Q & A

Geraldine Wright

Jeri Wright studies the neural basis of behaviour and the nutritional ecology of honeybees in the Institute of Neuroscience at Newcastle University. A Wyoming native, she studied botany at the University of Wyoming while working as an assistant researcher in the entomology museum. As an undergraduate, she first combined her interest in plants and insects by studying insect nutrition as a Rhodes scholar at Oxford University in the Department of Zoology. As a postdoc, she came back to the US to study olfaction in honeybees in the Rothenbuhler Honeybee Laboratory at Ohio State University. After six years (and a master's degree in statistics), she returned to the UK to set up her own lab in Newcastle upon Tyne.

What turned you on to biology? I grew up in Wyoming and spent most of my time outside. I had a strong affinity for animals and had many kinds of pets — from chickens, guinea pigs, horses, rabbits, cats, and dogs. Wildlife documentaries such as those by David Attenborough certainly had a strong influence on me; I remember getting so excited at the age of 10 by one program on African savannahs that I was running around pretending to be a cheetah. From an early age, I also developed a keen interest in insects, especially grasshoppers and ants, and their ways — in grade school I made an insect collection as part of a 4H project (an agricultural club in the US). In high school, an excellent biology teacher inspired my first appreciation of plants, and this, combined with a desire to help solve world problems like famine and biodiversity loss, led to me deciding to study botany at university. It was a hard decision at the time, though, because I was good at English and I loved art, but I thought that science would afford me the best future opportunities.

My career has not been narrowly focused and instead followed my developing interests — and my opportunities — which led me to study and live both in the UK and the US. I realized as an undergraduate that I wanted to work in the tropics and I liked insects, so I decided to pursue chemical ecology in graduate school. I had studied abroad in London as an undergraduate for a semester and worked in the Natural History Museum, and this inspired me to apply for a Rhodes Scholarship during my final year as an undergraduate. At Oxford, I did my DPhil on insect nutrition and herbivory with Steve Simpson and David Raubenheimer in the Department of Zoology. Steve and Dave were just developing and testing their nutritional models, and so the angle of my doctorate was to understand herbivory from the perspective of insect nutrition. My DPhil research helped me to appreciate the difficulty of field work: part of my work was done in the field in Costa Rica watching individual weevils eating leaves continuously for 10 hour periods. I certainly gained an appreciation for how challenging it can be to interpret animal behaviour, and how important doing something as simple as watching an animal for a continuous period can be to understanding it.

After Oxford, I switched fields slightly, and started working with Brian Smith on olfaction and how honeybees perceive and learn floral scent at Ohio State University. When I started working with bees, I was excited by the ease of the lab-based assays for learning and memory, and how it was possible to obtain a lot of information quickly using the conditioned proboscis extension assay. It was a natural next step in my research to start learning more about the mechanisms of the bee's behaviour, and Brian's lab was developing methods for studying olfaction and sensory physiology. As well as being a good model animal for the neural basis of behaviour, the honeybee is also fun to study because its social life is fascinating and it has beautiful mutualism with plants. So, I've worked in several disciplines throughout my career, and this, combined with a superb study animal (the honeybee), has made it possible for me to occupy a unique scientific niche.

Any advice for someone starting a career in science? I find I have a tendency to stop seeing the wood for the trees at times. In a career-altering moment at a conference, Mike Pankratz (University of Bonn) once asked me: 'what is the big question that you are trying to answer?' At the

time, I was a little surprised at the difficulty I had at answering this simple question. As scientists, we have to be focused to dig deep into a problem. However, it's important to keep in mind how what you are doing fits into the bigger picture. Why is what you are doing important? If you've got a quick answer to either of these questions, then what is standing between you and the answer to the big question? Understanding this in a deep way should at least provide a road map — and it also means you can justify why you are spending your precious time doing science when things aren't easy (and it is unlikely that they will be most of the time).

What has been the most important thing about life you've learned as a scientist? Academics are constantly scrutinizing and being scrutinized: scientific research is a creative venture just like art or music, the merit of one's research easily becomes a metaphor for one's own worth as a person. This can make it hard to have the confidence to do really creative work and to stay afloat when things are hard or go wrong. I think it is important to stay focused on the reasons why your research is interesting to you, and to do the work with as much integrity and clarity as you can.

What are the main challenges facing women in science? Most modern careers require a certain amount of social savvy. Women can be at a disadvantage here in science simply because most faculty and admin posts are held by men. It isn't always easy for young women to have social confidence necessary to not only engage but stand out in their respective scientific communities and the competition for faculty positions is stiff. That being said, I think a lot has changed for the better in the last 20 years that I have been in science and the climate is still improving. A second challenge that women face is the fact that they are at a fitness disadvantage if they opt for a scientific career in spite of measures to overturn this. If you consider that most people do not reach tenure until their late 30s or early 40s — it is easy to see how this presents a disadvantage for women, who are most fecund before the age of 35. Further, babies and the careers of early investigators both require a lot of investment…..I guess you get the picture. My male colleagues do not face the same trade-offs between family and career. There are ways around it for women, but they aren't simple. Perhaps society will eventually make it easier for young women to do both. This will depend in part on how much we value having women in science.

What's the next big question in your field? I'm most interested in the neural basis of learning and memory. Bees are a great model for studying this because adult workers are excellent at learning to associate scent, visual and even tactile cues with food. For me, one of the most exciting areas of research in this field is to identify how state influences learning and memory, and I think that studying it in invertebrate models presents a great opportunity to get at the fundamental principles. For example, my friends and I recently showed that decision-making in bees is influenced by 'emotional' state. Whether or not bees have a genuine correlate of emotion is debatable, but state definitely alters their decision-making.

Drug and alcohol addiction claims the lives of so many people and causes a myriad of social problems. I think that one of the world's greatest challenges at the moment is to find ways to combat addiction. As scientists, we can help by identifying the neural basis of addiction with the aim of developing therapeutic and pharmacological interventions. I believe that understanding addiction will likewise reveal fundamental principles about the way the brain functions — both in terms of what we understand about specific circuits, such as those involved in reward learning and memory — but also as a complex living organ whose activity is modulated by short- and long-term changes in state. Who knows if we can get the much smaller brains of invertebrates addicted to substances? There is some intriguing research on fruit flies that suggests this is possible. If we cannot, that is equally interesting.

What do you advise a student who doesn't know what topic in biology to specialize in? I would first say: read more. Start reading through the high impact general journals regularly, and make note both of things that interest you and who is doing them. Think about what you like to spend your time doing — is it being outdoors or spending time at the bench? What do you foresee yourself doing in 5 or 10 years? Talk to students and postdocs at your university, and find out how they spend their time and what their opportunities are. It is also useful to look at what kinds of jobs are offered to people in the field you are attracted to (there may not be many advertisements for behavioural ecologists studying tigers). Find an active lab that is publishing in the field that interests you, read their papers, and don't be afraid to write to the lab head to ask what kinds of projects you could get involved in.

What do you like most about your job? The opportunity to spend my time pursuing what is intellectually interesting to me is by far the best thing about being an academic. I love learning and that's a real bonus for me. I also love looking at and interpreting data. It can be extremely rewarding to develop a hypothesis and see how it pans out. After one has spent time and effort collecting data, for me there is real joy in using statistics to test a hypothesis: I still get a thrill when I run a stats program to analyse data from an experiment. If anything, my Achilles heel is knowing when to stop collecting and analysing, and when to start writing it up!

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Quick guides

Equisetum

Anne Knowlton

What is* Equisetum*? *Equisetum,* a genus whose species are collectively known as horsetails, are the living descendants of giant prehistoric trees that once dominated the Earth. These ancient giants remain with us today in the form of coal. The living species of *Equisetum* offer biologists a peek into the history and evolution of vascular land plants.

Equisetum is the single extant genus of a class of anciently evolved land plants. Fossils of the ancient giants are found dating back to the Devonian, and in the late Devonian and Carboniferous periods, the world's forests were dominated by the calamites — huge tree-like horsetails that reached heights of up to 18 meters. These ancient forests were a far cry from forests in today's world — many large land animals had not evolved by this point, and fossil records indicate that giant insects had the run of the place! The calamite forests were so rich that they eventually formed the world's large coal deposits. As the climate grew drastically drier and colder in the Permian, concomitant with a change in atmospheric oxygen content, the giant calamites eventually died out, leaving only the herbaceous genus *Equisetum* in modern times.

Equisetum species are almost identical to the ancient calamites in morphology, earning *Equisetum* the label of 'living fossils'. Horsetails are found in various habitats around the world, though they usually prefer wet, swampy areas. Although there are examples of 'giant' horsetails (e.g. one Mexican species has been reported to reach heights of 8 meters), most horsetails are much smaller than their ancestors, and are usually around 1 meter or shorter.

How would I know a horsetail if I saw one? *Equisetum* have a very distinctive appearance, growing in dense clusters as jointed, photosynthetic stems (Figure 1A). These stems are sometimes branched, with whorls of branches appearing at the joints between