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Research Article

A comparison between representative types of Platyhelminthes in their nervous components

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ABSTRACT

A trial was made during this investigation to explore the nervous systems in some representatives of the main platyhelminthes groups, turbellarians, digeneans, monogeneans and cestodes. . *Mesostoma ehrenbergi* and *Udonella caligorum* were selected as representative of turbellarians,in addition to *Temnocephala fulva*, *Phyllodistomum folium* and *Gorgodera vitelliloba* as digeneas, *Khunia scombri* as monogenean, and a cyclophyllid *Hymenolepis diminuta* and a tetraphyllid, *Phyllobothrium pirieri*, as cestodes, using enzymatic technique(acetylthiochole iodide for esterases) . The nerves distribution, including both cerebral ganglia and their anterior connections and posterior nerve trunks, of each species, are given as revealed by this enzymatic technique.

KEYWORDS

Helminthes, nervous system, enzymatic technique

INTRODUCTION

In the book written by Bullock and Horridge (1965) a chapter was devoted of the nervous structure of platyhelminth groups, most of their demonstration using ordinary laboratory stains such as methyline blue. Recently published book by Roberts and Janovy (2009) gave demonstrations on the nervous systems of some helminthes.

Anyhow, studies on turbellarian nervous systems were done by many investigators (Hickman, 1967; Koopowitz and Chien, 1974; Moraczewski et al.,1977; Faisst et al. 1980; Keenan et at.1981). Furthermore, advanced techniques have been used on turbelarians to detect amide-related peptides (Maule et al.1994).

Nervous systems of digeneans have been carried out by using histological techniques for adults (Kolmogorova 1959; Rohde 1968; Lee 1971; Jennings and LeFlore 1972),while studies on the nervous system of cercariae were also carried out (Shyamsundari and Rao 1975; Zdarska 1975; Bhatangar et al 1980) ,while those using enzymatic techniques (Halton 1967; Ramisz and Szankowska 1970; LeFlore 1979; Grabda-Kazubska and Moczon, 1981). Rahemo (1990) a study was carried out on nervous system and chaetotaxy of *Cercaria paludinae* using both enzymatic and silver nitrate impregnation techniques . Digeneans obtained from frogs were studied for their nervous structures (Mohammad and Rahemo 1993). Arafa et al. (2002) a work was done on cholinergic components of the nervous system of a digenea, *Haplorchoides cahirinus* and *Acanthostomum absconditum* .A recent technique was applied studied the gross anatomy of the muscle systems and associated innervation of *Apatemon cobiridis proterohini* metacercaria as visculized by confocal microscopy (Stewart et al., 2002) .

Researches on monogenean nervous system using ordinary techniques started by Goto (1894), and Andre (1910), some noteworthy studies of individual monogeneans have been published: Halton and Jennings (1964) on *Diplozoon paradoxum*, Rohde (1968) on *Polystomoides malayai*, on *Diclidophora merlangi* using both conventional and enzymatic techniques (Halton and Morris, (1969). Rahemo and Gorgees (1987) made a detailed description of the nervous system of *Polystoma intregerrimum* was given. In experiments of Lyukshina and Shinov (1988) biogenic amines were detected in the nervous system of *Eudiplozoon nippoicum*. Furthermore El-Naggar et al. (2001) studied the nervous system and chaetotaxy of *Macrogyrodactylus clarii* and *M. congolensis* with a note on argentophilic elements in the nervous system. Zurawski et al. (2001) by using immune-microscopical techniques traced the nervous system of *Eudiplozoon nipponicum*. The cholinergic components of the nervous system of *Pseudodactylogyrus bini* and *P.anguillae* from the eel *Anguilla anguilla* in Nile Delta waters have been investigated by Reda and Arafa (2001),

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while El-Nagar et al. (2004) studied the nervous system of the monogenean fish parasite, *Macrogyrodactylus clarii*. Recently Rahemo, (2012) published a research about nervous system of four peculiarly clamped monogeneans namely *Gastrocotyle trachuri*, *Microcotyle donovani*, *Axine belones* and *Pseudaxine trachuri*, and it has been concluded that the haptor innervations of the four monogeneans studied cope with the modification of haptor with its armature.

Most important work on cestodes gross morphology using classical histological techniques was carried out (Rees, 1963, 1969; Rees and Williams, 1965; Schardein and Waitz, 1965). Some others using ultrastructural study revealing some nervous elements (Schardein and Waitz, 1965 ; Wilson and Schiller, 1969), or using enzymatic techniques such (LeFlore and Smith, 1976; Krishna and Simha (1980). Two cestodes collected from birds were also investigated for their nervous system using enzymatic techniques (Rahemo, 1993). Furthermore, the nervous system of *Raillietina echinobothrida* was studied using acetylthiocholine activity and anthelmintic efficacy of certain plant extracts (Pal and Tandon(1998).

The aim of the present study is to make a comparative study on the nervous system using enzymatic techniques of a selected types of Platyhelminthes groups namely, *Mesostoma ehrenbergi* and *Udenella caligorum* representing turbellarian and *Temnocephala fulva*, *Phyllodistomum folium* and *Gorgodera* vitelliloba representing digeneans, *Kuhnia scombri* representing monogenean, and *Phyllobothrium pireri* and *Hymenolepis nana* representing cestodes.

MATERIALS AND METHODS

Specimens of *M. ehrenbergi* were taken from laboratory of genetics, University of Birmingham, UK.

U. caligorum is found on parasitic copepod, *Caligus minimum* which infects the buccal cavity of the bass *Dicentrarchus labrax*, obtained from marine biological station at Plymouth.

T. fulva lives on the exoskeleton of the Tasmanian crayfish, *Parasitacoides tasmanicus*.

K. scombri from makrel, *Scomber scombrus* obtained from marine biological station at Plymouth, UK.

P. folium recovered from urinary bladder of three-spine stickleback and *G. vitelliloba* were collected from the urinary bladder of the toad.

H. nana collected from the intestine of white laboratory rats.

Specimens were fixed in 10% formalin, then washed in water, and incubated in the working solution of acetylethiocholine iodide for esterases (Gomori, 1952).

RESULTS & DISCUSSION

Turbellaria

The nervous system of ***Mesostoma ehrenbergi*** (Fig.1) consists of two prominent cerebral ganglia connected to a pair of eyes which lie just dorsal to these ganglia. Two large nerves arise from these ganglia to supply the antero-lateral most part of the worm, and 2 less prominent nerves pass posteriorly. These posterior nerves end in the posterior third of the body. The nervous system of *M. ehrenbergi* has a very characteristic feature which is the presence of a coarse-meshed plexus making a superficial cover all over the body. This plexus is connected to the anterior and posterior nerve cords, and becomes more dense near the anterior end of the anterior pair of nerves, possibly to be connected to many nerve endings, since this area is an exploratory region of the animal to detect its food and surroundings. The presence of coarse-meshed plexus making superfacial cover all over the body is similar to that found in other flatworms (Koopowitz and Chien, 1974).

Udonella caligorum (Figs. 2, 3)

The nervous system of *U. caligorum* is similar in its basic pattern to that of monogeneans, but instead the ventral nerve cord becomes stout before entering the posterior sucker and giving off fine nerves to supply this sucker. The supply of posterior sucker is similar to innervation supply in monogeneans (Rahemo, 2012)but no such supply was found in digeneans (Smymsmsundari and Rao, 1975; Mohammad and Rahemo, 1993) which may indicates it close relation to monogeneans than to digeneans.

Temnocephala fulva (fig 4).

The main character of the nervous system of *T. fulva*is is that, in addition to the three usual nerve trunks namely the ventral, lateral and dorsal nerve cords there are 2 other nerve cords situated close to the lateral margins of the animal. All these cords are connected together by many transverse commissures to give a network appearance. The other interesting feature of *T. fulva* is the prominent innervation of the anterior tentacles, "anterior lobe" and the posterior sucker. The posterior sucker has characteristic radial nerves. Innervation of the anterior lobes "tentacles" are expected since these organelles are exploratory organelles to the animal to detect its surrounding, similar to the high innervation observed in *M. ehrenbergi*. The high number of nerve cords and transverse commissures detected in this worm is similar to the high number of nerve cords present in cestodes which may reach more than 60 (Bulock and Horridge, 1965).

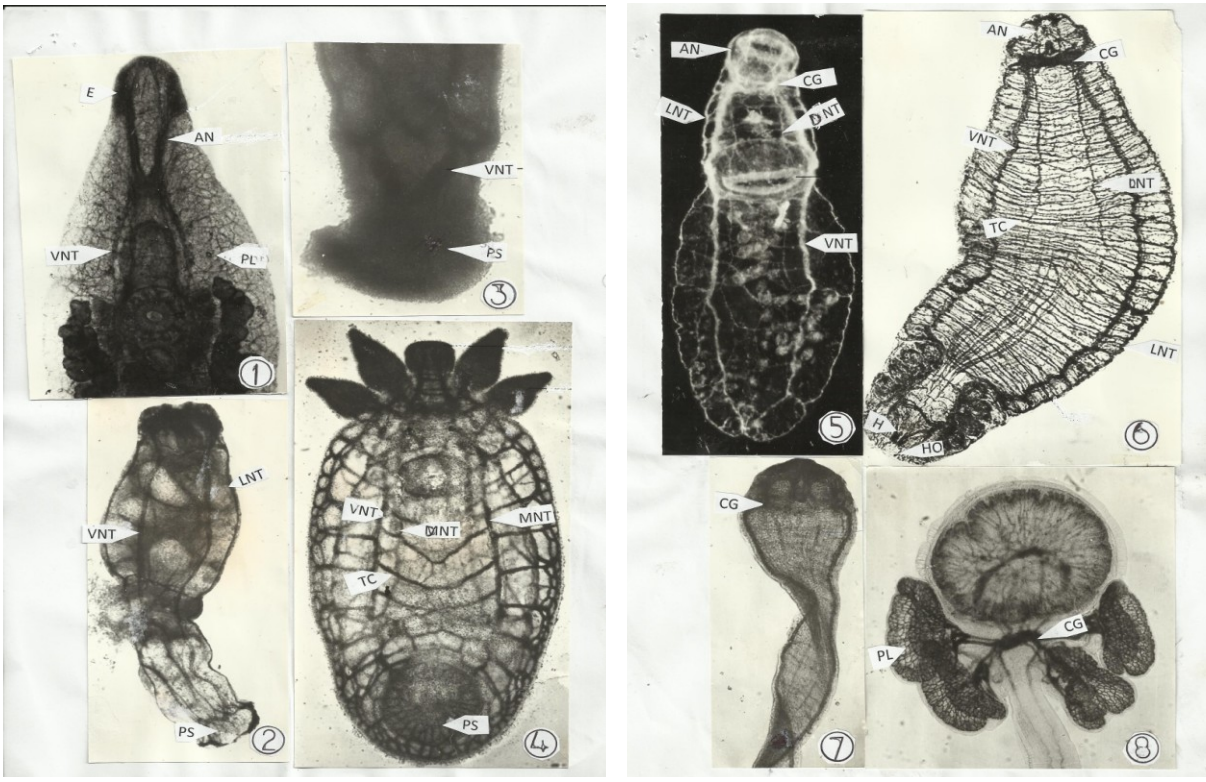

Fig.(1): Photomicrgraph (transmitted light)of *M. ehrenbergi* showing its nervous system as revealed by acetylthiocholine iodide technique(AcThT);abbreviations see below .**Fig.(2):** -- *U. caligorum* --. **Fig.(3):** ---in the posterior end of *U. caligorum* --. **Fig**.(4); --- *T. fulva*--- .**Fig.(5);** -- Epi-illumination of P. folium. **Fig.(6);** --- of K. scombri---. **Fig.(7);** --anterior end of *H. diminuta*.**Fig.(8);** --scolex of *P. pirieri*-- .

Abbreviations: AN: anterior nerve ;CG: cerebral ganglia; DNT: dorsal nerve trunk; E: eye;H: hamuli; HO; hooks ; LNT: lateral nerve trunks; MNT: median nerve trunk; PL: plexus; PS: posterior sucker; PHG: pre-haptoral ganglia; TC: transverse commisurre; VNT: posterior nerve trunk.

Digenea

The nervous system of ***Phyllodistomum folium*** (Fig.5) consists of 2 cerebral ganglia which give off 3 pairs of small anterior nerves to supply the oral sucker and 3 pairs of prominent nerves anteriorly, namely ventral, lateral and dorsal, to supply the main body parts. From the ventral nerve cords two ventral commissures arise near the ventral sucker and surround it on all sides and then send fine nerves to the sucker. The sucker itself has an intrinsic nerve ring which sends a number of radiating nerves anteriorly. In addition a few multipolar cells are present near the inner border of the ventral sucker. It is worthy of note that *P. folium* has numerous ganglia just beneath the body surface with some commissures connecting them (commissural ganglia). Similar pattern of innervations were recovered in other digeneans such as *Ceylonocotyle scoliocoelium* by Bhatangar et al., 1980, *Fasciola hepatica* and *Dicrocoelim dendriticum* by Ramisz and Szankowska (1970)., and others.

The nervous system of ***Gorgodera vitelliloba*** is very similar to that of *P. folium*, including the network of commissural ganglia near the surface of the body. The innervation recovered in this study is very similar to same species parasitizing frog, studied in Iraq(Mohammad and Rahemo, 1993).In general the digeneans examined in this investigation are similar to in their nervous system to the generalized pattern of trematode nervous system reported by Roberts and Janovy, 2009).

Monogenea

The nervous system of ***Kuhnia scombri*** (Fig.6) consists of two cerebral ganglia giving off 2 -3 pairs of anterior nerves to supply the anterior feeding/ attachment organs and 3 pairs of prominent posterior nerves. The three pairs of posterior nerve trunks fuse together forming two pre-haptoral ganglia from which 2 main nerves arise to supply the main attachment organ, the posterior haptor, an organ corresponding in function to the scolex of cestodes and the ventral sucker of digeneans. The nervous system of monogenean is modified according to the type of haptor and its attachment organs. The haptor of *K. scombri* possesses four pairs of clamps and the posteriormost part of the haptor(the languette) has one pair of large hamuli and 2 pairs of small persistent marginal hooks. After the usual fusion of the ventral, lateral and dorsal nerve cords, immediately anterior to the haptor, 2 main nerves arise which run along each side of the haptor. These nerves, after supplying each of the 4 pairs of clamps, run posteriorly and supply each hamulus with 2 nerves, one of them being more prominent and supplying the gurd(spur) muscles of the hamuli, forming a large irregular ring, while the other, which is less prominent, supplies the proximal end of the hamulus by fusing with the tendons of the posterior muscles present near the proximal region of the hamulus. Similar results were obtained in four peculiarly-clamped monogeneans, such as *Gastrocotyle trachuri*, *Microcotyle donovani*, *Axines belones Pseudoaxine trachuri* (Rahemo, 2012) and in *Macrogyrodactylus clarii* a gill parasite Nile catfish.

Cestoda

In the two species studied, ***Hymenolepis diminuta*** and ***Phyllobothrium pirieri*** the main concentration of the nervous system is in the scolex. The scolex itself exhibits different forms in different groups of cestodes as observed in the cyclophyllid and tetraphyllid studied in the present investigation. From the two cerebral ganglia present in the scolex of *H. diminuta* many nerves arise to supply the four suckers .In the tetraphyllid, the cerebral ganglia are connected together by a short thick transverse commissure. From each ganglion 2 pairs of nerves arise to supply the two bothridia on each side. The terminal sucker receives about 5 fine nerves. It is worthy of note that the bothria have a nerves network resembling the venation of plant leaves. Through each segment of the tetraphyllid and cyclophyllid examined there are four pairs of nerves: the main nerve trunk is the lateral and 3 pairs of slender median nerve cords are present. At the posterior end of each segment the lateral nerve trunk swells into a small ganglion. Many fine commissures are present connecting the main nerve trunk. Anyhow details of scolex innervations of *P. pireri* is comparable to those reported by Roberts and Janovy, (2009) in *Acanthobothrium coronatum*. Similar innervation of scolex and the presence of numerous longitudinal nerve cords and transverse commissures were also seen in *Oochritica sigmoides* and *Raillietina tetragona*, and in fowl tapeworm, *Raillietina echinobothria* (Gomori, 1952)

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