Dense clusters of the chemosynthetic tube worm *Lamellibrachia* sp. were discovered co-occurring with the bivalve *Acesta* sp. 130 km south of Louisiana at a depth of 635 m. The bivalves, which have unfused mantle margins and feed by filtering water past ciliated gills, are in all cases attached to the distal ends of the tube worms. This close association may have important implications for the physiology of the chemosynthetic *Lamellibrachia*. The photograph was taken by LGL Ecological Research Associates Inc., Texas, supported by the US Department of the Interior. Gregory S. Boland

vous system is drastically remodelled to mediate the change from the crawling, non-sexual behaviours of the caterpillar to the flying and sexual behaviours of the adult moth. To do this, some neurones die, some are remodelled and some develop *de novo*[4]. What emerges are animals that display the overt kind of sex-specific behaviour described above.

The antennal-disk epidermis gives rise to the antennal sensory neurones whose axons navigate to the antennal lobes of the central nervous system at the pupal stage. The lobes become organized into glomeruli which may be the targets of afferents responsive to different airborne molecules. In normal males, one of these glomeruli is particularly large and is the termination point of the male-specific afferents. This macroglomerulus is absent in normal females[5]. Because each antenna develops from its own disk, gynanders can be readily constructed by replacing female disks with male ones at the late larval stage[6]. This operation has a dramatic effect on the brain; the male sex-specific antennal sensory neurones, forced to grow into the foreign environment of the female brain, cause the appearance of a macroglomerulus and interneurones responsive to the female attractant[6]. These elegant anato-

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Great Peacock moth (*Saturnia pyri*) — early observations (Bruce Coleman).

mical and physiological observations were limited to the brain; the paper in this issue[3] provides the evidence that the cellular changes manifest themselves behaviourally, as females with male antennae show anemotaxis to the female pheromone. Interestingly, these experimental animals do not fly in circles as if confused by the presence of their own pheromone gland.

Females do have their own sex-specific behaviour which resembles the anemotaxis of the male in some respects; tobacco plants are the requisite sites for egg laying and females (but not males) show positive anemotaxis towards them. Work in progress in Hildebrand's laboratory will reveal whether males with female antennae show a sudden interest in tobacco.

One interpretation of the data presented in this issue[3] might be that females have sex-specific antennal receptors tuned to some element of the cocktail of odours emanating from the tobacco plant. These tobacco receptors in the female and the pheromone receptors in the male would provide the sensory input to the same anemotaxis motor circuits in the central nervous system in both normal and transplant animals. (The size of the male macroglomerulus would result from the large number of pheromone-sensitive afferents.)

A clear way to refute this notion would be to demonstrate that females bearing male antennae still show anemotaxis to tobacco plants. But even in the absence of this behavioural evidence, it seems unlikely that the female does have her own set of sex-specific afferents since both male and female brains contain 'generalist' interneurones that respond to tobacco odours (ref. 5; J.G. Hildebrand, personal communication). It seems more likely that it is the presence or absence of the male-specific afferents which influences the development of the central nervous system, with important behavioural consequences. The central issue, of course, is how does it work? In one scheme, interneurones of the antennal lobes would be pluripotent at the time of afferent ingrowth and the ingrowing male-specific afferents would provide some signal to cause the determination and differentiation of male-specific pheromone interneurones (instructive development). In another, the antennal-lobe interneurones may already be determined at the time of afferent arrival; only those cells receiving an appropriate signal survive (permissive development) — interneurones without the signal die.

In the moth, it is not easy to distinguish between these two possibilities at the cellular level because the olfactory system comprises thousands of neurones. Large cell populations do, however, encourage other approaches. Hildebrand and colleagues are investigating the nature of the putative signal that triggers sexual differentiation by examining the biochemical and antigenic differences between male and female antennal afferents[7,8].

The mate-seeking behaviour that Fabre first observed more than 100 years ago is likely to provide a focus of research for years to come. The discovery that the sex of the antenna alone seems to be critical for the sexual differentiation of the brain and anemotaxis to a pheromone source provides a dramatic example of the common, yet poorly understood, mechanism by which cells affect the development of their neighbours. □

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