

## Recent findings by David Woodruff on nautilus

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NAUTILUS IS NO LIVING FOSSIL

IT'S 'YOUNG' AND EVOLUTIONARY, UCSD BIOLOGIST SAYS

The chambered nautilus, elegant trophy of many shell collectors, may lose its standing as a living fossil due to recent findings by David S. Woodruff, an associate professor of biology at the University of California, San Diego.

"Its lineage goes back 450 million years and there are relatives of the nautilus--fossils that look like the nautilus--that are 75 million years old. So the nautilus has been widely regarded as a living fossil," Woodruff said. "But we now know that it actually doesn't qualify."

A living fossil, according to evolutionary biologists, is the sole surviving member of an ancient species that is unchanged in form and has ceased to evolve at "normal" rates.

Woodruff and research associate Patricia Carpenter have recently completed a genetic study that suggests there are five, and possibly more, species of nautilus thriving in the depths of the western Pacific Ocean today.

"This is probably the first time that anyone has looked at a whole group of closely related 'living fossils.' With this group of nautiluses, we have been able to show that these are not ancient species at all. There is no evidence of arrested evolution. All the genetic evidence points to the fact that the present species have their origins in the last few million years. One is on the order of five million years old and the others are much younger," Woodruff said.

Molecular biologists began applying their sophisticated techniques to the genes of various "living fossils" about ten years ago, and a new picture has begun to emerge.

Work on the population genetics of the horseshoe crab showed that the genes of different populations of the same "relic" organism can differ, sometimes dramatically. Such variability, Woodruff says, is an indication that the animal is continuing to evolve actively.

"Within our own species, about 25 percent of the genes are variable, and that makes us the diverse species that we are. The nautilus, it turns out, is twice as variable as the human species. This is important because we've always heard that living fossils can't evolve because they have no genetic variation," Woodruff said.

Nautiluses live on coral reefs at depths of 200 to 500 meters, their shells rising to the surface only when they die. As a result, almost nothing was known about the natural history of the animals until a few years ago when divers began trapping them and bringing them to the surface for scientific study.

Bruce Saunders, a professor of geology at Bryn Mawr College and an authority on nautilus natural history, supplies Woodruff with the tissue he needs to study the genetics of the living nautilus.

Working with tissue from the tips of a nautilus' tentacles or a piece of muscle, he and Carpenter have been able to compare specific biochemical molecules in the cells of individual animals and measure their genetic differences.

The technique involves the movement of a protein molecule in an electric field. The size and charge of that protein determine the distance it will move in the field and enable researchers to establish how much variation there is among the proteins. "Such molecular differences are analogous to the different eye colors or blood groups seen in people," Woodruff said.

These molecular "genetic distances," are converted into time, giving the researchers a rough approximation of the age of the species they are working with.

The evolutionary history of the nautilus has been obscured up to now by two factors: a 25 million year gap in the fossil record and a shell that has remained the same over the eons.

Woodruff's molecular study of the animal was an attempt to "develop the family history, a family tree, of a group in the absence of a fossil record."

His finding that the nautilus is a relatively youthful species generated considerable interest when it was announced at the recent annual meeting of the American Association for the Advancement of Science in Philadelphia.

"Certainly, what we see today are not the terminal stages of a species' extinction, the end of a 450 million year old line, but rather the early stages of a radiation--we see diversification, the formation of new species. Nautilus is making a comeback. There is life in the old line yet."

Is it time to change the definition of a living fossil? "The living fossils looked at genetically so far turn out not to be--in the original sense that they are an ancient species. Other living fossils, like the horse shoe crab and the coelocanth, the lobefinned fish, will now have to be examined genetically to see if they too are in fact evolving at typical rates," Woodruff said.

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