



MOTHS AND BUTTERFLIES



GRASSHOPPERS AND CRICKETS



ANTS AND BEETLES



WASPS, BEES, AND MORE

ANNA COMSTOCK'S

HANDBOOK OF NATURE-STUDY

Handbook of Nature-Study: Insects

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D. GORDON E. ROBERTSON (CC BY-SA 3.0)

Male black swallowtail

The Black Swallow-Tail Butterfly

TEACHER'S STORY

THIS graceful butterfly is a very good friend to the flowers, being a most efficient pollen carrier. It haunts the gardens and sips nectar from all the blossom cups held out for its refreshment; and it is found throughout almost all parts of the United States. The grace of its appearance is much enhanced by the "swallow-tails," two projections from the hind margins of the hind wings. The wings are velvety black with three rows of yellow spots across them, the outer row being little crescents set in the margin of the wing; and each triplet of yellow spots is in the same cell of the wing between the same two veins. The hind wings are more elaborate, for between the two inside rows of yellow spots, there are exquisite metallic blue splashes, more vivid and more sharply outlined toward the inside of the wing and shading off to black at the outside. And just above the inner angle of the hind



Black swallowtail eggs on parsley

wing is an orange eye-spot with a black center. On the lower surface of the wings, most of the yellow spots are replaced with orange.

The mother butterfly is larger than her mate and has more blue on her wings, while he has the yellow markings of the hind wings much more conspicuous. She lays her egg, just the color of a drop of honey, on the under surface of the leaf of the food plant. After about ten days there hatches from this egg a spiny little fellow, black and angular, with a saddle-shaped, whitish blotch in the middle of its back. But it would take an elfin rider to sit in this warty, spiny saddle. The caterpillar has six spines on each segment, making six rows of spines, the whole length of the body; the spines on the black portions are black and those on the saddle white, but they all have orange-colored bases.

When little, spiny saddle-back gets ready to change its skin to one more commodious for its increased size, it seeks some convenient spot on the leaf or stem and spins a little silken carpet from the silk gland opening in its under lip; on this carpet it rests quietly for some time, and then the old tight skin splits down the back, the head portion coming off separately. Swelling out to fill its new skin to the utmost, it leaves its cast-off clothes clinging to the silken carpet and marches back to its supper.

But after one of these changes of skin it becomes a very different looking caterpillar, for now it is as smooth as it was formerly spiny; it is now brilliant caraway green, ornamented with roundwise stripes of velvety black; and set in the front margin of each of these stripes are six yellow spots. In shape, the caterpillar is larger toward the head; its true feet have little, sharp claws and look very different from the four pairs of prolegs and the hind prop-leg, all of which enable him to hold fast to the stem or the leaf; these fat legs are green, each ornamented with a black, velvety polka-dot.

When we were children we spent hours poking these interesting



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Color variations in the black swallowtail caterpillar

creatures with straws to see them push forth their brilliant orange horns. We knew this was an act of resentment, but we did not realize that from these horns was exhaled the nauseating odor of caraway which greeted our nostrils. We incidentally discovered that they did not waste this odor upon each other, for once we saw two of the full-grown caterpillars meet on a caraway stem. Neither seemed to know that the other was there until they touched; then both drew back the head and butted each other like billy-goats, Whack! whack! Then both turned laboriously around and hurried off in a panic.

The scent organs of these caterpillars are really little Y-shaped pockets in the segment back of the head, pockets full of this peculiar caterpillar perfume. Under the stimulus of attack, the pocket is turned wrong side out and pushed far out making the “horns,” and at the same time throwing the strong odor upon the air. This spoils the flavor of these caterpillars as bird food, so they live on in serene peace, never hiding under the leaves but trusting, like the skunk, to a peculiar power of repelling the enemy.

We must admire this caterpillar for the methodical way in which it eats the leaf: Beginning near the base, it does not burn its bridges behind it by eating through the midrib, but eats everything down to the midrib; after it arrives at the tip of the leaf it finishes midrib and all on



SDETWILER (CC BY-SA 4.0)
Black swallowtail chrysalis

its return journey, doing a clean job, and finishing everything as it moves along. (See *Moths and Butterflies*, Dickerson, p. 42.)

When the caterpillar has completed its growth, it is two inches long; it then seeks some sheltered spot, the lower edge of a clapboard or fence rail being a favorite place; it there spins a button of silk which it grasps firmly with its hind prop-leg, and then, with head up, or perhaps horizontal, it spins a strong loop or halter of silk, fastening each end of it firmly to the object on which

it rests. It thrusts its head through, so that the halter acts as a sling holding the insect from falling. There it sheds its last caterpillar skin, which shrinks back around the button, revealing the chrysalis which is angular with ear-like projections in front. Then comes the critical moment, for the chrysalis lets go of the button with its caterpillar feet, and trusting to the sling for support, pushes off the shrunken skin just shed and inserts the hooks, with which it is furnished, firmly in the button of silk. Sometimes during this process, the chrysalis loses its hold entirely and falls to the ground, which is a fatal disaster. The chrysalis is yellowish brown and usually looks very much like the object to which it is attached, and is thus undoubtedly protected from sight of possible enemies. Then some day it breaks open, and from it issues a crumpled mass of very damp insect velvet, which soon expands into a beautiful butterfly.

References— *Everyday Butterflies*, Scudder; *Moths and Butterflies*, Dickerson; *How to Know the Butterflies*, Comstock; *Moths and Butterflies*, Ballard.



KENNETH DWAIN HARRELSON (CC BY-SA 3.0)

A female black swallowtail butterfly

LESSON

Leading thought— The caterpillars of the swallow-tail butterflies have scent organs near the head which they thrust forth when attacked, thus giving off a disagreeable odor which is nauseating to birds.

Method— In September, bring into the schoolroom and place in the terrarium, or breeding cage, a caraway or parsley plant on which these caterpillars are feeding, giving them fresh food day by day, and allow the pupils to observe them at recess and thus complete the lesson.

THE CATERPILLAR AND CHRYSALIS

Observations—

1. Touch the caterpillar on the head with a bit of grass. What does it do? What color are the horns? Where do they come from? Are there two separate horns or two branches of one horn? What odor comes from these horns? How does this protect the caterpillar? Does the caterpillar try to hide under the leaves when feeding? Is this evidence that



GREG HUME (CC BY-SA 3.0)
Side view of female swallowtail

it is not afraid of birds?

2. Describe the caterpillar as follows: What is its shape? Is it larger toward the head or the rear end? What is its ground color? How is it striped? How many black stripes? How many yellow spots in each black stripe? Are the yellow spots in the middle, or at each edge of the stripe?

3. How do the front three pairs of legs look? How do they compare with the prolegs? How many prop-legs are there? What is the color of the prolegs? How are they marked? Describe the prop-leg. What is its use?

4. Observe the caterpillar eating a leaf. How does it manage so as not to waste any?

5. Have you found the egg from which the caterpillar came? What color is it? Where is it laid?

6. How does the young caterpillar look? What are its colors? How many fleshy spines has it on each segment? Are these white on the white segments and black on the black segments? What is the color of the spines at their base?

7. Watch one of these caterpillars shed its skin. How does it prepare for this? How does it spin its carpet? Where does the silk come from? Describe how it acts when shedding its skin.

8. When a caterpillar is full grown, how does it hang itself up to change to a chrysalis? How does it make the silk button? How does it weave the loop or halter? How does it fasten it? When the halter is woven what does the caterpillar do with it? Describe how the last caterpillar skin is shed. How does the insect use its loop or halter while getting free from the molted skin?

9. Describe the chrysalis. What is its general shape? What is its

color? Is it easily seen? Can you see where the wings are, within the chrysalis? How is the chrysalis supported?

10. How does the chrysalis look when the butterfly is about to emerge? Where does it break open? How does the butterfly look at first?

THE BUTTERFLY

1. Why is this butterfly called the black swallow-tail? What is the ground color of the wings? How many rows of yellow spots on the front wings? Are they all the same shape? How are they arranged between each two veins? Describe the hind wings. What colors are on them that are not on the front wings? Describe where this color is placed. Describe the eye-spot on the hind wing. Where is it? How do the markings on the lower side of the wing differ from those above? How does the ground color differ from the upper side?

2. What is the color of the body of the butterfly? Has it any marks? Has it the same number of legs as the Monarch? Describe its antennae. Watch the butterfly getting nectar from the petunia blossom and describe the tongue. Where is the tongue when not in use?

3. How does the butterfly pass the winter? How does the mother butterfly differ in size and in markings from her mate?

“The ‘caraway worms’ were the ones that revealed to us the mystery of the pupa and butterfly. We saw one climb up the side of a house, and watched it as with many slow, graceful movements of the head, it wove for itself the loop of silk which we called the ‘swing’ and which held it in place after it changed to a chrysalis. We wondered why such a brilliant caterpillar should change to such a dull-colored object, almost the color of the clapboard against which it hung. Then, one day, we found a damp, crumpled, black butterfly hanging to the empty chrysalis skin, its wings ‘all mussed’ as we termed it; and we gazed at it pityingly; but even as we gazed, the crumpled wings expanded and then there came to our childish minds a dim realization of the miracle wrought within that little, dingy, empty shell.”

—HOW TO KNOW THE BUTTERFLIES, COMSTOCK.



The Katydid

TEACHER'S STORY

*"I love to hear thine earnest voice
Wherever thou art hid,
Thou testy little dogmatist,
Thou pretty katydid,*

*Thou mindest me of gentle folks,
Old gentle folks are they,
Thou say'st an undisputed thing
In such a solemn way."*

—HOLMES.



DISTANCE, however, lends enchantment to the song of the katydid, for it grates on our nerves as well as on our ears, when at close quarters. The katydid makes his music in a manner similar to that of the cricket but is not, however, so well equipped since he has only one file and only one scraper for playing. As with the meadow grasshoppers and crickets, only the males make the music, the wings of the females being delicate and normally veined at the base. The ears, too, are in the same position as those of the cricket, and may be seen as a black spot in the front el-

bow. The song is persistent and may last the night long: “Katy did, she didn’t she did.” James Whitcomb Riley says, “The katydid is rasping at the silence,” and the word rasping well describes the note.

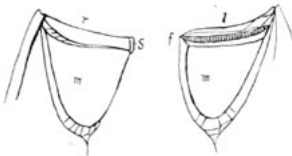
The katydids are beautiful insects, with green, finely veined, leaf-like



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Katydid eggs attached in rows to a plant stem

wing-covers under which is a pair of well developed wings, folded like fans; they resemble in form the long-horned grasshoppers. The common northern species (*Cyrtophyllus*) is all green above except for the long, delicate, fawn-colored antennae and the brownish fiddle of the male, which consists of a flat triangle just back of the thorax where the wing-covers overlap. Sometimes this region is pale brown and sometimes green, and with the unaided eye we can plainly see the strong



The front portions of the wings of a male katydid showing file on one wing and scraper on the other.

cross-vein, bearing the file. The green eyes have darker centers and are not so large as the eyes of the grasshopper. The body is green with white lines below on either side.

There is a suture the length of the abdomen in which are placed the spiracles. The insect breathes by sidewise expansion and contraction, and the sutures rhythmically open and shut; when they are open, the spiracles can be seen as black dots. The legs are slender and the hind pair, very long. The feet are provided with two little pads, one on each side of the base of the claw. In the grasshopper there is only one pad which is placed between the two hooks of the claw. The female has a green, sickle-shaped ovipositor at the end of the body. With this she lays her flat, oval eggs, slightly over-lapping in a neat row.



DIDIER DESCOUENS (CC BY-SA 4.0)

The katydids are almost all dwellers in trees and shrubs; although I have often found our common species upon asters and similar high weeds. The leaf-like wings of these insects are, in form and color, so similar to the leaves that they are very completely hidden. The katydid is rarely discovered except by accident; although when one is singing, it may be approached and ferreted out with the aid of a lantern.

The katydid, when feeding, often holds the leaf or the flower firmly with the front feet, while biting it off like a grazing cow, and if it is tough, chews it industriously with the sidewise working jaws. A katydid will often remain quiet a long time with one long antenna directed forward and the other backward, as if on the lookout for news from the front and the rear. But when the katydid “cleans up,” it does a thorough job. It nibbles its front feet, paying special attention to the pads, meanwhile holding the foot to its mandibles with the aid of the palpi. But once washing is not enough; I have seen a katydid go over the same foot a dozen times in succession, beginning always with the hind spurs of the tibia and nibbling along the tarsus to the claws. It cleans its face with its front foot, drawing it downward over the eye and then licking it clean. It cleans its antenna with its mandibles by beginning at the base and drawing it up in a loop as fast as finished. After watching the pro-



The angular-winged katydid and her eggs

cess of these lengthy ablutions, we must conclude that the katydid is among the most fastidious members of the insect "four hundred."

References— *Manual for Study of Insects*, Comstock; *American Insects*, Kellogg; *Ways of Six Footed*, Comstock; *Grasshopper Land*, Morley.

LESSON

Leading thought— The katydids resemble the long-horned grasshoppers and the crickets. They live in trees, and the male sings "katydid" by means of a musical instrument similar to that of the cricket.

Method— Place a katydid in a cricket cage in the schoolroom, giving it fresh leaves or flowers each day, and encouraging the pupils to watch it at recess. It may be placed in a vial and passed around, for close observation. In studying this insect, use the lesson on the red-legged grasshopper and also that on the cricket. These lessons will serve to call the attention of the pupils to the differences and resemblances between the katydid and these two allied insects.



The House-Fly

TEACHER'S STORY



THE house-fly is surely an up-to-date member of that select class which evolutionists call the "fit." It flourishes in every land, plumping itself down in front of us at table, whether we be eating rice in Hong Kong, dhura in Egypt, macaroni in Italy, pie in America, or tamales in Mexico. There it sits, impertinent and imperturbable, taking its toll, letting down its long elephant-trunk tongue, rasping and sucking up such of our meal as fits its needs. As long as we simply knew it as a thief we, during untold ages, merely slapped it and shooed it, which effort on our part apparently gave it exhilarating exercise. But during recent years we have begun trapping and poisoning, trying to match our brains against its agility; although we slay it by thousands, we seem only to make more room for its well-fed progeny of the future, and in the end we seem to have gained nothing. But the most recent discoveries of science have revealed to us, that what the house-fly takes of our food, is of little con-

sequence to what it leaves behind. Because of this, we have girded up our loins and gone into battle in earnest.

I have always held that nature-study should follow its own peaceful path and not be the slave of economic science. But occasionally it seems necessary, when it is a question of creating public sentiment, and of cultivating public intelligence in combating a great peril, to make nature-study a handmaiden, if not a slave, in this work.

If our woods were filled with wolves and bears, as they were in the days of my grandfather, I should give nature-study lessons on these animals, which would lead to their subjugation. Bears and wolves trouble us no more; but now we have enemies far more subtle, in the ever-present microbes, which we may never hope to conquer but which, with proper precautions, we may render comparatively harmless. Thus, our nature-study with insects which carry disease, like the mosquitoes, flies and fleas, must be a reconnaissance for a war of extermination; the fighting tactics may be given in lessons on health and hygiene.

Perhaps if a fly were less wonderfully made, it would be a less convenient vehicle for microbes. Its eyes are two great, brown spheres on either side of the head, and are composed of thousands of tiny six-sided eyes that give information of what is coming in any direction; in addition, it has on top of the head, looking straight up, three tiny,



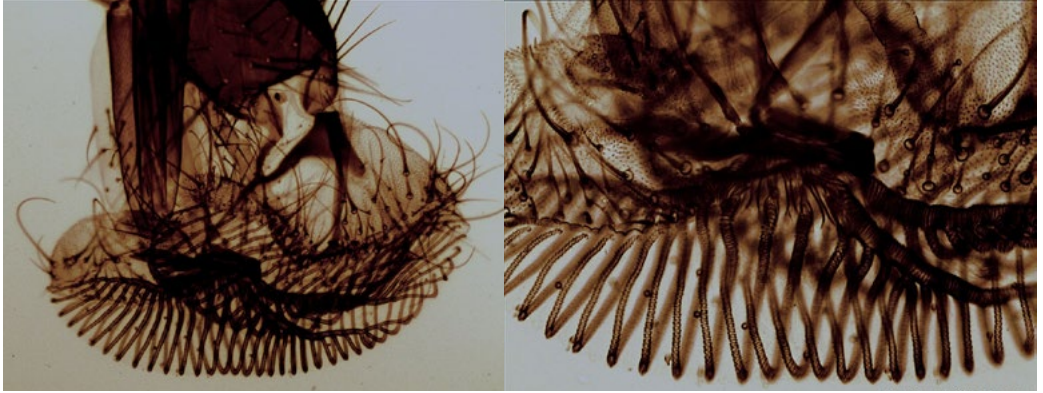
SANJAY ACHARYA (CC BY-SA 4.0)
The eyes and head of a housefly



Head of fly showing eyes, antennae and mouth-parts



ROBERT D. ANDERSON (CC BY-SA 3.0)
A micrograph of the foot of house-fly

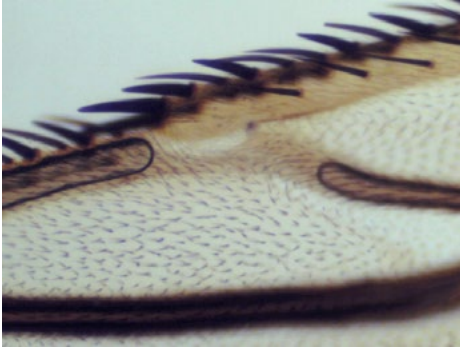


JOHN ALAN ELSON (CC BY-SA 4.0)

A housefly mouth magnified 40x and 100x

shining, simple eyes, which cannot be seen without a lens. Its antennae are peculiar in shape, but are evidently sense organs; it is attracted from afar by certain odors, and so far as we can discover, its antennae are all the nose it has. Its mouth-parts are all combined to make a most amazing and efficient organ for getting food; at the tip are two flaps, which can rasp a substance so as to set free the juices, and above this is a tube, through which the juices may be drawn to the stomach. This tube is extensible, being conveniently jointed so that it can be folded under the “chin” when not in use. This is usually called the fly’s tongue, but it is really all the mouth parts combined, as if a boy had his lips, teeth and tongue, standing out from his face, at the end of a tube a foot long.

The thorax can be easily studied; it is striped black and white above and bears the two wings, and the two little flaps that are called balancers and which are probably remnants of hind wings which the remote ancestors of flies flew with. The fly’s wing is a transparent but strong membrane strengthened by veins, and is prettily iridescent. The thorax bears on its lower side the three pairs of legs. The abdomen consists of five segments and is covered with stiff hairs. The parts of the leg, seen when the fly is walking, consists of three segments, the last segment or tarsus being more slender, and if looked at with a lens, is seen to be composed of five segments, the last of which bears the claws; it is with these claws that the fly walks, although all of the five segments really form the foot; in other words, it walks on its tip-toes. But it clings to ceilings by means of the two little pads below the claws, which are cov-



AMANDA TEAR (CC BY-SA 4.0)
House-fly wing magnified 250x

ered with hairs that excrete at the tips, a sticky fluid. Because of the hairs on its feet, the fly becomes a carrier of microbes and a menace to health.

The greatest grudge I have against this little, persistent companion of our household is the way it has misled us by appearing to be so fastidious in its personal

habits. We have all of us seen, with curiosity and admiration, its complex ablutions and brushings. It usually begins, logically, with its front feet, the hands; these it cleans by rubbing them against each other lengthwise. The hairs and spines on one leg act as a brush for the other, and then lest they be not clean, it nibbles them with its rasping disc, which is all the teeth it has. It then cleans its head with these clean hands, rubbing them over its big eyes with a vigor that makes us wink simply to contemplate; then bobbing its head down so as to reach what is literally its back hair, it brushes valiantly. After this is done, it reaches forward first one and then the other foot of the middle pair of legs, and taking each in turn between the front feet, brushes it vigorously, and maybe nibbles it. But as a pair of military brushes, its hind feet are conspicuously efficient; they clean each other by being rubbed together and then they work simultaneously on each side in cleaning the wings, first the under side and then the upper side. Then over they come and comb the top of the thorax; then they brush the sides, top and under sides of the abdomen, cleaning each other between the acts. Who, after witnessing all this, could believe that the fly could leave any tracks on our food, which would lead to our undoing! But the house-fly, like many housekeepers with the best intentions in the matter of keeping clean, has not mastered the art of getting rid of the microbes. Although it has so many little eyes, none of them can magnify a germ so as to make it visible; and thus it is that, when feeding around where there have been cases of typhoid and other enteric diseases, the house-fly's lit-



Empty pupa skin of fly, enlarged



These pupae were killed by parasitic wasp larvae

tle claws become infested with disease germs; and when it stops some day to clean up on our table, it leaves the germs with us. Thus our only safety lies in the final extermination of this little nuisance.

It is astonishing how few people know about the growth of flies. People of the highest intelligence in other matters,

think that a small fly can grow into a large one. A fly, when it comes from the pupa stage, is as large as it will ever be, the young stages of flies being maggots. The house-fly's eggs are little, white, elongated bodies about as large as the point of a pin. These are laid preferably in horse manure. After a few hours, they hatch into slender, pointed, white maggots which feed upon the excrement. After five or six days, the larval skin thickens, turns brown, making the insect look like a small grain of wheat. This is the pupal stage, which lasts about five days, and then the skin bursts open and the full-grown fly appears. Of course, not all the flies multiply according to the example given to the children. The house-fly has many enemies and, therefore, probably no one hibernating mother fly is the ancestress of billions by September; however, despite enemies, flies multiply with great rapidity.

I know of no more convincing experiment as an example of the dangerous trail of the fly, than that of letting a house-fly walk over a saucer of nutrient gelatin. After three or four days, each track is plainly visible as a little white growth of bacteria.

Much is being done now to eradicate the house-fly, and undoubtedly there will be new methods of fighting it devised every year. The teacher should keep in touch with the bulletins on this subject published by the United States Department of Agriculture, and should give the pupils instructions according to the latest ideas. At present the following are the methods of fighting this pest: Keep the stable clean and place the manure under cover. All of the windows of the house should be well screened. All the flies which get into the house should be killed by using the commercial fly papers.

LESSON

Leading thought— The house-fly has conquered the world and is found everywhere. It breeds in filth and especially in horse manure. It is very prolific; the few flies that manage to pass the winter in this northern climate, are ancestors of the millions which attack us and our food later in the season. These are a menace to health because they carry germs of disease from sputa and excrementitious matter to our tables, leaving them upon our food.



PAVEL KROK (CC BY-SA 3.0)
Housefly larva

Method— Give out the questions for observation and let the pupils answer them either orally or in their note-books. If possible, every pupil should look at a house-fly through a three-quarters objective. If this is not possible, pictures should be shown to demonstrate its appearance.

Observations—

1. Look at a fly, using a lens if you have one. Describe its eyes. Do you see that they have a honeycomb arrangement of little eyes? Can you see, on top of the head between the big eyes, a dot? A microscope reveals this dot to be made of three tiny eyes, huddled together. After seeing a fly's eyes, do you wonder that you have so much difficulty in hitting it or catching it?

2. Can you see the fly's antennae? Do you think that it has a keen sense of smell? Why?

3. How many wings has the fly? How does it differ from the bee in this respect? Can you see two little white objects, one just behind the base of each wing? These are called poisers, or balancers, and all flies have them in some form. What is the color of the wings? Are they transparent? Can you see the veins in them? On what part of the body do the wings grow?

4. Look at the fly from below. How many legs has it? From what part of the body do the legs come? What is that part of the insect's body called, to which the legs and wings are attached?

5. How does the fly's abdomen look? What is its color and its covering?

6. Look at the fly's legs. How many segments can you see in a leg? Can you see that the segment on which the fly walks has several joints? Does it walk on all of these segments or on the one at the tip?

7. When the fly eats, can you see its tongue? Can you feel its tongue when it rasps your hand? Where does it keep its tongue usually?

8. Describe how a fly makes its toilet as follows: How does it clean its front feet? Its head? Its middle feet? Its hind feet? Its wings?

9. Do you know how flies carry disease? Did you ever see them making their toilet on your food at the table? Do you know what diseases are carried by flies? What must you do to prevent flies from bringing disease to your family?

10. Do you think that a small fly ever grows to be a large fly? How do the young of all kinds of flies look? Do you know where the house-fly lays its eggs? On what do the maggots feed? How long before they change to pupae? How long does it take them to grow from eggs to flies? How do the house-flies in our northern climate pass the winter?

11. *Lesson in Arithmetic*— It requires perhaps twenty days to span the time from the eggs of one generation of the house-fly to the eggs of the next, and thus there might easily be five generations in one summer. Supposing the fly which wintered behind the window curtain in your home last winter, flew out to the stables about May 1st and laid 120 eggs in the sweepings from the horse stable, all of which hatched and matured. Supposing one-half of these were mother flies and each of them, in turn, laid 120 eggs, and so on for five generations, all eggs laid developing into flies, and one-half of the flies of each generation being mother flies. How many flies would the fly that wintered behind your curtain have produced by September?

12. Pour some gelatin unsweetened, on a clean plate. Let a house-fly walk around on the gelatin as soon as it is cool; cover the plate to keep out the dust and leave it for two or three days. Examine it then and see if you can tell where the fly walked. What did it leave in its tracks?

13. Write an essay on the house-fly, its dangers and how to combat it, basing the essay on *Bulletins of the U. S. Department of Agriculture*.