Curious genitalia are signposts of evolution

Elaborate and peculiar sex organs give us eye-opening insights about the world, says **Brian Langerhans**

What made you want to study genitalia?
I just wanted to understand how there is so much biological diversity in the world. And to do that, it made sense to me to study the evolution of one of the most rapidly evolving things known in the entire animal kingdom – male genitalia.

How do you explain what you do when you're at parties?
I usually pitch my research regarding genital diversity as trying to understand how the world works.

If you want to understand how all this life has evolved, then you need to know what causes the rapid evolution of traits that are the most elaborate and peculiar. You also want to be able to answer questions about what traits influence the origin of new species, and how human activities might drive rapid evolutionary change. Male genitals are a good place to look to address those questions.

You study the genitalia of both sexes. Why have penises hogged the limelight in biology?
Science is finally getting around to studying female genitals in earnest, and understanding how important these structures are – and we are seeing a lot of really interesting and complex variation. But historically it was received wisdom that female genitals just didn't vary that much, so why bother? The male structures are very obvious because they often have hard, rigid attributes that are much easier to measure. Female genitals are typically made of soft tissue that can conform to different sizes and shapes during different activities, and often have no obvious external features that can be measured.

So, historically, scientists went for the low-hanging fruit, so to speak.

What is the most elaborate and peculiar set of genitalia you've encountered?
It's hard to pick just one. Reproductive organs that have really elaborate spikes, hooks or some sort of weird pointed appendage are more common than you might think: there are thousands of outrageous sets of genitals in the world. You can see some crazy beetles that have spikes all over their sexual organs. Bedbugs have sword-like appendages that they use to pierce the abdomens of females in order to inseminate them. Some primates have enormous testes. Mosquitofish, which I study, have these harmful-looking spikes on the male sex organ, or gonopodium. And there are even species, such as squirrels, that have sexual organs to insert plugs into the female to prevent future mating.

Many male genitals look more like medieval torture devices than organs that transfer sperm from A to B. It makes you wonder why any female would ever mate with them.

And the strangest female genitalia?
A peculiar one I found is in the live-bearing fish *Gambusia vittata*, which looks dramatically different from its close relatives. The female has evolved a flap of tissue that conceals the entire genital region. Copulation in these fish is extremely rapid and athletic, with males performing a complicated torque-thrust manoeuvre in just 20 to 50 milliseconds, including dealing with this flap. The genitalia of both sexes in this species is so peculiar that the species was originally given in its own genus, *Flexipenis*.

PROFILE
Brian Langerhans is an assistant professor of ecology and evolutionary biology at North Carolina State University in Raleigh. He explores the evolution of biological diversity

Photographed for New Scientist by Travis Dove

How did human genitals end up with such relatively boring structures?
I don't know if I'd say they were boring. Clearly, human genitals serve a function and are performing that function quite well. If we put the human penis in the context of the entire animal kingdom, say, we see that you don't always need spikes, hooks or plugs to get the job done. Evolution always comes up with multiple solutions to similar problems.

What drives the diversity of male genitals?
There doesn't seem to be a lot of natural selection at play. We're reaching a consensus that male genitalia are so diverse because of sexual selection, or selection that acts on traits that bring about reproductive success. These very different types of genitalia have evolved to make sure that these species can keep successfully reproducing in whatever environment they are in.

What's the difference between natural selection and sexual selection?
Darwin originally defined the two terms as a dichotomy, but they are essentially the two major components of evolutionary fitness. A species has to be able to survive day to day – and it has to be able to reproduce. Natural selection acts on the surviving, whereas sexual selection acts on the reproducing. It's the latter that seems to be driving the rather dramatic diversity we see in penises and testes.

You study how human activities are affecting mosquitofish genitalia. What's happening?
We look at mosquitofish in tidal creeks across different islands in the Bahamas. Over the past 50 years, there have been a lot of roads built to connect different settlements across the islands, and they've dramatically changed the landscape. I'm sure the last thing the Army Corps of Engineers was thinking about as it built these roads was, "I wonder if blocking off this creek might change the reproductive organs of the fish that live here". But that's what happened.

These creeks used to connect to the ocean and were huge nurseries for all kinds of other fish. Once they were blocked off, those populations went away. Predation of the mosquitofish plummeted and the mosquitofish gonopodia got much bigger. And not just the gonopodia – we also saw changes to the female genitalia in these species. With less predation, the genital openings of females are larger and more oval-shaped. And all of these changes to the genitalia have evolved rapidly, in just four or five decades.

"So many sets of male genitals look like medieval torture devices"

What can we learn from these effects?
Our activities aren't just changing mosquitofish genitals. Or even just animal genitals. They are also making changes to different species' body shape, colour, habits and other things – and really fast. We need to learn about how human activity affects the ecology of different biological systems, so we can prevent damage that, if we aren't careful, we can't undo.

Is bigger better for the animals you study?
Female mosquitofish prefer to associate and mate with males that have a large gonopodium. But those males experience increased drag thanks to that larger organ hanging off their body, so what they gain in mating, they lose in manoeuvrability and speed. And that's a big problem, because if you're swinging around this large gonopodium, you may find that you're not only catching the eye of the females, but also the eye of predators. Fish with a bigger gonopodium are more likely to get eaten.

Interview by Kayt Sukel