4.8 CENTRAL NEURONAL INTERACTIONS IN THE FLIGHT SYSTEM OF THE LOCUST

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ABSTRACT

Central and sensory neuronal elements interact to produce the flight behaviour of a locust. The central component is capable of producing a flight motor pattern in isolation from phasic feedback from the periphery. This central motor pattern is produced primarily as a result of the properties and interactions of interneurons located in the thoracic ganglia. Interneurons phasically active with the flight rhythm can be identified both morphologically and physiologically. This paper reviews the properties and interconnections of identified flight interneurons. An interneuronal network which can account for certain features of the flight motor pattern recorded in deafferented preparations is presented.

INTRODUCTION

Locomotor behaviours of insects are particularly enticing for neurobiologists who wish to understand how nervous tissue controls behaviour. This is evident in the content of this volume. Such behaviours despite being agreeably complex have proved amenable to analysis from various approaches. The approach which interests me is to determine the neuronal circuitry underlying behaviour by recording from identified neurons. Is it possible to describe behaviour in terms of the properties and interactions of identified neurons? Locust flight is a behaviour which lends itself to such an approach not only because intracellular recordings can be made during the expression of a flight motor pattern but also because there exists a wealth of background information on this behaviour (e.g. WILSON, 1968; BURROWS, 1976, 1977).

It is clear from the preceeding papers in this volume that sensory input has a major role to play in controlling the flight of locusts (MÖHL, 1985; NEUMANN, 1985; HORSMANN & WENDLER, 1985; ROWELL & REICHERT, 1985). In fact some sense organs fulfil the criteria necessary for inclusion in the rhythm generator for flight (BACON & MÖHL, 1983; HORSMANN et al., 1983; PEARSON et al., 1983). Notwithstanding these demonstrations, it is also clear and has been known for some time that there is an element of the flight rhythm generator in the thoracic ganglia which can function and produce rhythmical activity without phasic input from the periphery (WILSON, 1961; ROBERTSON & PEARSON, 1982). This central element is revealed by the pattern of activity of wing motoneurons which can be recorded in essentially deafferented preparations under the appropriate stimulus conditions, e.g. after presentation of a wind stimulus to the head of the dissected animal. The motor pattern recorded from deafferented preparations (HEDWIG & PEARSON, 1984) is not identical to that recorded in intact flying locusts (WILSON & WEIS-FOGH, 1962) but it is sufficiently similar to recognize it as a flight motor pattern. The rationale behind the work described here is that an understanding of how the central flight rhythm is generated will be a major step towards understanding how flight itself is controlled at the cellular level. Indeed, to understand precisely how sensory information is integrated it will be necessary to know the neural substrate upon which it acts.

Gewecke/Wendler (eds.), Insect Locomotion