which he interpreted as microorganisms transmitted through the generations by the test cells.

If the spherical particles are considered to be microorganism-like cells, what relation-ship could they display with the test cells of *Ciona intestinalis?* We suggest that the test cells could function as filters against bacteria or other microorganisms to protect the egg and the embryo. On the other hand, the particles of the test cells are present in all stages of development from the unfertilized egg onwards, and in spite of their presence the test cells keeps its integrity until the larval stage. We propose that the particles could be transported by the test cells with which they live in symbiosis.

Goldberg et al.[36] found high concentrations and incorporation of vanadium in the ovarian follicles of *Ciona intestinalis* and *Ascidia ceratodes,* suggesting that this element may become part of a metabolic system that is present from the beginning in the developing embryo. Moreover, it has been demonstrated that the test cells of the oocyte and the unfertilized egg of *Ascidia pygmaea* and *Ciona robusta* accumulate vanadium and iron in some test granules and are thence absorbed by the oocyte[22-37]. By which mechanism are metals absorbed in the inclusions of the test cells? Since the electron micrographs show that the test granules are close to the microorganism-like cells, perhaps the latter could be the site for selective absorption and concentration of particular metals.

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Demonstration of a sexual dimorphism in the olfactory pathways of the drones of *Apis mellifica* L. (Hymenoptera, Apidae)

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Summary. An important sexual dimorphism is demonstrated in the drone at the level of the first central relay of the antennal olfactory pathway (antennal lobe of the deutocerebrum), represented by large and easily identifiable glomerular complexes. This preparation seems to be an excellent model for a functional study of the olfactory system.

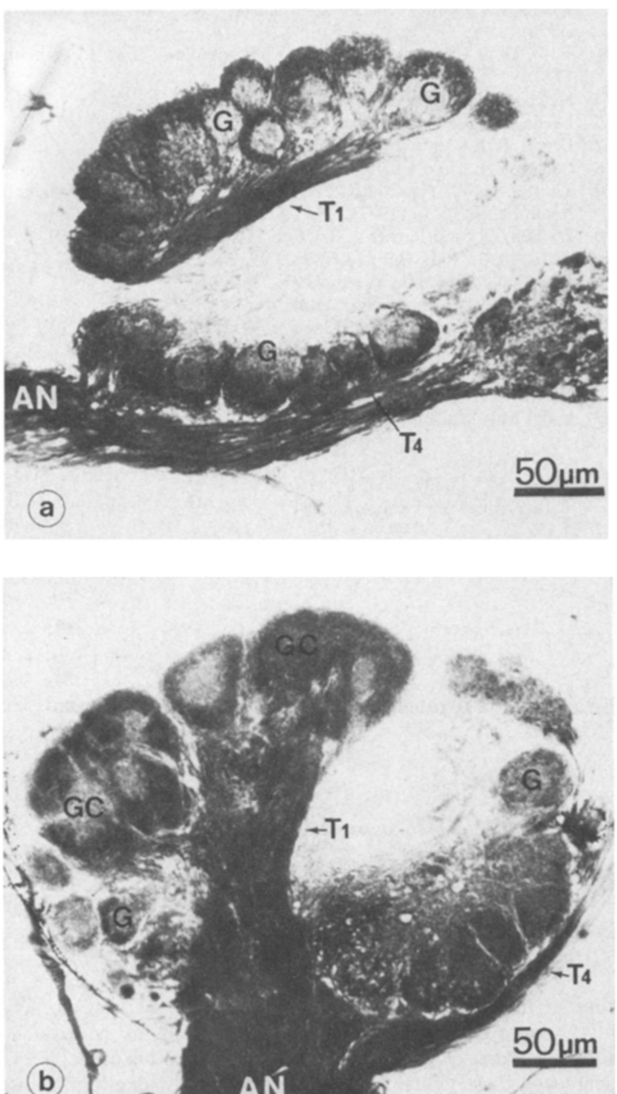
In both useful and noxious insects, many behavior patterns which have a great biological and economic importance have an olfactory determinism. In order to study the mechanisms of olfaction in insects it seems that drones are potentially good experimental models. This is because their single known function is the mating of the females (queens), in the course of which olfactory clues play a fundamental role[1-3]. Their highly developed olfactory abilities justify a detailed functional study of their olfactory system.

Amongst insects the olfactory information is collected by the primary neurons of specialized sensilla along the antennae and reaches the first central relay, the antennal lobe of the deutocerebrum, along some tens of thousands of axons of the antennal nerve which converge there by means of synaptic connections onto the dendritic processes of some hundreds of deutoneurons at the level of specialized neuropilar areas, the glomeruli[4-6]. Amongst some insects, for example in the cockroach, *Blaberus craniifer*, and in the moth, *Mamestra brassicae*, it appears that these glomeruli are morphologically identifiable and moreover invariant[7,8]. Thus, it is possible to study the general mapping of these structures. Moreover, a sexual dimorphism in the deutocerebrum of the males of some species has been shown: in cockroaches and in moths, the antennal lobe contains specific structure(s), the so-called 'macroglomerulus'[7,9,10] or 'macroglomerular complex'[8,11] which is (are) involved in the specific processing of the pheromonal information[10-12].

In fact, in insects there are 2 distinct sub-systems, on the one hand during the detection of the odorants (at the level of the antenna) and on the other hand, during the processing of the olfactory information (at the level of the central nervous system); a specialist sub-system for the specific pheromonal information and a generalist sub-system, used for example for alimentary information[13,14].

It is now evident that the glomerular level of the deutocerebrum is the main level for amplification and integration of the sensory message which is received by the olfactory receptors. In order to obtain a result for a morphofunctional study by using an autoradiographic technique (in progress), it was necessary to know precisely the glomerular organization, especially to verify whether a particular structure for the processing of the specific olfactory function (sexual pheromones), similar to a glomerular complex exists.

Materials and methods. The animals used for the present investigation were adult drones of *Apis mellifica ligustica* with known ages of 5–20 days old. The topography of the antennal afferent pathways has been studied by cellular marking following localized application of cobalt chloride to the cut end of one antenna of a living bee. There is a passive migration of cobalt ions along the neurons from the periphery to their targets in the central nervous system[15]. The experimental schedule is detailed elsewhere[16–18]. The histological sections (7 µm) are examined with a light microscope and analyzed on photographic plates. (To describe the different bundles of the antennal lobe, we adopt here the usual terminology[20,21].)



Sexual dimorphism in the antennal lobe of the honeybee (sagittal section). The pictures show 2 bundles (T1 and T4) of the antennal nerve (AN), whose sensory axons impinge onto the dorsal group of glomeruli (T1) and the more posterior group of glomeruli (T4). The sexual dimorphism appears mainly in the dorsal part of the lobe innervated by the dorsal bundle T1. *a* In the worker bee, the glomeruli (G) of the dorsal part are egg-shaped, quite homogeneous, with an average diameter between 18 and 60 µm. *b* In the drone, this dorsal region shows three glomerular complexes (GC). Their diameters vary between 90 and 150 µm and their average volumes are 19–37 times that of the glomerular units (G).

Results. We used as reference the antennal lobe of the worker honeybee from which we have studied the detailed structure and the ontogeny[17,18]. There are 165 ± 2 glomeruli, generally egg-shaped. Their diameter varies between 18 and 60 µm. In the worker, the structure of the antennal lobe appears quite homogeneous: all the glomeruli have rather similar shapes and volumes.

In the drone the antennal lobe shows 2 types of glomeruli. On the one hand there are glomeruli of which both shape and volume are similar to those of the workers. Their average number in one antennal lobe is 103. We propose to call them 'glomerular units'. On the other hand, there are 4 glomerular complexes; 3 structures in the dorsal region and 1 in the central region. These glomerular complexes are similar in shape to the cap of a mushroom, as shown in *Periplaneta americana*[19]. Their diameters vary between 90 and 150 µm and their average volumes are 19–37 times that of the glomerular units. These glomerular complexes occupy 60% of the dorsal region and 21% of the neuropile of the antennal lobe. The 4 glomerular complexes occupy the same volume as the 103 glomerular units. In both drones and workers, the deutocerebral glomerular organizations is invariant. The glomeruli of any individuals of the same sex are homologous in position, shape and dimensions.

On the other hand, there is no total homology between the glomeruli. Nevertheless the 4 main areas of the antennal lobe of the worker exist in the drone. Each is innervated by a bundle of axons which is homologous in the two sexes. This is especially the case for the most developed area, the dorsal area, which is innervated by the bundle T1. However, the diameter of this bundle is thicker for the drone, in which the number of the antennal sensory axons is larger than for the worker[22].

We assume that the glomerular complexes of the drone result from the fusion of several glomerular units during the nymphal period. These units could be homologous with those of the worker pupae. Experiments are in progress to verify this hypothesis.

The structure of the antennal lobe of the queen is close to the worker's: there are no glomerular complexes. Moreover, the number of glomeruli is almost the same in these 2 castes: 150 in the queen and 165 in the worker versus 107 in the drone.

Discussion and conclusion. In the antennal lobe of the drone there are several large and easily identified structures whose functions are most probably linked with specific processing of the sexual information. These structures are placed simultaneously with the glomerular units which process other olfactory information (alimentary, alarm, etc...). Thus they offer us a good experimental model for functional studies, which could lead to a further understanding of the mechanisms of olfactory information processing together with the generalist sub-system and the specialist sub-system.

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A hypothalamic channel-system in the inferior lobes of a trigger-fish (*Rhinecanthus aculeatus*, Balistidae)

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Summary. In the course of a general investigation of the optic system in some trigger-fishes, a hypothalamic, ventricular channel-system with pores, leading to the outside of the brain, has been discovered in the inferior lobes of *Rhinecanthus aculeatus* (Balistidae). A description of the morphological relations of the channel-system to the blood-vessel-supply and the cranium suggests that the organ-systems involved form a functional unit. The possibility of a hormone-producing system is discussed in the light of physiological and ecological aspects.

A general morphological investigation of the optic system in balistid species[2] seems to be useful for comparative morphological reasons, as reports on this subject in advanced teleost fish are infrequent and seem to be entirely absent for members of the family Balistidae (Tetraodontiformes)[3–5].

The hypothalamus, which is indirectly[3,5–8] connected to the optic system, deserves special attention, as, in teleosts, it is the most highly differentiated part of the diencephalon (unlike in most land vertebrates, for example) and displays structures unique to the fish: saccus vasculosus and lobi inferiores[3,4] (figs 1, 2b). It is in these latter structures that a peculiar ventricular channel-system has been found in *Rhinecanthus aculeatus*, a member of the family Balistidae.

Material and methods. Reconstructions were done on cross-section series (14 µm) of heads of *R. aculeatus*. The cross-sections were impregnated with bodian-silver and counterstained with cresyl-violet[9]. Microphotographs were taken using a Zeiss Photomicroscope on a Agfapan 25-film.

Results. We report, to our knowledge for the first time, the existence of a hypothalamic ventricular channel-system in the inferior lobes of a teleost species (figs 2a and 2b)[3–5,10–14].

The anatomical evidence suggests a functional unit, in which the following are involved: 1. the central nervous system (ventricular channel-system and surrounding nucleus), 2. blood vessels (arterial and venous) and connective tissue, and 3. bone structures (cranial base).

As a common feature in teleosts the 3rd ventricle protrudes bilaterally into the paired inferior lobes with a lateral recessus, which is surrounded by a periventricular nucleus (nucleus periventricularis recessus lateralis)[11,15]. In *R. aculeatus* the lateral recessus has several ventro-median, channel-like extensions (figs 2a and 2b), reaching the medial surface of the inferior lobes. The same applies to the periventricular nucleus (fig. 3). The most caudally situated channels seem to be open, allowing direct contact between liquor cerebrospinalis and meninx primitiva (fig. 3).

It is in this particular region that fine vessels of a branch of the cranial portion of the vena cardinalis anterior lead to the meninx primitiva and the underlying connective tissue. The resulting dense venous network is located in a pouch of the cranial base, which, in contrast, closely ensheaths the meninx primitiva and hence, the central nervous system (fig. 2a) more rostrally as well as more caudally.

In addition, the periventricular nucleus is provided by a branch of the carotid artery, which on each side intrudes from a lateral position into the inferior lobe at the level of the rostral beginning of the lateral recessus, then reaches the periventricular nucleus and runs parallel with it caudally (figs 2a and 2b).

Discussion. From the point of view of comparative morphology, the ventricular channel-system described is a unique fea-

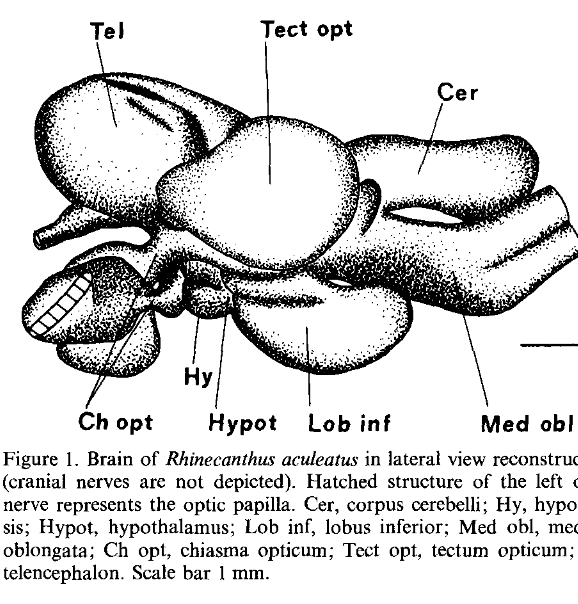

Figure 1. Brain of *Rhinecanthus aculeatus* in lateral view reconstruction (cranial nerves are not depicted). Hatched structure of the left optic nerve represents the optic papilla. Cer, corpus cerebelli; Hy, hypophysis; Hypot, hypothalamus; Lob inf, lobus inferior; Med obl, medulla oblongata; Ch opt, chiasma opticum; Tect opt, tectum opticum; Tel, telencephalon. Scale bar 1 mm.