

POSTERIOR CAPSULE OF HALLER'S ORGAN IN THE
LONE STAR TICK, *AMBLYOMMA AMERICANUM*
(ACARI: IXODIDAE)

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ABSTRACT

The complex external and internal structure of the capsule of Haller's organ in the Lone Star tick, *Amblyomma americanum* (L.), was studied using scanning electron microscopy. Externally, the organ opening consists of a complex rectangular aperture. Internally, 2 distinct types of structures were observed: irregularly shaped elements and thin-walled setae. The variation, placement, and configuration of these structures are described.

Haller's organ is comprised of an anterior (distal) pit bearing several setae and a posterior (proximal) capsule and is located at the tip of tarsus I. There is evidence to suggest that this organ is an olfactory receptor and may also serve as a hygroreceptor (Hindle and Merriman 1912, Lees 1948, Zolotarev and Sinitsyna 1965). Because of the importance of this organ as a sensory structure considerable attention has been given to its morphology (Nuttall et al. 1908, Schulze 1941, Arthur 1954). Previous descriptions of the capsule of Haller's organ in the ticks have been restricted to observations of sectioned and whole-mounted material. Direct observation of the internal structures comprising the capsule of Haller's organ is nearly impossible because of the small entrance opening and the surrounding cuticular structure. Indirect observation is possible, however, through the thin, transparent covering cuticle. This method, while providing much information regarding structure, position, and numbers of elements, is rather unsatisfactory. Interpreting the organs as reconstructed from sectioned materials is difficult and subject to error because the delicate structures are easily distorted in preparation for study. Despite the difficulty in accessibility of the internal structures, it has been possible to observe the structure of Haller's organ using scanning electron microscopy (SEM).

This paper describes the external and internal morphology of the capsule of Haller's organ and provides an anatomical base for future morphological and physiological studies.

MATERIALS AND METHODS

The ticks used in this study were obtained from a laboratory culture of *Amblyomma americanum* (L.) maintained at the USDA Insects Affecting Man and Animals Research Laboratory, Gainesville, Florida.

For study of the internal structures, the cuticle forming the roof of the capsule was removed with a scalpel blade. Both coated and uncoated adult ticks were then prepared for SEM study by affixing them to an ob-

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ervation stage with aluminum paint. Specimens were coated with a solution of 20.0% isopropyl alcohol—2.0% Joy® (detergent) 1 hr before examination.

Observations were made with a Cambridge Scanning electron microscope and conventional light microscopy. Thirty fed, 60 day old, adult ♂ and ♀ ticks were examined.

RESULTS AND DISCUSSION

Externally, a well defined horizontal slit or aperture is located in the thin, membranous cuticle covering the capsule. Internally, the complex of



Fig. 1-3. Scanning electron micrograph. *Amblyomma americanum*, dorsal aspect of tarsus I. Fig. 1—capsule entrance of Haller's organ, ♂, 1,150X, coated. Fig. 2—capsule entrance of Haller's organ and pre-Haller setae, ♀, 1,000X, uncoated. Fig. 3—capsule entrance of Haller's organ and pre-Haller setae, ♀, 1,000X, uncoated.

structures is arranged along the inner surface of the capsule except on the membranous covering cuticle. By removing this covering and selectively cutting into the organ, it has been possible to determine the morphology and relative position of the complex sensory structures which in part comprise Haller's organ.

External Morphology.—The basic rectangular slit aperture includes the following observed variations: 1) margins entire (Fig. 1); 2) ventral margin with medial, ovate depression (Fig. 2); 3) margins entire; medial circular opening below ventral margin (Fig. 3).

Aperture variation occurs most noticeably at the margins. The pattern occurring with greatest observed frequency appears to be that in which the ends are slightly expanded with the medial margins raised dorsally. Observed aperture sizes range between 50.0-60.0 μ long and between 3.0-4.0 μ wide, excluding and expansion.

At present, there is insufficient data concerning the ovate depression (Fig. 2) and the circular opening (Fig. 3) to make a definitive statement regarding its frequency or variability.

Internal Morphology.—Internally, 2 distinct types of configurations are represented: 1) irregularly shaped structures and 2) setiform elements.

The irregularly shaped structures or pleomorphs (= Sinnesstifte?, Schulze 1941) are borne on the anterolateral, posterodorsal, and anteroventral surfaces of the capsule. No structures are located on the membranous covering cuticle, although occasionally pleomorphs may protrude through it. Structurally, there are at least 4 types of pleomorphs which can be classified: 1) amorphous; 2) conical; 3) cylindrical; 4) angular (Fig. 4, 5A-D). Each type consists of a main body borne on a stalk which appears, in SEM studies, to be continuous with the capsule wall, but in some light microscopy studies, appears to emerge from a socket-like rim of capsule cuticle. Each type can be distinguished by the following characteristics:

I. Amorphous (PA): posterodorsal and lateral in position, posterior to aperture (Fig. 5A, cf. Fig. 3), anterior to thin-walled setae (Fig. 6-8); stalk short, narrower than body; surface irregular, smooth.

II. Conical (Pc): anteroventral, anterolateral in position; stalk broad, continuous with body; surface irregular, rough (Fig. 9).

III. Cylindrical (Pcy): dorsal in position, stalk continuous with body; surface smooth; body with or without branches (Fig. 8, 10).

IV. Angular (Pa): anterolateral, anteroventral in position (Fig. 9, 11); stalk long, narrower than body; surface irregular or smooth; body compressed.

The setiform elements are borne on the posterior, lateral and ventral surfaces of the capsule. Pleomorphs partially conceal the setiform structures from either dorsal or anterior observation (Fig. 6-8). Structurally there appear to be 2 basic types of setiform elements: 1) tapered, thin-walled setae (St) and 2) cylindrical spines (Ss). The 8 tapered setae are arranged in a definite pattern (Fig. 9, 12) in a small arc along the posterolateral wall of the capsule. All are surrounded basally by a raised socket-like rim of capsule cuticle and appear to be directed anteriorly toward a common point (Fig. 12, 13) at the level of the slit aperture. The cylindrical type, however, has no observed socket, is flared basally, pointed api-

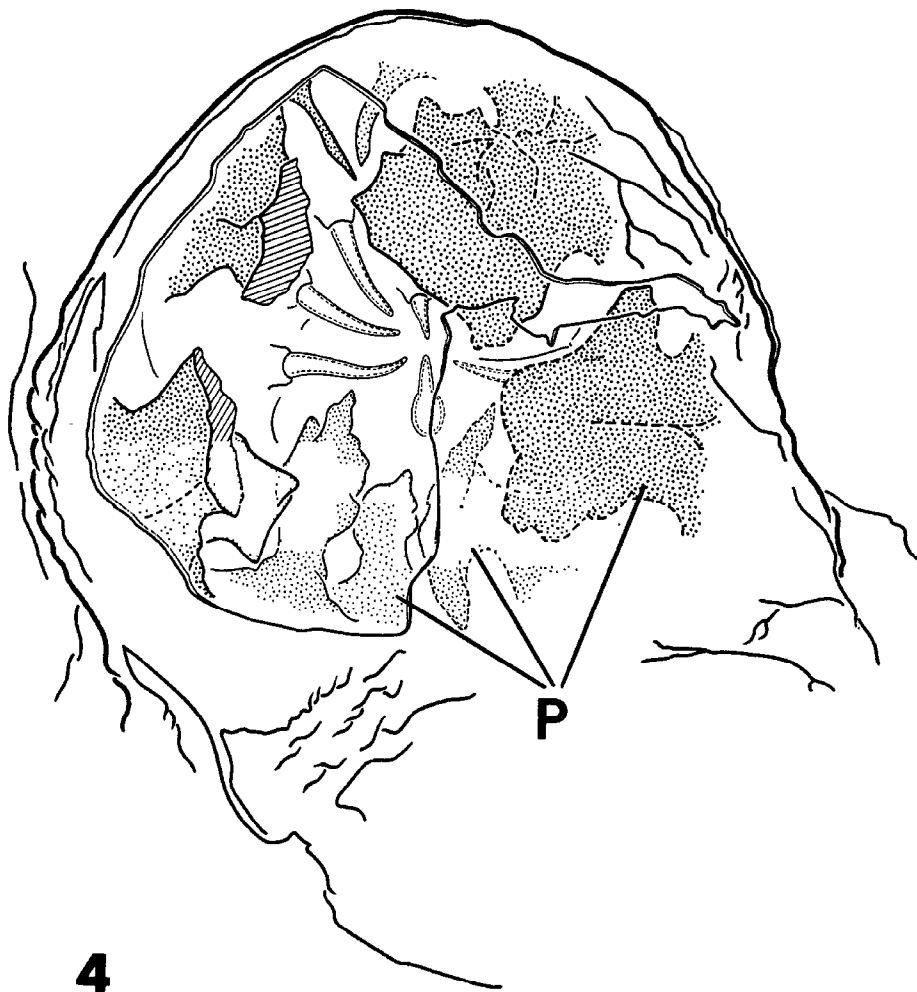


Fig. 4. Dorsal aspect of tarsus I of *Amblyomma americanum*. A portion of the covering cuticle and some pleomorphs (P) are removed to expose the arrangement of pleomorphs and setiform structures.

cally, and arranged asymmetrically at the periphery of the arc formed by the tapered setae.

SEM and light microscopy indicate 8 symmetrically placed tapered setae in both ♂ and ♀ *A. americanum*. Seven are of similar configuration: tapered toward the free end, slightly curved, tip rounded, and surface smooth. The remaining seta (Fig. 12) is slightly less tapered with a corrugated appearance (Fig. 12 median seta (b) may be of the same type but resolution was not sufficient for appropriate determination). The tip resembles an inverted yoke but apparently does not have an aperture at the tip (Fig. 12). Approximate dimensions of setae observed: length 25.0 μ ; width 4.5 μ .

The cylindrical spines differ greatly in dimensions and configuration of the tip (Fig. 7-10, 12). Distally, the tip may be either rounded, pointed,

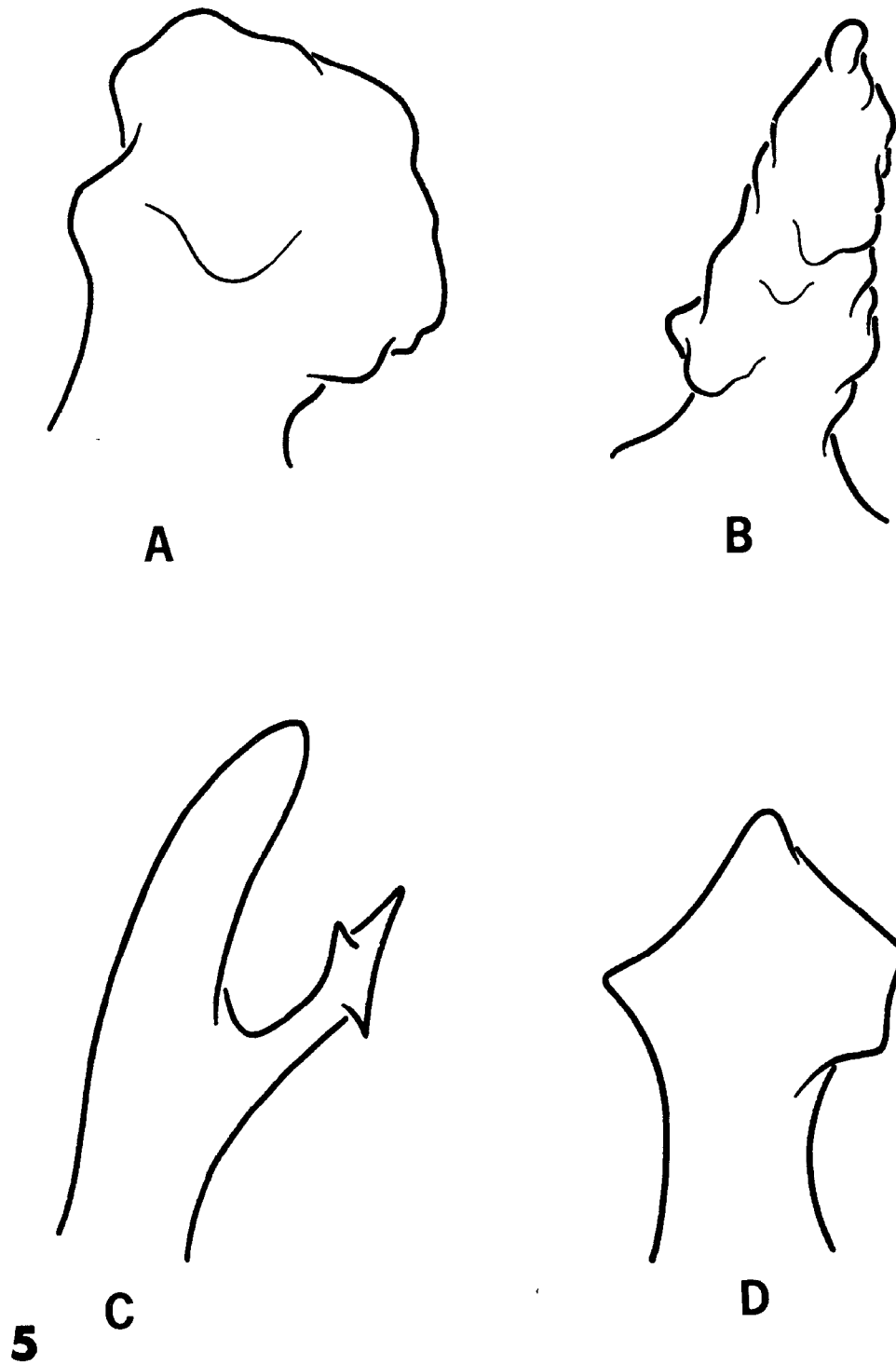


Fig. 5. Pleomorphic types observed in the capsule of Haller's organ in both ♂ and ♀ *Amblyomma americanum*. A, amorphous; B, conical; C, cylindrical; D, angular.

or bifurcate (Fig. 12). These setae are difficult to characterize because of the lack of symmetry in position and because of the scarcity of the elements observed.

The above account suggests that the capsule of Haller's organ is perhaps an even more complicated structure, morphologically, than was previously thought. Certainly the complexity and variability in the design of

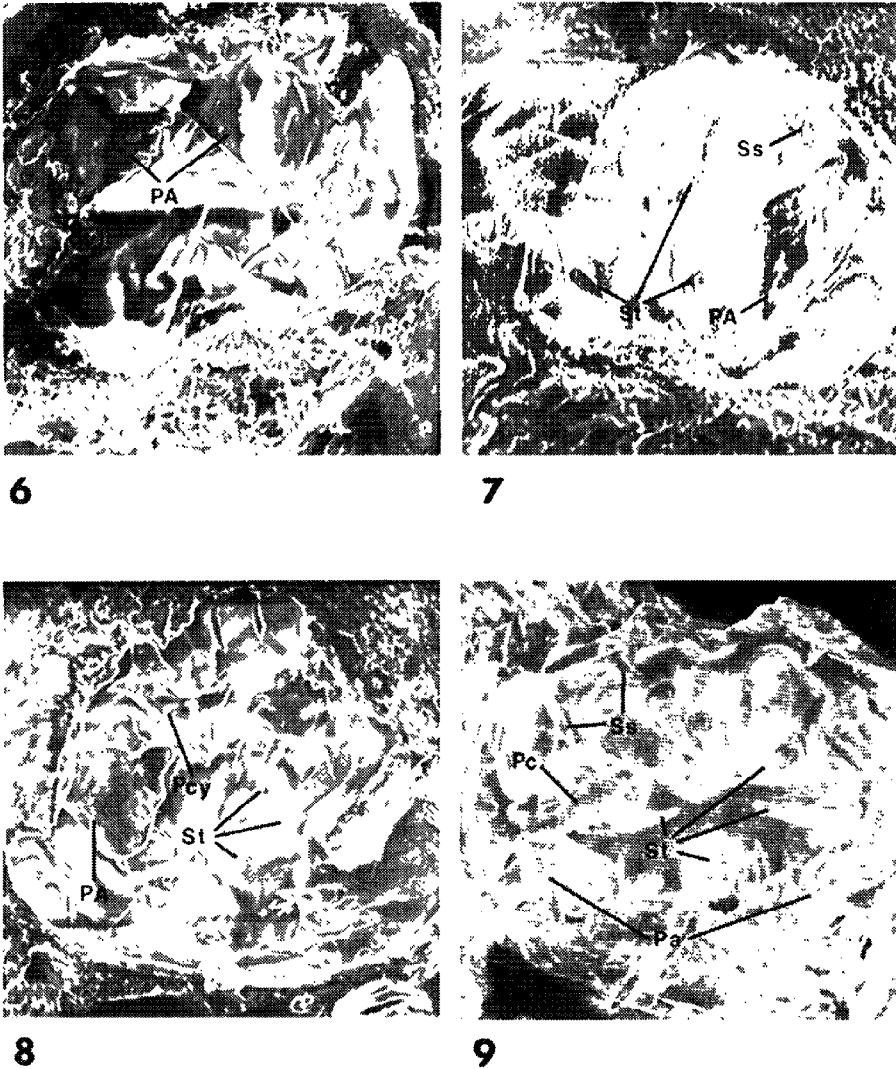


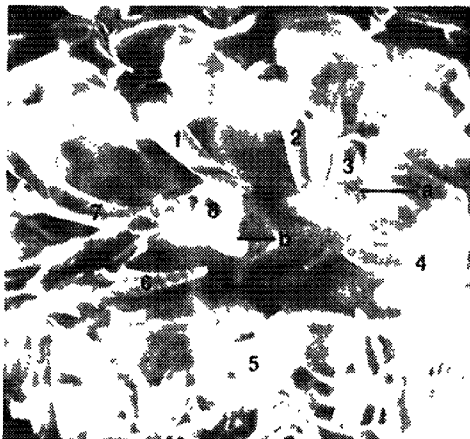
Fig. 6-9. Scanning electron micrograph. *Amblyomma americanum*, dorsal aspect of tarsus I. Fig. 6—covering cuticle of capsule removed, pleomorphs behind capsule entrance exposed, ♀, 1,225X, coated. Fig. 7—oblique section into capsule of Haller's organ; portion of entrance (E) remaining; amorphous pleomorphs (PA), solid spines (Ss) and thin-walled setae (St) exposed; ♂; 1,050X; coated. Fig. 8—transverse section into capsule of Haller's organ; amorphous (PA), cylindrical (Pcy), and setae (St) exposed; ♂; 1,150X; coated. Fig. 9—transverse section into capsule of Haller's organ; conical (Pc), angular (Pa), amorphous (PA) pleomorphs, spines (Ss) and setal arrangement exposed; ♂; 1,000X; uncoated.



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Fig. 10-13. Scanning electron micrograph. *Amblyomma americanum*. Fig. 10—dorsal aspect of tarsus I, transverse section into capsule of Haller's organ, cylindrical (Pcy) pleomorphs and spines (Ss) exposed, ♂, 1,100X, uncoated. Fig. 11—irregular surface, angular (Pa) pleomorph; ♀; 2,340X; uncoated. Fig. 12—dorsal aspect of tarsus I, transverse section into capsule of Haller's organ, setal pattern exposed (note corrugated surface (a)), ♂, 2,000X, uncoated. Fig. 13—dorsal aspect of tarsus I, saggital section into capsule of Haller's organ, setal position exposed, ♂, 2,000X, uncoated.

the entrance opening is indicative of this. The margin entire pattern, however, was observed more frequently than the others and pattern No. 3 was not observed to occur in the males. All other patterns were observed on either left or right leg or both and in both sexes. Internally, no differences between left or right legs or between sexes were observed. Thus, the variation observed is seemingly restricted to the capsule entrance and does not appear to involve the internal chaetotaxy.

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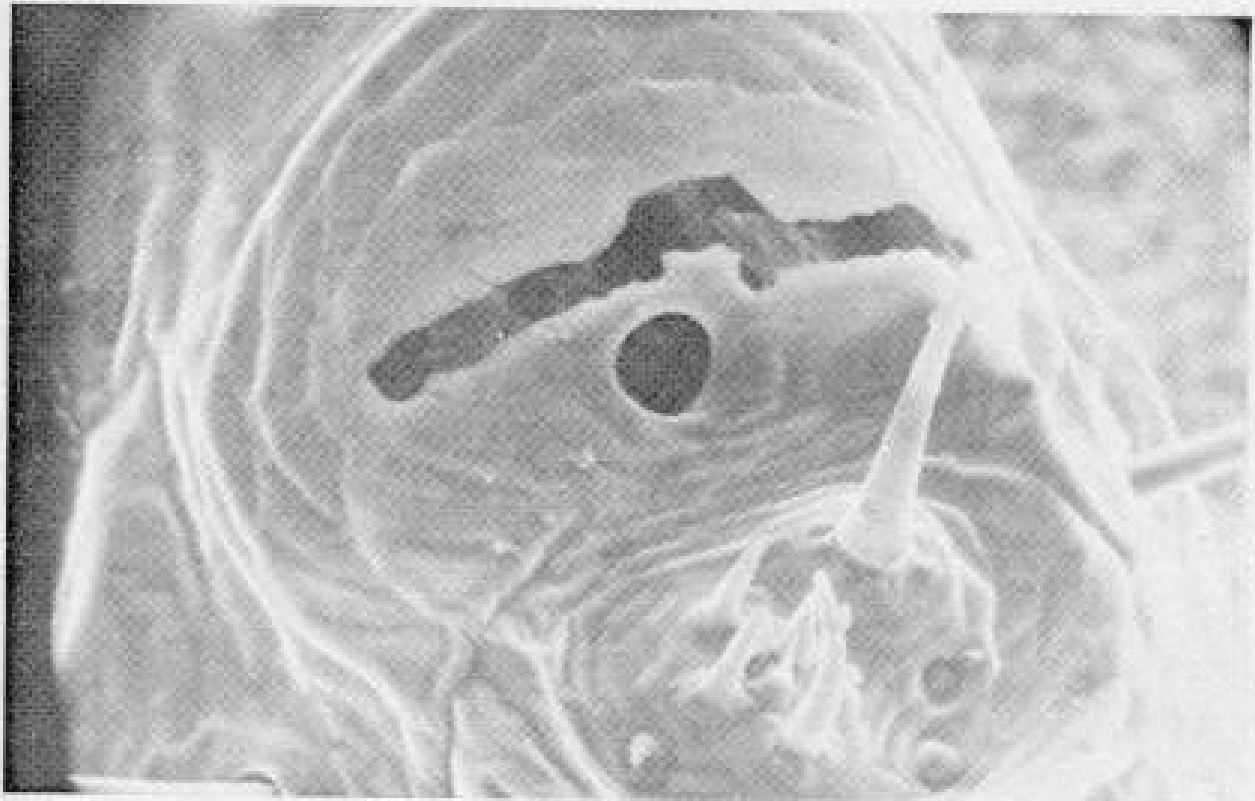
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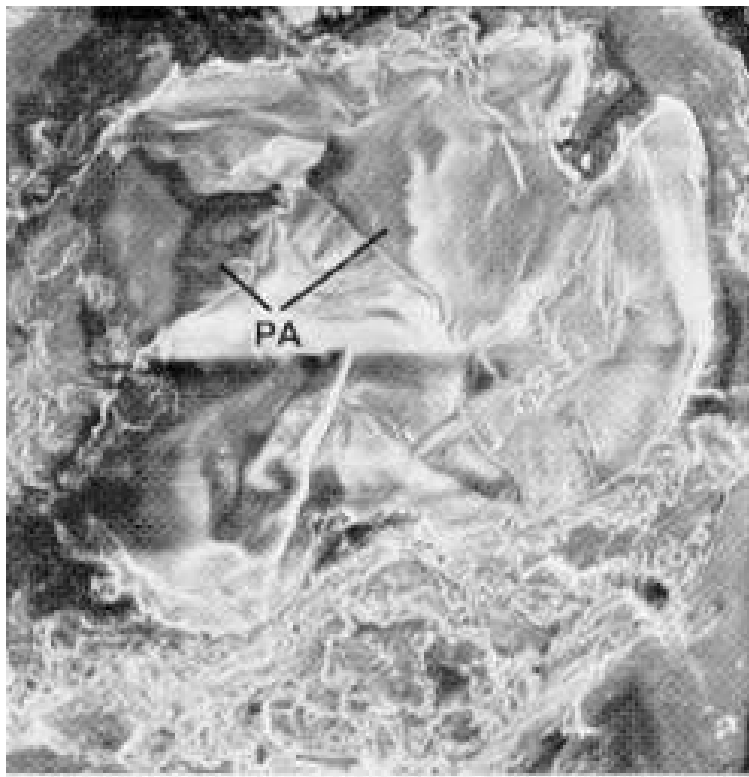
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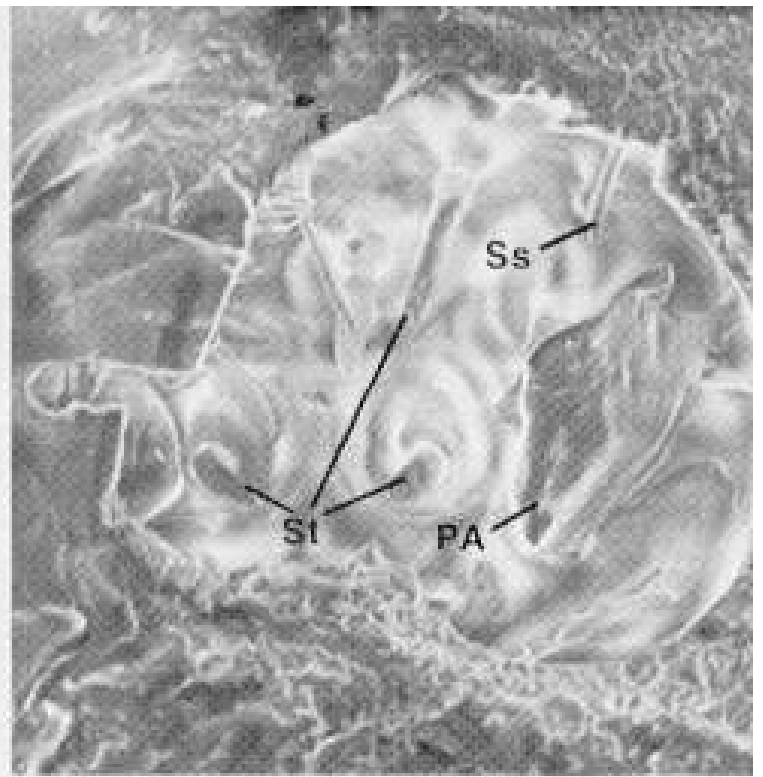
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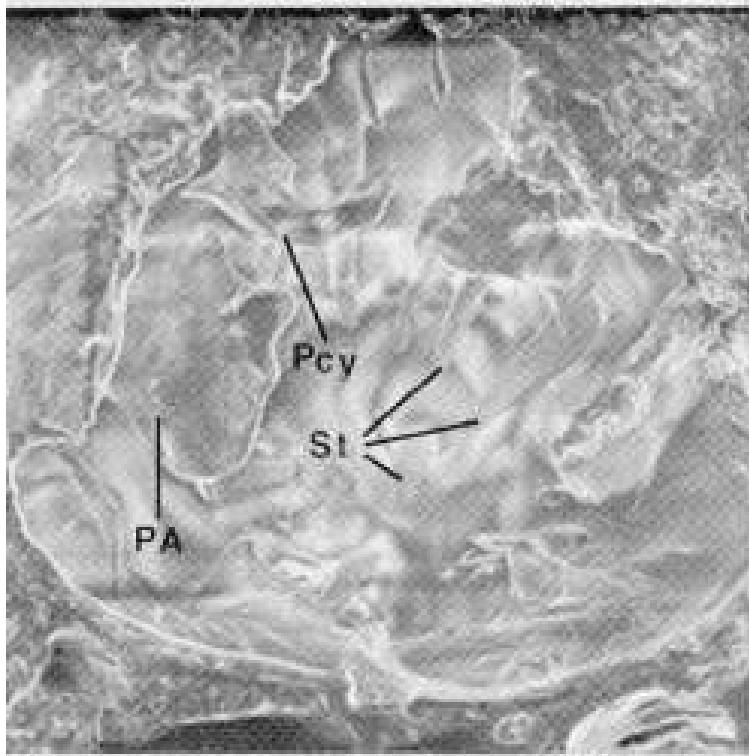
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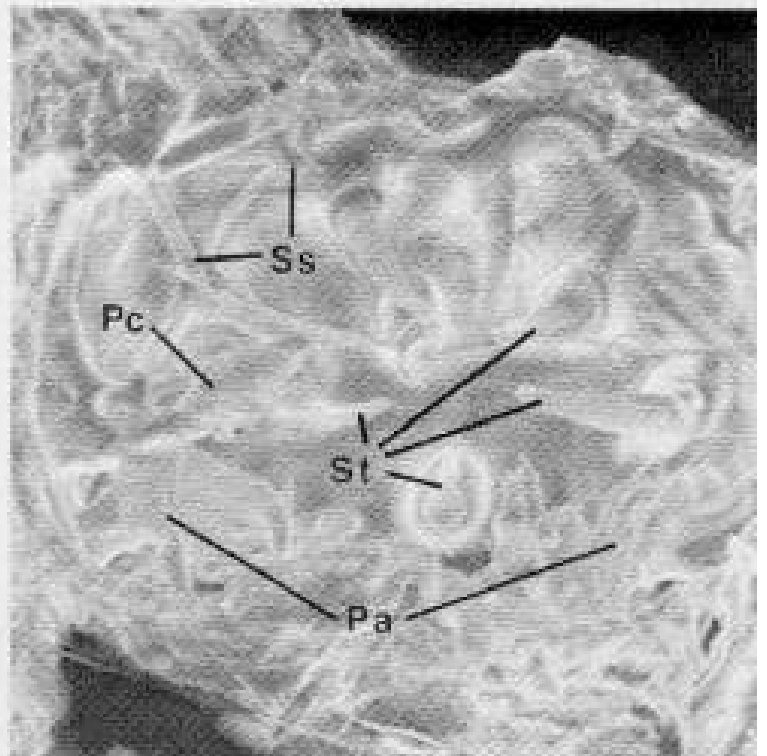
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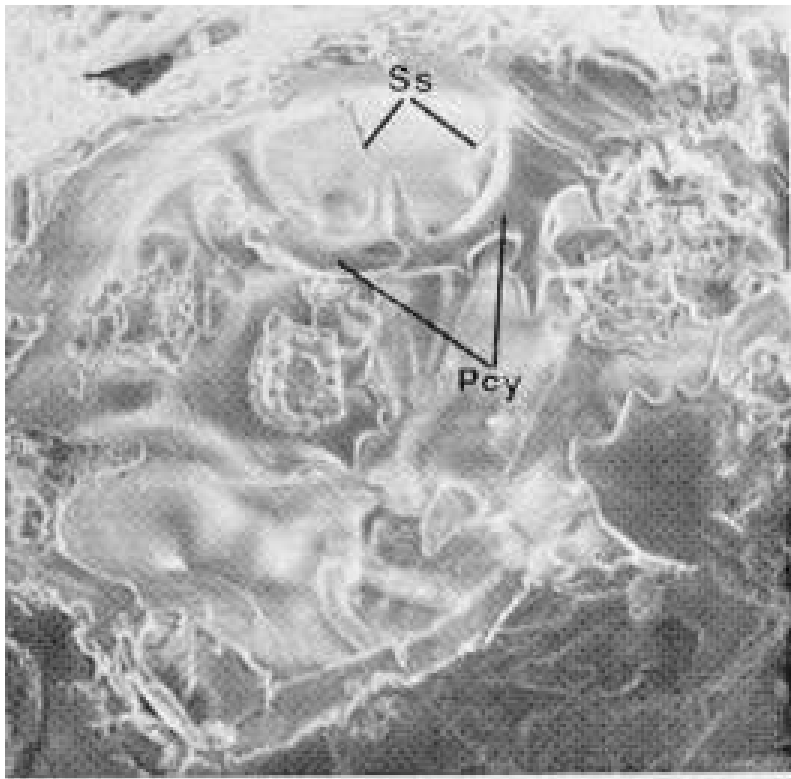
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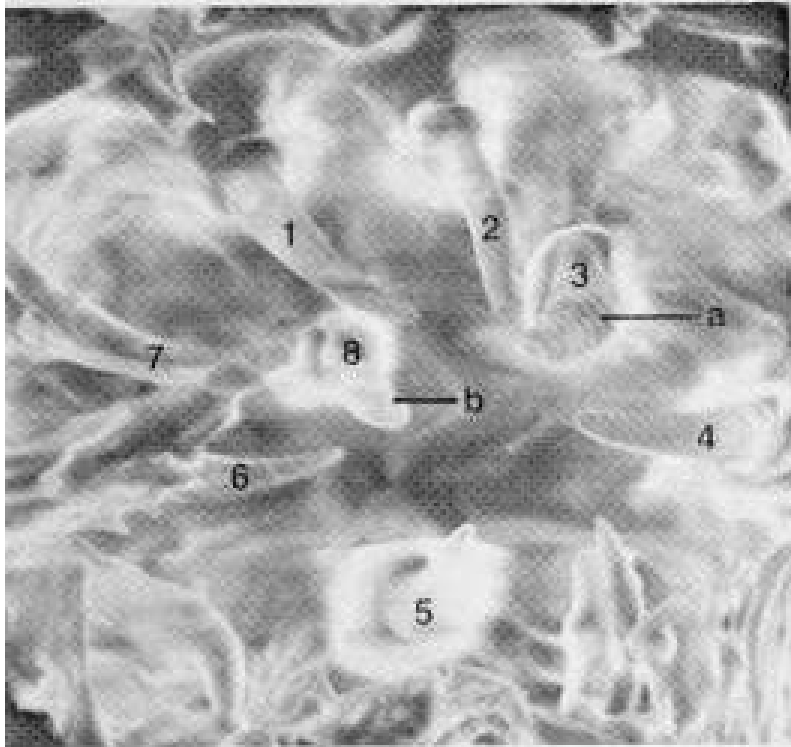
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