So-called 'sandfish' could help materials handling and process technology specialists

October 3 2008

It moves as quickly in sand as a fish moves through water, which is why this lizard, a species of skink (*Scincus scincus*) that grows to about 15 cm long and lives in the deserts of North Africa and the Near East, is commonly known by the name "sandfish."

Although it looks fairly unremarkable, this desert animal has a thing or two to teach materials-handling and process-technology specialists,as it spends most of its time below the surface of the sand and moves through its element extremely efficiently,and scientists hope to apply the insights they gain from nature to improve industrial technologies for the handling of granular materials.Whether it's gravel, sand or flour, optimising the technology for handling such materials could significantly reduce energy and maintenance costs for businesses such as quarries and industrial bakeries in the future.

In a new article published in the journal *PLoS ONE,* Prof. Werner Baumgartner and colleagues from the Department of Cellular Neurobionics at RWTH Aachen used an MRI scanner to observe the sandfish as it "swims" through the sand.

"We took a round container that would fit snugly into the MRI and filled it with sand," says Prof. BaumgartnerBaumgartner.The project, which was carried out in collaboration with researchers from the University of Würzburg and Museum König in Bonn, has provided a visual record of the animal's movements in the sand as viewed from above and from the side.

The scientists found the results highly surprising:until now, it was thought that the sandfish pulled its legs in against its body, but the experiments revealed that it actually moves its legs back and forth in a fixed pattern."This seems illogical at first, because sand provides resistance," says Baumgartner."But we found out that its leg movements are very well coordinated with the wriggling of its body."

It turns out that the sandfish moves in a way very similar to the crawl stroke in swimming.When the animal moves its head or upper body to the left, for example, it leaves a gap and thus an area of looser, less dense sand to its rightthat allows the animal to move its front right leg forward with little effort.Conversely, when the sandfish moves its upper body to the right a moment later, the sand on that side is compressed; this compact sand provides a stable basis from which to push off its front right leg.The time displaced-movements of the lizard's legs according to this principle add up to a very efficient and extremely rapid form of locomotion.

Interestingly, the biologists discovered that the sandfish always moves through sand at the same frequency."The lizard's winding movements produce vibrations in the sand," explains Baumgartner."Our experiments showed that these vibrations have a consistent frequency of 3 hertz (three motions per second)."

The scientists hypothesized that this frequency allows the animal to move forward with the least amount of energy,and subsequent tests confirmed their assumption.They did so by building an aluminium model of a sandfish with a motor and having it move back and forth through the sand at different frequencies.They found that the force required to move the aluminium sandfish forward was lowest at exactly 3 Hz, as that was when the sand surrounding its body was loosest.

"The sandfish adapted to moving efficiently through granular material

over millions of years," says the Aachen-based neurobionics expert.Scientists are increasingly applying insights gained from nature to a wide range of innovative technological uses."For example, we can use mathematical and computer-based models to calculate the ideal frequency for transporting all different kinds of granular materials," says Baumgartner.

Thus materials-handling and process-technology engineers are not the only ones who can learn from the sandfish;structural engineers stand to benefit, as well.For instance, by using the optimal frequency for the job, they will now be able to sink ground anchors into granular soil layers more efficiently, which will save both energy and money.

Citation: Baumgartner W, Fidler F, Weth A, Habbecke M, Jakob P, et al. (2008) Investigating the Locomotion of the Sandfish in Desert Sand Using NMR-Imaging. PLoS ONE 3(10): e3309. doi:10.1371/journal.pone.0003309
dx.plos.org/10.1371/journal.pone.0003309

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