IOSR Journal Of Pharmacy And Biological Sciences (IOSR-JPBS)
e-ISSN:2278-3008, p-ISSN:2319-7676. Volume 10, Issue 4 Ver. V (Jul. –Aug. 2015), PP 77-86
www.Iosrjournals.Org

Study of Cephalic Capsule and Its Appendages of Certain Indian Apoidea In Relation To Phylogeny

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I. INTRODUCTION

The Apoidea, Ashmead knowan as "Bees" in common english, form a distinct group, placed under a separate super-family of aculeate Hymenoptera of the class Insecta. These bees could be readily distinguished from all other hymenopterous insects, mainly by the presence of plumose or feathery hairs over their bodies.

As regards habits, three distinct groups of bees could be recognized. These are, the social bees, the solitary bees, and the parasitic bees. This group of insects render excellent help to the farmers, horticulturists and the foresters by cross polinating their valuable crops. This group of insects abundantly represented in tropical and subtropical regions of the globe, excepting only extreme arctic latitude and torrid desters and even in these latter parts more species are to be found than might generally be supposed. The study of Indian Apoidea is quite in its infancy. About 250 species were known from India (including Nepal, Sikkim, Bhutan, Burma and Ceylon) as late as 1897 since the publication of Bingham, Fauna of British India. Since the date certain groups have been revised and only 350 new forms are added to the Bee Fauna of India.

The food of the bees consists of nector and pollen, the former supplying the carbohydrate ingredient and the later, proteins. The adult's food differ from their young ones in one respect, that is in the later case it is converted into honey or regurgitated before being served to them. Most member of the group make nests in soil, the cells are usually lined with a waxy water proof secretion. In the suitable climate the bees continue their activities throughout the year and in place where there is prolonged winter, they may hibernate for sometimes or may undergo diapauce, or suspend their activities for sometimes as we find in the Allodape and Anthophora colonies. Mating in bees has always been observed in the air. Three to four days after mating the fameles being to lay eggs, provided the place to lay eggs is there, otherwise, first, the next is built, provisions are laid and than they laying commences.

Very little is known about the cephalic capsule and its appendages (mouthparts) of Indian Bees. Our knowledge of cephalic capsule and its mouthparts of Indian bees, has largely been derived from the work of Binghrn (1897), Rehman and Sardar (1949), Sehgal (1963) and Kapoor (1970). But their work gave a preliminary knowledge of the cephalic capsule and mouthparts of Indian Bees.

The aim of the present study is to bring together the information on the cephalic capsule and its mouthparts of some Indian Bees in relation to the taxonomy of the group. The detailed information regarding the cephalic capsule mouthparts of some Bees would serve good purpose for future workers in India. A considerable attention has been paid to present information in this thesis.

However, the present work does not suffice for alround claim. The present work is not be confused with attempt to base a new system of classification one set of characters. Rather it is realised that an adequate classification of the Apoidea will only be possible if many characters were studied in detail. This study of Apoidea (Bees) on the cephalic capsule and mouthparts is certainly useful for the taxonomy of higher groups, we donot hesitate in stating that this study can be regarded as first preliminary attempt on the cephalic capsule and mouthparts of some Indian Bees. It will be necessary to examine many more characters other than cephalic capsule and mouthparts in order to establish the systematics of all categories (including lower categories) of Apoidea.

Most of the families and sub-families of Indian Apoidea (Bees) which appeared to be interest are included in this work. A few families and subfamilies, which could not be collected to the best of my belief. In the course of study, I have collected a large number of Bees from various parts of India. The classification followed in this thesis is based on well known work of Michener (1944 and 1965).

Crampton (1912) is the only article devoted exclusively to this subject discusses the phylogenetic origin of the mandibles of insects and their anthropodan relatives a contribution to the study of the evolution of the Arthropoda. Crampton (1923) again gave a very important contribution regarding the phylogenetic comparision of the maxillae and labium throughout the orders of insects. His accurate description, relating mainly to the maxillae and labium, is of great value. Cockerell and Jacobs (1924) contributed some important notes on the structural peculiarities of bees.

Dusemet and Alonso (1924) published an important paper on the morphology of Xylocopa, which include the detailed account of cephalic capsule and mouthparts. Bugnion (1925) described the buccal parts of Xvlocooa violette. In the same year, Liu (1925) described the morphology of submentum in the Hymenopterous insects. Crampton (1928), gave a comparative study on the mentum, submentum and gular region in the insects.

The study of the insects head and its appendages was done by Snodgrass (1928, 1932). He gave a detailed account of the morphology and evolution of the insects head and its appeendages. Metcalf (1929) also gave a detailed comparatice account of mouthparts in insects. Walker (1932) gave a important morphological description on the clypeus and labium of primitive insects and also discussed their taxomic importance in the insects.

The work of Duncan (1939), is one of the very important contribution for the morphological study of Apoidea. He has described in detailed the cephalic capsule of many Hymenopterous insects, showing the general structure and more evident relations of the parts and adding much to the meagre accounts of other authors. He also recognised the taxonomic importance of different cephalic sutures in the insects. Linsley and Michener (1937, 1939), described the frontal & Coronal coronal sutures and their importance in the cephalic capsules of bees.

Ferris (1942 and 1944) and Du Porte (1946), gave the general account on the morphology of the face in insects and discussed the significance of clypeus and sutures in the classification of insects. Cook (1944), described the morphology and musculature of the labium and clypeus of insects.

The living world authority on the Apoidea, Michener (1944) published his very valuable work on the morphology, classification and phyogeny of bees where he has described in detail the comparative morphology of cephalic capsule and mouthpart in different genera of bees and pointed out their significance in the evolutin and classification of bees. The taxonomic importance in the classification of insects was discussed in detail by Snodgrass (1947). Lanham (1949), discussed the morphology of cephalic capsule and mouthpart of new world bees of the genus Andrena and pointed out their significance in their subgeneric classification, Rehman and Singh (1949) also pointed out the variation in the tongue length of Indian honey bees in their papers.

Du Portr (l953) gave a detailed account of morphology of clypeus and epistomal sutures in the Hymenopterous insects, Bugelow (1954), in the study of Hymenopterious insects described the morphology of cephalic capsule and their mouthparts in detail. Stephen (1954), studied in detail the significance of mouth-parts in the classification during the revision of the Bee genus Collete in America, North of Mexico. In the same year Taniguchi (1954) studied the feeding habits of the Japanese Bees. Knechtel (1955) discussed the taxonomic importance of mouthpart in the Bees of subfamily Apinae.

The work of Du Porte (1957) is of great importance, as it has cleared many confusions in the structure of cephalic capsule and their mouthparts. Borgmeir (1957) gave a valuable account of maxillary and labial palpes of the Neotropical insects, where he has mentioned in detail the taxonomic importance of number of articles present in the maxillary and labial palpes. In the same year Michener and Moure (1937) clearly discussed the importance of cephalic sutures and mouthparts in the study of the classification of the more primitive non-parasitic Anthophorine Bees.

Tuga, Victoriar G. (1958 and 1960) discussed in detail the morphgology of cephalic capsule and mouthparts in the Bees of the family Apidae and Anthophoridae. Du Porto (1962) made a important contribution in the morphology of mandibles in the insect. Dade (1962) gave a detailed account of the anatomy of the honeybee. Medler (1962) in the same year discussed the morphometric analysis of mouthparts in the Bumble Bees. Sehgal (1963), in the study of the common Indian Yellow Wasp, polistes olivaceus (De Geer), described the skeletomusculature and appendages of head in detail.

Hirashima (1965), during the monographic study of the subfamily Nomiinae of Japan, described the cephalic capsule and mouthparts of bees in detail and recognized their taxonomic importance. Matsuda (1965) gave a detailed account of morphology and evolution of the insects head. In the same year (1965) Sakagami and Mour studied the cephalic polymorphism in some Neotropical Halictine bees. Wafa (1965) did the biometrical analysis of Egyptian honeybee.

Drdway (1966), added the important notes on the cephalic capsule and mouthparts during the systematic study of the genus Augochlorella, a halictine bee. Shiokava in the same year gave a comparative account of cephalic capsule of two closely allied sympatric Ceratina beees, ceratina flavipes and C.japonica. Malyshev (1968), studied the evolution of mouthparts in the Hymenopterous insects.

Iuga Victoria G.(1968) made a very important contribution on the labro-maxillary complex of the Apoidea by correlating the morphological variations to the taxonomic values. He has described all the important variations present in the labro-maxillary complex of bees and their taxonomic significance.

Eickwort (1969), revised the augochlorine bees of family Halictidae on the basis of comparative study of their cephalic capsules. The external morphology of Megachile rotundata was described in detail by Gerber and akre (1969). Stephen, Boharat and Torchio (1969) made an important contribution on the biological and morphological studies of bees.

Altenkirch (1970), studies the morphology of cephalic capsule and mouthparts of bees and gave their taxonomic importance. Graf (1972), has given an important account of musculature and labio-maxi1lary complexcity in Apoidea. Youcelf (1972) studied the topography of the cephalic musculature of honeybee.

Schremmer (1973), studied the structural variations in the proboscis of carpenter bees (xvlocopa). The work of maria De Lourdes Maciel De Almeida Correia (1974) is of great importance, as it has removed many controversial points in the structure of mouthparts. His main work was on the morphological and morphometric study of mouthparts of the main genera of Apoidea. He has discussed in detail all the important structural variations which are having taxonomic value.

Zavortink (1973), described the species of Eucerine bees from North America. During this, he has described the cephalic capsule of Eucerine bees. Marikovakaya (1976), studied the taxonomic variations in the Anthophorine bees.

Michener (1977) studied the Allodaplne bees of Madagascar and also studied in detail the evolutin and classification of Allodapine bees. This important contribution of Michener including the detailed morphological study of cephalic capsule of Allodadapine bees. Michener (1978), again gave a important account an comparative anatomical study of mandibular structure in bees.

Hurd (1979) studied the feeding and nesting habits of Carpenter bees. In this study, he has described the adaptive features in the mandibles of bees. Winston (1979) has given an important account of mouthparts in long tongued bees (family Apidae, Anthophoridae, Fidelidae and Megachi1idae). In this comparative study of labio-maxi1lary complex of bees, Winston has mentioned all the adaptive features in the different parts of maxilla and labium and has clearly pointed out their phylogenetic and taxonomic importance. Mcginley (1980) studied the glossal morphology of colletidae tooth the help of electron microscope and discussed all the important structural variations which are having taxonomic value. In the same year Snelling also studied in detail the evolution and classification of colletidae bees of Sri Lanka and India. Mcginley (1981), investigated the phylogeny of the colletid bees on the basing their latval study. Harder (1982) studied the variations in the probisus length of bumble bees. Tadauchi in the same year made a numerical taxonomic study of the bees of genus Andrena of Japan during this, he has described the cephalic capsule of these bees. Harder (1983) again made a good contribution on functional differences of proboscis of short tongued and long tongued bees. Michener (1984) studied the phylogeny of bees on the basis of comparative study of the mentum and lorum.

Ember (1985) gave an important taxonomic notes on the palaearctic species of the genus lasioglossum and in the same year Pesenko gave a subgeneric classification of bees of the genus Halictus Sensustricto. In these studies they have described the significance of cephalic capsule of bees. Daly in the same year studied the phylogenetic relationship of Ceratine bees. Tweari and Gupta (1987) described a new species of genus lithugrgus latreille from India and added some an important notes on the significance of cephalic capsule in the taxonomic. Plant and Pavlus in the same year sutdied the comprative morphology of the postmentum of bees with special remarks on the evolution of the labrum in the bees. Tewari and Singh (1989) pointed out the significance of cephalic capsule in the description of new species of Nomia (Curvinomia) from India.

Pauly (1990) studied the classification of African Nomiinae and in the same year Kim gave a classification of Andrena bees from Kenea. During this they have pointed out the importance of cephalic capsule. In the taxonomy of these bees. Alexander (1991) made a contribution on phylogenetic analysis of bees of the genus Apis on the basis of morphological studied of cephalic capsule. Pauly in the same year studied the classification of madagascar bees of the family Halictudae and described the cephalic capsule of these bees.

It is very clear form the above that, the maximum attention by the Entomologist seen to have been attributed on the simple description of species, families and subfamilies etc. Thus most of the research papers are purely on the taxonomical aspect in which the colouration of the body and wings, body chactotaxy and the structure of legs have been described time to time.

Therefore, the perusal of literature shows that, no attention has been paid so far on the study of the phylogeny on the basis of caphalic capsule and its appendagaes of Indian Apoidea. Therefore, I propose to start the work on the topic “Phylogenic significance of the cephalic capsule in certain Indian Apoidea (Hymenoptera : Apoidea).

II. GENERAL MORPHOLOGY OF CEPHALIC CAPSULE AND MOUTH PARTS IN MALE AND FEMALE.

The Apoidea, as a member of the order Hymenoptera, are characterised by the two pairs of membranous wings. The front pair is always larger than the hind one and the latter is interlocked with the former by means of hooks called "Hamulii" during flight. Although apterous forms are also found among the Hymenoptera, apoids are invariably with full developed wings. The bees having their first abdominal segment fused with the metathorax and this union being basally constricted, fined their place under the suborder Apocrita. An ovipositor is present which is also modified for stinging and this charcter places the apoids under the division aculeata. The characters, pronotum not extanding back to tegulae, presence of plumose or feathery

hairs on the body, hind tarsi more or less dialated and often densely pubescent, separte theapoids from all other members of the Hymenoptera.

The various parts of the cephalic capsule and mouthparts are taken into account for the classification of the Apoidea and the various modifications come across with and the useful for classification purposes are dealt here.

Head (Plate I : Fig.1).

The head is hypognathous which face perpendicular to the longitudinal axis of the body (Plate I). The large convex compound eye occupy much of the lateral surface of the head (Platao I Fig.1). In some genera, such as Ceratina (Plate XXIV; Fig. 1), the compound eyes do not nearly reach the upper margin of the sides of the head, where in the males of some species of Pombus and Apis the compound eyes extend over the to of the head and meet at the mid line. The inner margins of the compound eyes, inner orbital maragins, may

PLATE-I (Figs. 1-4)

Fig. 1. Dorsal view of Head.

Fig. 2. Lateral view of Head.

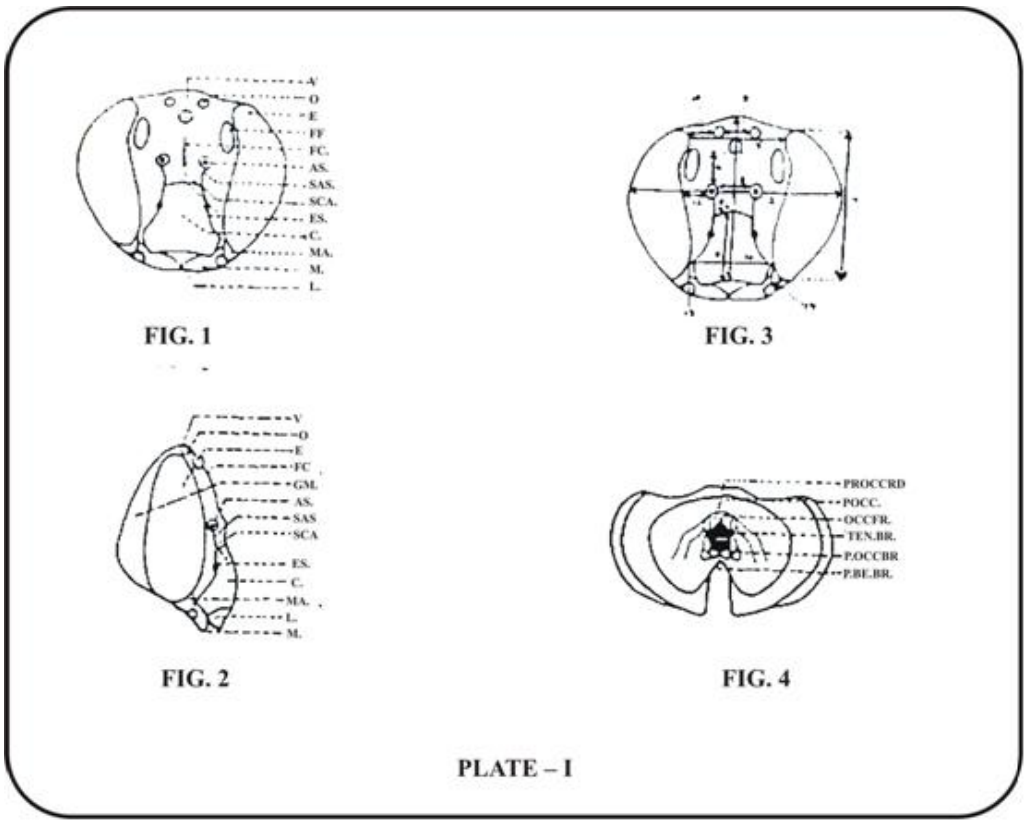
V=Vertex; 0=Ocelli; E=Eyes; FF^Facial Foveae; EC= Frontal Carina; AS=Antennal socket; SAS=Subantennal suture; SA='Supraclypeus area; ES=Epistomal suture; C=Clypeus; MA=Malar area; M=Mandible; L=Labrum.

Fig. 3. Dorsal view of head, showing measurements.

l=Length of Head; 2=Width of Head; 3=Clypeal length; 4=Lower interorbital distance; 5=Upper Interorbital distance; 6=Clypeoantennal distance; 7=Length of Eye; 8=Interantennal distance; 9=Interocellar distance; 10-Ocellorbital distance; ll=Ocelloan*-ennal distance; 12=Antennocular distance 13=Clypeocular distance; 14=Length of malar area.

Fig. 4. Ventral view of Head.

PR.OCC.RD.=Preoccipital ridge; P.OCC.=Postocciput; OCC.FR.^Occipital foramen; TEN.BR,^Tentorial bridge; P.OCC.BR.=Postoccipital bridge; P.GE.BR.=Postgenal bridge.



The vertax is the top of the head, bounded anteriorly by an imaginary horizontal line beneath the anterior ocellus, posteriorly by the preoccipital ridge, and laterally by the inner margins of compound eyes. This region of the head contains three ocelli of varying size (Plate I; Fig.1). They are usually arranged in the form of a broad triangle at the summit of the vertex, but their position and size varies considerably in bees, as in Bombus, they are positioned in almost a linear order at the summit (Plate I; Fig.1), where as in Apis and Xvlocooa males (Plate I; Fig.1) they are closely arranged well down on the face. In Helictus, they are usually large. The triangular arrangement of the ocelli is being given the name of a "curve" by the taxonomists. The arrangement of the ocelli thus is an important character for the taxonomic purpose. Between the imaginary line under the anterior ocellus and the upper margin of the clypeus lies the frons or frontal area. The portion of the frons lying above the antennal sockets is called the supra antennal area. In many bees a median elevated ridge or furrow extends dorsally from near the anterior ocellus to below the antennal bases, this is referred to as the frontal line, as in Andrena.

The antennal sockets in bees as in Anthophora and Nomia are located about midway between the vertex and the apical margin of the clypeus. The position of the antennal sockets on the face is a significant taxonomic character. The antennal sockets of most bees are located at or near the middle of the face.

Extending from the base of the antennal socket to the epistomal suture in almost all the bees there is a single subantennal suture, (plate I, Fig. I.). The upper end of the subantennal suture may be at inner, mesal or outer margin of the antennal socket, depending upon the genus of the bees. Its position is highly variable and apparently is of little phylogenetic significance. Most of the bee genera have but a single subantennal suture arising from each antennal socket. However, in genera of the family Andrenidae there is usually an inner and an outer subantennal suture, arising from each socket (Plate V; Fig. I).

The portion of the frons below the supra-antennal area and above the epistomal suture is referred to as the supraclypeal area. Its lateral margains are defined by the outer subantennal sutures, where only one suture arises from each antennal socket, or by inner subantennal sutures, where two subantennal suture arise from each socket. In andrenid bees the area between the Xvlocopa. In Nomia the lateral sections are weakly convex dorsally.

The dimensions of the clypeus likewise vary among the bees. The length and breadth of the clypeus in Colletes and Bombus are approximately equal. Generally the clypeus reaches its greatest breadth at, or near, the extremities of the epistomal arms. The apical margin of the clypeus is entire in most bee genera, and it is slightly concave or straight along its apex. In ttegachi1idae the margin of the clypeus is usually modified.

The apex of the clypeus is defined by the clypeolabral suture which is hidden in most bees by the overhanging clypeus. As with the clypeus, labrun is variable among the bees. In most bees the labrum is subrectangular with a truncate or weakly rounded apex. It is longer than broad in Megachile, Coe1ioxys and Anthidium, subquadrate in Anthpohora, Ceratina and Nomada and approximately four limes as broad as long in Apis, Bombus and Nomada. Labrum is subtriangular among the species of Andrena, Col1etes and Xylocopa.

The areas on each side of the face, delimited by the compund eyes laterally, the vertex above, the supra antennal area, supraclypeus and epistomal suture mesially, and the anterior mandibular articulation below, are referred to as paraocular areas (Plate I Fig 1). These areas are simple in nomia and in most bee genera. However, in Colletes (fomale), and anrenids, there are distinct depressions in the upper portions of the paraocular areas termed facial foveae (Plate I; Fig 1). These depressions are most pronounced in females of Col1etes and Andrena.

Between the compound eyes and the preoccipital ridge 1 the broad, convex genal areas (Plate I). The genal areas are variable in size among bee genera, being extremely narrow in males of Apis to three times the width of compound eyes in females of certain Osmia.

Between the lower margin of the compound eye and the base of the mandible is an area of variable length termed the malar are (Plate I; Fig 1). This region is generally short in most bee genera. However in Apis and many Bombus and Colletes (Plate III; Fig 1), it is much longer than broad.

The Mouthparts (plate II; Fig. 3).

The organs of the apoids directly concerned with the intake of the food, as in other insects are, the mandibles, the maxillae and the labium. These organs exhibit various shapes and sizes; however, as stated earlier these have been modified for sucking. The mouth parts of apoids are of great taxonomic value. C.T.Bingham (1897) divided the bees into two groups on the basis of the mouth parts. Langnoffer (1898) also based his classification of bees, on the mouth parts. The mouth parts are folded when not functionally active and the arrangement of folding of the tongue differes according to the shape of the same, and therefore, only two patterns have been observed by the author. In the case of the long-glossed tongues, e.g. in Apis, Bombus and Hegachile etc, the tongue is directed backward, whereas in short-g1ossaed, e.g. in Andrena and Halictus, etc., the reverse is the case and the glossae are protected by the fold of the labrum, over the same, and further protection to the delicate organs is afforded by closing the mandibles over the labrum.

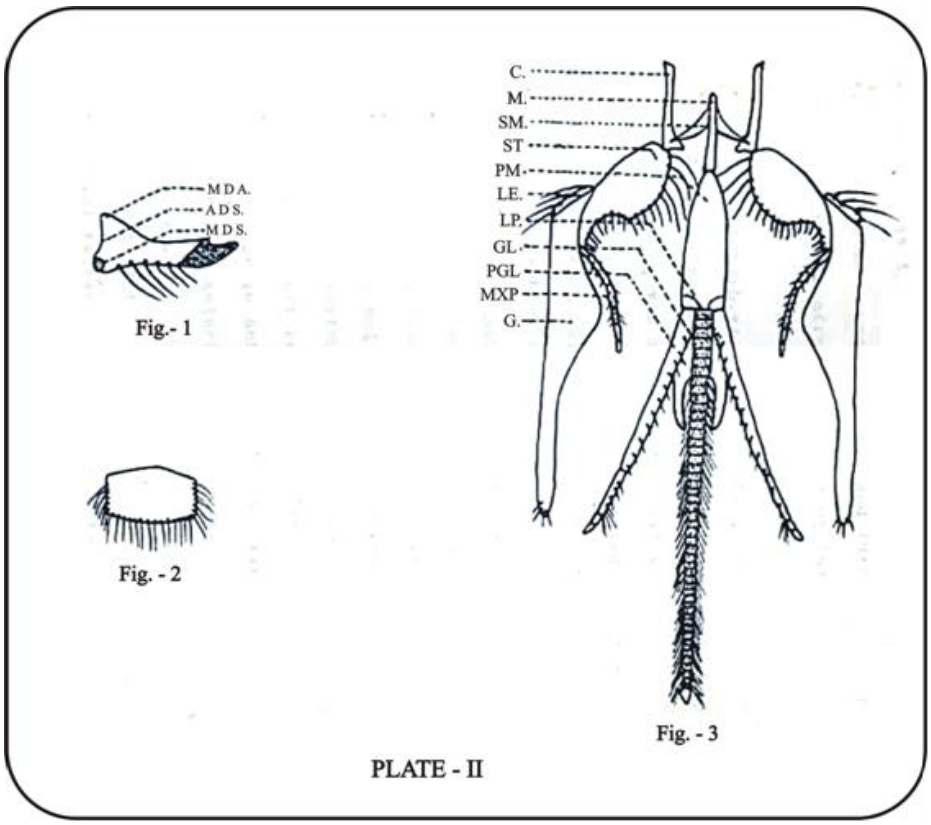
PLATE – II (Figs. 1 – 3)

Fig. 1. Mandible,
MDA, = Mandibular acetabulm; ADS, = Aductor swelling; MDC, = Mandibular condyle;

Fig. 2. Labrum

Fig. 3. Mouthparts

C = Cardo; M = Mentum; SM, = Submentum; ST = Stipe; PM = Prementum; LE = Lacinia; LP = Labial Palp; GL = Glossa; PGL = Paraglossa; MXP = Maxillary palp; G = Galea



The mandibles (Plate II; Fig.1). A pair of mandibles is found in all the apoids. The shape and size differs according to the need of the individual species depending upon their mode of life. These can be called the tools of their trade. These are highly chitinized structures resembling the blade of sickle hard enough to perform various duties, like boring words as in Xvlocooa and Ceratin etc., boring the earth as Halictus, Andrena, Anthophora, etc. cutting leaf discs as in Meoachile, scraping resin and cotton as in Anthidium, making wax combs as in Apis and Bombus. These may be toothed as in solitary bees or spathulate as in social forms. In the social forms these exhibit sexual dimorphism, whereas In the others these are similar in both the males and females. The mandibles are hinged to the anterior lateral edges of the cranial walls by their proximal, thickened ends and thus the movements of the same is restricted to horizontal plane. Their use in the apoids is industrial rather than biting or chewing of food.

The Maxillae (Plate II; Fig. 3). The maxillae, again, in all apoids are two in number, each placed on either side of the labium and they are united by a V-shaped sclerite called lorum, at the distal end of the cardo, the basal part of the same. These are suspened from the membranous floor of proboscis fossa on the back of the head, the proximal ends of the cardo being attached to the side walls of the cranium. The maxilla of an apoid is divided into two parts, the proximal cardo and the distal stipes. The cardo is invariably a rod-like structure and is of different proportion in different apoids. In Hal ictus, Andrena and Colletes, etc, which have short glossae, the cardo is proportionately longer than that in the case of Apis, Xvlocopa and Anthoohora etc., which have long glossae. Perhaps this length of the cardo in the former cases compensates the proboscis as a whole to attain the desired length in comparison to the latter. The stipes, the distal part of the maxilla, is of different sizes and shapes in apoids. It is long and boat-shaped, beaming palpifer which bears palpus and longer or shorter than gales and lacinia the latter part being absent as in Andrena etc., and present in Apis etc.

The maxillary palpus undergoes great variation among the bees and varies from two to six segments even among closely related genera. In Anthophorine bees the maxillary palps area u usually six jointed, e.g. in Xylocopa. Intermediate number of segments like three, four and five are also found in some forms. The maxillary palp is, therefore, of great toxonomic importance. The palp joints may be equal or unequal, hairy or without hairs; the hairy joints are found in some species of Anthophorine bees.

The labium (plate II; Fig. 3). The apoid labium is a composite structure as in other insects, but highly and wonderfully modified for sucking. It is supported on the labrum at its basal part of which the proximal end is so narrowed to fit closely in the angle of the labrum. The body of the labium is divided into two parts, the elongated flattened part is mentum and the small triangular part the submentum the latter being absent in short-tongued bees. Diverging at the distal end of the mentum, from the palpigers are the labial palpi, closing inward on either side are paraglossae and in centre the paired glossae forming the proboscis. This composit structure is also termed 'ligula. The length of the glossae makes the bees short or long tongued. The paraglossae are short lobes at the base of the proboscis on either side. The labial palpi are four jointed and the joints may be almost equal as in short tongued bees or unequal as in long tongued ones. In the latter case the palpi afford additional protection to the glossae by sheathing them. The union of the glossae at the tip of the distal end may be emerginated as in Prosopis and Col1etes acute in others, the ligula therefore is of great taxonomic importance.

III. MATERIAL AND METHODS

The meterial for the present study was collected from the various localities of Ultar Pradesh, Rajasthan, Kadhya Pradesh, Himachal Pradesh, Punjab, Haryana and South India. The Bees are found almost everywhere, particularly on flowers and are easily recognized by their hairy body and potlen-collecting appartus. The pollen-collecting apparatus consists of brushes of hairs (called scopae), located either on the hind legs or on the ventral side of the abdomen. They were collected by using an ordinary hand net from various gardens and wild flowers. They were killed immediately on the collection in benzene chloroform fumes which were found to be a very good preservatives.After determination, the bees were pinned as usual and kept in entomological boxes.Their cephalic capaule were thoroughly studied. The various lengths of cephalic capsules were measured.

The study of the mouthparts of the Apoides can be effected completely only by dissection followed by mounting in balsam of Canada. Whatever the methods employed, dissection or mounting. It is necessary to previously soften the insects. This operation is effected most often by placing the entire insects in an insulateda tube containing a layer of humid sand covered with a leaf of filter paper. One adds in the enclosuresome drops of a liquid preservative creosote of beech or paradichlorobenzene. The duration of the stay i n the softener is in general 24 hours, but perhaps longer for insects of bigger size and very aclerotinised. In the very difficult case it is necessary to boil the insect for a few minutes in a mixture of equal parts of distilled water and acetic acid.

On insects thus prepared, it is possible to deduct the entire head. Before the dissection, it is necessary to clean and make supple the pieces by placing them either in boiling solution of 10% potash for 5 to 10 minutes or in a solution of acetic acid and distilled water (in equal parts) which one bolls very slowly over 2 or 3 minutes. After rinsing with distilled wataer, one may proceed with the dissection.

IV. DISSECTION :

The dissection of the head is performed in alcohal 70% with fine pincers and needles mounted on mandril. The labrum and nandibles are isolated but the maxi1lo-labial complex which forms the tongue is preserved entire while separating the constituting elements to permit the detailed study there of.

Mounting of the Pieces :

Before proceeding to this last operation, the buccal parts are subjected to a dehydration by an ascending serves of Alcohals then by tolune. There after, the pieces are immersed in a drop of balsam of Canada ovear the slide and covered with a rover slip. All the drawings of mouthparts were made with a camera lucida.

DESCRIPTION OF THE CEPHALIC CAPSULES AND THEIR MOUTH PARTS STUDIED.

(a) Caphlic Capsules & mouthparts of short tongued bees :

Among the short tongued bees, the most primitive are collitedae, then come to the and renidae and halictidae.

Family : Colletedae

Colletidae include six subfamilies of which only two, collitinae and hylaeinae, occur in India. Since the other four subfamilies are confined to South Africa or Asutralia, the distributional pattern indicates an ancient origin for the family. This is supported by many morphological characteristics as well as, although considerable

specialization has occured in various subfamilies. More primitive characteristics (those shared by many sphecid wasps) are found in this family than in any other. According to Michener (1944 a) all of the other bees derived from a colletid ancestor.

The colletides are the most primitive bees on the basis of the tongue and structures of the nest. The most distinctive feature of the family is the pretence of short and bilobed glossa. The other feature are, the labrum broader than long, subantennal area absent, antennal sutures directed towards inner margins of antennal sockets, facial foveae often present and the arcuation of the posterior part the vein m-Cu of the fore wing towards the wing apex is another distinctive characteristics of most members of the family.

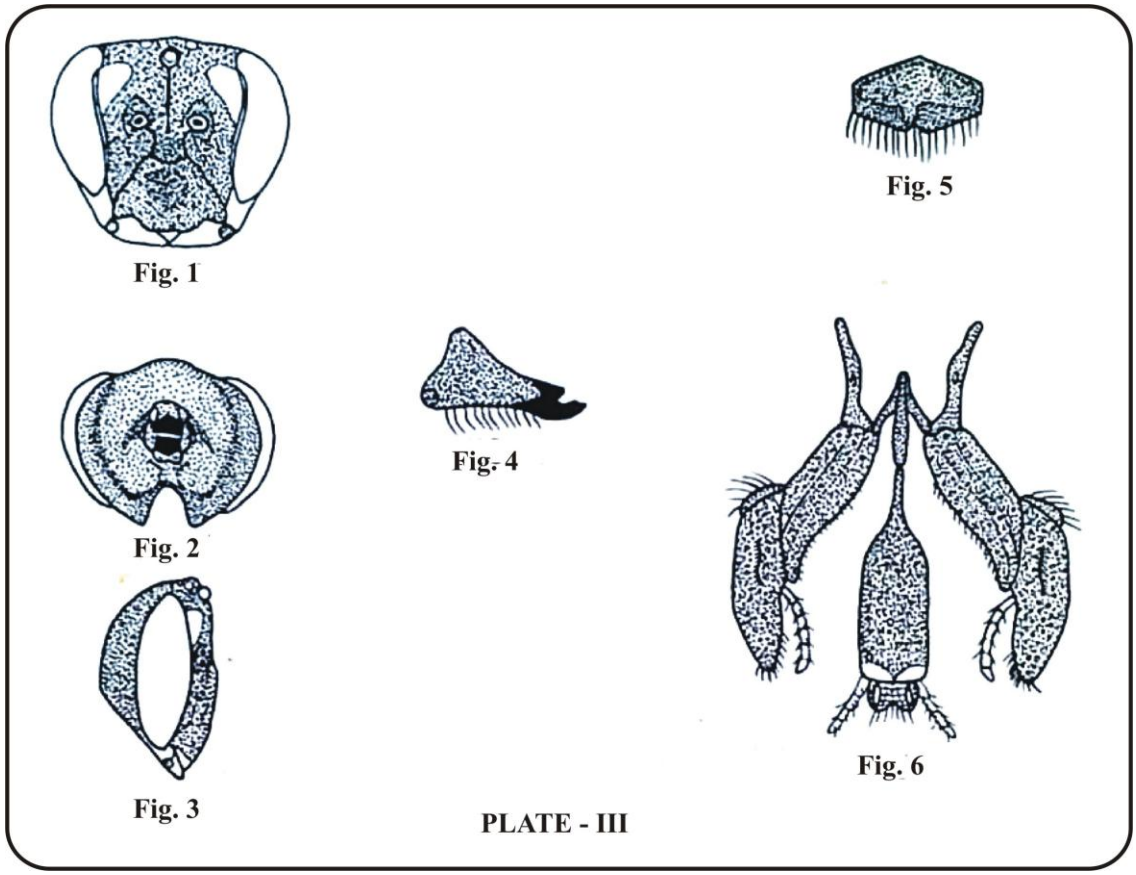
Subfamily : Colletinae
The most distinctive features of the subfamily are, the malar areas short to moderate in length, Jugal lobe of the posterior wing reaching at least to middle of vannal lobe, and females have a well developed scopa. It is a word-wide subfamily. Under this subfamily the following one speies of the genus Colletes Latreille has been studied.

Col1etes dudqeionii Bingham
Body of large size; thickly pubescent and densely punctuate; integument black; wings long, narrow and infuscated.

Morphology of Cephalic Capsule : Male (Plate No. III Fig. 1-6) :
Face : broad : coarsely punctate beneath the dense snow white hairs. Vertex at the top of the head; sparsely pubescent; area between lateral ocelli elevated Eyes small and more convergent below than above. Ocel1i glabrous and at the level of eyes; interocellar distance shorter to ocellorbital and interantennal distance anterior ocellus slightly greater than antennal socket. Antennal sockets slightly nearer to clypeus than anterior ocellus.
Paraocular area paraocular carina present apically with facial foveae which is smooth but below this densely punctate.

Supraclypeus area medially strongly elevated; densely punctuate; frontal carina present; apical half of its weakly elevated but apex with nodule which is reaching below the level of antennal sockets. Clypeus roughly triangular; elevated but medially with a longitudianal concavity; baselly and laterally densely punctate while medially apical half sparsely punctate; shorter than clypeocellar distance. Subantennal suture short; strongly concavely incurved in middle; upper end mesal. Epistimal future transverse section concavely incurved towards the clypeus; lateral lines with small tentorial pits and slighly incurved below them towards the paraocular area. Maiar area well developed and smooth.

Measurements : length of head 2.15 mm; width of head 2.60 mm; length of eyes 1.5 mm; lower interorbital distance 1.40 mm; upper interorbital distance 1.60 mm; inter ocellar distance 0.40 mm; ocellorbital distance 0.50 mm clypeocellar distance 1.0 mm; interantennal distance 0.50 mm; ocelloantennal 0.40 mm antennocular distance 0.40 mm; clypeoantennal distance 0.35 mm; clypeal length 0.80 mm; width of clypeus at upper end 0.40 mm; width of clypeus at lower end 1.15 mm; clypeocullar distance 0.25 mm; length of malar area 0.35 mm.
Morphology of Mouth Parts : (Figs. 4, 5 & 6). Labrum (Fig. 5)



It follows the clypeus to which it is joined by a membranous zone, which permits it to move in a vertical plane. It is sclerified with the exception of its distal extremity. It Labium (Fig. 6).

In the bees, the labium has lost its primitive connection with the base of the cephalic capsule and has in corporatod it self in the maxillo labial tube in its basal part. Its movements are necessarily co-ordinated with those of maxillae. The sclerites of the base of the labium are situated on the posterior surface of the maxillo-labial tube. Submentum is short wide and slightly elongated. It is almost inverted V-shaped and its arms articulate with the cardos. Men turn, is flat, very slightly sclerified, almost membraunous and tapering basally its apical end is wide and rounded. Pre-mentum, highly sclerified, longer than it is wide, is eight and a half t i m e s as long as the glossa, three and a half times as long as wide. It is narrow at the base, and provided with thick bristles arranged on the entire surface. By the posterior view, the extremity of the prementum is three lobed, its lateral lobes c a r r y the labial palpes, the middle lobe carry the glassa and the distal lobe having the paraglassae Labial palpes. longer than the glassa and are composed of four similar and hairy elements or articles. The palpiger highly developed, displays a row prickles in the interior. Paraqlossae. as long as the glossa, short, thin and membranous and having a simple structure with rounded contours. Glossa, would be the result of the fusion of two primitive glossae (Michener, 1944). The distal part is curved back ward like a spoon and having

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