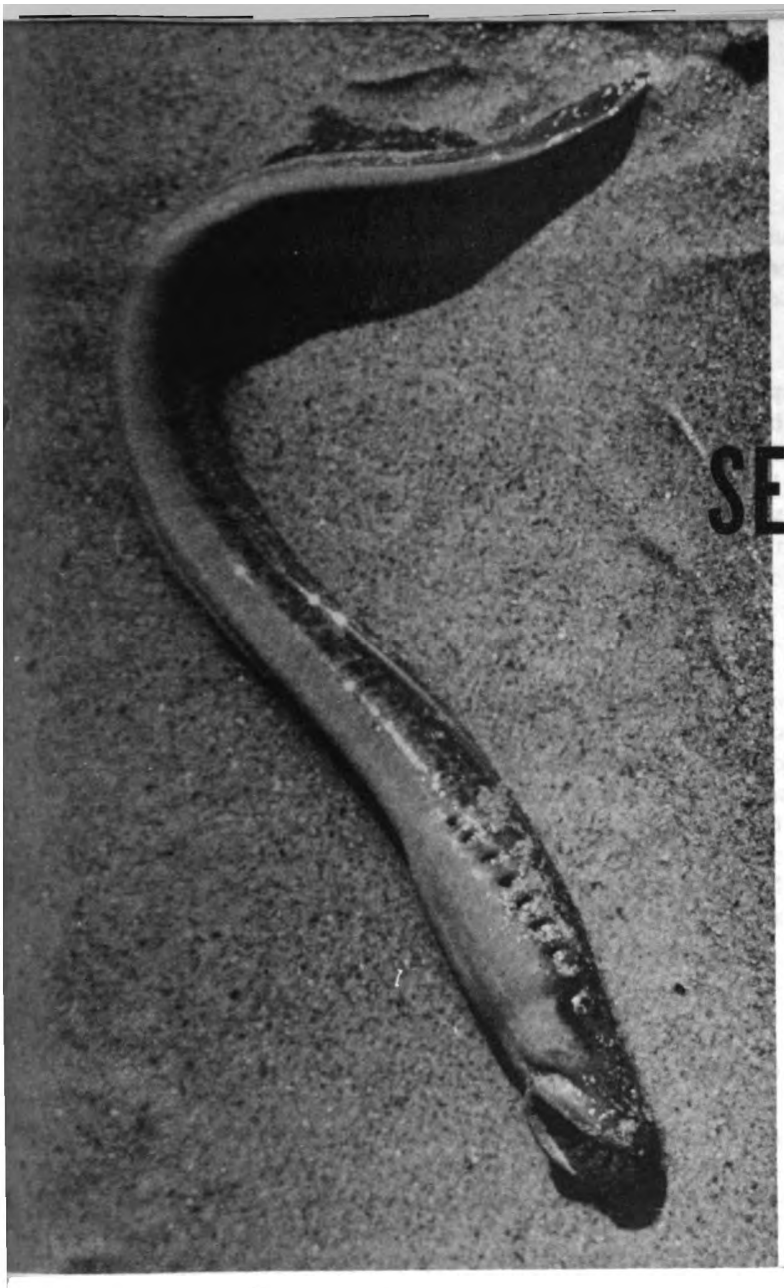

SEA LAMPREY

Lola T. Dees
Publications Writer
Division of Biological Research

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ourtesy of Michigan Conservation Department)

In 1829 when the engineers finished the Welland Canal which connects Lake Ontario with Lake Erie they thought they were providing a passage for ships only. They could not know they were letting in a "monster" from the Atlantic Ocean, the sea lamprey, which about a hundred years later was to destroy the 10-million-pound lake trout fishery of the Great Lakes.

The sea lamprey, Petromyzon marinus, is found in the North Atlantic Ocean from Iceland and northern Europe to northwestern Africa and from the Grand Banks and Gulf of St. Lawrence to northern Florida. The adult lamprey, once found in marine waters only, has become well established in the lakes of western and northern New York and in the Great Lakes.

No one knows when the lampreys, members of the family Petromyzonidae, first moved into the Finger Lakes of New York State, where they abound. They probably came from Lake Ontario through the canals between Oswego and Buffalo.

Sea lampreys move each spring from the Atlantic Ocean into the coastal streams of Europe and North America to build nests, deposit eggs and die. Some, however, deserted the Atlantic Ocean to live in the fresh water of Lake Ontario, feeding on its fish, spawning and dying in its tributary streams. Niagara Falls prevented the lampreys from migrating into the other Great Lakes. However, in 1829 the Canadian Government finished the Welland Ship Canal which provided the lampreys a route around Niagara Falls.

Even after the canal was completed the lampreys seem to have been slow in establishing themselves in Lake Erie. The first one was caught there in 1921. They did not thrive in Lake Erie as the waters were too warm and the spawning conditions poor. By the 1930s they reached Lakes Huron and Michigan, where the food supply, cold waters and clear, gravel-bottomed tributary streams were ideal for growth and survival. Then they moved toward Lake Superior, but the dam and the navigation locks at the head of St. Mary's River slowed the rate of invasion into this lake. However, enough lampreys arrived in the lake to establish a rapidly growing population. The first specimens were taken off Isle Royale and Whitefish Point in 1946.

Effect of Lamprey Attacks on the Fishery

The effect of the lamprey attacks on the lake trout, the most prized food fish and the backbone of the fishing industry of the Great Lakes, was devastating. For the 10-year period of 1930-1939 fishermen took annually about 5 million pounds of lake trout from Lake Huron and the same amount from Lake Michigan. By 1950 the total catch in both lakes was only about 0.5 million pounds--a decline of 95 percent. The catch of trout in Lake Superior has declined to 25 percent of normal.

Because the lampreys have virtually eliminated the large, flavorful lake trout from Lakes Huron and Michigan, they are preying on the larger chubs and whitefish which, like the lake trout, inhabit deep water.

As a result of the lamprey invasion the commercial fishermen of Lakes Huron and Michigan lost an annual income of more than $5 million. Losses to other channels in the trade and to sport fisheries cannot be estimated.

Cooperative Research to Control the Lamprey

The Great Lakes states (New York, Pennsylvania, Ohio, Michigan, Indiana, Illinois, Wisconsin and Minnesota), the Province of Ontario and the Federal Governments of Canada and the United States have joined in efforts to save the lake trout from lamprey destruction. In 1946 the United States and Canada began a cooperative research program to find means to control the lamprey. On September 10, 1954, they signed a treaty for joint action and the Great Lakes Fishery Commission was set up in 1956 to direct this action.

Effective methods for controlling the lamprey in the Great Lakes could not be developed until scientists learned more about its life cycle. They thought that during certain periods of its life it might be vulnerable to methods of control. From studies conducted they found that lampreys spend 12 to 20 months in the lakes and in late winter congregate in bays and estuaries of rivers to mature their sex products. Prior to spawning, the sex glands grow enormously while the muscles, skin and eyes degenerate. The digestive tract shrinks and the lampreys cannot feed but live on their stored fats and body tissues.

Natural History

Spawning

After the streams warm to about 40 degrees the lampreys ascend those that contain gravel, clear water, and a moderately strong current. The spawning migration may last 20 weeks.

When a satisfactory spawning site in the stream has been chosen, a male lamprey starts building a nest and is joined by a female who helps in the construction. They clear a small area, picking up stones with their mouths and piling them in a crescent-shaped mound on the downstream side of the nest.

After the nest is finished and the water is warm enough (over 50 degrees) spawning begins. The female, which lays an average of 61,500 eggs, deposits a few eggs at first and the male at once fertilizes them. The current carries the eggs to the rim of the nest, where they lodge in the spaces among the stones. Then the female lays another batch of eggs and the process is repeated. The pair continue laying and fertilizing eggs until they are spent--spawning may take from one to three days--and then both die within a few hours and decompose rapidly. The lampreys which have no opportunity to spawn die also.

Larval lampreys

Less than one percent of these heavy, small eggs hatch. Depending on the water temperature, hatching occurs in 2 to 3 weeks.

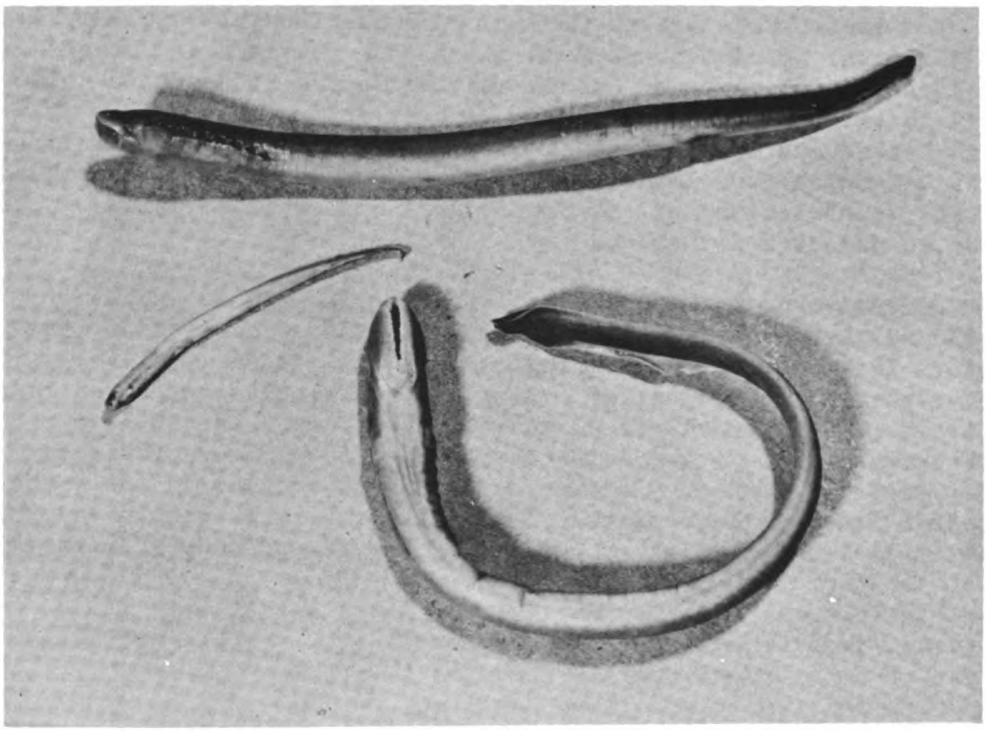

Figure 1.--Larval forms of the sea lamprey of the Great Lakes: Upper photograph shows side view of untransformed larva about 4-1/2 inches long; center, an early eyeless stage, about 1-3/4 inches long; lower, same as upper photograph, but with ventral view showing untransformed mouth parts.

The newly hatched larvae remain in the nest until about the 20th day. Then, about a quarter of an inch long, they drift downstream to quiet waters. Each larva digs a burrow in the soft bottom which will be its home for about five years unless erosion washes it away. Throughout their larval life the young lampreys, termed ammocetes (figure 1), are blind and harmless. They suck food, mainly microscopic organisms, from the water passing the mouth of the burrow. A filtering apparatus in the throat keeps out debris and passes food organisms to the digestive tract.

After about five years each larva develops large prominent eyes, a round mouth lined with horny teeth, a file-like tongue, and enlarged and unpaired fins. Its slim body, with a soft skeleton of cartilage rather than bone, becomes dark blue above and silvery white beneath. Now 4 to 7 inches long, it may emerge from its burrow when late fall rains raise the stream level, but usually it waits until the spring ice breakup and high water before migrating downstream to the lakes. It will feed there upon the blood, body fluids, and dissolved flesh of fish, its sole food.

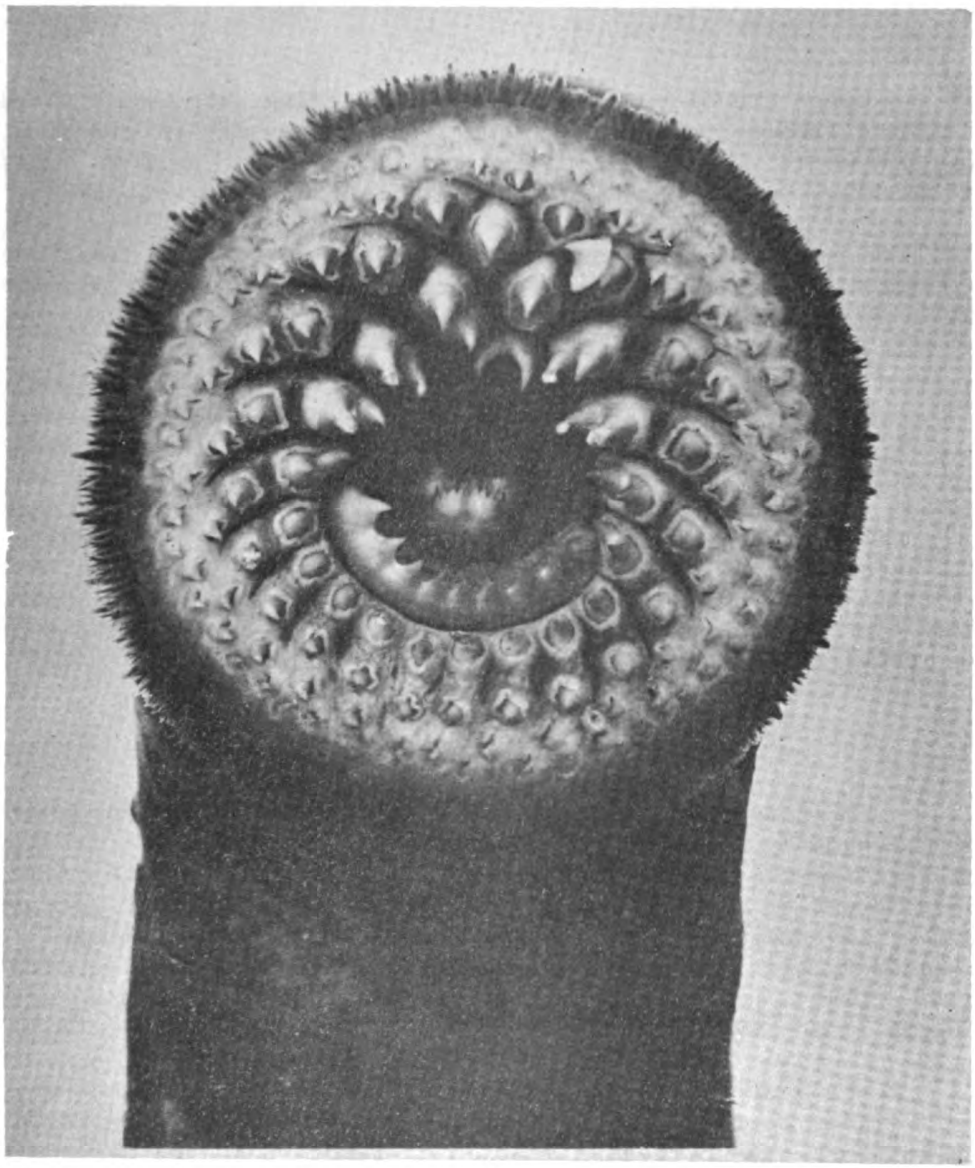

Figure 2.--Mouth of the sea lamprey which is lined with horny teeth. In the center of the mouth is the rasping tongue.

Adult lampreys

This jawless predator, which does not school, attaches its sucker-like mouth (figure 2) to almost any part of a fish. Sometimes several lampreys feed upon one fish at the same time. The victim thrashes about violently, but rarely shakes off the lamprey. The strong teeth and the rasping tongue soon penetrate the fish's scales and skin. Lamphredin, a substance in the lamprey's saliva, dissolves the torn

flesh and keeps the blood from clotting. Feeding stops when the host fish dies or the lamprey becomes glutted. The lamprey may remain attached to a fish for weeks, but some fish may die in as little as four hours. If a fish escapes, it is scarred so badly it is often unmarketable.

Feeding upon a succession of fish, the lamprey, which destroys no less than 20 pounds of fish in its life, grows rapidly, attaining a length of 12 to 24 inches and a weight of about 8 ounces. A lamprey rarely weighs more than 1 pound.

Value of Lampreys

Efforts to find commercial uses for the lampreys to compensate for the destruction they cause were unsuccessful. They are not palatable to the people of the United States although they are eaten in many European countries. Analyses indicate that vitamin A potency and oil yield of the lamprey are much too low for commercial exploitation. Biological supply houses require only a few as study specimens.

Control of Lampreys

Knowledge acquired about the lamprey, which has no known natural enemies, suggested several possibilities for control. The researchers found that the most vulnerable period in the lamprey's life is when it is in the stream as a larva or a young migrant and later when it enters the stream as an adult to spawn. Efforts were made to prevent adult lampreys from entering streams to spawn. Mechanical weirs, installed for this purpose as physical barriers to migration, proved expensive and undependable and flash floods washed them out.

The researchers then developed a combination of mechanical traps and electrical barriers. An electrical field produced in a stream was found to block the upstream migration of lampreys and is not subject to being washed out by floods or clogged with debris as are conventional barriers. Fish and some lampreys enter traps placed at each end of the electrical barrier while others penetrate the electrical field and are killed. A different type of barrier, which is energized by pulsed, direct-current electricity, is employed in streams where movements of important food fishes coincide with the lamprey migration. This device guides the fish and most of the lampreys into traps where they can be sorted and separated. The fish are passed upstream and the lampreys destroyed. A typical electromechanical weir is shown in figure 3.

Attempts were made to stop the downstream migration of juvenile lampreys. Mechanical, inclined-plane screens that strain all of the water of a stream were installed. These are extremely vulnerable to floods and accumulations of debris, which occur during the height of the downstream migration of lampreys.

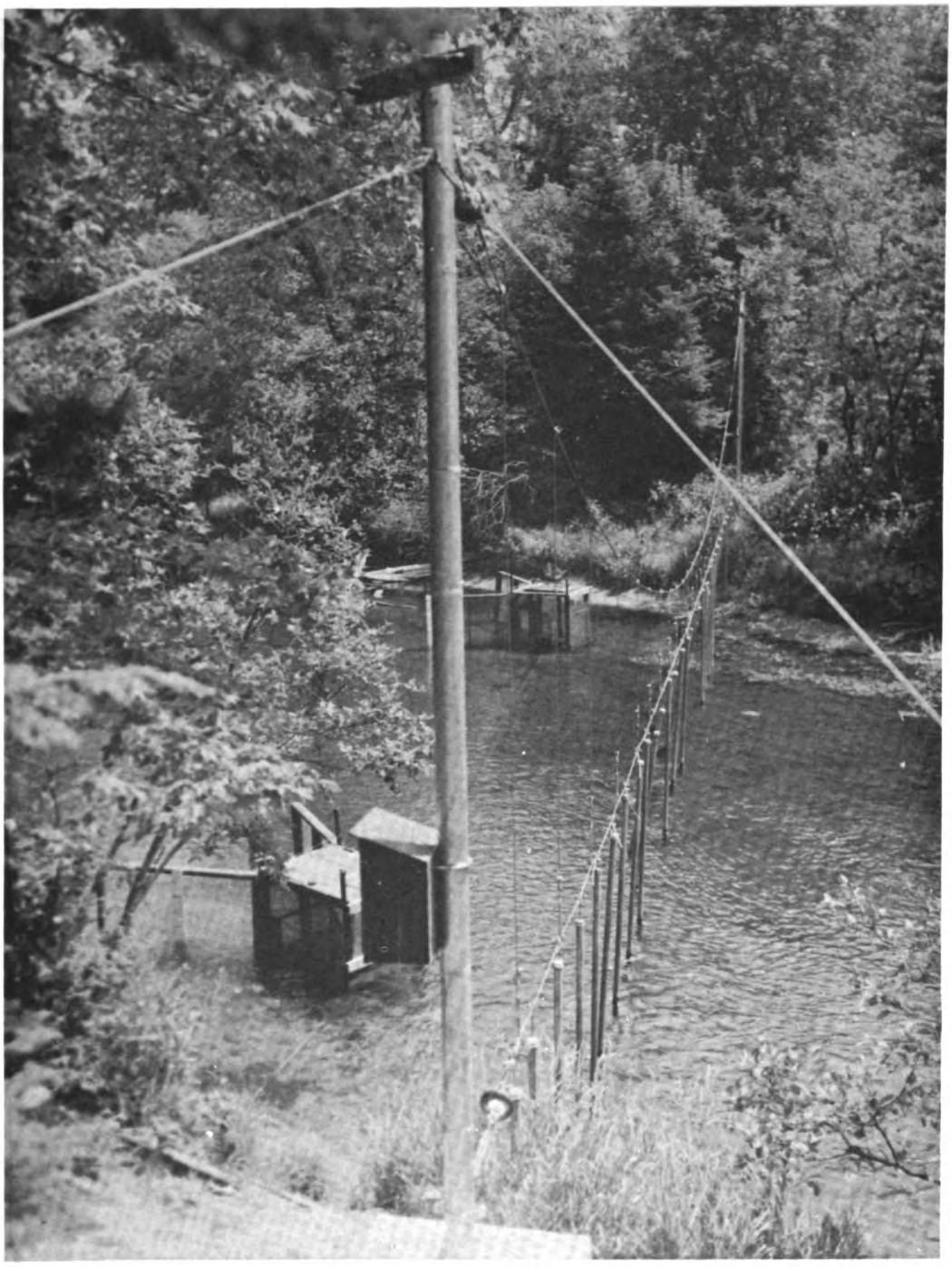

Figure 3.--Electromechanical weir in use in a number of streams tributary to Lakes Superior and Michigan. The electrodes for alternating current suspended upstream prevent fish from passing. Downstream is shown a submerged direct-current electrode used to guide fish and lampreys migrating upstream into the two traps.

Replacing this type of structure with devices designed to electrocute immediately all downstream migrants is not economically feasible. Voltages that kill fish only stun young lampreys and enough electricity to kill lampreys at this stage would cost an exorbitant amount.

The researchers next considered using selective poisons to kill juvenile lampreys. After three years of testing some 5,000 chemicals, they found that halogenated nitrophenols successfully kill larvae in streams, but do not harm fish.

One of these chemicals, 3-trifluoromethyl 4-nitrophenol, is being used to destroy lamprey larvae in the streams tributary to Lake Superior. Results of this work should be known by mid-1961. If successful, the application of chemicals will be expanded to streams feeding the other Great Lakes.

Restoring the Lake Trout

Controlling the lampreys in the upper Great Lakes is solving only half of the problem of restoring the lake trout resource. Once control of the lamprey is attained in the Great Lakes it will be necessary to repopulate the lake waters with hatchery-reared juvenile lake trout. Preparations are now being made to carry out this project.

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