possibilities for new experiments. I have been extremely lucky to have worked closely with so many talented people who have an immense enthusiasm and curiosity for understanding how biological systems work. What is true for an individual is also true for an institution as a whole. In my early days at LMB the open seminars discussing, for example, Francis Crick's wobble hypothesis and Fred Sanger's new sequencing protocols were a revelation and an inspiration. LMB remains an institution where usually someone somewhere can answer your most obscure question and, more importantly, produce stimulating suggestions. But conversely it is clear that whenever the will to discuss results and ideas openly falters the science inevitably suffers.

What is the best advice you've been given? Towards the end of my Ph.D. I was wondering what to do next and Sydney Brenner told me that I would have to leave the lab and go somewhere where people think differently to gain a broader perspective. He was absolutely right. As a post-doc the change in environment was tremendously stimulating and opened my eyes to a different culture of practising science. I always give my own students the same advice even though for them Cambridge is sometimes a difficult place to leave.

Apart from the science itself what else is especially rewarding about a scientific career? To see students mature, become independent scientists in their own right and then to follow their future success gives an immense satisfaction. Sometimes you can almost see the metamorphosis as a student makes their first real discovery and gains the confidence that they need.

Do you have a particular gripe about the way science is administered? My main concern is that group leaders are being distracted by more and more time-consuming requests to complete seemingly irrelevant forms. An excess of bureaucracy is anathema to curiosity. Given that, for many, curiosity is the driving force of creative science, this seems a self-defeating development. To be fair, LMB has, so far, been spared the worst excesses of this creeping authoritarianism.

What advice would you give to scientific planners? In the UK, well-established and still productive scientists are still often put out to grass when they reach their nominal retirement age. It seems a tremendous waste that, in the present much vaunted knowledge culture, so much experience and understanding should be so arbitrarily discarded. Surely it would be far better to follow the example in the USA, where in many institutions scientists can keep their bench for as long as their minds remain agile? Ageism has no place in science.

What do you think a scientist needs most? One extremely important aspect of practising science is to have the time and space to think. I am extremely fortunate to have a family who understand that on occasions I can become so engrossed with a new idea or an intellectual roadblock that I am oblivious to all other inputs.

What advice would you give to a young scientist starting out today? Beware of being seduced by your own hypotheses, however elegant they may seem to you. Unless you believe that you've discovered the equivalent of the structure of DNA, Nature has probably evolved a more satisfying and an even more elegant solution. On the other hand, if you believe there is sufficient evidence for your favourite idea, however radical it may seem to others, keep faith with it.

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Quick guide

Amazon mollies

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What are Amazon mollies? The Amazon molly (*Poecilia formosa*; Figure 1) is a small, livebearing fish of the family Poeciliidae and is found in diverse freshwater habitats from the lower Rio Grande valley (USA) to Tuxpan in Northeast Mexico. Mollies of the genus Poecilia are mainly found in Central America and the USA, but have been introduced worldwide.

Why are they called 'Amazon' mollies? The species is named after the Amazons — an all-female tribe of warriors from the Greek mythology. The mythical Amazons used males from neighboring tribes to reproduce and killed their male offspring. Like the mythical Amazons, Amazon mollies come only as females. However, they don't kill their males, but simply do not produce them in the first place.

How can they do without males? They can't entirely. Amazon mollies reproduce through a process called sperm-dependent parthenogenesis (gynogenesis). They produce diploid eggs without meiosis and these eggs are pseudo-fertilized by the sperm of males of different, related species. The sperm are only used to trigger embryogenesis and do normally not contribute genetic information. Thus, the reproduction of Amazon mollies is strictly clonal.

How do they 'mate'? Mollies —like other members of the Poeciliidae, such as guppies— are livebearing and fertilization takes place internally. Thus, Amazon mollies need to trick heterospecific males into copulating with them. Three species are known to serve as sperm donors in the natural habitats: the Sailfin molly (*Poecilia latipinna*) in the USA and both the Atlantic molly

(*P. mexicana*) and the Tamesi molly (*P. latipunctata*) in Mexico. Amazon mollies always coexist in the same habitat with at least one of these species.

Why do heterospecific males bother mating with the Amazons? In theory, as they do not contribute their genes to the next generation, males would be expected to be under selection to avoid such unproductive heterospecific matings. Also, it appears that males are able to tell the difference between females of their own species and the Amazons. However, the actual costs for these matings may be low. Males may even gain an indirect benefit via mate-choice copying, as mating with Amazon mollies makes them more attractive to conspecific females.

And there is really no transfer of genes at all? Only in rare cases are all or parts of the sperm's chromosomes included into the Amazon mollies genome. This leads to triploid clones or clones with microchromosomes, both of which are found in Nature. Their evolutionary significance is not clear yet, but the introgression of male genetic information could increase the genetic variability of Amazon mollies.

Do other organisms show similar modes of reproduction? Yes, quite a few invertebrates are clonal, but only very few vertebrates. Of these, the fishes (e.g. *Poeciliopsis monacha-lucida*) and amphibians (e.g. *Rana esculenta*) are always sperm-dependent, whereas the reptiles (e.g. *Cnemidophorus uniparens*) show true parthenogenesis. Eggs can be formed in multiple ways, and there is a great diversity in the actual reproductive modes of such species.

What is the evolutionary history of the Amazon molly? Amazon mollies — like all clonal vertebrates— are of hybrid origin. Why this is so, is currently not clear, but several asexual invertebrates are not of hybrid origin. The single, original hybridization between a Sailfin molly-like male and an Atlantic molly-like female is presumed to have occurred about 120,000 generations ago.

Figure 1. Amazon molly 'mating'.

An Atlantic molly male (bottom) interacting with an asexual Amazon molly (top) in the natural habitat. The approaching behaviour shown is part of the mating behaviour. (Photo by Juan Miguel Artigas Azas.)

What can Amazon mollies tell us about sex (that we didn't dare to ask)? A female that only produces daughters has a two-fold advantage over a female that produces sons and daughters: all of her offspring can produce their own offspring, while only 50% can do so when both sexes are produced at a 1:1 ratio. This is known as the two-fold cost of males. In addition to this cost of males, due to meiosis, sexual offspring are only half as related to their siblings and parents as clonal offspring. Therefore, asexuals should replace sexuals relatively quickly. But sexual reproduction is highly prevalent in nature and thus must provide some benefits that outweigh the two-fold advantage of asexuals. What these benefits are is still a problem in evolutionary biology. The stable coexistence of Amazon mollies with closely related sexuals provides an ecological puzzle and an opportunity to study the potential benefits of sexual reproduction.

So what is sex good for? Many hypotheses have been proposed, two of which are currently being widely discussed. First, sex may be advantageous because deleterious mutations can be purged more efficiently from the genome through recombination, while beneficial mutations can be combined in one genome more easily. Recombination may also be beneficial in rapidly changing environments. The second currently popular hypothesis (Red Queen Hypothesis) posits that genetically uniform asexuals should be more susceptible to rapidly coevolving parasites than genetically more diverse sexuals. Recently, it has been argued that both hypotheses may act in synergy.

How then do Amazon mollies and sexual mollies stably coexist? We don't know yet. Neither do Amazons seem to suffer from accumulated deleterious mutations, nor are they more susceptible to parasite infections as would be predicted by the Red Queen hypothesis. Male mating behavior may act as a regulating factor in sperm-dependent asexuals, if males avoid asexuals under certain conditions (e.g. if asexuals are very abundant). Differences in the life histories between Amazon mollies and their sexual relatives, such as in the number of offspring or the temporal spacing between broods, may contribute to the stable coexistence.

Where can I find out more?

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