The reptile database

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Experts predict that 2014 will be a big year for reptiles. Reptiles, which include snakes, lizards, turtles, crocodiles, tuataras and amphisbaenians, are projected to become the most diverse vertebrate group in the world. As it stands now, there are approximately 10,000 bird species – the most of any vertebrates – but reptiles are forecast to reach and surpass that milestone in 2014.

Among the experts studying these developments is Peter Uetz, Ph.D., associate professor of systems biology and bioinformatics in the Center for the Study of Biological Complexity (CSBC), part of Life Sciences at

Virginia Commonwealth University. Uetz is the founder, editor and curator of the Reptile Database, a web-based catalogue of all living reptile species and classification. The catalogue is shared with several global projects that collect similar information for other living species on the planet.

In 1995, as a graduate student at the European Molecular Biology Laboratory (EMBL) in Heidelberg, Germany, Uetz founded the Reptile Database while working on his thesis project, which focused on vertebrate limb development. His interest in web technologies was initially sparked by the EMBL DNA sequence database and the new opportunities the worldwide web offered in the early 1990s.

The Reptile Database has become a collaboration of hundreds of scientists and hobbyists around the world who study reptiles. Currently, the database includes 9,900 species of reptiles, including another 2,800 subspecies.

According to Uetz, the Catalogue of Life (CoL), a consortium of 133 species databases, uses the taxonomic information from the Reptile Database and passes its information to the Encyclopedia of Life. The Encyclopedia of Life, said Uetz, is an ambitious project that plans to set up a web page for each of the roughly 2 million species on the planet.

Why study reptiles?

For many, a slithering, scaly snake offers a hefty dose of fear, panic and dread, but it may also help scientists advance the treatment of human disease.

While the legless reptile is critical in conservation of the natural environment and controlling pest populations – and thus keeping their ecosystems in check – they also play a key role in research, serving as model organisms of study.

"From a research perspective, reptiles have a couple of unique and amazing features that make them very interesting to study and learn about," Uetz said.

An example is in the genetics of sex and reproduction. According to Uetz, many reptiles have temperature-dependent sex determination, which means that the sex of their offspring does not depend on X and Y chromosomes the way it does in most mammals. Rather, sex determination in many reptiles is dependent on environmental temperature.

"There are also dozens of species that are parthenogenetic – there are no males but only females," Uetz said. "The genetic basis of these phenomena is poorly understood, but most likely of general importance as there are many other species which have such features."

Scientists hope to advance the treatment of human diseases based on what they are learning from studies of snake development, metabolism and protein structures and function. For example, understanding the molecular makeup of toxic snake venom could lead to the development of therapeutic drugs to help save human lives. Examining snake genes and proteins may allow researchers to gain important clues into the functioning of molecular pathways in humans and other vertebrates.

"In fact, the saliva of the poisonous Gila monster, a lizard found in the southwestern U.S. and Mexico, has already yielded the drug exenatide for the management of type 2 diabetes," Uetz said. Exenatide is marketed as Byetta and is administered as an injection under the skin. The drug stimulates the pancreas to secrete insulin when blood sugar levels are high, according to the National Institutes of Health.

"Given that there are hundreds of other compounds in snake and lizard toxins, many more drugs can be expected from reptiles," he said.

Lastly, by mapping the snake genome, evolutionary biologists can learn more about the evolution from lizard to snake. Knowledge gained here could provide critical insight into limb development and one day help researchers understand the same processes in humans. This arena is of particular interest to Uetz, given his previous research at the European Molecular Biology Laboratory in vertebrate limb development. According to Uetz, snakes evolved from lizards by losing their limbs, with rudimentary limb bones left in some species.

Recent findings: snake genome

A study published online in the December 2013 issue of the *Proceedings of the National Academy of Sciences*, led by Todd A. Castoe, Ph.D., assistant professor of biology at the University of Texas at Arlington, detailed the findings of the first complete snake genome of a Burmese python – a huge, non-venomous snake with a giant appetite. According to Uetz, who contributed peripherally to the study via the Reptile Database, the team showed that hundreds of genes are switched on in response to a meal.

"We don't know the meaning of many of these genes and how they help the snake digest and process all that food, but one thing that happens is that snakes have dramatic proliferation of intestinal cells that help with digestion," Uetz said.

"And it's not only the genes in the intestine, it's also liver genes and all kinds of other things that happen in the snake body as a response to feeding. This is an interesting physiological adaptation that may help to understand how obesity works."

Uetz is working on a detailed follow-up study addressing certain questions of evolutionary biology, including how some of the genes may play a role in limb development.

"Related to our snake genome project is our work to understand how genes affect limb development – or the disappearance of limbs," Uetz said. "Limbs have been lost dozens of times in evolution. There are many lizards which have lost their limbs independently."

"The first snake genomes will help us to find the mutations that happened in the past when limbs were reduced and eventually lost. This will also help us to understand limb development in general, which down the road may be applied to understanding how humans develop limbs."

Moving forward, Uetz hopes scientists will gain a detailed phylogenetic tree of reptiles through collaborations made possible by the Reptile Database. In 2013, Uetz said, the scientific community produced publications highlighting genome sequencing for two turtles, a crocodile and two snakes. He said a lizard genome was the first reptile genome when it was published two years ago.

"The phylogenetic tree of reptiles and most other vertebrates has been studied intensively during the past decade," Uetz said.

"The next 10 or 20 years will be focused on how genes determine the morphological and physiological traits of these species—that is, the evolutionary adaptations that separate them from amphibians or birds (which are essentially reptiles) and mammals."

More information: www.reptile-database.org/

Provided by Virginia Commonwealth University