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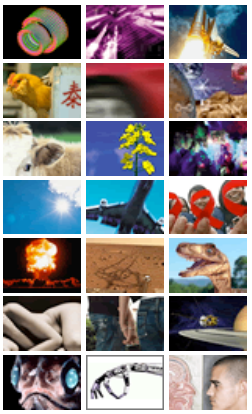

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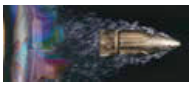

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Robo-turtle answers some flippery questions

17:39 24 April 2006
NewScientist.com news service
Tom Simonite

A robotic turtle could help engineers build better autonomous underwater vehicles and answer fundamental questions about how prehistoric beasts swam. The robot, called Madeleine, is already helping researchers understand when it is best to swim with four flippers and when to use two.

Madeleine is similar in size and weight to a Kemp's Ridley or Olive Ridley sea turtle, measuring 80 centimetres by 30 cm and weighing 24 kilograms. The robot also has a comparable power output, between 5 and 10 watts per kilogram, depending on how hard it is working.

The robot's polyurethane flippers have the same stiffness as a real turtle's, but are operated by electric motors connected to an onboard computer. These motors rotate each flipper so that its back lifts up, before rapidly sweeping it down again to generate propulsion. The robot is controlled remotely but has several sensors including video cameras, sonar and altimeter and accelerometer. See a short video of Madeleine swimming along here.

By imitating the design of a turtle, the researchers hope to build more efficient ocean robots, with flippers. "The thinking is that if nature did it, it must be good," explains John Long, one of Madeleine's makers from Vassar College, in New York, US.

Mesozoic seas

But Madeleine could also help scientists understand why animals use their flippers in different ways. Sea turtles, sea lions and penguins, for example, all rely on one pair of flippers to propel themselves through the water, and use the other pair to steer. But the plesiosaurs and giant turtles that dominated Mesozoic seas – between 251 and 65 million years ago – apparently used all four flippers for power instead.

"Evolution has come up with different ways to use flippers, and we don't really know why," Long says. "It would be nice to know, and it could also tell us when a flippered robot should use four or two flippers to propel themselves."

Long and colleagues used their robo-turtle and a swimming pool to experiment with different forms of flipper propulsion. They showed that four flippers are best for acceleration and stopping, while two flippers are more efficient for simply cruising along.

On average, Madeleine could stop in 44% less space using four flippers, and could reach a cruising speed of 0.7 metres per second 20% faster by using two. Long says cruising using four flippers probably takes more power than using two because the wake of the front flippers interfere with those at the back. "But to avoid obstacles you might want to switch from two to four flippers," he notes.

Cruising for food

Although the results are specific to Madeleine, Long says they suggest that extinct turtles and plesiosaurs hunted by ambush

Enlarge image
Madeleine is already helping researchers understand when it is best to swim with four flippers and when to use two (Image: John Long)

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using bursts of four-flippered speed. By contrast, animals that use two-flippered propulsion, like penguins, hunt while cruising.

"This work is very useful," says Frank Fish, who was not involved with the research but is building bio-inspired robots at West Chester University in Pennsylvania, US. "Lots of animals have multiple propulsion mechanisms that can be used depending on circumstance for a particular task. Or, if we're talking about robots, for a particular mission."

But Fish is sceptical about using Madeleine to learn about extinct animals. He notes that Plesiosaur fins would have moved in a very different way to the robot turtle's, flapping more like a bird's wing. "I think this approach would be more useful for copying living animals," he says.