SECONDARY SEXUAL CHARACTERS OF PTEROMALID WASPS (HYMENOPTERA: CHALCIDOIDEA, PTEROMALIDAE)

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Abstract. The idea of sexual selection was proposed by Darwin in order to explain some morphological traits that could not develop through classic natural selection. The paper discusses the results of the intersexual selection where females are choosing the males based on some preferred morphological characteristics. In the West-Palearctic Pteromalidae several genera have males displaying obvious secondary sexual characters. The paper illustrates such examples, discussing the characters involved. It is the first approach of the subject for this group of insects.

Keywords: Hymenoptera, Chalcidoidea, Pteromalidae, sexual selection, intersexual selection, secondary sexual characters.

Rezumat. Caracterele sexuale secundare ale pteromalidelor (Hymenoptera: Chalcidoidea: Pteromalidae). Ideea de selecţie sexuală a fost propusă de Darwin pentru a explica anumite trăsături morfologice care nu puteau apărea prin acţiunea selecţiei naturale clasice. Lucrarea discută rezultatele selecţiei intersexuale în care femelele aleg masculii pe baza unor caractere morfologice preferate. La pteromalidele din palearcticul de vest mai multe genuri au masculi la care caracterele sexuale secundare sunt evidente. Lucrarea ilustrează astfel de exemple, discutând caracterele morfologice implicate. Este prima abordate a subiectului la acest grup de insecte.

Cuvinte cheie: Hymenoptera, Chalcidoidea, Pteromalidae, selecţie sexuală, selecţie intersexuală, caractere sexuale secundare.

Introduction

Sexual selection was proposed (and discussed in detail) by Darwin (1871) to explain how certain traits can appear in one sex (males) by intraspecific competition. Darwin saw sexual selection as the "struggle between the individuals of one sex, generally the males, for the possession of the other sex". It is generally accepted that sexual selection can be divided in two categories: intrasexual selection i.e. males compete against other males for females, and intersexual selection i.e. the female chooses the male.

The first category of sexual selection leads to "weapons" used in fights against other males e.g. horns, enlarged mandibles etc., while the latter gives rise to various "ornaments" consisting in exaggerated morphological features (bright colors, long tails etc.).

The female's preference for a specific morphological character contributes in time to the development of that particular trait, until it begins to negatively influence the male fitness, lowering its chances of survival. The male will develop its unusual character(s) as long as it can "afford" it (Dawkins, 1986). It is supposed that the females benefit from these choices because the males displaying these special traits are usually more resistant to diseases, parasites etc. The positive selection of these characters by the females surpasses the energetically costly investment of the males and other dangers they involve (visibility to predators etc.). The morphological differences between sexes, related to sexual selection, are called secondary sexual characters.

In the family Pteromalidae, intrasexual selection does not seem to play an important role, although sometimes larger males seem to have a reproductive advantage

over smaller males (Lacourne *et al*., 2005). Thus, all the characters discussed below have presumably resulted from intersexual selection.

The present note is the first general approach of the subject for this group of insects. Only presumed "ornaments" are discussed here i.e. structures that seem to have no other role than to attract / give important clues to females regarding their potential mating partner. Thus, the structure of the antennae, even if sometimes very different in males, is not treated here since this is almost certainly correlated with an increased ability to detect pheromones. Even so, until detailed behavior observations will be carried out the precise role of the analyzed structures remains largely unknown.

Some of the characters presented here were also mentioned in Mitroiu (2008), but no special attention was paid then. Gibson & Reigada (2009) discuss the case of the *Spalangia dozieri* Burks male, which displays unusual characters for the males of this genus.

Material and Methods

The material examined is located in Mitroiu collection (MICO), Alexandru Ioan Cuza University Iasi, Romania and consists in West-Palearctic genera and species. Classification follows Bouček (1988) and genera are arranged according to the modified characters discussed. Specimens were examined using a Krüss MSZ5400 steromicroscope with a maximum magnification of 180X and a Krüss KL5125 fiber optic light source. A JVC TK-C1381 digital camera attached to a Nikon SMZ800 stereomicroscope was used to photograph most of the specimens. Line drawings were made using a *camera* lucida; figures 12 and 13were previously published in *Zootaxa* (Magnolia Press). Images are not to the same scale.

Results and Discussion

The genera discussed below are classified in the following subfamilies:

MISCOGASTERINAE:
Halticoptera Spinola
Halticopterina Erdős
Sphaeripalpus Förster

PIRENINAE:
Macroglenes Westwood
Spathopus Ashmead

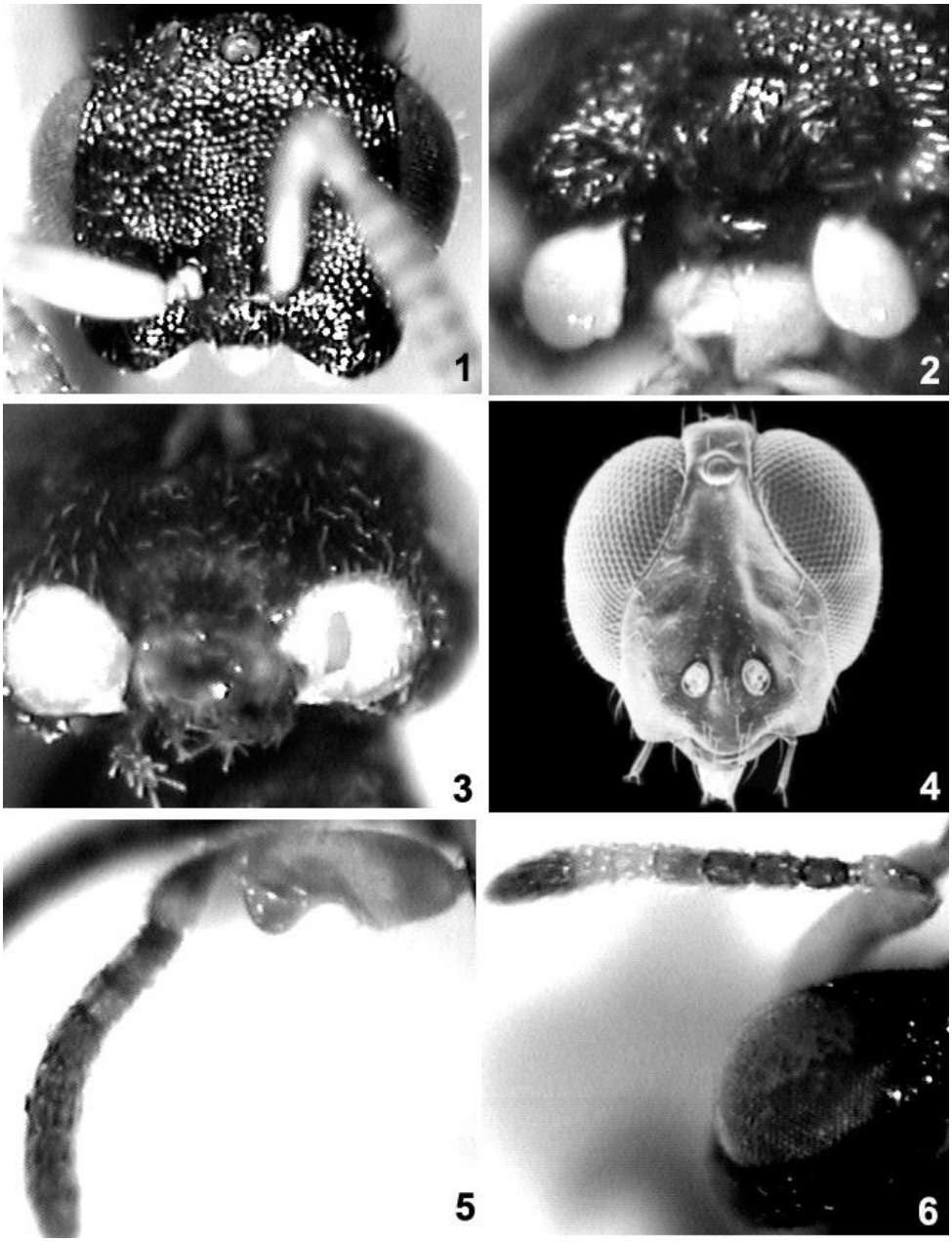
PTEROMALINAE:
Cyrtogaster Walker
Diglochis Förster
Trichomalus Thomson
Peridesmia Förster
Meraporus Walker
Leptomeraporus Graham
Pteromalus Swederus
Mesopolobus Westwood
Spaniopus Walker
Stichocrepis Förster

Head. The head of males can be modified in different ways: the general shape is different from that of the females and sometimes special structures develop (e.g. membranous areas), or the sculpture has different peculiarities, especially smooth dark areas which can be relatively wide or only lines-shaped.

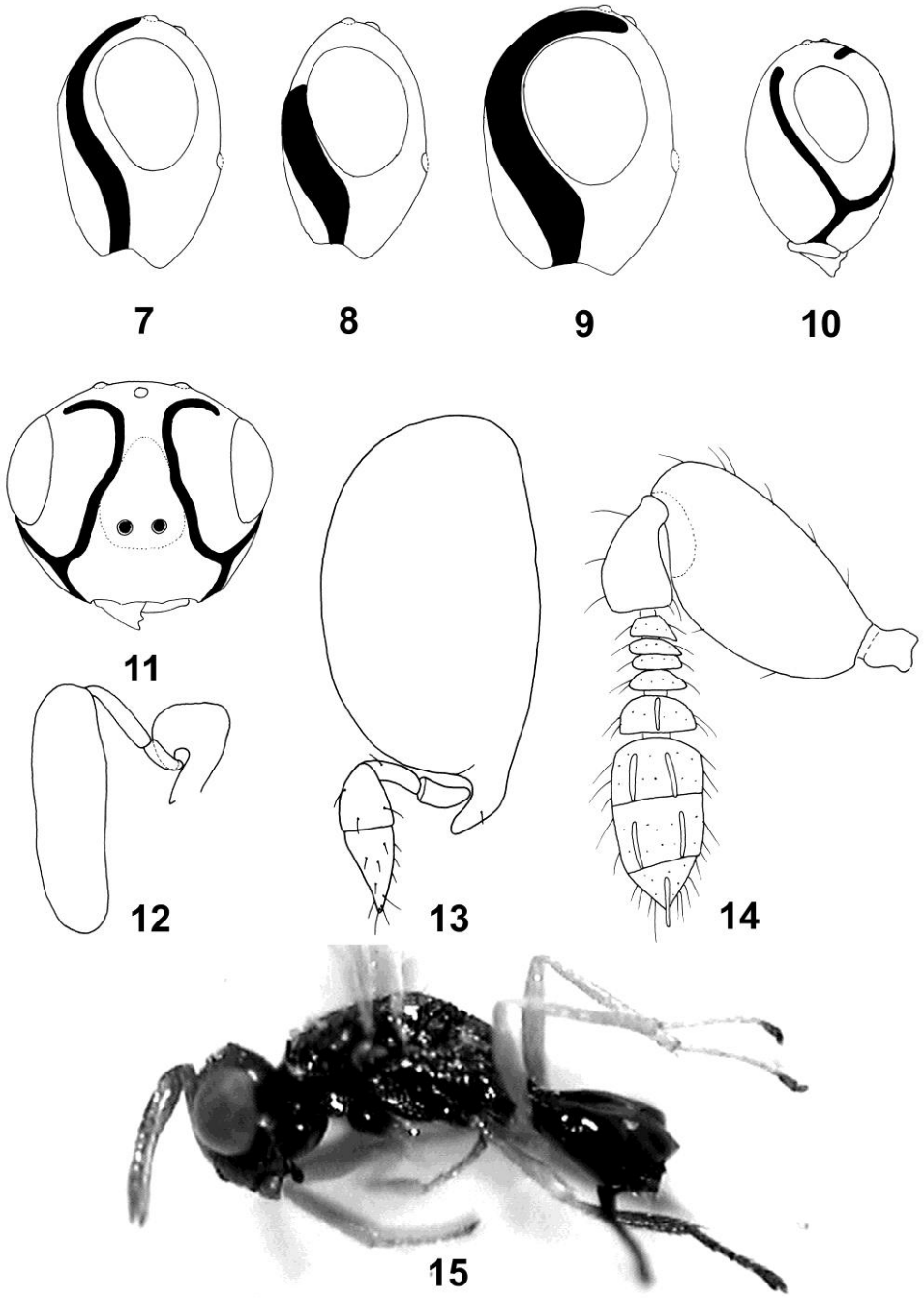
The male *Diglochis* (Figs. 1-2) has un unusual head. Its lower part is deeply excavated, the gena appearing lobe-like and the mouth unusually wide with conspicuous yellowish projections.

The male *Pteromalus microps* (Graham) (Fig. 3) has its gena separated from base of mandible by a large subcircular white membranous area.

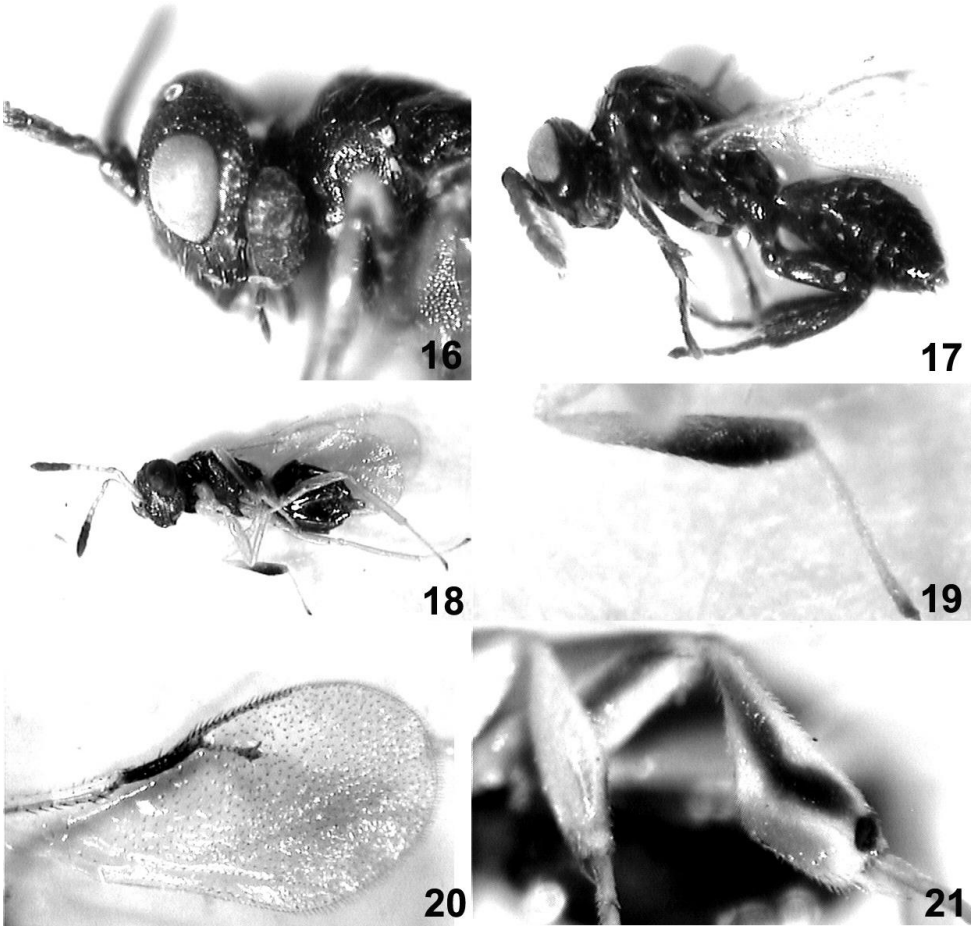
The males of all *Peridesmia* species (Figs. 7-9) have more or less wide dark smooth areas on genae and temples, which can extend up to vertex.



Figures 1-6. 1. *Diglochis* sp., male head; 2. Idem, detail with oral fosa; 3. *Pteromalus microps*, male head from antero-ventral view; 4. Macroglenes penetrans, male head from anterior view; 5. *Sichocrepis armata*, male antenna; 6. *Trichomalus campestris*, male antenna.



Figures 7-15. 7. *Peridesmia congrua* (Walker), male head in lateral view; 8. *P. discus* (Walker), idem; 9. *P. montana* Bouček, idem; 10. *Leptomeraporus nicaee* (Walker), head in lateral view; 11. Idem, head in frontal view; 12. *Halticoptera askewi*, male palpus and stipes; 13. *H. andriescui*, idem; 14. *Macroglenes chalybeus*, male antenna; 15. *Cyrtogaster vulgaris* Walker, male in lateral view.



Figures 16-21. 16. *Sphaeripalpus viridis* Förster, male head and anterior part of the thorax in lateral view; 17. *Spathopus* sp., male body in lateral view; 18. *Spaniopus* sp., male body in ventrolateral view; 19. Idem, mid tibia and tarsus; 20. *Mesoplobus morys*, male forewing; 21. *M. tibialis*, male fore and mid tibiae.

The males *Meraporus* and *Leptomeraporus* (Fig. 10-11) have sinuous smooth lines extending over face, genae, temples and vertex.

Eyes. The compound eyes can be strongly enlarged in several species of *Macroglenes* e.g. *M. penetrans* (Kirby) (Fig. 4) and *M. gramineus* (Haliday), where they can virtually touch the posterior ocelli. Usually the facets are different: the larger ones are arranged in the upper part of the eye and smaller ones in the lower part. In these cases the median ocellus is also larger than usual. It is possible that the enlarged eyes are also better in perceiving the females, but many other species of the same genus have normal eyes. Moreover, the species with normal eyes usually have greatly enlarged antennal scapi (see bellow), while the males with enlarged eyes always have thin scapi, suggesting that these structures are used by females as signals for male recognition.

Antennae. The male antennae, apart from modifications which are probably due to the increased number of sensory structures i.e. more elongated flagellar segments, denser pilosity etc., can be modified in several other ways which are probably related to intersexual selection and involve especially the scape.

In several species of *Macroglenes* e.g. *M. chalybeus* (Haliday) (Fig. 14) and *M. varicornis* (Haliday), the males have a very conspicuous inflated scape. The scape can be moderately enlarged also in some *Trichomalus* males (Fig. 6), where the flagellum has also a different, contrasting coloration than in females. The latter situation may also be encountered in *Spaniopus* (see below) and some *Halticopterina*.

A particular case is the male *Stichocrepis armata* Förster (Fig. 5), where the scape is distinctly widened and deeply excavated ventrally.

Mouth parts. The males from several genera of Miscogasterinae and Pteromalinae have distinctly enlarged palpi and/or stipites, which are usually conspicuously colored in yellow, so presumably visible and attractive for females.

The males of virtually all species of *Halticoptera* and *Halticopterina* have modified palpi and/or stipites. For example in male *H. askewi* Mitroiu (Fig. 12) the stipes is small, inconspicous, but the palpus is very enlarged. In *H. andriescui* Mitroiu (Fig. 13) the situation is opposite: the stipes is enlarged and the palpus in small.

A similar situation can be found in males of some *Sphaeripalpus* (Fig. 16), where the palpus is very inflated, brownish, and visible in the posterior part of the head.

Cyrtogaster males (Fig. 15) also have enlarged palpi, but in this case they are metallic and shiny.

Legs. The legs can be modified regarding their color and width of some segments, especially the mid and hind tibiae.

In males *Mesopolobus tibialis* (Westwood) (Fig. 21) the mid tibiae are much wider than normal, with a brown stripe along the middle, a bright red one near the interior edge and a conspicuous black spot just above the tarsal articulation.

In males *Spaniopus* (Fig. 18-19) the outer margin of middle tibiae is more or less expanded and black, contrasting with the pale color of the rest of the leg segments. The distal antennal segments are also black and contrasting. In males *Cyrtogaster vulgaris* Walker the mid legs have also contrasting colors (femora light, tibiae and tarsi dark) (Fig. 15).

In males *Spathopus* (Fig. 17) the hind tibia is distinctly more expanded than is the case in females.

Wings. Apart from the cases of brachypterous females and macropterous males that are not linked to the intersexual selection, there are only few examples of wing dimorphism in Pteromalidae. One such example is *Mesopolobus morys* (Walker) (Fig. 20), where males have a distinctly thickened, sausage-like, marginal vein.

Conclusions

Male pteromalids, even when considering only part of the West-Palearctic fauna, display a wide range of secondary sexual characters, ranging from modifications of head shape and sculpture, antennal scape widening and eye enlargement, mouth parts modifications, thickened tibiae and venation, as well as various color displays, especially on antennae and legs. All these traits are probably connected to female preference, although this remains to be demonstrated by field observations and laboratory experiments.

Acknowledgments

I thank Prof Ionel Andriescu for the useful discussions regarding the subject of this paper. This study was supported by the Sectorial Operational Program "The Development of Human Resources" through the project "Development of the innovation capacity and increase of the research impact through postdoctoral programs POSDRU/89/1.5/S/49944.

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