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Tissue regeneration of the purple sea urchin *Heliocidaris crassispina*

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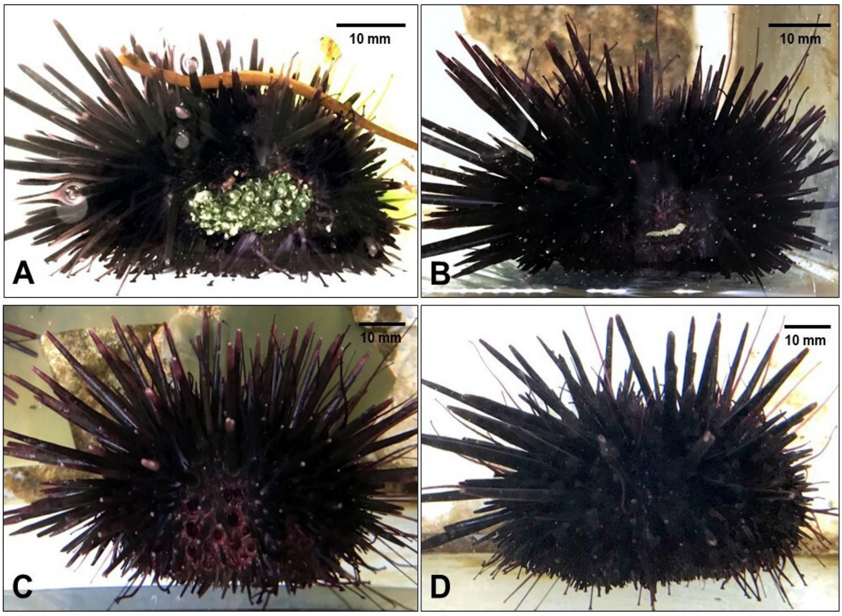

Sea urchins are ecologically important bioeroders and algal grazers that are able to regenerate broken and damaged appendages, such as spines, tube feet, and pedicellariae (Emerson et al. 2017). For instance, the regenerative ability of the green sea urchin *Lytechinus variegatus* has been demonstrated through experimental breakage or removal of spines (Reinardy et al. 2015, Emerson et al. 2017). This tissue regeneration in sea urchins is through a morphallactic process that involves cells derived from existing tissues (Dubois and Ameye 2001, Carnevali 2006, Dupont and Thorndyke 2007). The present study contributes to this knowledge by reporting an observation on the regeneration of the body wall tissues and appendages of the purple sea urchin *Heliocidaris crassispina*.

Heliocidaris crassispina with a test diameter of 40–50 mm was collected at about 2 m water depth from Clear Water Bay, Hong Kong (10°17´2.44˝N, 114°17´36.67˝E) in May 2021, to be used for aquaculture experiments. Immediately after collection, *H. crassispina* was placed in a cooler with seawater and small ice packs and transported to an indoor recirculating aquaculture system using artificial seawater (800 L) at The Hong Kong Polytechnic University. *Heliocidaris crassispina* was reared in a flow-through tank with aeration (25 × 25 × 25 cm^3 for 10 individuals; temperature = 24 °C; salinity = 30; pH_{NBS} = 8.2) and fed three times a week with the Kombu alga *Saccharina japonica* (Dorey et al. 2018).

One individual of *H. crassispina* was accidentally pressed hard and damaged during the collection in May 2021. The peristomial membrane and appendages in the contact area were removed, exposing the test plates (Panel A). This injured sea urchin was maintained with the other individuals as normal. The damaged area of 184 mm^2, which was roughly equivalent to 5%–10% of the surface tissue area of the sea urchin, gradually recovered during the study period, as observed in December 2021 (Panel B). The peristomial membrane was completely regenerated in May 2022 (Panel C), at which time the newly formed spines and tube feet were measured to be 8 (SD 4) mm and 14 (SD 7) mm in length, respectively. The healed sea urchin was alive without observable abnormality as of the time of writing in January 2023 (Panel D).

Sea urchins with broken spines might have decreased ability in collecting and handling food, which could reduce feeding efficiency and alter energy allocation, and these changes could compromise growth of the test (Ebert 1968, Edwards and Ebert 1991). Nevertheless, positive growth of the test was still observed in our study, with a growth rate of 14 mm in diameter per year, and this annual growth rate was comparable to that of *H. crassispina* measured in Hong Kong waters (Urriago et al. 2021). Overall, the present study provides evidence of the strong ability of *H. crassispina* to survive and regenerate from serious injuries.

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