Peckham, E. G. 1889. Protective resemblances in spiders. Occasional Papers of the Natural History Society of Wisconsin 1 (2): 61—113, Plates III—IV.

Any notes added to the original text are indicated in red. Errors in the original text are indicated in blue. Pagination of the original document has been retained. Scientific names that were not italicized in the original have been italicized in this version. All illustrations are presented in their original size.

PROTECTIVE RESEMBLANCES IN SPIDERS.

ELIZABETH G. PECKHAM.

Introduction.

There are, among spiders, two forms of protective modification: the first, including all cases of protective resemblance to vegetable and inorganic things—that is, all modifications of color or of color and form that tend to make them inconspicuous in their natural relations—I shall call direct protection. The second form, which I shall call indirect protection, includes two classes, the spiders which are specially protected themselves and those which mimic other creatures which are specially protected.*

Spiders are specially protected when they become inedible through the acquisition of hard plates and sharp spines. The modification of form is frequently accompanied by conspicuous colors, which warn their enemies that they belong to an unpalatable class.†

The second class of indirectly protected spiders—those that mimic specially protected creatures—presents some difficulties, since it is not always easy to determine whether the purpose of mimicry is protection or the capture of prey. The resemblance may, as is frequently the case in direct protection, serve both purposes.

In looking for instances of protective form and color among spiders we encounter one difficulty at the outset. The

---

* Wallace classifies the colors of animal organisms as follows:

1. Protective colors.

2. Warning colors. { *a*. Of creatures specially protected. *b*. Of defenseless creatures mimicking *a*.

3. Sexual colors.

4. Typical colors.

Tropical Nature and Other Essays, p. 172..

† Under special protection would also fall cases, such as are common among other animals, of the development of some nauseous taste or odor; but we know of no such case among spiders.

meaning of a protective peculiarity can be determined only when the animal is seen in its natural home. The number of strangely modified forms depicted in descriptive works on spiders is enormous. Bodies are twisted, elongated, inflated, flattened, truncated, covered with tubercles or spines, enclosed within chitinous plates, colored like bark, like lichens, like flowers of every imaginable hue, like bird droppings, like sand or stones, and in every one of these modifications there is doubtless an adaptation of the spider to its surroundings which when it is studied out of its natural relations, we can only guess at.

It has been well said that in these protective resemblances those features of the portrait are most attended to by nature which produce the most effective deception when seen in nature; the faithfulness of the resemblance being much less striking when seen in the cabinet.*

Before entering upon a consideration of protective modifications, I wish to give some account of the enemies of spiders and also to call attention to the remarkable variations in the fertility of the different species.

ENEMIES OF SPIDERS.

The enemies of spiders are numerous and vary greatly in different countries. Among them we may enumerate birds, wasps, lizards, snakes, monkeys, ichneumons, some kinds of ants, and spiders. They are also eaten in inconsiderable numbers by beetles and by fishes.

Outside of the Trochilidae comparatively few of the North American birds feed to any extent upon spiders, although they form an insignificant part of the food supply of many species.†

---

* H. W. Bates, in *Lepidoptera of the Amazon Valley*, p. 507.

† Prof. F. H. King has examined the stomachs of 1608 Wisconsin birds, including five humming-birds, 34 families being represented. In these he found, among other things, 1779 *Hymenoptera*, 1262 *Coleoptera* and 52 spiders. The whole number of birds eating *Hymenoptera* was 189, the whole number eating *Coleoptera* 430 and the whole number eating spiders 35.

Prof. S. A. Forbes finds that spiders appear to the following extent in the food of Illinois birds: Robin, 1%; Catbird, 2%; Brown Thrush, 1%, other Thrushes, 1%;

The humming-birds feed largely on our small spiders. Mr. Gentry tells me that he has opened hundreds of stomachs of the Rubythroat (*Troch. colubris*), subjecting them to microscopical examination, and has always found an abundance of small spiders associated with Coleoptera and Aphidae, the spiders being ten times more numerous than the other insects. This agrees with the statement of Mr. Belt that he has found the crops of humming-birds full of small, soft-bodied spiders.*

In Central and South America the destruction of spiders from this source must be enormous, since in those countries the humming-birds are exceedingly numerous. Mr. Belt estimates that they are so plentiful in some parts of Nicaragua as to equal, if not to greatly exceed, all the other birds together.†

In both temperate and tropical regions a dreaded foe of spiders is the solitary wasp. This strange creature stings and lays up as food for its larvae great stores of spiders, or in some species, beetles, flies, or caterpillars.

Reports from many parts of the world show how universal is the enmity between spiders and wasps. Fabre, in speaking of some European species of Pompilidae and of the spiders with which they do battle, says: "D'une part sont les Pompiles,

---

Bluebird, 8%; House-wren, 6%; Chestnut-sided Warbler, 6%; Summer Yellow-bird, 6%, Yellow-winged sparrow, 30%.

Mr. Thomas Gentry has, with a kindness which I gratefully acknowledge, made out for me the percentage of spiders in the food of the land birds of Eastern Pennsylvania. It will be seen that his results agree with those of King and Forbes in showing that the *Arachnida* furnish but an insignificant part of the food of North American birds, always excepting the *Trochilidae*.

The *Turdidae*, consume a few spiders, but the ratio to the whole number of insects eaten is so small as to be of little value.

Saxicolidae, about 2%; *Sylvidae*, less than ½%; *Pardae*, less than ½%; *Sittidae* 1%; *Certhiidae*, ½%; *Troglodytidae*, 2%; *Sylvicolidae*, 2%; *Tanagridae*, ¾%; *Hirudinidae*, 1%; *Ampelidae*, none; *Vireonidae*, 2%; *Laniidae*, none; *Fringillidae*, represented by 28 species, 0.01¾%; *C. passerinus* consumes about 32%; *P. gramineus*, often as much as 10%.

Icteridae, represented by eight species, are occasional spider eaters, especially the sub-family *Icterinae*. *Corvidae*, none; *Tyrannidae*, ¾%; *Caprimulgidae*, occasional traces of spiders; *Cyprelidae*, very few; *Trochilidae*, 80%; *Alcedinidae*, none; *Cuculidae*, a few traces; *Picidae*, 1½%; *Strigidae*, none; *Falconidae*, none; *Cathartidae*, none; *Columbidae*, none; *Tetraonidae*, none.

* *The Naturalist in Nicaragua*, p. 315.

† *Loc. cit.*, p. 140.

champions toujours vainqueurs; d'autre part sont les Araignées, champions toujours vaincus."*

Wallace also has a reference to this family: "The Pompilidae comprise an immense number of large and handsome insects, with rich blue-black bodies and wings, and exceedingly long legs. They may often be seen in the forests dragging along large spiders, beetles, or other insects they have captured. Some of the smaller species enter houses and build earthen cells, which they store with small, green spiders, rendered torpid by stinging, to feed the larvae."†

In *The Naturalist in Nicaragua* we find the following remarks on the relations between spiders and wasps: "The tramway in some parts was on raised ground, in others excavated in the bank side. In the cuttings the nearly perpendicular clay slopes were frequented by many kinds of wasps that excavated round holes of the diameter of their own bodies, and stored them with sting-paralyzed spiders, grasshoppers, or horse-flies. Amongst these they lay their eggs, and the white grubs that issue therefrom feed on the poor prisoners. I one day saw a small, black and yellow-banded wasp (*Pompilus polistoides*) hunting for spiders; it approached a web where a spider was stationed in the center, made a dart towards it—apparently a feint to frighten the spider out of its web; at any rate, it had that effect, for it fell to the ground and was immediate]y seized by the wasp, who stung it, then ran quickly backwards, dragging the spider after it, up a branch reaching to the ground, until it got high enough, when it flew heavily off with it. It was so small, and the spider was so heavy, that it probably could not have raised it from the ground by flight. All over the world there are wasps that store their nests with the bodies of spiders for their young to feed on. In Australia, I often witnessed a wasp combating with a large, flat spider that is found on the bark of trees. It would fall to the ground, and lie on its back, so as to be able to grapple with its opponent;

---

* *Les Pompiles*, *Noveaux Souvenirs Entomologiques*, p. 206.

English translation: On one hand are the spider wasps (Pompilidae), the champions always the victors; on the other are the spiders, the champions always the vanquished.

† *Loc. cit.*, p. 90.

but the wasp was always the victor in the encounters I saw, although it was not always allowed to carry its prey off in peace. One day, sitting on the sandbanks on the coast of Hobson's Bay, I saw one dragging along a large spider. Three or four inches above it hovered two minute flies, keeping a little behind, and advancing with it. The wasp seemed much disturbed by the presence of the tiny flies, and thrice left its prey to fly up toward them, but they darted away immediately. As soon as the wasp returned to the spider, there they were hovering over and following it again. At last, unable to drive away its small tormentors, the wasp reached its burrow and took down the spider, and the two flies stationed themselves one on each side of the entrance, and would, doubtless, when the wasp went away to seek another victim, descend and lay their own eggs in the nest."*

Mr. Bates, speaking of a wasp of the genus *Pelopatus*, says: "On opening closed nests of this species, which are common in the neighborhood of Mahicá, I always found them to be stocked with small spiders of the genus *Gasteracantha*, in the usual half-dead state to which the mother wasps reduce the insects which are to serve as food for their progeny."†

This is a particularly interesting fact since the Gasteracanthides belong to specially protected group, being so armed with spines that birds cannot eat them. Mr. Bates also mentions two species of *Trypoxylon* which provision their nests with spiders.

Monteiro, writing on the natural history of Angola says:

"Whilst at Bembe, I fortunately witnessed a fight between a large specimen of these wasps (*Pelopaeus*) and a powerful spider which had built its fine web on my office wall. The spider nearly had the wasp enveloped in its web several times, and by means of its long legs prevented the wasp from reaching its body with its sting, but at last, after a few minutes of hard fighting, the wasp managed to stab the spider right in the

---

* P. 133.

† *Naturalist on the River Amazons*, p. 186.

abdomen, when it instantly curled up its legs and dropped like dead to the ground. * * * I have counted as many as twenty spiders in a single cell, and there are seldom less than three cells together, and sometimes as many as eight or ten."*

On the wasps of South America, in their relation to spiders, I will also quote from a letter written by Mr. Herbert Smith† in answer to some questions about the enemies of spiders.

"In my opinion, the chief enemies of spiders in the tropics are Hymenoptera. The solitary wasps are far more numerous than here; some of the larger Pompilidae provision their nests with *Mygale*, but commonly take great numbers of small Epeiridae, Attidae, etc. Some of my best specimens of spiders were obtained from wasps' nests, though the wasps have an unpleasant habit of cutting off all the spiders' legs."

To come nearer home, Hentz, in the United States, found about forty spiders in one tube of *Sphex cyanea*.‡ He says that these wasps commonly enclose from twenty to forty spiders in their nests.§

Mrs. Treat has also noticed that wasps make war upon a large spider, *T. tigrina*, which lives in a hole which it excavates in the ground. She had at one time twenty-eight spiders of this species under observation. She writes: ''In August the 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 spiders with unclosed doors, for she is sure to find them. * * * 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. * * * Toward the end of August out of the twenty-eight spiders only five are left.''¶

---

* *Angola and the River Congo*, p. 324.

† Author of *Brazil, the Amazons and the Coast*.

‡ *Spiders of the United States*, p. 122.

§ *Ibid*., p. 154.

¶ *Home Studies in Nature*, p. 82.

The wasps that were watched by Fabre, dared not enter the nests of the spiders they wished to capture, only attacking them when they came partly outside.

Lastly, we ourselves have opened a number of *Sphex* nests which we always found to contain twenty-five or thirty spiders, nearly all of them being *E. strix*.

In regard to the other enemies of spiders, I will quote again from Mr. Smith's letter:

"The smaller monkeys, I know, prey upon spiders a good deal; they seem to delight in tearing them to pieces even when they do not eat them. I have observed this frequently with small Cibi and marmosets. To these mammalia I should add some kinds of armadilloes and all the ant-eaters; the latter devour 'white ants' by preference, but I have generally found their stomachs filled with all sorts of insects, wasps, beetles, etc., and (if I remember rightly) terrestrial spiders. Snakes eat spiders sometimes, as I can attest from actual observation; no doubt lizards do the same. Owls may sometimes eat the larger nocturnal species; and I feel pretty sure that I have seen other birds eating them. Foraging ants (*Eciton*) kill great numbers of terrestrial spiders and some arboreal ones, though the latter generally escape them by letting themselves down on lines. Scorpions do not eat spiders I think; at all events the latter do not seem at all afraid of them. Except the foraging ants, I never saw ants attack living spiders; the butchery is all on the other side. As you observe, the spiders eat each other; yet I should not think that the destruction from this cause was very great. Spiders as well as insects are sometimes killed by parasitic fungi."

My own observations have led me to think that hunting and running spiders prey to a considerable extent upon each other. We have had great difficulty in keeping numbers of Attidae, even of one species, together in our boxes, since, although they were supplied with gnats and flies, they preferred to devour each other. *Phid. morsitans*, *Phid. rufus*, *Hasarius hoyi*, *Astia vittata* and *Phil. militaris** were especially troublesome in

---

* These abbreviated generic names (*Phid.* and *Phil.*) are *Phidippus* and *Philaeus*, respectively.

this respect. A large *Lycosa*, which we kept under observation for some time, instantly seized and devoured any smaller spider that was put into the box with it. The Thomisidae are very fierce and voracious, attacking and eating Attidae larger than themselves when caught with them in a sweep-net—a time at which all other captured creatures think only of how to escape.

Walckenaer refers again and again to the warfare going on among spiders. In his introduction, after giving some account of the conflicts between males and females of the same species, he goes on to say:

"If individuals of the same species behave toward each other with such ferocity, one may well believe that different species and different genera are in a state of continual war."*

Spiders of one genus, *Mimetus*, have developed a habit of taking possession of the webs of other spiders, first devouring the owners and sometimes their eggs as well.†

We have other instances of spider eggs being eaten by spiders. For example, Vinson gives a graphic description of the great Epeiridae of Madagascar, in the corners of whose mighty webs live many small *Argyrodes*, which thus secure immunity from the attacks of birds. These little spiders, unmolested by their big relatives, sometimes make a poor return for the hospitality shown them by devouring the eggs of their hosts.‡

Many spiders are destroyed by parasites whose eggs may be deposited upon, or within the body of the spider, or may be laid within the cocoon, the parasitic larvae devouring the eggs. It is a very common thing to find spider cocoons inhabited by

---

* *Hist. des Insectes Aptères*, I, p. 143. See also pp. 172,, 408., 644, and vol. II, pp. 32, 71.

† In characterizing this genus Hentz says: "The parasitic habits of the spiders composing this sub-genus, remind the naturalist of the depredations committed by various Hymenoptera upon many species of insects. The *Mimetus* can make a web like that of *Theridion*, but prefers prowling in the dark, and taking possession of the industrious *Epeiras*' threads and home, or the patient *Thendion*'s web, after murdering the unsuspecting proprietor." *Loc. cit.*, p. 137.

‡ *Aranéides des iles de la Reunion, Maurice et Madagascar*, p. 269.

young ichneumons; and it is probable that spiders have no more destructive enemies than these insects.

FERTILITY OF SPIDERS.

As we have for some years made a practice of keeping notes on all observations relating to spiders, whether they touched on work on hand at the time or not, it happened that we found ourselves, some time ago, in possession of a good many facts concerning the number of eggs laid by different species. These numbers varied so greatly, running from forty or fifty up to several hundred, as to excite considerable speculation, on our part, as to the meaning of the variation.

Why should one species lay eight hundred or a thousand eggs, while another, equally common, laid only fifty?

At about this time we had, in confinement, one male and half a dozen females of the little ant-like spider, *Synageles picata*, and before long each female made a cocoon containing three eggs. This number was so small as to still further arouse our interest and the idea suggested itself that a possible explanation might be found in the principles laid down by Herbert Spencer in regard to the inverse variation, in every species, of its birth rate to the powers of self-maintenance possessed by its individual members; and that if this could be established it would have a direct bearing on protective resemblances, since one test of the advantage of its own peculiar modification to a species might then be found in the number of eggs laid by that species.

To show how this doctrine bears upon the subject I will briefly state Spencer's introductory considerations, and will then quote at length from that part of his discussion which applies to the point in question.

The varying degrees of fertility among organisms result from their conditions of life. We may class the actions which affect each race of organisms as forming two conflicting sets. On the one hand, by what we call natural death, by enemies, by lack of food, by atmospheric changes, etc., the race is constantly being destroyed. "On the other hand, (a) partly by the

endurance, the strength, the swiftness, and (b) partly by their fertility, it is constantly being maintained. These conflicting sets of actions may be generalized as the forces destructive of race and the forces preservative of race."

There exists an equilibrium between the destructive and preservative forces of every species. Any excess of either of these sets of forces itself generates, by the deviation it produces, certain counter-forces that eventually out-balance it and initiate an opposite deviation.

"Is this the sole equilibration that must exist? Clearly not. The temporary compensating adjustments of multiplication to mortality in each species are but introductory to the permanent compensating adjustments of multiplication to mortality among species in general. The above reasoning would hold just as it now does, were all species equally prolific and all equally short-lived. It yields no answer to the inquiries—why do their fertilities differ so enormously, or why do their mortalities differ so enormously? And how is the general fertility adapted to the general mortality in each? The balancing process we have contemplated, can go on only within moderate limits—must fail entirely in the absence of a due proportion between the ordinary birth-rate and the ordinary death-rate; * * * the minor adjustment of varying multiplication to varying mortality in each species, implies some major adjustment of average multiplication to average mortality. What must this adjustment be?

"We have already seen that the forces preservative of race are two—ability in each member of the race to preserve itself, and ability to produce other members—power to maintain individual life, and power to generate the species. These must vary inversely. When, from lowness of organization, the ability to contend with external dangers is small, there must be great fertility to compensate for the consequent mortality; otherwise the race must die out. When, on the contrary, high endowments give much capacity of self-preservation, a correspondingly low degree of fertility is requisite. Given the

dangers to be met as a constant quantity; then, as the ability of any species to meet them must be a constant quantity too, and as this is made up of the two factors—power to maintain individual life and power to multiply—these cannot do other than vary inversely: one must decrease as the other increases."*

To make a fair application of this to spiders—to determine with any degree of certainty whether the spiders that lay a large number of eggs are poorly equipped for individual maintenance, while those that lay a small number are well equipped, we ought to have many more facts than are at present available about the conditions of life in the different species. It is interesting, however, to see how what facts we have accord with the theory, and, supposing the theory to be correct, to see which forms of protection are most successful.

To take two species from the same family, we have no other Epeirid which lays so many eggs (500—2,200) as *Argiope cophinaria*† and no other which lays so few (34) as *Tetragnatha laboriosa*. According to the theory, *cophinaria* should be ill equipped for the battle of life while *laboriosa* should be in much closer harmony with its relations.

Both depend upon their webs for their food supply and probably both secure as much as they need, so that their advantages in this respect may be considered equal.‡

In regard to their means of protection from enemies, a first view of the two spiders would seem to favor our theory. The slender, elongated form, the greenish-golden color, blending with that of the leaves, the habit of clinging, with legs extended in a line with the body, close to the branch upon which it rests, all combine to render *laboriosa* inconspicuous. On the other hand, we have in the great *cophinaria*, dressed

---

* *Principles of Biology*, Vol. II, p. 396, *et seq*.

† *A. riparia* Hentz.

‡ The zig-zag band of white silk which runs up and down through the middle of the *cophinaria* web is used in the capture of prey by a relation of our spider in Madagascar. It serves as a reserve line with which to tie up any extraordinarily large insect, such as a grasshopper, when he becomes entangled in the web. *Cophinaria*, however, is not known to make this use of it, its only usefulness to her being the added strength which it gives to the web. Vinson, *loc. cit*., p. xv..

in deep black and brilliant yellow, hanging out in the middle of her web, so striking an object that every passer-by must see her. An old-fashioned naturalist might be pardoned for calling her a wonderful instance of an all-regulating Providence, which has not only provided this lucious morsel to be the food of some bird, but has also made her so conspicuous that the bird cannot fail to see and recognize its natural prey.*

Cophinaria, however, is not unprotected. Of one means of defense common among conspicuous creatures, *i. e.*, the possession of a nauseous flavor, she seems to be destitute, as some chickens, to which she was offered, ate her with relish; but her size alone must protect her from a host of enemies that prey upon smaller species. For creatures large or fierce enough to attack her we must look to birds and wasps. From these foes she is protected by a number of irregular lines which she stretches beyond her web (fig. 1). These must be passed before the spider can be reached. Now *cophinaria* has a delicate sense of touch. Place your finger lightly upon one of the outlying lines—she falls like a shot to the ground, where, with her back down, and her legs drawn in she is difficult to find, unless you have followed the drop with your eye. Or approach the web without touching it; your shadow, the sound of your footstep, or perhaps the vibration of the

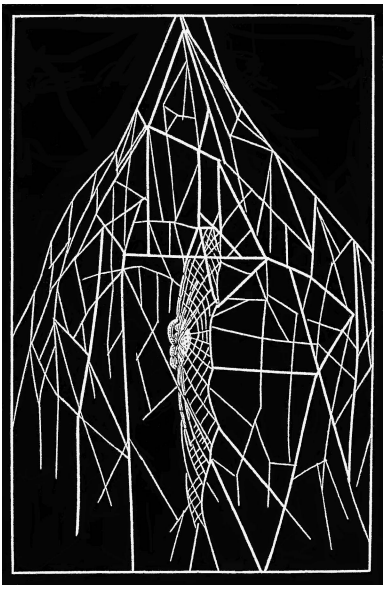


Fig. 1.—Web of *Argiope cophinaria*, showing outlying lines (from McCook).

* Darwin (*Descent of Man*, p. 343) says that M'Clelland, in describing certain Indian Cyprinidae, supposes that their remarkable brilliancy serves as a better mark for the birds which are destined to keep the numbers of these fishes in check.

ground warns her; still, the danger does not seem imminent; she has time to make use of another power—she will render herself invisible. The web begins to sway backward and forward; the rapidity of the motion increases; the outlines become indistinct, and within a few seconds of the first movement, spider, web and all have vanished from sight!

If a wasp, in attacking *cophinaria*, becomes in the least entangled in the web the position is quickly reversed. The spider darts to the spot, holds the would-be destroyer, who is now the victim, away from her body with her long legs, while she rapidly binds it up and reduces it to a condition of perfect helplessness.*

The young *cophinaria* is more open to attack than the adult, but is by no means so conspicuous. It is of a light, somewhat greenish tint, so intermingled with dark gray as to give the effect of transverse dark bands on a light ground. The legs are also light, banded with a darker shade. The web made by the young spider differs from that of the adult and is curiously adapted to conceal it, having a thickened place in the middle, which extends as far as the tips of the spider's legs. This thickened portion is made up of concentric lines of web joined by short, transverse threads, so that it blends with the banded body and legs of the spider and protects it from observation.

Cophinaria, then, is so protected, at different periods of its life, that the disadvantage of its conspicuousness is, to some extent, counterbalanced. How, then, shall we account for its enormous number of eggs?

There is one stage of its existence which we have not yet examined. Serious dangers assail it while it is still in the egg, and here, probably, is the secret of its excessive fertility. The

---

* Once, when wishing to mark a number of social wasps (*Vespa maculata*), which we had caged, we liberated a few at a time in our wire-enclosed porch, and then catching them with gloved hands, cut their wings. At the time there were three or four individuals of *A . cophinaria* in the porch and many of the wasps were lost by becoming entangled in their webs. The spiders bound them up very quickly, showing no sign of fear. *V. maculata* is, of course, far from being so redoubtable an enemy as the solitary wasp.

cocoons of *cophinaria*, though a little smaller, closely resemble in shape and color the oak-apple, *Quercus inanis*, which abounds among red oaks; but if this is a case of protective resemblance, which seems improbable since *cophinaria* inhabits open, marshy places and is not found in the woods, the disguise is far from being a complete protection. Each cocoon contains many hundreds of eggs, but among them a wholesale destruction is carried on by *cophinaria*'s most dangerous evemy, the ichneumon fly. The cocoons are hung among the long grass and are not difficult to find, but when opened they so frequently contain nothing but young ichneumons as to make it reasonable to believe that where the enemies of other species slay their hundreds this one enemy of *cophinaria* slays its thousands.*

Another, and perhaps the most serious of all the dangers to which this species is exposed, is the flooding of the marshy land upon which the cocoons are deposited. During the present spring we collected 62 *cophinaria* cocoons, some of which were in a fragmentary condition. Of the whole number 26 contained live spiders, 6 contained eggs just about to hatch, 24 had been destroyed by parasites and 6 by water. In the marsh where the full-grown spider is most abundant in August, every bush being covered with them, we found only three water-soaked cocoons. When they are destroyed by parasites the case remains, but when the water spoils them they are probably decayed, broken up and washed away, seldom leav-

---

* Of 406 cocoons of this species taken in one spring by Prof. Wilder, 134 were entire; 190 were pierced, but contained live spiders; 59 were torn, probably by birds, most of them still containing some of the spiders, and 23 contained the remains of parasites by which the young spiders, or the eggs, had been destroyed.—*American Association for the Advancement of Science*, Vol. XXII, p. 261.

Prof. Wilder thinks that the young spiders devour each other to a considerable extent, as they are shut up for weeks or months after they are hatched with no food but one another. Young spiders, however, probably do not eat until after about the second or third moult, and although those that he observed did eat each other they were under unnatural conditions, and must have grown less rapidly and remained longer in the cocoon than they would had they been left out of doors, as even with our late Wisconsin spring we find the young of *cophinaria* running about, half grown, in June.

The eggs of this species are also open to the attacks of another spider. Emerton has found the young of *P. morsitans* in cocoons of *cophinaria* (Note Hentz's *Spiders of North America*, p. 58.).

ing a trace behind. This recalls Prof. Wilder's suggestion that the immense fertility of *Nephila plumipes* is counter-balanced by the destruction of its cocoons, which are so placed, depending from* leaves, that great numbers of them are washed away and destroyed by rain.

Let us look at the Attidae. In this family the most fertile species on record is *Phidippus morsitans*, laying about 180 eggs; while the least fertile is the little, ant-like *Synageles picata*, laying three.

So far as defending itself from the attacks of enemies of its own class is concerned, *morsitans* has an unquestionable advantage. It has not only superior agility; it is also one of the largest and fiercest of the family, and it is improbable that any other spider preys upon it; while nothing more defenseless can be imagined than the little *picata*, with its tiny body, weak falces and slender legs. The fierceness of *morsitans*, however, would be useless against such foes as birds and wasps, while the strongly contrasted black and white of its coloration make it conspicuous.

Beyond the fact that it is small and dark-colored, *picata* has absolutely nothing to protect it excepting the resemblance which it bears to an ant. Can this alone give the species so great an advantage that it is enabled to maintain itself with as low a birth-rate as three or four in a season?

We must accept one of two alternatives. The direct relation between mortality and multiplication is well established, and it is plain that no species could maintain itself with so low a birth-rate were not its mortality correspondingly low. It must, then, either have practically no enemies, or its means of protection from its enemies must be uncommonly efficacious. We cannot accept the first alternative. No creatures are exposed to the attacks of more enemies and none are more helpless under such attacks than small, soft-bodied spiders; and the conclusion seems unavoidable that *picata* enjoys immunity from attack because it appears to be not a spider but an ant.

---

* *Suspended from.*

A species, then, may depend for its preservation upon either active or passive means of protection, the passive means often outvaluing* the active. But whatever the means may be—fierceness, inedibility, protective resemblance, or mimicry—I would suggest that one test of its efficiency may be found in the fertility of the species.

DIRECT PROTECTION.

Resemblances to Vegetable and Inorganic Things.

As a general rule the forms and colors of spiders are adapted to render them inconspicuous in their natural homes. Bright colored spiders, except where sexual selection has been at work, either keep hidden away or are found upon flowers whose tints harmonize with their own. This rule, while it has numerous exceptions, is borne out by the great majority of cases. A good illustration is found in the genus *Uloborus*, of which the members bear a deceptive resemblance to small pieces of bark or to such bits of rubbish as commonly become entangled in old, deserted webs. The only species in our neighborhood is *Uloborus plumipes*, which I have almost invariably found building in dead branches, where its disguise is more effective than it would be among fresh leaves. The spider is always found in the middle of the web, with its legs extended in a line with the body. There has been, in this species, a development along several lines, resulting in a disguise of considerable complexity. Its form and color make it like a scrap of bark, its body being truncated and diversified with small humps, while its first legs are very uneven, bearing heavy fringes of hair on the tibia and having the terminal joints slender. Its color is a soft wood-brown or gray, mottled with white. It has the habit of hanging motionless in the web for hours at a time, swaying in the wind like an inanimate object. The strands of its web are rough and inelastic, so that they are frequently broken; this gives it the appearance of one of those dilapidated and deserted webs in which bits of wind-blown rubbish are frequently entangled. The web represented in Plate IV was unusually perfect, and yet did not appear as it does in the drawing. The pattern was made out by

---

* Read *being of greater value than.*

using a magnifying glass and turning the branch from side to side, only two or three of the radii being visible from any one point of view. The web, moreover, is built in such a place that the spider is easily confounded with the objects among which it is seen.* To these characteristics we must add its habit of making a number of roughened grayish or brownish cocoons, and of so disposing them in the web, either heaped one above another or strung along tip to tip, that they seem to be nothing more than a mass of rubbish.

Out of seven examples of the species taken during one summer, five were found in dead tamarack branches, one on a dead bush, and the seventh, an interesting variety, under the eaves of a porch. My eye was caught by what seemed to be a string of eleven cocoons (it is not common to see more than four in a web). On attempting to take them down I was surprised to see one of the supposed cocoons begin to shake the web violently. Ten were what they seemed to be, but the eleventh was the mother spider, whose color and general appearance was exactly like that of the little cases that she had made for her eggs.

The *plumipes* which is represented in Plate IV was brought from a tamarack swamp and placed on some dead branches in the corner of a porch. She proved a most patient little model, hanging in one position all day long. When the drawing began she had one cocoon; two more appeared at intervals of three days. She lived in the porch for several weeks. At one time, becoming dissatisfied with her position, she raised her cocoons seven inches, to a higher crotch in the branch, and there built a new web. She moved rather slowly.

From the descriptions of *U. productus*, *U. borbonicus* and *U. Walckenaerius*, these species must be close to *plumipes* in shape and general coloring, in habits, in the character of their webs and in the form and color of their cocoons.

---

* Simon says of this species: "Il s'établit soit sur les broussailles sèches, soit dans les trous des vieux murs; il se tient toujours les pattes étendues longitudinalement et se confond avec les objets sur lesquels il est placé." *Arachnides de France*, Vol. I, p. 169.

English translation: It resides either on dry undergrowth, or in the holes of old walls; it always extends its legs and is easily confused with the object on which it is placed.

Near to *Uloborns* is *Hyptioides*, in which is found the same kind of protective resemblance. The little brown spider, *H. cavatus*, is so inconspicuous that no ordinary observer ever sees it, and even when his attention is called to it he takes it to be a bit of dirt. Looking closely, we find it to be of a light, yellowish gray, with several dark humps and lines; while the legs and cephalothorax are blackish. It usually crouches, with its legs drawn in, at the end of a branch, holding the elastic thread which runs to its web, and in this position it is all but indistinguishable. Emerton has noticed that it is colored like the ends of the dead pine branches among which it usually lives.*

In many ways similar to *H. cavatus*, is *H. paradoxus*. Of this species Thorell says: "The identity of color between the animal and the dry branches causes it not to be so easily perceived."†

Among the Epeiridae there is no prettier instance of protective form and habit than *Cyrtophora conica*, the little spider whiich we once taught to recognize the sound of the tuning-fork. Its color is gray, broken with irregular lighter and darker lines, and its abdomen, behind, has a rounded projection. This neutral coloring and irregular outline give it the same advantage as that possessed by *Uloborus* and *Hyptioides*, and like the former genus it strings its cocoons across the web; but it is protected in a still higher degree by its habit of accumulating a quantity of light rubbish, remains of insects, etc., which it places in a band across the web, binding all together with some loose strands. The cocoons are partly hidden in this mass of debris, and they, as well as the spider itself, standing at the central point, appear to be a part of it. This resemblance is extremely close —so much so that although we visited the little spider before referred to at least once a day for several weeks we were frequently deluded into thinking she was gone,

---

* *New England Spiders of the Family Ciniflonidae*, Trans. Connecticut Acad., Vol. VIII, 1888, p. 456.

† *European Spiders*, Part I, p. 70.

a close inspection being necessary before she could be distinguished.*

The same kind of resemblance is found in the genus *Argyrodes*. These spiders are usually of parasitic habit, building in the corners of webs of larger species. Two of them are common in this country, *fictilium* and *trigonum*. They are small and slender, with elongated bodies. Of *trigonum* Mr. Emerton says: "These spiders live among the upper threads of the webs of *Agelena*, *Linyphia* and *Theridium* and are most common in woods of pine and spruce. They look, in the web, like straws, or still more like the scales from pine buds, which are often caught in the same webs."† We find it in Wisconsin on the ground among the grass. *Fictilium* has not been found in the web. We have caught it always in a swampy piece of ground, where the long grass is partly green and partly dead and yellow. In this locality its slender, yellowish, elongated body affords it good protection.

A foreign species, *A. epeirae*, is referred to by Cambridge as follows: "It appeared to have spun its own little irregular snares among the mazes of the Epeira's webs, in which it sat, looking like a little morsel of dead stuff, and perhaps deluding the other spiders into a belief that it was so, and thus escaping being devoured."‡

In *Ariamnes attenuata* (fig. 2, see p. 80), the abdomen is still more elongated than in *Argyrodes*. This species is also yellowish in color and is probably protected by its resemblance to a straw or blade of dead grass. Many related forms have been described by Simon, Taczanowski and others.

---

* While the *C. conica* of Menge seems to be identical with *C. caudata* Hentz, his description of the web as from seven to ten feet wide, and stretching from tree to tree, does not at all correspond to the web of the American species, which does not exceed twelve or fifteen inches in diameter. The measurements that he gives seem strangely out of proportion to the size of the spider, which is only 8 mm. long.

Menge says that Lister, who first observed the habits of this species, thought that the remains of insects which the spider had devoured were hung across the web as trophies of victory. *Preussische Spinnen*, p. 76.

† *New England Spiders of the Family Theridiidae*, Trans. Connecticut Academy, Vol. VI, 1882, p.24.

‡ *Spiders of Palestine and Syria*, Proc. Zool. Soc. 1872. Part I, p. 279.

Similar in many respects to the *Argyrodes* group are the Tetragnathinae. These spiders are all slender, and, whenever they are at rest, keep their legs extended in a line with the body. Their usual position is on a branch at one side of the web. Their coloring runs through the shades of brown, yellow and green, and they are frequently mottled or lined with black or white. Mr. Atkinson speaks of a *Tetragnatha* (probably *grallator*) which mimics elongated, dark blotches on grass stems; he says: "I have often seen them, when frightened, leave the web and, clinging to a grass-stem, place their bodies close to the stem, stretching the anterior legs above and the posterior ones below. The body being dark and the legs green the spider was well protected."*

Fig. 2.—*Ariamnes attenuata* (from Cambridge).

In some species of *Tetragnatha*, as in *Argyrodes*, the tip of the abdomen is elongated and turned upwards.

We come now to a large and interesting class in genus *Epeira*. I refer to those species, most nocturnal, which are protected during the day, not by hiding in crevices nor in any way actually getting out of sight, but by the close resemblance which they bear to the bark of the trees to which they cling. This resemblance is brought about in two ways; through their color, which is like that of wood or lichens, and through their tuberculated and rugose forms, which resemble rough bark.

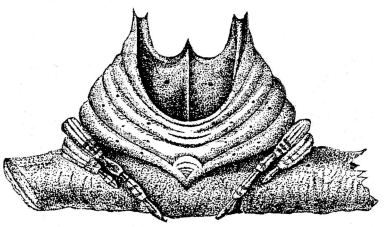


Fig. 3.—*Caerostris mitralis* (from Vinson).

One of the most remarkable of these forms is *C. mitralis*, a Madagascar species, which, looked at in profile, probably resembles a woody knot. The abdomen is divided into two divergent cones (fig. 3). The entire upper surface of the body is covered

* I quote from some manuscript notes which Mr. Atkinson has kindly allowed me to make use of.

with conical elevations, which render it rough and uneven; the sides of the abdomen are made up of several layers, which form stages, one above another, like the ridges of bark on a woody excrescence. The legs, formed of wide, flattened plates, make the base. The color of the spider is yellowish-gray, varied with white and dark reddish-brown. It has the habit of perching on a branch and clasping it like a bird,* so that the elaborate modification of form, which would be useless if the spider hung exposed in the web, is made as effective as possible.

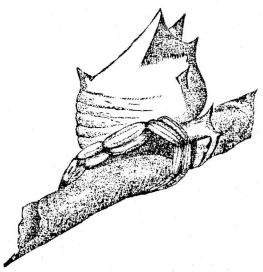


Fig. 4.—*Caerostris mitralis*, in profile (from Vinson).

To take an example nearer home, *E. infumata* is a large, round-bodied spider with two humps on the abdomen, which Emerton describes from New England as being brown, mottled with white and black; he adds that when it draws in its feet it looks like a lump of dirt. *Infumata*, in Wisconsin, has always a good deal of bluish green on the upper surface of the abdomen. This may be a variety which has been so developed as to resemble the lichens which cover the tree to which it clings. It is one of the spiders which bear a good deal of handling without uncurling its legs, or showing any sign of life. Its humpy form and its color give it a very inanimate appearance. It is rather common in our neighborhood and may be caught in the late twilight while building its web, but to search for it in the daytime, even among the trees that it most frequents, is an almost hopeless task. A more grotesque form is *E. stellata*, in which the abdomen has not two, but twelve or fifteen humps. These are so disposed that the edge of the abdomen, all around, is scalloped. The colors are light and dark brown, modified by gray and white hairs. This spider remains motionless during the daytime, keeping its legs drawn up to its body. It is common on grass and low bushes. It is not found in Wisconsin,

---

* Vinson, *loc. cit.*, p. LIII.

but the description of it suggests a resemblance to a piece of dead leaf.

There are many other spiders in this genus that have humps and are colored in brown, gray or dull yellow as *nordmanii*, *angulata*, *solitaria*, etc. It is an almost universal habit among the Epeiridae to drop to the ground when threatened, and when a humped gray or brown spider drops to the ground and draws in its legs it is nearly indistinguishable from the lumps of earth, sticks and stones that surround it.

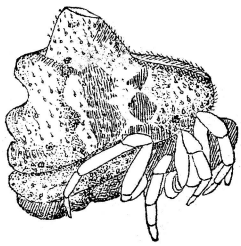


Fig. 5.—*Ulesanis americana* (from Emerton).

One of the Theridiidae which has the same protection is *Ulesanis americana** (fig. 5). The abdomen, which covers the cephalothorax nearly to the eyes, has a prominent hump in the middle of the back and four or five others behind. Its color is in shades of brown and yellow.

Analogous to the humped Epeiridae is *Thomisus foka*, of Madagascar, a spider which is regarded with great terror by the natives, as being so poisonous that even its breath is deadly. They say that cattle, when about to lie down, look carefully about to see if one of these spiders is in the neighborhood. This dread is, no doubt, inspired by the strange and uncanny aspect of a perfectly harmless creature. It has a rugose, tuberculated body of trapezoid form, the colors being brown and reddish, while the whole aspect is crab-like. The thick, short legs are reddish, covered with tubercules. The secret of its strange form is made clear when we learn that it resembles in color and general appearance the fruit of *Hymenaea verrucosa*, a tree common in the forests where this spider is found.‡

Among the curious forms which must have been developed

---

* This species, Emerton says, looks like a seed or a lump of earth.

‡ Vinson, *loc. cit.*, pp. 70—71.

Hymenaea verrucosa is the source of Zanzibar copal. All other members of this genus are native to the American tropics.

through advantageous variation, but which we are unable to explain, is *Eriauchenus workmanni* (fig. 6).

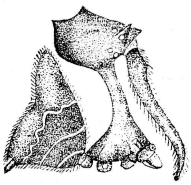


Fig. 6.—*Eriauchenus workmanni* (from Cambridge).

Epeira prompta (a variety of *parvula*, Plate IV, fig. 2) is a common spider in Wisconsin. It is most frequently seen on cedar bushes, where its color harmonizes with that of the foliage and fruit. During the day it usually rests on a branch near its web. The back of the abdomen is of a peculiar bluish-green, exactly like that of the lichens growing on tree trunks. The bluish color is broken by waving black lines which imitate the curling edges of the lichens. The one represented in the plate was found on an old cedar that was covered with lichens. It was kept for two weeks in a glass-covered box, where it spent most of the time crouching in a corner. It built no web, but spun some irregular lines to run about on. It ate gnats, flies, and once a little jumping spider, *S. pulex*, which we were keeping in the same box, leaping upon its prey, as noted by Hentz,* like an *Attus*. This seems a curious habit to be acquired by an Epeirid, since these spiders, as we have noticed among our captives, are usually dependent for food upon what is caught in their webs. *Prompta* moves awkwardly, but very rapidly.

Drapetisca socialis, while quite a different looking spider, is protected in the same way—by its resemblance to the bark upon which it lives. Emerton speaks of finding it on the bark of spruce trees, which it "closely resembles in color."† Menge says that it is common in Prussia, where it is seen in great numbers on fir trees, whose spotted bark it resembles in color, so that it is not easily seen.‡ We have found them, most commonly, upon birch trees, and in this situation their color adaptation is perfect. Both the spider and the peeling bark of the tree are of a light silvery brown, covered with little blackish marks.

---

* "This very distinct species is very active after sunset, running with great speed, and leaping like an *Attus*. It is motionless during the day." *Loc. cit.*, p. 112.

† *New England Theridiidae*, p. 67.

‡ *Preussische Spinnen*, p. 142.

On the bark these marks are, of course, irregular, while on the spider they form a pattern made up of straight and curved lines and dots, the legs being silvery, barred with blackish.

Another little *Theridion* that is found on birch bark has the same colors arranged a little differently. The abdomen above has a large and peculiarly irregular black patch, which shades off into mottled brown and black on the sides and below. The cephalothorax has stripes of brown and black, and the legs are barred with light and dark brown.

Spiders that live upon walls, fences, tree trunks, or on the ground harmonize in color with the surfaces upon which they are found, being usually gray, brown or yellow, mottled with black and white. This proposition is so well established* as to need but few illustrations. The Theridiidae furnish many examples, as *T. murarium*, a gray spider varied with black and white, said by Emerton to live usually "under stones and fences, where it is well concealed by its color"; and *Lophocarenum rostratum*, a yellowish brown spider, found among leaves on the ground. Among the Attidae bright sexual coloring often gains the ascendancy over the protective tints, yet this family gives us good examples in such species as *M. familiaris* and *S. pulex*.

To these may be added an as yet undescribed species which we discovered last season in a neighborhood that we had searched thoroughly for eight summers. We found the new spider in great numbers, but could only detect it by a close scrutiny of the rail fences on which it lived, its color being dark gray.

Among the Lycosidae we have scores of dull-colored species that live on the ground. Vinson refers to *L. vulcani*, which is of a smoky black color and which lives in the crater of a volcano, saying: "Its sinister color seems to conform to its

---

* Dr. McCook says: "Spiders that nest in stables, houses, on fences, etc., ordinarily have dusky colors harmonious with the environment."—*Notes on Relations of Structure and Function to Color Changes in Spiders*. Proc. Acad. of Natural Sciences of Philadelphia, 1888, p. 174. See also *Cenni sulle colorazioni e forme mimetiche utili nei ragni*, by Prof. P. Pavesi, in *Atti d. Società Ital. d. Scienze Naturali*, Vol. XVIII, 1875.

habitat."* A more peculiar example is *D. sexpunctatus*, which is said by Dr. McCook to have a tint like that of the water upon which it is constantly found.†

In the Thomisidae we find the rule holding good through whole genera with scarcely an exception, as with *Xysticus* and *Synema*, whose members, colored yellowish brown or gray, haunt fences and tree-trunks. These spiders, moreover, often have the body very much flattened, so that they the more easily escape notice and can readily conceal themselves by slipping into cracks and crevices.

In the Drassidae we have the same resemblance, as in *H. ecclesiasticus*, a gray spider found running on walls, and in *H. bilineatus*, whose distinct black and white would seem to render it conspicuous, but really have the opposite effect on the stony beaches where it is found.

A spider of another family, *Hersilidia lucasii*, is spoken of by Cambridge as follows: "'their position is usually with the legs extended flat upon the under side of the stone, with the sandy-yellow, mottled color of which the color of the spider so admirably agrees that it requires a practiced eye to detect it."‡

Another general rule is that spiders living in dark places are dull-colored, usually having more or less livid white, mingled with gray, as *Pholcus phalangioides*, which is pale with dark bands, and is common in cellars; or *Meta menardi*, which is dull brown and yellow with light stripes, and lives in damp, shady places or in caves. Many species of *Clubiona* come under this head. They have commonly pale or livid coloring and are found under bark or stones, in caves, etc.

Turning from these to the brightly colored spiders the most obvious instances of protective coloring are the green species which live on leaves. Such are *Lyssomanes viridis* and many other Lyssomanae, which are of a faded yellow color in

---

* *Loc. cit.*, p. 16.

† *Loc. cit.*, p. 174.

‡ *Catalogue of a Collection of Egyptian Spiders*, Proc. Zool. Soc., 1876, p. 563.

alcoholic specimens, but which, I am told by Mr. Herbert Smith, are of a bright green in their tropical homes. *Olios viridis* and *Linyphia viridis** come under this class. The former is entirely "of a tender yellowish green" and is found on the leaves of orange trees. The latter has both male and female of a tender green color and is found on the leaves of rose bushes.

Pavesi enumerates the following green species which live on leaves: *Micromata virescens* (*Cl.*), *Epeira cucurbitina* (*Cl.*), *Theridium viride Nic.*, *Dictyna viridissima* (*Wlk.*), *Clastes viridis Wlk.*, *Peucetia viridis* (*Blkw.*), *Attus pistacius*.†

The spiders which imitate the colors of flowers are found, to a great extent, among the Thomisidae; and here a point of interest must be noted. The resemblance of Epeiridae and Theridiidae to the surfaces upon which they are found are simply protective. It is useful in preserving the spider from enemies, but does not assist it in capturing prey. In the Thomisidae, on the other hand, the protective disguise serves a double purpose, and it seems probable that it is fully as great an advantage to them to deceive their prey as their enemies.

No family can show more brilliant and beautiful colors than the Attidae. Wallace speaks of them in the tropics as being so exquisitely colored as to resemble jewels rather than spiders. Yet no cases have been cited in which spiders of this family imitate the colors of flowers; and from what we know of the mating habits of our own bright colored Attidae there can be little doubt that these jewel-like spiders also owe their beauty to sexual, and not to natural selection.

It is probably to Thomisidae that Bates refers when, in speaking of spiders with showy colors, he says: "Some double themselves up at the base of leaf-stalks, so as to resemble flower buds, and thus deceive insects on which they prey;"§ and again: "Some hunting spiders mimic flower buds and sta-

---

* Vinson, *Loc. cit.*, pp. 103 and 277.

† *Loc. cit.*, p. 2.

‡ *Tropical Nature*, p. 97.

§ *Loc. cit.*, p. 54.

tion themselves motionless in the axils of leaves and other parts of plants to wait for their victims."*

Mr. Herbert Smith also refers to this habit. He says: "Some of the spiders, we find, are excellent imitators. The cylindrical species lie extended in their webs, with the legs stretched out, to look like a stick; round-bodied kinds draw their legs close and look like a leaf-bud, or a ball of their own silk entangled in the web. * * * How shall we notice this one that sits on a leaf, all in a heap; the pink three-lobed body appears just like a withered flower that might have fallen from the tree above; to the flies, no doubt, the deception is increased by the strong, sweet odor of the spider, like jasmine."†

Trimen gives several instances in which Thomisids mimic flowers. He says: "Many species of *Thomisus* are well adapted to succeed by being colored in resemblance to the flowers in or on which they await the arrival of their victims. One that inhabits Cape Town is of the exact rose-red of the flowers of the oleander; and to more effectually conceal it, the palpi, top of cephalothorax, and four lateral stripes on the abdomen, are white, according remarkably with the irregular white markings so frequent on the petals of *Nerium*.

"I was led to notice a yellow spider of the same group, in consequence of seeing that two of a number of butterflies on the flowers of *Senecio pubigera* did not on my approach fly off with their companions. Each of these unfortunates turned out to be in the clutches of a spider, and when I released them I observed their captors very narrowly, and I found that the latters' close resemblance to the *Senecio* flowers was not one of color alone, but due also to attitude. This spider, holding on to the flower-stalk by the two hinder pairs of legs, extended the two long front pairs upward and laterally. In this position it was scarcely possible to believe that it was not a flower seen in profile, the rounded abdomen representing the central mass of florets, and the extended legs the ray florets; while, to complete the illusion,

---

* *Lepidoptera of the Amazon Valley*, *Trans. Linn. Soc.*, Vol. XXXIII, p. 509.

† *Loc. cit.*, p. 221.

the femora of the front pair of legs, adpressed to the thorax, have each a longitudinal red stripe which represents the ferruginous stripe on the sepals of the flower.

"On another occasion I witnessed the actual capture of small blue butterfly (*Lycaenesthes*) by a white spider of the same genus. The butterfly was engaged in honey-sucking on a white flower-head of *Lantana*, and explored each individual flower with its probiscis. While I was watching it, the butterfly touched and partly walked over what looked like a sightly folded or crumpled flower about the middle of the cluster. This turned out to be a spider, which instantly seized the butterfly, throwing forward its front legs somewhat after the fashion of a Mantis. In this spider the effect of the little depressions on the limb of the corolla was given by some depressed lines on the back of its smooth white abdomen."*

Among our own Thomisidae we have a pretty example of flower copying in *Misumena vatia*, a very variable little spider, which is usually golden yellow, living upon the yellow flowers of our fields. Sometimes it is light green, when it is found upon low trees and bushes, and sometimes light pink, living upon wild roses. Each variety is a perfect match, in color, for the leaves upon which it is found. Pavesi says that this species when living on flowers is white, or white or yellow with red stripes on the abdomen; but that when found among the grass it is grass-green, with dark, obscure stripes on the cephalothorax and palpi.†

Bright spiders seem to feel the necessity of keeping out of sight more than dull-colored ones. Thus such bright Epeiridae as *insularis* keep hidden, during the day, in tents by the side of the web, only coming down into the center at night. Bright Theridiidae, as *frondeum*, usually live under leaves. This seems to hold even with Attidae. I have noticed among those kept in captivity that while the dull-colored ones ran about in the box,

---

* Roland Trimen, *Protective Resemblances and "Mimicry" in Animals*, p. 4.

† *Loc. cit.*, p. 5.

the brilliant male *splendens* passed his entire time curled up in a corner under a sheet of web, seeming very morose and sulky.

Cambridge notices a peculiar case of protective resemblance among the Thomisidae. This is *T. setiger*, whose abdomen, covered with spines and bristles, is whitish mingled with yellow. He says: "The peculiar clothing of bristles affords an evident protection to this and the preceding species (*T. buffoni*), making them look exactly like bits of coarse, fleecy wool, or the rough seeds of some plant or other; had I not observed them moving, they would probably have escaped notice."*

The last instance that I shall cite is a predaceous spider which is disguised from both its enemies and its prey by an elaborate combination of form, color, position and character of web. I refer to *Ornithoscatoïdes decipiens* (fig. 7), first described by Forbes and afterwards by Cambridge, the latter author giving in the same paper descriptions of three other species of the same genus, whose habits have not been noted, but whose protection is evidently of the same order as that of *decipiens*. I give Forbes' interesting account of his capture of *decipiens*, quoting also the remarks by which Cambridge prefaces his description, since his explanation of the gradual development, through Natural Selection, of the spider's deceptive appearance applies as well to all the cases of protective disguise which have been here enumerated.

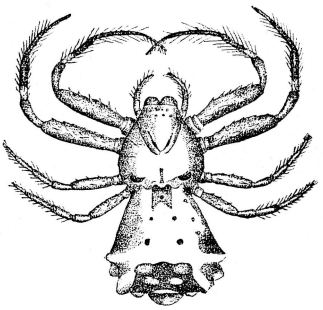


Fig. 7.—*Ornithoscatoïdes decipiens* (from Cambridge).

The capture is described as follows:

"On June 25th, 1881, in the forest near the village of Lampar, on the banks of the Moesi river in Sumatra, while my 'boys' were procuring for me some botanical specimens from a high tree, I was rather dreamily looking on the shrubs before me,

---

* *Spiders of Palestine and Syria*, Proc. Zool. Soc., 1872, Part I, p. 308.

when I became conscious of my eyes resting on a bird-excreta-marked leaf. How strange, I thought, it is that I have never got another specimen of that curious spider I found in Java which simulated a patch just like this! I plucked the leaf by the petiole while so cogitating, and looked at it half listlessly for some moments, mentally remarking how closely that other spider had copied nature, when to my delighted surprise, I discovered that I had actually secured a second specimen, but the imitation was so exquisite that I really did not perceive how matters stood for some moments. The spider never moved while I was plucking or twirling the leaf, and it was only when I placed the tip of my little finger on it, that I observed that it was a spider, when it, without any displacement of itself, flashed its falces into my flesh.

"The first specimen I got was in W. Java, while hunting one day for Lepidoptera. I observed a specimen of one of the Hesperidae sitting, as is often a custom of theirs, on the excreta of a bird on a leaf; I crept near it, intending to examine what they find in what one is inclined to consider incongruous food for a butterfly. I approached nearer and nearer, and at last caught it between my fingers, when l found that it had as I thought become glued by its feet to the mass; but on pulling gently the spider, to my amazement, disclosed itself by letting go its hold; only then did I discover that I was not looking on a veritable bird's excreta. * * * The spider is in general color white, spotted here and there with black; on the underside its rather irregularly shaped and prominent abdomen is almost all white, of a pure chalk white; the angles of the legs are, however, shining jet-black. The spider does not make an ordinary web, but only the thinnest film on the surface of the leaf. The appearance of the excreta rather recently left by a bird on a leaf is well known. There is a pure white deposit in the centre, thinning out round the margin, while in the central mass are dark portions variously disposed; as the leaf is rarely horizontal, the more liquid portions run for some distance. Now, this spider one might almost imagine to have in its rambles 'marked and

inwardly discerned' what it had observed, and to have set about practicing the 'wrinkles' gained; for it first weaves a small, irregular patch of white web on some prominent leaf, then a narrow streak laid down towards its sloping margin ending in a small knob; it then takes its place on the center of the irregular spot on its back, crosses its black-angled legs over its thorax, and waits. Its pure white abdomen represents the central mass of the bird's excreta, the black legs the dark portions of the slime, while the web above described which it has spun represents the more watery marginal part (become dry), even to the run-off portion with the thickened knob (which was not accidental, as it occurred in both cases), like the residue which semi-fluid substances ending in a drop leave on evaporation. It keeps itself in position on its back by thrusting under the web below it the spines with which the anterior upper surfaces of the legs are furnished."*

In answer to the idea that the supplementing of the color and form of the spider by its peculiar web almost implies consciousness,† Cambridge says:

"It seems to me, on the contrary, that the whole is easily explained by the action of Natural Selection, without supposing consciousness in the Spider in any part of the process. The web on the surface of the leaf is evidently, so far as the Spider has any design or consciousness in the matter, spun simply to secure itself in the proper position to await and seize its prey. The silk, which by its fineness, whiteness, and close adhesion to the leaf causes it to resemble the more fluid parts of the excreta, would gradually attain those qualities by Natural Selection, just as the Spider itself would gradually, and probably *pari passu*,§ become, under the influence of the same law, more and more like the solid portion."‡

We may repeat, in regard to this species, what Wallace has

---

* On the habits of *Thomisus decipiens*, by H. O. Forbes, Proc. Zool. Soc., 1883, p. 586.

† Mr. Forbes has especially disclaimed any idea of consciousness on the part of the spider.

‡ *On two new Genera of Spiders*, Proc. Zool. Soc., 1884, p. 197.

§ *With equal step*, or *hand-in-hand.*

said about a butterfly which imitates a shrivelled leaf: "We thus have size, color, form, markings, and habits, all combining together to produce a disguise which may be said to be absolutely perfect."*

PROTECTIVE HABITS.

Going along with these forms of protective resemblance, we find certain habits which sometimes serve independently to protect the spider, but oftener are supplemental to color and form. Many species hide in crevices or in leaves which they roll up and bind together at the edges. In the Epeiridae some are like *thaddeus*, which makes a little tent of silk under a leaf near its web. The young *thaddeus* also makes a tent, but spins its little geometrical web on the under-side of the leaf, the edges being bent downward. *E. insularis* has the more common habit of forming its tent by drawing the edges of two or three leaves together with strands of web; in this it sits all day, but at night descends and occupies the center of the web during the hours of darkness. I have often found it in this position when hunting nocturnal species by lantern light. It is probable that in tropical countries the monkeys, and perhaps the birds, which devour these large Epeiridae have learned to recognize their webs, which are very large and conspicuous, and to trace them to their hiding places close by; and thus may have arisen the curious habit noticed by Vinson as possessed by *E. nocturna* and *E. isabella* of destroying the web each morning and rebuilding it at night;† the spider in this way gaining greater security from diurnal enemies.

Atypus abbotii builds a purse-shaped tube which is found attached to the bark of trees, and which has the external surface dark and covered with sand.‡ The trap-doors which close the nest of some of the Territelariae are wonderful examples of

---

* *Natural Selection*. p. 61.

† *Loc. cit.*, p. CXIII.

‡ For a complete account of this species see *Nesting Habits of the American Purseweb Spider*, by Rev. Henry C. McCook, Proc. Acad. Nat. Science of Philadelphia, 1888, p. 203.

protective industry. They fit with such absolute accuracy into the openings of the nests and are so covered on the upper side with moss, earth, lichens, etc., as to be indistinguishable from the surrounding surface.

The rectilinear lines which are stretched in front of the webs of many Epeirids are useful in taking and sending on to the spider the shock which tells of an approaching enemy. Some spiders, when danger threatens, shake the web so violently as to grow indistinct to the eye, and others, as *Pholcus atlanticus*, hang by the legs and whirl the body rapidly with the same bewildering result.

Mr. Herbert Smith gives me the excellent suggestion that the sideways movement of the Thomisidae, or Laterigradae, has a direct protective value, since the enemies of spiders are accustomed to allow for a forward, but not for a lateral movement of their prey.

A habit common to many spiders, especially among the Epeiridae, is that of dropping to the ground at the approach of danger and resting motionless among the dirt, sticks, leaves, etc., which they resemble in color. The holding of the body in some peculiar position, as in *Uloborus*, *Hyptioides*, and the flower-like Thomisidae, is a necessary accompaniment to the color modification.

The cocoons of spiders are seldom left exposed and unprotected. We find them in corners and crevices, concealed in rolled up leaves or under bark. Very often the cocoon itself is covered over with a sheet of web. In some families the mother carries it about with her attached to the underside of the abdomen. In others she carries it in her falces until the young are hatched. The cocoons of others, as *Uloborus*, *Argyrodes*, etc., while hung out in the web are still concealed by deceptive form and color, or by being covered with rubbish.

Cambridge speaks of *A. brunnea*, whose cocoons "are covered over very soon after they are made and the eggs deposited in them, with a coating of clay, which effectually destroys all their form and beauty. This coating of clay answers probably two ends: first, the concealment of the cocoon and its protection from

insect enemies; and, secondly, the protection of the eggs from the too powerful rays of the sun, dry clay being (as is well known) one of the best non-conductors of heat."*

The peculiar cocoon of *C. bisaccata* is described by Emerton† as follows: "Only one specimen of this (*bisaccata*) was found on a beech tree at New Haven with two cocoons. These were dark brown, as dark as the bark of the tree and as hard. Around the middle of each was a circle of irregular points. One of the cocoons was attached by a strong stem to the bark, and the other was attached in a similar way to the first cocoon. The spider held on to one of the cocoons." In this instance the egg has evidently the same protection as that possessed by the gray, bark-haunting spiders, with the added advantage of hardness.

The habit of distributing the eggs through a number of cocoons made at intervals of several days, is protective. In this way, although one or two of the cocoons may be pierced by the ichneumon, there is a chance that part of the brood may survive.‡

INDIRECT PROTECTION.

The indirectly protected group includes those spiders which are rendered inedible by the possession of sharp spines and chitinous plates, and also those that mimic other specially protected creatures.

The females of the specially protected group are characterized by the following attributes:

1. Their inedibility, which they owe to a more or less coriaceous epidermis and an armature of strong sharp spines (fig. 8, see p. 95).

2. Their brilliant colors—glistening black and white, yellow, fiery gold, metallic silver, rose-color, blue, orange and blood-red.

---

* *Ann. and Mag. of Nat. Hist.*, Feb., 1887, p. 113.

† *New England Epeiridae*, p. 325.

‡ *E. sancta benedicti* Vinson makes as many as thirteen cocoons. Vinson, *loc. cit.*, p. 204. *Cyrtophora bifurca* McCook sometimes makes fourteen, which, like the mother-spider, are light-green in color. *Proc. Acad. of Nat. Sci. of Philadelphia*, 1887, p. 342.

3. Their habit of hanging always exposed in the center of the web.

In an interesting discussion of the protective value of color and marking in insects, Poulton says that "the smaller convergent groups of nauseous insects often present us with ideally perfect types of warning patterns and colors—simple, crude, strongly contrasted—everything subordinated to the paramount necessity of becoming conspicuous," the memory of enemies being thus strongly appealed to.

This proposition is well illustrated by the Gasteracanthidae. Among larvae the warning colors are almost invariably black and white, or black (or some very dark color), in contrast with yellow, orange and red.* These are the colors that also constantly recur among the Gasteracanthidae.

I will cite a few species as illustrative of the general coloring in the group.

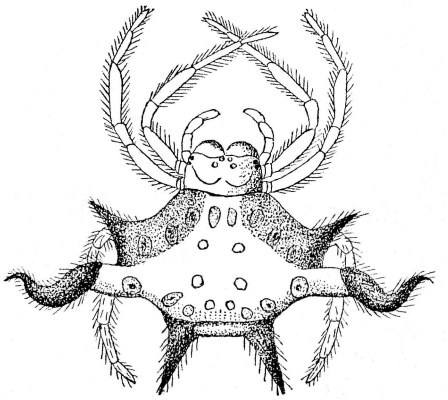


Fig. 8.—*Gasteracantha crepidophora* (from Cambridge).

G. lepida Camb., Proc. Zool. Soc., 1870, p. 821. "The upperside is of a bright, rich, orange yellow, with two broad parallel transverse bands of blood-red tinged with carmine. * * * The abdomen might almost be described as alternately barred on the upper side, with traverse bars of red and yellow."

Phoroncidia aurata Camb., (Plate III, fig. 4). Referred to by Butler, Proc. Zool. Soc., 1882, p. 766, as follows: "Four examples of this rare and extremely beautiful species were obtained. * * * Two of these are typical, their abdomen being

---

* *Experimental Proof of Protective Value of Color and Markings in Insects*, by E. B. Poulton, Trans. Ent. Soc., 1887, p. 230.

† Poulton, *loc. cit.*, p. 231.

The second footnote (†) on this page did not appear in the text. The correct reference for Poulton's paper is: Poulton, E. B. 1887. *The experimental proof of the protective value of colour and markings in insects in reference to their vertebrate enemies.* Proceedings of the Zoological Society, London, 1887, 191—274.

of a fiery golden color, with black spines upon red bases; the two others are considerably larger, and the abdomen is of a metallic silver color, the spines black with red-brown bases and the ocellations black."

Paraplectana thorntoni Blk., referred to by Cambridge, Proc. Zool. Soc., 1879, p. 293.

"The jet-black ground-color of the abdomen, with its somewat raised, large and conspicuous bright-yellow markings, and yellow cephalothorax, render it one of the most striking and handsome known spiders of this family."

G. alba Vinson, *loc. cit.*., p. 240. Milk-white, with the glisten and polish of porcelain. A dorsal stripe of a beautiful black in the middle, dividing the shell into two equal parts.

G. helva Blk., described by Cambridge. Proc. Zool. Soc., 1879, p. 287. Yellow or yellow-brown, with the spines of a deep, rich, shining steel-blue color.

The Gasteracanthidae are not all brilliantly colored; many are of a light écru† tint, with black spots and spines, but even in these the smooth, glistening character of the shell gives them a certain degree of brightness.*

Cases that may be more justly considered exceptions to the rule that these hard, uneatable spiders are conspicuous are such species as *Acrosoma rugosa* (fig. 9, see p. 97). One of this species was sent me bv Mrs. Treat last summer. It lived for several weeks in my window, making no regular web, but hanging among a few irregular strands. It ate nothing, although provided with insects, but drank greedily of water. It might seem that its black and white coloring would make it conspic-

---

* Alcoholic specimens of this group usually lose their bright colors. Thus we have a number of species described by Cambridge (Proc. Zool. Soc., 1879) as "dull yellowish-brown," "blackish-brown," etc., but the author warns his readers than in his opinion alcoholic and more especially dried specimens of Gasteracanthidae lose their original brightness. He says: "We are probably therefore, in nine cases out of ten, totally ignorant of the true colors and markings of the Gasteracanthides." P. 280.

He then goes on to note, in proof of this proposition, the case of an African species which had been described as of a uniform, dull, muddy, brown hue, which, in life, has a shade of "the loveliest and most delicate yellow, scalloped at the edges, where occurs a dainty moulding of blue."

† Écru is a greyish pale-yellow, or a light greyish yellowish brown color.

uous, but in connection with its irregular shape and its way of hanging motionless in the web it had the opposite effect.

We have no reason to suppose that the class represented in *rugosa* is like that touched upon by Poulton, in which very protectively colored larvae suddenly assume a terrifying aspect on the near approach of an enemy; still they do enjoy a kind of double protection. They are inconspicuous, and thus likely to escape attack, but in case they are attacked they have still the advantage of being quickly rejected. This experience cannot be as fatal to them as to the soft and thin-skinned larvae. Their hard covering and projecting spines would protect them to such an extent as to give them a fair chance of surviving.

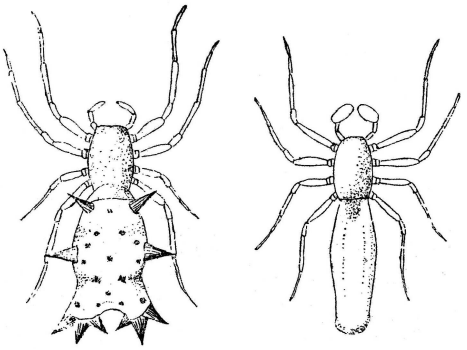


Fig. 9.—*Acrosoma rugosa*. Left-hand figure female, right-hand figure male (from Emerton).

In one respect the inconspicuous Gasteracanthidae have a decided advantage over their bright colored relatives. The birds, indeed, avoid the conspicuous ones, but their brilliancy serves to attract another enemy against which spines are no protection—the hunter wasp which, as we have seen in the work of Bates, sometimes provisions its nest wholly with spiders of this family. Mr. Smith gives like testimony, saying:

"Spines on the abdomen of certain spiders would serve as a protection against vertebrate enemies, though they do not protect against the hunter wasps, which frequently provision their nests with these species." He adds, however, that most of the spiny spiders are common, and that their colors make them conspicuous; just as butterflies that are protected by an odor are common and bright-colored.*

---

* Letter on Enemies of Spiders.

Taczanowski says that *A. horrida* (Pl. III, fig. 5,) is very like *rugosa*, and adds that he considers this species as transitory between *Epeira* and *Acrosoma*.

Cambridge remarks upon the great variability in the length and direction of the spines in individuals of the same species of *Gasteracantha*.* Vinson notices the same character in regard to the color of at least one species.† That variability in the spines is found also in *Acrosoma*, as illustrated in Plate III, where figures 1 and 3 represent extreme forms of the female of *A. spinea*, the former being found in the northern and the latter in the southern part of the United States. *A. oblonga* (Plate III, fig. 6) is given to show the sharpness of the spines in some of these species.

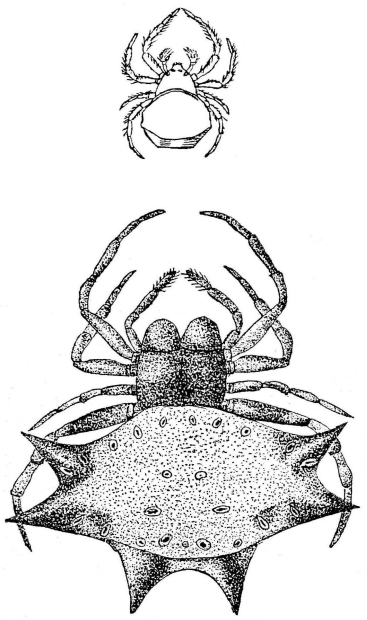


Fig. 10.—*Gasteracantha rufispinosa*. Upper figure male, lower figure female (from Marx).

The sexes in *Gasteracantha* and *Acrosoma* are entirely different. The males are small, sometimes very minute, and lack both the spines and the brilliant color of the females (fig. 10, and Plate III, figs. 1, 2, and 3). Indeed, they resemble the females so little that for many years the relations between the two were undiscovered. In the genus *Gasteracantha*, up to so late a date as 1879, only two males had been described, against one hundred and seventy females.‡

This disparity has come about through the different habits and functions of the female. Wallace has shown that among insects the females often acquire protective colors which are

---

* *Proc. Zool. Soc.*, 1879, p. 279.

† *Loc. cit.*, p. 241.

‡ Cambridge, *Proc. Zool. Soc.*, 1879, pp. 279 and 281.

lacking to the males, because long life in the females is of greater importance to the species than long life in the males.*

This applies also to the Gasteracanthidae where the females are much larger, much more inedible, and much more conspicuous than the males. Wallace, however, limits his proposition to cases where the modification is for concealment, and illustrates it by instances among butterflies where the female alone mimics some nauseous species. The Gasteracanthidae are an exception to his rule, that in groups which have a protection of any kind independent of concealment, sexual differences of color are either quite wanting or slightly developed.† That I do not misinterpret his meaning is shown by the fact that after stating this rule he goes on to enumerate several cases in which specially protected species have the sexes almost or quite alike.

In *Gasteracantha* and *Acrosoma* the habits of the female as well as her functional importance call for some special protection. She is much exposed, remaining in her web all the time, while the male passes most of his life in concealment. Thus the female of *A. spinea*, though not so gaudily colored as many others, is easily recognized, and is constantly seen on low bushes during the summer. At about the first of August the males appear, quite suddenly and in large numbers, and may be seen running about the leaves and branches near the webs of the females. Toward the end of the month they disappear. *Acrosoma* and *Gasteracantha* are so near together that this tends to prove the correctness of Cambridge's surmise that the males of the latter genus are short-lived.‡

---

* "The comparative importance of the sexes varies much in different classes of animals. In the higher vertebrates, where the number of young produced at a birth is small and the same individuals breed many years in succession, the preservation of both sexes is almost equally important. * * * In insects the case is very different; They pair but once in their lives, and the prolonged existence of the males is in most cases quite unnecessary for the continuance of the race. The female, however, must continue to exist long enough to deposit her eggs in a place adapted for the development and growth of her progeny. Hence there is a wide difference in the need for protection in the two sexes; and we should therefore expect to find that in some cases the special protection given to the female was in the male less in amount or altogether wanting." A. R. Wallace, *Natural Selection*, p. 112.

† *Loc. cit.*, p. 113.

‡ This shortness of life is common in the males of the Attidae. In several species it is almost impossible to find the male, which is very common earlier in the season, after the first of August, although the females are still numerous.

In at least two genera of the Gasteracanthidae, then, there is a difference between the sexes, which is the result of the inheritance of special protective modifications by the female alone.

In replying to Wallace's theory that color differences between the sexes are due to the keeping down for protective purposes of the color of the female, Darwin says: "I do not wish to deny that the females alone of some species may have been specially modified for protection."* In most cases when the female is dull and the male bright colored it is difficult or impossible to show that the difference his resulted from the greater need of protection in the female. The difference in the Gasteracanthidae, however, is just such a case as was referred to by Darwin, since it is unquestionably due to natural and not to sexual selection.

The young of *Gasteracantha* and *Acrosoma* present certain pecularities. Darwin's propositions in regard to differences between the two sexes in birds are as follows:

"Wherever (...whenever) and in whatever manner the adult male differs from the adult female, he differs in the same manner from the young of both sexes. * * *

"When on the other hand, the adult male closely resembles the young of both sexes (these, with rare exceptions, being alike), he generally resembles the adult female."†

Acrosoma and *Gasteracantha* are not included in these rules, since although the young are alike at the very first, both resembling the adult male. the young females very early begin to vary toward the form and color of the adult female; so that we have the young males and females resembling the adults of the same sex, while the adult male and female differ greatly from each other.

Darwin notes the occasional occurrence of such cases as this in the following words:

"As variations occurring late in life, and transmitted to

---

* *Descent of Man*, p. 321.

† *Loc. cit.*, pp. 232, 233.

There were several editions, and multiple published versions, of this work by Charles Darwin. These page numbers correspond to the second edition of *The Descent of Man and Selection in Relation to Sex*, published in a single volume in the United States by D. Appleton and Company, New York, 1875—1887.

one sex alone, have incessantly been taken advantage of and accumulated through sexual selection in relation to the reproduction of the species; therefore, it appears at first sight an unaccountable fact that similar variations have not frequently been accumulated through natural selection, in relation to the ordinary habits of life. If this had occurred the two sexes would often have been differently modified, for the sake, for instance, of capturing prey, or escaping from danger. Differences of this kind between the two sexes do occasionally occur, especially in the lower classes. But this implies that the two sexes follow different habits in their struggles for existence, which is a rare circumstance with the higher animals."*

In the Gasteracanthidae we have the necessary conditions for the production, by natural selection, of a difference between the sexes early in life, *i. e.*, the habits of the sexes are distinctly different, the males living in some place of concealment, while the females soon begin to sit exposed in the web. It is naturally of the greatest importance that the young females, while adopting the habits of the adults, should acquire also her special protection of form and color.

The variations in the female, although entirely due to natural selection, probably first occurred in the adult, since variations occurring early in life tend to be inherited by both sexes.

MIMICRY.

Mimicry, or the imitation of animal forms, while it is a form of indirect protection, differs in no essential respect from the imitation of vegetable and inorganic things. As Bates has said, the object of mimetic tendencies is disguise, and they will work in any direction that answers this purpose.†

In nearly all respects spiders come under the three laws given by Wallace, as governing the development of mimetic resemblances in several large classes. These laws are as follows:

1. In an overwhelming majority of cases of mimicry, the

---

* *Loc. cit.*, p. 241.

† *Lepidoptera of the Amazon Valley*, Trans. Linn. Soc., Vol. XXIII, p. 514.

animals (or the groups) which resemble each other inhabit the same country, the same district, and in most cases are to be found together on the very same spot.

2. These resemblances are not indiscriminate, but are limited to certain groups, which, in every case, are abundant in species and individuals, and can often be ascertained to have some special protection.

3. The species which resemble or "mimic" these dominant groups, are comparatively less abundant individuals, and are often very rare.*

The second and third of these laws are confirmed by what we know of mimetic resemblances among spiders. They mimic ants much oftener than other creatures, and ants are very abundant, are specially protected, and are much more numerous than the mimetic spiders. To the first law, also, they conform to a great extent, since everything tends to show that in tropical America and in Africa the ant and the spider, the one mimicked and the other mimicking, are always found together. So far as I can discover, however, the ant-like spiders of North America, are not found in company with any species of any that they resemble. This may be because they do not mimic any particular species, but only the general ant-like form; or, considering that the genera which contain their nearest relatives are much more abundant in Central and South America, it may be that these forms were originally tropical, mimicking some tropical species of ants, and that after the Glacial Epoch they migrated northward, leaving the ants behind them. However this may be, their peculiar form has served them well, since they have maintained themselves as fairly abundant species with a lower fecundity than is found in any other group of spiders.

The cases in which one species mimics another may be divided, according to the kind of benefit derived, into four classes: Class 1. As a rule, where we find one species mimicking another, the mimicked species possesses some special means

---

* *Natural Selection*, p. 76.

of defense against the enemies of both. This defense may consist of a disagreeable taste or odor, as in the Heliconidae, which are mimicked by other butterflies; of some special weapon of offense, as where wasps and bees are mimicked by flies and moths, or poisonous vipers by harmless caterpillars; or of a hard shell, as where the coriaceous beetles are mimicked by those that are soft-bodied.

Instances of this rule are exceedingly numerous; indeed, Wallace says that specially protected forms are always mimicked; still we have nothing mimicking our Gasteracanthidae.

Class 2. The mimetic may prey upon the mimicked species, its disguise enabling it to gain a near approach to its victims; as the mantis, mentioned by Bates as exactly resembling the white ants upon which it feeds; and the flies which mimic bees, upon which they are parasitic, and are thus able to enter the nests of the bees and lay eggs on the larvae.

Class 3. The mimetic species may, by its imitation, be protected from the attacks of the creature it mimics, as is the case with the crickets and grasshoppers which mimic their deadly foe, the hunter wasp.

Class 4. The mimetic species may prey upon some creature which is found commonly and is not eaten by the mimicked species.

No two of these classes are mutually destructive† so that in any case of mimicry a double advantage may be gained.

Let us see which of these advantages has directed the development of mimetic tendencies among spiders.

While among beetles and butterflies we most commonly find mimicry of one species by another within the same order, we have no instance of a spider mimicking another spider.* This may be accounted for by the fact that the specially protected spiders depend for their safety upon the possession of hard plates and spinous processes, and although the hardened epidermis might be imitated (We know that hard-shelled beetles

---

* The spiders instanced by Pavesi (*loc. cit.*, p. 7) which resemble other genera rather than their own, such as *Nephila tetragnathoides*, *Tetragnatha epeirides*, etc., cannot, it seems to me, be classed properly under mimicry.

† Mutually *exclusive*.

are mimicked by others that are soft), spines could scarcely be imitated by a soft-bodied creature with sufficient accuracy to insure disguise.

While spiders most commonly mimic ants, we hear also of their imitating beetles, snail-shells, ichneumons and horse-flies. There is also a curious Madagascar species which looks exactly like a little scorpion, the resemblance being heightened by its habit of curving its flexible tail up over its back when irritated.

Those that resemble beetles comprise nearly all the species of the genera *Coccorchestes* and *Homalattus*. These are small spiders with short, convex bodies. The abdomen fits closely over the cephalothorax and the epidermis, which has usually a metallic lustre, is sometimes coriaceous. Striking examples are found in *H. coccinelloides*, which bears a strong resemblance to beetles of the family Coccinelloidae and in *C. cupreus*, in which certain marks on the abdomen imitate the elytra of beetles.

The following account of a spider which mimics a snail-shell is given by Mr. G. F. Atkinson:

"An undescribed species of *Cyrtarachne** mimics a snail-shell, the inhabitant of which, during the summer and fall, is very abundant on the leaves of plants in this place. In the species of *Cyrtarachne* the abdomen partly covers the cephalothorax, is very broad at the base, in this species broader than the length of the spider, and rounds off at the apex. When it rests upon the under side of a leaf with its legs retracted it strongly resembles one of these snail-shells by the color and shape of its abdomen. The two specimens which I collected deceived me at first, but a few threads of silk led me to make the examination. The spider seemed so confident of its protection that it would not move when I jarred the plant, striking it several hard blows. I pulled the spider forcibly from the leaf, and it did not exhibit any signs of movement until transferred to the cyanide bottle."†

---

* *C. multilineata*.

† *New Instances of Protective Resemblances in Spiders*, American Naturalist, June, 1888, p. 545.

Cambridge, in the *Enc. Brit.*, says that a species of *Cyrtarachne*, found in Ceylon, resembles a small mollusc and that some of the genus *Erysoma* are very like a minute crab, giving *E. cabindae* as an example. But he does not seem to imply that the crabs are actually mimicked, and he gives no details. Stoliczka describes a small *Xysticus* which both in form and color strongly resembles a minute crab, but the habits of the spider, which we always found inside of flowers, preclude any idea of mimicry.

Trimen gives an account of the imitation, by spiders, of horseflies, a case falling into class 2, as follows:

"Hunting spiders are in some cases very like their prey, as may everywhere be noticed in the case of the species of *Salticus* which catch horseflies on sunny walls and fences. The likeness is not in itself more than a general one of size, form and coloring; but its effect is greatly aided by the actions of the spider, which walks hurriedly for short distances, stopping abruptly, and rapidly moving its falces, in evident mimicry of the well-known movements so characteristic of flies."

Instances of spiders mimicking ants are very numerous and in many cases the resemblance is so close as to, at first sight, deceive a trained naturalist. This resemblance is brought about by the spider's body being elongated and strongly constricted, so that it appears to be composed of three segments instead of two, by the color, by the way in which the spider moves about, zig-zagging from side to side like an ant, and by its habit of holding up one pair of its legs and moving them in such a way that they look exactly like the antennae of an ant.

Ants may be regarded as specially protected, by their sharp, acid flavor, and in some species by the possession of stings or of horny processes.

On the ground that there are birds which do eat ants, and eat them greedily, it has been thought by some naturalists that they cannot be considered specially protected creatures, and that, as spiders can therefore derive no protection from mim-

icking them, all cases of such mimicry depend upon the spider's increased ability to capture the ants as prey, but I am convinced that this is too hasty a conclusion. It is unquestionably true that some birds feed almost exclusively upon ants, but these are the exceptions. It is a common thing to find that specially protected groups, which are safe from the attacks of most creatures, have their special enemies. Thus, even the nauseous Heliconidae are preyed upon by certain spiders and wasps; and bees, in spite of their stings, are preferred to other insects by the bee-eaters. Moreover, the ant-devouring birds are found largely among the wood-peckers, which eat the ants that run on the trunks of trees, and are therefore not a source of danger to the ant-like spiders, the American species of which, so far as I can learn, live entirely upon the ground.

In the United States comparatively small numbers of either ants or spiders are eaten by birds, but in tropical America there are enormous numbers of humming-birds feeding almost exclusively upon spiders, and there the protective advantage of looking like ants must be of great importance to the smaller species.

Belt considers that the advantages gained by ant-mimicking Central American spiders lies entirely on the side of protection. In relation to this subject he says: "Ant-like spiders have been noticed throughout tropical America and also in Africa. The use that the deceptive resemblance is to them has been explained to be the facility it affords them for approaching ants on which they prey. I am convinced that this explanation is incorrect, so far as the Central American species are concerned. Ants, and especially the stinging species are, so far as my experience goes, not preyed upon by any other insects. No disguise need be adopted to approach them, as they are so bold that they are more likely to attack a spider than a spider them. Neither have they wings to escape by flying, and generally go in large bodies easily found and approached. The use is, I doubt not, the protection the disguise affords against small insectivorous birds. I have found the

crops of some humming-birds full of small, soft-bodied spiders, and many other birds feed on them. Stinging-ants, like bees and wasps, are closely resembled by a host of other insects; indeed, whenever I found any insect provided with special means of defense I looked for imitative forms, and was never disappointed in finding them."*

The ant-like species are probably protected by their appearance from the attacks of many of the larger spiders. We have kept great numbers of Attidae in captivity, and, although they devoured flies, gnats, larvae, and other spiders, they would never touch ants. Among spiders, however, as among birds, we find that certain groups subsist almost entirely upon ants.†

The class of spiders whose mimicry protects them from their enemies, whether they are birds or other spiders, probably includes at least two of our own ant-like species, *Synageles picata* and *Synemosyna formica*, which, in confinement, are always hungry for gnats, but will not touch ants, even of small size.

The existence of a class of spiders which mimic the particular species of ants upon which they prey is not to be questioned, but it is doubtful whether the benefit to the spider is increased facility in capturing the ant, or whether it is merely protective. It may be that the spider, by virtue of its resemblance to the ant, not only gets an abundant supply of food, but also escapes being eaten itself, and thus enjoys a double advantage. Both Bates and Wallace‡ take the ground that the advantage derived by

---

* *Loc. cit.*, p. 314.

† Dr. McCook tells me that *L. formidabilis* pitches her tent over or near the formicary of the powerful agricultural or stinging-ant of Texas, *P. barbartus*, and captures the insects as they climb the stalks of ant-rice. He also says that *T. tepidariorum* devours large numbers of ants, and he has seen them eaten by *A. fasciata*. Simon also gives an interesting account of the depredations committed upon ants by spiders of the genus *Enyo*, *Arachn. de France*, Vol. I, p. 243.

‡ Bates says: "There are endless instances of predaceous insects being disguised by having similar shapes and colors to those of their prey; many spiders are thus endowed." *Lepidoptera of the Amazon Valley*, p. 509; and Wallace: "There is a genus of spiders in the tropics which feed on ants, and they are exactly like the ants themselves, which, no doubt, gives them more opportunity of seizing their prey." *Natural Selection*, p. 98.

the spider consists in greater ease in the capture of prey, but both of these writers refer to spiders only incidentally to illustrate a general proposition, without special consideration of their peculiar conditions.

Mr. Herbert Smith, who has paid a good deal of attention to this subject, is inclined to believe that the mimicry in question is entirely protective. He writes as follows:

"In the United States there are a few rare spiders that mimic ants. Here at Taperinha† we find a good score of species of these spiders aping the various kinds of ants very closely; even the odd, spiny wood ant, *cryptocerus*, furnishes a pattern, and there are spiders that mimic the wingless ichneumons. We find, after awhile, that the spiders prey upon ants just as our spiders catch flies; indeed, this fact has already been noted by other observers. But we go a step beyond the books when we discover not only that the spiders eat ants, but that they eat the particular ants which they mimic. At all events, we verify this fact in a great number of cases, and we never find the spiders eating any but the mimicked species. * * * I do not like to hazard a theory on this case of mimicry. It is difficult to suppose that the quick-witted ants would be deceived even by so close a resemblance; and, in any case, it would seem that the spiders do not require such a disguise in order to capture slow-moving ants. Most birds will not eat ants; it seems likely, therefore, that this is simply another example of protection; the spider deceives its enemies, not its prey; it mimics the particular species that it feeds on, because it is seen in that company when it is hunting, and among a host of similar forms is likely to pass unnoticed."*

At first sight, and especially in view of the fact that such cases are not uncommon among insects, it would be naturally supposed that the object of the mimicry was to enable the spider to approach its victim without exciting suspicion; and it is difficult to account, on any other supposition, for the very close resemblance between certain species of spiders and the

---

* *Loc. cit.*, p. 223.

† Near Belém and the mouth of the Amazon, in Para, Brazil.

particular species of ants which they prey upon. It seems as though the highest point of *protective* benefit would have been reached long before the resemblance of the spider to the ant had become so close as it really is. On the other hand, it is difficult to believe that ants are deceived, even by those spiders which mimic them most closely, when we remember that their perceptions are so keen that they discriminate not only between ants of their own and different species, but even between ants of their own species living in two different communities.*

The mimicry of ichneumon flies by spiders was noted some years ago by Mr. Herbert Smith. This case comes under Class 3, in which one species mimics another which preys upon it. Great destruction is caused by ichneumons which lay their eggs on the bodies of the live spiders, and the disguise probably protects the spider by leading the fly to mistake it for one of its own species.

We have no proof that spiders ever mimic ants as a method of escaping from them, but it is possible that this sometimes happens. We know that some ants prey upon them. The foraging ants of South America destroy spiders as well as many kinds of insects, and Wallace mentions a small, wood-boring ant which fills its nest with small spiders.†

If the spiders that feed upon ants deceive them by their mimicry those which are preyed upon by ants would gain an advantage by a similar disguise. I once placed a little ant-like spider of the genus *Herpyllus* in a bottle with three ants no larger than itself, which I had caught with it in the sweep-net. In a very few minutes the ants had killed and began to devour the spider. It may be that the resemblance was sufficiently close to deceive them in the open, but failed when spider and ants were confined together in close quarters.

I will now give some account of an ant-like spider which we have studied closely.

---

* Sir John Lubbock.

† *Tropical Nature*, p. 83.

Synageles picata (fig. 11), while not a rare spider with us, is not often caught in the sweep-net, as it usually keeps close to the ground. One hot afternoon in July, however, while sweeping on a sunny, stony hillside, sparsely covered with grass, I captured five females and one male of this species along with eight or ten ant-like beetles and a dozen or fifteen small ants of two or three different species. Being anxious to discover what relations existed between these creatures, which, though belonging to different orders, bore so strong a resemblance to each other, I put them all together in a glass-covered box. The results of this experiment were negative. The spiders, while greatly interested in each other, paid but little attention to the beetles and none at all to the ants. The ants ran wildly about and seemed to be entirely absorbed in trying to get out. The beetles took matters more philosophically and kept quiet.

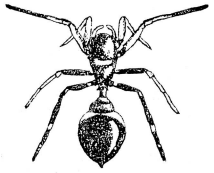


Fig. 11.—*Synageles picata* (from nature, by Mr. L. Kumlien).

After several hours I put some gnats into the box. These were caught and devoured by the spiders. A little later I liberated the ants and beetles. The spiders lived in the box in good health and spirits for the remainder of the summer. They were very fond of heat, running about very actively as long as their box stood in the sunshine, but retiring into their little, tubular nests as soon as it became cool or cloudy.

While *picata* is ant-like in form and color, by far the most deceptive thing about it is the way in which it moves. It does not jump like the other Attidae, nor does it walk in a straight line, but zig-zags continually from side to side, exactly like an ant which is out in search of booty. This is another illustration of what Wallace has shown in relation to butterflies—that that which is an important functional structure in the mimicked group may be imitated by the mimetic species, even when the habits of the latter render it perfectly

useless.* The ant only moves in this way when it is hunting; at other times it goes in a straight line; but its little imitator zig-zags always.

In addition to its ant-like walk, *picata* holds up its second pair of legs in such a way that they appear like antennae. The first legs are short and support the anterior part of the body. The second pair, although it is sometimes used, seems not to be needed for locomotion. All the threatening and similar movements made by other spiders with the first pair, are, with *picata*, made with the second.

Spiders commonly remain nearly motionless while they are eating; *picata*, on the other hand, acts like an ant which is engaged in pulling some treasure-trove into pieces convenient for carrying. I have noticed a female *picata* which, after getting possession of a gnat, kept beating it with her front legs as she ate, pulling it about in different directions, and all the time twitching her ant-like abdomen. Pavesi says that the ant-like Drassidae and Attidae continually move their abdomens exactly as ants do.† I have not noticed this habit in any of our spiders excepting this species.

Picata is found in company with several small species of ants, but does not seem to resemble one more than another. It does not molest, and neither is it molested by the ants, so that the cause of its mimicry must be looked for in either Class 1 or Class 4. I should not have formed this latter class, in which it is supposed that one species mimics another because it preys upon a third species found with the mimicked form, but not eaten by it, had it not been suggested to me by the fact that when, as before related, I captured the spiders, ants and beetles together, one of the spiders (*picata*) was engaged in eating a tiny beetle. It may be that *picata* preys upon some small beetle which is not eaten by ants—possibly one of those which, undisturbed by the proprietors, inhabits their nests. In

---

* *Natural Selection*, p. 91.

† *Loc. cit.*, p. 12.

this case the disguise of the spider would enable it to approach the beetle without arousing suspicion. While I give this as a possible explanation, it is improbable that any such disguise is necessary in order to capture beetles, and I think it most likely that the object of the mimicry is to preserve the spider from some enemy that would rather eat spiders than ants.

To sum up the peculiarities of *picata*—it is ant-like in form and color; it moves like an ant and holds up its second pair of legs to represent antennae; it is found among ants, but neither eats them nor is eaten by them.

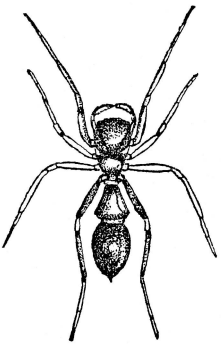


Fig. 12.—*Synemosyna formica* (from nature, by Mr. L. Kumlien).

Synemosyna formica (fig. 12) agrees in all respects with *picata*, unless it is in the zig-zag walk; upon that point I am unable to speak with certainty. Of *formica*, which it more ant-like in form and color than *picata*, Hentz says: "I had seen individuals of this species running on the blades of grass and stems of weeds long before I distinguished them from ants. They move with agility and can leap, but their habitus is totally different from *Attus*. They move by a regular progression or regular walk, very different from the halting gait of that subgenus."*

Both *formica* and *picata* hold the second pair of legs like antennae. Many of the ant-like Epeiridae from South America, seen in collections, have palpi that look extremely like antennae, while their long legs can only be useful in locomotion. Belt speaks of a spider in Nicaragua which holds up its first legs like antennae and moves them about like an ant. He also says that in one spider the palpi are lengthened and thickened so as to resemble an ant's head. The following quotation from J. P. M. Weale, shows that some African ant-like species also hold up their first legs: "The most perfect cases of mim-

---

* *Loc. cit.*, p. 73.

icry I know of are two spiders (specific name unknown to me) which bear the closest resemblance to ants. They belong to the Salticidae and are apparently related to *S. formicarius*. The one is smooth, black and shining and runs rapidly on the ground and bark of trees, and resembles the ant which builds its nests in *Acacia horrida* and is used by the Kafirs for the purpose of torture. The other is larger and has its cephalothorax dull black and its abdomen covered with short yellowish hairs. It is generally found running on the stems of herbaceous plants and small bushes and closely resembles an ant found in similar situations. The fore legs in both species are larger than the second pair and are frequently held up, when they closely resemble the antennae of ants. So exceedingly close is the resemblance that at first sight I have nearly always taken them for the imitated ants."*

Among spiders, then, as among other arthropods, we find that some groups have reached a condition of close harmony with their environment; this harmony being brought about through the same modifications of color, form and habit as those seen among insects, the common ends of capture of prey and protection from enemies being thus attained.

---

* *Nature*, 1871, Vol. III, p. 508.

The two plates (III and IV) referenced in this document were attached to a subsequent number (Volume 1, Number 3) of the Occasional Papers of the Wisconsin Natural History Society, issued in 1890. Here captions that originally appeared on a separate sheet have been added directly to the respective plate, to facilitate their use.

Plate III.

Figures 1 and 3. *Acrosoma spinea*, two forms of female.

Figure 2. *Acrosoma spinea*, male.

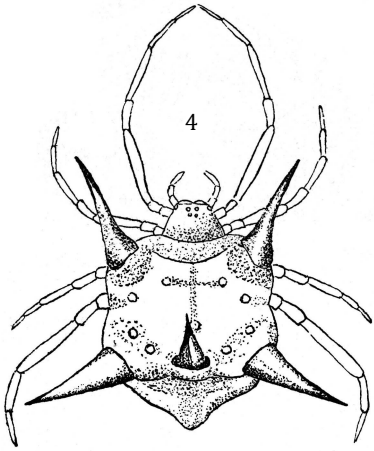


Figure 4. *Phoroncidia aurata*, female.

Note: By mistake, figures 5 and 6 were included as being drawn from nature by Mr. Kumlien.

They were, in reality, copied from Dr. Taczanowski's work, *Araneides de la Guyane Française*.

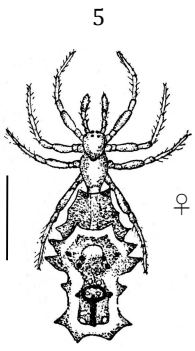


Figure 5. *Acrosoma horrida*, female (from Taczanowski).

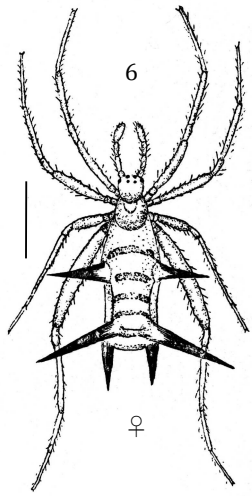
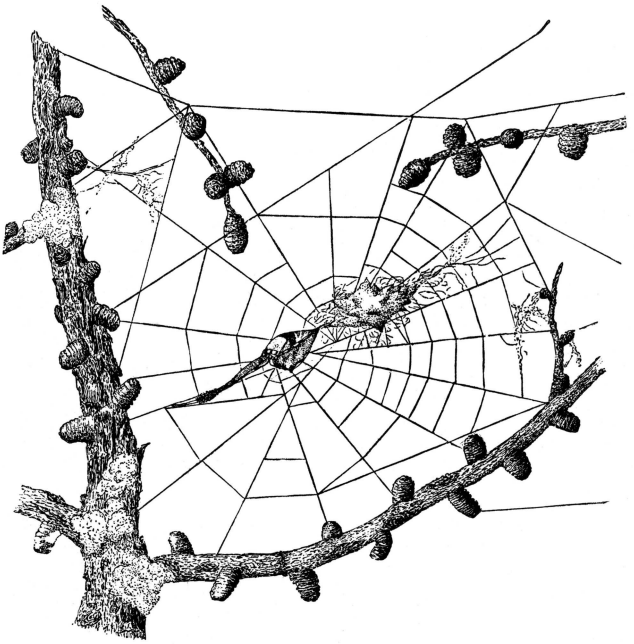


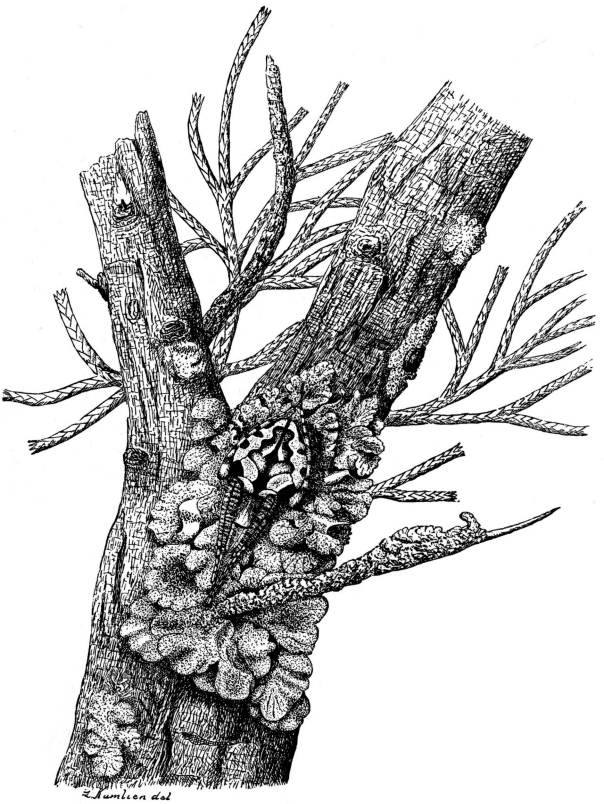
Figure 6. *Acrosoma oblonga*, m female (from Taczanowski).

L. Kumlien ad nat. del.

Plate IV.



Upper figure: *Uloborus plumipes* in web, with one cocoon, to show protective resemblance.



Lower figure: *Epeira prompta*, resting on lichen-covered tree-trunk, to show protective coloring.