

Nervous system in *Olveria indica*, a rumen paramphistome (Digenea) of bovines, as revealed by non-specific esterase staining

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ABSTRACT

On the basis of esterase localization the complete nervous system has been visualized in *Olveria indica* Thapar & Sinha, 1945, a paramphistome from the rumen of cattle, recorded for the first time from the north-east region of India. The basic number of posterior longitudinal nerves (i.e., 3 pairs) is the same as in other paramphistomes; four pairs of anterior longitudinal nerves are present, there being an extra pair of pharyngeal nerves. Conspicuous differences in the innervation patterns were observed, mainly in the innervation of the genital atrial region and acetabulum. The presence of prominent longitudinal connections, joining the anterior and posterior dorsal nerves and the anterior and posterior ventral nerves on either side, is a feature not hitherto found in other paramphistome species. The details of the course of all the nerves and their branches are discussed.

KEY WORDS: *Olveria indica*, nervous system, paramphistomes

INTRODUCTION

The technique of histochemical localization of non-specific esterases (NSE) described by HOLT & WITHERS (1952), has been successfully used in demonstrating the complete nervous system in trematodes (see MISHRA & TANDON, 1984). Recently, the complete nerve arrangement has been described in other digeneans (KISHORE & SHYAMASUNDARI, 1980; KRISHNA, 1981; RAO, *et al.*, 1982; SIMHA & FERNANDEZ, 1982, FERNANDEZ *et al.*, 1982; and KISHORE *et al.*, 1982).

Most of the available accounts on the topography of the nervous system of paramphistomes are based on the histological studies (GUPTA & DUTTA, 1967; LEE, 1971; ROY, 1980), but in *Fischoederius cobboldi*, the system has been visualized in whole flukes following the demonstration of NSE (MISHRA & TANDON, 1984).

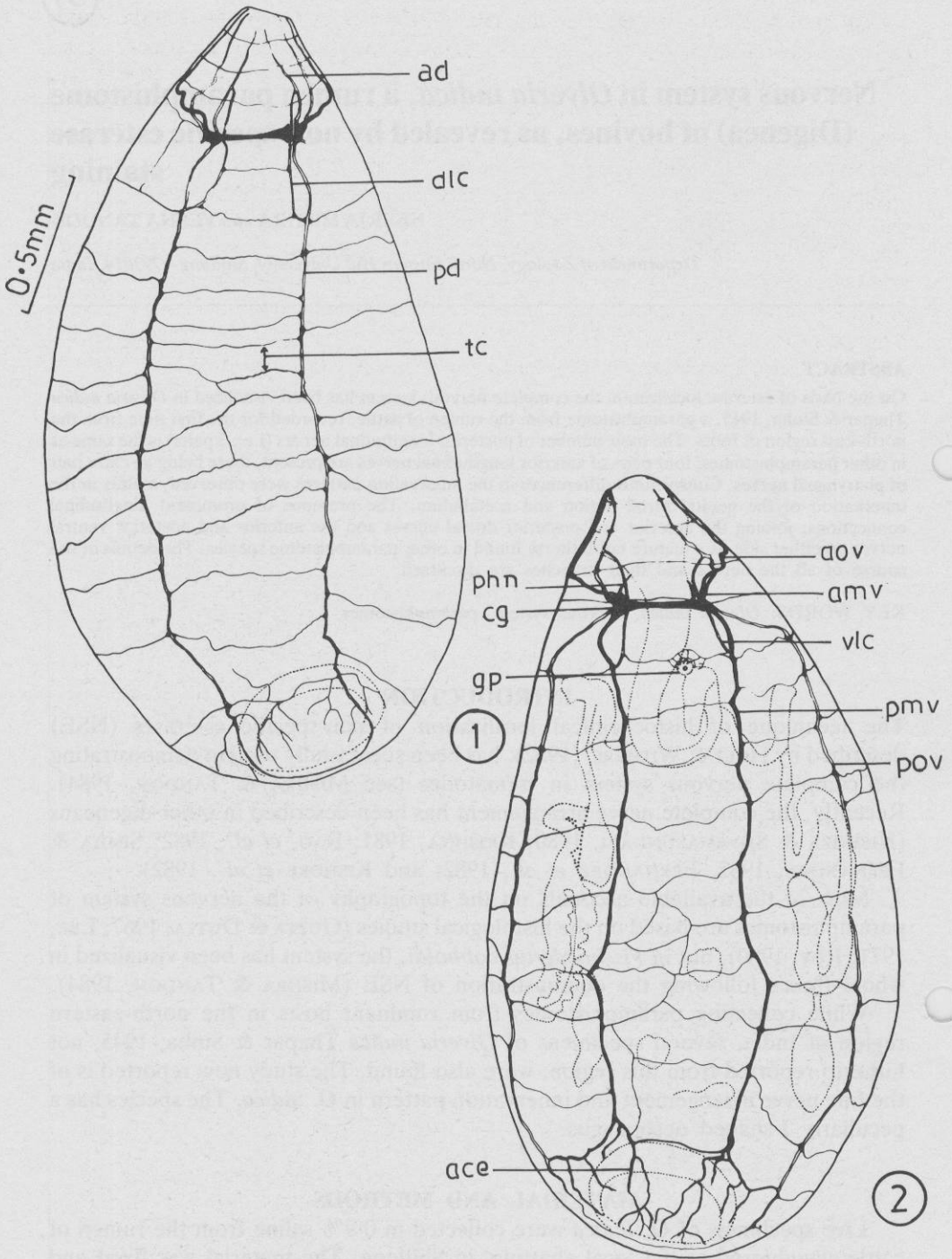
While collecting paramphistomes from ruminant hosts in the north-eastern region of India, several specimens of *Olveria indica* Thapar & Sinha, 1945, not hitherto reported from this region, were also found. The study now reported is of the fine nerve arrangement and innervation pattern in *O. indica*. The species has a peculiarly J-shaped oesophagus.

MATERIAL AND METHODS

Live specimens of *O. indica* were collected in 0.9% saline from the rumen of cattle slaughtered at the local abattoirs in Shillong. The material was fixed and processed for localization of NSE as described elsewhere (MISHRA & TANDON, 1984).

OBSERVATIONS

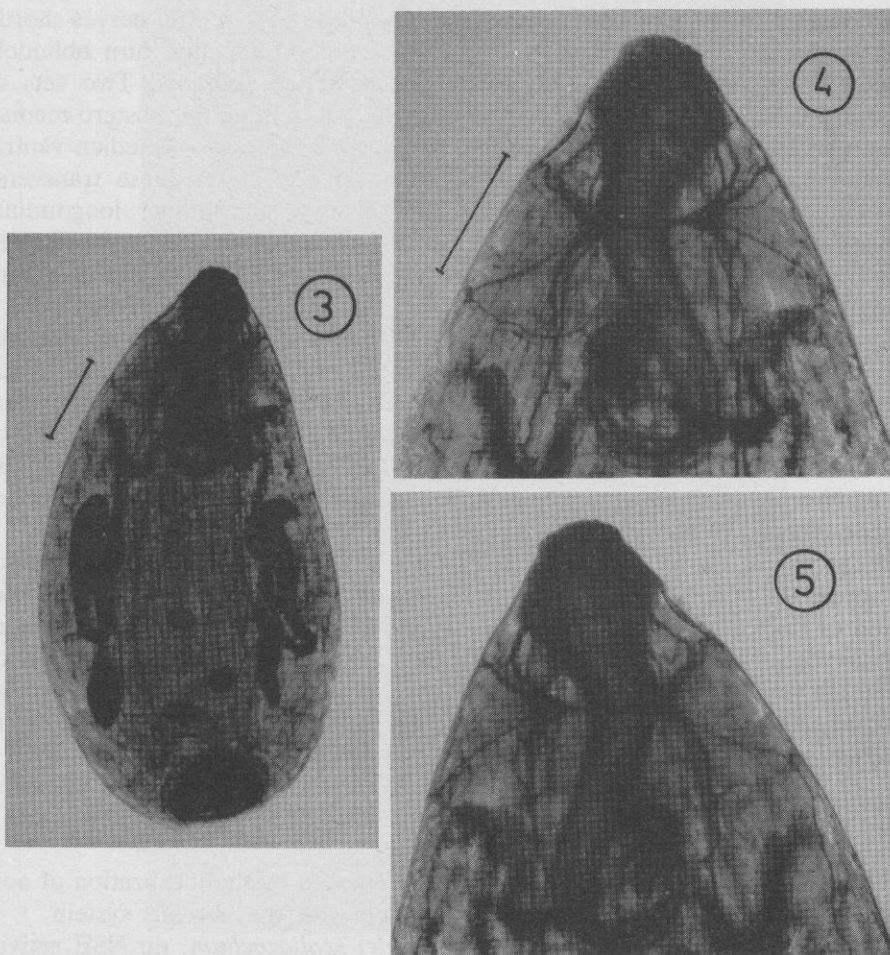
The nervous system of *Olveria indica* comprises one pair of cerebral ganglia and four pairs of anterior and three pairs of posterior longitudinal nerves (Figs. 1, 2 and 3).



FIGS. 1, 2. Diagrammatic representation of the nervous system in *Olveria indica*. 1. Dorsal view, showing the main nerves and the nerve net of the postero-dorsals in the post cerebral region. 2. Ventral view, showing the posterior ventral nerves and their nerve net.

ad—antero-dorsal nerve; amv—antero-median ventral nerve; cg—cerebral ganglion; aov—antero-outer ventral nerve; gp—genital pore; dlc—dorsal longitudinal connective; pd—postero-dorsal nerve; pmv—postero-median ventral nerve; pov—postero-outer ventral nerve; ace—acetabular nerve; phn—pharyngeal nerve; tc—transverse connective.

The two cerebral ganglia are connected by a stout dorsal transverse commissure and are situated immediately behind the pharynx and dorsal to the oesophagus. From the cerebral ganglia four pairs of longitudinal nerves proceed cephalad (Figs. 4 and 5). Of these, the innermost pair are the small, stout pharyngeal nerves which, shortly beyond their origin, penetrate the pharynx at its postero-lateral margins. The remaining three pairs of anterior longitudinal nerves include the antero-dorsal, antero-median ventral and antero-outer ventral nerves, named according to their emergence from the cerebral ganglia. The antero-dorsal nerves of either side arise from the dorsal side of the cerebral ganglia in between the pharyngeal and antero-median ventral nerve and proceed to the oral tip, where they become gradually thinner and finally peter out in the tegumental parenchyma. The two pairs of anterior ventral nerves are particularly well developed and arise from the ventro-anterior part of the cerebral ganglia. Of these, the median ventral nerve, shortly beyond its origin, separates from the pharynx and, running parallel to the lateral body wall, reaches to the oral extremity, while the outer ventral nerve runs laterally to the pharynx. All the anterior longitudinal nerves, but the pharyngeal nerves, are interconnected with one another by means of two or three thin



FIGS. 3-5. *Olveria indica*—Photomicrographs of the nervous system. 3. Complete nervous system in the whole worm, (scale bar=0.4 mm); 4-5. Brain mass and the main anterior and posterior nerves, 4. as seen in dorsal view, and 5. as seen in ventral view. (scale bar=0.3 mm; same scale in Figs. 5-8).

transverse connections. Of the anterior nerves, only the pharyngeal nerves are deep-seated in the parenchyma, the others being superficially located.

The post-cephalic longitudinal nerves consist of a pair of postero-dorsals and two pairs of postero-ventrals (Figs. 4 and 5). The postero-dorsals originate from the middle facet of the cerebral ganglia and proceed posteriad; on their way to the acetabulum fine branches from these nerves innervate the gut, the reproductive system and the excretory bladder (Fig. 4). The postero-dorsals of the two sides are joined with each other by thin transverse connectives throughout their course; the connectives in turn are further connected to one another by two or three still thinner longitudinal connectives in some places (Fig. 6). Each postero-dorsal is also joined with the postero-outer ventral on the same side by means of another set of transverse connectives. A prominent longitudinal connective joins the postero-dorsal nerve with the antero-dorsal on the same side a short distance behind the cerebral ganglia. In the acetabular zone, the branches of the postero-dorsals innervate the floor and lateral walls of the acetabulum. The two nerves extend to the posterior extremity of the body where they join medially (Fig. 8).

Of the posterior ventral nerves, the two postero-median ventral nerves arise from the inner facet of the cerebral ganglia, proceed downwards close and parallel to the median axis of the body, whereas the postero-outer ventral nerves shortly after their origin from the lateral edge of the cerebral ganglion turn obliquely towards the lateral body-wall and then run posteriad (Fig. 5). Two sets of transverse connectives join the postero-ventrals, one joining the postero-median ventrals of either side and the other interconnecting the postero-median ventral with the postero-outer ventral on each side. At few places these transverse connectives are also interconnected by one or two still thinner longitudinal connectives. Thus, on the ventral surface of the body a nerve net is also formed (Fig. 7). The branches from the postero-ventrals supply the ventral tegument, gut, the reproductive system and the excretory bladder. However, the genital pore is solely supplied by a pair of transverse genital nerves derived from the postero-median ventrals. The genital nerves of both the sides join just anterior to the genital pore forming an arch. Minute branches from the latter approach the genital pore.

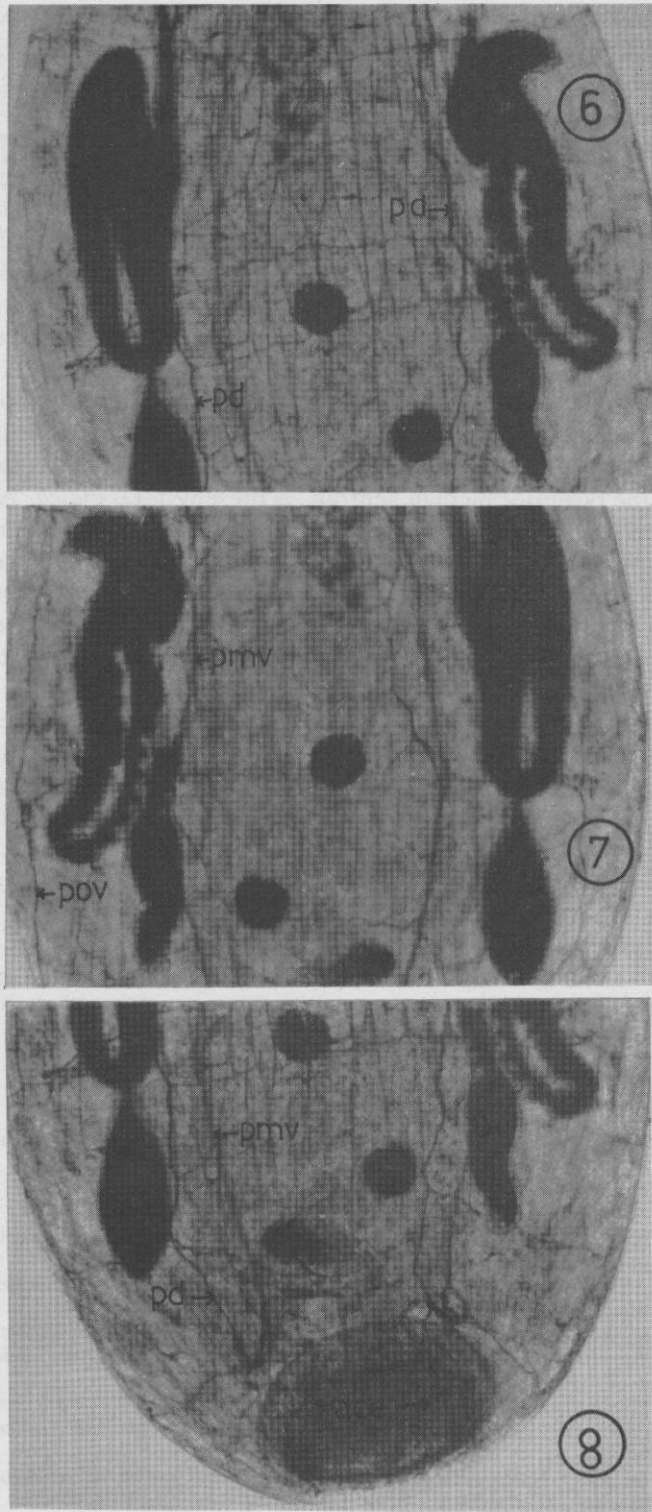
In the region immediately anterior to the acetabulum all the postero-ventrals join one another. The postero-median ventrals proceed further as acetabular nerves, branches from which supply the different regions of the sucker (Fig. 8).

A longitudinal connective, similar to the one occurring between the postero- and antero-dorsals, joins the postero-median ventral nerve with the antero-outer ventral of the same side, at the level a little away from the point of their origin. With a slight increase in the concentration of the substrate (5-bromoindoxyl acetate) in the incubation medium a superficial network of longitudinal and circular fibres in the tegument are also revealed, as described by LEFLORE (1979) in cercariae of *Plagiorchis elegans*.

DISCUSSION

The neuroanatomy of *O. indica* has been revealed by the localization of non-specific esterases, well known to be associated with the nervous system.

However, in *Orthocoelium* (= *Ceylonocotyle*) *scoliocoelium*, no NSE activity was found by ROY (1980) who detected acetylcholinesterase activity in the nervous system (ROY, 1980). A comparison of the nerve pattern in *O. indica* with that in other paramphistomes, namely, *Fischoederius elongatus*, *Gastrothylax crumenifer*



FIGS. 6-8. *Olveria indica*—photomicrographs of the nervous system. 6. postero-dorsals and their nerve net in the middle-third and testicular region of the body. 7. postero-outer and postero-median ventrals in the same region. 8. Termination of the posterior longitudinal nerves in the acetabular region.

and *F. cobboldi* (studied by LEE, 1971; BRANDES, 1898; MISHRA & TANDON, 1984) shows several differences and some general resemblances. The presence of a pair of pharyngeal nerves, in addition to the usual three pairs of anterior longitudinal nerves, has been described in *F. elongatus*, *Parorientodiscus magnus*, *Paramphistomum calicophorum* (LEE, 1971) and *G. crumenifer* (BRANDES, 1898) but not in *F. cobboldi*. The presence of a conspicuous nerve-basket encircling the pharynx is a prominent feature of the last-named species, whereas in the present study and also that of LEE (1971) the main anterior nerves, except the pharyngeal nerves, are interconnected by means of only two or three transverse connectives.

The occurrence of three pairs of posterior longitudinal nerves is the most constant feature of the paramphistome species investigated so far (referred to as above).

All the posterior main nerves contribute towards the formation of the ventral and dorsal surface network. Similarly, all the posterior main nerves innervate the acetabulum. However, this pattern is variable; a conspicuous acetabular nerve, derived from the posterior median ventrals, is present in *O. indica*. An acetabular nerve has been reported by LEE (1971) in *F. elongatus*, *Parorientodiscus magnus* and *Paramphistomum calicophorum*. In these species, like in *O. indica*, the genital nerves are also described. However, in *F. cobboldi* fine branches from transverse connectives of the main posterior nerves supply the acetabulum and the genital nerves are absent (MISHRA & TANDON, 1984). The latter were not reported in *G. crumenifer* by BRANDES (1898).

The two sets of longitudinal connectives, one between the antero- and postero-dorsals and the other between the antero-outer ventral and postero-median ventral as observed in *O. indica*, are also described in *Paraorientodiscus magnus* and called accessory nerves by LEE (1971). These longitudinal connectives do not occur in *F. cobboldi* (MISHRA & TANDON, 1984).

ACKNOWLEDGEMENTS

The authors are indebted to Professor J. P. Thapliyal, Head, Department of Zoology for providing laboratory facilities. The award of a senior research fellowship to one of the authors (NM) is thankfully acknowledged.

REFERENCES

- BRANDES, G. (1898) Die Gattung *Gastrothylax*. *Abhandlungen der Naturforschenden Gesellschaft zu Halle*, **21**, 183–225.
- FERNANDEZ, H., RASHEED, U. & SIMHA, S. S. (1982) Nervous system of *Singhiatrema najai*. *Indian Journal of Parasitology*, **6**, 303–305.
- GUPTA, N. K. & DUTTA, T. (1967) On *Fischoederius cobboldi*—a pouched amphistome from cattle in India. *Research Bulletin (N.S.) of Panjab University*, **18**, 41–52.
- HOLT, S. J. & WITHERS, R. G. J. (1952) Cytochemical localization of esterases using indoxyl derivatives. *Nature*, **170**, 1012–1014.
- KISHORE, B. & SHYAMASUNDARI, K. (1980) Nervous system and neurosecretory cells in a trematode: *Encyclometra colubrimurorum* (Digenea-Plagiorchiidae). *Indian Journal of Parasitology*, (1980) **3** (Supplement) 130 pp.
- KISHORE, B., SHYAMASUNDARI, K. & HANUMANATHA RAO, K. (1982) Observation on the nervous system of *Euparadistomum herpestes*. *Proceedings of National Academy of Sciences of India*, **52**, (B), 11.
- KRISHNA, G. V. R. (1981) Esterase localization and nervous system in *Echinostoma revolutum*. *Indian Journal of Parasitology*, **5**, 191–193.
- LEE, S. K. (1971) A light microscopic study of the nervous system of three species of amphistomes (Trematoda: Paramphistomidae). *Zoologischer Anzeiger Leipzig*, **187**, 1–25.
- LEFLORE, W. B. (1979) Histochemical observations on hydrolytic enzymes in cercariae of *Plagiorchis elegans*, with notes on morphology of the nervous system. *Transactions of the American Microscopical Society*, **98**, 225–232.

- MISHRA, N. & TANDON, V. (1984) Nervous system in the bovine pouched paramphistome, *Fischoederius cobboldi* (Trematoda: Digenea) *Indian Journal of Parasitology*, **8**, 33-39.
- RAO, S. L., KRISHNA, G. V. R. & SIMHA, S. S. (1982) The nervous system and esterase distribution in *Schistosoma spindalis* (Trematoda). *Current Science*, **51**, 363-365.
- ROY, T. K. (1980) Cytochemical studies of esterases in the bovine *Ceylonocotyle scoliocoelium*. *Indian Journal of Experimental Biology*, **18**, 872-876.
- SIMHA, S. S., & FERNANDEZ, H. (1982) The nerve arrangement in *Isoparorchis hypselobagri* Billet, 1898. *Indian Journal of Parasitology*, **6**, 207-209.
- THAPAR, G. S. & SINHA, B. B. (1945) On the morphology of a new genus of amphistomes from the rumen of cattle in the United Provinces. *Indian Journal of Veterinary Sciences and Animal Husbandry*, **15**, 219-221.

Accepted 21st August, 1985.