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THE MOUTH PARTS OF THE FIREBRAT, *THERMOBIA DOMESTICA* (PACKARD), (THYSANURA).

ROBERTA O'HARRA AND J. ALFRED ADAMS

The purpose of this paper is to present detailed drawings of the external form of the mouth parts of the adult firebrat, as a representative lepismatid. That the Lepismatidae, or silverfish insects, are of great significance in insect morphology, is well known to students of the subject. In certain respects they are the principle morphological link between the Apterygota and the Pterygota. While any of the widely distributed, domestic species of *Lepisma* or *Ctenolepisma* might well be used for morphological study, the firebrat, *Thermobia domestica*, is the species which seems to us the most likely to be practical for use in experimental biology, largely because it is thermophilic and can be reared comparatively quickly at high constant temperatures (Adams, 1933, 1936; Sweetman, 1938). This insect has been used successfully in a series of toxicological studies carried on at Iowa State College: one of the more recent of these is an investigation of the toxicity of barium compounds (Richardson and Seiferle, 1941). The morphology of this insect, including the structure of its mouth parts, is likely to be of interest to a considerable variety of workers.

No detailed drawings of the mouth parts of the firebrat are known to us. Spencer (1924), at the University of Illinois, filed a thesis containing detailed drawings of this insect, but his work has remained unpublished.

Materials and Methods

The specimens used were reared in a culture which has been maintained continuously since 1931 without the introduction of new stock. The present rearing chamber is similar to the thermal gradient box elsewhere described (Adams, 1937). Whole specimens were studied alive, etherized, and in balsam mounts. Detached parts were fixed and mounted, usually by the use of acetic acid and clove oil as described by Britten (1930). Some specimens were briefly boiled in caustic and others were fixed in Bouin's fluid and sectioned. Owing to the fragile nature of the material it was usually necessary to make composite drawings from several specimens. Because of their larger size, females were studied most; but sex differences in the mouth parts, if constant, appear to be

very slight. As an aid in the preliminary study a clay model of the head was made.

Features which are entirely evident from the drawings or have already been adequately described by Escherich (1905) or others, may not be discussed. The terminology is mostly that of Snodgrass (1935).

General Features of the Head

In the full-grown firebrat the breadth of the head including the eyes (about 1.6 mm.) is roughly twice as great as the length (about 0.8 mm.). In the living animal, the broad, and almost straight, posterior margin of the head is closely applied to the thorax. The vertex, which is weakly convex transversely, is strongly convex longitudinally and has a rather abruptly curved occipital rim which overhangs the cervical membrane (Figs. 8A-D).

Projecting forward over the occiput, and further protecting the cervical membrane, is a row of strong setal bristles on the anterior margin of the first thoracic tergite. The occiput is clothed with flat scales which extend forward in the form of a triangle, with the apex well behind the epistomal suture. These scales are anteriorly directed and vary in color so as to form a pattern harmonizing with that on the thorax. Perhaps the most striking feature of the head, as seen dorsally, is the presence of strongly developed systems of setal bristles around the eyes, on the discal and frontal regions of the vertex, and on the right and left thirds of the clypeus. These bristles, which usually have a pinkish tinge, have to be removed before examination of the head sutures is possible. The convex surface of the body of the mandible can then be seen from above, just ventral to the triangular antennal sclerites (Fig. 1).

The ventral, or oral, surface of the head is well provided with setal bristles on the labrum, mandibles, and labium. The difficulty of ventral examination is caused mainly by the dense whiteness of the inner tissues and the colorless, semi-transparent condition of the cuticula. The face is structurally dominated by the large mandibles, whose dark and heavily sclerotized tips are visible through the transparent labrum. In Fig. 2 the mouth parts are represented as slightly retracted from the pre-oral cavity in order to reveal the tip of the hypopharynx. When the pre-oral cavity is closed, the space between the lower margin of the labrum and ligulae is

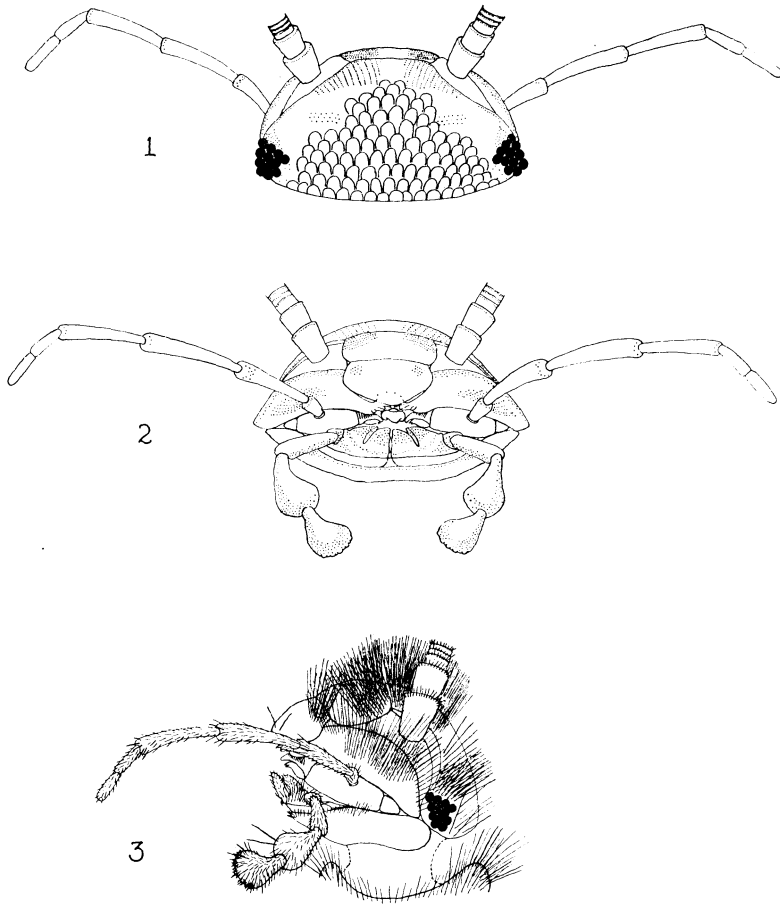


Plate One

Fig. 1. Dorsal view of the head of the firebrat. The dots represent the sockets of setal bristles. Only the basal segments of the antennae are shown. Scales of antennae omitted.

Fig. 2. Ventral view of the head. Setal sockets shown by dots.

Fig. 3. Left lateral view of the head, with setal bristles, extended cervical membrane, and the anterior margin of the prothorax, included. Scales of the vertex omitted.

Plate Two

- Fig. 4. Clypeus and labrum of firebrat, exterior or anterior view. Setal sockets shown; most of the setae omitted.
- Fig. 5. Right mandible, external, or anterior, surface view. Setal sockets shown; most of the setae omitted.
- Fig. 6. Left maxilla, internal view; with setae. The ventral edge is turned uppermost in the drawing.
- Fig. 7. Labrum, anterior view. Setae shown only on left side of the drawing. Infolded membranes shown on left by dotted lines. Postmental scales omitted.

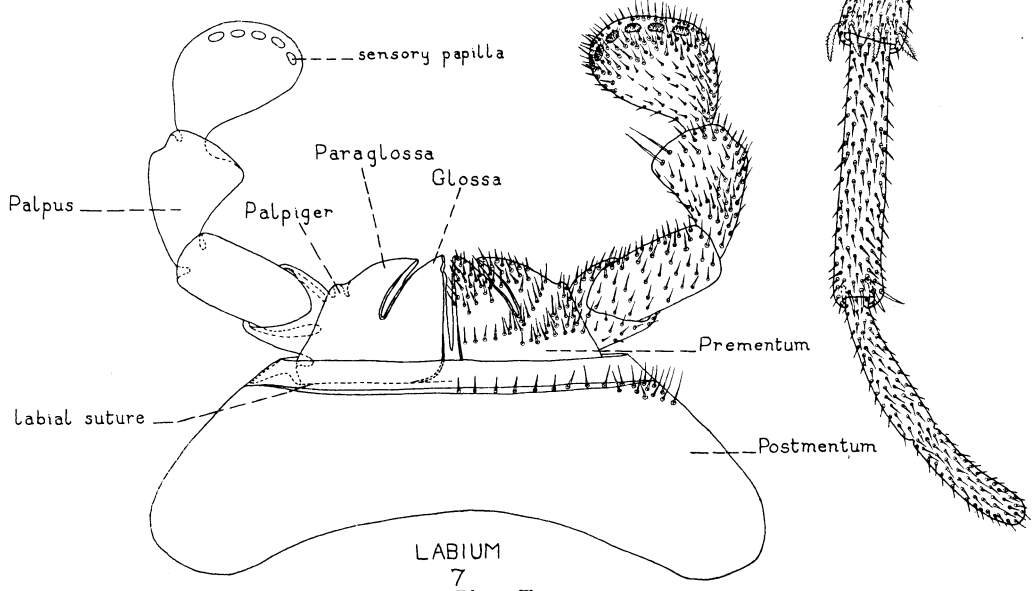
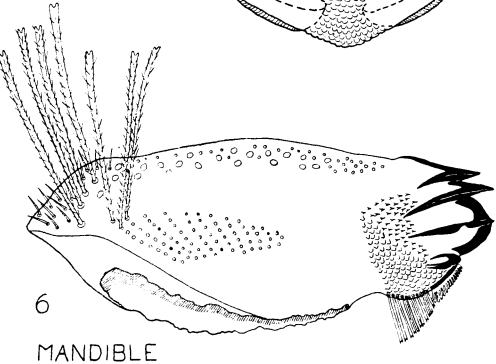
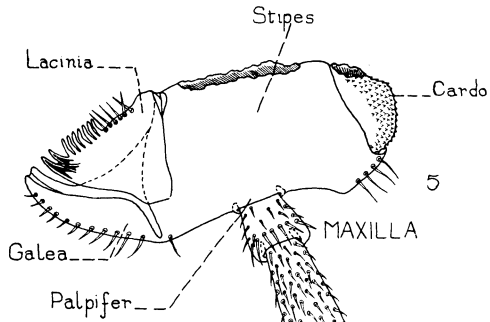
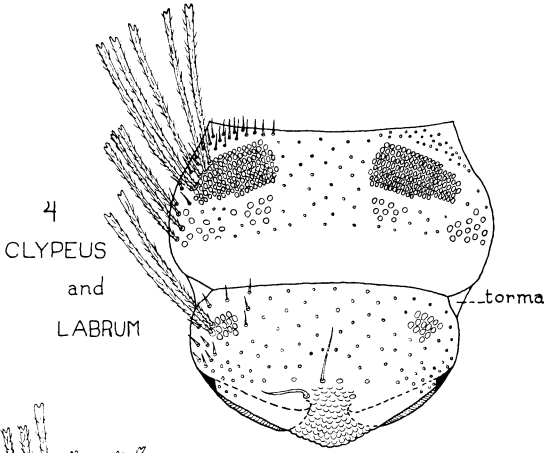


Plate Two

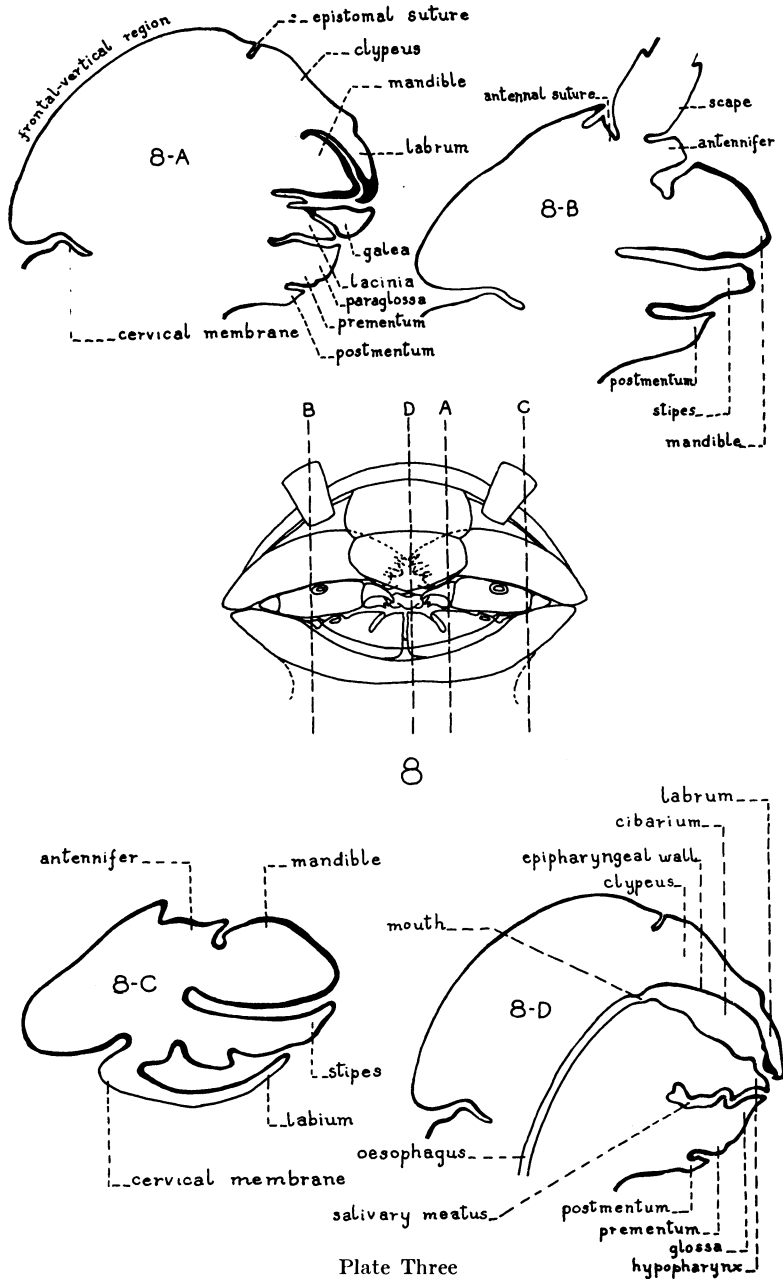


Plate Three

Fig. 8. Diagram of the ventral view of the head of the firebrat to show the planes of sagittal sections, 8a-D. The bases of the palps are shown as ovals.

Figs. 8a-D. Sagittal sections made along planes marked by vertical lines on the central figure. Only the cuticular layer is shown.

completely filled by the galeae. The dark tips of the laciniae are visible through the semi-transparent galeae.

The ventro-posterior wall of the head is formed by the large, simple, weakly sclerotized postmentum.

The Labrum

Figs. 2 and 4 show the anterior view of the labrum with its setal bristles or their sockets. The central area above the tip is roughened by what appears to be a row of scale-like cuticular processes. A pair of membranous pockets, which project below the latero-ventral margins, appear to be produced by invagination of the epipharyngeal wall. When the pre-oral opening is closed, the medio-ventral edges of the mandibles fit into these pockets. This relationship is shown in Figs. 8 and 8A. The lateral corners of the pockets are distinctly brownish and are evidently slightly sclerotized.

The Mandibles

The mandibles of *Lepismatidae* are discussed in considerable detail by Escherich (1905, p.13), and their homologies are discussed by Snodgrass (1935, p. 133). Fig. 6 shows the exterior aspect of the right mandible as it appears when the mandible is removed and slightly rotated so that the ventral articulation is brought into view. Fig. 8 shows the arched form of the mandible and its relation to the epipharyngeal pockets of the labrum. The sagittal sections (Fig. 8 A, B, and C) show the sectional form of the mandible. As in other *Lepismatinae*, the upper two of the heavy, dark, medial teeth are sharply pointed and those located more ventrally are blunt. Ventral to the latter the medial edge bears a comb-like row of short, curved, cuticular processes, which are progressively longer ventrally. On the arched, medio-ventral edge are located about ten cleft, setal bristles, also graded in length. Just lateral to the teeth, on the anterior face of the mandible, is an area in which the surface is roughened by minute cuticular, spine-like and scale-like processes. Running the length of the dorsal surface are long, cleft, feathered setal bristles interspersed with small, naked, pointed setae. On the disc of the mandible is a homogeneous group of setal bristles arranged in diagonal rows.

The Maxillae

The cardo, which Escherich (1905) appropriately called the pivot, is roughened on its projecting, rounded surface with minute, cuticular spines. The stipes bears only a few setal bristles on the dorsal edge continuous with those of the galea. Its form in section may be seen in Figs. 8 A, B, and C. The palpus in full-grown individuals consists of six visible regions, the last two of which are separated by a constriction about the middle of the fifth segment. The palpus is remarkable for the variety of its setal bristles. The entire surface is clothed with small, naked setae, and the first and fourth are crowned by large bristles of the same simple, pointed type. At the distal end of the third segment there stand a few feathered, pointed, setal bristles. From the second segment extend several enormous bristles which are both cleft at the tip and feathered. The galea acts as a hood, arching over the lacinia and completely covering it from view when the pre-oral cavity is closed (Fig. 8A). The medial processes of the lacinia are strikingly analogous to those of the mandible, there being sharp sclerotized teeth dorsally, followed ventrally by a cuticular comb and a row of setae.

The Labium

The postlabium consists of a broad postmentum which is contiguous at its lateral edges to the cervical membrane and the occiput, as is shown in an extreme lateral section of the head (Fig. 8C). The surface is covered with delicate colorless scales. The suture between the postmentum and the prementum is invaginated; that is, the prementum is telescoped into the anterior border of the postmentum (Figs. 8A and D). On the ventral surface of the postmentum parallel to the enclosed suture is a strong transverse fold bearing a row of setal bristles, those near the midline being weak, those toward the sides progressively stronger.

The prelabium is plainly a paired structure. The prementum consists of right and left halves which give evidence of their evolutionary origin by being distinct sclerites joined only near their bases by a membrane. Small setae occur on the distal parts of each glossa and paraglossa. Two curved rows of bristles are characteristically visible in the living animal; one of these extends from the lateral margin at the base of the paraglossa to the base of the cleft between the glossae; the other, lying lateral and par-

allel to this row, extends from the palpiger region and forms the median side of a group of small setae.

The palpus consists of three distal lobes and a short scoop-shaped proximal lobe, the homology of which is not clear. Escherich (1905) regarded the labial palpus as including all four segments. Spencer (1924) regarded the shallow basal segment as a palpiger. The cylindrical second segment is deeply telescoped into this proximal segment (Fig. 7, left side). When the palpus is forcibly pulled from the prementum this proximal segment remains adherent to the palpus, which fact to us supports the view that it is part of the palpus; if this is the case, the slightly lobed side of the main body of the prementum may be termed the palpiger region. (See dotted lines in Fig. 7). Opposed to this view is the fact that the labial palpi of *Machilis* are clearly only three-jointed (Snodgrass, 1935, p. 149), there being an insertion of the palpus into a lobe of the prementum which might be homologous to the insertion of the second segment into the proximal segment in *Thermobia*.

The sub-terminal segment of the palpus always bears on its medial, arched surface two prominent setae. On the ventral edge of the rounded tip of the clavate, terminal segment are five so-called sensory papillae, which lie in a row and are covered with numerous minute setae. The papillae were noticed by Womersley (1928).

The form of the hypopharynx, which is fairly large but very weakly sclerotized, was not worked out completely. The organ is slightly tri-lobed, the lateral members being regarded as superlinguae, and it projects upon a muscular stem. The hypopharynx, like the other mouth parts, cannot be fully understood without a study of the musculature and other internal features of the head.

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