How does tube foot coordination generate a novel bouncing gait in the Indo-Pacific seastar Protoreaster nodosus and the North Atlantic seastar Asterias forbesi?

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Abstract

Echinoderms display unique and complex patterns of locomotion that are not well understood biomechanically. In particular, they often use fluid-filled podia, or tube feet, to move. Although the gait of seastars is typically described as ‘crawling,’ recent research has characterized a novel bouncing gait in the Indo-Pacific seastar Protoreaster nodosum, finding that it is associated with faster horizontal speeds (Ellers et al., 2014). Only one other study, Montgomery & Palmer (2012), observed a similar up and down movement during locomotion of the seastar Patiria miniata; however, that study had no interpretation of this movement’s function. Thus, it is not known how widespread the bouncing gait is in seastars. We discovered that the bouncing gait also occurs in the Atlantic seastars Asterias forbesi and Asterias rubens, suggesting that this gait may be widely used. Through motion analysis of videos of seastars, we discovered that the bouncing gait of Asterias was similar to that of Protoreaster. For example, in both species, kinetic and potential energy were in phase - similar to terrestrial running, bouncing increased speed, and groups of podia were coordinated to push together during a bounce. For Protoreaster, on average each podia contributed to a push every third bounce; whereas for Asterias preliminary analysis suggests that the average number of bounces between a given podia’s push occurred over longer intervals and was less regular. Taken together, our study supports the hypothesis that a bouncing gait driven by coordinated podial pushes may function in escape locomotion among broadly distributed seastars.