XI - THE APPENDAGES

1. The Head and Thoracic Appendages

The appendages of *A. proxima* arise as paired hollow outgrowths of the body-wall. As they grow the segmental mesoderm extends into their developing cavities. All the appendages do not develop simultaneously, those of the head and thorax are formed first followed by others on the abdominal segments. The abdominal appendages with the exception of the first pair are retained as prolegs in the larva.

(i) The Labrum. There is some variation in the time of appearance of the labrum. In certain embryos it arises at a time when the appendicular buds are forming in the head region (24-26-hours), while in others it does not appear until they become well defined. In either case it develops as a pair of faint swellings situated in the mid-line and at the extreme anterior end of the embryo (Plate 6, Fig. 41). As the labral rudiments grow they fuse to form a single large rounded structure with a median notch that gives the labrum a bifid appearance. With the development of the protocephalic region it becomes much enlarged and over-hangs the circular depression of the stomodaeum. Anteriorly the pre-oral mesoderm fills the cavity of the labral rudiment and in early stages presents the form of a bilobed mass connected medially (Fig. 41). Similar paired mesodermal masses have also been recorded in *Chalicodoma* (Carrière and Bürger, 1897) in *Pieris* (Eastham, 1927) and in *Pteronidia* (Shafiq, 1954). Nelson (1915) however, records an unpaired origin of the labrum in *Apis*. 
The nature of the labrum as a true segmental appendage has been a subject of some discussion. Embryologists generally agree that a segmental appendage arises in ontogeny as a paired hollow ectodermal evagination containing a pair of coelomic sacs. It will be noted that labral coelomic sacs as such have been described only in a few insects viz., *Carausius morosus* (Wiesmann, 1926, quoted by Roonwal, 1937); *Rhodnius prolirus* (Mellanby, 1936); *Locusta* (Roonwal, 1937); *Stenonarcys* (Miller, 1940) and more recently in *Pyrilla* (Sander, 1956). Their occurrence in the above mentioned insects, apart from other considerations, affords substantial evidence to regard labrum as a structure homologous to other body appendages.

Among the Hymenoptera such coelomic sacs do not develop and this is not to be expected as paired somites are not formed in any of the body segments except the antennal. In such cases it has been argued that the paired mesodermal masses developing in association with the labral rudiments are indicative of collapsed or disorganised coelomic sacs and that they reflect upon the paired origin of the labrum. In *A. proxima*, though there is no evidence of the coelomic sacs having disorganised but the paired masses of the mesoderm are suggestive of a paired origin of the labrum. Accordingly, the present writer associates himself with
the generally accepted view to regard the labrum as an appendicular structure of the head.

(ii) The Antennae. In *A. proxiima*, as in other insects, the antennae when first make their appearance are post-oral in position. Their final pre-oral position seems to be in response to the mechanical necessity brought upon them due to relative growth of parts in the head region. At the age of 24-26-hours the antennary rudiments arise as backwardly directed papillae from the postero-ventral margin of the protocephalic region. They rapidly elongate and their developing cavities become filled with the segmental mesoderm. As the head gradually assumes its definitive form the antennae appear as conical pegs pointing in an antero-dorsal direction (Text-Fig. 4).

(iii) The Intercalary Appendages. In the premandibular or intercalary segment paired appendages are not formed. At the time when the embryo undergoes shortening slight swellings appear in this region, but soon disappear before the embryo straightens out. Transverse sections passing through this region show that these swellings mainly contain neurogenic tissue belonging to the tritocerebral ganglion and an inconspicuous mass of mesodermal cells. Nelson (1915) has described similar swellings in *Apis* in the intercalary segment and Shafiq (1954) records them in *Pteronidea* between the rudiments of the antennae and mandibles. These swellings are
transitory and consist of neurogenic tissue which Nelson
calls, 'exaggerated ganglionic swellings'. Their fate
is very similar to what has been described for *A. proxima.*
In *Calandra* (Tiegs and Murray, 1938) also there are no
appendages associated with the intercalary segment. In
*Locusta* (Roonwal, 1937) the intercalary appendage is
represented by a thickening of the ectoderm but no
definite evagination of the body-wall has been observed.
This thickening according to the author lasts for a long
time but disappears before hatching.

(iv) **The Gnathal Appendages.** In the following three
gnathal segments, the mandibular and the first and second
maxillary, paired rounded ectodermal protuberances
appear on the sides of the segmental areas. These
are the rudiments of the gnathal appendages. Of the
three pairs, the first forming the mandibles is the largest
from the very beginning (Text-Figs. 2 and 4). The first
and second maxillae grow more rapidly than the mandibles
and appear like digitate processes. At the age of 30-hours
they have grown considerably and the mandibles have
acquired massive form. The mandibles look like stout pegs
which have slight thickenings towards their mesal surfaces.
During the next few hours all these appendages come close
to each other along the median line. At about this time
the first and second maxillae become transversely constricted
to form a basal and a distal portion. The right and left
halves of the protocephalic region now begin to rise up and fuse in the mid-dorsal line, to be followed by a similar fusion in the gnathal segments. The fusion of the two components of the second maxilla occurs at about 46-48-hours. Before hatching all the appendages become well developed. The mandibles lie partly concealed between the labrum and the maxillae.

(v) The Thoracic Appendages. The three pairs of walking legs develop as paired papillae from their respective segments at the age of 24-26-hours. They rapidly elongate and become directed backwards. Further development of the legs is temporarily retarded until the head is definitely constituted, after which they grow much faster and extend a few segments ahead of their own segment.
2. The Abdominal Appendages

The rudiments of the abdominal appendages appear six or seven hours after the formation of head and thoracic appendages. They arise simultaneously as bulbiform protuberances from the ventral side of 1-8 abdominal segments. As they grow and elongate the segmental mesoderm extends into their developing cavities. The first pair of abdominal limbs gradually disappears before hatching while the remaining 7 pairs persist as prolegs in the various larva instars.

Rudimentary abdominal appendages have also been recorded in Chalicodoma (Carrière and Bürger, 1897) but Nelson (1915) did not find any in the embryos of Apis. Among Tenthredinidae, on the other hand, well developed embryonic appendages are formed in the embryos most of which persist as prolegs in the larvae. Thus Graber (1890) reports 12-pairs in Hylotoma and Shafiq (1954) records them on segments 2-7 and 10 in the embryos of Pteronidae. The abdominal limbs of the larva of A. proxima are directly derived from the appendages on 2-8 segments. Similarly in the Lepidoptera the abdominal legs of the caterpillars of Chaerocampa (Friedmann, 1934) and those of Pieris (Eastham, 1930) have been shown to be derived from abdominal appendages on 3-6 and 10 segments.

The Pleuropodia. Considerable interest centres round the first pair of abdominal appendages forming the pleuropodia. In A. proxima all the appendages appear simultaneously but
the pleuropodia from the very beginning are only a little smaller than but similar in appearance to the rest of the appendages on the following trunk segments. They attain maximum development at a time when the embryo is undergoing ventral flexure (40-48 hours). A pleuropodium when fully developed appears conical with a broad base and a bluntly rounded apex. It is continuous with the body-wall by its base and not through a stalk as shown by Roonwal (1937) in *Locusta*. With the advancing age of the embryo they gradually shrivel up and at about 72-hours appear as short conical stumps pressed between the third thoracic and the second abdominal segments. Before the close of the embryonic life (96-hours) they disappear altogether.

The true nature of the pleuropodia as segmental appendages can hardly be questioned. They arise as segmental outgrowth of the body-wall into which extends the segmental mesoderm. Histologically pleuropodial cells appear like the rest of the body-wall cells but in other insects viz., *Locusta* (Roonwal, 1937), *Pteronarcvs* (Miller, 1940) and *Pyrilla* (Sander, 1956) they are large and glandular. In *Pteronarcvs* the pleuropodia are like spherical glands embedded in the ventral wall of the segment with a large fibrillar tuft projecting out of it. The entire structure degenerates before hatching. Miller (1940) regards them as pleuropodial glands whose secretion serves as 'hatching enzyme'. Recently Sander (1956) has described in *Pyrilla* similar pleuropodia with uncertain function. Among
Tenthredinidae apart from their phylogenetic significance they are of little interest as they are stated to be absent in *Pteronides* (Shafiq, 1954), and in *Hylotoma* (Graber, 1890) they are said to disappear in the late embryonic life—a fate similar to what has been recorded in *A. proxima*.