



INTRO TO NATURE-STUDY



BIRD STUDY



INSECT STUDY



PLANT STUDY

ANNA COMSTOCK'S

# HANDBOOK OF NATURE-STUDY

# Handbook of Nature-Study:

## Introductions to Nature-Study

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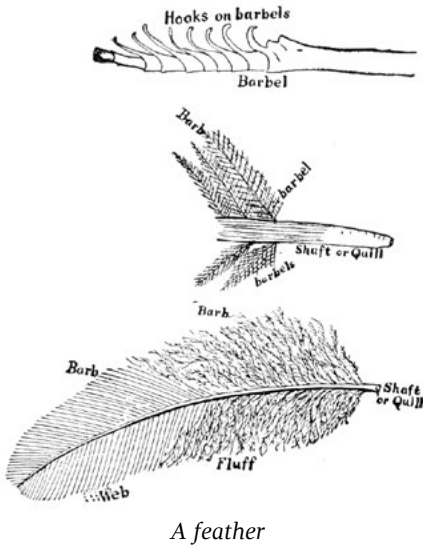
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# Feathers as Clothing

## TEACHER'S STORY

THE bird's clothing affords a natural beginning for bird study because the wearing of feathers is a most striking character distinguishing birds from other creatures; also, feathers and flying are the first things the young child notices about birds.

The purpose of all of these lessons on the hen are: (a) To induce the child to make continued and sympathetic observations on the habits of the domestic birds. (b) To cause him involuntarily to compare the domestic with the wild birds. (c) To induce him to think for himself why the shape of the body, wings, head, beak, feet, legs and feathers are adapted in each species to protect the bird and assist it in getting its living.



The overlapping of the feathers on a hen's back and breast is a pretty illustration of nature's method of shingling, so that the rain, finding no place to enter, drips off, leaving the bird's underclothing quite dry. It is interesting to note how a hen behaves in the rain; she droops her tail and holds herself so that the water finds upon her no resting place, but simply a steep surface down which to flow to the ground.

Each feather consists of three parts, the shaft or quill, which is the central stiff stem of the feather, giving it strength. From this quill come off the barbs which, toward the outer end, join together in a smooth web, making the thin, fan-like portion of the feather; at the base is the fluff, which is soft and downy and near to the body of the fowl. The teacher should put on the blackboard this figure so that incidentally the pupils may learn the parts of a feather and their struc-



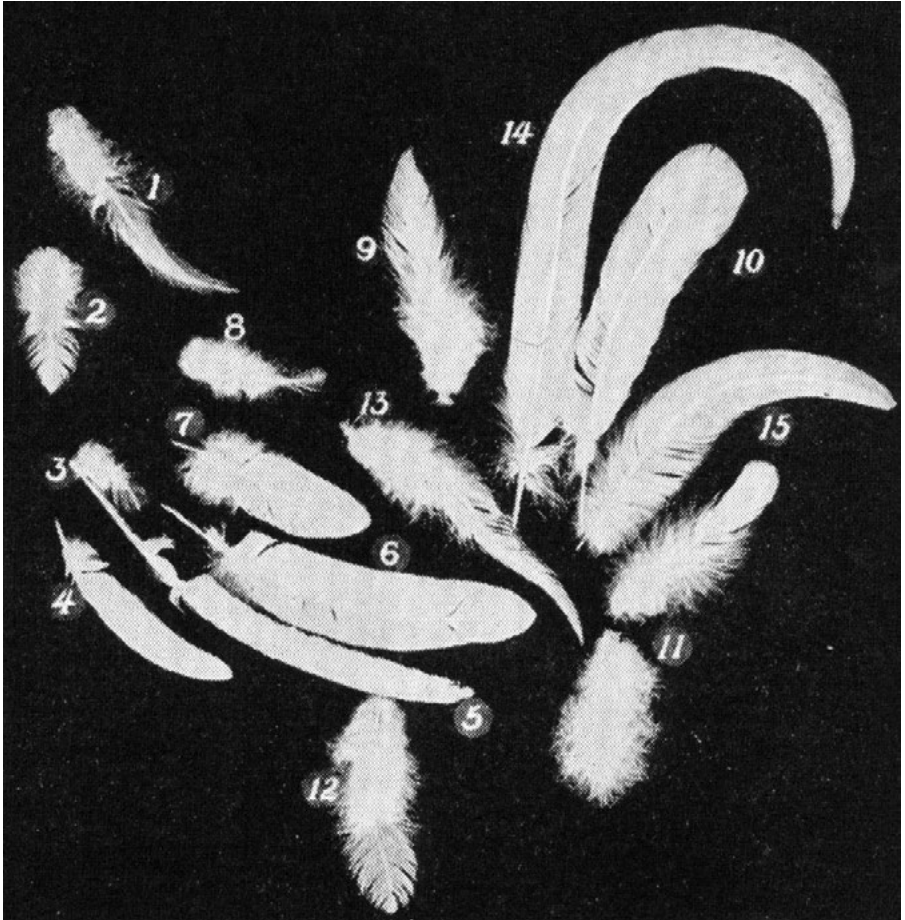
*Feathers help birds to endure the cold.*

ture. If a microscope is available, show both the web and the fluff of a feather under a three-fourths objective.

The feathers on the back of a hen are longer and narrower in proportion than those on the breast and are especially fitted to protect the back from rain; the breast feathers are shorter and have more of the fluff, thus protecting the breast from the cold as well as the rain. It is plain to any child that the soft fluff is comparable to our woolen underclothing while the smooth, overlapping web forms a rain and wind-proof outer coat. Down is a feather with no quill; young chicks are covered with down. A pin-feather is simply a young feather rolled up in a sheath, which bursts later and is shed, leaving the feather free to assume its form. Take a large pin-feather and cut the sheath open and show the pupils the young feather lying within.

When a hen oils her feathers it is a process well worth observing. The oil gland is on her back just at the base of the tail feathers; she squeezes the gland with her beak to get the oil and then rubs the beak over the surface of her feathers and passes them through it; she spends more time oiling the feathers on her back and breast than those on the other parts, so that they will surely shed water. Country people say when the hen oils her feathers, it is a sure sign of rain. The hen sheds her feathers once a year and is a most untidy looking bird meanwhile,

a fact that she seems to realize, and is as shy and cross as a young lady caught in company in curl papers; but she seems very pleased with herself when she finally gains her new feathers.



*Feathers of a rooster, showing their relative size, shape and position.*

1. neck hackle; 2. breast; 3. wing shoulder covert; 4. wing flight covert; 5. wing primary; 6. wing secondary; 7. wing covert; 8. back; 9. tail covert; 10. main tail; 11. fluff; 12. thigh; 13. saddle hackle; 14. the sickle or feather of beauty; 15. lesser sickle.

## LESSON

*Leading thought*— Feathers grow from the skin of a bird and protect the bird from rain, snow, wind and cold. Some of the feathers act as cloaks or mackintoshes and others as underclothing.

*Method*— The hen should be at close range for this lesson where the children may observe how and where the different kinds of feathers grow. The pupils should also study separately the form of a feather from the back, from the breast, from the under side of the body, and a pin-feather.



*Pelicans are born naked, but are soon covered with white down.*

### *Observations*—

1. How are the feathers arranged on the back of the hen? Are they like shingles on the roof? If so, what for?
2. How does a hen look when standing in the rain?
3. How are the feathers arranged on the breast?
4. Compare a feather from the back and one from the breast and note the difference.
5. Are both ends of these feathers alike? If not, what is the difference?
6. Is the fluffy part of the feather on the outside or next to the bird's skin? What is its use?
7. Why is the smooth part of the feather (the web) on the outside?
8. Some feathers are all fluff and are called "down." At what age was the fowl all covered with down?
9. What is a pin-feather? What makes you think so?
10. How do hens keep their feathers oily and glossy so they will shed water?



11. Where does the hen get the oil? Describe how she oils her feathers and which ones does she oil most? Does she oil her feathers before a rain?

*“How beautiful your feathers be!”  
The Redbird sang to the Tulip-tree  
New garbed in autumn gold.  
“Alas!” the bending branches sighed,  
“They cannot like your leaves abide  
To keep us from the cold!”*

—JOHN B. TABB.



GEEK2NURSE (CC BY 2.0)

*Not a candidate for a beauty contest...  
Look at the pin feathers!*

## Feathers as Ornament

### ***TEACHER'S STORY***

THE ornamental plumage of birds is one of the principal illustrations of a great principle of evolution. The theory is that the male birds win their mates because of their beauty, those that are not beautiful being doomed to live single and leave no progeny to inherit their dullness. On the other hand, the successful wooer hands down his beauty to his sons. However, another quite different principle acts upon the coloring of the plumage of the mother birds; for if they should develop bright colors themselves, they would attract the eyes of the enemy to their precious hidden nests; only by being inconspicuous, are they able to protect their eggs and nestlings from discovery and death. The mother partridge, for instance, is so nearly the color of the dead leaves



*Peacock feathers. Is beauty useful?*

on the ground about her, that we may almost step upon her before we discover her; if she were the color of the oriole or tanager she would very soon be the center of attraction to every prowler. Thus, it has come about that among the birds the feminine love of beauty has developed the gorgeous colors of the males, while the need for protection of the home has kept the female plumage modest and unnoticeable.

The curved feathers of the rooster's tail are weak and mobile and could not possibly be of any use as a rudder; but they give grace and beauty to the fowl and cover the useful rudder feathers underneath by a feather fountain of iridescence. The neck plumage of the cock is also often luxurious and beautiful in color and quite different from that of the hen. Among the ducks the brilliant blue-green iridescent head of the drake and his wing bars are beautiful, and make his wife seem Quaker-like in contrast.

As an object lesson to instil the idea that the male bird is proud of his beautiful feathers, I know of none better than that presented by the turkey gobbler, for he is a living expression of self-conscious



JATIN SINDHU (CC BY 4.0)

*A peacock showing off its colors*

vanity. He spreads his tail to the fullest extent and shifts it this way and that to show the exquisite play of colors over the feathers in the sunlight, meanwhile throwing out his chest to call particular attention to his blue and red wattles; and to keep from bursting with pride he bubbles over in vainglorious “gobbles.”

The hen with her chicks and the turkey hen with her brood, if they follow their own natures, must wander in the fields for food. If they were bright in color, the hawks would soon detect them and their chances of escape would be small; this is another instance of the advantage to the young of adopting the colors of the mother rather than of the father; a fact equally true of the song birds in cases where the males are brilliant in color at maturity. The Baltimore oriole does not assist his mate in brooding, but he sits somewhere on the home tree and cheers her by his glorious song and by glimpses of his gleaming orange coat. Some have accused him of being lazy; on the contrary, he is a wise householder for, instead of attracting the attention of crow or squirrel to his nest, he distracts their attention from it by both color and song.

A peacock's feather should really be a lesson by itself, it is so much a thing of beauty. The brilliant color of the purple eye-spot, and the

graceful flowing barbs that form the setting to the central gem, are all a training in aesthetics as well as in nature-study. After the children have studied such a feather let them see the peacock either in reality or in picture and give them stories about this bird of Juno; a bird so inconspicuous if it were not for his great spread of tail, that a child seeing it first cried, "Oh, oh, see this old hen all in bloom!"

The whole question of sexual selection may be made as plain as need be for the little folks, by simply telling them that the mother bird chooses for her mate the one which is most brightly and beautifully dressed, and make much of the comb and wattles of the rooster and gobbler as additions to the brilliancy of their appearance.

### LESSON

*Leading thought*—The color of feathers and often their shape are for the purpose of making birds more beautiful; while in others, the color of the feathers protects them from the observation of their enemies.

*Methods*—While parts of this lesson relating to fowls, may be given in primary grades, it is equally fitted for pupils who have a wider knowledge of birds. Begin with a comparison of the plumage of the hen and the rooster. Then, if possible, study the turkey gobbler and a peacock in life or in pictures. Also the plumage of a Rouen duck and drake, and if possible, the Baltimore oriole, the goldfinch, the scarlet tanager and the cardinal.

*Observations*—

1. Note difference in shape and color of the tail feathers of hen and rooster.

2. Do the graceful curved tail feathers of the rooster help him in flying? Are they stiff enough to act as a rudder?

3. If not of use in flying what are they for? Which do you think the more beautiful: the hen or the rooster?

4. In what respects is the rooster a more beautiful fowl?

5. What other parts of the rooster's plumage is more beautiful than that of the hen?

6. If a turkey gobbler sees you looking at him he begins to strut. Do you think he does this to show off his tail feathers? Note how he turns his spread tail this way and that so the sunshine will bring out

the beautiful changeable colors. Do you think he does this so you can see and admire him?

7. Describe the difference in plumage between the hen turkey and the gobbler. Does the hen turkey strut?

8. Note the beautiful blue-green iridescent head and wing patches on the wings of the Rouen ducks. Is the drake more beautiful than the duck?

9. What advantage is it for these fowls to have the father bird more beautiful and bright in color than the mother bird?

10. In case of the Baltimore oriole is the mother bird as bright in color as the father bird? Why?

11. Study a peacock's feather. What color is the eye-spot? What color around that? What color and shape are the outside barbs of the feather? Do you blame a peacock for being proud when he can spread a tail of a hundred eyes? Does the peahen have such beautiful tail feathers as the peacock?

*The bird of Juno glories in his plumes;  
Pride makes the fowl to preene his feathers so.  
His spotted train fetched from old Argus' head,  
With golden rays like to the brightest sun,  
Inserteth self-love in the silly bird;  
Till midst its hot and glorious fumes  
He spies his feet and then lets fall his plumes.*  
—“THE PEACOCK”, ROBERT GREENE (1560).



CHARLES J SHARP (CC BY 4.0)

*Common tern. While we are having winter this bird spends the summer in South America.  
It will return to spend our summer with us*

## How Birds Fly

### **TEACHER'S STORY**

TO convince the children that a bird's wings correspond to our arms, they should see a fowl with its feathers off, prepared for market or oven, and they will infer the fact at once.

The bird flies by lifting itself through pressing down upon the air with its wings. There are several experiments which are needed to make the child understand this. It is difficult for children to conceive that the air is really anything, because they cannot see it; so the first experiment should be to show that the air is something we can push against or that pushes against us. Strike the air with a fan and we feel there is something which the fan pushes; we feel the wind when it is blowing and it is very difficult for us to walk against a hard wind. If we hold an open umbrella in the hand while we jump from a step we feel buoyed up because the umbrella presses down upon the air. The bird presses down upon the air with the wings, just as the open umbrella does. The bird flies by pressing down upon the air with its wings just as a boy jumps high by pressing down with his hands on his vaulting pole.



*A hens wing outstretched showing primaries and secondaries of the wing and the overlapping of the feathers.*

Study wing and note: (a) That the wings open and close at the will of the bird. (b) That the feathers open and shut on each other like a fan. (c) When the wing is open the wing quills overlap, so that the air cannot pass through them. (d) When the wing is open it is curved so that it is more efficient, for the same reason that an umbrella presses harder against the atmosphere when it is

open than when it is broken by the wind and turned wrong side out.

A wing feather has the barbs on the front edge lying almost parallel to the quill while those on the hind edge come off at a wide angle. The reason for this is easy to see, for this feather has to cut the air as the bird flies; and if the barbs on the front side were like those of the other side they would be torn apart by the wind. The barbs on the hind side of the feather form a strong, close web so as to press down on the air and not let it through. The wing quill is curved; the convex side is up and the concave side below during flight. The concave side, like the umbrella, catches more air than the upper side; the down stroke of the wing is forward and down; while on the up stroke, as the wing is lifted, it bends at the joint like a fan turned sidewise, and offers less surface to resist the air. Thus, the up stroke does not push the bird down.



Observations should be made on the use of the bird's tail in flight. The hen spreads her tail like a fan when she flies to the top of the fence; the robin does likewise when in flight. The fact that the tail is used as a rudder to guide the bird in flight, as well as to give more surface for pressing down upon the air, is hard for the younger pupils to understand, and perhaps can be best taught by watching the erratic unbalanced flight of young birds whose tail feathers are not yet grown.

The tail feather differs from the wing feather in that the quill is not curved, and the barbs on each side are of about equal length and lie at about the same angle on each side the quill.

*References*—The Bird Book, Eckstorm, pp. 75-92; Story of the Birds, Baskett, pp. 171-176; Bird Life, Chapman, p. 18; The Bird, Beebe, Ch. XIII; First Book of Birds, Miller.

### LESSON

*Leading thought*—A bird flies by pressing down upon the air with its wings, which are made especially for this purpose. The bird's tail acts as a rudder during flight.

*Method*—The hen, it is hoped, will by this time be tame enough so that the teacher may spread open her wings for the children to see. In addition, have a detached wing of a fowl such as are used in farm houses instead of a whisk-broom.

*Observations*—

1. Do you think a bird's wings correspond to our arms? If so why?
2. Why do birds flap their wings when they start to fly?
3. Can you press against the air with a fan?
4. Why do you jump so high with a vaulting pole? Do you think the bird uses the air as you use the pole?
5. How are the feathers arranged on the wing so that the bird can use it to press down on the air?
6. If you carry an umbrella on a windy morning, which catches more wind, the under or the top side? Why is this? Does the curved surface of the wing act in the same way?
7. Take a wing feather. Are the barbs as long on one side of the quill as on the other? Do they lie at the same angle from the quill on both sides? If not why?

8. Which side of the quill lies on the outer side and which on the inner side of the wing?

9. Is the quill of the feather curved?

10. Which side is uppermost in the wing, the convex or the concave side? Take a quill in one hand and press the tip against the other. Which way does it bend easiest, toward the convex or the concave side? What has this to do with the flight of the bird?

11. If the bird flies by pressing the wings against the air on the down stroke, why does it not push itself downward with its wings on the up stroke?

12. What is the shape and arrangement of the feathers so as to avoid pushing the bird back to earth when it lifts its wings?

13. Why do you have a rudder to a boat?

14. Do you think a bird could sail through the air without something to steer with? What is the bird's rudder?

15. Have you ever seen a young bird whose tail is not yet grown, try to fly? If so, how did it act?

16. Does the hen when she flies keep the tail closed or open like a fan?

17. Compare a tail feather with a wing feather and describe the difference.



## The Life History of Insects



INSECTS are among the most interesting and available of all living creatures for nature-study. The lives of many of them afford more interesting stories than are found in fairy lore; many of them show exquisite colors and, more than all, they are small and are, therefore, easily confined for observation.

While the young pupils should not be drilled in insect anatomy, as if they were embryo zoologists, yet it is necessary for the teacher, who would teach intelligently, to know something of the life stories, habits and structure of the common insects. Generally speaking, all insects develop from eggs. To most of us the word egg brings before us the picture of the egg of the hen or of some other bird. But insect eggs are often far more beautiful than those of any bird; they are of widely differing forms, and are often exquisitely colored and the shells may be ornately ribbed and pitted, sometimes adorned with spines, and are as beautiful to look at through a microscope as the most artistic piece of mosaic.

From the eggs, larvae (*sing. larva*) issue. These larvae may be cater-



*The egg of the cotton moth, greatly enlarged.*

pillars, or the creatures commonly called worms, or may be maggots or grubs. The larval stage is always devoted to feeding and to growth. It is the chief business of the larva to eat diligently and to attain maturity as soon as possible; for often the length of the larval period depends more upon food than upon lapse of time. All insects have their skeletons on the outside of the body; that is, the outer covering of the body is chitinous, and the soft and inner parts are attached to it and supported by it. This skin is so firm that it cannot stretch to accommodate the increasing size of the growing insect, thus from time to time it is shed. But before this is done, a new skin is formed beneath the old one. After the old skin bursts open and the insect crawls forth, the new skin is sufficiently soft and elastic to allow for the increase in the size of the insect. Soon, the new skin becomes hardened like the old



*Caterpillar of the monarch butterfly*



*Butterfly chrysalis*

one, and after a time, is shed. This shedding of the skin is called molting. Some insects shed their skins only four or five times during the period of attaining their growth, while other species may molt twenty times or more.

After the larva has attained its full growth, it changes its skin and its form, and becomes a pupa. The pupa stage is ordinarily one of inaction, except that very wonderful changes take place within the body itself. Usually the pupa has no power of moving around, but in many cases it can squirm somewhat, if disturbed. The pupa of the mosquito is active and is an exception to the rule. The pupa is usually an oblong object and seems to be without head, feet or wings; but if it is examined closely, especially in the case of butterflies and moths, the antennae, wings and legs may be seen, folded down beneath the pupa skin.



*Mosquito larvae and one pupa, one of the only active pupa* JAMES GATHANY (CC BY 2.5)



*A luna moth.*

The delicate, exquisite green of the luna's wings is set off by the rose-purple, velvet border of the front wings, and the white for on the body and inner edge of the hind wings. Little wonder that it has been called the "Empress of the night". The long swallow tail of the hind wings give the moth a most graceful shape, at the same time probably afford it protection from observation. During the day time the moth hangs wings down beneath the green leaves, and these long projections of the hind wings folded together resemble a petiole, making the insect look very much like a large leaf

Many larvae, especially those of moths, weave about themselves a covering of silk which serves to protect them from their enemies and the weather, during the helpless pupa period. This silken covering is called a cocoon. The larvae of butterflies do not make a silken cocoon, but the pupa is suspended to some object by a silken knob, and in some cases by a halter of silk, and remains entirely naked. The pupa of a butterfly is called a chrysalis. Care should be taken to have the children



BEATRIZ MOISSET (CC BY-SA 4.0)

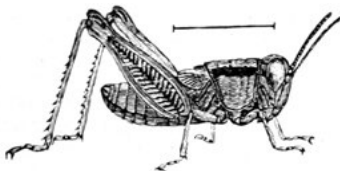
*An adult Ichneumonid wasp emerging from a cocoon*

use the words—pupa, chrysalis and cocoon—understandingly.

After a period varying from days to months, depending upon the species of insect and the climate, the pupa skin bursts open and from it emerges

the adult insect, often equipped with large and beautiful wings and always provided with six legs and a far more complex structure of body than characterized it as a larva. The insect never grows after it reaches this adult stage and, therefore, never molts. Some people seem to believe that a small fly will grow into a large fly, and a small beetle into a large beetle; but after an insect attains its perfect wings, it does not grow larger. Many adult insects take very little food, although some continue to eat in order to support life. The adult stage is ordinarily shorter than the larval stage; it seems a part of nature's economic plan that the grown-up insects should live only long enough to lay eggs, and thus secure the continuation of the species. Insects having the four distinct stages in their growth, egg, larva, pupa and adult, are said to undergo complete metamorphosis.

But not all insects pass through an inactive pupa stage. With some insects, like the grasshoppers, the young, as soon as they are hatched, resemble the adult forms in appearance. These insects, like the larvae, shed their skins to accommodate their growth, but they continue to



*A young grasshopper, enlarged.  
The line shows its actual length*



*The adult of the same grasshopper,  
natural size*

feed and move about actively until the final molt when the perfect insect appears. Such insects are said to have incomplete metamorphosis, which simply means that the form of the body of the adult insect is not greatly different from that of the young; the dragon-flies, crickets, grasshoppers and bugs are of this type. The young of insects with an incomplete metamorphosis are called nymphs instead of larvae.

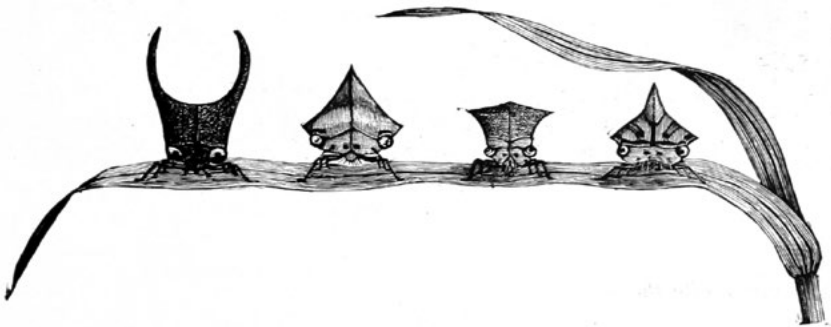
### **SUMMARY OF THE METAMORPHOSES OF INSECTS**

#### Complete Metamorphosis

- Egg.
- Larva.
- Pupa. (The pupa is sometimes enclosed in a cocoon.)
- Adult or winged insect.

#### Incomplete Metamorphosis

- Egg.
- Nymph (several stages).
- Adult, or imago.



*Insect brownies; tree-hoppers as seen through a lens*