

His Subject: Highly Evolved And Exquisitely Thirsty

By Carl Zimmer

The tub full of leeches sat on a table in Mark Siddall's office at the American Museum of Natural History. The leeches, each an inch long and covered in orange polka dots, were swimming lazily through the water.

One leech in particular attracted Dr. Siddall's attention. It had suddenly begun undulating up and down in graceful curves, pushing water along its body so that it could draw more oxygen into its skin.

"This is beautiful. Look at that," Dr. Siddall said. "It's a very complex behavior. The only other animals that swim in a vertical undulating pattern are whales and seals."

For Dr. Siddall, leeches are a source of pride, obsession and fascination. His walls are covered in leech posters and photographs. He owns a giant antique papier-mâché model of a leech, with a lid that opens to reveal filigrees of blood vessels and nerves. His lab is filled with jars full of leeches that he has collected from some of the most dangerous places in the world.

He considers the risks well worth it, because he can now reconstruct the evolutionary history of leeches – how an ordinary worm hundreds of millions of years ago gave rise to sophisticated bloodsuckers that spread across the planet.

This was not a case of love at first sight. As a boy growing up in Canada, Dr. Siddall was disgusted by the leeches that attacked him when he went swimming in forest ponds. Their biology began to intrigue him as an undergraduate at the University of Toronto, where he became interested in how leeches spread parasites among frogs and fishes.

"It was hard for family conversations,"¹ he said. "You couldn't exactly talk about it over Thanksgiving dinner."

¹ Die Interpunktion ist genau umgekehrt richtig.

No one knew whether the parasites that leeches carry could hop from species to species or they were restricted in their choice. Knowing that required knowing how leeches are related to one another, something that Dr. Siddall found was an open question.

In the late 1990`s, scientists were developing methods that could shed light on the evolution of leeches like sequencing animal DNA and computer programs that could use the sequences to reconstruct evolutionary trees.

By the time Dr. Siddall joined the museum in 1999, the evolution of leeches had become his chief obsession.

There was just one catch. To chart the entire tree, Dr. Siddall had to obtain species from all of its major branches. That required series of expeditions to places like South Africa, Madagascar, French Guyana, Bolivia, Chile and Argentina.

To collect leeches, Dr. Siddall and his colleagues take off their shoes, roll up their pants and wade into the water, even if its waist-high muck full of electric fish.

“You can’t set traps for leeches,”² Dr. Siddall said. “We are always the bait. You can turn over rocks. You can turn over branches. But ultimately the interesting stuff is going to come to you.”

Turning himself into bait is paying off. Dr. Siddall’s research has shown that the ancestors of leeches were probably freshwater worms that fed harmlessly on the surface of fish or crustaceans, as the closest living relatives of leeches do. Not only do these worms have the most leechlike DNA of any animal, but they also grow the same sucker on the base of their tail that leeches use for crawling.

The leech evolutionary tree suggests that the earliest land vertebrates may have been the first hosts for leeches. Dr. Siddall has identified several major innovations that early leeches evolved as they became blood feeders. They acquired a proboscis they could push into their hosts to drink blood. Later, some leeches evolved a set of three jaws to rasp the skin.

Leeches also needed chemicals that could keep their host’s blood thin so that it would not clot in their bodies.

² Die Interpunktion ist genau umgekehrt richtig.

Leeches have evolved many different molecules for that work that interfere with different stages in clotting, along with other molecules that prevent inflammation. Pharmaceutical companies have isolated some of these molecules and sell them as anticoagulants. Blood is good source of energy, but it does not make for a balanced diet. Mosquitoes and other blood feeders have evolved a symbiosis with bacteria that can manufacture vitamins and amino acids necessary for life.

Leeches appear to have evolved their own partnerships, even producing special chambers in their throats where bacteria can live.

It is particularly tough to study these bacteria, because scientists need to find leeches with big bacteria-housing organs to dissect. It turns out that some of the biggest are in a species that lives just on the rear end of the hippopotamus. So Dr. Siddall has travelled to South Africa in recent years to wade into crocodile-infested waters to look for them.

“Obviously, we didn’t wrestle hippos to the ground,”³ Dr. Siddall said. Instead, he hoped to attract a few leeches that had dropped off the hippos. He failed to find any.

But fortunately for him, a game warden remembered him when a hippo was shot after raiding backyards. He sent Dr. Siddall a leech from the hippo’s hindquarters.

“It turned out to harbour a completely unique lineage of bacteria,”⁴ Dr. Siddall said.

After the original leeches had evolved the basic equipment to feed on blood, they moved into new habitats. Dr. Siddall’s research suggests that they first evolved in fresh water and later moved to the ocean and to dry land. Terrestrial leeches became particularly adept at ambushing hosts, using their keen senses to detect carbon dioxide and heat.

They have 10 eyespots on their heads that they can use to detect moving objects.

“They’ve got incredible vision,”⁵ Dr. Siddall said. “You move your hand across their field⁶ of view, and they’ll track the movement.”

In his office, as he waxed poetic about leeches, one in the tub on his table crawled out.

“Oh, jeez, this guy is getting away,”⁷ he said. “Well, that’s an interesting story.”

³ Die Interpunktion ist genau umgekehrt richtig.

⁴ Die Interpunktion ist genau umgekehrt richtig.

⁵ Die Interpunktion ist genau umgekehrt richtig.

⁶ fields

⁷ Die Interpunktion ist genau umgekehrt richtig.

He plucked up the leech and let it suck on his finger for a moment before putting it back in the water.

The leeches in the tub, Dr. Siddall explained, belong to the species *Macrobdella decora*, the North American medicinal leech. They are part of a lineage of leeches that returned from dry land to live in fresh water. But they still like to come out of the water to lay their egg cases.

After the eggs hatch, the young leeches have to crawl to the water.

Dr. Siddall has been making a careful study of North American medicinal leeches in recent years, figuring out which genes do the best job of revealing the variations between different populations of leeches. It turns out that some populations may actually represent entirely new species.

“We think we’ve found a new species in Harriman State Park here in New York,”⁸ he said. But the biggest surprise came when Dr. Siddall applied the new techniques to the best-known leech of all, the European medicinal leech, *Hirudo medicinalis*.

In ancient Rome, physicians used that species to bleed patients to treat maladies like headaches and obesity. The tradition continued for 2,000 years. In the 1860’s, London hospitals used seven million medicinal leeches a year.

Although physicians no longer bleed their patients, *Hirudo medicinalis* has been enjoying a renaissance. Surgeons reattaching fingers and ears find that patients heal faster with the help of leeches. By sucking on blood and injecting anticoagulans, leeches increase the flow through the reconnected blood vessels.

In 2004, the Food and Drug Administration approved *Hirudo medicinalis* as a medical device, and a number of companies do a brisk business importing them from Europe to the United States.

Working with Peter Trontelj at the University of Ljubljana in Slovenia, Dr. Siddall began collecting the leeches from across Europe and ordered them from supply houses. When they analyzed the leech DNA, they received a big surprise. “The European medicinal leech is not one species at all,”⁹ Dr. Siddall said. “It’s at least three.”

⁸ Die Interpunktion ist genau umgekehrt richtig.

⁹ Die Interpunktion ist genau umgekehrt richtig.

Dr. Siddall and Dr. Trontelj are trying to determine the ranges of the three species and their differences. He expects his discovery will lead to changes in F.D.A. regulations. More important, he hopes it will draw attention to the plight of European leeches. Overharvesting and habitat destruction have cut their numbers drastically.

“The situation for the true European medicinal leech may be a lot more dire than we thought,” Dr. Siddall said.

To understand the true condition of all three species, Dr. Siddall plans to go to Europe. He will have to work the trip into a schedule filled with other expeditions.

“There are all sorts of things out there like *Dinobdella ferox*, which means the terrifying and ferocious leech,”¹⁰ Dr. Siddall said. “It lives in eastern Bengal, and it will literally crawl up your nose and lodge in the back of your throat.”

Dr. Siddall knows that the notion of leech conservation may strike some people as an odd pursuit.

He points out how many medical surprises leeches have yielded. New species will presumably yield new surprises. But he also thinks people should be concerned about leeches simply because they are leeches.

“Don’t you think the world would be a colder, darker place without leeches?”¹¹ he asked. He raised his tub with a smile. “Especially ones with orange polka dots?”

ON THE WEB

A video interview with Mark Siddall is online. The articles in this section, along with breaking news and daily features, can be found all week:

nytimes.com/science¹²

¹⁰ Die Interpunktion ist genau umgekehrt richtig.

¹¹ Hier gehört ein Komma hin.

¹² Trotz gründlicher Recherche auf der angegebenen Website konnte das Interview nicht gefunden werden.