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An illustrated key to the subfamilies of Braconidae (Hymenoptera) in Chitral district of Khyber Pakhtunkhwa, Pakistan

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Abstract

Braconids collection was made from different areas of district Chitral in Khyber Pakhtunkhwa. During the course of study, a total of 350 specimens were collected and examined later on. Results revealed that 32 genera in thirteen subfamilies were occurred in district Chitral. These subfamilies were included of Alysiinae, Aphidiinae, Braconinae, Cheloninae, Doryctinae, Euphorinae, Hormiinae, Homolobinae, Macrocentrinae, Meteorinae, Microgasterinae, Opiinae and Rogadinae. Among all these, subfamily Aphidiinae was found the most diverse group with 9 genera. Alysiinae was recorded the second wide-ranging group having 5 different genera. Subfamily Microgasterinae was represented by 4 genera and similarly, Braconinae by 3 genera. Two genera were recorded in Subfamily Euphorinae. Subfamilies, Cheloninae, Homolobinae, Macrocentrinae, Meteorinae, Opiinae, Rogadinae and Doryctinae were represented by one genus each. The present study describes distributional notes for each subfamily and a key was constructed for the identification of all these subfamilies.

Keywords: braconidae, taxonomy, wasps, parasitoids and khyber Pakhtunkhwa, Pakistan

1. Introduction

According to (Achterberg 1979) ^[1] Braconidae is the second largest family of the order Hymenoptera. This family is divided into about 47 subfamilies and over 1000 genera (Beyarslan 2013) ^[3]. The number of known species in the world is around 15,000 (Mason 1979) ^[22]. Due to great contribution to the taxonomy of braconid wasps in different parts of the world, presently, the number of recognized species approximately 17000, and many thousands more undescribed (Jones, *et al.* 2009) ^[15]. Braconids are the members of Apocrita, which is a suborder of Hymenoptera. All apocritans have propodeum, which is the modified 1st abdominal tergite fused with the thorax. Superfamily Ichneumonoidea is divided into two families, Braconidae and Ichneumonidae. Braconidae can be differentiated from the Ichneumonidae by absence of second recurrent vein in the forewing and lack of articulation between metasomal segment 2 and 3 except Aphidiinae (Fig1-2). Body size of braconids range from 1-30 mm. Majority are reddish or yellowish dark brown in colour (Tobias 1995) ^[32]. Almost all braconids are parasitoids containing both ectoparasitoids and endoparasitoids. Many of them parasitized on larval or nymphal stages of their hosts. Some euphorines also attack on pupae and adults as well (Tobias 1995) ^[32]. The species they parasitize belong to orders Homoptera, Coleoptera, Lepidoptera, Diptera and Hymenoptera. Majority of these insects are serious pests of field crops, vegetables, fruit trees and timber. Many braconids have been reared from important pests. These wasps therefore, are of high value in the natural and biological control of pests (Inayatullah 2002) ^[11].

Some euphorines have previously been utilized for biological control, particularly for the suppression of beetles and bugs, e.g. species of *Microctonus* have been used for control of weevils on forage crops in Europe and North America (Loan 1967, 1975) ^[16, 17]. A South American species, *Microctonus hyperodae* Loan, was imported to New Zealand to aid in the suppression of the Argentine stem weevil (Shaw 1993) ^[27]. Due to their value in the natural and biological control of pests, attention has been paid to the taxonomy of these wasps.

Valuable contributions have been made by (Inayatullah 1996) ^[9] who recorded 12 subfamilies from Khyber Pakhtunkhwa province. (Inayatullah 2002) ^[11] Recorded 6 genera of subfamily Euphorinae and provided a key for their identification. (Inayatullah 2003) ^[12] provided taxonomic notes and key to the identification of nine aphidiine genera. Later, (Inayatullah and

Naeem 2004) [13] presented another subfamily key with 18 subfamilies. (Ahmad 2006) [2] provided a key for the identification of fourteen genera of subfamily Aphidiinae from Khyber Pakhtunkhwa.

No special attention has been paid to braconids of Chitral. Keeping in view the importance of the group, the present study was therefore, conducted to record the subfamilies, their distribution and seasonal occurrence in Chitral District of Khyber Pakhtunkhwa.

2. Materials and Methods

Braconids collection was made from different areas of District Chitral in Khyber Pakhtunkhwa (KP). The main areas were Drosh, Proper Chitral, Bomborait, Madaklasht, Khoth, Arandu and Kalas. Hand net was used to collect the braconids, as they are small in size. Braconids were sorted from the collected material. Smaller species were removed from the net by using aspirator. Malaise traps were also installed in different agro-climatic zones of Chitral. The collected braconids were preserved in 70% alcohol for

preventing them from damage on becoming dry.

Specimens were identified with the help of available literature. The Comstock Needham system of wing vein nomenclature was employed. Terminology for surface sculpturing is that of (Harris 1979) [8].

3. Results and discussion

During the present study a total of over 350 braconid specimens were collected from different localities of Chitral. These specimens fall into 32 genera belonging to 13 subfamilies. Among these, subfamily Aphidiinae was the most diverse with 9 genera. Alysiniinae was recorded to be another diverse group with 5 genera. Subfamily Microgastrinae was represented by 4 genera. Subfamily Braconinae was represented by 3 genera. Subfamily Euphorinae was represented by 2 genera. Subfamilies, Cheloninae, Homolobinae, Marocentrinae, Meteorinae, Opiinae, Rogadinae and Doryctinae were represented by one genus each. The subfamilies can be identified with the following key.

Key to the subfamilies of Braconidae of the Chitral, Khyber Pakhtunkhwa

- | | | |
|---------|---|-----------------------|
| 1 | Exodont; mandibles not touching when closed, teeth facing outwardly (Fig. 3)..... | Alysiinae |
| 1' | Endodont; mandibles touching when closed, teeth facing inwardly (Fig. 11)..... | 2 |
| 2(1') | Articulation present between abdominal segment 2+3; hind wing without cross vein cu-a; scutellum smooth; aphid parasitoids (Fig. 2)..... | Aphidiinae |
| 2' | Abdominal segments 2+3 immovably jointed; hind wing vein cu-a present; (Fig. 1)..... | 3 |
| 3(2') | Labrum exposed and concave not concealed by clypeus and forming an ovoid cavity; with cyclostome condition; (Fig. 10)..... | 4 |
| 3' | Labrum completely concealed by clypeus and not forming an ovoid cavity; non cyclostome condition (Fig. 11)..... | 7 |
| 4 | Occipital and prepectal carinae absent (fig. 8); hind wing vein M+CU less than 0.5 times the length of 1M (Fig. 7)... | Braconinae |
| 4' | Occipital and/or prepectal carinae present (Fig. 9); 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. 13)..... | Doryctinae |
| 5' | Fore tibia without such a row of teeth..... | 6 |
| 6(5') | Petiole with antero-lateral dorsal carinae which converge and meet near the anterior end of the segment, (Fig.23)..... | Rogadinae |
| 6' | Petiole without such carinae..... | Hormiinae |
| 7(3') | Abdomen petiolate, segment 1 at least 2.5X longer than width at posterior margin (Fig. 14, 20)..... | 8 |
| 7 | Abdomen not petiolate..... | 10 |
| 8 | Hind trochantellus with small teeth, which may be difficult to see, mesonotal lobe very prominent, ovipositor longer than abdomen; brachial cell closed (Fig. 18)..... | Macrocentrinae |
| 8' | Hind trochantellus without teeth, mesonotal lobe normal, ovipositor shorter than abdomen; brachial cell open..... | 9 |
| 9(8') | Petiole strongly narrowed basally making a continuous line with abdominal segment 2 (Fig. 20) marginal cell long, radial vein straight and 3 submarginal cells present (Fig. 19)..... | Meteorinae |
| 9' | Petiole either tube-like or narrowed basally and not making a continuous line with abdominal segment 2 (Fig. 12); marginal cell usually short, 2 (Fig. 14)..... | 11 |
| 10(7') | First three abdominal tergites fused into a carapace that conceals the rest of the abdominal segments Fig.12)..... | Cheloninae |
| 10' | Abdomen without such carapace..... | 12 |
| 11(9') | Brachial cell open and radial vein directed towards anterior wing margin.(Fig. 15)..... | Euphorinae |
| 11' | Brachial cell closed and radial vein straight (Fig. 16)..... | Homolobinae |
| 12(10') | Forewing radial vein indistinct and almost straight, lateral tergites of petiole desclerotized, antennae 18 segments (Fig.21)..... | Mirogastrinae |
| 12' | Forewing radial vein distinct and reaching wing margin, lateral tergites of petiole sclerotized (Fig.22)..... | Opiinae |

Alysiinae

Alysiinae belongs to noncyclostome-group of Braconidae. This group contains very small (0.8mm–1mm) to medium sized (3.5mm–4mm) braconids. The group was recognized by their exodont mandibles (Fig. 3), usually having 3-4 dentate mandibles. Wing venation complete often with long cuneate or linear stigma, forewing having 2-3 cubital cells. In Chitral area it was represented by genera *Aphaerata*, *Aspilota*, *Dacnusa*, *Dinotrema* and *Orthostigma*. Since no studies have been made for Chitral area therefore all are new records for

the area. Out of these *Dinotrema* and *Orthostigma* are new records for Pakistan. Alysiinae are endoparasitoids of dipterous larvae (Wharton 1984) [34]. All the recorded genera have worldwide distribution. Tobias (1962) [31] provided a key for the species of genus *Aspilota* recorded from the fauna of USSR. Fischer (1967) [5] recorded the genus *Aspilota* as *Synaldis*. Again Fischer (1976) [6] provided description and key for ten new species of genus *Aspilota*.

Wharton (1980) [33] also included the genus *Aspilota* in his key to the genera of braconids. Tobias (1995) [32] reported 20

species of the genus *Aspilota* from the fauna of USSR. Wharton *et al.* (1997) [35] included the genus *Dacnusa* in his key to braconid genera of the new world. Inayatullah (2001) [10] recorded the genus *Dacnusa* from both hilly and plain areas of NWFP (Now Khyber Pakhtunkhwa). In the present studies specimens of this genus were collected from Arandu, Drosh, Bomburait, areas of the District Chitral.

Aphidiinae

They were recognized by the combination of small size, reduced wing venation (except *Ephedrus* and *Toxares*) (Figs. 4, 6); hind wing cross vein cu-a absent (Fig. 5), and the presence of occipital carina.

These wasps are distributed worldwide. In Chitral they were collected in great number from brassica and grasses from February through August. They are parasites of aphids and keep aphid population low especially during April and are good natural enemies of aphids (Inayatullah, 2002) [11]. In the present studies 9 genera were recorded from Chitral. The recorded genera are *Aphidius*, *Binodoxys*, *Diaeretaeilla*, *Lipolexis*, *Lysaphidus*, *Ephedrus*, *Monoctonus*, *Praon* and *Toxares*. *Aphidius* was recorded from Drosh, Bomborait and Madaklusht. *Binodoxys* from Arandu, *Diaeretaeilla* from Drosh and Bomborait *Lipolexis* from Arandu, *Lysaphidus* from Drosh, *Ephedrus* from Drosh, *Monoctonus* from Arandu, *Praon* from Arandu and *Toxares* from Drosh and Arandu. Among these, the *Aphidius* was very diverse and were collected throughout the Chitral from June to October. All The genera of Aphidiinae are new record for Chitral except *Lipolexis*, *Aphidius* and *Lysaphidus*. Many species were present and active from April to September, which shows that the environmental conditions are conducive for their development and they can be incorporated in to an integrated management of aphid pests.

Braconinae

Braconinae is the well-known and very speciose subfamily of Braconidae. It belongs to the cyclostome group of braconids and can be recognized by the cyclostome condition in combination with the absence of occipital and prepectal carinae and the presence of a raised median dome shaped area on tergum 1 (Fig. 11). These braconids are ectoparasitoids of exposed and concealed larvae of Lepidoptera and Coleoptera. Quicke (1987) [24] provided comprehensive morphological and biological notes on braconids of the Old World. Mason (1979) [22] reported that the genus *Myosoma* is widely distributed from southern USA to Brazil. From Chitral, 3 genera were recorded from different localities. These genera are *Bracon*, *Myosoma* and *Vipio*. *Bracon* species are of great value as they attack the pink bollworm, *Pectinophora gossypiella* and *Helicoverpa* species (Tillman 1985) [30]. Genus *Vipio* is a new record for Chitral. It was recorded from Arandu and Drosh area of Chitral.

Cheloninae

The chelonines are a well known group of medium sized wasps. They were identified by metasomal carapace, formed by fusion of first three abdominal segments, (Fig. 12). Only one genus *Chelonus* was recorded from Chitral area. Shenefelt (1973) [26], Marsh (1979) [20] and Shaw (1983) [28] provided morphological information on the genus. Marsh and Carlson (1979) [21] recorded *Heliothis* and *Spodoptera* as the hosts of *Chelonus insularis* from New world. Rodriguez-del-Bosque *et al* (1990) [25], repeatedly reared *Chelonus sonorensis* from Pyralid stalk borers in Texas and Mexico.

Tobias (1995) [32] reported several species of genus *Chelonus* from central Kazakhstan, Central Asia, Western Europe, to Far East, Orenburg region, North Africa, Iran and Northern Europe, half of them Palearctic. Inayatullah and Karimullah (1996) [9] also recorded the genus *Chelonus* in NWFP (Now Khyber Pakhtunkhwa). According to Wharton *et al* (1997) [35] the genus *Chelonus* is more heat and drought tolerant; occur commonly in meadows, prairies and grasslands. Papp (1999) [23] discussed the taxonomic position of genus. Inayatullah (2001) [10] collected the genus *Chelonus* from almost every habitat in the NWFP (Now Khyber Pakhtunkhwa). In the present studies specimens of genus *Chelonus* were collected from Bumburait area of Chitral.

Doryctinae

The subfamily were recognized by the presence of a row of stout teeth or spines on the lateral side of the fore tibia. (Fig. 13). They belong to the cyclostome group of braconids having oral cavity between clypeus and mandibles, (Fig. 11). Additional characters include the presence of occipital carina; and the presence of a flange at the apico-lateral corner of the propleuron just above the fore coxae. In most genera the ovipositor is at least as long as abdomen or longer. Although they are very diverse but in Chitral only one genus *Spathius* has been recorded from Khoth area. These wasps are parasitoids of concealed larvae of Coleoptera, Lepidoptera and Diptera. Species of *Spathius* attack larvae of wood boring beetles and could prove good natural enemies.

Euphorinae

The subfamily Euphorinae is moderately large subfamily of Braconidae. Within Braconidae they were recognized by the combination of characters like petiolate abdomen, (Fig. 14). Fore wings radial vein sharply curved towards anterior margin of wing, the presence of two to three cubital cells in the forewing and the open 1st subdiscal (bracheal) cell (Fig. 15). These genera occur worldwide, but not frequent globally; several species of *Liophron* have been used as biocontrol agents for lygus bug (Ioan and Shaw 1987) [19] and other mirids (Ioan 1980) [18]. Two genera including *Dinocampus* and *Liophron* were recorded from Drosh area of Chitral.

Hormiinae

These wasps were recognized by the absence of characters present in other cyclostome braconids. From Doryctinae they were separated on the basis of absence of a row of teeth from the fore tibia. Braconines have lost the occipital carina, hormiines have it. Rogadines have two carinae anteriorly on petiole, the hormiines lack this character. They belong to the cyclostomes group of braconids with oral circular opening, (Fig. 17). In the subfamily Hormiinae, only one genus *Hormius* has been recorded from Drosh area of Chitral.

Homolobinae

They are parasitoids of the larvae of Noctuidae and Geometridae (Wharton *et al* 1997) [35]. They were recognized by the presence of occipital and prepectal carina; 2-3 submarginal cells in the forewing (Fig. 16) and the presence of antescutal depression mid-dorsally behind the pronotal collar. These wasps are rare. Only one specimen of *Homolobus* was collected from Drosh area of Chitral in May.

Macrocentrinae

This is a rare group and were recognized by the presence of spines on trochantellus, (Fig. 18). The genus *Macrocentrus* is

also rare. They parasitize Pyralids and Tortricids. Their occurrence in hilly areas is of value in the natural control of forest pests. Only one specimen was collected from Kalas area of Chitral.

Meteorinae

Members of Meteorinae have been included by many authorities (Tobias *et al* 1995) [32] in Euphorinae. They differ from Euphorinae in two aspects. Meteorinae are parasites of immature holometabolus insects while euphorines parasitize adult paurometabolus and holometabolus insects. In Meteorinae the forewing vein 3RSb is straight and marginal cell long, while in euphorines the vein 3RSb is short and curved thus marginal cell short, (Fig. 19). Following Wharton *et al* (1997) [35] Meteorinae is treated here as a separate subfamily. Meteorinae is a small group, only two genera are recognized worldwide, these genera are *Meteorus* and *Zelex*. They are parasitoids of Coleoptera and Lepidoptera. They have been utilized in the biological control of various cutworms (on crops) and Papilionids (on citrus) (Zintani *et al* 1997) [36]. Only one specimen of genus *Meteorus* was collected from Arandu area of Chitral in July.

Microgastrinae

Microgastrinae are parasitoids of larvae of Lepidoptera and Coleoptera (Fallis 1942) [4]. Important morphological characters include the 16-segmented flagellum and reduced wing venation, (Fig.21) (Inayatullah and Karimullah 1996) [9]. Microgastrinae is a large and diverse group of small and usually black braconids. Four genera including *Apanteles*, *Cotesia*, *Dolichogenidia* and *Microplitis* have been recorded from all plain and hilly areas of Chitral. Genus *Dolichogenidia* is a new record for Chitral. The genera *Apanteles* and *Cotesia* were collected from Drosh and the other two genera were found in Madaklusht and Bomborait areas of Chitral.

Opiinae

This is one of the larger groups of braconid wasps dominated by genus *Opius*. Species of this subfamily are usually small in size 1-3mm in length; usually with a short body and relatively long forewing. Distance from base of stigma to the apex of wing longer than distance from base of stigma to base of wing (Fig. 22). Forewing lacking anal cross-veins and lacking recurrent vein on the hind wing. They are endoparasitoids of dipteran larvae which has been considered sufficient for the separation of these wasps from others except the Alysiinae which are also parasitoids of the same order but differ from Opiinae in the shape of mandibles. Inayatullah and Karimullah (1996) [9] recorded the genus *Opius* in Khyber Pakhtunkhwa. In the present studies only one genus *Opius* was collected from Drosh area of Chitral in July. This genus could prove a useful biological control tool for the control of fruit flies.

Rogadinae

Rogadinae is a diverse group of small to moderately large wasps. They were identified by the presence of cyclostome condition and occipital carina. Other important characters include the presence of a mid-longitudinal carina on abdominal Tergum 1 and 2 (Fig. 23) and the 6-segmented maxillary palpus. The body of these wasps is distinctly sculptured. Subfamily Rogadinae is a group of koinoboint

endoparasitoids, mostly of exposed-feeding macrolepidopteran larvae (Shaw 1983) [28]. Members of genus *Rogas* have been recorded from Bumburait area of Chitral in June. Specimens of *R. testaceus* were reared from okra fruit borer in Peshawar. The possibility of their usefulness exists for the control of okra fruit borer if mass rearing techniques are developed (Inayatullah 2002) [11].

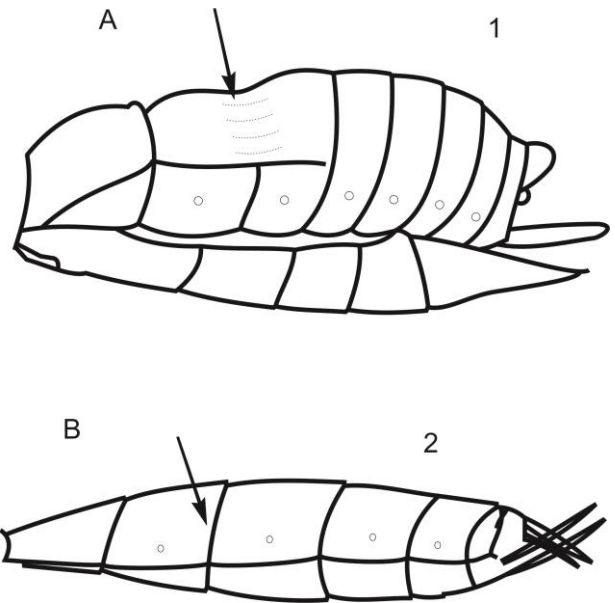


Fig 1: Metasoma (Abdomen) of braconid showing immovable metasomal targa 2 & 3.
Fig 2: Metasoma of Aphidiinae showing movable metasomal targa 2 & 3

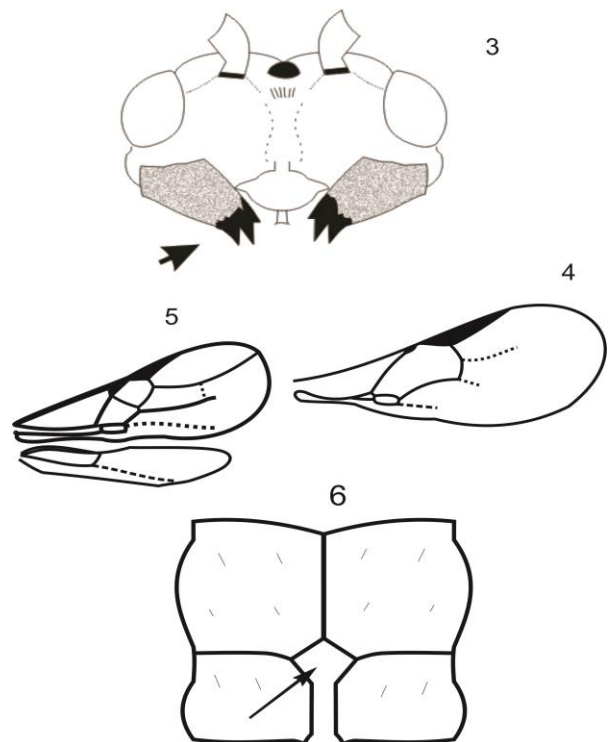


Fig 3: frontal view of Alysia head showing exodont mendibles.
Fig 4: Fore wing of Aphidiinae (*Monoctonus*). Fig. 5, Fore and hind wing of Aphidiinae (*Toxares*). Fig. 6, Propodeum of Aphidiinae (*Aphidius*) showing pentagonal areola.

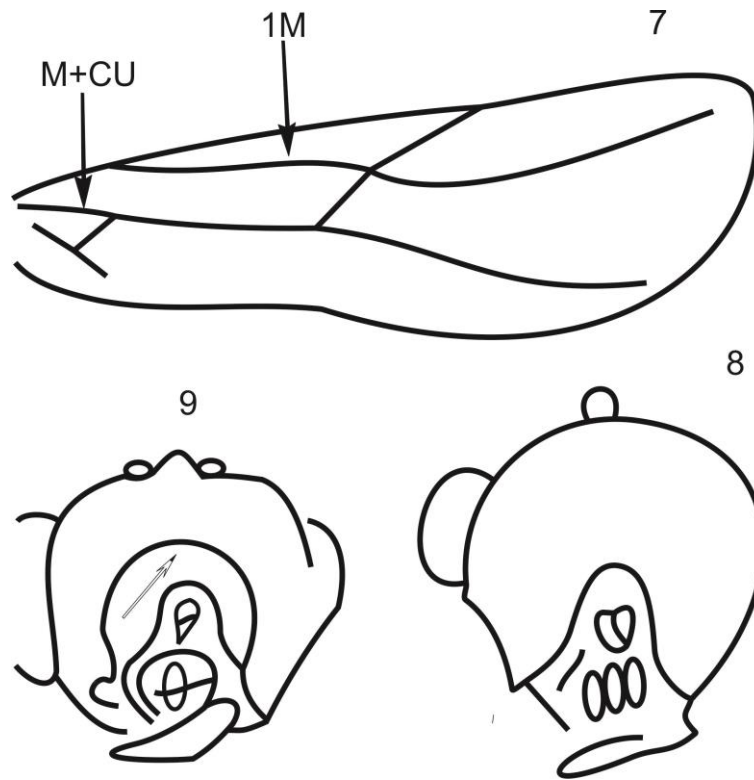


Fig 7: Hind wing of braconinae showing relative vein of M+CU and M

Fig. 8, Head back view showing no occipital carina.

Fig. 9, Head back view showing occipital carina

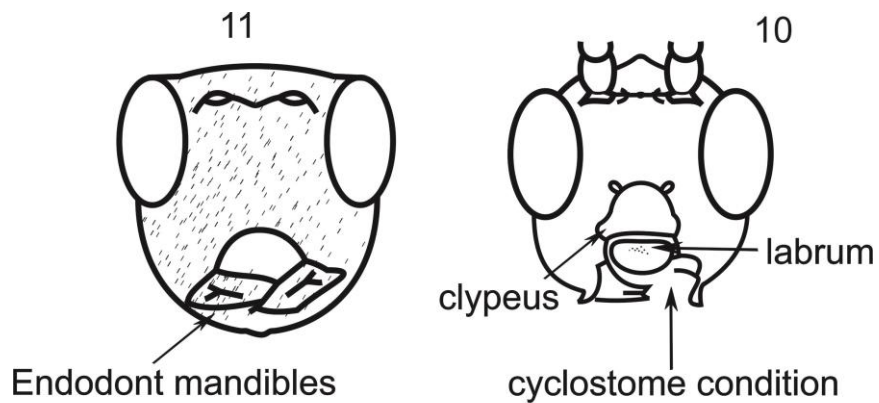
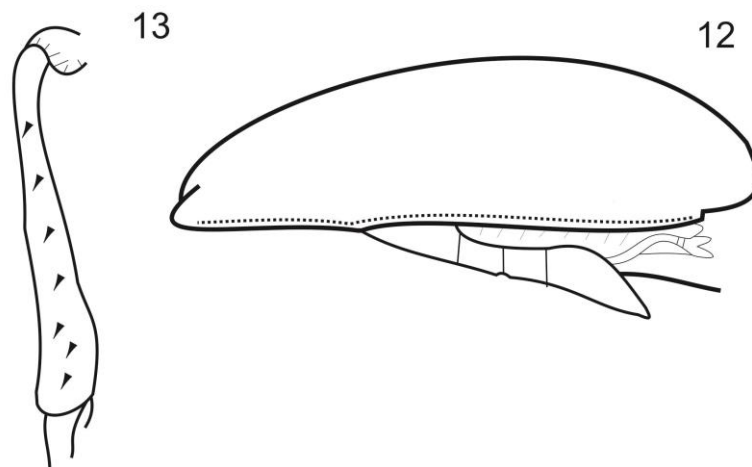


Fig 10: Head, showing cyclostome condition, labrum not exposed

Fig 11: Head, showing non-cyclostome condition, labrum exposed

Fig 12: Metasoma of Cheloninae spp

Fig. 13: Front tibia of Doryctinae showing pegs



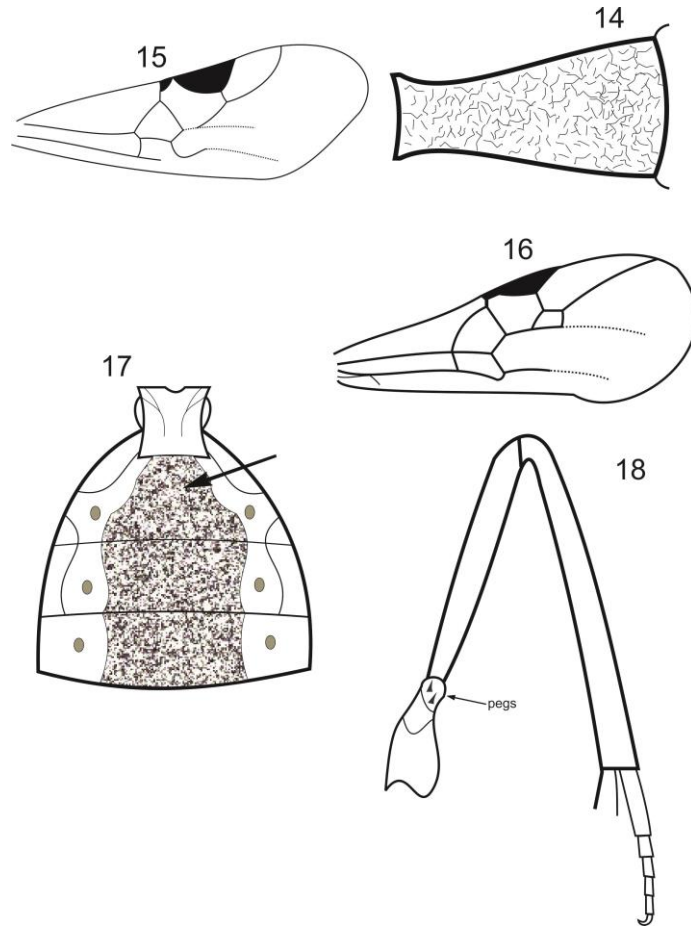


Fig 14: Ist metasomal segment of *Dinocampus*.

Fig 15: Forewing of *Dinocampus*

Fig 16: Forewing of *Homolobus* (Homolobinae)

Fig 17: Unsclerotized part of metasoma of *Hormius* (Hormiinae)

Fig 18: Leg of *Macrocentrus* (Mecrocentrinae) Showing pegs on trochantellus

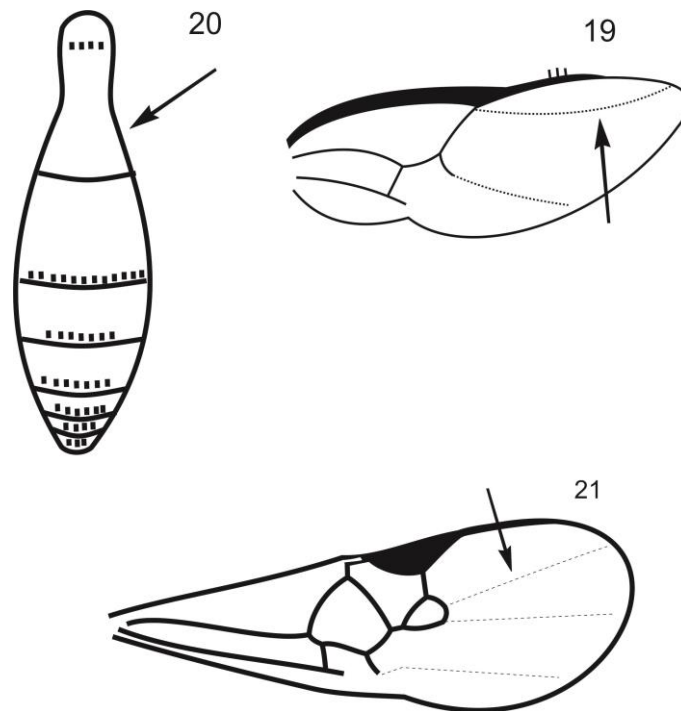


Fig 19: Hind wing of *Meteorus* (Meteorinae), showing RS bending forward.

Fig 20: Petiol of *Meteorus* showing continuous line with abdomen.

Fig 21: Forewing of *Microgatrinae*, showing indistinct and almost straight radial vein.

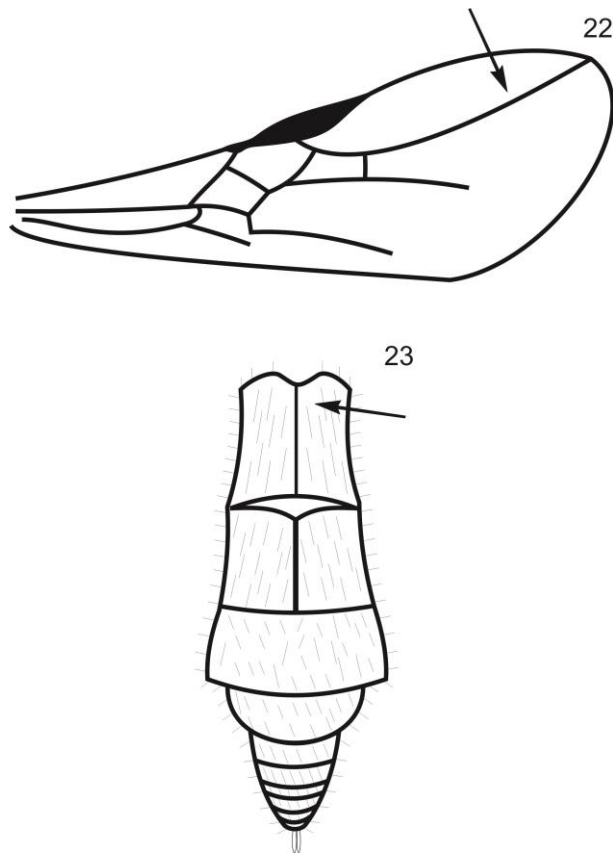


Fig 22: Forewing of *Opius* (Opiniinae), showing distinct radial vein.

Fig 23: Metasoma of *Rogas* (Rogadiinae) showing anterior two carinae joining to form a midlongitudinal caria.

4. Conclusion

To sum up, all studies carried out about Braconidae subfamilies in district Chitral, it has been shown that Aphidiinae is the most abundant subfamily captured with 9 genera followed by Alysiinae, Microgastrinae, Homolobinae and Euphorinae with 5, 4, 3 and 2 genera each. While subfamilies, Cheloninae, Homolobinae, Marocentrinae, Matorinae, Opiinae, Rogadinae and Doryctinae were represented by one genus each. Members of these subfamilies of Braconidae are best parasitoid of Hemipterous, Lepidopterous, Dipterous and other pests of important agricultural crops. They were present and active from April to September, which shows that the environmental conditions are conducive for their development and they can be incorporated in to an Integrated Pest Management programmes.

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