BIOLOGY-PALEONTOLOGY

All Flyers Began as Gliders

Hypothetical Ancestor of All Flying Insects Had Six Stubby Wings That Helped to Lengthen Leaps

By FRANK THONE

ALL FLIERS began as gliders.

Aviators acknowledge their debt to the experimental gliders who preceded them—Lilienthal, Chanute, the mythical Icarus. The Wrights, first of successful aviators, were gliders before they flew. Their first flying machine, indeed, was not so much a real airplane as a power glider—a glider with an engine and a couple of propellers. It was a real connecting link in a line of mechanical evolution.

Man, the latest of all creatures to learn the mastery of the air, has only repeated a story already long told by many of his lesser brethren with wings. For the birds of the air, and the insects of the field that flew long before there were any birds, and bats and pterodactyls as well, all seem to have gone through an experimental stage of gliding before they took confidently to the air for long, true flights.

Scientists are constantly uncovering new evidence in support of an evolution of flying through gliding, in a wide variety of animals that fly. As with all other lines of evolutionary development, this evidence is partly found in fossil records, partly in the behavior of animals now existing that seem to be in the midst of the job of changing from something into something else.

Flying-fishes and flying-squirrels are examples of the latter class of animals. They cannot fly, in spite of their complimentary names, but they are successful gliders; and it is quite conceivable that either or both of them might give rise to lines of descendants that in some later age would be true fliers.

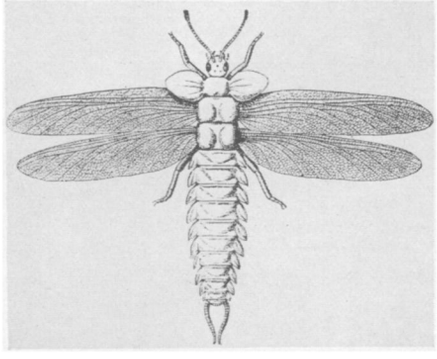
But it is the record of the rocks that gives the most striking and dramatic story in this, as in all other evolutionary narratives. We cannot see the beginning or the end of such lines as flying-fishes in the living specimens. Time is too short. But fossils carry us back over long ages, and the contrast between these pages away up in the front of the book and the pages of yesterday and today, in the back of the latest volume, gives distance and perspective.

Not only do these records of the past give this perspective, but they enable properly trained students to project the line still farther into the past, and to conjecture, with some chance of being right, what the still missing links may have been like.

This is what Dr. R. E. Snodgrass of the Bureau of Entomology, U. S. Department of Agriculture, has done with the story of insect flight. In a report written for the Smithsonian Institution he not only makes a detailed examination of the technical mechanics of the flight of the highly successful insect models of today but harks back to the strange fliers of the Coal Age, millions of years ago, and even reconstructs for us a very probable-looking hypothetical glider ancestor for all flying insects.

The creatures that gave him his clue are known only from fossils. They were a family of very primitive insects, a little like the modern stoneflies, that lived during the Coal Age and have apparently been extinct ever since.

These insects had, in front of the two pairs of wings that constitute the equipment of all typical insects, an additional pair of stubby round wing-like lobes that stuck out from the front segment of the chest region or thorax. Since the two regular wings of all insects are attached to the second and third segments of the same region, it has long been supposed by many scientists that these lobes represent a third pair of primitive wings. These ancient insects probably could have flown without them, but they helped a little, giving a slight additional lift as they were pushed against the air.



INSECT OF THE COAL AGE

Restored from broken fossils. The two wing-like lobes in front of the true wings suggested the possibility that all insect wings originated as such structures.

Dr. Snodgrass, interested in the riddle of the origin of insect wings, asked why they might not have evolved from lobes of just this kind, projecting from the bodies of primitive insects able to run and possibly hop, but not able to fly. Extending rigidly on either side of the body, not equipped with muscles to make them fan the air, they would yet offer a considerable sustaining surface, enabling their owners to make a fairly long glide or swoop.

To make a glide of this kind, one of two types of take-off would be necessary. Either the "glider" insect would have to climb a tree or tall weed and launch itself into the air at an object some distance off and at a lower level, or else the insect would have to work up momentum by running along the ground, or perhaps by pushing itself up with a pair of catapult-like hind legs.

A Modern Example

We can find a modern instance of just such an insect. The grasshopper has a pair of catapults aft, which hurl it into the air to very good effect, as we can see in the case of many crickets and some species of wingless grasshoppers. In other grasshopper species that have wings, the latter have apparently very little true wing power, but serve as wide glider-fans, to extend the "hopper's" leap. It is also worth noting that though grasshoppers can take off perfectly well from the ground, they are also much given to crawling up weed stems and other heights, thereby gaining also the flying-squirrel's advantage.

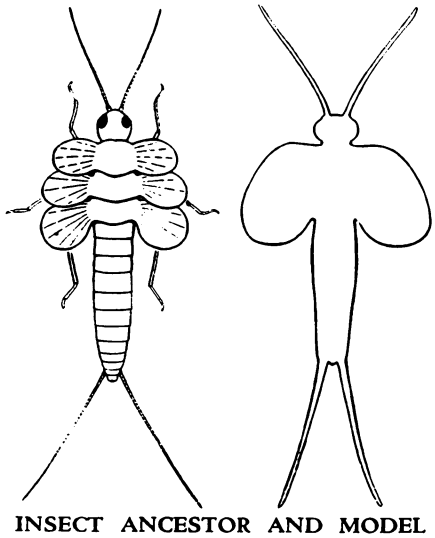
To make a practical test of this theoretically possible glider insect, Dr. Snodgrass drew an outline of its body on a piece of thin, stiff cardboard. He cut this out, and to its under side, at about the midpoint of the "glider-wing" area, where the chest of the insect would naturally be, he stuck a wadded-up piece of tinfoil. This was to represent the insect's body-weight. He trimmed this down to the right proportions, and then launched his imitation insect on the air. He found that if he just let go of it, the model would merely fall to the floor. But if he gave

it a little push, it would sail away in a graceful glide.

How the originally fixed and immovable lobes were evolved into the much larger, rapidly vibrating, frequently beautifully ornamented wings of insects as we now know them would be a very long story. Not much of it is known as yet. The most important step came with the achievement of movement. This required the development of muscles, and since wings were a brand new addition to the insect's equipment, and not merely a new job given to already existing forelimbs, as in birds, bats, and all other flying vertebrates, the muscles had to be borrowed somewhere or else developed completely *de novo,* like the wings themselves. After an exhaustive study of the internal musculature of insects, Dr. Snodgrass is inclined to think that the wing muscles are borrowed leg muscles trained to a new job.

What Dr. Snodgrass has done in building a hypothetical ancestry of "gliders" for flying insects, another scientist, Dr. Gerhard Heilmann, has done for flying birds.

Years ago, when the famous primitive bird skeleton now known as *Archaeopteryx* was found in Germany, people would hardly believe it was real. The creature was so much like a reptile that if the plain imprint of feathers had not been found in the fine-grained stone around it there is no likelihood whatever that it would have been called a bird. But a bird it undoubtedly was, and it established for good and all the belief that most evolutionists had anyway, that birds were the offspring of reptiles.



INSECT ANCESTOR AND MODEL

As imagined by Dr. Snodgrass. The six rigid lobes were not true flying organs, but rather glider planes. A cardboard model cut in the shape of the outline at the right, but larger, and properly weighted under the thorax will go into a graceful glide if launched with a little push.

Again rose the question: How did they learn how to fly? How did their wings develop?

Again the fossil suggested a solution to its own riddle. Its wings were not like those of a modern condor or gull—long, narrow, highly specialized and evolved. They were rather stubby, suggesting that the bird was not a particularly strong flier. The long tail, too—something wholly unknown in all other birds living and fossil—hinted at a considerable usefulness as a gliding organ in addition to its normal function as a rudder.

Archaeopteryx a Glider?

Was it not possible that this ancestor bird was a partial glider, starting from a high point on one tree and swooping, more or less like a flying-squirrel, to a lower point on another? Was it not possible that it had an ancestor even more lizard-like, than itself, even more of a glider?

A number of scientists have tried their hand at reconstructions of such a hypothetical gliding reptile-bird "pro-avian," but Dr. Heilman's picture comes perhaps nearer combining the features of both without doing violence to either than any that have yet been attempted.

The body is long, spindle-shaped, lizard-like. The head and hind limbs are reptilian. The feathers are short, and part of them are rather scale-like. From the sides of neck, trunk and tail there are frills of feathers, suggested by frills of skin and scales still to be found on modern lizards, but developed to a point where they could serve as auxiliary gliding planes. The tail, if fact, serves to support a great part of the body weight.

In seeking the reptile ancestors of birds, scientists have of course not forgotten the flying reptiles that ruled the air when the dinosaurs ruled the earth and the sea. Pterodactyls and their kin were highly successful fliers, probably as able on the wing as hawks or buzzards are today. But they were a tribe to themselves, and have left no modern descendants. They had their day, a great day, but they have ceased to be.

What the ancestors of the pterodactyls were there is as yet no telling. They came and went rather suddenly, in the geological sense. But it is not unlikely that they, too, descended from some type of gliding reptile whose bones are still denied us by the concealing stone.

"PRO-AVIAN" BIRD ANCESTOR

As imagined by Gerhardt Heilmann. Its front limbs were neither wings nor legs. It could not fly, but with its numerous flattening frills of feathers and its long tail it could make long gliding leaps like a flying squirrel.

There remain, of the principal groups of flying animals, the modern bats, which are the only really successful flying mammals. They are far advanced in flight, too, for while they cannot make the world-girdling trips of terns or curlews they can maneuver as expertly as swallows and fly more silently than owls. They glide but little, and there is no way of conjecturing their ancestry from their habits.

One hint we may get from the structure of its wings. The bat wing, like the parachute membrane of the flying squirrel, involves both front and hind leg. It stretches between the exaggerated finger-bones and continues from the last one down the side of the body, and usually down the hind-leg also. This is strongly suggestive of a possible origin as a glider on the model of the flying-squirrel.

Possibly, if we wait long enough, other leaping mammals will become gliders, too. Possibly the flying-squirrel will become a real flying animal, a squirrel-bat. Flying monkeys are not evolutionary impossibilities. But with his better head for figures and his insatiable curiosity, greater even than that of the monkeys, man has by a single leap, within less than the lifetime of a single individual of his species, evolved into the leader of all creatures that fly.