

ART. XXVIII. *On the manner in which the Geometric Spiders construct their Nets.* By JOHN BLACKWALL, Esq., F.L.S., &c.

FEW animals of solitary habits are endowed with more extraordinary instincts than Spiders. The ardent affection for their offspring so strikingly manifested by some species; the exquisite skill displayed by many in fabricating silken cocoons to contain their eggs, and in the construction of their habitations; the highly curious contrivances by means of which others traverse the regions of air, or descend beneath the surface of water; and the various stratagems had recourse to by all in eluding their numerous enemies and in securing their living prey, are eminently calculated to attract the attention and elicit the admiration of every person who has a mind alive to the wonderful physiological phenomena exhibited by the inferior orders of animated beings. But interesting as the general economy of this remarkable tribe of animals is, and well deserving of more minute investigation than has hitherto been bestowed upon it, on the present occasion I purpose to limit my observations to the manner in which several British species of geometric Spiders construct their snares.

By the elegance of their symmetrical structure and their extreme delicacy of texture, the nets of these uneducated geometricians never fail to excite astonishment, even in the most thoughtless observer, and the pen of the natural historian has been frequently employed in describing the singular process by which they are formed. Among the various authors whose works I have consulted, Messrs. Kirby and Spence have given the most circumstantial account of this process in their comprehensive and excellent Introduction to Entomology;* I shall, therefore, avail myself of what these gentlemen have done, without reserve, introducing such particulars in addition as have resulted from my own researches, and attempting to solve a few of those difficulties which they have left without explanation.

The geometric Spiders usually suspend their nets in an oblique or nearly vertical position, fixing them to trees, shrubs, plants, buildings. &c.

* Vol. I., Letter XIII.

in places where the insects they prey upon abound. After selecting a suitable situation for her purpose, the Spider's first operation, in most instances, is to enclose an area, the figure of which appears to be a matter of indifference, with lines of her own spinning. This is effected by proceeding along the objects immediately surrounding the space destined to be occupied by the net, and attaching to several points, by pressing the spinners against them, a line drawn out after her in her transit from one to another. These marginal lines she strengthens with a few additional ones, and finally gives them the requisite degree of tension by applying to them in different directions numerous smaller threads. Having thus completed the foundations of her snare, in the next place she commences to fill up the outline. Fixing a thread to one of the boundary lines, along which she walks, she guides the filament produced in her progress with one of her hind feet, that it may not touch in any part and adhere prematurely; and crossing over to the opposite side, she there attaches it firmly by applying her spinners. To the middle of this diagonal thread, which is to form the centre of the net, she fixes a second, which in like manner she conveys and fastens to another part of the lines encompassing the area. Along this last-formed thread she returns, drawing out another after her, which, as she does not employ any means to keep it distinct, becomes connected with that on which she is advancing, and is ultimately glued by its extremity to the centre of the net. In this manner, but without observing any regularity in the order of her progression, she forms about twenty or thirty radii, composed of double lines, diverging from the centre to the circumference, and giving the net the appearance of a wheel. She then proceeds to the centre, turns herself round, and pulls each radius with her feet to ascertain its strength, breaking such as seem defective and replacing them by others. Her next proceeding is to produce, round the centre of the net, a spiral line extending thence to the circumference, and intersecting the radii, to which she attaches it by pressing her spinners against them. This spiral line, a few of the more central circumvolutions of which are much nearer to each other than are those removed to a greater distance from that point, serves as a temporary scaffolding for the Spider to walk over, and also to keep the radii properly stretched during her succeeding operations. It, together with the radii and marginal lines, is composed of unadhesive silk; but a spiral line has

now to be spun from the circumference around the centre, which may be regarded as constituting the most important part of the snare. It consists of a fine thread closely studded with minute dew-like globules, easily separable from each other by extending the elastic filament on which they are arranged. They are, in fact, globules of viscid gum, as is proved by their adhering to the finger and retaining dust thrown upon the net, while the unadhesive radii and exterior threads remain unsoiled. These viscid threads alone retain the insects which fly into the net, and as they lose their adhesive property by the action of the air, it is requisite that they should be frequently renewed, a process not neglected by the Spider, which evinces a perfect consciousness of its necessity. Placing herself at the circumference of the net, and fastening her viscid thread to the end of one of the radii, the Spider walks up that radius towards the centre, till she comes in contact with the last produced circumvolution of the unadhesive spiral line, along which she passes to the adjoining radius, drawing out the thread in her transit with the claws of the hind leg nearest to the circumference. She then transfers the thread to the claws of the other hind leg, and passing down the radius at which she has just arrived towards the circumference, she places the foot of the hind leg previously employed in drawing out the thread, on that point in the radius to which her filament is to be attached, and bringing the spinners to the spot there makes it secure. The precise place in each radius at which to fix the thread, is always ascertained by the situation of the foot of the hind leg, and this is determined by touching with the feet of those legs nearest the circumference, the marginal line, or, when the structure of the net is further advanced, the last-formed circumvolution of the viscid spiral line. As this last line approaches the several circumvolutions of the unadhesive spiral line, the Spider bites them away, being sensible that they are no longer of any use to her, and this fact explains why they are never seen intermixed with the circumvolutions of the former in finished nets. The viscid spiral line, whose circumvolutions are nearly equidistant, being separated by a space of one or two lines, is thus produced till it extends to the most proximate circumvolutions of the unadhesive spiral line, which occupying the central part of the net are suffered to remain; it is then discontinued, and the Spider making choice of some retired spot in the vicinity, there constructs a cell in which she may con-

ceal herself from observation. From the centre of the net to this retreat she spins a line of communication, composed of several threads united together throughout their entire length, the vibrations of which speedily inform her of the capture of her prey; and here her labours terminate.

Such is the process, with some slight modifications now to be noticed, employed by the geometric Spiders in the formation of their snares. One species generally converts a radius into the line of communication between the net and its retreat, instead of spinning a separate line for that purpose; and this peculiar appropriation, whether the radius be in the plane of the snare, or whether it be withdrawn from that plane, as is frequently the case, imparts an unfinished appearance to the net, as it prevents the spider from giving her viscid line a spiral form, though this is sometimes attempted with a greater or less degree of success. No sooner does the Spider arrive at one of the radii adjacent to that in connection with her cell, than she returns, traversing the frame-work of her snare till she arrives at the adjoining radius on the opposite side, when she again retraces her steps, and thus oscillating between the two, spins a number of curved viscid lines, or arcs of circles, diminishing in length from the circumference of the net towards the centre. Dr. Lister, who has figured and described this species in his *Treatise de Araneis*, fig. X. p. 47-8, was well acquainted with this peculiarity so common in the structure of its snare, but he has fallen into the error of supposing that it occurs invariably, as appears from the following passage cited from his work. “Rete
“ amplum & elegantissimum tendit: illud autem in eo perpetuum & sin-
“ gulare est, nimirum è radiis unicum *maculis utrinque nudari*, idque è
“ centro reticuli ad ejus usque circumferentiam; qui ferè ad aliquam in
“ pariete rimulam aut alibi, ubi animal tutò totum diem latet, porrigitur:
“ atque hic radius ei velut scala est, per quem ascendat descendatque.”

The learned authors of the Introduction to Entomology, in treating upon the construction of the nets of geometric Spiders, (for their remarks, though limited to the proceedings of an individual for the convenience of description, seem intended to apply to all,) state that the Spider always leaves a vacant interval round the smallest first spun circles that are nearest the centre, but for what purpose they are unable to conjecture; and that lastly, she bites away the small cotton-like tuft that united all the radii at the centre of the net, and in the circular opening resulting from

this procedure she takes her station and watches for her prey. In this account I recognize the proceedings of one only among several species of geometric Spiders with which I am acquainted. As far as my own observations extend, it never, like the last species, converts a radius into a line of communication with its retreat; and when it occupies the aperture in the centre of its snare, a thread from its spinners is generally connected with the innermost circumvolution of the unadhesive spiral line, by means of which it quickly lowers itself to the ground when suddenly disturbed. But there are other species which rarely, if ever, leave a vacant interval round that portion of the unadhesive spiral line allowed to remain near the centre of the net; neither do they form an opening at the centre, which almost invariably is left entire.

The reason why the viscid spiral line is not continued to the centre of the net is obvious, for by this arrangement the Spider is enabled to superintend her toils without incurring the risk of being entangled in them. The species referred to by Messrs. Kirby and Spence as always leaving a vacant interval round the smallest first spun circles that are nearest the centre of her net, produces fewer of these small circles than any other Spider that has fallen under my notice; consequently, if the viscid line were prolonged till it made a near approximation to them, the unadhesive lines about the centre would be too closely circumscribed, and the Spider would be subjected to great inconvenience.

Hitherto I have supposed the Spider to form her snare in places evidently easy of access to her; but it is not unusual to see nets fixed to objects between which it is quite impossible that a communication can have been established by any process alluded to above; between distant plants, for example, growing in water. "Here then," as the authors of the Introduction to Entomology observe, "a difficulty occurs. How does the Spider contrive to extend her main line, which is often many feet in length, across inaccessible openings of this description?" To this curious fact my attention has long been directed, and I have thoroughly satisfied myself, by observation and experiment, that in such instances Spiders invariably avail themselves of currents of air, by which their lines are sometimes conveyed to a surprising distance.

If the geometric Spiders be placed on twigs set upright in glazed earthen-ware vessels with perpendicular sides, containing a sufficient

quantity of water completely to immerse their bases, the Spiders, thus insulated, use every means in their power to effect an escape; all their efforts, however, uniformly prove unavailing in a still atmosphere; nevertheless, when exposed to a current of air, or when gently blown upon with the breath, they immediately turn the abdomen in the direction of the breeze, and emit from the spinning apparatus some of their liquid gum, which being carried out in a line by the current, becomes connected with some object in the vicinity. This the Spider ascertains by pulling at it with her feet, and drawing it in till it is sufficiently tense, she gums it fast to the twig, and passing along it speedily regains her liberty. Now, that the same means are frequently resorted to by Spiders in their natural haunts, for the purposes of changing their situation and fixing the foundations of their snares, I have repeatedly observed. I am aware that in the Introduction to Entomology an objection has been urged against the explanation of the difficulty here insisted upon. "If," say the learned authors, "the position of the main line be thus determined by the accidental influence of the wind, we might expect to see these nets arranged with great irregularity, and crossing each other in every direction; yet it is the fact, that however closely crowded they may be, they constantly appear to be placed not by accident but design, commonly running parallel with each other at right angles with the points of support, and never interfering." In favourable weather, it is well known, that the geometric Spiders usually begin to construct their nets soon after the close of day, and as similar processes must be influenced in a like manner by the simultaneous operation of the same cause, the lines of individuals carried out by a current of air till they become attached to some distant object, will be all parallel or nearly so. This regularity, therefore, instead of militating against the opinion maintained above, appears to me to furnish a powerful argument in support of it.

Sometimes the geometric Spiders suspend their nets in places not entirely surrounded by objects to which, in the first instance, they can proceed and attach their boundary lines. In such cases their operations are deserving of attention. After spinning a few radii, which are fixed to several distant points most accessible to her, the Spider fastens a thread to one of them, gluing it to that extremity which is farthest from the centre of her net. Along this radius she walks, drawing out the thread

after her, and guiding it with one of her hind feet, till she reaches its point of union with one of the adjoining radii: on to this radius she steps, and passing along it to the other extremity, there makes fast her thread; by this simple process connecting with marginal lines distant objects between which no direct communication previously existed.

In the formation of their nets Spiders are regulated chiefly by the sense of touch, which they possess in high perfection. This is rendered extremely probable by the general tenor of their proceedings; for example, they ascertain when they have the full complement of radii by approaching the centre of the net, which is their common point of union, and touching each in succession with the feet, supplying deficiencies wherever they are perceived; and I have already remarked, which greatly tends to confirm this opinion, that they generally construct their snares in the night. The fact, however, is established beyond dispute by the following circumstance. I have repeatedly confined Spiders in glass jars placed in situations absolutely impervious to light, and yet during their captivity they have produced perfect nets of admirable workmanship.

Spiders were supposed by Dr. Lister* to be able to retract their threads within the abdomen; and whoever minutely observes the geometicians when fabricating their silken snares, will be almost induced to entertain the same belief. The viscid line produced in the Spider's transit from one radius to another, is sometimes drawn out to a much greater extent than is necessary to connect the two, yet on approaching the point at which it is to be attached, it appears rapidly to re-enter the spinners, till it is reduced to the exact length required. This optical illusion, for such it is, is occasioned by the extreme elasticity of the thread, which may be extended several inches by the application of a slight force, and on its removal will contract into a minute globule of almost inappreciable dimensions. The viscid line alone possesses this property in a remarkable degree, (the radii and marginal lines being almost destitute of it,) by which it is adapted to the frequent and rapid changes in distance that take place among the radii when the net is agitated by winds or other disturbing forces; and by which the insects that fly against it are more completely entangled than they otherwise could be, without

* *De Araneis*, p. 8.

doing extensive injury to the frame-work of the snare. How this viscid line is fabricated is at present unknown. An examination of its structure, and of the apparatus by which it is produced would furnish interesting employment for the microscope.

In order to determine whether objects entangled in their toils are animate or inanimate, the geometric Spiders pull with their feet the radii immediately in connection with that part of the snare in which they are suspended, and suddenly letting go their hold, produce by this means a vibratory motion in the net which seldom fails to excite to action such insects as are ensnared. Guided by the struggles of her prey, the Spider runs along the most contiguous radius to seize her victim, avoiding any contact with the viscid line as much as possible, and drawing out after her a thread attached to one of the lines near the centre of her net, which serves to facilitate her return.

I regret that I am unable to particularize those species of Spiders which have been more especially the objects of the preceding observations and experiments; but so little has been accomplished in this interesting branch of zoology by British faunists since the time of Lister, that hitherto all my attempts to determine some of them have proved ineffectual.

Previously to giving my remarks publicity, I would gladly have availed myself of the labours of our continental neighbours in this department of natural history, but this would have been attended with considerable inconvenience and much delay, and I am well informed that the works of M. Walckenaer, who is regarded as the highest authority on this subject, are out of print, and cannot be procured either in London or Paris.* A book descriptive of British Spiders, if ably conducted, and accompanied with accurately coloured engravings illustrative of species, would, I do not doubt, be very favourably received by the naturalists of this kingdom. That such a publication should still be a desideratum in the country which has produced a Ray, a Lister and a Willughby is a humiliating reflection.

* M. Walckenaer has commenced, in the *Faune Française*, (a work now in progress,) a history of the spiders which inhabit France. This will probably include the greater number of the British species.—ED.