

ON THE SNARES OR SNAP-NETS OF THE AMERICAN AND EUROPEAN TRIANGLE SPIDERS (*HYPTIOTES CAVATUS* AND *H. PARADOXUS*).

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THE present paper, which does not record personal observations, attempts to bring together certain somewhat scattered information concerning the spinning habits of the spiders of the genus *Hyptiotes*, creatures whose triangular snap-nets present, without doubt, one of the most remarkable types of spider's snare as yet known.

Of the two well-recognised species, *Hyptiotes cavatus** belongs to America, and *H. paradoxus*† to Europe. Both are small inconspicuous animals; and are apparently attached, chiefly, to woods of fir and pine trees. *H. paradoxus* is widely distributed in Europe, ranging from Stockholm to Milan, and occurring also in England, France, Austria, etc. In this country, unfortunately, little is known of it; a single specimen was reported in 1863 from the North of England (Lake District of Cumberland),‡ and this for a long time was the only evidence of the creature's existence in these islands.¶ Within the last four years, however, the Rev. O. Pickard-Cambridge (as that naturalist obligingly informs the writer) has met with this spider in some abundance in the New Forest; and it is possible that the creature occurs in suitable spots in many parts of the country. From its occurrence in Cumberland and in Sweden, new localities for it are as likely to be found in the North as in the South of England, and it is hoped that the present compilation, by calling attention to the creature, may lead to its discovery in Yorkshire or Lincolnshire, or in other counties to which 'The Naturalist' is devoted. The American *H. cavatus*, which also ranges widely, is closely allied to *H. paradoxus*, but the writer is told by Mr. Cambridge, who possesses specimens of both, that the two are quite distinct. Originally found by Hentz in Alabama, *H. cavatus* has been attentively observed by Professor Wilder in the neighbourhood of

* *Cylopodia cavata*; *Hyptiotes americanus*.

† *Mithras paradoxus*.

‡ Blackwall, Notice of the capture of *Mithras paradoxus* in England, *Annals and Magazine of Natural History* (3), XIII. (1864), pp. 435-6.

¶ See Cambridge, *Spiders of Dorset*, 1879-81, p. 533.

Ithaca, New York, and by Dr. McCook in the neighbourhood of Philadelphia and elsewhere; in the opinion of the last-named naturalist it will probably be found to inhabit a great part of the United States.

The snares of these spiders, from their almost unique shape, and from the almost unique fact that they are capable of being 'snapped' by the owner, have naturally awakened deep interest among naturalists;* and it has even been doubted whether it is here or among the symmetrical orb-webs of Epeirids that the snare-making instinct has attained its greatest perfection.†

The general form of the roughly triangular snare will be readily gathered from the accompanying illustrations. The structure is seen to consist of a more or less horizontal trap-line, of four radii, attached distally to a more or less perpendicular base-line, and of a variable though limited number of cross-lines overlaying the radii. The trap-line and one of the radii are continuous, and this thread, presumably, is the original foundation-line of the snare. On the under-side of the trap-line, close to the object to which the line is attached, the spider takes up its position, clinging back downwards, and having, above it, as shown in Figs. 2 and 5, a coil or loop of slack line, furnishing a clue to the snapping-process already alluded to. The little animals possess the cribellum and calamistra, and use these organs in the fabrication of the cross-lines, which constitute the adhesive prey-catching part of the snare.

The earlier accounts of the snare refer to *Hyptiotes paradoxus*, the first with which the writer has any acquaintance being that of Thorell, published in 1860.‡ It was in the neighbourhood of Stockholm, in 1855, that Thorell first met with this spider. July, August, and September were the months in which it was found fully grown; and it occurred principally in woods of trees of the fir kind, especially in pine woods. The following is the account of the snare:—

Between the dry bare branches of two neighbouring trees, she spins a strong thread in a horizontal direction, from a point of which she afterwards draws obliquely downwards three other threads, which form equal

* McCook, *American Spiders and their Spinningwork*, I. (1889), p. 180.

† Pocock, *Royal Natural History*, VI. (1896), p. 223.

‡ Thorell, *Till kännedomen om släktena Mithras och Uloborus*, Öfversigt af Kongl. Vetenskaps Akademiens Förhandlingar, XV. (1860), pp. 191-205; the writer quotes from the paragraphs translated by the author in his *European Spiders*, 1869, pp. 67-71 (*Nova Acta Regiæ Societatis Scientiarum Upsaliensis* (3), VII., 1870).

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angles with the original thread and each other and lie in the same vertical plane. These four threads form the radii of the web; over them are laid concentric cross-threads, 16-22 in number, and tolerably wide apart. The loose net thus constructed forms a circular sector of about 45 degrees with a radius of a foot or more. It is therefore very large in proportion to the spider itself. The animal does not build itself any shelter or nest near the web, but hangs on the first-named horizontal thread that bears the web, near one of the twigs to which it is fastened, and at a considerable distance from the common point of intersection of the radii.

Next we have a note, in 1867, by Ausserer, who found the spider plentifully in the dry pine-woods of the Tyrol. It spins, he says, on coniferous trees, an incomplete orb-web, consisting of but 3-4 radii, and presenting, therefore, the form of an isosceles triangle;* the author is probably mistaken, however, in speaking of 3-4 radii, the number apparently being always four.

In 1872, Sordelli, who does not appear to have been acquainted with Thorell's account, published another descrip-

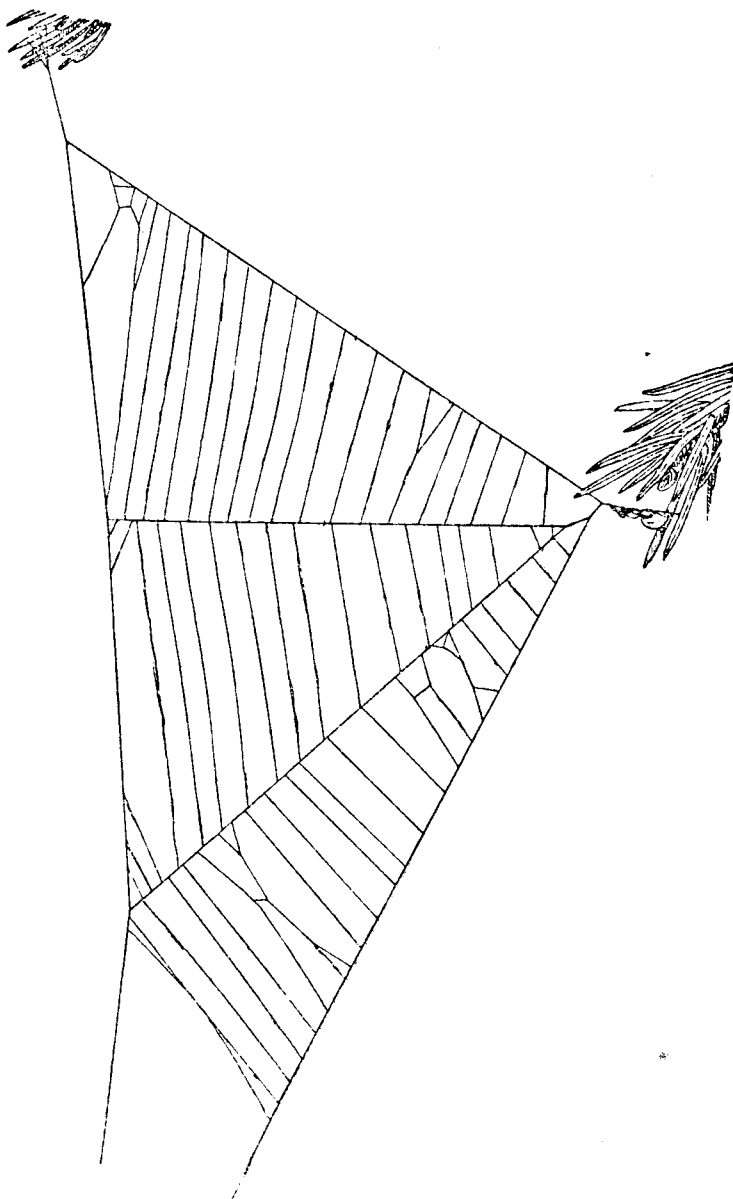


Fig. 1.—The snare of *Hyptiotes paradoxus*; from a sketch taken at Milan in 1871. After Sordelli, Atti della Società italiana di Scienze Naturali in Milano, XV. (1872) Tav. I., Fig. 1. Reduced.

* Ausserer, Die Arachniden Tirols nach ihrer horizontalen und verticalen Verbreitung, Verhandlungen der k. k. zoologisch-botanischen Gesellschaft in Wien, XVII. (1867), p. 150.

tion of the snare, accompanied by an illustration (Fig. 1). In the autumn of 1871 he found the spider within the city of Milan, close to the Museum to which he was attached, and was thus able to observe it at leisure. It begins its snare, he says, by extending an inclined thread between two small branches, in such a manner that the lower end is fixed firmly to the free extremity of one of the branches; and this extremity becomes the pivot of the snare and the point at which the spider remains in observation. From a point upon this thread, more or less near its lower end, the spider sends down another thread, much inclined, towards some lower branch, and placed so as to fall in a vertical plane with the first thread. Then by a third thread, vertical or almost so, the creature joins the first two, forming thus the triangular outline of the snare. From the angle formed by the first two threads are extended in succession two other threads to the opposite side of the triangle, in such a manner that they belong, as a rule, to the second, not to the first, thread. The warp of the snare, consisting of four convergent threads (radii) and a base-line, is now complete. Upon the convergent threads, however, have still to be woven other threads said by this author to be perfectly comparable to the spirals of *Epeira*, but here reduced to simple segments, instead of embracing a complete circle. These segment-threads (cross-lines) vary in number, from snare to snare, from about 15 to 25. The angle formed by the marginal radii also varies; as also does the size of the whole structure. The parting of the two intermediate radii from the lower marginal radius, not from the upper, and not both from the same, but from neighbouring points, are circumstances believed by the author to be useful in the matter of transmission of vibrations: he thinks that this disposition is calculated the more effectually to make known to the spider the exact part of the snare in which a struggling insect is to be found.*

These authors do not, as far as the writer is aware, make any mention of the snapping process, which American observers fully describe. I am indebted to Mr. Cambridge, however, for the information that his nephew, Mr. Fredk. O. Pickard-Cambridge, who was with him when *Hyptiotes paradoxus* was discovered in the New Forest, observed the habit in this animal

* F. Sordelli, *Intorno alla tela ed ai costumi di una specie di ragno (Mithras paradoxus)*, Atti della Società italiana di Scienze Naturali in Milano, XV. (1872), pp. 22-30.

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'of gathering the slack line of the snare in its claws, and suddenly releasing it.'

Hyptiotes cavatus, in America, has been more fully studied. Professor Wilder has published two papers on its snare and habits, one in 1873 and one in 1875: both illustrated, and having the advantage of being wholly original, the author being unacquainted with the writings of Thorell, Ausserer, and Sordelli; the second paper embodies the results of five seasons' work.* The subject has been further described and illustrated by Mr. Emerton† and by Dr. McCook.‡ The little spider, which is seen chiefly in late summer and autumn, resembles the European species in its attachment to pine trees. It has been found abundantly by McCook among the mountain pines of Central Pennsylvania; as well as in the flat, sandy, pine barrens of New Jersey; in pine groves on the sea-shore at Ipswich Bay, Massachusetts, etc. But it is frequently found in other situations, the same naturalist having observed it among shrubs and evergreens on the lawns of country residences; in groves of deciduous trees; in the under-bush of Woodland Cemetery, Philadelphia, etc. Wilder found it, in woods, on hemlock twigs; and Mrs. Treat|| found it, in New Jersey, among flowering-peas, the snare being attached to the dry sticks supporting the plants. In hanging the snare between the branches of trees, the creature generally chooses those which are dry and bare; but this is not a universal preference, the snare being often found among green needles of pine boughs and amidst green

* Wilder, The nets of *Epeira*, *Nephila*, and *Hyptiotes*, Proceedings of the American Association for the Advancement of Science, XXII. (1873), Part 2, pp. 264-74; The Triangle Spider, Popular Science Monthly, VI. (1875), pp. 641-55. The writer has to tender his thanks to Professor Wilder, who most obligingly sent him, from America, copies of these papers (and of other papers on spiders), and gave and obtained permission for the copying of Figs. 4-6.

† Emerton, The cobwebs of *Uloborus*, American Journal of Science (3), XXV. (1883), pp. 203-5; New England Spiders of the family Ciniflonidæ, Transactions of the Connecticut Academy of Arts and Sciences, VII. (1888), pp. 454-7; Structure and Habits of Spiders, 1878, pp. 75-9.

‡ McCook, On the Snare of the Ray Spider (*Epeira radiosa*), a new form of Orb-web, Proceedings of the Academy of Natural Sciences of Philadelphia, 1881, pp. 163-75; American Spiders and their Spinningwork, I. (1889), pp. 180-94, 195-207, III. (1893), pp. 275-7. The writer is indebted to Dr. McCook for permission to copy Figs. 2 and 3.

|| M. Treat, quoted by McCook, 1889, op. cit., I. (1889), p. 181.

foliage of other plants. The spider, a little dull-coloured creature about one-eighth of an inch long, is by no means uncommon; but it is not easily discovered. When in its usual position under the trap-line, its body is close against the twig to which the line is attached, and its legs are drawn together, so that the animal forms a compact brown mass, about the size and shape of a raisin-seed, much resembling the little projections commonly found on dry twigs.* Even the peculiar snare is apt to be mistaken for a fragment of the snare of some

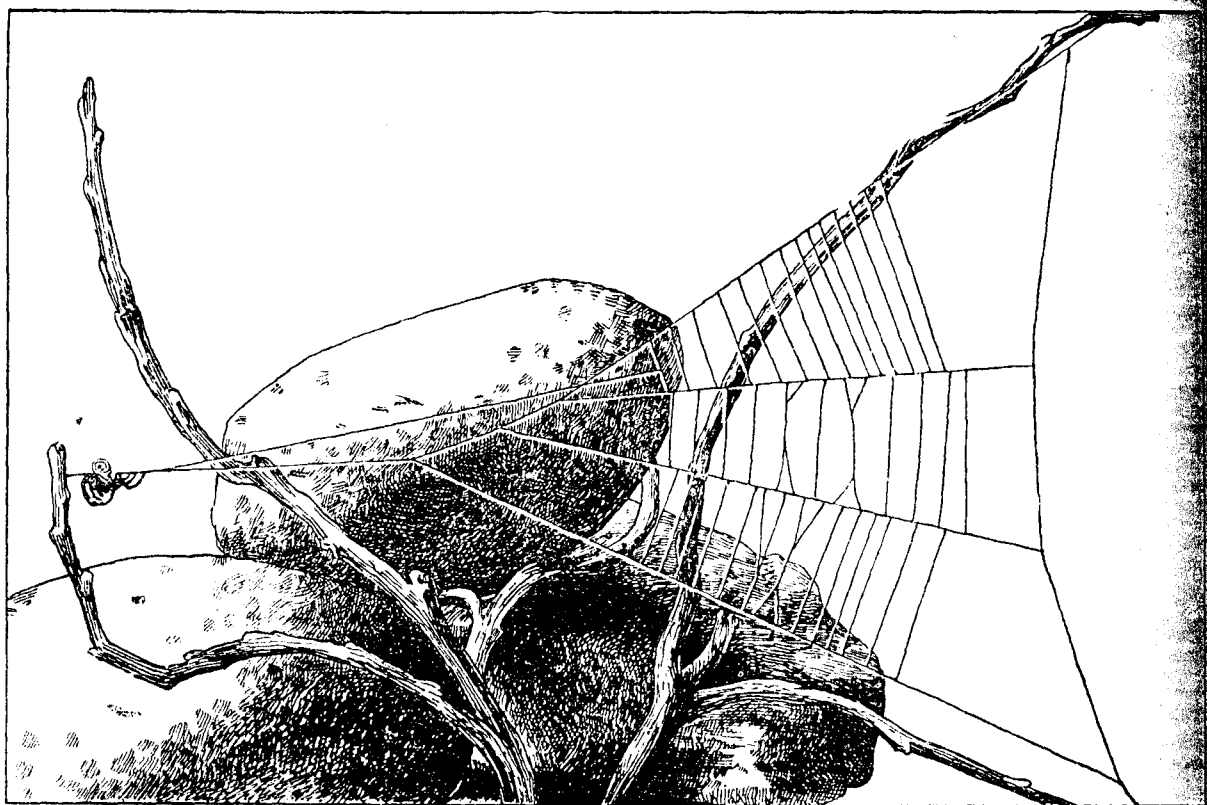


Fig. 2.—A snare of *Hyptiotes cavatus*, spun on a dry bush in a New England stone-fence. After McCook, [American Spiders and their Spinningwork, I. (1889), p. 181, Fig. 169. Reduced.

ordinary Epeirid. 'Strolling through the woods near Ithaca, New York, one October afternoon,' says Wilder, 'I saw, upon a leafless hemlock branch, what looked like a piece of the net of some geometrical spider;' still there was a regularity in the triangular net which did not accord with the idea of its being a fragment, and a closer examination showed that its form and structure were perfect and unbroken; and, moreover, 'instead of hanging loosely from the twigs, it was upon the stretch, as if constantly drawn by a power at one or the other end.'

* Wilder, 1875, l.c.

Fig. 2 (after McCook: reduced) represents a snare of this spider, spun on a dry bush in a New England stone-fence. According to McCook, the structure is usually placed low down, rarely more than three or four feet from the ground. It is generally more or less vertical; but perhaps never absolutely so, being usually somewhat inclined; often, as stated by Wilder, at an angle exceeding 45° ; and McCook mentions having occasionally found it more or less horizontal. According to Wilder's papers these snares are the work of females only, the males being believed to get a precarious living by hanging on to the snare of a female; Wilder admits, however, that young males may possibly spin snares; and it has since been ascertained by McCook that the males make snares exactly like those of the females; though here, as in Epeirids, males may sometimes be observed, during the breeding season, about the outskirts of the snares of females. As described by Wilder:—

The net is triangular in form and consists of four radii, never more or fewer, crossed by several (6-10) *independent* viscid lines; the centre of radiation is prolonged into a single nearly horizontal strong and short line which is attached to a branch or twig; the outer ends of the radii are attached to a second strong line more or less nearly vertical and nearly at right angles with the first.

Or, as stated by McCook:—

The appearance which the snare presents to the observer, is that of a circular sector, attached at the open or outer end to surrounding objects, and at the apex to a straight line of varying length, similarly anchored. The number of radii is always four, never more nor less, and in this number, of course, are included the two outside rays. The two central radii are crossed by lines which may be regarded as the equivalent of the spiral lines which intersect the radii in ordinary orbwebs.

The fact that the radii are constantly four in number is of interest, for uniformity in matters of this kind is exceedingly rare among spiders. In a hundred or more snares examined by Wilder there was no variation in this respect, and very numerous observations by McCook confirm that the number is invariably four. The radii do not, as a rule, diverge from a common point, so that there is ordinarily no true centre of radiation. This want of a common starting-point is well shown in Figs. 2 and 3: both from drawings of actual webs; but it is not indicated in Thorell's description of the European snare, or in Emerton's description and figure of the snare of the present species; Wilder's drawings (Figs. 4-6), moreover, show the radii running from points nearer together, apparently, than is usual in nature. Sordelli's drawing (Fig. 1) makes it clear that a common centre is wanting in the European snare, and in his

description, as we have seen, this author makes special mention of the different points from which the radii diverge; thus the two snares are doubtless similar in this respect, in which, as in every other respect (except as regards the number of the radii), both exhibit considerable variation. The distances between the radii, says Wilder of the present species, the number of the cross-lines, and the distances between them, as well as the dimensions of the several parts of the snare, all vary considerably; in ten snares, the trap-line (exclusive of the coil of slack) varied from less than half an inch to nearly 6 inches; and the triangular net itself from the apex to the base-line, from about 4 inches to more than 8 inches; by McCook the trap-line was found to vary from $1\frac{1}{4}$ inches to 13 inches; the net from $2\frac{1}{2}$ inches to 13 inches; and one snare measured by this author had a base-line of the extraordinary length of 26 inches. As regards the number of cross-lines, Wilder, as above quoted, gives 6-10, and in his second paper 6-15. Emerton gives 'a dozen or more,' and McCook, while regarding the prevailing number as 16 or thereabouts, notes a range of 5-22. These lines are possibly a little more numerous in the European snare, Thorell, as we have seen, giving 16-22, and Sordelli 15-25. McCook mentions of *Hyptiotes cavatus*, however, that the number is not constant even with the same individual: thus, for instance, a spider having 14 one day, had 19 on the day following. In intersecting the radii, these lines do not pass directly across them, but on reaching each radius they run along with it a little way before starting off on the other side; this condition, well shown in Figs. 4-6, is similar to that obtaining in what is called the notched-zone of certain orb-webs.* The cross-lines are adhesive and highly elastic; Wilder at first supposed them to be beaded like the spirals of Epeirids; but he soon found that this was not the case. He states that they are not provided with a fine floss like the characteristic threads of Amaurobiidæ,† but are merely double lines, the two strands being from $\frac{1}{500}$ to $\frac{1}{2000}$ of an inch apart. This, however, is not in agreement with the findings of Emerton and McCook, who have shown that these lines are flocculent, somewhat after the fashion of the threads of the family just named, the calamistra doing the curling in both cases. Emerton found a smooth thread running through the centre, the flocculent part of the line being arranged

* McCook, 1889, tom. cit., p. 187.

† Ciniflonidæ.

in regular loops; according to McCook there are three strands, viz.: the central smooth thread, and two curled threads, the latter crossing and recrossing above and below, and forming loops. The curled threads are not made separately and attached to an already existing thread as in Amaurobiidæ; both smooth and curled threads being, in the present case, spun at the same time.

The spider appears to prefer to construct its snare just before day. To its early habits in this respect Wilder (who kept many individuals in his house) attributes his failure to observe the whole process; twice he attempted to sit up all night, but the spiders appear to have commenced work just as he fell asleep in the morning. The construction of the warp of the snare—the radii, trap-line, and base-line—was never witnessed by this observer. The original line, as he supposes,

is doubtless air-carried. As to the subsequent steps, however, Wilder refrains from speculation; and, referring to Figs. 4-6, merely states that in some way or other the spider connects with the original line (*OE*) four others, constituting the base-

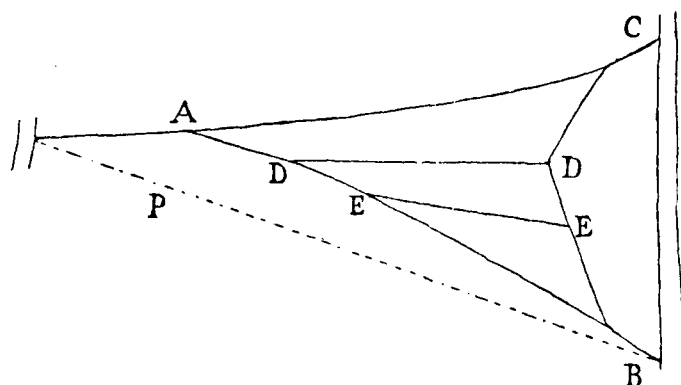


Fig. 3.—Diagram illustrating the possible manner in which *Hyptiotes cavatus* makes the framework of its snare. After McCook, *American Spiders and their Spinningwork*, I. (1889), p. 183, Fig. 171.

line (*BB*), and the three lower radii (R^{II} R^{III} R^{IIII}), which latter are joined to the base-line at *F*, *G*, and *H*. The upper radius (R^I) is formed, he adds, by the central part of the original line; and the three others unite with it at *A*, the apex of the triangle. McCook also failed to see the construction of these lines, and the order in which they are spun, by *Hyptiotes cavatus*, has not been observed, as far as the writer knows, by any naturalist. McCook, however, after a careful study of a number of snares, has made suggestions on this point, which may be here repeated. He thinks it probable that the spider first spins a thread represented, in Fig. 3, by the dotted line *PB*. She may then proceed to attach to this line, say at *A*, another thread, carrying it along *PB* to the place of attachment *B*, thence up the branch or other object to *C*, where the carried thread would be drawn taut and

fastened. Thus would be produced the line AC; and the original line, having been drawn upward by pulling upon AC, would assume the curved form of AB. The two marginal radii would now be in position. In the next place, presumably, the spider would drop from the point C to B, carrying with her a thread, which, attached at B, would become the base-line of the triangle CAB. Proceeding along BA, carrying with her a thread as before, she may now make another attachment at E, returning upon her course to B, and thence upward on the base-line to E, where the carried thread would be pulled taut and fastened, and would form the third radius EE; finally, it is supposed, the fourth radius DD would be put into position in a similar way. It is curious to note that while McCook here assumes the lower marginal radius to be part of the original line, Thorell, Sordelli, and Wilder, writing independently, each suppose the upper marginal radius to have this character. Sordelli appears to be the only author other than McCook who has entered into detail as to the order of construction of these lines. His remarks, relating to *Hyptiotes paradoxus*, already quoted, antedate those of McCook by seventeen years, but the latter author does not appear to have been acquainted with them; and it is interesting in this circumstance to find that, with the exception just alluded to, the statements of Sordelli and the suggestions of McCook are practically identical. According to the European author, the line AC (in Fig. 3) is the first, AB the second, CB the third, and DD and EE the fourth or fifth respectively. It is quite likely that this author, having ample opportunities for observation, saw the spider spin the lines in the order thus indicated; but the writer is not clear on this point.

Wilder, fortunately, twice witnessed the construction of certain of the cross-lines. In 1870 he saw the last cross-line (that nearest the apex) finished; and, in 1873, he watched the formation of the last five of these lines. At the time of the latter observation the spider had completed the warp and the first four cross-lines (in the wide basal region of the snare). As the observer took up his position, the creature was passing along the upper marginal radius from the direction of the apex; reaching the cross-line last completed, she turned round, seemed to make rough measurements with her body, and then, by drawing her spinnerets along the radius for a short distance (about 2 mm.) formed thereon an extended attachment. The spider then allowed her abdomen to fall away from the radius;

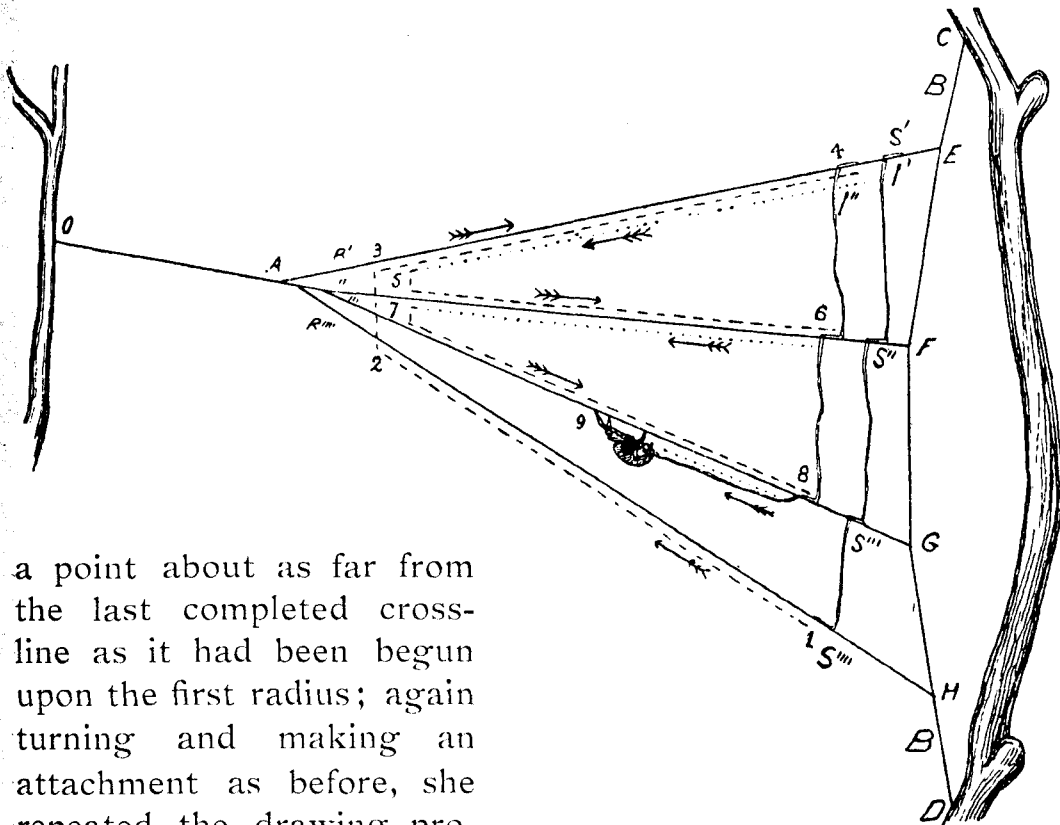
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and, hanging therefrom by the first and second pairs of legs and braced away by the third pair, she began to move the fourth pair simultaneously to and from the spinnerets, so as to extract from them an adhesive elastic line; while doing this, she moved slowly toward the apex, to a point where the inter-radial spaces were narrow enough to permit her to cross to the second radius; this she did, ceasing at the same time to draw out the line, which, as she now returned toward the last completed cross-line, contracted considerably, so that it was nearly of the proper length when the creature attached it to the second radius at



a point about as far from the last completed cross-line as it had been begun upon the first radius; again turning and making an attachment as before, she repeated the drawing process so as to carry the elastic line to the third radius, and from this to the fourth radius. The fifth cross-line was thus completed, and the spider, ceasing to draw out line, returned by way of the apex to the first radius, and began to spin a sixth cross-line, and afterwards a seventh, eighth, and ninth, all in the same way and at about the same distances apart. In the earlier more limited observation, the process, as far as it was seen, was identical; and the observer concludes that the method here indicated is the normal one; he assumes, moreover, quite safely no doubt, that the longer cross-lines (the construction of which he did not see) are put in in the same manner. The process is certainly

Fig. 4.--The snare of *Hyptiotes cavatus* in process of formation. After Wilder, Popular Science Monthly, VI. (1875), p. 649, Fig. 8.

curious, and well worth understanding; in his second paper Wilder illustrates it by a drawing (Fig. 4),* based upon the observations just noted, but referring, for convenience, to the longer cross-lines. In this drawing, the warp of the snare, and the first cross-line (I^1) are in position; and the manner of the subsequent movements of the spider are indicated by the numerals 1 to 9, and by the interrupted lines and arrows. The dashed line 1, 2, 3, 4, shows the route followed in order to commence the second cross-line (I^{11}). The dotted line 4, 5, represents the spider's track while spinning the first section of this cross-line; the dashed line 5, 6, shows her return to the proper point for attaching it. The dotted line 6, 7, and the dashed line 7, 8, in like manner indicate the track passed over in forming the second section of the same cross-line. The dotted line 8, 9, shows the progress of the spider towards making the third section. Thus, instead of beginning the second cross-line at S^{1111} , the spider begins it at 4; and instead of climbing up the first cross-line (I^1) or the strong and convenient base-line (BB), she runs to the point 2 near the apex, crosses the two intermediate radii, and passes along the upper radius (R^1) to the attachment of the first cross-line (S^1). On reaching this, she turns and forms the attachment of the second cross-line (I^{11}). Then applying the hind legs to the spinnerets as above described—moving them with great rapidity, at least five times a second, or 300 times a minute—the creature begins to spin the line, slowly moving the while along the radius until she reaches the point 5, where she can step across to the next radius (R^{11}). Ceasing to lengthen the line, she now runs along the second radius to the point 6, nearly under that whence she started. Again turning about, she here attaches the line to the second radius; and, recommencing the spinning process, she advances toward the apex, crosses at 7 to the third radius (R^{111}), runs out to 8, and attaches the line to the third radius. She then repeats, under this radius, the process of drawing out a line, and is represented, at 9, as having spun about half of it. It is necessary to remember that the spider, in the drawing, is not reduced like the snare; and that, in nature, the creature is

* In Figs. 4-6, the spider is of natural size, but the snare is considerably reduced; BB is the base-line, attached at C and D , to a hemlock branch; $E F G H$, points of attachment to the base-line of the four radii, R^1 to R^{1111} , which converge at A , the apex of the snare; I^1 to I^{11} [to I^{13}], the cross-lines; S^1 to S^{1111} , attachments of the first cross-line upon the radii; O , origin of the trap-line from a second branch.

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unable to step from one radius to another except near the apex. It will be seen, Wilder adds, that by first making the cross-line nearest the base, and afterwards the others in their order, the spider avails herself of the fact that a less and less distance has to be successively gone over before crossing from one radius to the next; whereas, if she made the shortest cross-line first, she would be liable to entangle the others if she crossed at the apex; or, if she went round by the base-line, the distances to be gone over would decrease inversely to the length of the lines to be

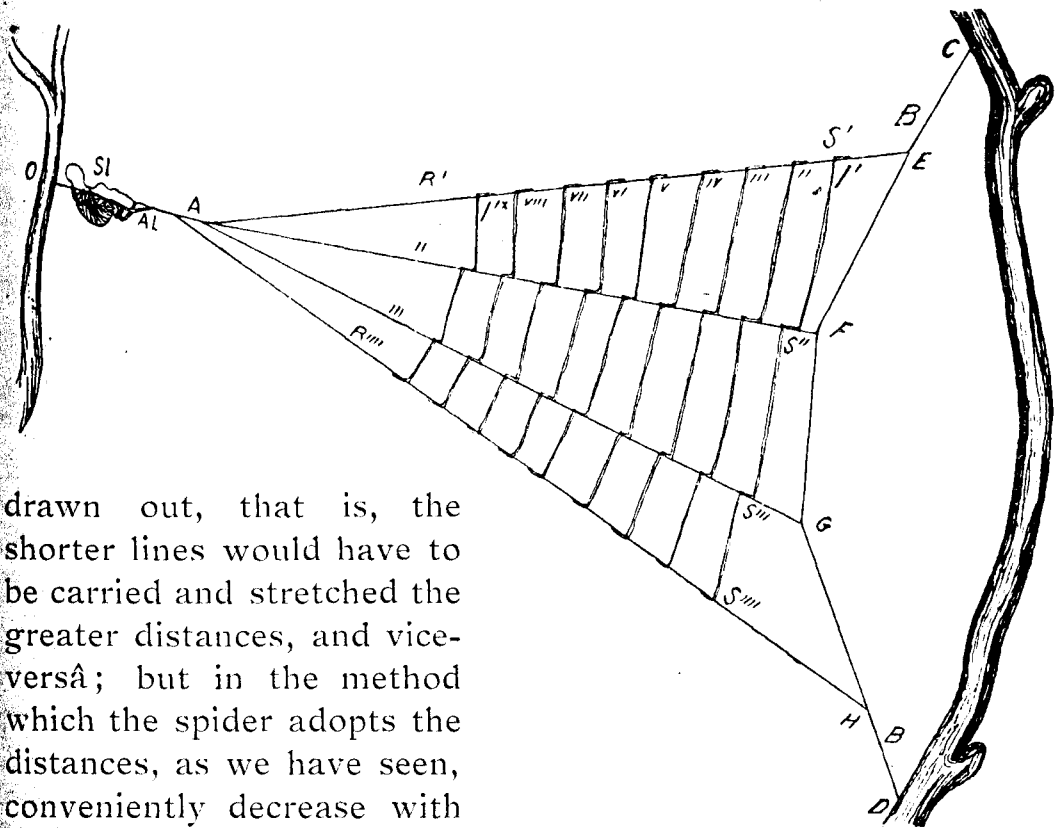


Fig. 5.—The snare of *Hyptiotes cavatus* upon the stretch. After Wilder, Popular Science Monthly, VI. (1875), p. 642, Fig. 1; Proceedings of the American Association for the Advancement of Science, XXII. (1873), Part 2, p. 267, Fig. 2.

drawn out, that is, the shorter lines would have to be carried and stretched the greater distances, and vice-versâ; but in the method which the spider adopts the distances, as we have seen, conveniently decrease with the length of the cross-lines themselves. As to the time required for the construction of these lines, Wilder mentions that those he saw spun (the five lesser ones) occupied the creature about ten minutes; the other longer ones, he thinks, may have taken twice as long, so that half-an-hour or more is probably occupied in the putting in of the whole of the cross-lines; during this time, Wilder estimates, the hind legs probably move over the spinnerets not less than 9,000 times.

The manner in which the spider uses the snare is fully described by Wilder, whose remarks on this part of the subject,

illustrated by Figs. 5 and 6, are based upon often-witnessed proceedings of many different individuals. The response to a continued disturbance of the snare by suitable prey, he says, is so sure that an observer may at any time witness the creature's operations.

As soon as the snare is completed, the spider, without a moment's rest, takes up her position under the trap-line (Fig. 5, *AL*), a little way from the point of attachment (*O*), with her head towards the snare. Firmly grasping the trap-line with the first and second pairs of feet, she pulls herself backward, by means of the hind pair of feet, until she reaches the point of attachment, into which, or into the trap-line near it, she fixes the hind feet. She has thus hauled in that part of the trap-line which intervenes between the point of attachment and the point grasped by the first and second pairs of feet; and this part of the line is now furled up above the creature in the form of a loop of slack (*SZ.*), which is held away from the body by the short legs of the third pair. This proceeding, of course, draws the snare towards the point of attachment, and puts it upon the stretch, the two intermediate radii (R^{II} R^{III}) and with them the central portion of the base-line (*BB*) being most affected. The strain put upon the structure is considerable; yet the spider often remains motionless for hours, perhaps for days, constantly holding the snare taut and ready for action.

After an insect has flown into the snare, the spider releases the slack of the trap-line, and the remarkable snapping process already alluded to is effected:

Our spider's ability to keep still is fully equalled by her capacity for action when the moment arrives; and yet she is by no means hasty; as a general thing (the exceptions being due perhaps to hunger, or inexperience), the vibration of the net by an insect must be pretty decided, and at least once repeated, before the spider feels justified in springing her trap; and when, as may sometimes happen naturally, but more often through experiment, a large or fierce insect is put into the net, nothing will induce the spider to budge; she will suffer her net to be wholly destroyed rather than expose herself or her reputation (?) to a doubtful encounter. Let us suppose, however, that a common fly, or a gnat, or a moth, has struck the net in passing—it may have touched a single cross-line*—but this adheres with the greatest tenacity, and is so elastic as to yield without breaking, so that each struggle involves the victim still more, and may even bring it into contact with the next cross-line. As soon as the violence

* Here, and elsewhere, Wilder does not use the term 'cross-line,' but writes instead 'double-line,' or 'interradial'; for the sake of uniformity I have ventured (without the usual indications) to suppress the latter terms in favour of the former.

and repetition of the vibration indicate that an insect is really entangled, the spider awakes from her apparent apathy; she lets go with her hind feet; the net, released from its tension, flies forward, and at the same time flaps from side to side. The comparative inertia of the fly causes the two or three cross-lines next to it on the side toward the apex to be, as it were, propelled against it, and the entanglement is aided by the sidewise flapping already mentioned; as may be imagined, all this is pretty apt to involve the fly beyond the possibility of escape; but, if the spider does not feel certain of this, she creeps backward again, foot over foot, as before, and again springs her net; and this I have seen repeated in quick succession

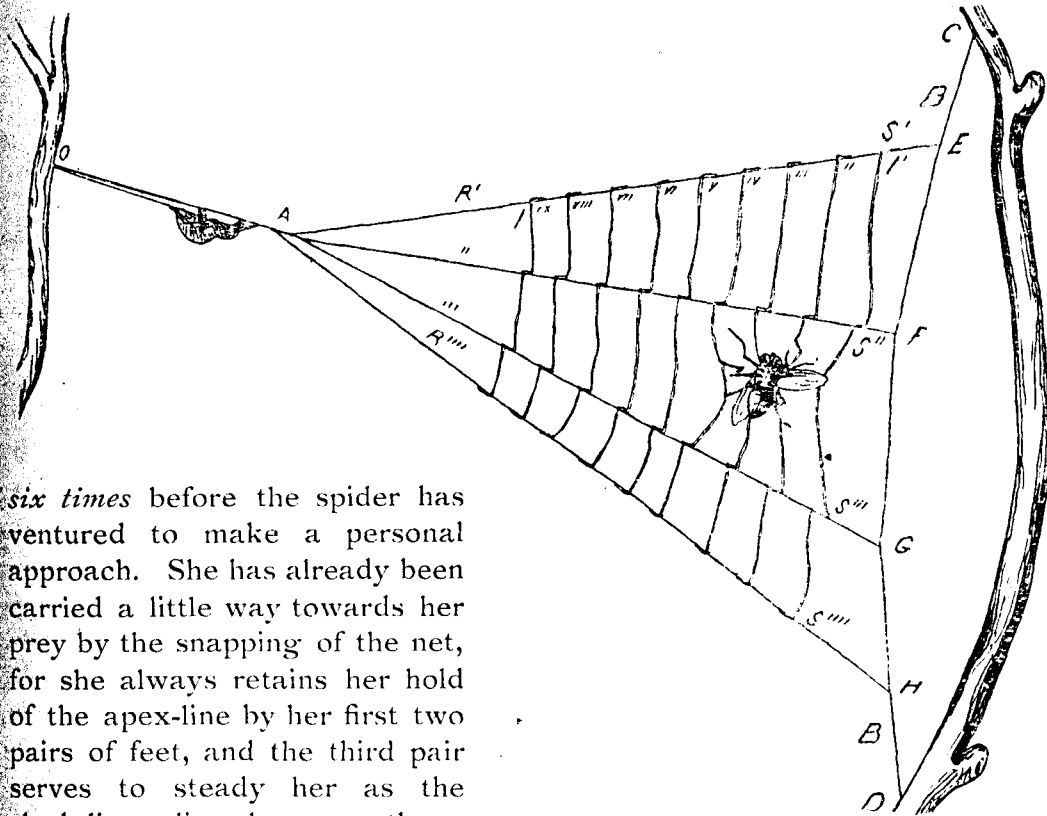


Fig. 6.—The snare of *Hyptiotes cavatus* relaxed for the entanglement of prey. After Wilder, Popular Science Monthly, VI. (1875), p. 651, Fig. 9.

six times before the spider has ventured to make a personal approach. She has already been carried a little way towards her prey by the snapping of the net, for she always retains her hold of the apex-line by her first two pairs of feet, and the third pair serves to steady her as the slack-line slips between them. Advancing now to the junction, she seems to ascertain the exact location of the fly by pulling upon the radii.*

The snare as it appears when relaxed is shown in Fig. 6; comparing this with Fig. 5 we see that the base-line is now more nearly straight; and, the loop of slack having disappeared, the trap-line is taut.

* Wilder, 1875, l.c. In the paper of 1873, the snapping process is thus described: by the loosing of the fourth feet, 'the strain is relaxed and the whole net regains its original condition with a sharp snap, which causes the elastic lines to vibrate in all directions and generally entangles two or more of them upon the insect; should this first attempt fail, the spider, which has been carried sharply forward with the line . . . again walks backward and again lets go; this is sometimes repeated six times in quick succession.'

Having decided as to the location of the entangled insect, the spider, Wilder continues, runs along the nearest radius; and sometimes, when the prey is small, or hopelessly entangled, merely pulls it up by means of the lines about it, and carries it to her accustomed station under the trap-line to be eaten. But more often the creature adopts a method of securing her prey believed by this observer to be peculiar to *Hyptiotes*:

Before reaching the apex (*A*), she cuts with her jaws the apex-line, but, as she keeps constant hold in front of the cut by her first and second pairs of feet, and has a communication in the rear through the line which most spiders always attach to a point behind them, she does not fall, neither is the net loosened beyond a certain limit; it usually seems to recoil about an inch; this recoil tends to entangle the prey like the original snaps of the net. The spider again advances, gathers the radii together and cuts them all, still keeping the line out behind; again the net recoils and collapses. Again she advances and cuts the radii; the net is now hardly distinguishable as such, and is falling together about the devoted fly; the spider now spreads her legs, gathers the net between them and flings it like a blanket over her victim; struggles are now in vain; but, 'to make assurance doubly sure,' the spider grasps the mass, transfers it to her third pair, and with them turns it over and over as a ball, hanging the while by her front legs, and, with the hinder pair used now *alternately*, drawing out from the expanded spinners broad sheets of silk which, relatively to the power of the fly, are like steel bands upon a man. Having in this way reduced the prey to a rounded ball, in which its limbs are hardly distinguishable, the spider takes it in her jaws and mounts to her place.

Thus, whenever this procedure is adopted, and in fact generally, the entire snare, made as it is with much labour and skill, is wholly destroyed in the capture of a single insect.*

McCook, also, has written on the manner in which the snare is used. One gathers that the just-quoted account of the way in which an insect is approached agrees with this author's experiences; but he does not regard the process as peculiar to *Hyptiotes*. Epeirids, he says, behave in a similar manner, and in capturing, swathing, and cutting out an insect they often destroy a sector of the snare consisting, sometimes, of as many as four radii: *Hyptiotes*, possessing only such a sector, destroys the whole snare. In many respects McCook's observations afford a general confirmation of those of Wilder; there are, however, certain points of difference in the two accounts. Examining the spider with a lens in its position under the trap-line, McCook found that between the second and third pairs of legs the line was usually taut, not slack as shown by Wilder, the slack being accumulated, in a considerable coil, between the

* Wilder, 1873, l.c.; 1875, l.c.

third and fourth pairs only. About three-quarters of an inch of line, according to McCook, is rolled up in this coil. Wilder, it will be remembered, attributes the tightening of the snare, brought about by the accumulation of the slack, to the pulling action of the hind pair of feet; but McCook, while admitting that the movements are very rapid and difficult to follow, says that the spider appears first to draw upon the trap-line with the fore feet, placing one before the other, as a sailor ascends a rope hand over hand; and, at the same time or immediately thereafter, she appears to execute a similar movement with the two hind feet, only reversing the direction. As regards the manner in which the snapping of the snare is effected, the result of Wilder's observation was, as we have seen, that the slack is released by the loosing of the hind pair of feet; and that the spider, which does not unclasp her fore feet, is carried forward with the snare. McCook's statement, however, is that the creature releases the coil by unclaspings simultaneously all the fore feet and those of the third pair; the hind feet, he says, 'hold to the trap-line and never let go until the spider abandons her position to visit the snare in search of prey;' and thus, he adds, the spider, though appearing to shoot forward with her snare, really remains stationary, or advances but a trifle.* McCook mentions, amongst other things, that he was successful in making the creatures exhibit the snapping process by touching them gently with a pencil; and it might be reasonably supposed that he attended carefully to the subject; but one is somewhat puzzled on finding that in a subsequent part of the work in which these observations are recorded he repeats a statement—made by him in a former publication†—which is in agreement, not with his own, but with Wilder's findings. The writer has had no opportunity of clearing up these points, to which, obviously, a future observer might usefully give attention.

We have still to compare the snare of *Hyptiotes* with those of other spiders. A glance at the figures will have been sufficient to suggest that this remarkable triangular net is none other than an incomplete, modified orb-web; and that this is the case has been maintained by Thorell and others, who entertain no doubt that the comparison thus made expresses a true relationship.

* McCook, 1889, l.c.

† McCook, 1882, l.c.

Hyptiotes, though anomalous, has undeniable affinity with *Uloborus*; and from various considerations, especially in view of the presence of the cribellum and calamistra, these two genera have been placed by a number of arachnologists, including Blackwall, among the tube-weaving spiders, in or near the Amaurobiidæ;* and this has been done even by Ausserer and Emerton, who were acquainted with the character of the spinning-work. Thorell, however, who has paid much attention to the classification of spiders, has no hesitation, on structural grounds, as well as with regard to habits and industry, in placing *Hyptiotes*, as well as *Uloborus*, among the orb-weavers; he makes for these genera a sub-family Uloborinæ, of equal value with Epeirinae, which together make up the great family Epeiroidæ of this author; other recent authorities, I believe, though they break up the family, speaking of Epeiridæ, Uloboridæ, etc., do not venture to disturb the general relationship which Thorell's classification implies. It is interesting in this connection to recall that the snare of *Uloborus*, unlike that of *Hyptiotes*, has the appearance of an ordinary full-orb.

Although the snare of *Hyptiotes* is so peculiar and so unlike that of any other known spider, it is easily seen, says Thorell, that it cannot be looked upon as a separate or independent form of web, and that, on the contrary, it must be classed with the orb-webs of other Epeiroids; 'here, as with them, it consists of radii diverging from a point, united by threads running concentrically; the difference is simply that, whereas with the other species belonging to the family it forms a closed circle, with *Mithras* [*Hyptiotes*] it is but a circular sector.' A transition, Thorell adds, 'may in a certain sense be looked for in the case, of which one sometimes meets with examples, where, in the common circular net, the interval between two radii is left open by the circular threads being terminated at these radii.' The author here refers, evidently, to 'sectoral orbs,' which are well represented, not only by *Nephila*, but also by *Zilla*, in which latter the small uncrossed sector is traversed by a single free-radius or trap-line. Another more evident transition, Thorell thinks, is furnished by a web noted by Darwin in a lofty valley of the Cordillera, near Mendoza; this singularly-formed snare consisted of strong lines radiating in a vertical plane from a common centre, where the spider had its station; two of

* Ciniflonidæ.

the rays only were connected by a symmetrical mesh-work; 'so that the net, instead of being, as is generally the case, circular, consisted of a wedge-shaped segment. All the webs were similarly constructed.'* Wilder, independently, has also compared the *Hyptiotes*-snare with the orb-webs of Epeirids, especially with the sectoral-orbs of *Nephila* and *Zilla*. Ideally, he says, one may at once draw a comparison between the triangle of *Hyptiotes* and the orbs of *Epeira* and *Nephila*; for the snare of *Epeira* is a complete circle, that of *Nephila* a circle lacking its upper sextant, while that of *Hyptiotes* is just about the sextant or sixth of a circle: the snare of *Epeira* is an entire pie, that of *Nephila* is a pie with a piece cut out, while that of *Hyptiotes* represents the missing piece: *Nephila* + *Hyptiotes* = *Epeira*. The triangular net, this author thinks, may perhaps be a further specialisation from the sectoral-orb of *Nephila*, the circle of *Epeira* being now reduced from five-sixths to one-sixth of its area; and a comparison with the sectoral-orb of *Zilla*,† he observes, is even more striking, for if we imagine the *Zilla*'s snare to be reduced from many radii to four, its free radius clearly represents the trap-line of *Hyptiotes*. Wilder is not satisfied, however, that these analogies involve any real zoological relationship; he points out that the *Hyptiotes*-snare differs from others in having a fixed number of radii; and that the entire independence of the cross-lines is in strong contrast with the spiral or looped cross-lines of the orb-webs. It will be remembered that the cross-lines of *Epeira* consist for the most part of a continuous spiral, and those of *Nephila* and *Zilla* of continuous loops running partly round the web, backwards and forwards, turning when the margins of the open sector are reached; these lines, further, are got into position by means of unadhesive scaffoldings. To be strictly comparable, *Hyptiotes* would have to lay down a similar scaffolding, and carry the adhesive line backwards and forwards from the upper to the lower marginal radius, from the lower to the upper, and so on in continuous loops; but, as we have seen, nothing of this kind occurs, the independent cross-lines of *Hyptiotes* being all commenced on the upper and finished on the lower marginal radius. The nature of the cross-lines, moreover, is absolutely dissimilar: beaded in *Zilla* and other Epeirids, and flocculent in *Hyptiotes*; but the importance of this distinction, perhaps, is diminished by

* Darwin, Beagle Journal, ed. 2, 1845, p. 38.

† *Epeira calophylla*.

the fact that the cross-lines of the full-orb of *Uloborus* are not beaded as in Epeirid-orbs, but flocculent as in *Hyptiotes*.

With regard to the snapping operation—commonly supposed to be peculiar to *Hyptiotes*—it is true that nothing clearly comparable is known among ordinary typical orb-weavers. Many of these latter, however, vibrate and even suddenly jerk their snares: according to Blackwall the Epeirids pull with their feet the radii immediately in connection with the part of the snare in which prey is entangled; and, suddenly letting go their hold, they thus produce a vibratory motion in the snare;* Wilder has observed that ‘ordinary *Epeiridae*, as well as *Nephila*, are accustomed to vibrate their snares, when touched by insects;† and many, perhaps all of them, ‘sometimes seize several radii in their claws, and draw them up and let them go suddenly’;‡ McCook states further that Epeirids, as they move cautiously toward their prey, sometimes pause and give two or three quick jerks; and those which, sitting in their dens, hold a trap-line in their claws, ‘frequently pull upon it, increasing the tension by drawing it towards themselves, and then letting it go again, making a series of rapid jerks.’ In these cases, however, as McCook adds, there is no coil of slack and no true snapping of the net. Moreover, the purpose of these movements does not seem to be that of increasing the entanglement of prey; for, while one can well imagine that such movements may often contribute to the embarrassment of a captured insect, McCook, who appears to have given considerable attention to this point, was never able to observe that such was the case.¶ All things considered, however, one cannot resist the conclusion arrived at by Wilder that the habits now mentioned may be the basis of the remarkable method by which *Hyptiotes* assures the entanglement of its prey.§

* Blackwall, *Researches in Zoology*, ed. 2, 1873, p. 288.

† Wilder, 1873, l.c.

‡ Wilder, 1875, l.c.

¶ McCook, 1889, tom. cit., pp. 195-207, 248-9, 338-9. Blackwall observes that Epeirids seldom fail by these means to excite ensnared insects to action, and guided by the struggles thus brought about the spider runs along the most contiguous radius to seize the victim; by these means also the spider probably ascertains, in the first instance, whether the entangled object is animate or inanimate (Blackwall, 1873, l.c.), and according to McCook, she appears also to determine the weight and energy of the victim in the same way. (McCook, 1889, l.c., p. 338.)

§ Wilder, 1873, l.c.; 1875, l.c.

This method, we find in conclusion, is not absolutely peculiar to *Hyptiotes*. It has been ascertained by McCook* that the little aberrant orb-weaver *Theridiosoma radiosum*† is in the habit of snapping its peculiar snare in a manner clearly comparable to the action of *Hyptiotes*. *Theridiosoma* was formerly regarded as belonging to the Retitelariæ, or as a connecting link between that tribe and the orb-weavers,‡ and though now looked upon as an orb-weaver, it should be noted that, being ecribellate, it is not of the family of Uloborids and thus not closely related to *Hyptiotes*. The snare is a vertical orb, the radii of which make up more or less distinct sectors, with axes meeting at the centre, from which runs a more or less horizontal trap-line. The spider takes up its position at the centre, resting partly on the trap-line, and looking away from the snare, not towards it as in *Hyptiotes*; the third and fourth pairs of feet command the axes of the sectors, while the two front pairs are extended along the trap-line. In its relaxed condition the snare is flat, but the spider habitually bows it, shortening the trap-line by accumulating a coil of slack between the fore pairs of legs or between these and the hind pairs; the snare is thus made taut, the centre being drawn inward until at last the whole structure takes the form of a cone or funnel. When the adhesive lines are struck by an insect, the spider, as described in detail by McCook, often springs the snare; and this it does by releasing the grasp of the fore feet upon the trap-line, whereupon the slack sharply uncoils, and the snare unbends and shoots quickly forward, instantly changing from the bowed form to the circular plane, and carrying the spider with it tail foremost. As in the case of *Hyptiotes*, the process is repeated if necessary, and the spider does not leave its position until it believes the prey to be well entangled.

POSTSCRIPT.—Since writing I have been favoured with a note from Mr. Warburton, in reply to an inquiry on the occurrence of *Hyptiotes paradoxus* in the New Forest. It is to Mr. Warburton that the credit of the rediscovery of the creature in England belongs||; he found it in August 1894, near Brocken-

* McCook, 1882, l.c.; 1889, l.c., pp. 195-207.

† *Epeira radiososa*.

‡ Cambridge, Spiders of Dorset, 1879-81, p. 427.

|| O. Pickard-Cambridge, Proceedings of the Dorset Natural History and Antiquarian Field Club, XVI. (1895), p. 116; F. O. Pickard-Cambridge, Naturalist, 1895, p. 33.

1900 July 2.

hurst (New Forest); but, taking the specimens by beating, he did not observe the snare. The Rev. O. Pickard-Cambridge, who visited the spot in June 1895, again collected the animal, finding numbers (immature) on dead lichen-covered branches of bushes of blackthorn and whitethorn; one was seen in its snare, and Mr. Frederick O. Pickard-Cambridge, by whom the elder arachnologist was accompanied, had the satisfaction of witnessing 'the sudden release by the spider of its trap-line, while at the same time it gave a sudden leap forward in the direction of the snare.'* Later, in July, adult specimens were obtained, but not without trouble, for the spider 'makes its snares among the dead lichen-covered twigs of almost impenetrable bushes of blackthorn and whitethorn, and is most difficult

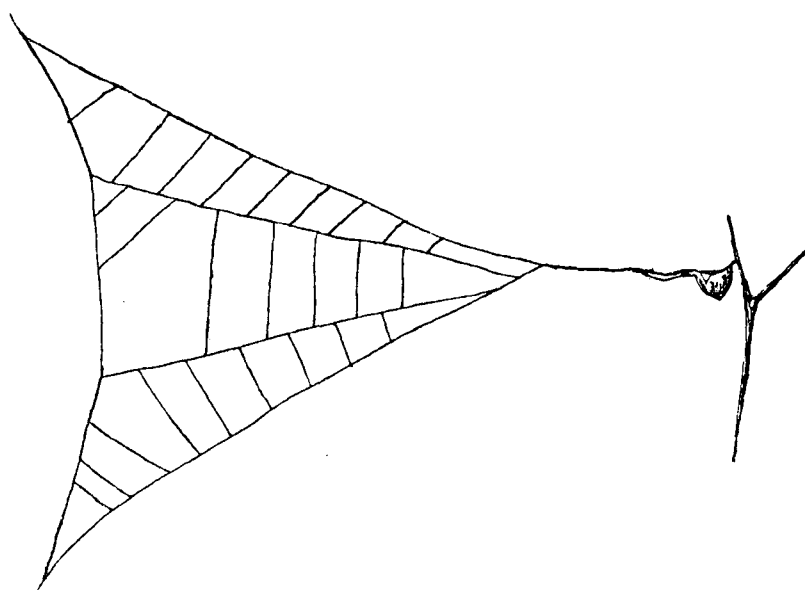


Fig. 7.—Sketch, from nature, of the snare of *Hyptiotes anceps*. After Castelnau, La Feuille des Jeunes Naturalistes, XXVII. (1897), p. 108. Reduced.

to obtain without getting right into the middle, underneath the thickest part of the bushes.'†

I may perhaps be permitted, finally, to call attention to a paper (previously overlooked by me) in which Mr. J. Castelnau, of Montpellier, writes of the habits of another European species, the *Hyptiotes anceps*.‡ The snare of this species, of which a rough sketch from nature is given, is of the characteristic

* O. Pickard-Cambridge, *ibid.*, p. 126.

† O. Pickard-Cambridge, *ibid.*, XVII. (1896), pp. 55-6, 61.

‡ J. Castelnau, Notes sur *Hyptiotes anceps*, La Feuille des Jeunes Naturalistes, XXVII. (1897), pp. 107-11.

triangular form, and has, like the snares of the other species, four radial lines (Fig. 7). It may well be compared, says Castelnau, to the snare of the fowler, for the spider can at will tighten or relax it. This, of course, is a reference to the springing process, a subject on which our author discourses at some length. There is a discrepancy, it will be remembered, between Wilder's and McCook's accounts of this process, as seen in *Hyptiotes cavatus*; and we have now to note that Castelnau's account for *Hyptiotes anceps* differs from both. When the spider is in position at the extremity of the trap-line, Castelnau says, this line is not attached to the twig near which the spider hangs, but is seen, on careful observation, to terminate between the animal's first two pairs of feet; the spider, the while, is attached to the twig only by the thread which runs from its spinnerets. It is this latter thread, according to Castelnau, which the spider—clasping it with the feet of the fourth pair—loops up into a coil, and which she releases (by unclasping the feet behind the coil) when she springs the snare; in this action, one learns, the spider immediately swings forwards, by reason of her own weight, a distance equal to the length of thread looped up in the coil, and the snare which she had been holding taut is thus at once relaxed.

NOTE—DIPTERA.

***Sphegina clavipes* near Grimsby.**—*Sphegina clavipes* has recently been taken in the Grimsby district.—A. SMITH, 5, Cavendish Street, Grimsby, 12th June 1900.

NOTES—ODONATA.

***Ischnura elegans* near Lincoln.**—At Burton-by-Lincoln, *Ischnura elegans*, 'A very small specimen (G. T. Porritt),' was taken by me, 18th June 1898.—J. EARDLEY MASON, Lincoln, 17th June 1900.

Swarm of Dragonflies at Grimsby.—At Grimsby quantities of *Libellula depressa* were seen about on the afternoon and evening of Sunday, 10th June, probably a migration.—A. SMITH, 5, Cavendish Street, Grimsby, 12th June 1900.

NOTES—COLEOPTERA.

***Telephorus paludosus* near Grimsby.**—*Telephorus paludosus* has recently been taken in the Grimsby district.—A. SMITH, 5, Cavendish Street, Grimsby, 12th June 1900.

***Rhagium bifasciatum* on the Summit of Helvellyn.**—As illustrating how far insects will fly, I found this wood-feeding species on the summit of Helvellyn to-day, weather fine and sunny. It was settled on the face of the Gough memorial-stone, fully 3,000 feet altitude.—W. DENISON ROEBUCK, Keswick, 18th June 1900.

1900 July 2.