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## ON THE MOUTH PARTS OF THE LARVAL INSTARS OF *CULEX QUINQUEFASCIATUS* (SAY)

[ *Diptera* : *Culicidae* ]

(with 38 Text-Figures)

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### I. INTRODUCTION

A gross study of the morphology of the larval head of *Culex quinquefasciatus* (Say) and, a detailed comparative description of the mouth parts in all the instars, is accomplished. The homologies of the different parts of the mouth with those of a generalized insect have been thoroughly discussed in a previous work by the author on the mouth parts of *Anopheles quadrimaculatus* (Say) (SHALABY, 1956) and *Aedes aegypti* (Linn.) (this Bulletin, pages 145-177). The same nomenclature is also used. Detailed illustrations of the mouth parts in all the stages of development are provided. This enabled the writer to construct a key to the instars, based on the differences between the mouth parts of the larvae in their various stages of growth.

### II. REARING, FEEDING HABITS AND TECHNIQUE

The larvae of *Culex quinquefasciatus* are not difficult to rear in the laboratory. However, they are easily collected outdoors, as they breed readily in semidomestic

situations, such as the water that accumulates in fish ponds, tin cans, or almost any other type of container.

The larvae in all the instars, have the filtering feeding habits. In the laboratory, the first instar larvae are transferred to special containers where they are fed on a suspension of crumbled yeast in water. Aeration is necessary for the survival of the larvae.

The larvae are killed in hot water before preservation in 70% alcohol. The specimens are transferred again to vials containing 95% alcohol. Dissection of the mouth parts is accomplished in a medium of glycerine. For permanent mounting, the specimens are cleared in beechwood creosote. After the clearing process is completed, the specimens are transferred to xylene for not more than a minute. Then they are mounted in Canada balsam and covered with a cover slip. The slide is then placed in an oven at 40 °C. for a short while, after which the specimen is ready for study.

### III. GENERAL MORPHOLOGY OF THE HEAD

The head, in all the instars, is prognathus. The frons (Fig. 2, F) covers almost the entire dorsum of the head. It is bounded cephalad by the fronto-clypeal suture (FCS) and laterad by the frontal sutures. A clypeal suture divides the clypeus into a preclypeus cephalad and a postclypeus caudad. The preclypeus is wide laterad and narrow mesad. Two preclypeal hairs arise from the lateral parts of the preclypeus and extend cephalad. The lateral extremities of the clypeus extend caudad on each side of the head and widen to become invaginated inside the head forming the paraclypeal phragmata (Fig. 1, PrPh).

The labrum (Fig. 2, Lr) is located at the distal end of the head. The antennae (Fig. 1, A) are long. Each antenna is provided with a conspicuous tuft (AF) which arises from the proximal end of its distal third. Arising from the distal end of the antenna are two papilliform short processes and two relatively long and fine setae, which probably are sensory. The larval eyes (Fig. 1, LE) are located on the ocular lobes on each side of the head. Each eye is composed of two parts, a large cephalic part which is in the shape of half a circle, and a very small caudal part which is roughly oval in shape.

The submentum (SMt) occupies the meso-caudal area of the ventral aspect of the head. It is oval in shape and more pigmented than the lateral postgenae (PG). The submentum is bounded laterally by the submental-postgenal sutures (SPS). The posterior tentorial pits (PT) are situated at the distal end of the proximal third of the submental-postgenal sutures before they reach the occiput (Oc). The submentum is partially divided length-wise by the median suture (MS) which extends only a short distance cephalad. In the larva of *Anopheles quadrimaculatus* the median suture is obsolete (SHALABY). The rest of the labium (Lb) is located cephalad of the submentum. A pair of maxillae (Mx) and a pair of mandibles (Md) are located

on the sides of the ventral aspect of the head. The mandibles are located dorsad of the maxillae. The mouth opening (MO) is the space enclosed by the epipharynx (Ep) above, the hypopharynx below and, the mandibles and the maxillae forming the side walls.

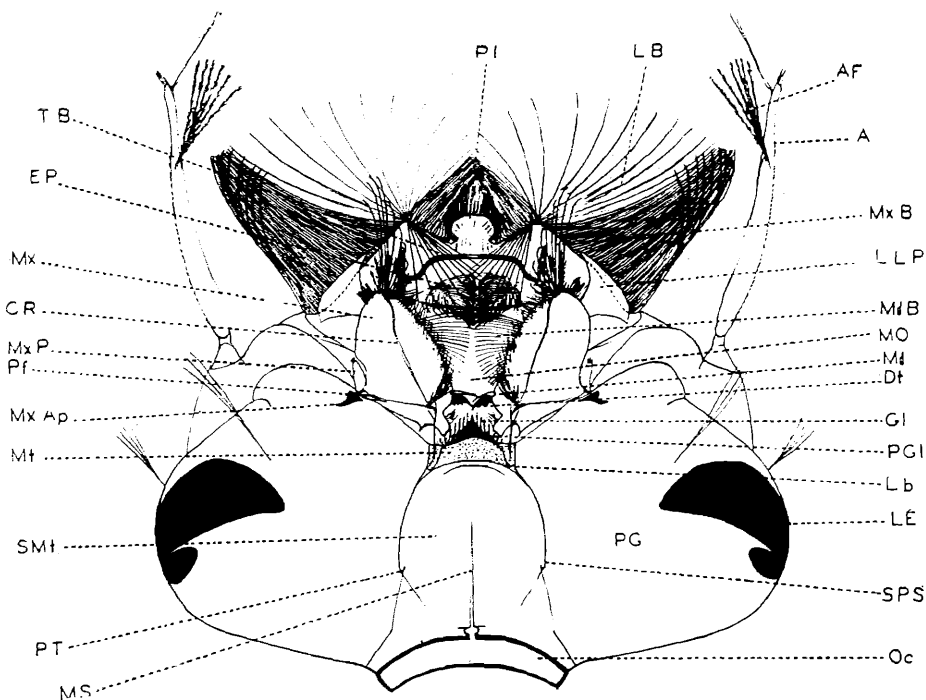
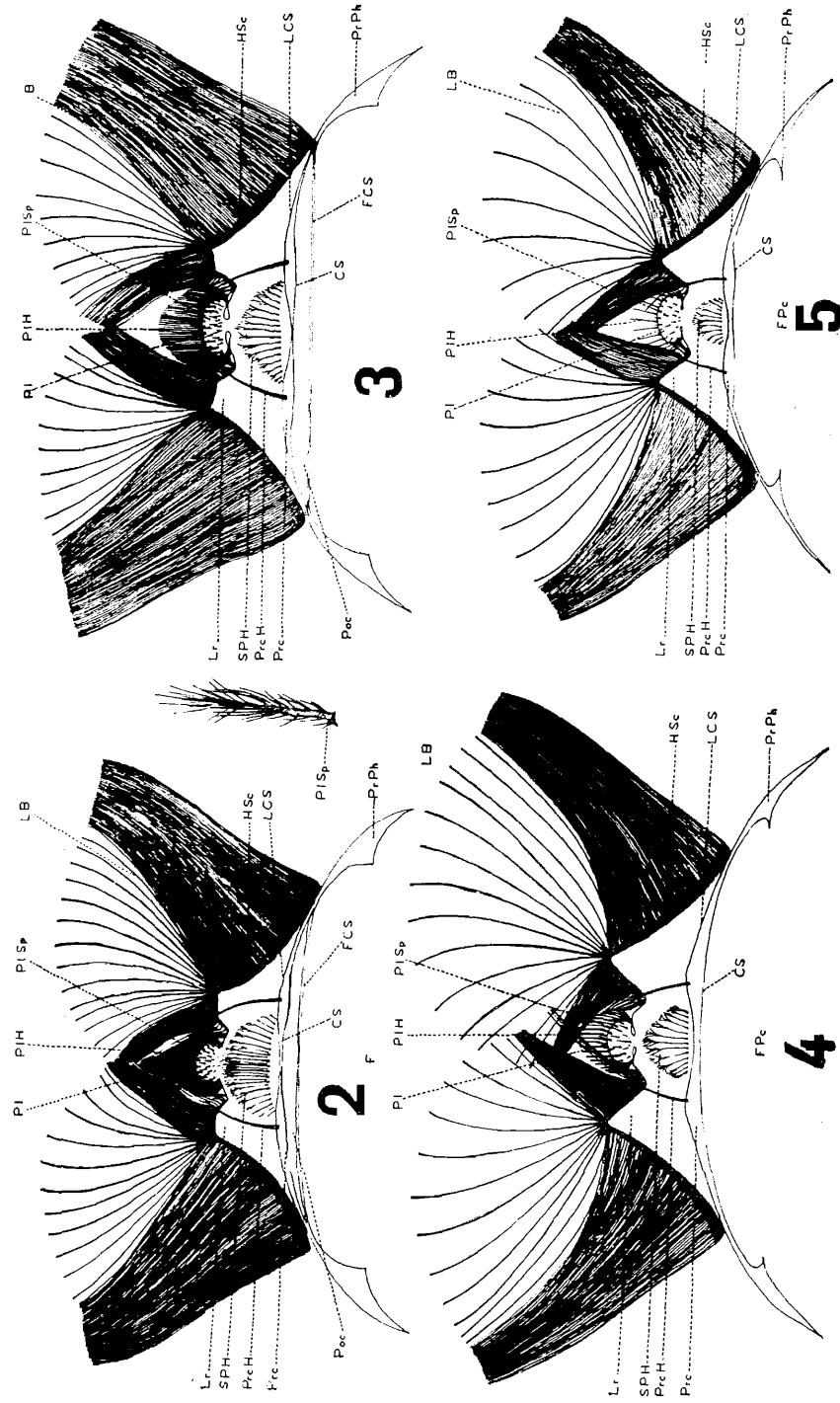


FIG. 1 : Ventral aspect of the head of the fourth instar larva.

#### IV. THE MOUTH PARTS OF THE FOURTH INSTAR LARVA

The head capsule in the fourth instar larva is about 1.104 mm. in width. The mouth parts are adapted for the filtering feeding habit. They consist of the labrum, the mandibles, the maxillae and the labium.

The LABRUM (Fig. 2, Lr) is located at the cephalic end of the head. It is composed of the disto-median palatum, and the two lateral labral brushes. The labrum is separated from the clypeus by the labro-clypeal suture (LCS), which is slightly concave mesad and convex laterad. The clypeus is divided by the clypeal suture (CS) into the preclypeus and the postclypeus (Prc and Poc). The postclypeus is separated from the frons (F) by a very conspicuous and pigmented fronto-clypeal suture (FCS). In the larval head of *Aedes aegypti* the fronto-clypeal suture is absent, which results in the fusion of the frons and the postclypeus forming a fronto-postclypeus (SHALABY). The preclypeal hairs (PrcH) are spine-like, heavily pigmented



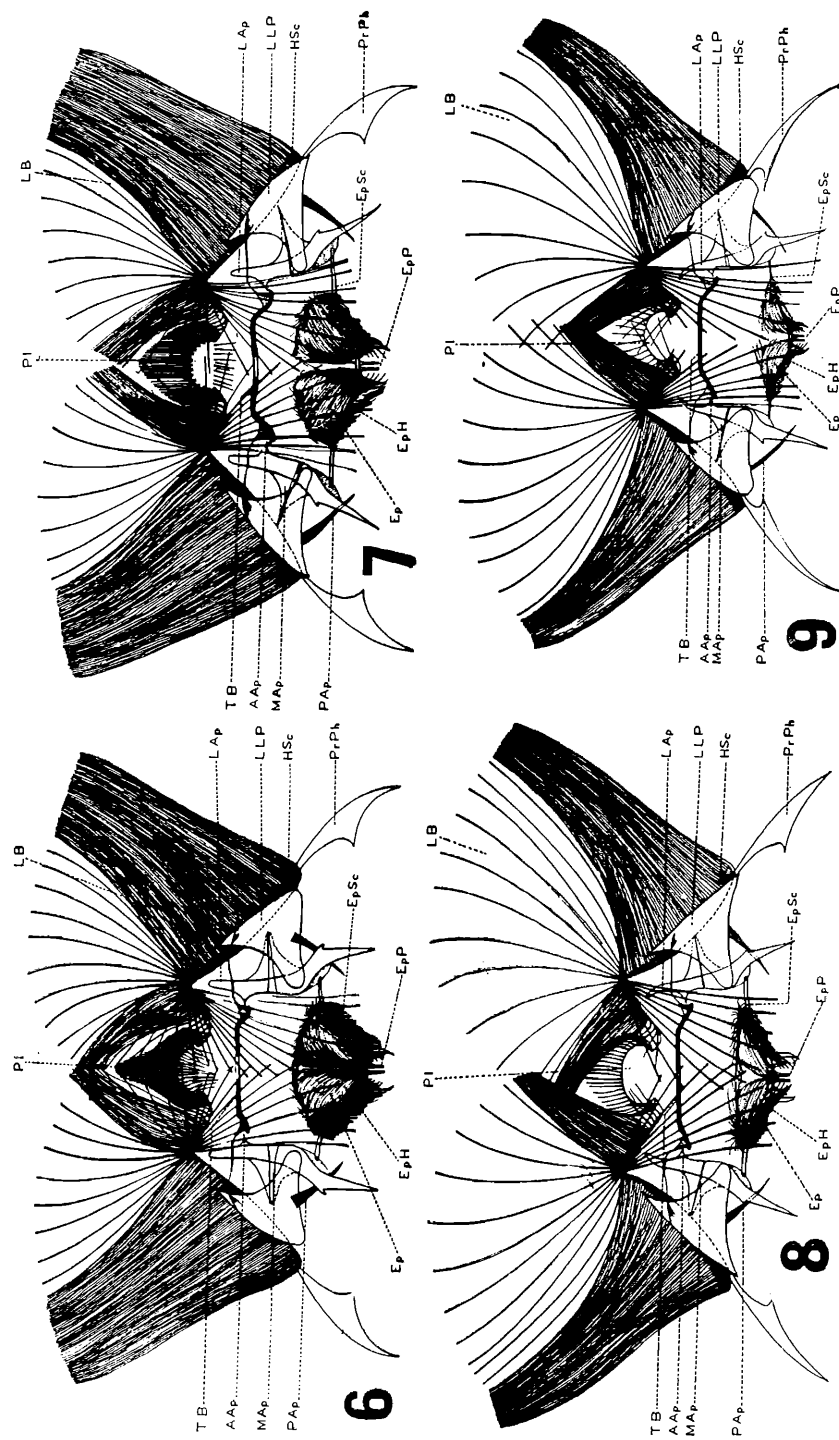
Figs. 2-5 : Dorsal aspect of the cephalic region of the fourth, third, second, and first instar larval head, respectively.

and sclerotized. The paraclypeal phragmata (PrPh) are triangular in shape, heavily pigmented and highly sclerotized.

The PALATUM (Figs. 2 and 6, Pl) is a small roughly rounded structure. Arising from the margin of the palatum are the palatal hairs (Fig. 2, PIH). They are simple, fine and numerous. They are long mesad and shorten gradually laterad. The ectal surface of the palatum is armed with dark, pointed palatal spines (PISp). Under high magnifications, the palatal spines are produced into short branches proximad and long branches distad. The distal end of the spine, however, divides into a great number of very fine and relatively long branches as shown in Figure 2. The ental surface of the palatum (Fig. 6, Pl) is also provided with spines which are fewer, less pigmented and slightly longer than the palatal spines. The palatum is connected with the preclypeus by means of a quadrangular shaped, membranous and flexible area. The suprapalatal hairs (Fig. 2, SPH) arise from the meso-caudal region of this membranous area, and form a fan-shaped structure. In the larval head of *Anopheles quadrimaculatus* the suprapalatal hairs are lacking (SHALABY). Each of these hairs are divided distally into numerous, very fine branches.

The LABRAL BRUSHES are located laterad of the palatum. They arise from an elongated and heavily pigmented hair-bearing sclerite (Figs. 2 and 6, HSc). The hairs of the labral brush are all simple. Each labral brush is composed of four groups of hairs. The first group is borne on the entire length of the hair-bearing sclerite. The hairs of this group are dense long, simple, slightly curved and directed cephalo-laterad. The second group of hairs is located mesad of the first group. It arises from the cephalic end of the hair-bearing sclerite. It is composed of fewer curved hairs which extend cephalo-mesad. The third group of hairs is the most mesal group, and is borne on the mesal part of the hair-bearing sclerite. The hairs are finer, more dense and slightly shorter than those of the second group. The fourth group of hairs is located on the ental aspect of the labrum, as they arise from the arched part of the hair-bearing sclerite, cephalad of the labral apodeme (Fig. 6, LAp). This group is composed of fine simple hairs which extend meso-caudad to overlap with the hairs of the same group of the opposite side forming a sieve-like structure which helps in the filtering process.

The apodemes of the labral brushes (Fig. 6, LAp, LLP and TB) are located on the ental aspect of the labrum. They serve as a support for the labral brushes, as well as for muscular attachments. The labral apodemes (LAp) are sclerotized and pigmented elongated structures which extend from the cephalic end of the head to the level of the middle part of the lateral margin of the mandible when the latter is in the adducted position. The cephalic end of the labral apodeme is rounded. Each labral apodeme possesses three processes. The anterior process of the labral apodeme (AAp) is short, pointed and directed mesad. It is attached to the proximal end of the mesal margin of the distal third of the labral apodeme. The medial process of the labral apodeme (MAp) is triangular in shape and extends laterad. It is attached to the lateral margin of the medial third of the



Figs. 6-9 : Ventral aspect of the cephalic region of the fourth, third, second, and first instar larval head, respectively.

labral apodeme. The posterior process of the apodeme (PAp) is heavily sclerotized and pigmented. It is attached to the distal end of the proximal third of the labral apodeme. The proximal third of the apodeme is pointed proximad, and bears on its disto-lateral end a small somewhat pointed protrusion which extends latero-caudad. This protrusion may be analogous to the slender short spine, arising from the same location in the labral apodeme of the larval head of *Aedes aegypti* (SHALABY). In the larval head of *A. quadrimaculatus* this protrusion is lacking (SHALABY). Attached to the disto-mesal extremity of the proximal third of the labral apodeme is a small oval shaped membranous area to which is attached the lateral extremity of the epipharyngeal sclerite (EpSc).

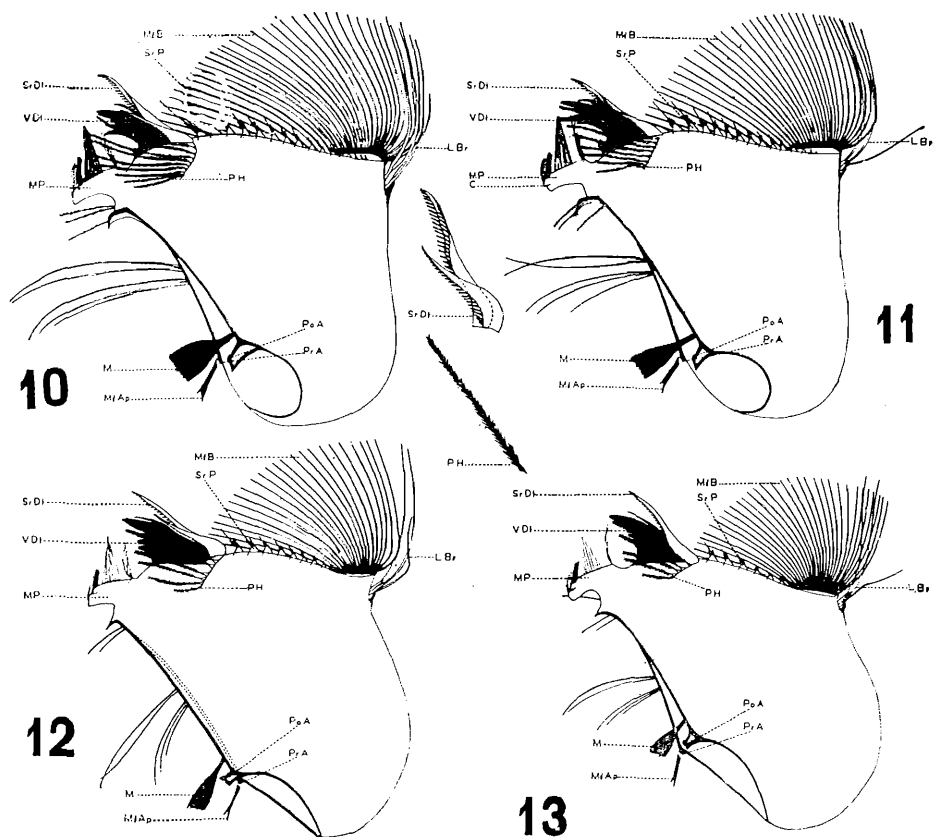
The lateral labral plate (LLp) is situated in the gap left between the labral apodeme and the hair-bearing sclerite. It is triangular in shape, slightly sclerotized and lightly pigmented, with its base partially covering the ental surface of the hair-bearing sclerite, while its mesal end lies across the median part of the labral apodeme. Unlike the labral plates of *A. quadrimaculatus* and *A. aegypti*, the lateral labral plate of *Culex quinquefasciatus* is attached at its cephalic end to the lateral extremity of the transverse bar (TB) by means of a slender wire-like sclerite which is heavily pigmented.

The transverse bar extends transversely across the ental aspect of the labrum, between the anterior processes of the labral apodemes. It is highly sclerotized and heavily pigmented. The heavily pigmented parts of the transverse bar on each side do not meet at the meson, but they are connected together mesad by means of a short slightly pigmented sclerite. The lateral extremities of the transverse bar are bent caudad and then laterad until they meet the anterior process of the labral apodemes. Arising from the lateral ends of the transverse bar are triangular-shaped, and lightly pigmented sclerites which extend cephalo-laterad. They taper distally into a heavily pigmented and flexible wire-like sclerites which extend laterad to connect with the cephalic region of the lateral labral plates. This wire-like sclerite may help in synchronizing the movement of the transverse bar and the labral plates and in turn the labral brushes.

The EPIPHARYNX (Fig. 6, Ep) is oval in shape and situated mesad between the proximal regions of the labral apodemes, on the ental surface of the labrum. It consists of the epipharyngeal sclerite (EpSc), the epipharyngeal hairs (EpH) and the epipharyngeal processes (EpP). The epipharyngeal sclerite is relatively slender, pigmented and conspicuously arched caudad at the mesal region. Its lateral extremities are connected with the membranous areas attached to the disto-mesal region of the proximal third of the labral apodeme. The epipharyngeal hairs consist entirely of simple and fine hairs. However, they can be divided into two groups, a mesal group which consists of very numerous simple hairs and a lateral group, which consists of dense hairs that overlap each other and extend caudad. There are three pairs of epipharyngeal processes which are attached to the arched mesal region of the epipharyngeal sclerite and are directed caudad. The most lateral pair is spine-like,

stouter and longer than the other two pairs. The other two pairs are papilliform in shape and with somewhat pointed ends.

The MANDIBLES (Figs. 10 and 14) are roughly quadrilateral in shape. The homologies of the different parts of the mandible with those of a generalized insect have been discussed by the author in his work on the mouth parts of *Anopheles quadrimaculatus*. The dentes-bearing area of the mandible is highly sclerotized, heavily pigmented and located at the meso-cephalic region. It bears three groups of dentes, a ventral group, a dorsal group and a serrated group. The ventral group of dentes (Figs. 10 and 14, VDt) consists of six dentes. The most cephalic tooth is spine-shaped



FIGS. 10-13 : Ventral aspect of the left mandible of the fourth, third, second, and first instar larva, respectively.

and arises from the middle of the cephalic margin of the dentes-bearing area and extends meso-cephalad. Caudad of this cephalic tooth and extending mesad are four ventral dentes which are relatively short. These four teeth vary in size and length. The sixth ventral tooth is biunt, short and arises from the meso-caudal margin of

the dentes-bearing area. The dorsal group of dentes (Fig. 14, DDt) consists of four dentes which are situated at the caudal region of the dentes-bearing area. They arise from one common base and vary in size and length.

The serrated group of dentes (Figs. 10 and 14, SrDt) consists of two dentes and arise from the ventro-lateral region of the dentes-bearing area. The writer believes that they are homologous as well as analogous with the serrated dentes in the mandible of *A. quadrimaculatus* (SHALABY). The two dentes vary in length, one is longer than the other and both are directed meso-cephalad. The longer tooth contains two rows of relatively long projections. The shorter tooth has only one row. The serrated dentes increase the crushing area of the mandible. Arising from the meso-cephalic region of the ventral aspect of the mandible caudad of the dentes-bearing area is a group of plumose hairs (Fig. 10, PH). It consists of nine spine-like and relatively long hairs which extend mesad. Under high magnifications, each plumose hair is somewhat stout proximad and tapers gradually to become pointed distad. These plumose hairs are probably analogous with the pectinate hairs which arise from the same region of the mandible of *A. aegypti* (SHALABY).

The membranous process (Figs. 10 and 14, MP) is located caudad of the dentes-bearing area. It has a convex cephalic margin, from which arise five clusters of hairs which differ in length and location. Two clusters arise from the dorsal aspect, and three clusters arise from the cephalic margin. The lateral dorsal cluster consists of numerous, fine and relatively long hairs which overlap distally and extend cephalo-laterad. The mesal dorsal cluster, consists of fewer and shorter hairs. The hairs arising from the cephalic margin are composed of three clusters, a lateral, intermediate and a mesal cluster. The lateral cluster consists of numerous long and fine hairs, which extend meso-cephalad. The intermediate cluster consists of fewer, shorter and more rigid hairs which extend cephalad. The mesal cluster is composed of finer but more numerous hairs which are slightly curved and extend cephalad. The mesal margin of the mandible is highly sclerotized and heavily pigmented along its entire length. Arising from its middle are fine, long and slightly curved hairs which extend meso-caudad. There are three plumose hairs which arise from the meso-cephalic region of the dorsal aspect of the mandible, laterad of the cephalic end of the mesal margin.

The mandible is articulated to the ventral wall of the head by means of the preartis and the postartis (Figs. 10 and 14, PrA and PoA). The articulation is strengthened by a heavily pigmented and sclerotized mandibular apodeme (MdAp). The abductor muscle (Fig. 14, M) is attached to the meso-caudal end of the mandible. The lateral margin of the mandible is more or less straight and devoid of setae or spines. At the distal end of the lateral margin is located a sclerotized socket which bears the lateral bristles (LBr). The lateral bristles are four in number, three long curved bristles which are directed cephalo-mesad, and a short mesal spine-shaped bristle.

The mandibular brush (MdB) contains a great number of setae which lie across the cephalic region of the dorsal aspect of the mandible. The most lateral

setae are long and curved. They shorten gradually and become more or less straight mesad. This brush arises from a heavily pigmented slender sclerite (Fig. 14, ScB). The cephalic margin of the mandible is produced into a number of triangular shaped and somewhat pigmented processes which are referred to as the serrated processes (Figs. 10 and 14, SrP). These processes are lacking in the mandibles of *A. quadrimaculatus* and *A. aegypti* (SHALABY). Each process is provided distally with a relatively long fine seta and a number of short setae. The writer believes that the mandibular comb of *A. aegypti* is the result of the growth of the serrated processes into long bristles forming a comb-like structure.

The MAXILLAE (Fig. 18) are located on either side of the head ventrad of the mandibles. The maxilla is oval in shape. It is composed of the galea (Ga), the lacinia (Lc), the cardostipes (CdSt), the maxillary palpus (MxP) and the palpifer (Pf). The homologies of the various lobes of the maxilla with those of a generalized insect have been discussed thoroughly by the author in his work on the mouth parts of *A. aegypti*. The mesal margin of the maxilla is prominently convex. It is clothed with a great number of spines and setae which extend cephalo-mesad. There are two or three rows of short and somewhat pigmented spines which overlap with the proximal ends of the setae thus forming a sieve-like structure. Five to seven relatively long pectinate spines (PcSp) arise near the caudal end of the mesal margin. They are long cephalad and shorten gradually caudad. The mesal region mesad of the chitinous ridge (CR) is clothed with numerous very fine hairs.

The chitinous ridge is heavily pigmented and sclerotized. It extends lengthwise along the middle of the maxilla. In the larva of *A. quadrimaculatus*, the maxilla does not possess a chitinous ridge (Shalaby). Arising directly from the middle part of the chitinous ridge are two papilliform membranous appendages (MACR). The maxilla is articulated to the ventral wall of the head capsule by means of the entoparartis and the exoparartis (Enp and Exp). The entoparartis is fused with the caudal end of the chitinous ridge. The exoparartis is situated at the caudo-lateral end of the maxillary palpus. The articulation is strengthened by the maxillary apodeme (MxAp).

The maxillary palpus (MxP) is relatively small and short. The lateral margin of the palpus is slightly sinuate. The palpus bears on its distal end six sensoria (S) which are short and papilliform. The palpifer (Pf) is triangular in shape and is situated caudo-laterad of the cardostipes and caudad of the maxillary palpus. In *A. quadrimaculatus* the palpifer is absent (SHALABY). The lateral margin of the maxilla is convex. It is provided with a group of quite distinct microspines (MSP) which range from 11 to 16 in number among different specimens. At the cephalic end of the galea arises a relatively long and pigmented maxillary spine (MxSp). Mesad of the maxillary spine and cephalad of the galea there is a cluster of short and rigid fan-shaped setae which extend cephalo-laterad.

The maxillary brush (MxB) consists of two types of hairs, simple hairs and pectinate hairs (PcH). The simple hairs are long and slender which range from 23 to 30 in number. The pectinate hairs are shorter and more slender than the simple

hairs. They are pectinate along their lateral margin. At the cephalic end of the lacinia arises a heavily pigmented spine (Sp) which extends meso-cephalad.

The LABIUM (Fig. 1, Lb) is located at the meso-caudal region of the ventral aspect of the head. The homologies of the various parts of the labium with those of a generalized insect have been discussed by the author in his work on the mouth parts of *A. quadrimaculatus*. Accordingly, the labium is composed of the submentum (Smt), mentum (Mt), glossa (Gl) and paraglossa (PGl). The submentum (SMt) is sub-rectangular in shape and is separated from the postgenae (PG) by the submental-postgenal sutures (SPS). The median suture (MS) as well as the anterior tentorial pits (PT) are quite distinct.

The mentum (Fig. 1, Mt and Fig. 22) is a narrow, more or less membranous plate, with a slightly convex cephalic margin. Its cephalic margin is produced mesally into a triangular-shaped protrusion which has a somewhat pointed end. Arising from this mesal protrusion are two relatively short spine-like setae which extend cephalad.

The glossa (Fig. 26) is located dorsad of the mentum and ventrad of the paraglossa (Fig. 1, PGI). It is a narrow plate, with a convex cephalic margin which is produced mesally, into a large pointed spine-like protrusion with wide base. The cephalic margin of the glossa bears a large number of bipectinate hairs (Fig. 26, BPH). They range from 48 to 52 with 24 to 26 bipectinate hairs on each side of the mesal line. These fringes are long mesad and shorten gradually laterad. Under higher magnifications, each of these fringes is provided with short and slender branches which extend along the entire length of its mesal margin, while they extend only a short distance proximad along its lateral margin. The equality in number of the bipectinate hairs of the two halves of the glossa and their apparent symmetry, may indicate that the glossa is the result of the fusion of two glossae at the mesal line.

The paraglossa (Fig. 1, PGI and Fig. 30) is roughly rectangular in shape, highly sclerotized and heavily pigmented. The mandibular dentes (Fig. 1, Dt) and the paraglossa form the crushing apparatus in the larval head. The paraglossa is composed of 23 teeth, 11 teeth on each side of the disto-central tooth. Three degrees of pigmentation and sclerotization are recognizable in the paraglossa. The distal and most lateral areas are highly sclerotized and heavily pigmented. The most lateral areas are highly sclerotized and heavily pigmented. The median area is less sclerotized and less pigmented. It fades gradually laterad to a lighter degree of pigmentation and sclerotization. The equality in the number of the teeth on each side of the mesal line and their apparent symmetry, also indicates that the paraglossa is the result of the fusion of two paraglossae along the mesal line, after being shifted dorsad of the glossa.

The HYPOPHARYNX (Fig. 34) forms the floor of the mouth cavity. It is heavily sclerotized, heavily pigmented and quadrangular in shape. The homologies of this structure with that of generalized insects have been discussed by the author in his work on the mouth parts of *A. quadrimaculatus* and *A. aegypti*. The disto-lateral ends of the hypopharynx are connected with the sclerotized and pigmented cibarial

bars (CB). The salivary duct (SO) opens through the meso-caudal area of the oval-shaped cephalic region of the hypopharynx. Two ear-shaped lateral lobes (L) are situated on the sides of the cephalic region. The middle region of the hypopharynx (Hyp) is more sclerotized and pigmented and is bounded laterad by two elongated, heavily pigmented structures which extend caudad until the cephalic margin of the paragnatha (Pgn). In the mesal region of this middle region are to be seen a few very slender transverse ridges which fade gradually laterad. Laterally, however, arise two longitudinal rows of microspines (MSP), which are small blunt and lightly pigmented. Two large hypopharyngeal processes (HypP) are located laterad of the boundaries of the middle region of the hypopharynx. These processes are heavily pigmented which are rounded cephalo-laterad and pointed caudad. There are two heavily pigmented mesal spines (MsSp) which are located between the cephalo-mesal ends of the paragnatha.

The paragnatha are located at the caudal region of the hypopharynx. Each paragnathus, for the purpose of description, can be divided into three regions, (a) the caudo-lateral region, (b) the intermediate region, and (c) the mesal region. (a) The caudo-lateral region includes numerous spines which are arranged into three rows (LSp) and two lateral groups. These three rows are the cephalic row, the intermediate row, and the caudal row; while the lateral groups are divided into the cephalic group and the caudal group. The cephalic row of each paragnathus consists of three large and somewhat pointed spines. The intermediate row consists of six small pointed spines and one large somewhat pointed spine. The caudal row is composed of numerous small spines. The cephalic lateral group of spines consists of four relatively large and somewhat pointed spines. The caudo-lateral group of spines is composed of three somewhat pointed spines, two small mesal spines and a large lateral one. (b) The intermediate region of the paragnathus is oval in shape, lightly sclerotized and barely pigmented. It bears two pairs of movable spines (MvSp) which are relatively short and somewhat pointed. (c) The mesal region of the paragnathus meets the other of the opposite side along the mesal line. It does not possess spines. There is a triangular shaped structure which is located between the meso-caudal ends of the paragnatha, which carries two sharply pointed spines at its cephalic end.

## V. THE MOUTH PARTS OF THE THIRD INSTAR LARVA

The head capsule of this instar is about 1.071 mm. in width. The larva in this instar has the same filtering feeding habits of the fourth instar larva.

The LABRUM (Fig. 3, Lr) is composed, as in the fourth instar, of the disto-median palatum (Pl) and the disto-lateral labral brushes (Figs. 3 and 7, LB). The preclypeal hairs (PrcH) are a little shorter than those of the fourth instar. The suprapalatal hairs (Fig. 3, SPH) are less dense and shorter than those of the fourth instar. They are long mesad and shorten gradually laterad.

The PALATUM (Figs. 3 and 7, Pl) is oval in shape. The palatal hairs (Fig. 3, PIH) arising from the margin of the palatum are shorter and fewer than those of the fourth instar. They are long mesad and shorten gradually laterad. The mesal palatal hairs, however, are not much longer than the lateral ones. The palatal spines (PlSp) which arise on the ectal surface of the palatum are fewer and a little shorter than those of the fourth instar. The ental surface of the palatum is provided also, with relatively long and lightly coloured hair-like spines, which are fewer than those of the fourth instar.

Each LABRAL BRUSH (Figs. 3 and 7, Lb) consists of four groups of hairs as in the fourth instar. However, the hairs of the labral brushes are shorter, finer and fewer than those of the fourth instar.

The APODEMES OF THE LABRAL BRUSHES are situated on the ental surface of the labrum and are five in number, equal to those of the fourth instar. The elongated labral apodeme (Fig. 7, LAp) is a little more slender and less sclerotized than that of the fourth instar. The anterior, medial and posterior processes of the labral apodeme (AAp, MAp and PAp) are present. The protrusion which extends caudo-laterad from the disto-lateral end of the proximal third of the labral apodeme is smaller than that of the fourth instar. Attached to the disto-mesal end of the proximal third of the labral apodeme is an oval-shaped membranous area as in the fourth instar.

The lateral labral plate (LLP) is smaller and less pigmented than that of the fourth instar. Its cephalic end, as well as the caudal end are pointed. The lateral labral plate of the fourth instar has only its cephalic end pointed and its caudal end rounded. The transverse bar (TB) is composed of two heavily pigmented symmetrical halves, as in the fourth instar. Connected with the lateral ends of the transverse bar are the wire-like sclerites which extend laterad to become attached to the cephalic end of the lateral labral plate on each side, as in the fourth instar.

The EPIPHARYNX (Ep) is suboval in shape. It is composed of the epipharyngeal sclerite (EpSc), the epipharyngeal hairs (EpH) and the epipharyngeal processes (EpP). The epipharyngeal sclerite is more slender, less pigmented and less arched than that of the fourth instar. The epipharyngeal hairs are similar to those of the fourth instar, with the exception of being lighter in color, fewer, and a little shorter. The three pairs of epipharyngeal processes are present, though they are more slender and less pigmented than those of the fourth instar.

The MANDIBLES (Figs. 11 and 15) are less sclerotized and less pigmented than those of the fourth instar. The dentes-bearing area contains three groups of dentes, the ventral group of dentes (Figs. 11 and 15, VDt), the dorsal group of dentes (Fig. 15, DDt) and the serrated dentes (Figs. 11 and 15, SrDt), as in the fourth instar. The ventral dentes are six in number. The dorsal dentes are four in number and are smaller than those of the fourth instar. The serrated dentes are two in number and are more slender and shorter than those of the fourth instar. The plumose hairs (Fig. 11, PH) are eight in number while those of the fourth instar are nine in number.

The membranous process (Figs. 11 and 15, MP) is a little shorter than that

of the fourth instar. Its mesal margin is clefted (Fig. 11, C), while that of the fourth instar is not. The five groups of hairs which arise from the membranous process are present. However, they consist of fewer, finer and shorter hairs than those of the fourth instar. The mesal margin of the mandible is heavily sclerotized and pigmented along its entire length. There are five long simple hairs which arise from the middle part of the mesal margin and extend meso-caudad. The three plumose hairs which arise from the meso-cephalic region of the dorsal aspect of the mandible are more slender than those of the fourth instar.

The mandible is articulated to the ventral wall of the head by means of the preartaris and the postartaris (Figs. 11 and 15, PrA and PoA). The articulation is strengthened by the mandibular apodeme (MdAp). The abductor muscle (M) is attached to the meso-caudal end of the mandible. The lateral margin ends distad into the sclerotized socket which bears the lateral bristles (LBr). The lateral bristles are three in number, while in the fourth instar there are four bristles. The most mesal short spine-like bristle which occurs in the fourth instar, is absent here.

The mandibular brush (MdB) arises from a heavily pigmented sclerite (Fig. 15, ScB) and it consists of a fewer number of hairs. The serrated processes (Figs. 11 and 15, SrP) which arise from the cephalic margin of the mandible range from 14 to 17, while those of the fourth instar range from 16 to 20. Each of these processes is provided distally with a relatively long median seta and a number of short, fine setae which are fewer than those of the fourth instar.

The MAXILLAE (Fig. 19) are smaller in size, less sclerotized and less pigmented than those of the fourth instar. The setae and spines which arise from the mesal margin of the maxilla are fewer and a little shorter than those of the fourth instar. The pectinate spines (PcSp) which arise from the caudal region of the mesal margin are four in number, while those of the fourth instar are five spines. The cluster of fine hairs, arising from the meso-caudal region of the cardostipes (CdSt), consists of a fewer and finer hairs. The chitinous ridge (CR) is slightly sinuate, sclerotized and pigmented. The two membranous appendages of the chitinous ridge (MACR) are shorter and more slender than those of the fourth instar.

The maxilla is articulated to the ventral wall of the head capsule by means of the entoparartaris and the exoparartaris (Enp and Exp). The articulation is strengthened by the maxillary apodeme (MxAp). The maxillary palpus (MxP) is shorter, less pigmented and its lateral margin is less sinuate than that of the fourth instar. The sensoria (S) are short, papilliform and five in number. In the fourth instar there are six sensoria. The palpifer (Pf) is comparatively small and slightly pigmented. The convex lateral margin is provided with 11 to 13 microspines (MSP), while those of the fourth instar range from 12 to 15 microspines. The maxillary spine (MxSp) which arises from the cephalic region of the galea (Ga) is a little shorter and more slender than that of the fourth instar. The cluster of hairs which arises from the cephalic margin of the galea consists of comparatively finer and shorter hairs. The maxillary brush (MxB) consists of simple, as well as pectinate hairs (PcH). The

simple hairs of the brush are long and slender and range from 19 to 23 hairs, while those of the fourth instar range from 23 to 28 hairs. The pectinate hairs are comparatively short and few. The spine (Sp) which arises from the distal end of the lacinia (Lc) is comparatively short and slender, and extends meso-cephalad.

The LABIUM is composed of the submentum, mentum, glossa and paraglossa. There is no illustration here for the submentum because of its similarity to the submentum of the fourth instar, except in being smaller in size.

The mentum (Fig. 23) is narrow, slightly sclerotized and lightly pigmented. The cephalic margin of the mentum is convex. Its mesal region is produced into a triangular shaped process which is considerably shorter, less pigmented and with a wider base than that of the fourth instar. The two spine-like setae which arise from the lateral margins of this projection in the fourth instar, are absent here.

The glossa (Fig. 27) is lightly sclerotized and slightly pigmented. Its cephalic margin is fringed with bipectinate hairs (BPH) which are equal in number to those of the fourth instar. The mesal region of the cephalic margin is also produced into a triangular-shaped protrusion with a pointed distal end. The protrusion is smaller and lighter in colour than that of the fourth instar.

The paraglossa (Fig. 31) is roughly triangular in shape. It is smaller, less sclerotized and less pigmented than that of the fourth instar. The paraglossa consists of 24 teeth, 11 teeth on the left side, 12 teeth on the right side and a single disto-central tooth. The disto-central tooth is relatively small and sharply pointed, while that of the fourth instar is large and somewhat pointed. The highly sclerotized and pigmented lateral areas of the paraglossa are comparatively narrow, while the median less pigmented area is relatively large. This median area fades gradually caudad into a lighter degree of pigmentation.

The HYPOPHARYNX (Fig. 35) is smaller in size, less sclerotized and less pigmented than that of the fourth instar. The cephalic area of the hypopharynx is comparatively narrow, with the salivary duct (SO) opening at its meso-caudal region. The ear-shaped lateral lobes (L) are slightly smaller than those of the fourth instar. The median region of the hypopharynx (Hyp) is provided mesally with transverse ridges which are less conspicuous and fewer than those of the fourth instar. The two rows of microspines (MSp) are comparatively fewer, less pigmented and less conspicuous. The two hypopharyngeal processes (HypP) are slightly smaller than those of the fourth instar. There is only one highly sclerotized mesal spine (MsSp), while there are two in the fourth instar.

The paragnatha (Pgn) are located at the caudal region of the hypopharynx. As in the fourth instar, each paragnathus can be divided into (a) the caudo-lateral region, (b) the intermediate region, and (c) the mesal region. (a) The caudo-lateral region contains three rows of lateral spines (LSp), the cephalic row, the intermediate row and the caudal row, besides the two caudo-lateral groups. The cephalic and the intermediate rows of lateral spines consist of the same number of spines as in the fourth instar. The caudal row, however, is composed of much smaller and more

numerous spines than in the fourth instar. The cephalic group of spines, is composed of two spines on each side. The caudal group is composed of three spines on the left side and two spines on the right side. (b) The intermediate region of the paragnathus is lightly pigmented and possesses two pairs of papilliform and somewhat pointed movable spines (MvSp), as in the fourth instar. (c) The mesal region of each paragnathus contains a small, blunt spine, though, the mesal region of the paragnatha in the fourth instar do not possess spines. The triangular shaped structure which projects in between the meso-caudal regions of the paragnatha, is produced distally into three small and sharply pointed spines.

## VI. THE MOUTH PARTS OF THE SECOND INSTAR LARVA

The head capsule of the second instar larva is about 0.536 mm. in width. There are no pronounced changes in the general arrangement of the sclerites of the head. The larva in this instar has the same filtering feeding habits as in the third and fourth instars.

The LABRUM (Fig. 4, Lr) is composed of the disto-median palatum and the disto-lateral labral brushes. It is noticed that the fronto-clypeal suture is absent in this instar. This results in the fusion of the postclypeus and the frons forming the fronto-postclypeus (FPc). The preclypeal hairs (PrcH) are a little shorter, more slender and more flexible than those of the third and fourth instars. The paraclypeal phragmata (Figs. 4 and 8, PrPh) are comparatively small and lightly pigmented. The suprapalatal hairs (Fig. 4, SPH) are much fewer, shorter and more slender than those of the third and fourth instars.

The PALATUM (Figs. 4 and 8, Pl) is comparatively small in size. The palatal hairs (Fig. 4, PIH) are much fewer, lighter coloured and finer than those of the third instar. The hair-like spin s which arise on the ental surface of the palatum of the third and fourth instars, are absent here.

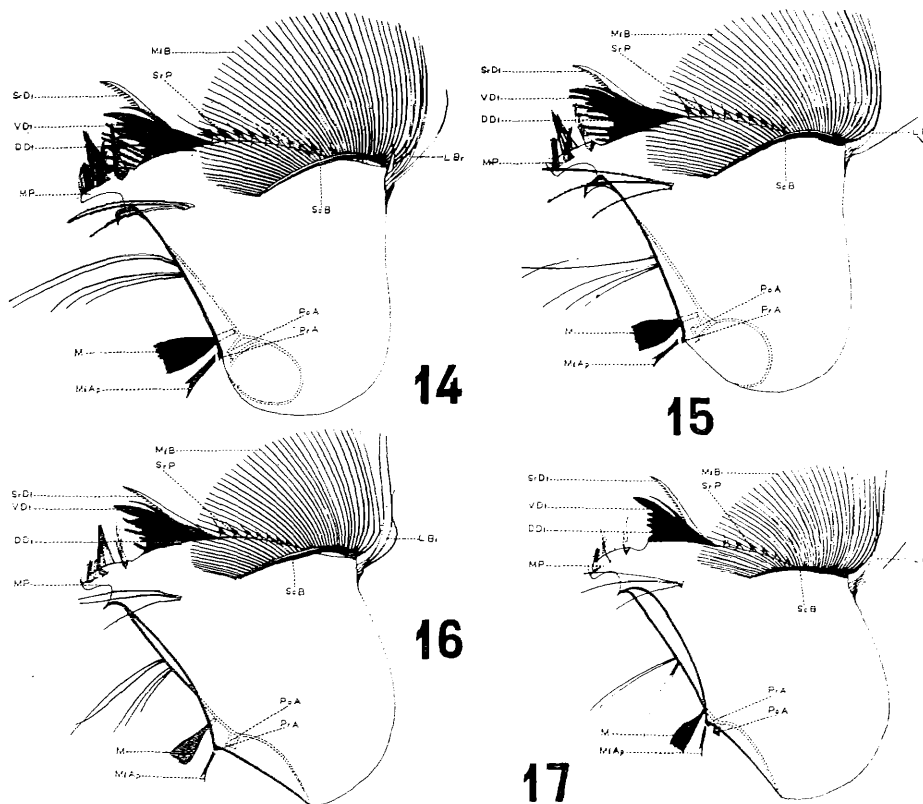
The LABRAL BRUSHES (Figs. 4 and 8, LB) are proportionally longer than those of the advanced instars. They consist of fewer and lighter-coloured hairs than those of the third instar. Each labral brush consists of four groups of hairs as in the third and fourth instars. The hairs are fewer and finer though a little longer than those of the advanced instars.

The APODEMES OF THE LABRAL BRUSHES are less sclerotized and less pigmented than those of the third and fourth instars. The labral apodeme (Fig. 8, LAp) is comparatively small in size. Its somewhat pointed distal end bends meso-cephalad, while that of the third and fourth instars is not bent. The anterior, medial and posterior processes of the labral apodeme (AAp, MAp and PAp) are present, though they are shorter and more slender than those of the advanced instars. The small projection which is attached to the disto-lateral end of the proximal third of the labral apodeme is less prominent. Connected with the disto-mesal end of the proximal

third of the labral apodeme, is the oval-shaped membranous area which is smaller than that of the third instar.

The lateral labral plate (LLP) is triangular in shape, less sclerotized and less pigmented than that of the third instar. Its cephalic and caudal ends are pointed. The transverse bar (TB) is slightly pigmented and lightly sclerotized. The two heavily pigmented symmetrical halves are connected mesad with a lightly pigmented sclerite. Attached to the lateral extremities of the transverse bar are the wire-like sclerites which extend laterad to become attached to the cephalic region of the lateral labral plate on each side.

The EPIPHARYNX (Ep) is smaller in size and lighter coloured than that of the third instar. It is triangular in shape, while those of the third and fourth instars are oval in shape. As in the advanced instars, it is composed of the epipharyngeal sclerite (EpSc), the epipharyngeal hairs (EpH) and the epipharyngeal processes (EpP). The epipharyngeal sclerite is less pigmented and relatively shorter than that of the third instar. The epipharyngeal hairs are comparatively few, fine and lightly coloured. The three pairs of epipharyngeal processes are small and lightly pigmented.



FIGS. 14-17 : Dorsal aspect of the right mandible of the fourth, third, second, and first instar larva, respectively.

The MANDIBLES (Figs. 12 and 16) are smaller in size, less sclerotized and less pigmented than those of the third and fourth instars. The ventral group of dentes (VDt) is composed of five dentes only. The serrated group of dentes (SrDt) is composed of two serrated teeth. Each tooth has one row of slender, short projections along its mesal margin, while the longer tooth of the serrated dentes in the third and fourth instars has two rows of these projections along its mesal margin. The dorsal group of dentes (Fig. 16, DDt) is composed of four dentes which are comparatively small. The plumose hairs (Fig. 12, PH) are six in number.

The membranous process (Figs. 12 and 16, MP) is short and bears five groups of hairs. These hairs are much finer and fewer than those of the third instar. The mesal margin of the mandible is pigmented and sclerotized along its entire length. Arising from its middle region are five hairs which extend meso-caudad. The three setae which arise from the meso-cephalic region of the dorsal aspect of the mandible, laterad of the distal end of the mesal margin are short and simple. Those of the third and fourth instars are long and plumose. The mandible is articulated to the ventral wall of the head by means of the preartaris and the postartaris (PrA and PoA). The articulation is strengthened by the mandibular apodeme (MdAp). The lateral margin of the mandible is convex, while in the third and fourth instars it is more or less straight. The lateral margin ends distad into the sclerotized and pigmented socket which bears the lateral bristles (LBr). The lateral bristles are three in number.

The mandibular brush (MdB) is considerably smaller and contains fewer setae than that of the third and fourth instars. The setae which arise from a heavily pigmented sclerite (Fig. 16, ScB) are less curved, shorter and finer than those of the advanced instars. The serrated processes (Figs. 12 and 16, SrP) which arise from the cephalic margin of the mandible are small in size and range from nine to twelve in number. Each process is provided distally with a relatively long spine-like seta and a number of short fine hairs.

The MAXILLA (Fig. 20) is comparatively small and consists of the same parts of the advanced instars. The convex mesal margin is provided with a great number of spines and setae, which are relatively short, less dense and lightly coloured. It must be noticed that the pectinate spines which arise from the caudal region of the mesal margin of the maxillae of the third and fourth instars, are here absent. The group of very fine hairs which occurs in the meso-caudal region, are considerably fewer and finer than those of the third instar. The chitinous ridge (CR) is slightly sinuate and relatively slender. The two membranous appendages of the chitinous ridge (MACR) are more slender and shorter than those of the third and fourth instars.

The maxilla is articulated to the ventral wall of the head by means of the entoparartaris and the exoparartaris (Enp and Exp). The articulation is strengthened by the maxillary apodeme (MxAp), which is less sclerotized and less pigmented than that of the advanced instars. The maxillary palpus (MxP) is shorter and more slender than that of the third instar. The sensoria (S) at the distal end of the palpus are four in

number only. The palpifer (Pf) is comparatively small and slightly sclerotized. The microspines (MSp) which arise from the slightly convex lateral margin range from seven to ten in number. The maxillary spine. (MxSp) which is attached to the cephalic region of the galea (Ga) is less sclerotized and more slender than that of the third and fourth instars. The cluster of hairs which arises from the cephalic margin of the galea consists of fewer, shorter and finer hairs than that of the third instar.

The maxillary brush (MxB) is smaller and less dense than that of the advanced instars. The brush is composed of simple as well as pectinate hairs (PcH). The simple hairs of the brush range from 14 to 19 hairs. The pectinate hairs are short, and range from four to five in number. The spine which arises from the cephalic end of the lacinia in the third and fourth instars, is absent in the second instar.

The labium is composed of the submentum, mentum, glossa and paraglossa, similar to that of the third and fourth instars. The submentum is oval in shape and smaller in size than that of the third instar.

The mentum (Fig. 24) is narrower, smaller in size, and less pigmented than that of the third instar. The convex cephalic margin is produced mesally into a short, small triangular shaped projection which is short and with a comparatively narrow base. The two spine-like setae which arise from the lateral margins of the projection in the fourth instar, are absent in the second instar also.

The glossa (Fig. 28) is narrower, smaller in size, less sclerotized and less pigmented than that of the third instar. Its cephalic margin is produced mesad into a triangular shaped and pointed projection. The cephalic margin is also produced into a fewer number of fringes which are composed of branched bipectinate hairs (BPH), while those of the third and fourth instars are unbranched. Each bipectinate hair possesses at least one or two branches which are simple and not bipectinate. The most mesal pair of the bipectinate hairs is unbranched. The bipectinate hairs range from 34 to 44, with 17 to 22 branched bipectinate hairs on each side of the meson.

The paraglossa (Fig. 32) is roughly quadrangular in shape. It is smaller in size, less sclerotized and less pigmented than that of the third and fourth instars. It is composed of 19 teeth, nine teeth on each side of the disto-central tooth. The heavily pigmented area which carries the teeth is narrower than that of the third and fourth instars. The median less pigmented area is larger than that of the advanced instars. The median less pigmented area is larger than that of the advanced instars. The caudal area is comparatively lighter in colour.

The HYPOPHARYNX (Fig. 36) is comparatively small. The cibarial bars (CB) are slender and lightly pigmented. The lightly pigmented cephalic area of the hypopharynx is proportionally wider than that of the third instar. The salivary ducts (SO) opens at the meso-caudal region of the cephalic area. The lateral lobes (L) are proportionally wider than those of the advanced instars. The median region of the hypopharynx (Hyp) is smaller in size and less pigmented than that of the third

and fourth instars. The mesal transverse ridges which occur in the third and fourth instars are not apparent here. The lateral heavily pigmented boundaries of the median region are comparatively short and slender. The hypopharyngeal processes (HypP) are smaller and less pigmented than those of the advanced instars. It should be noticed that the microspines which occur in the third and fourth instars (Figs. 34 and 35, MSp) are absent here.

The paragnatha (Fig. 36, Pgn) are slightly sclerotized and lightly pigmented. Each paragnathus is divided into (a) the caudo-lateral region, (b) the intermediate region and (c) the mesal region. The caudo-lateral region consists of three rows of lateral spines (LSp) and a caudo-lateral group of spines. The cephalic row of spines is composed of three sharply pointed spines which are smaller than those of the third instar. The intermediate row consists of five spines and a small detached spine. The caudal row consists of numerous small spines. There is only one caudo-lateral group of spines which consists of two spines only. (b) The intermediate region is very lightly pigmented and bears two pairs of movable spines (MvSp) which are more slender and a little shorter than those of the third and fourth instars. (c) The two mesal regions of the paragnatha fuse with each other along the mesal line, and bear two somewhat pointed spines, similar to those of the third instar. The oval-shaped structure which is located between the meso-caudal regions of the paragnatha, is considerably small, and bears only one blunt spine at its distal end.

## VII. THE MOUTH PARTS OF THE FIRST INSTAR LARVA

The head capsule of the first instar larva is about 0.468 mm. in width. There is no change, whatsoever, in the general arrangement of the head sclerites. The main difference is the presence of the egg bruster (Fig. 38, EB) in the middle of the frons. The larva in this instar, has the same filtering feeding habit of the second, third and fourth instars.

The LABRUM (Fig. 5, Lr) is smaller in size than that of the second instar. The fronto-clypeal suture is absent, which results in the fusion of the postclypeus and the frons forming the fronto-postclypeus (FPc). The preclypeal hairs (PrcH) are short slender and very lightly pigmented. The paraclypeal phragmata (Figs. 5 and 9, PrPh) are comparatively small and slightly sclerotized.

The egg burster (Fig. 38, EB) is located in the middle of the frons. It is less conspicuous, if compared with those of *Anopheles quadrimaculatus* and *Aedes aegypti* (SHALABY). The egg bruster is composed of a small, circular and membranous area with a conspicuous dark spine in the center. It helps to break the chorion of the egg during the hatching process.

The PALATUM (Fig. 5, Pl) is smaller than that of the second instar. The supra-palatal hairs (SPH) are fewer, shorter, finer and lighter coloured than those of the advanced instars. The palatal hairs (PIH) are comparatively few and fine. The palatal hairs (PIH) are comparatively few and fine. The palatal spines (PISp) which arise

on the ectal surface of the palatum are considerably few and short. The spine-like setae which arise on the ental surface of the palatum in the third and fourth instars are absent in the second as well as in the first instars.

The LABRAL BRUSHES (Figs. 5 and 9, LB) contain fewer and finer hairs than those of the advanced instars. As in the older instars, each labral brush consists of four groups of hairs. The hairs of the fourth group do not overlap with the hairs of the opposite side along the meson.

c) The APODEMES OF THE LABRAL BRUSHES are smaller in size, less sclerotized and less pigmented than those of the older instars. The elongated labral apodeme (Fig. 9, LAp) has its distal end bent meso-cephalad, similar to that of the second instar and differing from those of the third and fourth instars. The anterior, medial and posterior processes of the labral apodeme (AAp, MAp and PAp) are present, though they are short and very lightly pigmented. The protrusion which is attached to the disto-lateral end of the proximal third of the labral apodeme is very small. The oval shaped area which is attached to the disto-mesal end of the proximal third of the labral apodeme is smaller and lighter in colour than that of the second instar. The lateral labral plate (LLP) is smaller in size, less sclerotized and less pigmented than that of the second instar. The cephalic end of the labral plate is pointed, while its caudal end is rounded, as in the fourth instar. The transverse bar (TB) is shorter less sclerotized and less pigmented than that in the older instars. The two symmetrical halves of the transverse bar are connected mesad by a slightly pigmented sclerite. The lateral ends of the transverse bar are connected with the cephalic regions of the lateral labral plates on both sides, by means of the wire-like sclerites which are more slender than those of the older instars.

The EPIPHARYNX (Ep) is triangular in shape. It consists of the epipharyngeal sclerite (EpSc), the epipharyngeal hairs (EpH) and the epipharyngeal processes (EpP). The epipharyngeal sclerite is comparatively very slender. The epipharyngeal hairs are fewer, shorter and finer than those of the older instars. The three pairs of epipharyngeal processes are present, though they are very short and slender.

The MANDIBLES (Figs. 13 and 17) are small in size, slightly sclerotized and lightly pigmented. The ventral group of dentes (VDt) is composed of five teeth. The dorsal dentes (Fig. 17, DDt) are four in number, though they are very small and slender. The serrated dentes (Figs. 13 and 17, SrDt) consist of one serrated tooth only, which is relatively long and contains one row of serrations along its mesal margin. The plumose hairs (Fig. 13, PH) are five in number, while in the second instar there are six. In the third instar there are eight and in the fourth instar there are nine.

The membranous process (Figs. 13 and 17, MP) is lighter-coloured than those of the older instars. Its mesal margin is slightly cleft. The five clusters of hairs which arise from the membranous process are composed of much fewer, shorter and finer hairs than those of the older instars. The mesal margin of the mandible is sclerotized and pigmented along its entire length. The five hairs which arise from the middle of the mesal margin are short and fine. The three hairs which arise from

the mesal region of the dorsal aspect of the mandible, laterad of the cephalic end of the mesal margin are simple and not plumose.

The mandible is articulated to the head capsule by means of the preartis and the postartis (PrA and PoA), as in the older instars. The mandibular apodeme (MdAp) is comparatively short and slender. The lateral margin of the mandible is more convex than in the second instar. At its distal end, the sclerotized socket bears the lateral bristles (LBr), which are three in number. They are, however, finer, more slender and a little shorter than those of the second instar. The mandibular brush (MdB) is small. The hairs of the brush are few, short and slightly curved. They arise on a sclerite (Fig. 17, ScB) which is slender and less pigmented than those of the older instars. The triangular shaped serrated processes (Figs. 13 and 17, SrP) are small, and range from 9 to 12 in number. Each process is produced distally into a relatively long spine and a number of fine hairs which are fewer and shorter than those of the advanced instars.

The MAXILLAE (Fig. 21) are smaller in size, less pigmented and less sclerotized than those of the older instars. The convex mesal margin of the maxilla is provided with numerous hairs and spines which are comparatively few, fine and lightly coloured. The pectinate spines which arise from the caudal region of the mesal margin of the maxilla of the third and fourth instars are here absent, as well as in the second instar. The chitinous ridge (CR) is slightly sinuate, lightly pigmented. The two membranous appendages of the chitinous ridge (MACR) are present, but short and slender. The maxilla is articulated to the ventral wall of the head by means of the entoparartis and the exoparartis (Enp and Exp). The maxillary apodeme (MxAp) is slightly sclerotized and pigmented. The maxillary palpus (MxP) is small. It is provided distad with four sensoria (S), equal to those of the second instar. The palpifer (Pf) is comparatively small and lightly pigmented. The slightly convex lateral margin is provided with a few lightly pigmented microspines (MSP), which range from five to seven in number. The maxillary spine (MxSp) which arises from the cephalic region of the galea (Ga) is slender and short. The cluster of hairs which arises from the cephalic margin of the galea consists of a very few hairs.

The maxillary brush (MxB) consists of simple and pectinate hairs (PcH). The simple hairs are short, lightly coloured and range from 11 to 15 in number. The pectinate hairs are considerably shorter, fewer and lighter coloured than those in the second instar. There are three or four pectinate hairs. The spine which arises from the cephalic region of the lacinia in the third and fourth instars is absent here, as well as in the second instar.

The LABIUM is composed of the submentum, mentum, glossa and paraglossa. The submentum is much smaller than that of the second instar, and is very lightly sclerotized and pigmented.

The mentum (Fig. 25) is small and more or less membranous. The cephalic margin is slightly convex. The meso-cephalic triangular projection which occurs in the mentum of the second, third and fourth instars, is absent here.

The glossa (Fig. 29) is narrower, less sclerotized and less pigmented than in the advanced instars. The triangular-shaped projection which arises from the mesal region of the convex cephalic margin of the glossa is comparatively short and small. The cephalic margin is provided with short fringes which range from 22 to 26 branched bipectinate hairs (BPH), with 11 to 13 bipectinate hairs on each side of the mesal line. It should be noticed that each bipectinate hair contains at least three branches, while that of the second instar has not more than two branches, and those of the third and fourth instars are unbranched.

The paraglossa (Fig. 33) is smaller in size, less sclerotized and less pigmented than in the older instars. It is roughly triangular in shape. The paraglossa, here is asymmetrical, as its right half is larger in size than the left half, which is a unique case. It is composed of 18 teeth, eight teeth on the left side, nine teeth on the right side and a disto-central tooth. The lateral sclerotized areas which bear the teeth are slightly sclerotized and pigmented. The median area is also slightly pigmented. The caudal area is either fused with the median area or lacking.

The HYPOPHARYNX (Fig. 37) is comparatively small. The cephalic area of the hypopharynx is more or less membranous and roughly narrower than that of the second instar. The salivary duct (SO) opens in the meso-caudal region of the cephalic area. The ear-shaped lateral lobes (L) are comparatively small. The median area of the hypopharynx (Hyp) is small and simple. The transverse ridges and the microspines which occur in the median region of the hypopharynx of the third and fourth instars, are absent in the first instar. The hypopharyngeal processes (HypP) are very small. There is only one mesal spine (MsSp).

The paragnatha (Pgn) are smaller in size, less sclerotized and less pigmented than those of the older instars. As in the older instars, each paragnathus is divided into (a) the caudo-lateral region, (b) the intermediate region, and (c) the mesal region, besides the lateral group of spines at the extreme caudo-lateral end. The cephalic row of lateral spines (LSp) of the caudo-lateral region consists of three spines, the intermediate row consists of five small spines and the caudal row consists of numerous microspines. The caudo-lateral group of spines consists of two spines only as in the second instar. The intermediate region of the paragnathus is small, membranous and bears two pairs of movable spines (MvSp). The mesal region of the paragnathus fuses with that of the opposite side and contains one small blunt spine, similar to that of the second instar. The oval shaped area which projects between the meso-caudal regions of the paragnatha is small and contains no spines at its distal end, differing from those of the second, third and fourth instars.

### VIII. SUMMARY OF THE IMPORTANT INSTAR DIFFERENCES

Due to the great similarity in the mouth parts of the different instars, the writer thinks it is advisable to note the most pronounced differences and trace them through the first, second, third and fourth instars.

The egg burster (Fig. 38, EB) is present in the first instar only.

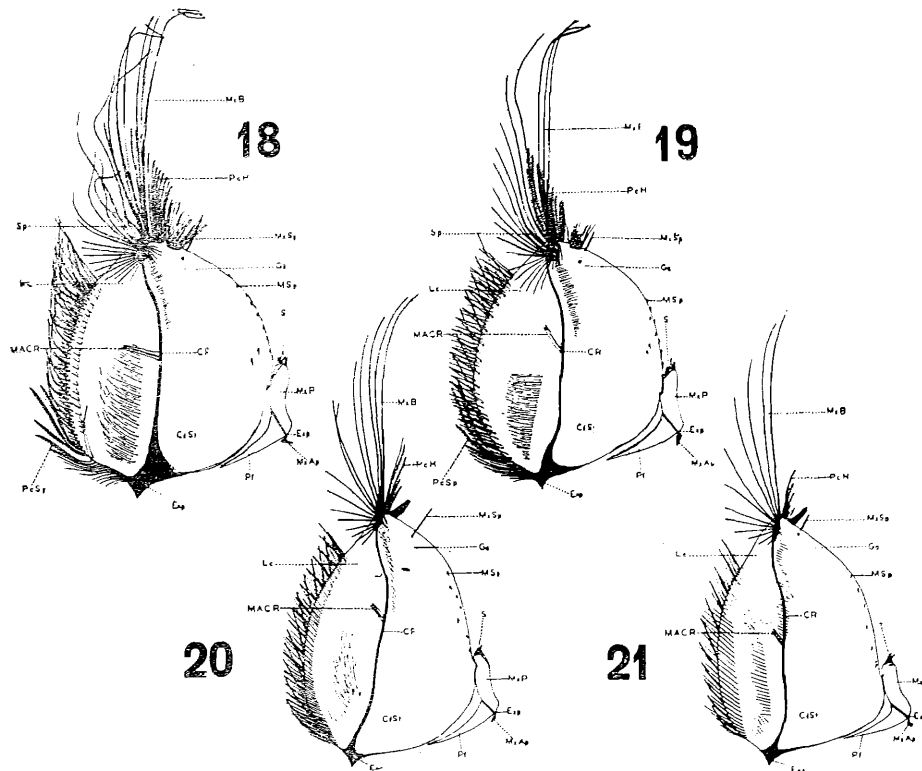
The postclypeus in the first instar is fused with the frons, forming the fronto-postclypeus (Fig. 5, FPc) due to the absence of the fronto-clypeal suture, as in the second instar. In the third and fourth instars, the postclypeus in (Figs. 2 and 3, Poc) is separated from the frons (F) by the fronto-clypeal suture

The ventral dentes in the mandible of the first instar (Figs. 13 and 17, VDt) are five in number as in the second instar. The ventral dentes in the third and fourth instars (Figs. 10 and 11, VDt) are six in number. There is only one serrated dent in the mandible of the first instar (Figs. 13 and 17, SrDt) which bears only one row of serrations. The serrated dentes of the second, third and fourth instars are composed of two serrated dentes; the longer of which bears two rows of serrations along the mesal margin. The serrated processes which arise from the cephalic margin of the mandible of the first instar (SrP) range from five to nine, while those of the second instar (Figs. 12 and 16, SrP) range from 9 to 12. The serrated processes of the mandible of the third instar (Figs. 11 and 15, SrP) range from 14 to 17, while in the fourth instar (Figs. 10 and 14, SrP) there are more than 17.

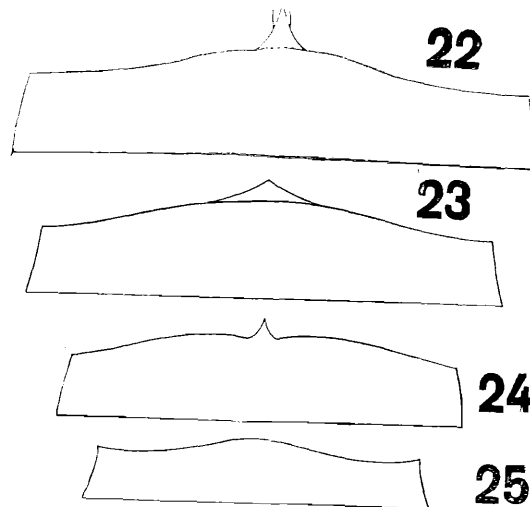
The maxillary brush of the first instar (Fig. 21, MxB) is small and consists of 11 to 15 simple hairs and a very few, short pectinate hairs. The maxillary brush of the second instar (Fig. 20, MxB) is a little longer and consists of 14 to 19 simple hairs, plus a few short pectinate hairs. The brush of the third instar (Fig. 21, MxB) is larger and consists of 19 to 23 simple hairs, in addition to the pectinate hairs which are more numerous than those of the earlier instars. The maxillary brush of the fourth instar (Fig. 18, MxB) is composed of 23 to 28 long simple hairs, plus a great number of pectinate hairs. The number of sensoria which are attached to the distal end of the maxillary palpus vary in number during the course of development. There are four sensoria in the first and second instars (Figs. 20 and 21, S). In the third instar (Fig. 19, S) there are five sensoria, while in the fourth instar there are six sensoria (Fig. 18, S). The mesal margin of the maxilla of the first instar is provided with numerous spines and setae, which increase in number and length in the second instar. After the second moult, in the third instar, a number of pectinate spines (Fig. 19, PcSp) are developed at the caudal region of the mesal margin. In the fourth instar, these pectinate spines (Fig. 18, PcSp) are longer and more pigmented.

The mentum of the first instar (Fig. 25) is a narrow plate, with a simple convex cephalic margin. The mentum of the second instar (Fig. 24) is a little larger, with its cephalic margin produced mesad into a short triangular shaped projection. In the third instar, this projection (Fig. 23) has a wider base, and in the fourth instar, it is longer, more pigmented and possesses two slender spine-like setae which arise from its lateral margin (Fig. 22).

The glossa of the first instar (Fig. 29) consists of 22 to 26 bipectinate hairs; each of these bipectinate hairs bears at least two or three branches. The glossa of the second instar (Fig. 28) consists of 34 to 44 bipectinate hairs, which also include one

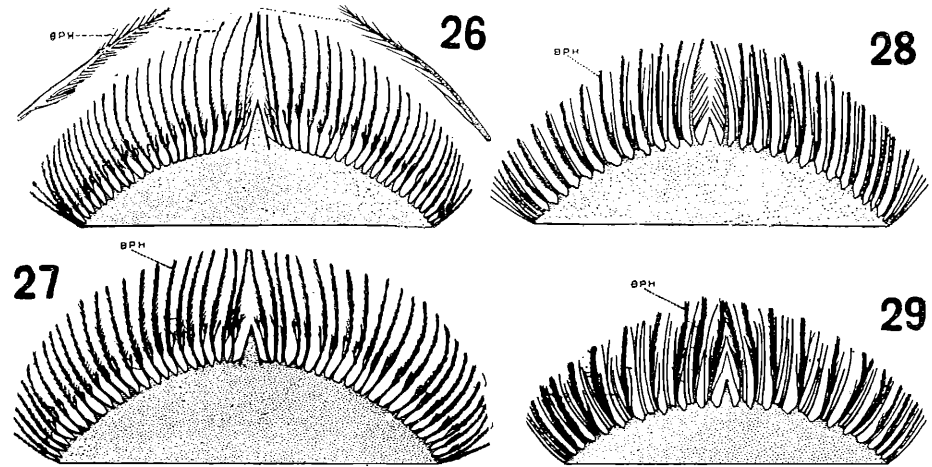


Figs. 18-21 : Ventral aspect of the left maxilla of the fourth, third, second, and first instar larva, respectively.

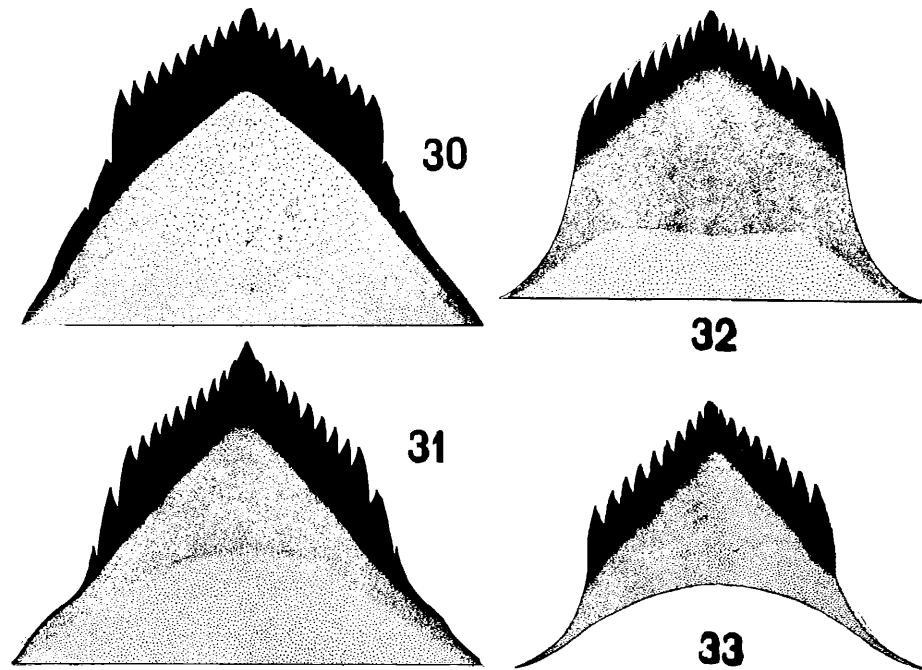


Figs. 22-25 : Ventral aspect of the mentum of the fourth, third, second, and first instar larva, respectively.

or two branches each. The fringes of the glossae of the third and fourth instars (Figs. 27 and 26) range from 48 to 52 unbranched bipectinate hairs.

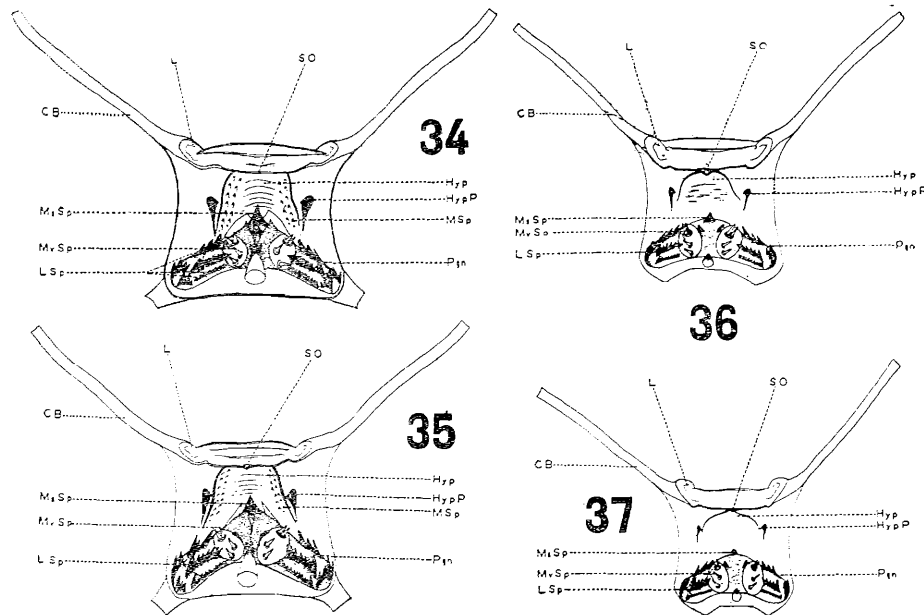


FIGS. 26-29 : Ventral aspect of the glossa of the fourth, third, second, and first instar larva respectively.



FIGS. 30-33 : Ventral aspect of the paraglossa of the fourth, third, second, and first instar larva, respectively.

The paraglossa of the first instar (Fig. 33) is asymmetrical and consists of 18 teeth, eight teeth on the left side, nine teeth on the right side and a disto-central tooth. The paraglossa of the second instar (Fig. 32) consists of 19 teeth, with nine teeth on each side of the disto-central tooth. The paraglossa of the third instar (Fig. 31) is composed of 24 teeth, 11 teeth on the left side, 12 teeth on the right side, and a disto-central tooth. The paraglossa of the fourth instar (Fig. 30) is composed of 23 large teeth, with 11 teeth on each side of the disto-central tooth.



FIGS. 34-37 : Ventral aspect of the hypopharynx of the fourth, third, second, and first instar larva, respectively.

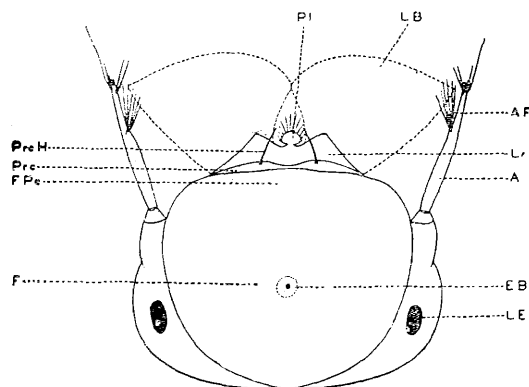


FIG. 38 : Dorsal aspect of the head of the first instar larva showing the presence of the egg burster (EB) in the middle of the frons.

The hypopharynx of the first instar larva (Fig. 37) is small. Its median region (Hyp) contains no transverse ridges or microspines. The median region of the hypopharynx of the second instar (Fig. 36, Hyp) contains very few ridges but does not contain microspines, while that of the third and fourth instars (Figs. 35 and 34, Hyp) contain both the ridges and the microspines. There are no significant differences between the paragnatha of the four instars except in the degree of sclerotization and pigmentation, and a slight irregular increase in the number of spines after each moult.

### IX. KEY TO THE LARVAL INSTARS

1. Egg burster on the dorsal side of the frons absent ..... 2
- 1 a. Egg burster on the dorsal side of the frons present (Fig. 38, EB). Head about 0.468 mm. in width. Fronto-clypeal suture absent. Postclypeus fused with frons forming fronto-postclypeus (Fig. 5, FPc). Ventral dentes of mandible five and serrated dentes one (Figs. 13 and 17, VDt and SrDt). Serrated processes of mandible five to nine (SrP). Pectinate spines at the caudo-mesal margin of maxilla absent. Sensoria of maxillary palpus four (Fig. 21, S). Mentum without meso-cephalic projection (Fig. 25). Glossa with 22 to 26 branched bipectinate hairs (Fig. 29). Bipectinate hairs with at least two branches. Paraglossa asymmetrical, slightly sclerotized and with 18 teeth (Fig. 33)..  
..... **First instar**
2. Fronto-clypeal suture and pectinate spines at the caudo-mesal margin of maxilla, present ..... 3
- 2 a. Fronto-clypeal suture and the pectinate spines at the caudo-mesal margin of maxilla, absent. Postclypeus fused with the frons forming fronto-postclypeus (Fig. 4, FPc). Head about 0.536 mm. in width. Ventral dentes of mandible five and serrated dentes two (Figs. 12 and 16, VDt and SrDt). Serrated processes of mandible, from 9 to 12 (SrP). Simple hairs of maxillary brush from 14 to 19 (Fig. 20, MxB). Sensoria of maxillary palpus, four (S). Mentum with a small meso-cephalic projection (Fig. 24). Glossa with 34 to 44 branched bipectinate hairs (Fig. 28). Bipectinate hair with not more than two branches. Paraglossa symmetrical, sclerotized, and with 19 teeth ..... **Second instar**
3. Head about 1.071 mm. in width. Postclypeus not fused with frons. Ventral dentes of mandible six (Figs. 11 and 15, VDt). Plumose hairs of mandible eight (Fig. 11, PH). Mandible with 13 to 17 serrated processes (Figs. 11 and 15, SrP). Simple hairs of maxillary brush from 19 to 23 (Fig. 19, MxB). Sensoria of maxillary palpus five (S). Mentum with a wide-based meso-cephalic projection (Fig. 23). Glossa with 48 to 52 unbranched bipectinate hairs (Fig. 27). Paraglossa sclerotized, pigmented and with 24 teeth (Fig. 31)  
..... **Third instar**

- 3 a. Head about 1.105 mm. in width. Mandible with nine plumose hairs (Fig. 10 PH). Mandible with more than 17 serrated processes (Figs. 10 and 14, SrP). Maxillary brush with 23 to 28 simple hairs (Fig. 18, MxB). Sensoria of maxillary palpus six (S). Meso-cephalic projection of mentum, with two lateral spine-like setae (Fig. 22). Paraglossa quadrangular in shape, heavily sclerotized, heavily pigmented with 23 large teeth . . . . . **Fourth instar**

## X. ACKNOWLEDGMENTS

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