ON THE STRUCTURE OF "HALLER'S ORGAN" IN THE IXODOIDEA.

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(Plate XVIII and one Text Figure.)

In the year 1881, G. Haller published a description of the sensory organ of ticks which has since borne his name; he was apparently so much impressed by its remarkable similarity in structure to the auditory organs of many Crustacea, that he assumed it to be an organ of hearing, and even went so far as to describe the presence of otoliths within one of the cavities of the organ. Since that time, other zoologists appear to have given little attention to this structure, the majority of those who have had occasion to mention it, contenting themselves with a brief resumé of Haller's observations and a reference to his paper.

The first to question the accuracy of Haller's interpretation of the function of the organ, was Lahille (1905), who published the results of numerous experiments made on living specimens of the South American Cattle-tick, *Boophilus annulatus* var. *microplus*. The conclusion which he drew from his observations was, that the function of Haller's organ is olfactory and not auditory. Lahille's observations concern only the function of the organ; he gives no anatomical description. Batelli (1891) calls attention to the fact that ticks frequently move their first pair of legs (bearing Haller's organ) in the manner of the antennae of insects, and suggests that the organs serve as a means of perceiving, at a distance, the presence of the host-animals which are so indispensable to their existence. He also points out the remarkable resemblance of Haller's organ to the sensory organs described by F. Dahl (1885), occurring in *Pachygnatha listeri*, but, after an examination of Dahl's description and figures, we think that the points of resemblance are somewhat remote. Other observers have alluded to the antenna-like movements of the first pair of legs in ticks (vide Wheler (1899, 1900), Hunter and Hooker

(1907), and Hooker (1908)). Regarding the structure of the organ, Lewis (1892) in a few cursory remarks on the subject, adds nothing to the information to be obtained from Haller's account. Martin (1895, p. 273, see Plate XIV, fig. 8) observed three vesicles on leg 1, in *Amblyomma quantini*: the median vesicle was described as spherical in shape and contained a small compact mass—apparently an otolith; the other two vesicles contained hairs only. Dönitz (1907) summarises, in three paragraphs, our knowledge of the structure and function of Haller's organ, up to that time.

In the course of our work on the Ixodoidea, we have investigated the anatomical structure of the organ in every genus, and we have come to the conclusion that Haller's description is erroneous in many respects, hence the present communication.

Throughout the entire super-family, the principal features of the structure of Haller's organ are sufficiently constant, that, for present purposes, a description of the organ as exhibited in *Haemaphysalis punctata*, after making due allowance for generic and specific differences in details, will suffice as a guide to all.

Haller's organ is a minute cavity or vesicle (diameter about 65 μ) containing sensory hairs and associated with specially modified hypodermal tissues which lie immediately beneath it. It is borne on the dorsal surface of the terminal article (tarsus) of the first pair of legs; Haller's statement that it is borne "auf der Bauchfläche der Extremität" is incorrect. It bulges down into the interior of the leg, its surface being flush with the surrounding parts, and is formed entirely of chitin which is continuous with the chitinous cuticle of the leg. The superficial part or roof of the vesicle is formed of thin transparent chitin, through which a minute slit-like pore opens (Fig. 1, p. 240), establishing communication between the interior of the vesicle and the external air[1]. In lateral view (Plate XVIII), as usually seen in mounted specimens of the tarsus,

[1] Knowing well the difficulty of correctly interpreting the real nature of minute structures formed of highly refractive chitin, especially in the case of a minute and thin-lipped pore, we have succeeded in demonstrating the patency of this opening in a fairly convincing manner. A leg of the first pair was snipped off a living tick, with scissors, and immersed in a syrupy solution of Canada balsam on a cover-glass: this was inverted over a small glass chamber mounted on a glass slip, in the manner of a hanging-drop preparation. A small lateral tube opening into the chamber made it possible to connect the apparatus with an air-pump, the excess of balsam on the cover-glass forming an efficient luting to form an air-tight fitting. The apparatus was placed on the stage of the microscope, and after sharply focussing the pore of Haller's organ, the air was slowly exhausted. In every case, immediately exhaustion commenced, a bubble of air was seen to exude from the pore.

the cavity of the vesicle is seen to be divided by folds or thickenings of its chitinous lining, into two chambers—a smaller superficial chamber from which the above-mentioned pore opens to the exterior, and a larger chamber, the floor of which, on the side towards the proximal end of the tarsus, is raised into a number of shallow conical papillae (Plate XVIII, Fig. 1), each of which bears a sensory hair. The sensory hairs are straight and stiff and protrude across the cavity of the larger chamber, their points being directed towards the irregular and indefinite opening between the two chambers. The sensory hairs are 20—25μ in length

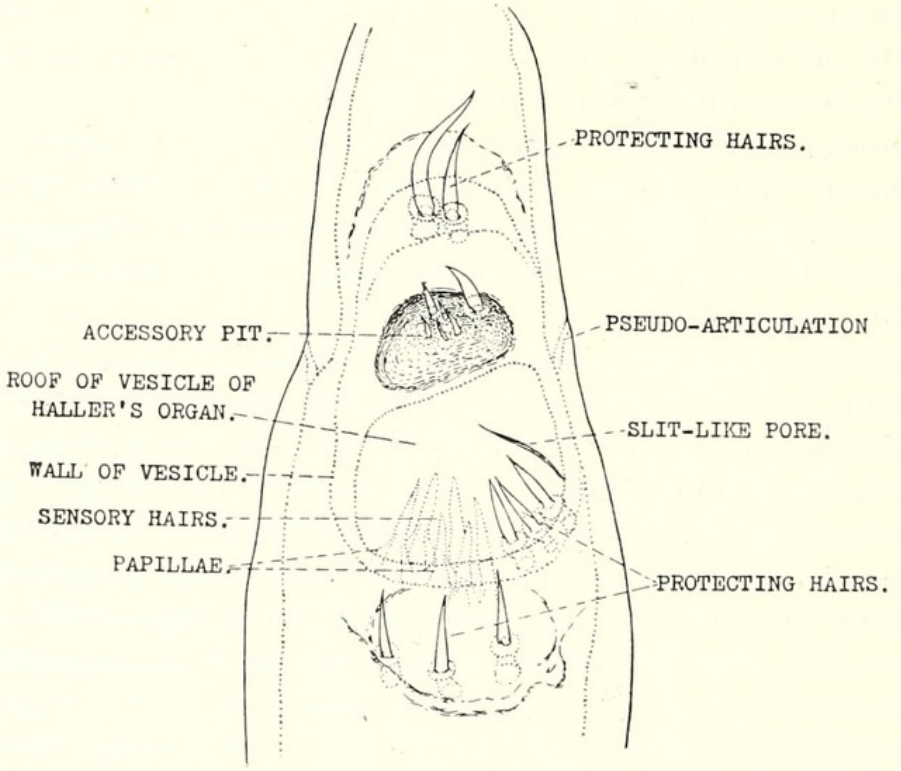

Fig. 1. Haller's organ as seen from the dorsal aspect. ×330. (L. E. R.)

and differ in their appearance from the other hairs on the body and appendages of the tick: the internal cavity of each is comparatively large, the bounding walls are unusually thin, and there is no constriction at the base, the contour of the shaft of the hair merging into that of the basal papilla without any perceptible line of demarcation.

With regard to the structure of the hypodermis underlying Haller's organ, we have been limited to a study of sections, the material for which was preserved by methods unsuitable for the determination of the structure of delicate cellular elements, and until new supplies of living

material are forthcoming, we are unable to complete our work on the histology of the soft parts. From the few observations which it has been possible to make, it appears that the hypodermal cells immediately beneath the sensory hairs are large and flask-shaped; each consists of a sac of finely granular cytoplasm surrounding a large central cavity or vacuole which communicates directly with the hollow interior of the hair. We have succeeded in identifying nerve fibrils running towards the bases of the sensory hairs, but cannot, at present, define their relationships with the modified hypodermal cells.

Closely associated with the vesicle of Haller's organ and included in Haller's description as an intrinsic part, is a pit-like depression which we have termed the *accessory pit* (Plate XVIII, Fig. 1): it lies a little distance beyond the distal side of the main vesicle, is widely open to the exterior, and is furnished on its floor with a number of short stiff hairs, some of which protrude beyond the mouth of the pit. This structure appears to have been considered as a small counterpart of the chief vesicle, but its appearance, together with the fact that the hairs which it contains are quite different in character from those of the latter, does not support this view. The surface of the leg on both the proximal and distal sides of Haller's organ bears a cluster of stiff hairs, the function of which is, presumably, protective (Text fig. 1).

As already stated, Haller alluded to the presence of an otolith in the cavity of the organ and a representation of such a body is clearly shown in his figure: we have diligently searched for such bodies in all our preparations but have failed to detect their presence and have no hesitation in denying their existence.

In conclusion, we are compelled to doubt that the function of Haller's organ is auditory. Haller based his interpretation on the presence of a supposed tympanic membrane, of otoliths, and the resemblance to the auditory organs of certain Crustacea. No one, as far as we know, has attempted any experimental proof of an auditory function. On the other hand, the structure of the organ, the peculiar antenna-like movements of the first pair of legs, and the results of Lahille's experiments are all strongly in favour of the assumption that Haller's organ is olfactory in function.

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DESCRIPTION OF PLATE XVIII.

Fig. 1. *Haemaphysalis punctata.* Lateral view of left tarsus of female. × 440. (L.E.R.) The figure is slightly schematised and represents the vesicle of Haller's organ and the accessory pit in optical section.

Fig. 2. *Haemaphysalis punctata.* ♀. Photomicrograph of Haller's organ from the side, showing the pore, accessory pit and part of the chitinous fold which differentiates the smaller chamber from the larger. × 150.

Fig. 3. As in Fig. 2. This photograph gives some slight indication of the slit-like character of the pore. × 400.

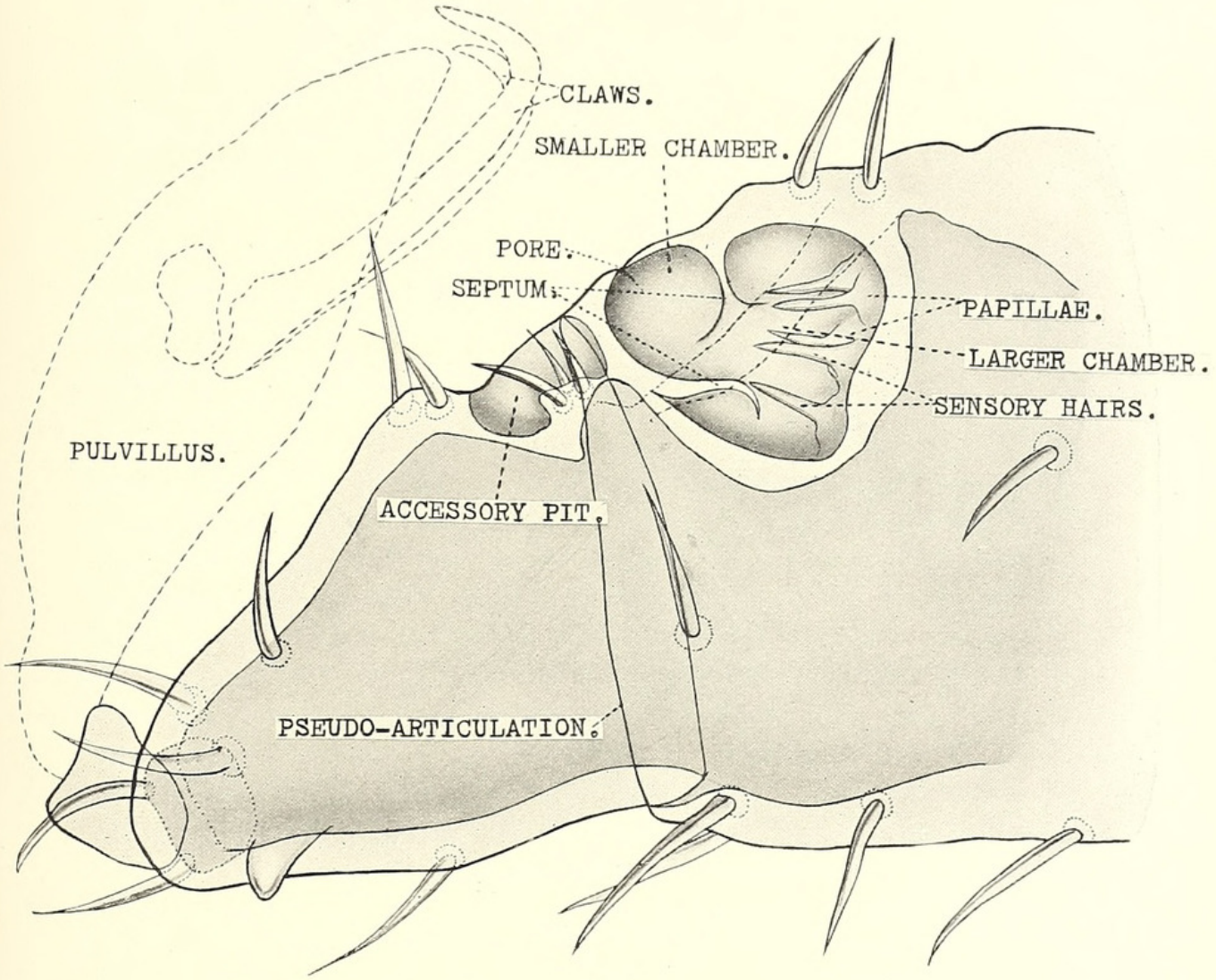

Fig. 1.

Fig. 2.

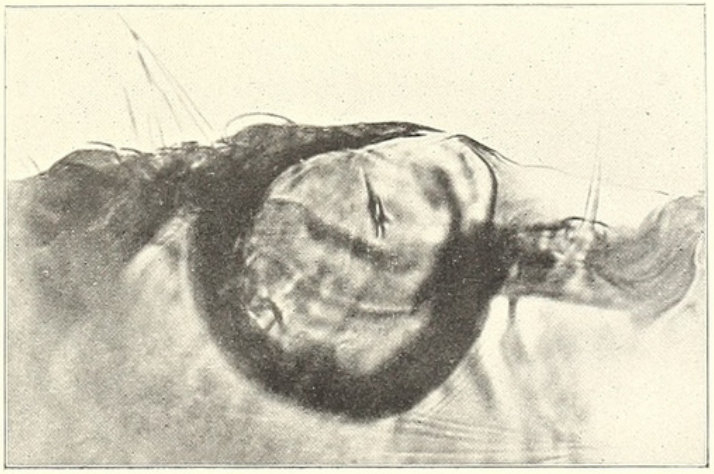

Fig. 3.