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OCTOPUS MIMICS FLATFISH AND FLAUNTS IT

The evolutionary history of the *Thaumoctopus mimicus* lineage reveals the steps it took to become a master of disguise

SAN FRANCISCO (August 26, 2010) — Paul the Octopus—the eight-legged oracle who made international headlines with his amazingly accurate football forecasting—isn't the only talented cephalopod in the sea. The Indonesian mimic octopus, which can impersonate flatfish and sea snakes to dupe potential predators, may well give Paul a run for his money when it comes to "see-worthy" skills. By creatively configuring its limbs, adopting characteristic undulating movements, and displaying conspicuous color patterns, the mimic octopus (*Thaumoctopus mimicus*) can successfully pass for a number of different creatures that share its habitat, several of which are toxic. Now, scientists from the California Academy of Sciences and Conservation International Indonesia have conducted DNA analysis to determine how this remarkable adaptation evolved. The research is reported in the September 2010 issue of the *Biological Journal of the Linnean Society*.

Like its relatives, the mimic octopus is very capable of hiding from hungry predators by blending into its background. However, this talented species often chooses to make itself *more* conspicuous to predators by mimicking flatfish, lionfish or sea snakes that display high-contrast color patterns. This daredevil maneuver is thought to help *T. mimicus* confuse or scare away predators. Because it is relatively rare for an animal to develop such a high-risk, conspicuous defense strategy, the authors of the recent study hoped to gain insight into the evolutionary forces that fueled this behavior by conducting genetic research on the mimic octopus and its relatives. They focused on the mimic's ability to flatten its arms and head and swim along the sea floor like a flatfish, while simultaneously exhibiting a bold, brown-and-white color pattern.

Using DNA sequences to construct a genealogy for the mimic octopus and more than 35 of its relatives, the researchers ascertained the order in which the *T. mimicus* lineage evolved several key traits: 1) First, *T. mimicus* ancestors evolved the use of bold, brown-and-white color displays, employed as a secondary

"shock" defense to surprise predators if camouflage fails. 2) Next, they developed the flatfish swimming technique and the long arms that facilitate this motion. 3) Finally, *T. mimcus* began displaying bold color patterns while impersonating a flatfish—both during daily forays away from its den and at rest. In evolutionary terms, this last step represents an extremely risky shift in defense strategy.

"The close relatives of *T. mimicus* use drab colors and camouflage quite successfully to hide from predators," says Dr. Christine Huffard, Marine Conservation Priorities Advisor at Conservation International Indonesia. "Why does *T. mimicus* instead draw attention to itself, and repeatedly abandon the camouflage abilities it inherited from its ancestors in favor of a bold new pattern? Somehow, through natural selection, being conspicuous has allowed *T. mimicus* to survive and reproduce more successfully than some of its less showy ancestors, and eventually evolve into its own lineage."

The researchers suggest several possibilities for why this bold coloration would be advantageous. It may fool predators into thinking the octopus is a toxic flatfish (such as the peacock sole, *Pardachirus pavoninus*, or the zebra sole, *Zebrias* spp.); it may obscure the octopus's outline against the black-and-white sandy bottoms; or it may serve as an honest warning sign of the mimic's unpalatable flesh.

"While *T. mimicus's* imitation of flatfish is far from perfect, it may be 'good enough' to fool predators where it lives, in the world's center of marine biodiversity," says Dr. Healy Hamilton, Director of the Center of Applied Biodiversity Informatics at the California Academy of Sciences. "These octopuses can change their color pattern to look similar to—but not exactly like—numerous toxic and non-toxic flatfishes in their area. In the time it takes a predator to do a double-take, the octopus may be able to get away."

Undescribed by scientists until 1998, much remains unknown about the mimic octopus. Future research will focus on observing *T. mimicus* in the wild in Indonesia, so that scientists can assess the possible reasons for its bold coloration and better understand the costs and benefits of this strategy.

"This study reminds us that evolution does not have an endgame, but is a continuous process," says Huffard. "These octopuses will continue evolving as long as we can protect them and their habitat from threats like trawling, land reclamation, and run-off."

These findings were published in Huffard CL, Saarman N, Hamilton H, and Simison WB. 2010. The evolution of conspicuous facultative mimicry in octopus: an example of secondary adaptation? Biological Journal of the Linnean Society *101: 68-77.*

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