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Some New Records and a Key to the Identification of Sub-families of Braconidae (Hymenoptera) Collected in the NWFP, Pakistan

MIAN INAYATULLAH AND MUHAMMAD NAEEM
Department of Entomology, NWFP Agricultural University, Peshawar

Abstract.- A vast survey for braconids conducted for a period of three years, showed that 18 subfamilies are occurring in different ecological zones of the NWFP. The subfamilies are Agathidinae, Alysiinae, Aphidiinae, Blacinae, Braconinae, Cardiochelinae, Cheloninae, Doryctinae, Euphorinae, Helconinae, Homolobinae, Hormiinae, Macrocentrinae, Meteorinae, Micrograstrinae, Neoneurinae, Opiinae and Rogadinae. Of these, six subfamilies including Blacinae, Helconinae, Hormiinae, Macrocentrinae, Meteorinae and Neoneurinae are recorded for the first time in the NWFP. An illustrated key to the identification of these subfamilies and their distribution records in the NWFP are provided.

Key words: Braconidae, Taxonomy, Wasps, Parasitoids.

INTRODUCTION

Braconid wasps belong to order Hymenoptera and thus possess two pairs of membranous wings, which are held together by the hooks (hamuli, located on the anterior side of the hind wings) during flight. Within Hymenoptera they belong to suborder Apocrita and thus have a constriction between thorax and abdomen. These wasps are parasitic (group *Parasitica*) and therefore lack sting but have venom glands which they apply for paralyzing the prey before laying eggs on/in it. Many superfamilies belong to *Parasitica* and braconids belong to superfamily Ichneumonoidea, which is characterized by the absence of costal cell in the fore wing (Fig. 2). The absence of costal cell in combination with the absence of second recurrent vein in the fore wing (Fig. 2) and lack of articulation between abdominal segments 2 and 3 (Fig. 5) make these wasps a distinct group (called braconids within Hymenoptera.

Members of the family Braconidae are primary parasitoids of aphids, exposed and concealed dipterous, lepidopterous, coleopterous and hymenopterous larvae (Gauld and Balton, 1988; Matthews, 1974). Some of these insects are serious pests of field crops, vegetables, fruit trees and timber; braconid species are, therefore of value in the natural control of the plant feeding insects. Braconidae is the second largest family of the Hymenoptera in species richness (Achterberg, 1988). The number of known species is around 15000 (Mason, 1979). Published estimates show that the number of species in the family ranges from 40,000 (Marsh and Carlson, 1979) to 50,000 (Mason, 1979). There is disagreement among braconid workers as to the number of subfamilies of Braconidae, however, Quicke and Achterberg (1990) recognize 44-46 subfamilies.

Considering the importance of this useful group of wasps, a good deal of faunal and taxonomic work has been done in different parts of the world.

Ashmead (1888) described many new species of the family in the collection of the US National Museum and provided the available host records for these wasps. The new species he described represented 22 subfamilies. Fahringer (1928) provided keys for the identification of genera and species from the Ethiopian and Palearctic regions. Baltazar (1962) studied braconids of Philippine and provided keys for the identification of genera occurring in that region. For the North American region, the first key to the subfamilies was presented by Marsh (1963). Later, Marsh (1971) presented a key to the genera of these subfamilies. With the discovery of new taxa, Marsh *et al.* (1987) constructed another illustrated key to the genera of the group for the North America. The work was

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Figs. 1-2. Fore and hind wing of Braconidae showing different veins, 2, Fore and hind wing showing different cells (Courtesy, Wharton *et al*., 1997).

Figs. 3-8. 3, Head of Alysiinae, front view showing exodont mandibles; 4, Head, front view, showing non cyclostome condition; 5, Head, showing cyclostome condition; 6, Head, back view, showing occipital carina absent; 7, Head, back view, showing occipital carina present; 8, Hind wing of Braconinae, showing vein M+CU much shorter than vein 1M.

further improved when Wharton *et al*. (1997) provided a comprehensive and illustrated manual for the identification of subfamilies and genera of the North American region.

Papp (1974) conducted studies on the systematics of the family Braconidae and provided a history of the classification of these wasps. Additionally, he gave the phylogenetic significance of many morphological and biological characters.

Tobias (1975) reviewed the braconids of the USSR and provided key to the identification of 17 subfamilies. With the discovery of more groups, Tobias (1995) presented a comprehensive work including key to subfamilies, genera and species. Achterberg (1976) presented a key to the subfamilies of Braconidae of the world. With the accumulation of more information and discoveries, Achterberg (1993) presented an unpdated key to the subfamilies. Shenefelt (1978) provided a catalog of the world species of the Braconidae. He provided information on literature and the known host records of these wasps. Papp (1989) studied the Braconidae of Korea and reported 58 species representing 8 subfamilies.

No comprehensive faunal or taxonomic work has been done on these useful wasps in Pakistan. However, in the NWFP Inayatullah and Karimullah (1996) conducted some studies on braconids and recorded 17 genera representing 12 subfamilies.

They also provided a key to the identification of the 12 subfamilies. During the recent past further surveys were conducted leading to the discovery of more groups. In the present work these newly discovered groups have been incorporated for updating the braconid identification knowledge. Also more taxa in the already recorded subfamilies have been discovered which further necessitate presentation of a new identification key.

MATERIALS AND METHODS

The key constructed here is based on the collection of specimens in different ecological zones over a period of three years. The collection was done using hand nets and operating malaise traps. Some specimens were reared from pest insects. Additionally specimens already present in the Entomology Laboratory of the NWFP Agricultural University, were also studied for the purpose.

The area surveyed include Peshawar, Nowshehra, Mardan, Swabi, D.I. Khan, Tank, Hangu, Hazara (Abbottabad, Mansehra, Haripur, Galiat), Swat (Mingora, Kalam, Mian Adam, Fatehpur, Malamjaba) Dir (including Shringle and Kumrat) and Chitral. The collection started in June, 1999 and continued through September, 2002.

The collected materials were sorted for braconid specimens. The desired specimens were put in 70% alcohol for a few hours, followed by storage in 95% alcohol for 24 hours. Specimens were then taken out, the larger ones were pinned directly while smaller were mounted on triangular card point for identification.

The Comstock Needhm system of wing vein nomenclature has been followed. Identification was done with the help of available literature. The following literature was used for the identification: Inayatullah and Karimullah (1996), Tobias (1995). Wharton *et al*. (1997).

RESULTS AND DISCUSSION

Results showed that 18 subfamilies occur in different ecological zones of the NWFP. The subfamilies are Agathidinae, Alysiinae, Aphidiinae, Blacinae, Brconinae, Cardiochelinae, Cheloninae, Doryctinae, Euphorinae, Helconinae, Homolobinae,

Figs. 9-13. Metasoma (abdomen) of Braconidae. 9, Aphidiinae with segments 2+3 flexible; 10, Rogadinae a, segments 2+3 immovably jointed; b, carina on segments 2+3; 11, Euphorinae, with petiolate abdomen; 12, Meteorinae, with petiole making a continuous line with the rest of abdomen; 13, Cheloninae, showing the rigid dorsal carapace.

Hormiinae, Macrocentrinae, Meteorinae, Microgastrinae, Neoneurinae, Opiinae and Rogadinae.

Specimens collected in the NWFP vary in size from 1 mm to 25 mm (excluding the ovipositor). They are generally red but a large number of species are black and still others are yellowish red and brown.

Subfamily Aphidiinae is treated by the Indian (Raychaudhuri, 1990) and Russian (Tobias, 1995) Entomologists as a separate family but majority of the braconid specialists (Marsh *et al*., 1987; Wharton *et al*., 1997) treat these wasps as a subfamily of Braconidae. On the other hand, members of subfamilies Blacinae and Neoneurinae are included in Euphorinae (Tobias, 1995) but the majority of braconologists (including Marsh *et al*., 1987; Wharton *et al*., 1997) consider these wasps as separate subfamilies and we have followed Wharton *et al*. (1997) in the present key construction.

The subfamilies can be identified using the following key.

KEY TO THE SUBFAMILIES OF BRACONIDAE OF THE NWFP

1. Exodont; mandibles not touching when closed with 3 or more teeth facing outwardly (Fig. 3) ..... Alysiinae

1’ Endodont; mandibles touching when closed with teeth facing inwardly (as in Fig. 4) 2

2(1’) Articulation present between abdominal segments 2+3 Fig. 9); hind wing without cross vein cu-a; scutellar sulcus smooth; aphid parasitoids.....Aphidiinae

2’ Abdominal segments 2+3 immovably jointed; hind wing vein cu-a present; (as in Figs. 10a, 11, 12).....3

3(2’) Labrum exposed and concave, not concealed by clypeus and forming an ovoid cavity; with cyclostome condition (Fig. 5).....4

3’ Labrum completely concealed by clypeus and not forming and ovoid cavity; non-cyclostome condition (Fig. 4) 7

4(3’) Occipital and prepectal carinae absent (Fig. 6); hind wing vein M+CU less than 0.5 times the length of 1M (Fig. 8) ..... Braconinae

4’ Occipital and/or prepectal carinae present (Fig. 7); hind wing M+CU more than 0.5 times the length of 1M...5

5(4’) Fore tibia with a row of spines or pegs (which may be difficult to see) (Fig. 25).....Doryctinae

5’ Fore tibia without such a row of teeth 6

Figs. 14-19. Fore wings of Braconidae. 14, Meteorinae, with second submarginal cell square-shaped; 15, Agathidinae, marginal cell very narrow; 16, Euphorinae; a, marginal cell short; b, brachial cell open; 17, Neoneurinae, reduced wing venation; arrow, showing vein C+SC+R gradually swollen distally; 18, cardiochelinae, showing strongly arched radial vein; 19, opiinae, long marginal cell.

6(5') Petiole with antero-lateral dorsal carinae which converge and meet near the anterior end and continue as a single carina posteriorly (Fig. 10b).....Rogadinae

6' Petiole without such carinae.....Hormiinae

7(3') Fore wing radial vein (RS) not reaching wing margin as a tabular vein; fore wing venation reduced in distal half (as in Figs. 17, 18, 22)..... 8

7' Fore wing radial vein (RS) complete, reaching wing margin as a tabular vein; fore wing venation complete (as in Figs. 20, 21, 23, 24)..... 10

8(7) Fore wing with vein C+SC+R quite thick and gradually swollen apically near pterostigma; the veins 1M and 1RS make a sharp angle at the junction of (RS+M) a (Fig. 94); maxillary palpus two segmented..... ..... Neoneurinae

8' Without such a combination of characters..... 9

9(7') Fore wing radial vein indistinct and almost straight, lateral tergites of petiole desclerotized; antenna with 16 flagellometes..... Microgastrinae

9' Fore wing radial vein (RS) anteriorly arched, not tubular (Fig. 59); lateral tergites of petiole only particularly sclerotized; antennae variable..... Cardiochelinae

10(7') First three abdominal tergites fused in to a carapace that conceals the rest of the abdominal segments (Fig. 13). 11

10' Abdomen without carapace, abdominal segments, except 2+3, all movable 12

11(10) Fore wing with three submarginal cells (Fig. 24) ....Cheloninae

11' Fore wing with two submarginal cells (Fig. 23) ....Helconinae

12(10') Abdomen petiolate, segment 1 at least 2.5 x longer than width at posterior margin (as in Figs. 11, 12)..... 13

12' Abdomen not petiole (as in Figs. 9, 10)..... 15

13(12) Hind trochantellus with small teeth, which may be difficult to see, (Fig. 26); mesonotal lobe very prominent, ovipositor longer than abdomen; bracheal cell closed (Fig. 20) ..... Macrocentrinae

13' Hind trochantellus without teeth, mesonotal lobe normal, ovipositor shorter than abdomen; bracheal cell open... 14

14(13') Petiole strongly narrowed basally making a continuous line with abdominal segment 2 (Fig. 11, 12), marginal cell long, radial vein straight; 3 submarginal cells present (Fig. 14).....Meteorinae

14' Petiole either tube-like (*Aridelus* spp.), or narrowed basally and not making a continuous line with abdominal segment 2 (Fig. 11); marginal cell short (Fig. 16a); brachial cell open (Fig. 16b) 2 or 3 submarginal cells ..... Euphorinae

15(12') Marginal cell very short, RS terminating far based the apex of the wing; a small second submarginal cell present (Fig. 15)..... Agathidinae

15' Marginal cell long, RS reaching wing apex, second submarginal present or absent 16

16(15') Second submarginal cell absent (Fig. 21).....Blacinae

16' Second submarginal cell present.....17

17(16' Second submarginal cell longer than wide, (Fig. 19); occipital carinae absent dorsally, present on lateral lower sides (Fig. 27).....Opiinae

17' Second submarginal cell square shaped (Fig. 20); occipital carina well developed..... Homolobinae

Biological significance and distribution

Species of Agathidinae are endoparasitoids of concealed Lepidoptera larvae (Shaw and Huddleston, 1991). They were recorded only from plain areas of Mardan, Swabi and Peshawar, Members of Alysiinae will attack dipterous larvae (Shaw and Huddleston, 1991). These wasps occur in large number throughout the province. Aphidiines are well known aphid parasitoids (Stary, 1966) and occur throughout the NWFP especially during the Spring.

Braconines are ectoparasitoids of Lepidoptera, Coleoptera and Diptera larvae (Quicke, 1987). They have been utilized in many biological control programmes in different parts of the World. This is a very diverse group found throughout the province. Subfamilies Blacinae and Cardiochilinae are small groups occurring in plain areas. Blacinae parasitizes coleopterous larvae in concealed situations (Achterberg, 1988), while cardiochilines attack lepidopterous larave (Huddleston and Walker, 1988).

Subfamily Chiloninae is a distinct and moderately diverse group of small wasps that occurs throughout the NWFP. They are egg-larval parasitoids of lepidopterous larvae especially the pyralids (Shenefelt, 1973). Doryctinae is a highly diverse group in the World but was found to be less diverse in the NWFP. It was recorded only from plains. They are parasitoids of Coleoptera and Lepidoptera larvae and helping in the natural control of the pests especially the wood boring beetle larvae (Marsh, 1997).

Euphorinae has many genera in the NWFP. They are parasitoids of adult paurometabolous and holometabolous insects. Majority will attack Hemiptera and Coleoptera (Shaw, 1985). They were recorded from both plain and hilly areas of the province.

Figs. 20-24. Fore wings Braconidae. 20, Homolobinae (*Homolobus*); 21, Blacinae (*Blacus*); 22, Microgastrinae; 23, Halconinae (*Triaspis*); 24, Cheloninae (*Ascogaster*).

Figs. 25-27. Fore tibia Doryctinae, showing spines; 26, Hind leg of Macrocentrinae showing pegs on trochantellus; 27, Head of Opiinae, back view showing occipital carina on sides only.

Subfamilies Helconinae, Homolobinae and Hormiinae are less diverse groups. Helconines are restricted to high elevation areas of Hazara, while homolobines occur only in the NWFP plains. Hormiinae occurs in both plain and hilly areas. Homolobinae and Hormiinae are the natual enemies of lepidopterous larvae, while helconines attack beetle larvae (Shaw and Huddleston, 1991).

Macrocentrinae is a rare group, restricted to high elevation areas of Dir and Hazara. They parasitize lepidopterous larvae (Shaw and Huddleston, 1991) and are of value in the natural control of forest pests. Meteorinae was recorded only from Hazara division. They parasitize lepidopterous larvae (Shaw, 1985).

Among all the subfamilies discovered in the NWFP, the Microgastrinae is a very diverse, widely distributed and much encountered subfamily occurring throughout the plain and hilly areas. They are equally abundant in agricultural and forest areas. Their efficiency as parasitoids of lepidopterous pests is well documented (Mason, 1981). They have been utilized in the biological control programmes of sugarcane borers in the NWFP.

Neoneurinae is poorly represented in the NWFP found only at high elevation hilly areas. They attack adult worker ants (Tobias, 1995) and are of less value to bio-control specialists.

Subfamily Opiinae is a very widely distributed and much encountered group of small braconids. They parasitize dipterous larvae (Wharton *et al*., 1997) and occur throughout the province in all habitats. In the present study they were reared from fruit flies attacking guava. They are therefore of great value in the biological control of these important pests.

Rogadinae was recorded from mountainous area of Swat and all the plain areas. These wasps are endoparasitioids of lepidopterous larvae (Shaw, 1997).

The above discussion shows that the majority of the braconid hosts belong to orders Lepidoptera, Coleoptera and Diptera. The majority of our crop pests also belong to these orders. This indicates the significance of these useful parasitic wasps to our agriculture and environment. These well established facts about these wasps necessitate further exploration, identification, conservation and evaluation of their efficiency against crop and forest pests.

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