

THE STORY OF THE COMMON EEL.

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The term "eel" is a name somewhat widely applied in popular usage, but extended particularly to the members of the family MURAENIDAE which is included in the order PHYSOSTOMI of bony fishes. The family is a large one, and over two hundred species are known to exist. They are all carnivorous in their habits and have well developed teeth and elongated ribbon-shaped bodies. Generally speaking, they exist near the bottom, sometimes at great depth. They have representatives in almost all fresh waters and seas in temperate and tropical zones.

In this paper I shall deal with only one species, namely, the Common Eel, so well known to everyone.

The life story of the Common Eel (*Anguilla vulgaris*) is one of the most amazing, romantic and fascinating dramas in the whole realm of nature.

From the days of the ancient Greeks and Romans down to the end of last century the history of the eel was shrouded in mystery. Several theories were promulgated by the learned and the unlearned as to the breeding and normal existence of this elusive creature. In the British Isles it was commonly believed for centuries that a hair from the tail or mane of a horse, if immersed in a shallow pool of water for a week or more, would ultimately evolve into an eel. In this connection I should like to note that this legend was not altogether without some foundation. Later on in my narrative I shall try to explain the origin and cause of this superstition.

The very identity of the sexes was not established until the middle of the nineteenth century. The female was discovered by Mondidi in 1777, and the male by Syriski in 1874.

Twenty years afterwards (1896), the Italian zoologists, Grassi and Calandruccio published their famous treatise on the larva of the eel. But the breeding ground and infant existence of the eel species were still unknown. However, after a lengthy period of patient investigation, the eminent marine biologist, Dr. John Schmidt of Copenhagen, was at last able to track the eel to its breeding ground in the deep waters of the Western Atlantic. These beds are now duly charted between the Leeward Islands and Bermudas, 22° and 30° N. Lat. and 48° and 65° W. Long. at a depth of 500 fathoms.

By raising the curtain on this intensely interesting drama and revealing to the gaze of science the enchanting and mysterious early life of the infant eel, Dr. Schmidt solved the problem which had baffled scientists for many years. This task, as might be expected, was a colossal one, involving years of accurate observation and research.

The male eel is smaller than the female, rarely exceeding twenty-one inches in length, and has a broad head and snout. The male eel always remains at the mouths of rivers in brackish waters, and never goes far up stream, so that all eels found in inland waters are females. The female has a narrow pointed head and snout and attains a much greater size than the male. Specimens have been captured measuring over three feet. The creature is armed with a small but powerful set of teeth, and it bites viciously. I have seen the severed head of an eel actually closing its teeth on an object. The tongue is free and the lower jaw slightly protrudes. The creature has no hind fins corresponding to our legs. The females are to be found in all our rivers, lochs, stagnant pools, and even in mud holes, far removed from the sea. On the upland passage the young eels will leave lochs and streams and travel over wet meadows to stagnant pools and isolated mountain tarns which may be a thousand feet above sea level, where they remain for at least seven years. They journey on during the day, and at sundown cease their forward movement by resting under stones or any other cover which may be at hand. But years afterwards, when the adult female eel is returning to the sea

to spawn, the overland journey is accomplished on a wet or dewy night—the reverse order of the inland route.

On the upland passage the creatures never miss their mark—guided by unerring accuracy born of an instinct which, putting it mildly, is astounding, they will arrive safely at their destination, perhaps an isolated pool or a mountain tarn. Eels are able to travel over land because of the complex mechanism of their gills which retain sufficient water to keep the delicate folds of the bronchial laminae afloat. In live eels these cavities can be seen bulging out at both sides of the neck, and so long as they are filled with water, the eel can remain alive ashore without any danger of being suffocated.

A procession of tiny eels, known as “eelfare,” is sometimes seen a hundred miles from the sea, wriggling, gliding and struggling up the face of a deep rock or a concrete embankment, which may be fifteen or twenty feet high, in order to reach higher water on the other side of the obstacle.

A few years ago, when on a visit to the Island of Lewis, I had first-hand evidence of the uncanny climbing abilities of the eel.

I found an eel twelve inches long in a spring of water, which measured five-and-a-half feet by four feet and twelve inches deep, with a muddy bottom. This spring is situated on the western seaboard of Lewis, about twenty-eight feet from the edge of a precipice. The precipice is thirty feet in height and overlooks a rugged gully or gap in the coast line where the Atlantic wave is constantly in motion. The high water mark is fully forty feet from the base of this cliff, and the intervening space is covered with large boulders and cobbly stones, making the surface very uneven. There is a trickle of water flowing from the pool and falling over the face of this rock and disappearing into the shingle at the bottom.

When the eel as an elver came ashore at this point, it would first have to traverse over the boulder-strewn pathway to reach the spot where the tiny thread of fresh water from the spring touched the bottom. But on arriving at the foot

of this face of rock the creature would have then to scale the thirty feet of cliff in order to get to the pool.

How it accomplished this feat is difficult to conceive. True enough there are a few ledges or steps here and there in this wall of rock, but even making due allowance for these, I confess that only for the evidence of my own eyes in finding the eel in this particular spring, I would at once, and without any hesitation, declare that it was a physical impossibility for a tiny creature to have surmounted this colossal obstacle. Yet “facts are chieftains that winna ding.” The presence of the eel in this spring is a self-evident proof of its climbing achievements.

It is remarkable beyond words—the abnormal instinct or rather extraordinary sense of smell and direction of this creature which, from the open sea, was guided to this isolated spot. We use the term “instinct” in a loose manner and very often to cover our ignorance. Pavlov, the brilliant Russian biologist, designates “instinct” as “unconditioned and conditioned reflex.” But in this case I decline to use it in that sense, because I am quite satisfied that eels are directed to unseen waters not by instinct but rather by their marvellous faculty of smell. Speaking in the abstract, what we term “instinct” may be a factor in intensifying and sensitising the organ of smell.

I should like to mention here that this spring could only support one eel. Now we have a right to postulate that this eel formed a unit of a large shoal of elvers which struck land at this point. How it is or why it is that this was the only one which parted from the procession and made for the shore at this spot? I confess I do not know, but it is conceivable that more than one, probably a shoal of them, made for this pool. Many would be killed immediately on touching land by being dashed against the rocks by the surf. Others on gaining land would perish by being eaten by predatory birds, while still a larger number would die of exhaustion in their attempt to scale the wall of rock which separated them from

their objective, and only one solitary eel reached the desired haven.

This is a concrete case of the survival of the fittest, and a striking illustration of how Nature, when left alone, weeds out the unfit. Her rules are the simplest of all rules; their working is infallible. They were made without Man and without Man's aid; they will attain their end. The eel sense of smell when hunting for food is also remarkable, as the following instance fully illustrates.

While spending my holidays last summer in a village on the west side of the Island of Lewis, I witnessed a remarkable phenomenon. There is a stream infested with eels passing through this township where housewives are in the habit of gutting fresh herrings. One day while watching this operation, a swarm of eels gathered in the pool and began to feed voraciously on the entrails of the fish. These creatures were so bold that they actually seized the herring in the woman's hand.

In order to test their boldness and power of smell, an idea came into my head. I asked the woman to be good enough not to throw any more of the garbage into the stream, but to place it in a dish beside her. I then picked up a length of gut and walked down to the other end of the pool, ten yards from where we were standing. I laid down my bait four feet from the edge of the water, and out of sight of the level of the stream, and walked back to my former position. Exactly three minutes afterwards, a large eel came out of the pool, wriggled up the slope towards the offal, and in a flash seized it and slid back into the stream like an arrow, trailing its prize behind it, and disappeared under the bank. This is surely a singular illustration, not only of the extraordinary sense of smell of the fish, but of their daring and courage when foraging for food.

The age of the eel can be determined by the zones or rings shown by its scales when examined by the microscope,

just in the same way as the age of trees can be told by the annular rings of growth in the wood. These scales are very small, indeed, I believe very few persons are aware that eels have scales. The scales are embedded in the skin transversely and obliquely—resembling a lattice-work formation. The Conger Eel has no scales.

The ages of other fish, notably the salmon and the herring, have been similarly ascertained by the annular zones of growth marked on the scales. Curious to relate, the age of the plaice has been recorded by the zones of growth formed annually on the ear stones found in the liquid-containing sac of the internal ear. Probably many of my readers will be surprised to learn that fish have an internal hearing apparatus. They have also an olfactory organ, and in some cases a well-developed tongue.

The longevity of the eel is remarkable. Specimens have been found to live from twenty-five to thirty-one years. When hard pressed for food it feeds on vegetable matter, but it never touches tainted material. The eel is stealthy and wily in its habits. Very often it will bury itself in mud during the day and wriggle out at night in search of food such as spawn and defenceless water animals. It is of a predatory nature.

Eels were considered a great delicacy by the Greeks and Romans, and enormous prices were paid sometimes for them. But on the other hand, they were repugnant to the Egyptians. Their slimy, snake-like appearance and their supposed affinity with the serpent species have been chiefly the cause of this prejudice. To the same prejudice may be traced the reason why this excellent fish in Scotland is entirely rejected as an article of food.

It is interesting to note that eels are found in the upper reaches of the rivers Thames and Clyde and other city waterways. The question naturally arises: how did they get there? That a swarm of elvers could survive the passage through the polluted and foul waters of these rivers and emerge into a cleaner stream above is improbable, if not impossible. The only other alternative that would explain their presence in

these rivers is a cross-country expedition from other neighbouring streams, through fields and meadows, aided by canals and ditches, until finally they land at their objective. This is surely an object lesson on the amphibian achievements accomplished by these creatures.

In passing, I should like to mention that the Danube and its tributary streams contain no eels, although the rivers which flow into the Mediterranean are well stocked with them. This anomaly is probably due to the fact that the bottom of the Black Sea is not suitable as a spawning ground; and through some mysterious cause that we cannot fathom, the way through the Dardanelles is closed to eels.

The tenacity of the eel to life is proverbial. Some years ago I inoculated a female eel, twelve inches in length, with adder poison, and she lived six hours after the injection. During this period the creature was writhing in agony, and I felt extremely sorry for the pain and suffering I was inflicting on the creature, but I was out for data on this point, and consequently I was reluctantly compelled to follow my experiment to the bitter end. Adder poison is a blood destroying element (haemolytic) which disorganises the nervous system governing respiration, so that the poor eel died of slow suffocation. The creature was, of course, kept in water during the experiment.

Owing to the fact of eels being found in all our lochs and rivers at all seasons of the year, one is not surprised that their breeding ground far out at sea remained so long unsuspected.

Every autumn a large number of eels pass down the rivers to the sea on their way to their breeding ground in the western ocean. During their migration a good number of them are caught in eel traps at the mouths of rivers and along the coast. Those eels being in prime condition are in great demand in the English markets. This annual migration refers only to a small percentage of our eel population—those only which have been stimulated by the sexual urge. Eels remain in certain lochs and rivers for years—say from seven to twenty-

one years, and in some cases much longer. In fact, they will not leave until the sexual impulse calls them back to the sea.

In the Island of Lewis there is an interesting legend about a monster fish living in some of the deep lochs in the interior of the Island. The fish is known as "Seilich Uisge" (The Water Brute). This translation is weak; the term means more than that in Gaelic, but I cannot find a suitable English word to describe it. The term "Seilich" involves repulsiveness and ferocity. It is said that if any person happened to step into the water of the loch, this creature could, by suction, draw the victim into its jaws. It is further said that eventually this mysterious and awesome creature would leave the loch to go to sea, never to return. I am quite certain that this allegory had its origin in an eel or eels which lived perhaps for forty years in one loch and grew to a gigantic size. About eighteen years ago an eel measuring five feet in length was caught in a loch in Lewis. These abnormal specimens are, of course, very rare, and may be said to be more or less neutral in sex and rather eccentric creatures, which have lost their normal way of life and have cut themselves off from the matrimonial "running down," but they have compensation in quietude, abundant food, and long life. The Loch Ness monster may be one of these huge eels. I have put forward this theory in an article in "The Glasgow Herald" on 6th December, 1933.

Once the migrating spirit or rather the sexual instinct begins to assert itself, the eels go on a restricted diet, i.e., they do not take their normal quantity of food. Gradually their bodies, or rather the under surface, take on a silvery sheen and the pectoral fin becomes pointed and black in colour. The male also becomes silvery, but at an earlier age—about four and a half years—and the female not earlier than seven years. Thus robed in their bridal garments and at the zenith of their strength and beauty, they leave their home and trek seaward to set out on the great romantic journey of their lives across the great waste of water to their nativity in mid-Atlantic, never to return again. Their non-return was proved

by the fact that no adult eels have even been observed ascending rivers from the sea.

At the estuary the female is joined by the male eel, and they start off together. The reproductive organs of the male and female are not fully developed when they set out on their western journey.

The duration of the passage from the British coast to the spawning ground is not known, but eels have been known to go down stream towards the sea at the rate of ten miles a day. When they arrive at their destination the female deposits her roe in a trench, and it is fertilised by the milt of the male and probably both carefully cover up the spawn and then, like the fassorial wasp and the ephemeral fly, die without ever seeing their offspring. The eel spawns only once during her lifetime. The incubation period of the fertilised ova is not known. Owing to the low temperature it will probably take from two to three months to hatch, or even longer. The eggs of the eel have never been seen because of the fact, already mentioned, that the milt and the roe of both male and female are in an undeveloped state when they leave our shores.

Just as every autumn there is an exodus of adult eels from our rivers for the breeding beds in the western ocean, so every spring or early summer sees the arrival at our coast of a vast multitude of young eels, or elvers as they are called, which ascend our streams as their forebears did before them. These elvers are slender and semi-transparent little creatures, measuring from two-and-a-half to three-and-a-half inches in length, and are greatly preyed upon by birds and fish. Although they are small and delicate, they are fully developed and have all the characteristics of the adult eel, but on hatching from the egg they bear no great structural resemblance to the type into which they are going to develop.

The story of the discovery of the identity of this primitive form of the eel is highly interesting. About the middle of last century, curious, small, transparent, leaf-like fishes began to

attract attention in the Straits of Messina. One of the earliest accounts of these peculiar flat-shaped creatures was written by Kaup and appeared in the British Museum Catalogue in 1856, in which twenty-two supposed species are described, and amongst them one called *Leptocephalus Brevirostris* figured for the first time. These little transparent fishes measured $4\frac{1}{4}$ to $5\frac{1}{2}$ inches in length and were shaped like a plantain leaf, but no one at this time suspected that they were "tadpoles" of the common eel. It was an American naturalist, Theodore Gill, who was the first to advance the theory that these odd-looking fishes were the primitive form of various species of the eels. Gill's hypothesis turned out to be correct, and at the time was upheld by Dr. Cunctier of the British Museum. Finally, Professors Grassi and Calandruccio conclusively demonstrated that the little fishes known to science for so many years as the *Leptocephalus Brevirostris* were the true larvae of the young of the eel, and, as already mentioned, Dr. Schmidt, many years afterwards, traced these creatures to their home in the distant Atlantic.

It is a far cry from a mountain tarn in mid Scotland to the Leeward Islands in the West Indies, yet every eel found in our lochs and streams and in the most isolated and stagnant pools was hatched on these banks. Moreover, every eel in our waters (excluding accidents) is destined to die where it was born.

The little fish grow rapidly during the early part of their life; in the first summer they attain the length of one inch. They at once leave their home, rise up in spiral formation to about thirty or forty fathoms from the surface, and they sometimes show themselves on the surface of the water. They then take an easterly course, steer for the rising sun, and at the end of two and a half years they arrive at our coast fully developed, tiny eels. They always strike land at the mouth of a river. When investigating this wonderful and fascinating life-story of the eel, Dr. Schmidt made another interesting discovery, viz., that the breeding ground of the American Eel (*Anguilla rostrata*) is in close proximity to that of the Europ-

ean species. Indeed, he discovered that there are extensive areas where the young of both species are mixed up together. Yet, despite this coming together of the baby eels during their early development, at a certain part they part company and set off for their respective continents. No American eel has ever been found in European waters, neither has a European eel ever entered an American river.

In this connection, I should like to point out here what is truly a remarkable biological phenomenon. The spawning ground of both species is two-thirds of the way across the Atlantic, or twice as far from the European coast as from the American shore; it therefore follows that it takes the Eastern contingent twice as long to reach their destination as the western one. Nature has, however, made provision to meet this situation, by ordaining that the British species take about two-and-a-half years to complete their larval development and the American eels only one year, with the result, that if the Westerners by any mischance started eastwards, they would experience the need of fresh water before their journey was more than half completed. On the other hand, the eastern shoal, if it turned westward, would reach the American continent before it was ready for its fresh water life, and would have to remain another year hanging about the coast before it would be equipped to go up-stream. In either case, the result of taking the wrong course would prove fatal to the common eel. The European eel has 104 vertebrae in its spinal column, whereas the American eel has only 95. The former is slightly longer and more slenderly built, or rather of a more graceful form.

I shall now for a brief space confine myself to a new phase of the existence of the eel which, so far as I know, has never before been touched by any zoologist.

For over thirty-five years I have been studying the eel species and from the data which I have collected in the course of my researches I have come to the conclusion that eels pass through a form of hibernation somewhat similar to land reptiles such as snakes, lizards, etc.

I have often noted with astonishment that when fishing with the bait in winter and spring I never could get an eel earlier than about the end of April, but after that period they became voracious feeders and consequently a regular pest to bait fishers. Some persons will no doubt be surprised to hear that I have been fishing in winter—seeing that is the close time for trout fishing. Well, meantime I make no apology for this infringement of the angling laws, beyond adding that I had an object in view for my unsportsmanlike activities.

I have made careful and special inquiries of other anglers regarding their experience of eels during the earlier spring fishing, and in every case I was told that no eel troubled them till the late spring or early summer. Naturally the non-feeding of eels in winter and spring was to my mind suggestive of these creatures passing through a phase or condition of inertia resembling hibernation during the frigid period of the year, and as might be expected, I became intensely interested in this anomaly.

Some years ago during March and April I carried out a thorough fishing test in a loch which I knew to be infested with eels during the warm season. I used not only worms but a great variety of bait, and set lines and all manner of attractive lure day in, day out—but my efforts were absolutely fruitless. No eel troubled my bait till the beginning of May. Of course, occasionally they have been known to take the bait about the middle of April.

In my quest for information on this subject I questioned several hill drainers as to their knowledge of eels during the winter. I was told by a number of these men that when following their vocation in winter and spring they often found eels in a torpid state, buried in mud at the bottom of old drains on the hillside, hundreds of feet above sea level.

The principle underlying hibernation is simply to evade death from extreme cold. Biologically speaking, this state of inertia of reptiles and fish during the cold season means that the action of the heart is slowed down to a minimum—just sufficient to enable the living tissues to absorb oxygen and to

discharge carbon dioxide and water, producing heat and energy, and in this way the flickering candle of life is kept burning. The respiration of the eel is twelve to the minute, and the heart beat under anæsthetic, eighteen to the minute.

Some years ago a gamekeeper near Campbeltown found half a dozen eels at the bottom of a drain which he had opened. He at once notified me of his discovery, and needless to say I was soon on the scene. Showing me the drain, he pointed out the exact spot where the eels were found. I also found one of the eels lying on the bank; the other five had apparently been picked up during the night by a hoodie crow or some other carnivorous bird. He further told me that he found the eels embedded in a soft, mossy, but adhesive soil through which the water was oozing, about 14 inches below the surface.

This drain, which is fed by a spring up the hillside, is half a mile away from a neighbouring river into which it flows, and 200 feet above the bed of the stream. It is a mere rivulet, but on account of its being watered by a spring it is always running. Six yards below where the eels were found there is a sheer drop over a boulder of three feet. Now, in order to get to the position where they were discovered, the eels must have come ashore and wriggled up the embankment.

The surface of the drain before being opened was covered over with coarse grass and rank vegetation, but down below, on account of the spongy nature of the soil, the water was percolating evenly through the whole mass. The gamekeeper also informed me that when he first exposed the eels, they appeared to be in a comatose state, but on being disturbed they began to move and show signs of life, but after their removal to the bank they lay motionless, and on examining them he was surprised to find that they were dead.

This incident shows very plainly that these creatures were undoubtedly hibernating at the time, and on being brought back to consciousness, they died of exposure. In my book, "The Life Story of the Adder," I mention this fact about adders: that is, if adders are awakened during the hiber-

nation period, they will immediately succumb to the cold. Apparently eels are liable to a similar fate.

On several occasions I have found eels hibernating in a drain similar to the one above. They were embedded in a muddy soil from 10 to 14 inches below the surface.

Finally I have carried out an experiment which should conclusively prove my case. A few years ago, about the beginning of October, I caught two eels, one measuring 14 inches, the other 4 inches—the latter an elver which had arrived in our waters from the sea that summer. I put them in a glass aquarium with a layer of gravel and mud at the bottom of the tank. For the first week of their captivity they fed freely on worms and minced liver, but after that period they became sluggish and indifferent about food, until finally they went off feeding altogether. About the end of October, or to be strictly correct, on the 29th of October, they buried themselves in the mud, where they remained in a comatose state until the end of April, when they appeared above ground and began feeding. This experiment was a remarkable demonstration of the winter sleep of the eel—a striking illustration of that mysterious state known as "suspended animation" or "latent life."

At this stage I felt quite satisfied that eels passed through the cold season in a slumbering unconscious state. I am of opinion that early in winter eels inhabiting mud-bottomed lochs will bury themselves there, and those in streams will branch off into tributaries and finally make their way into drains, ditches, and mud-holes, and then dig themselves deep down into soft soil, where they will remain until the advent of the warmer season.

It is remarkable to note that eels during the hibernation period invade only drains and channels which are watered by a spring. It is singular that they never make the mistake of entering a ditch or drain which is fed by surface water, and consequently would be liable to dry up during the sub-conscious period.

In making this statement I am not speaking at random

nor making irresponsible and dogmatic assertions. I have made a special study of the eel species, as already mentioned, and in following up my investigations, I have covered a wide area. I have travelled from the Mull of Kintyre in the South of Scotland, to the Butt of Lewis in the extreme north, and in every district I have found confirmatory evidence of the truth of this theory.

In the past, the life-story of the eel has been a succession of surprises to Science. When Dr. Schmidt discovered the spawning beds of the common eel, it was believed that the history of this elusive creature was complete, but strange to relate, the whole story was not yet revealed. There was another chapter to be unfolded. Zoologists took it for granted that the fresh water existence of the eel was like that of any other ordinary fish, but in this respect they were mistaken.

I have never known of the Common and Herring Gulls eating adult eels, and this is rather singular. When fishing with worms I have always left my eel victims on the bank of the stream, and although plenty of gulls were flying about, none of them would touch a dead eel. The carcase would lie there for days until it shrivelled up like a twig. But if I should leave a trout behind me, I would not go far until it was picked up by a hungry gull. This is very strange, because gulls are not by any means fastidious about their diet; they have been known to eat dead rats and all sorts of offal. Eel serum is of a toxic nature, and this may account for the abstemiousness of gulls. The blood is exceedingly acrid to the taste, and though highly poisonous when injected into the blood stream, it is not markedly injurious in the stomach. The virulence of the poison can be destroyed by high temperature.

The only real enemy the eel has in its fresh water existence is the otter, which feeds largely on eels, even more so than on salmon or trout.

I shall now refer briefly to the common eel in relation to trout life. Eels are voracious feeders to the point of cannibalism, for large eels have been known to attack and swallow

small ones. Now, if these creatures were not passing the cold season under ground in a comatose state, what would happen to the salmon and trout ova? In other words, if eels were feeding all the year round, the destruction of trout and salmon spawn in our rivers would be simply appalling. As it is, when they begin to feed in May, they levy a heavy toll on trout and salmon fry.

It is quite easy to imagine how eels could, with impunity, rob and plunder spawning beds on a large scale and with the greatest ease. Trout and salmon roe are not specially protected from intruders beyond being covered with a thin layer of gravel, and it should be remembered that the eel can burrow, so that it would be quite easy for the creature to get at the ova. Moreover, an eel could stealthily waylay and stalk trout when spawning, and once the roe would be discharged into the trench, the wily creature would then suddenly glide out from under cover and scare away the male and female trout and gobble up at leisure the dainty meal.

One eel would easily consume the contents of two spawning beds every day. Imagine then the wholesale destruction of ova that would be caused by, say, a thousand eels in one stream during the hatching season. To illustrate this point, let us in imagination assume that for some unaccountable reason the eel family suddenly ceased to hibernate and remained above ground, feeding all the year round. We could then calculate with tolerable accuracy the ratio of destruction which I have given above: that in about twelve years our trout species would become almost extinct, and the same fate would overtake the salmon family. I am not here referring to our trout hatcheries, which could be protected from this menace by eel-guards.

One can then realise how essential it is, indeed, I should say how providential it is, for the welfare and existence of the silvery denizens of our beautiful streams and lochs that nature has so constituted the physiology of the common eel that the creature must go below ground and cease feeding during the incubation period of the trout and salmon species. This is a

marvellous instance of the checks and counter checks in nature to protect the weaker species and prevent others from exceeding the speed limit in the race of life. Truly the method of nature in perpetuating the continuity of life in the organic world is wonderful, and even romantic to a degree. True enough natural selection is slow and prodigal in its range of operation, but nevertheless it is accurate in its ultimate results, and if left alone will maintain a true balance in the scale of life.

I shall now refer to the interesting legend that eels are evolved from horse hair. Curious to relate, this tale has sprung from three organic sources in nature, and I shall now submit each of these separately to a process of critical analysis.

The first to which I shall draw your attention is the gordius worm. The adult worm, which is dark in colour, is about four and a half inches long with a small round head. It has no fins and no real tail. These worms are not common in Scotland, but occasionally are to be found in ditches and pools. The appearance of the creature would be, to the uninitiated, a basis of the myth we are discussing.

The history of this worm is almost as interesting as that of the eel. The female lays a string of eggs on a weed in a shallow pool. A month later there issues from the egg a minute larva. Shortly afterwards the young worm finds its way into the grub of the alder fly (*Sialis*) and remains there until the fly stage is reached. Later the alder fly is preyed on by a certain beetle (*Pterostichus*) which unconsciously swallows the worm too. At this stage the worm begins a second parasitical career. It remains inside the beetle all winter; then in the following spring, the unfortunate beetle is found dead or dying in a ditch or pool of water, killed by the parasite. The worm, which by this time is nearly full grown, emerges from the carcase of the beetle and a month later is ready to lay eggs and to start its complex cycle of life again.

Another ground for the superstition is the frequent and sudden appearance in ponds of one or more of the

Nematode horse-hair worm. These so-called embryo eels found in stagnant waters are minute thread worms, or Nematodes, often belonging to the genus *Anguillula*. Their bodies have the usual thread worm shape and are almost transparent, though having a thick cuticle. They multiply with great rapidity. Both eggs and adults have considerable power of reviving after dessication. Adults have been known to reawaken after a dessicating period of fourteen years. Again the appearance of this worm would, to the layman, be in harmony with this legend.

Now, I have explained away two sides of the legend, but there is yet another side to be surveyed, which is perhaps even more interesting than those which I have related.

I have seen with my own eyes a horse hair four inches long showing animated movements by curling from side to side. This hair was immersed in a pool of stagnant water for about three weeks or a little more.

The explanation of this anomaly is a purely biological one. To begin with, let us remember that every hair is tubular. The pigment which gives colour to the hair is embedded in a central canal. After having been steeped in water for a considerable time the pigment decays and dissolves away, leaving a cylindrical opening in the stem. Thousands of microscopic organisms swimming in the water belonging to the infusorian family of the Protozoa enter this channel and lodge in it. Myriads of these adhere to the alkaline formed on the outside of the hair, and it is the concerted action of this vast army of organisms which causes the movement which I have described, giving the hair the appearance of life and vitality.

Taking these facts into consideration with their subtle and complex nature, we need not be surprised that this myth lived and thrived for centuries not only in Britain, but in Europe. Indeed, the layman could hardly do anything else but believe the evidence of his own eyes. This is another illustration of how the uninitiated might be easily deceived by their senses.

In order to confirm my last illustration I would suggest to anyone who may be interested in pond life that he pay a visit to a stagnant pool of water, say early in spring. The pool should have an airy situation. Let the investigator pick up gently a few strands of the confervae which generally abound on the margin of the water in tangled masses of hair-like filaments and very often matted together. Put the green stuff into a bottle with a little water from its native haunt, and cork it tightly and take it home. In the quietness of the home transfer a few threads on to a glass slide and spread out the fine fibres with a needle. Then examine the material with a high-power microscope, and the marvels of pond life will be revealed to the gaze of the observer. A veritable drama of colours and elegant forms will be staged on the area of vision. The dripping plants will be found not only to be objects of ineffable beauty far surpassing human production, but to be teeming with myriads of organisms of various shapes and sizes.

In this way then the secrets of pond life are linked up with the romantic life of the elusive eel.

In order to refresh your memory, let me now briefly summarise the story of the common eel.

- (1) the hatching of the larva in mid-ocean;
- (2) the passage of the flat-shaped creatures to our shores where they arrive as elvers at the end of $2\frac{1}{2}$ years;
- (3) the upstream journey;
- (4) hibernation during the cold season;
- (5) the silvery eel leaving loch and pond and travelling up river to the sea;
- (6) the meeting of the male and female in the estuary;
- (7) the long passage of the pair across the lonely waste of waters;
- (8) the depositing of the ova in a suitable locality, and finally the death of the parents.

A fascinating drama from real life, to be eternally repeated.

SURFACE FEATURES OF WESTERN SCOTLAND, WITH A NOTE ON A PRE-GLACIAL VALLEY IN NORTH BUTE.

By ARCHIE LAMONT, M.A., B.Sc., Ph.D.

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The boundary between ancient and modern in the interpretation of scenery may be drawn in the year 1795, when James Hutton, of Edinburgh, published his "Theory of the Earth." In earlier times surface features were attributed to uplift by convulsive agencies. In Hutton, while the factor of the uplift of land-masses was recognised (vol. ii., pp. 445-446), actual valleys and mountains were explained as being due to erosion of the earth's crust by atmospheric agencies, change of temperature, rivers, frost, and wind. These forces, which operate very slowly over immense periods of time, combine to etch out a landscape. Their final product can be seen in a mature river valley all parts of which have been smoothed down so as to be "in grade." But it is also the case that during prolonged intervals harder rocks like granites and basalts will stand up as eminences, while softer shales and sandstones are worn away. These facts were appreciated by Hutton, who even reached the point of speculating on the results of a formerly extended glaciation in Switzerland. But research had not gone far enough for him to realise that the same influence had played an important part in the surface history of Scotland. Indeed, more than most countries, Scotland offered features unexplained by Hutton's generalisations.

After the evidence of ice-action in Britain had been verified in 1841 by Agassiz and Buckland, a tendency arose to account for certain unusual features on glacial lines. In Western Scotland, deep glens and fiords—the latter of which in many instances become shallower towards the sea and cannot have been eroded by rivers—were attributed to excavation by glaciers. This explanation, while it may be accepted