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On the morphology and systematic position of *Sciarosoma borealis* CHANDLER, based on new material from Fennoscandia (Diptera: Sciaroidea)

[Zur Morphologie und systematischen Stellung von *Sciarosoma borealis* CHANDLER auf der Basis neuen Materials aus Fennoskandien (Diptera: Sciaroidea)]

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Abstract An intensive search for *Sciarosoma borealis* CHANDLER resulted in the identification of numerous individuals in unsorted Malaise samples from Sweden and Finland. These new records, including the first finds in Sweden, are documented. The morphology of *Sciarosoma* males is redescribed and females are described for the first time. In the light of these new data, the distribution and phenology of *Sciarosoma* in Fennoscandia is reviewed. Recent attempts to classify *Sciarosoma* within the family Sciaridae in a new, broad sense are critically examined.

Key words Diptera, Sciaroidea, *Sciarosoma*, morphology, faunistics, Fennoscandia, systematics

Zusammenfassung Im Ergebnis intensiver Nachsuche in unbearbeitetem Malaisefallen-Material konnten mehrere neue Nachweise für *Sciarosoma borealis* CHANDLER aus Schweden und Finnland erbracht werden. Für Schweden sind es die ersten dokumentierten Funde überhaupt. Die Beschreibung des Männchens von *Sciarosoma* wird ergänzt; das Weibchen wird erstmalig beschrieben. Unter Einbeziehung dieser neuen Daten wird die Verbreitung und Phenologie dieser Art in Fennoskandien dargestellt. Jüngste Bestrebungen, *Sciarosoma* innerhalb eines erweiterten Familienkonzeptes der Sciaridae zu klassifizieren, werden kritisch beleuchtet.

Stichwörter Diptera, Sciaroidea, *Sciarosoma*, Morphologie, Faunistik, Fennoskandien, Systematik

Introduction

Research interest in the phylogeny of the Sciaroidea, commonly known as fungus gnats in a broad sense, has experienced an enormous vitalisation in recent years, resulting in a renewed debate on the definition of some of the included families as well as on interfamilial relationships (CHANDLER 2002; JASCHHOF & DIDHAM 2002; GRIMALDI et al. 2003; BLAGODEROV & GRIMALDI 2004; HIPPA & VILKAMAA 2005). A number of phylogenetic hypotheses, differing from one another to various degrees, is not just the result of different methodological approaches applied in the character analyses. Perhaps even more influential is the discovery, and inclusion in the analyses, of phylogenetically intriguing taxa, both fossil and recent. What happened occasionally and exceptionally in the last century, has nowadays turned into an almost steady stream of new findings of enigmatic Sciaroidea, with *Sciarosoma borealis* CHANDLER, 2002 being one among many others introduced in the recent past (CHANDLER 2002; JASCHHOF & DIDHAM 2002; GRIMALDI et al. 2003; JASCHHOF & HIPPA 2003; BLAGODEROV & GRIMALDI 2004; HIPPA & JASCHHOF 2004; JASCHHOF 2004a, b; HIPPA & VILKAMAA 2005), and several more awaiting their publication in the near future (JASCHHOF, in press, in prep.). This accelerated process clearly involves the risk of a corresponding inflation of ever new phylogenies published, which are of more harm than use as soon as they are proposed in their immediate manifestation in the higher-level classification of the Sciaroidea. So the monotypic genus *Sciarosoma* was recently classified in its own subfamily, Sciarosominae, within a revised concept of the family Sciaridae (HIPPA & VILKAMAA 2005), whereas CHANDLER (2002) offered arguments for leaving *Sciarosoma* unassigned to any of the existing families traditionally recognised within the Sciaroidea. The latter view, that we consider modest and pertinent for the time being, is followed here, which will be discussed further below.

Sciarosoma borealis is one of the very few 'enigmatics' which belong to the recent northern hemisphere fauna. Its distribution comprises parts of northern and central Europe (CHANDLER 2002; KALLWEIT & JASCHHOF 2004). As regards Fennoscandia, a total of eight individuals were hitherto documented from Norway, Finland and Russian Karelia (see CHANDLER 2002; POLEVOI et al., in press). All individuals hitherto known from Europe, 11 in total, are male adults collected by various entomological standard methods in humid coniferous forests in early summer (for details, see CHANDLER 2002; KALLWEIT & JASCHHOF 2004).

A study in progress on the Fennoscandian fauna of the Lestremiinae (Sciaroidea: Cecidomyiidae) (JASCHHOF & JASCHHOF, in prep.) revealed, practically as a by-product, a number of new records of *Sciarosoma borealis*, including the first records from Sweden. This increase of faunistic knowledge is documented here in detail. The new material comprises numerous males and a few females, which allows us to supplement the description of the male (CHANDLER 2002), and to describe the female for the first time.

Material and methods

Specimens of *Sciarosoma borealis* were found in unsorted Malaise samples under care of the Swedish Museum of Natural History, Stockholm, where the new material is also deposited. Part of the material was mounted in Canada balsam on microscope slides, another part is kept in 70 % ethanol. Body length was measured on individuals extended in ethanol. Usage of morphological terminology follows that of SØLI (1997) and JASCHHOF & DIDHAM (2002). Drawings were made using an Olympus BX50 microscope in combination with the U-DA drawing unit. Photographs were taken using a digital Olympus C-3030 camera attached to Olympus SZH10 and BH-2 microscopes.

Sciarosoma borealis CHANDLER

(Figs 1–11)

Material studied. SWEDEN: 1♂ (on slide), Västerbotten, Skellefteå, Stensträsk, Björnhultet State Forest Reserve, in old-growth spruce *Picea abies* forest, 17 May–17 Oct. 1997, Malaise trap, B. VIKLUND; 1♂ (in ethanol), Norrbotten, Niemisel, Blåkölen State Forest Reserve, in moist forest of spruce with willow *Salix*, 13 June–20 July 1994, Malaise trap, B. VIKLUND; 4♂♂, 3♀♀ (on slides), 17♂♂, 3♀♀ (in ethanol), Norrbotten, Boden, Krokliden State Forest Reserve, over aspen *Populus tremula* log, 13 June–20 July 1994, Malaise trap, B. VIKLUND. FINLAND: 1♂ (in ethanol), Tavastia australis, Tammela, Liesjärvi National Park, in swamp forest of birch *Betula* and spruce, 28 May–26 June 2004, Malaise trap, M. & C. JASCHHOF; 1♂, 1♀ (on slides), 4♂♂, 1♀ (in ethanol), Tavastia borealis, Saarijärvi, Pyhä-Häkki National Park, E Poika-aho farm, in coniferous forest of spruce and pine *Pinus*, 7 June–4 July 2004, Malaise trap, M. & C. JASCHHOF; 3♂♂ (on slides), Karelia borealis, Lieksa, Patvinsuo National Park, Autiovaara, in mixed taiga of spruce, birch and aspen, 12 June–7 July 2004, Malaise trap, M. & C. JASCHHOF.

Supplement to description

CHANDLER 2002: 125 (description male; figs wing, thorax, and male terminalia)

Male (Fig. 1). Body length: 3.5–4.5 mm.

Head: Postcranium with strong setae of various lengths. Postgenae with median convexities well developed. Postfrons bilobed, slightly protruding; setose. Frontal tubercle two-pointed. Prefrons non-setose. Clypeus with large setae. Antenna with scape a little larger than pedicel, both setose. Flagellum with 14 flagellomeres; each flagellomere cylindrical, with very short neck; first flagellomere longest, i.e. 3.5 times as long as wide; fourth flagellomere 2.7 times as long as wide. Flagellum without microtrichia except a few basally on flagellomere 1; with dense cover of non-socketed setae as long as width of flagellomere, or shorter, intermingled with peg-like sensilla; in addition with a few socketed setae on first, second, terminal, and occasionally other flagellomeres. Interommatidial setulae long and numerous. Labrum beak-like; non-setose. Maxillae with stipites separate, large, setose; lacinia well developed, style-like. Maxillary palpus (Fig. 4) with 5 palpomeres on a weak swelling (palpifer); first palpomere well developed, non-setose; palpomeres 2–5 setose; palpomere 3 with numerous scattered hyaline sensilla, a few occasionally also on flagellomere 4. Labium with premental apodeme bearing a pair of short processes posteriorly.

Thorax: Antepronotum and episternum 1 clearly separate; both setose. Epimeron 1 large, subtriangular. Scutellum with setae as long as those on scutum. Mediotergite high, in lateral profile slightly arched. Mediotergite and laterotergites with distinct suture in between. Laterotergite somewhat bulging (not as flat as in, e.g., Sciaridae). Mid-pleural pit present, albeit comparatively flat and rather slit-like. **Legs**: Fore coxae 3/4 as long as height of thorax, mid and hind coxae a little shorter. Tibial spurs 1:2:2. Fore tibia with anteroapical depression indistinct, not delineated by a rim, bearing some 20 setae smaller and paler than neighbouring setae. Pretarsal claws small, slightly arched, without teeth. Pulvilli larger than empodium, latter consisting of 4–5 hairs shorter than claws. **Wing** (Fig. 3): With setae dorsally on all veins except Sc and Rs, and ventrally on R, R1, R5, ta, M1, and M2. R5 curved towards anterior wing margin before apical downcurve.

Abdomen: Tergites 1–8 subrectangular, densely setose. Tergal plaques hardly discernible, situated in an antero-lateral position on each of the tergites, with their pattern 0/1/1/1/1/1/1/0. Sternite 1 present as short, non-setose, sclerotised bar; sternites 2–8 subrectangular, densely setose. **Terminalia**: Gonocoxites (Fig. 5) ventro-centrally with large, setose subtriangular protrusion, presumably indicating the presence of sternite 9; ventro-posterior margin with 2 pairs of elongate processes, outer pair wider and bearing numerous setae ventrally, inner pair slender and bearing a very few scattered setae; gonocoxal apodemes strong and extending far anteriorly. Gonostylus (Figs 5, 6) consisting of 2 large, separately articulating portions; ventral portion flattened, broadly rounded distally, outside strongly setose except apically, inside less setose with long setae distally and a group of short setae on a small lobe subbasally; dorsal portion wide proximally, narrowed and flattened distally, in distal half with inner margin strongly sclerotised and bearing a fine, saw-like dentation, apically with tiny tooth, with 4–5 spine-like setae each subapically and inside subbasally. Aedeagus and parameres (Fig. 7) together forming a complex, comparatively weakly sclerotised structure. Aedeagus with very large sclerotised apodeme bearing a long, pointed process; ventro-distally with tiny, pale teeth. Ventro-central portions of parameres sclerotised, separate in middle; apodemes comparatively poorly developed. Dorsal portions of parameres forming large, subrectangular tegmen; posterior margin medially weak; apodemes strongly developed and interconnected by narrow transverse bridge. Tergite 9 (Fig. 8) short, subtrapezoid, strongly setose. Tergite 10 present, but extremely weak and in slide-mounts just occasionally traceable, sometimes with a few setulae. Hypoproct (Fig. 8) one-lobed, large, with large pubescence. Cercus (Fig. 8) blunt, strongly setose posteriorly.

Female (Fig. 2). Body length: 4.0–5.0 mm.

Head: Antennal flagellum shorter than in male; fourth flagellomere 1.6 times as long as wide; socketed setae usually present on all flagellomeres.

Terminalia (Figs 9–11): Tergite 8 posteriorly with setae of various lengths. Gonocoxites 8 massive; with large setae posteriorly and smaller setae of various lengths elsewhere. Gonapophysis 8 very weakly membranous. Tergite 9 well developed; setose. Gonapophysis 9 present as sclerotised internal ribs merging anteriorly to form a large notum. Tergite 10 well developed; setose; practically fused laterally with sternite 10. Sternite 10 setose laterally and ventrally, its inner margin sclerotised and smooth. Cercus two-segmented, setose; basal segment little longer than distal segment, with a few tiny, pore-like sensilla dorso-posteriorly; distal segment in lateral view almost circular. With narrow, spoon-shaped sclerite posteriorly of tergite 10 and in between basal segments of cerci, presumably representing epiproct. Two spermathecae strongly sclerotised, bean-shaped, with numerous tiny pores.

Fig. 1: Habitus of male *Sciarosoma borealis* CHANDLER (Finland, Tavastia borealis, Pyhä-Häkki National Park).

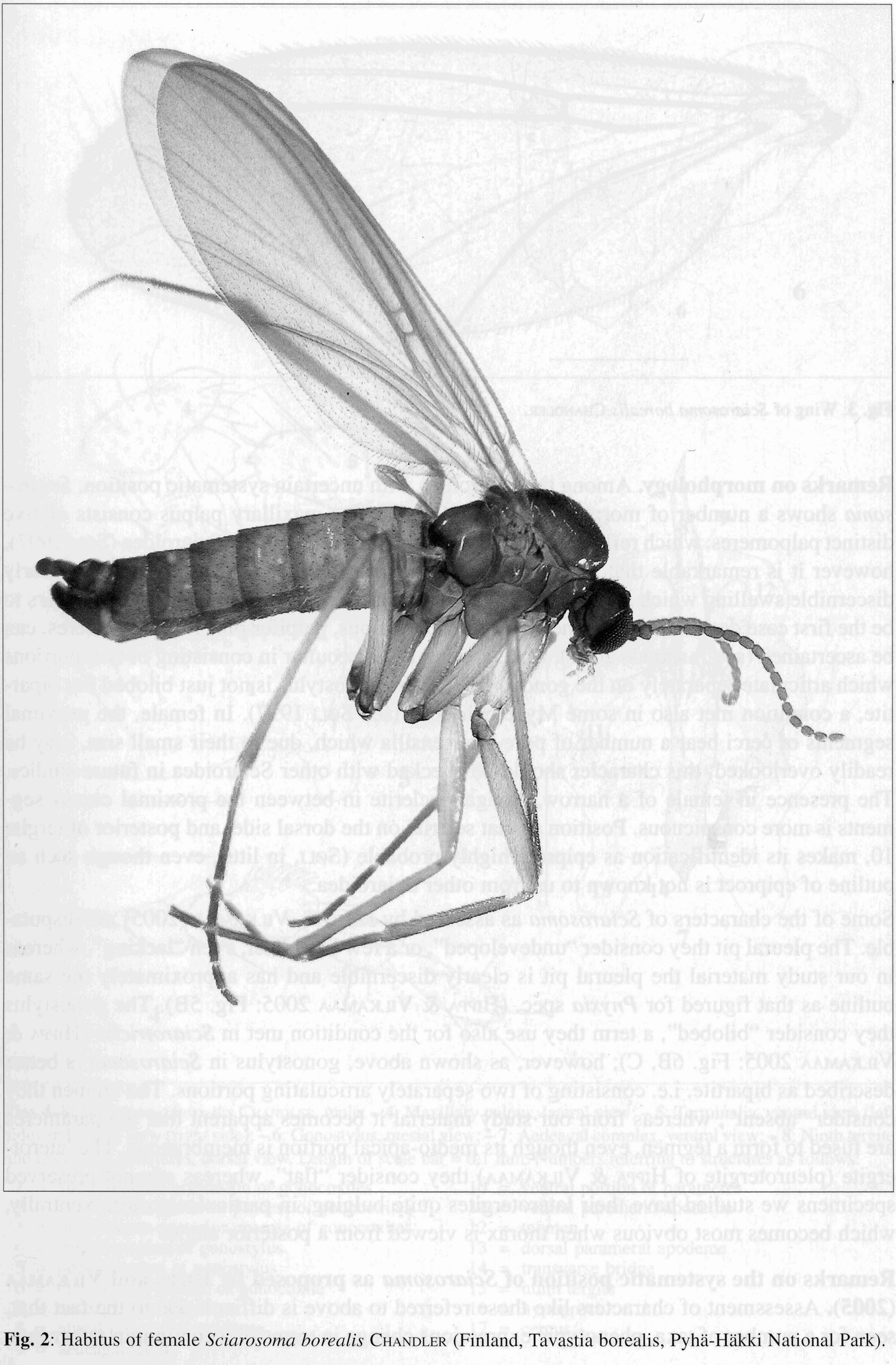


Fig. 2: Habitus of female *Sciarosoma borealis* Chandler (Finland, Tavastia borealis, Pyhä-Häkki National Park).

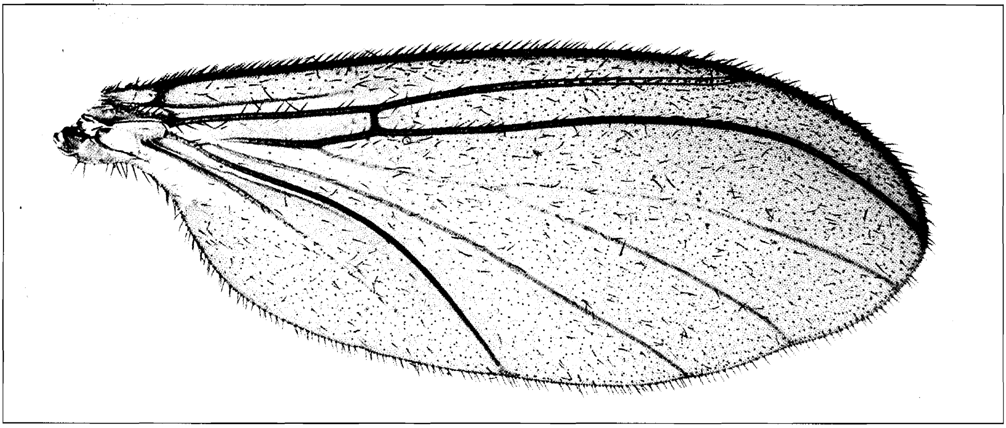
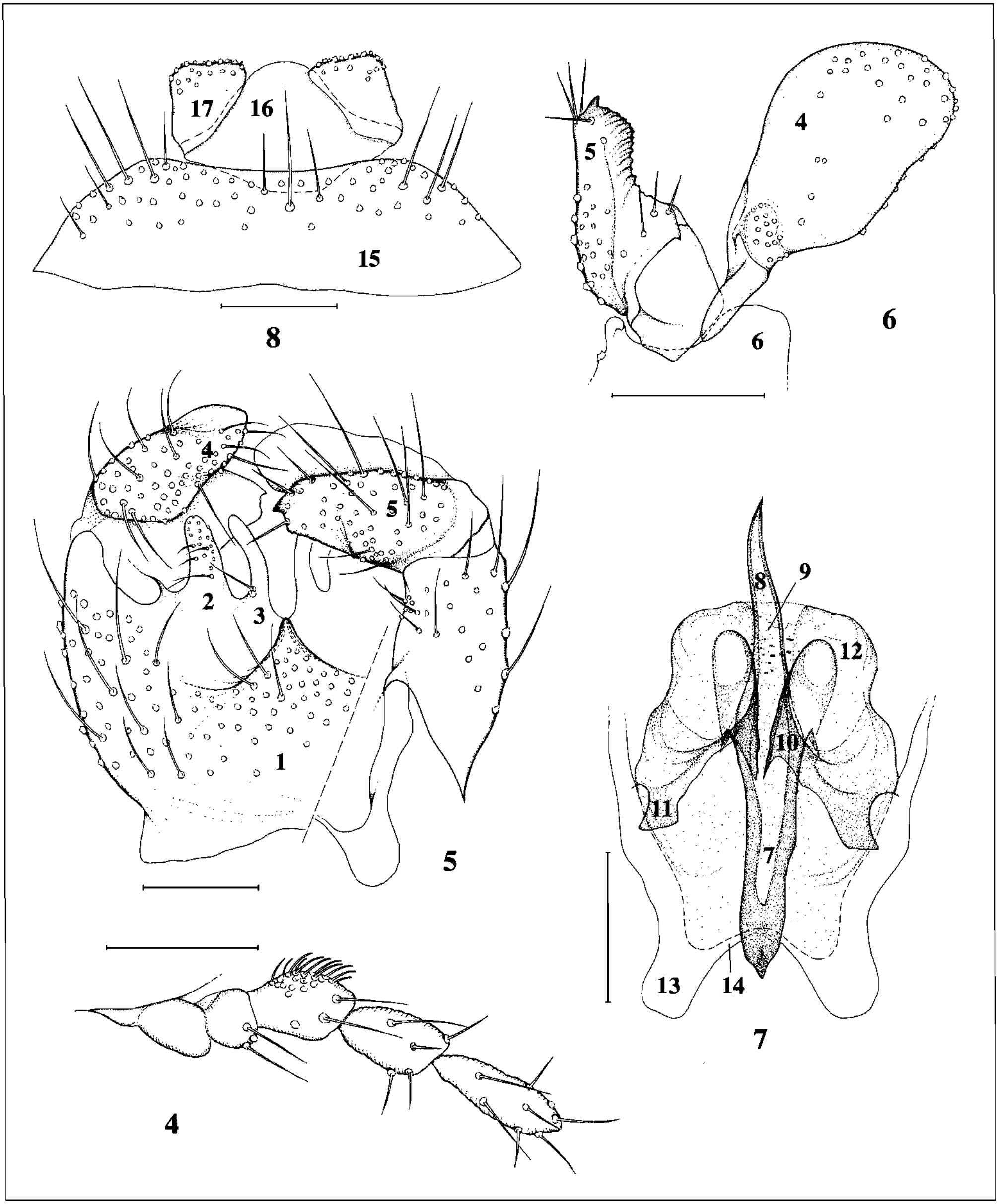


Fig. 3: Wing of *Sciarosoma borealis* CHANDLER.

Remarks on morphology. Among the Sciaroidea with uncertain systematic position, *Sciarosoma* shows a number of morphological pecularities. The maxillary palpus consists of five distinct palpomeres, which reflects the plesiomorphous condition in the Sciaroidea (SØLI 1997), however it is remarkable that the first palpomere is basally attached to a weak, but clearly discernible swelling which is here interpreted as being the palpifer. So *Sciarosoma* appears to be the first case described where the six-segmented palpus, palpifer plus five palpomeres, can be ascertained (see JASCHHOF 2001). Male gonostylus is peculiar in consisting of two portions which articulate separately on the gonocoxite, i.e. the gonostylus is not just bilobed but bipartite, a condition met also in some Mycetophilidae (see SØLI 1997). In female, the proximal segments of cerci bear a number of pore-like sensilla which, due to their small size, may be readily overlooked; this character should be checked with other Sciaroidea in future studies. The presence in female of a narrow, elongate sclerite in between the proximal cercus segments is more conspicuous. Position of that sclerite on the dorsal side, and posterior of tergite 10, makes its identification as epiproct highly probable (SØLI, in litt.), even though such an outline of epiproct is not known to us from other Sciaroidea.

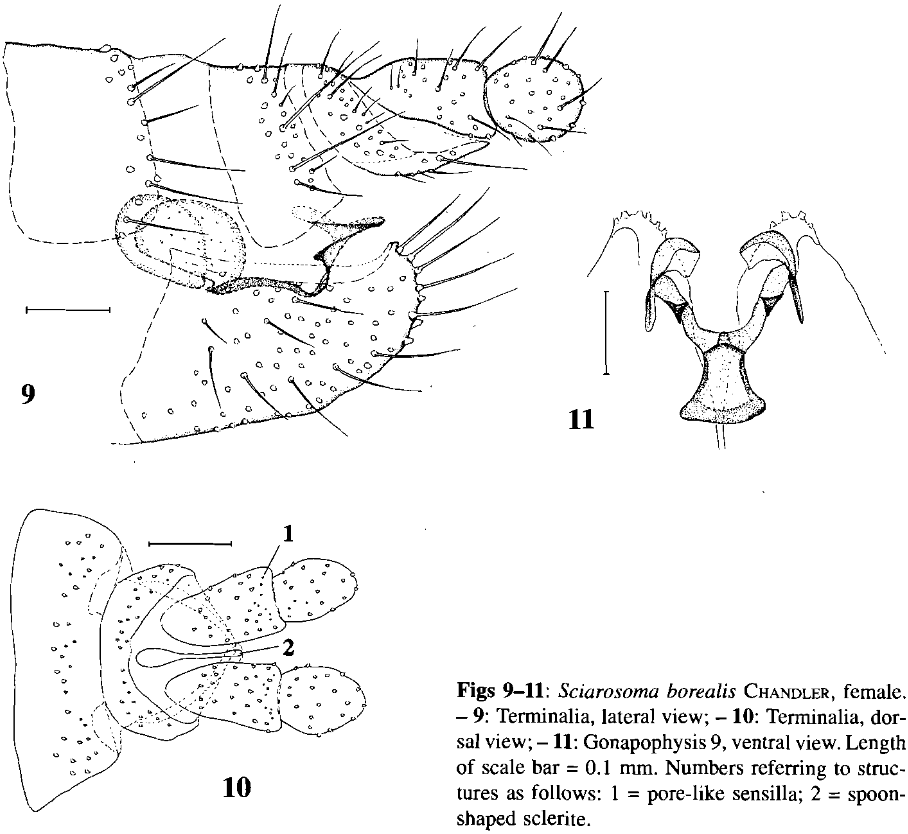
Some of the characters of *Sciarosoma* as assessed by HIPPA & VILKAMAA (2005) are disputable. The pleural pit they consider "undeveloped", or a few lines later, even "lacking", whereas in our study material the pleural pit is clearly discernible and has approximately the same outline as that figured for *Pnyxia* spec. (HIPPA & VILKAMAA 2005: Fig. 5B). The gonostylus they consider "bilobed", a term they use also for the condition met in *Sciarotricha* (HIPPA & VILKAMAA 2005: Fig. 6B, C); however, as shown above, gonostylus in *Sciarosoma* is better described as bipartite, i.e. consisting of two separately articulating portions. The tegmen they consider "absent", whereas from our study material it becomes apparent that the parameres are fused to form a tegmen, even though its medio-apical portion is membranous. The laterotergite (pleurotergite of HIPPA & VILKAMAA) they consider "flat", whereas ethanol-preserved specimens we studied have their laterotergites quite bulging, in particular postero-ventrally, which becomes most obvious when thorax is viewed from a posterior angle.

Remarks on the systematic position of *Sciarosoma* as proposed by HIPPA and VILKAMAA (2005). Assessment of characters like those referred to above is difficult due to the fact that, seen for a number of taxa, phenotypic expressions change in terms of a continuum rather than



Figs 4–8: *Sciarosoma borealis* CHANDLER, male. – **4**: Maxillary palpus, lateral view; – **5**: Terminalia, ventral view (left side) and dorsal view (right side); – **6**: Gonostylus, mesial view; – **7**: Aedeagal complex, ventral view; – **8**: Ninth tergite and associated structures, dorsal view. Length of scale bar = 0.1 mm. Numbers referring to structures as follows:

1 = ventro-central protrusion of gonocoxites
2 = outer ventro-posterior process of gonocoxites
3 = inner ventro-posterior process of gonocoxites
4 = ventral portion of gonostylus
5 = dorsal portion of gonostylus
6 = disto-lateral portion of gonocoxite
7 = aedeagal apodeme
8 = apical process of apodeme
9 = aedeagal teeth
10 = ventral portion of parameres
11 = ventral parameral apodeme
12 = tegmen
13 = dorsal parameral apodeme
14 = transverse bridge
15 = ninth tergite
16 = hypoproct
17 = cercus.



Figs 9–11: *Sciarosoma borealis* Chandler, female. – **9**: Terminalia, lateral view; – **10**: Terminalia, dorsal view; – **11**: Gonapophysis 9, ventral view. Length of scale bar = 0.1 mm. Numbers referring to structures as follows: 1 = pore-like sensilla; 2 = spoon-shaped sclerite.

falling under a few preferably only two discrete states. Attempts to end up in a minimum number of discrete states, as it is desired, involve the risk of oversimplification where structural diversity is real, which means loss of phylogenetic information or, more momentous, misinterpretation. This fact puts major importance into the completion of the data matrix, a process that consequently always involves a *subjective* component. This, of course, applies also to data matrices employed in phenetic cladistics (phänetische Kladistik, see Wägele 2001) which follows a numerical approach considered *objective* by its advocates (see, for instance, Krell 2005). The phylogenetic hypotheses proposed by Hippa & Vilkamaa (2005: Figs 1, 2), obtained by applying phenetic cladistics, are largely based on such characters with continuous states, which among other reasons makes their argumentation too weak in order to follow their proposal for a re-classification of the family Sciaridae. Moreover, their diagnoses of both Sciaridae, in a widened concept, and Sciarosominae, as integral part of this concept, lack any references to apomorphies which are crucial for the definition of monophyla (Hennig 1966). Apart from the processes of choosing and weighting characters, another crucial step in maximum-parsimony analyses is the choice of the taxa involved (see Wägele 2001). In the analysis by Hippa & Vilkamaa (2005), Sciaridae in the traditional sense is represented by four taxa, whereas the same authors leave no doubt that they know of a much wider "variety of the morphological diversity of the world fauna" (Vilkamaa & Hippa 2004: 699), and Menzel and

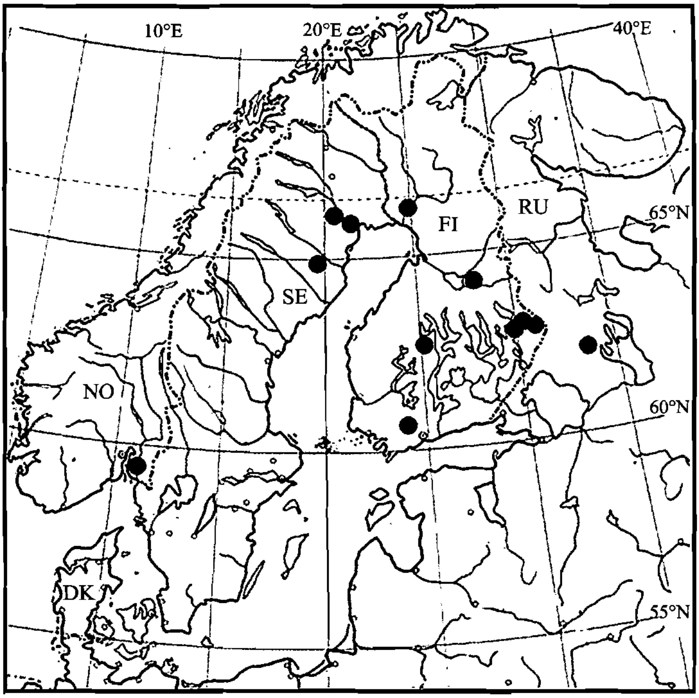


Fig. 12: Distribution in Fennoscandia as presently known of *Sciarosoma borealis* CHANDLER. Explanation of abbreviations: NO = Norway, DK = Danmark, SE = Sweden, FI = Finland, Ru = Russia.

MOHRIG (2000) refer to almost 60 genera of the Sciaridae worldwide. The diversity in the family Mycetophilidae (including Manotidae of HIPPA and VILKAMAA) is ignored in the same manner. Represented by three recent taxa in their analysis, the recent world fauna as presently known comprises up to eight subfamilies and more than 130 genera (see, for instance, BECHEV 2000). With these facts in mind, one may readily imagine the effect on tree topology when the few representatives of Sciaridae and/or Mycetophilidae chosen by HIPPA & VILKAMAA was to be substituted by other representatives exhibiting other structural types. To summarise, in our opinion phenetic cladistics failed hitherto to provide a convincing phylogenetic hypothesis for *Sciarosoma*, even though we recognise, of course, that leaving it unplaced is unsatisfactory as well. The re-classification of the family Sciaridae as proposed by HIPPA & VILKAMAA (2005) is unacceptable to us also because of the very problematic way they delt with earlier proposed classifications (see, in particular, MENZEL & MOHRIG 2000), which includes ignoring completely the availability of several family-group names, proposed for both subfamilies and tribes, by authors, like ENDERLEIN (1911) and LENGERSDORF (1928–30), and reiterated partially by MAMAEV (for instance, 1968). MENZEL & MOHRIG (2000: 648–650) explain in detail why generating a future suprageneric classification of the Sciaridae must include revision of non-Palaearctic types which family-level taxa are based on. It would lead too far here to discuss the proposal by HIPPA & VILKAMAA (2005) from a Rangomaramidae and Archizelmiridae perspective, two families also integrated within their widened concept of the Sciaridae.

Distribution and phenology. The northern European area of distribution of *Sciarosoma borealis* stretches from 66.17° N to 59.50° N, and 11.03° E to 33.58° E, which means a broad belt through the taiga, or boreal, zone of central Fennoscandia (Fig. 12). Its southern- and westernmost collection site, located southeast of Oslo, belongs factually to the boreo-nemoral zone. In terms of national boundaries, *Sciarosoma* is recorded from all Fennoscandian countries, Norway, Sweden, Finland, and Russia (Karelia). The accumulation of records in the east might indicate not just areas of more intensive faunistic survey, but reflect the route of recolonisation of Fennoscandia taken by *Sciarosoma* after the retreat of the Pleistocene glaciers. Data available at present suggest that the preferred, perhaps even the exclusive, habitat of this

Table 1: Distribution in Fennoscandia as presently known of *Sciarosoma borealis* (after CHANDLER 2002; POLEVOI et al., submitted; this study). Biological provinces following usage in recent issues of Fauna Entomologica Scandinavica.

Country	**Biological province**
Norway	Akershus
Sweden	Västerbotten, Norrbotten
Finland	Tavastia australis, Tavastia borealis, Karelia borealis, Ostrobottnia kajanensis, Ostrobottnia borealis N part
Russia	Karelia rossica

species is old-growth coniferous forest in a quasi-natural state, i.e. rich in dead wood and lignicolous fungi. This makes *Sciarosoma borealis* practically an indicator species of pristine boreal forest, even though most details of its biology remain unknown, and larvae and larval habitat have not yet been identified. One individual of *Sciarosoma* was captured by means of a trunk-window trap mounted on a fruiting body of Red-banded polypore, *Fomitopsis pinicola*, on a dead trunk of Norway spruce, *Picea abies* (see CHANDLER 2002; ØKLAND, pers. comm.). Even in its preferred habitat *Sciarosoma* adults are rarely collected, possibly partly due to the fact that at a certain site their flight period is short and confined to early summer. With these facts in mind, and considered that only a handful of specialist dipterists pay attention to these inconspicuous flies, one may anticipate further records from an even wider distribution area in, and beyond, Fennoscandia. As regards the significance of *Sciarosoma* as an indicator species of habitat quality, it is noteworthy that in two of its collection sites other 'rare' Diptera-Nematocera, belonging to the families Synneuridae, Pachyneuridae and Keroplatidae, were found which are discussed to "have an affinity to undisturbed, virgin forests" (SØLI et al. 1994; VIKLUND, unpubl.).

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