On the ultrastructure of nerve-muscle contacts in Onychophora[1]

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Summary. The polyneutral innervated muscle fibres in the somatic longitudinal muscles of *Peripatoides leuckarti* (Onychophora) have nerve-muscle-contacts with presynaptic vesicle accumulations, paramembranous presynaptic appositions, a 600-Å wide synaptic cleft and a specialized extracellular subcleft system. Synaptic sites resemble those of annelids.

Somatic muscles of Onychophora have been reported to be nonstriated muscles with an extensive smooth endoplasmatic reticulum system[2,3]. This study describes the innervation of muscles and the specializations of nerve-muscle contacts of the somatic ventro-longitudinal muscles of *Peripatoides leuckarti* (Onychophora). Animals fixed with formaldehyde-glutaraldehyde solution followed by osmic acid treatment were investigated with the electron microscope.

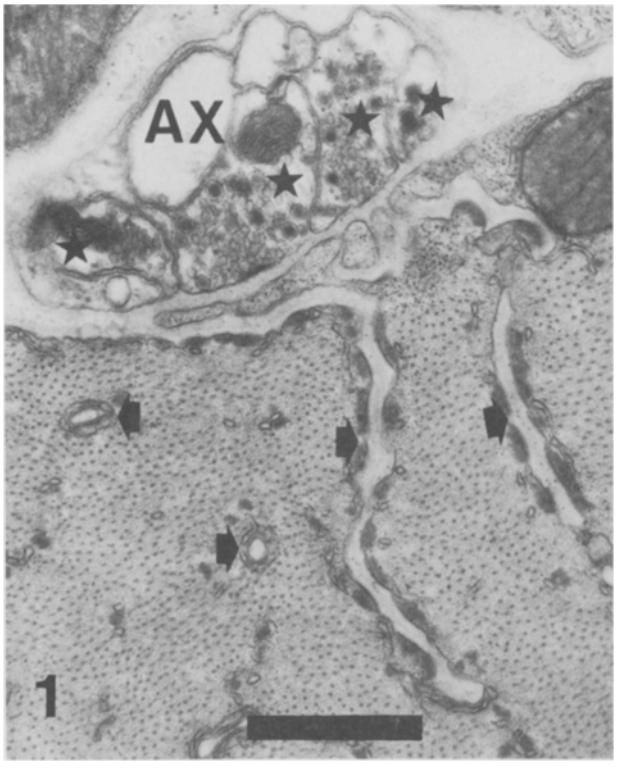

Fig. 1. Axons (Ax) of a nerve branch make synapses with a muscle fibre (stars). Invaginations of the sarcolemma (arrows) are surrounded by sarcoplasmic reticulum. Scale 1 µm.

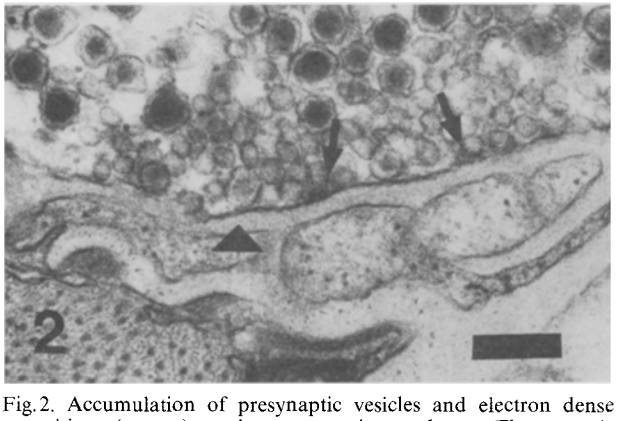

Fig. 2. Accumulation of presynaptic vesicles and electron dense appositions (arrows) on the presynaptic membrane. The synaptic cleft is marked by a triangle. Scale 0.2 µm.

The muscle fibres show a polyneural innervation. Axon fibre bundles are ensheathed by glial cells and run along the muscle fibres forming a number of specialized contacts (synapses) (figure 1). The nerve fibres normally appear naked and may interdigitate with each other at synaptic contacts. No axo-axonal contacts were found. Axon profiles appear enlarged at synaptic junctions and are often densely packed with vesicles. Translucent vesicles (diameter 600 Å) and dense core vesicles (up to 1300 Å diameter) occur together in different ratios (figures 1 and 2). Clear vesicles are predominantly accumulated around synaptic sites at the presynaptic membrane (figure 2). The presynaptic membrane exhibits electron dense paramembranous appositions which may protrude into the axoplasm up to 300 Å. Such presynaptic paramembranous appositions were also detected for the synapses of the central nervous system of the Onychophora[4]. The synaptic cleft is up to 600 Å wide and filled with faintly electron opaque substances, thus resembling the basal lamina between muscle fibres. The subsynaptic membrane is devoid of electron dense paramembranous appositions. The synaptic cleft gives rise to extracellular narrow gaps up to 200 Å wide which penetrate the peripheral sarcoplasma and which communicate with the tubular invaginations of the sarcolemma. These specializations run deeply into the muscle fibres and are closely associated with the sarcoplasmic reticulum (figure 1).

The described neuromuscular junctions of the Onychophora resemble those of earthworms[5,6] with respect to the broad synaptic cleft and the adjoining sarcoplasmic extracellular channels and differ from synaptic nerve-muscle junctions of arthropods[7,8].

The cuticle of the Onychophora was recently determined biochemically as arthropod-like[9], whereas the fine structure of the nerve-muscle junction may indicate the relationship to the annelid group.

1 Supported by the Deutsche Forschungsgemeinschaft (grant Schu. 374/1). The investigation was carried out in the Department of Neurobiology, R.S.B.S., The Australian National University, Canberra/Australia.

2 R. Lavallard, C.r. Acad. Sci. Paris, Ser. D *263*, 148 (1966).
3 J.J.A. Heffron, H.R. Hepburn and J. Zwi, Naturwissenschaften *63*, 95 (1976).
4 F.W. Schürmann, Cell. Tiss. Res. *186*, 527 (1978).
5 P.J. Mill and M.F. Knapp, J. Cell Sci. *7*, 263 (1970).
6 J. Rosenbluth, J. Cell Biol. *54*, 566 (1972).
7 M.P. Osborne, in: Insect Muscle, p. 151. Ed. P.N.R. Usherwood. Academic Press, London 1975.
8 H.L. Atwood and W.A. Morin, J. Ultrastruct. Res. *32*, 351 (1970).
9 R.H. Hackman and M. Goldberg, Science *190*, 582 (1975).