Function of the type II microtrich sensilla on the lotic amphipod, *Gammarus pseudolimnaeus* Bousfield

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Abstract

The type II microtrich sensilla on the lotic amphipod *Gammarus pseudolimnaeus* Bousfield enable it to control body orientation while swimming, as animals with their sensilla masked spent significantly more time swimming on their sides. These sensilla appear to be involved in the behavioural process that allows the animal to orient into the current (positive rheotaxis), as significantly fewer masked animals were able to turn into novel current flows compared with controls. The sensilla do not appear to play a role in detecting gravity. Results suggest that the sensilla transmit hydromechanical sensory information to the animal, and it is thought that the individual sensilla act in unison as a kinetic sensory organ. The sensilla are well adapted for such a hydromechanical role, as they would likely only be stimulated by currents hitting them broadside on. The sensilla are grouped, with each sensillum facing in a different direction, and the groups are located at appropriate positions for detecting current flows. The sensilla do not play a role in the detection of vibrations. Nor do they play a chemosensory role in the detection of food or predators; however, a role in conspecific chemodetection cannot be ruled out.

Introduction

To make decisions as to which behaviour would be optimal, animals require information about their environment (Laverack, 1976; Dill, 1987). In crustaceans, the transmitting of cues is thought often to be via sensilla on the cuticle surface. Unfortunately, although many studies have examined the structure and position of crustacean sensilla, and many have examined crustacean behaviour, few have tried to correlate sensillum type with behavioural function. While structure and position might provide clues to function (Laverack & Barrientos, 1985), interpretation is essentially speculative, and sometimes might prove to be as misleading as helpful (Halcrow & Bousfield, 1987). In insects there appears to be enough known to develop a rudimentary classification system whereby sensilla structure and behavioural function can be correlated (Dethier, 1963; Schwartzkoff, 1964; Altner, 1977; Altner & Prillinger, 1980; Kapoor & Zachariah, 1983). In crustaceans, in contrast, more information is needed before such a system can be developed (McIver, 1975; Ache, 1982; Bush & Laverack, 1982; Crouau, 1982; Derby, 1982; Kapoor & Zachariah,
This is a major shortcoming as, in order to fully understand the behaviour of crustaceans, their perceptual abilities must first be determined (Krebs, 1985).

The external surfaces of crustaceans often appear to be smooth, but close examination reveals a large number of structural elements (Bush & Laverack, 1982). For example, recent studies have discovered the existence of a series of short, bifurcated, cuticular structures, classified as type II microtrich sensilla (Platvoet, 1985; Oshel et al., 1988). These sensilla are located on the dorsal abdomen of some stomatopods (e.g. Gonodactylus and Squilla; Ferrero et al., 1984; Laverack & Barrientos, 1985). They occur on some isopods (Halcrow & Bousfield, 1987), and are found on most amphipods (Laverack & Barrientos, 1985; M. S. Laverack, personal communication; Oshel et al., 1988), including Gammarus pseudolimnaeus. On the latter species, dorsal and lateral groups of these sensilla differ slightly, while groups on the left and right sides of the animal show near perfect symmetry. Each sensillum consists of an elongated, flattened body with a bifurcate tip (Fig. 1), and each is oriented differently within a group (Fig. 2; Read & Williams, 1991).

There are many signs that these structures are sensory. While there is some controversy as to whether or not they are innervated (see Halcrow & Bousfield, 1987), as with the microtrich sensilla found on the stomatopod Squilla mantis L. (Ferrero et al., 1984) and the amphipod Gammarus roeseli Gervais (Schwedhelm, 1984), it is likely that the thin underlying cuticle is penetrated by dendritic tubules. Such sensilla are implanted inside the cuticular rings (Platvoet, 1985) of sockets having an articulating membrane (Oshel et al., 1988), which might be indicative of a sensory function (Laverack & Barrientos, 1985). Their dorsal and lateral locations imply that they are in appropriate locations for the detection of currents (Laverack & Barrientos, 1985). A chemosensory role is suggested by the possible presence of an open pore located between the bifid lobes (Laverack & Barrientos, 1985), while a mechanosensory role is suggested by the sensilla arrangement and bifurcated morphology which might result in sensitivity to mechanical disturbance (Platvoet, 1985). They might even have a bimodal mechanosensory function (Laverack, personal communication).

These sensilla are excellent candidates for study. In addition to the variety of species on which they are found, these structures might be analogous in function to a variety of other peg sensilla found on the external surface of many other crustaceans (Shelton & Laverack, 1970; Mauchline et al., 1977; Cuadras, 1982; Derby, 1982; Schwedhelm, 1984; Steele & Oshel, 1987). However, unlike many other sensory devices, these sensilla are distributed in clumps. As such, they are very amenable to experimental manipulation, although few such studies have been done (but see Ferrero et al., 1984).

The objectives of this study were to determine if the type II microtrich sensilla play a role in:

1) detecting gravitational cues. Orientation with respect to gravity is a primary response of many organisms (Laverack, 1976), and various animals are able to directly detect body position relative to gravity (Eckert & Randall, 1983). Although amphipods lack statocysts (Platvoet, 1985), they might use the sensilla as a mechanism for detecting and subsequently responding to gravity;

Fig. 1. SEM of a single type II microtrich sensillum showing the bifurcated tip and recessed position in the cuticle.