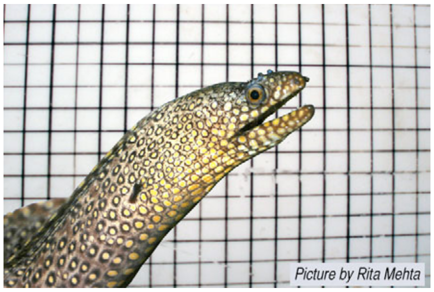
Inside JEB is a twice monthly feature, which highlights the key developments in the *Journal of Experimental Biology*. Written by science journalists, the short reports give the inside view of the science in JEB.

MORAYS DON'T SUCK, THEY BITE!


Picture by Rita Mehta

Lurking in the crevices of their coral reef home, moray eels take a different approach when it comes to dining. Most fish are suction feeders, however morays prefer to pounce on and bite their victims with a fearsome set of razor sharp teeth. Wanting to know more about morays' eating habits, Rita Mehta and Peter Wainwright from the University of California, Davis, measured morays' skull and jaw movements as they fed, and tested their idea that biting allows morays greater flexibility in the timing and movements of their jaws when they're capturing their prey (p. 495).

To suction feed, 'fish have to generate a negative pressure, by rapidly expanding the mouth cavity; one way to do this is to depress the floor of the mouth' says Mehta. An important head muscle, which helps lower the floor of the mouth, is the sternohyoideus muscle, which is found between the bony pectoral girdle and the skull and moves a bone called the hyoid. The sternohyoideus muscle and the hyoid bone are large and robust in suction feeders, but morays have a very reduced and thin hyoid bone, and small sternohyoideus muscle. This means that 'eels aren't able to lower the floor of the mouth', Mehta explains; they can't generate suction strong enough to feed.

Having shown that the sternohyoideus and hyoid of morays weren't up to the challenge of generating pressures strong enough to suck in prey, the team wanted to confirm that morays rely on biting rather than suction to feed. They filmed the morays feeding on juicy squid pieces, tracking the movements of six points on the skull and jaw. They compared the morays' feeding movements to those in a closely related suction feeding eel, distantly related suction feeding freshwater sunfish, and a cichlid.

Comparing the moray's skull movements with the suction feeders, they found that jaw and skull movements were different in morays to the other fish species. While the suction feeders all fed in a very similar way, morays had a wide repertoire of skull movements to capture prey. They would sometimes overshoot the target, correcting their meal-grabbing movements by reversing their direction, and then coming at their prey from a variety of directions and angles.

On the other hand, the suction feeders lined themselves up directly in front of their targets. The team saw the mouth floor lowering in suction feeders, and the squid morsels moved towards their mouths just before they grabbed them, both indicating that they were expanding their mouths and generating suction.

However, it took morays up to 10 times longer – 500 ms – to bite their prey than the suction feeders took to hoover up the squid pieces. While biting is slower than sucking, 'you don't necessarily have to be so precise, and you can go for bigger things' says Mehta. The team suspect that biting allows morays to be successful predators in the confined spaces in reef crevices; they can munch on larger prey to fuel their bodies, and attack their victims from many different angles.

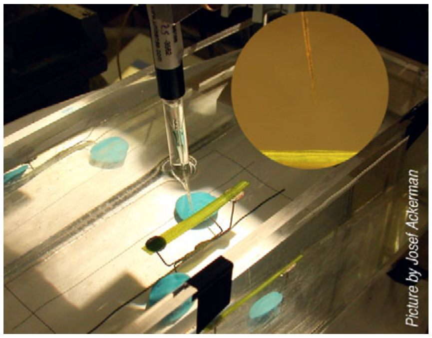
10.1242/jeb.02698

Mehta, R. S. and Wainwright, P. C. (2007). Biting releases constraints on moray eel feeding kinematics. *J. Exp. Biol.* **210**, 495-504.

A NEW TWIST ON TRANSPORT?

Rooted to the spot in their watery world, aquatic plants depend on the fluid flowing around their leaves to deliver the carbon dioxide (CO_2) that they need for photosynthesis. Josef Ackerman at the University of Guelph, Canada, has pondered for some time how the complex flow of water around plants' leaves affects this delivery. While some plants have flat leaves, others have twisted or crinkled leaves, which led Ackerman and his postdoc Gregory Nishihara to wonder if this influenced water flow over the leaves' surface, and CO_2 delivery. Nishihara and Ackerman decided to find out by looking at how the speed of water flow, CO_2 concentration and leaf shape influences the rate of photosynthesis, and oxygen production, in two closely related aquatic plants: the flat-leaved *Vallisneria americana* and the spiral-leaved *V. spiralis* (p. 522).

First the team cut 8 cm leaf samples from both plants, fastening them horizontally to a wire stand in a flow chamber that



Picture by Josef Ackerman

pumped water over the leaves at different speeds. To find out how fast the plants were photosynthesising at different water speeds and CO_2 concentrations, they adjusted the CO_2 concentration in the water using a chemical buffer, and positioned microsensors very close to the leaves' surface to measure how much oxygen they produced.

At a higher CO_2 concentration of 17.1 mmol m^{-3}, the twisted *V. spiralis* produced more oxygen, suggesting that this plant has a greater affinity for CO_2 and boosts its rate of photosynthesis when there is a glut of the gas dissolved in the water. Wondering how water speed affected the rate of photosynthesis, they found that oxygen production in both species levelled off when the water speed reached 4.4 cm s^{-1}, showing that both plants can't photosynthesise any faster at higher water speeds, despite faster CO_2 delivery.

However when the team dropped the CO_2 concentration by ten times to 1.7 mmol m^{-3}, *V. spiralis* produced the same amount of oxygen as *V. americana*. 'It's strange that they behave differently at one concentration and not at the other' says Ackerman. The next surprise came when the team discovered that both plants produced a different amount of oxygen in different areas of the leaf. 1 cm from the end of the leaf section facing into the water flow, oxygen production levelled off as water speed went up, showing that photosynthesis couldn't happen any faster.

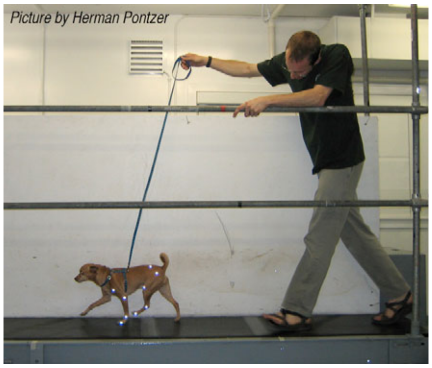
However, 7 cm from the end of the leaf, 6 cm downstream, oxygen production kept rising with increasing water speed, suggesting that this leaf area used every last scrap of CO_2 available in the water and that the rate of photosynthesis outpaced the rate of CO_2 delivery. This means that the assumption that CO_2 concentration stays constant as the water flows over the surface of the leaf probably isn't correct, Nishihara and Ackerman note.

But what about the twist? Unsure if the differences in oxygen production were due to physiology or leaf shape, the team twisted *V. americana* leaves before fastening them to the stand, and found that this didn't affect the results. However that isn't the end of the story – Ackerman hopes that future experiments will uncover whether there are any more twists to this tale. Then, he says, 'the real challenge will be working out what is going on when the plants are intact and moving in the water flow'.

10.1242/jeb.02699

Nishihara, G. N. and Ackerman, J. D. (2007). The interaction of CO_2 concentration and spatial location on O_2 flux and mass transport in the freshwater macrophytes *Vallisneria spiralis* and *V. americana*. *J. Exp. Biol.* **210**, 522-532.

LONG LIMBS COST LESS



Picture by Herman Pontzer

Unlike humans today, the earliest human ancestors were lanky-armed and short-legged. However, around two million years ago, our ancestors' legs grew longer. Why this happened is a mystery that intrigues Herman Pontzer from Washington University, St Louis. He wondered if leg length might affect the energetic costs of locomotion; that is, the amount of energy animals use to walk and run. To investigate, Pontzer built a mathematical walking model from scratch, called LiMb, to try and find out what affects the energetic costs of locomotion. Having already tested his model in humans, he wanted to see if it could predict the costs of moving around in four-legged animals too (p. 484). Not only could a model like LiMb tell scientists about what influences how much energy living animals use to get around, but it might also give them some clues as to why ancient humans developed longer legs.

The LiMb model has two steps: first the model estimates limb muscle forces, which accelerate the body, by taking into account a leg's length, its movements during walking, and stride frequency. The second step uses this information to predict how much energy is used. To measure leg movements during walking and running, Pontzer put his human volunteers, and obliging dogs and goats, to work on the treadmill. Using reflective markers attached to the limbs, he could track how each limb moved. He put this information into the model to estimate the muscle forces, and then the energy cost.

However, Pontzer needed to see if his model was hitting the mark, so he compared his model's predictions with measurements he made on his volunteers. First he measured forces produced by the legs during running using a force plate incorporated into the treadmill and compared these measurements with the model's predictions, finding that his measurements were a close match.

Then, to find out if the LiMb model was also accurately predicting the cost of locomotion in two- and four-legged creatures, he measured how much energy the humans, dogs and goats were using as they ambled along. Each individual wore a mask which collected the air they breathed out: because oxygen consumption is directly related to energy use, the amount of oxygen left in the exhaled air told Pontzer how much energy each animal had used. He found that the model did a very good job of predicting the cost of walking and running in humans, dogs and goats, showing that it works equally well for animals with four legs as well as two. However, the predictions weren't an exact match. This is probably because the model doesn't take into account everything that can affect locomotion, such as subtle differences in walking styles or variation in muscle fibre length.

Finally, because the model uses leg length to calculate cost, it probably has an important effect on the energy used to walk and run. 'All things being equal, leg length is one of the major determinants of cost', says Pontzer, adding that if two animals are identical except for leg length, longer legs are more efficient. As for our ancestors, it's possible that longer legs helped them walk more efficiently.

10.1242/jeb.02700

Pontzer, H. (2007). Predicting the energy cost of terrestrial locomotion: a test of the LiMb model in humans and quadrupeds. *J. Exp. Biol.* **210**, 484-494.

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