

NOTE

On the functional significance of masking behaviour in sea urchins—an experiment with *Paracentrotus lividus*

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ABSTRACT: Much literature in marine biology describes the extraordinary behaviour of sea urchins, e.g., *Paracentrotus lividus*, who cover their body with shells, stones and debris. The function of this strange behaviour, described as 'masking', is still a puzzle. Our experiment shows that sea urchins are loaded with more mussel shells when the delicate apical openings of their water vascular system which powers all their movements, are in danger of being occluded by floating sand. 'Masking' shells appear to function as an umbrella against floating particles.

KEY WORDS: Masking behaviour · Cleaning · *Paracentrotus lividus*

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Several species of sea urchins, e.g., *Paracentrotus lividus*, which is common in the Mediterranean and the Atlantic Ocean, actively cover their body with bivalve shells (see Fig. 1a), gastropod shells, stones, pebbles, algal thalli, leaves, and sea urchin tests (e.g., Zavodnik 1987, Ivesa 1998); even cherry and peach stones, coins, banknotes, and pieces of glass and plastic have been listed (Zavodnik 1987). Textbooks (e.g., Luther & Fiedler 1961, Riedl 1983), which describe this behaviour as 'masking', suggest that the shells and other objects may protect the sea urchin from harmful UV light. This is unlikely, however, since UV light is strongly attenuated with depth, e.g., the effect of sunlight is reduced to 50% at 1 m below the surface (Levington 1995). In addition, sea urchins living at greater depths are just as likely to be covered with shells as the ones closer to the surface (Ivesa 1998, authors' pers. obs.).

Here we report on an experiment performed to test our hypothesis that the covering behaviour of sea

urchins serves to protect the animal from deposition of mud, sand and other dirt. In fact, some of the sea urchins' vital organs, such as the sexual system and the internal water exchange system, drain on its upper side, partly through the fine sieve-like madreporite vulnerable to congestion. Furthermore, hundreds of small pedicellariae, which have tiny suckers and pliers on the end, are in constant action to clean the sea urchin's surface (Hayward & Ryland 1995, Levington 1995). Thus, active covering with shells may be an accompanying preventive mechanism.

Methods. We collected shell-covered sea urchins *Paracentrotus lividus* 200 m off the harbour area of Banyuls-sur-Mer, France. 'Masking' shells were removed from 54 sea urchins, which were individually placed into aquaria (30 × 30 cm) with fresh seawater (water level 13 cm). Experiments were performed in a cellar room (of the Station Biologique Arago), which was illuminated by fluorescent tubes from the ceiling. We placed a size- and species-matched collection of 5 mussel shells (collected from sea urchins in the field) in a half-circle 5 cm away from each urchin. Within a total of 27 sets, each containing 2 size-matched sea urchins, individuals were randomly assigned to 1 of 2 treatment groups. In one group, we slowly poured a quarter of a teaspoon of seawater-suspended sand over each sea urchin. In the other group, sea urchins were treated with clean seawater only. We determined the number of shells loaded by the sea urchins 10 min after they had been treated. The diameter of the body, not including spines, was 7.0 ± 0.2 cm (mean \pm SE) in the sand treatment and 7.0 ± 0.1 cm in the control treatment. Shell loading within the 27 sets was analysed by means of a repeated-measures ANOVA with body size defined as a covariate.

Results. In accordance with our hypothesis the sea urchins treated with water-suspended sand covered

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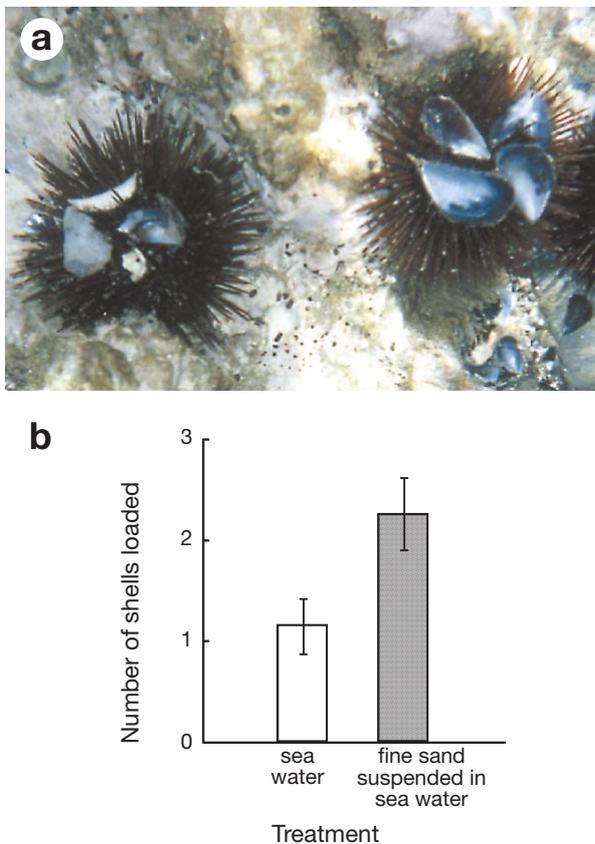


Fig. 1. *Paracentrotus lividus*. (a) Sea urchins 'masked' with mussel shells in the field. (b) Mean (\pm SE) number of shells loaded by the urchins 10 min after being treated with either seawater or seawater-suspended sand

themselves with a significantly higher number of shells than did the ones that were treated with clean seawater only (Fig. 1b, repeated measures ANOVA, $F_{1,25} = 5.92$, $p = 0.023$). Furthermore, larger sea urchins loaded a higher number of shells ($F_{1,25} = 5.65$, $p = 0.025$).

Discussion. The sea urchins must have somehow measured the amount of sand drifting over their body, because the rate at which they covered themselves with mussel shells significantly increased in the 'sand' treat-

ment group. Larger urchins loaded more shells, probably because the shells offered in all trials were of a similar size and thus more of them were needed to cover their body surface. Our experimental finding that the sea urchins' response to drifting sand functions to protect the body from floating particles does not exclude, however, the possibility that the 'masking' behaviour is also performed for other reasons which may differ in other parts of *Paracentrotus lividus*' distribution.

The conditional response suggests that a function of 'masking' is the protection from sand. Under natural conditions, floating particles might obstruct the sea urchins' sophisticated apical in- and outlet systems. This flexible 'masking' behaviour seems efficient because the urchin would otherwise have to remove the sand particle-by-particle with its pedicellariae. 'Masking' behaviour appears to be a preventive mechanism because sea urchins that had been treated only with clean seawater covered themselves with shells; however, fewer shells were used. The fact that the response is conditional suggests that loading shells must have a cost, the nature of which needs further investigation.

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