ECOSENSORY FUNCTIONS IN INSECTS

( WITH REMARKS ON ARACHNIDA )

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INTRODUCTION

The large number of insect species and their adaptations to the diversity of habitats and modes of life present an inexhaustable source for the study of ecophysiological adaptations in general and ecosensory functions in particular. According to the data from Borror and DeLong (1971) given in Romoser's (1973) handbook there are over 700,000 insect species described, with the biggest systematic groups being Coleoptera (290,000), Lepidoptera (110,000), Hymenoptera (100,000), Diptera (90,000), Hemiptera (55,000) and Orthoptera (20,000). All the other groups do not exceed 5,000 known species. Even the evaluation of ecosensory functions of bigger groups of insects such as Coleoptera, Hymenoptera or Diptera would require a lot of work and perhaps all the pages in this book. So the only possibility to remain in the reasonable limits of a chapter is to restrict ourselves to certain modalities and certain cases of sensory adaptations which seem to be typical of insects. Because of many similarities between the two groups there are some remarks added also for Arachnida, another important group of Arthropoda, which was almost as successful in the evolution as Insecta (estimated number of species 30,000).

GENERAL CHARACTERISTICS

In the vast number of animals belonging to different groups of insects we still can find some common properties, which hold for most if not for all insects and which are of great importance for their sensory relationship to the environment. Such common properties are from my point of view the following:
a) chitinous exoskeleton
b) relatively small physical dimensions
c) aerial locomotion
d) relation to the evolution of the higher plants

The first two properties are common also to the arachnids while the latter two are not common even for all of the insects, but yet typical for most of them.

Chitinous exoskeleton determines the general form and organisation of sensory organs, sensillas being in principle the "channels" through the cuticle with auxiliary chitinous structures, which are important in the transduction of stimuli. Characteristics of the cuticular layer with extremely wide range of mechanical properties (e.g.: possible extension 1,3 - 1500% - Neville, 1975) were studied by Barth (1969;1970 a) also in Arachnida. These properties are especially important for the reception of mechanical stimuli and for the production of vibrational communicative signals (see below). Chitinous material can be important also in photoreception and in other relationships to the photic environment, because it can be highly transparent (Neville, 1975) with suitable refractive properties to be a functional part in photoreceptive organs (Carriacaburu, 1967; Seitz, 1969) or can have extremely high optical density because of the pigment deposits in the cuticle. Good mechanical properties enable also the evolution of very elaborate structures, which give rise to the intense structural colours in many Lepidoptera, Coleoptera and others and which have important etho- and ecological functions (Fig. 5) (see below: u. v. patterns! Neville, 1975; Fox and Vevers, 1960). The electrical properties of the insect exoskeleton, also important for the sensory relationship to the environment, will be covered in the last part of this chapter.

Most of the adult insects range in size between 1 mm and 1 cm, some bigger ones reaching the next size class till 1 dm with only few being bigger than 1 dm or smaller than 1 mm. This range of physical dimensions which holds also for Arachnida, enables the insects to intrude habitats not available to bigger animals, but it has also some interesting effects on the sensory relationships, like the development of the near field sound communication in some groups, e.g.: Diptera (Bennet-Clark, 1971; 1975; see also Michelsen, this volume).

Another common property of the pterygote insects is flight. In this connection again some special adaptations of sensory organs have evolved, important for successful orientation (mechanoreceptors, photoreceptors) and for the regulation of motor activity during flight (Gewecke, 1974). Arachnida are in general not airborne, but some of them use the air streams for a special kind of locomotion.