Study finds starfish shed arms to protect against overheating

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A Starfish in Mauritius. Credit: Alain Feulvarch/Wikipedia

(Phys.org) —A team of marine biologists has found that some starfish lose a leg when faced with too-warm environmental conditions. In their paper published in *The Journal of Experimental Biology*, the researchers describe what they witnessed as they subjected 70 starfish to various heated environments and filmed the results with infrared cameras.

Starfish are considered to be a cold-blooded animal—they can't adjust their internal temperature as environmental temperatures change. Because of this, they are at the mercy of weather conditions. This can be a problem for them when tidewater recedes leaving them stranded on a beach exposed to the hot sun. Until now, most biologists have believed that starfish, like most other cold blooded animals, have a uniform internal body temperature reflective of the temperature around them.

To find out how the starfish survived changes in heat, the research team captured 70 ochre starfish found living off the California shore and subjected them to heat related tests. Groups of the starfish were put into different tanks with different temperatures and were then filmed using an infrared camera to see what was going on with heat distribution inside of their bodies. To their surprise, they found that the temperature in the legs of the starfish was different than that of their core—the disk at the center of their legs that holds their vital organs. They also found that starfish have a definite limit on core temperature—if it reaches 35 C they die. Most remarkably of all they discovered that if the starfish were subjected to high temperatures for very long, they would engage in abscission (intentional shedding of a body part) of their legs.

More specifically, the team found that all of the starfish were able to keep their central disk 3 C to 5 C cooler than their arms, suggesting that the animals were using their legs as heat sinks. In extreme cases, the diversion of heat to arms would cause the arms to shrivel up and fall off—though that shouldn't be a problem for them as starfish are able to regenerate lost legs.

The findings by the team are the first time that arm loss in an animal has been seen to be attributable to thermal regulation. They also show that not all starfish leg loss is due to predators.

More information: Survival and arm abscission are linked to regional

heterothermy in an intertidal sea star, *J Exp Biol* 216, 2183-2191 [doi: 10.1242/jeb.083881](doi:10.1242/jeb.083881) , June 15, 2013.

Abstract
Body temperature is a more pertinent variable to physiological stress than ambient air temperature. Modeling and empirical studies on the impacts of climate change on ectotherms usually assume that body temperature within organisms is uniform. However, many ectotherms show significant within-body temperature heterogeneity. The relationship between regional heterothermy and the response of ectotherms to sublethal and lethal conditions remains underexplored. We quantified within-body thermal heterogeneity in an intertidal sea star (Pisaster ochraceus) during aerial exposure at low tide to examine the lethal and sublethal effects of temperatures of different body regions. In manipulative experiments, we measured the temperature of the arms and central disc, as well as survival and arm abscission under extreme aerial conditions. Survival was related strongly to central disc temperature. Arms were generally warmer than the central disc in individuals that survived aerial heating, but we found the reverse in those that died. When the central disc reached sublethal temperatures of 31–35°C, arms reached temperatures of 33–39°C, inducing arm abscission. The absolute temperature of individual arms was a poor predictor of arm abscission, but the arms lost were consistently the hottest at the within-individual scale. Therefore, the vital region of this sea star may remain below the lethal threshold under extreme conditions, possibly through water movement from the arms to the central disc and/or evaporative cooling, but at the cost of increased risk of arm abscission. Initiation of arm abscission seems to reflect a whole-organism response while death occurs as a result of stress acting directly on central disc tissues.