EVOLUTION OF BIPARENTAL CARE AND MONOGAMY IN AN AMPHIBIAN.

American biologists have discovered in Peru the first confirmed species of monogamous amphibian. *Ranitomeya imitator*, better known as the mimic poison frog, has provided groundbreaking insight into the ecological factors that influence mating behaviour. The scientists' work may be the most solid evidence yet that monogamy can have a single ecological cause.

Analyzing data on 404 frog species the authors found a strong association between the use of small pools for breeding and the evolution of parental care, including intensive parental care involving egg-feeding and the participation of both parents.

Figure 1. Left, *Ranitomeya imitator* - deposits tadpole in tiny pools and exhibits biparental care/monogamy. Right, *Ranitomeya variabilis* - deposits tadpole in larger pools with no biparental care/monogamy. © Jason L. Brown.

The researchers then focused on the mating and parenting habits of two similar frog species which breed in pools of different sizes; the mimic poison frog *Ranitomeya imitator* and the variable poison frog *Ranitomeya variabilis* (Fig. 1). The researchers theorized that the differences in parental care and mating system between these otherwise similar species stemmed from the availability of resources in the breeding pools. The tadpole of the mimic poison frog grows in much small, nutrient poor water pools that form in the folds of tree leaves. Tadpoles are ferried there after hatching by males, who monitor them in the months following birth. About once a week, the male calls for his female partner, who lays non fertile eggs for the tadpoles to eat. The variable poison frog, however, raises its tadpoles in larger pools.

To test their theory, scientists moved tadpoles from both species into differently sized pools. Tadpoles in larger pools thrived while tadpoles in smaller pools did not grow. This, the authors believed, signalled that tadpoles living in the larger, more nutrient-rich pools did not need the work of two parents as much as their smallerpond counterparts. Species that raised tadpoles in smaller ponds were more likely to require the skills of both parents. The researchers used genetic analyses based on techniques similar to the DNA-based forensic methods used in human paternity cases to investigate the mating system of the mimic poison frog. Surprisingly, all but one of the families investigated were the offspring of monogamous pairs. Many animals thought to practice monogamy have been found through genetic testing to be less faithful than previously believed. Monogamy is relatively rare in any animal so finding a frog that has a monogamous mating system is notable. The authors' work has already attracted attention from scientific and popular media at an international level. While the idea that ecological factors like scarcity of resources have contributed to monogamous behaviour in humans and other animals is well accepted, the authors cautioned against drawing inferences about human behaviour from the findings.

Brown, J.L., Morales, V. & Summers, K. (2010). A key ecological trait drove the evolution of biparental care and monogamy in an amphibian. *Am. Nat.* **175**, 436-446.

NOVEL PROTEINS IDENTIFIED FROM KING COBRA VENOM.

Snake venoms contain a rich cocktail of pharmacologically active peptides and proteins that have contributed greatly to scientific advances. The authors of this paper have now added another member to a class of valuable peptides, providing a detailed structural and functional characterisation of a novel neurotoxin from the venom of the king cobra. Their 1.5-Å crystal structure revealed that the new toxin, haditoxin, exists as a homodimer, similar to the k-neurotoxin family. Interestingly, however, themonomeric subunits of haditoxin, which consist of a three-finger protein fold, closely resemble shortchain a-neurotoxins, unlike k-neurotoxin monomers, which resemble longchain a-neurotoxins. Perhaps more interestingly, while haditoxin could antagonise several classes of nicotinic acetylcholine receptors (nAChRs) in neurons and muscle, its greatest potency is against a7-nAChRs, which are recognised by neither shortchain a-neurotoxins nor k-neurotoxins.

Haditoxin is structurally unique and therefore expected to have unique pharmacological properties. The toxin is like a conjoined twin. It has a relatively large complex made up of two identical protein molecules. The three-finger toxins display diverse biological actions on the human nervous system, cardiovascular system and blood clotting. Some have directly led to the development of compounds with potent analgesic and blood pressure reducing properties so it is likely that haditoxin in its 'conjoined twin' state or as individual components could offer novel uses.

Researchers have been studying king cobra venom for over 50 years and yet are still identifying new compounds. It is a complex cocktail of biological molecules that can change composition depending on the environment, season or even the snake's diet. The venom primarily acts on neurotransmitter receptors which regulate communication between nerve cells or between nerves and muscles, resulting in symptoms such as paralysis and respiratory failure. The worldwide burden of snakebite is high with up to 125,000 deaths each year, and significant public health costs associated with snakebite treatment.

While not every new toxin will convert directly into a clinically useful drug, there is potential for haditoxin to be a lead compound or template from which to design other drugs. Haditoxin may also be useful as a 'molecular probe' which will help studies of neurotransmitter receptors and their role in disease. These receptors are also important in neurodegenerative conditions such as Alzheimer's and Parkinson's diseases as well as in schizophrenia, anxiety and depressive disorders and nicotine addiction.

The haditoxin research was conducted by an international team from the National University of Singapore, Griffith University and University of Geneva.

Roy, A., Zhou, X., Chong, M.Z., D'hoedt, D., Foo, C.S., Rajagopalan, N., Nirthanan, S., Bertrand, D., Sivaraman, J. & Kini, R.M. (2010). Structural and functional characterization of a novel homodimeric three-finger neurotoxin from the venom of *Ophiophagus hannah* (king cobra). *J. Biol. Chem.* **285**, 8302-8315.

MOLECULAR INVESTIGATION OF INFRA-RED DETECTION BY SNAKES.

Snakes possess a unique sensory system for detecting infrared radiation, enabling them to generate a ‘thermal image’ of predators or prey. Infrared signals are initially received by the pit organ, a highly specialised facial structure that is innervated by nerve fibres of the somatosensory system (Fig. 1.). How this organ detects and transduces infrared signals into nerve impulses is not known. In this article the authors use a technique called transcriptional profiling to identify infrared receptors on sensory nerve fibres that innervate the pit organ. These nerve fibres (called Transient Receptor Potential Channels from pit-bearing snakes (vipers, pythons and boas) are the most heat-sensitive vertebrate ion channels thus far identified, a factor consistent with their role as primary transducers of infrared stimuli. Thus, snakes detect infrared signals through a mechanism involving radiant heating of

the pit organ, rather than photochemical transduction. These findings illustrate the broad evolutionary tuning of transient receptor potential channels as thermosensors in the vertebrate nervous system.

Gracheva, E.O., Ingolia, N.T., Kelly, Y.M., Cordero-Morales, J.F., Hollopeter, G., Chesler, A.T., Sánchez, E.E., Perez, J.C., Weissman, J.S. & Julius, D. (2010). Molecular basis of infrared detection by snakes. *Nature* **464**, 1006-1011.

Figure 1. Anatomy of the pit organ. © Wikimedia.

POPULATION AND AGE STRUCTURE OF PALMATE NEWTS.

Studies of urodele newts in Europe are common but not a huge amount of literature exists on population and longevity in smaller bodied newt species. In this study the authors used capture-recapture techniques and skeletochronological analysis to investigate body size, population size, and age structure of a population of palmate newts (*Lissotriton helveticus*) living in two adjacent lakes at 2,300 m in Andorra (Eastern Pyrenees). They found that females were larger than males and heavier. The total adult population of the two lakes was estimated to be between 338 and 245 individuals. A number of population tests were performed. The study ascertained that both sexes matured in three years with males living for nine years and females up to eight years. There were no differences in age structure in the sexes. Inter-population differences in demographic traits between the population studied and low altitude populations of *L. helveticus* did not result in the predicted pattern of delayed sexual maturity and greater longevity that would typically be expected in higher altitude populations. To explain this complex and unexpected demographic pattern, the authors suggest that a differential effect of competition and predation exists along the altitudinal range of these populations. Competition for trophic resources in communities of aquatic newts is important at an intraspecific level because newt species have evolutionary strategies that reduce the interspecific competition (e.g. microhabitat use and body size. The study suggested that in communities consisting of two or three species of aquatic newts there was a gradual reduction of interspecific competition from low to mid-altitude populations.

Amat, F., Oromi, N. & Sanuy, D. (2010). Body size, population size, and age structure of adult palmate newts (*Lissotriton helveticus*) in Pyrenean Lakes. *J. Herpetol.* **44** (2), 314-320.

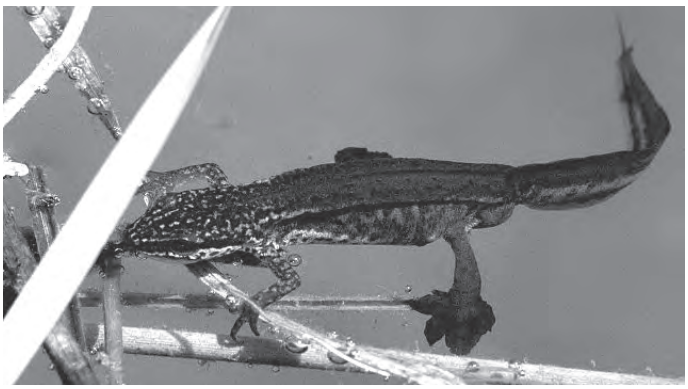

Figure 1. Male *Lissotriton helveticus*. © James K. Lindsey.