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Sinnesorgane
Zwischen Umwelt und Verhalten

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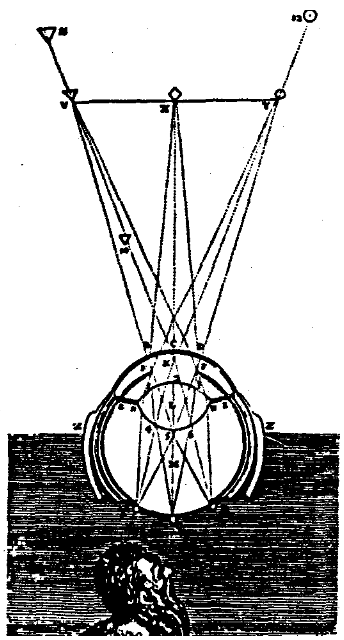

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COBALT PATHWAYS FROM HALTERE MECHANORECEPTORS TO INTER- AND MOTONEURONS CONTROLLING HEAD POSTURE AND FLIGHT STEERING IN THE BLOWFLY *Calliphora.*

R. Hengstenberg, K. Hausen, B. Hengstenberg

Max-Planck-Institut für biologische Kybernetik
Spemannstrasse 38
D-72076 Tübingen

Introduction: The halteres of Calliphora serve to sense self-rotations of the fly about its three body axes. Their signals are used to control head posture, flight attitude and flight path. Halteres also provide trigger impulses for the wingbeat-synchronous activity of particular steering muscles. The structure of the haltere and the arrangement and physiology of its mechanoreceptors have been described (for references see Hengstenberg R (1988) J. Comp. Physiol.). Very little, however, is known about the central nervous targets of the receptors, and about the neural network processing haltere signals. We have studied these structures by time-variant mass-impregnation of the receptors with cobalt, silver intensification, serial sectioning and phase contrast light microscopy.

The Compound Thoracic Ganglion of *Calliphora* comprises all thoracic and abdominal ganglia in one fused mass, but its segmentation can still be recognized by the neuropil surface. On each side originate four nerves containing axons of neck muscle motoneurons (VCN, PCN, ADN, FRN; Strausfeld NJ, Seyan HS (1985) Cell Tiss. Res. 240)), and three nerves with axons of flight steering muscles (AMN, PMN, MAN; Hausen et al, this vol.). Most neck- and steering muscles consist of only one motor unit. In unspecifically stained serial sections the placement and coarse structure of the motoneurons can be recognized. Their precise structure and identity is revealed by retrograde staining from the muscles. The thoracic neuropil contains two groups of giant heterolateral interneurons, one closely associated with neck motoneurons, and the other with flight motoneurons. The opposite ends of these fibres are closely apposed to the haltere tract which runs longitudinally as a compact bundle of axons through the thoracic ganglion, and ascends to the sub-esophageal ganglion.

Short cobalt incubation (1/2 - 1 h) reveals the course of the axon bundle and ca. 10 sites, where distinct tufts of collaterals arise from the main tract. They are confined to the ipsilateral side of the ganglion and close to the motoneurons mentioned above.

Medium incubation time (1 - 2 h) reveals that both groups of giant interneurons, two groups of smaller heterolateral interneurons, and numerous unidentifiable fibres are strongly cobalt-coupled to mechanoreceptor axons of the haltere.

Long incubation (2 - 5 h) reveals an the ipsilateral side of cobalt application a light staining of motoneurons in two neck nerves (ADN, FRN), and in two wing nerves (AMN, MAN) but never in the nerve supplying the flight power muscles (PMN). This staining is probably due to a direct contact of haltere axon collaterals with motoneuron dendrites. On the contralateral side one neck nerve (FRN) and the same two wing nerves contain lightly stained motoneurons. This only occurs when the heterolateral giant interneurons, mentioned above, are heavily stained. Then also the few stubby terminals of the different "wing giant interneurons" can be seen to be closely apposed to paler motoneuron dendrites.

Conclusions: Cobalt impregnations of the halteres of *Calliphora* yield neuron stainings in the CNS of up to third order (receptors to motoneurons). This is due to extensive cobalt coupling, most likely via gap junctions, reflecting fast functional connections which are to be expected in the haltere system. Slow pathways via chemical synapses probably arise from receptor axon collaterals which seem to end "blind" in the neuropil; such pathways cannot be revealed with the present techniques. Nevertheless the results demonstrate the structural outlines of two important movement control networks in the fly's central nervous system: one to control head posture, the other for flight steering.