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SENSE ORGANS ON THE LABRA OF SOME BLOOD-FEEDING DIPTERA

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The labra of 8 species of Diptera of which one or both sexes feed on blood were studied. All species have sensilla in the food channel of the labrum. In addition *Hybomitra* and *Chrysops* have 2 patches of basicone sensilla at the tip of the labrum at the sides of the entrance to the food channel. These sensilla are innervated by single neurons. A similar innervation is found in setiform sensilla while the basicone sensilla in the food channel of *Hybomitra* are associated with larger masses of nervous tissue, suggesting innervation by more than one neuron. Other sensilla found were of the campaniform type and in *Stomoxys* of a specialized structure which is described. In species where both sexes were studied the sensillum supply of males and females was identical, but in some males which do not feed on blood other minor differences from the females were noted.

Little is known about the sensory supply of the labra of blood-feeding Diptera. Jobling (1932) described setiform sensilla on the labrum of *Glossina palpalis* Rob.-Desv., but his drawings indicate sensilla with a structure different from those I have observed. Scudder (1953) described basicone and setiform sensilla on the labrum of (♀) *Tabanus quinquevittatus* Wiedmann. Interest in the morphology of the sensory supply of labra was stimulated by the discovery that females of most mosquito species have sense organs on the labrum that are not present in the male. This difference is related to the habit of blood-feeding exhibited only by female mosquitoes (von Gernet and Buerger, 1966). This paper describes the labra of various species of Diptera of which one or both sexes feed on blood.

METHODS

The following species were studied:

Ceratopogonidae

Culicoides variipennis Coquillett

Simuliidae

Simulium venustum Say

Simulium vittatum Zetterstedt

Tabanidae

Hybomitra rupestris McDunnough, females only

Chrysops nigripes Zetterstedt, females only

Muscidae

- Glossina morsitans* Westw.
Haematobia irritans L.
Stomoxys calcitrans L.

Males and females were always treated separately. Between 30 and 70 specimens of each species were examined. The sensilla were located on whole mounts of the labra. According to size whole specimens or heads only were treated with 5% KOH in a 100 C water bath for 15 to 30 minutes. The labra were then removed, washed, dehydrated and mounted in Canada balsam or DePeX. They were examined through a phase contrast microscope.

When sufficient live material was available the nerve supply of the labra was studied after vital staining with methylene blue. Various methods were attempted, none of which gave consistently reliable results. After staining, the labra were washed, dehydrated, and mounted in DePeX. The fine structure of the sensilla was studied in sectioned specimens. The mouthparts were fixed in Masson's fluid, dehydrated via n-butanol and embedded in paraplast. They were cross sectioned at 3, 5, 4, or 6 μ , stained with Mallory's and mounted in DePeX.

RESULTS

Ceratopogonidae*Culicoides variipennis*

The labrum of *C. variipennis* (fig. 8) has a mean length of only 0.25mm. There are 4 sensilla in the food channel a short distance from the tip. Their diameter at the base is 2.5 μ . Because of their small size no structural details could be distinguished. No differences between labra of males and females could be found.

Simuliidae*Simulium venustum* and *S. vittatum*

The labrum of *S. venustum* is a very fleshy stylet. A cross section is shown in fig. 10. Sensilla are found on the ventral side at three locations. There are 4 sensilla close to the tip arranged in a quadrangle (fig. 9). They consist of 2 basicones distally and 2 campaniform sensilla proximally. On the ventral side of the labrum there is a heavily sclerotized trough which runs along the mid-line of the labrum. Halfway between its tip and its basal end there are two very large basiconic sensilla. They arise from membranous sockets and are sunk in shallow depressions. They are opposite one another and are mostly found on the lateral walls, but sometimes on the dorsal wall of the trough. On either side of the ventro-lateral margins of the labrum there is a row of setiform sensilla. They are more closely spaced towards the basal end. Their total number is around 35.

Males and females have the same supply of sensilla. The labra of males and females differ slightly in the structure of the extreme tip. The female has a lobed, heavily sclerotized tooth-like projection on either side of the tip. These projections are reduced in the male. Instead there are more bristles at the tip than in the female.

S. vittatum differs from *S. venustum* only in minute details of the structure of the tip.

Tabanidae

Hybomitra rupestris

The labrum of a female *H. rupestris* (fig. 6) possesses sensilla at the extreme tip of the labrum and in the food channel. In the lumen of the labrum there are two canals (fig. 12) which contain the nerve supply of these sensilla.

The sensilla at the very tip of the labrum are found in two patches, one on either side of the entrance to the food channel. They are basicone sensilla with heavily sclerotized pegs. They are hollow, innervated and their individual dendrites soon combine to one common trunk on either side of the food channel. Groups of neurons which innervate these sensilla are found in the canals on either side a short distance from the tip. In one specimen, nine neurons could be distinguished, their distance from the sensilla on the tip ranged from 0.128 mm. to 0.212 mm. There were 12 basicone sensilla on the tip of that side, but probably not all neurons were stained enough to be visible. Between the two patches of sensilla on the tip there is a number of small teeth. Scudder (1953) who investigated the female *T. quinquevittatus* did not recognize sensilla at the tip although his drawing of a whole labrum closely resembles a labrum of *Hybomitra rupestris*.

The food channel, which has a minute entrance at the tip, quickly widens out and then runs as a trough of nearly constant diameter towards the basal end. Over the distance where the food channel widens out there are normally four sensilla, a basicone sensillum on either side distally followed by a setiform sensillum proximally. All four sensilla point towards the tip of the labrum. The basicone sensillum has a well sclerotized peg. The setiform sensillum is an extremely strong bristle on a membranous base. In some specimens treated with KOH the scolopoid sheath of the dendrite was visible. The average number of sensilla in the food channel was 67 in 36 specimens but the number varied from 45 to 102. Where the food channel had expanded fully the average sequence of sensilla from tip to base was as follows: 3 setiform sensilla, 1 basicone sensillum with a small and only slightly sclerotized peg, (figure 11), 4 setiform sensilla, 1 basicone sensillum with well sclerotized peg, 22 setiform sensilla. All these sensilla point towards the lumen of the food channel. The space between the individual sensilla increases towards the basal end of the labrum. The setiform sensilla are small hairs arising from membranous sockets. They appear to be innervated by one neuron only, the body of which is found a short distance from the sensillum towards the basal end of the labrum, similar to the innervation found in *Glossina morsitans*. In cross sections showing sensilla the appropriate neurons are therefore not visible. The basicone sensillum with slightly sclerotized peg arises from a membranous socket about three times the diameter of the base of the peg. The nerve supplies of both types of basicone sensillum in the food channel are similar. The strand of nervous tissue leaving a basicone sensillum is much thicker than the single dendrite innervating a setiform sensillum. Vital methylene blue staining

revealed that the mass of nervous tissue associated with a basicone sensillum is larger than for a setiform sensillum. It is possible that a basicone sensillum is innervated by several neurons. Scudder (1953) working with *T. quinquevittatus* described the number of neurons innervating a basicone sensillum in the labrum as four. However, he drew his conclusions from cross sections of the labrum. Therefore it is doubtful that the neurons he observed are in fact, those innervating the sensillum seen in the same section.

In the epipharyngeal region between the base of the labrum and the cibarium there are sensilla arranged in three patches, a median patch consisting in most individuals of 6 basicone sensilla and 16 setiform sensilla and two lateral patches consisting of about 17 setiform sensilla each. The cibarium itself has only 4 basicone sensilla on its posterior end.

Chrysops nigripes

The labrum of a female *C. nigripes* closely resembles the labrum of a female *Hybomitra rupestris*. There are similar patches of basicone sensilla at the entrance of the food channel. The average number of sensilla in the food channel was 24 in 9 specimens but varied from 20 to 29. Where the food channel widens out there is on either side a basicone sensillum followed by a setiform sensillum. The rest of the sensilla include as in *H. rupestris* one pair of basicone sensilla with normal peg, one pair of basicone sensilla with small and only slightly sclerotized peg and a varying number of setiform sensilla. The sensilla of *C. nigripes* are wider spaced than those of *Hybomitra rupestris*. There are groups of sensilla in the membranous region between labrum and cibarium and normally four basicone sensilla on the posterior part of the labrum.

Muscidae

Glossina morsitans

The labrum of *G. morsitans* is a thin stylet with an average length of 2.64 mm. It is nearly round in cross section close to the distal end and assumes a crescent shaped form towards the basal end. It has canals, one on either side, through which run the labral nerves. The food channel is supplied with numerous sensilla. They are arranged in two rows and are more numerous towards the basal end of the labrum. All sensilla are directed slightly towards the tip of the labrum. The most distal sensilla are located about 0.32 mm. from the tip. Where a sensillum is present the cuticle around it is thickened. The swelling extends into the labral canal. This observation differs from Jobling's (1932) account of *G. palpalis*. I examined the labrum of *G. palpalis* and found it very similar to that of *G. morsitans*. Nearly all sensilla are of the setiform type. They are small hairs arising from wide membranous sockets. Each sensillum is supplied by a nerve cell process the body of which is found a short distance towards the basal end of the labrum (fig. 14). Only two sensilla have a different structure; the third pair from the tip, at an average distance from it of 1.74 mm. A sensillum of this type is larger than a setiform sensillum. It consists of a round membrane without any projection.

In surface view it looks like a campaniform sensillum. A strand of nervous tissue is visible in the socket. I was unable to determine the exact relationship between this strand and the membrane of the sensillum. The axons of all nerve cells combine to form the labral nerves. The labra of males and females seem identical.

Haematobia irritans

The labrum of *H. irritans* is a thin stylet with an average length of 0.84 mm. The tip and cross sections at various levels are shown in figs. 1 to 5. The entrance to the food channel lies at A (fig. 1). From A to B, the food channel assumes the form of a trough which is ventrally closed by the hypopharynx. From B to D the food channel is almost divided into two parts by lateral evaginations. Passage of the food from the ventral to the dorsal part is possible. The dorsal part is richly supplied with sensilla, there are none in the ventral part. The dorsal portion contains an average of 15 sensilla. Among them are normally two sensilla which consist of a membranous area with a diameter of 4.3 microns. There are no projections from this area. This type of sensillum is innervated by a thick strand of nervous tissue. In surface view it has a slightly darker spot in the center which is probably the nerve supply. It looks like a campaniform sensillum, similar to the one described in *G. morsitans*. All other sensilla belong to the setiform type. These include the other 13 sensilla between B and D (fig. 1) and an average of 19 sensilla which line the food channel in two rows between D and the basal end of the labrum. They differ from those of *G. morsitans* in that they arise from small elevations, the thickening of the cuticle around a sensillum extends here into the food channel. Their innervation is slightly different, the dendrite is relatively long and the nerve cell body lies within the labral nerve. The setiform sensilla are extremely small, the membranous socket from which the hair arises has a diameter of only 2.9 microns.

I was unable to find any differences between the labra of males and females.

Stomoxys calcitrans

The labrum of *S. calcitrans* is a long, thin stylet with an average length of 1.75 mm (fig. 7). About 0.102 mm from the tip the entrance to the food channel is guarded by a ridge with sensilla (fig. 7). The number of these sensilla varied from two to five in 12 specimens but was usually four. Their structure is shown in fig. 13. A sensillum of this type is set in heavy cuticle which projects towards the lumen of the labrum. A strand of nervous tissue extends into the sensillum and ends in a thickening which is surrounded by a dome-shaped area of thin cuticle. Posterior to the ridge, sensilla are arranged in two rows for the whole length of the food channel. The nerve supply to these sensilla runs in one hollow canal on either side of the food channel. A cross section through the labrum halfway between tip and base closely resembles one of the labrum of *Haematobia irritans* at the same level (fig. 5). Most of the sensilla found basal to the ridge are of the setiform type. Close to the ridge there are 2 campaniform sensilla on either side of the food channel. In one

specimen the more distal campaniform sensilla were replaced by small basicones.

The labra of males and females seem identical.

DISCUSSION

On the labra examined setiform sensilla were the most numerous, followed by basiconic sensilla. There were never more than two pairs of other sensilla, usually of the campaniform type.

None of the species in which the labra of both sexes were examined showed the difference in sensilla between them which was consistently found in mosquitoes. However, other minor structural differences between the labra of the two sexes were found in some species of which only the female feeds on blood, but in no species of which both sexes show this feeding habit.

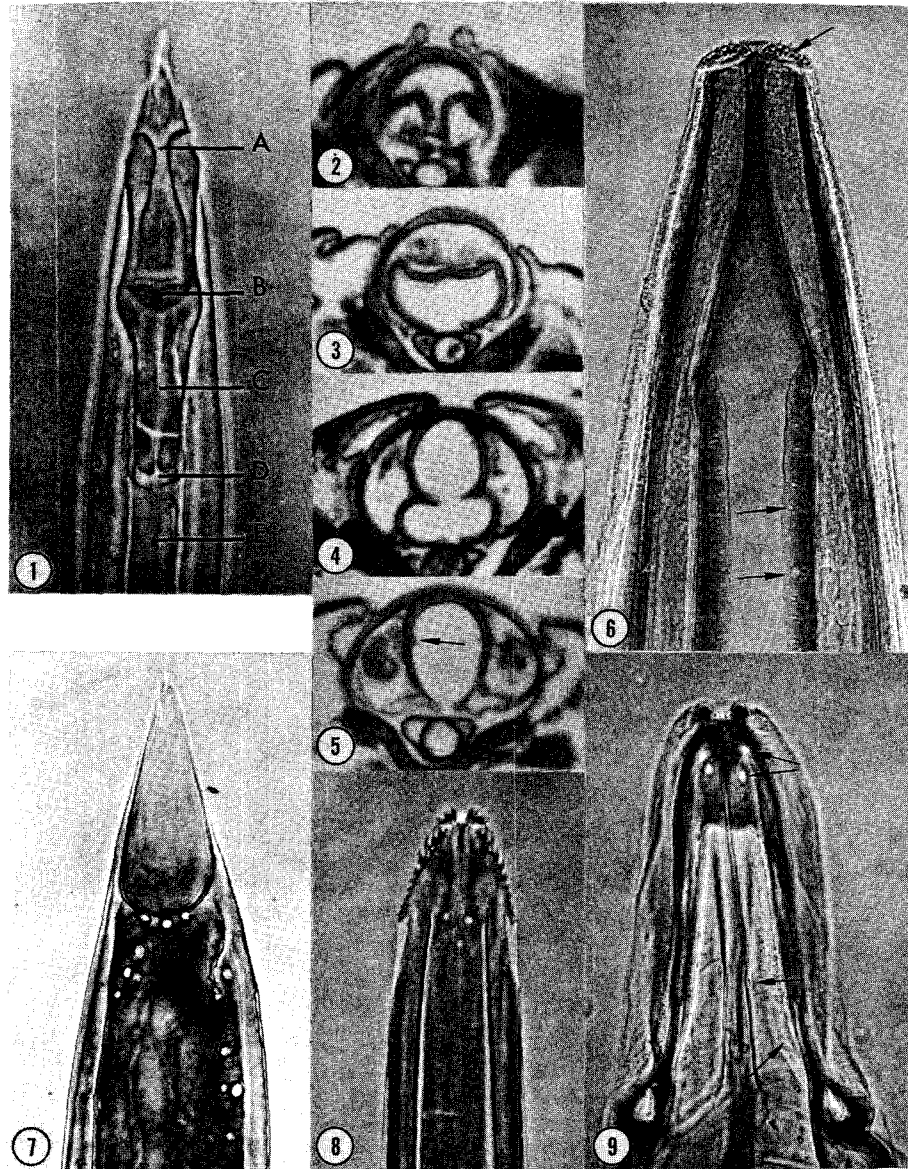
It may be suggested that the blood feeding habit is more firmly established as a female characteristic in the mosquitoes than in other groups of blood-sucking flies.

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Figs. 1-5. Labrum of *Haematobia irritans*, 1 whole mount x 400. Figs. 2-5 cross sections at levels A, B, C and E, x 600. For D see text p. 287, arrow indicates sensillum. Fig. 6. Labrum of *Hybomitra rupestris*, x 140. Arrows indicate sensilla at tip and in food channel. Fig. 7. Labrum of *Stomoxys calcitrans*, x 330. White dots are sensilla. Fig. 8. Labrum of *Culioides variipennis*, x 370. White dots are sensilla. Fig. 9. Labrum of *Simulium venustum*, x 260. Arrows indicate sensilla.

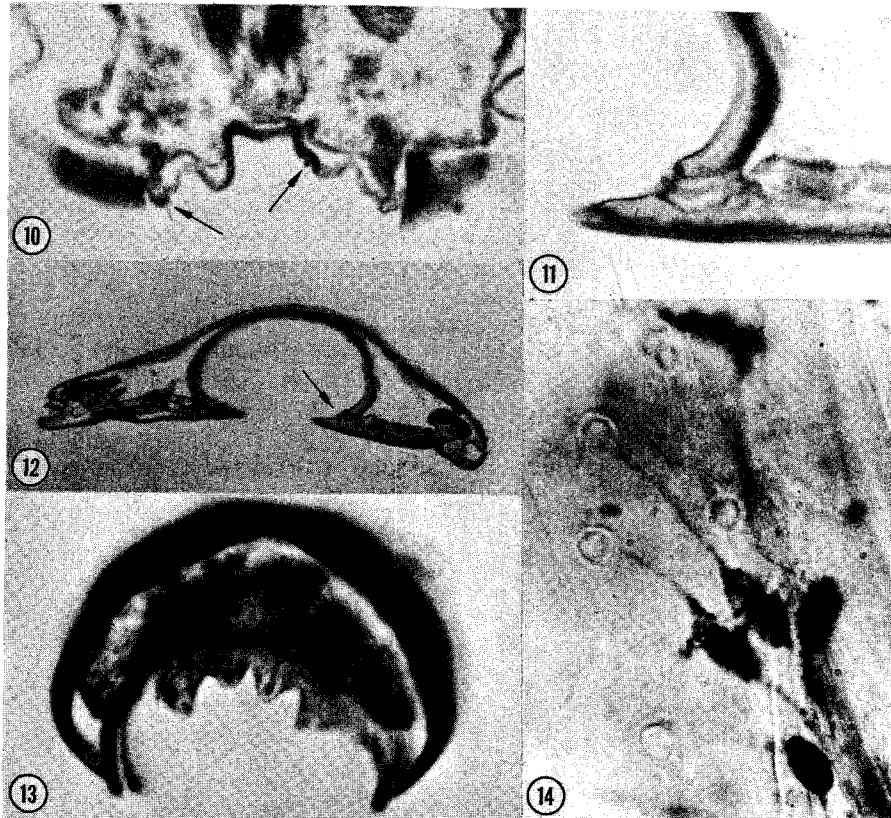


Fig. 10. *Simulium venustum*, cross section of labrum, x 600. Arrows indicate sensilla. Figs. 11 and 12. *Hybomitra rupestris*, cross section of labrum. Fig. 11. (x 740) shows the basicone sensillum with only slightly sclerotized peg indicated by an arrow in Fig. 12 (x 240). Fig. 13. *Stomoxys calcitrans*, cross section through ridge close to tip of labrum, x 1060. Fig. 14. Nerve supply of setiform sensilla in *Glossina morsitans* x 930.