Title
Marine and Freshwater Skaters: Differences in Surface Fine Structures

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which has been allowed for in calculating random expectations, must contribute independently to the maintenance of the polymorphism, because each is more likely to encounter the other morph in searching for a mate. The mechanism responsible for the unequal sex ratio in *dorippus* is not yet clear, but it seems that the phenomenon may be seasonal. It is hoped that further observations will clarify this.

Non-random mating has not been reported often in Lepidoptera although it has long been known in the arctiid moth, *Panaxia dominula*[3] where it is responsible for the maintenance of the *medionigra* gene in the population.

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Marine and Freshwater Skaters: Differences in Surface Fine Structures

TRACHAETE arthropods, notably insects, are almost totally absent from the open ocean for various reasons which are still largely speculative[1–3]. *Halobates* (Heteroptera) is an exceptional insect genus which is exclusively marine, with several open-ocean species that spend their entire lives thousands of miles away from land. It is a member of the family Gerridae, which includes the common pond-skaters or water-striders. Although species of *Halobates* have been known for more than 150 yr, there is little information about their biology and about specific adaptations which might enable them to live in the oceans where all other insects have failed[4].

Some of the special adaptive features of *Halobates* that may be involved in the conquest of their unusual habitat probably lie in the body surface, and we examined surface fine structures of *Halobates germanus* White, from the central Pacific Ocean, and *H. proavus* White, from the Malayan coast. A related freshwater *Ventidius* species of the same subfamily (Halobatinae) was also studied for comparison.

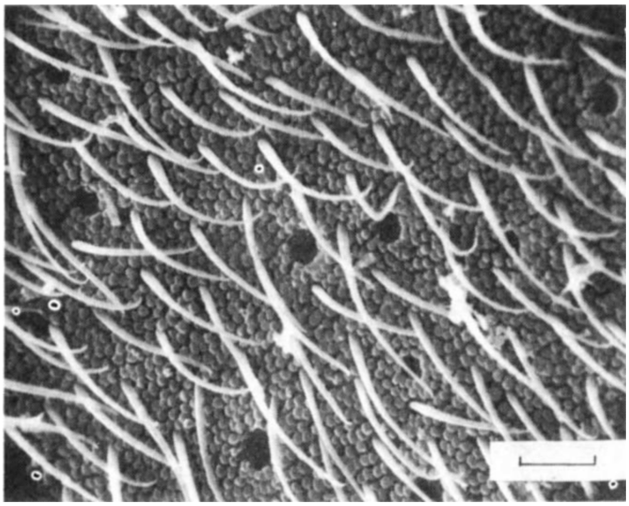

Fig. 1 *Halobates proavus*, dorso-lateral region of mesothorax showing hairs, pits, and mushroom-like microtrichia. (Scale = 10 μm.)

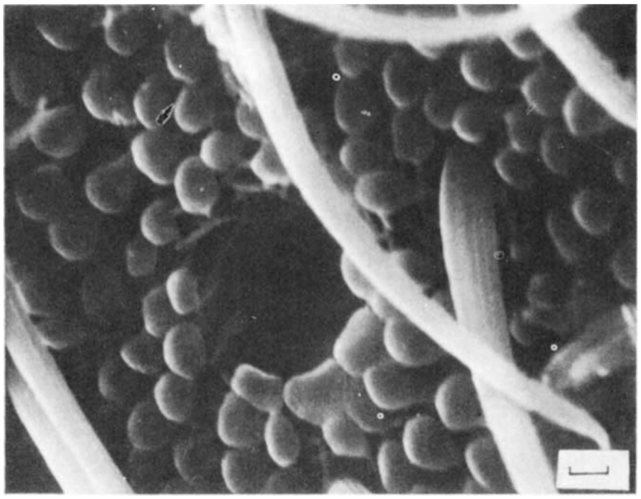

Fig. 2 *H. proavus*, same as Fig. 1. (Scale = 1 μm.)

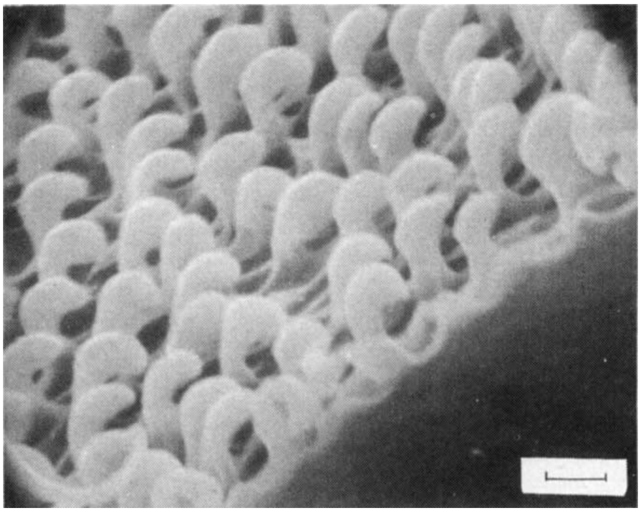

Fig. 3 *H. germanus*, lateral view of section of mesothorax showing microtrichia. (Scale = 1 μm.)

All the scanning electron micrographs shown here are of dorsal thoracic surfaces. Figs. 1 to 3 are of *Halobates* (surface fine structures of the two species studied were similar) and Figs. 4 and 5 are of *Ventidius*. In both genera, "pits" or "depressions" are found on the head and thorax, being more abundant on the sides than in the middle. Surface fine structures of the dorsal abdominal region are very similar to those of the thorax, although there are fewer pits; none have been found on the ventral surface.

The most striking difference between the two genera is in the shape of the microtrichia forming, presumably, the plastron, a thin film of gas supported by a layer of fine hairs which are set sufficiently close together to be resistant to wetting. The plastron serves to provide and maintain enough oxygen to satisfy the respiratory requirement of a submerged insect[5]. In *Ventidius* the microtrichia are simple pegs (Fig. 5) about 1 μm high, 0.3 μm wide at the base, and spaced 0.5 μm apart. In *Halobates* they appear from the top view like mushrooms, but from the side they are revealed to be thick hooks with the tips bent at about 90° (Fig. 3). These hook-like structures are about 1.5 μm high, 1.0 μm wide across the top, 0.5 μm wide at the base, and spaced 1.5 μm apart, the average "inter-

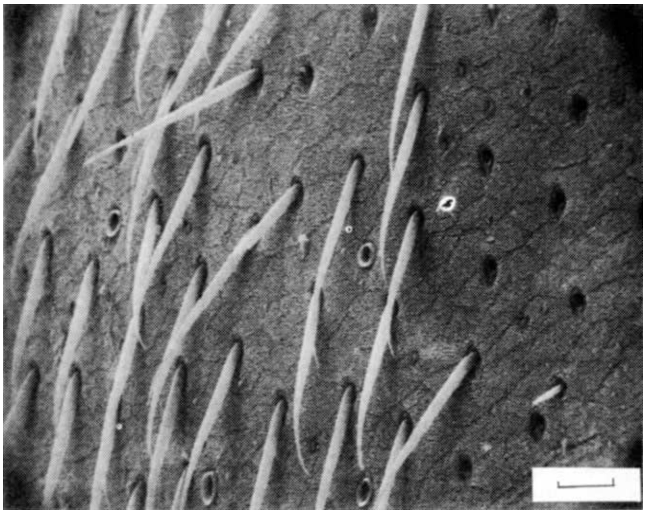

Fig. 4 *Ventidius* species; dorso-lateral region of mesothorax showing hairs, hair base, pits, and velvety mat of microtrichia. (Scale = 10 μm.)

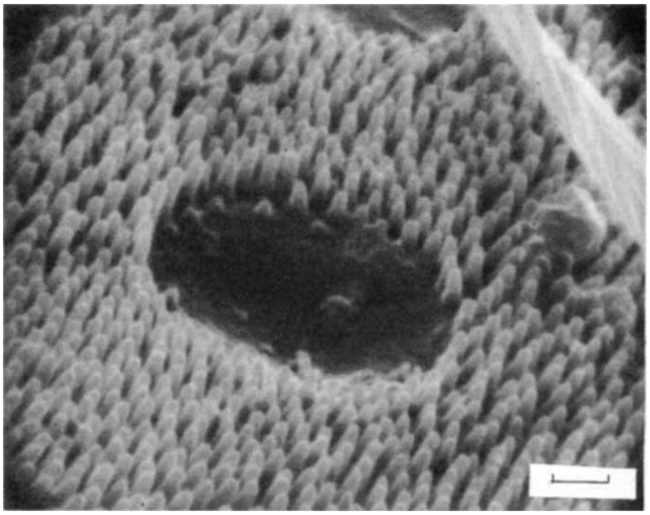

Fig. 5 *Ventidius* sp. Same as in Fig. 4, showing pit and peg-like microtrichia. (Scale = 1 μm.)

cap" distance being 0.5 μm. They are quite unlike the plastron of certain intertidal flies (Diptera) studied by Hinton[6,7]. According to Thorpe and Crisp[8], such an arrangement of bent hairs, as seen in *Halobates*, can be expected to form a more efficient plastron than a velvety layer of straight hairs.

The evident differences in surface fine structures between marine and freshwater skaters may be expected to have some biological or ecological significance. Species of *Ventidius*, which normally skate on the surface of running water in tropical streams, presumably sometimes need to dive (as has been observed for *Gerris* sp.) to lay eggs on submerged objects and would therefore be expected to have developed less water repellent surfaces, which would permit their occasional submergence. On the other hand, *Halobates* sp., being restricted to the ocean surface, without protection from rain, spray or waves, would presumably require their surfaces to be as water-repellent as possible in order to minimize the danger of drowning during periods of accidental submergence. They might therefore be expected to have developed a highly efficient plastron, as well as a markedly hydrofuge body covering. These features would not be expected to handicap them during oviposition, as they lay their eggs exclusively on flotsam[4].

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Acceleration by Ecdysterone of Premoult Substages in the Crayfish

An insect does not enter premoult if its thoracic glands have been removed, nor a crustacean if its y-organs have been removed, but once premoult is under way it continues whether or not the glands are present[1,2]. This suggests that the hormone secreted by these glands acts merely as a trigger to initiate premoult, and as the injection of ecdysone also initiates premoult, this is the hormone thought to be secreted. Also, the brain-ring gland complex of *Calliphora*, which contains the homologues of the thoracic glands, has been shown to produce substances similar to ecdysone and crustecdysone[3].

If ecdysone acts only as a trigger, then injections of ecdysone should have no effect on any stages of premoult development except the initial stage. Consistent with the trigger hypothesis, ecdysone produces an effect on insect pupal development only if injected early enough[4]. Ecdysone, however, is known to affect many diverse processes most of which are not restricted to early premoult, such as dopa decarboxylase synthesis[5], conversion of glucose to trehalose[6], cell movement[7,8], calcification[9], apolysis[10,11], formation of gastroliths[12], and many more. Levels of ecdysone rise and fall during the moult cycle[13–17], which also suggests that the hormone has separate control functions over different processes during the cycle. Furthermore, the effects of ecdysone vary according to the amount present; for example, Rao (personal communication) found that the injection of 5 μg of ecdysterone per animal into fiddler crabs caused apolysis but not moulting. Others found that the time required to initiate premoult after ecdysterone injection into crayfish varied inversely with the dose[11], while injected ecdysterone speeded the mount of animals already in premoult at the injection time[18], and crayfish induced to enter premoult by eyestalk removal moulted sooner if injected with ecdysterone[12,19]. Ohtake, Milkman and Williams[20] found evidence for a covert accumulation of the effect of ecdysone on the tissues. Thus, ecdysone does not produce a single event, but an accumulative series of events as hormone secretion continues over a span of time.

Ecdysone stimulates the production of additional ecdysone[15], a positive feedback system, which may explain how ecdysone can serve both as a trigger and controller. Thus, an injection of ecdysone may stimulate the production of sufficient hormone to produce all the changes necessary for moulting. The thoracic glands or y-organs need not be present for this response because other organs are capable of ecdysone synthesis, as shown by the fact that isolated abdomens of the silkworm *Bombyx* convert labelled cholesterol into ecdysone[21].

Little is known about the effects of ecdysone in crustaceans. How early in premoult must ecdysone be injected in order to have an effect? Does ecdysone stimulate events in every stage