Home Studies in Nature

Mary Treat

THE BATH.—[FROM A DRAWING BY FIDELIA BRIDGES.]

HOME STUDIES IN NATURE

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TREAT HOME STUDIES.
E-P 3

PREFACE.

MANY years ago, when I began my studies in Nature's open book, I had no thought of ever giving them to the public; but I soon became deeply interested, and found so many things new to me, and some new to science, that my correspondents, especially those engaged in similar pursuits, urged me to publish the result of these observations. Some of them were printed in scientific journals, but as the interest deepened, the wish came to tell a greater number of readers what I saw around me, and I therefore sent notes of my investigations to some of our popular periodicals, mostly to *Harper's Magazine*, and this volume is mainly composed of these papers.

"Our Winter Birds" and "Under the Maples" were published in the *Atlantic Monthly;* the first chapter on "Utricularia" appeared in the *New York Tribune*, and the chapter on "Drosera" in the *American Naturalist*, the remainder in *Harper's Magazine*.

If a perusal of this volume gives my readers a tithe

of the pleasure which the observations have given me, I shall be amply rewarded. The keenest, most thrilling enjoyment of my life has been found in the prosecution of these studies. A contemplation of Nature, her ways and works, large or small, far or near, in the heavens or on the earth, becomes a source of perennial pleasure, and a true lover of her gracious and unbounded revelations need not travel far in search of them. To the lover, especially of birds, insects, and plants, the smallest area around a well-chosen home will furnish sufficient material to satisfy all thirst of knowledge through the longest life.

MARY TREAT.

VINELAND, N. J.

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PART I.

OBSERVATIONS ON BIRDS.

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Chapter I.

OUR FAMILIAR BIRDS.

During the past summer my time and attention have been devoted almost exclusively to the birds which nested around the house, and I have fully verified the fact that in the grove and orchard they can be tamed and made quite docile pets.

The house is situated on the main avenue, near the business part of the village, and is surrounded by a thick grove of native oaks and other trees. Back of the grove is a fruit orchard, extending to the next street; between the grove and orchard is the shrubbery —a dense mass of various flowering shrubs. Climbing plants cling about the piazzas in tangled luxuriance. Surrounded as the place is by the din and hum of business, yet on the grounds it is very quiet. No cat is kept on the premises, and a continual warfare was waged against all neighboring cats which ventured within the enclosure. This the birds were quick to learn, and gave cries of alarm whenever this dangerous

enemy made his appearance, seeming to know that he would be quickly routed, and no place could he hide but the keen eyes of the birds would ferret him out.

Four years ago I commenced this warfare on the cats, when comparatively few birds nested here. This summer twenty-seven birds have built about the grounds, several of them in close proximity to the house.

THE VIREO.

The lovely warbling vireo (*Vireo gilvus*) fastens its neat pensile nest low down on the ends of the twigs,

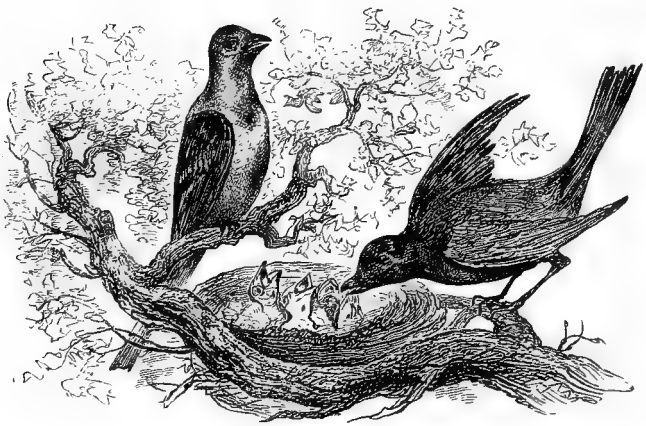
where it sits quietly while I stand immediately beneath it, and it looks down upon me with its large, lustrous eyes in a sweet, confiding way, or warbles its low, tender, whispering strain in the branches above my head.

In Coues's "North American Birds," where we find only the most rigid and exact scientific descriptions of birds, the author seems, for once, to have forgotten himself, and allows this charming little songster to betray him into expressing the following beautiful sentiment:

"The warbling vireo forsakes the depth of the woodland for the park and orchard and shady street, where it glides through the foliage of the tallest trees, the unseen messenger of rest and peace to the busy, dusty haunts of men. Its voice is not strong, and many birds excel it in brilliancy and execution; but not one of them all can rival the tenderness and softness of the liquid strain of this modest vocalist."

The elegant scarlet tanager (*Pyrangea rubra*), with its more soberly attired mate, constructed their frail tenement in the most retired part of the orchard, on the forked branch of a plum-tree. The eggs were four in number, of a dull greenish color, spotted with brown. This graceful and brilliant bird is quiet and unobtrusive, and more shy than most of the other inhabitants of the grove, yet his attachment to his mate and young made him at times quite bold and fearless. While the mate was sitting, he seemed to be ever on the alert. However quietly I approached the nest, he was there before me, and for the first few days made frantic

efforts to lure me from the spot; but gradually he became reconciled to my presence, and by the time the



SCARLET TANAGER.

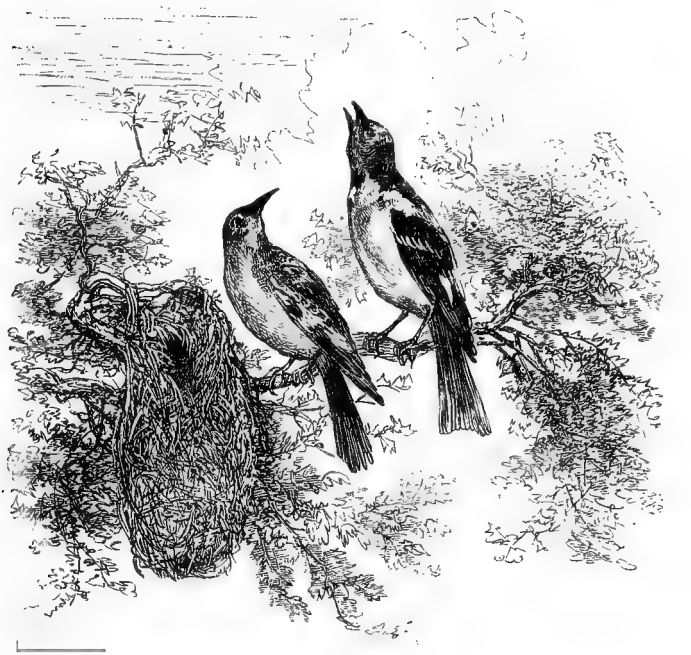
young were hatched he would feed them while I stood beneath the tree.

The species is very abundant in some localities, but this is the first pair I have observed here. It is not much larger than the house-sparrow, and the body of the male is a bright scarlet, while its wings and tail are a jetty black.

Another brilliant denizen of the grove was the Baltimore oriole (*Icterus baltimore*). In the spring I brought from Florida a large amount of the long gray moss, *Tillandsia usneoides*, and hung it on the lower branches of the trees, where it grew and blossomed finely. Several pairs of orioles soon found this good

building material, and used it in the construction of their nests. I found one nest several streets away composed almost entirely of it. It remains a mystery how so many birds of this species, domiciled in different parts of the village, should have found and appropriated this moss.

Although but one pair of orioles swung their ham-

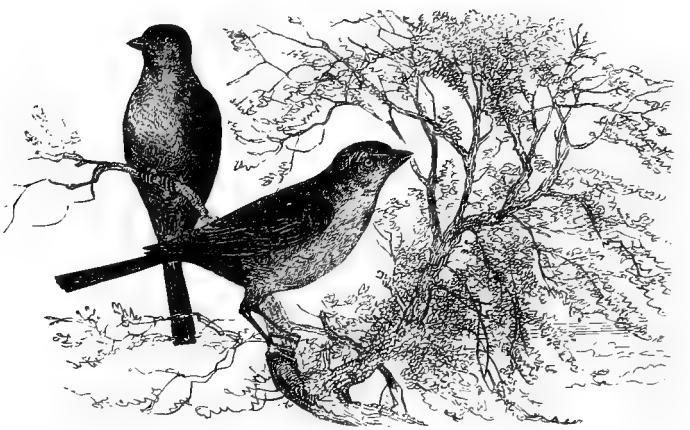


BALTIMORE ORIOLES—THE MATES.

mock-like nest in the grove, yet it was a favorite resort for many others, and after the breeding season was over

they cheered us with their song long after all the other vocalists were silent.

Many other birds used the moss more or less in the construction of their nests. The robin used it largely, one, especially, finding it such excellent material, and so handy too, was not content until she festooned her nest all around. It was built in the forks of an oak, and the long sprays of moss were left swaying in the wind. It was arranged so artistically that I have been asked if I did not drape the nest myself. The catbird, bluebird,



HOUSE-SPARROW.

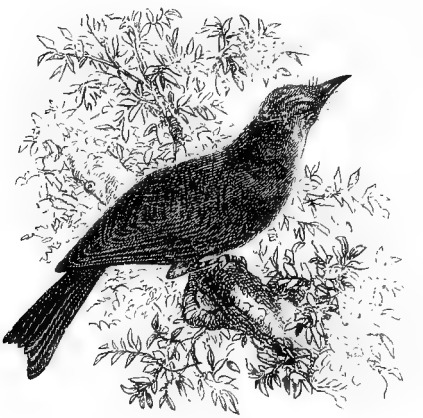
and kingbird all used it, and even the little house-sparrow (*Spizella socialis*) cunningly wove it into the foundation of its dwelling.

But there were some conservatives among the birds who would not be tempted by this new-fangled stuff to

deviate from the time-honored custom of their forefathers. Our little vireos even hung their nest on the branch of a hickory-tree on which the moss was hanging, yet they persistently turned their backs upon this innovation, and seemed to look with distrust and suspicion upon all the feathered builders who were so quick to take up with anything new. The inner bark of the honeysuckle, and nice long strips of bark from cedar posts or from any good, respectable, woody plant, was what their family had always used in the construction of their domiciles, and they were determined to preserve the established customs of their ancestors. And the moss might swing for all the little wood-pewees (*Contopus virens*) cared; had not their ancestors always used fibrous roots and strips of inner bark, and should they be tempted to deviate from their honored customs by this flaunting pendant from a foreign bough? So they too passed it coldly by, with suspicious looks on other families who were erecting their domiciles so near to theirs with this strange material.

Yet the wood-pewee's nests are not all of one pattern by any means. There are some fine architects among this species. One nest, located between the forked twigs of an oak, was very symmetrical in outline, and almost covered externally with beautiful lichens. The body of the nest was composed of fine fibrous roots, interwoven with a soft, downy substance which looked like the rusty wool of the cotton-grass (*Eriophorum*

virginicum), and which they must have gone a long distance to obtain. In a climbing rose-bush trained against the house was another nest so dissimilar in form and structure that I never should have taken it for the nest of the same species if I had not caught the builder at work. It was composed entirely of coarse strips of fibrous bark and roots, no soft material for a lining,



WOOD-PEWEE.

and the nest was a shallow, unsymmetrical affair. Yet the little architects attempted to embellish this humble abode. Near the top of the nest a bit of colored paper was glued on, and two or three small pieces of blue egg-shell—probably the cast-off shell of a robin's egg —and some small pieces of white paper. This was the extent of the decoration. No doubt the little artists became discouraged at this point, or were sensible

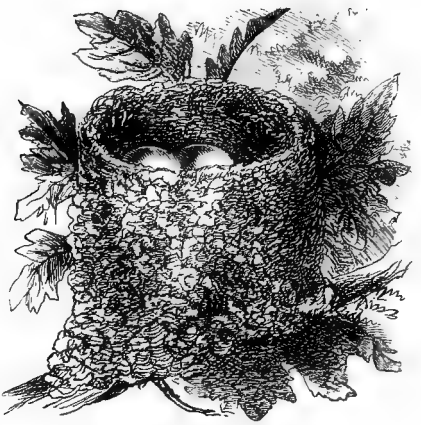
enough to see that so rude a home would not be improved by ornament.

Most writers take the ground that the nest of this species is covered with lichens in order to conceal it, but it certainly cannot be urged in this case that it was an attempt of the kind; and may not these lichens be used more for ornament than for concealment? The bird is far from shy, is one of the most familiar denizens of the grove, and seems to have no objection to a spectator while it proceeds with its building and stuccoing.

Until within a few years, according to good observers, this was a shy, retiring bird, nesting only in secluded woods; but here it is, all at once, even more familiar than its cousin, the common pewee, or Phœbe-bird. Like the other fly-catchers, it takes its food on the wing, and has a habit of returning to the same spot. Noticing that it specially liked a clothes-line to light upon, I kept one stretched all summer for its accommodation. The line was a little higher than my head, and I often stood quietly beneath it, when the bird would alight very near me, and utter his prolonged, mournful note, until a fly came within his range, when he would dart away in pursuit, the snapping of his bill testifying to his unerring aim.

Burroughs, in his charming little book, "Wake Robin," says it is an event in one's life to find a hummingbird's nest. The event happened to me without any effort on my part. Looking up from a seat in the

grove, I saw the ruby-throat drop down on its nest, like a shining emerald from the clouds; it did not pause upon the edge of the nest, but dropped immediately upon it. The nest was situated upon an oak twig, and was about the size of a black-walnut, and from where I sat it looked more like an excrescence than a nest. It



THE HUMMING-BIRD'S NEST.

was situated in the fork of two twigs, and firmly glued at the base to the lower, but was not fastened to the upper twig.

I waited for the tiny occupant to leave the nest, and then with the aid of a step-ladder had no difficulty in looking into it. I found it contained two white eggs, about as large as medium-sized peas. Sometimes the male would drop upon the nest when the female left. I never disturbed them while they were sitting upon

it, but often before I could get away, when I thought them out of sight, the male would suddenly appear, and greater demonstrations of anger I never saw manifested by any bird. He would ruffle up his tiny feathers, and seem nearly twice as large, and dash almost into my face, making a squeaking noise—scolding and threatening until he had driven me quite a distance. He soon learned that I was very much afraid of him, so he turned tyrant, and often drove me from my seat in the grove when I had not been near his dwelling. I always submitted to the little lord, for what business had I to be prying into his domestic affairs? When the young were hatched they were not larger than humble-bees, but in a week they had flown. I cut the twig off, and found the nest was composed of the same soft, downy substance which I had noticed in the wood-pewee's nest, but it was matted so closely together that it was almost as firm as the softer kinds of felt; it was a marvel of skill and beauty, and completely covered externally with lichens.

But of all the feathered choristers none were so charming, none so confiding and intelligent, as the cat-bird (*Galeoscoptes carolinensis*), three pairs of which nested close to the house, each pair rearing two broods of young. One nest was near a second-story window, in a climbing rose-bush; at first the birds slightly resented my attempts at familiarity, but I was persevering and very quiet, sitting by the open window with only a light wire screen between us; after they had

become accustomed to seeing me thus, I raised the screen and sat where I could have put my hand upon the occupant of the nest, but I never disturbed the mother bird; so by the time the young were hatched, the parents would feed while I sat by the window. But this pair simply tolerated me; they treated me with a sort of sublime indifference, just as they would

CATBIRD.

some large animal of which they were not afraid. When the young were fledged, they came upon the back piazza, where the old ones fed them close to my side.

Another pair of this species nested in a honeysuckle that climbed over the back piazza; and here was a bird —the male—who was not only not afraid, but he appreciated me, and was companionable and intelligent,

and the best musician of the grove, fully equal to his famed Southern cousin, the mocking-bird (*Mimus polyglottus*). I could call this catbird from any part of the grove or orchard, and set him to singing as if in an ecstasy of delight, but in return for this I must be his servant and do his bidding.

There is a keen sense of enjoyment—I might say of exalted happiness—in being able to bring free birds of the grove around one, which well repays for the time and patience and hermit-like life necessary to accomplish it.

If a cat made its appearance on the grounds, and I was not in sight, the bird would come screaming close to the door, when I would accompany him, he pointing out the cat, which I would drive in no gentle way from its lurking-place; other birds clamored about me, chasing the intruder, but he was the only one that returned with me to the house, where he expressed the most decided satisfaction. Several times, just as it was growing light, the wily cat was prowling about, and the bird would call me from my bed with his cries; hastily throwing on a water-proof cloak, I always went to the rescue, and often drove the robber through the wet orchard out across the street, the bird always accompanying and returning with me. The female was confiding and gentle, but not so intelligent as the male.

The second nest of this pair was built in a cedar-tree back of the house, within a few feet of the dense shrubbery before mentioned. The birds were three or four

days building, and during this time I could not win the male from his work. I tried the softest blandishments —talked, chirruped, and whistled—all in vain; he was intent upon his work, and I was of no consequence whatever. He was a most exemplary mate, doing his share of the work with a will and perseverance even in the face of temptation—an example of allegiance well worthy to be followed. I began to fear that I had lost my power over him; but no: no sooner was he at liberty than he returned to his pretty, confiding ways; he would flutter close to me, and chatter and sing and perform curious evolutions, as if in an ecstasy of happiness.

I had a large shallow dish of water set on the ground in the midst of the shrubbery for the accommodation of the birds; but soon so many came to bathe that it was necessary to renew it every morning. My favorite soon learned when I was coming with the water, so he was on hand superintending the work, and waiting for me to rinse out the dish and supply the fresh water, which was no sooner done than he was in it, splashing and enjoying himself.

It was August before the second brood was hatched, and now that he had graver duties to perform, he was much less attentive to me; still he occasionally recognized and played around me, but his powers of song were greatly diminishing.

On the evening of the 13th of August three of the young birds left the nest, and the female immediately took them into the orchard, many rods away; but she

left a younger-looking, helpless bird in the nest, to which, I am quite positive, she never returned. But the male fed and nourished this young one, and seemed wholly devoted to it, and would now pay no attention to me whatever: he was as much preoccupied as when building. This continued for three days. Towards the evening of the 16th this young one left the nest and accompanied the parent to the bushes, where he soon had it perched on the tallest shrub—a Judas-tree (*Cercis canadensis*); and now he manifested great delight, acting quite like his old self. All the next day he fed his charge, pausing now and then to assure me of his continued regard. On the second day the female came to the shrubbery, bringing the three young, reuniting the family; but as far as I observed, the male still persisted in feeding only the smaller bird.

I found the birds liked soft, sweet pears, but they would not break into a perfect one; so I cut a slice from each pear and laid them on the grass, when the parents would bring the young to feed. The three older ones could now help themselves, but the youngest would only look on and wait to have the pieces put into its mouth.

It was now very warm weather, and the family remained among the bushes a large part of each day for about three weeks, at night perching on the Judas-tree or in the branches of an adjoining Austrian pine.

The cats by this time were quelled. They had either become thoroughly frightened by missiles hurled at

them or had committed suicide by taking strychnine; at all events, they no longer prowled about the grounds, and the birds enjoyed quiet and peace.

My favorite bird was monarch of the shrubbery, except when the robins came for a bath, when, with a very ill grace, he took the place of a subordinate. Upon one occasion I witnessed a very amusing scene. I had just supplied the fresh water, and the bird was enjoying it, when a robin came flitting in, followed by a young speckle-breast. The catbird, without a single protest, left the water. Of course he was afraid of the robin, or he would not have left so promptly; but after he had gone, he manifested the greatest anger—he flew to a shrub just above them, and screamed with all his power, dropping his wings and looking very fierce and hostile—to all of which the robins paid no attention. Then he came towards me and back again, evidently asking me to drive them away; but I would not interfere. After the robins were satisfied, they left the water and flew into the sunshine, and coolly proceeded to arrange their feathers.

Upon another occasion an incident occurred showing the bird's intelligence. A side gate had been left open, and a neighbor's hen had wandered in. The bird's cries summoned me, when he pointed out the hen, which was scratching among the shrubbery. All summer the bird had been accustomed to seeing the fowls in the adjoining lot, and was not at all afraid of them; but he knew this hen had no business in his dominions, and he was

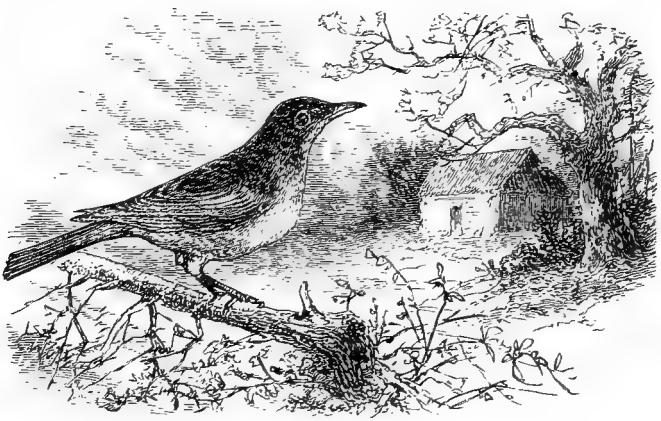
not content until she was driven out, which he assisted in doing, following her up with his mewing cry until she passed through the gate, when he returned to his place with a very complacent air.

The catbird has ever been a favorite with all good observers and lovers of birds. Audubon says of this species: "No sooner has the catbird made its appearance in the country of its choice than its song is heard from the topmost branches of the trees around in the dawn of the morning. This song is a compound of many of the gentle trills and sweet modulations of our various woodland choristers, delivered with apparent caution, and with all the attention and softness necessary to enable the performer to please the ear of his mate. Each cadence passes on without faltering; and if you are acquainted with the songs of the birds he so sweetly imitates, you are sure to recognize the manner of the different species. When the warmth of his loving bosom engages him to make choice of the notes of our best songsters, he brings forth sounds as mellow and as powerful as those of the thrasher and mocking-bird. These medleys, when heard in the calm and balmy hours of retiring day, always seem to possess a double power to delight the listener.

"The manners of this species are lively and grotesque. It is extremely sensitive, and will follow an intruder to a considerable distance, wailing and mewing as it passes from one tree to another, its tail now jerked and thrown from side to side, its wings droop-

ing, and its breast deeply inclined. In some instances I have known this bird to recognize at once its friend from its foe, and to suffer the former even to handle the treasure in the nest, with all the marked assurance of the knowledge it possessed of its safety; when, on the contrary, the latter had to bear all its anger."

For three successive years a robin (*Turdus migratorius*) nested on a projecting pillar that supports the



THE ROBIN.

front piazza. In *Harper's Magazine* for June, 1875, in an article entitled, "Do Birds Improve as Architects?" this bird and her ungainly mud domicile are mentioned. In the spring of 1874 she built her nest on the top of the pillar — a rude affair; it was probably her first effort. The same season she made her second nest in the forks of an oak, which took her only

a few hours to complete. She reared three broods that season; for the third family she returned to the piazza and repaired the first nest. The following spring she again came to the piazza, but selected another pillar for the site of her domicile, the construction of which is a decided improvement upon the first; for the next nest she returned to the oak, and raised a second story on the old one of the previous year, but making it much more symmetrical than the one beneath. The present season (1876) her first dwelling was, as before, erected on a pillar of the piazza—as fine a structure as I ever saw this species build. When this brood was fledged she again repaired to the oak, and reared a third story on the old domicile, using the moss before mentioned, making a very elaborate affair, and finally finishing up by festooning it with long sprays of moss.

This bird and her mate were quite tame. I fed them whortleberries, which they seemed to relish highly, and they would come almost to my feet to get them. But I had a great trial to my patience and temper with another pair of this species that nested in the orchard. They were new-comers, and this must have been the second family they were rearing, as it was as late as July. If the robin is not disturbed, as far as I have observed, she always builds her second nest near the site of the first. So these strangers had undoubtedly been badly used by some member of the genus *homo*, who had broken up and destroyed their home, making them hate and distrust all mankind. I blush for hu-

manity whenever birds treat me in the manner these robins did. There ought to be a rigid law enforced to protect our songsters against such vandals, who have never done as much good in the world as one pair of birds they have destroyed.

If birds were to discuss their own zoological position they might show abundant reason why they were at the head of creation, allowing them to use the degree of perfection of special organs or embryonic sequence as tokens of rank. The eminent naturalist Von Baer discusses the rank we hold in the scale of being as follows:

"We are not in all respects the head of the animal creation. In some points other creatures are further developed, more highly organized than ourselves, and we carry about in our bodies, as permanent structures, things which are but temporary and embryonic with them. In birds whose great organic specialty is flight, at a certain stage of the life within the egg the lungs are free in the chest and the bones are full of marrow, as ours are all our lives long. It is not till afterwards that the lungs become tied down back of the chest, that air-sacs communicating with them spread over various parts of the body, and the bones become hollow and thin. These are features specially adapted for flight, later [higher] developments of which we show no sign. In the same way it cannot be denied that feathers are more complex, and therefore higher developments of the simple structure we call hairs."

After this necessary digression, in order to show man his proper place, I return to the robins. I could not

THE DRAPED NEST.

make my appearance anywhere in the orchard but the birds would scream and raise such a threatening din

about me that it was almost deafening. Their cries would call the other feathered tribes to the scene of action, but finding nothing to alarm them, they soon returned to their quarters. Day after day I tried every means in my power to win these birds from their warlike attitude. At last I succeeded in this way: I took a box of whortleberries from which I had been in the habit of feeding the tame robins, and with this in my hand they would follow me to the orchard, where I threw out the berries as near as I could get to these belligerent fellows, when my pet robins would come close to me to eat the fruit. I would then walk away, and from a safe distance watch their proceedings. After several such attempts, I at last had the satisfaction of seeing the hostile male fly down and partake of the berries. He was a fine-looking bird, with a blacker head and redder breast than any of his relatives, all of whom he could master. The female also came and partook of the fruit, and by the time the young were fledged I could feed them all. They no longer threatened me, but were still a little shy. At last they came to the shrubbery to bathe, and were now fully domesticated.

Chapter II.

BIRDS OF FLORIDA.

The birds of Florida are more numerous and more brilliant in plumage than their Northern relatives, but with all their beautiful dress and coquettish ways, they cannot win me from the earlier, deeper love that draws me to the more soberly attired songsters of the North.

My observations are confined to the birds which frequent the grounds connected with the cottage where I reside. The cottage is situated on the banks of the St. John River, surrounded with native trees: live and water oaks and the great-flowered magnolia (*Magnolia grandiflora*) form the larger part of the grove. A hedge of Spanish-bayonets (*Yucca aloïfolia*) extends along the front of the cottage; the yellow jasmine and other vines cling about the piazzas or trail over trees. These natural advantages, with a little judicious training, make the place a favorite resort for many birds. During six months of the year they are sole possessors of the premises, and by natural right are more at home than the legal proprietors.

It is very amusing to note the curiosity manifested by these feathered denizens upon the arrival of the fam-

ily. They peer down upon us from their leafy screens, and chatter and warble, or stand out in bold relief, and fairly enchant us with their songs of welcome.

THE SPANISH-BAYONET IN FLOWER.

A fine mocking-bird (*Mimus polyglottus*) is king of the grove, but his more immediate dominion is in close proximity to the house. Near the hedge of Spanish-bayonets is a small cypress completely covered by a native grape-vine, forming a pyramid of living green.

This is his throne, which he mounts, and where he eclipses all the songsters of the grove with his wonderful and varied music, and at the same time can overlook the hedge, which he considers his exclusive property.

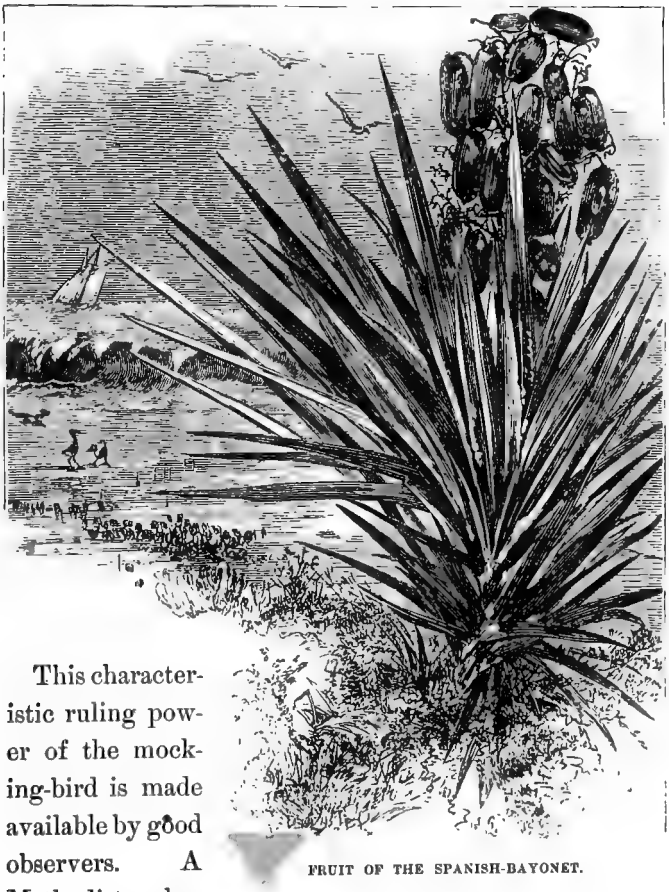
The fruit of the Spanish-bayonet is about the size of the banana, and grows in a large cluster at the top of the plant. When fully ripe it is soft and sweet, and highly relished by many birds. The cardinal-grossbeak, long-billed thrush, and the catbird, as well as the mocking-bird, are all fond of the fruit, and sometimes attempt to plunder; but while this tyrant mocking king is on guard, no bird except his mate is allowed to touch it.

THE MOCKING-BIRD.

His throne forms a very pretty arbor, where he retires at night and during rainy days. When he is away

from home I often step in; but he is seldom so far away but that his keen eye sees me, and I hear his scolding note, which I always promptly obey. Nothing will so quickly make a bird familiar as to show him that he can drive us; and following this up with patience and care, he will soon confide in us, and learn our voice, and manifest delight on meeting us. This is specially true of the mocking-bird, and his cousin the catbird. But the mocking-bird of East Florida is less confiding than our Northern catbird, for the very good reason that he looks upon man as an enemy who robs him of his young; and this shyness or distrust on the part of this glorious bird of song is in a large part attributable to the rapacity of Northern visitors, who sometimes pay as high as fifty dollars for a good singer. As long as this continues we cannot expect the birds to confide in us without much care and labor.

Nearly two weeks, with the greatest caution upon my part, had passed before I could approach this mocking king's dominion without hearing his threatening cry. He seemed determined to keep at a safe distance until he found he could drive me; then he ventured nearer; and now I have gained his confidence, sufficiently so that he listens to my nonsense. He turns his head in a comical manner, first one side and then the other, and looks down upon me patronizingly, as if pitying my poor attempts at bird language. Then he raises himself in a dignified manner, and pours forth such a strain of music that I am humbled in his presence.



FRUIT OF THE SPANISH-BAYONET.

This characteristic ruling power of the mocking-bird is made available by good observers. A Methodist clergyman residing across the river, in the neighborhood of Mrs. Harriet Beecher Stowe, informs me that a mocking-bird saved his grapes. One bird will do comparatively little damage in a vineyard; he is a light eater

of fruit, and has a habit of returning to the same spot. In the great cluster of fruit of the Spanish-bayonet he works systematically; he does not peck the whole cluster indiscriminately, but takes one berry at a time, and this one lasts him several days. So among grapes he has a particular spot when he feeds, but he overlooks and takes care of all within his dominion. If these birds are unmolested by man, they will regulate their own affairs so as to assist him.

The clergyman before mentioned had a near neighbor, who, finding a mocking-bird eating his grapes, shot him. Lawlessness now reigned among the birds, and the neighbor kept on shooting until a large number were slaughtered. The result was he lost all of his grapes.

The most familiar bird that frequents the grounds is the great Carolina wren (*Thryothorus ludovicianus*). This bold and voluble songster is about six inches in length, considerably larger than the house wren (*Troglodytes ædon*), and very inquisitive and egotistic withal. He comes into my study while I sit quietly at the table, and asserts his importance, while he looks me squarely in the eye, and then coolly proceeds to inspect the various things in the room. He peers behind the pictures on the wall, and looks into every nook and corner. Evidently he is thinking of taking up permanent quarters in my room, without as much as saying "By your leave." The mate is more timid; she simply stands in the door-way while her self-complacent lord

is making his tour of observation. Yet meek and quiet as she seems, she is, in truth, the master-spirit, and has her own way at last.

My study is a small, one-roomed cottage, a few rods distant from the main cottage, embowered in trees, and in this quiet retreat I am visited by many birds, who seem curious to learn whether it is safe to tolerate me.

THE GREAT CAROLINA WREN.

The wrens were a long time in deciding upon an eligible spot to erect their domicile. The study was abandoned because the door was often closed, and screens at the windows prevented an entrance there. Next the stable was thought of, and they commenced building behind a pile of boxes; but a colored man employed on the premises caught one of the builders, and was carrying it away when I rescued it. The stable was then given up for the laundry, where for several days

they flitted about, looking into every available nook. The laundry was finally abandoned for the front piazza —the most frequented place they could possibly have chosen. No room in the house was so much used. Easy-chairs were scattered about for the use of the family and for visitors; a table also stood here for the daily mail, where we read and discussed the questions of the day. And here this persistent, wide-awake couple chose to make their nest. They commenced building in a corner on the plate just under the roof.

Unlike the house wren, they do not use sticks in the construction of their nest, but an abundance of the softest material they can get. We had brought from the woods a quantity of a beautiful fern-like moss which we had stripped from decaying logs, and had placed it on the ground beneath one of the trees. This moss, so light and spongy, was just the thing for the little builders—ever so much better than the long gray *Tillandsia* which they had been using. They would alight upon it and chatter over its merits, and both seemed agreed as to its excellent qualities as a building material.

They worked harmoniously together for several days, the male stopping every now and then to express his happiness in a loud, prolonged strain of music. But the female proved very fickle-minded. All at once, without any apparent reason, she changed her mind with regard to the location of the domicile, and chose the other end of the piazza, near where we most frequently sat. Evidently the male did not like this. She had already

changed the location several times, and he had quietly submitted; but now he seemed to be reasoning with her, and was determined not to yield to this new whim of hers, and she was as fully bent on having her way. He continued work where they had commenced, and she persistently went on in the other corner. Occasionally he prevailed upon her to come and inspect his work, and with heads close together they would chatter over it. Then he would drop down upon the railing of the piazza, and throw up his head and express his delight in rapturous song. But it was no use; he could not win her back, neither could she prevail upon him to assist her in the other corner; they would meet upon the ground and chatter over the moss, and then fly with it to their respective corners, looking askance at each other.

The female worked very diligently for more than a week, while the male, with less to do, devoted half his time to song and vain attempts to lure her back. It was May when they finished building, and now the male, fairly beaten, yielded gracefully. He accompanied her to her cosy nest, and lovingly chattered over the pearly treasure deposited there; he seemed to forgive her then and there, and no longer visited the other nest, and henceforth was a most devoted partner.

While the little proprietors were away I took occasion to examine their work. I found both corners filled in with a large quantity of material, and in one side of this abundant mass was the soft symmetrical nest. The

eggs were nearly or quite white. The nest that the male completed was more beautiful than the female's, and how she could have refused such cosy quarters is a mystery.

During the winter a number of cardinal-grossbeaks (*Cardinalis virginianus*) were at home about the

THE CARDINAL-GROSSBEAK.

grounds, living harmoniously together; but towards spring, as early as February, they began to manifest a quarrelsome disposition, which finally ended in fierce battles. Jealousy seemed to be the sole cause of the disturbances, for they never attacked a bird of any other species. At last one stands alone, the proud possessor of a quiet, soberly attired partner, who looks up to

him as the hero of many hard-won battles. This daring conqueror is of striking appearance: a conspicuous crest ornaments his head, his plumage is elegant, with a rich vermilion hue, and he is a fine musical performer withal, his loud rolling notes even drowning those of the mocking-bird.

They select a fine water oak, and on a horizontal branch they have decided to rear their family. Although the unobtrusive partner attends strictly to her domestic duties, yet this brilliant hero is excessively jealous; he sees a lurking red-coat in the stable—his own image reflected in the window-glass — which he fiercely assails but cannot conquer. From morning until night, with brief intervals, he fights this imaginary foe. Fearing that he will fall a victim to his ungovernable passion, I try to fix the windows so he can no longer see his image. The windows slide in a groove; I push them back; he comes into the stable and looks around astonished, but only for a few moments, for the glass against the dark background of boards still proves a good reflector, so his antagonist has only gone inside, and here the battle is renewed. I frighten him away, but he soon returns—the enemy must be conquered at all hazards. At last I place boards over one window and hang a cloth over another. Now the foe is vanquished; so he tries his powers of song, swells his throat, droops his rosy wings, and makes the whole grove resound, as if in defiance of all lurking enemies, or challenging any red-coat to venture within his domain.

The diminutive ground-dove (*Chamæpeleia passerina*) is also an inhabitant of the grove. This charming species is about six inches in length. The general color is a lustrous steel-blue, but the sides of the head and neck are purplish-red color, more brilliant in the male; slender lines of black ornament the upper surface of the wings, while the under surface is suffused with a bright pink hue. These little doves are fully as tame as most domesticated pigeons.

Like the cardinal-grossbeak, during winter they live together harmoniously in communities, but towards spring the monogamic family relation is assumed; and so quietly do they arrange their domestic affairs that we do not know how or when it is accomplished; we only see that the ranks are thinning. A pair select a new home, and no longer return to the old, notwithstanding the bread and cracker crumbs with which they have been regaled.

Early in April all are gone but one pair, and these are becoming very tame. By the middle of April they no longer appear together—first one and then the other feeds about the door. In their domestic affairs they seem to maintain the same customs as their larger relatives, the male spending full half the time on the nest.

Meek and innocent as they appear, they are altogether too cunning for me. I have spent hours looking for the nest, but they delude and elude me; take me into the most dreadful places, and leave me there—a depth

of depravity that I should not expect in such innocent-looking creatures.

While the doves are feeding, almost invariably a long-billed thrush drops down from a tree, as if curious to know what they are eating; if he comes too close, they raise their wings in such a way that the two upper surfaces meet back to back, thus displaying the beautiful rosy tinge beneath. I suppose this is a defensive attitude, but I have never seen them attack anything; and the thrush, which is larger, would scorn to attack any bird smaller than himself.

The thrush, satisfied that they are not feeding upon anything which he particularly relishes, takes an acorn and proceeds to pound it on the ground until it is freed from the shell, and then breaks it into dainty bits before swallowing.

This thrush is a beautiful bird, with fine manners, and a good singer, yet he seems to be a confirmed bachelor. All winter he has been the sole representative of his species, and now, in spring, when all the other denizens of the grove have taken partners, he still remains in single blessedness.

He must be the bird mentioned by Coues, in his "North American Birds," as the variety of the common brown thrush (*Harporhynchus longirostris*). The locality of this variety is given as occurring in Mexico to the Rio Grande, but it answers exactly to the description of longirostris.

During the winter the Florida jay (*Aphelocoma flor-*

idana) is a frequenter of the grove; his shrill cry is echoed from tree to tree, and he goes where he will, unmolested. This species is about the size of our well-known blue-jay, twelve inches in length, and its habits are similar. The general color is blue, but the head is not crested, and the wings are not barred with black, as in the other species.

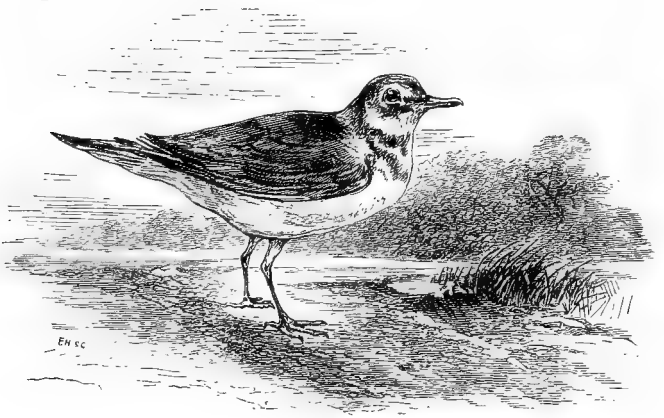
Notwithstanding the bad reputation of the jays, I must confess to a strong regard for them. Their plumage is beautiful, and their droll, comical ways are enough to bring a smile upon the face of the most sedate observer.

In the winter the Florida jay was so well behaved, feeding upon acorns of the live and water oaks, that I began to think that he in a measure redeemed the bad reputation of his family. The other feathered denizens of the grove did not molest him, and he in turn seemed peaceably inclined, except upon one occasion, when the taunting tones of a mocking-bird seemed to irritate him. He was answering the cry of a companion from a neighboring tree, when the mocking-bird, perched on his throne of grape-vine, took up the cry in a derisive tone. The jay turns and looks upon the mocker, who, seeing his movement, for a few moments is quiet. The jay renews the colloquy. The mocking-bird, unable to resist a spirit of mischief, cautiously resumes the jeering cry, at first low, not attracting the attention of the jay, but soon he becomes more bold, and raises the key-note. To be mocked at and insulted in this way is too much

for the self-conceited jay to pass by without resenting. With a sudden wheel he flies at the derider, who eludes him by slipping beneath his throne; the jay peers beneath, then follows, but the mocking-bird flits out and alights upon a little cypress bending over the river. The jay, satisfied that he is gone, comes out and takes his position on the throne, and recommences his cry. The mimic, not yet quelled, and now thoroughly indignant with the usurper of his throne, mocks him even louder than before. The angry jay again starts after him; he now flies directly out over the river. The river at this point is five miles across. The jay followed only a short distance, then returned, and went out of the neighborhood. The mocking-bird made a curve in his flight, and was soon back, looking cautiously around; finally he ventures on the hedge of Spanish-bayonets, and from thence to his throne.

In the spring there is a marked change in the behavior of the jay; he no longer comes openly and boldly upon the grounds, but glides in noiselessly, for he knows the birds of other species in a common interest will concentrate their forces, and as soon as he is discovered, a note of alarm will be sounded, when in flock the troops to the rescue. They seem to come from all quarters; even the smaller birds—wrens and sparrows—help to swell the ranks; and the intruder makes an inglorious retreat, followed by the justly indignant guardians of households. Audubon says, "The cardinal-grossbeak will challenge him, and beat him off the

ground. The red thrush, the mocking-bird, and many others, although inferior in strength, never allow him to approach their nests with impunity; and the jay, to be even with them, creeps silently to it in their absence, and devours their eggs and young whenever he finds an opportunity." But, as far as my observation extends, he seldom finds an opportunity: nests are not often left unguarded.



KILLDEE PLOVER.

A pair of killdee plovers (*Ægialites vociferus*) are at home on the lower terrace adjoining the river. The plumage of this bird is beautiful: a soft orange-brown color on the rump and upper tail coverts, the head white, with a clearly defined black band across the crown, and two others encircling the white neck and breast.

These elegant, graceful creatures are not very trust-

ful; they will not allow a too close familiarity. I have spent much time in trying to cultivate their acquaintance, but they keep a measured distance between us, seeming to say, "So far, and no farther." If I remain very quiet, they sometimes glide along within a few feet of me, with an air of sublime indifference, as if I were scarcely worth a second look. They take their bath and arrange their toilet each day. Wading out into the river a short distance, they plash a while in the water, and then return to the terrace, and spread themselves in the sun to dry; when nearly dry, they arrange their feathers with their stout beaks. They always announce their arrival and departure from the terrace with the not unmusical cry of killdee, killdee! dee, dee, dee!

The belted kingfisher (*Ceryle alcyon*) is another familiar bird that frequents the grounds. His name indicates his occupation, and a very successful fisher he is. His fishing-post is on the railing that runs along the wharf. The wharf extends from the grounds about two hundred and fifty feet into the river. Whether he remains at this post the entire year I do not know; we find him here upon our arrival, and leave him here when we depart for the North. I am inclined to think this his permanent residence; at all events, he objects to being disturbed, as if he had been sole manager too long to yield the ground without a loud protest. If more than one person goes upon the wharf, he leaves with a clang and clatter which sound like a watchman's

rattle, and usually flies to the terrace, and alights upon a small tree bending over the water, where he can overlook and watch proceedings. But he does not seem to be afraid of one person alone: if I go upon the wharf unaccompanied, he flits along before me, alighting upon the railing, often not more than fifteen or twenty feet

KINGFISHER.

distant, and faces about as if to intimidate me. Seeing this I quietly drop upon a seat; for really, with his rumpled crest and fierce-looking black eyes, he looks rather formidable, being a foot or more in length. Seeming to be satisfied that I am under subjection, he goes on with his fishing, in which he is very expert. Motionless he eyes the finny tribes beneath him until one of their number comes within his range to suit his

taste, when he dives into the water and brings it up; and now beating it upon the railing until it is quite limp, he swallows it. Small fish-scales are scattered along the entire length of the railing, where he has dressed his fish preparatory to taking his meals.

Notwithstanding the public wharf is only a few rods distant, with the confusion and noise consequent upon the landing of steamers, and crowds of people so near, yet this intrepid fisher continues his occupation as unconcerned as if alone in the wilderness.

This species is the only representative of the family in the United States. Although it is not classed by ornithologists among the *Raptores*, yet it has characteristics in common with this large order. After a meal it ejects from its mouth a large pellet made up of the indigestible bones and scales of the fish it has swallowed. The pellet seems to be so out of proportion to the size of the bird that it is something of a marvel how it manages to eject it; but it does not seem to cost it much of an effort: a little stretching of the neck upward, with the head thrown forward, and the feat is accomplished.

Chapter III.

OUR WINTER BIRDS.

After several years' careful observation in Southern New Jersey, I find that winter gives us a phase in the life and character of birds quite unlike that displayed in summer by the same species, yet none the less interesting.

The permanent residents of this latitude which come about our house and grounds are the song-sparrow, field-sparrow, English sparrow, yellow-bird, pine-linnet, blue-bird, robin, meadow-lark, quail, blue-jay, crow, and several species of hawks and owls. The Northern birds which make this section their winter home are the white-throated sparrow, fox-sparrow, tree-sparrow, chickadee, and the dark slate-colored sparrow, or snowbird, as it is more usually called. There are also several species restricted to the woods, with which I am unfamiliar.

Most of these birds will become quite tame with a little care on our part, and will soon come to look to us for their daily food. Especially if the ground be covered with snow, they will learn to become clamorous for their food, even alighting on the window-sills and striking the glass, apparently to attract attention to

their wants. In summer the same species are much more shy, so winter gives us a better opportunity to study the habits and dispositions of the various birds which remain with us.

With most species family ties are not broken in winter. Bluebirds, perhaps more so than most of our birds, maintain a strict family relation during the winter, even while assembling in large flocks. Not only do the partners remain true to each other during their lives, but they continue their care over the young throughout the first fall and winter.

When a pair of bluebirds succeed in rearing three broods in a season, in the autumn these broods unite and stay with the parents, making a little flock of about fourteen. All the autumn through they keep together, feeding from the same bushes — poke, ampelopsis, and other wild berries—and upon such stray insects as they may find.

The first cold days of December send them to the cedar swamps, where great numbers congregate. Here, too, large flocks of robins keep them company. But each mild day brings the bluebirds from their retreat back to their unforgotten home; and there is nothing more fascinating in bird life than to see the frolics of the young birds and the grave demeanor of the parents. The young visit the various houses in which they were reared, sometimes two or three entering at the same time, and all the while keeping up their low, sweet twittering, as if conversing.

But in the spring all is changed. The parents tell the young in a very peremptory manner that they must now seek new homes. Sometimes the young are quite persistent about remaining, when the parents at last seem to become exasperated, and drive them fiercely from the premises.

During the summer of 1880 I was particularly interested in a pair of bluebirds which had the misfortune to rear but one brood of three during the season. The young were hatched in a little house fastened to the railing of an upper piazza. They became quite tame, and remained with us until the first week in December. After this I saw them no more until the first day of January, 1881, when, to my surprise, the entire family came to my study window — a bay-window fronting south—and perched upon the sill. The mercury stood fifteen degrees below zero on this morning, an unusual temperature for our latitude.

I have found that an intensely cold day will drive both robins and bluebirds from their retreat in the cedars to our homes, as if they hoped for better protection against the cold.

Our little family had accompanied a sorry-looking flock of forty or fifty bluebirds, with ruffled feathers, which had halted in the vineyard near the house on this bitter morning.

By ten o'clock the sun shone brightly against the window-glass, and the warm fire within helped to make the window-sill comfortable; and here all five of the

birds perched, thus getting the full force of the sun's rays. After basking a while in the sun, their feathers smoothed down, and they seemed quite bright and happy, and towards noon disappeared with the flock. Several times, on the coldest days, during this severe winter, this little family came to my window in the same manner.

I could mention several other instances which have come under my observation, in proof that the parent bluebirds, with their broods of the previous season, are a united family; but one more will suffice.

The summer of 1881 a pair of bluebirds occupied a box placed on a projecting part of the cornice, in the rear of the house. After the first brood left the box, the parents soon commenced to tear out the old nest, preparatory for a second family in the same box. The second nest is usually built in some other place, in the vicinity of the first, and here was no lack of empty boxes for them to choose from; but for some reason, known only to themselves, they were determined to occupy the house of their first choice, notwithstanding the bad condition in which it was left.

Seeing their determination, we had the box emptied of its contents, and, as might be expected, found it swarming with vermin. We sprinkled it thoroughly with insect-powder, and the birds commenced at once to build.

When the second brood was hatched, the English sparrows annoyed the parent bluebirds exceedingly by go-

ing to the box and looking in, and one of the sparrows even had the audacity to attempt to adopt and feed the young bluebirds. What could the parents do? They could not stay and watch the sparrows continuously, for the lusty young were clamorous for food. So these wise birds called together the elder brood—elder brothers and sisters, whom I had not seen for weeks—who were by this time as large as the parents, but readily distinguished from them by their curiously mottled breasts, which they wear the first summer. The parents instructed these young ones to keep guard over the house while they were away in search of food, which they did for several days. The house was scarcely left a moment. One or more of the family were almost constantly present, and would dart at the sparrows whenever they made an attempt to come near, until the young left the box, when the happy family became reunited, both broods, with the parents, eating poke-berries from a large bush which I had allowed to remain expressly for them.

When the ground is covered with snow, the various species of our native sparrows, so full of life and jollity, will doubly repay any lover of birds for the care bestowed upon them.

Last winter I kept a space of ground beneath my study window free from snow, where I scattered coarse Indian meal and millet-seed, and this ground soon became a mimic stage for these bright actors. The names of the most noted were *Junco hyemalis*, *Zonotrichia*

albicollis, *Spizella monticola*, and *Melospiza melodia*. The names of these actors are known throughout the civilized world. All nations recognize the family name, and often the specific name gives a clew to the character: as *hyemalis*, our winter or snow bird; *monticola*, a dweller in the mountains, where this species spends its summers and rears its young; *melodia*, the sweet songster, or song-sparrow.

Junco hyemalis is excellent in dramatic performance. Two of these actors meet face to face on the stage, in their dark glossy coats, and each tries to make the other quail before his fixed gaze. Nearer and nearer they come, constantly chattering and bowing, until within a few inches of each other, when they elevate their heads and bodies to a perfectly upright position, and chatter vehemently with wide-open mouths. Sometimes one of the actors leaves the stage at this juncture, and the other remains; but generally they both withdraw and have a trial of strength in the air.

And now Zonotrichia albicollis comes forward in another act. He is the most gorgeously attired and the largest actor in the drama. The crown of his head is black, bordered with white, and his full muffled throat is pure white, sharply contrasting with the dark ash of his breast. The back of his coat is striped with black, chestnut, and fulvous white. He excels Junco in tragi-comic performance. He opens the act with a prolonged musical note, and flattens himself in front of a brother actor, and spreads his tail fan-shaped. Faster and faster

come the notes from the two actors, until they are so blended that we can scarcely distinguish one from the other. The birds approach each other squatted to the ground. Their feet have disappeared. When the climax is reached, like Junco they leave the stage in a twinkling.

Usually the actors are of the same species, but occasionally Junco and Zonotrichia enliven the drama, each acting his part with his own individual characteristics. Junco chatters and bows to Zonotrichia, who cowers apparently at his feet, meanwhile entertaining his audience with his long, musical notes. And now, while Junco is straightened to his utmost height, hurling his rapid invectives, Zonotrichia leaps up like a flash and strikes him in the breast, with sufficient force to hurl him across the stage. But Junco is not always taken by surprise and kicked from the stage in this inglorious fashion. Although the smaller bird, he is occasionally victorious.

I would not have it understood that these small actors are entirely given to theatricals; there are times when they are quiet and orderly, and seem to be enjoying one another's society.

My favorite among them all is Spizella monticola. He comes to us towards the end of October, and remains until April. The crown of his head is a bright chestnut, and upon his shoulders are chestnut epaulets; his breast is a soft ashy color, with a dark blotch in the centre; the back of his coat is streaked with black,

chestnut, and flaxen, and two conspicuous white cross-bars are on his wings. He is the handsomest member of the genus, and considerably larger than the little chipping sparrow (*Spizella socialis*) that is always about our doors in summer, but goes South to winter.

Although Spizella monticola flock together in considerable numbers, yet they keep the family relation as strictly as the bluebirds, generally in groups of four or six, which indicates that the parents rear but one brood in a season, or, if more, each brood keeps by itself. The birds comprising these groups do not quarrel, but are so closely attached that one cannot fly away without the others following. The actors in the quarrels and trials of strength are made up of birds from different groups—strangers trying for the championship. This species does not go through with many preliminaries before the final act. They commence chattering, and clinch at once. Up, up they go, high in the air, striking, railing at each other as they ascend, until one is victorious.

The English sparrow merits notice, although I must confess he is not a favorite with me. He is not so graceful or beautiful as our indigenous species, still I do not wish to be unjust towards him. I have uniformly found him to be the least quarrelsome of any bird that comes about the grounds. I have never seen him aggressive towards our own species, even when mixing thickly with them. He usually prefers to remain about the barn and stable, where an abundance of food is

scattered for the fowls and pigeons, but occasionally quite a flock comes and mingles with our native species beneath my window, and here I can watch them at my leisure. Our indigenous birds know better than to attack him, for he is stronger and more heavily built than they are.

Only once since my observations commenced have I seen anything like a quarrel between the English sparrow and our native species, and in this instance the aggressor was the champion Junco, who was ruler over his own tribe, and had also whipped many white-throats and song-sparrows.

A little group of English sparrows was quietly feeding beneath the window. Junco struts around them and chatters, but they pay no attention, not even deigning to look at him. Failing in his attempts to elicit any notice, he flits to the window-sill and looks down upon them. Finally he seems to single out one which has wandered a little apart from the rest, and in a twinkling he strikes him broadside, throwing him off his feet, and then flies several yards away. The English sparrow is on his feet in an instant, slowly turning his head all around in evident amazement, but is soon eating again. Junco does not renew the attack, but mingles with his kind, picking up seeds. The English sparrow, however, has his eye upon him, and now Junco has to keep at a safe distance.

The summer yellow-bird also mixes freely with the various sparrows. This charming little creature looks

so different in his plain gray winter coat, which he puts on in September and wears until April, that it is with difficulty we recognize him, so complete is the transformation. The brilliant yellow and black have disappeared, and only faint tracings of greenish-yellow about the head and throat remain. But he is apparently as happy in his sombre suit, picking up millet, as when more brilliantly attired and rollicking amid the rounded globes of the dandelion, scattering the airy seeds, and capturing them as they start on their winged course.

Our little gymnast, the titmouse, or black-capped chickadee, must not be forgotten. He is not regarded as migratory, and yet he comes to us each winter, and seems to go northward in the spring. He is the most fearless bird of my acquaintance, frequently eating from my hand, and is almost omnivorous, taking anything that comes in his way, from a bone that we hang on a tree for his tiny lordship to pick, down to a plate of preserved berries which we have placed on the doorstep for the bluebirds. But he is quite exclusive in his society, and does not mingle freely with the other winter birds. The cold Northern snow-storms seem only to increase his jollity; now here, now there, clinging to a bough head downward, chanting his chick-a-dee-dee. Emerson pictures him to the life in the following lines:

"When piped a tiny voice hard by,
Gay and polite, a cheerful cry,

Chic-chicadeedee! saucy note
Out of sound heart and merry throat,
As if it said, Good-day, good sir!
Fine afternoon, old passenger!
Happy to meet you in these places,
Where January brings few faces.
This poet, though he live apart,
Moved by his hospitable heart,
Sped, when I passed his sylvan fort,
To do the honors of his court,
As fits a feathered lord of land;
Flew near, with soft wing grazed my hand,
Hopped on the bough, then, darting low,
Prints his small impress in the snow,
Shows feats of his gymnastic play,
Head downward, clinging to the spray."

When the smaller birds have been driven from the fields and woodlands to our dwellings by the snow, the birds of prey are forced to follow them; so there is scarcely a day but we see various species of hawk or the day owl (*Surnia Hudsonica*) watching their opportunity for a meal. We vainly try to frighten them away; but hunger knows no law, and they are often successful in snatching a bird within a few feet of us.

The owl, S. Hudsonica, is less timid and much more persistent than the hawk in following his prey. Often when I think I have frightened him from the neighborhood he will noiselessly slip out of an evergreen, and with the coolest audacity take a sparrow in my near vicinity.

Sometimes one drops down from the roof of the

house among the feeding birds beneath my window, and taking one of these beautiful creatures in his claws, proceeds to the nearest post and crushes its life out. It is a mercy to my little favorite to let the owl alone after he has secured his prey, for he kills it much more quickly than when disturbed.

At sight of this apparent cruelty in nature comes the impulse to shoot these raptorial birds. But when we think of that other biped whom it is not lawful to shoot, who often hunts and kills the beautiful denizens of our fields and woodlands from mere wantonness and sport of the chase, the hawk or owl, which takes a bird only to appease his hunger, towers above him in moral rectitude. So our gun leans idly against the wall.

Chapter IV.

DO BIRDS IMPROVE AS ARCHITECTS?

If birds were allowed to discuss their own merits as architects, they might bring forward abundant proof to show that they do improve in building; and they also might lay fair claim to the possession of reason, not only in the management of the young, but in many other things. But as we cannot discuss this matter with them, we must patiently investigate their work, and thrust ourselves upon the privacy of their domestic arrangements, if we care to know intimately the life and habits of our feathered songsters.

Birds of the same species vary nearly or quite as much in their way, in the form and material used in building, as savages of the same tribe vary in architecture.

The brown thrush (*Harporhynchus rufus*, Cob.) is a good case in point. The male is a gay, careless, happy songster, and seems to lure his mate into the same thriftless habits, so that house-building is often postponed until within a few hours of actual need, when haste and rapid work are very manifest.

All through May I noticed a pair of brown thrushes flitting about the grove. The male was a splendid per-

former, fairly entrancing me with his song. Seated upon the topmost branch of some swaying tree, he seemed to drown all the other choristers near by; in fact, they, too, seemed entranced, and soon were silent listeners. All the other feathered inhabitants of the grove had already commenced house-keeping, or were making active preparations, while this lord of song seemed to have no care or thought of the future. June came. The bird was trilling his loudest note, when right in the midst of his song he paused. His mate had stopped the grand performance. He flew with her to the shrubbery, where they flitted about from bush to bush a few moments, finally selecting a place for building in a rose-bush, which was supported by a trellis. The foundation of the nest was laid partly upon the trellis.

I took a garden-chair, drew my hat pretty well over my face—birds are good observers, and we must manage with care or we shall alarm them — and watched their proceedings. The female was evidently the master-workman, and kept a watchful eye upon the mate, who came every few moments with such crooked, branched twigs that she often could do nothing with them but throw them down in a spiteful way; her own selections were much better, and were almost invariably used. If she were away when the mate arrived, he at once proceeded to place his crooked stick—he evidently did not believe in wasting material in such a reckless way; but this hindered the completion of the domicile,

for when the fair partner arrived she was obliged to lay down her stick and try to arrange his in some sort of shape; failing in this, down it went to the ground, when, turning to her own, she soon arranged it to her satisfaction.

Several times the mate attempted to shirk, flew to a tree and commenced his song; but this the energetic housewife would not allow: she always brought him back and set him to work, even if he did hinder more than help. His partner was probably an experienced architectress, and he may have been an apprentice, for certainly some of the males of this species seem to be as good architects as the females.

The nest was completed during the day, and on the following morning an egg was left in it. The mate, now relieved from work, resumed his joyous song; but he always ceased the moment I entered the shrubbery, and gave a quick note of alarm, when she would fly from the nest. In a few days she became so tame that she would allow me to cut roses from the bush without leaving her place. Of course, great care was necessary; I always drew my hat down so that she could not catch my eye, and apparently paid no attention to her.

A few years ago I was acquainted with a pair of brown thrushes much more thriftless than the pair above mentioned, who did not even attempt to build a domicile in the usual way, but simply scratched up a kind of nest on the ground, in a strawberry bed, much

after the fashion of a domestic hen, where they reared their young without any accident. When nearly full-fledged they sprawled about on the ground, all semblance of a nest having disappeared.

Only a few rods from this careless, improvident family resided another family of thrushes, in quite an elaborately designed structure. A peck measure would hardly have contained the sticks used in the construction of their domicile. It was built upon a rail fence adjoining a gate, through which cows were driven to and from pasture every morning and evening. Horses were also kept in this field, so that the gate was used more or less during every day; yet the family was reared in perfect safety, and became quite tame.

Were these poor, hastily constructed tenements the work of inexperienced architects, or the work of thriftless, improvident individuals? In either case it looks as if birds were capable of improving in architecture, or the nests of the same species would all be of one pattern.

With the robin (*Turdus migratorius*, Linn.) the curious will find every form of architecture, from the rude mud nest up to quite an elaborately constructed domicile. These mud nests compare favorably with the log-cabins of the early settlers.

I had a table standing in the grove, on which were a number of pots of the Venus's fly-trap (*Dionœa muscipula*). A robin espied them, and made up her mind that the moist, black, mucky earth in which

the plants were growing was just what she needed —and so handy, too, only a few feet from the tree she had selected in which to build her mud domicile. She had already carried off two of the plants, with a quantity of the earth, before I caught her at the mischief. Being an early riser she had the advantage of me. I had the plants moved to the piazza amid her scolding and protesting. Her mate, too, attracted by her clatter, came and added his protest. I left the two pots of earth from which she had abstracted the plants, and took a seat to watch the *dénouement.* She eyed me pretty closely. Seeming to satisfy herself that I had no hostile intentions, she returned to the pots I had left, and rapidly proceeded with the building, using her breast and feet for a trowel. She may have worked an hour in this way, and then I saw no more of her until towards evening, when she finished up her work by lining the nest with a few mouthfuls of coarse, dry grass.

Only a few rods distant another robin was building with entirely different material. For the main body of the structure she used fine fibrous roots and twine; she then added clean damp moss (*sphagnum*) instead of mud, which she must have gone at least a mile to obtain. She interwove long horse-hair and fine dry grass to hold the moss in place. It took her four or five days to complete the structure, whereas the mud nest was finished the same day it was commenced.

As far as I have been able to ascertain, the male

robin never assists in building. This is not because he domineers over the female, refusing to do his share of the work — for she is evidently the master-spirit and he the poor hen-pecked subordinate; she probably considers him incapable of so great an undertaking as to assist in the construction of even a mud cabin. Nevertheless, he is very watchful and solicitous while she is at work and during incubation; and when the young are hatched he does as much for their support while in the nest as the female. As soon as they leave the nest she shirks all the responsibility of protecting and providing for them upon him, while she proceeds to build another domicile or to fit up the old one. By this judicious management upon her part she sometimes succeeds in rearing three broods in one season, while most other birds rear but two.

The male must find his task rather arduous with this young household thrown upon his care, their gaping, never-satisfied mouths around him.

Recently I was the witness of quite an amusing scene. The male robin brought his young family—nearly as large as himself by this time—from the mud cabin to some raspberry bushes. The bushes were supported by narrow strips of board nailed to posts. This gave the birds secure footing while plundering the fruit. Two of the speckled-breasts helped themselves to the fruit, but the third one kept close to the father, with gaping mouth. In vain the parent flew from one support to another; the persistent offspring was close to

his side, and seemed determined not to help himself. Finally the parent, seeming to lose patience, gave him a tap on the head, and then coolly proceeded to regale himself with the fruit. The young one now shut his mouth for a little time, but soon was gaping again; upon this the irate father was more severe, and gave him quite a drubbing, as much as to say, "Now help yourself, and stop your gaping!" He continued, however, to provide his young family with insects several days after this incident.

Parental chastisement was inflicted in this case evidently for the good of the young one, or why would he have continued to supply them with insects, which were more difficult to obtain?

A close observer of birds cannot fail to see that they exercise reason and forethought, not only in the management of the young, but in many other things.

Let me ask those who deny to animals any faculty except instinct what it is that induces birds to vary from their usual mode of procedure. They sometimes leave their habitat in the woods for our lawns and gardens, and, as opportunity offers, choose new materials and new methods for the construction of their nests.

In the spring of 1870 a pair of house wrens (*Troglodytes ædon*) selected the oddest place imaginable for the site of their mansion, which looked as if solely prompted by a love of mischief. It was on the top of a barn-swallow's nest. There were several nests of the swallows attached to the rafters in a low room over a

stable. Some of the nests were completed, nicely lined with soft white feathers, and contained eggs. I had spent many hours with my favorites the swallows, watching their graceful movements and dainty ways, until they came to look upon me as their friend, and would continue their building with me standing so close that many times I could have put my hand upon a workman.

For a day or two something had prevented my usual visits to the swallows, when my brother, with mock gravity, informed me that a great calamity had befallen my favorites—that a pair of tiny wrens had made war upon them, and the swallows (a dozen or more), with everything at stake, had made an inglorious retreat, and had taken up their quarters in a grain barn near at hand. I at once repaired to the scene of disaster, and found the tiny victors the undisputed possessors of the premises. They had already commenced to rear their mansion, having taken a swallow's nest, eggs and all, for the foundation of their own structure.

The sprightly little housewife darted an angry look out of her bright eyes at me, and no doubt contemplated driving me as she had the swallows; but I was not to be intimidated: she should either go on with her work, with myself as witness, or give up the site she had surreptitiously taken. The male, less suspicious than the female, continued his work. They came through a knot-hole in the side of the stable with all their building material, and then, empty-mouthed, flew

out of the open window. They had, no doubt, in the first place, come in at this hole and chased the swallows out of the window, and so they continued to the end as they had commenced.

The female at first refused to place the sticks she brought, but dropping them on the hay, would fly close to me in a spiteful way, and then pass out of the window. At last she concluded to go on with the work, and I had the satisfaction of seeing the nest completed. It was built close up to the roof, only space enough left for them to enter.

I have often played with birds, evidently making them think that I was afraid, and that they were really driving me. One summer a pair of kingbirds (*Tyrannus carolinensis*) drove me about for a long time. They had built close to the piazza, and had become quite tame before they found how afraid I was of them.

The rose-bugs were very numerous at this time, and I soon found that the kingbirds were helping me exterminate them: they would alight on a rose-bush and devour the bugs greedily. As they came near to me I would cautiously move farther away; this the birds were quick to notice, and soon became so bold that they would drive me from bush to bush. After the bugs had entirely disappeared, when I went to the bushes to cut flowers the birds would often drive me away, and then hunt over the bushes, as if they thought my sole business was bug-hunting.

PART II.

HABITS OF INSECTS.

Chapter V.

SPIDERS AND WASPS.

I sometimes think the more I limit myself to a small area, the more novelties and discoveries I make in natural history. My observations for the past four summers have been almost wholly confined to an acre of ground in the heart of a noisy town. A bit of natural woodland occupies about a quarter of the acre, and here I have made several discoveries new to science.

The most interesting creatures that have rewarded me in my search are two species of large burrowing spiders that had heretofore escaped the attention of naturalists. These spiders build beautiful, complicated structures above their burrows, with which they take as much pains as most birds do in building their nests.

The Rev. Dr. McCook has named one of these spiders *Tarantula tigrina*, or tiger-spider, from the fact that the legs have annular stripes of gray and black, like a tiger's.

This species digs a tube in the earth six or seven inches in depth and uniformly straight. But its skill and wisdom are displayed in erecting the upper part of its domicile, which is evidently for concealment. It

first builds a broad, silk-lined funnel at the mouth of its burrow; the background is composed of whatever

COVER TO NEST OF TIGER-SPIDER REMOVED FROM ITS BED OF MOSS.

1. Upper side of cover. 2. Under side, showing place of connection with the tube and the room above. 3. Nest of tiger-spider with cover raised.

material it can reach with its long hind-legs, while its fore-legs rest in the edge of its tube. This funnel is the foundation of a concealed room, which sometimes takes it several nights to complete. It does not work during the day.

I had repeatedly tried to see one go on with its building, but the light of the lamp or my near proximity seemed to disturb it. At last I had the satisfaction

to see a fine large female go on with her work, undisturbed by the light or my presence. She first spins a canopy of web over the funnel, leaving a place of exit on one side. She next comes out and steps carefully over the canopy, as if to see whether it is strong and secure. Seemingly satisfied that it is all right, she steps down, just letting her fore-feet touch the edge of the web, while with her hind-legs she feels, examines, and handles various things which she rejects. Finally she selects a dry oak-leaf about two inches broad and three in length, and lays it over the canopy, and proceeds to fasten it down all around except at the entrance. After the leaf is made secure she reaches up and pulls down blades of grass, and lays them over the leaf, and fastens them down with web so dexterously that it cannot be seen except with the closest scrutiny. This makes a strong roof over her domicile. Now she goes within, and seems to be putting some finishing touches on the inside. This done, she stands in the door of her neat apartment, waiting for any chance insect that may come within her range. I see a beetle slowly crawling along, evidently in search for its supper. I carefully direct its course towards the spider. Quick as a flash she seizes it, and goes within her home to make her meal. Former experience has taught me that she will be a long time making this meal, so I leave my post of observation for that night.

In a few days thereafter I find that she has completely closed the entrance to her domicile, and if I did

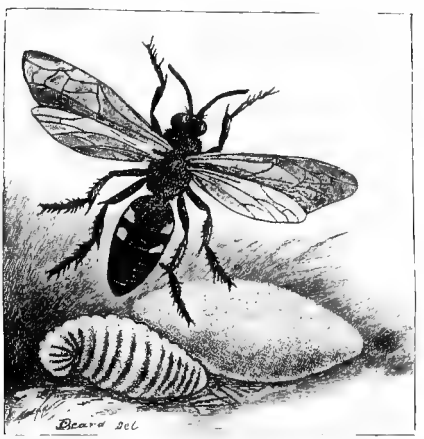
not know the precise spot in which it is located, I should not be able to find it.

I have twenty-eight of these spiders under observation. I visit them all, and find that more than half of the number, both males and females, have closed their doors very firmly. Some of these burrows are situated in beds of moss, and the moss is so cunningly arranged over them that the most expert naturalist would find it difficult to tell where they are. I have often tried my friends, to see if they could find one of these concealed burrows, and have limited the space to a few square inches, within which it was located, but they scarcely ever hit upon the right spot.

It is August, and a female digger-wasp is making sad havoc among these spiders. She wants them to feed her young, and nothing but this particular species will do; and woe now to all the spiders with unclosed doors, for she is sure to find them. The wasp is large and strong, and has steel-blue wings, and two bright orange spots on either side of the abdomen. She runs over the ground swiftly, peering here and there, until she alights upon an open burrow, down which she speedily goes, and soon comes out dragging her victim, which she has paralyzed with her powerful sting.

Sometimes two wasps are hunting in the same vicinity, and when one finds a spider, the other tries to wrest it from her. And now a fearful battle ensues. They drop the prey and clinch in deadly conflict, seemingly trying to stab each other with their stings. The

victorious party returns to the spider, which is heavier than herself, and proceeds to drag it to her nest. She runs backward for a time, dragging it over the ground; then tries flying a short distance, but the burden is so heavy that she soon comes to the ground again. She is so active and quick in her movements that I am



THE DIGGER-WASP, COCOON, AND LARVA.

obliged to walk quite fast to keep even with her. She carries the spider several rods from where she obtained it, lays it down on a gravelled walk, and hunts over the ground. She soon finds the burrow which she has previously dug, returns to the spider, seizes it, and disappears within. She comes out empty-handed, and proceeds to fill up the hole with the earth which she has thrown out. She works so rapidly that I can scarcely

tell which feet she uses the most. She seems to dig with her fore-feet, and to rake the earth in backward with her hind-feet. Soon the hole is full; and now she makes a battering-ram of herself by repeatedly striking her body on the ground, as if to pound the earth down. This done, she rakes the ground all over and around the place to make it level, and then seizes a small pebble in her mandibles and lays it over the spot, and scatters other pebbles all around it, so that it looks noways different from the surrounding ground.

The wasp is gone, and now like a thief I venture to dig up the treasure. I find the spider about four inches below the surface, with an egg sticking in the body which the wasp has placed there. The egg hatches into a legless white grub, which at once begins to feed upon the spider.

Some strange knowledge more than we possess enables the mother wasp to so prepare the spider that the meat will keep fresh and sweet from four to six weeks, or until the helpless baby wasp is full-grown and passes into the chrysalis stage. It remains a chrysalis until the following summer, when a full-fledged, bright-colored wasp emerges. In this state it does not feed upon spiders, but upon nectar and honey.

The wasps continue their raids for two or three weeks, only the spiders with closed doors escaping. Sometimes one has kept herself shut up for two weeks, and then timidly opens her door and looks out; but

the raid is not yet over, and sooner or later she is sure to become the wasp's prey.

Towards the end of August I see no more of the wasps, but out of twenty-eight spiders only five are left. These now soon open their doors, and occasionally one cuts the threads of web in such a manner as to make a sort of trap-door, leaving a hinge on one side; but more usually there is a hole in one end of the oven-shaped cover, which the spider can soon close by drawing the material together and fastening it with web.

In November they all hermetically close their doors, and keep them shut until the following April, when the spiders again come forth, the females each with a cocoon of eggs attached to the spinneret. The eggs hatch in May, and the young spiders crawl on to the mother's back—in fact, literally covering her body. After a few days they leave her, and all at once come rushing out of the burrow. For two or three months these young spiders flit about here and there, over bushes and on the lower branches of trees, seemingly ambitious to get in high places. Towards the end of July their roving life ceases, and they settle down and dig little burrows in the earth, which the first season they do not conceal. The wasps do not molest these young ones.

The following spring—when a year old—they are a little more than half grown, but during the summer they grow rapidly, and moult several times, each time

changing their appearance. By August they seem to be nearly full grown, when their enemy the wasp makes such havoc among them.

By thus tracing the life history of this spider we find it to be two years old before the first brood of young is hatched; and if no accident befalls it, it probably lives several years.

These spiders make very interesting pets. I capture them by cutting out the nests with a sharp trowel or large knife, and have ready some glass candy-jars from twelve to fourteen inches in height, in which I carefully place them. I then fill in with earth all around, making the jar about half full, and cover the surface with moss, introducing some pretty little growing plants, so that my nervous lady friends may admire the plants without being shocked with the knowledge that each of these jars is the home of a large spider.

Some of these spiders take kindly to their new surroundings, and at once begin to repair their domiciles; others utterly refuse to take advantage of my kindness, and try to climb up the side of the jar—which is impossible for them to accomplish—to make their escape. It is of no use to keep a discontented individual, for it will not build, however tame it becomes. Such a one I always let go to shift for itself, which it very soon does by digging a burrow, sometimes within a few feet from where I sent it adrift.

The male tiger-spider is a handsome fellow, and fully as large as the female. In color the body is a light

snuff-brown, with dashes of dark purple, while the legs are striped like a tiger's. The female is nearly black. The male takes as much pains in building his domicile as the female. In fact, one of the males in a jar entirely outdid the female in making a tasteful retreat. He utilized a little twining plant by winding it around and making a living green bower over his burrow.

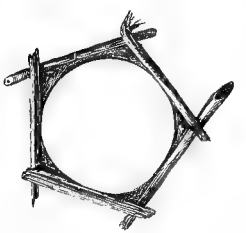
He has a voracious appetite, scarcely refusing anything I give him, even taking large hairy caterpillars. He has moulted three times during the summer, and now in September must be full grown.

But another species—of which this is the first public mention so far as is known—excels the tiger-spider in its curious architectural attainments. It belongs to the genus *Tarantula*, and is as large as the tiger but quite different in color. The male is a soft velvety black, while the female is grayish-brown, or like faded velvet. She has a light-gray spot on top of the thorax, and on the abdomen are three dark-brown longitudinal stripes alternating with light gray. In young specimens these markings are quite distinct, but in old ones the colors blend somewhat. The two sexes do not differ in size, the male being fully as large as the female. The body is a little more than an inch in length, and the legs are large and long, which gives it quite a formidable appearance, but it is perfectly harmless.

I have provisionally named it *Tarantula turricula*, reserving a further description. The name was suggested from its manner of building.

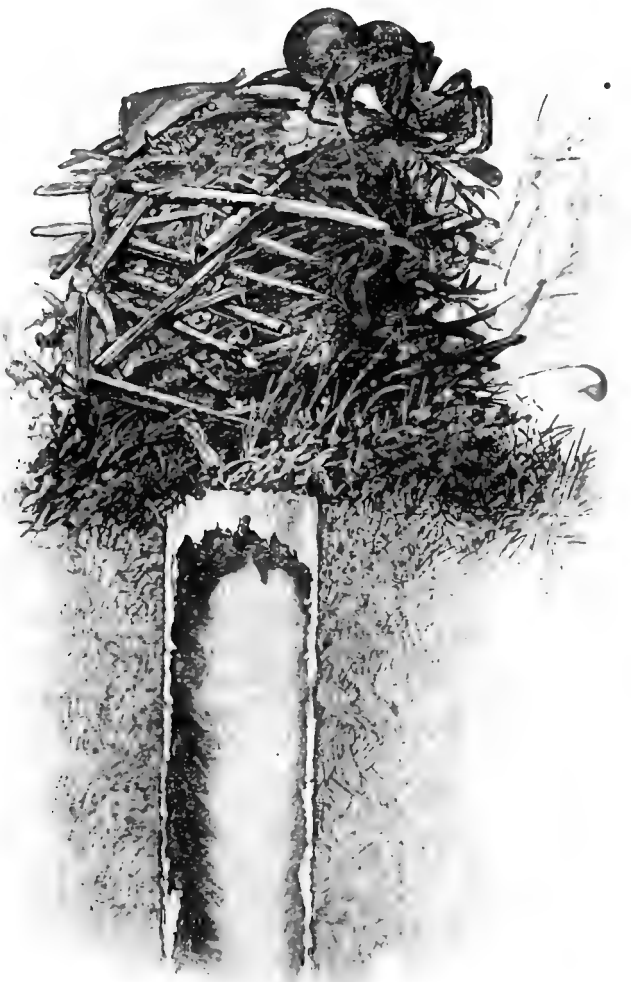
It digs a burrow in the earth six or seven inches in depth, but the upper part of its domicile is entirely unlike that of the tiger-spider. This species builds a little round tower above its burrow. It procures sticks from one to two inches in length, and arranges them very symmetrically one above the other, laying them so as to make a five-sided wall.

It is usually a most contented species in confinement. Early in July I took a fine female, surrounded and almost covered with baby spiders about ready to leave the mother—the young can readily run up the side of the jar and escape. As soon as they left her, I removed the jar to my study; I did not take the nest with this spider, as I wished to see what she would do with entirely new surroundings. The earth in the jar was about six inches in depth and well pressed down. I gave her sticks and moss to put around the top of her tube.



FOUNDATION OF TURRET.

She soon began to dig a burrow, and when it was about two inches in depth she commenced to build a tower above it. She takes a stick from my fingers and places it at the edge of her tube. She works while inside of her burrow, holding the stick with her fore-legs until it is arranged to suit her; she then turns around and fastens it with a strong web. She takes another stick and proceeds in the same way, and con-

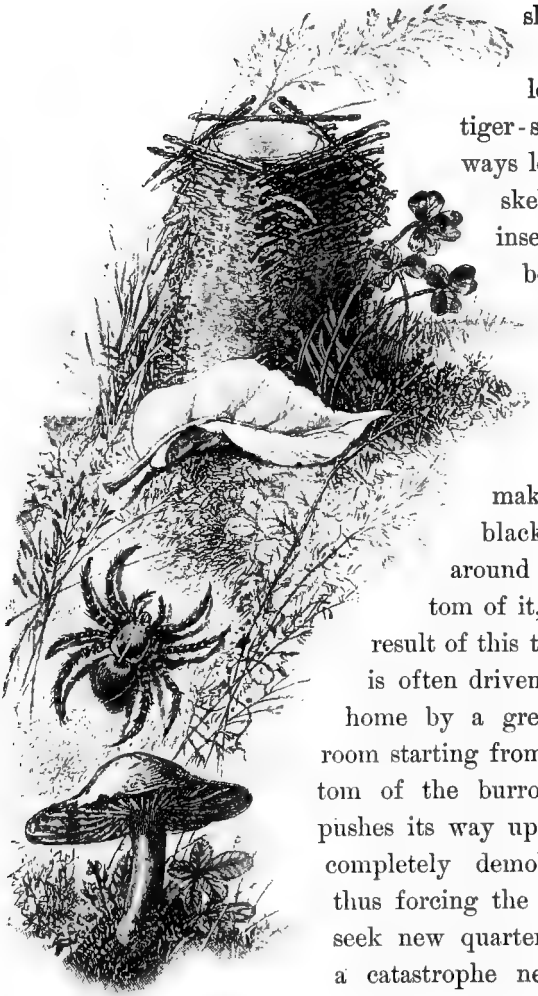


BURROW OF THE TARANTULA TURRICULA.

tinues this until she has laid the foundation of a five-sided wall. She now goes down to the bottom of her tube and brings up a pellet of earth, which she places on top of the sticks; she goes all around, making a circle of these pellets, which she flattens by pressing her body against them, and arranges them in such a manner as to cover the sticks on the inside, making the walls perfectly round and silk-lined. Now she is ready for more sticks, which she continues to alternate with the pellets until the tower has reached the height of two and a half inches above her burrow. I occasionally gave her bits of green moss an inch or two in length, which she would use by fastening them to a stick with web; this makes the wall on the outside fringed with moss.

If she is not in a mood for building, and I offer her a stick, she takes it in her mandibles, and with her fore-feet gives it a quick blow, often sending it with force enough to hit the jar; and when she is digging and bringing up pellets of earth which she does not wish to use in her tower, she throws them from the top of the walls with sufficient force to make them land a foot or more from the burrow, if it were not for the intervention of the glass. This accounted for the fact that I could never find any fresh earth near the burrows of these spiders.

She is also a very neat house-keeper; she leaves no *débris* in the cellar under her tower; the remains of all insects are thrown from the top in the same manner



MUSHROOM GROWING IN THE BURROW OF THE TIGER-SPIDER, AND HOUSE OF THE TARANTULA TURRICULA.

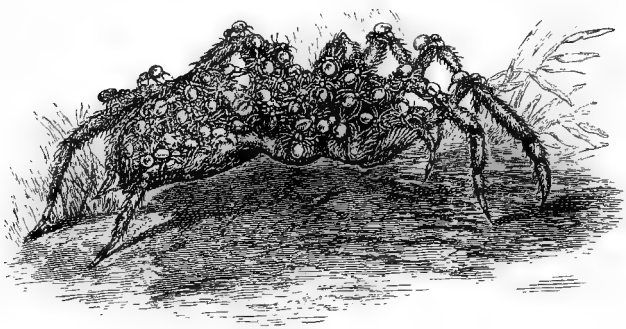
she throws the pellets. The tiger-spider always leaves the skeletons of insects in the bottom of its tube, and in process of time this makes a rich black mould around the bottom of it, and as a result of this the spider is often driven from its home by a great mushroom starting from the bottom of the burrow, which pushes its way upward and completely demolishes it, thus forcing the spider to seek new quarters. Such a catastrophe never happens to our neater tower-builder.

In confinement the female tiger-spider will kill and eat the male, but the tower-builder has no such wicked tendency; the two live in perfect harmony. I soon introduced a male into the jar with the female that I captured in July, but he would not build for himself, nor would he assist her. He often seemed to be watching her movements, and would go up on her tower and look down, but I never saw him venture within her burrow.

Towards the last of July the female appeared with a cocoon of eggs about as large as a hazel-nut attached to the spinneret. I now set the male free, and he dug a burrow not more than two rods distant from where I liberated him. His tower is not so fine as the female's, and as yet it is only about an inch above the burrow, and he has been at work on it for two months or more, but meanwhile two disasters have happened to it—probably some bird, catching a glimpse of the builder, demolished the structure in the vain hope of capturing him.

The female in the jar exercises the greatest care over her cocoon. On cool days she keeps out of sight down in her tube, which is now about eight inches in depth, including the tower; but when I set the jar in the sun, she soon comes up and puts the cocoon in the sunshine. When cool enough for a fire, if I set the jar near the stove, she places the eggs on the side next to the stove; if I turn the jar around, she soon moves the cocoon around to the warm side, letting it hang outside the walls of her tower.

On the 6th of October the young spiders are hatched, and very comical they look perched on the mother's back, and even on her head and legs. When I captured



FEMALE SPIDER WITH YOUNG.

her three months ago in this same condition she was wild and frightened; now she is tame and quiet. She carried the cocoon two months before the eggs hatched.

She never leaves her home; her favorite position is sitting on the top of her tower, with her legs folded beneath her. Any unusual noise, like the sudden closing of a door, always alarms her and sends her quickly within; but she has become so accustomed to my presence that she allows me to move the jar without leaving her position, and she takes food from my fingers, yet if a stranger comes into the room she always seems to know it.

She takes strong insects, like grasshoppers or large moths, into her cellar to kill them; and when their struggles have ceased she brings them up and deliber-

ately proceeds to divest them of their wings and legs, which she throws away, and then sucks the juices from the body and throws away the dry carcass.

Another individual of this species I kept several weeks in a similar jar; but she refused to build, and would not even repair her old home. However, she became quite tame, and I had the satisfaction to see

TIGER-SPIDER AND MOTH.

how she killed her prey. The moth was not allowed to flutter its wings; the spider would get astride of it,

GEOMETRIC WEB OF GARDEN-SPIDER (ARGIOPE).

and hold its wings down with her legs, and pierce it with her sharp mandibles until it was dead.

Among country people there is much superstitious dread of spiders; and the more ignorant, the greater the superstition. The colored people in Florida

believe the bite of a spider causes sickness and death. And a Florida "cracker" gravely informed me that the bite of an ant—a species of *Camponotus* that makes its home in fallen timber—would give them "the fever."

Fallen trees on the barrens that would make several cords of excellent wood would at once be abandoned by the chopper if these ants were found in them. But we need not go to Florida to find the existence of senseless superstition.

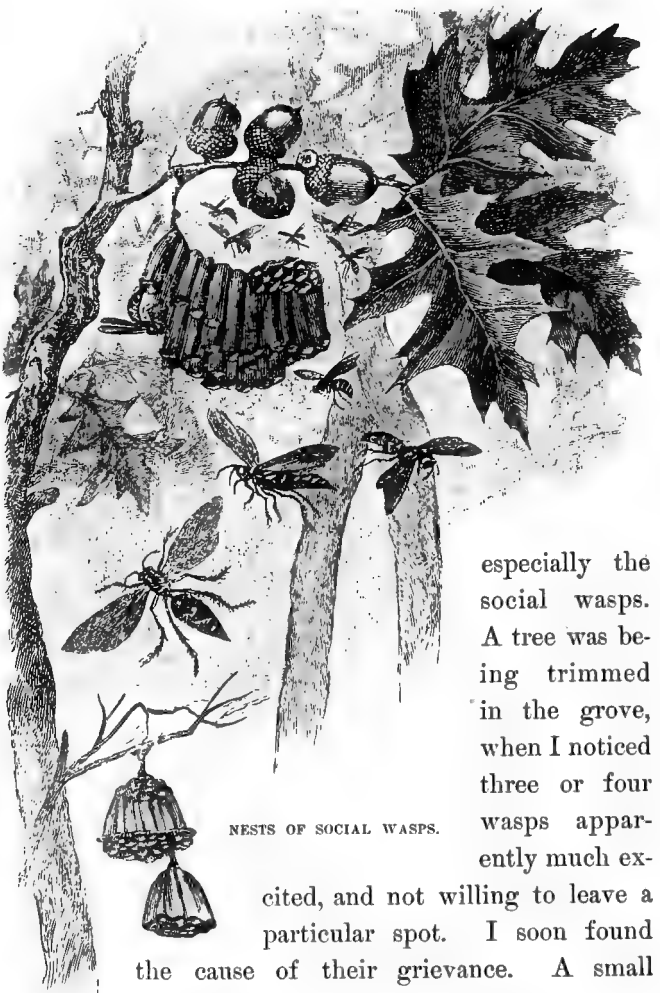
The handsome large black and yellow spider *Argiope* is perhaps the most dreaded, on account of its large size and bright colors. A fine specimen of this species had hung her pretty geometric web in a blackberry bush in a large field devoted to this fruit. On walking through the field I noticed the pickers had, day after day, left the fruit on this bush, and I supposed they did not wish to disturb the spider. At last she was gone, and upon making inquiries I learned that a woman more courageous than the rest had armed herself with a large stick and killed the monster!

This beautiful creature, with her exquisite web, is one of the most charming studies in nature—

> "The spider's touch, how exquisitely fine!
> Feels at each thread, and lives along the line."

She is readily tamed, and her solicitude over her great pear-shaped cocoon of eggs is often quite pathetic.

Some species of wasps are very interesting studies,



NESTS OF SOCIAL WASPS.

especially the social wasps. A tree was being trimmed in the grove, when I noticed three or four wasps apparently much excited, and not willing to leave a particular spot. I soon found the cause of their grievance. A small branch had been cut off and thrown down, upon which was fastened their curious paper nest. I

took the branch and stuck it in the ground under the tree. The wasps at once found it, and manifested so much intelligence that I resolved to watch them and see if they could be tamed.

They belonged to the genus *Polistes*. The nest is firmly fastened to the branch by a slender, strong pedicel, which is on one side of the mass of cells. The cells are so arranged as to form a concave curve, as may be seen in the engraving. One side is lower than the other, which makes a slanting roof.

To bring these wasps under subjection I supposed would require much and long-continued patience, but, to my surprise, I found them very tractable and easily won.

My first experiment was to handle the branch, which they resented by acting quite waspish; but I was very gentle with them, and they, never stinging me, soon allowed me to hold it in such a manner that I could see them feed their young and go on with their work, building their paper cells. They manufactured their paper out of wood. I placed a weather-beaten board near them. Two of the wasps used it; some of the others tried it, but seemed to conclude that they had a better manufacturing establishment of their own finding.

I held a small dish of moistened sugar and fruit sirup in my hand, which they found and relished highly. I never left this for them to help themselves, as I

wished to teach them that I was their benefactor, and they soon learned this and came to meet me. If I neglected to bring the sirup, they flew all around me, sometimes alighting on my hand, but they no longer made any demonstrations that looked like stinging.

I one day witnessed a most singular proceeding among this family. A large fat baby wasp died in its cell. The mother wasp pulled it partly out and stroked it with her antennæ, and seemed to be licking it. At this time there were a dozen or more mature wasps—the queen and workers. Nine of these were hanging about the cells, an unusually large number to be at home, all at the same time, during working hours. As soon as the mother stepped aside, another took her place and went through the same motions, stroking and licking it; and this in turn was repeated by all of the sister wasps that were present. Then one of the number pulled the dead baby out of the cell and flew away with it, followed by three or four of the family, and I soon lost sight of them.

All of the social wasps, so far as is known, commence the colony with one individual queen. The old queen, workers, and males die in the fall, while the young queens hibernate through the winter, under moss and leaves or beneath the bark of trees, and in the spring they select a spot to build, and lay the foundation for the future colony. As the queen has the entire work to do in building the first cells and feeding the larvæ,

the work progresses slowly; only two or three cells are completed when the first worker emerges. And now the work goes on more rapidly. The foundations of other cells are at once made, in each of which the queen places an egg, which develops rapidly, and soon the mature wasps appear, and join their mother and sisters in the work, until the colony — in the genus *Polistes* — often numbers a hundred or more individuals.

A small earthen wren-house had been fastened under the eaves of a building to accommodate the birds. I had often noticed a pair of wrens chattering and scolding and peering in at the door, but never venturing within. Wishing to learn the cause of their behavior, I mounted a step-ladder and looked in. I found that the rust-red social wasp (*Polistes rubiginosus*) had selected this novel place to build in, much to the chagrin of the birds, which were evidently afraid to venture within.

In the autumn, after the wasps were gone, I investigated their work, and found this had been their home for five years. Four large clusters of cells were suspended from above. This species attaches its nest from a central point, unlike the first-mentioned species. These four nests just about filled the space; the one last made was somewhat crowded and irregularly built, no space being left for future progeny.

In the spring a queen returned to the ancestral hall,

took in the situation, and resolved not to forsake the home of her forefathers. She selected a stick about an inch in length, and firmly welded it across near the lower edge of some of the old cells. This made a strong brace, capable of sustaining the future colony. She suspended her nest from the brace, where the brood was successfully reared.

Chapter VI.

GROUND SPIDERS.

Do insects really possess mind? If not, what is it that often impels them to behave precisely as reasoning beings? Some time since I read in the "Scientific Record" of *Harper's Magazine* the following passage:

"M. Félix Dujardin, of Rheims, verified in the nervous system of insects a centre of true brain, above the throat, imbedded among air-tubes, salivary glands, and fat. Hardened by alcohol or spirits of turpentine, its form and structure appeared beneath the microscope in regular convolutions, like those of our own cerebral hemispheres, and the outside pulp removed left nerve tracts winding into a white and firmer substance, like the nucleus of the white invertebrata."

If any one will closely observe the behavior of insects—especially ants, wasps, or spiders—he will not be at all startled or surprised with the announcement that these humble creatures have brains like our own

Many spiders build for themselves homes—not merely nests to rear the young, like birds and some of the higher animals, but homes to which they become strongly attached.

In a former chapter I gave some account of a pet spider which built a tower above her burrow, and therefore I named her *Tarantula turricula*. Just as I was closing the sketch she became the mother of a numerous family.

As far as I have observed, the young of other members of this family escape from their cocoon through the seam which extends around the central part: it is thinner at this point, and splits nearly around the whole circumference, so that the young come out in a body; but with this species they cut a smooth round hole in the cocoon, just large enough for them to come out one by one.

During the past eight weeks I have kept close watch of this curious family, carefully noting the behavior of the mother, who, like

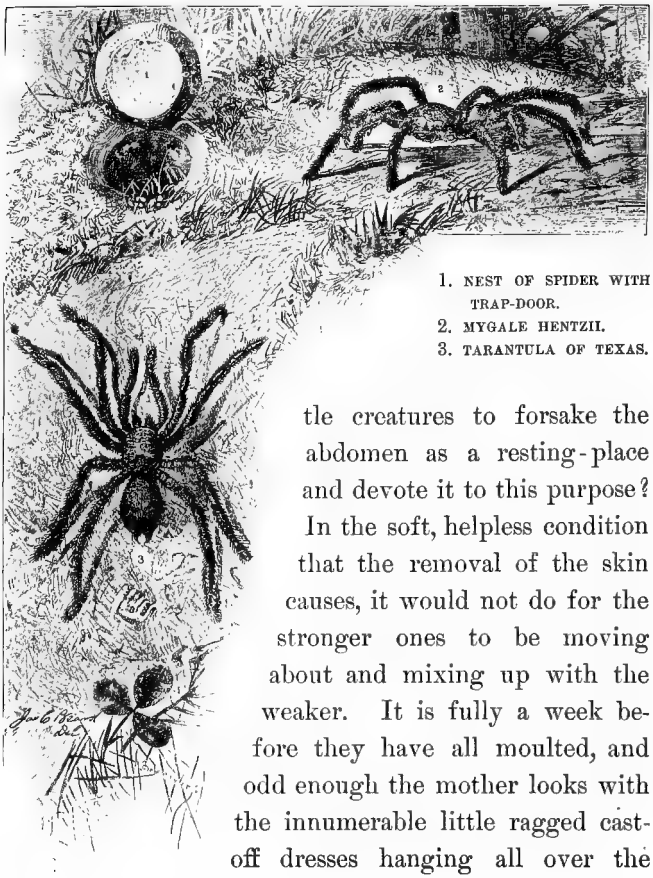
> "The old woman that lived in a shoe,
> Had so many children she didn't know what to do."

The first three weeks the little things are piled all over the head and thorax of the mother, often completely blinding her. They seem ambitious to reach the highest point, and jostle and crowd one another in their efforts to be at the top of the heap. The mother patiently endures it for a time, but when they become too thick over her eyes, she takes her long fore-legs, which she uses as feelers or hands, and reaching up scrapes off an armful, which she holds straight in front of her, as if looking at them, and perhaps giving them

a homily on manners. Soon she gently releases them, slowly opening her arms, and they quietly take their places around the edge of the tower, where they usually remain until the mother goes below, when they all follow. Upon her re-appearance they are again stationed upon her back.

When these little creatures were two weeks old they strung innumerable lines of web across the mother's back; this I soon found was to enable them to dispose of their baby dresses. Up to this time they had been piled upon her abdomen as well as upon her thorax, but now, as if by common consent, they entirely forsook the abdomen as a resting-place, and devoted it exclusively to a dressing-room. Sometimes two or three are divesting themselves at the same time. They fasten themselves by a short line of web to one of the lines which they have strung across the mother, and this holds them firmly while they undress. The skin cracks all around the thorax, and is held only by the front edge; next the abdomen is freed, and now comes the struggle to free the legs. The little one works and kicks vigorously, and seems to have no very easy task; but earnest perseverance brings it out of the old dress in about fifteen minutes, perfectly exhausted and almost lifeless. I take one upon my hand, where it lies limp and helpless for several minutes, and then it gradually comes back to life, and is soon as bright and as before.

Whence came the knowledge that impelled these lit-



1. NEST OF SPIDER WITH TRAP-DOOR.
2. MYGALE HENTZII.
3. TARANTULA OF TEXAS.

tle creatures to forsake the abdomen as a resting-place and devote it to this purpose? In the soft, helpless condition that the removal of the skin causes, it would not do for the stronger ones to be moving about and mixing up with the weaker. It is fully a week before they have all moulted, and odd enough the mother looks with the innumerable little ragged cast-off dresses hanging all over the lines of web.

Naturalists tell us that young spiders kill one another; but with this species I could detect no such tendency. I kill one and lay it upon the edge of the tower; many of the little ones crawl over it, but pay no atten-

tion to it whatever. Finally the mother notices it, feels and examines it with one of her fore-legs, and then takes it in her mandibles and shoots it across the jar, where she is in the habit of throwing refuse material. Neither will the young pay any attention to a fly that I kill and lay in their path; but if the mother holds it in her mandibles and crushes it, they crowd around it, and seem to be sipping the juices. In the absence of other food the mother crushes some of her own babies, and holds them so that the little cannibals can suck the juices.

The young do not leave the mother all at the same time, but go out in detachments. When three weeks old about a dozen manifest a disposition to leave the maternal home. They run up on the highest point of a plant, and remain there until I set the jar where the plants can lean against the trunk of a tree, when they speedily run up to the branches; the rest are quiet, staying with the mother a week longer. But now she manifests a disposition to send them adrift. She is no longer quiet and patient, but frequently picks one up and throws it across the jar, yet seems to be careful not to injure it. She behaves much in the same way that the higher animals do in weaning their young.

It is now a bright, sunny day in early November, and a large proportion of these little creatures—fully fifty—seem to be in great haste to leave. Like the first, they also run up the body of a tree, and I see no more of them; but in the spring I shall probably find

many little burrows in the neighborhood of the tree. where they have settled down as staid house-keepers.

Some twenty-five or thirty are still with the mother, and the weather being cold and disagreeable, these show no disposition to leave. I remove the plants from the jar that I may be better enabled to watch their proceedings.

The mother has cleared the web from her body, and looks plump and bright. She sits on the top of her tower, with the little ones stationed thickly all around the edge—seldom now are they resting upon her; but when she goes within her burrow they all follow. For several days past whenever I have given her food she quickly disappears with it, and this, no doubt, is the reason why they follow her. On her re-appearance I see that a few have availed themselves of the opportunity of being carried up upon her back, but they do not remain there.

One of these little creatures has resolved to set up house-keeping in the jar without taking its allotted period of roving life, and its performances are the most amusing of anything I have ever witnessed in insect life. It is making its tube down the side of the jar, so that the glass forms about a third of the wall, thus enabling me to see the movements of the little builder at all times.

The tube is very small, scarcely one-fourth of an inch in diameter. In two days it has excavated an inch below the surface, and built up a tiny tower fully half an

inch high. The tower is made wholly of earth and web. This diminutive architect brings the little pellets in its mandibles, and those it does not wish to use in the tower it lets fall down by the side. Unlike its mother and other elderly relatives, it does not shoot the earth to a distance, but stands on the top of its tower, and opening its mandibles lets it drop; at the same time it throws apart its legs or arms, as if that would help it to dispose of the earth. This movement is very baby-like; but with age will come the wily movements of the mother — shooting the earth away, and using moss and sticks for the better concealment of the home.

Yet this small house-keeper has rights, and means to maintain them. Her actions say most emphatically that she has shut herself apart from the rest of the family, and will not be annoyed by them. Frequently one of her brothers or sisters, meandering about, comes to this little tower, and not often will one pass by without going up and looking in. This always seems to exasperate the small madam. She drops her work, and springs from the top of her tower, sometimes chasing the running brother half way across the jar; she then turns and goes back to work. This is the more remarkable as no such disposition is ever manifested so long as they remain with the mother. While with her they crowd together, walk over one another, and never have any quarrels.

At the end of the sixth week most of the remaining

young are anxious to go out in the world. It is another pleasant day, and I again give them the opportunity; now only five besides the little house-keeper are left behind, and the next day I release two of these, leaving only four, and one of these has also concluded to settle down and build a cosy home in the jar. It builds precisely like the first, and has the same trouble with its inquisitive little brothers. It has chosen the site of its domicile not two inches distant from its sister's, and here they sit contentedly on the top of their towers, often facing each other, and watching the tiny scavenger beetles that breed in the jar and live on the refuse insects thrown out by the mother. These beetles are food for the young spiders, yet I think they are not to their taste as much as flies; but they dare not yet attack a living house-fly. If one comes near them, they quickly dodge within their burrows. If I kill a fly and lay it on the tower, either will try to take it within, but it is impossible to do this with the wings and legs adhering; yet it is wonderful to see their attempts. They turn it first one way and then another, and get beneath it and pull. I remove the wings and legs, and lay it back, when it is soon carried below. After a few hours the dry carcass is brought up and thrown out.

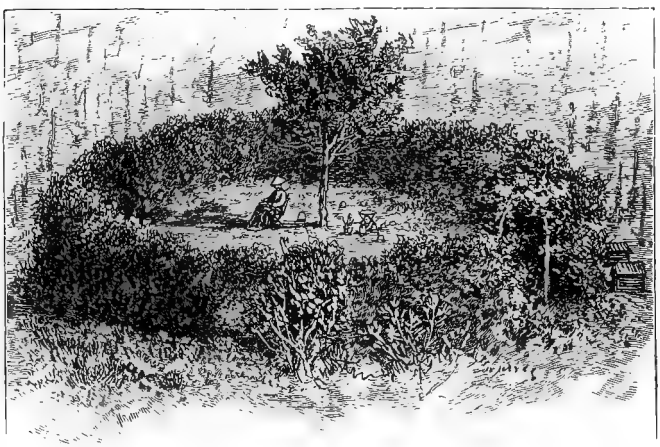
Wishing to photograph the mother's tower, I found it necessary to remove it from the jar. This seems to nonplus her; she does not know what to make of it. All at once her house is on a level with the ground.

She becomes timid, and runs out of sight at my approach. But after a while she comes up and begins to investigate matters. She examines the various things scattered over the surface. Now she finds the long legs of a grasshopper, and concludes these will do towards erecting another tower. I do not offer her any fresh sticks or moss, but let her work with what she can find. She comes across a moth about an inch in length which she has rejected as food, and it is stiff and dry; so she utilizes it by working it in with the other material. She is a persevering builder, and in about two hours has reared her domicile half an inch above the surface.

I return the tower, which is so firmly made that it has not been injured by the transportation, and place it in position as nearly as I can. Very soon this wise architect comprehends the situation. She sees where the welding must be made, and holds the tower firmly in place, pressing against it with her body, while round and round she goes, securing it with a strong web.

Satisfied with its stability, she takes her position on the top, sitting there very complacently, evidently expecting to be furnished with flies, which by this time —the last of November—it is no easy matter to procure. But occasionally there comes a warm, sunny day, when flies are on the wing; and now opening the door, a number are sure to come in and fly to the windows, where I easily capture them. They are much larger

than house-flies, and two or three will make her a good meal. I put half a dozen in the jar, and cover it so they cannot escape. And now madam is on the alert; she watches them as a cat watches a mouse; she crouches and moves cautiously, and when one alights she pounces upon it. Not often does she miss her



THE INSECT MENAGERIE.

prey, but when she does it is very amusing to see the astonishment she displays. She slowly straightens up and feels beneath her. Satisfied that the game is gone, she now becomes much more wary, and acts as if she did not care for flies at all, allowing one to come so near that it almost touches her before she springs upon it. When there are several flies in the jar she disposes of one much more quickly than she otherwise would.

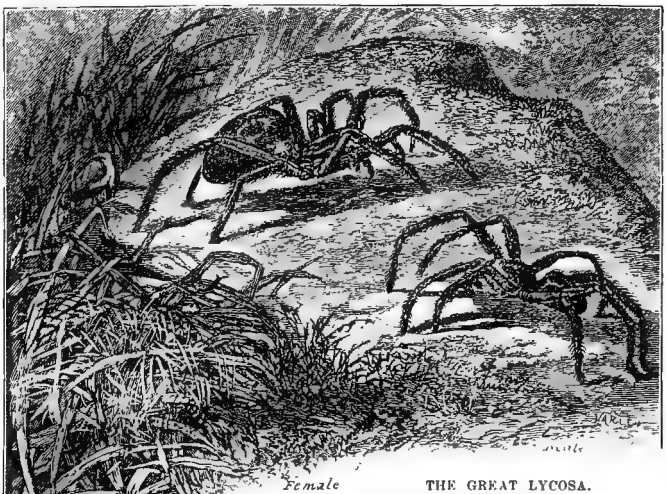
Sometimes she manages to hold two in her mandibles at the same time.

All the young have left her, and now she sets her house in order. She comes to the top with a bundle of the little ragged dresses bound together with web, and shoots them across the jar. Bundles of little sticks and loose earth follow in rapid succession. She works with energetic perseverance for an hour or more, and then stops and assumes her favorite position—sitting across the top of her tower—and proceeds to make her toilet. First one leg and then another is passed between the palpi several times, and all the while her mandibles are at work as if chewing, and moisture oozes up between them so that it is plainly visible.

Many other members of this large family (*Lycosidæ*) have very interesting habits, and are well worth observing. One of the largest species found at the North is *Lycosa carolinensis* (Hentz).

According to Dr. McCook this species has a wide range, being found all along the Atlantic seaboard and west as far as Ohio.

Fine specimens of this large spider were expressed to me from New Hampshire, and are now hibernating among a host of their relatives in my arachnidan menagerie. My menagerie is enclosed with a dense circular hedge of arbor-vitæ, fifteen feet in height and a hundred and fifty feet in circumference. In the centre is a maple-tree with drooping branches. Ornamental plants are scattered about, and two bird baths are pret-



Female THE GREAT LYCOSA.

tily arranged—large, shallow, earth-colored pans are set into the ground, and graceful twining plants are festooned above them. The birds seem to appreciate these cool, pretty baths, and their splashing keeps the earth so moist that the plants grow luxuriantly all about them. In this retreat I have brought together a large number of burrowing spiders, whose habits I wish to investigate, and to do this successfully I must devise some means to keep them intact from their enemies. For this purpose I have a number of oval glasses (such as gardeners use in starting early vegeta-

bles), with a small opening at the top, which I can close at pleasure. These I set over each burrow to keep my pets from the ravages of their relentless enemy, the digger-wasp. In this way I hope to be able to learn much more of the habits of other members of this curious and interesting family.

Most of these spiders readily adapt themselves to their new surroundings. I sometimes transplant the nest entire without disturbing the occupant; but when they are to be transported long distances this is not practicable. I have found the most satisfactory way to send them on a journey is to confine each in a glass bottle. The bottle should be about the diameter of the burrow in which the spider lived.

The great Lycosa from New Hampshire was sent in this way, and then packed securely in a wooden box with many other specimens.

As soon as they arrived I put the largest female Lycosa in a glass candy jar, hoping I could make a house-pet of her. But she had come from a grassy meadow, where her burrow was fourteen inches deep, and around the top of which she had woven grass and weeds to the height of four inches, and could she be content with a little six-by-twelve jar, with only about six inches of earth? She seemed to scorn the arrangement. I kept her confined several days. She was not at all afraid, and would drink and take flies, but she would not build, and even turned from the top of her own domicile, which was sent with her, and made so firmly that it was not

injured by the removal. Round and round she went, standing on the tips of her hind-feet, while her fore-feet stretched up fully four inches against the glass, making her look quite formidable; but she is perfectly harmless, never attempting to bite in the handling.

Despairing of her ever becoming contented in the jar, I put her in the menagerie with the rest. I first made a hole two or three inches deep, and set the top of her New Hampshire house over it. This was better. She took to it at once, and commenced to fix up. She soon welded New Hampshire—soil and grass—fast to New Jersey, and was now satisfied and happy, and did not shut herself in for the winter until late in November. Her burrow is only about eight inches deep, and yet there is a marked increase of temperature in it. This was observed by several persons on placing the hand at the mouth of the tube. One cold morning — only twenty degrees above zero—I introduced a thermometer into the burrow. It ran up to forty, making a difference of twenty degrees. Soon after this she closed her domicile with a canopy of thick close web; she also drew in a few sticks and straws.

There is a great difference in the size of mature individuals of this species. I have never found any specimens in New Jersey that would at all compare in size with four that were sent me from New Hampshire. The male, like others of its class, has very long legs, as may be seen from the engraving, and, poor fellow, he may often need them in making long strides to get out

of the reach of his lady-love, who is not very even tempered, sometimes petting him, at others savagely attacking him.

The best builders in my menagerie are *Tarantula tigrina* (McCook) and *T. turricula;* but there is a marked difference in individuals, even of the same species, and I am inclined to think that parentage tells with spiders as well as with the higher animals. The first brood which left my famous pet tower-builder, early in July, have built their little towers as neatly as the mother, and precisely in the same way; while some others of this species rake together whatever they can procure, without order or method. A fine builder of *T. turricula*, however, far outstrips *T. tigrina*, and the winter covering over the home of a good tower-builder is carefully made. Small sticks are laid side by side, and held together with web, forming a firm roof, which is lined on the inside with a thick silken web. But probably all of the various species dig and dispose of the earth in the same way.

Among the New Hampshire spiders sent was a small one — unknown to me — taken from a burrow sixteen inches deep. I put it in a glass jar, with five inches of moist earth well pressed down. It soon commenced to dig a burrow next to the glass, giving me a fine opportunity to see it work. It dug the earth loose with its mandibles and fore-feet, and then turned, and with its spinneret made the earth into a pellet; it again turned, seized the pellet in its mandibles, necessitating

a third turn, and now came to the edge of the tube, always with its back to the glass, and adjusted its fore-feet so that the tips touched beneath and partly behind the ball of earth, and with a sudden movement of the feet, like the snapping of a finger, it sent the earth with sufficient force to make it hit the opposite side of the jar. I took some of the pellets, and found that the earth was held together with a kind of mucilage, and sometimes mixed with web.

This little creature—only about half an inch in length—was the fastest worker of any I have on record. In four hours she had dug to the depth of three inches, never stopping for a moment, although the jar sat on the table near the lamp, where I was moving books and papers, and part of the time conversing with a friend, yet nothing diverted her from the main business of establishing a home. In the morning she had reached the bottom of the jar, and was not satisfied, so I put her with the rest, where her energy and perseverance might have full scope. The ground was in good condition, and she very soon commenced a second burrow. She has not covered her retreat, and every pleasant day — now December — she comes up and looks around; she is under glass, which makes it quite warm when the sun shines.

The greatest perfection of tubular nests, however, culminates with spiders that live in warm countries, and make trap-doors with bevelled edges that fit into the top of the tube perfectly; and the spider, when

pursued by an enemy, can shut the door tightly, and hold it fast with its two front pairs of legs. It inserts its claws into holes made near the edge of the door, and braces itself so firmly against the walls of its tube, and holds on with such pertinacity, that the cover cannot be raised without tearing it.

These curious nests are often brought from Southern California, but the spiders which construct them do not take kindly to confinement, at least in the North.

Chapter VII.

UNDER THE MAPLES.

There is a lively interest among students of history and society in the uncovering of rubbish heaps and the reconstruction of village communities out of institutional hints. I have found my pleasure in unearthing the villages and farms and pasture-lands and battle-fields which lie under my maple-trees. Every year the busy life goes on there, whether I watch it or not; it is a microcosm of that world which my daily newspaper reports; for here among the ants are the builders of cities, the governors and leaders, the masters of slaves, the harvesters, the herdsmen, and the mechanics. No emancipation proclamation has yet been issued, but there are wars and rumors of wars.

Failing to discover the official records of these busy creatures—too busy, may be, to trouble themselves about history—I have kept a journal of my observations. I have had, moreover, the opportunity of comparing the observations which I have made under my Northern maple-trees with what I have seen at the South, and I record with pleasure the fact that there is more common ground of pursuit between the two sections

than some would have us believe. Naturalists have given us the impression that no harvesting ants are to be found at the North. They are mistaken. Familiar as I am with those of the South, I have never found a more interesting species than one at the North—*Pheidole pennsylvanica*—a large colony whose subterranean city is beneath the spreading branches of a maple in near proximity to my house, affording an excellent opportunity to observe its habits.

The colony is composed of males and females and two sets of neuters, consisting of soldiers and workers, each set widely differing from the other in looks and occupation. The soldiers are at once recognized by their superior size and large heads, and they take no part in the ordinary work of the community. The workers are much smaller than the soldiers, and, as their name indicates, they are the architects, food providers, and nurses of the community. They gather various grains and seeds, which they store in underground rooms, usually below the frost line, which indicates that the grain is housed mostly for winter use; this idea is further confirmed by the fact of the great quantity of shells and chaff of seeds which they bring out when their city is undergoing its first thorough spring cleaning.

In what way the seeds are prepared so that they may be made into available food is something of a mystery, as the ants take all nourishment in a liquid form. I have noticed that they are partial to those which yield

an abundance of mucilage, such as plantain (*Plantago lanceolata*); but whether these seeds are gathered for the mucilage which they contain, or for the albumen, which is also abundant, is a question, for the ants are not confined to mucilaginous seeds by any means, but harvest those of *Oxalis stricta*, *Spergula arvensis*, and grass-seed, which are destitute of mucilage, but abound in albumen. As the embryo swells it acts upon the albumen, dissolving and chemically changing its substance into a large quantity of sugar, which seems to point to the way in which they are used for food.

But the ants also gather a great many seeds of a cruciferous plant (*Lepidium virginicum*) which contains no albumen. So instead of devoting my time to finding out the properties of the various seeds which they collected, and speculating upon how and in what way they use them, I have closely observed their habits from early spring until late autumn.

In the first warm days of April, sometimes in the latter part of March, several gates of the city are opened, and the busy inhabitants are engaged in bringing out the refuse of grain and other rubbish which has accumulated during the winter, and which they deposit in a heap outside of the city limits. The laborers work continuously during pleasant weather, and are attended by sentinels, or perhaps street commissioners, who seem to be watching and directing their movements. When the spring cleaning is completed, all the gates are permanently closed except one, and this is shut and barri-

caded at all times save when the ants are actively engaged at harvest or other work.

Upon excavating a formicary in July, I found several nearly empty chambers, some near the surface of the ground, others scattered irregularly about to the depth of three feet, where I came to several small rooms or granaries stored with seed. I noticed one chamber much larger than the rest, which from all appearances was the dining-room, as it contained some partly consumed insects. The ants were in great consternation over the loss of their city, running in every direction, and carrying the larvæ and pupæ, while many of them were buried beneath the ruins. It appears heartless and cruel to destroy one of these neatly built cities, doubtless the work of years and representing the labor of many thousand individuals. And, in fact, very little can be learned of the interior of such a formicary, even with the most careful handling, owing to the nature of the soil in which it is built. The most satisfactory way of obtaining knowledge of the interior of a formicary is to cut into one of some species that builds in wood, and take out sections that can be carried home; and at the same time secure a colony of the ants, together with the larvæ and pupæ. This I accomplished with a species of *Aphænogaster*, nearly related to the harvesting ants. The blocks were cut through several chambers, but fitted together perfectly. The ants were soon domiciled, and came out and walked timidly about among their new surroundings. I now placed dry

crumbs of cake and small lumps of dry, hard sugar near the blocks, which they soon found and carried within. Three days afterwards I carefully separated the blocks, and found the dining-room, where the cake and sugar had been taken. The blocks were dry, and placed where no moisture could reach them except what the ants might convey, and yet the cake and sugar were dissolved into a pulpy mass. The larvæ were in dry chambers not far removed from the food. This indicates that the harvesting ants bring their stored seeds from the granaries to another room as needed, and have some process unknown to us whereby they make the seed into available food.

When some reconnoitring member of the community has found an abundant harvest, the news is soon imparted, and the workers form in line and march to the spot. Here the line is broken, and the numerous individuals scatter about and collect the seeds, when they again form in line and return over the same road. Day after day this road is traversed, until the grain is exhausted, or until some enterprising member has found better harvesting grounds, when the old field is forsaken for the new. I have never seen the soldiers in line with the laborers carrying seeds, but they are always at the front, where strength and courage are required, and they will work in case of an emergency.

In common with other ants, the harvesters are very partial to animal food, upon which, no doubt, they greatly subsist during the summer. A dead fly several

times larger than one of the ants was placed a short distance from the gate of the city. A wandering individual from the tribe of Lasius discovered it at the same moment with one of the Pheidoles. (As our little harvester has a name and place in the scientific world, I will hereafter call it by its generic name, *Pheidole.*) The two are about equally matched in size and strength, and now a struggle ensues for the coveted prize. First one and then the other seems to have the advantage. Lasius succeeds in getting it a short distance from the place of discovery in the direction of her camp, but is obliged to drop it to make sure of her bearings, when Pheidole hurries with it in the opposite direction, eager to place it within her gate before the other again seizes it. But Lasius is not to be beaten in this manner, and again struggles for the mastery, and it begins to look as if she might be successful. At this point Pheidole seems to be discouraged, gives up the contest and starts for home. She enters the gate for a moment, and hastily returns, closely followed by a soldier. During this short interval Lasius has moved well forward in the direction of her camp. Pheidole reaches the spot where she left the prize only to find it gone, and now she rushes in frantic haste round and round, widening the circle as she advances, until she finds Lasius, and again lays hold of the fly. The soldier, meanwhile, moves more slowly, but makes the same circuit, until she reaches the contending parties, and takes hold of the fly by the side of her comrade; and now the

burden is easily carried, with Lasius clinging to the opposite side, and holding on with untiring pertinacity, occasionally preventing the rapid transit by bracing herself against some object in the path. This seems to provoke the soldier, who drops the fly, lays hold of Lasius, and tears her in pieces, while the smaller Pheidole carries the prize to the city and disappears within the gate.

I placed six freshly killed horse-flies near the city, any one of which was many times larger than one of the Pheidoles. Two workers soon made the discovery, and walked over and around this huge pile as if taking its dimensions. Satisfied that it was beyond their power to do anything alone, they simultaneously started for the city, as if each were anxious to be the first to impart the news. Not a soldier was visible, but several must have been just within the gate, for they immediately came pouring out in large numbers, and at once proceeded to this supply of food. The flies were soon carried to the city, but were too large to drag through the gate (the streets, or galleries, were much broader than the gate from which they diverged); so they were removed a short distance, and a company of laborers was employed in enlarging the gate, while the soldiers were engaged in cutting off the wings and legs from the flies. Soon one was brought back to the gate, two legs and a wing still adhering to the body. They tried to take it in head first, but it would not go; they lifted it out and turned it round, but succeeded no better

until the remaining legs and wing were severed. All of the flies were managed in the same way. The legs and wings, as fast as the soldiers severed them, were borne within by the workers. Sometimes the wings were at first rejected and thrown among the *débris*, but other more provident individuals were sure to find them, and bearing them aloft like banners, carried them into the city. In less than an hour all of the flies were housed, the gate closed, and not an inhabitant was to be seen.

Each tribe has its own peculiarities. *Lasius flavus* is a thieving, vagabond race, widely differing from the Pheidoles, who have regular settled homes, while the camps of the Lasius are scattered everywhere and often changed. Sometimes several camps are near the city, and prove to be a great annoyance to the citizens; the strolling tribes hinder them in their work, and interfere with their funeral rites. Several workers are employed among the Pheidoles to keep the dining-room in order; they bring out the chaff of grain, and shells of seeds, and remains of insects after the feast, and deposit them in a heap some distance beyond the gate-way. While they are thus engaged a sentinel is always patrolling around the gate to warn them of approaching danger. The Lasius are the most dreaded enemy. They are sure to be on the alert when the gate of the city is open, ready to snatch prey from the returning hunters; or they rush up to the workers, to see if they are carrying out anything desirable. So the sentinel, when she

meets any of this tribe, hurries to the entrance and stations herself there, and seems to whisper to each advancing worker, who hastily retreats with her burden. As long as the sentinel remains at the gate not one of the laborers passes out; but she no sooner returns to her rounds than they begin to emerge, at first slowly and cautiously, deposit their burdens, and return for more.

The Lasius are not only cannibals, but they will snatch the dead body of a Pheidole from its relatives when on the way to the place of interment. I was sitting near the closed gate of the city, and observed that the sticks and pebbles with which it was barricaded were being moved to make room for an individual to go through. The ants came out one at a time to the number of seven, and removed the stones and sticks to one side, leaving a free opening. And now one of their comrades came, bearing the dead body of a young female. She had died while still clothed in the white filmy material in which the young are swathed—a fitting shroud, through which her plump body was plainly visible. Her limbs were neatly folded across her breast. The bearer started alone to conceal the body in some distant place, while her comrades reclosed the gate and retired within the city. I followed the bearer, and saw, from the direction she was taking, that she would soon be in the midst of several camps of Lasius, of which she seemed to be unaware. No sooner had she reached the border of the camps than her footsteps were dogged by one of the tribe, who soon overtook her, seized the body

and tried to wrest it from her; but finding that her strength was not sufficient she let go her hold, and hastened to the nearest camp to tell of this desirable prize. Soon a dozen or more of the Lasius were on the track. She now became thoroughly alarmed, and impetuously rushed forward until she came to a deep pit. She did not drop the body, but clung frantically to the edge of the pit, until the little fragment of earth gave way, and she was precipitated with her burden to the bottom. The Lasius lingered a while, waiting for her re-appearance; but she did not come, and they returned to their quarters.

The Pheidoles' mode of defence when attacked by a large army is unlike that of any other species with which I am acquainted. A great troop of Lasius from surrounding camps came down upon the city, with the determination to take it. They scaled the fortified gate and hastily threw aside the barricade, but were met by a solid phalanx of large-headed soldiers which completely filled the gap. Defeated here, their next move was to mine into a street a short distance from the gate. But their labor was of no avail; here, too, was a phalanx of soldiers, and not a Lasius was allowed to pass within. But they had their revenge in another way. Every little while one of the workers, who had been away from home, returned, and tried to reach the entrance, but was invariably seized by the enemy, when one or two soldiers would come to the rescue, and the little worker would make her escape and promptly pass

into the city, while the soldier was immediately surrounded by a horde of the invading foe. She fought valiantly, and killed many, but sometimes succumbed to the overpowering numbers; more frequently she freed herself and escaped, not back to the city, but by climbing the nearest object—a stem of clover or grass—where the enemy never followed. Several soldiers escaped in this manner, and remained concealed until the defeated army returned to its quarters.

A good illustration of the care and sympathy which the members of a colony of Pheidoles have for each other was manifested in an artificial formicary, arranged by the Rev. Mr. Morris, and placed upon his study table. The formicary was in a glass jar, about two-thirds full of earth. The outside of the jar, as far as the earth extended, was encircled with paper, to exclude the light, in order that the ants might build their galleries and rooms next to the glass.

The colony soon became reconciled to their strange home, learning to come out of the jar and pass down the legs of the table to visit any part of the study and return. The workers had no difficulty in ascending the glass, but the large-headed soldiers could not get up without assistance. They would go as far as the paper extended, and fall back with every attempt to scale the smooth glass. Their large heads were a detriment rather than a help in such a novel emergency as this. And now the little workers, who had always looked to the Amazon soldiers for help in all trying circum-

stances, came to the rescue, and assisted them over the slippery place. One would come to the edge of the paper and meet a soldier, and gently take hold of her antennæ, and walk backward up the glass, steadying and supporting her until they both passed into the formicary. This soon became a fixed habit. After a while the soldiers did not try to walk up the glass alone, but would wait at the top of the paper for the workers to conduct them over it.

Several other species of ants in the North occasionally collect seeds and flowers and foliage. I have observed a tiny black ant, a species of *Tetramorium*, gathering honey from flowers, after the manner of bees. I first observed this species in New Hampshire, in the month of August, 1880, collected in great numbers on the golden-rod (*Solidago nemoralis*). They ascend the long stalks and enter the flowers, where they are almost entirely concealed, only the tips of their abdomens showing like black specks on the bright yellow florets. When they are satisfied they come slowly down, with their honey-sacks rounded out almost to bursting, and all follow the same path until they reach their subterranean formicary.

The harvesting ants and their allies have nothing to do with Aphides or other sweet-secreting insects. They seem to have some way of elaborating or obtaining sugar directly from plants. But many other species depend in a great degree upon their flocks and herds for subsistence. Notable among this latter class are the

Crematogasters—an interesting race, divided into many clans or tribes. They often keep large herds of Aphides—cows, the immortal Linnæus called them—upon which they are greatly dependent; so the prosperity of a colony may be known by its herds. The droves are jealously guarded from marauding tribes who are less fortunate in their possessions, and who frequently try to get the control of the cows of their more wealthy neighbors.

In the summer of 1881 I witnessed an exciting contest between two colonies of the same species over a fine herd. The pasture on which the cows were feeding consisted of tender green herbage, and they were in good condition and yielded an abundance of the saccharine fluid. Around this pasture was a space of bare ground, where the troops were marshalled to keep the neighboring colony from trespassing among the drove. Tier upon tier, a solid phalanx extended around the entire pasture, making it impossible for the invaders to break through the ranks. The assaulting army was lean and hungry-looking, but fully as large and strong as the one attacked. There was no general engagement, but every little while two of the opposing forces would clinch and tumble about over the ground like two dogs, but on relaxing their hold neither party seemed to be hurt. The cows were not neglected during this skirmishing. A host of kind and gentle milkers were constantly employed in obtaining the fluid, patting and stroking the cows with their antennæ until they gave

down the milk. I noticed that the soldiers often changed places, those at the front going to the rear. The cause was soon apparent. All along the rear the milkers were feeding the troops. Other milkers were constantly going to and from the subterranean city, which was situated not far from the pasture-lands. They were, no doubt, supplying the queens and other members of the colony who were unable to be in the ranks.

After witnessing this skirmishing for several days, I established a drove of Aphides near the city of the hostile colony. Some of the invaders were always on the road between the two colonies, slowly walking back and forth, like sentinels, to watch over their city, that it might not be taken by surprise while the protectors were absent. And now one of the sentinels came upon the cows, and ran around among them in an evident state of excitement, but did not stop to obtain any milk. Apparently satisfied with the fine condition of the herd, she ran with all haste to impart the good news to the army stationed around the neighboring colony. I followed her closely, never losing sight of her amid the throng. On her way she frequently met a returning comrade, whom she stopped for a moment and touched with her antennæ. The speed of the comrade after obtaining the news was greatly accelerated in the direction of home. The sentinel reached the outer ranks of the army, and communicated with every one with whom she came in contact, and somehow imparted

the same excitement with which her own body was quivering, until the whole army was aroused and on the homeward road. Very soon there was a host of eager milkers among the drove. But a large part of the army retired within the city, where they were fed by the milkers. Now that the invading force was withdrawn, the troops of the threatened colony also disappeared, only a few sentinels remaining to watch over the milkers and herd.

A tribe of Formica (*F. gagates*) also makes stock-raising its principal means of support, but the herds are entirely different from those of the Crematogasters: they do not graze in open fields, but are stabled, and feed on the roots of various plants. Underground stables are made expressly for them. The earth is removed from around the tender roots, and the dun-colored cattle are clustered in small groups around the roots upon which they are feeding. The groups are arranged so as to enable the milkers to pass easily and freely among them.

I have often carefully opened the stables, but the owners always resented it, and carried the cows away to subterranean galleries beyond my sight. When the stables were reclosed, in due time they were brought back and disposed in the same regular order.

There are two distinct races of slave-makers among these humble creatures, who capture and hold slaves to carry on their domestic affairs. *Polyergus lucidus* is the more remarkable of the two, and it would require

many pages to do it justice; but I can devote only a short space to this singular species, which is wholly dependent upon its slaves for its continued existence. These ants are very powerful warriors, and are furnished with sickle-shaped, pointed mandibles, sharp as spears, with which they can impale an enemy with great facility. Their wonderful prowess and skill in war seems to be recognized by all of the various tribes of the country. They are a ruddy race, about half an inch in length, with bright, shining coats; a nervous haste characterizes their movements. They make slaves of but one tribe of blacks (*Formica schaufussii*), whereas the other slave-makers (*F. sanguinea*) attack any and all tribes which they can overpower.*

From the indolent habits of Polyergus, and from the fact that they are never seen except on the war-path, it has been supposed that they are of rare occurrence. But in New Jersey they are quite as numerous as Sanguineas. By carefully observing the movements of the latter, I have been enabled to detect several colonies of the former of whose existence I was before unaware. If the Sanguineas pass a colony of blacks without attacking it, it is good evidence that the blacks are the slaves of the Polyergus. This can soon be ascertained by keeping watch over the colony.

The raids of Polyergus are made in the months of

* A detailed account of this latter species is published by Harper & Brothers in a number of their Half-Hour Series.

July and August, and always in the afternoon, usually between the hours of two and four. Their march is unlike that of any other tribe in this country. A dozen or more of the advance wheel and fall back in the ranks; those coming after make the same move; and so they continue, constantly changing places, until they reach the black colony, upon which they make war and rob them of their young. When they return with their plunder they march in a direct line—no turning back in the ranks. The slaves always remain at home during these raids; but they receive the young blacks from their masters, feed and nurse them, and rear them as slaves to wait on and serve their owners. As no slaves are born in the homes of Polyergus, it is needful each year to renew the stock from surrounding colonies.

In order to study the character of Polyergus more thoroughly, I captured several and made them prisoners. I gave them every necessary accommodation, and placed an abundance of food before them. But they seemed to scorn the idea of labor, and would not even feed themselves. I kept them in this condition three days, until I was satisfied they would all die without their slaves, so I put a few in the prison with them. These faithful creatures manifested joy on meeting their half-famished masters. They stroked and licked them, removing all dust from their bodies, and prepared food and fed them; finally they excavated a room for them, and took them from my sight.

PART III.

PLANTS THAT CONSUME ANIMALS.

Chapter VIII.

UTRICULARIA CLANDESTINA.

For several years past I have devoted much time to a class of plants that seem to have reversed the regular order of nature, and, like avengers of their kingdom, have turned upon animals, incarcerating and finally killing them. Whether the plants are really hungry and entrap the animals for food, or whether it is only an example of the wanton destructiveness of nature I leave the reader to judge.

Some of these curious plants are found in abundance in the Northern States, and others over a wide range in the Southern States. One alone, the Dionæa, has a limited area, being found only near Wilmington, North Carolina.

The *Utricularias* (named from utricle, a little bag or bladder) are, perhaps, some of the most remarkable of the plants which apparently do not conform to the usual methods of nature. Dr. Gray, in his "Manual of Botany of the Northern United States," describes twelve well-defined species found within this range; and Dr. Chapman, in his "Flora of the Southern States," describes nine species growing in Florida and the South-

ern States generally; but this is too low an estimate, as I have found more than nine distinct species in Florida alone.

Almost every muddy pond either North or South contains one or more of these plants. Some grow nearly or wholly out of water; but the species which I am about to describe are immersed, with finely dissected leaves on long stems extended in the water. Scattered among the leaves, or along the stems which are destitute of leaves, are numerous little bladders or utricles. It had always been taken for granted that these utricles were made to float the plant, although I had often noticed that the stems most heavily laden with these sank the lowest in the water.

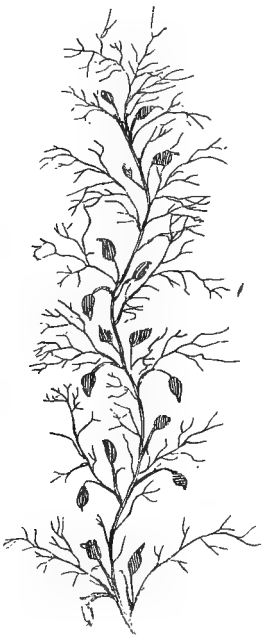


FIG. 1. — A SECTION OF STEM OF UTRICULARIA CLANDESTINA (NATURAL SIZE).

The flowering stems of most of the species are smooth, free from leaves or utricles, and shoot straight from the water to a height of from three to twelve inches, bearing at the top from one to ten curiously fashioned flowers of a yellow or purple color.

In December, 1873, on placing some of the utricles under the microscope I noticed animalcules within them, dead entomostraca, and the dead larva of some aquatic insect; but as the utricles appeared to be open, the significance of the dead creatures was not very apparent, and I was not aroused to earnest work until I saw the movements of a captured living larva, its struggles to escape, and its final death. This was in October, 1874. I now visited the ponds and procured abundant material. The plant that I experimented mostly with was the one known to botanists as *Utricularia clandestina*. I soon became so deeply interested that I scarcely took note of time, and the small hours of the morning frequently found me absorbed in the work.

My observations were now more specially directed to the structure of the utricle, which is quite complicated and beautiful. It is composed of irregular cells, and evenly distributed over the inner surface are clusters of star-like or stellate points, usually four in number, arranged very regularly: they are probably absorbents.

My next work was to see what prevented the creatures from escaping after being captured, and to this end I devoted my time for several days. The animal that I found most commonly entrapped was a snake-like larva (*Chironomus*) about the length of the mosquito larva, but more slender and of lighter color (see Fig. 13, p. 159).

Under the microscope it appears quite formidable, with fierce-looking jaws, and a pair of telescopic horns

which it thrusts in and out at pleasure. Near the head are two brush-like telescopic feet, and at the other extremity are two more feet, which the animal uses as a

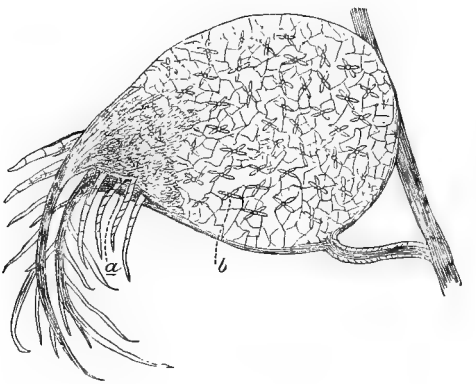


FIG. 2.—MAGNIFIED UTRICLE OF UTRICULARIA CLANDESTINA.

a, Entrance. *b*, Stellate point.

sort of propeller while swimming. I worked with this larva for several days, determined, if possible, to see it walk into the trap. I repeatedly took individuals from the water and placed them in the live box under the microscope, with a spray of plant containing utricles, but it was of no use. The light or unnatural position, or both combined, made them fairly frantic, and they dashed about, paying no attention to the utricles. But I entrapped them another way: I put growing stems of the plant in a small dish of water with several larvæ and set it aside. In a few hours thereafter I would find the living larvæ imprisoned. This served another

purpose, but not the object I was aiming at. Forced to give up this plan of seeing the larvæ enter the utricle, I now directed my attention to the smaller ones—animalcules proper. I placed the utricles in water inhabited by numerous tiny creatures, and soon had the satisfaction of seeing the *modus operandi* by which the victim was caught.

There is a depression at the entrance of the utricle, a pretty vestibule that seems to attract the little animals into the inviting retreat, where just beyond is a fatal trap or valve which if touched springs back and engulfs the unwary adventurers, never more to be released.

I was very much amused in watching a water-bear (*Tardigrada*) entrapped. It slowly walked around the utricle, as if reconnoitring—very much like its larger namesake; finally it ventured into the vestibule, and

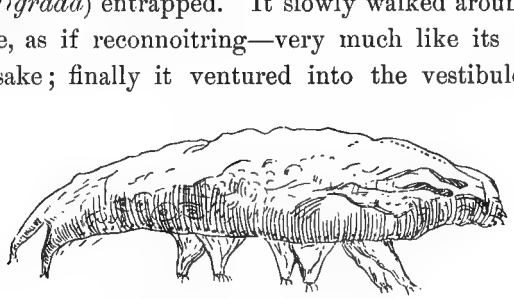


FIG. 3.—THE WATER-BEAR.

soon heedlessly touched the trap, when it was taken within so quickly that my eyes could not follow the motion. The utricle was transparent and quite empty, so that I could see the behavior of the little animal very distinctly. It seemed to look around as if sur-

prised to find itself in so elegant a chamber; but it was soon quiet, and on the morning following it was entirely motionless, with its little feet and claws standing out stiff and rigid. The wicked plant had killed it very much quicker than it kills the snake-like larva.

Entomostraca, too, were often captured—*Daphnia*, *Cyclops*, and *Cypris*. These animalcules are just visible to the naked eye, but under the microscope are beautiful and interesting objects. The lively little Cy-

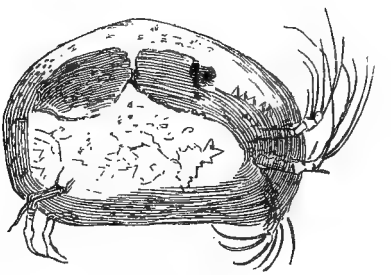


FIG. 4.—THE CYPRIS.

pris is encased in a bivalve shell, which it opens at pleasure, and thrusts out its feet and two pairs of antennæ, with tufts of feathery-like filaments. It was quite wary, but nevertheless was often caught. Coming to the entrance, it would sometimes pause a moment and then dash away; at other times it would venture part way into the vestibule and back out as if afraid. Another, more heedless, would walk in, touch the trap, and find itself a prisoner. And now it manifested alarm, drew in its feet and antennæ, and closed

its shell; but after its death the shell unclosed, displaying its feet and antennæ. I never saw even the smallest animalcule escape after it was once fairly inside the utricle.

So these points were settled to my satisfaction—that the animals were entrapped and killed and slowly macerated. But how was I to know that these animals were made subservient to the plant? If I could only prove that the contents of the utricles were carried directly into the circulation my point was gained. This now was my sole work for several days—to investigate this subject closely. I found the fluid contents to vary considerably from a dark muddy to a very light, transparent color. Hundreds of these utricles, one after another, were put to the test under the microscope, and I found that to a greater or less extent I could trace the same color that I found in them in the stem on which they grew, though the observation was not so clear and satisfactory as I could wish. After more critical examination I arrived at the conclusion that the cells themselves and not their contents change to a red color; the stems also take on this color, so as to make it appear as if a red fluid were carried from the utricles into the main stem, which is not specifically the fact so far as the observations yet made determine; though the main point, that the contents of the utricles are carried into the circulation, does not seem open to question.

The next step was to see how many of them contained animals, and I found almost every one that was

well developed contained one or more, or their remains, in various stages of digestion. The larva of Chironomus was the largest and most constant animal found. On some of the stems that I examined, fully nine out of every ten of the utricles contained this larva or its remains. When first caught it was fierce, thrusting out its horns and feet and drawing them back, but otherwise it seemed partly paralyzed, moving its body but very little; even small larvæ of this species that had plenty of room to swim about were soon very quiet, although they showed signs of life from twenty-four to thirty-six hours after they were imprisoned. In about twelve hours, as nearly as I could make out, they lost the power of drawing their feet back, and could only move the brush-like appendages. There was some variation as to the time when maceration or digestion began to take place, but usually, on a growing spray, in less than two days after a large larva was captured the fluid contents of the utricles began to assume a cloudy or muddy appearance, and often became so dense that the outline of the animal was lost to view.

Chapter IX.

IS THE VALVE OF UTRICULARIA SENSITIVE?

After the observations were made which are recorded in the last chapter, I continued my studies for several months on different species of Utricularia, and during this time Mr. Darwin's book on "Insectivorous Plants" appeared. It is so comprehensive, and the experiments have been so carefully conducted, that it seems presumptuous for any to attempt to differ in the least from his conclusions; and in the main a careful experimenter must agree with him. But there are a few of the points which he has treated in his chapter on Utricularia in regard to which my observations and experiments have led me to conclusions somewhat different from his.

The species that I most closely observed were *Utricularia inflata*, *U. vulgaris*, *U. clandestina*, *U. intermedia*, *U. striata*, *U. gibla*, *U. purpurea*, *U. cornuta*, and *U. subulata*. Most of these species vary slightly, and a few considerably, in the construction of the utricle. I have selected for illustration two of the most widely dissimilar species that I have examined, U. inflata and U. purpurea. Fig. 5 represents a portion of U. inflata, re-

duced in size. This species, unlike the others, has a whorl of white, spongy, inflated petioles encircling the flowering stem, which are branched at the apex, and bear a few thread-like divisions on which are scattered a few

FIG. 5.—FLOWERING STEM OF UTRICULARIA INFLATA (REDUCED IN SIZE)

utricles; these light spongy petioles give the plant a very elegant appearance, and their main office seems to be to float it at the time of flowering. The flowers are of a bright yellow color, with from five to ten on each slender stem. This plant grows in rather deep, still water. I have taken it from ponds of quite pure water with a depth of from eight to ten feet.

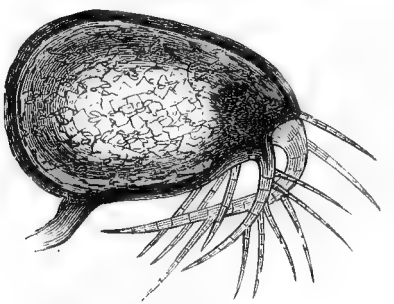


FIG. 6.—UTRICLE OF UTRICULARIA INFLATA.

Fig. 6 represents a young utricle of U. inflata magnified about twenty diameters. The antennæ, as Mr. Darwin calls the long branched prolongations of the utricle, are not fully expanded, and are not as long as in most specimens. The mouth or orifice is just beneath the long antennæ, and within this orifice is situated the valve or trap by means of which the plant captures its prey.

The manner in which the utricle is developed has been observed by some of the most able naturalists of our time. Through the kindness of Professor Asa

Gray, Professor Goodale, of Harvard University, has sent me a condensed translation from the German of Schacht, "On the Development of Utricularia Vulgaris," and as this species grows with us, and does not differ materially from the development of the utricle of U. inflata, I gladly give it a place here:

"According to Schleiden, in the sinuses of the leaves there appears a minute cornet-shaped body, from which

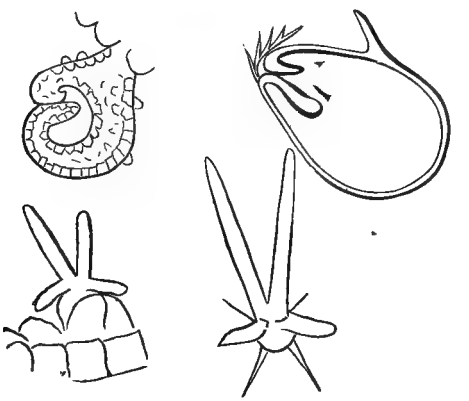


FIG. 7. — COPIED FROM SCHACHT, SHOWING EARLY STAGES OF THE UTRICLE, AND THE GLANDS FOUND ON THE INNER SURFACE OF THE UTRICULARIA VULGARIS.

there is developed, little by little, the stalked utricle, whose external opening is closed by a beard at the mouth. According to Benjamin, some segments of the leaf remain backward in developing. They do not elongate; on the contrary, they broaden and extend at their base, forming a relatively narrow neck, on which appears a little sphere, which is fastened by a short stalk

to the axis of the leaf. Often one can follow the different steps by observing on a single leaf their development from the base to the tip. The utricle, which at first is filled with cytoblast, becomes by rapid absorption changed to an air-vessel. By its further extension in all directions the utricle approximates more and more to its future form. It becomes flattened, and assumes the form of a stomach, the stalk is at the pylorus, the opening at the cardia. On the greater curvature both walls come together as if at a seam. The opening of the perfect utricle is, according to Benjamin, provided with a little flap turned inward, which he calls the *valve*. This valve appears in the earliest state of the utricle as merely a cluster of dark cross stripes. . . . The side walls of the young utricle grow rapidly; the air cavity which they contain becomes thereby greater. The edge of the lateral walls approach each other and bend inward; the original opening becomes closed, and exhibits the dark stripes described by Benjamin. The flap on the valve consists of the wall bent inward on that part of the utricle turned away from the stalk. On the side turned towards the stalk the edge is not so strongly developed. . . . The full-grown pouch presents itself as a roundish and somewhat laterally compressed body, which above is continuous by one angle with the stem, while the other exhibits an orifice which forms a little funnel projecting inward. The external orifice of this funnel is closed by a rim of beard growing on the upper border; the lower part of the internal surface

of the funnel is clothed with elegant hairs of various forms, but very regularly arranged, while the internal surface of the pouch exhibits its peculiar hairs consisting of two cells, each running out into a longer or shorter arm."

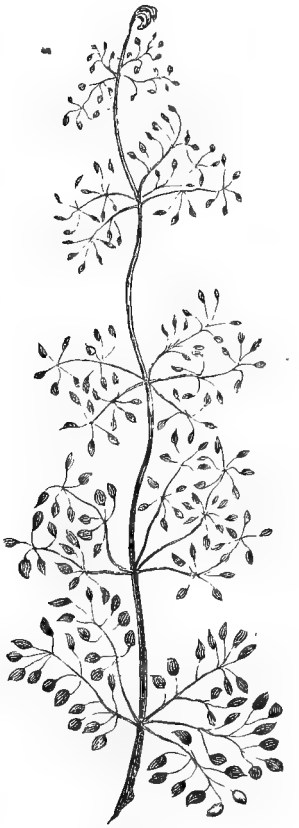


FIG. 8.—END OF GROWING BRANCH OF THE UTRICULARIA PURPUREA (NATURAL SIZE).

Fig. 8 represents the end of a growing branch of U. purpurea. Here we have a species that diverges widely from all of the others that I have examined, and as Mr. Darwin gives no account of any similar species, I shall dwell more upon its manner of growth and structure. The finest specimens of this plant that I have found were growing in deep, still water. The stems are long, sometimes two feet or more in length, and these stems or branches radiate in every direction, so that one plant often covers quite a large surface of water. At the points where the branches radiate, naked flowering stems shoot up, and stand above

the water, and bear at the top three or four violet-purple flowers. The leaves—if they can be called leaves—are scattered along the submerged stems in whorls of five or six, the branch always maintaining the same number that it starts with. The leaves are decompound, and in a healthy plant each division is terminated by a utricle.

All over the stems and leaves and outer surface of the utricle are thickly scattered curved hairs (Fig. 9), and

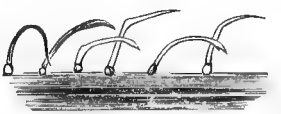


FIG. 9.—SECTION OF STEM WITH CURVED HAIRS.

these hairs seem to serve a twofold purpose: they arrest or capture both animal and vegetable decaying matter—apparently food for the plant, which they seem to absorb. With all of these mouths so thickly scattered over the outer surface of the plant, we wonder why the utricles are needed as reservoirs of food, but here they are, and in great numbers, and larger than in most other species, and they capture living animals. Fig. 10 represents a much enlarged utricle of this species. Here we find no antennæ, nor the least semblance of any; and the valve, instead of sinking into the orifice or mouth, projects above it. According to naturalists, the valve of all species of utricularia is formed of two layers of small cells, and is simply a continuation of the larger cells which form the wall of the utricle. It

is fast on all sides except on the margin marked "Entrance" in the figure; and here the two edges fit close together, and are always closed, except when something touches them in precisely the right way, when they suddenly open, and close again as quickly, and not often does it miss its prey. The valve is so large in this species, and projecting out and above the mouth as it does, it is not a difficult matter to cut it free and spread

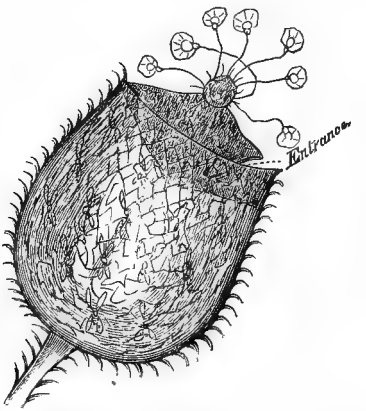


FIG. 10.—MAGNIFIED UTRICLE OF UTRICULARIA PURPUREA.

it out so as to examine its structure. We do not find glands on its surface, as we do in the other species. It seems as if all the energies of the plant had gone to construct the elegant cluster that crowns the summit of the valve, situated on the point where the valve doubles; it consists of a globular body which supports from twelve to fifteen beautiful, transparent, glassy-looking glands, the use of which is not clear to me.

Over the inner surface of the utricle—like the other species—are scattered numerous glands, which Mr. Darwin has named quadrifid processes, from the fact that the glands radiate from a central cell in the form of arms, four in number (Fig. 11). In this species the

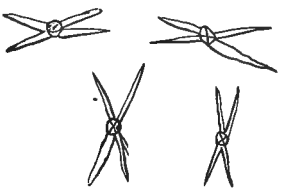


FIG. 11.—QUADRIFID PROCESSES.

arms are about of equal length. Near the valve, and close to where the walls of the utricle join together, we find cells with only two arms—bifid processes—and intermingled with these we occasionally see a cell with only one arm, no way different from the others except in the lesser number of arms. Mr. Darwin says these glands are absorbents, but he doubts if they ever secrete. Around the edge of the valve that extends into the utricle is a thick fringe of hairs or glands, all pointing inward, and so do not prevent anything from entering through the valve; but we can see that they prevent an exit. These are all the glands I find in this species, except a few oblong ones which have no pedicels, and are embedded in the smaller cells near where the valve lies.

In order to make it clear how my observations were

conducted, I will state that I had a tub of water in which were growing the various species of utricularia. When I wished to experiment with any particular species, I took such species from the tub and placed it in a small vessel of clear water. I also had other tubs of water for the purpose of securing the eggs of the mosquito and chironomus. The eggs of the mosquito are deposited in large clusters, which float on the surface of the water. Those of the chironomus are deposited in a jelly mass of matter, and fastened by a little thread to something to prevent them from sinking too low in the water. These masses of eggs are very conspicuous to the educated eye, one species producing a mass as large as a good-sized pea; the jelly is quite transparent, so the eggs can be distinctly seen with the naked eye. After they are hatched, the young chironomus larvæ remain in the jelly for a day or two, feeding on it until they are large and strong enough to venture out into the great world of water, where they can secure their own livelihood.

It can be seen how quickly and easily I could swarm a small vessel of water with the larvæ of the mosquito and chironomus by transferring to the vessel these masses of eggs. After this long but necessary digression I will return to the valve of the utricularia.

Mr. Darwin says ("Insectivorous Plants," p. 407): "To ascertain whether the valves were endowed with irritability, the surfaces of several were scratched with a needle or brushed with a fine camel's-hair brush, so

as to imitate the crawling movements of small crustaceans; but the valve did not open." And farther on he adds: "On three occasions minute particles of blue glass (so as to be easily distinguished) were placed on valves while under water. On trying gently to move them with a needle they disappeared so suddenly that, not seeing what had happened, I thought that I had flirted them off; but on examining the bladders they were found safely enclosed. The same thing occurred to my son, who placed little cubes of green boxwood (about one-sixtieth of an inch) on some valves; and thrice in the act of placing them on, or while gently moving them to another spot, the valve suddenly opened and they were engulfed." The same thing occurred to me several times when I was gently moving minute particles of various substances on the edge of the valve —it suddenly opened and took them in; which helped to confirm me in the belief that the valve was sensitive, and that the sensitiveness was of a special nature. But not upon these experiments did I wholly base my inference; it was based more upon observations made upon the growing plant and the living larvæ. By putting a spray of the plant and water under a low power of the microscope I could thus bring several utricles into the field, with numerous mosquito larvæ. If the tail of one of these larvæ happened to come in contact with the valve, the valve was almost sure to open and engulf the larva, often leaving its head sticking out, as is seen in Fig. 12. I have a large number of these utri-

cles with mosquito larvæ caught in this way. When the larva is thus caught it never struggles; the part of the body that is within the utricle seems paralyzed, and

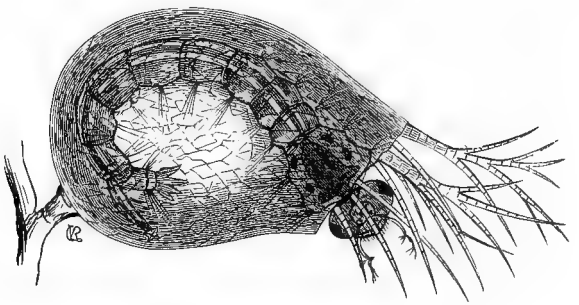


FIG. 12.—UTRICLE, WITH MOSQUITO LARVA ENCLOSED.

the larva dies much sooner than one that is wholly within the utricle; and this is the more singular from the fact that when the larva is not caught and held in the valve, but has passed through into the utricle, it is quite active for some hours after being caught. If it is caught in the valve, the part that is within the utricle seems perfectly powerless to move, but the part that is outside of the utricle can move and wriggle. And it would seem that when a larva as strong as the mosquito was caught, with its head and first joint of body sticking out of the utricle, it might escape, but as far as I have observed it never does.

The chironomus larva (Fig. 13), with its more slender body, was not often caught and held in the valve, but occasionally one was caught so. Usually they were

carried bodily into the utricle with a sudden, quick movement, and they were as often taken in tail first as head first. I have found as many as thirteen chironomus larvæ in a single utricle, and all caught within forty-eight hours. There could be no mistake here, for the larvæ and plant were introduced forty-eight hours before.

On two occasions I have found a dead chironomus larva held fast in the valve, and while I was looking

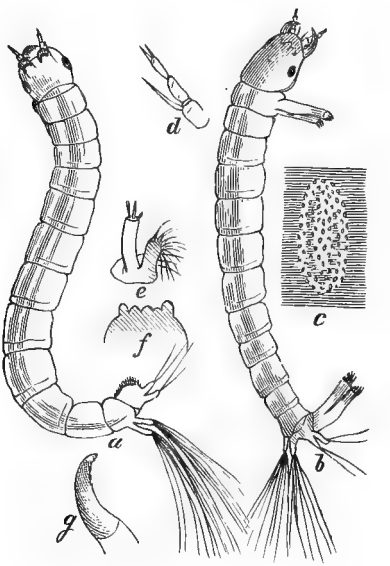


FIG. 13.—CHIRONOMUS LARVA.

a, Dorsal view, with pediform appendages retracted and jaws closed. *b*, Lateral view, with same parts extended. *c*, Egg mass. *d*, Maxillary palpus. *e*, Labial palpus. *f*, Labium. *g*, Mandible.

the valve suddenly opened and engulfed the larva with sufficient force to send it to the opposite side of the utricle.

Mr. Darwin says the valve does not appear to be in the least irritable, and continues ("Insectivorous Plants," p. 408): "We may therefore conclude that the animals enter merely by forcing their way through the slit-like orifice, their heads serving as a wedge." But we have seen in the instances of the mosquito and chironomus larvæ that this is not the case; the head does not serve as a wedge. But what is the force that impels them into the utricle? It seems too bad to try to overthrow a plausible theory and offer nothing better in its stead. But what can I do? The play is enacted before me, and I have tried in vain to get behind the scenes to learn what the power is that impels the larva into the utricle. No doubt if Mr. Darwin had had the excellent material that I had to work with, with his keener insight he would have ferreted out the cause.

If within the utricle was a partial vacuum, the sudden opening of the valve would create sufficient force to carry whatever happened to be in close proximity into the utricle; and this illustrates the movement we see executed. But how could a vacuum be formed?

We can see, if the valve is sensitive, that a mosquito larva would be much more likely to be caught tail first, for it is not often still—almost always wriggling—and when the forked tail brushes against the valve it causes it to open, and the force above alluded to carries the

larva into the utricle. And this is the fact with all of the species of utricularia that I have experimented with, except in the case of U. purpurea. In this species the valve does not seem to be so sensitive as in the others. A slight brush of the tail of a mosquito larva does not cause the valve to open; it takes a more vigorous blow with the head; hence in this species the mosquito larva is almost always caught head first.

I have a number of alcoholic specimens of the mosquito larvæ with only the head caught in the valve; the larva had grown too large to admit the first joint of the body through the orifice. Many of these specimens I put in alcohol while the larvæ were still living; others I observed until they were dead. With the head only caught in the valve, and the rest of the body sticking out, it was left free to thrash about, and it seemed the more the victim struggled, the closer the valve fitted about the head. A half-grown mosquito larva thus caught could sway the utricle from side to side, and make considerable demonstration that could be seen with the unassisted eye, but I never saw one escape.

Even here Mr. Darwin's argument would hardly hold good—that the head serves as a wedge—for the valve opens just as quickly as in the other species when the blow is hard enough, and the mosquito larva never goes poking about using its head as a wedge. But the chironomus larva not only swims and wriggles, but it uses its brush-like feet, and crawls along the leaves and stems of the plants, and often feeds on the hairs or

bristles about the entrance of the utricle, which I find in all of the species except in U. purpurea. So this larva looks more like using its head as a wedge, but, as we have seen, it is not at all necessary for it to use its head in this manner.

In a letter bearing date June 1, 1875, Mr. Darwin says: "I have read your article with the greatest interest. It certainly appears from your excellent observations that the valve was sensitive, and I hope it may be so from homologizing with pinguicula; but I cannot understand why I could never, with all my pains, excite any movement. It is pretty clear I am quite wrong about the head acting like a wedge. The indraught of the living larva is astonishing."

Chapter X.

PINGUICULA.

The pinguiculas, or butterworts, are carnivorous plants, and closely related to the utricularias, but to a casual observer they do not at all resemble each other. The utricularias usually grow in water, and have finely dissected leaves, and little stomach-like sacs, into which small insects are entrapped, from which they never escape any more than they would from the stomach of an animal; but the pinguiculas grow on land, and entrap insects on their large broad leaves, which are converted into stomachs, when they secrete a fluid corresponding to the gastric juice in the stomach of animals. The leaves lie flat on the ground in the form of a rosette, and are always moist, and feel greasy to the touch, from which it takes both its common and scientific name—*pinguis* being the Latin for fat.

At the North we have but one representative of this genus—*Pinguicula vulgaris*—and this is scarce, growing only in a few places on wet rocks. In the summer of 1875 specimens of this species were sent me from Cornell University, on which I made observations and found it to be carnivorous, as I had been previously

informed. But my material was not sufficiently ample nor in the best condition to experiment with very extensively; yet my curiosity was sufficiently aroused to impel me to visit Florida, where I could find winter-blooming species of pinguicula, which, so far as I knew, no one had experimented with.

I reached Florida in November, 1875, and soon found three species in large number — *Pinguicula pumila*, *P. lutea*, and *P. elatior*. They were already in a good condition to work with, the fall and winter seeming to be their growing season. P. pumila commenced blooming early in December, and in January the damp pine-barrens were flecked with the large bright-yellow flowers of P. lutea and the showy purple ones of P. elatior.

From all appearance these plants are annuals. They commence blooming in winter, and by the time the rainy season begins in spring the seeds are ripening and falling to the ground; the young plants soon become established, and evidently grow slowly during the summer and fall, or until about November. I did not find a single plant of either species but what bloomed during the winter or early spring, which inclines me to the opinion that they cannot be perennial. At all events the winter, or dry season, is the time they make their most rapid growth; and we can see that during the dry season they would be much more likely to digest the prey they capture, as in late spring and summer it rains almost daily, when the insects would be washed away.

The letters *a* and *b* (Fig. 14) represent the plant P. pumila. This species is less in size than the two previously mentioned, and has very small roots, barely large enough to hold the plant in place. It blooms all through the winter and early spring, constantly sending up its pretty, one-flowered scapes, surmounted by a white or purple blossom, until they reach the number of fifteen or twenty. The flower scapes are from three to six inches in height, brittle and delicate; and yet the roots are so small, even when the plants grow in damp soil, that it is almost impossible to cull one of the flowers without bringing up the whole plant; and in the more exposed dry places, when a plant had several flower stalks, I have often found it tipped over, apparently blown over by the wind.

I observed the plants closely where they grew, and found a great many minute dipterous flies on the leaves, held there by the viscid exudation; but I could only know that they were of real use to the plant by repeated experiment and close observation, so I carefully removed a number of fine plants to my study.

Under the microscope the plant presents a beautiful and complicated appearance. Along the midrib and veins of the leaf are spiral threads closely coiled. One of these spiral threads is represented by *d* as seen through the microscope partly uncoiled. On breaking the leaf and pulling it carefully apart the coils are set free, and stand out from the broken edge of the leaf.

The leaves are quite sensitive; when the plants are

removed from the earth, the leaves have a tendency to curve backward until the apex touches the roots. Have these spiral threads anything to do with this movement?

Over the outer surface of the leaves are curiously shaped hairs. Near the base are long multicellular ones, as seen by *c*. The hairs gradually become shorter, have fewer cells as they approach the blade of the leaf. Scattered thickly over the blade are short unicellular hairs tipped with a gland, as seen by *e*. These glands are the secretory organs.

It is interesting to note the transformation of the hairs. From the long pointed ones we find every gradation before they reach the short unicellular ones tipped with perfect glands. There are other organs imbedded in the cellular tissue of the leaf which remind me of the absorbing glands, "or quadrifid processes," found in utricularia; *f* represents one of these organs highly magnified.

I commenced experimenting with P. pumila in December. The thermometer stood at 80°, and it continued almost unvaryingly warm until the 10th of January. Towards noon of each day it ranged from 75° to 80° in the shade.

December 20th I placed seven house-flies on as many young, healthy leaves of P. pumila. In two hours and forty minutes the flies were bathed in a copious secretion, and in three hours and fifteen minutes two of the leaves had folded over the flies, so as to hide them from sight. The remaining five leaves had made little or no

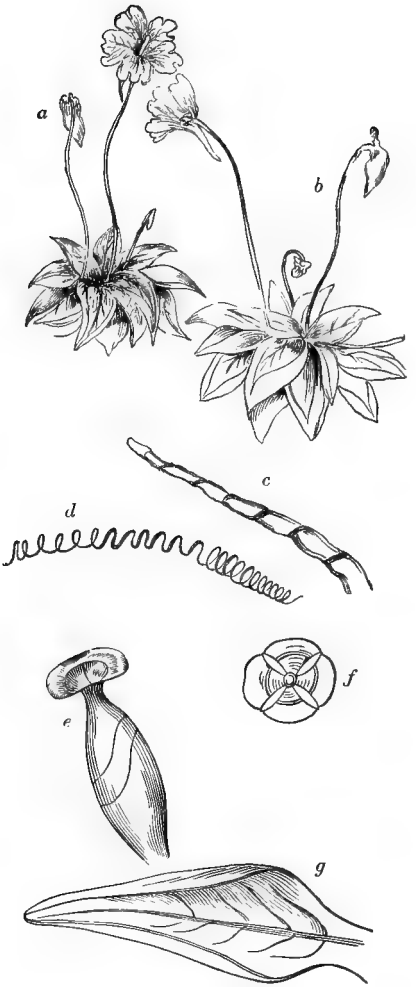


FIG. 14.—THE PINGUICULA.

a, *b*, P. pumila; *c*, multicellular hair; *d*, spiral thread; *e*, unicellular hair; *f*, gland in tissue of leaf; *g*, leaf of P. lutea.

movement, but were secreting abundantly, and the fluid was trickling away from the flies, running towards the base of the leaf and also to the apex, where it was held by the natural incurvation of the leaf. The flies were now so tender that on moving them with a needle they fell to pieces. In three days the leaves were comparatively dry, the secretion had been absorbed, and nothing remained of the flies but the outer integuments. The leaves looked healthy and fresh, but they would not secrete as before.

December 25th I placed tiny bits of raw fresh beef on ten leaves of P. pumila. In six hours the secretion was so copious that the spoon-tipped ends of seven leaves were filled. The secretion had mingled with the juice of the beef and looked bloody, but the meat itself was white and tender. In a little less than twelve hours the fluid had changed color; it now looked clear, and remained so until it was gradually absorbed.

On the same day I put bits of salt beef on eight other leaves, equally as fresh and vigorous as those on which I put the fresh beef, but the result was very different. The leaves secreted, but did not absorb the secretion. On the contrary, they turned brown—were killed—wherever the meat and the secretion that mingled with the meat touched them. The leaves partly digested old strong cheese, but finally succumbed and turned brown, as they did with the salt beef. I tried many other experiments with this species with various substances, and the sum of my recorded experiments

shows that the plants readily digested small insects and small parts of large ones, also tiny bits of fresh meat, and milk and fresh blood of animals.

But my main work for more than two months was on the larger species of Pinguicula — P. lutea and P. elatior. Unlike P. pumila, both of the above species have rather large and strong roots, and are firmly fixed in damp soil. They have from twenty-five to thirty leaves, often three inches in length, lying flat on the ground in a rosette. The leaves are all naturally incurved. *g* (Fig. 14) is an outline of a leaf of P. lutea showing incurvation. Under the microscope we find precisely the same organs—spiral threads, glands, etc.—that we find in the smaller species.

The flower stems of both these large species are often twelve or fourteen inches in length, and, like the leaves, they are sensitive, and I find the same spiral coils that I see in the leaves extending along their entire length.

In the morning, if the flower stems are not swayed about by the wind, nearly all will be found to have a short curve near the calyx, so as to bring the flower to face the east, and the spur points to the west; in the evening it is reversed, and at noon the flower looks up and the spur points downward.

The plants with which I experimented were set in boxes of wet sand, so it was an easy matter to turn them around when they were facing the east, and bring the back of the flower to the sun. I often turned them in this manner, and recorded the time it took for them

to again face the sun. On referring to my notes, I find the mornings of February 28th and March 6th and 14th are the shortest times recorded — only a few minutes' variation in the time. March 6th eighteen flowers had faced the sun at the expiration of an hour and ten minutes; thirteen others made but little movement, but these flowers were old, nearly ready to fall. The flower remains on its stem several days; after it falls the calyx is left surrounding the seed-vessel, but now it no longer follows the sun. The yellow flowers of P. lutea seem to possess this characteristic more strongly than those of P. elatior.

Thickly scattered over the whole length of the flower stems, the same as on the leaves, are unicellular hairs tipped with secretory glands, and all along the stems minute flies are held by the viscid secretion and rapidly consumed. Pinguicula does not capture as large prey as some species of Drosera, but I never found so great a number of flies, even on the thread-like leaves of *Drosera filiformis*, as I have found on the flower stems of P. lutea and P. elatior; but I experimented with Drosera filiformis at the North, where these small flies are not so numerous. I cannot see that there is anything to attract the flies, unless it should be the bright flowers. Every warm evening myriads of tiny dipterous flies of another species are attracted by the light of the lamp, where they scorch their wings and fall to the table, so that every lamp is surrounded by dead and dying victims. In the same way the bright flowers

of Pinguicula may attract these tiny creatures, and flitting about the flowers, they come in contact with the moist stems and leaves, where they are held fast and consumed.

The Pinguiculas are not only carnivorous, but also vegetable feeders. They consume a large amount of pollen. The long-leaved pine (*Pinus australis*) constitutes almost the entire growth of the pine-barrens, and the trees bloom while the Pinguiculas are making their most rapid growth. Any one acquainted with the pines knows what a large amount of pollen falls annually from the trees. I have often seen pools and sluggish streams of water almost covered with this yellow pollen dust; and the Pinguiculas growing as they do under and among these pine-trees, I naturally inferred that they must catch and retain a large amount of pollen; so, bringing a lens to bear upon the plants where they grew, I found my suspicions confirmed—that a large amount of pollen was mixed with small flies. The plants were secreting copiously, but the flies might cause the secretion independent of the pollen; so, in order to be sure that the pollen was really digested, I took the staminate flowers of the pine to my study, and dusted the pollen over fresh leaves of P. lutea, which I had carefully grown where they should be free from any chance prey. I put the pollen on so thick that it lay in little heaps. Soon the leaves were secreting, and the pollen was gradually dissolved, and disappeared with the secretion.

Many other experiments I recorded which I will not

inflict on the reader in detail. The plants almost invariably attempted to digest everything placed on their leaves, but the results were very different. Substances from which they could obtain no nourishment caused but a slight secretion, while all soft-bodied insects and bits of fresh meat caused abundant secretion. And even with digestible substances there was often quite a difference in the time it took to dispose of the same things. Some days the secretion was much more copious than others. This puzzled me for a time, until I found that on rainy days insects placed on the freshest leaves excited but little secretion. The drier the atmosphere, the better the plants worked. So I found by these experiments that I had a vegetable barometer, and that there was no danger of rain when the plants secreted abundantly.

The movement of the leaf is still a puzzle to me. Some leaves folded so that the two edges met over the prey, while others on the same plant that secreted and digested equally well made no movement.

Chapter XI.

DROSERA.

The Droseras are low marsh herbaceous plants, and over the leaves are thickly scattered reddish bristles or tentacles, each surmounted with a gland that exudes clear drops of an extremely viscid fluid that sparkles in the sunlight like dew, hence the common name of sundew. The flower scape is smooth—entirely free from tentacles, and has a one-sided raceme, the flowers opening only in the sunshine.

Dr. Gray mentions four species found at the North. Two of these—*D. rotundifolia* and *D. longifolia*—have a wide range, being indigenous to both Europe and America. In the United States they extend from New England to Florida and westward. *D. filiformis* is confined, so far as known, to the United States near the coast, from Massachusetts to Florida. It grows in wet sand. *D. linearis*, with which I am not familiar, grows about Lake Superior. Dr. Chapman describes two additional species peculiar to the Southern States—*D. capillaris* and *D. brevifolia.*

All of the species above mentioned, with the exception of D. linearis, I have closely observed in their hab-

itats, and experimented with each. They all behave in a similar manner—capturing insects, and digesting and absorbing the soft parts. Mr. Darwin ("Insectivorous Plants," p. 17) says: "The absorption of animal matter from captured insects explains how Drosera can flourish in extremely poor peaty soil — in some cases where nothing but sphagnum moss grows, and mosses depend altogether on the atmosphere for their nourishment. Although the leaves at a hasty glance do not appear green, owing to the purple color of the tentacles, yet the upper and lower surfaces of the blade, the pedicels of the central tentacles, and the petioles contain chlorophyl; so that, no doubt, the plant obtains and assimilates carbonic acid from the air. Nevertheless, considering the nature of the soil where it grows, the supply of nitrogen would be extremely limited, or quite deficient, unless the plant had the power of obtaining this important element from captured insects. We can thus understand how it is that the roots are so poorly developed. These usually consist of only two or three slightly divided branches, from one-half to one inch in length, furnished with absorbent hairs. It appears, therefore, that the roots serve only to imbibe water, though no doubt they would absorb nutritious matter if present in the soil; for, as we shall hereafter see, they absorb a weak solution of carbonate of ammonia. A plant of Drosera, with the edges of its leaves curled inward so as to form a temporary stomach, with the glands of the closely inflected tentacles pouring forth their acid secre-

tion, which dissolves animal matter afterwards to be absorbed, may be said to feed like an animal. But, differently from an animal, it drinks by means of its roots; and it must drink largely, so as to retain many drops of viscid fluid round the glands, sometimes as many as two hundred and sixty, exposed during the whole day to a glaring sun."

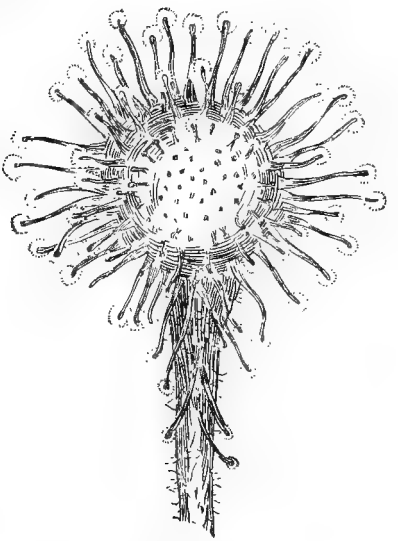


FIG. 15.—LEAF OF DROSERA ROTUNDIFOLIA (ENLARGED FOUR TIMES), WITH THE TENTACLES ON ONE SIDE INFLECTED OVER A BIT OF MEAT PLACED ON THE DISK. (AFTER DARWIN, "INSECTIVOROUS PLANTS," P. 10.)

Two years before Mr. Darwin's work on this subject appeared I published the following observations on Drosera in the *American Naturalist*, vol. vii., p. 705.

On the 7th July, 1873, I started in search of D. fili-

formis, and found the plant in Atlantic County, New Jersey. It was in full bloom, and growing as thick as it could well stand on either side of an extensive cranberry plantation. This charming plant, with its pretty pink blossoms, together with the viscid, dew-like substance exuding from the glands (the glands surmount the bristles, or tentacles, which cover the long thread-like leaves), was one of the most beautiful sights I ever beheld. From former observations I had supposed this plant caught only small insects, but now found I was mistaken; great Asilus flies were firmly imprisoned, innumerable moths and butterflies, many of them two inches across, were alike held captive until they died—the bright flowers and brilliant, glistening dew luring them on to sure death. But what is the use of this wholesale destruction of insect life? Can the plants use them? Upon examination I find that after the death of the larger insects they fall around the roots of the plants as if to fertilize them, but the smaller flies remain sticking to the leaves.

Careful and repeated experiments during several days revealed the fact that on some days the plants worked much better than on others. Whether it was the electrical condition or amount of moisture in the atmosphere is yet to be ascertained.

I experimented with three species of these plants—D. filiformis, D. longifolia, and D. rotundifolia. I carefully removed them from all atmospheric agitation, and found they were the most active on July 11th. I will

therefore give the record of this day's experiments and the state of the weather.

July 11th, thermometer stood thus: 7 A.M., 68°; 2 P.M., 79°; 9 P.M., 69°. Rain early in the morning, one-third of an inch. Wind in the morning, N. E.; 2 P.M., S. E.; 9 P.M., S. E.; with rising barometer from 29.96 to 30.05.

July 11th, 10 A.M., I pinned some living flies half an inch from the leaves, near the apex, of D. filiformis. In forty minutes the leaves had bent perceptibly towards them. At twelve o'clock the leaves had reached the flies, and their legs were entangled among the tentacles and held fast. I then removed them three-quarters of an inch farther from the leaves. The leaves still remained bent away from the direction of the light towards the flies, but did not reach them at this distance.

Whether the action of their wings may have created sufficient force to bring the leaves near enough to entangle them is a question I have not yet satisfactorily settled in my own mind, for dead flies did not seem to have the same power as living ones.

Fifteen minutes past ten of the same day I placed bits of raw beef on some of the most vigorous leaves of D. longifolia. Ten minutes past twelve two of the leaves had folded around the beef, hiding it from sight. Half-past eleven of the same day I placed living flies on the leaves of D. longifolia. At twelve o'clock and forty-eight minutes one of the leaves had folded entirely around its victim, and the other leaves had partially

folded and the flies had ceased to struggle. By half-past two four leaves had each folded around a fly. The leaf folds from the apex to the petiole, after the manner of its vernation. I tried mineral substances, bits of dry chalk, magnesia, and pebbles. In twenty-four hours neither the leaves nor the tentacles had made any move like clasping these articles. I wet a piece of chalk in water, and in less than an hour the tentacles were curving about it, but soon unfolded again, leaving the chalk free on the blade of the leaf.

The tentacles around the edge of the leaf of D. rotundifolia are longer than on those of D. longifolia, but the leaf of the former does not fold around a fly as it does in the latter—simply the tentacles curve around the object, the glands touching the substance, like so many mouths receiving nourishment.

At 10.30 A.M. I placed raw beef on some leaves of D. rotundifolia; by one o'clock the inner tentacles were curving about it, and the longer ones on the outer edge of the leaf were slowly curving upward. By nine o'clock in the evening all the tentacles on three of the most vigorous leaves were clasping the beef, almost hiding it from sight, while an equally vigorous leaf made no move towards clasping a bit of dry chalk.

About ten o'clock in the morning I placed bits of raw apple on some of the leaves of the last-named species; by nine o'clock in the evening part of the tentacles were clasping it, but not so closely as the beef. By ten o'clock next day, twenty-four hours, nearly all

of them were curved towards it, but not many of the glands were touching it. So it would seem that these

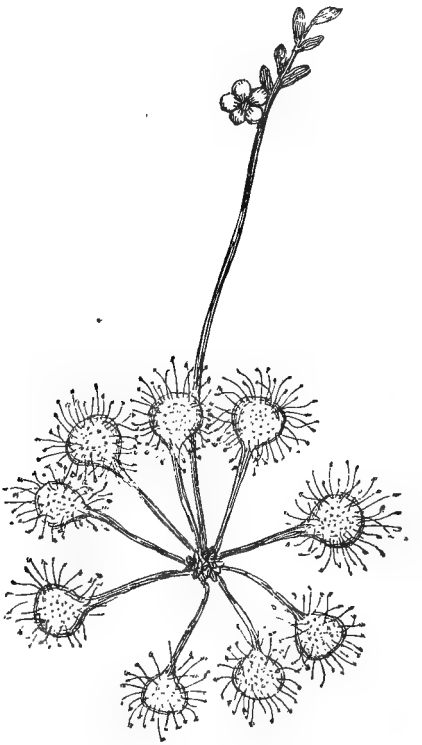


FIG. 16.—DROSERA ROTUNDIFOLIA.

plants are really carnivorous—that they prefer and absorb animal substances directly through their leaves. And Mr. Darwin informs me that by pricking a certain point in the leaf of Drosera he can paralyze half of it, and this indicates nerves!

The following is a brief summary of the experiments:

First, with D. filiformis.

July 11th, 10 A.M., pinned living flies half an inch from apex; 10.40 A.M., the leaves are bent perceptibly towards them; 12 M., the leaves have reached the flies, and their legs are entangled in the tentacles and held fast by the sticky substance exuding from the glands.

Second, with D. longifolia.

July 11th, 10.15 A.M., I place raw beef on the leaves; 12.10 P.M., the leaves are folded around the beef. July 11th, 11.30 A.M., I place living flies on the leaves; 12.48 P.M., one of the leaves has folded entirely around the fly; 2.30 P.M., four leaves have each folded around a fly.

Third, with D. rotundifolia.

July 11th, 10.35 A.M., raw beef on leaves; 1 P.M., the inner tentacles are curving about it, and the longer ones on the outer edge of the leaf are slowly curving upward; 9 P.M., all the tentacles of the most vigorous leaves are clasping the beef. July 11th, 10 A.M., I place bits of raw apples on the leaves; 9 P.M., part of the tentacles are clasping them. July 12, 10 A.M., nearly all the tentacles are curving towards the bits of apple, but very few of the glands are touching them.

Chapter XII.

DIONÆA.

In May, 1874, through the kindness of Dr. Wood, of Wilmington, N. C., I received over thirty fine plants of *Dionœa muscipula.* They had been removed with much care, and packed in such a manner that no plant interfered with another, neither were they smothered in a tight box, but slats were nailed across the top, so that they could receive both light and air. They reached me looking none the worse for their journey, and began capturing prey the next day after their arrival. The upper part of the leaf reminds me of the open jaws of an old-fashioned steel-trap, and when any insect alights on the inner surface of this leaf-trap, and touches one or more of the six bristles on its surface, if the leaf is healthy and vigorous it closes almost as quickly as the steel-trap when anything touches its spring. From the beginning of May until the last of June I devoted a large share of each day to these plants. I placed them in separate pots, and numbered each plant, and kept a careful record of the closing of each leaf over its prey, and the kind of insect it caught. Mr. Darwin, in a letter of June, 1874, says:

"My observations on cultivated plants [of Dionæa] are now complete, and I shall publish them in six or nine months, though they will be of little value compared with those made on the plant in its own country. * * * I should very much like to hear about one point. Dr. Canby says that the same leaf will catch two or three flies successively. Now I find with cultivated plants that a leaf which has once caught a good-sized insect, though it will open and remain so for a considerable time, has so little power of movement that it most rarely is able to catch a second insect or to close over any object. I should very much like to be able to say what the truth is on this head."

FIG. 17. — OPEN LEAF-TRAP OF DIONÆA MUSCIPULA.

To this I am now able to reply that a considerable number of leaves took the third fly, but most of them were not able to wholly digest them. Five leaves digested three flies each, and opened apparently healthy, and were soon ready for another meal, but died soon after closing over the fourth fly. On the other hand some leaves were not able to digest a single fly, as may be seen by the extracts from my record (1874):

"*May 5th.*—Plant No. 1. Two leaves caught house-flies, and another leaf a large blue-bottle fly."

"*May 12th.*—The two leaves on No. 1, with house-flies, are opening; leaves healthy, but the leaf with the large fly has succumbed; a moldy blight is making its appearance."

The plants were not restricted in their diet to dipterous or two-winged insects, but took beetles, bugs, spiders, millepeds; and later in the season a number of "Grand-daddy-long-legs" (a kind of spider) seemĕd to court death by leisurely dropping their bodies into the trap, while their long legs were left sticking out. The legs showed life from twenty-four to thirty-six hours after the victim was taken in. If I liberated a prisoner two or three hours after it was incarcerated, it did not seem to be injured at all, but would look about a moment as if astonished, and then speed away as fast as it could; but if I let one remain twenty-four hours, although often alive yet it never recoverĕd. By this time the insect was enveloped in a mucilaginous substance which was fatal to it; if I washed it off with the utmost care it made no difference, but was sure to die. The average time that it took for a leaf to digest soft-bodied insects, such as flies, spiders, and small larvæ, was seven days, but with bugs and beetles it took longer, as the record shows:

"*May 21st.*—Plant No. 5. A strong leaf closed over a homopterous insect (*Metapodeus nasalus*) almost as large as the squash-bug, and somewhat resembling it;

when fairly caught it emitted a disagreeable odor peculiar to this family of insects."

"*June 5th.*—The leaf on No. 5, which closed over the homopterous insect, opened to-day; leaf healthy, nothing left of the bug but the shell."

It will be seen from this that it took fourteen days to digest the bug; and beetles smaller than the house-fly were longer in being digested than soft-bodied in-

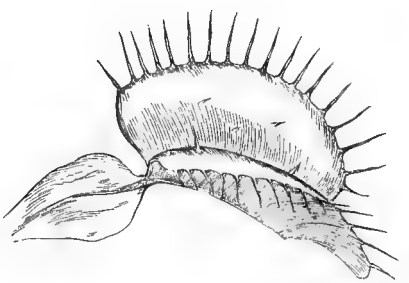


FIG. 18.—OPEN LEAF-TRAP OF DIONÆA MUSCIPULA (NATURAL SIZE).

sects—their shelly covering for a time seemed to resist the action of the slimy substance that soon envelops the insect. A beetle—the common rose-bug (*Macrodactylus subspinosus*) for instance—could not be held prisoner if it had sense enough to escape quickly, but it would usually press close to the bottom of the leaf-trap to hide — as is its habit when disturbed — and in a short time it was hid very effectually. I will again quote from my record:

"*June 7th.*—A large strong leaf on plant No. 9 attempted to entrap a 'rose-bug,' but the sprawling bee-

tle forced its way out between the crossed filaments. I then helped the beetle on to plant No. 5, and forced it into a trap; it hugged close to the bottom, and was soon made a secure prisoner."

In this way I managed to get nine of these beetles entrapped, but only one leaf was strong enough to digest its victim, the other eight leaves died in the attempt.

The plants I experimented with I did not allow to flower, as this would diminish their vigor. From May to October the strongest plant caught forty insects and digested most of them. But no one set of leaves has caught all of these flies; at one time there were thirteen good leaves on this plant, and as they died other fresh ones made their appearance. At the time of writing, October 22d, there are seven leaves on the plant, three of them closed over flies.

If I forced open a leaf in two or three days after an insect was caught, I found it enveloped in a copious slimy secretion; but when the leaf was ready to open of itself, had digested its victim, all this secretion had disappeared—no doubt gone through the circulation to the bulbous-like root, to help nourish and enable it to throw up other leaf-traps.

That I might the more fully test the strength and power of the plant, I one day placed the tip of my little finger in a trap, resolving to become a self-made prisoner for five hours at least. I took an easy-chair, and let my arm rest upon the table and my hand upon

the edge of the pot, and with plenty of reading matter before me, what should hinder me from keeping my resolve? In less than fifteen minutes I was surprised at the amount of pressure about my finger, and for more than an hour the pressure seemed slightly to increase, but by this time my arm began to pain me. Here is a problem for the psychologist. Was it the knowledge of my being held fast that caused the pain? Surely I have kept quiet longer than this without any discomfort! In less than two hours I was obliged to take my finger from the plant, defeated in so simple an experiment, and heartily ashamed that I could not better control my nerves. The slimy secretion had commenced oozing slightly from the inner surface of the trap, and if I could have kept the position for five hours, I presume it would have been much more copious, the plant not knowing but that I was as good to eat as a bug!

Chapter XIII.

SARRACENIA VARIOLARIS.

Early in March the new leaves of the pitcher-plant (*Sarracenia variolaris*) begin to make their appearance, and soon after the large yellow flower, with its drooping petals, is very conspicuous everywhere on the damp pine-barrens of Florida. It is one of the most remarkable of all our insectivorous plants, and destroys by far a larger number of insects than any carnivorous plant with which I am acquainted. The leaves are from six to twelve inches in length, hollow and trumpet-shaped; they stand very erect, and the opening is covered by a rounded arching hood. Just below the hood the leaf is spotted with pure white, and these spots are surrounded by bright scarlet veins. The inner surface of the hood is lined with brilliant colors: finely reticulated veins of scarlet run over a yellowish ground. A broad wing extends along one side of the leaf from the base to the opening at the summit; the wing is bound or edged by a purplish cord, which also extends around the opening. This cord or edge of the wing is one of the most wonderful features of the plant. (The flower stem is much longer than is shown in our engraving.)

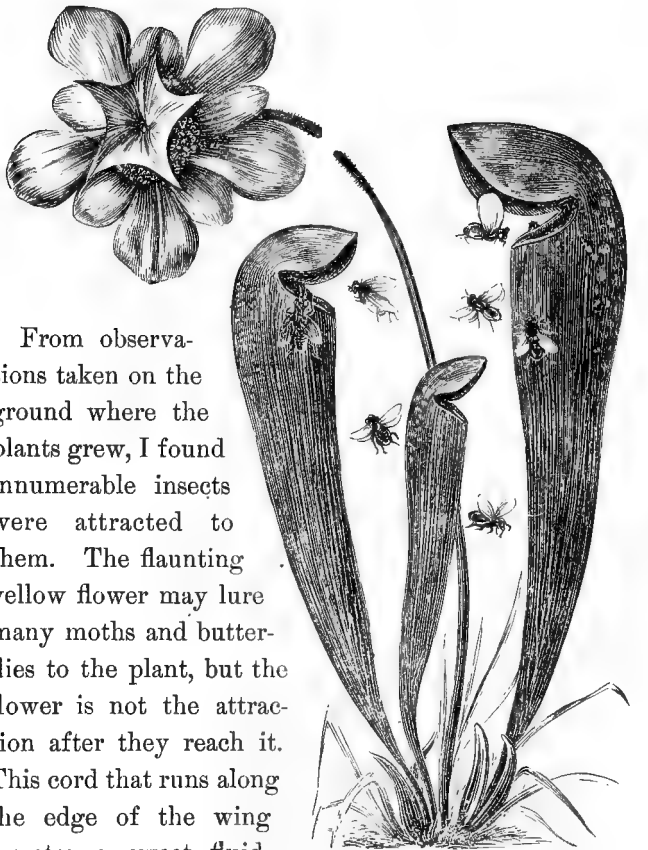


FIG. 19.—THE PITCHER-PLANT (SARRACENIA VARIOLARIS).

From observations taken on the ground where the plants grew, I found innumerable insects were attracted to them. The flaunting yellow flower may lure many moths and butterflies to the plant, but the flower is not the attraction after they reach it. This cord that runs along the edge of the wing secretes a sweet fluid, and as the wing reaches to the base of the leaf, insects that crawl on the ground as well as those that fly are attracted to this sweet secretion. I noticed on some of the plants a line of small ants extending from

the base of the leaf to the summit, feeding on the secretion; so numerous were they that they crowded one another, but all steadily advancing to the opening, down which they disappeared.

All persons who have observed ants feeding have probably noticed the regular order in which they move to and from their food. The Aphides (plant-lice) produce a sweet secretion of which the ants are very fond. The ants are very friendly towards the Aphides, for they supply them with abundant food, on which they thrive. Now if we observe the ants feeding on this secretion from the Aphides, we can also see that they form two regular lines, the hungry ones moving up the stem to take their food, and the satisfied ones returning down the stem; and very friendly and fraternal they seem, never getting in each other's way, but often greeting one another as they meet, putting their antennæ together as if communicating something, and then passing on, each his own way. Mark the difference when the ants are found feeding on the sweet secretion of S. variolaris: now they crowd and jostle one another, and seem wild in their movements, and all are advancing in one line towards the summit of the leaf, on reaching which they disappear down the wide throat of the insatiable Sarracenia. No return line here.

This I observed on the pine-barrens where the plants grew. I now took a large supply of leaves to my study, and placed them in an upright position in vases

of water to keep them fresh, and opened the windows to admit the various insects that are swarming in the air at this season. Soon the room was well supplied with the common house-fly. I now returned the screens to the windows, and sat down to watch results. A number of flies were soon attracted to the plants, and almost as soon as they tasted the secretion they acted strangely. It was astonishing to see how quickly it affected them. They became stupid, and did not notice my hand in close proximity, and they paid no attention to gentle efforts to shake them from the leaf. If I touched one, it would fly a short distance, but invariably it returned to the leaf, and very soon was buzzing inside of the tube, trying to walk up the dry, smooth surface, and ever falling back, until it was exhausted and still. It was no use to liberate them. I repeatedly took a leaf and turned the opening downward, and gently knocked it until I liberated half a dozen or more, but they were soon on the leaves again, evidently trying to straighten themselves. They would pass their legs over their wings, but they were unsteady on their feet, and seemed to be intoxicated. Every fly that I liberated eventually returned to the open mouth and walked in, as if fascinated by some spell.

In about two hours the room was cleared of flies—all lured into the fatal traps. I reopened the windows to admit more, and among the flies came two or three yellow-jackets—wasp-like insects. These yellow-jackets are very fond of anything sweet, and very soon one

found the tempting bait. It alighted upon a leaf, and commenced feeding about two-thirds of the way from the base. It seemed to relish the food highly, and ate eagerly and quietly for a few moments; but soon its wings began to flutter, and it proceeded hurriedly and wildly along the line of sweet until it reached the opening. Here it paused a moment to feed along the cord that surrounds the mouth of the tube, but its wings were still raised and fluttering. In a little more than a minute from the time it alighted it was a safe prisoner within, buzzing and fluttering and stirring up the imprisoned flies. On holding the leaf up to the light, I could see its frantic efforts to escape—trying to climb the smooth surface, but, like the flies, ever falling back, until it was powerless to move.

These experiments I repeated day after day. As the leaves became exhausted I brought in fresh ones.

I have been asked by an eminent scientist if I can *prove* that the flies are intoxicated. I do not see how I can prove it. I am not a chemist, and cannot analyze the secretion. I can only give the result of my observations and experiments. I might get a large quantity of the leaves and make a decoction of the secretion and drink it; but I find the flies never recover from their intoxication, and my fate might be the same if I took a sufficient quantity. At all events, the secretion excited the salivary glands to a wonderful extent, which continued for hours after I had tasted it. The sweet taste was succeeded by a disagreeable acrid feeling, the

same as that produced by the Indian turnip (*Arisæma triphyllum*), only in a milder form.

I called the attention of a lady friend—Mrs. Read, a good observer—to this strange behavior of the flies, and she is of the same opinion as myself, that the flies are made stupidly intoxicated before entering the tube. We also placed vases of leaves in the dining-room and kitchen, where the rapid disappearance of the flies highly amused the servants. On opening the leaves a day or two after they were brought into the house, I often found fifty or more flies in a single leaf. Of course a leaf could not digest such a mass of insects before they became putrid.

I carefully studied the inside structure of the leaf. More than half of the tube from the base up is lined with a firm, strong texture, and this lining is of a livelier green color than the remaining inner surface of the tube. On passing a finger over the surface from the base upward, we can detect a slight roughness as far as the brighter green color extends, and then it abruptly terminates; above this is a space of about two inches or more, according to the length of the leaf, which has a peculiar smooth feeling, and over this space no intoxicated insect can walk. There is no gradual blending of the two colors from the base up, but the line is distinct and marked, and easily seen with the naked eye. The smooth lighter-colored space is succeeded by the white spots before mentioned, and these white spots gradually blend with the fine scarlet veinings on the

inner surface of the hood. The peculiar smoothness does not extend over the bright colors, and here a fly can easily walk.

Under the microscope, the two colors on the inner

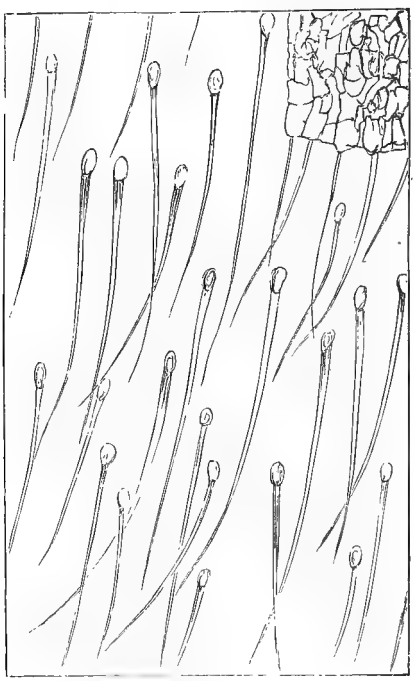


FIG. 20.—HAIRS OR ABSORBING GLANDS FOUND IN THE LOWER HALF OF TUBE.

surface of the leaf present a marked difference; the lower part of the tube seems to be a true stomach. Long hairs (Fig. 20), all pointing downward, are scattered thickly over the surface. If a leaf has caught no prey,

the hairs are clear and very transparent; but very soon after an insect is caught the hairs begin to absorb, and granular matter may now be seen extending along their entire length. When a small number of insects are caught, they seem to be digested quickly, and no disagreeable odor is detected; but, on the other hand, when a large number are caught, which is usually the case, a disgusting odor emanates from the tube. Yet this

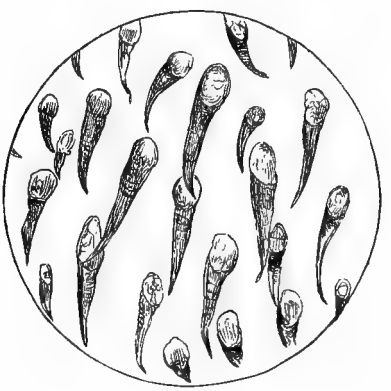


FIG. 21.—HAIRS ON THE SPACE ADJOINING THE OPENING IN THE MOUTH OF THE TUBE.

filthy mass does not injure the inner surface of the tube; it is evidently absorbed, and no doubt goes to nourish the plant. So this Sarracenia, like the disgusting buzzards in the animal kingdom, feeds on carrion, and as it cannot go in search of food, a tempting bait is set to lure insects into the fatal trap.

On the lighter-colored smooth surface, immediately

above the long hairs, the microscope reveals very short hairs, as seen in Fig. 21. In pinguicula and other plants which I have observed, when two sets of hairs are found they gradually blend into each other; but here a distinct line is drawn that can easily be seen with the naked eye, and close to this line the hairs are as distinct and marked in their character as on any part of the surface. On the inner surface of the hood and around the mouth of the tube is another set of curiously shaped hairs (Fig. 22), which creates a roughness, and over which the flies can easily walk.

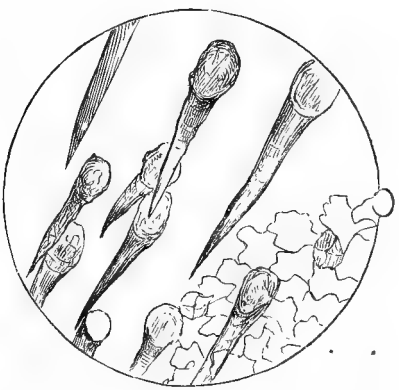


FIG. 22.—HAIRS ON THE INNER SURFACE OF HOOD.

The structure of the cord which secretes the sweet fluid presents a marked difference under the microscope from the rest of the plant. The epidermis is very thin here, and the secretory glands are large and numerous.

The plant secretes the sweet fluid only a few days,

while the leaves are young and vigorous, and it is while this is abundant that so many insects are caught. Yet even after I cannot detect the secretion, either in feel-

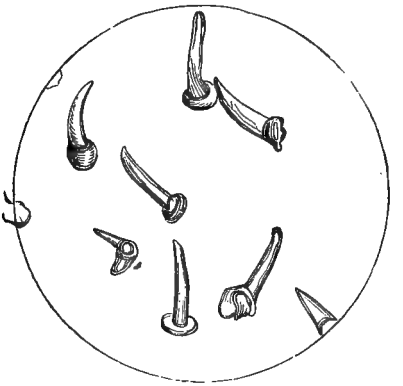


FIG. 23.—HAIRS ON THE WING AND OUTER SURFACE OF TUBE.

ing or taste, the flies still find enough to attract them, but it is in such small quantity that they sometimes fly away after feeding a while, which they never do when they get a good dose. I have taken flies that were stupidly intoxicated, and placed them under a glass where I could observe them, and I find they have a tendency to stand on their heads until they die. The first flies that are caught in a tube usually remain quiet, from the fact that they are wedged down so tight that they cannot move. This tendency to stand on their heads puts them in such a position that it is impossible to extricate themselves; but as the tube extends upward it becomes broader, and now the remaining flies that are caught

are no longer wedged in, and these try to climb the smooth surface, but, as far as I have observed, not one has ever succeeded.

It is not only house-flies on which the secretion acts, but all insects which I have noticed are affected by it. A large cockroach was feeding on the secretion of a fresh leaf which had caught little or no prey. After feeding a short time it went down into the tube so tight that I could not dislodge it, even when turning the leaf upside down and knocking it quite hard. It was late in the evening when I observed it enter; the next morning I cut the tube open; the cockroach was still alive, but it was covered with a secretion produced from the inner surface of the tube, and its legs fell off as I extricated it. From all appearance, the terrible Sarracenia was eating its victim alive. And yet, perhaps I should not say "terrible," for the plant seems to supply its victims with a Lethe-like draught before devouring them.

From the position in which the insects are placed after being made prisoners, it is impossible to see how much secretion they cause. In the case of pinguicula this is easily seen. On cutting the tube of Sarracenia open, we find a secretion very different from the sweet secretion in the cord, and this secretion, produced from the inner surface of the tube, seems to act on the flies in the same way as that produced by pinguicula.

As further evidence of the intoxicating power of the sweet secretion of Sarracenia, I must add the fact of a

wasp building its nest within the fresh young leaves, usually before the leaf has caught a single insect. The nest is made of dry, fibrous material—probably stripped from some dead herbaceous plant—and dry grass. This material is crowded as low down in the tube as the wasp can go, and it extends upward an inch or more. On this bed is laid the food for the young wasp. The food consists of five or six young grasshoppers, which the parent wasp has stung and paralyzed in such a manner that they are kept alive for the young wasp to devour. The grasshoppers are covered with the same material as that found in the bottom of the nest, to the depth of about an inch, the material being wadded in close and tight. I have also found the nest of a leaf-cutter bee in the tube of Sarracenia. These nests I sent to Professor C. V. Riley for identification.

I give here Professor Riley's account of the nests, and I also take this opportunity to acknowledge his kindness in aiding me in various ways in my researches, and especially in his excellent and very accurate drawings of the chironomus and mosquito larvæ on pages 142 and 143:

"The nest made of leaves belongs to a leaf-cutter bee, genus *Megachile*. The species cannot, of course, be determined except by breeding. These insects normally build their nests in burrows which they make in the stems of soft pithy plants, like elder, and the appropriation of the Sarracenia tube is very interesting. It is very likely that this bee aids pollination of the flower,

and partly stores her cells with it (the pollen). In the example you send, the plant had already captured some insects before the bee commenced building. I hope to breed the imago, as I think one cell contains the larva. The leaves employed seem to be oak. The other nest is that of some wasp, and evidently of some species belonging to the *Sphegidæ*. These insects all sting their prey and paralyze it, and make their nests in various ways, but generally by burrowing in gravelly soil or appropriating the tunnels of other species, such as the carpenter bee (*Xylocopa*). Mr. F. Smith, of the British Museum, records that *Sphex lanierii* (Guerin) 'constructs its nest of a cottony substance, filling a tunnel formed by a large curved leaf.' I have been trying to determine what the fibrous matter is composing the nest you send; it seems to be made of the slivers of some soft-stemmed plant."

Now in what way can we account for the safe exit of the wasp and bee except on the hypothesis that they did not feed on the secretion while building their nests? I have repeatedly seen wasps and other hymenopterous insects eat the secretion, and then go into the tube and never return.

But the most conclusive proof of the intoxicating power of the sweet secretion of Sarracenia is the marked effect it produces upon the cockroach. The Florida cockroach is one of the most agile of insects. It is almost impossible to catch one. He is ever on the alert and most impudent. I strike at him—he is yards

away. But at last I have come off conqueror. I have found his weakness—his love for the intoxicating beverage of Sarracenia. After he has partaken of this secretion, in a few moments he is usually very docile, his long antennæ sway back and forth, and he pays little or no attention to my movements; but occasionally a very large one will act perfectly wild after partaking of the beverage; it will suddenly dart from the plant and rush round and round the room, apparently without any end or aim in view. It seems to be in a regular drunken frolic. After a while it becomes quiet, and then is easily captured. I have just taken such a one and measured it. From the tip of its antenna to the end of its wings, which extend slightly beyond the body, it measured four inches in length. Its body is about two inches long. I shut it in a box overnight. In the morning it could move its legs and antennæ very slightly, but it did not recover after being taken from the box.

During the two months of my observations of the plant I have seen a large number of insects, both in the field and house, made intoxicated by this secretion on the outer edge of the wing, and I have seen insects belonging to every order caught after eating the secretion.

That the plant can digest a limited amount of food before it becomes putrid, I have verified by repeated experiments with fresh raw beef. I took young leaves before they had caught any prey, and inserted bits of

raw beef low down in the tube. In some cases in two hours' time the meat was surrounded by a copious secretion, the same as in pinguicula, and it looked white and was quite tender; but I found the leaves varied considerably in the power of digestion: in some cases, at the end of two hours, the meat had not changed color, and was not acted upon by the secretion, but remained quite dry. From some of the leaves I cut a small slice from near the base of the tube, and inserted the meat, so as to watch the effect produced by the secretion. In the larger number of leaves it acted upon the meat precisely as it did in pinguicula. Usually in about twenty-four hours the meat was very white and tender, and had no disagreeable odor.

But no doubt the plant receives its greatest benefit from the large amount of insects caught, and which become disgustingly putrid. When pinguicula and Drosera get more than they can digest, the leaves succumb —die in the effort to digest it. Not so with the Sarracenia: it seems to thrive on this filthy mass of insects, and in time absorbs all save the dry remains of the wings of beetles and other hard parts of the bodies of insects.

On observing these carnivorous plants it is easy to imagine them avengers upon their destroyers, and the metamorphoses of the ancients accomplished, by which living animals are transformed into trees and flowers. The "Loves of the Plants," as pictured by the elder Darwin, are shown by his grandson and other natural-

ists to have become transmuted into the love of sentient life; and if Drosera and Dionæa were furnished with tongues, this might be their invocation:

"Rest, silver butterflies, your quivering wings;
Alight, ye beetles, from your airy rings;
Ye painted moths, your gold-eyed plumage furl;
Bow your wide horns, your spiral trunks uncurl;
Descend, ye spiders, on your lengthened threads;
Glisten, ye glowworms, on our clasping beds."

PART IV.

FLOWERING PLANTS.

Chapter XIV.

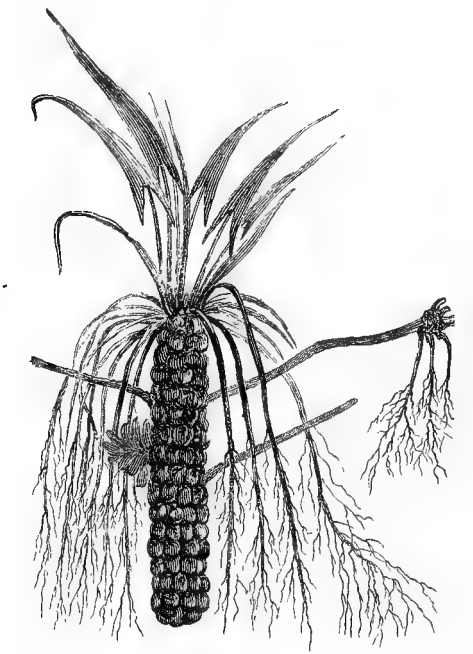
LIFE IN FLORIDA.

Animal and vegetable life in Florida is in striking contrast with what I see around me at the North. I can botanize all winter without leaving home, and not only do I find many plants new to me, but some are new to science, having been overlooked by tourists and naturalists who take a wide range, not being obliged to settle down and stay in one spot.

Even the streams and pools of Florida are no more like those of the North than is the vegetable and animal life with which they abound. Alligators and strange fish and many wonderful plants live in the deep, narrow streams that find their way to the broad St. John's. And the St. John's itself, where is its like? Five miles broad, flowing northward, deep and dark, but not always quiet and lazy — so depicted by some poetic writers—as we who live upon its banks can testify. A strong north-east wind will soon agitate and stir the water almost to its very depth, making it extremely dangerous for small boats. But there are weeks together when the river is so quiet that we feel perfectly safe to trust ourselves upon its placid surface in a row-

boat, by which means we can visit the coves near home which have escaped the eyes of the botanists who have traversed the river's length in larger craft.

Upon one of my first excursions in a row-boat I was attracted to the nearest cove, where acres of the water



NYMPHÆA FLAVA.

were covered by a beautiful variegated leaf of a strange water-lily, which bore a yellow flower. I saw it was a nymphæa; but its manner of growth and whole appearance were so unlike our white water-lily (*Nymphæa*

odorata, Ait.) that I knew it must be a distinct species, of which no mention was made in the text-books of Gray or Chapman.

I soon wrote to Dr. Asa Gray, our authority on botany, and to Professor Sargent, director of the Botanic Garden at Harvard, telling them of my discovery. They seemed as much elated over it as myself, and informed me that Audubon had figured a yellow water-lily in his book of birds of the South, but had made no mention of it in the text; and so botanists had generally believed it to be simply a fancy of the author. But here it was, acres and acres, a living testimony to Audubon's truth and skill.*

Its manner of growth is peculiar. How it maintains a foothold in the soft oozy mud when the water is so

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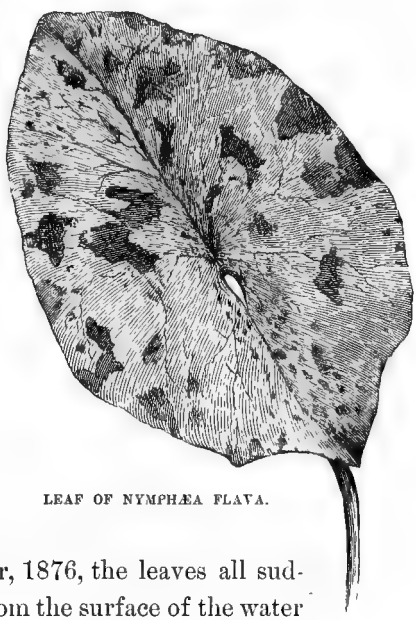
* Since the above was written, I have received the following additional information respecting the yellow water-lily from Professor Sargent:

"The authority for the name of *Nymphæa flava* rests on the figure of the white American swan in Audubon's 'Birds of America,' in which there is a very good representation of your plant. Under it, it says, '*Nymphæa flava* (Lutren).' There is no description of the flower or any character given, so that *Nymphæa flava* has never been published yet. It will, however, be proper to preserve Lutren's name, and he should stand always as authority for the species, whoever may draw up and print the technical description. You know, I dare say, that Lutren was a young German who, years ago, botanized in Florida, and who was killed there by the Indians. He probably made notes of his discoveries, but, so far as I know, these have never been published."

often agitated is almost a mystery. The rhizoma is not creeping, as in the white water-lily, but always stands in an upright position, and I have never found it more than a foot in length; the lower part rots away as the plant extends upward. Each year a new circle of leaves starts out above the old ones, these dropping away, leaving the scars on the rhizoma; so, also, a new set of roots starts just beneath the new leaves, the old roots dying away like the leaves. This makes the rhizoma a scarred, straight, underground stem, apparently useless.

In the larger plants it is a foot in length and six or eight inches in circumference. After it has done its work of supplying the plant with leaves and roots, this seemingly worthless appendage performs new duties in order to perpetuate its race. It sends out long white runners, often a yard in length, and on the end of each a little plant grows; as soon as this plant is well started, the runner continues, and throws out another plant, the same as the strawberry, only this is on a much grander scale. Sometimes as many as four runners are attached to one rhizoma, and three or four small plants strung along each runner. As soon as the new plants become well established, the runner decays, and the little ones are now able to stand by themselves, and each has an independent existence, repeating the history of its parent. But this is not the only way that the lily is perpetuated: it also forms small bulbs or bulblets, which drop into the soft mud and take root.

This work is all going on in the spring before the plant blossoms. It does not bloom until about the 1st of May. The flower is like the white pond-lily in form, but the inner surface of the petals is plain yellow, while the outer surface—as we often see in the white lily—is streaked with pink. It probably ripens seeds, but I stayed in Florida only long enough to see it well in flower, and when I returned, late in autumn, I could find no seeds.



LEAF OF NYMPHÆA FLAVA.

The cut on page 208 represents a plant soon after the old leaves have been cut down by frost. In December, 1876, the leaves all suddenly disappeared from the surface of the water—the effects of a sharp frost—but in January of the following year new ones reached the surface.

The upper surface of these new leaves is beautifully variegated with dark purple, and light and dark shades of green, and sometimes yellow; the under surface is a deep purplish red.

GOVERNOR'S CREEK.

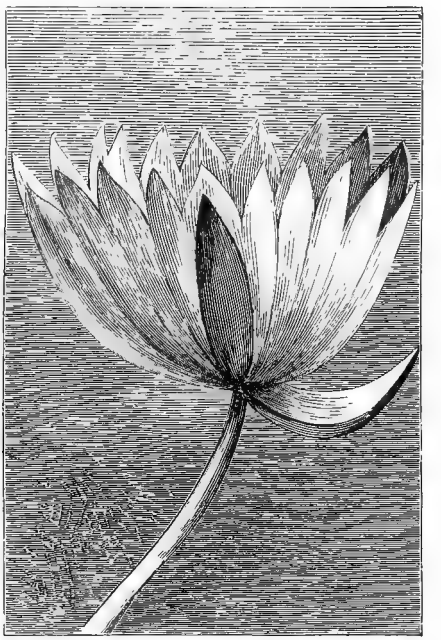
In a large cove only a few rods from home this lily extends over several acres. The beautiful leaves lie thick upon the water; and in May, when the flowers appear, it is one of the grandest sights I ever beheld. It grows in water from one to five feet in depth, the length of the leaf-stems and flower-scapes depending upon the depth of the water.

How far it extends remains to be seen. I have traced it about forty miles along the St. John's. It grows all about Jacksonville—thirty-five miles below us—within a few yards of the Grand National Hotel, and how it has so long escaped the botanist is a mystery. But the plants around Jacksonville are not so beautiful and striking in appearance as those near home, probably owing to the rough treatment to which they must naturally be subjected.

A short distance from home is a deep, narrow stream, known as Governor's Creek, which takes its rise in the low marshy grounds, and pursues its course amid a wild and tangled forest, increasing in size as it approaches the St. John's, in whose murky water it is lost. Alone on this stream, or with a single oarsman, and no sound save the plash of the oar, one's thoughts revert to primeval times. But the boats with their gay and fashionable occupants have almost spoiled the pristine look.

At the mouth of this creek we also find our lily—*Nymphæa flava*—in abundance, but it is soon replaced by the common yellow lily, or bonnets (*Nuphar advena*, Ait.), which here assume gigantic proportions. The leaves measure from eighteen to twenty inches across, and cover the water on either side of the deep channel for the distance of a mile or more. The leaves and flowers reach the surface of the water in some places from a depth of ten feet. A bouquet of these, with ten feet of flower-scape and leaf-stalk, would do to present to Swift's Brobdingnagian heroine!

Forcing our boat through these immense lilies to the shore, we land amid a tangled thicket of flowering shrubs and vines. The beautiful snowdrop-tree (*Halesia diptera*, L.), with its clusters or short racemes



FLOWER OF NYMPHÆA FLAVA.

of pure white blossoms, is one of the first to reward us for our effort. Myriads of insects are hovering about the flowers with a loud humming noise, as if warning us to beware of their anger. The yellow jasmine (*Gelsemium sempervirens*, Ait.) clambers over shrubs

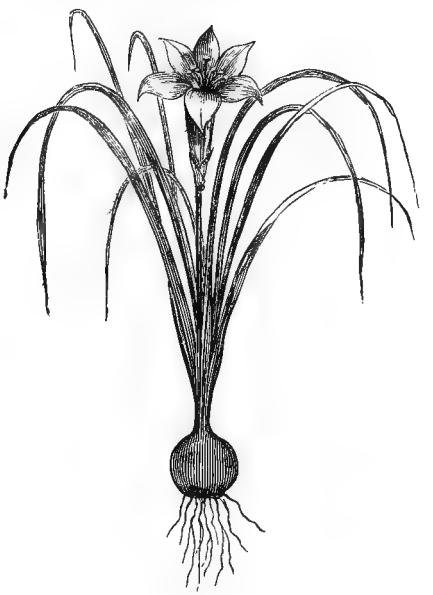
and trees in the greatest profusion, filling the air with its delicious fragrance.

A gigantic cypress (*Taxodium distichum*, Rich.), an old dying monarch of the forest, whose trunk measures thirty feet in circumference, is clothed from base to the towering branches above with the large shining emerald-green leaves of a lovely vine (*Decumaria barbara*, L.). It clings close to the trunk, throwing out little rootlets, which grasp the bark so closely that the vine seems a part of the tree. It is just coming into flower; the flower-stems are six to eight inches in length, stand straight out from the tree, and are scattered thickly along the entire length of the trunk. Each stem bears three or four pairs of large leaves, and is terminated by a cyme of numerous fragrant white blossoms.

Several members of the heath family are also in flower, the most conspicuous of them being the swamp-honeysuckle (*Azalea nudiflora*, L.). Some of these shrubs bear large clusters of pure white flowers, while others have deep rose-pink blossoms. This azalea is here so ambitious to show itself foremost among the flowering shrubs that it fairly forfeits the title of *nudiflora*, the blossoms appearing amid the old setting of leaves.

But my delight culminated in finding a beautiful amaryllis lily growing amid the dense thicket in the soft mucky soil along the banks of the stream. The leaf is much broader and longer than the old form

of *Amaryllis atamasco* (L.), and the flower finer and larger. Some of the largest leaves measure two feet in length, and the largest flowers five inches across and five inches in length. It commences to bloom in Jan-



AMARYLLIS ATAMASCO.

uary, and continues in flower until March. It bears transplanting to common garden soil, where it does not depreciate in size of leaf or flower.

In 1876 I sent some three hundred bulbs to the Botanic Garden at Harvard to have it tested, and the director writes me, under date of February 2, 1877: "Your atamasco lily is a splendid thing, much finer

than the old form, and is now charmingly in flower and very beautiful."

Early in February the damp pine-barrens are flecked with the golden and purple flowers of the pinguiculas. These flowers are arranged upon such a plan that cross-fertilization must depend upon the agency of some small insect. The stamens and pistil are concealed in a little cavity in the throat of the corolla, so that it is necessary to pull the flower to pieces in order to see them; and as the throat is half closed, only a small insect can do the fertilizing work.

Taking my stand in the midst of these flowers on a clear still day, I soon had the satisfaction of becoming acquainted with the little agent who accomplished the work. It was a hymenopterous insect—a spiteful little bee, so small that it could easily enter the half-closed throat, and disappear in the bulge or swelling of the upper part of the spur, where it was large enough for it to turn round and make its exit head-first. Placing my hand over the flower after the bee disappeared, I held it a prisoner, but not without a retaliating sting.

I watched these insects several successive days, and found them to be unerring workmen. Although there were other flowers in close proximity about the same size, color, and height as the pinguiculas (helianthemums and ascyrums), yet these, as far as I saw, were never visited by the little bee. How it could so unerringly discriminate between these flowers is almost a

marvel. Half a dozen yards distant I could not tell whether the golden-yellow flowers were those of *Pinguicula lutea* or *Helianthemum carolinianum*.

Butterflies visited the flowers indiscriminately, and, as they could be of no use to the plant—not being able to come in contact with the stamens—it was not necessary for them to discriminate. But every time the bee passed in and out of the throat, it unavoidably rubbed against the stamens, and carried with it some of the pollen, to be left on the stigma of the next flower visited.

In my excursions in the low pine barrens not far from the St. John's I came upon a large area of amaryllis in full bloom. As far as the eye could reach, these beautiful white lilies were thickly scattered among the grass. I saw the leaves were much more narrow and thicker than those of A. atamasco.

I sent the plant to the Botanic Garden at Harvard, where it was pronounced a new species, and named by Professor Watson *Zephyranthes treatiæ*. The florists advertise it in the *Century* and other periodicals under the name of *Amaryllis treatiæ*.

The domestic animals of Florida cannot fail to arrest the attention of the most careless observer. The hogs—a lank, black race—have developed an enormous length of snout, with which they turn up the soil in search of tubers and roots equal to a plough. Many of these hogs are running wild in the forest. Their ears have become erect, and they have long tusks, resembling the

wild-boar of Europe; and they seem to have developed an intelligence as marked as their looks. The dull, dead-looking eye of the well-fed, closely confined porker of the North is in striking contrast to the inquisitive bright eye of this vagabond race. I have often seen one digging for the wild yam (*Dioscorea villosa*), the tubers of which are sometimes two feet or more beneath the soil. The vine being annual disappears in the winter, but the hog seems to know just where to dig, and often the tubers are so deep that he is obliged to kneel upon his fore-legs, and has the appearance of standing upon his head before he reaches the esculent prize.

The cattle do very well for nine or ten months of the year, but in December and January, before the barrens are burned over and the grass starts afresh, there is often much suffering among them and many die from starvation. It is pitiful at such times to see them trying to eke out their lives by reaching up for the moss on the trees. Large herds of cattle also have their feeding-grounds in the rivers and streams. In the bays and coves of the St. John's are many acres of the *Valisneria spiralis*, which grows as thickly as grass upon the barrens. The grass-like leaves are from one to three feet long, and the slender, spiral, flowering stems often five or six feet in length. Sometimes hundreds of cattle may be seen together feeding upon this plant, frequently standing in water that reaches to their backs. With heads entirely under water they fill their mouths,

then elevate them to chew and swallow. The natives call them river-cattle, and see a difference in them from those which feed on the barrens. A true river-animal, they affirm, will not feed on the barrens.

With this plant (Valisneria) the cattle also eat a large quantity of animal food. Thickly adhering to the leaves are countless numbers of small cocoons, holding the larvæ of a species of chironomus fly. When fully grown the larvæ are from one-half to three-quarters of an inch in length, which, as will be seen, cannot fail to make a considerable part of their food. This kind of diet and manner of feeding ought in time, according to the Darwinian theory, to evolve a new species of *Bos;* and, if we are to take the testimony of the people, a new breed is even now recognized.

It may interest those curious in such matters to learn the life-history of the little creature which forms such a large share of the food of these cattle. Persons at all familiar with the St. John's have noticed at certain times countless myriads of mosquito-like flies everywhere along the banks—the herbage is fairly black with them. They are popularly called "blind mosquitoes," to distinguish them from the true mosquito, which bites. This fly is the parent of the larva which has its home on the leaves of the Valisneria. The larvæ do not eat the plant; their food consists of decaying vegetable matter and microscopic plants which lodge in abundance around the cocoons.

The flies have a novel method of placing their prog-

eny under water. Towards evening they rise almost in a body, and apparently alight upon the river. When the water is still and low, the ends of the leaves of the Valisneria stand above it in many places. A fly alights upon a leaf, and fastens thereto the end of a webby, mucilaginous thread. At the other end of the thread—sometimes several inches in length—is a little jelly-like mass, about as large as a good-sized pea, which floats in the water and contains the eggs; when they hatch, the little creatures feed on the jelly for a day or two, then attach themselves to the leaves and make cocoons, where they live until they are ready to emerge as flies. Sometimes a leaf is heavy with the combined weight of these larvæ.

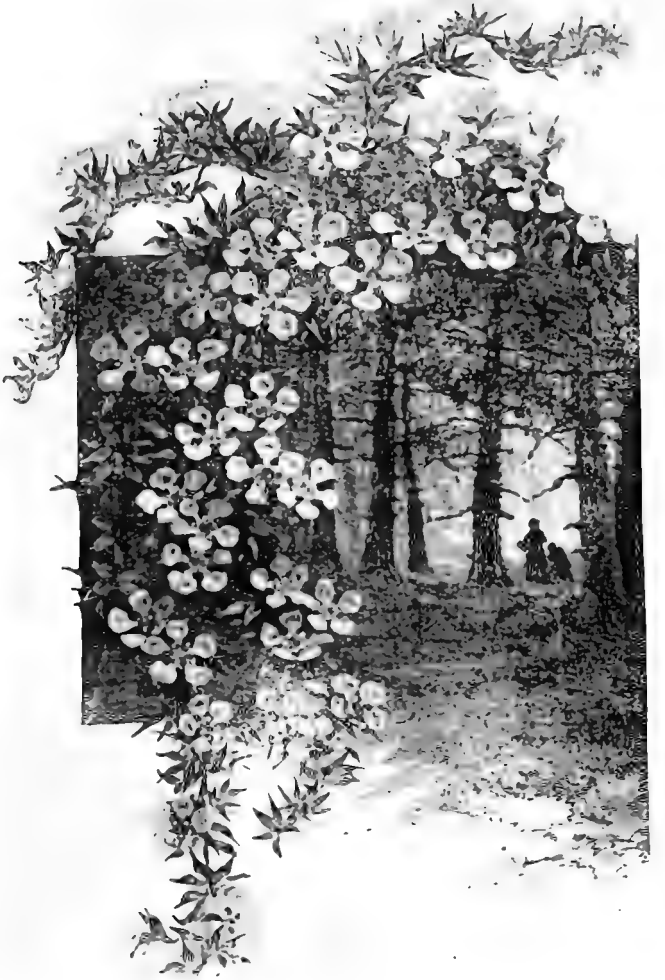
Chapter XV.

IN THE PINES.

It seems almost like a miracle that in the very heart of civilization, in one of the most healthful regions in the Union, great tracts of fertile land still remain Nature's gardens, where she nourishes the sweet wild-flowers in her own mysterious way, refusing to give her secret to her most ardent devotees. Here she has planted flowers not to be met with in any other part of the world.

First among her treasures is the delicate pyxie (*Pyxidanthera barbulata*), a little prostrate trailing evergreen, forming dense tufts or masses, and among its small dark green and reddish leaves are thickly scattered the rose-pink buds and white blossoms. It is strictly a pine-barren plant, and its locality is confined to New Jersey and the Carolinas, yet we may travel over large sections of these States without meeting it; but when we find its haunts, it is often in such profusion that the ground is thickly carpeted with its delicate sprays.

The trailing arbutus frequently blends its clusters of pink blossoms and exhales its delicious fragrance with the flowering sprays of pyxie. Nothing can be more



PYXIDANTHERA BARBULATA.

charming than Nature's blending of these two lovely plants. The arbutus blossoms from a month to six weeks earlier in the pines of New Jersey than in New England, where it takes the name of May-flower. It is not unusual to find it in the pines in full bloom by the middle of March. And by this time, or even earlier, we are sure to find the little shrub *Cassandra calyculata*, with its one-sided racemes of closely-set bell-shaped flowers.

There is an entrancing influence about these early flowers,

> "That come before the swallow dares, and take
> The winds of March with beauty,"

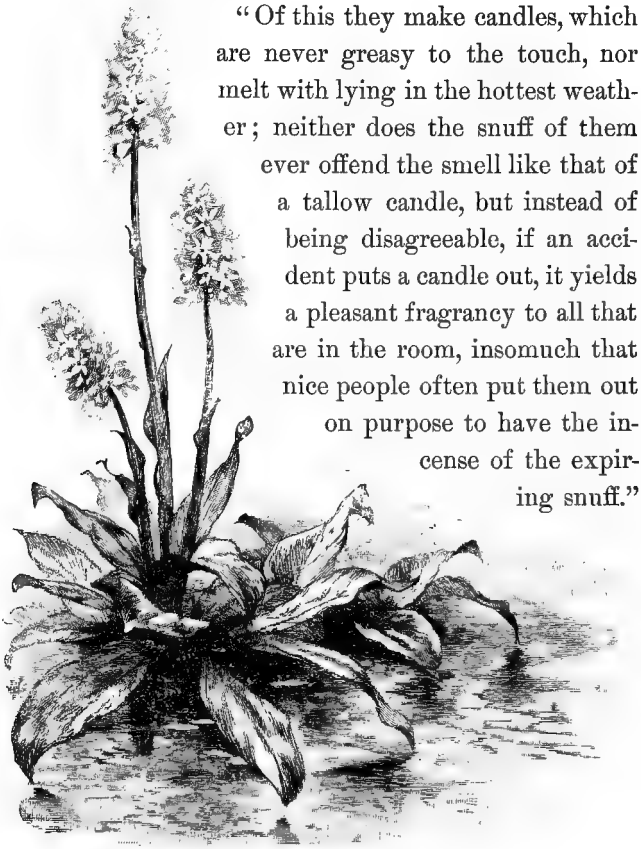
making the first days of early spring in the pines days never to be forgotten. And there is a subtle power in the atmosphere which stimulates the sluggish winter blood, and sends it coursing through the veins, giving us an exquisite realization of the delights in nature.

We listen to the whispering pines and catch their odorous breath, while beneath our feet the spicy aromatic winter-green, with its dark shining leaves and clusters of scarlet berries, yields its fragrance at every step. The sweet-fern, with its plumy catkins, is redolent with perfume, and the wax-myrtle adds its share of grateful aroma.

The wax-myrtle, with its crowded clusters of greenish-white waxy berries, takes us back to the early settlers, who, Kalm informs us, used these berries to make can-

dles, and also an agreeable-smelling soap. And Thoreau says that in Beverley's "History of Virginia," published in 1705, mention is made of the myrtle, and how the early settlers made a hard, brittle wax from the berries.

"Of this they make candles, which are never greasy to the touch, nor melt with lying in the hottest weather; neither does the snuff of them ever offend the smell like that of a tallow candle, but instead of being disagreeable, if an accident puts a candle out, it yields a pleasant fragrancy to all that are in the room, insomuch that nice people often put them out on purpose to have the incense of the expiring snuff."



HELONIAS BULLATA.

So our poet-naturalist tries to emulate the early settlers and turn chandler himself, and gives us his process of making tallow in the following paragraph:

"I have since made some tallow myself. Holding a basket beneath the bare twigs in April, I rubbed them together between my hands, and thus gathered a quart in twenty minutes, to which were added enough to make three pints, and I might have gathered them much faster with a suitable rake and a shallow basket. They have little prominences like those of an orange, all creased in tallow, which also fills the interstices down to the stone. The oily part rose to the top, making it look like a savory black broth, which smelled much like balm or other herb tea. You let it cool, then skim off the tallow from the surface, melt this again and strain it. I got about a quarter of a pound weight from my three pints, and more yet remained within the berries."

What use he made of his tallow is lost to the world, and we are left to infer that the experiment was simply to test the truth of the record, which gives us another instance of his accepting nothing upon trust.

How many lives have come and gone since the children of the pioneers gathered the berries to light their cabins, and what a change in the lives of their descendants! while extensive tracts of pine-barrens are to this day unchanged—precisely the same as the early settlers found them two centuries ago. But within a few years past it has been found that the pine-barrens of Southern

New Jersey are quite fertile, and at no distant day they are destined to become the greatest fruit gardens in the Union. And then farewell to the rare floral treasures which no art can save.

Looming in the distance is a long sinuous line of dense cedars, forming a dark background to the more open pine-barrens, towards which I direct my steps. I peer among the thickly set trees, standing like sentinels, dark and forbidding—the place for ghouls. Darker and darker it grows as I cautiously advance, with an oppressive dread of something which I cannot define. But the spirit of adventure overcomes the fear, and I am wholly occupied in finding secure spots to stand upon.

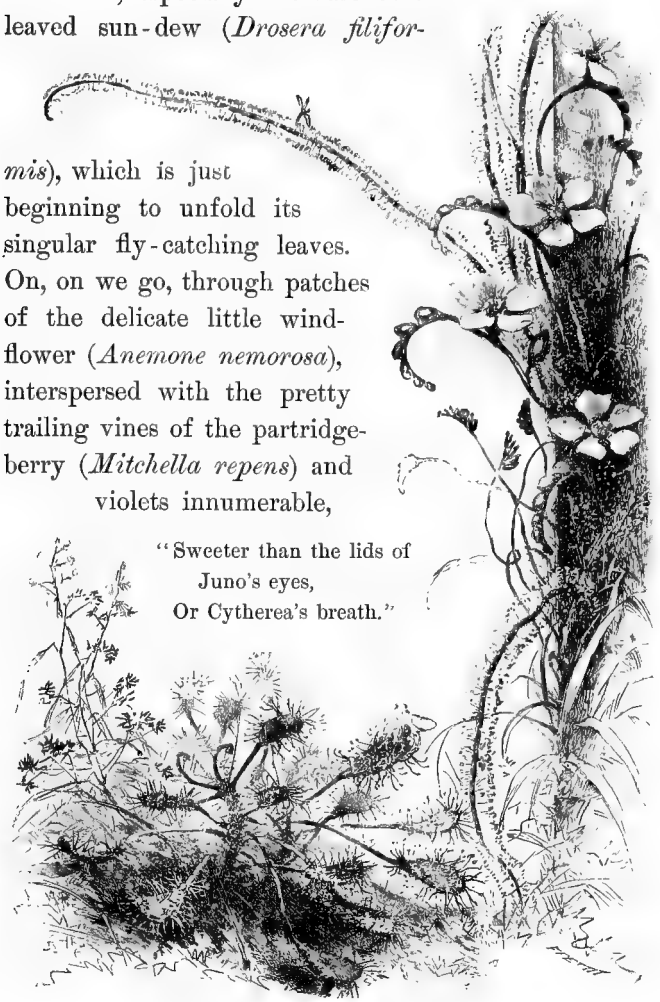
Ample compensation comes at last. Here, hidden among the underbrush, is the rare and local *Helonias bullata* in full bloom, standing thickly among the trees. The flower-stalk of this fine plant rises from a mass of large, glossy, evergreen leaves to the height of a foot or two, with a dense raceme of reddish-purple flowers at the summit. And here too is the golden-club (*Orontium aquaticum*), with its large, dark, velvety leaves and elongated scape of yellow flowers standing above the water.

It must not be inferred that the Helonias can be found anywhere in the cedars. At this point the plant extends over two or three acres, when it wholly disappears. And now we follow the winding course of the swamp, lured on by many attractive plants near its borders, halting now and then to gather the interesting

GOLDEN-CLUB (ORONTIUM AQUATICUM).

sun-dews, especially the rare thread-leaved sun-dew (*Drosera filiformis*), which is just beginning to unfold its singular fly-catching leaves. On, on we go, through patches of the delicate little wind-flower (*Anemone nemorosa*), interspersed with the pretty trailing vines of the partridge-berry (*Mitchella repens*) and violets innumerable,

"Sweeter than the lids of
Juno's eyes,
Or Cytherea's breath."



DROSERA LONGIFOLIA, D. FILIFORMIS, AND SCHIZÆA PUSILLA.

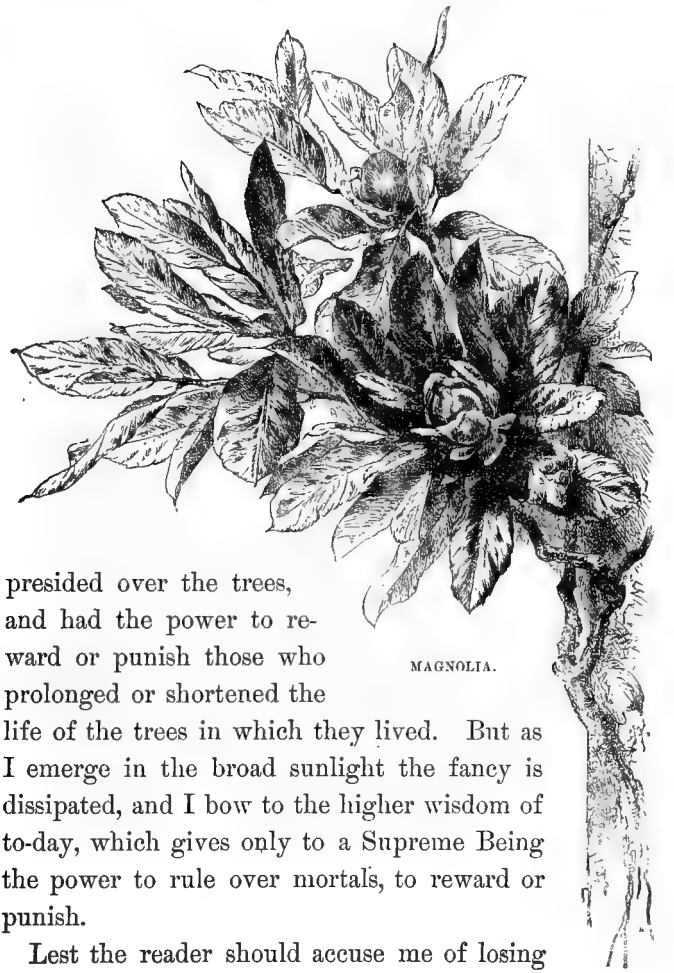
The shrubs of the heath family seem to have inspired the early botanists with poetic fancy. We find a genus dedicated to Cassiope, and another to her daughter Andromeda. Cassiope, however, belongs wholly to the mountains of the North, but Andromeda and Cassandra and Leucothoe skirt the cedars in profusion. The bright, showy pinxter-flower (*Azalea nudiflora*) also helps to make up the coterie. And now, parting a thick clump of Ilex, we find the beautiful orchid Arethusa, hid away in the gloom as if guarded by this nymph of night.

Still we wander on. Ten miles are passed before we come to another locality of Helonias. Again penetrating the dense forest, we discover that the plant extends over several acres, and then suddenly ceases. Great clumps of the royal fern (*Osmunda regalis*) are just beginning to unfold their large fronds. Here it attains almost gigantic proportions, the magnificent fronds towering above our heads, six to seven feet in height.

The origin of Linnæus's name, Osmunda, seems doubtful. Possibly he intended to dedicate it to the deity which presided over the mischievous spirits of the elements, Osmunder being the Saxon name of Thor. But what there is about this grand regal fern to have suggested the idea to dedicate it to the god of thunder is veiled in obscurity.

In the gloom and death-like stillness which surround me a mysterious awe steals over my senses, and I am

transported back through the ages, and become one with the ancients, when nymphs peopled the woods and



MAGNOLIA.

presided over the trees, and had the power to reward or punish those who prolonged or shortened the life of the trees in which they lived. But as I emerge in the broad sunlight the fancy is dissipated, and I bow to the higher wisdom of to-day, which gives only to a Supreme Being the power to rule over mortals, to reward or punish.

Lest the reader should accuse me of losing

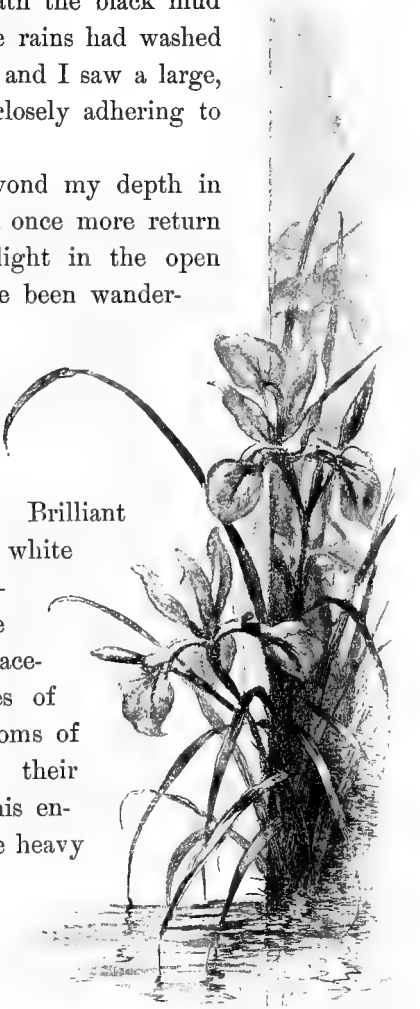
my subject in the cedars, I hasten to say that these great swamps are simply the banks of the rivers and streams which run through the pine-barrens; so I have a legitimate right to wander on. The banks sometimes extend a mile or two beyond the edge of the stream, and are not very picturesque nor generally attractive. But when it is asserted that there is nothing of interest connected with them, it only shows how little some people can manage to see. The streams themselves are not devoid of interest. Their red waters are constantly undermining the trees, causing them to fall, when they do not decay, and the falling trees are slowly and continuously changing the bed of the streams. How far below the surface they extend I do not know, but they are found to a considerable depth, in an excellent state of preservation. They are often extricated, and made into shingles and other useful things, which are said to be much more durable than when made from trees which have been cut for such purposes.

If the geologist did not tell us that the structure of the State of New Jersey forbids the possibility of ever finding coal-mines within its borders, we might be disposed to think that we had not wholly emerged from the carboniferous era, and that ages hence coal would be found where these cedars now stand. The coal might even have the imprint of the great ferns which grow among the cedars, and earth's inhabitants might ponder over the impress of these strange ferns. This thought was suggested on seeing a log which had been

XEROPHYLLUM SETIFOLIUM.

extricated from beneath the black mud and left to dry. The rains had washed off the surplus mud, and I saw a large, well-preserved fern closely adhering to its surface.

But lest I get beyond my depth in the red waters, I will once more return to the glorious sunlight in the open pines. While I have been wandering amid the dark cedars, and lost in speculation, the pines have come out in May-day attire—full gala dress. Brilliant clusters of pink and white laurel (*Kalmia latifolia*) as far as the eye can reach, and graceful drooping panicles of the pure white blossoms of the fringe-tree, add their charms to light up this enchanted garden. The heavy odor of the magnolia tells us of its close proximity. And now we come to another of



IRIS.

ORCHID.

Nature's plants which she has restricted to these gardens, the stately *Xerophyllum setifolium*. The flowering stem arises from a thick mass of long, grass-like leaves to the height of three or four feet, and is surmounted with a large globular head of showy white flowers.

Until recently this fine plant has stood with Nuttall's name (*X. asphodeloides*), but in the "Revision of the North American Liliaceæ," by Professor Watson, of Harvard, we find he has restored Michaux's name of *setifolium*. Of the smaller shrubs now in bloom we find the sand-myrtle, with its terminal umbel-like clusters of small, pinkish flowers, and gaylussacia (named in honor of the distinguished chemist Gay-Lussac), with its lovely racemes of open bell-shaped white and pink flowers. The pitcher-plant and golden-winged iris also add their charms to this May-day attire.

As summer advances we find a constant succession of beautiful shrubs and herbaceous plants, the fragrant

clethra, and azaleas and lovely orchids too numerous to mention. But we cannot bid adieu to the pines without mention of the very local little fern, *Schizæa pusilla*. This is one of Nature's rarest treasures, to which she has given but one lone spot on earth—in damp grounds amid the pines, where it extends a mile or two, and then is seen no more.

This little fern I have transported with the greatest care to similar-looking spots, miles away, and given it to the care of Nature, but she refuses to recognize any right to the change, and allows the poor plants to languish and die.

Southern New Jersey has ever had an irresistible fascination to the botanist, unequalled by any other section in the Union. Picturesque New England, with her charming flowers, cannot equal it, nor the great plains of the West. And even Florida—the land of flowers—must yield the palm to the pines of New Jersey.

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THE END.