaucolepis* from Europe



and Central Asia

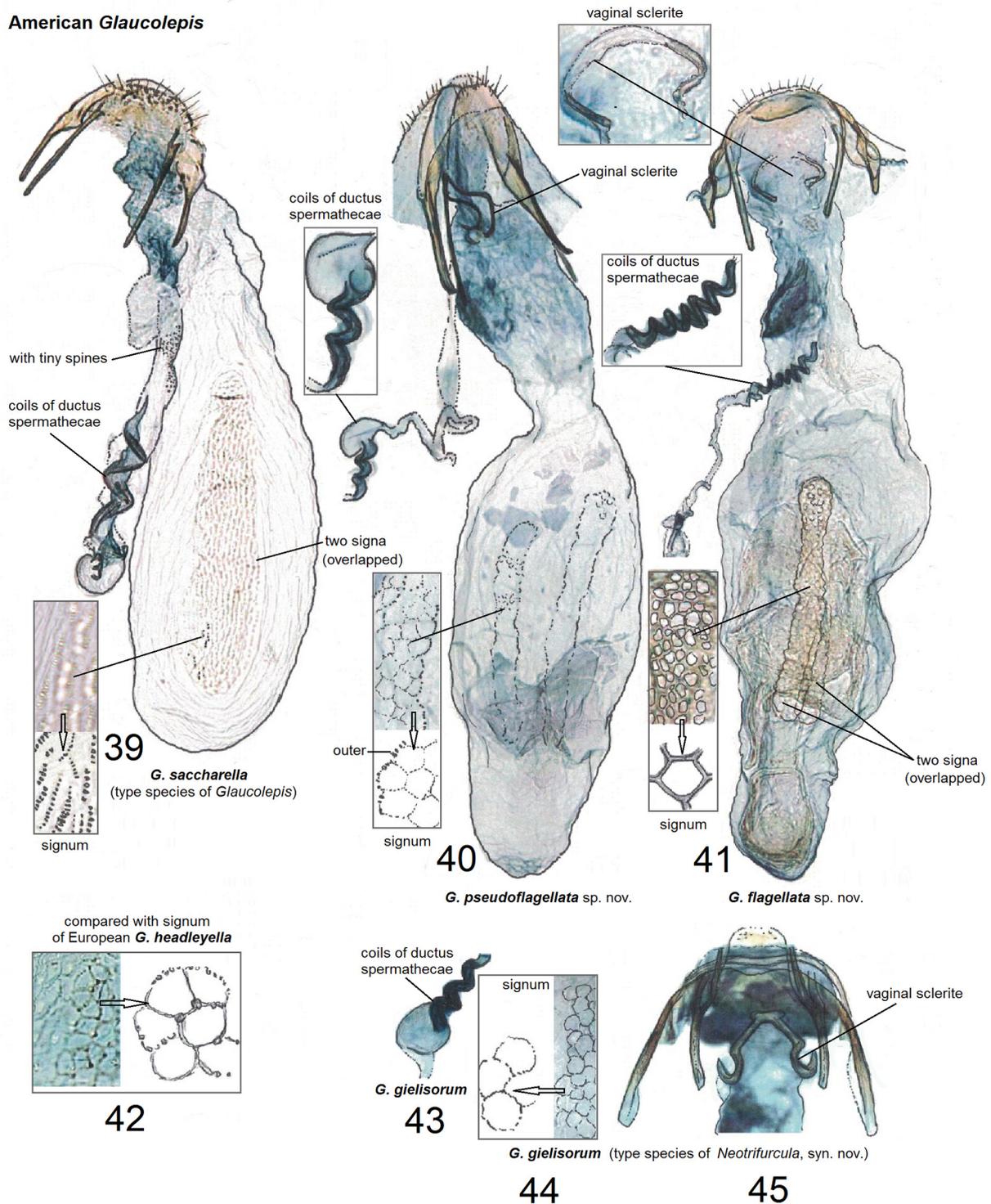


FIGURES 25–34. Male genitalia, phallus of *Glaucolepis* Braun. 25, *G. saccharella*, slide no. 16711, paralectotype (ANSP); 26, *G. pseudoflagellata* Remeikis & Stonis, **sp. nov.**, holotype, slide no. RA587 (ZMUC); 27, *G. flagellata* Remeikis & Stonis, **sp. nov.**, holotype, slide no. RA370 (ZMUC); 28, *G. gielisorum* (van Nieuwerkerken), after van Nieuwerkerken *et al.* 2016b, enhanced; 29–32, European taxa, modified after Laštuvka *et al.* 2013, and Ivinskis *et al.* 2012; Asian taxa, original sketches of specimens from Turkmenistan and Tajikistan (* cathrema, a striate thickening of the base of ductus ejaculatorius, is characteristic for all Nepticulidae though its rather obvious presence in a few genera was previously incorrectly ignored; the term was proposed by Schoorl *et al.* 1985).



FIGURES 35–38. Male genitalia, capsule of the American *Glaucolepis* Braun. 35, *G. saccharella* (Braun), slide no. 16711, paralectotype (ANSP, currently USNM); 36, *G. gielisorum* (van Nieuwerkerken), after van Nieuwerkerken *et al.* 2016b, enhanced; 37, *G. pseudoflagellata* Remeikis & Stonis, **sp. nov.**, holotype, slide no. RA587 (ZMUC); 38, *G. flagellata* Remeikis & Stonis, **sp. nov.**, holotype, slide no. RA370 (ZMUC).

American *Glaucolepis*

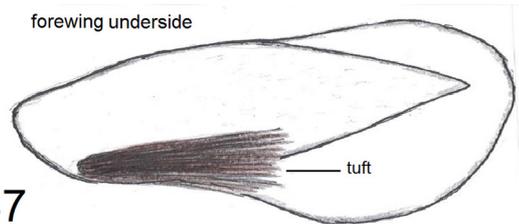


FIGURES 39–45. Female genitalia of the American *Glaucolepis* Braun. 39, *G. saccharella* (Braun), slide no. 17357, lectotype (Cotype) (ANSP, currently USNM); 40, *G. pseudoflagellata* Remeikis & Stonis, **sp. nov.**, paratype, slide no. RA624 (ZMUC); 41, *G. flagellata* Remeikis & Stonis, **sp. nov.**, paratype, slide no. RA591 (ZMUC); 42, fragment of signum of European *G. headleyella* (Stainton), modified after Ivinskis *et al.* 2012; 43–45, details of *G. gielisorum* (van Nieukerken), modified, after van Nieukerken *et al.* 2016b.

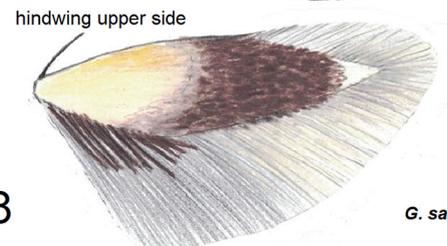


46

G. saccharella

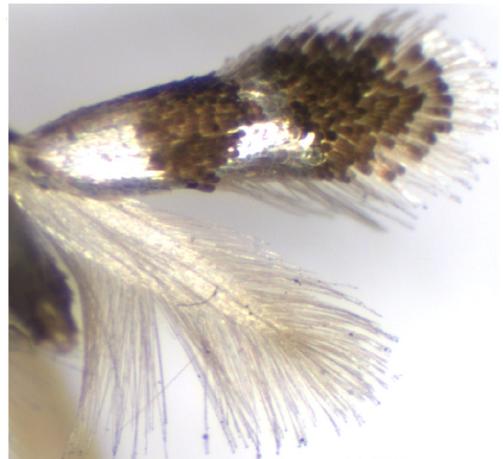


47



48

G. saccharella



49

G. saccharella



50

G. saccharella



51

G. flagellata, sp. nov.



52

G. pseudoflagellata, sp. nov.

FIGURES 46–52. Wing scaling of the American *Glaucolepis* Braun. 46–48, *G. saccharella* (Braun), male paratype (ANSP, currently USNM); 49,50, same, female paratypes (ANSP, currently USNM); 51, *G. flagellata* Remeikis & Stonis, **sp. nov.**, male holotype (ZMUC); 52, *G. pseudoflagellata* Remeikis & Stonis, **sp. nov.**, male holotype (ZMUC).

Diagnosis. The combination of a forewing with postmedian fascia, absence of large compact cluster of spines near phallotrema, and wide caudal process of the gnathos in the male genitalia, and 3.5 coils of ductus spermathecae in the female genitalia distinguishes *G. pseudoflagellata* **sp. nov.** from all congeneric species, including the most similar *G. flagellata* **sp. nov.** The species belongs to the *Glaucolepis flagellata* group.

Male (Fig. 52). Forewing length 2.7–3.5 mm; wingspan 6.1–7.7 mm. Head: palpi brownish grey; frontal tuft pale orange to dark ferruginous orange; collar comprised of piliform scales, pale orange; scape very shiny, golden cream to silvery shiny; antenna slightly longer than half the length of forewing; flagellum with about 44 segments, grey-brown on upper side and underside, usually every segment annulated with cream at its base. Thorax and tegula golden brown. Forewing very shiny, golden brown with purple iridescence, coarsely speckled with dark golden brown scales with purple iridescence over apical part; fascia oblique, silvery shiny (or cream in other angle of view), sometimes split into two irregular spots; fringe dark brown with golden gloss, pale brown apically; underside of forewing dark brown, without spots or androconia. Hindwing relatively wide, very dark brown with some golden gloss on upper side and underside, without androconia; fringe dark brown. Legs pale brownish grey, with fuscous grey scales on upper side. Abdomen fuscous grey on upper side and underside; anal tufts grey cream to pale brown, very short, indistinctive; genital plates grey cream to pale brown.

Female. Similar to male. Forewing length 3.7–3.8 mm; wingspan 8.1–8.3 mm. Fascia of forewing very distinctive, wide.

Male genitalia (Figs 26, 37). Capsule 390–400 µm long, 220–255 µm wide. Valva 210–220 µm long. Juxta thickened, bifid (Fig. 37). Phallus (Fig. 26) 390–415 µm long, 105–130 µm wide; spines near phallotrema not collected into cluster (Fig. 26); rod-like sclerite (“flagellum” which actually represents an enlarged cornutus) about 230–270 µm long.

Female genitalia (Fig. 40). Total length about 1300 µm. Anterior and posterior apophyses very long. Vestibulum with a vaginal sclerite (Fig. 40). Corpus bursae with two hardly visible reticulate signa, without pectinations. Accessory sac absent; ductus spermathecae with 3.5 coils.

Bionomics. Host plant: Unknown. Adults fly in November–January.

Distribution. This species occurs in the southern Andes (Argentina and Chile) at altitudes 50–1600 m.

Etymology. The species is named after other, similar species, *Glaucolepis flagellata*, but with a Ancient Greek prefix *pseudēs* (false) in reference to the similarity to *G. flagellata*.

First photographic documentation of the central Andean *Glaucolepis aerifica* (Meyrick, 1915) (Figs 53–58)

Nepticula aerifica Meyrick, 1915: 255.

Stigmella aerifica (Meyrick); in Davis, 1984: 18.

Glaucolepis aerifica (Meyrick, 1915); in Puplesis & Robinson 2000: 56–57, Figs 59, 203, 204, 222.

Glaucolepis aerifica (Meyrick, 1915); in Stonis *et al.* 2016: 66, 67; Stonis *et al.* 2017: Figs 33, 99.

Material examined. PERU: 1 ♂ (lectotype, designated by Puplesis & Robinson, 2000), La Oroya, 3720 m, vii.1914, Parish, genitalia slide no. 28965 (BMNH).

Male genitalia (Figs 53–58). Capsule about 435 µm long, 295 µm wide. Valva 190 µm long, 75–80 µm wide, with a large curved dorsal process (Fig. 54). Juxta thickened, bifid. Phallus (Figs 56–58) about 245 µm long, 115–120 µm wide; spines form two distinctive clusters near phallotrema (Fig. 57); rod-like sclerite (cornutus) about 180 µm long.

Distribution. Currently *Glaucolepis aerifica* is known from a single locality of the Peruvian Altiplano (Yauli Departamento) at an altitude of about 3720 m.

Remarks. With respect to the male genitalia, this is a peculiar species. Its taxonomic position remained unclear for a long time (Stonis *et al.* 2017). The previously published hand drawings of the genitalia of the lectotype slide 28965, BMNH (Puplesis & Robinson 2000: Figs 203, 204; Stonis *et al.* 2017: Fig. 99) were made from a freshly made mount; therefore, the uncus was turned ventrally and it looked like a wide band with setose corners (Stonis *et al.* 2017: Fig. 99). However, our current re-examination of the same slide as dried, showed that in fact the uncus is identical with the sclerite in *Glaucolepis*. Moreover, the presence of a thickened bifid juxta, the shape of gnathos (in Figs 53, 54 turned ventrally as compared with a freshly made slide illustrated by Puplesis &

Robinson 2000: Figs 203, Stonis *et al.* 2017: Fig. 99), the large, rounded vinculum, two sets of distinctive spines near the phallotreme, and the long rod-like sclerite (cornutus) of the phallus make this species very similar to other *Glaucolepis* species, in particular to the American representatives. Even at first glance the uncommon dorsal process of the valva is analogous to some *Bupleurum*-feeding European *Glaucolepis*. Nevertheless, *G. aerifica* possesses the following specific (and possibly autapomorphic) characters: 1) long sclerites connected to (or arising from) cathrema, and 2) basal processes of valvae almost connected, but without a transverse bar. Therefore, based on these characters, this *Glaucolepis* species cannot be attributed to any other species group within the genus. Unfortunately, nothing is known about the female genitalia of *G. aerifica* because the available female “paralectotype” from the type series belongs to another unknown species, and probably *Stigmella*. The wing venation of the lectotype was not studied by Puplesis & Robinson (2000), nor by us in order to preserve the badly damaged lectotype (see Stonis *et al.* 2016: 67).

Unnamed American *Glaucolepis* species

We have no doubt that in the Americas there are more *Glaucolepis* species than are discussed in the current paper. We are aware of two new species that remain undescribed due to reasons discussed below.

Glaucolepis specimen RA346

Our recent study of the material collected in 1981 by Danish colleagues from Chile revealed one specimen (slide no. RA346, ZMUC) which externally was almost identical to *G. flagellata* but in the male genitalia had no a large compact cluster of spines near phallotreme and, compared with *G. flagellata*, its genitalia capsule is smaller: 300 µm long, 195 µm wide. We recognize it as a new species of *Glaucolepis*, but we left it undescribed because of the severely broken adult in a plastic tube and rather poor genitalia slide. This specimen RA346 belongs to the *G. flagellata* group.

Material examined. 1 ♂, CHILE, 20 km S Valdivia, Rincon de la Piedra, at elevation ca. 180 m, 15.xi.1981, E. S. Nielsen & O. Karsholt, genitalia slide no. RA346 (ZMUC).

Glaucolepis specimen EvN4504

Neotrifurcula specimen EvN4504; in van Nieukerken *et al.* 2016b:39, 42; Figs 99, 107–110.

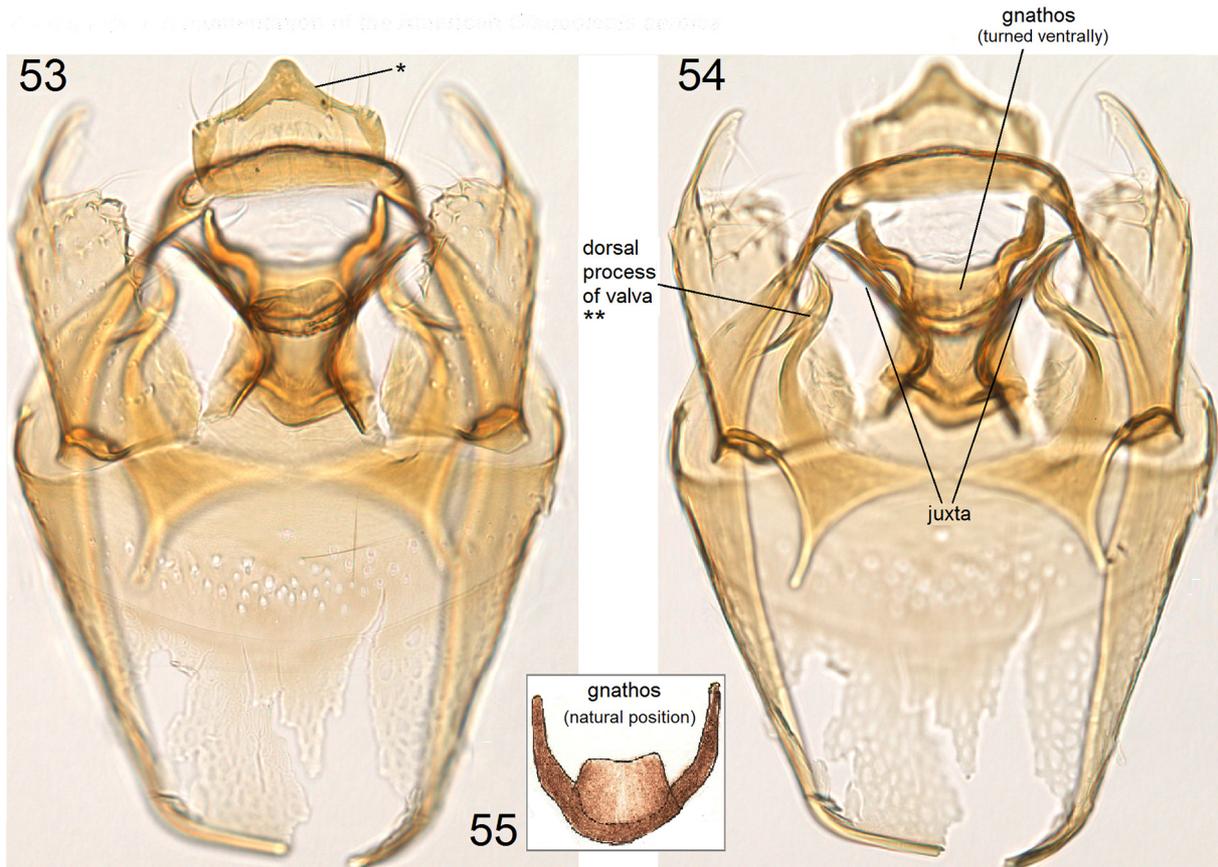
A single female specimen EvN4504 collected in Chile, Parque Natural La Campana, 19.ii.2001, by R. T. A. Schouten and H. W. van der Wolf (RMNH) and illustrated in van Nieukerken *et al.* 2016b: Figs 99, 107–110, most likely represents a new, still unnamed *Glaucolepis* species. It belongs to the *G. flagellata* group.

Species excluded from *Glaucolepis*

Acalyptris argentosa (Puplesis & Robinson, 2000), *comb. nov.*

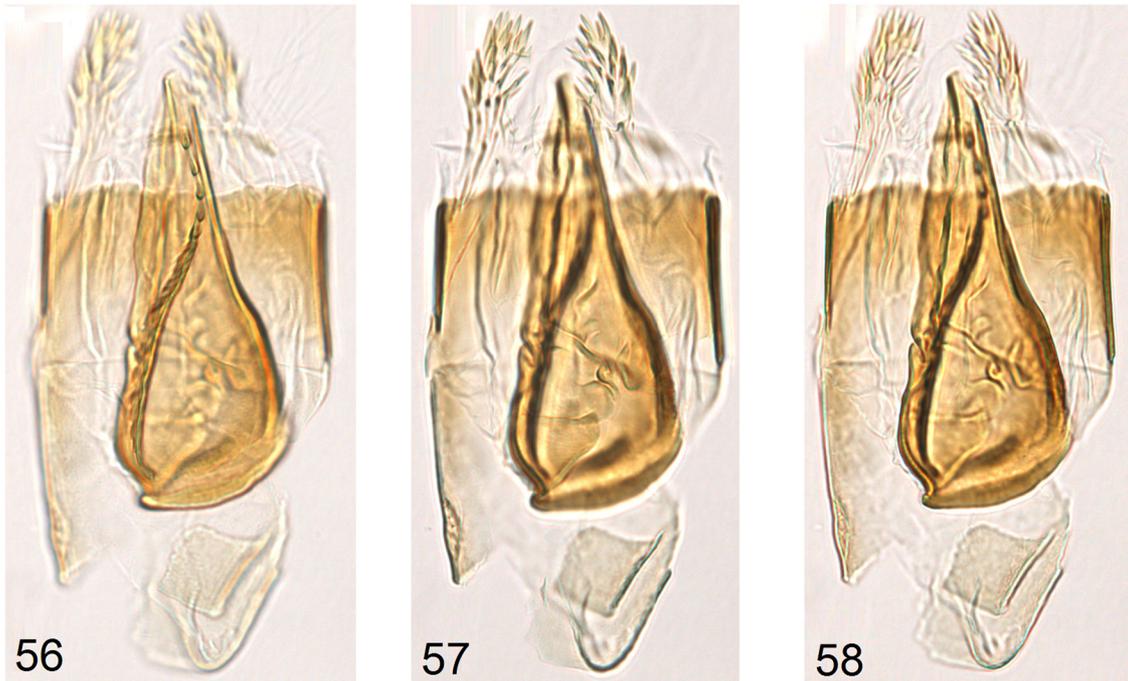
Glaucolepis argentosa Puplesis & Robinson, 2000: 57.

The species is known from Central America (Belize). The host plant remains unknown. On the basis of our current re-examination, this species, previously with uncertain and provisional taxonomic position (see Puplesis & Robinson 2000), is transferred from the genus *Glaucolepis* Braun to *Acalyptris* Meyrick (a description and figures of a re-examination of the male genitalia, wing venation and wing scaling, with formerly unnoticed but hardly visible and very specific androconia, will be presented by Stonis & Remeikis, *in prep.*).



* Note the uncus in natural position but strongly turned ventrally in Fig. 99 by Stonis *et al.* 2017

** similar to *Glaucolepis megaphallus* (Spain)



FIGURES 53–58. Male genitalia of *Glaucolepis aerifica* (Meyrick), lectotype, genitalia slide no. 28965 (BMNH). 53, 54, capsule with phallus removed; 55, gnathos in its natural position, after Stonis *et al.* 2016; 56–58, phallus.

Discussion

In this paper we expand and refine the concept of the *Glaucolepis*, with the description of new South American

species. In the course of the study we made some discoveries about the morphological characters of *Glaucolepis*, specifically the female signum, male androconial scales of the hindwing, and structures of the male genitalia.

Although the unusual, non-reticulate, signa (Fig. 39) of the type species *G. saccharella* greatly contrast with the clearly reticulate ones (Fig. 41) of the South American *G. flagellata*, they are comparable to some degree to those of South American *G. pseudoflagellata* (Fig. 40) or even some European species (including *G. headleyella*; Fig. 42), which possess incomplete cells of a signum without distinctive edges. Therefore, despite certain differences, there is probably some common origin of the structure of signa of *Glaucolepis*.

Examination of *Glaucolepis flagellata* and *G. pseudoflagellata* showed that apical spines near the phallosoma of the phallus also occur in the *flagellata* group (see Figs 26, 27).

The so-called "velvet patch" of raised androconial scales on the underside of male hindwing (illustrated in Johansson *et al.* 1990) was considered a highly valuable character for the definition of *Glaucolepis* (van Nieukerken 1986a, Johansson *et al.* 1990). However, the "velvet patch" does not occur in some European or Asian representatives of the genus, and we have not found it in any of the South American *Glaucolepis*.

Re-examination of the male genitalia of the *G. raikhonae* group (ie. Central Asian representatives of *G. raikhonae* and *G. melanopectera*) revealed the presence of a juxta which was previously unknown for the *G. raikhonae* group. It should be also noted that there is no transverse bar or transtilla in the species of the *G. raikhonae* group (Stonis *et al.*, *in prep.*).

In this paper we synonymize the recently erected *Neotrifurcula* van Nieukerken (van Nieukerken *et al.* 2016b) based on shared morphological characters with *Glaucolepis*. Recent molecular research by Doorenweerd *et al.* (2016) failed to place *Neotrifurcula*. It was recovered in very different parts of the tree (Doorenweerd *et al.* 2016: 7, 14). As the authors themselves state (Doorenweerd *et al.* 2016: 15), their study was not able to show suprageneric relationships for some genera. Additionally, some parts of the phylogeny proposed, specifically the grouping of *Hesperolyra* with *Neotrifurcula*, contradict our morphological data and possible relationships of nepticulid taxa. The phylogeny by Doorenweerd *et al.* (2016) was not congruent with a previously published molecular phylogeny (notably Hoare & van Nieukerken 2013).

Glaucolepis can be divided into at least four well-defined, distinguishable entities, and remaining true to the nepticulid tradition in our paper, they are here considered species groups. It would not be practical to elevate each species group to the rank of genus.

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