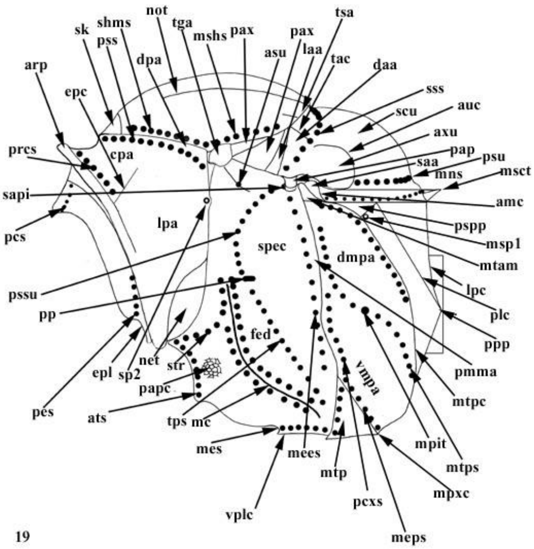
University of Szeged, Faculty of Science
Doctoral School of Environmental Sciences, Conservation Ecology Doctoral Program
Program leader: Prof. Dr. László Gallé

SCELETOMUSCULATURE AND SYSTEMATICS OF SCELIONIDAE (HYMENOPTERA: PLATYGASTROIDEA)

ISTVÁN MIKÓ

Vas County Plant Protection and Soil Conservation Service

Summary of the PhD dissertation



Supervisors:

Dr. George Melika
Vas County Plant Protection and Soil Conservation Service

and

Dr. Lubomir Masner
Agriculture and Agri-Food Canada, Canadian National Collection of Insects

VAS COUNTY PLANT PROTECTION AND SOIL CONSERVATION SERVICE, TANAKAJD 2007

INTRODUCTION

The Platygastroidea with two families, Scelionidae and Platygastridae, is the third largest superfamily of parasitic wasps, after Ichneumonoidea and Chalcidoidea, and comprising some 4460 described species worldwide (Johnson 1992). The target group of my dissertation is one of the families of Platygastroidea, the Scelionidae, and concentrated on two main topics:

1) functional morphology of Scelionidae and its importance in the classification of Scelionidae;

2) defining new characters for species descriptions

2) the world revision of the *Xenomerus* Walker genus (Platygastroidea: Scelionidae: Teleasinae).

The present dissertation is based on two major works:

1) Mikó, I., Johnson, F., Vilhelmsen, L., Masner, L. & Pénzes, Z. (2007) Morphology of Scelionidae (Platygastroidea: hymenoptera): head and mesosoma. *Zootaxa*, in press.

2) Mikó, I. & Masner, L. (2007) World revision of *Xenomerus* Walker (Hymenoptera: Scelionidae). *Zootaxa*, in press.

Morphological characters are important sources of data in systematics and taxonomic research. Specialists in different taxonomic groups have often developed independent terminologies, resulting in numerous synonymies and a general barrier to effective communication. The intimate relationship between form and function and the correspondence of internal and external anatomy is well known but merely used in taxonomy, especially in the classification of parasitic wasps. To facilitate the phylogenetic studies in parasitic wasps the proper recognition of homologies between structures, and of synonymies between terms is of urgent necessity.

The main foci of this research are:

1) a re-appraisal of different terms used in current taxonomy of the focused group and its coordination with the nomenclature used in other Hymenoptera groups.

2) establishing a precise nomenclature for scelionid anatomy for a correct using it in systematics and phylogeny.

3) a comprehensive examination of the internal and external morphology of

the insect family Scelionidae (Hymenoptera: Platygastroidea).

4) the recognition of homologous characters within different groups of Hymenoptera – a basic for further robust phylogenies in the entire order.

With 466 species in 11 genera (Johnson 1992) the subfamily Teleasinae (Platygastroidea: Scelionidae) is one of the largest and most common groups of Platygastroidea, however, the limits of genera within the subfamily are not well defined. This caused many problems in generic placement of new teleasine species, including also the *Xenomerus* species. In the present dissertation we tried to:

1) clarify the generic level concept of the genus *Xenomerus*, based on the newly established morphological characters given in Mikó et al. (2007a).

2) revise the *Xenomerus* genus and interpret it as a modell for further revisions in Hymenoptera; which should be based on the results of functional morphology first of all.

MATERIALS AND METHODS

Insect material examined

For the purposes of "functional morphology" research members of 25 scelionid genera and many non-scelionid Hymenoptera were examined (specimens obtained from the collections of the Systematic Parasitoid Laboratory, Kőszeg, Hungary; Columbus University, Columbus, Ohio, USA; University of California, Riverside, USA; University of Perugia, Italy; Natural History Museum, Copenhagen, Denmark; Canadian National Insect Collection, Ottawa, Canada. A detail list of examined species and specimen numbers and locations is given in the dissertation. For the world revision of the genus *Xenomerus* 430 specimens were loaned for the examination from 13 institutions worldwide (The Natural History Museum, London, United Kingdom; Canadian National Collection of Insects, Agriculture and Agri-Food Canada, Ottawa, Canada; Collection of F. Bin, Universitá di Perugia, Perugia, Italy; Hungarian Natural History Museum, Budapest, Hungary; Naturhistorisches Museum, Vienna, Austria; Naturhistoriska Riksmuseet, Stockholm, Sweden; Natal Museum, Pietermaritzburg, South Africa; South Australian Museum, Adelaide, South Australia, Australia; South African Museum, Cape Town, South Africa; South African National Collection of Insects, Pretoria, Republic of South Africa; Zoological Institute, Ukrainian Academy of Sciences, Kiev, Ukraine; United States National Museum, Washington, D.C., USA; Zoological Museum, USSR Academy of Sciences, St. Petersburg, Russia).

Techniques

Dissections for examination of muscles were based on specimens preserved in 70% ethanol. All specimens were transferred to 96% ethanol and critical-point dried. The specimens were transferred to Blu Tack (Bostik Findley 2001) and dissected with insect pins (size: 000) or minutens. Almost all of the muscles were removed from the body parts during dissections. The remnants of the specimens are deposited in the collection of the Systematic Parasitoid Laboratory (Köszeg, Hungary). Dissections for skeletal structures were based on dried or ethanol-preserved specimens. The dissected specimens were macerated in KOH and transferred to 96% ethanol. Part of the series was critical-point dried and examined with SEM and part was transferred to clove oil and examined under stereo (Leica MZ6) and phase-contrast (Olympus BH2) microscopes.

Digital images were taken with a Nikon Coolpix 4500 camera attached to an Olympus BH2 phase-contrast microscope. The CombineZ5 (Hadley 2006) software was used to get combined high-quality photos. Linear drawings were made in Adobe Photoshop 6.0.

Terminology

For skeletal structure terms I generally followed Masner (1980), Ronquist & Nordlander (1989), and Vilhelmsen (2000a, b). Additional terms are derived from Bin & Dessart (1983), Duncan (1939), Gibson (1985, 1986, 1997), Gordh & Headrick (2001), Heraty et al. (1994), Huber & Sharkey (1993), Johnson (1984, 1996), Johnson & Masner (1985), Masner (1972, 1979a, b, 1983, 1991), Ronquist (1995), Snodgrass (1942), Vilhelmsen (1999), and Yoder (2004). In naming muscles, I followed Vilhelmsen (1996, 2000a, b).

Measurements

Most of the measurements used in the revision of the *Xenomerus* genus are followed Johnson (1984) and Masner (1980), however, some new measurements were established by me (in the dissertation they are marked with *). In all descriptions the maximum and minimum values, mean (M=) and standard deviance (SD=) of ratios were also calculated.

Descriptions

Species of *Xenomerus* were described from holotypes, except *X. ergenna*, *X. canariensis*, *X. varipes* and *X. laticeps*, where types were not available or they were in a very bad condition for measuring metrics. Specimens not involved in type series are also listed as other material examined.

RESULTS

1. Morphology of Scelionidae

The sceletomusculature of the head and mesosoma of the parasitoid wasp family Scelionidae is reviewed. Terminologies used for other groups of Hymenoptera are compared, and a consensus nomenclature is proposed. External characters are redescribed and their phylogenetic importance is discussed on the basis of corresponding internal apodemes, attaching muscles and putative exocrine gland openings. All skeletal structures and corresponding muscles in different parts of the insect body are described and named, particularly:

1.1. head – skeletal structures (56), muscles (9);

1.2. propleuron, prosternum and profurca -- skeletal structures (26), muscles (12);

1.3. pronotum -- skeletal structures (18), muscles (5);

1.4. scutellar-axillar complex -- skeletal structures (17), no muscles originate from the scutellar-axillar complex muscles;

1.5. mesopectus -- skeletal structures (7), muscles (2);

1.6. mesopostnotum and the second phragma-- skeletal structures (35), muscles (20);

1.7. metanotum -- skeletal structures (9), muscles (2);

1.8. metapectal-propodeal complex -- skeletal structures (40), muscles (18).

2. World revision of *Xenomerus* Walker (Hymenoptera: Platygastroidea: Scelionidae)

2.1. Fifteen additional **new** characters are used in the descriptions of species groups and species, which can be used in revisions of other groups.

2.2. 27 new species of *Xenomerus* are described, 3 **comb. nov.**, 4 species redescriptions, and 2 **syn. nov.** are given.

2.3. Four species groups were recognized

2.4. A key to the *Xenomerus* species is given also.

DISCUSSION

1. Morphology of Scelionidae

1.1. The following characters states are considered as autapomorphy for Scelionidae:

The presence of the cranio-antennal muscle, an extrinsic antennal muscle originating from the head capsule, all extrinsic antennal muscles of other Hymenoptera originates from the tentorium.

The dorsally bented epistomal sulcus and the corresponding internal epistomal ridge extend to the anterior margin of the oral foramen, the clypeo-pleurostomal line is absent and the tentorium is fused with the pleurostomal condyle.

The protractor of the pharyngeal plate originates dorsally of the antennal foramen in Scelionidae.

The propleural arm is reduced, thus the site of origin of muscles originate from the propleural arm in other Hymenoptera were transferred to other propectal structures.

1.2. The frontal ledge of the frons is present in those scelionid genera having the anterior mandibular articulation located on the lateral margin of the oral foramen. The ledge corresponds to the site of origin of the mandibular abductor muscle, which is replaced from the genal area to the top of the frons. The correlation between the location of lateral madnibular articulation, site of origin of mandibular abductor, presence of frontal ledge and movement of mandible is discussed.

1.3. The first flexor of the fore wing originates from the posteroventral part of the pronotum in Scelionidae and Vanhorniidae, whereas the muscle originates from the mesopleuron in all other Hymenoptera. The netrion apodeme limits anteriorly the site of origin of the first flexor of the fore wing. This condition could consider as an autapomorohy for Scelionidae+Vanhorniidae.

1.4. The lateral and dorsal axillar surfaces and the axillar carina were defined and described first time in Platygastroidea.

1.5. The term sternaulus is redefined on the basis of the site of origin of the mesopleuro-mesobasalare muscle.

1.6. The term speculum is adopted from Ichneumonidae and Cynipoidea taxonomy on the basis of the site of origin of the mesopleuro-mesofurcal muscle.

1.7. The remnants of the mesopleural ridge, sulcus and mesopleural arm and pit and the putative border between the mesepisternum and mesepimeron is discussed.

1.8. The mesopleural depressor of the mesotrochanter sensu Gibson (1985) originates from the anterior extension of the mesofurca and therefore the muscle is redefined and referred in the present study as the lateral mesofurco-mesotrochanteral muscle.

1.9. The second flexor of the hind wing at least partly originates from the posteriorly delimited area of the mesopectus in Scelionidae similarly to some other Proctotrupoidea s.l. and Chalcidoidea. The serial analogy of this area and the netrion is discussed.

1.10. The homology of the medially elevated area of the metanotum (dorsellum) of apocritans and mesoscutellum and the possibility of the usage of the term metascutellum in Apocrita is discussed with the descriptions of correlating internal structures.

1.11. Vilhelmsen (2000a, 2003) considered the anteriorly located metafurca on the metadiscrimenal lamella to an autapomorphy for Hymenoptera. The metapleuron is extended secondarily dorsally of the metapleural ridge and corresponding metapleural sulcus in Scelionidae. In Telenominae, *Gryonini* and *Baeini* the metafurca is located posteriorly on the metadiscrimenal lamella.

2. World revision of *Xenomerus* Walker (Hymenoptera: Platygastroidea: Scelionidae)

2.1. The generic level concept of the genus *Xenomerus* was clarified on the basis of 15 newly established morphological characters, based on the correlation of external and internal structures, such as internal apodemes, sceleto-musculature and gland systems (Mikó et al. 2007b).

2.2. Whether the coriaceous sculpture and median opening of posterodorsal patch of T3, felt field and posterior felt field are secondary cuticle modifications related to Type III. exocrine glands requires more detail examination of the metasoma using TEM techniques.

2.3. We assumed, that the arosternal calyx of S5 could serve as a secondary reservoir for type III gland cells. Acrosternal calyx closure could be result from the contraction of the acrosternal muscles, while opening might be result from the change of hydrostatic pressure of the hemoplymph during oviposition. The function of acrosternal calyx and the putative exocrine gland is unknown.

2.4. Descriptions of different character states used in keys and species descriptions are explained and figured in the generic description of *Xenomerus*.

PUBLICATIONS RELATED TO THE DISSERTATION

Articles

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