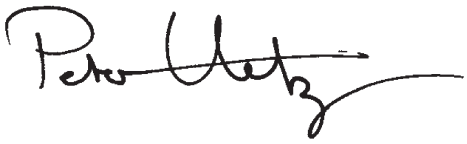
Name and surname.
Peter Uetz



Where do you live now and what is your main job or activity?
Currently, I am an Associate Professor in Systems Biology at the Virginia Commonwealth University in Richmond, VA (USA). Luckily, «systems biology» is such a fuzzy term that I can do almost everything. However, officially we work in genomics and proteomics research, primarily on microrganisms and host-pathogen interactions.

What did you study in your life? If of general interest, you may start from high school.
When I got my first iguanas at about age 12 I started collecting data about their growth. I measured them once a month and made growth curves etc. When one of them died I dissected it, so I also became interested in anatomy. Later on I obtained dead lizards from a veterinarian. I prepared iguana skeletons and I still have two bone collections left from that time. At age 17, I wanted to become an anatomist. However, it was a mystery to me where all those anatomical structures came from, and so I became interested in embryology and genetics. In fact, it was at age 17 when I published my first scientific paper about the reproduction and embryonic development of chameleons. About 10 years later (in 1993), I started my Ph.D. thesis on limb development, as this was a neat way to find out how snakes lost their limbs and how anatomical features come about in the first place. Unfortunately, in a way, this pulled me more into molecular biology, as developmental biology is heavily molecular these days. As part of my thesis work I studied a protein that was involved in limb development (in mice and chicken) and whose function was completely unknown although it was known that its mutation caused problems with limb patterning. So, finally I became interested in finding out about the functions of uncharacterized proteins, which is what I am still doing today.

When and how did your interest in reptiles and amphibians start?
I became interested in herpetology when I was about 12 years old. I grew up in a rural village with plenty of nature around where I found lizards, snakes, frogs etc. Their secretive lifestyle stirred my interest in finding out more about them. There was also an aesthetic aspect—I simply thought they were beautiful!

Was there something—a book, a movie, a documentary, a place you visited—that made it all start for you?
One of the first books I bought as a kid was the German translation of Archie Carr's «*The Reptiles*» (published in 1976). I remember this book also because a little later some Jehova's Witnesses gave me a creationist book that quoted Carr as proof that even biologists doubted evolution. In fact, Carr was said to admit that «there are no links between mammals and reptiles». I couldn't believe this and looked it up in the book. Indeed, the quote was from Carr's chapter on the evolution of reptiles, but it was continued after a comma, «... similar to *Archeopteryx* for birds» (p. 40 in the German edition). Of course, Carr was an evolutionist and described many intermediary fossils in his book and the creationists simply quoted him out of context. This was one of the first cases I encountered of how creationists distort scientific facts. The incidence also was one of the reasons why I became an atheist.

Did your parents oppose or encourage your interest?
My parents encouraged my interests although it was sometimes difficult because they had a bakery. For example, it was difficult for me to maintain insect colonies as reptile food. This was the reason why I started with a pair of Green Iguanas, because we had fresh fruit etc. available all year. My parents were also pretty tolerant when I started my anatomical studies and piled up frozen lizards in our freezers even though it caused quite a mess and bad smells when I dissected them.

Which difficulties did you encounter on your path towards herpetology?
Given that I am not a professional herpetologist, I did not have any serious difficulties in my career, except that I changed subjects a couple of times. For example, I changed from herpetology to anatomy to embryology to molecular biology to bioinformatics. There are so many interesting questions in biology that I was compelled to work at least on some of them! However, each time you change your research area you have to learn new methods, get familiar with the literature and get connected to a new scientific community. So, for most people it is probably not a good idea to switch subjects too often.

Have you had some sort of tutor who introduced you to the world of herps? An uncle, a professor, a friend, etc.?
Not really anyone who «introduced me», although I shared my interests with a friend and classmate, Alexander Haas, who is now a professor of zoology at the University of Hamburg. Another classmate, Thomas Kuner, was a computer geek and we wrote a computer program on DNA sequence analysis when we were still in high school. This project won us a prize in the German student competition «*Jugend forscht*» which certainly encouraged me to stay interested in this subject.

What is a herpetologist? What is herpetology? Or what should they be, according to you?
Herpetology is anything in biology that deals with reptiles and amphibians, although many «herpetologists» (like me) may see living animals only rarely. Even when you are not working as a *bona fide* herpetologist, there are many amazing properties in amphibians and reptiles, such as parthenogenesis, temperature-dependent sex-determination, or green blood (in the New Guinean skink genus *Prasinohaema*). This makes them also interesting for geneticists or physiologists.

What is your advice for young herp enthusiasts wishing to become herpetologists? What should they study? Which books should they read?
Students who want to become professional herpetologists must be extremely productive as there is tremendous competition on the job market. That is, there are very few jobs for professional her-

petologists. If you are not as productive as the leading taxonomists are, you should find another interesting niche where you can become the «market leader», e.g., studying some interesting aspect of physiology, genetics, evolution, or ecology. Herps, like any other taxonomic group, offer plenty of exciting questions such as the evolution of venom systems, which is even of medical relevance. There is no particular book I would recommend except that students should simply read as much as they can.

What makes of you a herpetologist?
Technically, I work with taxonomic data and the pertinent literature. I' m not sure whether this makes me a herpetologist, but in molecular biology and even ecology and most lab-oriented disciplines, data-driven scientists have long been accepted as «computational biologists». Although I spent most of my «herpetological» time collecting and organizing data, we have recently started to do some *bona fide* bioinformatics work, analyzing some of these datasets, and generated some metadata. I hope to publish some of that work soon.

Which are your favourite species and why?
I love lizards because of their bizarre looks and behavior, which is much more interesting than that of snakes.

What do you think of herpetoculture?
To be honest, I am mostly against keeping exotic vertebrate pets, even though my interest in herpetology started with a couple of pet iguanas. However, pet herps are a serious threat to natural populations and many, if not most, people simply do not keep them properly. I have seen too many poor herps in cages that were too small and not properly equipped.

Have you travelled a lot? If so, where and which are your favourite places in the world? Can you also please tell us some anecdotes of your herp trips, either funny, dangerous or just particularly interesting?
I am traveling a lot for business purposes, usually to meetings. In addition, I have projects in both Germany and the US and thus have to see my students, collaborators and colleagues. Unfortunately there is not a whole lot of time for herping trips, although I always try to do a short trip outside town to take photographs of local herps when I go on meetings. That way, I have taken a number of photos of Southern European, North American, Middle Eastern or Caribbean reptiles, most of which are available online from our reptile database.

Which are the political, practical and legislative priorities in order to ensure the efficient conservation of reptiles and amphibians in your country?
As a native German, I always felt that there are way too many people in Germany and in the world in general. The population density of Germany is about 230 people per square kilometer. If you fly over Germany you have trouble finding any unused spot of land. There are not many reptile and amphibian species in Germany, but reducing the human population growth and, as a consequence, land use, should be a priority for politics. Of course, politically this is heresy.

I have been living in the US for about 10 years now and I feel the same about the USA. Americans are luckier by having a population density that is only one seventh of that of Germany, but I don't see much of an effort to limit their population growth, land use, and pollution either. However, they do have more national parks and more pristine land and they should make an effort to keep that.

Personally, I would also limit pet trade and the commercial exploitation of reptiles, especially in

the US where people are crazy about exotic pets. In South Asia, people seem to be crazy about eating all kinds of reptiles. Another problem is the leather industry. Finally, I am always appalled about stupidity and superstition, e.g., the belief that rhino horn has healing powers, and nonsense like this. Education is the only way to stop people from believing crap like this.

What are your present or recent fields of interests?

Currently I am working on microbial genomics and proteomics, mapping protein interactions in a number of viruses and bacteria. The main goal of that is to develop some biology model systems of protein interaction networks. Another one is to find out the functions of those thousands of uncharacterized genes and proteins nobody knows what they are doing. Remember that I started out studying an uncharacterized protein and its role in vertebrate limb development.

What are your projects for the nearer future?

We have recently started some new projects about host-pathogen interactions. I would love to go back to vertebrate genetics. There are plenty of genes of unknown function.

If you are not a «bona fide» herpetologist, then what is your contribution to herpetology?

My main contribution is certainly the Reptile Database. I started that in 1994 when I was a graduate student at the European Molecular Biology Laboratory (EMBL) in Heidelberg, Germany. EMBL had started the EMBL DNA sequence database in 1982 and released it on the web in the early 1990s. Remember that the WWW had been started at CERN just a few years earlier and EMBL was kind of a sister institution to CERN, so they were at the leading edge of information technology. I asked Thure Etzold, one of the database pioneers at EMBL whether his software could be used to set up a taxonomic database as well. He said, «sure, no problem, just give me a disk with the data» and so I collected a species list with some basic data on each species and gave it to him. In late 1995, we had one of the first searchable taxonomic databases online and I have maintained it since then. It can be accessed at ~~http://www.uetz.us or~~ http://www.reptile-database.org/~~, with free publications at http://www.reptile-database.org/db-info/publications.html and http://www.people.vcu.edu/~phuetz/publications/~~. I have thought many times about publishing the Reptile Database as a book, but it simply doesn't make a lot of sense. It changes daily. A book can never capture that. But for documentary purposes we have published it as CD and as a download version.

Around the year 2000, I was approached by the Species2000 consortium, which was funded by the European Union~~,~~ to set up a database of all living species on the planet. They gave me a bit of money and I provided our reptile database to what became their «Catalogue of Life» (CoL). A few years ago, the CoL data was incorporated into the Encyclopedia of Life, an even more ambitious plan to describe all species on individual web pages. So, our reptile database continues to provide the basic species lists for these global projects.

How do you view the «evolutionary species concept», and what does it change in the conception of taxonomy?

The evolutionary species concept defines species as diagnosable, evolutionary units. This avoids the major shortcoming of the biological species concept, namely its definition of species by means of reproductive isolation. It is extremely difficult to prove reproductive isolation between populations, especially as most taxonomists do not have the time or means to keep a larger number of reptiles in captivity. Technically, you not only have to demonstrate reproductive isolation, but also that the offspring of hybrids, if hybridization occurs, are less fit than their parents. Besides these practical limitations the biological species concept makes perfect sense: as long as populations can exchange

genes, they will form a continuum that cannot be easily separated. Note the emphasis on the word «can». It means that populations don't need to exchange genetic material and thus may *appear* like separate and morphologically different populations even if they are still reproductively compatible. However, we also know that a single or a few mutations may cause striking morphological differences between populations without isolating them reproductively. The same is true for humans who may be white or black without the slightest evidence for reproductive isolation.

For practical purposes, the evolutionary species concept makes a lot of sense and it is actually very helpful for database curators because many subspecies can be considered as evolutionary species. As a biologist and geneticist, however, I have never been very happy with that concept.

I am sure that either species concept will eventually be replaced by a genetic species concept, based on the molecular understanding of morphogenesis and reproduction. Once we understand what reproductive isolation means in molecular terms and know which genes determine morphology, we will be able to define species on that basis. Within 10 years we will surely reach a level of DNA sequencing technology that allows us to completely sequence every new species. In fact, I wouldn't be surprised if the International Commission on Zoological Nomenclature (ICZN) changed their «Code» in a way that requires complete sequencing of every new species described, even if this may take a couple of decades.

With your being at the heart of the Reptile Database, how many species of reptiles have been described so far?

The current count in our database is about 9,800 (March 2013). I add about 2 or 3 a week, including species that are revalidated from synonymy or subspecies that are elevated to full species. If the trend to use evolutionary species concepts persists then we will cross the 10,000 species line in 2014. Remember though that there are about 1,200 species with a total of almost 2,800 subspecies that could be considered «evolutionary» species. Looking at it from this angle, we have crossed the 10,000 species limit a few years ago.

What is your opinion on genetics?

Genetics is the key to all of biology as much as evolution is. The two disciplines are the foundation of biology. When I became interested in biology as a highschool student (in the late 1970s), DNA sequencing had just been invented. At that time, it was pretty much unclear how genes encoded developmental programs, ecological adaptations, or even behavior. Now we have many complete genomes and begin to understand how they program life. This is an incredibly exciting time in history. In a few years, we will have reliable phylogenetic trees of reptiles and, of course, most other organisms.

It will take a few decades, but later in this century we will be able to predict complex phenotypes from genome sequences. We will understand why reptiles have scales and how they evolved into hair or feathers. We will know which mutations caused limb loss in anguids and snakes, and how venoms evolved in venomous snakes. All these questions can only be studied seriously using genetics and molecular biology.

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