

STUDIES ON THE MOUTH-PARTS OF MALLOPHAGA INFESTING NORTH-INDIAN BIRDS.

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A. Introduction.

THE study of the mouth-parts of Mallophaga is of great value for the Morphologists as well as for those who are engaged in the systematic work on this group of Insects. Snodgrass and Cummings have done a great deal to study the mouth-parts of Mallophaga in a comparative way. Still there are many points to be cleared and a number of modifications to be studied and homologised. The best way to settle the disputed points lies in the comparative study of a large number of forms, from simpler to specialised ones. The observations of the writer of this paper are based on the dissections of as many forms as he could obtain. Still a number of forms remain to be studied in order to clear certain other points with regard to the nature of palpi and the structures associated with pharyngeal glands and sclerite. The present work does not include an important group of Mallophaga infesting the mammals. This is mainly due to the fact that a representative collection of Mammalian Mallophaga is not yet present in the Zoological Museum of the Aligarh Muslim University nor could it be obtained from elsewhere in India.

B. Material and Technique.

The material was obtained from the collection of the Zoological Museum of Aligarh Muslim University, through the courtesy of Dr. M. B. Mirza, Director, Zoological Laboratories. The lice were fixed in Bouin's alcoholic fixative, cleared in 90% and preserved in 80% alcohol. For dissections and mounting, the specimens were treated in caustic potash 5 to 10% according to their size. They were passed through acetic acid, absolute alcohol and were finally transferred to clove-oil for clearing. The dissections were done in clove-oil under a binocular and gave satisfactory results.

C. Description of Mouth-Parts.

(i) *Amblycera*: *Mandibles*.—The mandibles in Amblycerans are fairly uniform in their features (Fig. 1). Generally in many cases the right mandible

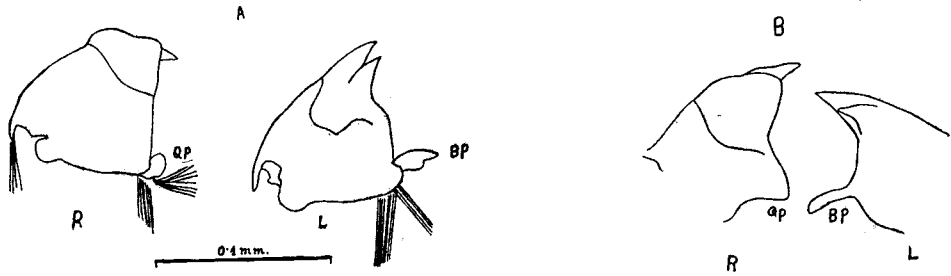


FIG. 1.—Mandibles of Amblycera. *A*, Mandibles of *Myrsidea nigram*; *B*, Mandibles of *Trinoton*; *R*, Right mandible; *L*, Left mandible; *BP*, Basal process; *QP*, Quadrangular process.

is stouter than the left one. They are provided with two or three apices, the tips of which are pointed and densely chitinised. The apices of the right mandible are much more heavily chitinised than those of the left mandible and one apex is blunt while the other is sharply pointed. The cutting surface of each mandible is provided at its base with a protuberance or a short process; that of the right one is smaller and convex anteriorly. The process on the left mandible is larger and concave posteriorly so as to accommodate the process of the right one below it. A number of peculiarly modified and abortive muscle-fibres are attached to the lower end of these processes and the latter are probably of the nature of lacinia mobilis which have fused with the bases of the cutting surfaces of the mandibles.

In general outline the mandibles are roughly triangular, the sides are nearly sub-equal. The condyle is a well-formed rounded projection and it articulates with an anteriorly produced process of gena concave at its distal end; the point of articulation lies just below the origin of maxillary palp at the side of antennal fossa. The ginglymus is more or less an oval groove articulating dorsal to the condyle with a process of clypeus in front of the base of maxillary palp.

The mandibles are provided with two sets of muscles, the one is abductor inserted dorsally near the ginglymus and the other adductor which is inserted near the base of the processes of the cutting surfaces. The latter muscles are stronger than the former.

The mandibles of the Amblycerans are weaker and less modified than those of Ischnocerans. Firstly, because they are removed to the anterior end of the head and secondly, due to their smaller apices. The tips of the apices of one, close outside the tip of the other, opposite the mandible. The working of the mandible is more or less scissor-like for cutting small barbs and barbules along the horizontal-plane.

First Pair of Maxillæ.—The first pair of maxillæ are of fairly generalised features (Fig. 2 B). There is, probably, no room to doubt now that the

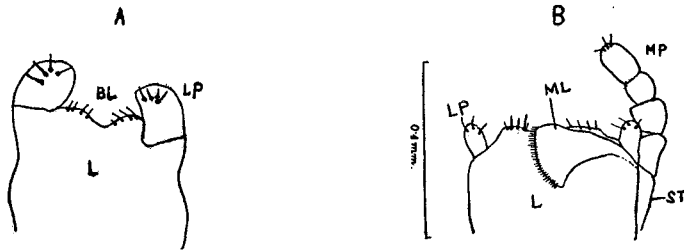


FIG. 2.—Labium and Maxillæ of Amblycera. A, Labium of *Trinoton querquedula*; B, Labium and Maxilla of *Menopon gallinae*; BL, Bilobed Ligula; L, Labium; LP, Labial Palp; ML, Maxillary Lobe; MP, Maxillary Palp; St, Stipes of Maxilla.

jointed palpi of Amblycerans which Grosse once assigned to labium, belong to maxillæ. The writer has dissected out the maxilla of a number of forms and observed thinly chitinised strips connecting the bases of the palpi with the stipes in many species of *Læmobothrion* Nitzsch, in *Menopon gallinae* Linné, and in *Myrsidea nigram* Kellogg and Paine.

The maxillæ are closely approximated to the sides of the labium and since the dissection of the mouth-parts of Amblycerans is slightly difficult, their real structure is often not clearly detected except only in a few forms. The first pair of maxillæ, in a typical form, consists of a jointed palp, a maxillary lobe which has an inner cutting surface beset with short spines and a stipe lying slightly dorsal along the side of the labium. The maxillary lobes are narrow basally, connected with the stipes by thinly chitinised connecting strip. The stipes of the maxillæ are faintly chitinised and closely associated with the sides of the labium. The jointed palpi originate from the stipes and the thin connecting bands can be seen in some cases (Fig. 2 B).

Labium.—In Amblycera labium is distinct and not very greatly modified. In a typical form cf. *Læmobothrion*, we can find a well-marked pre-mentum, a well-developed and broad mentum and a reduced strip of sub-mentum. The pre-mentum carries one jointed palp on either side, which is beset with spines at its tip. The ligula is flat and a number of setæ are borne by it. In *Trinoton querquedula* Linne, (Fig. 2 A) the ligula is narrow and bilobed. The labial palp is single jointed and oval in shape. In Colpocephalids the labial palpi are generally very elongated and prominent and beset at their tips with a number of short spines.

Oesophageal Sclerite and Lingual Glands.—The presence of œsophageal sclerite and lingual glands is a special peculiarity of Mallophaga which they share only with Psocids among the Insects. In Mallophaga these structures

are complicated and present a number of modifications specially among the Amblycerans. The sclerite and the associated glands are characters of great taxonomic value. Snodgrass and Cummings have done a great deal to clear many points of detail and have described a number of modifications of these structures, but in spite of this several structures are still doubtful and a number of forms should be examined in order to observe the various modifications.

In Amblycera the œsophageal sclerite and glands are of wide occurrence. They are present in many of those forms where they have been supposed to be absent. They have been left unobserved owing to their thinly chitinised and reduced nature. Cummings' revised list of the distribution of sclerites and glands in Mallophaga needs many alterations because of the separation of a number of forms from the former genera and the creation of new

Genera with sclerite and glands more or less typical	Genera with sclerite and glands modified	Genera with sclerite and glands absent	Genera with sclerite and glands present or absent
Colpocephalum	Boopia	Eureum	Acolpocephalum ?
Læmbothrion	Dennyus	Eomenopon ?	Philandasia ?
Eulæmbothrion	Heterodoxus	Machærilæmus ?	Harrisonia ?
Ricinus	Trinoton		Cummingsia ?
Trochilœctes	Ancistrona		Menopon
Gyropus	Latumcephalum ?		
Somaphantus	Tetrophthalmus		
Myrsidea	Pseudomenopon		
Amysrsidea	Menacanthus		
Neocolpocephalum *	Gliricola		
Pseudocolpocephalum *			
Numidicola			
Kurodaia			
Cuculiphilus			
Heleonomus			
Actornithophilus			
Chapiana			
Neumania			

* N. Gen. (in press).

genera and also owing to the fact that recent observations have revealed new data to us. The preceding revised table shows the distribution of sclerites and glands in Amblycera.

Genus *Menopon* possesses typical œsophageal sclerite and glands in nearly all reported cases with the exception of *M. distinctum* and *M. præcursor* recorded by Snodgrass. The other species recorded by the same author have been included in other genera.

Werneck records reduced sclerite in *Gliricola pintoi*. Ewing in his revision and description of the genus *Eureum* Nitzsch does not record the presence of œsophageal sclerite and glands.

A typical and generalised type of sclerite and glands are present in a number of Amblycerans as will be evident from the above table, especially in *Læmobothrion*, *Menopon*, *Myrsidea*, *Colpocephalum* and *Ricinus*. The position of sclerite and glands is more anterior in the head than in Ischnocera. Typically the whole complex consists of a chitinised sclerite with which is associated a frame-work slightly dorsal to it. The frame-work consists of a chitinous bar on either side which unite anteriorly with the sclerite to be produced forward as a pair of anterior cornu. Posteriorly there is a transverse bar joining the side bars which may proceed a short distance behind as posterior cornu. A duct-like tracheal tube comes out from the centre of the sclerite and after a short course bifurcates anteriorly into two diverging arms which bend backward and proceed to the centre of thinly chitinised and roughly spherical, large and paired glands where it branches and sub-branches. Each gland is supported on a chitinous bar which Cumming calls as lateral piece. Over each arm of the duct lies in close opposition an anterior plate which basally abuts against the anterior cornu, its distal end is broad, slightly anterior to the arm of the duct and provided with a number of spines on its inner face (Fig. 3 A).

Description of Special Cases.—Cumming has clearly figured different forms of modification in the genera *Trinoton*, *Ancistrona*, *Tetrophthalmus*, *Dennyus*, and *Heterodoxus* which need no recapitulation. Below the writer has mentioned two important cases in which modifications are conspicuous and notable, namely, those of *Menacanthus* Neumann and *Pseudomenopon* Mjöberg.

Menacanthus masudi Qadri. (Fig. 3 C).—The œsophageal sclerite has been recorded to be absent in *Menacanthus* Neumann by Uchida and others. The writer has, however, dissected out a very weakly chitinised and reduced œsophageal sclerite from the above-mentioned form. The œsophageal sclerite resembles to some extent with that of *Tetrophthalmus titans* Piaget,

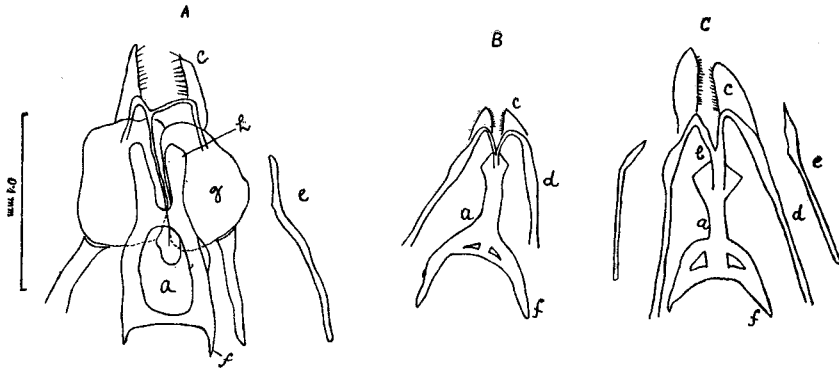


FIG. 3.—Oesophageal sclerite and lingual glands of Amblycera. *A*, *Menopon gallina*; *B*, *Pseudomenopon poilocephalus*; *C*, *Menacanthus masudi*; *a*, Oesophageal sclerite; *b*, Fused rami; *c*, Anterior plate; *d*, Lateral piece; *e*, Maxillary fork; *f*, Posterior cornu; *g*, Glands; *h*, Anterior cornu.

described and figured by Cummings. The anterior cornu are wanting. They probably form the short central rod. The rami of the duct are overlain by the paired anterior hypopharyngeal plates and the lateral pieces are comparatively broader and run backward along the sides of the sclerites, diverging posteriorly. There are no glands. The weakly chitinised maxillary forks can be observed lying on the sides of the lateral pieces.

Pseudomenopon poilocephalus Qadri (Fig. 3 B).—The oesophageal sclerite has not been thoroughly described in the genus *Pseudomenopon* anywhere. The writer has observed the sclerite in the above species to be similar in features as in *Menacanthus masudi*. The difference is that the central rod is very short and lateral pieces are stouter and broader. Maxillary forks could not be detected.

The Maxillary Forks.—The so-called maxillary forks have been problematic ever since they have been investigated. The writer has not yet observed the presence of the maxillary forks in any of the Ischnocerans except in *Goniodes dissimilis* N., where they are also mentioned to exist by Cummings. The homology and function of these maxillary forks have not yet been ascertained, and various divergent views have been mentioned by Cummings. To the writer they appear to be vestigial sclerites of the hypopharynx. They gradually atrophy and are missing among specialised forms of Amblycerans, *cf. Colpocephalum* and others, and finally almost wanting among Ischnocerans.

Another structure associated with these sclerite and glands is a median thinly chitinised plate posterior to the glands between the two lateral pieces. The writer has observed in *Læmbothrion* sp. ? (Fig. 9 A) the opening of the common salivary duct on it. It is probably the basal part of hypopharynx,

whereas the lingual glands and œsophageal sclerite are the modifications of the rest of the hypopharynx and its associated structures.

(ii) *Ischnocera*.—Mandibles are much more strongly built in *Ischnocerans* than in *Amblycerans*. They are also remarkable for the fact that they are inserted at right angles to the head, the condyle being posterior and ginglymus being anterior. A further marked difference lies in the position of the mandibles in the head of *Ischnocerans*. In *Amblycera* they lie near the anterior end of the head but in *Ischnocera* they retrace far back nearly to the centre of the head. The mandibles of *Ischnocera* (Fig. 4) are more or less tri-

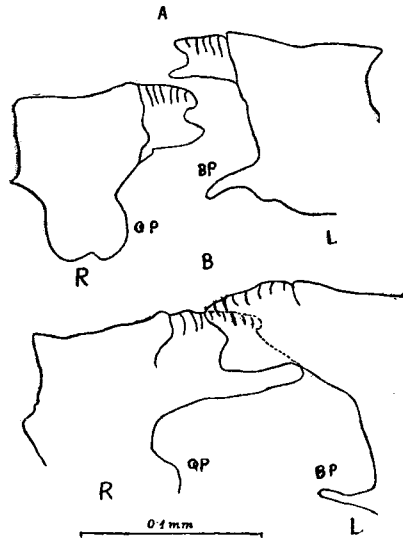


FIG. 4.—Mandibles of *Ischnocera*. A, *Lipaurus caponæ*; B, *Philopterus rotundatus*; BP, Basal process; QP, Quadrangular process; R, Right mandible; L, Left mandible.

angular. They are in many cases provided with two apices, those of the right mandibles being slightly more developed. The apices of the mandibles in most of the cases are dorsally striated and produced inward. Among the *Ischnocerans* of Indian Birds the writer has found that the mandibular apices are not striated in *Goniodes dissimilis* N. only. This fact, together with other features of the mouth-parts, to be described later on, suggests that forms belonging to *Goniodes* N. are primitive among the *Ischnocerans*.

Towards the base of the cutting surface the left mandible is provided with a long and posteriorly concave process—the basal process. In the right mandible at the corresponding position is not a very prominent protuberance, the quadrangular process. In addition to these processes

there may be additional processes in the mandibles in the middle of the cutting surfaces which project and are called Auricularian processes.

The working of the mandibles is peculiar in Ischnocera. The tips of the apices are bifid and fit outside each other. The basal process of the left mandible does not come over the quadrangular process of the right and in this way cutting surfaces of the mandible do not completely cross each other. It is only the apex which performs most of the cutting work. The bifid tips of the apices fit outside each other and nibble off the barbes and barbules of the feathers of birds.

1st Pair of Maxillæ.—The problem of the first pair of maxillæ and their palpi has been a point of dispute among many workers on this group. Shipley in his description of sketches of *Goniodes tetraonis* Denny marks the labial palpi as the lobes of first maxilla and small chitinised processes on the ligula of labium as palpi of second pair of maxillæ; on the other hand, Cummings rejects Shipley's view and describes the labial palpi as paraglossæ and the chitinous processes on the labium as chitinous nodules. He also describes the labial palpi of Amblycerans as paraglossæ, a view which is highly disputable on good grounds. The writer has observed in many Ischnocerans (see Fig. 5) that there is a lobe supported by a chitinous frame-

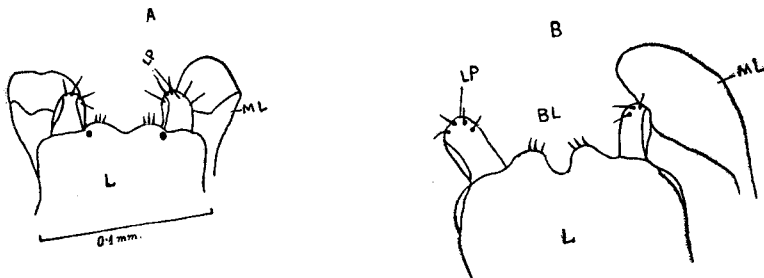


FIG. 5.—Maxillæ and Labium of Ischnocera. A, *Columbicola ewingi*; B, *Philopterus rotundatus*; BL, Bilobed Ligula; L, Labium; LP, Labial Palp; ML, Lobe of Maxilla.

work situated on each side of the labium and slightly dorsal to the latter. These structures from their form and position appear to represent the maxillæ in which the maxillary lobes and palpi are highly reduced. In *Goniodes dissimilis* N., the maxillæ are more prominent than in others. They are very well formed in *Columbicola ewingi* Qadri.

2nd Pair of Maxillæ.—The second pair of maxillæ or labium is more or less similar to that found in Amblycerans (Figs. 5 and 6). It consists of a broad thinly chitinised mentum and small pre-mentum which carries ligula and palpi. It is about the ligula and the palpi that a great difference of

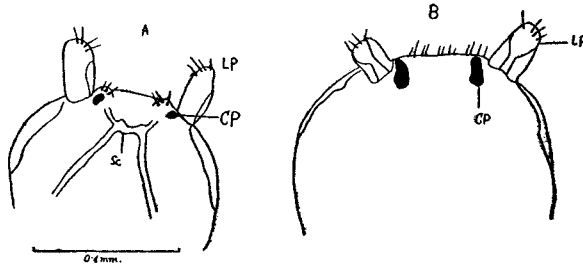


FIG. 6.—Labium of Ischnocera. A, *Esthiopterum secretarium*; B, *Goniodes dissimilis*; CP, Chitinous process; LP, Labial Palp; Sc, Sclerite.

opinion exists. The ligula is either flat or slightly bilobed in the middle. Below each palp there is a chitinous nodule or process very prominent and well-developed in *Goniodes* N., specially in *G. tetraonis* Denny. In *G. falcicornis* N., Cummings has shown it to be very small and describes it as chitinous nodule. In *G. dissimilis* N., (Fig. 7) they are mid-way between

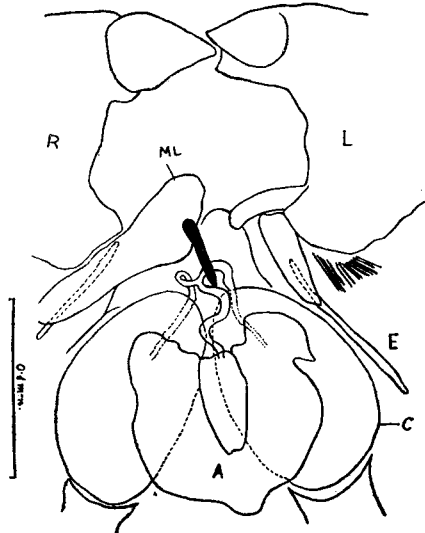


FIG. 7.—*Goniodes dissimilis*—Mouth-parts. A, Oesophageal sclerite; C, Lingual gland; E, Maxillary fork; L, Left mandible; R, Right mandible; ML, Lobe of maxilla.

G. tetraonis D., and *G. falcicornis* N. The writer has observed similar nodules smaller than those of *Goniodes* to exist in a number of forms.

A characteristic feature of the labium of the Ischnocera is the presence of a sclerite on the dorsal surface of it. The sclerite consists of a transverse band just below the ligula. It has got a pair of limbs at each end. One of the pairs is anterior and runs towards the base of the labial palpi into the

chitinous process, the other posterior runs backward towards the posterior margin of the labium slightly diverging from the median line. It is peculiar that the writer did not find the sclerite in *G. dissimilis* N., though it is clear in many forms specially in *Esthiopterum secretarium* Giebel, *Columbicola ewingi* Qadri and *Lipeurus caponæ* Linné.

As it has been mentioned above Shipley describes the chitinous processes below the labial palpi as representing the palpi of labium and the labial palpi as lobes of first pair of maxillæ. Cummings homologises the labial palpi with those of the Amblycerans but describes them in both as paraglossæ. In my opinion the paraglossæ of Cummings and first maxillæ of Shipley are same and homologous and belong to labium or second pair of maxillæ and are homologous with the labial palpi of Amblycerans. This view specially in *Amblycera* is held by a number of old and modern workers, e.g., Ewing, Ferris and others. The palpi of 2nd pair of maxillæ of Shipley and chitinous nodules of Cummings are specially chitinised lobes developed in connection with ligula. The ligula, as already mentioned above, is generally flat, sometimes bilobed and beset with erect spines.

The œsophageal sclerites observed by the writer in the genera *Degeeriella* Neumann, *Philopterus* Nitzsch, *Columbicola* Ewing, *Lipeurus* Nitzsch, *Esthiopterum* Harrison, *Goniodes* Nitzsch, *Neophilopterus* Cummings and *Eustrigiphilus* Ewing, are not much widely different from their typical form (Fig. 8). The only great modification of these structures was observed

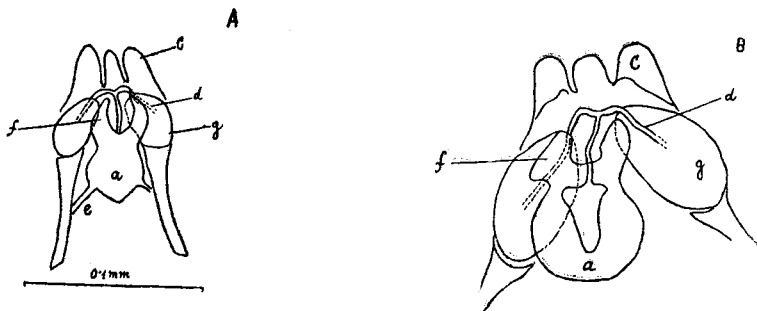


FIG. 8.—œsophageal sclerite and lingual glands of Ischnocera. A, *Columbicola ewingi*; B, *Degeeriella subcuspidatus*; a, œsophageal sclerite; C, Anterior plate; d, Duct; e, Posterior cornu; f, Anterior cornu; g, Lingual gland.

in *Ibedæcus* Cummings. The anterior cornu are present in nearly all the forms, the posterior cornu are present in some forms, while absent in others. The lingual glands are hard, oval and thinly chitinised. The posterior median lobe of hypopharynx on which the salivary duct opens overlies the base of the labium and is situated between the two lateral pieces. It can be

observed in *P. rotundatus* Piaget (Fig. 9 A). Maxillary forks were not detected in any case except in *G. dissimilis* N.

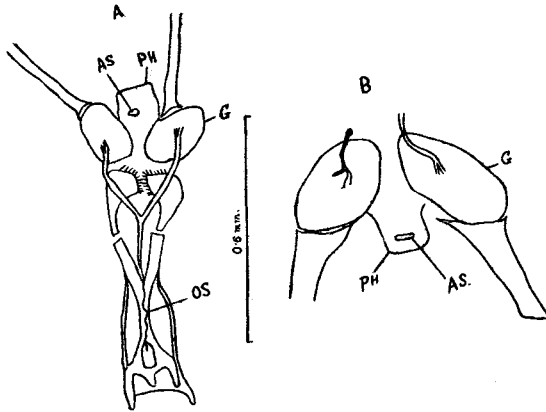


FIG. 9.—Hypopharynx and lingual glands. A, *Læmbothrion* sp.; B, *Philopterus rotundatus*; AS, Aperture of salivary duct; G, Lingual gland; OS, Oesophageal sclerite; PH, Posterior lobe of hypopharynx.

The greatly modified pharyngeal sclerite described by Cummings in *Ibedæcus flaveus* Cummings has its corresponding structures in *I. robustum* Qadri.

D. Summary.

1. The mandibles of Ischnocera, apart from their other well-known features, are stouter than those of Amblycera. Their apices are striated in most of the cases in Ischnocerans, an important exception being *Goniodes* N.

2. First pair of maxillæ are present in Amblycera with a jointed palpi, a maxillary lobe beset with spines at its inner face, and a stipe closely applied to the labium. The connecting bands between palpi and stipes can be observed in a number of forms specially in *Læmbothrion* N., in *Menopon gallinæ* Linné and *Colpocephalum semicirctum* Rudow.

3. First pair of maxillæ in Ischnocera are represented by reduced lobes present on the sides of the labium. Their stipes with chitinous framework can be easily observed in *Goniodes dissimilis* N., *Columbicola ewingi* Qadri, and *Esthiopterum secretarium* Giebel.

4. The labium or second pair of maxillæ in Amblycera consist of a reduced sub-mentum, a broad and thinly chitinised mentum and a prementum with a reduced and flat or bilobed ligula. One or two jointed labial palpi are present.

5. Labium of Ischnocera has its corresponding parts in that of Amblycera. One jointed labial palpi are present in nearly most of the forms. The

so-called chitinous nodules of Cummings or labial palpi of Shipley described in *Goniodes* N., and found in others as well, are short chitinous processes developed in connection with the ligula.

6. The œsophageal sclerite and associated glands are of wide occurrence in Amblycera, though modified in a number of forms. In most of the cases when they are believed to be absent they are generally highly reduced and weakly chitinised. The maxillary forks are also not very uncommon in Amblycera. They have nothing to do with maxillæ and seem to be vestigial sclerites of the hypopharynx.

7. In most of the Ischnocera the œsophageal sclerite is strongly chitinised. It is remarkably modified in *Ibedœcus* Cummings. The *maxillary* forks have so far been detected only in *Goniodes dissimilis* which along with other features mentioned above, represents a primitive form among the Ischnocerans.

8. A posterior median lobe of hypopharynx can be observed in *Læmobothrion* sp.? and *Philopterus rotundatus* Piaget, between the two lateral pieces supporting the lingual glands. On this opens the common duct of the salivary glands.

E. Conclusion.

The anatomy of mouth-parts in Mallophaga is still a disputed problem. Snodgrass, Cummings and others have done a good deal to explain various structures found therein. There is, however, still some dispute over certain structures with labium, maxillæ and œsophageal sclerite. Apart from this, various modifications in a number of forms have got to be homologised. The homology of the œsophageal sclerite and its associated glands is far from being decided. The writer agrees with Cummings, Mjöberg and Grosse to call these structures as a compound hypopharynx. The lingual glands are most probably greatly modified superlingue as Enderlein thinks them to be. The maxillary forks, as the writer has mentioned above, are vestigial sclerites of hypopharynx, and not superlingue or maxillulæ. The above-mentioned opinion is, however, open to question until more work is done on the anatomy and specially on the nymphal stages of various biting-lice.

The writer takes this opportunity to offer his sincere thanks to Dr. M. B. Mirza for his keen interest and guidance during the preparation on this work.

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