Sea smarts: Scientists studying mollusks discover there is more than one way to make a brain

September 15 2011

(PhysOrg.com) -- Seemingly simple animals such as the snail and squid have ransacked the genetic toolkit over the last half billion years to find different ways to build complex brains, nervous systems and shells, according to an international team of researchers, including a neuroscientist with the University of Florida Whitney Laboratory for Marine Bioscience.

Using genomics and computational approaches, the scientists have reconstructed the evolutionary history of the entire phylum Molluscsa, which includes more than 100,000 living species, ranging from giant squid to microscopic marine worm-like creatures.

One of the surprising outcomes of the study, recently published online in the journal *Nature*, suggests that the formation of a complex brain in mollusks has independently occurred at least four times during the course of evolution — a finding that may prove useful to regenerative medicine scientists trying to develop new ways to help people with degenerative brain diseases.

“Nature did many experiments for us over the past 500 million years, using different molecular tools to build complex brains by independently centralizing smaller neuronal structures,” said Leonid L. Moroz, a member of the department of neuroscience with the UF College of Medicine. “The octopus, for example, is very intelligent. It can learn by

watching, and it has one of the most complicated brains of any animal without a backbone. And it evolved completely independently from us, using different genes, gene regulators and, in part, different neuronal signaling molecules."

By looking at the genomic data collected from the various classes and families of mollusks, the scientists were able to better understand the relationships between aplacophorans, which are worm-like creatures; gastropods, which include slugs and snails; cephalopods, such as octopuses and squids; and a variety of other shell-producing creatures.

Researchers extracted RNAs from dozens of marine organisms for deep genomewide sequencing and backed that information with all publicly banked data, revealing for the first time a blueprint of the molluscan life history on Earth.

Every major lineage of mollusk was represented in the analysis except for a class called monoplacophorans, which are tiny, shelled animals that live at the bottom of the deep sea and are too scarce to be captured. Kenneth M. Halanych and graduate student Kevin M. Kocot of the department of biological sciences at Auburn University led the computational analysis, while the gene sequencing was led by Moroz at UF's Whitney Lab.

"Surprisingly, cephalopod mollusks — octopuses and squid that are known for intelligence and considered 'primates of the seas' — represent one of the earliest branches of shelled mollusks, while simpler mollusks such as clams and oysters were a later branch," Moroz said.

The study helps resolve many conflicting hypotheses constructed in the past 100 years regarding the evolutionary tracks of these animals, according to Rhanor Gillette, a professor of molecular and integrative physiology, and of neuroscience, at the University of Illinois at Urbana-

Champaign, who was not involved in the research.

Gillette has studied mollusks and their nervous systems for more than 40 years, focusing on how they make decisions about defense, reproduction and predation by analyzing their behavior and neural circuitry.

“The researchers put the gastropods — snails and slugs — into a sister group with bivalves — clams and oysters — which have far less complex nervous systems,” Gillette said. “I was under the impression that snails were closer to more complex cephalopods, like squid and octopus, but now we find they are more closely related to the oyster. That’s quite an unusual fisherman’s platter.

“What is of extreme interest will be to find out the nature of the basic neuronal circuits that different animals use to make the cost-benefit decisions of their daily lives, such as finding food or defending themselves,” Gillette said. “There is likely to be a simple, core function for decision-making in neuronal circuitry that has evolved in tandem in mollusks and much more complex mammals, including humans, despite their remarkable differences in lifestyle, biochemistry and body structure.”

Moroz said the discovery says much about the value of using genomic approaches to reveal the true diversity of life.

“Some of these organisms, including a sea slug called Aplysia and the octopuses, have turned out to be good biomedical models for understanding learning, memory and disease in people,” Moroz said. “It is important to establish ancestral relationships between organisms using genomic information, and to understand why this very successful group resulted in so many different forms and unique biochemical and behavioral adaptations.”

Moroz's graduate student Mathew R. Citarella and molecular biologist Andrea B. Kohn, of the Whitney Laboratory were on the research team, as were scientists from the University of Bergen in Norway and the Johannes Gutenberg University in Germany.

Provided by University of Florida