EVOLUTION

Aviation Problems Solved Under Water

Remote Ancestors of Present Day Fish Learned The Tricks of Streamlining, Lift, and Stability

By DR. FRANK THONE

MANKIND is more than a little proud of itself for having, at long last, learned the trick of flying. Takes brains to do that kind of thing, we tell ourselves with an unconcealed smirk.

Yet hundreds of millions of years ago the remote ancestors of our present-day fishes, with scarcely any brains to speak of, solved a very similar problem for themselves, and in a very similar way. Their final solution is, indeed, rather more successful than our best efforts so far—really a better engineering job.

The problem faced by the fishes was nothing less than learning how to swim. It may sound decidedly "fishy" to suggest that there ever were fish that could not swim, but such seems to be the case. The earliest fish of which we have any fossil record—and they were already pretty well advanced evolutionally—spent their lives squatting on the bottom. They had very imperfectly developed fins and tail, and probably could swim only a few strokes before they had to settle down on the sand again. Their swimming was about as much like real swimming as a boy's jumping is like flight.

The struggle of fish for the freedom of the seas, foreshadowing paradoxically man's struggle for the liberty of the air, was portrayed before a meeting of the American Association for the Advancement of Science by an English scientist, John E. Harris of the department of zoology at Cambridge University. Mr. Harris told, point for point, how fish unconsciously adopted the same engineering principles for "flying" in the water that man, with painful conscious thought, ages later found necessary for efficient flying in the air.

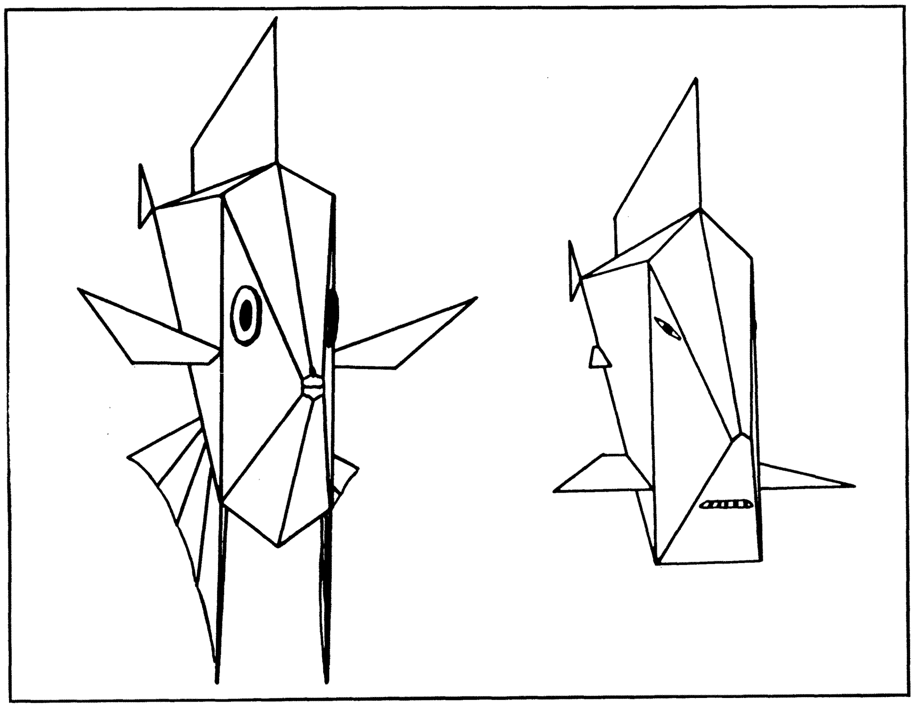
Streamlining, which man did not trouble to use in his first flight efforts, was without much doubt an already accepted feature of construction in the very first fish. Nobody has yet seen any fossils of these very first fish, but we do have some fossils of pretty early ones—300 million years, or some such matter, is their age—and they have quite satisfactorily streamlined bodies. No matter if they didn't swim against the water: in tidal flow or river current the water swam against them, so streamlining was an advantage even at the beginning of things. And if advantageous to these early descendants of the pioneer First Families of Fishdom, then presumably also to the still-unknown pioneers themselves.

Streamlining in these early fish, however, was not perfect. They were bottom dwellers, and naturally would be pretty flat underneath. A lengthwise section, from head to tail, would have looked very much like a section through an airplane wing: blunt, rounded forward end, gently arched back and flat underside, tapering gradually to a tail-point which may or may not have had a flaring fin at the outset.

When such a primitive fish made one of its half-swimming leaps into the water, either to capture some edible morsel drifting overhead or perhaps just because it was tired of staying where it was, its semi-streamlined body brought into play the same kind of forces that act on an airplane wing. The flat underside, shoving at an angle against the mass of water, pushed up. The arched back, moving *away* from the water mass, was *pulled* up by "negative pressure," just as the curved back of an airplane wing gets additional "lift" from the area of low pressure, or "partial vacuum," above it.

So long as the "pre-fish" could keep pushing itself along through the water by vigorous lashings of the after part of its body, it could keep itself lifted above the bottom, and experience the thrill of free, untrammeled motion—supposing an archancestral "pre-fish" to be capable of experiencing thrills. At any rate, it could "airplane" about in the water.

But if you have ever played with toy airplanes, even the simple primitive ones made of folded paper, you will know without be- (*Turn to Page* 154)



"IDEAL" SWIMMERS

As a designer would draw the ideal fish and shark. The shark, at the right, is an early type fish without swim-bladder whose fins must serve as water-planes to carry weight as well as stabilize. The ideal fish, at left, is of more modern evolutionary date and has a swim-bladder. Its fins are now freed from carrying weight and serve as brakes and stabilizers only.

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ing told what would happen to our imaginary "pre-fish," with its airplane body but no rudder or stabilizer or ailerons. As soon as its nose got up a little, the continued "lift" of the water would raise it still more, upsetting the unstable equilibrium. The center of lift and the center of gravity would part company, and the poor fish would either go into a series of loops or back-somersaults in the water, or it would swim along inclined at a steep angle to the horizontal, with its tail dragging on the bottom.

First the Tailfin

The first invention of fish, as well as the first invention of airplanes, to remedy this fore-and-aft instability was the development of a tail-fin. In the earliest fish-like fossils, this tail-fin was unsymmetrical, mainly on the underside of the long tail. With the long leverage it thus received, this relatively small surface could counteract effectively the tendency of the body to go into backloops or to stall. When body said "nose up," tail answered "nose down," and the fish could get along fairly well on an even keel.

Another device that could be used for maintaining a proper "nose-down" attitude was to turn down the whole tip of the tail itself. This seems to have been adopted by only a few fossil forms. The foundation of a shark's tail took an exactly opposite direction, with the end of the spinal column bending *up*. However, in both these cases, a fin was developed downwards as well as upwards, the extent of both lobes varying in different species, but always working out so as to prevent excessive nose-tilting. These more generously lobed tailfins, incidentally, gave their owners an added advantage, in that they helped greatly in the body's writhing thrusts forward through the water. Like the gondolier's one oar, they became both propeller and rudder.

Problem of "Roll"

But the fish's problem of getting along through the water was not solved solely by the evolution of a tail, useful though that member became. The problem of lateral stability, or prevention of "roll," had to be taken up also. This became the first job of the paired fins, on opposite sides of the body.

Typically, fishes nowadays have two pairs of these side fins, one pair forward, one pair aft. The forward pair, which sometimes stick out like great round "ears," are known to zoologists as the pectoral fins; they might therefore be nicknamed the "breast fins." Similarly, the after pair, known technically as the pelvic fins, might be common-Englished as the "hip fins." They are believed to have been at one time only parts of a long, curtain-like continuous fin-fold projecting from each side of the body. But the middle part of this has long since disappeared, leaving only the paired ends.

Efficient from the outset as balancers, these side fins soon added another job, in the case of early fishes, especially sharks, that have no swim-bladder, and therefore have to keep moving in order to avoid sinking to the bottom, just as an airplane must keeping moving if it is to remain aloft. In more technical language, sharks and other primitive fish forms must depend on "dynamic lift" to stay up.

Here is where the paired fins came in handy, especially after the fishes, having achieved full freedom of movement in the water, no longer spent most of the time roosting on the bottom. For they then lost their flat under-suface, and so could not present so efficient a lifting device in the shape of the body itself. The shark's paired fins are always held horizontally or nearly so. Nearly at opposite ends of the long shark body, they function in the water rather like the wings and the stabilizers of a low-wing monoplane, giving lift and steadiness at the same time. Naturally, since they function in relatively dense water instead of in thin air, they do not need to have nearly so much surface to be adequate as lifters.

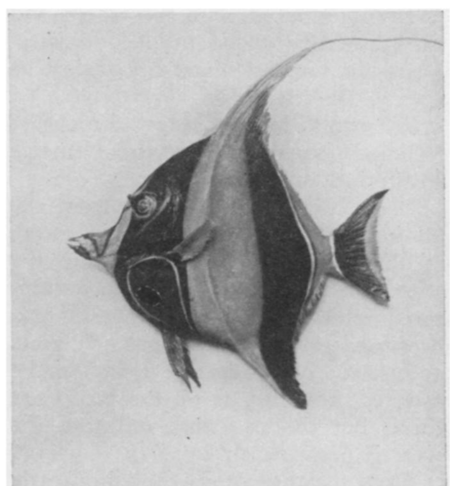
Efficient "Waterplane"

With this equipment, then, the shark is a most efficient "waterplane," able to climb fast and maneuver swiftly, so long as his striving muscles continue to supply engine-power. But if he lets up for a moment, he begins to sink, for he has no swim-bladder as the higher fishes have, and so cannot hover. Perhaps this may account partly for the great number of shark-cousins that have given up the active trade of piracy on the high seas and settled back to their old, dull jobs as scavengers and gleaners on the bottom: rays and skates and guitar-fish, and their weird second cousins the chimeras. These have reverted to the "bellyflopping" habits of their arch-ancestor, and probably surpass even his prone flatness of body.

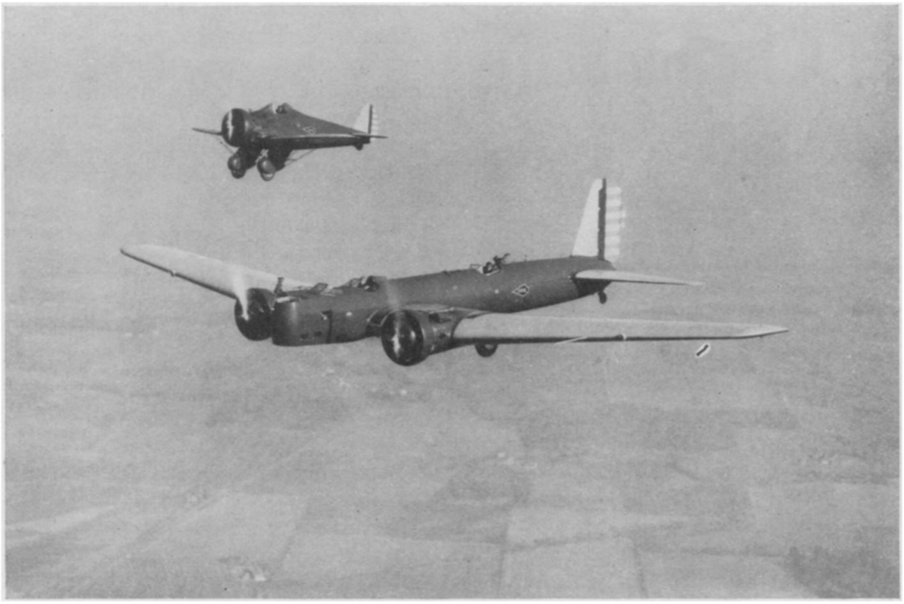
The great invention of the fishes higher in the evolutional scale than sharks is the swim-bladder. By filling a relatively small part of the body with a fluid much lighter than the one they live in, these higher fishes can "hover" in the water, like a well-ballasted lighter-than-air craft; and the ease with which they do it is increased by the fact that their "center of flotation" coincides very nearly with their center of gravity. The size of the swim-bladder, moreover, is adjustable at will, so that the fish can make himself lighter or heavier, as suits his convenience at the moment.

The Higher Fish

The higher fish, then, is no longer on an airplane basis, no longer needs to keep constantly moving to remain afloat. His muscles can be used entirely for pushing him along through the water, and his fins, no longer needed for lifting purposes, can be devoted more largely to steering and balancing. For the forward pair a new function is added: they have become brakes. Have you never, before an aquarium tank, seen a fish suddenly spread his pectoral fins out wide, like a pair of startled hands, and "come up all standing"? This greater maneuverability, especially this braking trick, is due very largely to the greater flexibility permitted by giving up the fins' function as lifting planes. They can now be trusted on thinner "wrists," and can be turned clear around to a position at right angles to the body axis, instead of being always parallel to it, as in the "planing" sharks. Also, the fins can be folded up to a considerable extent. This reaches its extreme in the flying-fish, where the pectorals (and in some species the aft-



LOST EFFICIENCY
An "advanced" fish that has "gone fancy" and lost its efficiency as a swimmer.



LIKE SHARKS IN THE SEA

These low-wing airplanes, lacking gas-bags to serve as swim-bladders, must depend on their fore and after "fins" to support as well as to balance and steer them.

ermost pair as well) develop to an exaggerated size, but are kept folded back as the fish darts through the water and out into the air. Then they are spread out, and actually function as gliding wings, on which the fish can sail for scores or even hundreds of feet.

Mr. Harris concluded his study of the engineering efficiency of the body designs worked out by fishes for themselves, with a look at their tails. The more primitive or less active a fish, the blunter its tail-lobes, he found, and also the thicker the "stem" between the body and the flare of the tail. Thus, the not-very-speedy cod has a conservatively blunt-flared tail, while the highly efficient swimmers of the mackerel tribe (which includes the long-finned albacore —the "tuna" of the fisheries) have deeply notched, widely flaring tail lobes, narrow and curved sickle-fashion, in just the shape that airplanes would be built if it were structurally feasible. On the albacore at least this same sickle-shape repeats itself in the wide-reaching pectoral fins. And in all the mackerel clan, the tail is on a slim, elegant, tapered "stem," permitting the body to come down to a most efficient end-point of its streamline design.

The illustration on the cover of this week's SCIENCE NEWS LETTER shows fish that have developed their fins to the point where they can, at need, become "tandem gliders" in the air, fleeing from dolphins, which are highly efficient swimmers—probably the fastest of all water-creatures. The artist, Wilfrid S. Bronson, visions this drama from the under-water, "fish's eye" point of view. The painting is in the Buffalo Museum of Science.

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PSYCHIATRY

Glands and Homes Blamed For Problem Children

GLANDS and chaotic homes were variously blamed for bad behavior of children, in the discussion of the American Orthopsychiatric Association.

Disorders ranging from speech defects, mental retardation and truancy to stealing and sex delinquency were traced to glandular disorder in 93 out of the first thousand children studied at the Cincinnati Child Guidance Home, Dr. Louis A. Lurie said. Glands may so importantly affect the personality and behavior of the child that a thorough examination of the endocrine or ductless glands should be made in the case of every child whose behavior makes him a problem, Dr. Lurie believes. Many of the children he studied were helped by treatment with gland extracts.

Physical causes, contrary to general belief, are not what make children overactive to the point of abnormality, Dr. Asher T. Childers, psychiatrist at the Central Clinic in Cincinnati, insisted. When a child like eight-year-old Mary C., of normal intelligence, cannot pay attention long enough to get her lessons, is constantly moving about the schoolroom, talks too much and too loudly, is boastful and always seeking attention, the home life is at fault, Dr. Childers found.

Mary and children like her suffer from an unconscious feeling of insecurity and of not belonging permanently to a family, a school or a neighborhod. Living first with one set of relatives and then with another, staying up too late, eating irregularly, going to too many movies, getting no regular training in behavior and self-control are the factors that make dangerously over-active children like Mary. The danger is that when these children grow older, their over-activity takes the form of stealing and truancy among boys and sex misconduct among girls.

The remedy, Dr. Childers discovered, is to have these children live in institutions. The regularity of the life and the interesting as well as inhibiting nature of an institutional program will help them more than anything else.

If Johnny is going to have serious difficulty in learning to read, it can be foretold before he enters the first grade. Eight signs by which the prediction can be made were presented by Dr. Burton M. Castner of Yale University.

The signs include tendency to or family history of lefthandedness, weakness in drawing, inattentiveness, and excitable personality. Not all eight are likely to be found in any one child, and no one of these signs alone is enough basis for predicting that the child will have trouble in learning to read. But a significant combination of them shows that the child in question should be watched so that he can be given special help with his reading troubles before they get so bad that his discouragement over them will distort his personality and make him a behavior problem.

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