

tumours ; and it is common to see a peculiar white appearance, often in rings, on the interior of the stomach. These portions are denser than the ordinary mucous surface, and often slightly elevated. Under the microscope they are fibro-granular. It is probable that they originate in some former parasitic inroads.

A succinct Review of recent Attempts to explain several remarkable Facts in the Physiology of Spiders and Insects. By JOHN BLACKWALL, F.L.S.

[Read April 2, 1863.]

MY friend Mr. Meade, in his valuable report "On some Points in the Anatomy of the *Araneidea*, or true Spiders, especially on the internal structure of their Spinning Organs," * has been induced by his researches to adopt the opinion that these animals can propel from their spinners, to a considerable distance, fine lines formed of the viscid fluid secreted by appropriate organs situated in the interior of their abdomen. This hypothesis, based on zoological considerations, being directly opposed to the conclusion arrived at by myself from numerous carefully conducted experiments, merits an impartial examination.

After having briefly stated the general results obtained by his dissection of several species of spiders, and minutely described the organization of the internal vessels that elaborate the material which, on issuing from the papillæ connected with the spinners, forms filaments of extreme tenuity, Mr. Meade remarks, "I have now arrived at the most interesting but most difficult part of my task, viz. the question whether there is anything in the structure of the silk-forming organs that will decide the question as to the power of spiders to eject their threads to a distance. Looking at the strong fibrous coat on the ducts of the membranous sacs, and the fibrous tissue surrounding the glands themselves, I think that they must possess a powerful contractile power, which may also be increased by the muscular coat of the integument enabling the spider to compress its abdomen. May not the striated bands of muscular fibres, which run in a parallel direction down the middle of the abdomen quite into the interior of the spinnerets, and surround the termination of the ducts, also assist in this object? They are not attached to the tegumentary coverings of the spinnerets like the other muscles, and cannot therefore be for the

* Report of the Twenty-eighth Meeting of the British Association for the Advancement of Science, p. 157.

purpose of moving these processes ; their action must be to draw the spinnerets inwards." Such is the evidence supplied by dissection in support of the opinion that spiders can forcibly eject their lines to a distance.

Now it is manifest from well-known physiological facts that the muscles distributed to the spinning-organs perform various functions, the office of some being to give motion to those parts, of others to close either the minute aperture in the dilated base of the tubular papillæ, or that of the fine ducts which terminate the vessels that secrete the fluid employed by spiders in the process of spinning, as its issue from the papillæ can be instantaneously prevented at the will of the animals ; others, moreover, must possess a contractile force sufficient to propel the fluid to the open extremity of the delicate hair-like papillæ, exactly as the non-viscid fluid, propelled by the contraction of the muscles connected with the vessel that secretes it, passes out of, but is not ejected in a stream from, the minute orifice situated near the extremity of the fang that terminates the falces.

To this extent I am prepared to admit the influence of the muscles that contribute directly or indirectly to the action of the spinning apparatus ; but that a remarkably viscid fluid, which immediately becomes concrete on exposure to the air when drawn out in a filament of such marvellous tenuity as the lines produced by spiders, can, notwithstanding its extreme levity and flexibility, and quite irrespective of the size of the animals producing it, be propelled by any physical power with which they are endowed in a straight line of many feet in length, through a resisting medium liable to rapid fluctuations like the atmosphere, does appear to be in the highest degree improbable, and is, as already asserted, directly at variance with the result of an extensive and elaborate experimental investigation of the subject*, a brief abstract of which I proceed to give.

Spiders, if placed on wooden or metallic rods set upright in glass vessels with perpendicular sides, containing a sufficient quantity of clean water completely to immerse their bases, in vain attempt to effect an escape from them in a still atmosphere ; all their efforts to accomplish the desired object, though perseveringly persisted in, proving quite unavailing when they are placed under a glass-shade, or in any situation where the air is not liable to be

* Transactions of the Linnean Society, vol. xv. p. 455 ; Researches in Zoology, pp. 242-248 ; A History of the Spiders of Great Britain and Ireland, part 1st, p. 12.

disturbed. However, should individuals thus insulated be exposed to a current of air, either naturally or artificially produced, they instantly turn the abdomen in the direction of the breeze, and emit from the spinners a little of their viscid secretion, which, being carried out in a line by the current, becomes connected with some object in the vicinity, and affords them the means of regaining their liberty. This line uniformly moves in the direction and with the velocity of the stream of air; but if, while proceeding from the spinners, it be subjected to the action of a lateral or opposing current, it immediately becomes deflected from its course by the new impulse thus imparted to it.

I may here remark that numerous species belonging to various genera of spiders,—*Drassus ater*, *Ciniflo similis*, *Ergatis latens*, *Tegenaria civilis*, *Celotes saxatilis*, *Dysdera erythrina*, and *Oonops pulcher*, for example,—though provided with highly organized spinners, yet do not appear to be endowed with the instinct to avail themselves of a current of air for the purpose of transmitting their lines to a distance.

The manner in which the lines of spiders are drawn out from the spinners by a current of air admits of an easy explanation. As a preparatory measure, the extremities of the spinners are brought into contact, and viscid matter is emitted from the papillæ; they are then separated by a lateral motion, which extends the viscid matter into filaments connecting the papillæ; on these filaments the current impinges, drawing them out to a length which is regulated by the will of the animal, and on the extremities of the spinners being again brought together, the filaments coalesce and form one compound line.

The only legitimate deduction from the foregoing experiments, which have been frequently repeated under every variety of circumstances likely to affect the result, appears to be that the lines produced by spiders are not propelled from the spinners by any physical power possessed by those animals, but that they are invariably drawn from them by the mechanical action of external forces.

§ 2.

The importance of the greatly diversified form of the remarkable organs connected with the radial and digital joints of the palpi of male spiders, in affording valuable specific characters in numerous cases in which species so closely resemble each other in size, colour, and economy as scarcely to be distinguished except by minute differences in their external structure, is beginning to

be duly appreciated by arachnologists, whose attention hitherto has been almost exclusively directed to investigations having for their object the discovery of the function performed by those organs—a highly interesting problem undoubtedly, the solution of which long continued to exercise the skill and ingenuity of zootomists and physiologists. Though the palpal appendages are now known to have a strictly sexual character, and have, in fact, been demonstrated by experiment to constitute a true intromittent organ absolutely essential to fecundation *, yet no direct communication has been ascertained to exist between them and certain vermicular vessels situated in the abdomen, and usually regarded as testes, whose ducts terminate in the space intermediate between the branchial stigmata. M. Dugès has attempted to obviate this difficulty by shrewdly suggesting that these parts may have been voluntarily brought together prior to the act of copulation, and then proceeds to ask, “le conjuncture” (palpal organ) “ferait-il alternativement l’office de siphon absorbant et d’organe éjaculateur?”—a question which he answers in the following terms:—“cela se peut, mais je n’ai rien pu observer, qui justifiât directement cette conjecture.” †

In a concise notice of a work on the habits of the *Arachnida*, by A. Menge, given in the ‘Reports on Zoology,’ for 1843 & 1844, p. 195, published by the Ray Society, the following passage occurs:—“Copulation. It was reserved for the author to solve the physiological enigma which this act had hitherto presented. The spoon-shaped palpi of the males are in fact the copulative organs, with which they take the semen from the appropriate openings of the seminal ducts on the base of the abdomen, and transfer it to the sexual opening of the female. The procedure is carefully described in various Spiders.” Not having had an opportunity of perusing the work of M. Menge, I am unable to state the particular observations which have led to a conclusion so precisely in accordance with the supposition previously entertained by M. Dugès.

This view of the subject I am incompetent either to confirm or refute, as in the course of extensive and minute investigations I have not succeeded in observing the act above described; and yet

* Researches in Zoology, pp. 295–298; Report of the Fourteenth Meeting of the British Association for the Advancement of Science, pp. 67–69.

† Annales des Sciences Naturelles, 2de série, Zoologie, tome vi. pp. 189, 190.

in numerous cases it ought to be very apparent, as the shortness of the palpi would render a strong inflection of the cephalothorax towards the inferior surface of the abdomen absolutely requisite before they could be applied to the part indicated as the seat of the seminal ducts.

I shall conclude these remarks with the statement of a few facts bearing upon the question, which have come to my knowledge in pursuing researches relative to the generation of Spiders.

In the act of copulation, the extremity of the organ of each palpus of the male, in a state of tumefaction, is usually introduced alternately into the vulva of the female, and that many times in succession, without being once brought into contact with any part of its own abdomen, though it is very frequently conveyed to the mouth; and I have observed a male *Lycosa lugubris* apply its right palpus eighty times, in the manner above described, to the vulva of a female (both of which had been placed in a clean glass phial), without the possibility of bringing it into contact with the inferior surface of its abdomen, except by a very conspicuous change of position; and as an equal number of similar acts were performed by the left palpus, we have the extraordinary fact of the palpal organs being employed 160 times during this greatly protracted process, unaccompanied by any contact whatever with the part where the seminal ducts are considered to terminate.

A male *Agelena labyrinthica*, confined in a phial, spun a small web, and among the lines of which it was composed I perceived that a drop of white milk-like fluid was suspended; how it had been deposited there I cannot explain, but I observed that the Spider, by the alternate application of its palpal organs, speedily imbibed the whole of it. Perhaps the only safe conclusion to be drawn from this very remarkable circumstance, taken in connexion with the previously well-ascertained office of these parts, is that it affords a complete answer in the affirmative to the question asked by M. Dugès, namely, "le conjoncture ferait-il alternative-ment l'office de siphon absorbant et d'organe éjaculateur?"

§ 3.

My explanation of the means whereby various animals are supported in their movements on the vertical surfaces of highly-polished bodies having recently been called in question, I am induced to offer a few remarks in vindication of its accuracy.

Mr. Tuffen West, in treating "On certain Appendages to the

Feet of Insects subservient to Holding or Climbing''* advocates the hypothesis that the papillæ distributed over the inferior surface of the pulvilli of flies and other species of the class *Insecta* act separately as independent suckers, adhesion being assisted by the emission from each of a small quantity of fluid. This view of the subject, being absolutely irreconcilable with the results of observations and experiments regarded as having established a widely different conclusion, I am not prepared to adopt. That fluid is emitted from the papillæ connected with the pulvilli of the House-fly and Flesh-fly when in motion is unquestionable, as finely pulverized nitrate of silver brought into contact with those parts is immediately acted upon by it; but that its agency is merely to effect a more complete vacuum between the climbing apparatus and the plane of position is evidently inadmissible. This fluid, which appears to possess a moderate degree of viscosity, assumes a gelatinous consistency when coagulated by exposure to the atmosphere, and by its adhesive property enables animals provided with the requisite organs to move with facility and security on the vertical surfaces of dry, highly polished bodies. In confirmation of the explanation of the phenomenon here insisted on, many facts might be advanced; but it will suffice, in the present instance, to direct attention to one, the decisive character of which cannot be mistaken.

That flies are not supported on the vertical sides of highly polished bodies by the pressure of the atmosphere, experiments with the air-pump plainly demonstrate; for they can not only traverse the upright sides and the interior of the dome of an exhausted receiver, while their physical energy is unimpaired, but individuals occasionally remain fixed to the sides of the glass after they have entirely lost the power of locomotion—a circumstance which can only be explained by admitting the adhesive property of the fluid emitted from the extremity of the papillæ on the inferior surface of their pulvilli.

To the same cause must also be attributed the power of Spiders that are provided with scopulæ or tarsal brushes to run with celerity on the vertical surfaces of highly polished bodies, as those instruments consist of numerous appendages slightly curved downwards and somewhat enlarged towards their extremity, which is densely covered on its inferior surface with minute hair-like papillæ for the emission of a viscid fluid, but which, from

* Journal of the Proceedings of the Linnean Society, vol. vi. p. 26.

their organization, cannot possibly contribute to the formation of a vacuum.

The foregoing solution of this interesting physiological problem, I have reason to believe is applicable not to insects and Spiders alone, but also to some species of reptiles.

Catalogue of the Heterocerous Lepidopterous Insects collected at Sarawak, in Borneo, by Mr. A. R. WALLACE, with Descriptions of New Species. By FRANCIS WALKER, Esq., F.L.S.

[Continued from p. 84.]

Gen. ARTIGISA, n. g.

Mas. *Corpus* vix robustum. *Proboscis* conspicua. *Palpi* subarcuati, verticem paullo superantes; articulus 3^{us} lanceolatus, 2^o brevior. *Antennæ* setis longiusculis instructæ. *Abdomen* alas posticas non superans; fasciculus apicalis parvus, compressus. *Pedes* robusti, pilosi, femoribus tibiisque anticis dense pilosis, calcaribus longis. *Alæ* anticæ apice subrotundatæ, costa recta, margine exteriori vix convexo sat obliquo.

Male. Body hardly stout. *Proboscis* distinct. *Palpi* slightly curved, rising a little higher than the vertex; 3rd joint lanceolate, much shorter than the 2nd. *Antennæ* with rather long bristles. *Abdomen* not extending beyond the hind wings; apical tuft small, compressed. *Legs* stout, pilose; fore femora and fore tibiæ densely pilose; hind tibiæ with four long spurs. *Wings* moderately broad. *Fore wings* slightly rounded at the tips; costa straight; exterior border hardly convex, rather oblique.

354. ARTIGISA NIGROSIGNATA, n. s. *Mas.* Ochraceo-cinerea, alis fascia media e atomis nigris, lineis exteriori et submarginali undulatis lunulisque marginalibus nigris, alis anticis lituris costalibus, plaga basali fasciaque exteriori nigris.

Male. Cinereous, tinged with dull ochraceous, paler beneath. *Fore legs* partly black. *Wings* with a few black speckles, which form a very incomplete middle band; exterior line black, slender, distinct, undulating, bent in the fore wings; submarginal line undulating, much less distinct; submarginal lunules black, forming a festoon with the marginal line. *Fore wings* with black marks along the costa, and with a black basal patch formed of confluent speckles; a black band, broadest by the costa, partly contiguous to the outer side of the exterior line, and traversing the submarginal line; this band is diffuse hindward, and emits a diffuse streak from its exterior side. *Length of the body* 4 lines; *of the wings* 10 lines.

Gen. VEIA, n. g.

Mas. *Corpus* vix robustum. *Proboscis* conspicua. *Palpi* compressi,



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