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Effects of desiccation on the ventral nerve cord-neurosecretory system of tropical earthworm, *Metaphire peguana* (Rosa, 1890)

D K NANDA, P S CHAUDHURI and A K BEJ

Department of Zoology, Calcutta University, 35, Ballygunge Circular Road, Calcutta 700019, India

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Abstract. Desiccation engenders "super elevation" in the osmotic concentration of the body fluid which eventually provokes characteristic alterations in the functional activity of the ventral nerve cord-neurosecretory system. Enhancement in the number of deep stained cells and partial to acute depletion in association with interruption in axonal transport in moderately stained cells are some of the interesting features revealed in course of this investigation. The results indicate a correlation between the neurosecretory mechanism and ecophysiological bearing.

Keywords. Axon-hillock; desiccation; *Metaphire peguana*; neuropile; secretory cycle.

1. Introduction

Neurosecretory control of osmoregulation is well documented for invertebrates (Ude 1964; Kamemoto 1976; Maddrell 1976; Ferraris 1979). In the temperate earthworm, *Eisenia rosea*, characteristic changes in brain neurosecretory cells are observed under the condition of desiccation (Aros and Bodnar 1960). According to Zimmermann (1971), both aminergic and peptidergic neurones of the supraoesophageal ganglion are considered to be indispensable for the regulation of the osmotic balance of dehydrated worms, *Lumbricus terrestris*. Later, Carley (1975, 1978) found that in *L. terrestris* the neurosecretory principle from brain influences the osmotic and ionic regulation by changing the functional activities of integument or nephridia in dehydrated worms. Furthermore, he observed that injection of suboesophageal ganglion and ventral nerve cord homogenates reduces water exchange below levels of brainless animals and opined that "active factor" in addition to brain, may also be present throughout the central nervous system of *Lumbricus terrestris*.

The object of the present investigation is to record the effects of desiccation on the ventral nerve cord-neurosecretory system of *Metaphire peguana* and ascertain their involvement in the phenomenon of osmoregulation from the standpoint of micro-morphological alterations and secretory dynamics.

2. Material and methods

Twenty fully-grown earthworms, *Metaphire peguana* (average length 120 mm) were collected from the neighbourhood of Calcutta and acclimated to laboratory conditions (temperature 28°C and RH 88%) for 4 days. On the fifth day, 10 worms were segregated and allowed to remain in oven-dry soil for 48 hr in a petridish. The container with its

open end covered by a porous lid was transferred to a dark place so as to avoid the effect of light. The remaining 10 worms, serving as control, were maintained in a similar condition except that the petridish contained a bed of natural moist soil. The ventral nerve cord comprising suboesophageal ganglion and some anterior ventral ganglia (30–40 ganglia) both of experimental and control groups were fixed in Bouin's fluid. The sections (7 μm thick) were stained with aldehyde fuchsin following acid permanganate oxidation (Cameron and Steele 1959).

3. Observations

3.1 *Control*

Majority of the neurosecretory cells of the ventral nerve chain show various phases of secretory activity (figures 1 and 2), determined on the basis of their staining intensities

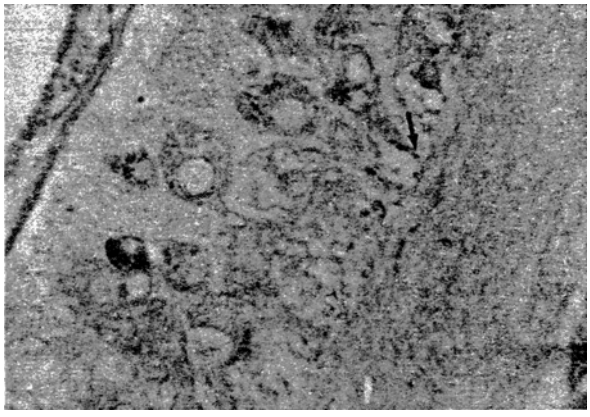

Figure 1. Control section of the ventral ganglion of earthworm, *Metaphire peguana* showing disposition of AF-positive neurosecretory cells. Note the axonal transport of NSM in some cells and their confluence with the margin of the neuropile (× 532).

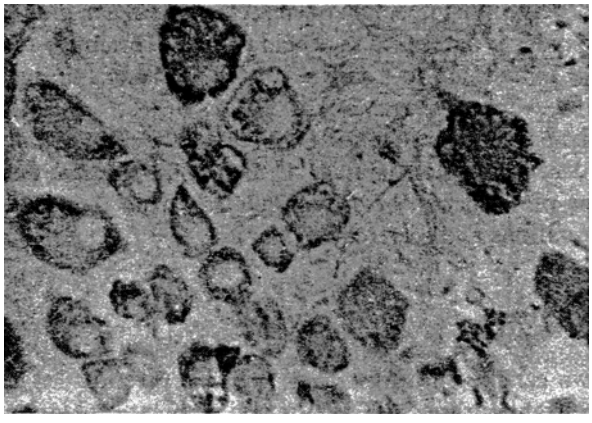

Figure 2. Control section of the suboesophageal ganglion showing the fluctuating content of secretory inclusions in the AF-positive neurosecretory cells (× 532).

(Nanda and Chaudhuri 1982). Relatively small deep-stained cells being distributed beneath the neural lamella usually do not exhibit detectable cytoplasmic inclusions and bear more or less homogeneously stained cytoplasm. Large moderately-stained cells, lying between the deep-stained cells and the neuropile proper, show graded amount of secretory inclusions in the form of clusters and cytoplasmic vacuoles of various dimensions. Some of these categories exhibit axonal transport and subsequent release. There is seldom evidence of rich accumulation of NSM both at the margin of the neuropile and the outer periphery of the ganglia.

3.2 Experimental

Desiccation for 48 hr causes characteristic changes in the neurosecretory perikarya of the ventral nerve cord including suboesophageal ganglion. The deep-stained cells of the ventral ganglionic complements show remarkable increase in their number (figure 3). Majority of them possess colloidal clusters instead of homogeneous deep-stained cytoplasm. The moderately-stained cells, in contrast, bear abundant cytoplasmic vacuoles and irregular distribution of paltry secretory inclusions (figure 3). Irrespective of cell types, axonal transport is disrupted to a considerable degree although accumulation of NSM at the axon-hillock regions is not seldom. Response of suboesophageal ganglionic neurosecretory cells (figure 4) to desiccation is different from that of the ventral ganglia. Here the extent of enhancement in the number of deep-stained cells is not that much explicit as in the case of ventral ganglia. The other type of cells possesses vacuolated cytoplasm containing scarce secretory inclusions rather than coarse consistency (figure 4). In addition, the tendency to possess voluminous nuclei in these types is not ruled out.

4. Discussion

Desiccation exerts a striking effect on the neurosecretory activity of the ventral nerve cord ganglia of *M. peguana* which can be assessed by the correlative changes in the

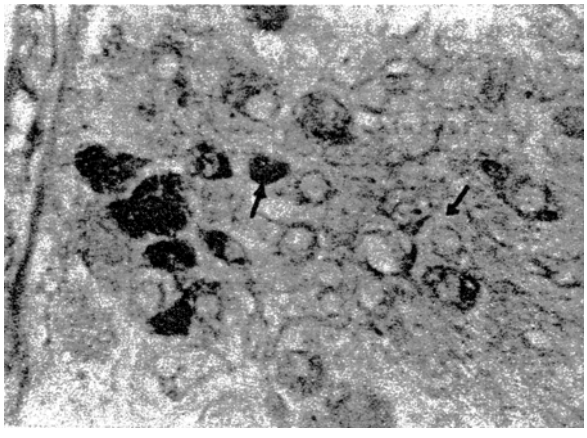

Figure 3. Section showing the effect of desiccation (48 hr) on the AF-positive neurosecretory cells of ventral ganglion. Note the remarkable increase in the number of deep-stained cells and secretion-poor condition of moderately-stained cells (× 532).

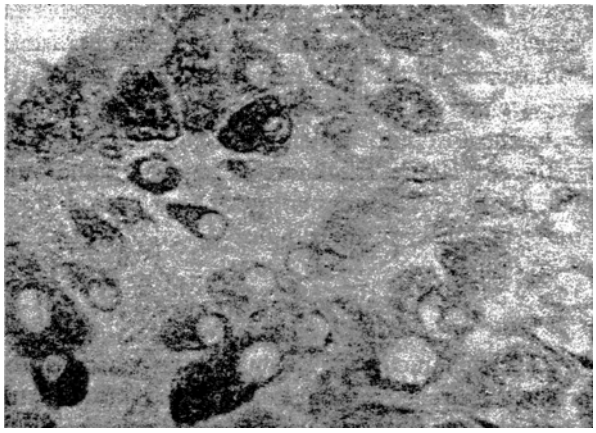

Figure 4. Section showing the condition of moderately-stained cells of the suboesophageal ganglion following 48 hr of desiccation. Note the voluminous nuclei and scarce distribution of cytoplasmic inclusions in the moderately-stained cells (× 532).

cytoarchitectural pattern of the neurosecretory cells. Drastic enhancement in the number of deep-stained cells and marginal to acute depletion of the moderately-stained cells are some of the interesting features displayed in this investigation. These criteria indicate the functional attributes in the two types of cells especially when possible "super elevation" in the osmotic concentration of the body fluid is accounted for. Accordingly, the distinction coupled with sudden enhancement in the number of small deep-stained cells become apparent to substantiate their participation for the inhibition of water loss. Despite their role in the elaboration of a diuretic factor under normal condition to regulate the osmotic balance of the body (Awasthi and Misra 1974; Takeuchi 1980), the moderately-stained cells possibly become functionally inactive under adverse situation like desiccation which, in fact, is evidenced by their retarded axonal transport, marginal to acute depletion and considerable reduction in the volume of nuclei. In this context, it should be borne in mind that depletion of NSM having meagre evidence for axonal transport may well be accounted for the phenomenon of lysosomal breakdown (autophagy)—a condition that causes retarded cellular activity (see review by Ericsson 1969; Ferraris 1979). Furthermore, descrepancies in the reactive response of the neurosecretory cells encountered in the ventral and suboesophageal ganglia under conditions of elevated plasma osmotic pressure in *M. peguana* may well be due either to a difference in sensitivity of the aforesaid ganglia or to a possible difference in their respective function (Sheela and Pandalai 1968). The present results clearly indicate correlation between water conservation and ventral nerve cord-neurosecretory mechanism of this tropical worm, *M. peguana* which are under a constant threat of dehydration in their native environment during a major part of the year.

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