SPIDERS: THEIR DEVICES FOR CONCEALMENT AND PROTECTION.

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(The sketches illustrating this paper were drawn rapidly from memory in order to illustrate a lecture given before the Society. They are therefore not exact in the minutest details and must be regarded as purely diagrammatic.)

Concealment devices for securing protection are widespread throughout Nature. Insects, especially, supply numerous examples. We have stick-insects, and leaf-insects and moss-insects and bark-insects all of which closely resemble their environment. We have caterpillars which make themselves look like venomous snakes, innocent grasshoppers that look like dangerous ants, flies that mimic poisonous wasps. The variety of these similitudes is so immense that it seems to have no end. But in almost all these examples which we find among insects the creatures themselves have been passive in the business. They have taken no part in the manufacture of their concealment. The stick insect, for example, lives in sticky surroundings, but it has taken no part in the fashioning of those surroundings. Nature has made it stick-like and has given it a stick-like environment to live in. It is the same with almost all these insect devices. Nature has made the creature of a special pattern and has placed it in surroundings that will suitably protect it.

But there is another class of instances, hitherto much neglected, in which we find a different plan of defence. In this case the animal makes its own concealment. Nature does not put it into surroundings that match with it. It manufactures for itself an artificial surrounding specially designed to conceal it from view.

These creatures are the orb-weaving spiders, the species that make those cart-wheel snares which are common in every field and garden in all parts of the world. Their great enemies are the parasitic wasps which carry them off to their mud nests. It is in order to protect themselves from these marauders that they make the series of protective devices which I briefly describe in the following notes.

The String of Pellets. (Fig. 1.)

In this case the spider makes a string of pellets along one of the diameters of its snare. The pellets are made of bits of insects bound together with silk threads. They are the same size, shape and mottled colour as the spider. The spider sits at the centre of the

snare. It huddles itself up into a pellet-like shape, and, being exactly like the pellets it has manufactured, it becomes perfectly concealed. Unless one knows that the spider always sits at the centre, it is impossible by ordinary inspection to pick it out from the pellets in the string. Here then we have a clear illustration of an animal manufacturing its concealing device.

THE PELLETS WITH HUB.

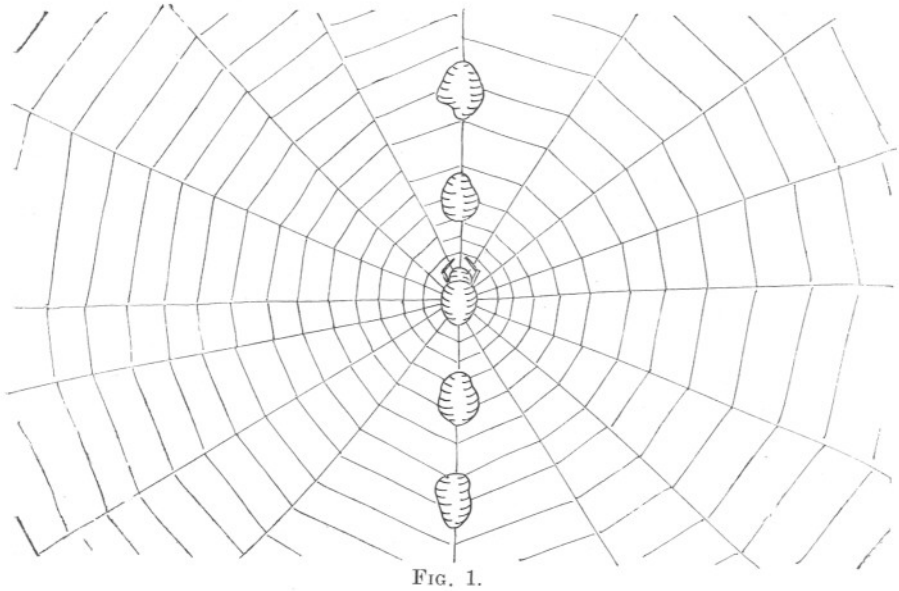
In this instance the spider goes one better. It again makes pellets as in the previous instance. The pellets are the same size, shape and colour as itself, and they serve to conceal it efficiently. But the creature is not content with this. It makes an additional improvement. Around its seat at the centre the snare has a close-wound spiral thread; it is the hub which in the cartwheel snare binds the radiating spokes together at the point where they all meet. Now the spider makes an attempt to mimic this hub in the case of each of its pellets. It spreads around each of them a loose skein of threads. It has not the same neat spiral arrangement as has the hub round the spider at the centre. A spiral can be made only where spokes diverge. Thus the spider cannot make a true spiral round its pellets. But it makes the best attempt it can at a spiral, which is the loose skein of threads.

THE BUNDLE OF PACKETS.

This device is made by one of the *Gasteracantha* spiders met with in the Andaman Islands. The spider is black in colour and sharply angulated. Rounded pellets would not, therefore, serve to conceal it. What it requires is irregular shaped lumps. It manufactures these from its captured insects. Each capture it rolls up in a little packet of silk, and then collects the packets into blackish irregular shaped clusters which it hangs in different parts of its web. The clusters are the same colour and size as the spider and something of the same irregular shape. Their number is usually 2 to 4, no doubt varying with the number of the captures taken. Their function is to act as a decoy. When a parasitic wasp approaches the web it is just as likely to strike at a cluster of packets as it is at the actual spider. When a cluster is touched then the web vibrates, and the spider, immediately it feels the vibration, drops to the ground and escapes. The spider's safety will be in proportion to the number of its decoys. If the decoys are two in number, then it has a 2 to 1 chance of escape. If the decoys are four in number, then its chances of escape become 4 to 1.

PELLETS AND CONFUSING DEVICE. (Fig. 2.)

There is a Himalayan species which, in addition to pellets, puts in its snare a set of oval bands which has the effect of confusing the enemy and thus increasing the chances of escape. The pellets, some



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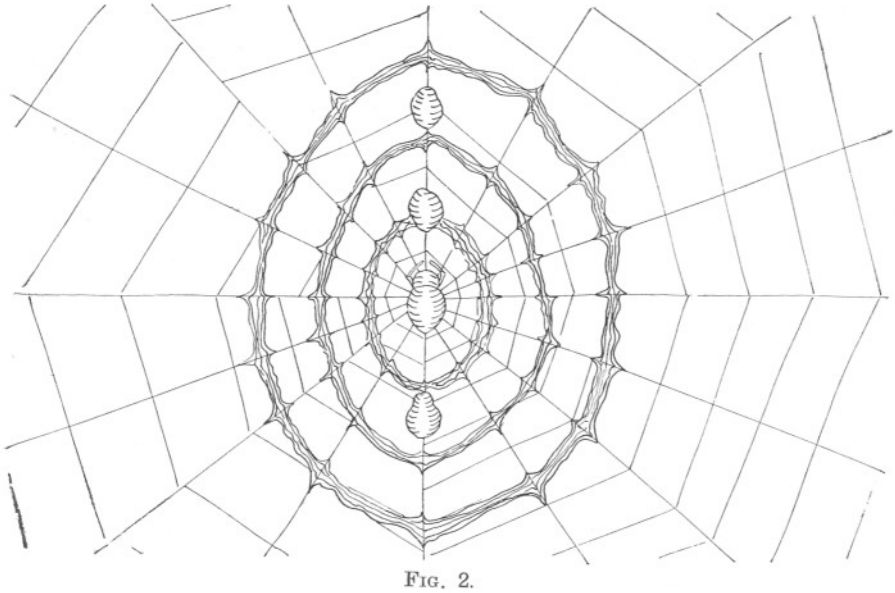

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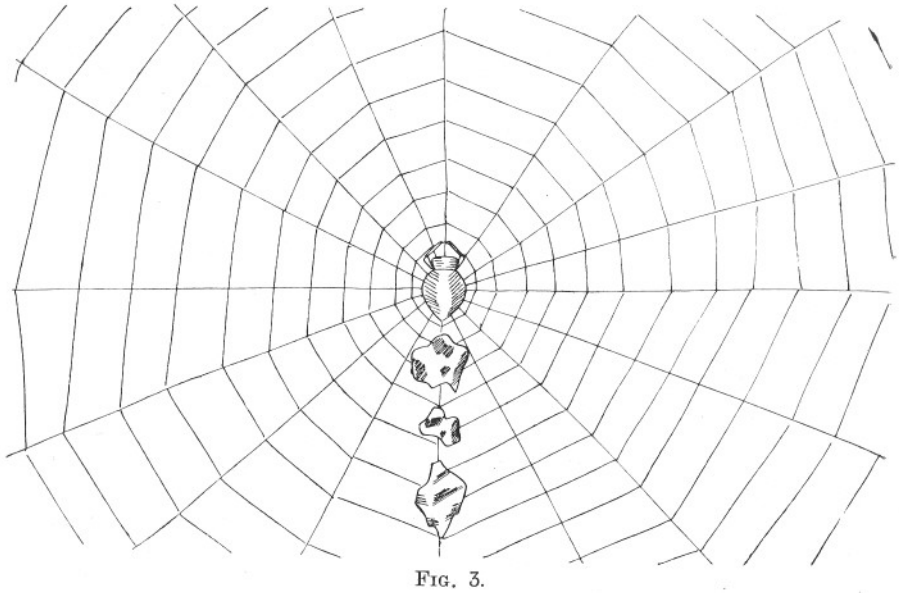

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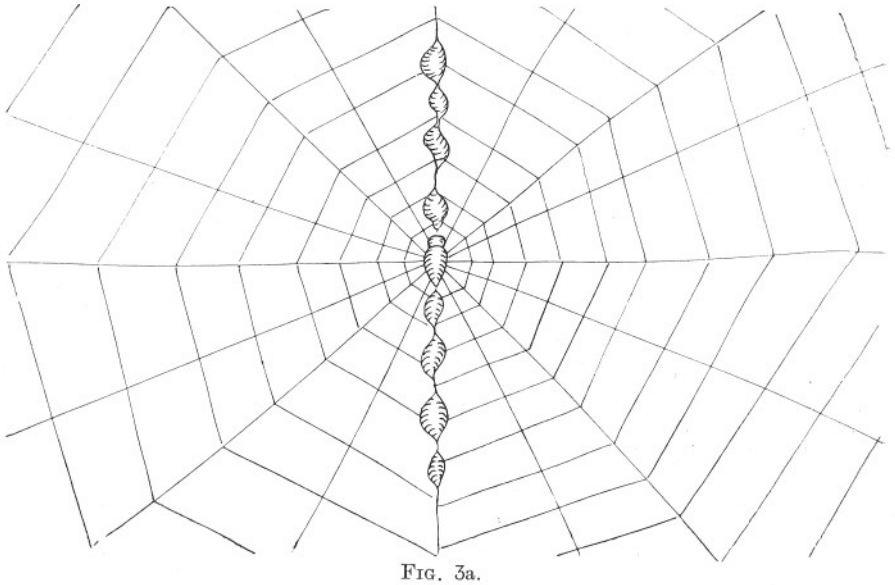


FIG. 3a.

six to eight in number, are aligned along one diameter of the snare. The spider huddles up at the centre where it looks exactly like one of the pellets. In addition it places round the whole string of pellets a series of conspicuous white bands. There are usually three, one inside the other. When the web is inspected they attract immediate notice, being far more conspicuous than the ordinary threads of the snare. Their purpose is to confuse the enemy through their attractiveness, draw its attention away from the centre and thus increase the spider's chances of escape.

BITS OF BARK. (Fig. 3.)

This species comes from Guiana. It places its snare between the spreading buttresses that occur at the bases of tropical trees. The snare is set close against the bark, and the spider cuts off small pieces of bark and strings them along the upper vertical radius of its snare. The bits of bark are the same colour as the spider and about the same size and shape. The spider sits at the centre of the snare where it looks exactly like one of the pieces of bark.

STRINGS OF COCOONS. (Fig. 3a.)

Another species, instead of fixing pellets or bits of bark, makes a string of its cocoons in order to fulfil the same end. The cocoons are silken bags stuffed full of eggs. They are strung along the vertical diameter of the snare. The spider sits at the centre in a gap in the string where it is mistaken for one of its own cocoons.

SPIDER DIFFERING IN COLOUR FROM ITS PELLETS. (Fig. 4.)

In all the instances hitherto mentioned the colour of the spider is the same as that of its device whether it be pellet, bark or cocoon. Clearly this is of the first importance, for if the spider were not identical in colour with its device then the concealing effect would fail. But in one instance from British Guiana I met with a pellet-making species which was totally different in colour from its pellets. The pellets were mottled brown and the spider was conspicuously black and white. This was an extraordinary exception, and for the moment it seemed difficult to fit it in with the protective principle involved. But a brief investigation explained the anomaly. For when the snare was approached, and especially when the leaf that suspended it was touched, the spider went through an extraordinary performance which had the effect of making it the same colour as its pellets. It raised itself from the snare on the tips of its legs, threw its body into an extremely delicate vibration, a fine rapid rhythmical tremor. This rapid tremulating movement changed its white and black colour into brown. What happened, so far as one's eye was concerned, was that the rapid rhythmical tremor brought the black colour and the white colour alternately within the vision. The two colours, therefore,

appeared to become fused with the result that black and white was changed into brown. Thus we see here a delightful modification. The spider makes not only an artificial device, but in addition throws its body into a tremor in order to give itself the colour of its device. By the combination of the two processes perfect concealment is brought about.

DIAMETRICAL BAND. (Fig. 5.)

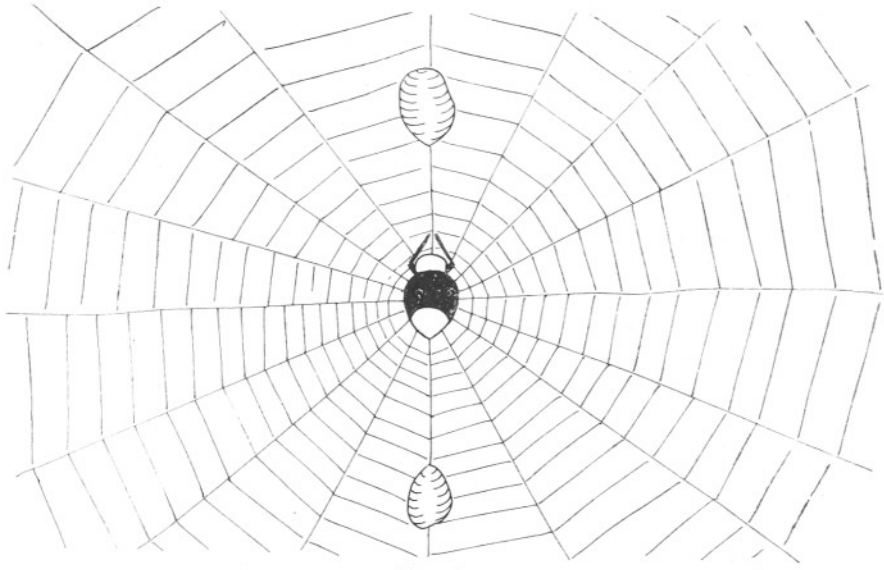
Other species, instead of going in for pellets, make diametrical bands in their snares. The band is composed of silk with little bits of insects included. It is aligned along the snare, usually in its vertical diameter, and a gap is left in the middle of the band in which gap the spider sits. The spider exactly fills the gap. Its body is the same width as the band and its colour is identical with that of the band. Thus the spider appears to be just part of the band and is efficiently hidden from view.

BAND AND PELLETS. (Fig. 6.)

A species from Guiana makes an improvement on the band. It places pellets in addition in its snare. The pellets are usually two in number, each being situated half an inch from the ends of the diametrical band. The spider as before sits at the centre, occupying a gap in the middle of the band, and becoming to all appearances a mere part of the band. The pellets supply an additional defence. For the pellets have a more spider.like appearance than has the real spider which is just part of a band. Hence when the parasitic enemy approaches it is more likely to strike at a pellet than it is at the actual spider. And the moment it touches a pellet the spider drops instantly from the centre and gets lost in the undergrowth beneath the snare.

CRUCIATE BANDS. (Fig. 7.)

In this case the bands have a cruciate arrangement. One is in the horizontal and one in the vertical diameter. The bands are thin, whitish in colour, made altogether of fine silk, and drawn out at their edges into angulated points. A gap is left at the centre of each band, and the spider sits in the space made by these gaps. The spider exactly fills this place; it therefore becomes part of the cruciate arrangement, being no longer a spider, but just a bit of a cross. It will be noted that the gap left in the vertical band is longer than the gap left in the horizontal band. These differences are adapted to the spider's dimensions. Its length fits into the vertical band which must therefore possess a long gap; its breadth fits into the horizontal band which must therefore have a smaller gap. It indicates the little points of neatness that go to make up these concealment schemes.



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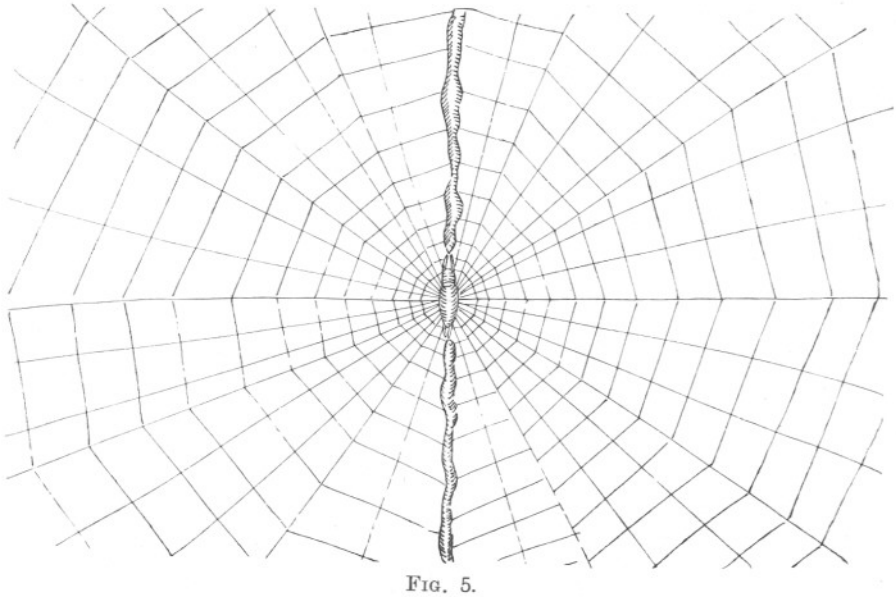

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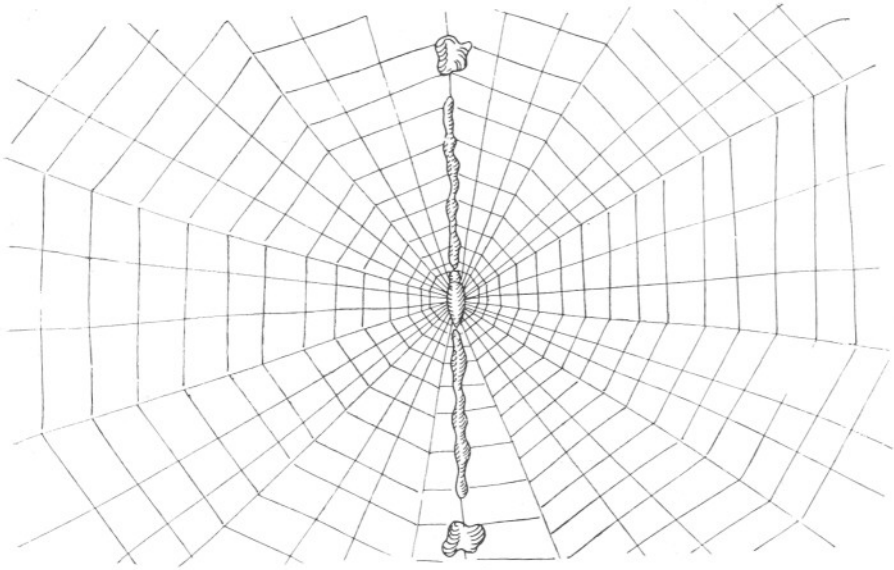

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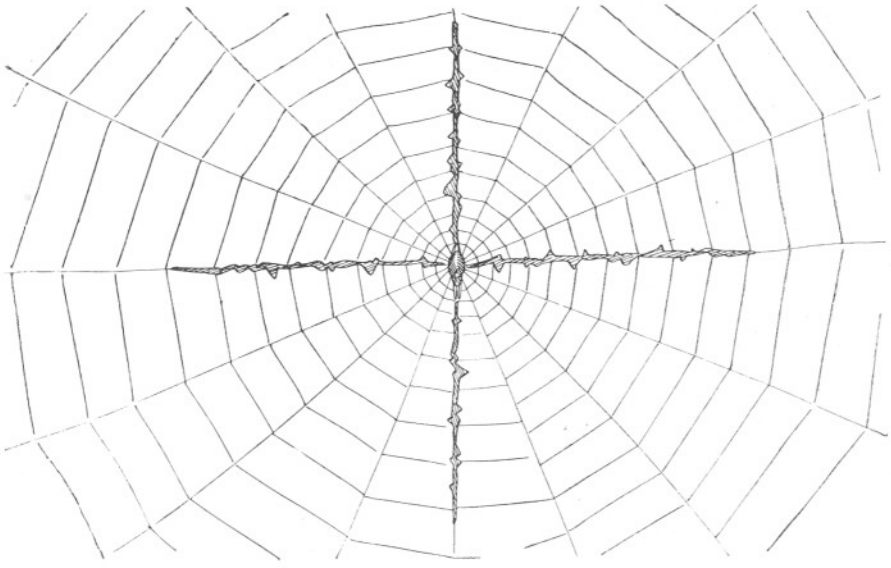

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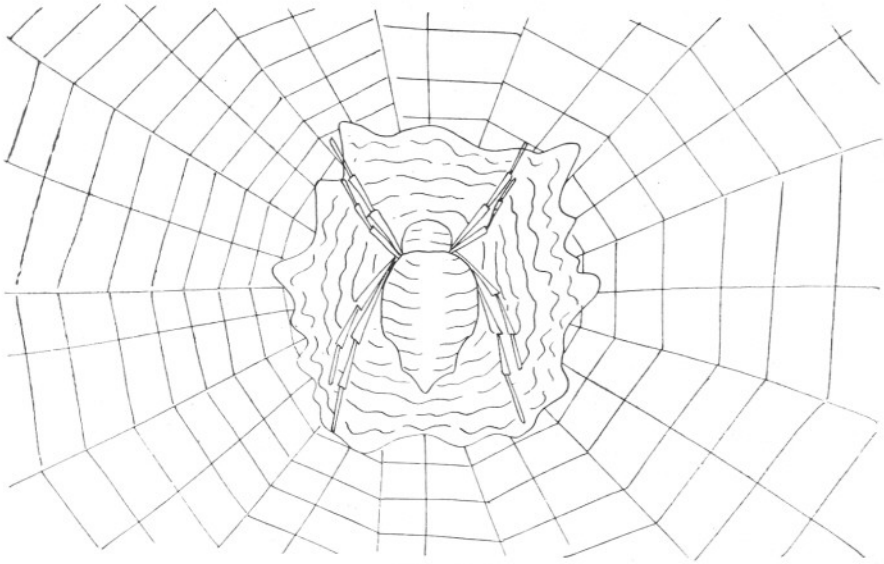

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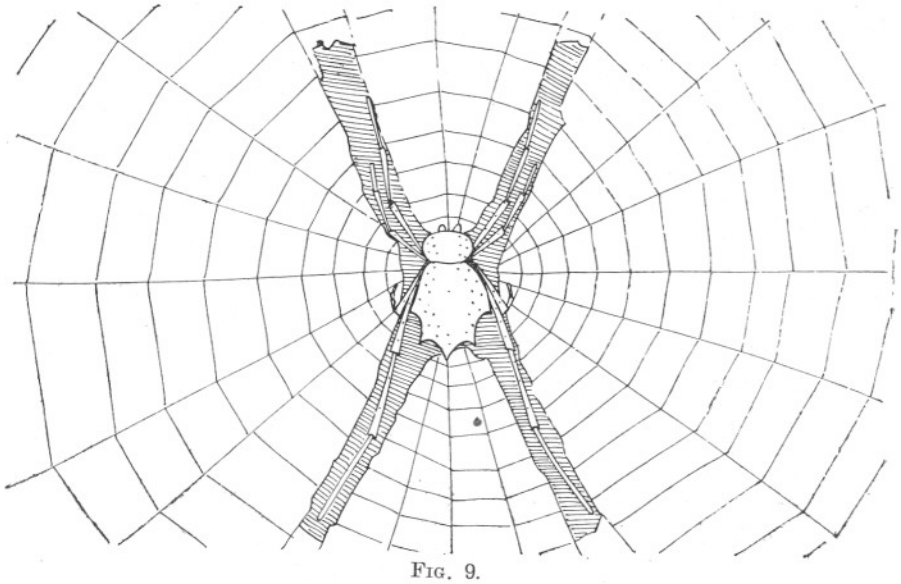


FIG. 9.

DIAMETRICAL BAND WITH CONFUSING DEVICE.

We saw that in the case of the pellet-making species there was one which, in addition to pellets, made a series of oval bands which had the effect of increasing the protection by producing a confusing effect. We find exactly the same in the band-making species. The spider makes the usual vertical band and fills a gap in the band with its body. But in addition it makes two or three oval bands, one within the other, around the snare centre. These confusion bands are whitish in colour and attract more attention than does the vertical band. Their effect is to confuse the enemy and draw its attention away from the spider when it is engaged in searching the snare.

CENTRAL SHEET. (Fig. 8.)

A simple, but not very usual form of device, is a sheet of silk at the centre of the snare. The sheet is white, either translucent or opaque. It forms a background against which the spider blends. The spider itself is silvery in colour and harmonises with the silk sheet.

SHEET IN FORM OF A CROSS. (Fig. 9.)

A modification of this simple form was met with in the Game Warden's garden at Nairobi. The sheet is not merely a central sheet; it is rather a cross-shaped carpet, broad at the centre on which rests the body of the spider, and with wide arms spread crosswise against which rest the spider's outstretched legs. The cross is white, almost opaque. The spider's body is in the main silvery and blends with its artificial cross.

CROSSED BANDS.

A rare species from the Nicobar group of islands puts two bands crosswise in its snare behind which it manages to hide itself. This cross is different from the last example. It is not a blending cross, but one which puts a barrier in front of the spider; it is a shield behind which the spider hides. The snare is spun against the bark of a tree, and the spider fits itself behind the cross, that is between the cross and the bark. Its body lies behind the centre of the cross and its outstretched legs behind the cross arms. The spider is therefore fully protected, by the cross on one side and the bark on the other.

SPIRAL THREAD. (Fig. 10.)

Several species put in their snares a conspicuous spirally arranged thread. The thread is quite distinct from the ordinary snare-threads. It is thicker, opaque, white and conspicuous. It is usually arranged in a somewhat wavy spiral around the body of the snare. The spider is small and inconspicuous and holds the usual seat at the snare centre. This spiral is one of the confusing devices. It is the thing

in the snare that most attracts attention. When the enemy approaches, it is attracted by the spiral, becomes confused by its wavy outline, and in this confusion the spider drops and escapes.

SPIRAL THREAD AND PELLETS. (Fig. 11.)

Another species improves on this spiral thread by supplying in addition a few decoy pellets. The thread is, as in the previous example, a white conspicuous confusing device. The pellets are usually two in number, one near each end of the spiral thread. The spider is small and inconspicuous and sits in the usual seat at the centre. In this instance the enemy is not only confused, but in addition is decoyed away by one or other of the artificial pellets. They are more spider-like than the spider itself, and the confused wasp is no doubt more tempted to strike at them than it is at the inconspicuous spider. Thus again we have the combination of confusion device and decoy.

CENTRAL ZIGZAGS.

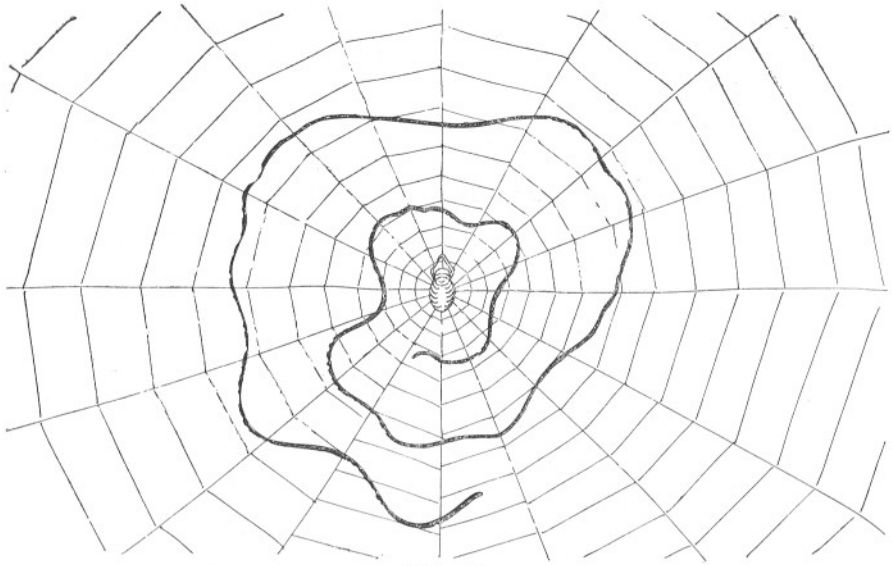
Other kinds of spiders go in for zigzag manufacture. One species makes a complicated system of zigzag threads all over the central area of its snare. The threads are white and very conspicuous. They are arranged in an outer circle of zigzags with a transverse series of zigzags inside it. They are closely packed with some of them overlapping. They give a confused appearance to the central area of the snare in the middle of which the spider sits. These zigzags partly confuse the enemy and partly conceal the spider by supplying a background with which it can to some extent blend.

DIAMETRICAL ZIGZAG. (Fig. 12.)

This is made by a large *Argiope* found in the gardens of Baghdad. A very conspicuous silvery zigzag ribbon is stretched along the vertical diameter of the snare. It is very vivid and attracts immediate attention, and is by far the most striking feature in the snare. In the middle of this zigzag ribbon is a gap in which the large spider sits. It aligns itself along the gap with its legs spread out in pairs crosswise around it. Its colour is uniform silver which makes it blend with the silvery zigzags. In addition the edges of its body are angulated and these angulations fit in with the angulations of the zigzag ribbon. The whole construction is of protective signficance. The spider, by sitting at the gap in the ribbon, makes itself part of a diametrical zigzag. It has no longer the appearance of a spider. It is just part of a weird silvery zigzag and has no longer the significance of a living thing.

CRUCIATE ZIGZAGS.

Another kind of *Argiope* from the Himalaya makes these zigzags on a more elaborate system. It places them in the form of the arms



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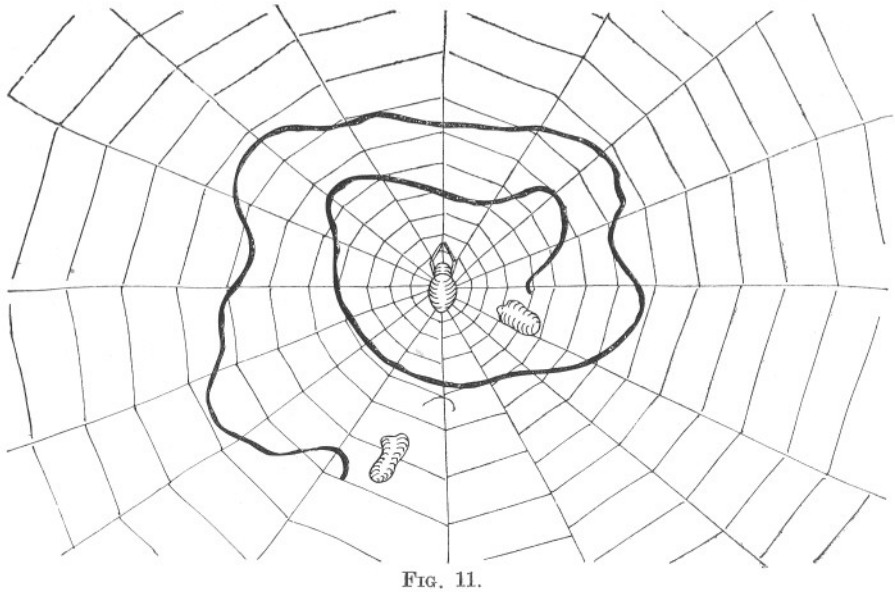

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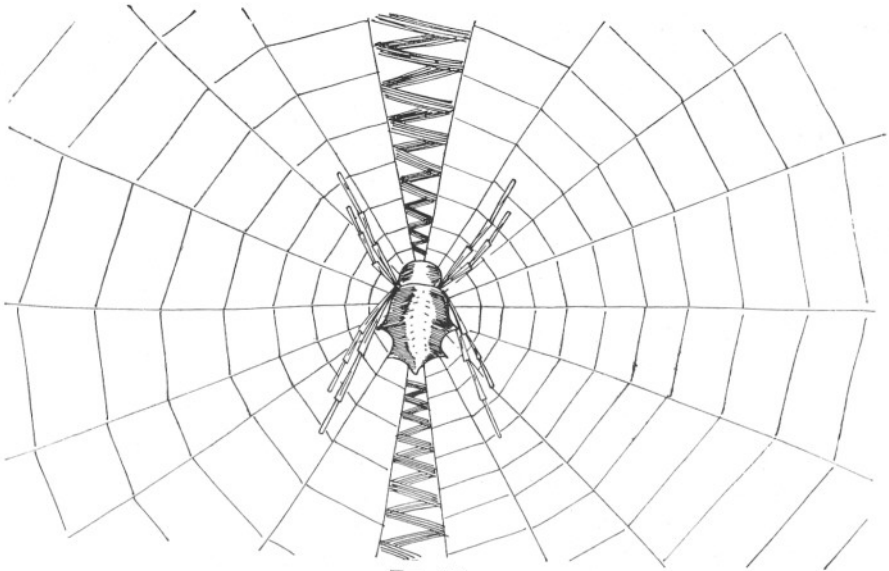

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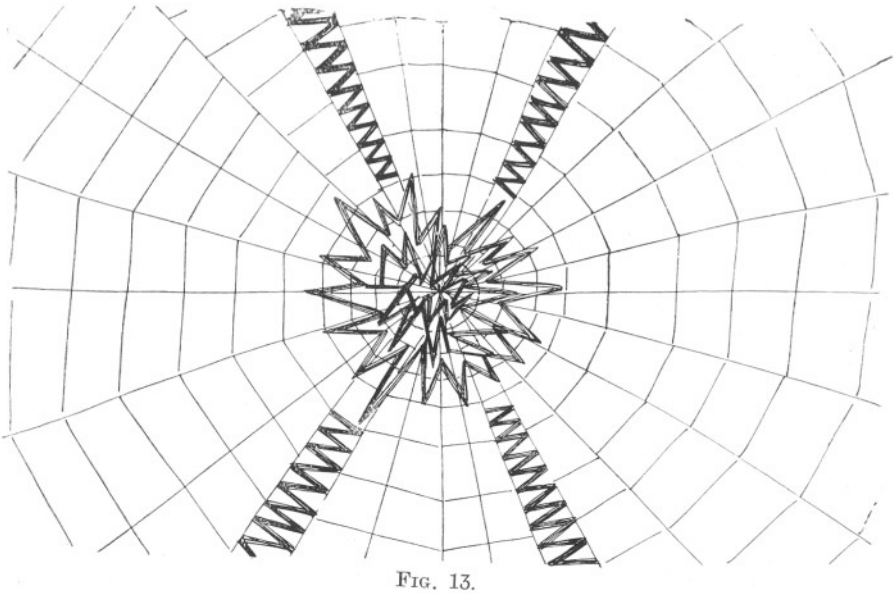

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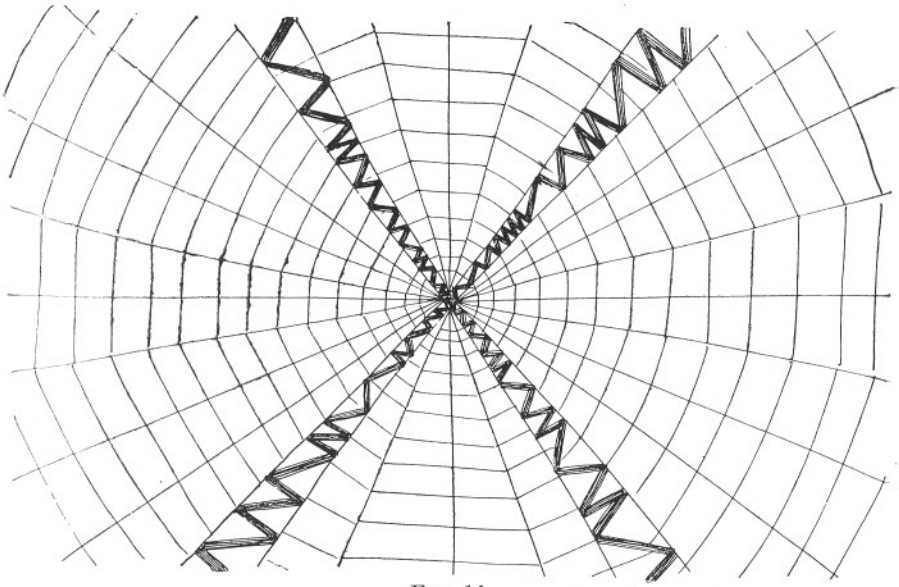

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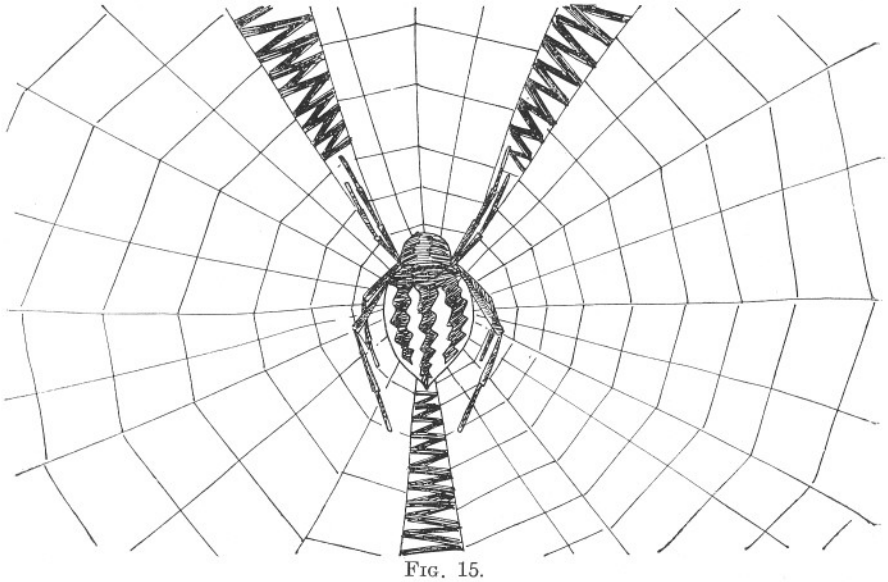

FIG. 15.

of a cross, leaving out the centre of the cross and filling the space with its own body. It stretches out its legs crosswise so that they are continuous from its body out into the arms of the cruciate zigzag. The body and the legs of the spider are silvery. Consequently the spider together with the zigzags forms a complete St. Andrew's Cross spread conspicuously through the snare. The result is that the spider looks no longer like a spider: it is just a bit of a silvery cross.

CRUCIATE ZIGZAG WITH CENTRAL ZIGZAG. (Fig. 13.)

Another kind from Central America elaborates the device a little further. It makes the cruciate arrangement as in the last example. But in addition it places at the centre a somewhat circular-shaped seat of zigzags. Again it becomes part of a St. Andrew's Cross, but in addition it has a silvery seat which helps to conceal it from view. It endeavours to hide itself behind this seat, and when danger happens to approach on one side it jumps across to the opposite side of the seat.

CRUCIATE ZIGZAG RIGHT ACROSS CENTRE. (Fig. 14.)

Another modification of this cruciate arrangement is the manufacture of a complete cross. In the previous instances the cruciate system consisted only of the cross arms. But a Central American species carries the arms of the cross right into the centre of the snare and thus perfects the cruciate arrangement.

TRIRADIATE ZIGZAGS. (Fig. 15.)

A species from Burmah is particularly instructive. Instead of making the zigzags diametrical or cruciate it spreads them in a triradiate system. A gap is left in the centre and the spider sits in the gap. Then the spider makes itself a part of the triradiate system of silvery zigzags. But the point of special importance is this: the spider's body is itself decorated with a triradiate silvery pattern. Its cephalothorax and the front of its abdomen are uniformly coloured silver. On the rest of the abdomen there are three irregular bands, one down the middle and one down each side. The silvery decoration is thus triradiate, and this triradiate adornment fits in well with the triradiate system of zigzags. The middle of the silvery abdominal bands appears continuous with the silvery zigzag that runs through the snare from the tail of the spider. The silvery bands on the sides of the abdomen appear continuous through the spider's front pairs of legs with the zigzags that stretch out from the head end of the spider. It indicates how these zigzag arrangements have essentially a colour significance and are designed for the purpose of protecting the spider.

CONCLUSION.

Thus it is clear that this group of creatures goes in for many kinds of artificial manufacture in order to conceal themselves and guard

themselves from attack. Small pellet-like globular forms make globular pellets exactly like themselves. Others make pellets to serve as decoys. Others use cocoons, others, bits of bark, others, bundles of packeted insects, all with the same definite object of putting in the snare artificial materials which as closely as possible resemble themselves. The others of a more elongated structure make bands of different kinds and hide themselves by becoming part of these bands. Others add different kinds of confusing devices, such as circular ribbons or spiral threads, which serve to disperse the enemy's attack. Then others make sheets against which they blend, others, bands behind which they hide, others, a strange variety of zigzags with which their silvery colours harmonise and destroy their spider-like shape.

When we consider all the peculiar variety of these contrivances, all the labour that is involved in their manufacture, all the expenditure of precious silk, all the wonderful elaboration of instinct that has been developed, we can get some dim idea of the struggle that these little creatures have to face in order to survive in the battle of life.