The genus *Xenosciara* gen. n. and the phylogeny of the Sciaridae (Diptera)

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Abstract

The phylogeny of 50 genera or subgenera of the Sciaridae was studied by parsimony analysis. A cladistic analysis using 138 morphological characters from the adults of fifty-one ingroup and one outgroup species produced one most parsimonious cladogram. *Schwenckfeldina, Chaetosciara*, and *Scythropochroa* appeared successively as the sister groups of all other genera included in the analysis. The solution obtained was, in part, different from earlier, traditional views of sciarid phylogeny. The new Oriental genus *Xenosciara* had the phylogenetic relationship *[Metangela + (Pnyxiopalpus + Xenosciara)]*. *Xenosciara invisa* gen. n., sp. n., is described and illustrated. The new monotypic genus is exceptional in its hypopygial structures.

Key words: phylogeny, morphology, Sciaridae, *Xenosciara*, new genus, new species

Introduction

Sciaridae are small and usually dark-coloured nematocerous Diptera, rich in species, that occur in the world’s forested areas. They prefer shaded and humid conditions. They are nonbiting as adults and mostly soil-living or subcortical as larvae. Being rather uniform in structure and, with a few exceptions, lacking striking morphological modifications, their taxonomy has proved difficult at both the species and the supraspecific levels, and their taxonomy as well as their general biology has remained the least studied of all the large nematoceran families. More than 1800 valid species in some 90 genera are currently known. Judging by the abundance of morphospecies, only a small percentage of the actual species and genera have been described so far. In taxonomic revisions that have treated certain tropical genera, about 90% of the species recognized have been new to science.
The supraspecific taxonomy of the Sciaridae is even less studied. Rübsamen’s (1894) and Frey’s (1942) studies are the only attempts to study the world fauna at the generic level. For the Palaearctic fauna, Tuomikoski (1960) was the first to try to find natural groups within the family, and his outstanding work is the basis for all subsequent work on the systematics of the Sciaridae. Tuomikoski’s (1960) views on genera have generally been followed by most subsequent authors, including Mohrig and Menzel and their co-workers (Menzel and Mohrig 1997, 2000 and references therein), Freeman (1983), and Steffan (1966, 1981). The present authors have used cladistic analysis to test the monophyly of some of the currently recognized genera, and have sometimes obtained strikingly different results when compared with the traditional views (Vilkamaa 2000, Hippa et al. 2003, Vilkamaa et al. 2004, Hippa and Vilkamaa 2004, Vilkamaa and Hippa in press).

In a large-scale consideration of the phylogenetic relationships among the genera, Menzel and Mohrig (2000) put forward a phylogeny of all the Palaearctic genera and subgenera. They gave a cladogram and a data matrix, but did not perform any numerical computer analysis on these data. Consequently, their phylogeny was not based on parsimony, and possible character conflicts were not considered from a cladistic point of view (e.g. Schuh 2000).

Our aim here was to find a phylogenetically correct placement for the new and exceptional genus discussed here, and to describe it as an example of a previously unknown structural type of Sciaridae. At the same time, we wanted to study the phylogenetic relationships among the genera of the Sciaridae by parsimony analysis, to obtain a preliminary, parsimony-based hypothesis. Although not complete, our aim was to include in the analysis as wide a variety of the morphological diversity of the world fauna as possible.

Materials and methods

The new taxon

The specimen was collected with a sweep-net and was placed in ethanol. Other body parts except for the abdomen were removed from ethanol and mounted on a microscope slide in Euparal after dehydration in absolute ethanol. The abdomen was briefly treated with potassium hydroxide (KOH), studied under a stereomicroscope in ethanol and under a compound microscope in glycerol. The illustrations were made with the help of a drawing tube attached to a Leitz Diaplan compound microscope, while the abdominal structures were in glycerol. The methods of the phylogenetic analysis are explained below.

Phylogenetic analysis

The terminals

We studied the phylogenetic relationships by parsimony analysis; 138 characters from
the adult morphology were coded for 52 terminal taxa (Appendices 1–3). Selected species, the type-species of genera or subgenera when possible, were used as terminals instead of composite taxa or predetermined ground-plan character states. Of the ca. 90 described genera of the traditional Sciaridae, the ingroup consisted of 47 genera or subgenera, including the new genus *Xenosciara*. Representatives from the other groups of of Sciaroidea were *Rangomarama edwardsi* Jaschhof & Didham, *Sciarosoma borealis* Chandler, and the undescribed *Sciarontricha biloba* Hippa & Vilkamaa (Hippa and Vilkamaa, in press). *Rhynchoheterotricha* Freeman (an undescribed species) was selected as the out-group to which the resulting cladograms were rooted. In our cladistic analysis of the Sciaroidea (Hippa and Vilkamaa, in press), *Rhynchoheterotricha* proved definitively to belong outside the Sciaridae. Many species included in the analysis were known only from the male, but a few were known only from the female. We do not regard this as a problem in this particular data set because most external characters in the Sciaridae are identical in males and females. All terminals were studied from slide-mounted specimens, with the exception of some glycerol-mounts.

The material studied is deposited in the following collections (see Appendix 2): Bishop Museum, Honolulu (BPBH), Entomological Museum, Utah State University, Logan (EMUS), Forschungsinstitut Senckenberg, Frankfurt-am-Main (SMFD), Museu de Zoologia da Universidade de São Paulo, São Paolo (MZSP), National Museum of Namibia, Windhoek, (NMNW), New Zealand Arthropod Collection, Auckland (NZAC), Kai Heller Private Collection, Kiel (PKHK), Swedish Museum of Natural History, Stockholm (NRM), The Natural History Museum, London (BMNH), Zoological Museum, Finnish Museum of Natural History, Helsinki (MZH), Zoological Museum, University of Copenhagen (ZMUC).

The characters

In the analysis, we used the characters with equal weights, and the states of the multi-state characters as unordered. We coded the character state as inapplicable (-) when the character in question was absent from a terminal, and as '?' if the character state was not known. The search programme used does not differentiate between these cases. The data matrix (Appendix 3) was constructed and manipulated with the programme WinClada, Version 100.08 (Nixon 2002).

The procedure

We searched for the shortest cladograms with the computer programmes NONA, version 2.0 (Goloboff 1999), and Ratchet, together with WinClada. The search parameters used with NONA were ‘hold100000, hold/1000, mult*1000, max* and sswap*’. With these commands and settings, the programme makes a heuristic search and swaps branches with ‘tree bisection-reconnection’. The unsupported nodes were collapsed to accept only unambiguous support for the nodes in the strictest sense. The Ratchet search was done using 1000 iterations, with 100 trees to hold per iteration, 25 characters to sample. The resulting cladograms (Figs. 1–5) were studied with Winclada.
FIGURE 1. Phylogeny of the Sciaridae. The most parsimonious cladogram (881 steps, CI 19, RI 45) obtained with the program NONA.
FIGURE 2. Synapomorphies of the outgroups and the basal genera of Sciaridae. Numbers above hatch marks (open circle = homoplasious, black dot = unique, reversals allowed) refer to characters; numbers under hatch marks refer to state changes to the state indicated. Only unambiguous changes are shown.
FIGURE 3. Synapomorphies of the Eugnoriite and Phyoftsciara assemblage. Open circle homoplaseous, black dot unique, reversals allowed.

(cont.)
FIGURE 4. Synapomorphies of the Bradysiopsis and Cratyna assemblages. Open circle homoplaseous, black dot unique, reversals allowed.
FIGURE 5. Synapomorphies of the *Claustropyga*, *Lycoriella* and *Sciara* assemblages. Open circle homoplous, black dot unique, reversals allowed.

(cont.)
Phylogeny of the Sciaridae and the placement of *Xenosciara*

The parsimony analysis with NONA and with Ratchet produced one identical shortest cladogram (881 steps, CI 0.19, RI 0.45; Fig. 1). The result supports the monophyly of the traditional Sciaridae, although with this data set the undescribed *Sciarotricha* appeared as the sister-group of the Sciaridae, whereas in the analysis of the whole Sciaroidea (Hippa and Vilkamaa in press) that sister-group was the *Rangomarama. Schwenckfeldina* Frey, *Chae
etosciara* Frey, and *Scythropochroa* Enderlein appeared successively at the base of the traditional Sciaridae (Figs. 1 and 2). The rest of the analyzed genera were in three main clades (Figs. 1 and 3–5). The peculiar new *Xenosciara* was placed in the *Lycoriella*-clade, with the relationship \{*Metangela + (Pnyxiopalpus + Xenosciara)\}. The rather unexpected sister-group relationship between *Pnyxiopalpus* Vilkamaa & Hippa and *Xenosciara* was supported by five character state changes in the cladogram: first flagellomere longer than second (Character 3: 1), dense setosity on flagellomeres (12: 1), dark notal setae (43: 0), very small aedeagal teeth (113: 2), and high number of setae on male sternite 10 (115: 1) (Fig. 5). All these character state changes are homoplasious throughout the data set and have little to do with the general appearance of the species in question.

With regards to cladogram as a whole, the phylogenetic result now obtained is, in part, rather similar but, in part, totally different from earlier hypotheses. When compared with Menzel and Mohrig’s (2000) cladogram, which includes 48 of the Palaearctic genera or subgenera, perhaps the most striking differences are that in our solution there is no monophyletic basal *Sciara-Trichosia*-clade, nor a monophyletic clade including all genera with a front tibial comb, and that *Corynoptera* s.s. is in the same clade with *Epidapus* and *Bradysia*. Some problematic genera such as *Xylosciara* also have a completely different placement. Menzel and Mohrig’s (2000) phylogeny was based on parsimony but it neglected the character conflicts, and, in spite of the phylogenetic terminology used, the coding of characters and the procedure used for obtaining the result cannot be regarded as phylogenetic in the modern sense.

In evaluating the results presented here, the following points need to be taken into consideration: 1) The Sciaridae is one of the most difficult dipteran families to analyse because of the a high level of homoplasy in the character states. Molecular data and more precise morphological data (SEM, for example) would have to be included in the analysis to obtain a more stable solution. The instability of recent cladistic solutions is reflected in the position of certain problematic genera (e.g. *Xylosciara, Pseudolyctrielia*) that seem to have a different position, depending on which taxa are included in the analysis (e.g. Hippa *et al.* 2003, Vilkamaa and Hippa (in press) and Hippa and Vilkamaa (2004)). Furthermore, it is precisely the main clades in our cladogram that have the least support from the characters (Figs. 2–5), and their mutual positions would probably be the first to be falsified with better data. 2) Our present analysis includes about 60% of the described sciarid genera of the world, biased towards the Holarctic groups. Most of the excluded genera were described from the female sex alone and are available only as poorly preserved specimens,
which makes their analysis a challenge. Better material and better understanding of the characters of these poorly known genera is necessary. 3) There are still at least tens, if not hundreds, of undescribed groups, especially in the tropics, which should have generic status according to current thinking. The inventory and description of this vast biodiversity should precede further attempts to obtain hypotheses on sciarid phylogeny. The present work is an illustration of the problems involved in attempting to place a previously unknown morphological type into a preliminary phylogenetic system of the family.

The genus Xenosciara gen. n.

Type-species Xenosciara invisa sp. n.

Characters

Medium-sized Sciaridae, wing length 3.2 mm.

**Head** (Fig. 6). Eye bridge present, 4 facets wide. Eyes without interfacetal microtrichia, with interfacetal setae which extend well beyond the curvature of the facets. Ocelli three, in an equilateral triangle. Anterior vertex short, setose. Prefrons setose, the setae unequal in size. Clypeus distinctly separated from prefrons, setose. Antennal scape and pedicel (Fig. 6A) subglobular, with several ventral setae, flagellum with 14 flagellomeres which are subequal in size, the body about two and a half times as long as wide, the neck short, about one-third the width of the body, the vestiture of the flagellomeral body (Fig. 6C) with long seta-like sensillae arising from weak plate-like depressions, with a few short seta-like sensillae, without socketed setae, without hyaline sensillae, the ultimate flagellomere (Fig. 6D) apically with two sharp pegs, microtrichia present only basally on flagellomere 1. Maxillary palp with palpifer and three palpomeres; galea long, about as long as palpmere 1, apically branched; palpmere 1 unusually long, about four times as long as broad, palpmere 2 one-third of the length of palpmere 1, palpmere 3 about the length of palpmere 2, only slightly constricted basally; palpifer non-setose, palpmere 1 with one large lateral seta and several weaker dorsal setae, with scattered hyaline sensillae dorsally, palpmeres 2–3 with numerous setae, all with blunt apex.

**Thorax** (Fig. 7). Dark brown, setae dark. Scutum broadly setose laterally, with shorter and longer setae, dorsocentral setae in three rows, with longer and shorter setae, acrostichal setae in one row which is present only on the anterior half. Scutellum with numerous setae of unequal length, with a few long curved setae posteromedially. Anterior pronotum with a few setae, posterior pronotum non-setose, episternum 1 setose. Anepisternum with a deep v-shaped cleft dorsally, non-setose. Anepimeron with the anterior margin interrupted by the pleural pit, the posteroventral process reaching metepisternum and posteroventral margin of katepisternum, not shortened, the anterior margin ending ventrally at anterodorsal corner of episternum 3, non-setose. Katepisternum high, the dorsal margin slightly curved, not angulated, non-setose. Pleural pit at the middle of the dorsal margin of
katepisternum. Laterotergite with anterior margin strongly sigmoid, non-setose. Metepisternum non-setose. Metanotum non-setose, phragma intruding into the base of abdomen.

**FIGURE 6.** *Xenosciara invisa* sp. n. (holotype). — A: Head, frontal view, — B: Maxillary palp, basal palpomeres, dorsal view, apical palpomere, mesioventral view, — C: antennal flagellomere 4, ventral view, — D: apex of flagellomere 14, ventral view. Scale for A 0.50 mm, for B and C 0.10 mm, for D 0.05 mm.

**Wing** (Fig. 8). Hyaline, tinged with brown. R1 slightly shorter than R. r-m unusually long. stCu present, C, R, R1, R5 setose, other veins dorsally non-setose, all except C ventrally non-setose; wing membrane non-setose, the setae on posterior wing margin only on dorsal side. Haltere as long as coxae, the knob with a dorsal stripe of setae.

**Legs** (Fig. 8). Unicolorous, slightly paler brown than thorax; slender. Coxae long, several times as long as broad, metacoxa slightly shorter than the others. Tibiae with both
socketed setae and non-socketed setae (enlarged microtrichia), both subequal in size, middle and hind tibia with a few enlarged dorsal and lateral setae, on front tibia only apically, front tibia prolaterally with a subapical patch of setae, hind tibia with a retrolateral subapical transverse row of strong setae, without a dorsal row of strong setae. Tibial spurs 1+2+2, all subequal in size, longer than the apical width of tibia. Tarsomeres short, basitarsomere less than half the length of tibia, the two basal tarsomeres with enlarged setae ventrally/lateroventrally, tarsomeres 3 and 4 only apically; tarsal claws simple, pulvilli and empodium branched.

FIGURE 7. Xenosciara invisa sp. n. (holotype): Thorax, lateral view. Scale 0.50 mm. 1 = scutum, 2 = scutellum, 3 = metanotum (phagma), 4 = anterior pronotum, 5 = episternum 1, 6 = anterior anepisternum, 7 = anterior anepimeron, 8 = pleurotergite, 9 = katepisternum, 10 = pleural pit, 11 = episternum 3, 12 = halter, 13 = coxa 2, 14 = anterior spiracle, 15 = posterior spiracle.
Abdomen (Fig. 8). Brown. Tergites 2–7 with one pair of plaques. Male sternum 9 united with hypopygium. Hypopygium (Fig. 9). Tergite 9 large, apically rather evenly curved. Gonocoxites ventrally completely fused, gonocoxal apodemes short, weakly sclerotized, ending far posterior from the anterior margin of hypopygium, the apodemes of both sides medially united only by membrane. Gonostylus flexible in vertical plane, without apical tooth, with two apical megasetae, without flagellate setae, with the basomesial structures simple, with the basolateral apophysis strong, basoventral in position. Parameres weak, united to form a tegmen, parameral apodemes transverse, free from gonocoxal apodemes. Aedeagus without teeth or microtrichia, aedeagal apodeme/genital rod absent; a setose membrane extending from the ventral apicomesial part of gonocoxites to aedeagus. Tergite 10 membraneous, bilobed, with several short setae. Cercus flattened, setose only on posterior margin.

Female characters unknown.
FIGURE 9. Xenosciara invisa sp. n. (holotype). — A: Hypopygium, lateral view, — B: Hypopygium, dorsal view, — C: Hypopygium, ventral view, — D: Hypopygium, posterior view. Scale 0.20 mm. 1 = gonocoxite, 2 = gonostylus, 3 = basolateral apophysis of gonostylus, 4 = apical megasetae of gonostylus, 5 = tergite 9, 6 = cercus, 7 = tegmen, 8 = apodeme of tegmen (parameral apodeme), 9 = sternite 10, 10 = apicodorsal flagellate seta of gonocoxite.

Diagnostic characters

Xenosciara differs from all known Sciarinae by each of the following characters: 1) the very long palpomere 1, 2) ventrally fused male gonocoxites, 3) gonostyli movable in a vertical direction, 4) vertical tegmen, 5) setae only on the margin of the cercus, and 6) a setose membrane from the fused ventral part of the gonocoxites covering the aedeagus.

In its habitus, Xenosciara is a normal, unspecialized member of the Sciaridae. With its long maxillary palp, Xenosciara resembles Dolichosciara Tuomikoski, Prosciara Frey,
and *Keilbachia* Mohrig, but in these groups palpomere 3 is elongated and distinctly longer than the other palpomeres, and only *Xenosciara* has palpomere 1 strongly elongated. The basoventrally fused gonocoxites is not a rare character in the Sciaridae and the fused basal part can take up to half the length of the coxites in some groups (*Claustropyga* Hippa, Vilkamaa & Mohrig), but there are no other taxa in which the ventral aspect of hypopygium resembles that of *Xenosciara*. A reminiscent structural type is found in several other Sciaroidea, however. The gonostyli that work in a vertical direction are quite exceptional in the Sciaridae, but occur in some taxa of the other Sciaroidea (e.g. *Heterotricha* Loew, *Rhynchoheterotricha* Freeman and a few groups of the Cecidomyiidae). The type of association of the gonocoxites and the aedeagus/tegmen complex does not resemble that of any other Sciarinae but is reminiscent of *Sciarotricha* in terms of the membranous connection between the aedeagus and gonocoxites. *Sciarotricha*, however, has separate parameres and the membrane is only microtrichose.

**Xenosciara invisa** sp. n.


*Description* (male). **Head** (Fig. 6): Eye bridge 4 facets wide. Anterior vertex with 5 setae, prefrons with 12 setae, clypeus with 4 setae. Length/width of flagellomere 4 of antenna 2.25. Maxillary palp with 3 palpomeres, palpomere 1 with 5–6 setae, sensillae scattered on dorsal side. **Thorax** (Fig. 7): Brown. Anterior pronotum with 4 setae, episternum 1 with 11 setae. **Wing** (Fig. 8C): Length 3.2 mm, width/length 0.45, c/w 0.75, R1/R 0.80. M and Cu non-setose, r-m with 5 dorsal setae, bM non-setose, hind margin of wing with dorsal setae only. **Legs** (Fig. 8A, B): Apex of front tibia (Fig. 8A), length of basitarsomere 1/length of tibia 1 0.50. Spinose setae absent on T1, present on T2 and T3. **Abdomen** (Fig. 8D). **Hypopygium** (Fig. 9).

For other characters, see under the description of the genus.

*Female*: Unknown.

*Biology*: Unknown. The single specimen was found in a semi-cultivated habitat.

*Diagnostic characters*: See under *Xenosciara*.

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References


Appendix 1. The characters used in the phylogenetic analysis.

0. Number of ventral setae on pedicel: (0) <=6; (1) >6.
1. Form and size of pedicel: (0) normal; (1) enlarged, globular.
2. Length of female antennal flagellum: (0) normal; (1) shortened.
3. Male antennal flagellomere 1: (0) subequal in length to flagellomere 2; (1) distinctly longer; (2) distinctly shorter.
4. All antennal flagellomeres: (0) almost similar from base to apex of flagellum (Fig. 23A); (1) becoming much more elongated towards apex of flagellum (Fig. 33C).
5. The body of antennal flagellomere 4: (0) subcylindrical, straight; (1) subcylindrical but slightly curved (asymmetrically in relation to neck in lateral view); (2) subconical; (3) constricted.
6. Apical margin of flagellomeral bodies of antenna: (0) sharp; (1) rounded.
7. Necks of male antennal flagellomeres: (0) strongly shortened; (1) normal; (2) strongly elongated.
8. Length/subapical width of body of male antennal flagellomere 4: (0) >2.0; (1) 1–1.9; (2) <1.0.
9. Male antennal flagellomeres with setae arising from sockets, similar to those on scape and pedicel (0), setae with sockets on flagellomeres 1–5; (1) setae with sockets only on flagellomeres 1–2; (2) setae with sockets absent.
10. Length of the longest subapical setae/subapical width of body of antennal flagellomere 4: (0) <1.4; (1) 1.5–2.5; (2) 3.0–4.0; (3) >4.5.
11. Ground setosity of male antennal flagellomere 4: (0) short, individual setae at most 1/2 of flagellomeral width; (1) moderate, individual setae 3/4–1 of flagellomeral width; (2) long, individual setae more than twice flagellomeral width.
12. Setosity of antennal flagellomeres: (0) normal; (1) very dense; (2) sparse.
13. Colour of body of basal antennal flagellomeres: (0) dark; (1) pale.
14. Colour of body of medial and apical antennal flagellomeres: (0) dark; (1) pale.
15. Surface of basal antennal flagellomeres: (0) almost smooth; (1) irregularly crested; (2) with regular crests and/or depressions.
16. Female head: (0) normal, roundish; (1) dorsoventrally flattened and caudally elongated.
17. Male head: (0) normal; (1) dorsoventrally flattened and caudally elongated.
18. Eyes: (0) dichoptic; (1) holoptic.
19. Shape of occiput: (0) normal; (1) high (elongated).
20. Setae on female anterior vertex: (0) present; (1) absent.
21. Setae on male anterior vertex: (0) present; (1) absent.
22. Sensillae on anterior vertex: (0) present; (1) absent.
23. Setosity of prefrons: (0) all setae subequal; (1) with short and long setae.
24. Shape of clypeus: (0) normal; (1) reduced; (2) elongated; (3) strongly elongated.
25. Number of setae on clypeus: (0) zero; (1) one or two; (1) three or more.
26. Size of labium: (0) normal; (1) reduced.
27. Shape of gena: (0) normal; (1) produced.
28. Setae of gena: (0) normal, few; (1) numerous; (2) absent.
29. Number of palpomeres of maxillary palp: (0) three; (1) two; (2) one; (3) five.
30. Shape of palpomere 1 of three-segmented maxillary palp: (0) elongated; (1) short and roundish.
31. Number of setae on palpomere 1 of three-segmented maxillary palp: (0) more than six; (1) two to four; (2) one.
32. Arrangement of sensillae on palpomere 1 of maxillary palp: (0) scattered; (1) in a patch; (2) in a pit.
33. Elongated sensillae with truncate apices on palpomere 1 of three-segmented maxillary palp: (0) present; (1) absent.
34. Length of palpomere 2 of three-segmented maxillary palp: (0) elongated; (1) short, about as long as wide.
35. Number of sharp setae on palpomere 2 of three-segmented maxillary palp: (0) one; (1) two; (2) three or more.
36. Length of palpomere 3 of maxillary palp: (0) elongated; (1) short.
37. Posterior pronotum: (0) setose; (1) non-setose.
38. Form of katepisternum: (0) high; (1) low.
39. Dorsal margin of katepisternum: (0) straight; (1) angulate.
40. Pleural pit: (0) absent; (1) present.
41. Position of pleural pit: (0) anterior in position on the dorsal margin of katepisternum; (1) approximately at the middle of the margin; (2) posterior.
42. Front margin of anepimeron: (0) reaching to middle coxa; (1) reaching to upper corner of episternum 3.
43. Colour of notal setae: (0) dark; (1) pale.
44. Rows of acrostichals and dorsocentrals: (0) present; (1) absent.
45. Position of acrostichals: (0) present from anterior to posterior part of scutum; (1) present on anterior part only or absent.
46. Size of setae of scutellum: (0) all weak; (1) strong and weak present.
47. Female mesothoracic pleura: (0) setose; (1) non-setose.
48. Colour of pleura: (0) dark; (1) pale.
49. Form of normally developed wing: (0) wing with concave anterior margin (Sciara-type); (1) with straight anterior margin (Phytosciara-type).
50. Anal lobe of normal wing: (0) normal, developed; (1) strong; (2) greatly reduced.
51. Wing vein Sc: (0) elongated, gradually fading apicad; (1) with distinct, more sclerotized basal part.
52. Length of wing vein R1: (0) normal; (1) elongated, much longer than R; (2) very short, curved for almost all of its length.
53. Length of wing vein R: (0) normal; (1) elongated, distinctly longer than R1.
54. Wing vein St-Cu: (0) absent; (1) present.
55. Length of wing vein St-Cu: (0) normal; (1) very long; (2) very short.
56. Form of M1: (0) normal; (1) highly arched.
57. Setosity of wing membrane: (0) setose (with macrotrichia); (1) non-setose (without macrotrichia).
58. Ventral setosity of wing vein R1: (0) absent; (1) present.
59. Ventral setosity of wing vein R5: (0) absent; (1) present.
60. Dorsal setosity of wing vein M: (0) present; (1) absent.
61. Dorsal setosity of wing vein Cu1: (0) present; (1) absent.
62. Dorsal setosity of wing vein Cu2: (0) present; (1) absent.
63. Setosity of wing vein A1: (0) present; (1) absent.
64. Shape of wing vein Cu2: (0) smoothly curved; (1) strongly curved.
65. Wing vein A2: (0) distinct; (1) indistinct or absent.
66. Setosity of hind margin of wing: (0) ventrally setose; (1) ventrally non-setose.
67. Male halter: (0) normal; (1) reduced in size; (2) strongly elongated.
68. Female halter: (0) normal; (1) reduced in size; (2) strongly elongated.
69. Shape of coxae: (0) strong and long; (1) weak.
70. Colour of coxae: (0) pale; (1) dark.
71. Female front femur: (0) thin; (1) intermediate; (2) thick.
72. Subapical prolateral setae of front tibia: (0) not differentiated; (1) differentiated.
73. Bare non-setose subtriangular area on basal side of the modified subapical prolateral setae of front tibia: (0) absent; (1) present.
74. Size of subapical prolateral patch of modified setae on front tibia: (0) large; (1) small.
75. Proximal side of subapical prolateral patch of modified setae on front tibia: (0) non-bordered; (1) bordered.
76. Differentiated prolateral subapical setae on front tibia: (0) in a patch; (1) in an incomplete comb; (2) in a comb.
77. Colour of modified setae of subapical prolateral patch or comb of front tibia: (0) pale; (1) dark.
78. Length of front tibial spurs: (0) long, > tibial diameter; (1) short, < tibial diameter.
79. Length of middle tibial spurs: (0) subequal; (1) one shortened; (2) one absent.
80. Spinose setae on tibiae: (0) thick, oblique; (1) thin, appressed.
81. Dorsal spinose setae on front tibia: (0) absent; (1) present.
82. Lateral spinose setae on front tibia: (0) absent; (1) present.
83. Lateral spinose setae on middle tibia: (0) absent; (1) present.
84. Dorsal spinose setae on middle tibia: (0) absent; (1) present.
85. Apical setae of hind tibia: (0) strong; (1) weak.
86. Front basitarsomere: (0) elongated; (1) normal, short.
87. Midventral comb of setae on tarsi: (0) present; (1) absent.
88. Length of 4th tarsomere: (0) normal, as long as or longer than 5th; (1) shortened, shorter than 5th.
89. Teeth on tarsal claws: (0) absent; (1) small and oblique; (2) strong, perpendicular.
90. Length of male tergite 9: (0) short; (1) long.
91. Width of male tergite 9: (0) broad; (1) narrow.
92. Shape of apex of male tergite 9: (0) roundish; (1) acuminate.
93. Length of intercoxal area of hypopygium: (0) short; (1) long; (2) very long.
94. Seta-bearing intercoxal lobe of hypopygium: (0) absent; (1) present.
95. Setosity of intercoxal area of hypopygium: (0) continuously setose; (1) with non-setose stripe; (2) with broad non-setose area.
96. Broad non-setose area of intercoxal area: (0) microtrichose; (1) non-microtrichose.
97. Medial part of intercoxal area of hypopygium: (0) without a sclerotized stripe; (1) with a stripe.
98. Basal part of gonocoxite: (0) without a lobe-like aggregation of setae; (1) with a lobe-like aggregation of setae.
99. Ventromesal membrane of gonocoxite: (0) setose; (1) non-setose.
100. Apex of gonocoxite: (0) normal; (1) elongated, ventrally produced over base of gonostylus.
101. Apicominal ventral elongated seta of gonocoxite: (0) one present; (1) 2–5 present; (2) absent (not differentiated).
102. Length of gonocoxite: (0) short; (1) long.
103. Length of gonocoxal apodemes: (0) very long; (1) rather long; (2) short.
104. Dorsal ridge of tegmen: (0) absent; (1) present.
105. Sclerotization of parameres: (0) strong, parameres appearing brown; (1) weak, parameres appearing pale.
106. Shape of parameres: (0) gently curved; (1) strongly curved.
107. Tegmen: (0) absent; (1) present.
108. Shape and direction of the apodemes of the tegmen: (0) transverse; (1) short, directed anteriorly; (2) long, directed anteriorly.
109. Aedeagal margin: (0) absent; (1) present.
110. Genital rod: (0) well developed, sclerotized; (1) weak, poorly sclerotized; (2) absent.
111. V-shaped dorsal sclerotization of tegmen: (0) absent; (1) present.
112. Lateral sclerotization of aedeagal plate: (0) weak; (1) strong, U-shaped; (2) strong, short and V-shaped.
113. Aedeagal teeth: (0) small and microtrichia-like, in groups; (1) large, solitary; (2) very small, needle-like; (3) absent.
114. Size of setae of male sternite 10: (0) fine; (1) strong.
115. Number of setae of male sternite 10: (0) 1–2; (1) 4 or more.
116. Microtrichia on male sternite 10: (0) absent; (1) present.
117. Shape of male tergite 10 (cercus): (0) halves entire; (1) slightly incised or bilobed; (2) strongly bilobed or bifurcate; (3) shortened.
118. Length/width of gonostylus: (0) <2; (1) 2.0–2.5; (2) 2.6–3.0; >3.0.
119. Basomesal area of gonostylus: (0) simple; (1) impressed.
120. Basomesal impression of gonostylus: (0) short and compact; (1) deeply notched asymmetrically.
121. Mesal side of gonostylus: (0) not impressed; (1) impressed.
122. Mesal megasetae of gonostylus: (0) absent; (1) present.
123. Subapical megasetae of gonostylus: (0) absent; (1) present.
124. Mesal lobe of gonostylus: (0) absent; (1) present.
125. Position of mesal lobe: (0) dorsal; (1) medial; (2) ventral.
126. Conspicuous basal bodies of gonostylar megasetae: (0) absent; (1) present.
127. Short straight mesal setosity on gonostylus: (0) absent; (1) present.
128. Specialized thickened setae on mesal side of gonostylus: (0) absent; (1) present.
129. Apical tooth of gonostylus: (0) present; (1) absent.
130. Size of apical tooth: (0) very small, triangular; (1) small; (2) large; (3) very large.
131. Structure of apical tooth of gonostylus: (0) entire; (1) divided longitudinally.
132. Megasetae on lateral (apical) side of apical tooth: (0) absent; (1) present.
133. Whiplash-like seta(e) on gonostylus: (0) absent; (1) present.
134. Basolateral apophysis of gonostylus: (0) present; (1) absent.
135. Membrane between gonocoxite and gonostylus: (0) non-microtrichose; (1) microtrichose.
136. Megasetae at the actual apex of gonostylus (without apical tooth): (0) absent; (1) present.
137. Sclerotized spermathecae: (0) present; (1) absent.
Appendix 2. Taxa used in the phylogenetic analysis.

*Rhynchoheterotricha* Freeman (undescribed species) (South Africa; NRM)
*Rangomarama edwardsi* Jaschhof & Didham (New Zealand; NZAC)
*Sciarosoma borealis* Chandler (Finland; MZH)
*Sciarotrucha biloba* Hippa & Vilkamaa (in press) (Namibia; NMNW, MZH)
*Aerumnosa furcillata* Mohrig (New Guinea; BMNH)
*Apelmogreagris thoracica* (Macquart) (Malawi; BMNH)
*Bradysia angustipennis* Winnertz (Norway; MZH)
*Bradysiapysis vittata* (Meigen) (Finland; MZH)
*Camptochaeta camptochaeta* (Tuomikoski) (Finland; MZH)
*Chaetosciara estlandica* (Lengersdorf) (Finland; MZH)
*Clausstrophyga clausa* (Tuomikoski) (Finland; MZH)
*Corynoptera perpusilla* Winnertz (Germany; MZH)
*Cratyna atrata* Winnertz (Finland; MZH)
*Cratyna ambiguca* (Lengersdorf) (Finland; MZH)
*Cratyna (Spathobdella) nobilis* (Winnertz) (Finland; MZH)
*Ctenosciara hyalipennis* (Meigen) (Finland; MZH)
*Dichopygina nigrohalteralis* (Frey) (Finland; MZH)
*Dolichosciara flavipes* (Meigen) (Finland; MZH)
*Epidapus atomarius* De Geer (Finland; MZH)
*Eugnoriste sp.* (USA: Colorado; EMUS)
*Hyperlasion wasmanni* Schmitz (England; MZH)
*Keilbachia nepalensis* Mohrig (Nepal; SMFD)
*Leptosciarella scutellata* (Staeger) (Finland; MZH)
*Lobosciara spinipennis* (Sasakawa) (Micronesia; BPBM)
*Lycoriella (Lycoriella) castanescens* (Lengersdorf) (Finland; MZH)
*Lycoriella (Coelostylina) freyi* Tuomikoski (Finland; MZH)
*Lycoriella (Hemineurina) conspicua* (Winnertz) (Finland; MZH)
*Metangela spinata* Lane (Brazil; MZSP, MZH)
*Mohrigia hippai* Menzel (Burma; MZH)
*Peyerimhoffia brachyptera* Kieffer (Finland; MZH)
*Phytosciara halterata* (Lengersdorf) (Finland; MZH)
*Pnyxia scabiei* Hopkins (Finland; MZH)
*Pnyxopalpus raptor* Vilkamaa & Hippa (Malaysia, Sabah; MZH)
*Prosciara porrecta* (Lengersdorf) (Finland; MZH)
*Prosciara angustiloba* Hippa & Vilkamaa (Thailand; MZH)
*Pseudolycoriella subbruckii* (Mohrig & Hövemeyer) (Russia: Primorye; MZH)
*Pseusoisciara sp.* (Belize; MZH)
*Pseudozygoneura conica* Hippa, Vilkamaa & Heinakroon (Malaysia, Pahang; NRM)
*Rhynchosciara* sp. (Ecuador; MZH)
*Scatopsciara vitripennis* (Meigen) (Finland; MZH)
*Schwenckfeldina carbonaria* (Meigen) (England; MZH)
*Sciara thomae* (Linnaeus) (Finland; MZH)
*Scyphropochroa radialis* Lengersdorf (Finland; MZH)
*Trichomegalosphys melanocephala* (Fabricius) (Brazil; MZSP)
Trichosia splendens Winnertz (Finland; MZH)
Trichosia (Mouffetina) pulchricornis (Edwards) (Finland, Germany; MZH, PKHK)
Zygoneura sciarina Meigen (Finland; MZH)
Xenopygina paradoxa Frey (Finland; MZH)
Xenosciara invisa sp. n. (Malaysia, Pahang; NRM)
Xylosciara lignicola (Winnertz) (Finland; MZH)
Appendix 3. Data matrix for phylogenetic analysis. A = 0/1 polymorphism.

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