Q & A

Michael J. Ryan

Michael J. Ryan is the Clark Hubbs Regents Professor in Zoology in the Section of Integrative Biology, University of Texas, Austin, USA, and a Research Fellow at the Smithsonian Tropical Research Institute in Panama. His main research has been on sexual selection and communication and his 1985 book The Túngara Frog: A Study of Sexual Selection and Communication *has become a classic in that field. His research on animal communication continues, and emphasizes the integration of brain, behaviour and evolution.*

What turned you on to biology in the first place? There was no single epiphany but a series of smaller acts of revelation. I was always interested in nature and in animals. I lived in New York City, in the Bronx, until I was 10. My mother regularly took us — I have 10 younger brothers and sisters — to the American Museum of Natural History and my dad often carted us off to the Bronx Zoo; dinosaurs and snakes were the biggest lures at each. My family then moved to a quite rural part of northwestern New Jersey, and I experienced what was akin to 'ecological release'. We were surrounded by forests that were inhabited with creatures you never encountered in alleys of the Bronx. My brothers, friends and I almost lived in the forest, spending all day hiking and looking for animals and sleeping under the stars as we were serenaded by the nocturnal choruses of insects and frogs. When I first encountered a formal biology course in high school my interests were well primed. I attended a Catholic high school and had a wonderful biology teacher, a Benedictine monk, Father Patrick Bonner. One topic he taught was evolution, an illustration that much of the current conflict between religion and evolutionary theory is motivated by fundamentalist sects invested in the bible's literal interpretation and is not relevant to many religions.

I attended a small state college to become a high school biology teacher. There I became fascinated by the idea that the scientific process was accessible to mere mortals, and thrilled that one could do this as a career. Eventually, in 1977, I ended up at Cornell University for Ph.D. work. This was when the sociobiology revolution was at its peak and Cornell was one of its epicentres. I was in the Section of Neurobiology and Behavior, where the excitement about the adaptive significance of social behaviour existed with a usually healthy tension alongside laboratories studying neuroscience. The faculty on both sides of that equation, such as Steve Emlen and Bob Capranica, respectively, were awe-inspiring, and there was a cadre of graduate students that afforded the most stimulating intellectual atmosphere I have encountered. During my tenure at Cornell I spent about half of my time at the Smithsonian Tropical Research Institute's field station on Barro Colorado Island, Panama. This began my long involvement with tropical biology and introduced me to Stan Rand, who was my STRI sponsor and became one of my closest friends. I collaborated with Stan almost continually for 30 years, until recently when he passed away. STRI also attracted some of the best minds in evolutionary biology for sabbaticals. I got to know quite well and benefited greatly from discussions with Ernst Mayr, Robert Trivers, John Maynard Smith and Amotz Zahavi during this critical stage of my thesis development.

Do you have a favourite paper? It might be the 1979 essay by Mary Jane West Eberhard, 'Sexual selection, social competition, and evolution', in the *Proceedings of the American Philosophical Society*. Mary Jane is a research scientist at STRI well known for her work on eusociality in wasps. But she was then starting to think about sexual selection. She gave me that paper in manuscript form on one of her visits to Panama, and we talked about it as I later drove her to the airport. Her ideas extended the phenomenon of mate choice and sexual selection into the more general context of social interactions, and presaged the general ideas of sensory biases and sensory exploitation that were later formalized by some of us, with slightly different emphases. This idea posits that the sensory, neural and cognitive systems that one sex uses to evaluate mates during sexual selection can evolve under other selective forces and constraints outside of the context of mate choice. Thus, in some cases, selection favors the signals of one sex that can best stimulate preexisting mechanisms that mediate mate choice in the other sex. As a recent study has suggested, for example, female guppies might prefer orange males not because orange indicates anything about a male's genetic quality but because the guppy's visual system has evolved under selection to find the orange fruits upon which it feeds.

What is the best advice you've been given? My graduate program was an integrative one, on neurobiology and behavior. The implicit advice we all received was to integrate. That is the same message I try to convey to my students. The distinction between ultimate and proximate causation is sometimes important for communicating our science, but fails at proscribing a research program aimed at understanding the diversity of nature. If one is interested in how behaviour evolves, one must study what evolves; that is, the details of the behavioural phenotype, the brain, the genes and hormones controlling it, as opposed to treating behaviour as a black box. There are many wonderful tools being developed, especially in molecular genetics and molecular neurobiology. Much of the work they are being used for is still in the descriptive stages. The challenge in my field is to integrate these tools into

our studies not merely to add more descriptive data but for hypothesis-driven research.

Do you have a favourite conference? Two. One is the Winter Animal Behavior Conference. This is an informal meeting of about 30 attendees convened at various sites in the Rocky Mountains of North America. It lasts a week, everyone gives a talk, and there is ample time for serious discussion both in the conference and on the ski slopes. I usually find the discussions on the slopes more rewarding; it is probably the cold mountain air. The other is the biennial conference of the International Society for Behavioral Ecology. This meeting is larger, but usually there are fewer than 1000 attendees. It always has a very international flavour, the presentations are of the highest quality, and the social atmosphere is also quite conducive to interaction.

Do you have a scientific hero? Any evolutionary biologist, especially any who has read Darwin's works carefully, has to have him as a hero. His insights were, of course, revolutionary, but also his struggle to understand the natural world by documenting it with such precision and such care is inspirational. Another is Peter Marler, one of the pre-eminent animal behaviorists of our time. His studies often defined the course of modern animal behaviour, and his work has always been integrative, never invested in the false dichotomy between ultimate and proximate causes. The group of graduate students and postdocs he has mentored is legendary.

What are the big questions to be answered next in your field? One question for the short or medium term is how constrained are complex behavioural systems in their response to selection? Does evolution in one context constrain a behavioral system's ability to evolve in another context? Does it influence the details in how it responds? Essentially the same question can be recast for different research programs, for example: "how common is pleiotropy in behavior?" or "how domain specific are cognitive functions?"

In the long term, the future of animal behaviour lies in its integration. The whole animal is at the intersection of those disciplines that concern processes inside the skin, such as genetics, development, and neuroscience, or those addressing issues outside the skin, such as ecology, population biology and evolution. At least for me, behaviour is the most interesting aspect of the animal's phenotype. It is shaped by developmental experiences, can sometimes be influenced by fairly simple genetic mechanisms, and is usually quite susceptible to gene-by-environment interactions. Behavior is critical in various aspects of ecology (e.g. habitat choice), evolution (e.g. mate choice in sexual selection and speciation) and conservation biology (e.g. flexible responses to anthropogenic disturbances). And risky as this might sometimes be, it can offer us insights into our own species. To have a deep biological understanding of biology — to link, let us say, questions of development and genetics with ecology and evolution — understanding behaviour will often be the linchpin. Consider, for example, some of the recent studies showing the roles of gene expression in caste determination in eusocial insects, and opsin sequence changes in the rapid speciation in cichlids.

In this quest it will also be important to consider behaviour as part of an integrated phenotype. This begs the questions raised above about pleiotropy and domain generality versus domain specificity. Also, behavior is the social glue that integrates phenotypes across individuals and even across kingdoms. All of these issues require animal behaviorists to become even more-general biologists.

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Deeper and down

One of most popular emerging extreme sports is that of freediving; people test their ability to dive to depths and swim lengths while holding their breath, using little more than an attached fin. Current records held are diving to 109 metres deep, staying under water for 9 minutes and swimming under water for a distance more than 220 metres.

While, for humans, these are impressive achievements, they are nothing compared to the skills of marine mammals. For all air-breathing organisms, diving presents one of the most demanding challenges: lack of oxygen is obvious, but adaptation to the changes in pressure and the need for a means of navigation and prey location are additional requirements.

A recent study of the behaviour of two little-known small-beaked whales, finds that they regularly dive deeper and longer than any other species, adding to the intrigue of these adaptations. The researchers found that the whales regularly dived to depths of more than 1800 metres for a duration of up to 85 minutes. While other species such as sperm whales and elephant seals are known to go deeper and longer, they do so only occasionally compared with the regular deep dives of these beaked whales.

The researchers believe the new findings may also throw light on the impact on these animals of deep naval sonar activities.

The work by Peter Tyack at Woods Hole Oceanographic Institute and colleagues in Spain, Italy and Denmark, is reported in the *Journal of Experimental Biology* (published online). They have worked with the two poorly known species *Ziphius*