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NERVOUS SYSTEM IN THE BOVINE POUCHED PARAMPHISTOME, *FISCHOEDERIUS COBBOLDI* (TREMATODA : DIGENEA)

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SUMMARY

Following the localization of non-specific esterases, the nervous system in toto has been traced in the bovine pouched paramphistome, *Fischoederius cobboldi*. A pair of cerebral ganglia, which are joined to each other by a commissure, give off three pairs of nerves that run cephalad. A similar number of nerves from these ganglia proceed in the posterior direction. The course and distribution of all these nerves and the innervation to the various regions of the body have been described.

INTRODUCTION

The indigogenic method of Holt and Withers (1952) for the localization of esterases has proved to be of great value in demonstrating the nervous system in toto in platyhelminth parasites. Following the work of Halton and Jennings (1964), who applied this method in the monogenetic trematode, *Diplozoon paradoxum*, the nervous system in many trematode species has been studied. Notable work on this aspect pertains to *Fasciola* spp. by Kravavica, Lui and Becejac (1967); Kravavica, Thommen and Becejac (1967) and Probert and Durrani (1977); *Singhiatrema longifurca* and *Paradistomoides orientalis* by Simha and Rao (1977); *Prosthodendrium* spp. by Ramalu and Rao (1979); *Gangesia* sp. by Krishna and Simha (1980); *Schistosoma spindalis* by Rao, Krishna and Simha (1982), and the aspidogastrean, *Lissemysia indica*, by Ramalu, Rao and Simha (1981). Besides these, this sytem has been traced in some larval trematodes (Bruckner and Voge, 1974; Diconza and Basch, 1975; Leflore, 1979; Leflore, Bass and Smith, 1980; Grabda and Moczon, 1981; Venkatanarsaiah, 1981). From amongst the paramphistomes, the bovine fluke, *Ceylonocotyle scoliocoelium*, has been investigated by Roy (1980).

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In the present study an attempt has been made to trace the distribution of nerves in the bovine pouched paramphistome, *Fischoederius cobboldi* (Poirier, 1883) Stiles and Goldberger, 1910. This study reveals many deviations from the description of the nervous system in this species given by Gupta and Dutta (1967) based on histology.

METHODS

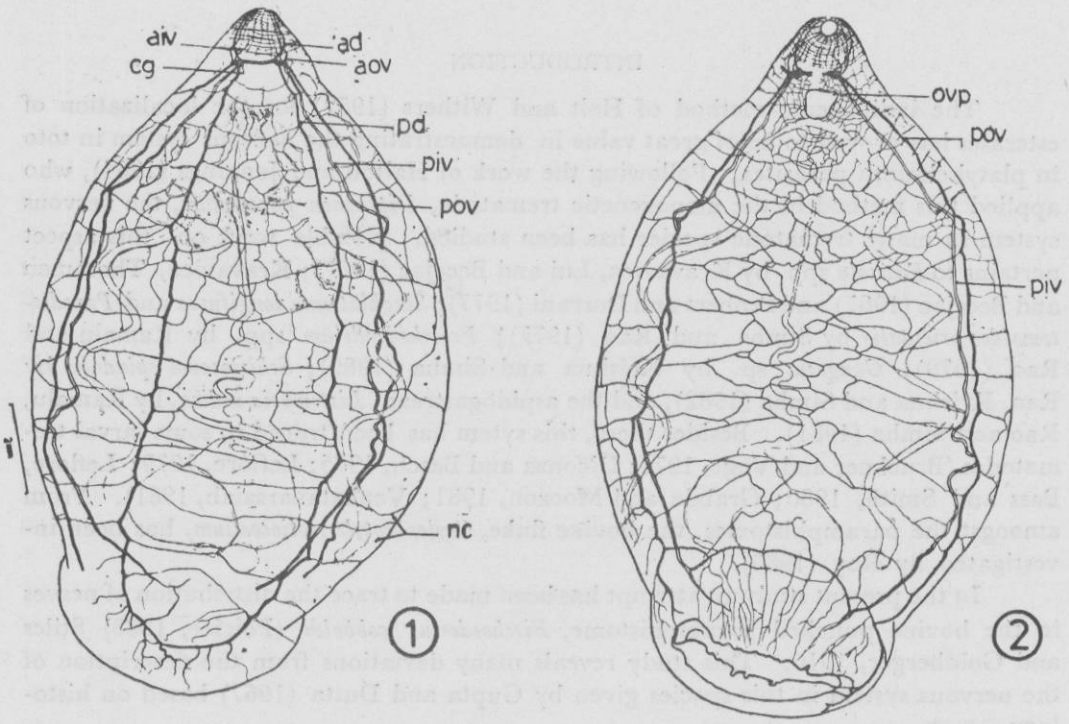
Live specimens of *F. cobboldi* were collected in 0.9% saline from the rumen of cattle slaughtered at the local abattoirs. The worms were fixed in 10% neutral formalin at 5°C for 4-6 hrs and incubated in standard bromoindoxyl acetate medium following Holt and Withers (1952). The non-specific esterases (NSE) were localized in the whole mount of the worm cleared in methyl benzoate by their deep indigo blue staining.

OBSERVATIONS

Following the intense localization of the NSE, it was possible to trace the details of the nervous system in *F. cobboldi*.

A pair of small thickenings, the cerebral ganglia, connected to each other by a transverse commissure, constitute the brain mass which lies immediately posterior to the muscular pharynx and dorsal to the oesophagus. From each cerebral ganglion three anteriorly and three posteriorly directed longitudinal nerves are given out, and these are named according to their position (Figs. 1-3).

Of the nerves traversing cephalad, one pair is of the antero-dorsal nerves, each of which arises from the inner border of the cerebral ganglion but soon comes to lie close to the lateral margins of the body, innervating the oral rim. The other two pairs of nerves are ventral in position. Each antero-outer ventral nerve arises from the outer border of the cerebral ganglion; it proceeds inner to the antero-dorsal nerve



Figs. 1, 2. Diagrammatic representation of the nervous system in the whole worm. 1. Dorsal view showing the main nerves and the nerve net of the postero-dorsal nerve in the post cerebral region (nerve cells not drawn to scale). 2. Ventral view, showing the posterior ventral nerves and their nerve net.

ad-antero-dorsal nerve; aiv-antero-inner ventral nerve;
cg-cephalic ganglion; aov-antero-outer ventral nerve;
m-mouth; nc-nerve cell; ovp-opening of ventral pouch;
pd-postero-dorsal nerve; piv-postero-inner ventral nerve;
pov-postero-outer ventral nerve.

and immediately close to the pharynx, innervating the side walls and the rim of the latter. The antero-inner ventral nerves originate between the antero-dorsal and antero-outer ventral nerves. They extend only up to the middle length of the pharynx giving out many branches to supply its walls and lower half. All these nerves are connected to one another by transverse connectives encircling the pharynx. These rings get closer and denser towards the oral opening and together with numerous longitudinal connectives and their branches constitute a fine basket-like nerve net in the oral region (Figs. 4a and b). Fine branches from the transverse connectives also innervate the tegument in this area.

From amongst the three pairs of the posterior longitudinal nerves, the innermost (nearer the median axis of the body) comprises the postero-dorsal nerves (Figs. 3 and 5). These, on their way towards the acetabulum innervate the gut, the reproductive organs and the excretory bladder, also giving off branches to the tegument. In the region of the acetabulum the two postero-dorsal nerves of either side join with each other and innervate the middle portion and posterior edges of the sucker (Fig. 6). The postero-outer ventral nerves, running somewhat parallel to the lateral body margins, give off branches to the reproductive organs and parenchyma. Just a little ahead of the acetabulum each postero-outer ventral nerve bifurcates into two (Fig. 7), of which the inner branch meets its fellow of the outer side making a prominent transverse connective. From the latter, numerous fine branches proceed downwards ramify and supply the rim of the sucker (Fig. 8). The other branch of the postero-outer ventral nerve runs lateral to the acetabulum and terminates giving off branches to its lateral walls. The postero-inner ventral nerves, running between the dorsal and outer ventral nerves, in each longitudinal half of the body, supply the tegument, parenchyma, reproductive organs and also the excretory bladder. Before terminating in the floor of the acetabulum, this nerve joins the transverse connective of the postero-outer ventral nerves through a side branch. A dense nerve net contributed by the branches of the postero-outer and inner ventral nerves encircles the opening of the ventral pouch within which also terminate the genital ducts.(Fig. 9). The ventral pouch is innervated by the branches from all the posterior nerves. Each postero-dorsal nerve has transverse connections with the postero-outer ventral nerve of its side. Minute branches from these connectives are observed terminating in the tegument. The postero-outer ventral nerve is, likewise, connected to the postero-inner ventral nerve. All the three posterior longitudinal nerves are joined to their counterparts by means of numerous thin ring-like transverse connectives which in turn are connected to one another by still thinner longitudinal connectives. Thus a fine nerve net is formed on both the dorsal and the ventral sides of the worm (Fig. 10 and 11).

Numerous nerve cells (Fig. 10) resembling putative neurosecretory cells described in other paramphistome flukes (Mehrotra and Bhutia, 1979; Tandon and Bhutia, 1981) were observed in close vicinity of the various organs of the body. Under high resolution these cells reveal very fine connections with the nerve net or the main nerves.

The NSE activity is also strongly evidenced in the components of the excretory system and to a lesser extent in some parts of the reproductive system, viz., the ovary, Mehlis' gland complex, spermatocytes in the testes, seminal vesicle and pars prostatica. However, the pharynx, acetabulum and the genital pore region appear darkly stained because of the presence of dense nervous innervations in these areas.

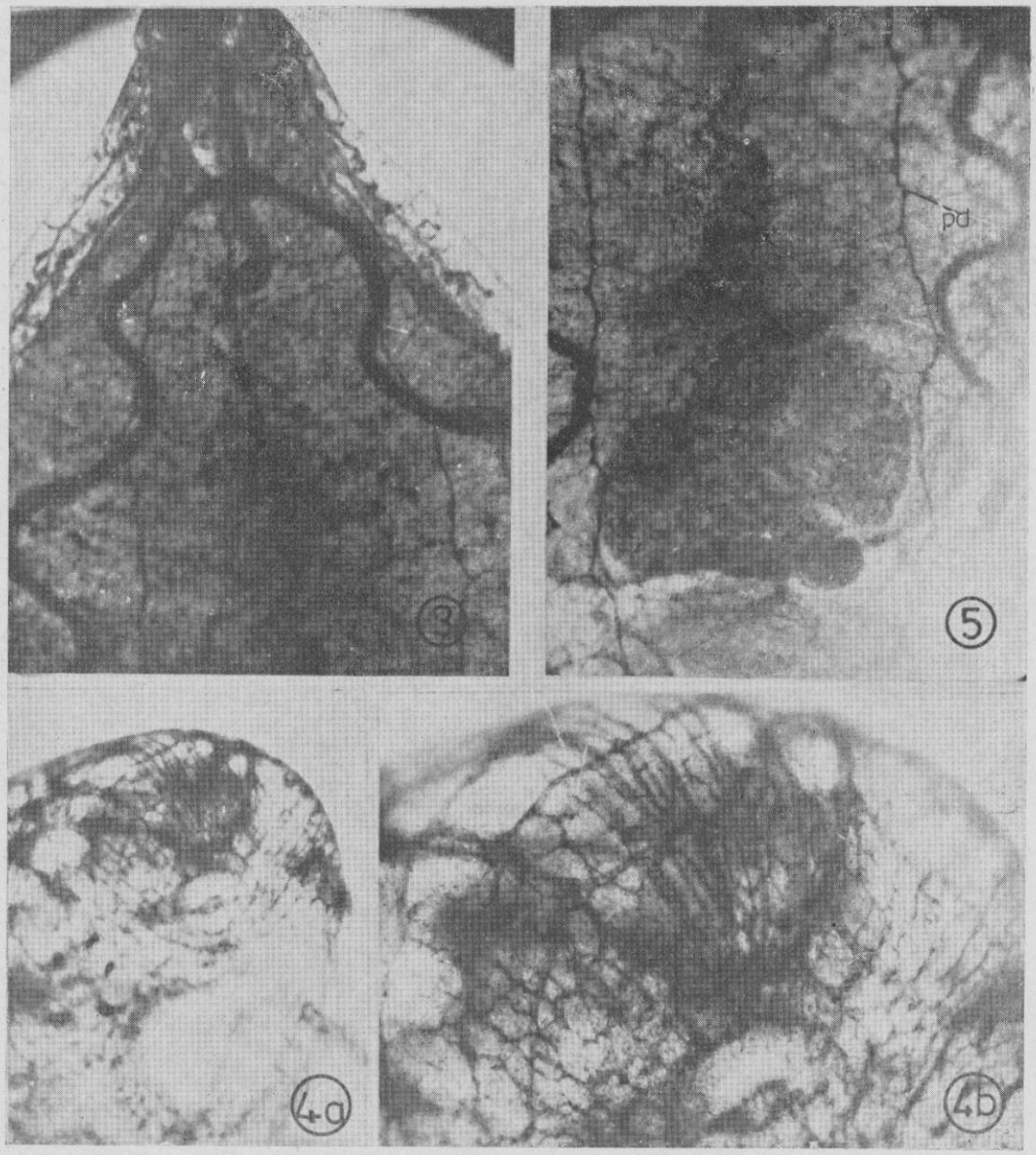


Fig. 3. Brain mass and the main anterior and posterior nerves×12.5. Fig. 4a. Nerve net in the oral region, in top view×30. Fig. 4b. A portion of the same under higher resolution. The ramification of the nerves between the transverse connectives is eviedent×68. Fig. 5. Postero-dorsal nerve and its net work in the posterior half of the body ×12.5.

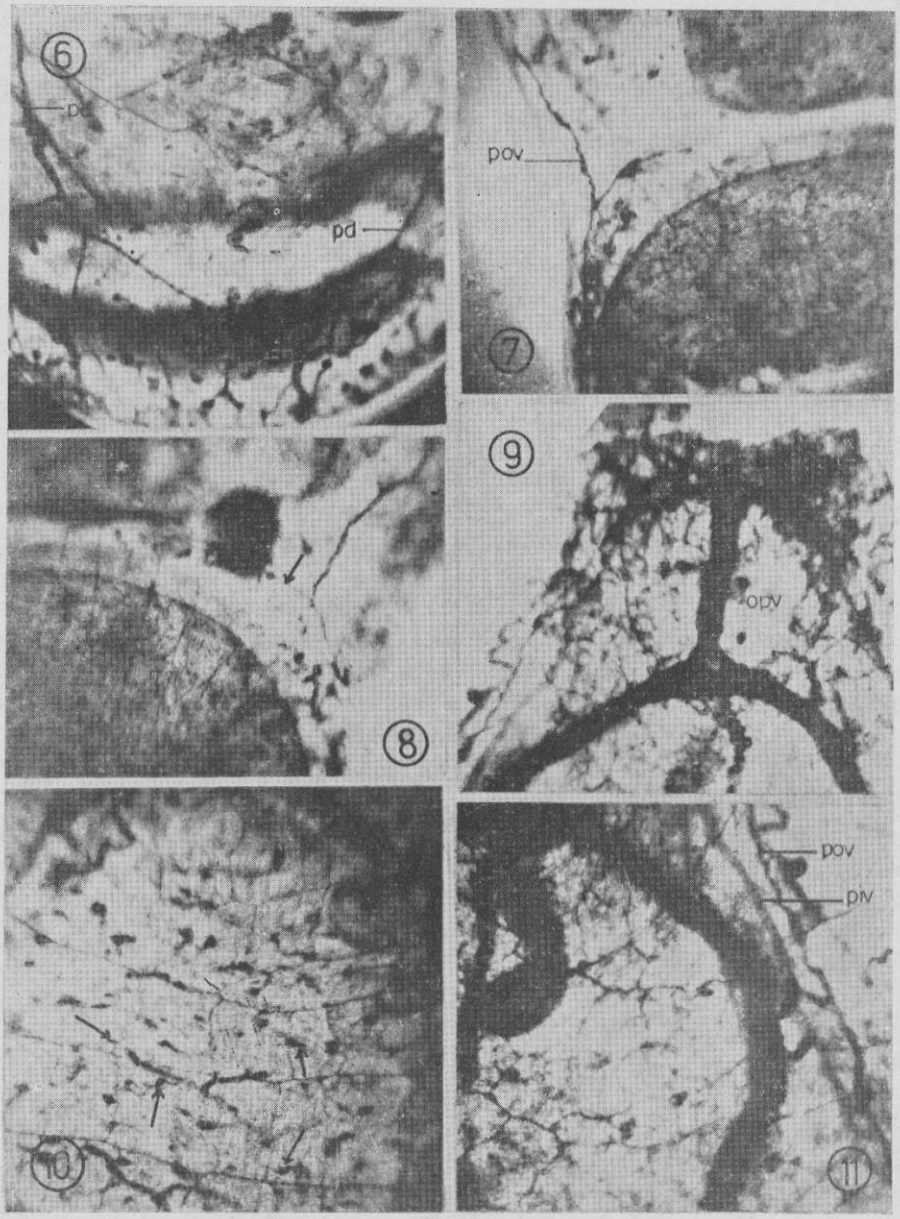


Fig. 6. Postero-dorsal nerves joining in the acetabular region ×23. Fig. 7. Postero-ou ventral nerve bifurcating in the acetabular region ×23. Fig. 8. Transverse connective (arrow) forn by the postero-ventral nerves just before the acetabulum. Fine branches from it are seen supplying latter X 30. Fig. 9. The dense nerve net around the opening of the ventral pouch × 23. Fig. Nerve net of the postero-dorsal nerve in the mid body region. Note the associated nerve cells (arro ×23. Fig. 11. Postero-ventral nerves and their nerve net in the anterior half of the body.

DISCUSSION

NSE of carboxylesterase group (E. C. 3.1.1.1.) hydrolyse the indoxylacetates (Pearse, 1972). The components of the nervous system of *F. cobboldi* were clearly visualized using this substrate for localizing NSE. However, Roy (1980) observed no NSE activity in the nervous system of *Ceylonocotyle scoliocoelium*, using napthyl acetate as the substrate. Similarly, in *Pharyngostomoides adenocephala* the nervous tissue lacks NSE activity (Allen and Harkema, 1972). In both these species acetylcholinesterase (AChE) activity was evidenced in the nervous system. For determination of the precise nature of NSE present in the nervous system of *F. cobboldi*, further investigations are under way.

Our observations tally with those of Gupta and Dutta (1967) only in respect of the basic number of the anterior and posterior nerves given off from the two cerebral ganglia. However, there are considerable differences with regard to the position and distribution of the posterior longitudinal nerves, as also the course of their branches. From their relative positions, the posterior lateral, dorsal and ventral nerves described by Gupta and Dutta (1967) correspond to the postero-outer ventral, postero-inner ventral and postero-dorsal nerves, respectively. Further, according to them it is only the posterior dorsal nerve (our postero-inner ventral) that reaches the acetabulum. In fact, all the posterior longitudinal nerves are seen terminating in the acetabulum.

The rich innervation of the acetabular, oral and genital pore regions is indicative of a strong nervous control on the muscular activity of these regions. Further, the concentration of fine tributaries of nerves, seen terminating toward the tegument in all these regions, suggests their association with the tegumental papillae, as reported in other paramphistome species (Tandon and Maitra, 1981, 1982).

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