

**THE WORLD SUBGENERA OF *GLOSSOSOMA* CURTIS (TRICHOPTERA:
GLOSSOSOMATIDAE), WITH A REVISION OF THE CHINESE SPECIES OF
GLOSSOSOMA SUBGENERA *SYNAFOPHORA* MARTYNOV AND
PROTOGLOSSA ROSS**

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Abstract.—Newly discovered morphological evidence suggests that there are six principal monophyletic lineages of *Glossosoma* globally. We designate these as subgenera and infer the relationships among them using PAUP (*Ripaeglossa* ((*Protoglossa* + *Lipoglossa*) (*Muroglossa* (*Glossosoma* + *Synafophora*))))). Species of *Glossosoma* subgenus *Synafophora* are reported from China for the first time. Subgenus *Synafophora* is represented in Palearctic China by five species: *Glossosoma* (*Synafophora*) *altaicum* (Martynov), *G. (S.) intermedium* (Klapálek), *G. (S.) minutum* (Martynov), *G. (S.) nylanderi* (McLachlan), and *G. (S.) ussuricum* (Martynov). *Glossosoma* (*Protoglossa*) currently includes two species, both of which are known only from Oriental China. We transfer the Indian (Sikkim) species *Glossosoma* (*Lipoglossa*) *kchinam* Schmid 1971, to subgenus *Protoglossa* and review the Chinese species of subgenera *Synafophora* and *Protoglossa*.

Key Words: Trichoptera, Glossosomatidae, *Glossosoma*, *Synafophora*, *Protoglossa*, phylogeny, male genitalia

The genus *Glossosoma* Curtis 1834, is widely distributed in the Oriental and Holarctic Biogeographic Regions and contains 115 species and 2 subspecies (Morse 2001). Ross (1956) inferred nine subgenera for the genus but Morse and Yang (1993) inferred only six subgenera. Schmid (1980, 1998) said that the genus “is of Oriental origin, with its most primitive subgenera, *Lipoglossa* Martynov and *Muroglossa* Ross, being located there.” A review of these opinions is warranted, requiring careful examination of representatives of all purported groups and reinterpretation of several characteristics of male genitalia that were thought by Ross (1956) to be novelties in the genus.

Thirty-two species of *Glossosoma* have been reported from China to date. Major cooperative expeditions in southeastern, south central, and north central China in 1990, 1996, and 1998 have increased our knowledge of Chinese *Glossosoma* species considerably. Yang and Morse (2002) reported on the species of *Glossosoma* subgenus *Lipoglossa*. In this paper, we are able to report five *Glossosoma* species of subgenus *Synafophora* Martynov that are new records for China and to review the two Chinese species of *Protoglossa* Ross. All specimens used in this research are preserved in the collections of Nanjing Agricultural University (NAU) unless otherwise indicated (see Acknowledgments).

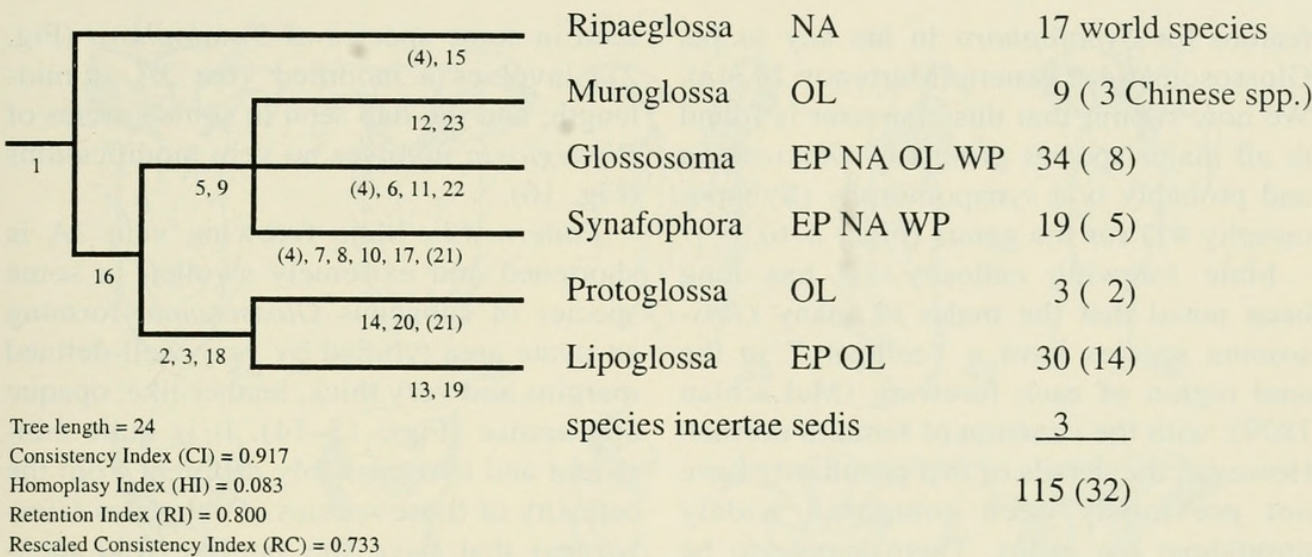


Fig. 1. Phylogeny, distributions, and species numbers of subgenera of *Glossosoma*. EP = East Palearctic, NA = Nearctic, OL = Oriental, WP = West Palearctic.

Glossosoma Subgenera

The family Glossosomatidae was revised at the family-group and genus-group levels by Ross (1956) and Morse and Yang (1993). In the course of redescribing the species herein and reviewing the structure of additional species, our knowledge of the synapomorphic homologues at the generic and subgeneric levels for *Glossosoma* was much improved. Besides the consolidation of several of his subgenera, our phylogeny (Fig. 1; inferred with PAUP version 3.1.1.; CI = 0.917, HI = 0.083, RI = 0.800, RC = 0.733) differs from that of Ross (1956) because of new understanding of structures of sternum IX, the inferior appendages, and the phallus. By examination of specimens from a broader range of species than were available to Ross (the genus has more than doubled in number of species since 1956), we have come to realize that the structures he called “claspers” (= inferior appendages) are, in fact, a ventral projection of sternum IX and that his new so-called “fixed spiny lobes of the aedeagus” are, in fact, the inferior appendages, much modified in this genus. Our interpretations of these and other synapomorphies and reinterpretations of our earlier (1993) conclusions, relative to outgroups *Agapetus* (Glossosomatidae) and *Rhyacophila* (Rhyaco-

philidae) are numbered below to correspond with the numbers in Fig. 1.

As a result of this analysis, we still recognize six subgenera, although the justification for them now is more firmly established by this investigation. The six subgenera and their synonyms are as follows (Morse and Yang 1993):

- Glossosoma* Curtis 1834
- Anseriglossa* Ross 1956
- Lipoglossa* Martynov 1930
- Muroglossa* Ross 1956
- Protoglossa* Ross 1956
- Sinoglossa* Ross 1956
- Ripaeglossa* Ross 1956
- Synaophora* Martynov 1927
- Diploglossa* Martynov 1934a
- Eomystra* Martynov 1934a
- Klapalekia* Botosaneanu 1955
- Mystroglossa* Kobayashi 1982
- Mystrophora* Klapálek 1892
- Mystrophorella* Kloet and Hincks 1944

MORPHOLOGY AND SYNAPOMORPHIES

Unguitractor plate.—For his new genus *Synaophora*, Martynov (1927) described a new character, an enlarged inner unguitractor lobe present apically on each front leg in all males of the *Synaophora*. Later, he used this character as a major diagnostic

feature for *Synafofophora* in his key to his Glossosomatidae genera (Martynov 1934a). We now submit that this character is found in all major species groups of *Glossosoma* and probably is a synapomorphy (Synapomorphy #1) for the genus (Figs. 2–6).

Male forewing callosity.—It has long been noted that the males of many *Glossosoma* species have a “callosity” in the anal region of each forewing (McLachlan 1879), with the venation of females normal. However, the details of this peculiarity have not previously been compared widely throughout the genus. There appear to be three general patterns that seem not to be part of the same transformation series:

Pattern #1: Male forewing vein 2A is elongated (Synapomorphy #2; Figs. 8–12, 60, 66) in subgenera *Lipoglossa* and *Protoglossa*, and in many species it extends nearly to the arculus (Figs. 8, 12, 60, 66). Vein 2A (Fig. 8) and sometimes also 3A (Figs. 8, 10–12, 60, 66) are thickened in a variable pattern (Synapomorphy #3). When both veins are thickened, the two are sometimes fused with each other over much or all of their length, forming a broad diffusion area which is only slightly thickened, flat, and translucent.

Pattern #2: Male forewing vein 2A is shortened and strongly curved toward 3A, often weakened apically, usually accompanied by a rounded, thickened, translucent diffusion area on the posterior side or both sides of the vein (Synapomorphy #4; Figs. 16–25) in subgenera *Ripaeglossa* and *Synafofophora* and some *Glossosoma*. We are unable to distinguish consistent patterns among these callosities, although other characters suggest that *Ripaeglossa* is distantly related to subgenera *Glossosoma* and *Synafofophora*, suggesting a homoplasious parallelism in this “synapomorphy.” Some species have a dorsally protruding flap (Figs. 15, 16, 21), but this flap is not homologous in the three subgenera: The flap seen in some species of subgenus *Glossosoma* (Figs. 15a, 15b) entails a highly modified anastomosis of 1A and 3A; the flap

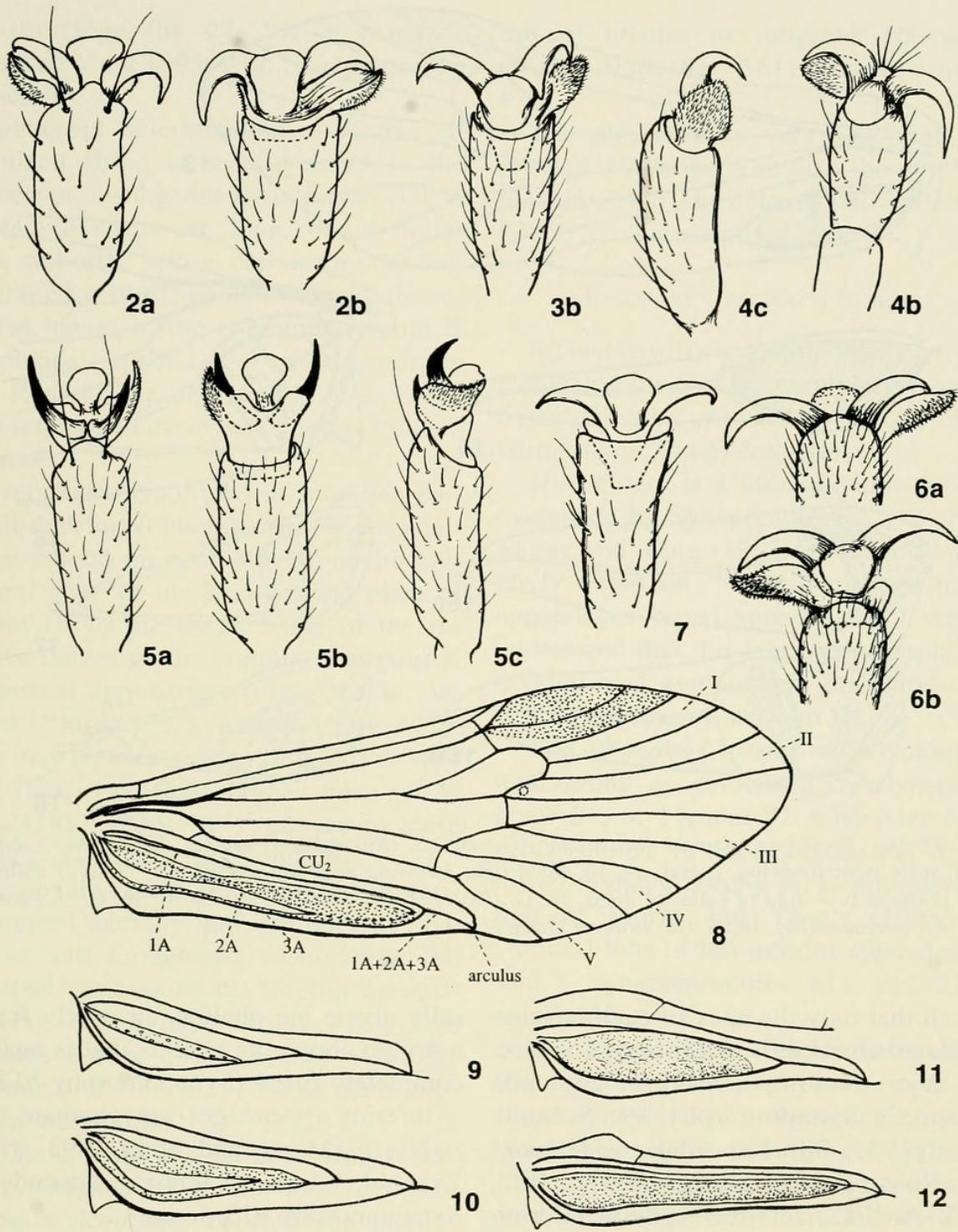
seen in some species of *Synafofophora* (Fig. 21) involves a modified vein 3A at mid-length; and the flap seen in some species of *Ripaeglossa* involves no vein modifications (Fig. 16).

Pattern #3: Male forewing vein 2A is shortened and extremely swollen in some species of subgenus *Glossosoma*, forming an ovate area typified by very well-defined margins and very thick, leather-like, opaque appearance (Figs. 13–14). It is quite consistent and is remarkably different from the callosity of those species of subgenus *Glossosoma* that have the fan-like fold mentioned above (Figs. 15a, 15b); there are no intermediate forms between these two types of callosity in subgenus *Glossosoma*. For now, we consider these two types of callosity as possible synapomorphies that may have relevance for recognizing species groups within subgenus *Glossosoma*.

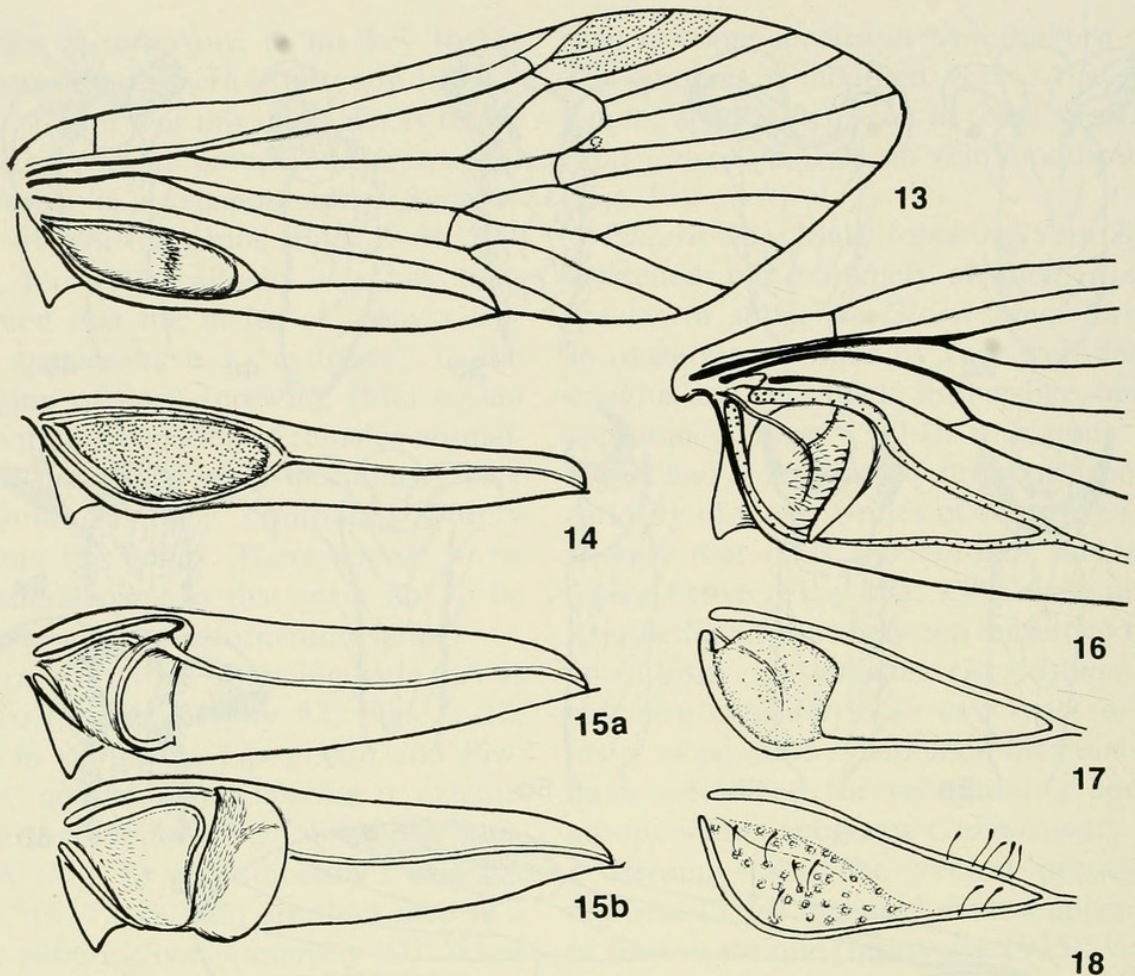
Sternum IX.—The ventral process of segment IX [= unpaired ventral appendage of the 9th sternite (Martynov 1935); ventral process of IX (Kimmins 1953); tongue of IX (Ross 1956)] is evident in the lineage of *Muroglossa* + *Synafofophora* + *Glossosoma* (Figs. 26, 28, “v.p.IX”). This structure (Synapomorphy #5) clearly arises from segment IX without articulation, although its base is sometimes quite slender; it is symmetrical in *Glossosoma* (*Muroglossa*), asymmetrical in *Glossosoma* (*Glossosoma*) (Ross 1956, figs. 327B, 328B; Synapomorphy #6), and deeply divided (and sometimes asymmetrical) in *Glossosoma* (*Synafofophora*) (Figs. 28, 35, 40, 45, 51; Synapomorphy #7).

In *Synafofophora*, the sclerotization of the ventral process of sternum IX continues into the phallocrypt as a high keel (Figs. 26, 30; Ross 1956) from which the inferior appendages arise (Synapomorphy #8).

Inferior appendages.—In subgenera *Muroglossa* + *Glossosoma* + *Synafofophora*, the inferior appendages are vertical basally, with the bases parallel with the caudal edges of segment IX and attached by narrow membranous strips laterally with segment



Figs. 2-12. Characters of *Glossosoma* species. 2-6, Distotarsus, claws, and unguitactor lobes on *Glossosoma* male front legs; a. = dorsal, b. = ventral, c. = mesal. 2, *G. (G.) aequale* Banks, 1940, right front leg. 3, *G. (Ripaeglossa) califica* Denning, right front leg. 4, *G. (Synafophora) minutum*, left front leg. 5, *G. (Synafophora) altaicum*, left front leg. 6, *G. (Lipoglossa) adunatum* Yang and Morse, left front leg. 7, *G. (G.) aequale*, female right front leg, ventral. 8, *G. (L.) mirabile* Yang and Morse, male right forewing, dorsal. 9-12, Male right forewing anal region, dorsal. 9, *G. (L.) adunatum*. 10, *G. (L.) tortum* Yang and Morse. 11, *G. (L.) kelleyi* Ross. 12, *G. (L.) phyllon* Yang and Morse. 1A, 2A, 3A = independent first, second, and third anal veins; 1A+2A+3A = fused anal veins; I, II, III, IV, V = first, second, third, fourth, and fifth apical Forks; arcus = junction of 1A+2A+3A and Cu₂ on hind margin; Cu₂ = second cubital vein.



Figs. 13–18. Forewings of male *Glossosoma* (G.) and *G. (Ripaeglossa)* species. 13, *G. (G.) subaequale* Schmid, male right forewing, dorsal. 14–18, Male right forewing anal cell, dorsal, a. = fold of callosity in normal position, b. = fold of callosity lifted. 14, *G. (G.)* n. sp. A. 15, *G. (G.)* n. sp. B. 16, *G. (R.) calificum*. 17, *G. (R.) velonum* Ross. 18, *G. (R.) brunum* Denning.

IX, such that only the apex of each inferior appendage, characteristically setose, is free from the membrane (Figs. 26, 30, “inf.app.”; Synapomorphy #9; Schmid 1971, figs. 33, 38). For subgenus *Glossosoma*, Ross (1956, e.g., figs. 331A, “lt,” and 327A, “tf”) referred to these inferior appendages as the “lateral tendons” and their setose, free ends as “tendon flaps.”

The inferior appendages of subgenus *Synafophora* are deeply imbedded in the phallocrypt, intimately appressed to the phallus, embracing it laterally (Figs. 26, 33, 38, 43, 49; Synapomorphy #10). Ross (1956) referred to this form of the inferior appendages in *Synafophora* as the “dorsal lobes of the aedeagus.”

The apices of the inferior appendages of subgenus *Muroglossa* are approximate dor-

sally above the phallus, anteriorly forming a bridge above the phallus that is nearly or completely fused (Synapomorphy #12).

Inferior appendages are elongate in *Li-poglossa* (Morse and Yang 1993, #39, as “ventral lobes of inferior appendages”; Synapomorphy #13 herein).

Inferior appendages are short and triangular in lateral view in *Protoglossa* (Figs. 56, 62; Synapomorphy #14).

Tergum X.—Tergum X is reduced in size and retracted beneath tergum IX and pre-anal appendages in *Ripaeglossa* (Morse and Yang 1993, #31 as “tergum IX hood-like”; Synapomorphy #15 herein).

Paired preanal appendages and tergum X are fused with each other and generally indistinguishable in *Muroglossa* + *Glossosoma* + *Synafophora* + *Protoglossa* + *Li-*

poglossa (Figs. 26, 27, "X + pr.app."; Morse and Yang 1993, #32; Synapomorphy #16 herein).

Phallocrypt sclerotizations.—A pair of sclerotized strips is seen dorsally in the phallocrypt of subgenus *Glossosoma*. These dorsolateral strips are long, broad, foliaceous, and often setose, connecting the dorsolateral edge of the phallobase with the respective halves of the combined tergum X and preanal appendages (Synapomorphy #11). Ross (1956, e.g., figs. 327A, 329A, "dt") referred to these structures as "dorsal tendons."

In subgenus *Synafofophora*, a unique pair of well-developed lateral strips of the phallocrypt extend on each side from the apicolateral edge of the keel-bearing plate of sternum IX to the mesal bases of the respective halves of the combined tergum X and preanal appendages (Figs. 26, 33, 38, 43, 49, "lat.str."; Synapomorphy #17). These may be narrow (e.g., Fig. 26) or very broad (Fig. 49). Ross (1956, figs. 314A, 315A, 318E, 320A, "t") referred to these structures as simply the "tendons."

The phallic shield is sclerotized in various degrees laterally and ventrally in *Protoglossa* and *Lipoglossa*, fusing with the basomesal surfaces of the inferior appendages (Fig. 59; Synapomorphy #18). This represents a new understanding of Morse and Yang's (1993, #33) "basal plate cupping the phallobase."

In *Lipoglossa*, this sclerotization is extensive, causing the ventral phallocrypt to become a deep cup beneath the phallus (Yang and Morse 2002, fig. 5; Synapomorphy #19).

Phallus.—The phallobase and phallicata are fused in *Protoglossa* (Figs. 59, 65; Synapomorphy #20).

Paramere spines are absent in *Synafofophora* and *Protoglossa* (Figs. 29, 59; Morse and Yang 1993, #34 and 36; Synapomorphy #21 herein), apparently having been lost independently in these lineages.

The paramere spine is single, on a long erectile lobe, and terminating in a conical

tuft of bristles in subgenus *Glossosoma* (Ross 1956, fig. 331E; Synapomorphy #22).

The phallicata is very long and compressed, bladelike, and also the phallobase is elongate in *Muroglossa* (Ross 1956, fig. 325C; Synapomorphy #23).

MONOPHYLY OF EACH SUBGENUS

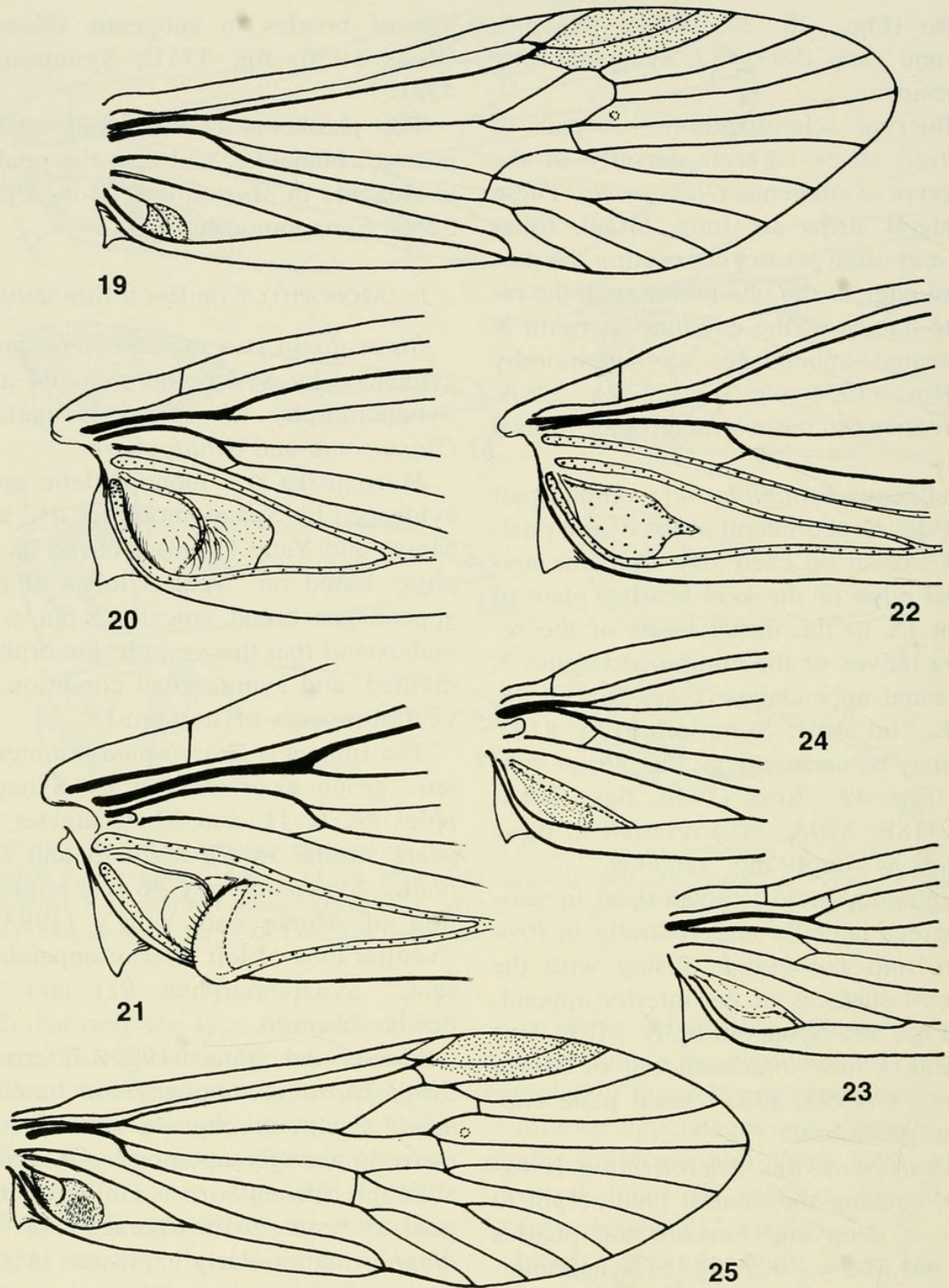
Ripaeglossa is a monophyletic group as evidenced by Synapomorphies #4 and 15. Synapomorphy #4 occurs in parallel in *Glossosoma* and *Synafofophora*.

Muroglossa is a monophyletic group as evidenced by Synapomorphies #12 and 23. Morse and Yang (1993) inferred its monophyly based on "ventral lobes of inferior appendages broad apically," but we now understand that this is a plesiomorphic, undivided, and symmetrical condition of the ventral process of sternum IX.

The subgenus *Glossosoma* is a monophyletic group as evidenced by Synapomorphies #4, 6, 11, and 22. Character #4 appears similar in *Ripaeglossa* and *Synafofophora*. Synapomorphy #6 is a reinterpretation of Morse and Yang's (1993, #42) "ventral lobe of left inferior appendage absent." Synapomorphies #11 and 22 are newly observed.

Morse and Yang (1993) inferred that *Synafofophora* is monophyletic based on a single synapomorphy: the absence of paramere spines (Synapomorphy #21 herein), although *Synafofophora* is similar in this regard to *Protoglossa*. Character #4 of *Synafofophora* is similarly expressed in *Glossosoma* and *Ripaeglossa*. However, with four additional synapomorphies (#7, 8, 10, 17), the monophyly for *Synafofophora* is corroborated.

The characters observed for *Protoglossa* that suggested its monophyly for Morse and Yang (1993) were "basal plate cupping phallobase" and "paramere spines absent," respectively characters #18 and 21 herein. The former is now shown to be a synapomorphy for *Protoglossa* + *Lipoglossa* and



Figs. 19–25. Forewings of male *Glossosoma* (*Synafophora*) species. 19, *G. (S.) ussuricum*, male right forewing, dorsal. 20–24, Base of male right forewings, dorsal. 20, *G. (S.) dulceji*. 21, *G. (S.) nichinkata*. 22, *G. (S.) nigrior*. 23, *G. (S.) nylanderii*. 24, *G. (S.) minutum*. 25, *G. (S.) intermedium*, male right forewing, dorsal.

the latter is also seen in *Synafophora*. In this work, we observed additional Synapomorphies #14 and 20 in support of the monophyly of this subgenus.

Morse and Yang (1993) observed for *Lipoglossa* “superior appendages with basov-

entral hook” (their #38) and “ventral lobes of inferior appendages long” (their #39, Synapomorphy #13 herein). We now consider the hooks and other projections of the preanal appendages too variable to provide reliable evidence for monophyly. We add

here Synapomorphy #19 in support of the monophyly of this subgenus.

RELATIONSHIPS OF SUBGENERA

Morse and Yang (1993) inferred that *Synafofophora* + *Lippoglossa* + *Muroglossa* + *Glossosoma* are a monophyletic group based on "dorsal projections of basal plate present" (their #35). We now understand that these "projections" are actually inferior appendages and that they do not have the same configuration in *Lippoglossa* as in the other three subgenera. The subgenera *Muroglossa*, *Glossosoma*, and *Synafofophora* are an unresolved trichotomy. Their sister-group relationship is evidenced by Synapomorphies #5 and 9, of which #5 is newly observed and #9 is a reinterpretation of Morse and Yang's (1993) character #35.

Synapomorphies #2 and 3 are new observations and Synapomorphy #18 is a reinterpretation of Morse and Yang's (1993) character #33, supporting a sister-group relationship for *Protoglossa* and *Lippoglossa*.

These two clusters of genera are probably sister groups as suggested by Synapomorphy #16 (Morse and Yang 1993, #32), leaving *Ripaeglossa* as the basal lineage of the genus. Ross (1956) inferred the same monophyletic group based on similar evidence ["cerci (?) absent"].

Glossosoma (*Synafofophora* Martynov 1927)

Synafofophora Martynov 1927: 165. Type species by original designation: *Synafofophora minutum* Martynov.

Mystrophora Klapálek 1892: 459 [preoccupied by Kayser, 1871, in Brachiopoda].

Type species by monotypy: *Mystrophora intermedia* Klapálek. Synonym of *Eomystra* according to Ross 1956: 154.

Eomystra Martynov 1934a: 84; 1934b: 327.

Type species by monotypy: *Eomystra dulkeji* Martynov. Synonymy with *Synafofophora* implied by Schmid 1971: 619; synonym of *Synafofophora* by placement of type species in that subgenus by Levandova 1982: 156.

Diploglossa Martynov 1934a: 85; 1934b:

327–328. Type species by monotypy: *Diploglossa nylanderi* McLachlan. Synonym of *Synafofophora* by placement of type species in that subgenus by Levandova 1982: 156.

Mystrophorella Kloet and Hincks 1944: 97, *nomen novum* for *Mystrophora* Klapálek, 1892, *nec* Kayser, 1871.

Klapalekia Botosaneanu 1955: 792, *nomen novum* for *Mystrophora* Klapálek 1892 *nec* Kayser, 1871.

Mystroglossa Kobayashi 1982: 7. Type species by original designation: *Mystrophora altaica* Martynov. Synonym of *Synafofophora* by placement of type species in that subgenus by Levandova 1982: 156.

Martynov (1927) distinguished his genus *Synafofophora* from its apparent ally *Mystrophora* by three diagnostic characters. (1) Third apical fork pedicellate. This is a variable character. In our examples of type species *Synafofophora minutum*, three male specimens have the pedicel of the third apical fork very short and one male specimen is without a pedicel. Furthermore, the character is a plesiomorphy, common in *Rhyacophila*, *Agapetus*, and *Glossosoma* (*Muroglossa*). (2) The fourth fork is shorter than the third. This is true in all members of most genera in this family. (3) "In the male anterior legs inner pulvilli form, each, a thick pale outgrowth inwards, nearly equal in the length to the claws." We found that this is true not only in *Synafofophora*, but uniquely so in the males of all species of this genus, as we discussed above. In the male genitalia, the purportedly diagnostic characters Martynov (1927) provided are no more than autapomorphies of the species. Therefore, we agree with Ross (1956) that *Mystrophora* and its replacement names *Mystrophorella* and *Klapalekia* are synonyms of *Synafofophora*.

We reexamined *Glossosoma* (*Synafofophora*) *dulkeji*, the type species of *Eomystra*, using specimens from the Kuriles (Figs. 53–55). The species bears all of the synapomorphies of *Synafofophora*, such that we

are able to confirm Schmid's (1971) opinion that *Eomystra* is a synonym of *Syna-fophora*.

Glossosoma (*Syna-fophora*) *altaicum* and *G. (S.) nylanderi* are redescribed and reillustrated below. These type species share most of the synapomorphies of *Syna-fophora*, confirming the opinions of Levanidova (1982) that *Mystroglossa* and *Diploglossa*, respectively, also are synonyms of *Syna-fophora*.

Diagnostic characters for the subgenus include Synapomorphies #7, 8, 10, and 17 above. Also, the species of this subgenus usually differ from those of all other subgenera except *Ripaeglossa* and some species of *Glossosoma* in that male forewing vein 2A is shortened and strongly curved toward 3A, often weakened apically, usually accompanied by a rounded, thickened, translucent diffusion area on the posterior side or both sides of the vein. In addition, paramere spines are absent in only subgenera *Syna-fophora* and *Protoglossa*. Furthermore, males of all species examined by us have the phallocrypt above the phallus inflated to accommodate the apices of the inferior appendages; this possibly synapomorphous inflation is supported dorsally by a pair of sclerotized tendons in the phallocrypt wall (Figs. 26, 27, 38, 39, 43, 44), occasionally fused in a single dorsal plate (Figs. 33, 34, 49, 50).

The 19 world species of subgenus *Syna-fophora* are widely distributed in the Holarctic Biogeographic Region; its five Chinese species, redescribed below, occur only in the Palearctic portion of China.

- Glossosoma* (*Syna-fophora*) World Species
- G. (S.) altaicum* Martynov 1914b, Far East Russia, Korea, Japan, northeastern China.
 - G. (S.) angaricum* Levanidova 1967, Far East Russia.
 - G. (S.) dulkeji* (Martynov 1934a), Far East Russia.
 - G. (S.) hospitum* (Tsuda 1940), Japan.
 - G. (S.) inops* Tsuda 1940, Japan.

- G. (S.) intermedium* (Klapálek 1892), Holarctic Region.
- G. (S.) lividum* (Hagen 1861), northeastern North America.
- G. (S.) kiritchenkoi* (Martynov 1927), central Asia.
- G. (S.) minutum* (Martynov 1927), central Asia.
- G. (S.) neffi* Arefina 2000, Far East Russia.
- G. (S.) nichinkata* Schmid 1971, Japan.
- G. (S.) nigrior* Banks 1911, eastern North America.
- G. (S.) nylanderi* McLachlan 1879, Palearctic Region.
- G. (S.) sadoense* Kobayashi 1982, Japan.
- G. (S.) spinatum* Ruiter 2000, northwestern North America.
- G. (S.) sumitaense* Kobayashi 1982, Japan.
- G. (S.) uogalanum* Kobayashi 1982, Japan.
- G. (S.) ussuricum* (Martynov 1934a), Far East Russia, northeastern China.
- G. (S.) verdoni* Ross 1938, western United States.

KEY TO MALES OF CHINESE *GLOSSOSOMA* (*SYNAFOPHORA*) SPECIES

- 1. Forewing vein 2A resembling other veins. Inner apical spur of each hind leg broad basally, abruptly narrowed and hooked apically (Fig. 31). Tergum X + preanal appendages each with two, simple, large acute projections and without multiple teeth (Fig. 26). Ventral processes of sternum IX with inner branches slender and much shorter than lateral branches (Fig. 28) *G. (S.) altaicum*
- Forewing vein 2A callous (Figs. 41, 47). Inner apical spur of each hind leg tapered and curved (Fig. 36). Tergum X + preanal appendages each with 5–15 small acute projections (Figs. 33, 38, 43, 49, 53). Ventral processes of sternum IX with inner branches thick (Figs. 35, 40) or longer than lateral branches (Figs. 40, 45, 54) or absent (Fig. 51) 2
- 2(1'). Tergum X + preanal appendages each slender and with 3–4 long, slender, irregular teeth (Figs. 38, 39). Ventral processes of sternum IX with inner branches much broader than lateral branches (Fig. 40) *G. (S.) minutum*
- Tergum X + preanal appendages broad and with 5–15 apical teeth of more nearly uni-

- form size and shape (Figs. 33, 43, 49, 53). Ventral processes of sternum IX with inner branches much more slender than lateral branches (Figs. 34, 45, 54) or absent (Fig. 51) 3
- 3(2'). Lateral branches of tergum X + preanal appendages each with about 15 spines of uniform shape and size (Figs. 33, 34). Ventral processes of sternum IX with inner branches shorter than lateral branches (Fig. 35) *G. (S.) intermedium*
- Lateral branches of tergum X + preanal appendages each with about 5 spines that may be uniform in size and shape (Fig. 49) or of different lengths (Fig. 43). Ventral processes of sternum IX with inner branches longer than outer branches (Fig. 45) or with only one pair of processes (Fig. 51) 4
- 4(3'). Lateral branches of tergum X + preanal appendages with spines of different lengths (Fig. 43). Ventral processes of sternum IX four in number (Fig. 45) *G. (S.) nylanderi*
- Lateral branches of tergum X + preanal appendages with spines of uniform lengths (Fig. 49). Ventral processes of sternum IX two in number (Fig. 51) *G. (S.) ussuricum*

Glossosoma (Synafophora) altaicum
(Martynov 1914b)
(Figs. 5, 26–32)

Mystrophora altaica Martynov 1914b: 72–84; holotype male (Russia, Altai), probably Zoological Institute, St. Petersburg.

Mystrophora lauta Tsuda 1940: 191; holotype male (Japan, Honshu), destroyed (M. Tanida, personal communication). Synonymized by Ross 1956: 155.

Glossosoma (Eomystra) altaicum: Ross 1956: 155.

Synafophora altaicum: Botosaneanu 1970: 289.

Glossosoma (Mystroglossa) altaicum: Kobayashi 1982: 7, type species of *Mystroglossa*.

Glossosoma (Synafophora) altaicum: Levanidova 1982: 156; Vshivkova 1986: 63–64.

This species, widely distributed in the Palearctic Region, now is found in China. It is one of a few members in this subgenus with 2A of the male forewing normal, but the inner spur of the male hind legs is high-

ly modified (Fig. 31). It somewhat resembles *G. (S.) nylanderi* in that (1) the pair of dorsolateral tendons of the phallocrypt have their anterior ends more widely separated from the phallobase (Figs. 30, 45) and (2) the setose apices of the inferior appendages are not so strongly recurved. These two species, together with *G. (S.) dulkeji*, all have their ventral process of sternum IX divided into four projections, but *G. (S.) altaicum* is similar to *G. (S.) dulkeji* in the shape of the upper branch of each process (Figs. 26, 53). Unlike other species of *G. (Synafophora)*, the inferior appendages are not angled but are more nearly aligned with the phallus throughout their length.

Length of forewing: Male 5.1–7.4 mm; female 6.9–8.2 mm.

Length of body: Male 5.8–8.2 mm; female 7.9–9.2 mm.

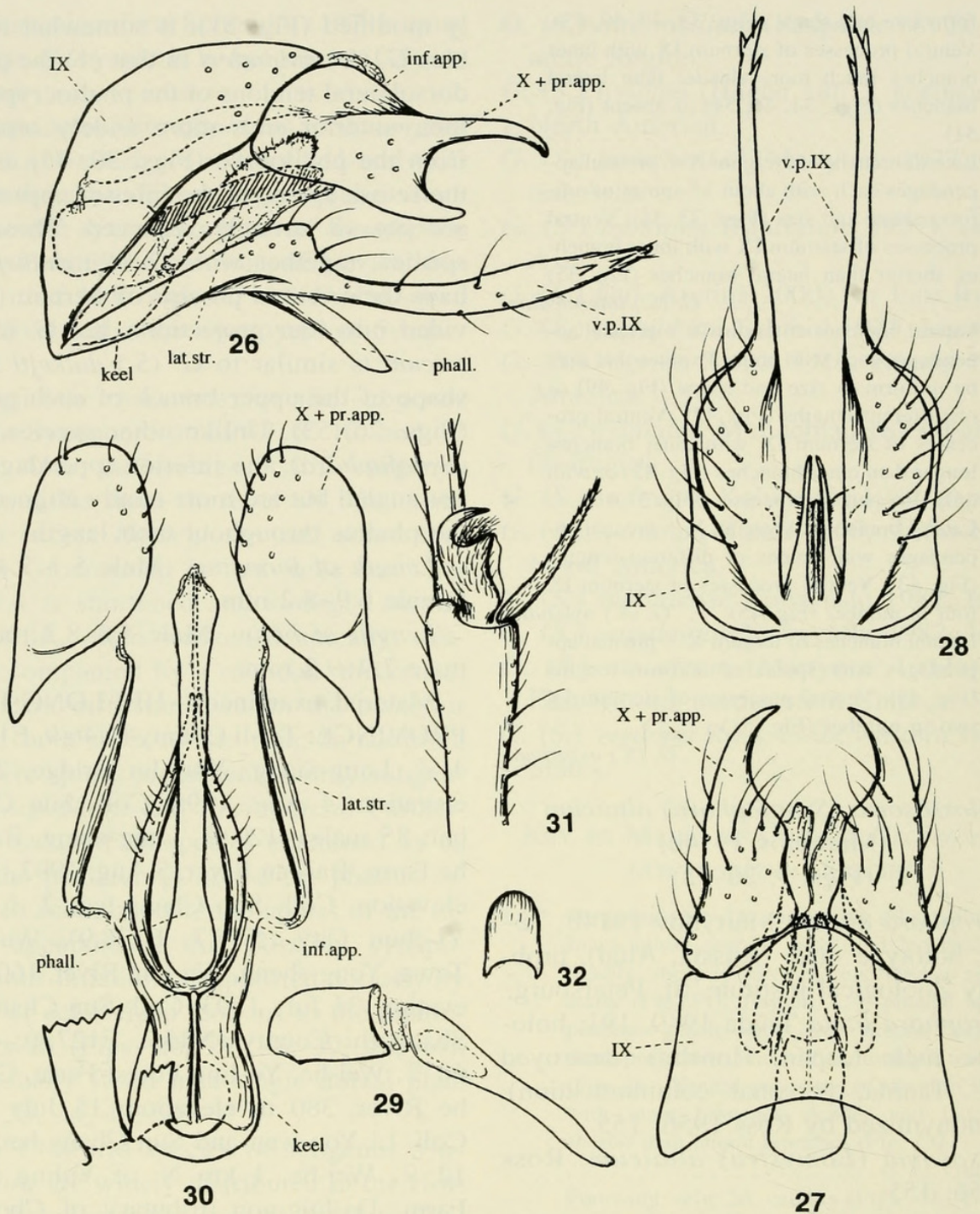
Material examined.—HEI-LONG-JIANG PROVINCE: Tie-li County (N46.9, E128.0): 4 ♂, Lang-xiang, Xing-lin Bridge, 200 m elevation, 4 Aug. 1993, Coll. Sun Chang-hai; 85 males, 120 ♀, Lang-xiang, Bai-lan-he Farm, Bai-lan River, 5 Aug. 1993, 160 m elevation, Coll. Sun Chang-hai; 2 ♂, 2 ♀, Yi-chun City (N47.7, E128.9), Wu-yi-lin Town, Yong-sheng, Wu-yun River, 160 m elevation, 31 July 1993, Coll. Sun Chang-hai.

Shang-zhi County (N45.2, E127.9): 40 ♂, 60 ♀, Wei-he, Yu-ling Forest Farm, Chong-he River, 380 m elevation, 15 July 1993, Coll. Li You-wen and Sun Chang-hai; 1 ♂, 12 ♀, Wei-he, 1 km N. of Yuling Forest Farm, Da-ling-gou, tributary of Chong-he River, 380 m elevation, 16 July 1993, Coll. Li You-wen and Sun Chang-hai.

Distribution.—Previously known from Far East Russia, Korea, and Japan, this species is now known in northeastern China: NEW CHINESE RECORD.

Glossosoma (Synafophora) intermedium
(Klapálek 1892)
(Figs. 25, 33–37)

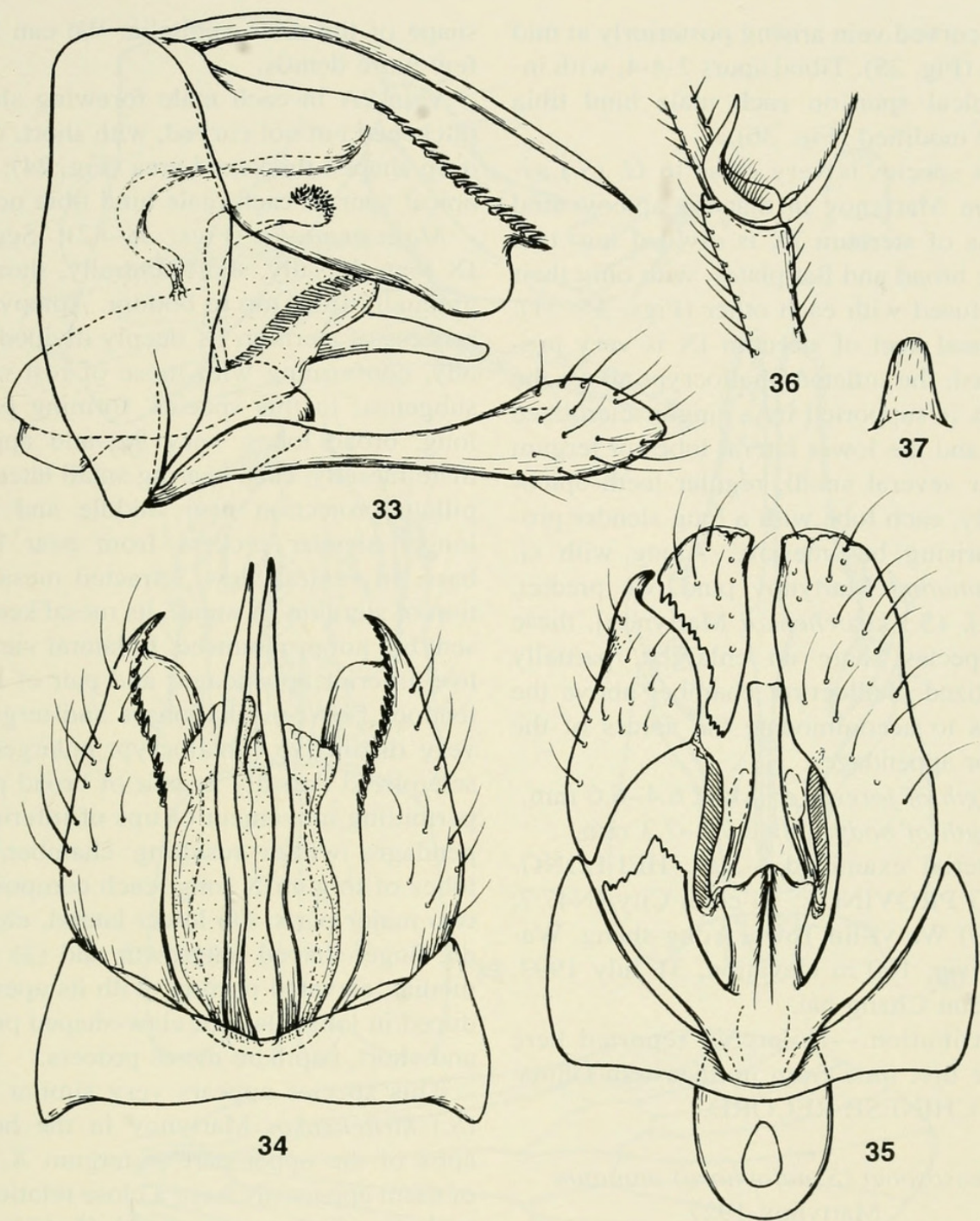
Mystrophora intermedia Klapálek 1892: 461, figs. 1–5; syntypes 1 female, 1 male [Bohemia, “Mumlava 5. VIII. (jedna fe-



Figs. 26–32. *Glossosoma (Synafophora) altaicum*. 26–30, Male genitalia. 26, Lateral. 27, Dorsal. 28, Ventral. 29, Phallus, lateral. 30, Relationship of phallus to lateral tendons, retracted inferior appendages, and ventromesal keel of abdominal segment IX, ventral. 31, Inner spur of right hind leg of male, mesal. 32, Male abdominal sternite VI process, ventral. dor.lat.str. = dorsolateral strip of the phallocrypt (paired), inf.app. = inferior appendage (paired), IX = abdominal segment IX, keel = keel of sternum IX, lat.str. = lateral strip of the phallocrypt (paired), phall. = phallus, v.p.IX = ventral process of abdominal sternum IX (paired), X + pre.app. = abdominal tergum X and preanal appendage (paired).

male), Milnice 14. VIII. (jeden male)”), apparently Czech Republic Academy of Sciences, Prague. Many authors have reported this species in various scattered locations in Europe and northern North

America by this name or in genera *Synafophora* or *Glossosoma* or *Klapalekia* or *Mystrophorella*. Martynov (1914a) first reported it in eastern Asia (Russia: Kamchatka) by this name.



Figs. 33–37. *Glossosoma (Synafophora) intermedium*. 33–35, Male genitalia. 33, Lateral; 34, Dorsal; 35, Ventral. 36, Inner spur of right hind leg of male, mesal. 37, Male abdominal sternite VI process, ventral.

Glossosoma (Eomystra) intermedium: Ross 1956: 154–155.
Glossosoma (Synafophora) intermedium: Schmid 1980: 24; Levanidova 1982: 156; Vshivkova 1986: 69–70, 72; Schmid 1998: 24–25.

Two male specimens collected from northeastern China are very similar to the description and illustration of *G. (S.) inter-*

medium provided by Ross (1956) and Vshivkova (1986) in coloring, the shape of the spurs of the male hind tibiae, and the structure of the male genitalia. Our illustrations show clearly that the species has all the synapomorphies, which are shared in this subgenus.
Anal cell of each male forewing with small, suboval thickened area bearing hairs; 2A very short and curved, with small, spu-

rious, curved vein arising posteriorly at mid length (Fig. 25). Tibial spurs 2-4-4, with inner apical spur on each male hind tibia highly modified (Fig. 36).

This species is very close to *G. (S.) ussuricum* Martynov in that the apicoventral process of sternum IX is divided into two simple broad and flat plates, with only their bases fused with each other (Figs. 35, 51); the mesal keel of sternum IX is very pronounced; the inflated phallocrypt above the phallus is supported by a single sclerotized plate; and the lower lateral lobes of tergum X bear several small, regular teeth apico-dorsally, each lobe with a long slender process arising basomesally. Along with *G. (S.) minutum* Martynov [and, we predict, with *G. (S.) kiritchenkoi* Martynov], these two species share an enlarged, partially sclerotized phallocrypt chamber above the phallus to accommodate the apices of the inferior appendages.

Length of forewing: Male 6.4–6.6 mm.

Length of body: Male 7.2–7.3 mm.

Material examined.—2 ♂, HEI-LONG-JIANG PROVINCE: Yi-chun City (N47.7, E128.9) Wu-yi-lin Town, Yong-sheng, Wuyun River, 160 m elevation, 31 July 1993, Coll. Sun Chang-hai.

Distribution.—Holarctic, reported here for the first time from northeastern China: NEW CHINESE RECORD.

Glossosoma (Synafophora) minutum

Martynov 1927

(Figs. 4, 24, 38–42)

Glossosoma (Synafophora) minuta Martynov 1927: 167–168, pl 7 f 8–10; holotype male (Turkestan: “Vicinity of Kopal, Semiretchje district; 4–5 VI 16, Coll. W. Snitnikov”), probably Zoological Institute, St. Petersburg.

This species was collected for the first time in China (Xin-jiang Province) by Dr. W. Mey (in litt.). Martynov’s original description was very detailed in the color pattern, forewing venation, and the general

shape of the male genitalia. We can add a few more details.

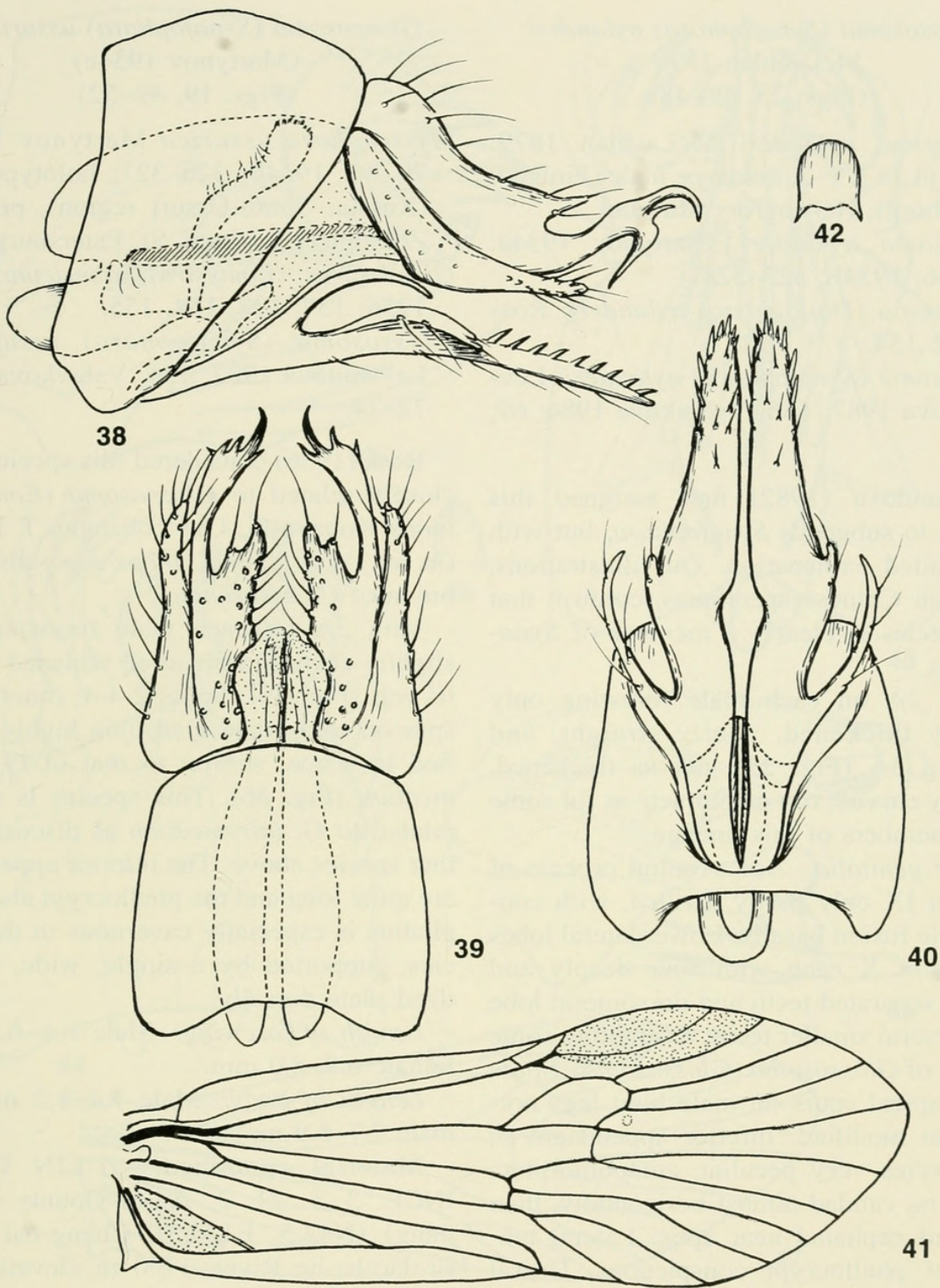
Vein 2A in each male forewing slightly thickened but not curved, with short, water-drop-shaped thickened area (Fig. 24); inner apical spur of each male hind tibia normal.

Male genitalia (Figs. 38–42): Segment IX long dorsally, short ventrally, shortened gradually from top to bottom. Apicoventral process of sternum IX deeply divided mesally, conforming with those of rest of this subgenus; in this species, forming pair of long, broad lobes, very flat and approximate mesally, each bearing small lateral papillate projection near middle and much longer slender process from near lateral base. In ventral view, retracted mesal portion of sternum IX small, its mesal keel present but not pronounced. In lateral view, setose inferior appendages and pair of lateral tendons between phallobase and tergum X very distinctive. Phallocrypt enlarged and sclerotized dorsally as pair of broad plates, permitting movement of tips of inferior appendages within resulting chamber. Side lobes of tergum X long, each composed of two major parts: (1) lower lateral, elongated, finger-shaped outgrowth and (2) upper medial, elevated portion, with its apex produced in long, slender, claw-shaped process and short, papillate mesal process.

This species appears very similar to *G. (S.) kiritchenkoi* Martynov in the hooked apex of the upper part of tergum X. Both of them apparently have a close relationship with *G. (S.) ussuricum* and *G. (S.) intermedium* by sharing the following synapomorphies: (1) divided ventral process of sternum IX very flat and broad; (2) dorsal phallocrypt very deep and sclerotized, forming spacious chamber for apices of inferior appendages (character predicted for *G. kiritchenkoi*, since we have not yet seen this species); and (3) tergum X lobes each bearing dorsomesal process.

Length of forewing: Male 5.1–6.0 mm; female 5.8 mm.

Length of body: Male 5.8–6.8 mm; female 6.7 mm.



Figs. 38–42. *Glossosoma (Synafophora) minutum*. 38–40, Male genitalia. 38, Lateral. 39, Dorsal. 40, Ventral. 41, Male right forewing, dorsal. 42, Male abdominal sternite VI process, ventral.

Material examined.—XIN-JIANG PROVINCE: 4 ♂, 1 ♀ (NAU) and 183 ♂, 71 ♀ (MNH), Tian-chi (N44.2, E88.0), Bao-dong Shan, 3–11 Oct. 1991 and 3–15 June 1992, Coll. W. Mey; 1 ♀, 8 larvae (MNH), U-rumu-qi Shi (N43.8, E87.6), Nan Shan, 3–15 June 1992, Coll. W. Mey; and 3 larvae

(MNH), Yining County (N43.9, E81.3), Borohoroshan, N.W. of Yining, 11 X 1991, Coll. W. Mey.
Distribution.—Previously known from “Turkestan,” now known also from Xinjiang Province, northwestern China: NEW CHINESE RECORD.

Glossosoma (Synafophora) nylanderi

McLachlan 1879

(Figs. 23, 43–48)

Glossosoma (Synafophora) ussuricum

(Martynov 1934a)

(Figs. 19, 49–52)

Glossosoma nylanderi McLachlan 1879: 474, pl 50 f. 1–2; holotype male (Finland: Uleaborg), Helsingfors Museum.

Diploglossa nylanderi: Martynov 1934a: 85–86; 1934b: 327–328.

Glossosoma (Diploglossa) nylanderi: Ross 1956: 154.

Glossosoma (Synafophora) nylanderi: Levanidova 1982: 156; Vshivkova 1986: 69, 71.

Levanidova (1982) first assigned this species to subgenus *Synafophora*, but with no detailed explanation. Our illustrations, based on Chinese specimens, confirm that this species is clearly a member of *Synafophora*.

Vein 2A on each male forewing only slightly thickened, nearly straight, and reaching 3A (Fig. 23), not as thickened, strongly curved, nor incomplete as for some other members of this lineage.

Male genitalia: Apicoventral process of sternum IX only partly divided, with considerable fusion basally. Lower lateral lobes of tergum X each with four deeply and widely separated teeth and dorsomesal lobe with several smaller teeth, resembling some species of *Glossosoma* (*Glossosoma*). Spurs 2-4-4, apical spurs on male hind legs normal, not modified. Inferior appendages in this species very peculiar, autapomorphic, extending caudad almost horizontally, then recurved cephalad near apex. Lateral tendons of phallocrypt conspicuous. Dorsal tendons of phallocrypt paired.

Length of forewing: Male 5.8–7.3 mm;.

Length of body: Male 6.7–8.4 mm.

Material examined.—HEI-LONG-JIANG PROVINCE: 5 ♂, Tie-li City, Lang-xiang (N46.9, E128.8), Xing-lin Bridge, 200 m elevation, 4 Aug. 1993, Coll. Sun Chang-hai.

Distribution.—Palearctic Region, now reported here for the first time from the Palearctic part of eastern China: NEW CHINESE RECORD.

Mystrophora ussurica Martynov 1934a: 79–80; 1934b: 326–327; holotype male (Russia: South-Ussuri region), probably Zoological Institute, St. Petersburg.

Glossosoma (Eomystra) ussuricum: Ross 1956: 137, 138, 154, 155.

Glossosoma (Synafophora) ussuricum: Levanidova 1982: 156; Vshivkova 1986: 72–74.

Ross (1956) considered this species most closely related to *Glossosoma (Eomystra) inops* Kobayashi. Our colleague T. Nozaki (in litt.) considers *G. inops* a possible synonym of *G. ussuricum*.

Vein 2A on each male forewing only slightly curved, with small widened area at its end (Fig. 19). Spurs 2-4-4, inner apical spur on each male hind tibia highly modified in shape, similar to that of *G. intermedium* (Fig. 36). This species is closely related to *G. intermedium* as discussed for that species above. The inferior appendages are quite long and the phallocrypt above the phallus is especially cavernous in this species, supported by a single, wide, sclerotized plate dorsally.

Length of forewing: Male 6.4–6.9 mm; female 6.9–8.0 mm.

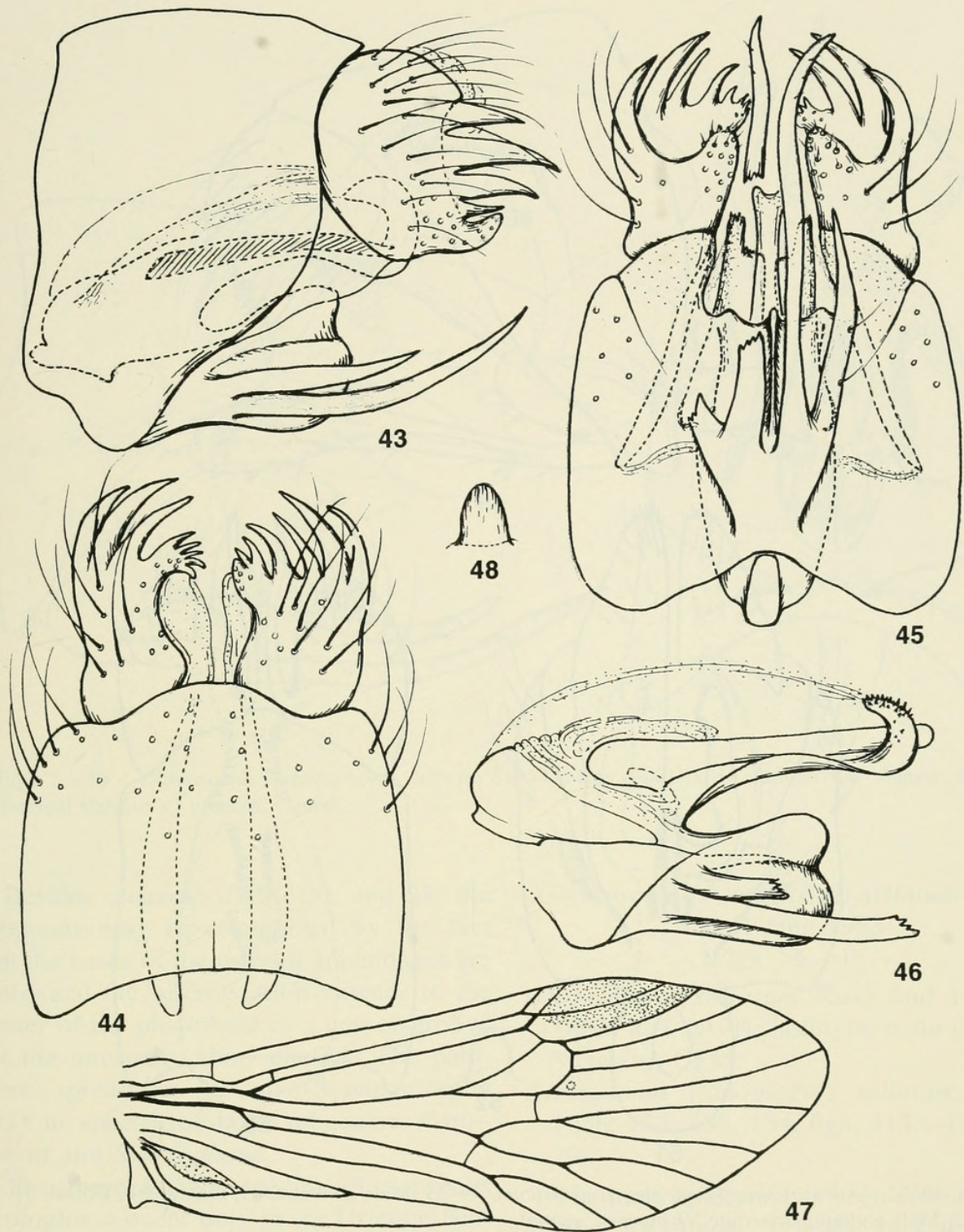
Length of body: Male 7.4–8.2 mm; female 7.7–8.9 mm.

Material examined.—JI-LIN PROVINCE: 3 ♂, 21 ♀, An-tu County (Song-jiang) (N42.5, E128.3), Chang-bai Shan, Er-dao-ba-he River, 1700 m elevation, 10 Aug. 1993, Coll. Sun Chang-hai.

Distribution.—Previously reported from the South Ussuri region of Russia, now known from northeastern China: NEW CHINESE RECORD.

Glossosoma (Protoglossa) Ross 1956

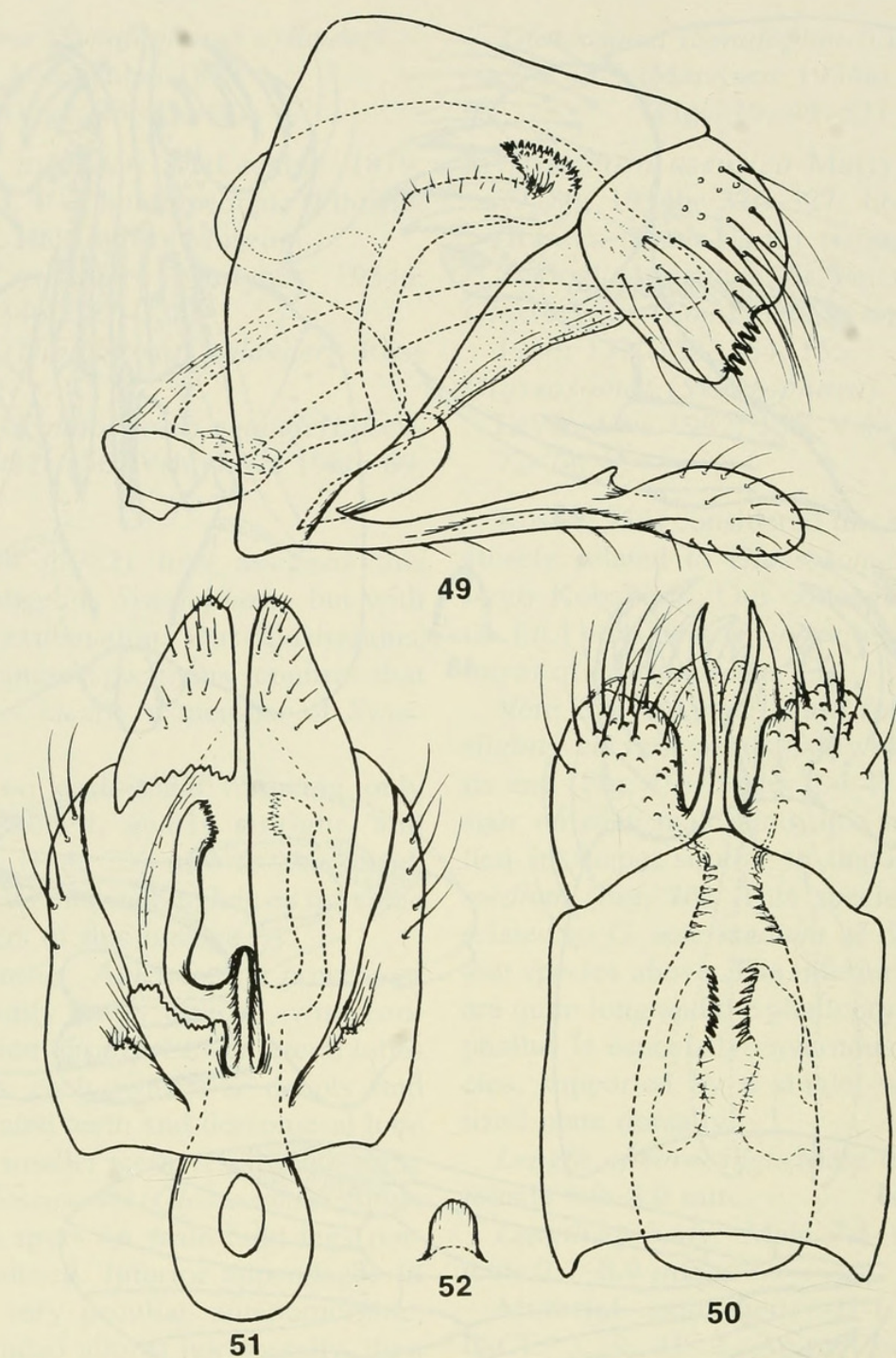
Protoglossa Ross 1956: 152, 154, as subgenus of *Glossosoma*. Type species by original designation: *Glossosoma taeniatum* Ross and Hwang.



Figs. 43–48. *Glossosoma (Synafophora) nylanderi*. 43–46, Male genitalia. 43, Lateral. 44, Dorsal. 45, Ventral. 46, Phallus and ventro-mesal keel of segment IX, lateral. 47, Male right forewing, dorsal. 48, Male abdominal sternite VI process, ventral.

Sinoglossa Ross 1956: 152, 154, as subgenus of *Glossosoma*. Type species by original designation: *Glossosoma sellatum* Ross and Hwang. Synonymized by Morse and Yang 1993: 140, 144.

Ross (1956) described his subgenus *Protoglossa* with only the type species. Morse and Yang (1993) synonymized Ross' monobasic subgenus *Sinoglossa* with *Protoglossa* to minimize redundancy after they in-

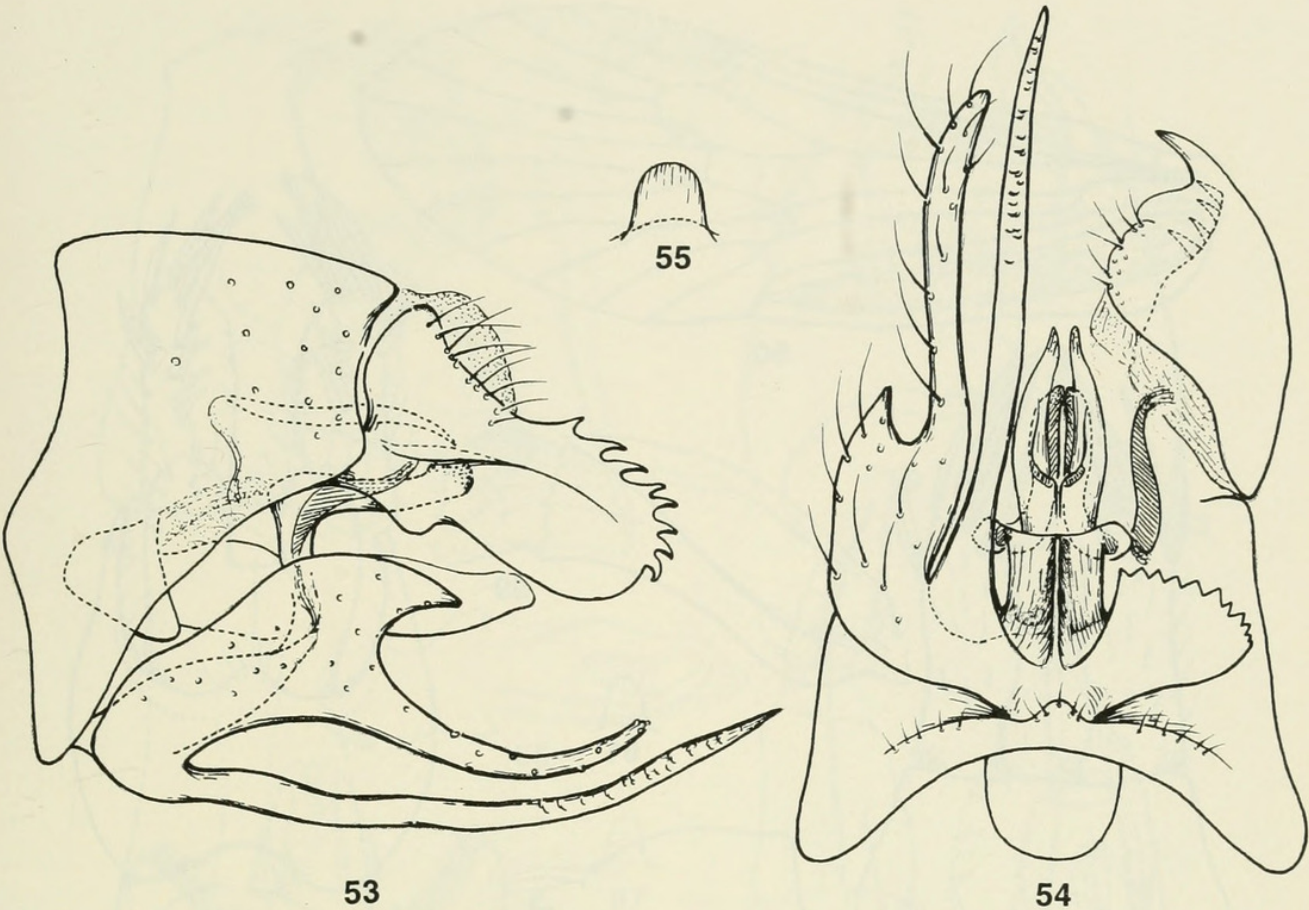


Figs. 49–52. *Glossosoma* (*Synafophora*) *ussuricum*. 49–51, Male genitalia. 49, Lateral. 50, Dorsal. 51, Ventral. 52, Male abdominal sternite VI process, ventral.

ferred that the two genera and species are sister lineages. Although the present reassessment of characters revises and adds to our 1993 inferences, the sister-group relationship, and thus our conclusion for synonymy, is confirmed. The type species of each of these two subgenera was described from China (Sichuan).

We now add a third species to subgenus

Protoglossa: *Glossosoma* (*Protoglossa*) *kchinam* Schmid, 1971, from India (Sikkim) because it shares Synapomorphies #14, 20, and 21 with *G. (P.) taeniatum* and *G. (P.) sellatum*. Although Schmid considered his species to be close to *G. (P.) taeniatum*, he placed it in the subgenus *Lipoglossa* because he (1958) disagreed with Ross' subgeneric classification.



Figs. 53–55. *Glossosoma (Synafophora) dulkeji*. 53–54, Male genitalia. 53, Lateral. 54, Ventral. 55, Male abdominal sternite VI process, ventral.

Besides characters #14, 20, and 21, the subgenus may be recognized by the fact that the bases of the inferior appendages are fused and the sclerotization extends to the venter of the phallobase as a cup or groove for the unusually short phallus. The paramere spines are absent (Synapomorphy #21) in species of both subgenera *Protoglossa* and *Synafophora*.

The three known species of subgenus *Protoglossa* occur only in the Oriental Biogeographic Region; the two Chinese species are known only from Oriental Sichuan Province.

- Glossosoma (Protoglossa)* World Species
- G. (S.) kchinam* Schmid 1971, India (Sikkim).
 - G. (S.) sellatum* Ross and Hwang 1953, China (Sichuan).
 - G. (S.) taeniatum* Ross and Hwang 1953, China (Sichuan).

Glossosoma (Protoglossa) sellatum Ross and Hwang 1953 (Figs. 56–61)

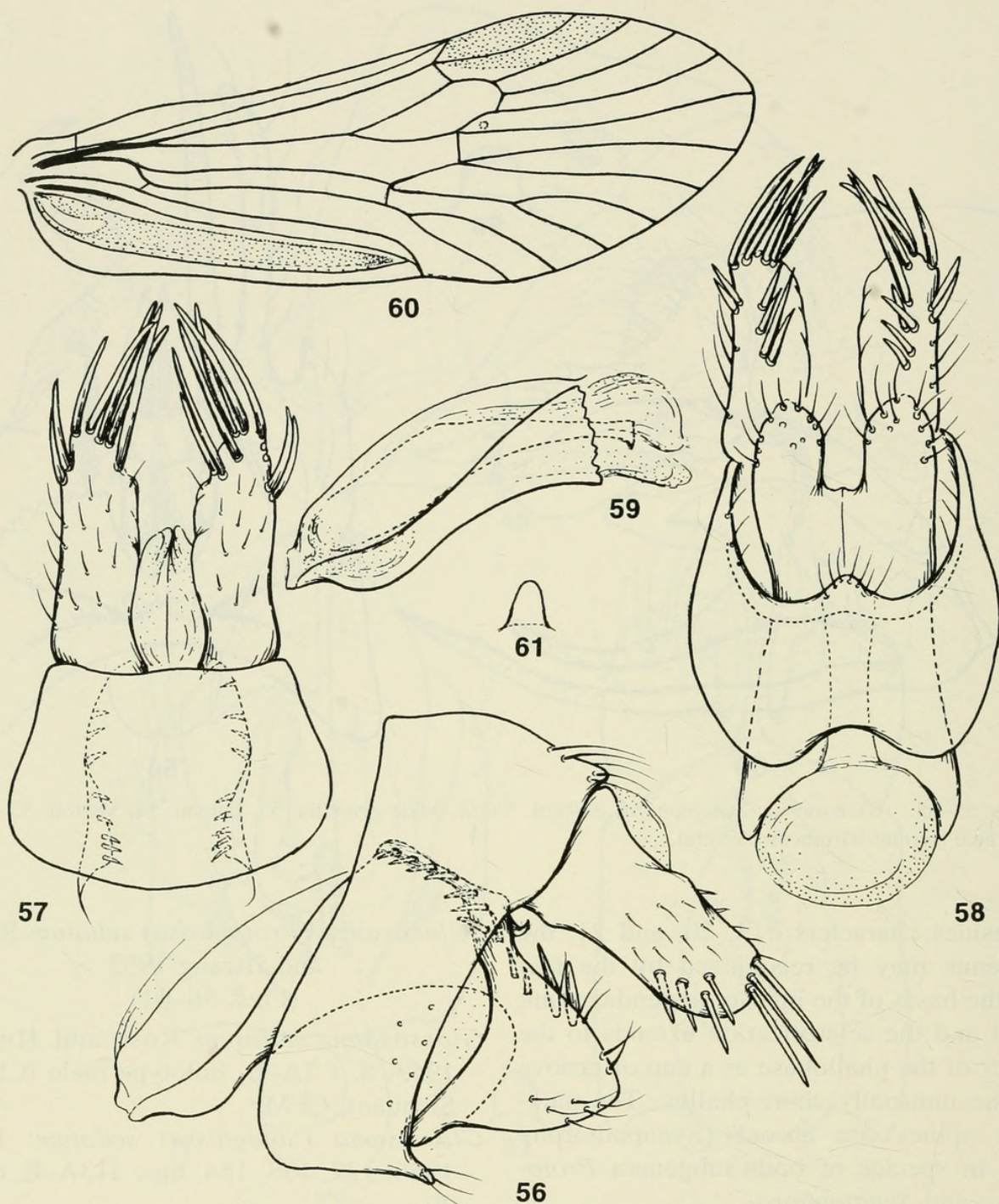
Glossosoma sellatum Ross and Hwang 1953: 8, f 2A–B; holotype male (China: Sichuan), CFM.

Glossosoma (Sinoglossa) sellatum: Ross 1956: 137, 138, 154, figs. 313A–E, chart 29.

The male holotype has been preserved in alcohol for almost 50 years, such that it is very difficult to see any color pattern, but we take this opportunity to provide new figures for the male forewing and genitalia.

Vein 2A on each male forewing distinctively elongated, with its distal end beyond the cross vein m-cu (Fig. 60); this vein and 3A thickened in pattern similar to those of *Glossosoma (Protoglossa) kchinam* and *G. (P.) taeniatum*.

Male genitalia (Figs. 56–59, 61): Sternum VI process very small. Tergum X lat-



Figs. 56–61. *Glossosoma (Protoglossa) sellatum*. 56–59, Male genitalia. 56, Lateral. 57, Dorsal. 58, Ventral. 59, Phallus, lateral. 60, Male right forewing, dorsal. 61, Male abdominal sternite VI process, ventral.

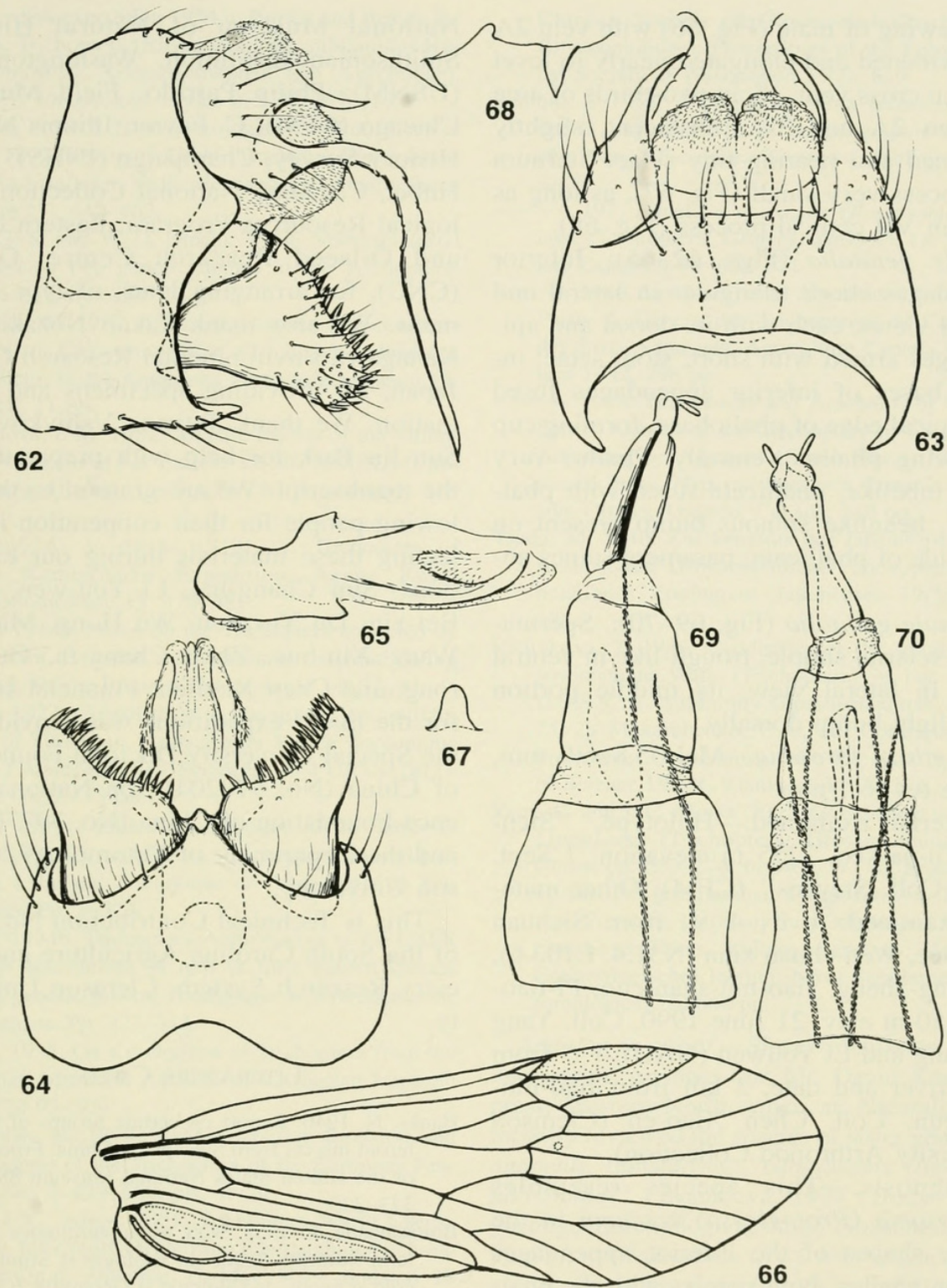
eral lobes elongated and bearing long, stout setae. Inferior appendages short, triangular in lateral view, fused with each other in basal half and extending along venter of phallobase to its anterior end.

Length of forewing: Male 5.8 mm, female 6.4 mm.

Material examined.—Holotype, “Sichuan, Tu-pa-keo, 2,255 m elevation, 4 Sept. 1929, Coll. Stevens” (CFM).

Diagnosis.—This species is quite different from the other two members of this subgenus in the elongated, lateral lobes of tergum X with long, stout setae; in the ventral position of the phallobase; and in the long fused bases of the inferior appendages extending along the venter of the phallobase to its anterior end.

Distribution.—Known only from the type locality.



Figs. 62–70. *Glossosoma (Protoglossa) taeniatum*. 62–65, Male genitalia. 62, Lateral. 63, Dorsal. 64, Ventral. 65, Phallus, lateral. 66, Male right forewing, dorsal. 67, Male abdominal sternite VI, ventral. 68, Male abdominal sternite VI (left) and VII (right) sternite processes, lateral. 69–70, Female genitalia.

Glossosoma (Protoglossa) taeniatum Ross and Hwang 1953
(Figs. 62–70)

Glossosoma taeniatum Ross and Hwang 1953; holotype male (China: Sichuan), CFM.

Glossosoma (Protoglossa) taeniatum: Ross 1956: 138, 154, fig. 298, chart 29.

Specimens from northern Sichuan were compared with the holotype. New structures are figured here and the female is associated with confidence for the first time.

Forewing of male (Fig. 66) with vein 2A both widened and elongated nearly to level of m-cu cross vein, about two-thirds of area between 2A and 3A translucent, slightly thickened and bearing tiny setae. Sternum VI process very small (Fig. 67), as long as sternum VII conical process (Fig. 68).

Male genitalia (Figs. 62–65): Inferior appendages short, triangular in lateral and ventral views, each with its dorsal and apical edges armed with short, stout setae; interior bases of inferior appendages fused with apical edge of phallobase, forming cup embracing phallus ventrally. Phallus very short, tubelike, phallicata fused with phallobase, beanlike spinous bump present on each side of phallicata; paramere spines absent.

Female genitalia (Fig. 69–70): Spermathecal sclerite simple, trough-like in ventral view; in lateral view, its middle portion with slight bump dorsally.

Length of forewing: Male 5.8–6.0 mm, female 6.4–6.7 mm.

Material examined.—Holotype, "Sichuan, Tu-pa-keo, 2255 m elevation, 7 Sept. 1929, Coll. Stevens" (CFM). Other material examined: 1 ♂, 4 ♀, from Sichuan Province, Wen-chuan xian (N31.4, E103.6), Wo-long-zheng, Jiao-mu-shan-cun, Pi-tiao-he, 1850 m elev. 21 June 1990, Coll. Yang Lianfang and Li Youwen (NAU); 1 ♂ from same river and date, 3 km from Jiao-mu-shan-cun, Coll. Chen Xiao-en (Clemson University Arthropod Collection).

Diagnosis.—This species resembles *Glossosoma* (*Protoglossa*) *kchinam* in the similar shapes of the inferior appendages and the phallus, both species with the phallicata bearing a setose patch, but the shapes of the side lobes of tergum X are obviously different in the two species.

Distribution.—Known only from Sichuan Province, southwestern China.

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Addition in proof.—Since submission of our manuscript, we note that Mr. David Ruiter (in press, *Western North American Naturalist*) has recently reviewed the species of sister genus *Anagapetus*, transferring “*Glossosoma* (*Anagapetus*) *shmidi*” Levanidova, 1979 (*Trudy Vsesoyuznogo Entomologicheskogo Obshchestva* 61: 92–95), to *Glossosoma* as a fourth unplaced species in the genus (bringing the genus *Glossosoma* to 116 species). This species apparently has Synapomorphies #1 and #16, placing it close to the two clusters of genera *Muroglossa*-*Glossosoma*-*Synafophora* and *Protoglossa*-*Lippoglossa*. However, it has none of the synapomorphies (#2, 3, 5, 9, 18) of either of these clusters of genera nor does it have any evident new synapomorphies to relate it to one or the other of them. Therefore, we infer that it may represent a third lineage, sister to them in a trichotomy.



Morse, John C and Yang, Lianfang. 2004. "The world subgenera of *Glossosoma curtis* (Trichoptera: Glossosomatidae), with a revision of the Chinese species of *Glossosoma* subgenera *Synafophora* Martynov and *Protoglossa* ross." *Proceedings of the Entomological Society of Washington* 106, 52–73.

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