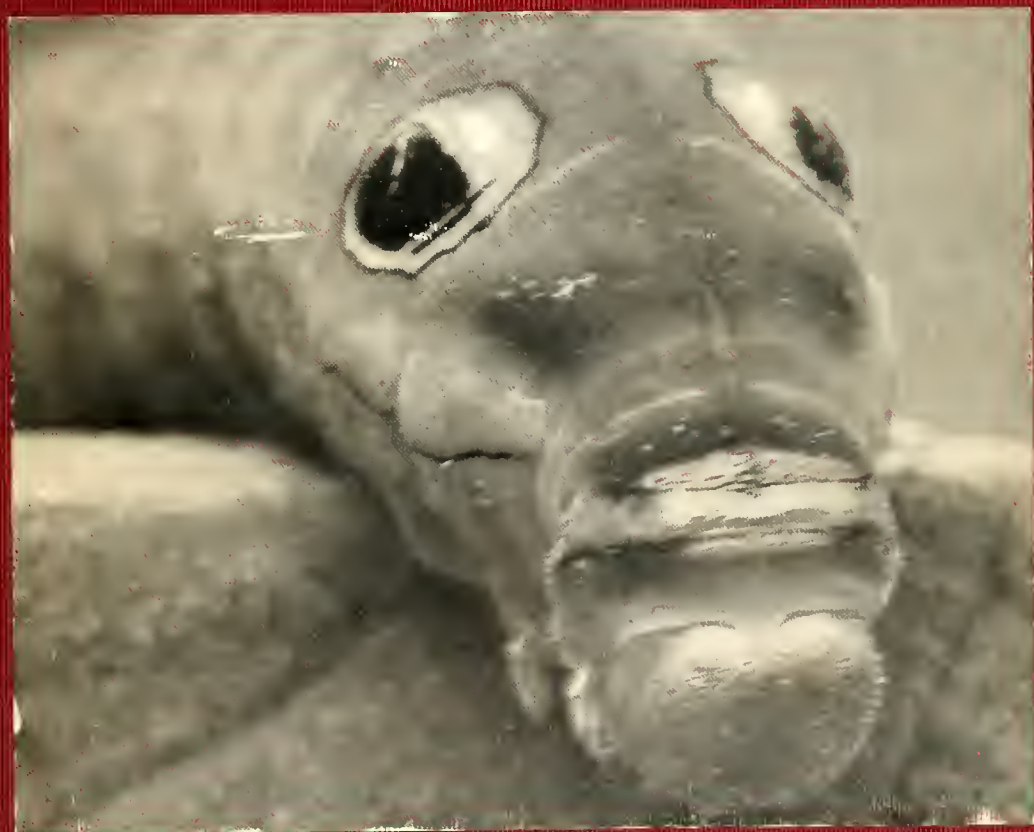


BOOK *of* MONSTERS

— BY —

DAVID AND MARIAN
FAIRCHILD



NATIONAL · GEOGRAPHIC · SOCIETY
WASHINGTON



U. S. Government

BOOK OF MONSTERS

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DAVID AND MARIAN FAIRCHILD



PORTRAITS AND BIOGRAPHIES OF A FEW OF THE
INHABITANTS OF WOODLAND AND MEADOW

WASHINGTON
NATIONAL GEOGRAPHIC SOCIETY

1914

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CONTENTS

- I. THE SPIDER WORLD.
- II. THE INSECT WORLD.
 - STRAIGHT-WINGED INSECTS (*Orthoptera*).
 - ORDER OF THE BUGS (*Hemiptera*).
 - THE BEETLES (*Coleoptera*).
 - TWO-WINGED INSECTS (*Diptera*).
 - FEATHERED INSECTS (*Lepidoptera*).
 - NERVE-WINGED INSECTS (*Neuroptera*).
 - THE STINGING INSECTS (*Hymenoptera*).
- III. THE WORLD OF MYRIAPODS AND A SINGLE LAND CRUSTACEAN.

BOOK OF MONSTERS

The pictures in this book are portraits of creatures which are as much the real inhabitants of the world as we are, and have all the rights of ownership that we have, but, because their own struggle for existence so often crosses ours, many of them are our enemies. Indeed, man's own real struggle for the supremacy of the world is his struggle to control these tiny monsters.

The plague of the middle ages, which spread like some mysterious supernatural curse over Europe and carried off millions of people, the yellow fever that has haunted the coasts of South America, the malaria which has strewn the tropics of the world with millions of graves, have been caused by the activities of two of these monsters so universally present in our homes as to have become almost domesticated creatures, the flea and the mosquito. During these last two decades these have come under our control, and the flies which leave a colony of germs at every footstep will not much longer be tolerated, indeed, every creature that bites and sucks our blood or that crawls over our food and dishes has been placed under suspicion.

Man struggles against these tiny monsters not only for his life and health but for his food as well. Almost every cultivated plant has its enemy, and some of them have many. The bugs alone which stick their beaks into all sorts of plants to suck their juices would starve man out in one or two brief seasons if they in turn were not held in check by enemies of their own. The chinch bug alone has demonstrated his power to devastate the wheat fields. The bark beetles that girdle square miles of forest trees, the moths that destroy their foliage, the creatures that burrow into the fruit and fruit trees, the gall-forming flies that form galls on the roots of the grape vines able to destroy the revenues of a whole country, the beetle which strips the potato of its leaves, the one which infects with its dirty jaws the melon vines of the South and turns the melon patches brown—these are a few of the vast array of our enemies. It would require a book much larger than this one just to enumerate those well known.

It should make every American proud to know that it is the American economic entomologist who has, more than any other, pushed his way into this field and shown mankind how to fight these monsters which destroy his food, his animals and himself.

But all these fascinating little creatures are not our enemies. We must not forget that man has domesticated certain of the insects and that gigantic industries depend upon them for their existence.

The honey-bee furnished mankind with sweets during the generations

preceding the discovery of the sugar cane, and the silk worm furnishes still the most costly raiment with which we clothe ourselves.

The friends we have in the insect world are those which destroy the pests of our cultivated crops like the Australian lady-bird beetle which has been sent from one country to the other to keep in check the fluted scale which is so injurious to the orange orchards, and the parasites of the gipsy-moth which, in Europe, helps to keep under control this plague of our forest trees, must certainly be counted as our friends.

Also, they are our friends if, like the spiders, they kill such monsters as suck our blood or make our lives unsafe, or, like the great hordes of wasps and hornets, wage unending warfare against the flies but which, because they attack us personally if we come too near their nests, we kill on sight. Strangely enough, it is often these same stinging insects which help us by fertilizing the blossoms of our fruit trees. Indeed many plants are so dependent on these little creatures that they have lost the power of self-fertilizing and thousands of species of trees and plants would become extinct in a generation without their friendly aid.

The ancestors of some of the creatures pictured in this book were buried in the transparent amber of the Baltic many thousands of years ago and the fossil remains of others date back a million years or more, but while man has been developing his surroundings from the primitive ones of savagery to the almost inconceivably complicated ones of civilized life, these creatures, most of them at least, seem to be leading essentially the same kind of lives that they led hundreds of thousands of years ago.

They have powers which neither man nor any other mammal ever dreamed of having.

Some have powers of flight which enable them to sail a thousand miles before the wind. Others can jump a hundred times their own length. One of these monsters can manufacture a liquid rope as easily as mammals produce milk and with it weave aerial nets to trap their prey or, by attaching it, can drop from the dizziest heights without danger, and when the rope has served its purpose they eat it up.

Their weapons of defense are comparable to the deadly ones that only poisonous serpents have. If they were larger they would be, in fact, what legend pictures the dragons to have been.

The unthinkable old germ plasm of these species produces creatures which act with a precision of purpose and a degree of absolute self-sacrifice which cannot fail to stagger the most conscientious of the human race. They might even make one wonder whether the fulfillment of biological life does not consist in sacrifice of the individual for the good of the species to which it belongs.

Certain it is, that human thought is now drifting away from the consideration of the individual and is coming to pay more attention to the species and the things which affect its development. This is a picture book produced in

the playtime hours of two busy people. It is a collection of actual photographs of a few of the small-sized monsters which inhabit the tall grass, the flower garden and vegetable garden, the pines and oaks of a place in the woods of Maryland.

If it should show to others a world of new and fascinating things it would be simply doing for them what the taking of the photographs has done for us, opened the door into a realm of real life, of a terrible struggle to live, which is as full of fascination as the dragon tales of old Japan. At the same time, it makes us realize what vast and yet untouched fields of material value lie in the efforts man is making to outwit and circumvent and even, perhaps, to exterminate such of the monsters as encroach upon his own environment.

HOW THE MONSTER PHOTOGRAPHS WERE TAKEN

If you compare these photographs with those to be found in most books on insects, you will find that they differ in several particulars. They are all either front views or side views of the creatures, whereas those in books on entomology are generally views from above. Imagine a book on the horse in which only top views were shown, or a guide to a zoölogical garden illustrated with the various wild beasts photographed from above. It is true that, being so much larger, we generally look down at these monsters, but a mouse also generally runs along the floor or under our feet and yet a zoölogist pictures it from the same point of view that he does an elephant. Crows look down upon us, yet I imagine that no one will admit that the crow's impression of human beings is as correct or as interesting as that which we have of ourselves. Every creature has a right to be portrayed from its own level, and the reason these photographs are unusual is because they carry out this principle and do each creature justice.

Another particular in which these pictures are new is that, although they represent magnifications of from five to twenty diameters, they are not enlargements from small photographs, but views taken directly from 5 x 7 photographic negatives.

Then too, these creatures have been posed with considerable care in order to give them a lifelike appearance, and this work was done immediately after they had been anesthetized, and in some cases while they were still alive.

The whole art of taking these large photographs of insects is so simple that thousands of amateurs ought to be able to take them.

The outfit consists of the camera, which is just a long box, a long-focus lens, a piece of ground glass and a focusing glass, a flash light, a pair of pincers, some needles mounted in handles or else some small dental tools, a few little blocks of wood, a candle, a piece of glass covered with tissue paper, and a long hollow cylinder made of stiff black paper or cardboard. Add to these a great deal of patience and you have all that is needed.

I made my camera box out of thin quarter-inch whitewood boards and pasted black paper over the joints to keep out the light. Into one end of this box I set the front board with the objective screwed into it. Squaring off the other end of the box, I carefully fitted to it a 5 x 7-inch ground glass holder, exactly the size of an ordinary 5 x 7 plate holder. I framed this in with pieces of wood so that I could slip out the ground glass holder and put a plate holder in its place. For purposes which will be explained later, the ground glass was not fastened into its holder, but a narrow slit through one end of the frame was made just large enough so that it could be slid in or out without taking out the frame itself.

The object to be taken, having been mounted on a little block of wood and fastened there with candle wax, is placed in front of the long focus lens by an assistant, who stands ready to move it back and forth, or sideways, or up and down, according to directions.

Getting to the far end of the camera under the focusing cloth, I begin to hunt for the dim image on the ground glass, and, by directing the assistant to move the object in various ways, am quickly able to bring it into view, but not into sharp focus. In order to do this, I slip the ground glass itself half way out, take up the focusing glass, holding it against the edge of the ground glass in order to steady it. I am thus able to see every detail distinctly without looking through the ground glass at all and can make sure that they are in focus. With the focusing lens, one is able to see the image in the air very plainly, even when the diaphragm is nearly closed and when only the faintest shadow could be seen on the ground glass.

Having made sure that the image covers the plate well and is in good focus, I put in my plate holder, my assistant places the cap over the objective, I draw the slide and walk down to the front of the long camera. Wills, my assistant, then prepares a charge in the Prosch flash lamp and puts the tube of black paper in front of the lens to protect it from the glare of the flash. With one hand I hold up a pane of glass on which thin white paper has been fastened to protect the insect from the direct sunlight; with the other hand I remove the cap of the camera and expose the plate for from 50 to 80 seconds, depending upon the lightness of the object, the brilliancy of the sunlight and the stop employed, 16, 32 or 64. In the meantime, Wills blows off a full charge of magnesium powder in the flash lamp, so holding the lamp that the rays from it will light up the shadows which are underneath the creature's body. The cap is then put on again and the plate holder closed in the ordinary way. Only the freshest obtainable orthochromatic double-coated plates are used.

The friends who visited us on holidays helped make the long camera, and it was made at three separate times, an eight-foot length at a time. When the creature is very small I use the twenty-four-foot length, but when it is large the twelve or eight-foot one. Each length fits into the one in front of it and is covered with black cloth to make it tight.

The taking of the photographs is not, however, the hardest work of monster photographing, although perhaps the hottest, for in summer it is no joke to swelter under a focusing cloth for half an hour at a time, and the focusing itself is hard on the eyes. It is the mounting of the beasts which wears upon one's nerves, and here is where the woman's skill comes, for Mrs. Fairchild learned the art of insect taxidermy and many of the most lifelike photographs in the book were mounted by her.

It has been a source of keen satisfaction to find, upon showing the results to professional entomologists, that many of them did not realize that the insects were not alive when photographed. But, although they were not alive, they had just recently been put to sleep with ether, for we soon discovered that to get a lifelike photograph one must photograph a monster at once, within half an hour after death, the sooner the better.

Many ways of mounting were tried, but none were so successful as the following: Cover the top of a small block of wood with a thin, even coating of paraffin or ordinary candle wax by letting the drippings of the candle fall upon it. Pick a large leaf and turn its upper surface down upon the wax, before it cools, and let it stick there; this will give a natural looking ground for the insect to stand upon. Hold the insect over the block of wood and arrange the legs in as natural a position as you can with a long needle or fine dental tool. Then fasten each foot in place by heating the needle in the candle flame and pricking a hole in the leaf just under each foot so that the wax will come up through the leaf and hold it fast.

This mounting is not so simple as it seems, and, until one has actually experienced it, he can have no idea of the perversity of these six-legged beasts. The way the contracting muscles of a grasshopper's back legs will pull the other four legs loose, or the way the hornet will refuse to hold its head up, or the way long flexible antennae will droop are exasperations which lead straight to profanity, unless one is very careful.

The whole thing is a game of quickness, ingenuity and patient skill, for so many things must be watched at once. The wilting insect cannot wait, the sunlight shifts, clouds drift across the sun and then, just as everything is in readiness, a breeze springs up which stirs the creature's wings and the whole thing has to be given up.

The pioneer in this field of photography is Dr. N. A. Cobb, for it is he who first showed what the face of a fly looks like. His suggestions are what first encouraged me to take up the work, although the method finally used by me is quite different from that which he employed. I substituted the long horizontal camera and the long focus lens for his vertical bellows and short focus lens, believing that for larger creatures I get a greater depth of focus and more lifelike appearance.

After my first mild success, that critical period beyond which so many experiments never go, three friends came to the rescue with their enthusiastic approval and encouragement and I desire that their names be connected with



THE LONG CAMERA WITH WHICH THE MONSTERS WERE TAKEN

The camera, consisting of several long boxes which fit into one another, is stretched on a table made of a board and a number of posts set in the ground. At one end is the lens and at the other, the ground glass plate to focus the image on. The monster is mounted on a small wooden block and set up the proper distance in front of the lens. It is moved back and forth in response to directions from the operator, at the other end of the camera, who is watching the image on the ground glass. Lying on the camera above the lens is a black paper cone which, when everything is ready, is put over the lens between it and the monster to prevent the smoke from the flash powder from drifting between the lens and the insect during the exposure. Wills, the assistant, is holding the Prosch magnesium blow lamp, and the insect is shaded from the direct rays of the sun by a large pane of glass covered with a thin sheet of tissue paper. Direct sunlight is reflected from the hairs and polished surfaces of the insects and makes spots on the negative.



SOME OF THE MONSTERS AS THEY APPEAR WHEN MOUNTED ON PINS IN AN INSECT BOX

It has always seemed a pity to me that these beautiful forms of life should be so evanescent. We look at their dried remains in collections and are impressed by their colors and grotesque forms, but we should not forget that after all these are nothing but their dried-up corpses and scarcely more to be compared in real beauty with their living bodies than are the Egyptian mummies comparable to the living faces and forms of the great Pharaohs.



THE MONSTERS PICTURED ON THE SUCCEEDING PAGES, AND MANY MORE, IMPRISONED IN ONE MUSEUM CASE

They are all pinned in the box and have dried out and changed almost beyond recognition, but the impression which their portraits have made will, I hope, be lasting.

this book which they have helped to make, Mr. and Mrs. Alexander Graham Bell and Mr. Barbour Lathrop.

Knowing little about insects I have been dependent upon the kindness of the entomologists of the National Museum, in particular on Dr. L. O. Howard, for the scientific names of the monsters, which names have given me access to what is published about them in the handbooks on entomology.

Practically all of the negatives and prints have been made by Mr. Scott Cline of the Department of Agriculture, who took a particular interest in their preparation.

To Mr. Gilbert H. Grosvenor, Director and Editor of the National Geographic Society, is due the credit of realizing the popular interest these pictures would have and who, in contrast with more timid publishers, reproduced thirty-nine of them in the National Geographic Magazine and urged the preparation of this book.

CHAPTER I
THE SPIDER WORLD

THE SPIDER WORLD

In enlarging the images of these small spiders to many times their size, one is at once struck by their similarity to crabs and lobsters. Their jointed legs encased in shells, which from time to time they shed, remind one strongly of the crabs, and they do in fact belong to the same great family, the family of arthropods, and they are not insects.

The spider world is the world of eight-legged creatures just as the insect world is the world of the six-legged ones, and educated men and women should no more confuse these great classes of beings than they confuse the bipeds with the quadrupeds.

They differ from the insects in other ways than in the number of their legs—they have no feelers or antennæ, those wonderful sense organs which all insects have, but here and there, especially on the legs, are strange hollow bristles or spines, which end in nerves. Their eyes also are not like insects' eyes. An insect's eyes, at least its large prominent ones, are composed of hundreds of lenses or facets, while the spider, though he generally boasts of eight, has only simple ones with single lenses.

Their life is very simple as compared with that of many of the insects. In the fall, the mother spiders lay their eggs in a bag of their own silk, often several hundred eggs being laid in one sac. The spiderlings hatch out in the sac, and, in the North, they spend the long winter there.

They do not have two stages of existence as beetles or butterflies do, but are hatched out mature and equipped with the poison fangs which aid them in their strictly carnivorous, and often even cannibalistic, existence.

They grow and shed their skins as do the baby grasshoppers, but they do not change their form with each moult and none of them have wings.

They have inside their bodies, reservoirs of strange, sticky fluids which they can pour out through spigots in many different ways. This fluid, as it dries, may form drag lines which they trail behind them and fasten as they go to use for safety lines; with some spiders it may even be poured out in such quantities that it makes an aeroplane; with the majority, however, it is used to make their nests or their egg sacs or the marvelously beautiful orbs that prove the graveyards of so many careless insects. For the spiders are the enemies of the insect world; were they more discriminating, they would be perhaps the greatest friends of the human race, but, as they suck all kinds of insects' blood, all that we can be sure of is that those among them which we find in our houses are a benefit, for there they kill the flies and other insects which we do not want indoors.

To their Southern and especially their tropical cousins, which attack and sometimes kill human beings, this group of fascinating creatures owes the dread in which it is held by people in general. It is a pity, for throughout the Northern states, no dangerous species is known to exist, and those which frequent our houses will no more attack us than do the flies they catch and devour.

Until a child has gazed in wonder at an orb weaver as it spins its web between the trees, or been an eye-witness of the death of some insect unlucky enough to fall into a web, he has not taken his first step toward the wonderland which touches him on every side and he is in grave danger of growing up with a blind side—the side turned toward the field and forest.

There are millions upon millions of spiders, and thousands of species, and they live everywhere from the Arctic Regions to the Tropics. They devour countless myriads of flies and gnats and hosts of other insects, and nobody knows just what good they do us, but every entomologist would hold up his hands in fear at what the result might be should the spiders of the world be blotted out. They must hold countless parasites in check and help to keep the balance even.

If all the little children should learn that they are harmless, I wonder if they could not stop their nurses from killing them. It is the ignorance of those who train our little ones that keeps alive the unreasoning hatred towards so many of the wonder creatures of the woods.



AN EIGHT EYED ENEMY OF THE FLY; A JUMPING SPIDER

(*Phidippus audax*, Hentz.)

We are so accustomed to beasts with two eyes that it is hard to realize that all around us, though hard to see, are little monsters with many eyes of various sizes.

This one has eight eyes, four of which are invisible from the front. The eyes are diurnal, enabling the creature to hunt only by day. Its eight stout legs fit it for jumping forward or sideways with great ease. In comparison with its size, its jumping powers are incredible. If it were the size of a tiger, it would be a beast of prey which could clear a quarter of a mile at a bound.

It can sit on a branch and throw out an elastic dragline behind, strong enough to bear its weight, and by this means it is able to jump at and catch its prey on the fly, regaining its position by climbing up the dragline. Add to this that it possesses a pair of powerful hollow fangs, into which poison sacs empty, and a voraciousness which often leads it into cannibalism, and you have a fair picture of this jumping spider, which is one of a thousand species of little creatures found everywhere except in the polar regions. They range in size from a third to a half an inch long and live under stones and sticks, spending the winter in a silken bag of their own manufacture, but never spinning a web. The males of some species have been observed to dance before the females, holding up their hairy legs above their heads apparently to show off their ornamentation.



READY TO POUNCE ON A FLY ON THE WING; THE JUMPING SPIDER

There is something diabolical in the way these four black eyes in a row stare one out of countenance.



A JUMPING SPIDER READY TO SPRING FROM A LEAF

(*Phidippus togatus*, Koch.)

I must confess to a peculiar feeling of embarrassment, almost of fear, towards a jumping spider. It stares at you so intently and seems so fearless as it wheels to keep you covered with its battery of eyes; and you never know which way it is going to jump.



THE WOLF SPIDER

(*Lycosa carolinensis*, Walek.)

This is not the photograph of a polar bear, but that of a wolf-spider, with a battery of eight eyes on the top of its head and poison fangs hanging below.

Some such impression as this, I imagine, must be made on the retina of a fly or beetle when, in wandering through the grass at dusk, it suddenly finds itself face to face with a wolf-spider sitting on the turret which forms the entrance to its web-lined hole in the ground.

Behind and above the fangs and hidden in their shadow is the creature's mouth, toothless and made for sucking only. With his fangs, this wolf-spider kills and crushes his victim; then he sucks the body dry and throws away the carcass.

Seen here and there above the body hairs are black spines, hollow inside and connected with the nerves of touch. Of his eyes, the two in the center in front are supposed to be for use by day, while all the others are nocturnal, enabling him to stalk his prey at dusk. It is the wolf-spider that often appears at night within the circle of lamplight searching for nocturnal insects.

The nocturnal eyes are remarkable organs, with reflecting structures so placed behind the retina that the light entering the eye traverses the retina twice, and it is supposed that this reflecting structure increases the effect of any faint light, enabling the creature to "see in the dark."

This is a hunting spider, chasing its prey through the grass or burking under stones, especially in damp places. It does not spin a web, but lives in a silk-lined hole six or eight inches deep, which it digs in the ground, and around the entrance to which, out of sticks and grass, it builds a turret or watch-tower, from which it can see its prey more readily than from the ground. These spider holes are common in the meadows of Maryland.

In form and color the wolf-spider resembles the famous tarantula of southern Europe, the bite of which was supposed to cause the tarantella, or dancing madness; but it is as harmless as a butterfly, and indeed, Doctor Comstock, who is the authority on spiders, believes that no spiders in the Northern states are poisonous to man.



THE CAST OFF OUTER SKELETON OF A WOLF-SPIDER

(*Lycosa punctulata*, Hentz.)

This photograph is of the outer skeleton or shell of a small wolf-spider which I found clinging to the focusing cloth of my camera after it had been lying on the grass.

With us the bony skeleton is internal and grows as we grow. With spiders the skeleton is a tough, leathery structure, which cannot change; so that the young, rapidly growing spider soon finds his shell too tight for him, and, like a crab, he bursts his shell and pulls his soft body from each leg and complicated cavity.

This process seems marvelous, but is really comparatively simple when we realize that before the old shell is cast off it is loosened from the new skin by the moulting fluid which is excreted from glands opening through this new skin.

After the old skin is loosened it splits along the sides of the body and in front of the eyes, the slit being just above the legs and jaws, and that portion of the old skeleton which had covered the back is lifted off like a lid. The new skin, at first elastic enough to accommodate the increased size of the body, soon becomes hardened like the old, and must in its turn be shed.

Imagine, if you can, the surprise of a wolf-spider who, in running through the grass, should stumble over his own outgrown skeleton, so like his former self in all its details that he could scarcely fail to recognize it as his own; for even the transparent cornea of the eye is a part of this outer skeleton and is shed with it, as well as the jaws, sensitive spines, and hairs.



THE SPINY-BELLED SPIDER WHICH BUILDS NETS ACROSS THE PATH

(*Arrosoma gracile*, Walck.)

We are accustomed to the dromedary's hump and the kangaroo's big tail, but had this creature been as big as either, or were we Lilliputians, its black and white spiny body, shaped at the bottom like an umbrella stand, would attract more attention at the zoo than either of those desert beasts.

Its eight long, crab-like legs are made for spinning, and across the openings in the forest it stretches a great net in which to snare its game. On this it sits protected from the birds to whose eyes it looks from above like some bird's droppings in the web. This one is a female and its mate is said to be much smaller and quite different, with no humps or spines at all and a long narrow body.

The courtship of spiders is often a dangerous business for the male, and perhaps it is quite as well for him that he is often smaller and more agile than his mate, for if the female is not ready to receive his advances, she is apt to pounce upon him and destroy him.



THE BIRD DROPPING SPIDER, A CREATURE WITH PROTECTIVE COLORING

(*Epiria verrucosa*, Reutz)

This orb weaver had swung its net across a wood road, and so perfectly did the white patch on its back resemble a bird's dropping that until my hand touched the net I failed to realize that a living thing was hanging there. There is something strangely fascinating about the compelling force of instinct: a spider hatched in captivity who has never seen a web made, will weave its own in the same delicate and intricate pattern that its mother made, using the different kinds of rope correctly, and spacing each strand with a mathematical precision. Indeed, the web of this untutored little spiderling will be as characteristic of its species as the white spot upon its back. It would be as though a child, cast alone on a desert island, should build a house in all details precisely like its ancestral home.



THE AERIAL TRAPPER: THE ORB-WEAVING SPIDER

(*Epeira trivittata*, Keys.)

Hidden behind these eight four-jointed legs of varying lengths, covered with hollow, sensitive bristles, is the spider's head, with eight eyes, strong jaws, poison fangs, and a pair of palpi, which look like extremely short legs and seem to serve as hands. The hairy body is filled with thousands of eggs and contains also a marvelous reservoir of liquid rope opening into spinnerets on the under side of the body. Some of the tubes or spinnerets make strong and dry filaments and others make sticky ones. The radiating threads of the spider's web, those which compose the framework, are stiff and dry; the spiral threads, however, which join them together, are coated with a substance which no little flying creature can strike against without running the risk of sticking fast.

Before you are up on a summer's morning this wonderful creature will have manufactured what would be equivalent to two miles of elastic and sticky rope if she were as large as a six-foot man. With the skill of an experienced fish-net maker, she will, in a few hours, construct a net as large as a cartwheel, which like the whale-nets of New Zealand, though they may break with the floundering of the prey, bewilder it and tire it out with struggling.

The orb-weaver is the aerial trapper among living creatures, stretching its sticky, elastic web across the aerial runway of its prey and waiting with a patience which would drive a fisherman insane.

To insects of its own size, the orb-weaver is a hideous, bloodthirsty monster. It sinks its fangs into its struggling prey, injects a poison quite as deadly as that of the rattlesnake, and quickly sucks the blood of its victim.



ORB WEAVER FILLED WITH A THOUSAND EGGS WHICH SHE LAYS ALL AT ONCE
(*Epicra domiciliorum*, Hentz)

Atlas with the world on his back, as imagined by the boys of Athens, could not have been more strange than this creature with her distended yellow body.

Some of her kin have fasting powers almost beyond belief; they have been kept alive in captivity for eighteen months without food.

This species is one of the commonest orb-weavers on the American continent, and its webs, like great cart-wheels, are to be found across the pathways in the woods and everywhere in clearings in the wood-lot.

She is a tight-rope performer her whole life-long and her long, muscular legs seem well fitted to enable her to hang, week after week, from her web, supporting in her much enlarged body a thousand or so eggs, which she will later lay, not one at a time, but all at once. No surprise is sudden enough to catch her unprepared and make her fall from the dizzy heights where she lives, without first being able to attach an anchor line. This she does by rubbing her spinnerets over the surface on which she stands, and by quickly spreading and bringing them together again she makes an attachment disc from which she can reel out her rope and check her fall.

The gift of spinning from internal reservoirs, supplied by active secreting cells, is common in the insect world as well as in the world of spiders, for thousands of species of caterpillars make cocoons of silk which they spin as rapidly as any spider makes its web. I doubt if any silk-gowned lady ever stops to think how many thousand gorgeous moths have been cut short in their careers in order that the threads which the silkworms have thrown around them to make a nest in which to pupate could be reeled off to make the silken stuff she wears.



A SPIDER FROM A FLY'S POINT OF VIEW

(*Dolomedes tenebrosus*, Hentz)

A spider from the fly's point of view is a terrible monster, indged. Its claws of polished chitin, sharp as sword points, each with an aperture leading to a sac filled with deadly poison, its array of eyes of different sizes, its mottled, hairy skin covered with hollow sensitive bristles, and its powerful, leg-like palpi must strike terror to the heart of any fly or cockroach which may happen in its neighborhood.

Civilized man rarely sees the ferocity of wild beasts displayed, for even in the jungle it is hard to observe. To anyone, however, who will watch a spider devour a fly, the true picture of merciless cruelty will be apparent. With its poisoned sword-like fangs it kills its prey, and then, with its sucking mouthparts, it sucks the juice out of the carcass.



THE MOTHER SPIDER AND HER NEST: A NURSERY OF LITTLE CANNIBALS

This mother belongs to the nursery-web weavers. She wove a silken bag for her eggs and carried it about with her under her body until she found a suitable place to leave it. She had to stand on tiptoes to prevent its dragging—it was so big.

The photograph shows the spiderlings hatched and running about, hundreds of them, over the fine-spun mass of silk.

In these nurseries the strong eat up the weak.



A VAGABOND SPIDER (*Pardosa milvina*, Hentz)

This is a vagabond of the spider world, building no nest or web, content to use her marvelous silk in the construction only of a sac in which to lay her eggs. This sac she carries about with her until the eggs have hatched and the spiderlings are strong enough to take care of themselves, and then she rips open the sac along a distinct seam on the edge and turns her babies loose to shift for themselves.

These voracious little cannibals have, however, already learned to forage, as the struggle for existence in many species of spiders begins in the egg sac, and it is only the strongest who emerge. In other words, they eat each other up.

They do not grow to be more than half an inch in length, but they are among the most active of all spiders, and in the United States alone there are nearly a score of species of these little soldiers of fortune living nowhere and roaming the damp fields in search of prey.



THE MALE GRASS SPIDER

(*Lopidina nariva*, Walck.)

On a summer morning, if you rise with the sun, and if the night has been cool, you will find your lawn covered with most exquisite shimmering gossamer patches, so diaphanous that if you touch them or breathe on them they fade away. These are the webs of the young grass spiders and, if you watch one of them closely, you will see that the tiny spider is waiting below the web in a funnel of woven spider's silk. It will run out quickly enough if you throw a fly into its net. It is not an orb-weaver and runs over its net instead of climbing along the under side of it as many orb-weavers do.

That this is the photograph of a mature male is evident from the genital palpi, resembling a pair of short front legs.

In the autumn the males and females both desert their webs to wander, for it is not only their mating season but the close of their brief existence. Under a bit of bark the female lays her eggs and waits for death, guarding her progeny till she dies, although she has no hope of seeing them alive.

How, by what marvelous machinery, do these microscopic eggs beneath the bark inherit, not only the color and the form but the knowledge of web building which their dead parents possessed? Is there not something wrong in our idea of the individual as a separate thing rather than as a transitory part of a living network which has been in existence perhaps a million years, alternating in its form, now as a moving hairy-legged thing, and now as a round immobile egg?



THE CRAB SPIDER THAT LURKS AROUND THE NECTARIES OF FLOWERS

(*Xysticus gulosus*, Keys.)

Like the beasts of prey which lurk around the water holes of African deserts, waiting for the feebler game to come down to drink, the crab spiders conceal themselves around the nectar-bearing discs of flowers. These nectar cups are the feeding places of thousands of sucking creatures, and the tragedies which take place in the shadows of the rose or lily petals are things we do not like to think of, for they are quite as real, quite as horrible and bloody struggles as those upon a larger scale, the very thought of which makes our blood run cold.

The crab spiders cannot run forward but dart sidewise and backward at great speed. One cannot help wondering if this ability may not often be an advantage rather than a drawback and enable the creature to surprise its prey by turning its back on it, something as a left-handed man often surprises an antagonist.

That these spiders run their own grave risks in this life around the nectar "water holes" is evident, for they form a large proportion of the food of mud wasps and if you want a handful of them, tear down a few mud daubers' nests sometime in June and empty out their contents. The brilliant colors will surprise you and suggest that possibly the yellow ones haunt the yellow flowers and the blue the blue ones.

The particular species whose low, sprawling form is shown in the photograph is one of forty occurring in the United States and, although it is only from a fourth to a third of an inch long, is considered one of the large species. It is dull-colored, and, unlike its gaily-colored relatives, awaits its prey under bark and stones.

It spins no web and the small male leads a thoroughly vagabond life, whereas the female, in most species at least, settles down toward the end of her life and, after depositing her silken lens-shaped sac of eggs in some protected spot, she lingers near as if to guard it till she dies.



A FRONT VIEW OF A MATURE MALE SPIDER

The reason for existence is so perplexing that it is no wonder we fall back on mysticism whenever we try to explain it.

Inexplicable as it seems when we consider our own lot as humans, the mystery is no less great when we try to view existence from the standpoint of a male spider.

Is it not probable that we cling so dearly to the idea of our own existence as individuals that we forget we are only halves of a whole, and that the whole itself is only a fraction of that vague living something spread out over the earth, moving in millions of places at once which we call a living species?

When we shall have shifted our sympathies and made them cover a thousand generations of beings, we shall have risen to the point of view that a divinity must take.

The enigmas of existence, I venture to say, will only be understood from this standpoint and not from the more sympathetic one of regret over the shortness, cruelty or barrenness of any individual's life.

The male spider seems peculiarly to be just a tool in the machinery of descent, merely a carrier of the male germ cells which, whenever, and not before, they come in contact with their female counterparts, start into activity the marvelous growth which results in new individuals similar to itself.

These male cells which form within its body, mature, and are ejected as living, ciliated things into a web of special make; and two special syringes formed late in life at the tips of the leg-like palpi draw them up and hold them stored until it is time for them to be injected during the mating process into special sacs within the female, where they fuse in some strange way with female cells and start the following generation.

His palpi once emptied of these male cells, of what further use to the species can he be and why should not the carnivorous female promptly eat him up?



THE DADDY-LONG-LEGS OR HARVESTMAN

(*Leiobunum grande*, Weed)*

Who has not watched daddy-long-legs stalk majestically across the floor or up the wall, one long slender leg waving in front of him like the arm of some gesticulating prophet of old? Indeed, the fly or mosquito is hardly more familiar.

Long-leggedness is all relative to size of body, and viewed from this standpoint everyone must agree that the harvestman is the longest-legged creature in the world. If its body were the size of a flamingo its legs would cover over thirty feet of ground. As it has eight legs and each leg is eight times the length of its body it has sixty-four times as much length of leg as of body.

It is a strange, spider creature having only two eyes which look to right and left from a turret-like hump in the middle of its back. Its claws in front have pincers like a crab's. Opposite the first pair of legs are scent glands from which it pours out a fluid which has so bad an odor that it seems to protect it from its foes.

Swung low between its legs, this creature of twilight and shade wanders in search of small insects which it catches and devours as other spiders do. It only lives one season in the North and spins no web and makes no nest. The female lays her eggs deep down in the ground or under stones or in the crevices of the bark of trees.

CHAPTER II
THE INSECT WORLD

STRAIGHT-WINGED INSECTS

(*Orthoptera*)

When children play with pebbles on the beach, they often put the red ones in one group, the white ones in another. It is much the same with men, they try to put the things that are alike together, and in the bewildering multitude of shapes and forms and habits with which the insect specialists have had to deal, they catch at any similarity, and put together in one group a lot of creatures which are only alike in a few particulars.

In the straight-winged order of orthoptera they have put the creatures which have four wings, the front pair being leather-like and smaller than the other pair, which latter fold up like a fan. They are also all equipped with strong biting jaws. Bugs often look like them, but bugs have beaks and never jaws.

It is in this order that are found nearly all of the true song-insects, at least so far as human ears can tell. The grasshoppers, the katydids and crickets are the great music makers of the insect world, although it is true that there is one, perhaps the loudest, shrillest singer of them all which is classified among the bugs, the lyreman, or cicada, one of the species of which is known as the seventeen-year locust.

When we talk of the hum of insects we do not often stop to think that it is quite a different thing in general from their song. Most insects in their flight, providing that their wings move fast enough, make some kind of a noise. The humming of the bee, the buzzing of the house fly and mosquito and the whirring of the chmisy beetle's wings are quite a different thing from the conscious song of the katydid to its mate, or the singing of the cricket on the hearth.

Of course it is impossible for us to be quite sure that there is not a host of insects who have means of making some kind of a noise which is so high up in the scale of noises as to be too faint for us to hear.



THE KING GRASSHOPPER

(*Hippiscus sp.*)

As this young king grasshopper stands looking so inquiringly at one with his varicolored eyes, each of which is composed of hundreds of facets, I cannot help thinking that he represents a creature quite as fascinating and actually more dangerous than the East African monsters of our school geographies.

Perhaps it is perfectly natural, but it does not seem right, that so little emphasis should be laid in our histories upon the terrible struggles of man with his insect enemies. The time will come when we shall recognize this warfare, when we shall realize how much of human happiness lies buried on the battlefields of our struggle against the insect hordes.

The members of one species of this great family can sail for a thousand miles before the wind, and they go in such numbers that they make a cloud 2,000 square miles in extent.

They multiply in such numbers as to baffle all calculation, and every living green thing for thousands of square miles disappears down their throats, leaving the country they infest desolate. The great famine of Egypt, mentioned in the book of Exodus, the grasshopper years of Kansas, which ruined thousands of families on our plains, and more recent devastations in Argentina and South Africa are examples of the tremendous effects which the migratory locusts have had upon the happiness of mankind.

The famines which have followed in their wake have cost the lives of hundreds of thousands of human beings and ruined the lives of millions of others. We have become so accustomed to the idea that the farmer must expect to lose his crop every few years from the devastations of these beasts, that we have not yet realized that it would be profitable to spend vast sums of money in learning how to fight them.

In the evolution of the race, this change will come about, and I feel that no honor is too great to bestow upon the American entomologists who have led the world in its fight with these enemies of the human race. Some day these quiet, resourceful, far-sighted men of knowledge will take their places beside the organizers of industry and the warriors of mankind in the hero worship of our boys and girls.



A BABY GRASSHOPPER

A baby creature, scarcely two weeks since it issued from a grasshopper egg, and yet with two moults behind it—two bright green baby skins cast off!

Imagine looking forward, as this baby creature does, to the day when its internal air sacs shall be filled with air and the pads on its back have grown so long and parchment-like that it can leave its hopping, terrestrial existence and sail away across the fields. Until that time, however, it must be content with its six spiny legs, pushing its way among the blades of grass, tasting everything green and eating what it likes, and hiding from its enemies when moulting time comes round.

A young chick finds itself shut inside the eggshell and must work its way out alone, but the young grasshoppers when they hatch out find themselves—the whole nestful—shut in a hardened case in the ground made by their mother, and it takes half a dozen of them working together to dislodge the lid which shuts them in.

Unlike the beetles and the butterflies, which spring full-fledged from the metamorphosis of a caterpillar, the grasshopper comes to be a winged creature by slow stages, each one a little more advanced than the former, with wings a little better developed. The baby grasshopper is essentially a small, wingless adult, and not a grub or larva in the ordinary sense.



A YOUNG GRASSHOPPER'S SKELETON

When the young grasshopper emerges from the egg, it is very small indeed—a wingless, helpless little creature, all legs and mouth.

It passes through successive ages, or stages, as they are called, each one of which is separated from the other by a moult or casting of its outer shell.

These moults take place at fixed periods, and as the insect finds itself restrained by its firm, inelastic skeleton, a longitudinal rent occurs along the back, and the insect, soft and dangerously helpless, struggles out of the old skin, inclosed in a new but delicate cuticle, which takes some time to harden and color up.

Some people go to great trouble and expense to keep the baby portraits and even the baby shoes, and I cannot help wondering whether a full-grown grasshopper, leading a life in the open air, is ever interested in observing the baby skeletons which show its five stages of terrestrial life.

What an interesting collection could be made of these insects' skeletons, photographed large enough so that we could see and study them!



THE GRASSHOPPER IS GOOD TO EAT

How much mere prejudice controls us! Whence came our aversion to the spotless, winged grasshopper as food and our fondness for the flesh of the wallowing swine? We thoughtlessly pass on to our children the idea that certain things are not good to eat while others are, and so, although the grasshopper has been eaten for centuries by millions of people, even by the ancient Assyrians, and is today one of the candied delicacies of Japan, our American boys, hungry as they always are, have not yet caught them to cook over their campfires.

The spiny legs deter us, perhaps, and yet, when one thinks that we eat up all of the soft-shelled crabs, sardines, reed birds and some other delicacies, that seems to be no argument at all against the pasture fed and fattened locust of our summer time.

In Barbary, according to Miss Margaret Morley, the recipe in common use is to boil them for half an hour, remove the heads and wings and legs, sprinkle with salt and then fry them and season with vinegar to taste.

The Maoris of New Zealand, it is said, prefer them to the pigeons which they raise.

The Bedouins bake them in a heated pit in the ground, much as a woodsman cooks his beans, and later dries them in the sun, then grinds them to powder and makes a kind of gruel, or else he eats them without grinding, simply removing the legs and wings with his fingers as one would the shell of a shrimp.

Some people say they taste like the yolk of a hard-boiled egg, while others compare them in flavor to prawns.

Now, whether all the different kinds are good or not, and which are best to eat are questions which the American boys must find out for themselves—the girls, it is assumed, will take no part in this new field of cookery!

Should any boy desire to dip into this vast subject and become an acridophagus it would take him back in his study to the hieroglyphics on some of the oldest monuments of the human race and be a most fascinating subject.



A GRASSHOPPER'S EAR IS UNDER ITS WING

(*Dissosteira carolina*, Linn.)

If you raise the wing of a full-grown grasshopper and look behind its big fat thigh, you will see a strange hole into its body. This is supposed to be its ear, but what it hears and what it does not hear, who can tell? When on a warm summer day you hear a male grasshopper chirping, for the males alone can sing, you can think that somewhere nearby, perhaps with wings lifted to hear the song better, sits some attentive female whose ears are tuned to catch the plaintiveness of this courting song.



THE GRASSHOPPER'S HEARING ORGAN

(*Dissosteira carolina*, Linn.)

As we grow older and certain sounds which we heard in childhood with the greatest ease become harder for us to hear and are finally lost to us altogether, we begin to appreciate the relative character of sound. Some boys can hear the faintest twitter of the shyest song bird in the tree tops, while others strain their ears in vain to catch its note.

Is it any wonder then that men should be puzzled to know just what the true grasshopper hears? They know there are males of certain species which sing so loud they make our ears ache, but there are others whose noises, if they make any, have never yet been heard by human ears, and yet they all have these ears. They believe, too, that there are certain sounds the grasshopper can hear without the use of these special ears.

So whether this strange organ furnishes a special means by which the males and females find each other or not, and what part it has played throughout the centuries in the development of this marvelous form of living matter, are things that man may be a long time yet in finding out.

In the photograph it lies to the left, a dark kidney-shaped opening with the ear drum membrane at an angle just inside its rim. It has a well-formed tympanum, and nerves and muscles of a complex nature.



THE SHORT-WINGED GREEN LOCUST

(*Dieromorpha viridis*, Scudd.)

Whether this creature has a personality or not may be forever extremely difficult for humans to decide. Its eyes that look like cows' eyes really cast hundreds of images on a special kind of brain, so different from our own that we cannot understand it, and then, besides these great big eyes, it has three others scarcely visible in the picture. Its short-ringed horns are not horns at all, but sense organs of so complicated a nature that we do not yet know certainly whether they are organs of smell or not, and it is supposed that they may be the seat of sense organs that we humans do not have.

The jumping legs of the creature are filled with powerful muscles, which, when they expand, can hurl it through the air and enable it to escape from its enemies. On the inner side of the femur is a musical instrument, a row of hard, bead-like projections, which are very highly developed in the males, but not at all in the females. When one of the veins of the upper wing, which is prominent and has a sharp knife edge, is scraped over these projections, a musical sound is made by the vibration of the whole wing. It would seem to be the case, as with so many of the birds, that only the male can sing, the female being mute.



THE KATYDID

(*Scudderia sp.*)

How marvelously equipped such a creature as this is to live! The great eyes, with many facets, enable it to see by night as well as by day. Its long, slender antennae catch the faintest odor, and probably are sensitive to a host of perfumes that we do not know. In the front of each fore leg, just below the knee, is a dark, sunken area, the ear, with which it can probably hear sounds too faint for our ears, and by moving them can tell from which direction the sounds come. Its long muscular legs enable it to jump a hundred times its length whereas man can scarcely cover three times his length at a leap. Its wings not only enable it to fly well, but in the males are provided with an apparatus near their base for making a musical sound. This sound is made by half opening the long green wings and closing them again rapidly.

The left wing bears a file on its inner surface near the base, while the other, the right wing, has a sharp knife edge on the outside just below the file on the left wing. In closing the wings together the knife edge scrapes across the file and makes at least one of the wings vibrate. While the wings are opening no sound is produced; as they close the characteristic sounds so like the words "Katy did" are made.



THE NARROW-WINGED KATYDID

(*Scudderia sp.*)

If it is any comfort for sleepless ones to know it, the katydid is one of the noisiest creatures of its size in the world. It is only the males which call their "Katy-did, Katy-didn't, she did, she didn't," and they are calling to their mates.

There are people who prefer the noises of the street-ears to the noises of Nature, and who complain that the buzz of insect life on a summer evening makes them feel lonesome and unhappy, but to me half the mystery and charm of tropical life lies in the music of the night insects. Our southern states, with their tropical summers, have a wealth of insect life quite comparable to that of the tropics and vastly more varied than that of northern Europe.

The katydid is the greatest songster of this night choir and is a truly American species—as truly a thing to be proud of as the mocking-bird.

Ladadio Hearn in his "Kusa Hibari" has put us in touch with the soul of a Japanese katydid, and if ours did not have quite so shrill a voice we too might domesticate him, but the idea of caging an American katydid as the Japanese do their tiny-voiced creatures will not, I fear, appeal to the average American citizen.

The male of this species sings sometimes by day as well as by night and has different calls for day and night.

The female lays her eggs in the edges of leaves, thrusting them in between the lower and upper cuticle, and from these hatch out the wingless, long-legged green creatures which are hopping everywhere about the grass in early summer.

They are borne for the summer season only, and with the frosts of winter they all die off. Nature seems to make just as complicated a being whether it is to last a score of minutes or a hundred years—one season or a hundred is all the same to her.

Just why the katydid should want to hear its own song some city people may wonder, but it is evident that he does, for just below each knee, on his foremost legs, is to be found a well-developed ear with a tympanum which probably vibrates much as ours do.



A YOUNG KATYDID

(*Scudderia sp.*)

It is doubtful if there are any animals so largely legs as the young katydid. It cannot fly yet, for the wings upon its back are still too small to carry it through the air, but it can escape from its enemies by jumps which put those of a gazelle or a kangaroo to shame. The muscles in its legs are like our own muscles so far as can be determined, except that they are attached to projections on the inside of a skeleton which encases them all, instead of being attached to the outside of a skeleton which they themselves encase, so when a katydid jumps one cannot see the muscles move as one can those of a horse.



THE CRICKET ON THE HEARTH

(*Gryllus pennsylvanicus*, Burm.)

Through the ages, who knows if not from the times of the cave-dwellers, this friendly visitor of the fireside has rubbed his rough wings together over his head and sung man to sleep. The European form seems quite as domesticated as the cat or dog, leading nowhere a truly wild life, and it may be questioned whether any living creature has become more a part of human life than the cricket on the hearth.

The carrying power of their song is extraordinary; there are species whose strident notes can be heard for a mile, although their little bodies are scarcely more than an inch in length. The males alone are musical, and it is reasonable to suppose, since the females have ears in their fore legs, that they are singing to their mates and not to mankind.

As one listens to their friendly song it is hard to appreciate what fighters they are among themselves, the larger ones even turning cannibals when food is scarce, although a glance at the photograph shows how well equipped they are for battle. Their great black eyes, only shinier black than their coal-black armored necks, their jointed palpi with which they feed themselves, their thick, leathery wings pressed against their sides like a box cover, and their strong, muscular, spiny hind legs, with which they jump a hundred times their own length, do none of them contribute to beauty, though quite in keeping with their armored war-horse appearance.

Two long, flexible cerci protrude like tails behind, but the task of finding out what they are for has been too difficult for man. Perhaps the strange nerve-ending hairs which they bristle with may be sensitive to vibrations of the air, of which we yet know nothing.



THE GROUND CRICKET

Unlike its jet black relative of the hireside, the striped ground cricket forages by day on grassy slopes. It is a more omnivorous scavenger than the hycena, for it eats decaying plants as well as animals.

Its big brown eyes, which cover half its head, see, doubtless, many ways at once, and its long, whiplike antennae, which it waves constantly as it springs through the grass, are believed to scent odors which are inconceivably faint, such as the odor of a blade of grass, a pebble, or a decaying leaf.



THE STONE OR CAMEL CRICKET

(*Ceuthophilus uhleri*, Scudder.)

It would not be a good idea to let the children think that creatures such as this were prowling round the house at night—that is, unless you assure them that it is only a harmless, tawny yellow stone-cricket from the shady woods, where it generally hides under stones and damp, decaying logs.

It seems strangely equipped for its night life, for it has antennæ as long as its body. I cannot help wondering if these help it to jump in the dark. Fabre, the great French entomologist, has tried, as others have, to find out just how the insects use their antennæ and what they are really for. He says at last, "our senses do not represent all the ways by which the animal puts himself in touch with that which is not himself; there are other ways of doing it, perhaps many, not even remotely analogous to those which we ourselves possess."



A MONSTER OF THE UNDERWORLD: THE MOLE CRICKET

(*Gryllotalpa borealis*, Burm.)

The creatures of the air which hide away their eggs that their larvæ may hatch out underneath the ground must reckon with this burrowing beast.

All his life long he tunnels beneath the ground from place to place. When you think of how long it would take you, even with the best tools, to dig a hole in the ground big enough to crawl into, you will get some idea of the power which these two front legs, four-pointed like a spading fork, must have, to enable such a creature to disappear into the ground in a few seconds as he does. These paws, proportionately many times more powerful than bears' paws, are snippers too, for moving back and forth behind them is a sharp-edged instrument which, like the shuttle-bar on a mowing machine, shears off the grass roots which interfere with the mole cricket's progress through the ground. The poor defenseless angleworms must fall an easy prey to such a foe as this!

Upon the first joint of each clumsy front leg, it has a narrow slit-like ear which is but faintly visible in the photograph. Can you imagine a male and female calling to each other through the long and winding passages beneath the ground? Possibly they call to each other only in the night-time, on the rare occasions when they venture out above the ground.

He is a curious creature with eyes that are only rudimentary and a noxious smell that he emits if he is touched. The female excavates a chamber near the surface of the ground and lays her eggs in it to be incubated by the sun's heat, as are most insects' eggs.

For some time it was supposed that both parents devoured their progeny, as many as 90 per cent being eaten up, but a French observer, Monsieur Decaux, has found that the male alone is the cannibal and the mother, far from doing this, watches over them and when they hatch she feeds the little ones with bits of plant roots, earthworms and the larvæ of various insects.

The discovery of one of these mole crickets is really an event. Most people see but one or two in all their lives. In Porto Rico, however, there is a form with longer wings which eats the roots of sugar cane, tobacco and other crops so that the "changa," as it is called, is considered the most serious insect pest in the island.



THE COCKROACH

(*Blattella germanica*, Linn.)

In carboniferous times this was a dominant creature, crawling over the giant club mosses and tree ferns which composed the marshy vegetation of the young world. Today it crawls over the cricket-box and makes its way through every crevice in the kitchen and is, of all the creatures of our houses, the most detested. This is the German cockroach, an importation from Europe, which has spread around the world, and which New Yorkers know as the croton bug.

Its long, spiny legs are built for the scurrying for which it is noted, while its slippery body enables it to squeeze through crevices and holes. It carries its head tucked under its body, as if looking for food, and its whiplike antennae, always in motion, detect at long range the presence of anything edible which can be crammed into its capacious crop.

Housewives may be surprised to learn that a cockroach can live five years, and that it takes a year to develop to maturity from the egg. The female lays her eggs in a horny capsule, like a spectacle case, which she carries about with her until she is ready to deposit it in some suitable place. Later she returns to help her cockroach babies out of their shells.

Like the cricket, cockroaches love the night and shun the daylight. They cannot tolerate cold weather, and though there are 5,000 species they mostly inhabit the tropics, where they are the plague of domestic and ship life. It is said that "ships come into San Francisco from their long half-year voyages around the Horn with the sailors wearing gloves on their hands when asleep in their bunks in a desperate effort to save their fingers from being gnawed off by the hordes of roaches which infest the whole ship." (Kellogg.)

And now a rumor comes to us that the cockroach carries cancer.



A DEMON FLY KILLER: THE PRAYING MANTIS

(*Paratenodera sinensis*, Sauss.)

Its spiny fore legs are built to hold the struggling flies, while, with its sharp jaws, it tears them to pieces much as a hawk or eagle holds its prey with its talons and tears it to shreds with its beak. It is wasteful, too, of its food, as wasteful as the sea lion, or the seal, throwing away the half-consumed carcass before it is finished and pursuing another victim.

So voracious is its appetite and so successful is it as a hunter that Doctor Slingerland of Cornell has introduced the eggs of a species of this mantis from Europe and distributed them among his friends in the Northern states as a beneficial insect.

To kill a praying mantis has been in Mohammedan countries almost as great a crime as it is to kill an albatross at sea, but this was not because it kills the swarms of flies so common in those lands, but rather because of the prayerful attitude made necessary by its fiercely spined and powerful front legs.

Its head is so loosely set on its long neck, or thorax, that it can move it from side to side with the greatest ease. Fabre declares that "the mantis is alone among all the insects in directing its attention to inanimate things. It inspects it examines, it has almost a physiognomy."

Perhaps one is warranted in having a feeling of repugnance toward the mantis, for no other living creature has more horrible habits. There has always been something horrible about the cannibalism of human beings who ate their enemies killed in battle, but this has never seemed so revolting as the practice of the Fijians who killed members of their own tribe in cold blood for purposes of the cannibal feast. The female mantis goes a step farther than this, for she begins eating her lover even before the courtship is over.

There is nothing about the spiders, terrifying though they must appear to their defenseless prey, to indicate that they try consciously to frighten their victims, but the mantis, by spreading out its wings and curling up its abdomen, and raising its talon-tipped, spiny legs, seems to deliberately petrify with terror the cricket or grasshopper which comes within its reach.

THE ORDER OF THE BUGS

(*Hemiptera*)

How blind mankind must seem to the insect world! To look at beetles with their massive jaws and armor-plated bodies, or flies with their gauzy wings, or grasshoppers with their long jumping legs and then class them all as bugs, must seem to them incomprehensible, for to be a bug, an insect must have a sharp pointed beak, whatever else it has. It may or may not have wings, it may have a larval stage or it may not, but if it hasn't a beak and can't suck then it can't be classed as a true bug.

These sucking insects of many shapes, although directly connected with the welfare of the human race, have been, until recently, the least known of the great orders of insects.

To this order belong the chinch bugs, the cause of an estimated loss to the grain growers of twenty million dollars a year; the great Phylloxera, which destroyed the vines on three million acres of French vineyards, and the San José scale, which has spread during the past ten years through every state and territory in the United States and become a menace to the fruit-growing industry.

It is of this order of the insect world that David Sharp remarks " . . . if any thing were to exterminate the enemies of Hemiptera we ourselves would probably be starved in a few months." It does seem strange in face of all these statements of authority that our best friends, the insectivorous birds, are being killed out for lack of forest refuge. We spend millions to fight the pests when once they get the upper hand, but pay little or no attention to the comforts of those tireless workers, the birds, which would keep them down.

I am ashamed of such a fragmentary picture showing of this most important order, and hope someone will follow on with a bug book which will do the subject justice.



THE SQUASH BUG

(*Anasa tristis*, De G.)

The smell of the squash bug is known to every country boy. The odor is emitted through openings in the abdomen from special stink glands, which vary with each species.

The tough external skeleton explains, perhaps, why no spray is strong enough to kill the fully grown insects without also injuring the young squash and pumpkin vines, and why the best method of prevention consists in screening the young plants with a wire screen until they have grown large enough to be immune from attack. If you can find the young insects which are not yet encased in such a hardened shell, spraying with a 10 per cent kerosene emulsion will stop up their breathing pores and asphyxiate them.

The one in the picture is an old specimen, preparing to go into winter quarters under the leaves and wait for the tender squash and pumpkin vines to appear above the ground next spring.

It is surprising how quickly they find these juicy shoots, which they pierce with their sucking beaks and upon which they lay the eggs which in a few days hatch out into a brood of small but voracious squash bugs.



A STRANGE-SHAPED BUG

(*Fuschistus tristigmus*, Say)

A strange-shaped bug walked into the laboratory to have his picture taken, not willing, evidently, that he should be left out of the collection. The handbooks on entomology which I possess seem not to have heard of him. He is just a common, ordinary bug, but he, doubtless, has an interesting life for all our scorning of his acquaintance.



A QUEER, UNWORLDLY MONSTER

(*Corynorcis distinctus*, Dallas)

Could anything be more autediluvian and unworldly than this old, broken-down creature, with six crooked legs, a pair of popping-out eyes, two shining ocelli which look straight up into the air, and a long, stout beak that is partly hidden behind one of the fore legs?

A discussion of how such a fright of a thing came into existence leads one into the realms of evolutionary science, and there we should perhaps find it suggested that it is so ugly and looks so much like the bark of the trees on which it roosts that birds have passed its ancient forefather by, and through the weird workings of that little-understood law of heredity this thorny, spotted creature has waddled along year after year, keeping up in the race for hundreds, perhaps thousands, of centuries. I cannot help exhibiting a little of the showman's pride in it; for, as Barnum would say, this is positively the first real appearance of this century-hidden, hoary monster before the everyday public.

According to the books, this species belongs to a strange family, in which are even more remarkable-looking creatures. They are all, however, characterized by having the femora of their back legs covered with knobs or spines. One of the species is so spiny all over its back that the male makes use of it to carry around the freshly laid eggs of the female.



THE THREAD-LEGGED BEG

(*Emesa longipes*, DeG.)

When you consider how slight a jar of a spider's web will bring its maker running swiftly across the web, it is interesting to be told that this thread-legged beg has the temerity to pick off insects from a spider's web. It is plain that he stands on stilts, and with his powerful tong-like front legs, which end in spiny gripping hands, he must, I imagine, reach out across the web and pick the smaller insects from it, for he is much too small and weak and incredibly fragile to fight a spider on its own web.

Even to someone fairly familiar with the insect world he might easily be mistaken for a mantis, but his short, sharp beak, bent backwards under his chin, puts him among the bugs, where he takes his place beside the assassin bugs.

In one form of thread-legged beg in South America, it is said that the young larva is so long and slender that it curls itself around the mother's body and is carried about with her, papoose-like, on her back.



THE ASSASSIN BUG

(*Pseliopus cinctus*, Fab.)

The human species puts its assassins into striped clothing and it is a rather curious coincidence to find in the insect world an assassin bug in convict's stripes.

I think no visitor to our portrait gallery has seen a more fantastic being than this little bow-legged beast. Until I found out what he was, I could not understand his rank impertinence, for he stalked leisurely about as though afraid of nothing.

I wonder if he has a nasty flavor and advertises the fact by his curious coat.



AN ASSASSINATION

(*Pselliopus cinctus*, Fab.)

I once took a photograph, without realizing it, of some Arab women at the gates of Bagdad, trying to assassinate an old man; and I cannot pass the picture in my album without shuddering.

This photograph affects me in the same way, for it, too, is of a real tragedy and portrays the death of a lady-bird, one of the few friends man has in the whole order of beetles, and that, too, at the hands of a member of the order of bugs, the most destructive order of our insect pests.

It must be admitted that, as things go in Nature, the ladybird has met her just fate, for she has spent her life devouring bugs, the sucking aphids and scale insects of our rose bushes and cherry trees. Somehow the old nursery rhyme of

"Ladybird, ladybird, fly away home,
Your house is on fire, your children will burn."

seems to have endeared to us all this beneficent little beetle which wanders everywhere, cutting short the lives of the sap-sucking insects that deform and injure our plants, and it does not seem to matter that this particular assassin bug preys upon our enemies as well as on our friends. To find this convict striped, spiny bug, with its beak buried to the base in the vitals of the ladybird, and realize that it had first poisoned its victim with poison saliva and was now sucking its blood, rouses a peculiar feeling of hatred towards this hideously ugly creature. Perhaps this is heightened by the contrast between the pretty, trim form of the ladybird and the ugliness of the assassin bug.

I was puzzled to know how a creature so nearly armor-clad could be successfully attacked by a soft-bodied bug of such deliberate habits of movement. How the start is made I do not know, but it is evident that between the base of the wing covers of the ladybird and her neck or thorax is a weak spot in her armor and the assassin thrusts his beak into this crack.

There are members of this assassin bug class which do not hesitate to attack little children in the South, and produce nasty wounds with their poisoned beaks.



THE CICADA

(*Cicada sagii*, Grossb.)

The coming of the swallow is scarcely more significant to Americans of the Southern States than the arrival of the cicada. Its song is the noisiest song in the insect world, and is made in a curious way, by the stretching and relaxing of a corrugated drum-like membrane in the side of the abdomen by means of specially strong muscles. The sound is controlled in rhythmic cadences by means of semicircular discs or covers to the drums, which can be closed and opened at the will of the insect.

This noisy song, which the male alone can sing, he doubtless sings for his mate and not for us, although entomologists are not agreed as to how his partner hears his song, as she seems to have no ears. Although this is the photograph of a two-year cicada the story can be told here of that weirdest of all the insects,—the Rip Van Winkle of the insect world as David Sharp has called it,—the seventeen-year cicada.

From a tiny egg laid by its mother in a twig of your back-yard shrubbery there issues a creature which is as unlike this monster as it can be, with soft, white body and mole-like front legs. It hurries to the ground and disappears beneath its surface sometimes to a depth of a hundred times its length—twenty feet it is said. For seventeen years it digs its way around in the absolute darkness of this underworld, and then, as though by some prearranged agreement, it comes to the surface to join in a marriage revelry of a few brief weeks in summer with its kinsmen of the same generation who disappeared as it did into the darkness seventeen years before.

Most insects live for a few months only, and one, indeed, the male at least, for only fifteen or twenty minutes; but the seventeen-year cicada, the oldest of the insect world, lives as long as a cat or dog. But what a life! Seventeen years of it in the dark and a few weeks in the sunlight. And yet compared to the life of an angle-worm, condemned to the darkness forever, what an interesting career!

When the cicada's shrill song disturbs you, then remember how brief is the pleasure of its existence.



THE AMBUSH BUG

(*Phymata pensylvanica*, Handl.)

We are personally so afraid of a bee's sting that it is hard for us to believe that any mere bug exists which is strong enough to overcome and kill a wasp or honey bee. A look at the thick armor of this creature and its powerful, black pointed beak will go a long way towards convincing one that this may be such a bug; it has a close relative, anyway, which does so. Its front legs have been developed into enormously strong claws with which to catch and hold its prey.

It lurks in flowers and preys on honey-sucking insects, and one can easily imagine the unequal struggle between it and a butterfly, or realize that it might come off victor in a fight with bees or wasps.

There are such romantic scenes and bloodcurdling spectacles to be observed in this world of insects that I cannot understand why there are so few who, having ample time, have not the patience to sit and watch them as Fabre and others less well known have done.

No schoolroom training in observation can compare in value with the outdoor observations of living insects. To look and wait and think and try to understand; what habits of observation, perseverance and reflection these actions cultivate!



A BUG THAT IS ALWAYS WALKING AROUND

(*Brochymena arborea*, Say)

No photograph in the collection illustrates better the marvelous variety of form which abounds in the jungle of our back yards. To the naked eye all the interesting details are invisible and one's hand instinctively brushes the intruder from the table where it has crawled in to take a look at a human being.

The spotted, crablike legs, covered with bristles, the beadlike facet eyes, the oyster shell shaped body, the moving antennae all covered with white scales, the curious trunk or sucking pipe descending from the chin, give to the creature a personality which combines something of the wistful with the curious. And yet this is, as my friend Dr. Schwartz says, "just one of those bugs that is always walking around on our plants and nobody seems to know just what it is doing."



THE TARNISHED PLANT BUG

(*Lygus pratensis*, Linn.)

If you have ever carefully tended young vegetable plants, set them out by hand and watched over them, you will certainly have made the acquaintance of this vicious little creature a quarter of an inch long. At least you will have found where he drove his proboscis and sucked the juices from your tender plant, leaving his irritating fluids behind to distort the tissues of the leaf or bud. He lives in the rubbish which was left littering up the garden and is waiting now for spring to come when he will make his appearance and do whatever damage is necessary for his existence. You cannot spray him with kerosene for he is too agile, skipping away from you in the sunlight, but when his mate lays her eggs, and the young nymphs with wingless bodies crawl about, you can kill them with a dose of kerosene oil emulsion which will close their breathing pores and suffocate them.



THE LANTERN FLY BUG (*Hilicoptera variegata*, Van D.)

This creature belongs to the family of lantern flies and is also related to the little leaf hoppers which one startles from the grass by the hundred in walking across a lawn or meadow.

It is a small, grey bug, not a quarter of an inch long, and quite insignificant when looked at with the naked eye, yet it is quite as strange in form as any of the prehistoric monsters.

Its powerful beak is made up, as are the beaks of all the great order of sucking insects, of four hairlike bodies, four fine, flexible, closely connected rods enclosed in a narrow groove and sharp enough to puncture the skin of a succulent young plant. Not only are these hairlike rods as sharp as needles, but the outer pair are usually barbed so that, once introduced, a hold is easily maintained.

Under the throat is an organ of the nature of a force pump which injects an irritating fluid into the plant. It is supposed that this gives rise to an irritation or congestion of the plant tissue, and thus keeps up a supply of liquid food for the bug at the point operated upon, which, rising by capillary attraction along the grooved rods, finds its way into the stomach of the insect.

That these leaf-sucking insects inject a poison is shown by the way in which the punctured leaves curl up, turn brown and die.

THE BEETLES

(*Coloptera*)

Beetles are distinguished from the other orders of flying creatures by having the first pair of wings changed into shells under which the other pair can be safely folded and laid away. You can usually recognize them when they spread their wings to fly, for they have to raise their wing covers in order to do so. Also they generally have prominent jaws, as they are biting creatures and do not suck the juices of plants and animals as the bugs do.

Beetles are almost everywhere. You cannot turn over a stone or break down a stump or roll over a log without disturbing some of them, and yet perhaps less is known about the lives of beetles than about those of any other of the great orders of insects.

They lead two lives, distinct as two lives can be: one in the form of a grub, the other as a full-grown beetle. To make the transformation, they burrow into the ground or into the wood of trees and but rarely make for themselves silken cocoons such as the butterfly larvæ spin.

They do not lead so aerial an existence as some other orders, but, nevertheless, they are today, perhaps because of their closely fitting outer shells, the predominant order of insects of the present epoch and already there are known the bewildering number of 150,000 species. In North America alone (Mexico excepted) 12,000 species have been described and these have been grouped into eighty families and 2,000 genera. The general public is beginning to realize that not everyone can be an entomologist, and that the quality of brains and training required before one can travel safely among this maze of forms and distinguish between the friends and foes of our agriculture is a quality of the greatest value to mankind.

So far as man is concerned, this gigantic class of creatures is among the most destructive with which we divide life on this planet, and though there are beetle friends which help us by preying on other beetles and by making humus out of leaves and twigs, and by feeding millions of our song birds, yet, as a whole, they represent a restless, armored multitude which perhaps we should be just as well without.



THE JUNE BEETLE

(*Melolontha nitida*, Linn.)

In looking at these two strange beings (this picture and the next), we cannot feel confident that science has gone very far in giving us the reasons for the things we see. They seem no more alike than fish and tortoise or bird and quadruped and yet, before our very eyes, in one brief year, the one turns into the other.

This beetle dies, and leaves behind a hundred little cells, parts of its own body and the body of its mate. These paired cells, the fertilized eggs, grow rapidly into the form of the clumsy, helpless grub which feeds upon the leaves, only to break up and form themselves again into this armor-plated creature of the beetle world.

There must be something as radically wrong with our individualistic ideas of today as there was with the conception of a flat world which prevailed before the time of Columbus. Perhaps if we stop trying to think of these manifestations of beetle life as individuals and think of them as parts of one great organism scattered over the surface of the earth, these striking differences will seem no stranger to us than do the differences in the various stages of a flower's life. The beetle forms inside the grub and the tulip flower bud forms inside the bulb. If tulip flowers could fly, we should then have the strange spectacle of the opening of the scale-covered tulip bulb and the coming forth of the gorgeous colored flower which sailed away to shed its seeds in someone else's garden. I think that this is the way we must look at it if we would get a clear idea of this strangest of phenomena,—metamorphosis.



THE JUNE BEETLE LARVA

(*Allochlaia nitida*, Linn.)

How is it possible that this fat creature, with eye-like breathing pores along its body, whose legs are worthless, and which is so helpless that it has to turn over on its back to wriggle over the ground, can change into the emerald-green June beetle which wings its way like an aerodrome across the meadow? This is the apparent miracle of metamorphosis which it has well-nigh baffled the intellect of man to explain.

Though the reasons for it are still unknown, modern research has shown us how this incredible change has taken place.

When this creature, which has grown a hundred times its size since it was born, has reached the age for this great change, it doubtless feels the impending transformation coming, and instinct tells it to crawl away into some protected nook or corner and pupate underneath the protection of a silken coverlid of its own spinning.

The change begins: each organ goes to pieces, disintegrates, becomes a mass of disconnected cells, so that the body filled with these, becomes, as it were, a bag of mush. This mushy fluid has been likened by entomologists to the disintegrated tissues which inflammation causes in our own bodies. If, then, you should slit it open at this stage, you would find no alimentary canal, no salivary glands, no muscles, simply a thick fluid, with here and there a thicker lump, that is attached at certain places to the inside of the sac wall. These lumps are formed of groups of active cells which were not disintegrated in the general breakdown of the muscle tissue, and these form the nuclei around which the new creature is to be built. These groups of cells grow rapidly, feeding on the fluid mass of broken-down tissue much as a young chick inside the egg feeds on the yolk, and builds up the whole complicated structure of the winged beetle, which seems to have no possible relation to the white grub out of whose body it was made.

It is as though the insect hatched twice, first from the almost microscopic egg its mother laid and from which it emerged as a tiny little creature in the image of this grub, growing and manufacturing from the leaves it eats enough nitrogenous matter so that when it emerges again from the yolk-like substance of its cocoon it will be a full-grown beetle, for it must be remembered that once made the beetle never grows.

This wonderful process is the same which is gone through by every flying insect that has a grub or caterpillar stage.



ONE OF THE JUNE BUGS OR MAY BEETLES

(*Laehnosteria quereus*, Knoch)

OF the wild creatures of our back yards, none is better known than this hard-shelled buzzing creature, which whirs into the circle of light around your lamp and commits suicide, if you will let it, by flying into the flame.

It is one of the so-called June bugs, or May beetles, which every boy and girl knows, and is not the June beetle of which the larva was shown previously.

Its hard, pitted skeleton covers it completely, and it is most interesting to watch it open its wing covers with great deliberation, unfold the wings which are carefully stowed away beneath them, and holding its wing covers elevated so they will not interfere, start the transparent wings into motion and fly away with the whirr of a miniature aerodrome. Indeed, it was this resemblance which caused the members of the Aerial Experiment Association to name one of their first aerodromes after it, and the first trophy ever given for an aerodrome flight was won by Curby's "June Bug."

This creature's first life is spent beneath the sod of your lawn, where it curls up around the roots of the grasses and clover and other plants which you do not want it to eat, and the first year of its subterranean existence it is the white grub, with the brown head, which everybody knows. At the end of the second summer of its life it changes to a soft brown beetle, which throughout the winter is hardening its shell preparatory to coming out in late spring as a winged creature to feed upon the leaves of trees. The beetle which is walking toward you lives upon the oak.



ONE OF THE TWIG-PRUNERS

(*Elaphidion atomaricum*, Deu.)

The long-horned beetles, as they are called, are remarkable for the length of their antennae and for their eyes of many facets, which almost encircle the antennae at their base. They have, like other beetles, two lives, so to speak, and their grub-life is spent inside some twig or branch, burrowing and living on the juices which their stomachs extract from the sawdust made by their jaws. They kill the twig they burrow in, so that the wind blows it to the ground, and they go through their transformation on the ground. The story is told of a long-horned beetle, belonging to a different species, that lived for years in its larval stage, burrowing patiently into the dry wood of a boot-last or shoe-stretcher, trying vainly to get enough nourishment out of it to make a beetle of itself.



THE PREDACEOUS GROUND BEETLE

(*Chlaenius astivus*, Say)

This creature almost anyone will recognize as a beetle. It is built for running, and its jaws are made for fighting. You have only to catch one and watch it open and shut its jaws to realize that it would bite you if it could. But for all that it is a great friend, for it is what the entomologists call predaceous, and at night or at twilight it hunts everywhere for the larvæ of insects which attack the plants we live on. In its larval state, in which it looks for all the world like a centipede without the "ped," it burrows in the ground in search of the plant destroyers, which think to escape notice by getting under the cover of the soil. It is by nature, then, opposed to the vegetarians, the herbivores, and hunts them wherever they are likely to occur.

When you see a black or dark-brown beetle running swiftly from under some stone or log which you have just turned over and which makes faces with its jaws as though it would chew your fingers when you pick it up, you can be quite sure in eight times out of ten that it is one of these carabidæ or predaceous ground beetles, and if you let it drop from your fingers you may be saving the life of a friend, because some day it may eat the worm which, lying close to some pet flower of yours, had planned to eat it off beneath the ground.

It is one of the hardest things in all the world to understand how balanced is this scale of foe and friend. One year there is a wiping out of our insect friends through frost or floods or microscopic disease, and, freed thus from the check which kept their numbers down, the foes to our plants can multiply to such an extent that nothing we can do will save our crops from total failure. Next year, perhaps, the parasitic beetle, finding such a wealth of food to live upon, increases and holds well in check the pest which last year ate up all our plants. Each wave of insect pests could be explained, no doubt, if all the facts were known, and nowadays no one who knows what modern agriculture means will fail to reckon on the risks from losses caused by these pests.



THE CLOVER LEAF WEEVIL

(*Phylonomus punctatus*, Fab.)

Could anyone suspect this modest antediluvian creature coming toward you out of the gloom, hanging his head, as it were, of any designs against anyone? He has them, however, and if you will examine your clover leaves in June you will find them scalloped with irregular patches eaten out of them. It would be easy for him to prove an alibi, since it is his other self, his larval existence, which does it and does it at night, too, coming up out of the base of the clover plant where it hides during the daytime. Occasionally in August he can himself be seen feeding on the clover leaves. In his two existences he manages to do a good deal of damage to the clover fields of the farmer, necessitating the plowing up of old fields when he becomes too numerous.

But let us look at the company he keeps. He is in the same class with the alfalfa weevil which came over from central Asia recently and spread through the alfalfa fields of Utah, threatened the alfalfa growers with ruin and set the Entomological Bureau of the Government out on the trail of some parasite, some enemy of his which they were sure must have held him in check in his native land. If you could have heard the conferences which were held and the drastic measures relating to traffic which were proposed you would realize that it is no child's play to fight the Asiatic relative of this modest-looking creature.

But it has in this country worse relatives even than the alfalfa weevil. It is related to the cotton boll weevil, which has brought thousands of families in the South to the point of starvation and drawn millions of dollars from the federal treasury of the country in an effort to fight it and lessen its ravages throughout the cotton belt of the Southern states. Thousands of lectures are being given to tell the farmers what its habits are and how it can be prevented.

It has other more distant relatives which live in the forest trees and make wonderful burrows which look like hieroglyphics. As that remarkable entomologist, Hubbard, discovered, they are cultivators of microscopic mushrooms as wonderful as those of the mushroom nests of the Atta ants or the termites of the tropics. Incidentally, and this is the important point, they kill the trees, fires start in the dead trees, and it is estimated roughly by Dr. Hopkins, the Forest Entomologist, that they destroy over a hundred million dollars' worth of timber annually or, at least, are one of the principal causes of this gigantic loss.



THE SPOTTED VINE CHAPER IN FLIGHT

(*Pelidnota punctata*, Linn.)

How often one sees lame butterflies limping along in their flight, because their wings have been injured by the rose bushes or by striking against the pine needles or have been nipped by some hungry bird. The beetles, when they alight, carefully fold up each delicate wing, close down over them polished covers as hard almost as steel and fitting as closely as the engine covers of an automobile. Whether these wing covers act as acropplanes or as rudders for the beetles when in flight is as yet unknown. There are strange, almost microscopic, markings over the surface of these wing covers and in some species there are glands inside them which secrete a fluid which reaches the surface through minute pores, but the use of this fluid we are still unable to discover.

It seems likely that the discovery, if we may so term it, of these wing-protecting shells, has been of tremendous advantage to the class of organisms where it first appeared. At any rate, among the insects the order of beetles (Coleoptera) is the predominating one of this epoch.

When one thinks that man has just begun to fly, whereas the beetles flew perhaps a hundred million years or more ago, these wings and their most perfect chitinized wing covers are deserving of our wonder and of our admiration, too.

This light, yellowish brown and black spotted beetle prefers the leaves of the grape vine to those of any other plant, and in its grub life it burrows in rotten wood, especially in decaying roots of apple, pear and hickory trees.



ONE OF THE BLISTER OR CANTHARIDES BEETLES

(*Epicauta marginata*, Fab.)

I can never look at this beetle without a feeling of emotion, for in a desperate struggle to escape from the fate predestined by a bald-headed ancestry, I once submitted to the treatment of a noted hair-specialist and allowed him to apply to my scalp the acrid oil of the blister beetle. And the melancholy part is that it did no good.

Fabre has described how the female European blister beetle lays a thousand or two eggs in the ground in close proximity to the nest of the solitary bee whose eggs form the only food of the blister beetle larva. From the beetles' eggs hatch out strong-jawed, six-legged spiny larvae called *triangulins*. Although born close to the nests of the bees, which in this case are in the ground, these *triangulins* do not enter the nests, but attempt to attach themselves to any hairy object which may come near, much as burrs attach themselves to the wool of sheep.

A certain number of them by merest chance, apparently, succeed in getting onto the bodies of the bees and are carried by them to their nests. As the male bees, in this particular species, appear a month before the female, it seems probable, Fabre thinks, that the vast majority of *triangulins* attach themselves at first to the males and later, when a chance occurs, discovering their mistake, transfer themselves onto the females and so get carried to the underground cells, and are present when the mother bee fills the cell with honey and then lays an egg which floats around on top.

There is something ghastly in the picture of the mother bee laying her single egg, with the blister beetle larva on her back waiting till the last moment in order to slip unexpectedly from her body to the egg, on which it floats in the honey as on a raft. When the unsuspecting bee has closed in her unborn child, the hideous monster which is perched on top of it eats it up. This takes eight days, and when it has eaten up its raft, the *triangulin* moults and becomes, as it were, an aquatic creature with breathing pores so placed that it can float on the honey, and with a stomach so changed that it can be nourished by it. In about eight more days the honey is consumed and the final moult takes place.



A HIPPOPOTAMUS AMONG THE INSECTS

(*Prionus sp.*)

Why beetles as large as elephants never came into existence on this planet, or have they developed on some other of the countless worlds of space, are questions too hard for us to answer.

This wonderfully protected creature with long horn-like antennae and hippopotamus-like jaws is a relative of the largest of the beetles, those which live in the great forests along the Amazon or in the tropical jungles of the Fijian Islands, and whose grubs are good to eat. Some years ago, in a clearing in a New Zealand forest, a Maori dug out several handfuls of the white wriggling creatures for me and a settler's wife fried them with butter over the fire in her kitchen stove, and I can testify that they were as crisp and delicate as fried oysters. Like the other giant creatures of the forest, these Prionids, as they are called, are growing rarer with the destruction of the forest trees on which they live, and some day their skeletons in museum cases may be all that remain of them.

These long-horned wood borers do not themselves bore into the wood; how could they with their long antennae? It is their other selves, their grubs, that live deep in the solid heart wood of some oak or hickory tree. There is something strange in their solitary hermit-cell life. Think of living for two years or more in a narrow hole which shuts you in on all sides and having for a steady diet the walls of your cell to feed upon. Prisoners have burrowed under prison stockades to escape, but these larva deliberately leave the outer, softer sawwood in which they hatch, and start for the interior of the trunk, packing behind them with sawdust and excrement the tunnel which they eat out.

The fact that the grubs of some species of these Prionids choose to live in the roots and trunks of trees which we choose to cultivate makes them our enemies, and every good orchardist knows that the only way to stop them is to dig them out or stab them with a wire run through them in their burrows.

This fellow bit savagely at a pencil, and when he finally caught hold, I lifted him up as one does a bull dog, and he hung there almost as long.



ONE OF THE LONGHORN BEETLES

(*Orthosoma brunneum*, Forst.)

At first glance this longhorn might pass for a Prionus, but its antennae are very different and the shape of its broad collar or prothorax is not the same. To a trained eye they could never be confused, which cannot be said of all beetles! In fact there is perhaps no group of living organisms which scientific men have more difficulty in classifying than the beetles, unless it be the lichens on the stones and trees. Their differences are so minute and their grub lives so obscure that they have sometimes to be bred in order to determine their relationships.



AN AMERICAN SCARAB

(*Copris carolina*, Linn.)

I cannot help wondering what one of the priests of ancient Egypt would think of this picture of a New World relative of his sacred scarab. To me there has always been something strangely beautiful in the veneration which the great Egyptian race has shown for thousands of years towards the humble, industrious beetle which spends its life in the droppings from Egyptian cattle.

Go to Gizeh, and look at the images of the scarab beetle carved from the rarest stones the lapidary could find, mounted in the loveliest gold settings he could fashion, and reflect that the ladies of the court wore these dung beetles around their necks and were buried with them on.

Was this veneration of the scarab as old, almost, as the race, and did it come with the race into its civilization, or did it arise as the whim of some great Pharaoh?

It is said that somewhere with this veneration there was included a symbolism. The living scarab is a tumble bug, the female makes a ball of dung much larger than herself and either with her shovelled pointed nose, or else standing on her head with her hind legs on the ball, she either pushes or pulls the ball along until she finds some suitable place in which to dig a hole and bury this ball so that later she may consume it at her ease. It has been suggested that some Egyptian astronomer, watching the rolling ball, may have suggested an analogy with the movement of the heavenly bodies with the traveling of the moon around the earth. For we must not forget that in those days the wonder of the heavens was fresh and new and the idea of world-balls of matter was a subject of intense intellectual excitement.

But there was yet another reason for the veneration of the Egyptians. The fact that these beetles suddenly disappeared into the ground and that later they appeared again was taken as proof of a future life.

It seems to me that we can take a lesson from the ancient Egyptians and see in things as insignificant as the beetles of manure the greatness of the world of change and really feel the wonder of it all.

It is a pity, but I have to admit that this American species is not a "tumble bug," but contents herself with digging holes, filling them with manure and laying her eggs on it, instead of rolling a well-made ball to some special place as her Egyptian cousin does.

The mother scarab, unlike every other beetle, lives to see her children grow up, indeed she produces two families of little scarabs.



THE TWELVE-SPOTTED CUCUMBER BEETLE

(*Diabrotica duodecim punctata*, Oliv.)

There are few of our insect enemies which do their destructive work more rapidly than do the cucumber beetles. Every child in the South who has left his cucumber hills unsecured knows this, for he has found them some morning literally eaten up over night by the spotted or striped yellow-green cucumber beetles.

The puzzle is, where do they come from so suddenly? It is as though they were waiting for cucumbers to come up, and this is pretty nearly true, for the adults have wintered in the leaves and rubbish of the garden and are all ready to concentrate on the plantlets in the spring.

Unlike so many pests, which are content to trouble us only during a part of their existence, this twelve-spotted cucumber beetle is our enemy all its life long, for it spends its larval life eating the roots of corn and other field crops.

It is a wide-spread pest, with many relatives quite as bad as it is, and not only does it eat up the young and defenseless cucumbers and the roots of the corn, but it is the carrier of a germ infection of a serious nature to the cucumber. My friend, Dr. Erwin F. Smith, informs me that its kind has infested large areas in the South with this disease and dashed the hopes of thousands of boys who, instead of feasting on the melons they have planted with such care, must stand helplessly by and watch the leaves and flowers wilt and the vines decay. It must be remembered that this is a winged carrier of disease and anyone who still fails to understand the speed of travel of an epidemic had better watch the cucumber beetles busy spreading this destructive germ disease. A single beetle-feeding on a diseased leaf can carry on its jaws enough germs to infect every melon or cucumber plant in a neighboring field, and that, too, in a single day.



ONE OF THE SAWYERS

(*Monohammus titilator*, Fab.)

While standing on a street corner waiting for a street-car one day last summer my attention was attracted to this beautiful squirrel-gray creature at my feet. It was so evidently ill that, as I picked it up, I began to examine it to find out what was the matter. Clustered on its neck, out of reach of its feet or jaws were whitish bodies which evidently did not belong to its external skeleton but were probably the eggs of what I took to be some parasite whose growth within the body of the beast had brought about its pitiable condition. These are just visible between the creature's "horns" in the photograph. It was, in other words, a sick insect.

It is because biologists see these parasites so plainly all down through the scale of living things that they are so sceptical of accepting any other cause of human disease until all possibility has been excluded of its being caused by some parasite or other, too small to be seen even by using the best microscopes.

My sympathy for this long-horned beetle would be keener did I not read that its larval self is spent inside the wood of the pines and firs of our forests, doing great damage to them.

When one is puzzled to know why any living thing should be burdened by such antler-like antennae, let him remember the peacock's tail and the bird of paradise's plumage and be content to know that the laws of evolution are not yet fully known, and that, given time and growth, almost any form can be evolved.

TWO WINGED INSECTS

(*Diptera*)

Years ago in Berlin, my German landlady called me in as an expert to decide a controversy between her children and herself as to whether a frog had four legs or six. It seemed strange to me then that a grown-up woman should not know the number of a frog's legs. Yet there will be many who read these pages who do not know how many wings a fly has. And flies are much more important than frogs.

In fact the mosquito and the house fly, both included in the order of the flies, probably cause more deaths and are more dangerous to human life than any other creatures in the world.

These portraits are of a few only of the vast myriads of forms of two-winged insects which haunt the world. Were I to photograph just one individual of each different species which inhabit the globe, I would have to spend a lifetime doing it, and when it was finished it would make five hundred volumes about the size of this one.

There should never be the slightest difficulty in telling a fly from other insects for there are no other two-winged forms.

Although the flies are sucking insects, their beaks lap up liquid food and are not at all like the beaks of the bugs. In the great majority of flies, the beaks resemble a trunk with curious fleshy folds or lips. It is true some species, like the mosquito, have long, sharp-pointed stylets which, working up and down, puncture the skin of plants and animals.

The larval forms of many flies are maggots, those squirming, often almost headless creatures that abound in rotting carcasses or decaying matter of all kinds, and this is one of the reasons why less is known about the flies than about some others of the insect world which have selected less revolting birthplaces.

Of course, in such a gigantic family no general rules apply, and still, a maggot, whether in an orange or a dead horse, is most likely to be the larva of a diptera or two-winged insect.



THE CRANE FLY

(*Limnobia* sp.)

Every lover of the autumn woods must have noticed on some still October day, in the little clearings in the woods, these awkward, long-legged flies which, frightened by the approach of a human being, gather their ungainly hind legs together behind and their forelegs in front of them and slowly and laboriously flutter upward into the sunlight. They are well-named, these creatures, "the crane flies," for their legs are as long and apparently much more useless than those of the crane. In fact some entomologists have expressed themselves as wondering why they have such legs at all for they are so fragile that they break at the slightest touch.

They belong to a family with a thousand species in it and perhaps the most peculiar thing about them is that some forms of the family live and fly about when there is snow on the ground. This is a very rare exception in the insect world.



AN INSECT HAWK: ONE OF THE ROBBER FLIES

(*Erao astans*, Linn.)

Her strong, spiny legs, her powerful body filled with strong wing muscles, and her sharp beak, make this robber fly one of the most dreaded enemies of the other winged insects for, like the hawk among the birds, she pounces on them in their flight and tears them to pieces with her beak, sucking the blood from them as she carries them in the air. A single one of these insect hawks, or robber flies, as they are called, has been known to catch and devour as many as eight moths in twenty minutes.

These robber flies are fearless creatures, for they attack and kill bumble bees and wasps and even, it is said, that monster demon, the dragon-fly. Tiger beetles, too, are said to fall a prey to this insect hawk.

Its other or larval self is also predaceous, boring into beetle larvae in the ground.



A ROBBER FLY

(*Dasylis grossa*, Fab.)

When I learned that this powerfully winged, hairy fly tears beetles' wings from off their backs with that wedge-shaped beak of hers, and sucks the blood of bees and wasps, it gave me a different idea of the great fly family, which hitherto I had thought was made up of defenseless creatures like the house fly.

Of all the insects we have photographed, few have seemed to be more thoroughly fearless or more ugly than the robber flies. I have never seen one capture and devour a creature larger than itself, but it must be as thrilling an adventure as to see a dragon-fly devour a gnat, or a spider pounce upon the prey entangled in its net.



ANOTHER VIEW OF THE ROBBER FLY

(*Dasypollis grossa*, Fab.)

At first it looked as though this creature had two heads, one at each end of its body, but the great facet eyes, of which only one can be seen in the photograph, make it clear which is the head and which the egg-laying end of this strange, fearless robber of the air.

Just why it is called a robber fly when it really doesn't rob at all, but kills, is a mystery to me.



ONE OF THE LARGE ROBBER FLIES

(*Mallophora sp.*)

This robber fly is not so quick nor so savage as many of its family. It waits for some slow moving insect to come along then pounces upon it.

It probably breeds in decaying wood, although this is not certainly known, and it is very difficult to breed them artificially.

To the economic entomologist the ability to breed these monsters in captivity is one of the most important factors in studying out their life histories, as they are called, their various stages, the plants they feed on, their habits of moulting, of breeding and of feeding their young.



ONE OF THE WORST OF THE ROBBER FLIES

(*Deromyia*)

This creature is very savage and pounces upon even large sized insects, paralyzing them instantly by a sting of its poisoned beak.



THE CULEX MOSQUITO

(*Culex sp.*)

The flat white wings of this long-legged creature, vibrating rapidly in the air, make what everyone will agree is the most annoying sound in the world. They make the mosquitos' hum. The cigar-shaped abdomen is striped like a convict's jacket. As a boy there was to me a peculiar fascination in watching that abdomen pinken and turn red along its sides as it filled with blood sucked from my hand.

The large eyes compose almost the entire head of a mosquito and in some species they are of an emerald green hue. Straight out in front, close together, curved downward at the tip, are two antennae furnished with delicate hairs arranged like a bottle-brush. With these the creature hears the love hum of its mate and probably scents also the neighborhood of any warm-blooded animal.

Were this a male, instead of a female, these hairs would be much longer and there would be many more of them—they are the smelling organs of the creature and the hearing organs, too, being set into vibration by sound waves of a certain rate. It is important to remember this, for only the females are bloodthirsty. The long, slender proboscis projecting from the head, downward, is furnished with sharp, piercing stylets which, by working up and down, cut their way through the skin. Ordinarily the males and females both are content with sap of plants and fruits as their food, and blood does not seem to be a necessary part of their diet. It is curious that what is supposed to be merely an acquired habit of the female only, of an insignificant little fly, should mean so much to mankind.

Just why a mosquito bite is poisonous is still a matter of question—the suggestion has been made that since both male and female really live on plants, the fluid which the female injects is for the purpose of preventing the plant juice from coagulating during the process of sucking and merely happens to be irritating to warm-blooded animals.

There are three hundred different species of these creatures already described and fortunately this one, a species of *Culex*, is not responsible, so far as known, for the carrying of any human disease.



ONE OF THE HARMLESS ANOPHELES MOSQUITOS

(*Anopheles punctipennis*, Say)

The malarial mosquito, so called, has spotted wings, but otherwise it looks quite like this harmless form from Maryland. This whole tribe of Anopheles differs from the Culex in the length of its mouth feelers, which project from the base of the proboscis and appear in the photograph almost as long as the proboscis itself, whereas in a photograph of the Culex it would appear so short as to seem merely a thickening of the base of the proboscis.

The wildest fancy of the Arabian story-teller is lacking in imagination compared with the story which the facts of modern science have woven about these tiny representatives of the fly family.

Who could imagine that just because the lady mosquitos, tiring of their usual meal of ripe bananas and plant juices, acquired the habit of sucking blood, vast regions would be devastated and beings millions of times their size would die by thousands. And this, too, not through any real fault of the tiny creatures themselves, but just because some of the persons whose blood they sucked had microscopic wiggling things living in their blood corpuscles, which crawled into the soft throat glands of the mosquito and waited there for a chance to get out into the blood channels of some other human beings.

When one pictures the grief of desolated homes, death-bed agonies of tossing fever patients, the quarantined vessels at anchor in tropical harbors, yellow flagged, with crews dead or dying, the streets of deserted houses from which all life has gone forever through yellow fever and malaria, there is something ghastly in the picture of the winged lady mosquitos flitting airily from pale-faced patients to ruddy-checked happy people, unwitting carriers of death.

No conquest of science seems more wonderful in its simplicity and more remarkable in its importance than the discovery that the glands at the base of the mosquito's bill can become diseased and harbor a microscopic parasite, and transform this merely buzzing, annoying insect into one of the most dangerous creatures alive. To Dr. L. O. Howard, the pioneer of economic entomology, is due the great credit for first showing how this creature can be killed by the use of kerosene on the stagnant waters where the females lay their eggs.



ONE OF THE BEE FLIES

(*Spartanopolis fulvus*, Wied.)

No butterfly or any other creature of the air could be more beautiful than this dream of early summer. The black velvet body, into which the sunlight sank and disappeared, the fringe of golden hairs along its sides, the steel gray, myriad-facet eyes of which its head was made, and the delicately formed wings, so thin that the light in passing through them was refracted into rainbow tints, made it seem to me more beautiful than almost any of those gorgeous forms of insect life which sometimes fill the clearings in Brazilian forests.

It does seem strange that such a thing as this should live its other life a parasitic grub within the larva of some caterpillar, or in the egg-case of some grasshopper; but so it seems to do. It spends its childhood as a disease, and its mating days as a dainty fly among the nectar-bearing flowers.



ANOTHER OF THE BEE FLIES

(*Spogostylum simson*, Fab.)

Where you see the carpenter bee you always see these bee flies waiting for the bee to go away from home. When the mother bee is out the female fly goes into the cell of the bee and lays her egg, and when her larva hatches out it eats up the bee's larva.



LARGE SYRPHID FLY

(*Mesia virginensis*, Dru.)

This is a very bright-colored syrphid fly often seen soaring in shadowy places, but what he is doing we do not know. He stays poised in the air and is one of the most beautiful flies we have.

The larvae of some of the smaller syrphid flies feed upon the larvae of other insects, aphids in particular; but the larva of this one has never been seen, at least it has never been recognized.



NOT A HOUSE FLY

(*Archytas aterrima*, Des.)

This portrait of one of the many species of fly, not a house fly, however, is as different as it is possible to be from the maggot from which it grew. The eggs of the mother fly, deposited in some decaying animal matter, hatched in a few days, and out of these eggs come maggots with rudimentary legs and looking like beasts from another world entirely. In a few days more they reach the limit of their growth, and stop, the tissues break down to a mush and out of this mush-like substance are formed flies with wings and sucking, trunklike mouths just like their mothers. The maggots have no sexual organs, and yet, out of the creamy mass of cells, the sexual organs of the flies are formed as though directed by a force as certain in its effects as the law of gravitation.

We have been so intent on killing the fly and so afraid of it as the great carrier of human diseases that we have lost sight of one phase of its character, so to speak. Think of having under our eyes animals like these dipteras from which you can breed a new generation in twelve days! And would it not be strange if, from studying the fly, we should learn the meaning of heredity and sexuality, for this is one of the places where the scientists of the day are at work on the problem of inheritance, that problem which, when elucidated, is likely to make more changes in the world of humankind than almost anything which has so far been discovered. The bearing of the fly on the welfare of the world is one of the most spectacular developments of modern times and a tribute to the value of knowing the minutest details of the world in which we live.



THE HORSE FLY

(*Tabanus atratus*, Forst.)

The head of the horse fly appears to be all eyes, and it is no wonder that we can so seldom take it by surprise.

Below the oblong, compound eyes are the sharp mouthparts, which in the female are provided with lancets, which enable her to puncture the skin of warm-blooded animals and suck their blood. It is curious that the female should have such habits, while the males are content to lap up nectar from the flowers.

This jet black, loud-buzzing creature flew into my laboratory and made so much noise that I was forced to kill her. This photograph of her is nine times her real diameter.

She belongs to a large and important family of flies, whose females make the lives of men and animals miserable in many parts of the world by their bites, which form most annoying wounds.



A GREEN HEADED HORSE FLY

(*Tabanus punctifer*, O. S.)

There are nearly two hundred species of horse flies in North America, and this creature represents one of the commonest forms. It doubtless hatched out somewhere on the edge of the brook which flows through my place in Maryland, and its larval self fed upon other insect larvæ or on the snails and slugs it found itself among.

The heads of iridescent green and copper and purple across its enormous eyes made it a beautiful creature to look upon.

We never used to think the bite of flies was anything worse than annoying, but recently, since we have discovered the danger of letting the germs of disease into the blood streams of our bodies, we have come to see the ghastly possibilities which lie in the piercing mouthparts of these flies. They suck the blood of animals whose blood streams may be swarming with disease germs, and then fly directly to our horses and puncture our skins with a beak covered with these germs which slip off into our veins.

Until we know that the diseases of the birds, and field mice, the coons and possums, and all other warm-blooded beasts of a locality are harmless to us, or that it is impossible to transmit them to human beings, it is best to look upon these blood-sucking creatures as winged hypodermic syringes laden with disease.

It has been suggested that the horse flies carry anthrax, and their bites sometimes cause malignant pustules. They are also under suspicion as carriers of infantile paralysis.

FEATHERED INSECTS

(*Lepidoptera*)

These are peculiarly the feathered fliers of the insect world, for their wings and their bodies, too, are covered with most remarkable one-celled feathers or scales of gorgeous colors which make of some of them the most brilliant of all living things.

Just what these scales are for is not entirely clear, and will not be, perhaps, until we understand the purpose of the gorgeous coloring itself. There is a theory that these scales help to grip the air in flying.

It is a curious coincidence that one of these gorgeously colored creatures should furnish mankind with the material for his own most gaily colored raiment. The silkworm is one of the very few domesticated insects, so to speak, of all the hundreds of thousands of insect species in existence, and a hundred millions of dollars is paid every year for the delicate silk threads unraveled from countless millions of cocoons which the silkworm larvæ have laboriously fashioned around themselves.

To many people, moths are known by what they leave behind—holes in the winter woollens; and butterflies are to them, somehow, things of the sunlight and the summertime. It is worth while to know that these great families of butterflies and moths are not by any means divided equally, that for every family of butterflies there are at least nine of the moths and that the butterflies form but a small proportion of the gaily colored insects of the fields.

Perhaps it makes but little difference to the public, who call them all alike, but it is as easy to tell a butterfly from a moth as it is to tell a lizard from a snake, for all the butterflies have club-shaped feelers, or antennæ, whereas the moths do not, and any child of six can learn to tell the two apart.

No butterfly or moth in its winged state can harm us or our plants. It has no jaws, but keeps itself alive by sucking nectar from the flowers or juices from the fruits or other parts. Its other self, its larva, however, can cause no end of damage. One inconspicuous, brownish form, the codling-moth, no larger than my thumb nail, costs apple growers about ten million dollars every year, while the cabbage moth, the clothes moth, the cutworm and the dreaded gipsy-moth are only a few examples of a gigantic army of voracious larvæ against which man has been struggling ever since he first began to plant seeds in the ground or set out trees for fruit.



LARVA OF THE SWALLOW-TAIL BUTTERFLY OF THE SPICE-BUSH

(*Papilio troilus*, Linn.)

Is this, I wonder, an insect make-believe, a caterpillar mask, as it were, to frighten away enemies? The black and white eye-spots are not real eyes, but to a bird they doubtless seem so. Its real eyes are inconspicuous points at each side of the head, too small to appear in the photograph.

Few of us stop to think, as the beautiful swallow-tail butterfly, gorgoons in its black and yellow painted wings, flits by us, that it is made of sassafras and spice-bush leaves gathered together and ground up. This monster is a leaf-eating creature, its purpose being the accumulation of food material out of which is made inside of it the gorgoons swallow-tail butterfly. It feeds on sassafras and spice-bush leaves, and when the time arrives makes a nest for itself by fastening the edges of a leaf together. In this nest it passes the winter. When spring comes it breaks open the gray shell of the chrysalis, unfolds a pair of black and gold wings with long tails to them, and flies away in the sunshine in search of flowers and a mate. It is then no more like this monster than an eagle is like a hippopotamus, yet after it has flown about, sucking nectar through its long beak, it mates and lays a mass of eggs, out of which hatch again these strange, weird beings.



FORE PART OF A BROWN BUTTERFLY

(*Argynnis cybele*, Fab.)

It is hard to realize that this is the portrait of the head and fore part of a beautiful brown butterfly.

Its head is almost all taken up with the gigantic eyes, which are composed of thousands of tiny facets. The long, trunklike mouth with which it sucks the nectar from the flowers is coiled up like a watch spring. Like shingles on a roof, the scales are fastened in tiers over the broad surface of the wings stretched over the stiff ribs or framework.

The white spots are made by hundreds of white scales and the brown blotches by brown scales, and what these scales are for nobody seems to know. Perhaps they help to grip the wind, for they have running lengthwise of them deep and parallel corrugations so small and fine that were a single scale as large as a lady's opened fan these corrugations would represent its sticks.

The caterpillar from which this splendid creature came is black, with branching spines, and feeds at night on violets and other plants.

The graceful beauty of the butterfly, its seemingly happy existence, its life among the flowers, where it sips the nectar that the flowers provide, are all a part of common knowledge.

The real life of the butterfly, however, is not so pleasant as we think. Have you ever found a butterfly hanging beneath a leaf on a cold summer morning drenched with dew and stiff with cold? Have you ever seen one trying to cross a field in a rain-storm and observed it vainly attempting to navigate the conflicting air currents? Where do they roost at night and on rainy days? Where do they come from and what becomes of them? These are matters which it has often taken men years to find out, and even now there are many thousands of species of butterflies which are known only by a preserved specimen caught in its flight by the net of some collector.



YELLOW BUTTERFLY

(*Colias philodice*, Gdt.)

The Doctor Jekyll and Mr. Hyde is so complete between the butterfly which flits over the cabbage patch and the velvety green worm that eats holes in the leaves of the cabbages that it is no wonder that for centuries no connection between the two careers of these creatures, seemingly so far apart, was suspected. In general it is true that no moth or butterfly is injurious to plants except in its larval stage, and herein has lain the clever deception which has doubtless protected these gay nating creatures of the air from the systematic attacks of man until quite recent times.

This picture shows what every boy and girl should know, that every butterfly has club-shaped feelers or antennae.

It is said of certain species of yellow butterflies that the males give off a pleasing, aromatic odor which is exhaled from the front wings through hundreds of minute, slender scales quite different from those with which the wings and body are covered. This scent, which is so strong that it can be detected by even our blunted olfactory organs if we rub the wings between thumb and forefinger, is supposed to attract the females in some way that is little understood. As among these particular butterflies the male seeks out its mate, it is difficult to understand why it should be the male which has the perfume, since it does not serve to tell the female where her mate is to be found. The inference is that in some way the perfume charms the female.

In some species it is the females which give off an odor, and in either case the distances over which these odors extend and are detected by the males or females respectively are analogous to the inconceivable reach of wireless telegraphy. And who knows but the mechanism of these creatures is set to respond to the swiftly travelling ions which make wireless telegraphy possible?



A BABY OF THE SKOPPER BUTTERFLY

(*Eudamus tigrus*, Fab.)

There is something fascinatingly strange to me in the babies of the winged butterflies, and I wonder why so many people have an aversion for them? Can there be an instinctive fear of anything that crawls, or is not this fear taught us by unthinking persons? The child is not afraid of the wide-mouthed naked little birds in the nest, or the little blind pink mice, and certainly they are no more innocent looking than the brilliant colored larva of the butterflies or moths.

What helpless things these babies are! They cannot fly, they cannot fight, they can barely see, and even their gait is a hobbled one.

Their business is to eat, and their jaws must keep busy pretty constantly to fill their stomachs with leaf fragments, for the greater part of the soft, flabby bodies is stomach. They are males and females but which they are you cannot tell until they turn into butterflies.

Along this creature's sides, like portholes in an ocean liner, are the breathing pores, nine in number. Most animals which live on land take air in through a single opening into a great cavity through which the blood circulates and is purified, but the caterpillars, and all insects in fact, instead of circulating their blood in and out of a pair of lungs, have, running through their bodies, a labyrinth of air passages, all connected with the outside air by means of breathing pores.

This caterpillar's eyes are poor affairs, and unless you look closely you will not find them, for they are merely a few raised spots, like blisters, beneath the skin on either side of its jaws.

It has, like the spiders, a spinneret and a reservoir of liquid silk with which, as it outgrows its baby state, it can spin its own arbor of tough silk fibers and hide itself from view while it is changing to a butterfly. If in late summer you will put one of these creatures in a tumbler and watch it for a day or two, you can see it plainly through the glass pouring out the liquid silk in a steady stream, waving its head from side to side. The silk comes from a spinneret which is just behind the jaws and is about the color of thin starch paste. The way it loops back upon itself and flows in curves reminds me most forcibly of the way the pastry cook, with frosting in a paper cornucopia, writes one's name upon a birthday cake.



A BUTTERFLY'S MUMMY CASE

One of the most marvelously beautiful of all living creatures lies waiting within this case for the resurrection day, when growth shall split open this polished casket and it shall feel the wings, close packed for weeks, unfold, and, stretching to a hundred times their size, bear it away into the sunshine.

Did the Pharaohs, I wonder, or their wise men, seeing this, model their mummy cases after those which the butterflies make?

This is the chrysalis of a butterfly, that wonder of poets since poetry began, that life-stage of the butterfly which our faith and hopes make comparable to our own rest in the tomb from which man in all ages has believed there came a resurrection and another life, no more to be compared with this than the butterfly's own existence among the flowers is to be likened to his crawling one upon the leaves. And because the minds of many men in seeking to understand, have broken down this beautiful analogy by finding that there is no real decay within the chrysalis, we must not hence conclude they have done more than brush away a fancied similarity. The mystery remains.

If you should open this butterfly mummy case, lay bare the mummy as it were, you would find a pair of wings in process of formation, a head, a curled-up sucking beak, legs and embryo antennae, that is, providing it were near the resurrection time. If not, and you had broken in too early, the greater part within the case would be a semi-fluid mass of broken down cell tissues from which the legs and wings and all the other parts are made.

The portholes along the side lead deep into the body and are probably as necessary to the growing butterfly inside as they are to it when it once emerges. The chrysalis must breathe.

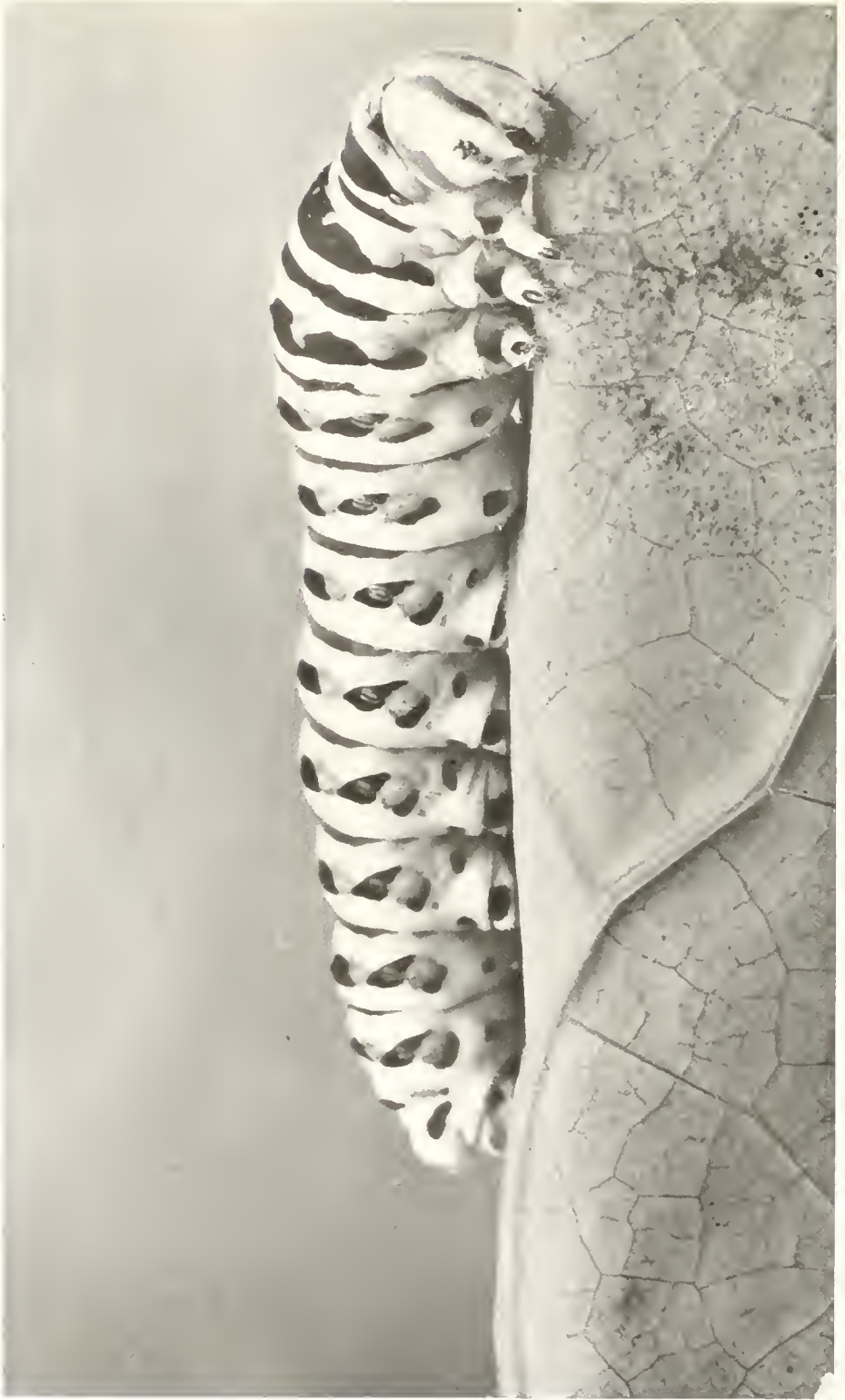
To many people there is much confusion as to what is a chrysalis and what a real cocoon. Every cocoon is a silken case spun by the caterpillar in which it can securely hide while it changes first into the chrysalis and then into its winged and final form. This chrysalis, or pupa, forms within the body skin and some caterpillars do not spin a cocoon at all, but merely rest somewhere away from view, until this strange process has been completed within the out-worn shell. This photograph is of such a chrysalis.



A MOTH

We commonly picture the moths and butterflies with their wings spread out or else upright in the air, but many moths trail their wings when they alight and escape our notice by their quiet colors. Walk through the grass and you will frighten thousands which, when they alight again, you cannot for the life of you detect upon the grass stems.

There are hardly any butterflies that trail their wings like this and not one of them has beautiful feathery antennae.



NOT GOOD TO EAT

Have you never wondered at the temerity with which certain of these slow-moving, helpless creatures expose themselves to the attacks of their enemies? In a world so full of hungry, winged beings it does seem strange, and when the markings are black and white or some such striking color in contrast with the leaves or bark the temerity seems even more extraordinary, until one learns the simple fact — these creatures are not very good to eat.

Not good enough to eat! Supposing that the fly and the mosquito were equipped with some flavor distasteful to the insectivorous birds; if cattle were not good to eat, nor sheep, nor hogs, nor any living, breathing things, what a change there would be in a world like ours! And yet to chemists there is very little difference between some compounds that are good to eat and others that are deadly poison, no greater than that between the poison bitter almond and the sweet one of our dinner table.

One cannot help but wonder why it is that when the border-land twist food and poison is so narrow in the chemistry of the living cell that every creature has not equipped itself with prussic acid enough to preserve itself from its enemies.

While this protection holds good against many predaceous creatures, there are various birds and even snakes that have found this particular caterpillar not too bad to eat.



A Hairy Spectacle

(*Euchaetes cyle*, Dru.)

Many of the caterpillars of our fields are striking in their form and color. This one could easily be seen some distance off and might to birds and others of its enemies be what the skunk is to its enemy the dog—a thing to shun.

In the luxuriance of its "plumage" it, in some respects, reminds one of those fantastic forms of fowls produced by close line breeding, the Indians, for example, or the long-tailed roosters of Japan.

Few creatures that we have photographed have been more beautiful than this black and white larva with its hairs in graceful tufts all over its body. What it eats or what its other self is like, I have not yet been able to find out.



AN UNKNOWN CATERPILLAR

Creatures like this, when they come walking down a garden path, are so striking and so gracefully weird that one would think their forms deserving of more study than they get. There is a reason for this, though, that is not hard to find; they are such transient creatures. A few days in the egg, a week or two as caterpillars, and they pass into their cocoons to emerge as moths or butterflies, and of the two weeks when they are caterpillars, the first part of the time they are too small to make much impression upon us.

Then too, you cannot collect and keep them as you can the butterflies or beetles, in fact this strange horned beast is still unnamed because its carcass shriveled and faded until it bore so little resemblance to its living self that it could not be identified. It is quite unlike the hickory borer or horned devil, being dark red-brown in color. It takes a skilled taxidermist-entomologist to squeeze them out, blow up the skin and mount them in a case, and that is the only way to keep these forms, unless we have found another way in these photographs of them.



A CATERPILLAR DEVoured BY A FUNGUS

(*Apantesis nais* attacked by *Empusa* sp., Dru.)

One cold morning in early autumn I saw this caterpillar lying so still on the grass stem on which you see it that I thought I could photograph it before it woke up. I picked the grass particle, but when I came to look closely at the caterpillar I found it was a shriveled corpse and that there were gaping wounds in its sides, filled with the threads of a parasitic fungus; a fungus familiar to me through one of its distant relatives which I spent six months of my life studying, and which lives in the intestines of the frog. There is something ghastly about the slow but resistless working of a fungus in the body of a caterpillar. One cannot help wondering where the plant got in and how the caterpillar felt about it. Was there the horror of finding that it could not be dislodged and the hopelessness of the struggle against it and the impending death and shortening of an already very brief existence?

So these, and seemingly all other creatures, have their diseases, and the studies which men have made and are making upon them in all parts of the world are helping us to understand the causes of those which attack and often conquer human beings.

NERVE WINGED INSECTS

(*Neuroptera*)

There was a time before all living things were classified, when there were no groups of plants or animals or insects. It is something to be proud of that man has grouped the likes together and formed, out of the chaos of living species, a system into which most of them can go like letters into pigeon-holes. Is it any wonder that with half a million species in this insect world there should be some groups in which the species forming them seem to have very little likeness to each other? The nerve-winged insects seem to form just such a group, for the principal things they have in common seem to be peculiar nerve-veined wings and blood-thirsty habits.

If we could be quite sure that dragon-flies and scorpion-flies and caddis-flies preyed only upon our foes, we could say with more confidence than we do now, that they are our friends and not our enemies, and that men should find some means by which to help increase the number of them in the world.

It is conceivable that, as we learn more about them, they may take a much more important place in public esteem, just as insectivorous birds are doing. Perhaps they will come to be protected and their breeding places guarded by the drainage engineers.



THE DRAGON FLY

No dragon of legend could be more blood-thirsty or terrible than this. With four wings like the supporting planes of an aeroplane, it can fly as fast as a railway train. With thousands of eyes crowded together like cells in a honeycomb, forming eye masses that cover most of its head, it can see in all directions at once. With massive jaws and teeth as sharp as needle points, it can pierce and crush the strongest shell of its prey. With its long-jointed spiny legs held out in front like a basket, it rushes through the air, catches and devours its prey and lets the carcass fall to the ground, all without slackening its terrible speed.

It is hard to realize, as you watch this swiftly moving dragon of the air, that it has spent the first stage of its life as a slowly crawling, ugly water monster lying in wait among the reeds and grasses for some unsuspecting water bug or larva to pass by.

The female, as she skims the surface of some pool, drops into the water her clumps of dragon eggs, a thousand at a time, and from these are born the ugly water dragons, which, when come of age, grow wings and, crawling to the surface, split their old skins open, unfold and dry their closely packed wings, and dart away into the sunshine to prey upon the other creatures of the air.



THE DRAGON FLY AND ITS VICTIM

(*Macromia* sp.)

Who would suspect, as one of these dragon-flies darts by him on the roadway, that every few minutes its jaws are crunching some helpless insect caught in its flight?

When I caught the dragon-fly whose picture is shown here, I held him by the wings, and, catching a fly that buzzed about the table, dropped it in his claws. Without a moment's hesitation his mouth opened wide and closed upon the fly. I watched it disappear underneath his great upper lip and almost fancied I could hear its shell crack as the powerful jaws and lower lips turned it around and around in the mouth. A few seconds only, and the sucking throat had drawn out all the blood and the lips threw out a ball-like mass made up of the fly's wings, legs and crushed body skeleton. Then it opened again for more.

One entomologist has said that in two hours a dragon-fly will eat at least forty house flies, and Doctor Howard says that if starved for food it will eat up its own body.

No doubt these dragons of the air are to be counted as among our greatest friends, and in places in the East where life is made a burden by that humming, stinging pest, the mosquito, its presence in great numbers helps amazingly in keeping down the day-flying forms of that insect. It has gone into the Hawaiian Islands with the mosquito and has learned there to breed in the water found on the leaves of lilies growing on dry land.

Perhaps someone will find a way to domesticate this creature and make it live upon the house flies around the house. As a first step, Needham has fed the larva on bits of meat.

Sharpe, the British authority, has observed a dragon-fly returning again and again to the same bush, and Westwood believes he saw the same individual hawking for several weeks together over the same small pond.



DRAGON FLY NYMPH MASKED

(*Libellulid*)

As Kellogg says, it must, indeed, be worth more than a week of study in the house to see just once the transformation of one of these mud dragons from the bottom of a pond into a beautiful dragon of the air, a dragon-fly.

Of all the strange, weird monsters with which I have ever had to deal, this water one seems somehow weirdest. It reminds me of those sandy-colored, deep-sea fishes which, struggling under the sand of the sea bottom, wait for their prey to come along and then dart out and seize them with their powerful jaws.

The mud dragon has a mask which, for the purpose, is certainly the most effective thing one can imagine. Its victims must be greatly surprised to see the mask drop, revealing a sheep-like nose, mouth, and lips, while the mask itself opening out and spitting down the middle, becomes a pair of needle-margined, powerful claws so strong that even fishes are sometimes caught and held by them.

It is strange to think of this dragon concealing its claws by making a shield of them to cover its ugly face while it waits in ambush for its game.

Its eyes and body are the color of mud and must be very hard to see.

This photograph shows the mask in place, the grinning mouth a long curved slit across the face, while resting on the ground, as one would rest one's elbow on the table, is the powerful claw arm, so strong that you would find it difficult to pull the mask away, or having done so to keep it down.



DRAGON FLY NYMPH UNMASKED

(*Libellulid*)

Pulled down from the mud dragon's sheep-nosed face, the mask is resting on the ground. It can be stretched out much further and also opened up to form a pair of powerful claws. Along the edge of the mask is a fringe of inward-pointing spines like those which edge the leaf margins of a venus flytrap. The eyes are large and many-faceted and form the blunt-pointed corners of its head.

The under-water battles in which these mud dragons, or dragon-fly nymphs, take part must be something terrible. It is recorded that in Hungary 50,000 young fishes were put into a pond in which enormous numbers of these nymphs occurred and only fifty-four fishes survived. One is not surprised to learn, too, that they will eat each other up.

On the whole, however, it is doubtful if between the flies and other injurious insects which the dragon-flies destroy in the air, and those larvae of mosquitos which the water nymphs destroy in the ponds, there is any other family of insects toward which man should feel more indebted than toward the family of the odonata or dragon-flies.

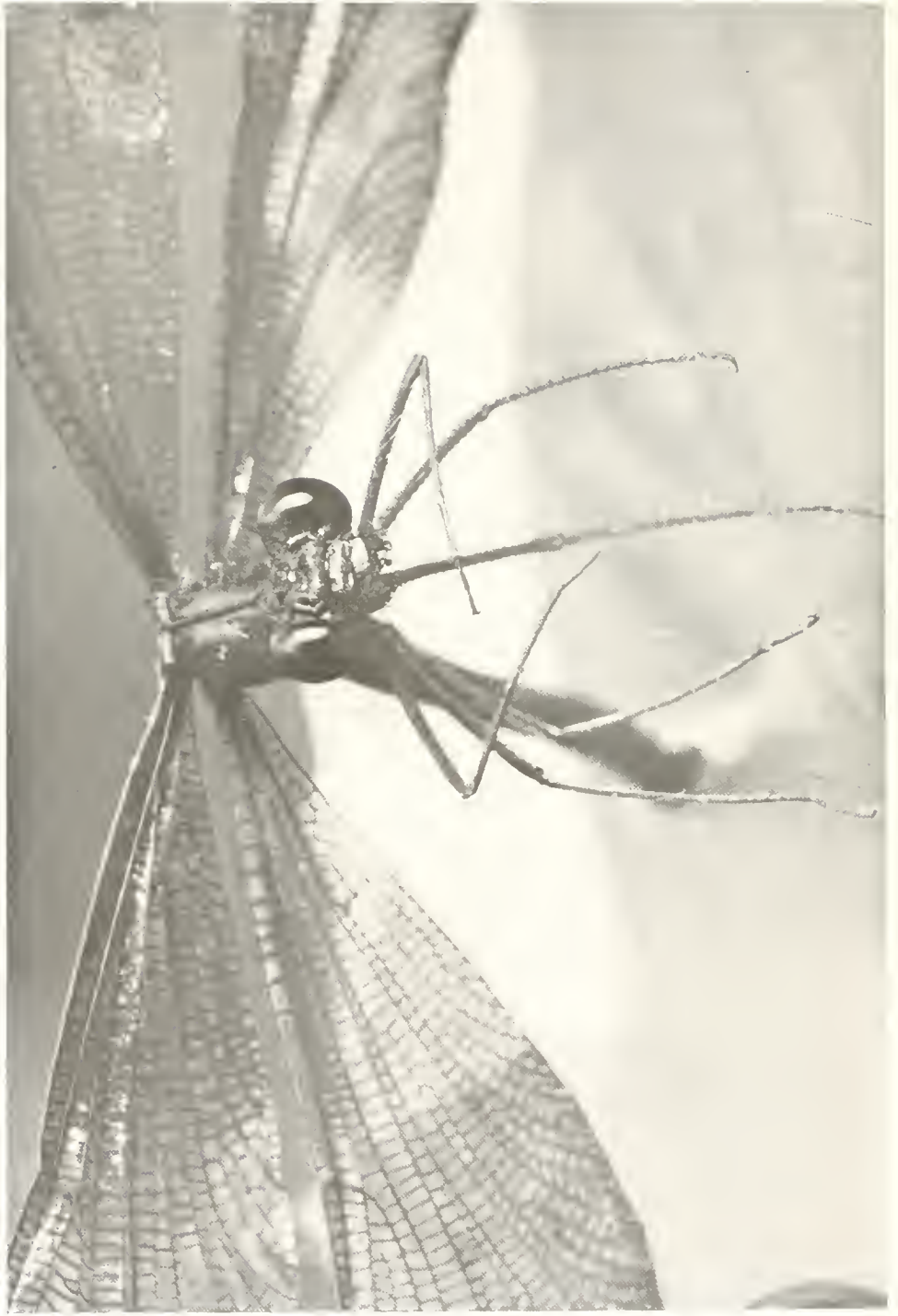


AN ABANDONED DRAGON CASE

(*Lábelluid*)

From this muddy outworn shell, left to decay at the bottom of a pool, there came, sometime last summer, a gorgeous, four-winged dragon-fly. A little after dawn, what was once this water nymph or mud dragon, tired perhaps of its mud existence, ready anyway for the transformation, crawled up out of the water upon some stone or stick and waited there for its back to split open up and down. It pulled its soft, boneless legs from their cases, now lying along the abandoned shell, its wings closely packed together from the two cases on its back and its head and jaws from out the broken head shell. Even every air passage running through its body shed its parchment lining.

Soft and helpless it crawled away into the grass to wait until its wet, soft outer skeleton should harden and make it possible for the powerful wing muscles to pull against it and for the broad wing films to dry and straighten out. By noon the transformation was doubtless quite complete, and flitting across the pond went the recent inhabitant of this dragon-fly case.



THE DAMSEL FLY

(*Agrion maculatum*, Beauvois)

Most insects' legs are made to walk with, but those of the dragon-fly are not. They are bunched together so near the head that when the creature alights it can do little more than cling to what it lights upon. Instead, the legs, with their spines, form a perfect basket, open towards the front, and thus become the organs with which flies are caught.

This damselfly, as it is called, is smaller and more delicate than the dragon-fly with quite a different head. It inhabits shrubby woodland and is not often seen. Some of its tropical relatives are creatures of extraordinary fragility and delicacy.

Its wings, which move in perfect unison, although distinct, are operated by such ingenious mechanical devices within the body as to have long ago suggested a flying machine, and it is strange how like a dragon-fly Professor Langley's aerodrome, the first of them all, does look, although of course the aerodrome's wings were rigid.

One realizes what enormous eyes these dragon-flies have when one begins to compare them with the size of the head.



THE LACE-WINGED FLY AND THE APHIS LION

(*Chrysopa* sp.)

So fragile and delicate does this creature appear that one can but wonder how it exists in the jungle of the grass. It has a disagreeable odor, it is said, and this is perhaps the reason that it holds its own, for it flies so slowly and is so conspicuous that it would otherwise fall a prey to every insectivorous bird and dragon-fly.

Its other self is the Aphis Lion, a wingless but very active creature which hunts for plant lice and when it finds one punctures it with its mandibles, raises it in the air and lets the blood trickle down into its mouth. It sucks eggs, too, and, shameless creature that it is, it sucks those of its own species, or would, at least, if the mother insect had not taught the winged females to lay their eggs on the ends of long, slender, stiff stems which the indiscriminating larvæ cannot climb, much as a human mother puts the pot of jam on the top shelf where the children cannot get it.



THE WINGED ANT LION

(*Myrmoleon immaculatus*, De G.)

As with many of these monsters, it is the other self, the larva of the winged ant lion, which is the fascinating study.

This winged form merely lays the egg from which hatches out the soft, spindle-shaped young with jaws like pincers. This little creature at once marks out a tiny circle in some dry, sandy place, and begins to dig a pitfall for its prey, the ants.

By pitching the sand with its broad, flat head, just as a man who digs a well would pitch out shovelfuls of dirt, the young ant lion excavates a tiny crater in the sand and hides itself in the crater's pit with its pincers sticking upwards through the fine, loose sand.

Any child who has jumped into his father's oat bin and tried to climb up the hillside of tumbling grain, knows how hard it is to get out. If he will imagine a hidden monster waiting with jaws opened at the bottom, he will have some sympathy for the mulecky ant which, slipping upon the rolling sand of the ant lion's crater slides slowly towards its pit—helped perhaps by dirt thrown on it by the ant lion.

There seems to be no escape, and once within reach, the pincers close on it, and along their grooved inner faces, helped down by special tongue-like licking organs, the blood trickles and is guided to the mouth and thence into the stomach of the lion. And, curiously enough, this stomach is the only organ of digestion which the ant lion has. The stomach has no outlet and everything that is not digested must wait within it until the change of life brings on this winged state, when, like a tiny egg, the gathered excreta of the weeks and even months of feeding is thrown out from the body. Perhaps this strange structure of the beast has something to do with the fact that it can live six months at least without a particle of food.



THE SCORPION FLY

(*Panorpa confusa*, Westw.)

When the scorpion fly, standing still, raises above its head that pair of pincers which forms its tail, it seems almost like some two-headed monstrosity.

It is interesting to know that the great Aristotle knew these insects and thought of them as winged scorpions. It is only the males which have these curious tails.

One might easily mistake the long snout for that of some sucking insect, but at the very tip there are two oblong, plate-shaped jaws, each armed with two very sharp teeth which enable the creature to live a carnivorous existence. Although little is yet known about it, the scorpion fly appears, like a hyena, to live chiefly on dead animal matter, although it has been seen to attack injured or helpless insects.



A SOLDIER TERMITTE

(*Termites flavipes*, Koll.)

Although too poor a photograph, perhaps, to be worthy of a place in this collection, I have a sentimental reason for its reproduction here, for it brings to mind the days I spent in Java lying flat on the ground studying the mushroom gardens of its tropical relatives.

There are few more interesting creatures than these termites. They have been mushroom eaters and mushroom growers for thousands of years. They have their kings and queens, their workers and their soldiers, and they build gigantic caverns and tall mounds out of earth and half-digested wood.

They tear to pieces and reduce to powder the dead trees of the tropical forests.

Their nymphs, the young kings and queens, are winged and perform a marriage flight, then, tearing off their own wings, they settle down to form a home of dirt and start a new and numerous colony.

They seem to be upon a higher plane of social life than are the true ants, with which they are not in any way related, for the members of a species seem all to be quite friendly towards each other even though they may come from widely different nests. This is never true of ants.

Their queens are strange, egg-laying machines as large as a man's thumb, and they lay an egg a second for nobody knows how long.

The workers stun the fight and make long, covered ways of mud in which they go from place to place. With their miring energy they honeycomb the building timbers of houses and ships in the tropics, making mere hollow shells of them, and so causing disasters of all kinds.

Some of their soldiers have mandibles so strong and sharp as to drive away all animals and make them formidable enemies of man, and some have squirt guns in their heads with which they spray their enemies with an obnoxious fluid.

This tiny representative is all we have in Maryland, but though so small and quiet in his habits he does great work among the pine stumps of any place. The stump of any pine that is felled one year can be kicked out the next, honeycombed with the chambered runways of this creature. Beware lest any pine timbers of your house are near the ground and become infested with termites.

THE STINGING INSECTS

(*Hymenoptera*)

This order is another one in which it takes an entomologist to see the characteristic likenesses in the various species of insects composing it. They all have membranous wings, and all the females have either a saw, an ovipositor or a sting at the tip of the abdomen. One may say, indeed, that practically all the stinging insects are in this order.

Bees, wasps, ants, gall flies, saw flies, and ichneumon flies are Hymenoptera, the ants coming into this membranous winged order because the males and females are winged for the marriage flight, and lose them only after this is over.

This is considered the highest order of insects because it contains members with the most marvelously developed instincts of any creatures in the world, insects whose habits, skill and industry excite our admiration and wonder. Whether they live in colonies with highly developed social states, or whether they live the lives of solitary hermits, their industry and sacrifice to keep alive and perpetuate their kind, are things that make us wonder whether, after all, we have the right to call ourselves the most altruistic of living creatures.

It is around these Hymenoptera that centers the great question of what instinct is, and how it differs from intelligence. We cannot help but feel that it is memory of some kind, not necessarily like the memory of our own brains, but a race memory, transmitted in the almost microscopic egg laid by the mother before she dies.

The instinct of the bee, or wasp, or ant is quite a different kind of thing from reason. Since these creatures have stood still in their development, or at least have changed but little since tertiary times, it is quite possible that their present state represents the highest type of evolution along the lines of instinct. The power to reason, to meet a new emergency, are things which came much later in the development of the world, and man, the creature having them in the highest degree, seems destined to control all other creatures in the end.



THE PORTRAIT OF A BALD-FACED HORNET

(*Vespa maculata*, Linn.)

I wish I could convey to you my sensation when, in hunting for the focus on my ground glass, this creature burst upon my sight. It was as though, exploring in some strange land, I suddenly stood face to face with a beast about which no schoolbook had ever taught me anything. It peered at me out of the gloom of imperfect focus, and it took me some time to realize that I was looking into the eyes of a bald-faced hornet.

There is no wild creature in the northern United States that a man will run away from so fast as from a bald-faced hornet.

At the tip of her flexible armor-plated abdomen is the poison-fed stiletto with which she drives off enemies from the nest or paralyzes her prey.

Her six powerful legs are spined to help her, no doubt, in climbing over the smooth surfaces of flowers and twigs. She has two kinds of eyes—three lens-shaped ones on top of her head and two marvelous compound ones composed of hundreds of little lenses, which take up half the head. Just what she uses each kind for is still unknown.

From her forehead hang ringed antennae, which doubtless are the organs with which she scents the presence of her prey, and they may also help her find her way about.

Her massive jaws lie below her eyes and look like shears with jagged edges; they are meant for crushing, not for grinding, and with these she tears to pieces bits of wood and cements the particles together with the sticky secretion of her salivary glands, making thus the combs and shelter of her wood-pulp paper nest.

She is an undeveloped female, but with the professional care of a baby's nurse she tends her sister hornets in the nest. On the wing, from daylight to dark, she scours the country for the flies and other insects with which to feed the young. Of all the fly-destroyers which frequent the house she is perhaps the most efficient, pouncing upon the flies with murderous voracity, tearing off their heads and legs and wings, and macerating their bodies to a pulp to feed the hungry grub-like baby hornets which are hatching out in the paper nest over the front door. Her life, and the life of every other worker, is ended by the autumn, and it is left to a few of the young queens to carry on the species.

Does this picture represent, I wonder, one of the nightmare visions which haunt the dreams of baby flies?



THE QUEEN HORNET

(*Vespa maculata*, Linn.)

The summer was over but the cold weather had scarcely begun when I found this creature under a rotten log in the pasture. The paper nest over the front door was empty and rapidly falling to pieces, but even so, it was hard to believe that the active, dangerous creatures we had watched for so many weeks had suddenly disappeared, and that, of the whole busy colony, only a few females were left.

There is something fascinating in the picture of the young queen hornet, after mating is over and all her relatives are dead, crawling away beneath some log and passing there the long cold winter. Then, when spring has come, she emerges from her sleep, the only survivor of her race, and builds, unaided even by her mate, the beginning of a nest just large enough to hold her first-laid eggs. From these hatch out the grubs, which later, after days of feeding, emerge as workers, undeveloped females, and help build up around her a colony of hundreds of busy hornets.

The death of the wasp and hornet workers does not seem to be a matter of cold alone, for, in the regions of perpetual summer, the workers of many species live short lives. They feel the cold, of course, as all our insects do, and inside the nest, on the shelves formed by the flat tops of the combs where the larva live, they find dry roosting places at night. The heat of their own bodies materially raises the temperature inside the nest.

Though many people think them just alike, the bees and wasps (the hornet is a kind of wasp) are very different creatures. The wasps have trim, slender forms with a few scattered hairs upon their bodies, whereas the bees are generally hairy and short bodied. They both build combs, but the wasps make theirs of paper wetted with saliva, while the bees build theirs of wax secreted from their bodies. The wasps depend upon fresh food gathered in the day's hunt through the air, whereas the bees store up their food in empty cells. The wasps' nests are the wigwams of a season, the bees' hives the more permanent abodes of a higher type of social beings.



THE YELLOW JACKET

(*Vespa carolina*, Dru.)

Who has not wished that these brown and yellow-striped creatures would build their nests where people could see them and be warned to stay away, instead of underneath the ground as they do now.

They hunt in flocks, and it is no wonder that with the sides of their heads all eyes and with three other eyes on the top of the head they should quickly find anyone who treads on their underground nests.



ONE OF THE SOCIAL WASPS

(*Polistes metrica*, Say)

No insect's nest is better known than the small, hanging, paper comb of this social wasp. You find it under eaves and suspended from the ceiling of the porch and from the rafters of the barn. Then, as the cold days of autumn come and the workers and males of the colony die off, their hibernating queens seek shelter from the cold in our houses.

In the spring these queens start out to build a few small, paper cells with finely chewed up fibers of wood wet with sticky saliva. In these they rear up workers to help add new cells and gather food for a new family, and before the summer season has rolled by, the few small paper cells have grown to several scores.

If you have the hardihood to stand quite close to one of these nests you will see the grubs with hungry-looking mouths, wiggling and stretching out their necks, each in a cell quite open to the air, waiting to be fed by its sister or the queen. As to which will come forth from these white grubs as queens, which as males, and which are doomed to be but workers—undeveloped females—nobody can foretell, but certain it is that there will be all three of these forms represented.



A MUD DAUBER WASP

(*Scoliphron cenicarium*, Klug)

Think of all the marvelous mechanism and chemistry required in order that a wasp may feed its young upon fresh meat!

The solitary wasps have stings whose venom is much less powerful than that of the bees. Fabre declares that his experiments convince him that the reason may lie in the fact that for paralyzing its prey the wasp needs only a weak poison whereas when the bee stings it does so in self-defense and it stings to kill.

The busy mud dauber females build their nests of mud brought from the nearest puddle and in each carefully made cell lay an egg and around it pack the paralyzed insects on which the voracious little grubs begin to feed as soon as they hatch out.

By the time the young grubs have eaten up the food that has been so thoughtfully supplied by their parents and have changed from grub to pupa and emerged as flying, stinging wasps, their parents are dead and gone. Imagine, if you can, a civilization in which the mothers slave for offspring which they never see, and the children grow up with no education, yet possessed of all the knowledge that their parents had. As Sharpe remarks, the solitary wasps are among the most instinctive creatures of the animal kingdom.



THE FOOD OF A MUD DAUBERS' BABY

This little white spider I found in the nest of a mud dauber wasp.

How long this white spider would have lived its paralyzed existence I do not know. Fabre has watched insects so paralyzed for six weeks, and this one was on my table for several weeks in June without moving and without showing any sign of decay.

We are accustomed to think of the wonders of cold storage as a result of this age of invention, and to look upon its achievement as the accomplishment of the human brain. The mud dauber, in common with most of the so-called solitary wasps, possesses the means of paralyzing the nerve centers of its prey and thus preserving it alive for weeks in the nests of the baby wasps. With the most amazing aim it darts its poison sting between the joints in the armor plate of its victim and touches with a drop of poison one of the nerve ganglia which lies on the abdominal side of most insects.

Fabre has shown that the same result can be produced by a needle and a drop of ammonia, and insects paralyzed in this way hang, as it were, between life and death for weeks or months. If too heavy a dose is given the insect dies in a few hours and putrefies in a few days, and if given too light an application it soon recovers. Different insects require different amounts of the poison to paralyze them and the solitary wasps make mistakes just as man would do. According to Fabre these insects have also discovered that in certain species of their prey the nerve ganglia are grouped close together and can be easily reached with the poison while in others the ganglia are separated, and each ganglion must be touched.

It is a weird thought that for thousands of centuries these creatures have had a perfectly satisfactory way of preserving and storing fresh food while man still kills his animal food and is now quarreling as to how it should be stored and whether if frozen for months it is really good to eat.



THE FIG INSECT ON WHICH DEPENDS A GREAT PLANT INDUSTRY

(*Blastophaga grossarum*, Grav.)

Into every dried Smyrna fig that you eat a queer little beast like this has crawled; unless she does so, no seeds will form, for the inside of a young fig is filled with flowers waiting to be dusted with pollen and it cannot develop until this is done. This tiny, female wasp, so small you can scarcely see her with the naked eye, is the pollen-duster of this miniature flower-garden.

The *Blastophaga* hatches out from a tiny egg which her mother lays in a special flower or gall in the flower cavity of a wild, inedible Caprifig that came originally from the islands off the Syrian coast. Her mate, an ugly little thing with no wings at all, hatches out before she does and mates with her even before she comes out of her tiny cocoon. After wandering about among the stamens in the cavity in the Caprifig until her back and sides are covered with pollen, she finds her way out through the hole in the end of the ripening wild fig and flies away in search of another young and ripening fig in whose gall flowers instinct impels her to lay her eggs.

The larger, juicier Smyrna fig attracts her, and she crawls inside, searching for gall flowers there. But the Smyrna fig has no special places for her eggs and, after wandering around over the flowers in the floral cavity she wanders out again, or dies. But in this scramble over the sticky stigmas of the Smyrna fig flowers, she irritates them and leaves upon them the pollen which she brought with her from the wild fig. This is what causes the young seeds of the Smyrna fig to grow and the fig itself to swell and become the honey-sweet fruit which we eat.

Without the visits of this tiny wasp the figs either fall off on the ground when young, or else form insipid tasteless fruits. So it might be said that the great fig industry of Smyrna hangs on the blundering instinct of this little creature.

Some enterprising Californians brought over and planted orchards of the Smyrna fig and could not understand why they did not bear. Then they brought in the wild Caprifig from Smyrna and planted it side by side with the Smyrna figs, but still with no result. Finally the experts of the Department of Agriculture were called in and solved the problem by introducing the insect, which had been left behind.

This little creature, in the picture, crawled out in my laboratory from a Caprifig which Doctor Rixford, the fig expert of California, sent me, requesting that I photograph his pets.



THE COW KILLER OR VELVET ANT—A WINGLESS WASP

(*Mutilla similima*, Sm.)

Can you imagine an insect daring enough to brave the stings of the thousands of workers in a bee's nest? This wingless, solitary female ant lives habitually in their nests and eats the food they have so busily gathered, an unbidden and probably a most unwelcome guest. Powerful jaws, formidable sting, an armored shell to protect her from the stings of the bees and wasps in whose nests she lives, seem to fit her for the strange life she leads.

If you should find her mate he would doubtless be on the wing, for unlike all others of the order, it is the male alone which flies. So different from their mates do some of these male cow killers look that they have often been mistaken for quite different species.

It is supposed that the female lays her eggs inside a bumble-bee grub and in a few days' time they hatch and eat the babies up, from the inside outwards. Then they hatch again, so to speak, as full-fledged cow killers and feast upon the honey of their hosts.



THE WORKER BUMBLE-BEE.

(*Bombus vagans*, Sm.)

Everybody has a friendly feeling for the bumble-bee, that clumsy rover of the clover field whose buzzing seems part of the still summer air. She is the real worker of the hive, an undeveloped female, her hind legs laden with a mass of pollen from the flowers she has visited, and her honey sac filled with nectar.

As every boy who has hunted her nest will know, the bumble-bee lives in burrows under ground. The cells that she makes are of wax, secreted from special plates which lie arranged in rows beneath her hairy body. Each cell is like a little jar, standing on end, quite different from the cells in a honey bee's comb. In some of these the eggs are laid and the baby bees hatch out, while others are filled up with nectar.

While the bee is gathering pollen with her legs, she is also gathering nectar with her tongue and storing it in a special honey stomach from which she later regurgitates it into the honey cells in her nest.

The nectar, when it is gathered, is thin, like the sap of the maple tree, and, like it, must be condensed. Part of the water seems to be taken out in the honey stomach, and part evaporates from the honey cell.

It will, perhaps, be a satisfaction to those who hate getting up early to know that there is a well-founded rumor that some bumble-bees have a trumpeter who, somewhere between three and four o'clock in the morning, wakes up the sleepy hive.



THE POLLEN PLATES OF THE BUMBLE BEE

(*Bombus americanorum*, Fab.)

If you will watch a bumble-bee closely as she crawls over the stamens of a wild rose, perhaps you can see that, although she covers the whole under part of her body with pollen, yet she scrapes off all she can with her feet and packs it in a yellow mass on the smooth, hairless segments of her large hind legs, the pollen plates as they are called. To make the pollen stick on these smooth plates and hang together during the flight to the nest, it is claimed by Muller that the bee mixes nectar with the pollen grains. The kind of pollen that she gathers is, however, not generally the dusty kind, like the pollen of the pines or grasses, but the sticky kind that comes from insect-fertilized flowers. When the bumble-bee reaches her nest, she scrapes the pollen from the pollen basket and with it feeds the young, for pollen is the solid food of baby bees.

There is one strange thing about these smooth pollen plate legs which, from our human, individualistic point of view, is hard to understand. It is only the workers, the undeveloped females, which have them; the legs of the males and of the queens are hairy and are not at all adapted for pollen gathering. Thus, since workers bear no children, we see a race of parents transmitting to certain of their offspring characters which neither they nor any of their ancestors have ever possessed.



THE BUMBLE-BEE AT WORK

This photograph shows the great hybridizer at work.

She is on one of the single roses, her hairy body spread over the stamens which, with their yellow anthers, look like a circular bed of tulips. In the middle of the circle, where her right foot rests, is the stigma.

If you will sometime take a hand lens and watch a bee at work (and if you don't get too close she will pay no attention to you), you will notice the clumsy way she crawls about, knocking the pollen off the stamens and getting her body covered with the yellow dust. As you watch, any feeling of there being some mystery about cross fertilization will be dispelled. How this same bumble-bee could crawl across another rose blossom *without* leaving a trail of yellow pollen on its stigma would be the mystery!

Since the earliest days of the world of plants and insects, the bumble-bee and her ancestors have been at work mixing the pollen on hundreds of different plants and playing, doubtless, a perfectly gigantic role in the creation of the flowering plants which now cover vast areas of the globe.

It is perhaps an idle speculation, but it would be interesting to know how many plants would become extinct were some disease or parasite to exterminate the bees.



THE TELETYPE MILKWEED POLLEN

(*Bombus sp.*)

Although this bumble-bee was caught in flight across my meadow, her photograph shows beyond the shadow of a doubt that she had been a recent visitor to the blossom of some milkweed, for, projecting from her right hind leg and plainly visible, are the pollen masses of the milkweed flower. They look like little paddles and hang in pairs, although this you cannot see in the picture.

We know that flowers depend upon the bees to fertilize them, but somehow I do not think we grasp the completeness of this dependence, nor realize how many flowers there are which, unless they have their own pet insect visitors, would soon become extinct.

The milkweed hires its visitor with little cups of nectar, and beside each cup it sets a trap which is as carefully worked out as the steel traps which the modern trappers use. Across the top of a little slit, wide below and narrow above, lie the small ends of the paddles or pollen masses, firmly joined together. As the bee alights to sip the nectar, her foot slips into this crack, and in trying to extricate it she pulls up the pair of paddles which fasten themselves onto a hair of her leg like a clothespin on a line. In drying, the paddles clap together in such a way that by the time another milkweed flower is visited they can slip with the leg right into the little slit and are broken off and left there as the bee again pulls out her leg. Once inside, these pollen grains throw out a score or more of tiny, rootlike tubes which grow into the lining of the slit and carry to the ovary below the fertilizing germ plasma which makes the seed develop.

The bumble-bee, of course, is strong enough to slip into these traps and pull her legs out as a routine thing, but many small moths and butterflies are not, and these get caught and die upon the blossoms.



THE POOR MALE BUMBLE-BEE

(*Bombus americanorum*, Fab.)

It was late in October before I noticed, flying low here and there across the clover tops, large bumble-bees, which seemed to be more covered with golden hairs than those which I had watched throughout the summer time. At first I thought them queens, but as their number multiplied I felt I must be mistaken, and one of my insect-knowing friends explained that they were only males, and that with the approaching days of winter they were all doomed to death. Already, he pointed out, their wings were battered and frayed from flying against the autumn winds.

The importance of the males! Could there be a weaker argument against woman's suffrage than the one which has been brought forward that throughout nature the duty and the right of protection rests with the male? Perhaps the drones do fight among themselves; but, as in most other fighting of the males, it is not to protect the nest or young from perishing, but merely to determine which one of them shall win the queen's attention. The males are stungless.

In this world of the clover field all the work of the society is done by the queen herself, or by the workers, which are infertile females. Apparently few males are wanted in the colony until late in the season, when, for a brief period, they are tolerated in considerable numbers as the necessary courtiers who accompany the young queens of late summer in their marriage flight. This takes place before the winter comes to kill all but a few fortunate queens, which find safe shelter in some crevice in the rocks or underneath some old, decaying log.



SOLITARY LEAF-CUTTING BEE

(*Megachile brevis*, Say)

Unlike the social honey and bumble-bees, this bee leads a solitary life.

With her strong, saw-like jaws, the female makes her burrow in soft wood and lines it with bits of leaf which she has cut from some plant. When the leaves of plants in the garden have large round holes in them, in nine cases out of ten you may be sure that they have been cut by some solitary bee.

When the burrow is complete she makes a ball of pollen and nectar, puts it in the bottom of the burrow, lays an egg upon it, and, with a wad of leaves, securely shuts it in; over this she lays down another food ball with its corresponding egg, and so on, until the burrow is full.



THE STINGER OF THE LEAF-CUTTING BEE

(*Megachile brevis*, Say)

The sting or "stinger" of a bee is indeed a most wonderful piece of mechanism. At the base, inside the body of the bee, lie bars or levers, operated by muscles, which push the darts out and draw them in. The poison sac lies just behind this mechanism and pours the poison into a set of cup-like valves, from which it escapes into the wound along longitudinal grooves in the sting like grease along the piston of an engine.

The sting itself is not, then, hollow, like the spider's poison fang, but is a poisoned stiletto as long as the bee's foreleg which she can thrust in and out with incredible rapidity, and which, as everyone knows, can inflict a painful wound on creatures millions of times her size.



A COMMON RED ANT

(*Formica sp.*)

Ants are undoubtedly the highest, structurally and mechanically, of all insects, and at the same time the most efficient. Their social organization has been the admiration of human beings from the earliest times, because the interest of the individual is merged so completely into that of the colony; but, as Wheeler remarks, their organization must strike the individualist with horror.

It is an organization of females, too. The workers are females, the soldiers are females, the nurses are females, and there is one queen mother for them all, who lays all the eggs of the colony. Where are the males, those representatives of society, those voters of our human colonies? They do not exist as such, for the males of ant colonies are but mates for the young queens. Together with them they leave the nest on their marriage day and together make the marriage flight, but as soon as this is over they die, and the colony gets on easily without them.

To man, who is the most rapidly evolving organism on the earth today, it is a strange thought that the most highly developed insect which the world has produced, and which has not changed materially since the Tertiary epoch, has relegated the males to the short-lived function of reproduction, leaving him to work to perform and getting rid of him as quickly as possible. Why did the ants, with their marvelous instincts, fail to conquer the world? Why have they stood still for thousands of years after they had perfected their social organization? Did they go as far as evolution could go when it leaves the male out of account? It is perhaps a comfort to think that, after all, they have failed and the man-guided organization of human beings has surpassed them in its development!



A BLACK ANT

It is strange to think that just because the sunlight which poured upon this little creature's shiny body was reflected back against a photographic plate, its rays being made to diverge widely in so doing, we can get an image of this tiny ant as large as though it were a mouse.

What a world this would be to us had we microscopic vision! A thousand times as many beasts to look at, a thousand times as many things to see and understand!



ANT GATHERING NECTAR FROM LEAF NECTARIES OF THE CHINESE WOOD OIL TREE

A year ago I planted in my garden in Maryland three young wood-oil trees from the Yangtse valley of China, broad-leaved trees something like the catalpa. Just where the leaf stem joined the leaf blade there were two curious, dark red, oval glands. The use of these I did not understand until one morning I discovered a big black ant on each leaf, and each ant was stationed at the base of its leaf near these glands and evidently was lapping up from them small drops of nectar which kept oozing out from the center of each gland.

These rapidly-walking little creatures, which spend their time roaming everywhere, had discovered the use of these nectar glands although they were on the leaves of a plant which they had never seen before.

Whenever I touched a leaf the ant upon it ran about as if to frighten an intruder away, and I could not help but wonder if in China, where the wood-oil tree is at home, there might not be some stinging ant which takes upon itself to protect the foliage from the attacks of caterpillars, and gets, in payment for its labor, the nectar from these glands. The tropics are full of such agreements between the plants and the ants, and very effective ones they are, too.

The photograph shows a black ant with antennae extended, reaching over one of these big glands for the drop of nectar which glistens just below its head. On the other gland, just back of the ant's left antenna, a second drop of nectar can be seen.

First one and then the other of these nectaries is licked clean by the ant, and so well was the work done that throughout the summer it was only when I visited the leaves in early morning, before the ants were out, that I could find the beads of nectar in their places in slight depressions in the glands.



THE ICHNEUMON FLY: ENEMY OF THE SPIDER

(*Crypturopsis* sp.)

It would seem as though the spider ought to be able to protect itself from such a beautiful creature as this, but she is said to be one of the spider's worst enemies. With the long ovipositors which may be seen in the photograph and might almost be mistaken for her sting, she lays her eggs inside those of the spider and the larvæ hatching from them eat up the spider's eggs. It is, so to say, an insect cuckoo, or worse than that, for the bird cuckoo only crowds the real children out of the nest, whereas the ichneumon fly devours them.

From man's point of view, however, many of the tribe to which this so-called fly belongs are his good friends, for they hold in check some of the pests which molest the plants he lives upon.

CHAPTER III
THE WORLD OF MYRIAPODS AND A SINGLE
LAND CRUSTACEAN

THE WORLD OF MYRIAPODS AND A LAND CRUSTACEAN

Every one who has turned over a rotten log has seen these thousand-legged worms, and yet I wonder if many of us have known that these weird wandering things resemble, and are the direct living descendants of some of the first animals which crept up out of the sea to live upon the land.

Long ages before the warm-blooded, lung-breathing beasts came into existence, they worked their way up out of their water life among the corals, sponges, worms, shellfish, and fishes, onto the dry land.

This was in the great transition time when all sorts of amphibian monsters came into existence, monsters which have long since passed away. These myriapods deserve respect if for no other reason than because their forefathers crept across the fresh footprints and mud wallows of the prehistoric monsters.

How comes it that these forms of life have changed so little in a million years?



A MILLIPEDE, ONE OF THE VEGETARIAN MYRIAPODS

Slow moving ringed creature with four legs to each ring or segment of its body! Watch its legs move in ripples as it finds its way over the ground! Unlike its distant relative, the centipede, which has but two legs to each body ring and darts about with most surprising rapidity, this millipede lives mainly on plant food and seldom eats, as does its savage relative, the bodies of small animals which make their home beneath old rotten logs.



A CENTIPEDE, ONE OF THE CARNIVOROUS MYRIAPODS

(*Scotopendra sp.*)

Perhaps no photograph in the collection serves better to illustrate the vastness of the back yard jungle than this one, for myriapods are the only representatives of a gigantic branch of the animal kingdom, the individuals of which are no more insects than they are lobsters. They live their lives altogether on or in the ground, they do not mind the cold as insects do. Some of them have poison fangs and are reputed to inflict fatal wounds. Their matrimonial habits are strange beyond belief.

They compose a vast neglected assemblage of creatures which some of their admirers believe have a value which we do not yet understand nor appreciate; just as we did not appreciate the role of the mosquito or the earth worm until the researches of modern science taught us of their importance.

A great untouched field for exploration lies here among the Myriapods.



TWO PILL BUGS

(*Armadillidium vulgare*, Fab.)

Down from the time of the prehistoric monsters comes the armadillidum, the last survivor of the great land crustaceans. As the serpents and the lizards are all that remain to remind us of the monsters which swarmed and fought in the tertiary swamps and oceans, so this strange creature, no larger than a pea, which rolls itself into a ball when you startle it as you turn over a stone in the meadow, is the survivor of the land crustacea which at one time, in countless forms, abounded everywhere in the then young world.

It is not an insect, but a last survivor, related to the crabs more closely than to any other branch of the animal kingdom.

INDEX

- Ant Lion, Winged, 207.
Ants—Black, 247.
 Common Red, 245.
 Gathering Nectar, 249.
Aphis Lion, 205.
- Bee-flies 157, 159.
Bee, Solitary Leaf-cutting, 241.
 Stinger of the Leaf-cutting, 243.
 See Bumble-bee.
- Beetle, 111.
 Blister, 127.
 Chafer, Spotted Vine, 125.
 Cucumber, Twelvespotted, 135.
 Hippopotamus among the Insects, 129
 June, 113.
 "June Bug," 117.
 June, Larva of, 105.
 Longicorn, 131.
 May, 117.
 Predaceous Ground, 121.
 Sawyer, 137.
 Scarab, An American, 133.
 Twig-pruner, 119.
 Weevil, Clover Leaf, 123.
- Bugs, The Order of, 87.
 Always Walking Around, 105.
 Ambush, 103.
 Assassin, 97.
 Assassination, 99.
 Cicada, 101.
 Lantern Fly, 109.
 Monster, Queer, Unworldly, 93.
 Pill, 261.
 Squash, 89.
 Strange Shaped, 91.
 Tarnished Plant, 107.
 Thread Legged, 95.
- Bumble-bee, at Work, 235.
 Male, the Poor, 239.
 Pollen Plates, 233.
 Pollen, Telltale Milkweed, 237.
 Worker, 231.
- Butterfly,—Baby of the Skipper, 177.
 Forepart of a Brown, 173.
 Swallow-tail of the Spice-bush, Larva
 of, 171.
- Butterfly—*continued*.
 Mummy Case, 179.
 Yellow, 175.
- Caterpillar—Devoured by a Fungus, 189
 Unknown, 187.
- Centipede, 259.
Cicada, 101.
Cockroach, 83.
Cowkiller, 229.
Crickets—Camel or Stone, 79.
 Ground, 77.
 On the Hearth, 75.
 Mole, 81.
 Stone or Camel, 79.
- Crustacean, 261.
- Daddy-long-legs, 49.
Dragon-fly, 193.
 Case, an Abandoned, 201.
 And Its Victim, 195.
 Nymph Masked, 197.
 Nymph Unmasked, 199.
- Fig Insect, see Wasp.
- Fly, Bee, 157, 159.
 Crane, 141.
 Damsel, 203.
 Horsefly, 165.
 Horsefly, Green Headed, 167.
 Ichneumon, 251.
 Lace-winged, 205.
 Not a House Fly, 163.
 Robber, 143, 145, 147, 149, 151.
 Scorpion, 209.
 Syrphid, Large, 161.
- Grasshopper—Baby, 57.
 Ear Under its Wing, 63.
 Good to Eat, 61.
 Hearing Organ, 65.
 King, 55.
 Skeleton, 59.
- Harvestman, 49.
Hornet—Bald-faced, 215.
 Queen, 217.
 Yellow Jacket, 219.

- Insects, Feathered, 169.
- Insects, Nerve Winged, 191.
- Insects, Stinging, 213.
- Insects, Straight-winged, 53.
- Insects, Two-winged, 139.

- Katydid, 69.
 - Narrow-winged, 71.
 - Young, 73.

- Locust, Short-winged Green, 67.

- Mantis, Praying, 85.
- Mosquito, Anopheles, 155.
 - Culex, 153.
- Millipede, 257.
- Moth, 181.
 - Not Good to Eat, 183.
 - Spectacle, Hairy, 185.
- Myriapods, 255.

- Spider World, 16.
- Spider — Bird-dropping, 31.
 - Crab, 45.
 - Daddy-long-legs or Harvestman, 49.
- Spider- *-continued.*
 - From a Fly's Point of View, 37.
 - Grass. The Male, 43.
 - Harvestman, or Daddy-long-legs, 49.
 - Jumping, 19, 21, 23.
 - Male, a Mature, 47.
 - Mother Spider and Nest, 39.
 - Orb-weaver with Eggs, 35.
 - Orb-weaving, 33.
 - Spiny-bellied, 29.
 - Vagabond, 41.
 - Wolf-spider, 25.
 - Wolf-spider, Skeleton of, 27.

- Termite, Soldier, 211.

- Wasp — Cow Killer, 229.
 - Fig Insect, 227.
 - Food of a Mud Dauber's Baby, 225.
 - Mud Dauber, 223.
 - Social, 221.
 - Velvet Ant or Cow Killer, 229.
 - Wingless, 229.
- Yellow Jacket, 219.

INDEX TO LATIN NAMES

- Aerosoma gracile*, Walek., 29.
Agelina naevia, Walek., 43.
Agrion maculatum, Beauvois, 203.
Agrymnis cybele, Fab., 173.
Allorhina nitida, Linn., 113, 115.
Anasa tristis, De G., 89.
Anopheles punctipennis, Say, 155.
Apantesis nais attacked by *Empusa*, sp.,
 Dru., 189.
Arctiytas aterrima, Des., 163.
Armadillidium vulgare, Fab., 261.

Blastophaga grossorum, Gray., 227.
Blattella germanica, Linn., 83.
Bombus americanorum, Fab., 233, 239.
 sp., 237.
 vagans, Sm., 231.
Brochymena arborea, Say, 105.

Ceuthophilus uhleri, Scudd., 79.
Chlaenius aestivus, Say, 121.
Chrysopa sp., 205.
Cicada sayi, Grossb., 101.
Coleoptera, 111.
Colias philodice, Gdt., 175.
Copris carolina, Linn., 133.
Corynocoris distinctus, Dallas, 93.
Crypturopsis sp., 251.
Culex sp., 153.

Dasyllis grossa, Fab., 145, 147.
Deromyia, 151.
Diabrotica duodecim punctata, Oliv., 135.
Dicromorpha viridis, Scudd., 67.
Diptera, 139.
Dissosteira carolina, Linn., 63, 65.
Dolomedes tenebrosus, Hentz, 37.

Elaphidion atomarium, Dru., 119.
Emesa longipes, De G., 95.
Epeira domiciliorum, Hentz, 35.
 trivittata, Keys., 33.
 verrucosa, Hentz, 31.
Epicanta marginata, Fab., 127.
Erax astuans, Linn., 143.
Euchaetes egle, Dru., 185.
Eudamus tityrus, Fab., 177.
Euschistus tristigmus, Say, 91.

Formica sp., 245.

Gryllotalpa borealis, Burm., 81.
Gryllus pennsylvanicus, Burm., 75.

Helicoptera variegata, Van D., 109.
Hemiptera, 87.
Hippiscus sp., 55.
Hymenoptera, 213.

Laemosterna quereus, Knoch, 117.
Leibonium grande, Weed, 49.
Lepidoptera, 169.
Libellulid, 197, 199, 201.
Limnobia sp., 141.
Lycosa carolinensis, Walek, 25.
 punctulata, Hentz, 27.
Lygus pratensis, Linn., 107.

Macronia sp., 195.
Mallophora sp., 149.
Megachile brevis, Say, 241, 243.
Melesia virginicensis, Dru., 161.
Monohammus tifilator, Fab., 137.
Mutilla similima, Sm., 229.
Myriapods, 255.
Myrmeleon immaculatus, De G., 207.

Neuroptera, 191.

Orthoptera, 53.
Orthosoma brunneum, Forst., 131.

Panorpa confusa, Westw., 209.
Papilio troilus, Linn., 171.
Paratenodera sinensis, Sauss., 85.
Pardosa milvina, Hentz, 41.
Pelidnota punctata, Linn., 125.
Phidippus audax, Hentz, 19.
 togatus, Koch, 23.
Phymata pennsylvanica, Handl., 103.
Phytonomus punctatus, Fab., 123.
Polistes metrica, Say, 221.
Prionus, sp., 129.
Pselliopus cinctus, Fab., 97, 99.

Scoliphron cementarium, Klug, 223.
Scolopendra sp., 259.

Scudleria sp., 69, 71, 73.
Sparnopolius fulvus, Wied., 157.
Spogostylum simson, Fab., 159.

Tabanus atratus, Forst., 165.
 punctifer, O. S., 167.

Termes flavipes, Koll., 211.

Vespula maculata, Linn., 215, 217.
Vespa carolina, Dru., 219.

Xysticus gulosus, Keys., 45

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