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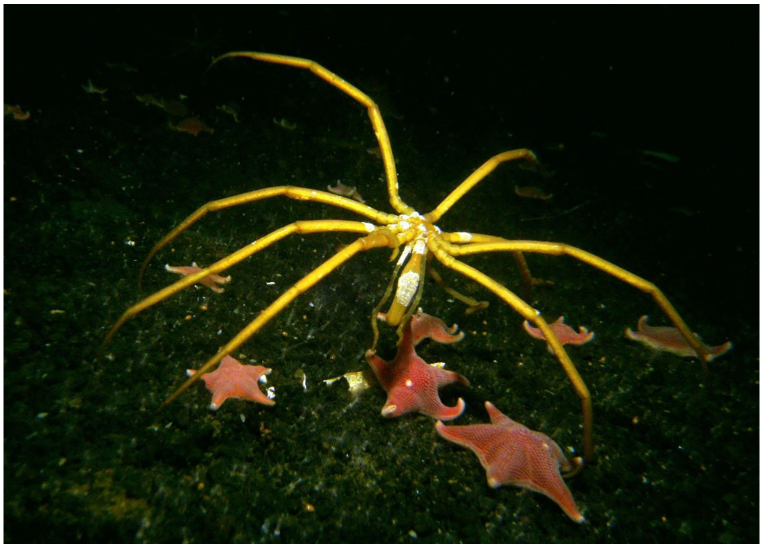
INSIDE JEB

Gigantic Antarctic sea spiders need pores to breathe



An Antarctic sea spider, *Colossendeis scotti*. Photo credit: Bret Tobalske.

The monochrome landscape of Antarctic is almost devoid of animals, yet beneath the sea ice the waters team with life. 'Scuba diving in Antarctica is like entering another world', says Steven Lane from the University of Montana, USA, adding, 'A lot of the organisms we saw were giants compared to their tropical or temperate relatives'. Describing immense sea spiders with leg spans of about 40 cm, Lane explains that the animals face an unprecedented challenge for their size: they have no gills to breathe. 'Most animals that rely solely on cutaneous respiration [where oxygen travels directly into the body across the skin or shell] are either really small or really flat with high surface areas', says Lane. So how are the outsized Antarctic animals able to supply sufficient oxygen to their tissues? According to Lane, the sea spider's thick carapace is riddled with pores; could they provide the channel for oxygen to enter their bodies? In a bid to solve the riddle, Lane and colleagues Art Woods, Amy Moran and Bret Tobalske plunged into the frigid Antarctic water where they collected members of 10 different sea spider species.

Although dive lights were essential for illumination beneath the sea ice, Lane recalls that collecting the sea spiders was straightforward: 'The animals were relatively large and common, so they were pretty easy to see', he says. Back in the Crary Lab in McMurdo Sound, Lane, Tobalske and Caitlin Shishido took photographs of the gangly creatures to calculate their surface area. Meanwhile, Moran counted the number of leg pores and measured the pore shape and volume with Lane. They found that the pores became longer and wider in the larger sea spiders, while the pores of the smaller species were shorter. In addition, the team inserted a probe into one of the femurs of each of the sea spiders to measure the oxygen gradient across the animals' armoured shell.

After returning to Montana, Woods and Lane built a computational model of how oxygen should move across the pores of each of the 10 species based on their Antarctic measurements, and discovered that the oxygen flow across the pores of the smaller species was not sufficient to fuel their energy demands. However, the cavernous pores of the larger species were more than adequate to meet the sea spiders' needs. 'This implies that the cuticles [shells] of smaller species are thin enough to allow in plenty of oxygen even if there are technically enough pores to support it all. In contrast, the cuticles of larger species are disproportionately thick and therefore they require substantially higher pore volumes as none of the oxygen can diffuse directly through the solid parts of the cuticle', says Lane.

However, the team points out that the porous shells of the larger sea spiders are likely to be weaker than if they were solid, which is an essential compromise to insure that the animals can meet their oxygen demands. In addition, they realised that the pores of the larger animals are conical, to reduce their impact on the strength of the shell. Lane explains that the longest pores are wider to speed up oxygen diffusion, so the larger sea spiders developed conical pores to insure oxygen transport efficiency without risking the strength of their shells, which is crucial for bearing their larger frames.

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