



SWEDISH TAXONOMY INITIATIVE PROJECT REPORT

Project period: 2007–2011

Mathias Jaschhof & Catrin Jaschhof

Senckenberg Deutsches Entomologisches Institut, Müncheberg, Germany

INSECTS:

The Porricondylinae (Diptera, Cecidomyiidae) of Sweden

Abstract

Porricondylines are tiny, mainly forest-dwelling dipterans, whose larvae are fungus-feeders in decaying plant litter. Previously, Porricondylinae were treated as one of five subfamilies of the Cecidomyiidae, gall midges, with nearly 620 extant species known worldwide and 24 species recorded in Sweden.

In 2009–2012 the Swedish porricondyline fauna became subject to a comprehensive inventory, which proved the occurrence of 206 species and 53 genera. Of those, 57 species and 10 genera were new to science; another 125 species and 32 genera were new to the country. At the same time, the taxonomy of Holarctic Porricondylinae was revised, resulting in, among others, 81 new synonyms (specific, generic, and tribal) and 49 new combinations. Re-examination and analysis of adult morphology led to a re-classification of the paraphyletic Porricondylinae in two monophyletic groups, Winnertziinae and Porricondylinae *sensu stricto*.

The outcome of this project was published in a monographic volume titled 'The Porricondylinae (Diptera: Cecidomyiidae) of Sweden, with notes on extralimital species'. Aside from the systematic content, this book provides information on the geographic distribution and phenology of the species in Sweden, and facilitates their identification through adult morphological diagnoses, with plenty of illustrations and keys. As another result, a collection of reference specimens was prepared on microscope slides for deposition at the Naturhistoriska riksmuseet in Stockholm (NHRS).

Background

In previous classifications of the family Cecidomyiidae (gall midges) Porricondylinae were treated as a subfamily, although they were identified as a paraphyletic grouping. Porricondyline larvae are fungus-feeders living in plant debris, including dead wood, so may



Figure 1 (left). A male porricondyline, less than 2 mm long, showing the fragile appearance and the long antennae, legs and wings that are typical of this group of gall midges. Photo: M. Jaschhof.

Figure 2 (right). Despite its rather large body size of 4 mm and reddish coloration, this female porricondyline is hard to detect among the dense shoots of moss. Photo: M. Jaschhof.

be regarded as members of the saproxylic guild. The biology of most species has never been studied in detail. Adults are characterized by tiny body size, which averages 1–3 mm, delicate appearance (Figure 1), and a cryptic lifestyle (Figure 2). The group is cosmopolitan in distribution and especially abundant and diverse in forest ecosystems.

The taxonomy of Porricondylinae is based on the morphology of adults. The world fauna, as far as it was known in 2009, comprised nearly 620 extant species classified in 94 genera. The fauna of the Palearctic region, especially Europe, is the best-studied worldwide, for Europe is a traditional stronghold of porricondyline research, where usually one or two expert taxonomists actively work on this group.

As regards northern Europe, Porricondylinae were studied to some extent by Samuel Panelius in Finland in the 1960s, and sporadically before and after that. In Sweden, where Porricondylinae were never studied systematically, as few as 24 species of 11 genera were recorded in the past. In recognition of this neglect, the Swedish Taxonomy Initiative ranked Porricondylinae as a group in need of thorough faunistic survey and fundamental taxonomic revision. According to our estimate, 150–200 species of Porricondylinae should occur in Sweden, including 20–25% unknown to science.

Derived from this starting situation our project had the following targets:

- (1) to prepare a reference collection of Swedish Porricondylinae based on specimens from the Swedish Malaise Trap Project, general insect samples in museum holdings, and group-specific collecting during the course of the project;
- (2) to identify the species found in Sweden using adult morphology and revise their taxonomy, including study of types, review of synonyms, redescription of poorly documented species, redefinition of generic concepts, etc.;
- (3) to describe species new to science;
- (4) to compile keys for the identification of genera and species;
- (5) to gather information on species distributions and phenologies in Sweden;
- (6) to analyse generic interrelationships and rework the tribus and subfamily classification;
- (7) to analyse the biogeographic relationships of Swedish Porricondylinae to neighbouring faunas;
- (8) to publish all results in a monographic paper.

Material and Methods

All work related to the project was carried out within four years, January 2009 to December 2012. For most of this period, work was voluntarily supported by Catrin Jaschhof, who assisted with collecting specimens, sorting samples, labelling specimens, etc. Due to this technical support, large amounts of study material could be processed, altogether 148 general insect samples from 39 different localities taken by Malaise trap, trunk emergence trap, sweepnet, and aspirator, which altogether produced an estimated 4000–5000 porricondyline specimens.

In addition to that, we studied 91 Cecidomyiidae samples from the Swedish Malaise Trap Project (Figures 3, 4); 25 Cecidomyiidae samples from an insect inventory in Limhamnns kalkbrott, Skåne (in collaboration with the Museum of Zoology of Lund University); and the yield of Porricondylinae from the insect inventory in Tyresta, Södermanland. The latter material, prepared by Voldemars Spungis of the University of Latvia in the early 2000s, was the only slide collection of Swedish Porricondylinae available for our studies.



Figure 3 (left). A vial with 2 cubic centimeters, or several hundred individuals, of gall midges – the result of many hours sorting of a single insect sample taken by the Swedish Malaise Trap Project. Photo: M. Jaschhof.

Figure 4 (right). After longer storage in ethanol specimens of gall midges, including porricondylinae, have lost their natural coloration and have turned brown instead. Even so, the morphological structures of taxonomic importance remain unimpaired. A sample like this will contain dozens of different species. Photo: M. Jaschhof.



Figure 5. Trunk emergence traps – here the model developed by Finnish entomologists and used in the Porricondylinae project – produce both specimens for study and information on larval habitats. Photo: M. Jaschhof.

Group-specific collecting in Sweden was performed in 2009 and 2010, including 425 hours of hand-collecting, 2129 days of Malaise trapping, and 134 days of trunk emergence trapping (Figure 5). From 16 June to 1 September 2009, 24 Malaise traps were kept running at 7 different sites, and 9 trunk emergence traps at 3 sites. From 26 May to 29 July 2010, 20 Malaise traps were managed at 5 different sites. Travel was by private car.

Collection permits for nature reserves and national parks were issued by Länsstyrelsen of Skåne län, Östergötland län, Uppsala län, Jämtlands län, and Västerbottens län.

Specimens were presorted and identified to genus by means of a dissecting microscope. More than 2400 specimens were mounted in Canada balsam on microscope slides for morphological study in detail and the identification of species using a light-transmission microscope (Figure 6).



Figure 6. For untrained eyes, a porricondyline specimen mounted on a microscope slide resembles a little piece of dust. Mounted under a separate, smaller cover slip are the male genitalic structures, which provide the taxonomist with the characters crucial for the identification of species. Photo: M. Jaschhof.

The identification of species was usually based on comparison with type material by previous taxonomic authors, such as Ephraim P. Felt in North America, Boris M. Mamaev in Russia, Samuel Panelius in Finland, and Voldemars Spungis in Latvia. Felt's collection was studied on the spot during a visit to the US National Museum in Washington, DC, in October 2011, with a small amount of specimens borrowed from that museum for further investigation at home.

As regards Mamaev's material, we received a considerable amount of specimens on loan from museum collections in Sanda (Japan) and Moscow (Russia). Mamaev had described Porricondylinæ of so many different species, and from so many different parts of the former Soviet Union, that we requested for loan only the holotypes of those species that we regarded as likely occurring in Sweden. Furthermore, we studied the type species of all the genera introduced by Mamaev.

The museum in Helsinki met our need to loan the Panelius collection of Porricondylinæ, which we had at our disposal for the most of 2011 and 2012 (Figure 7). Of Spungis's collection we saw an important part, including many type specimens, during a visit to Latvia in August 2011. On this occasion Voldemars Spungis commented on specimens brought from Sweden, thereby verifying our identifications made on the basis of the literature.



Figure 7. A rather unspectacular treasure box: one of the four cardboard boxes that contain the Panelius collection of Porricondylinæ in Helsinki—a most important resource for students of Nordic Porricondylinæ. Photo: M. Jaschhof.

Species distributions in Sweden were described on different scales, such as collection locality, biological province (according to *Fauna Entomologica Scandinavica*), and major forest zone. Species distributions outside Sweden were given on the scale of country or, in the case of common and widespread species, of continent or biogeographic region. Also, information on the species' seasonal occurrence (adult flight period) in Sweden was provided.

The phylogenetic analysis of adult morphological characters followed a non-quantitative approach, with the raw data (characters states) obtained from the examination of actual specimens rather than from the study of literature.

Results

The Swedish fauna of Porricondylinae was shown to comprise 206 species, 53 genera, and all the 6 tribes recognized after revision. This means, compared with the initial situation, an addition of 182 species and 42 genera, of which 57 species and 10 genera were new to science, and 125 species and 32 genera new to the country. In other words, one out of four species found in Sweden proved to be new to science!

New genera were named to honour Swedish institutions or persons, as follows (information in quotation marks is from the original etymology sections). The name *Ekmanomyia* "pays tribute to the Swedish novelist Kerstin L. Ekman, bom 1933, for her spirited commitment to preserving the last stretches of wild forest in her homeland. Mrs. Ekman's conservation ethic shines through especially in her 2007 work *Herrarna i skogen* (Masters of the Forest)."

Glemparon "is named in appreciation for the *Svenska Malaisefälleprojektet*, The Swedish Malaise Trap Project (SMTP). Founded to support the inventory of terrestrial arthropods, particularly dipterans and hymenopterans, under the framework of The Swedish Taxonomy Initiative, SMTP emerged as an extremely successful collection effort. The name refers to three scientists whose commitment was crucial for the success of SMTP: Kajsa *Glemhorn* (Linné Station, Öland, Sweden), Thomas *Pape* (University of Copenhagen, Natural History Museum of Denmark) and Fredrik Ronquist (Swedish Museum of Natural History, Stockholm)."

Svenartia (Figure 8) "renders honour to the *Svenska artprojektet*, The Swedish Taxonomy Initiative, for financing taxonomic research, notably on groups of organisms that are poorly known and otherwise neglected."



Figure 8. This is the only picture ever taken of the porricondyline *Svenartia spungisi*. A remarkable midge named to honor a remarkable initiative! Photo: M. Jaschhof.

A number of putative Nearctic or Eastern Palearctic species were newly recorded for the Palearctic region or the Western Palearctic subregion. Swedish collection locality data were provided for over 2900 specimens, yet were considered as still too sparse as to realistically describe species ranges and larger-scale distribution patterns.

Species richness appeared to be greatest between 59°N and 67°N. The maximum number of Porricondylinae taxa found at a single site (forest stand) was 76 species and 34 genera, found to occur in Fiby urskog, Uppland (Figure 9). Records of Porricondylinae were made from 17 of 30 biological provinces in Sweden.

Almost all the species found were redescribed and their diagnostic characters were illustrated. Other identification tools, such as keys and diagnoses, were provided for tribes, genera, and species. The definitions of supraspecific taxa were reworked and outlined also in a historical context.

Revision work took account of taxa from throughout the Holarctic region, resulting in 81 new synonyms (at the tribal, generic and species levels) and 49 new combinations. Based on actual specimens, adult morphology was re-examined and the observed characters were analyzed in terms of phylogeny.



Figure 9. Perhaps the most valuable part of the old-growth forest in Fiby: a grove of old aspen trees, both live and dead. It is the dead wood of these trees that provide a unique habitat for certain porricondyline larvae. As a result, a new classification was proposed that eliminated the traditional, paraphyletic Porricondylinae in favor of two monophyletic subdivisions, Winnertziinae and Porricondylinae *sensu stricto*. Photo: M. Jaschhof.

Discussion

Our inventory of Swedish ‘Porricondylinae’ (here used in the old sense) resulted in a nine-fold increase in the number of species, and more ‘porricondyline’ species are now known in Sweden than in any other country in the world. In Germany, where ‘Porricondylinae’ were never studied systematically, we know of 58 species records, all unrevised by modern standards. A single few-hectare forest in Uppland provides the habitat for more species of ‘Porricondylinae’ than are known to occur in all of Germany!

We estimate that the Swedish fauna should actually comprise 250–300 species of ‘Porricondylinae’, considering that we stopped the processing of specimens at a time when additional species appeared with each new insect sample examined. In other words, even more new discoveries were impeded merely by time constraints. We expect most future additions to the Swedish faunal list to come from the nemoral and boreonemoral zones, i.e. the southern parts of the country.

Many ‘Porricondylinae’ species in Sweden were found on only one or two occasions, a fact suggesting that to discover such rare species requires considerable, group-specific effort. Our survey demonstrated once more the importance of old-growth forest for the long-term thriving of porricondyline populations and for maintaining a high biodiversity. Several remarkable (and at present inexplicable) exceptions from the picture of porricondyline being typical saproxylics in humid forests were also noticed. Most notably, a grazed pine forest on

calcareous ground in Gotland was found to be extremely prolific for new and rare species. Similar observations relate to open habitats in Öland (Figure 10). Such information will be important for any efforts in the future to proceed with the inventory of Swedish 'Porricondylinae' .



Figure 10. Open landscapes, such as the steppe-like alvar in Öland and Gotland are likely habitats for a less biodiverse but unique fauna of porricondylines. Something to study more intensively in the future! We regard our project design as the most effective way to achieve, all at once, phenological, faunistic, morphological, taxonomic, and phylogenetic information on an organismic group, especially when it is as poorly known as the 'Porricondylinae' were prior to our project. (Here the attribute 'poorly known' means both 'on a backward state of taxonomic revision' and 'with a high potential for new discovery'.) Photo: M. Jaschhof.

As any inventory of 'Porricondylinae' requires special skills, for example in collecting and preparing specimens, modern technology cannot compensate for experience and expertise gained during many years of practical work. The rich output of our project provides proof of the effectiveness of morphology-based taxonomy.

The taxonomic knowledge of 'Porricondylinae' and other poorly known groups can be fundamentally advanced even through research with a primarily narrow geographic scope (note that the number of 'Porricondylinae' species in Sweden is equivalent to about one third of the known world fauna!). Accordingly, the impact of The Swedish Taxonomy Initiative goes far beyond the national scale.

PUBLICATION

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