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SCANNING ELECTRON MICROSCOPY OF THE TEGUMENTAL SURFACE OF *HETEROBILHARZIA AMERICANA* (TREMATODA; SCHISTOSOMATIDAE)

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ABSTRACT

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An attempt is made in this paper to define more clearly the tegumental microstructure of the schistosome, *Heterobilharzia americana*. The adult parasites were examined with scanning electron microscopy at 75–10 000 magnifications. The morphology of the oral and ventral suckers, the tegument, and the gynecophoral canal with the *in copula* female were closely scrutinized. The tegument of the female is simple and uniform in structure, an adaptation which may allow for a more efficient mode of penetration through the smaller mesenteric venules. The male tegument, however, is characterized by papilla-like elevations of irregular size, shape, and distribution. These papillae may represent different kinds of sensory endings.

INTRODUCTION

Heterobilharzia americana is a digenetic trematode which resides in the mesenteric veins of a variety of mammalian hosts. Price (1929) originally described the male trematode from specimens which had been collected from a bobcat (*Lynx rufus*). In 1943, Price redescribed the male and described the female from specimens collected from a raccoon (*Procyon lotor*). Other hosts reported include the nutria (*Myocaster coypu*) and swamp rabbit (*Silvilagus aquaticus*) (Malek, Ash, Lee & Little, 1961), opossum (*Didelphis marsupialis*) (Kaplan, 1964) and the whitetailed deer (*Odocoileus virginiana*) (Byrd, Prestwood & Maples, 1967). Recently, Custer & Pence (1981) added new records from the red wolf (*Canis rufus*), coyote (*Canis latrans*) and hybrids of these wild canids. Malek *et al.* (1961) were the first to report the domestic dog (*Canis familiaris*) as a host.

This parasite is of particular interest in canine medicine because of its recent occurrence in kennels and in dogs obtained from private owners (N. C. Ronald, personal communication, 1977). The pathogenicity of this fluke is a function of the definitive host parasitized. Heavily infected dogs may develop a local dermatitis and a debilitating, sometimes fatal, periportal fibrosis (Pierce, 1963; Bartsch & Ward, 1976). The most pathogenic stage is the egg, which causes the formation of granulomas in the liver (Lee, 1960). The eggs are deposited by the female in the smaller mesenteric venules of the small intestine and may be accidentally transported thence to the liver via the portal system.

Brief descriptions of the morphology of *H. americana* have been given by Price (1929; 1943) and Lee (1962). This, however, is the first study in which electron microscopy was used to demonstrate the tegumental surface of the adult flukes.

MATERIALS AND METHODS

Adult *H. americana* were recovered by the perfusion technique described by Yolles, Moore, DeGuisti, Ripsom & Meleney, 1947. Adult flukes were flushed from the hepatic portal blood vessels of raccoons and opossums which had been trapped in the Brazos Valley near College Station, Texas.

The parasites were fixed in 3% glutaraldehyde and 1% osmium tetroxide (Allison, Ubelaker, Webster & Riddle, 1972), and dehydrated in a series of ethanol baths (30, 50, 70, 85 and 100%). Specimens were critical point-dried with carbon dioxide, mounted on stubs with silver paint as an adherent and coated with 400A of gold palladium, using an ion sputterer. The body surfaces were scanned at 75–10 000 magnifications with a JSM-U3 JEOL scanning electron microscope at 25 KV.

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RESULTS

The oral and ventral suckers at the anterior extremity of the male are representative of normal tegumental architecture (Fig. 1–3). The latero-dorsal tegument posterior to the oral sucker bears many tuberculations (Fig. 4–5).

The anterior area of the gynecophoral canal appears smooth at the lateral margins (Fig. 6). In the area distal to the canal folds, papilla-like elevations transcend to papillae and then to blunt spines (Fig. 6 & 8). The inner surface of the canal is lined with spines (Fig. 9 & 10). The sharp spines that are scattered irregularly over the postero-internal part of the canal floor (Fig. 9–11) are more pronounced than those on the outer surface (Fig. 7).

The dorsal surface of the male is covered with various tegumental structures. Tubercle-like structures, porous and spongy, resemble the surrounding tegument in appearance (Fig. 12). The medial tegument has a porous network of elevations which are possibly sensory papillae (Fig. 13). The posterior dorsal surface is deeply folded, with a few tubercle-like structures distributed throughout (Fig. 12).

A segment of the *in copula* adult female parasite could be seen protruding from the male (Fig. 15). This portion is representative of her girth. The ratio of the size of the female to the male is approximately 1:5.

The tegumental surface of the female (Fig. 14), which was less differentiated than that of the male, bore relatively few, small, irregularly spaced elevations. These may be sensory receptors.

DISCUSSION

The adult female *H. americana* is smaller and slimmer than the male. She resides most of the time *in copula* in the gynecophoral canal of the rather sickle-shaped male and leaves this canal only to deposit her eggs in the smaller mesenteric venules of the host's small intestine. The tegument of the schistosome is undoubtedly a protective structure, but much controversy exists regarding its other functions. There is evidence that it may be absorptive (Stirewalt, 1963), and it has been suggested that secretions, excretions, and osmoregulation may also occur at this interface. Physiological and immunological interactions, which are critical aspects of any host-parasite relationship, are other possible functions of the tegument. Despite this uncertainty, little attention has been given to the structure of the tegument.

Scanning electron microscopy revealed certain basic features of *H. americana* which may be of great importance for a further understanding of the relationship between this parasite and the dog. The tegumental spines and the roughened lining of the gynecophoral canal may

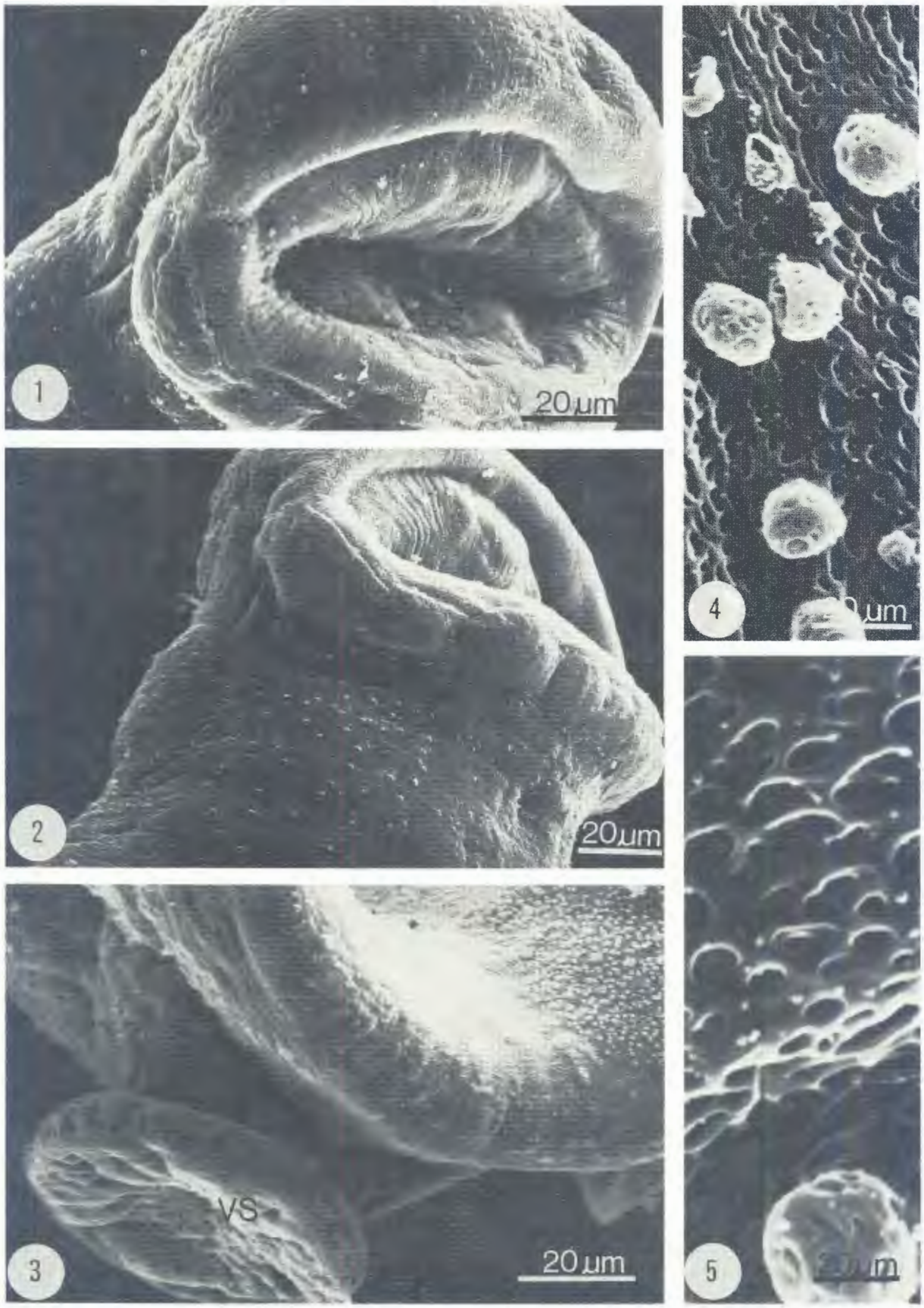


FIG. 1–5 Photomicrographs of the anterior extremity of the adult male *Heterobilharzia americana*

1, 2 Oral sucker (os) 500 ×

3 Ventral sucker (vs) 100 ×

4 Tuberculations on ventrolateral surface of the tegument: 2000 ×

5 Higher magnification of tuberculations and tegument: 6000 ×

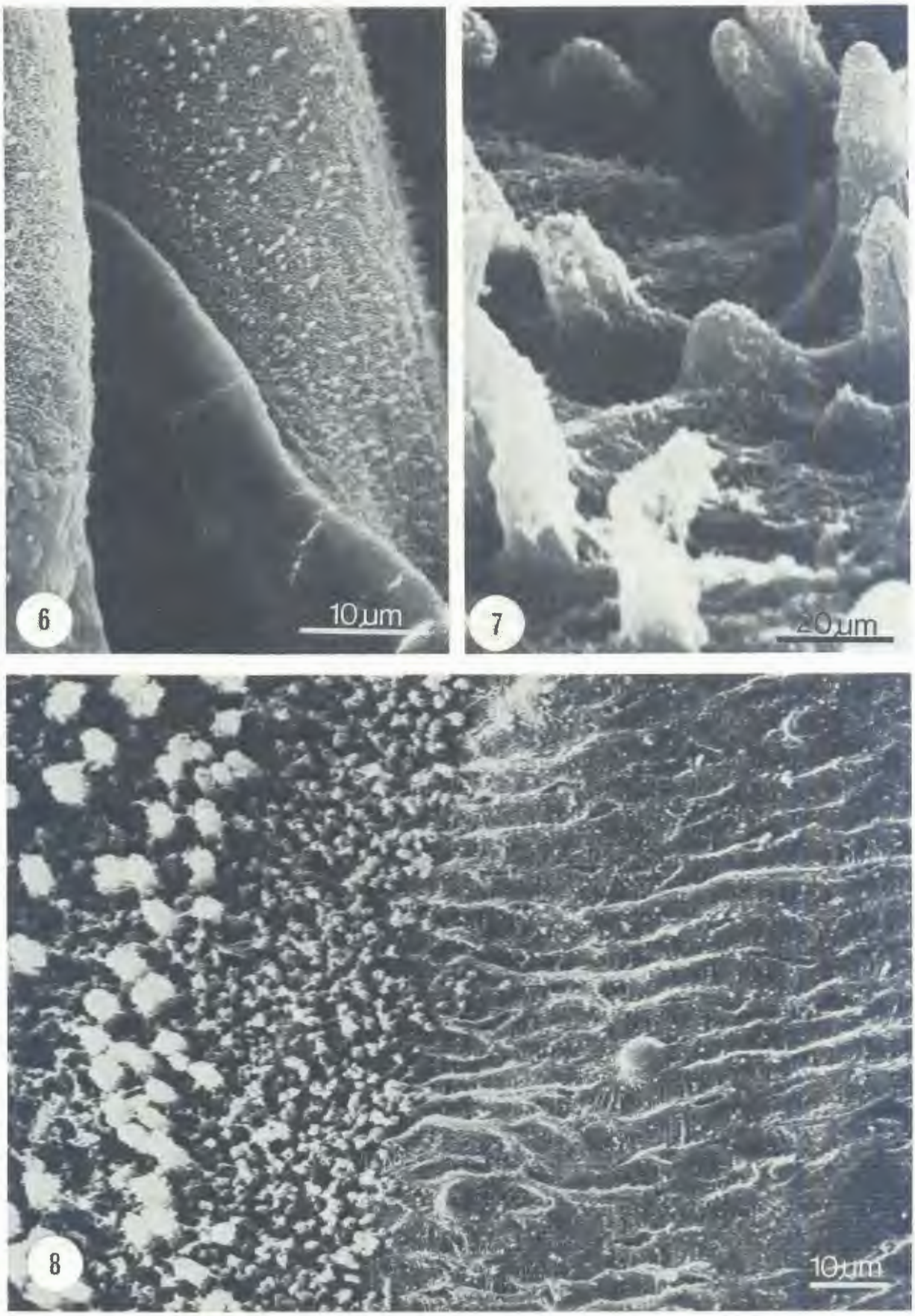
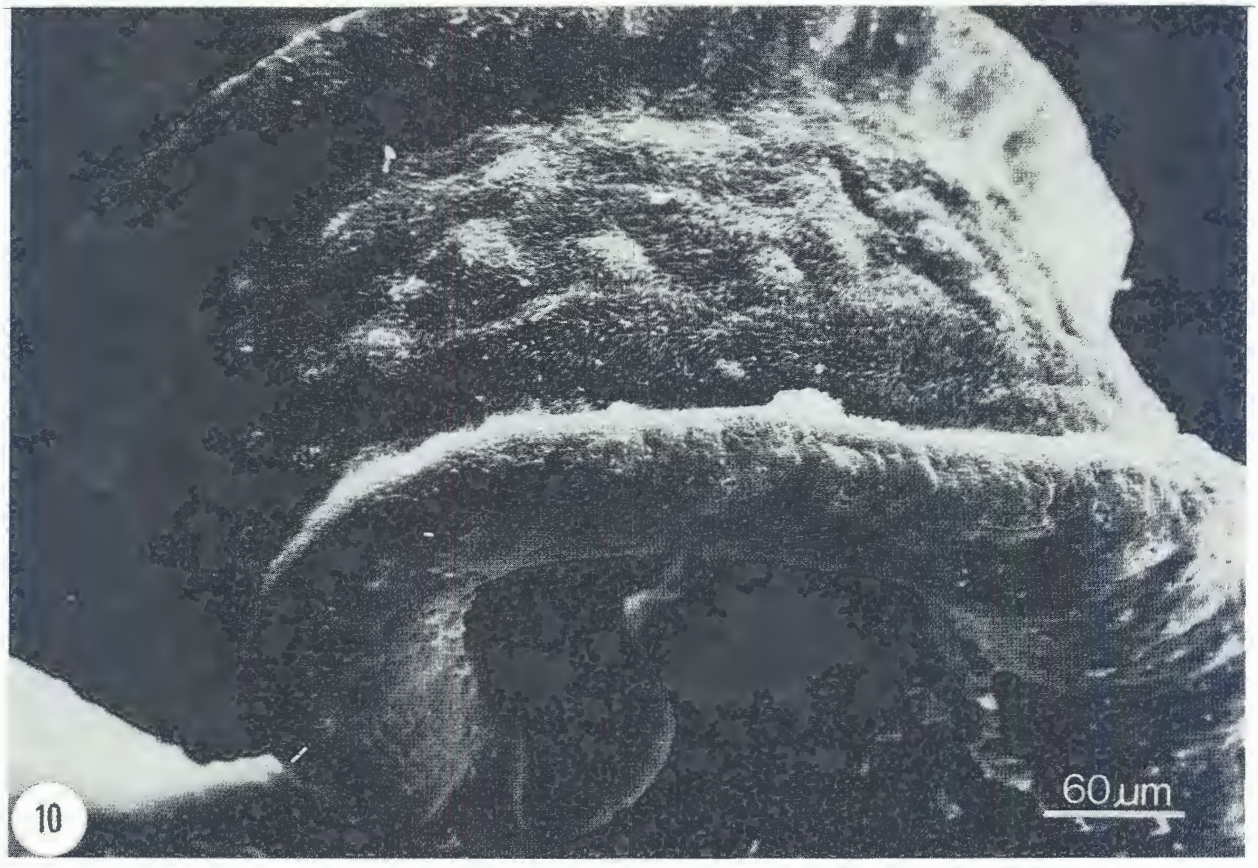


FIG. 6–10 Photomicrographs of the gynecophoral canal of the male *Heterobilharzia americana*

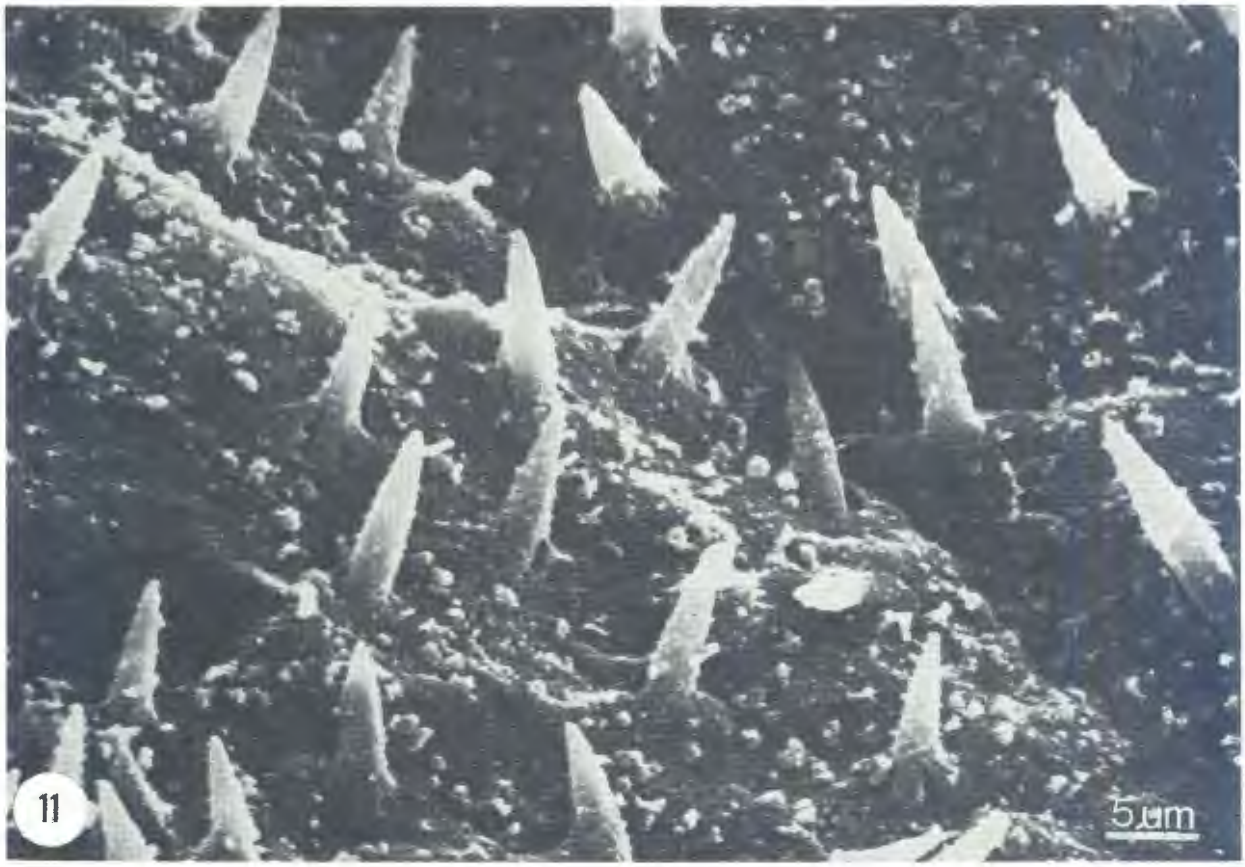
6 Lip of gynecophoral canal with smooth surface and blunt spines of rough surface: 200 ×

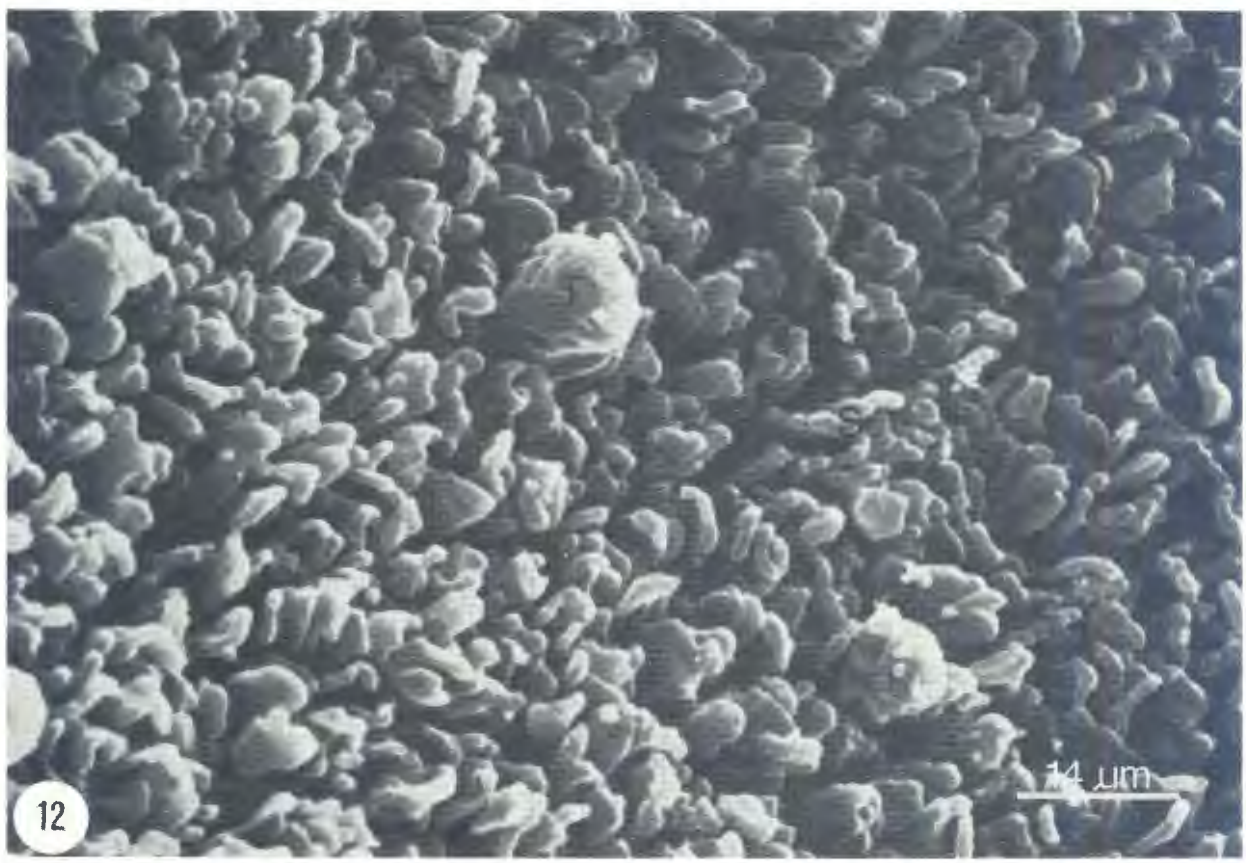
7 High magnification of blunt spines: 2000 ×

8 Transition from smooth to bluntly spinose surface of gynecophoral canal edge: 800 ×



9, 10 Two views of posterior portion of folded gynecophoral canal with spines: 75 and 150 × respectively





11 High magnification of spines: 1000 ×

FIG. 12–14 Photomicrographs of areas of the tegument of male and female *Heterobilharzia americana*

12 Antero-dorsal surface of male, with tuberculations (T) and possible sensory receptors (S): 1000 ×

13 Sensory papillae (S) on porous medial dorsal surface of male: 9000 ×
14 Surface of female with possible sensory receptors (S): 400 ×

FIG. 15 Photomicrograph of male (M) and female (F) *in copula:* 75 ×

enable the male fluke to grasp the female more efficiently. These features may also aid both schistosomes to adapt to residence in the blood stream of the dog (Miller, Tulloch & Kuntz, 1972). The male tegument is characterized by papilla-like elevations of irregular size, shape, and distribution, which may represent different kinds of sensory endings. The uniform tegument of the female with some possible sensory structures may be an adaptation for residence in the gynecophoral canal.

The tegumental surface of *H. americana* resembles the surfaces of 2 species of blood flukes that infect man. The dorsal surface of the male *H. americana* is reminiscent of *Schistosoma japonicum* (Sakomoto & Ishii, 1977). Both species reveal a vastly enfolding body surface with a dispersion of tuberculations throughout the fold. *Schistosoma haematobium* is also similar to *H. americana* (Kuntz, Tulloch, Davidson & Huang, 1976). While the tegument of both parasites is porous and spongy, the sensory receptors that characterize *S. haematobium* are evident in *H. americana*, although their function has not yet been established.

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References

ALLISON, V. F., UBELAKER, J. E., WEBSTER, R. W., Jr. & RIDDLE, J. M., 1972. Preparation of helminths for scanning electron microscopy. *Journal of Parasitology*, 58, 414–416.

BARTSCH, R. C. & WARD, B. C., 1976. Visceral lesions in raccoons naturally infected with *Heterobilharzia americana*. *Veterinary Pathology*, 13, 241–249.

BYRD, E. E., PRESTWOOD, A. K. & MAPLES, W. P., 1967. A new host and two new locality records for the blood fluke, *Heterobilharzia americana*. *Journal of Parasitology*, 53, 1115–1116.

CUSTER, J. W. & PENCE, D. B., 1981. Ecological analyses of helminth populations of wild canids from the Gulf Coastal Prairies of Texas and Louisiana, USA. *Journal of Parasitology*, 67, 289–307.

KAPLAN, E. H., 1964. *Heterobilharzia americana* in the opossum from Louisiana. *Journal of Parasitology*, 50, 797.

KUNTZ, R. E., TULLOCH, G. S., DAVIDSON, D. L. & HUANG, TAE-CHENG, 1976. Scanning electron microscopy of the integumental surfaces of *Schistosoma haematobium*. *Journal of Parasitology*, 62, 63–69.

LEE, H. F., 1960. The life history of *Heterobilharzia americana*. *Journal of Parasitology*, 46 (supplement), 34.

LEE, H. F., 1962. Life history of *Heterobilharzia americana* Price 1929, a schistosome of the raccoon and other mammals in Southeastern United States. *Journal of Parasitology*, 48, 728–739.

MALEK, E. A., ASH, L. R., LEE, H. F. & LITTLE, M. D., 1961. *Heterobilharzia* infection in the dog and other mammals in Louisiana. *Journal of Parasitology*, 47, 619–623.

MILLER, F. H., TULLOCH, G. S. & KUNTZ, R. E., 1972. Scanning electron microscopy of integumental surface of *Schistosoma mansoni*. *Journal of Parasitology*, 58, 693–698.

PIERCE, K. R., 1963. *Heterobilharzia americana* infection in a dog. *Journal of the American Veterinary Medical Association*, 143, 496–499.

PRICE, E. W., 1929. A synopsis of the trematode family Schistosomatidae with descriptions of new genera and species. *Proceedings of the United States National Museum*, 1975, 1–39.

PRICE, E. W., 1943. A redescription of *Heterobilharzia americana* (Trematoda): Schistosomatidae. *Proceedings of the Helminthological Society, Washington*, 10, 85–86.

SAKAMOTO, K. & ISHII, Y., 1977. Scanning electron microscope observations on adult *Schistosoma japonicum*. *Journal of Parasitology*, 63, 407–412.

STIREWALT, M. A., 1963. Seminar on immunity to parasitic helminths. IV. Schistosome infections. *Experimental Parasitology*, 13, 18–44.

YOLLES, T. K., MOORE, D. V., DE GUISTI, D. L., RIPSOM, C. L. & MELENEY, H. E., 1947. A technique for the laboratory animals for the recovery of schistosomes. *Journal of Parasitology*, 23, 419–426.