EVOLUTION

Found: Most Important Missing Link

Fossilized Ostracoderms Furnish Proof for Theory That Vertebrates and Invertebrates Had a Common Ancestor

By FRANK THONE

DIFFERENT persons attach quite different meanings to the words "missing link." To many it means but one thing: the hypothetical hairy creature midway between man and monkey —a figure of the Devil to the literalist theologian, and almost the image of a god to the equally naive "free-thinker." He is the more fascinating to the mind, and the more protean in his outline as imagined by artists, because he hasn't been found yet, and so we can make him look like anything we've a mind to.

But the more serious scientist is always mildly bothered when he hears people talk of "the missing link," as though there were but one of him. He knows that there are many missing links in the evolutionary chain, many gaps between groups of animals probably related by descent, which must be closed before that descent can be considered reasonably well demonstrated.

The gap between ape and man, even between the highest ape and the most beetle-browed of the old cave-men, is not the widest one that exists in the evolutionary Chinese puzzle, either. Most scientists, in fact, have quit concerning themselves greatly about it, and now consider the physical kinship between man and the rest of the primates, if not definitely proven, at least something to be taken for granted. They extend the family tree away back of that, indeed, and include all backboned animals, clear down to the poorest fish that swims, in one great cousinship. St. Francis, calling the wolf his brother and the birds his sisters, was no more gravely serious than a modern zoologist, and not half so literal-minded.

But when it comes to the invertebrates, to giddy Brother Grasshopper and to Sister Spider, that industrious spinster, to Cousin Crab and Uncle Oyster and poor old Grandfather Worm, we cannot assert our relationship with nearly so much confidence. We can slap a brother Elk on the back, be he two-legged or quadruped, and we find a fraternal backbone there; but these creatures that have no vertebral column continue to be somewhat alien and aloof; and it does leave us a trifle uncomfortable. Here is the place where the big gap stands; here is where a missing link is most missed. Who shall tell us which of these rather queer fourth-cousins-thrice-removed is our nearest kin, and which one of them shares great-great-eversogreat grandfathers with us?

Forty years ago, just at the sunset of Charles Darwin's life, a young Dartmouth College professor, William Patten, thought he had seen one of those resemblances by which cousinships can be traced. It began with eyes, as it often does in identifying cousins.

That Third Eye

Only it wasn't the two eyes that we all know we have. It was the hidden third eye inside of our heads, buried in the front of our brains, which we and all the higher vertebrates use as a gland nowadays. Only in a few of the lower vertebrates does this third eye, the pineal eye, located on the mid-line of the head, come near to the surface; and even in these it is inconspicuous and sightless. But though we don't use this third eye as an eye any more, it is an almost unique organ, and only one of the several lines of invertebrate animals have it. These are the arachnids: the spiders, scorpions, horseshoe crabs, etc.

But arachnids have more than this curious and unique third eye in common with vertebrates, underlying their wide surface dissimilarities. Prof. Patten came out boldly with the suggestion: why not an arachnid as ancestor to the vertebrates? He backed up his theory with a long series of technical papers showing that the basic pattern of bodily organization and development in the arachnids and vertebrates is essentially the same and quite different from that of any other kind of animals.

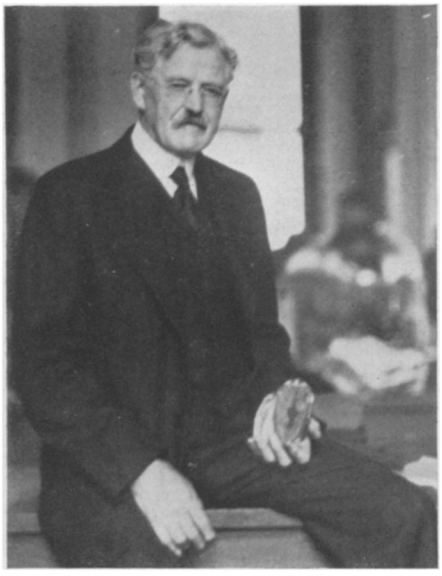
That is, the arachnid theory is *not* based merely on outward appearance.

Of course it would have been nonsense to suggest a familiar spider or a tropical scorpion as ancestor of the backboned animals. These creatures are themselves too highly evolved along special lines ever to be the ancestors of anything but more spiders or scorpions. But back along the line somewhere might there not be an ancestor-arachnid not so specialized, capable of begetting separate progenies so diverse as modern archanids and modern backboned animals? Prof. Patten thought there was. He pointed to the sea-scorpions, or eurypterids, creatures that swarmed in the Silurian seas.

There's nothing especially unfamiliar about the outline of the sea-scorpions. They had the elongate, jointed bodies that we have always known in such things as lobsters and insects, and some of them had long spines sticking out behind their tails, suggestive of the stings of modern land scorpions, and their general plan of organization was like that of all vertebrates. There were giants in those days, too; plenty of sea-scorpions have been found that are more than six feet long. But they are all dead and gone now—were ages gone even before the first fishes appeared or the first dinosaur pipped his reptilian eggshell. Only their fossils are still quite abundant in certain old shaly rocks, to show that once they flourished and dominated sea society.

These primitive arachnids are the oldest and most highly organized animals preserved as fossils. They were the rulers of the sea long before any of the fish-like vertebrates made their appearance. They were the first animals highly enough organized to perceive (or sense) their prey at a considerable distance and could effectively chase and capture it. For that reason alone, says Prof. Patten, they are more logical and *respectable* predecessors than the many kinds of worms and such-like traditional ancestors—which so far as we know had none of these bodily qualifications for higher development.

Along with the sea-scorpions' remains, geologists find the fossils of creatures of another type, enough like them in general structure to be descendants of the same line. These are the ostracoderms, sometimes called "dawn fishes." A casual observer looking at a reconstructed ostracoderm would probably call it a fish, though a queerish kind of a fish. There is something undeniably fish-like about its general outline, especially abaft o' 'midships. The body has the fish-like tapering form,



PROF. WILLIAM PATTEN

—holding a slab bearing the fossil of an ostracoderm, which he believes the probable ancestor of all vertebrate animals.

ending in an upsweeping tail-fin very much like that of the sharks, which are sometimes regarded as the most primitive of fishes.

But the front end of an ostracoderm is highly unlike that of any modern fish. The head and forepart of the body were covered with a stiff armor of bony plates, that made some of them look more or less like a horseshoe crab. This armor gave the ostracoderm its name, which is Greek for "shell-skin." Despite their armor, however, it is highly improbable that the ostracoderms were at all belligerent: more likely they wore it because they were too proud to fight, or too lazy, or slow, or stupid. All evidences indicate that they were bottom-dwellers and mud-shovellers, like catfish.

Submarine Armored Tanks

Although their armored heads made them unlike modern fish, even that did not make them un-fishlike, by ancient geological standards of comparison. In the next geological age after the days of sea-scorpions and ostracoderms, the Devonian, when the world belonged to the fishes, there were swimmers in the sea that were veritable submarine armored tanks; and while it is by no means certain that they descended from the sea-scorpions, armor and all, yet the fact remains that there was a kind of family resemblance.

And above all else, in this catalog of connecting resemblances, stands the fact that these ostracoderms, like the sea-scorpions on one side and the fishes and other vertebrates on the other, possessed that third, pineal eye.

Yet for all that, Prof. Patten's fellow-scientists did not assent to his doctrine of an arachnid ancestry of vertebrates, through the sea-scorpions and the ostracoderms. Some of them had favorites of their own, whose claims they were interested in pushing. And in any case, there was the difficulty of finding a resemblance in the rest of the face. It is all very well to find a similarity in eyes, even in third eyes; but how about the mouth?

There, for forty years, Prof. Patten was stumped. There is an undeniable difference between the vertebrate and the invertebrate mouth. Our mouths open on the under-side of our heads; the mouths of the invertebrates open in front, or on top. Although the fossils of the ostracoderms were for the most part very equivocal on this point (for the animals died pretty unanimously back up, and so their fossils show better detail of their dorsal than of their belly sides) what evidence there is has all been that the ostracoderm mouth opened in front, like all other invertebrate mouths.

For forty years Prof. Patten spent most of his spare time travelling to places where ostracoderm-digging was reported to be good, always seeking fossils that would show their mouths. To Canada, Newfoundland, Scotland, Spitsbergen, Russia, Australia, Java and Central America he went. He added vastly to the world's knowledge of these strange creatures and of the first fishes that swam the seas. But always the main point eluded him.

At last, just as he was looking forward to his retirement to the position of professor emeritus, he found what he was seeking. There is a rich deposit of Silurian fossils on the little Baltic island of Oesel, once a part of Russia, now held by the new republic of Esthonia. There, and there only, a small species of ostracoderm has been found that Prof. Patten believed would show what he wanted, if he could only find a good specimen. Twice before he had visited the island and dug, but found only imperfect fossils. Finally, Dartmouth College financed a third expedition, and gave him enough money so that he could hire laborers to help him.

And he found his specimens, and they showed their mouths!

They showed that the ostracoderm mouth was evolving toward the vertebrate pattern, with a series of bony arches closing over the opening. In vertebrate animals also there are these same bony arches. They have become involved in other structures, some of them; the slender arch called the "hyoid" that holds the base of the tongue, two pairs of them infolded to become a part of the palate-and-nose complex. But various parts of these arches do go to make jaws, do help to form a mouth, to build a face.

True, the paired jaws of the little ostracoderm from Oesel work sidewise instead of up and down, and the mouth therefore lies lengthwise instead of crosswise. But that is relatively a minor matter. The important thing is that the skeletal arches have closed over.

Similar in Human Embryo

In the human embryo it is possible to see a very similar thing happening. At an early stage, the mouth is open, gaping, has no united jaws; there is, indeed, no face at all. Several pairs of arches start to grow in from the sides, gradually closing the gap. For a time there is a lengthwise opening as well as a crosswise one, and remnants of this sometimes persist in such physical misfortunes as cleft palate and harelip. Normally the cleft is quite closed, and the mouth comes to be the gap between two pairs of arches instead of between the abutting ends of several pairs.

But what difference does it make whether worms, insects or scorpions were the ancestors of man and the other backboned animals?

It makes a very great difference, declares Prof. Patten. For countless problems of vertebrate anatomy and embryology are dependent for their solution on the particular kind of animals that were the remote ancestors of the vertebrates. Moreover, some of the most fundamental problems of the philosophy of organic evolution depend on the course or path that evolution has followed in the remote past and the relative value of the various factors, internal and external, that have brought it about.

For example, was it the initial pattern of bodily organization, established in the sea-scorpions something like a thousand million years ago, that largely or wholly determined the subsequent course of organic evolution? Or was it mainly the cosmic environments of suns and seas and lands? Or was it mainly the swarming social environments procreated by their germ-like type of bodily organization, one which has always held the leadership in the kingdom of animal life?