

Serendipity and Lampreys

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(President's note from Fritz: The following was modified from an article published in the *Delaware Conservationist*, Vol. 21, No. 2, pp. 16-20. Summer 1977, written by my long-time colleague Rudy Arndt. It's based on studies we did on some of our weekends back in the early 1970s while at our first full-time jobs after graduation from college. An interesting follow-up to this story would be to re-visit all of the known locales for lampreys in Delaware to determine if they still survive there.)

An Average Weekend

On a fine March day in 1973, Fred C. (Fritz) Rohde and I decided to drive south to the Trap Pond State Park area in Sussex County from our homes in Middletown, Delaware, where we were both biologists for the consulting firm of Ichthyological Associates, Inc. (IA). Our objective was to ward off our winter "cabin fever" and collect and photograph wildlife. We were rushing the season as it was still rather cold and most of the reptiles and amphibians in which we were primarily interested would not yet be out of hibernation. But we were definitely optimistic that we would find some interesting salamander or frog or turtle or snake. And even if not, the drive through the state and a look at the Bald Cypress, *Taxodium distichum*, swamp at Trussum Pond and the Loblolly Pine, *Pinus taeda*, woods at Trap Pond (dominant stands of both trees here are at the northern extent of their distribution on the Atlantic Coast) would still make the trip worthwhile and whet our appetite for the creatures we would be sure to find on our next visit. We also decided to take along a small seine (net) with which to perhaps collect some fishes to examine and photograph. And we were on our way!

As we had somewhat expected, we didn't find much in the way of amphibians and reptiles—only one or two of the Northern Fence Lizard, *Sceloporus undulatus hyacinthinus*, near the northern edge of Trap Pond Park and several young of another lizard, the Five-lined Skink, *Eumeces fasciatus*, basking under some sun-warmed pieces of sheet metal off the road between Trap Pond and nearby Trussum Pond. As we drove by a small and enticing stream at Bethesda Church near the south-east corner of Trap Pond Park, and as things were slow in the herps department, we decided to stop to collect fishes. Putting on our chest waders, we quickly entered the chilly water and worked the net. On our first or second haul, along with various sunfishes and Swamp Darter, *Etheostoma fusiforme*, and young of the Golden Shiner, *Notemigonus crysoleucas*, which we had seen often in other places in Delaware, we noted several adults of a fish which we had not collected before and which we knew had not previously been recorded for this state, the Least Brook Lamprey, *Okkelbergia aepyptera* (now *Lampetra aepyptera*) [see page 16]. Talk about excitement! We

quickly continued to seine until we had collected a small series of this lamprey.

Future Plans

On our drive north, very pleased and excited about our unexpected discovery, we wondered to each other if the spot where we found the Least Brook Lamprey was the only place in the state where it occurred or if it was more widely distributed, and whether or not it was rare. We quickly remembered that Dr. Johnson C.S. Wang, a colleague at IA, had collected a number of immatures of this lamprey at Long Creek in Cecil County, Maryland. So it appeared that this fish might be widely distributed on the Delmarva Peninsula, and that it might not be uncommon. As a result of our discovery that fine day in March, Fritz, Johnson, and I decided to find out what we could about the Least Brook Lamprey in Delaware.

Basic Lamprey Biology

Lampreys are fishes with which few people are familiar. If you have heard of them at all, it is probably of the Sea Lamprey, *Petromyzon marinus* [see page 17], the world's largest lamprey and common in the oceans and brackish waters of most of the U.S. east coast and of the western and southern coasts of Europe, with land-locked populations in the Great Lakes, Lake Champlain, and in some of the Finger Lakes in New York State. The depredations of this parasitic fish on many commercial and sport fishes such as mackerels, herrings, Lake Trout (*Salvelinus namaycush*), whitefishes, and perch has resulted in much publicity. (It is usually not a serious pest in most of its range. It is most known for its massive depredations on fishes in the four upper Great lakes, which were relatively recently invaded by this lamprey as a result of the activities of man, and in which the parasite-host relationship is highly unusual and unstable). While there are many other species of parasitic lampreys, marine as well as freshwater, there are also many nonparasitic forms. Lampreys are found in the cooler regions of much of the Northern Hemisphere with two species found as far south as Mexico, as well as in the cooler regions of the Southern Hemisphere, excluding only Africa and Antarctica.

Lampreys comprise the class Cephalaspidomorpha, with a known total of 41 living species. While the layman may lump all fishes into one group, there are actually five (according to some authorities) major groups (known as classes by zoologists) living today. Each class is considered by zoologists to be as different from one another in terms of basic body structure as much as amphibians differ from reptiles, reptiles from birds, and birds from mammals. For example, whereas lampreys look like our common American Eel, *Anguilla rostrata* (caught by probably every

Delaware fisherman or crabber at one time or another), since both have an elongate body which is roughly circular in cross-section, this similarity between them is only superficial and is not an indication of close relationship. All lampreys lack jaws, lack paired appendages, and possess numerous (seven pairs) gill openings. The combination of these three characteristics will differentiate lampreys from all other fishes found in freshwater. In these ways (as well as in others) they differ from our eel which has jaws and can bite strongly, has paired pectoral fins, and has only one pair of gill slits. A lamprey much like those living today was found in a coal mine near Chicago, Illinois. These fossils are some 280 million years old. So, lampreys have been around for a long, long time, and they have remained essentially unchanged.

Further Lamprey Work

In the weeks after we returned to Middletown we searched the scientific literature and found that the Least Brook Lamprey had been reported on the basis of but a few specimens from three localities in the Maryland and Delaware portions of the Delmarva Peninsula (Figure 1). During those weeks, too, and in subsequent months, we searched in the field for other localities where this lamprey might occur. We found it in several other streams in Sussex County, as well as in Kent County, Delaware, and on the Eastern Shore of Maryland. It soon became apparent that this fish was widely distributed in Delaware, but only in those streams that drain into the Chesapeake Bay. So we decided to sample some streams that drain into Delaware Bay and the Atlantic Ocean directly, to see if it also occurred there.

What we found was another surprise. In a stream just north of Millsboro, Delaware, and draining into Indian River, Fritz and I collected two adult lampreys in March 1974. Having by this time collected many of the Least Brook Lamprey, we did not examine them closely and presumed them to be of this species. We

were very pleased at having found it in another drainage. A few days later Fritz and Johnson collected several lampreys at a creek in Kent County, Delaware, and draining into Delaware Bay. They recognized them as specimens of the American Brook Lamprey, *Lampetra lamottenii* (now *L. appendix*) [see pages 15-16], a species which had not previously been recorded from any place on the Delmarva Peninsula, and which we had not even thought of finding in Delaware. Suspicious of our find of a few days earlier, we quickly examined the specimens collected just north of Millsboro and found them also to be the American Brook Lamprey. Wow! Now all three of us looked for lampreys whenever we had the opportunity, to learn as much as we could about the distribution of the two species. And, as we had located a particularly large population of the Least Brook Lamprey in one creek in Sussex County, we decided to start a life-history study of this species in this stream.

After further search, we found the Least Brook Lamprey and the American Brook Lamprey to be widely distributed in Delaware. We noted the former to be abundant at many localities in Sussex and Kent counties (and it will probably be found also in New Castle County), but only in streams tributary to Chesapeake Bay. We found the American Brook Lamprey in the same two counties and Mr. Fred C. Bonner of the Delaware Division of Fish and Wildlife gave us a specimen he had collected from Red Clay Creek in New Castle County. However, we found it to be less common than the Least Brook Lamprey, and to occur only in streams tributary to Delaware Bay and to the Indian River. In addition, incidental to our efforts to collect the Least Brook Lamprey and the American Brook Lamprey, we also collected some specimens of a third species of lamprey found in Delaware, the Sea Lamprey. We found that it was widely distributed in waters throughout the state, and in the Chesapeake and Delaware bays and in the Indian River drainages.



American Brook Lamprey collection site

Collection localities for freshwater lampreys and selected collection localities for the sea lamprey in Delaware and the eastern shore of Maryland (circle—least brook lamprey; solid square—American brook lamprey; open square—sea lamprey). Some of the least brook lamprey localities shown were discovered after the pages mentioned at the end of this article went to press.

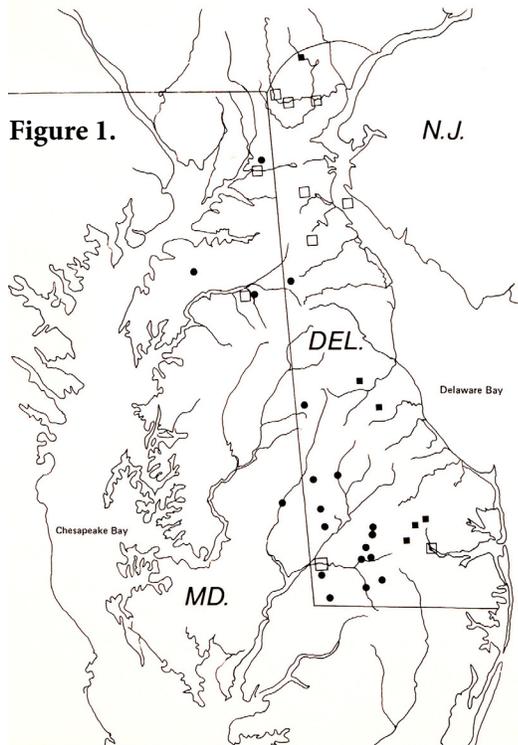


Figure 1.

More Lamprey Biology: To Be (Seen), Or Not To Be (Seen)

Why had the Least Brook and the American Brook Lampreys, which we found were both common species in Delaware, not previously been recorded here? The answers will tell us much about the life history of lampreys.

These two lampreys spend their entire life in freshwater, in Delmarva usually small- to medium-sized unpolluted streams with a slow to fast current. The entire life-cycle of a given population probably takes place in only a small section of stream. By contrast, the Sea Lamprey spends its early years in similar but usually larger freshwater streams, but later migrates into brackish and salt waters, and finally, when adult and ready to spawn, back into freshwater. These migrations, from fresh to salt water and back, sometimes include rather spectacular efforts to scale dams and other obstructions with the aid of its suckorial disc “mouth”, and have helped to bring it to the notice of many, while a life entirely in a small stream has helped keep our two freshwater species unnoticed.

Their small size, too, is probably a reason that the freshwater species on Delmarva have remained undiscovered until recently. The largest adult Least Brook Lamprey which we measured was about 4¾ inches long, and with the average length about one inch shorter. Our largest American Brook Lamprey was a little more than six inches long, with an average length of about five inches. On the other hand, the Sea Lamprey reaches a length of almost three feet, which helps to make it relatively conspicuous.

Other reasons that our freshwater lampreys remained generally undiscovered, and a reason why lampreys in general are but poorly known, is due to their life-history. In the summer, when

people mostly are in or near water, including most aquatic biologists, the only life history stage present of all three species is the larval stage, or more properly, the ammocoete stage. This stage is somewhat worm-like in appearance and behavior and for our freshwater species reaches a maximum length of about 5½ inches; the ammocoete of the Sea Lamprey grows considerably longer, but still will probably appear to be but a large worm to the uninitiated. Ammocoetes do not swim free in the water like the adults or like most of our other fishes, but live buried in mud in the stream bottom, and so are well concealed. To make things worse, even if one was found, because of their worm-like appearance, the chances are good that an ammocoete would not be recognized as being a lamprey. This concealment is necessary to their survival as, like worms, they have no other protection against predators, probably primarily other fishes. In fact, the American Brook Lamprey has been declared as an endangered species in Canada as a result of being caught by bait-fish suppliers to fishermen in parts of that nation.

The duration of the ammocoete stage of the Least Brook Lamprey is some five to six years, while that of the American Brook Lamprey probably lasts for four years; this stage in the Sea Lamprey lasts for at least five years. The ammocoete is typically buried tail-down in the substrate with only the head exposed and with the mouth facing into the current. Food is primarily small particulate living and dead animal matter—diatoms, protozoans, detritus, etc.—which is carried to it by the current and which it filters out of the same water from which it extracts the oxygen it needs to live. At the slightest disturbance, it can quickly pull deeper into the substrate and conceal itself.

The ammocoete stage of all three species looks quite similar because species recognition is not “important” to the larvae, and because ammocoetes of the three species have the same behaviors. Differences between the species include relative size, number of myomeres (muscle segments) on the body, and pigmentation on the fins. To the uninitiated observer, ammocoetes of different species will probably look identical.

Becoming Adults

Transformation or metamorphosis to the adult stage in the case of the two freshwater lampreys, and to the subadult stage in the case of the Sea Lamprey, begins in late summer and is completed during the winter. During transformation the worm-like body undergoes a number of pronounced changes. These include conspicuous changes of the mouth from a funnel-like structure in the larvae into a pronounced disc-like structure, the appearance of teeth, development of large and conspicuous eyes, development of pronounced gill openings, the enlargement of fins, and changes in coloration.

Our two freshwater lampreys do not feed after transformation; consequently, they have poorly developed teeth, only little nubs, particularly so in the Least Brook Lamprey. They then live on that energy that was stored in the body while they were larvae. These small, inconspicuous fishes, therefore, are of no negative value to man. The Sea Lamprey, however, after transformation, usually moves downstream into salt water (sometimes into large freshwater lakes) where it is parasitic on almost any species of fish it can catch. It attaches to the outside of its prey and, as an adapta-

tion to its parasitic way of life, has numerous large, hard, hooked and sharp teeth on its oral disc which aid this. With its wicked-looking tongue armed with sharp "teeth", it then rasps a hole into the prey and feeds on body fluids which ooze out of the wound. Some 12 to 24 months after the downstream migration and of the beginning of the parasitic mode of life, the Sea Lamprey ascends a freshwater stream for the purpose of breeding. At this point the life history of our freshwater species and of the Sea Lamprey is again similar.

Reproduction

Spawning of our freshwater lampreys occurs in late March-early April, shortly after transformation to the adult stage, when the water temperature is in the mid-50s F. It takes place at a time of year when few people are outside, when the last snow still covers the ground, and when the last winter winds blow. In the Sea Lamprey it occurs a few weeks later, when the water temperature is somewhat higher. Our freshwater species spawn in areas where the stream is about one foot deep and the bottom is composed of gravel and sand, and located perhaps only as far as several dozen yards from the mud beds in which they were ammocoetes. The Sea Lamprey spawns in a similar habitat, at a water depth of some one to two feet.

All three species construct nests of roughly circular excavations in the substrate by moving sand, gravel, and in the case of the Sea Lamprey, stones. Nests are dug by fastening the disc to gravel and wrenching the body, and by undulations of the body which, with the aid of the current, sweep sand and silt downstream. At least in the Least Brook Lamprey, several individuals may work at one nest site. Nest diameter is roughly somewhat larger than the length of the adults. Nest depth is an inch or two in the freshwater species, and several inches in the case of the Sea Lamprey. Nests may be located in mid-stream, or along the shore, and often occur in numbers near to each other. In general, they look much like the nests produced slightly later in the season by some of our freshwater sunfishes and basses. Nests of the freshwater species may be somewhat inconspicuous, while those of the Sea Lamprey are quite noticeable because of their larger size. The length of the nesting season for each lamprey species is some two to three weeks and after completion the nests typically quickly become indistinct as a result of filling in with detritus and a substrate growth of algae.

The small yellowish to greenish eggs sink and are caught among the sand and gravel of the nest cavity. Egg number produced per female is in the hundreds for Delaware's freshwater species, and in the thousands for the Sea Lamprey. The eggs hatch into ammocoetes in some two to four weeks, the exact time depending on the water temperature. The ammocoetes then find their way to a nearby mud-bottomed pool, burrow into the substrate, and a new generation has begun. After spawning, the adults die. I have found dead adults of the Least Brook Lamprey near the spawning sites, and their rapidly decomposing bodies fertilize the waters around the larvae.

In Sum

These small, boneless, and jawless fishes, with apparently

little going for them, have survived for hundreds of millions of years, to a large extent by being inconspicuous, as we began to appreciate on a field trip to southern Delaware in March 1973.

Those interested in learning more about these fascinating members of Delaware's fish fauna are referred to:

Raasch, M. S. 2003. Delaware's freshwater and brackish-water fishes. Delaware Nature Society, Hockessin, DE. Fourth Ed. 178 pp.

Rohde, F.C. 1979. Systematics of the American book lamprey, *Lampetra (Lethenteron) lamottenii* (Lesueur) (Pisces: Petromyzonidae). Master's thesis. University of North Carolina, Chapel Hill. 94 pp.

Rohde, F.C., R.G. Arndt, and J.C.S. Wang. 1975. Records of the freshwater lampreys, *Lampetra lamottenii* and *Okkelbergia aepyptera*, from the Delmarva Peninsula (East Coast, United States). Chesapeake Science 16 (1): 70-72.

Rohde, F.C., R.G. Arndt, and J.C.S. Wang. 1976. Life-history of the freshwater lampreys, *Okkelbergia aepyptera* and *Lampetra lamottenii* (Pisces: Petromyzonidae), on the Delmarva Peninsula (East Coast, United State). Bulletin of the Southern California Academy of Sciences 75(2): 99-111.

Rohde, F. C., R. G. Arndt, D. G. Lindquist, and J. F. Parnell. 1994. Freshwater fishes of the Carolinas, Virginia, Maryland and Delaware. The University of North Carolina Press, Chapel Hill. 222 p.

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American Brook Lamprey adult



Least Brook Lamprey male/female
Rudolf Arndt



Least Brook Lamprey
(*Lampetra aepyptera*)
Uland Thomas



Least Brook Lampreys spawning
Rudolf Arndt



Least Brook Lamprey disc
Uland Thomas



Suckermouth Minnow (*Phenacobius mirabilis*)
“hosting” a
Chestnut Lamprey (*Ichthyomyzon castaneus*)



American Brook Lamprey ammocoete head



American Brook Lamprey adult disc



American Brook Lamprey ammocoete



Konrad Schmidt



Fritz Rohde



Rudolph Arndt

Adult Sea Lampreys