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Echinoderms don't suck: evidence against the involvement of suction in tube foot attachment*

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Abstract

Suction has usually been regarded as the primary functional mean for attachment in sea star and sea urchin tube feet and this hypothesis has become widespread in the public knowledge. Yet, a few studies have suggested that adhesive secretions may also play a prominent role in tube foot attachment. Here we use a morphological and biomechanical approach to investigate the role of suction in asteroid and echinoid tube foot attachment. Microscopic observations of tube feet rapidly fixed while they were attached to a smooth substratum show that their distal surfaces are totally flat and lack a suction cavity. Detachment force and tenacity of a single tube foot appear to be independent of the pulling angle: *i.e.*, the introduction of a shear component in the pulling force does not decrease attachment strength as would be expected for a sucker. Moreover, sea urchin tube feet attach as strongly to perforated surfaces, which preclude pressure reduction, as to their unperforated counterparts. Taken together, these results clearly show that echinoderm tube feet rely on adhesive secretions and not on suction.

Key words: temporary adhesion, sucker, podia, Echinodermata, *Asterias rubens*, *Paracentrotus lividus*

Introduction

Animal structures designed for suction attachment are usually discs or hemispheres with elastic edges which can conform closely to surfaces. Their attachment depends upon the creation of a reduced pressure in the space between the suction cup and the substratum. This is generally achieved by muscular contraction arranged so as to draw the centre of the cup away from the surface, thus resulting in an increase of the volume of the suction cavity (Nachtigall 1974). In Echinoderms of the classes Asteroidea, Echinoidea and Holothuroidea, locomotion and attachment to surfaces are mediated by disc-ending tube feet. Since the first scientific echinoderm descriptions (*e.g.*, Forbes 1841; Hamann 1884; Romanes 1885; Cuénot 1891), these tube feet have been described as miniature suckers. This idea, imparted by most zoology textbooks, has pervaded popular knowledge. A typical illustration can be found in Pixar's animated movie "Finding Nemo" in which Peach the sea star makes the characteristic popping sound of a rubber sucker with its tube feet. This assumption that disc-ending tube feet function as suckers presumably originated from their distal end which looks like a cup with a central

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