

# THE PRESBYTERIAN AND REFORMED REVIEW

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## I.

### RECENT DISCUSSION IN MATERIALISM.

THERE are phases of contemporary materialism which have little in common with the doctrines of ancient and mediæval materialists, and which in point of subtlety and philosophical attractiveness are quite in accord with the advanced position of nineteenth century thought. The idealist of to-day flatters himself that he avoids the inconsistencies of Berkeley and Fichte, so the materialist smiles at the mention of Priestly, D'Alembert, and Holbach. But these growths respectively in idealistic and materialistic thought have not been parallel. Idealism has tended in the last thirty years to withdraw its gaze from the thought-ultimate as a monistic conception, to perception as a dualistic relation, that is from cosmic to psychological idealism; while materialism has tended in quite the opposite direction, *i. e.*, from the crude postulate of matter in bulk to the search for an ultimate materialistic principle, that is from psychological to cosmic materialism. Each has strengthened its flank and the battle is now joined between psychological idealism and metaphysical materialism.

Spiritualism has gained vastly by this change of base. As long as the ontology of spirit rested upon a dogmatic assertion of universal mind, there was no weapon at hand wherewith to attack the corresponding assertion of universal matter. I have as good right to assert an universal as you have and *chacun à son goût* is the rule of choice. But now that philosophy is learning to value a single fact more than a detailed system, and is sacrificing its systems to the vindication of facts, it is spiritualism and not materialism which is profiting by the advances of science. Materialism has appealed to the metaphysics of force, spiritualism has appealed to consciousness

### III.

## JONATHAN EDWARDS AS A NATURALIST.

### I.

THE recently issued work of Prof. Allen on the "Life of Jonathan Edwards" has renewed and awakened interest in that remarkable character. Most readers of general and theological literature possess some knowledge of the position held by him as a philosopher. His work on "The Will" still keeps rank as one of the greatest books written by an American. But the knowledge that Edwards is entitled to a place among the pioneers of Natural History has heretofore been limited to a small number of persons specially interested in science. To that little band it gives particular pleasure to note the recognition of that fact which these last few months have brought.

In a work on the life-history of American spiders, of which the first volume only has been issued, the present writer alludes to the araneological observations of Master Jonathan Edwards, whom he credits with anticipating, by at least one hundred and sixty years, some of the most interesting observations which he himself has made, and which he supposed to be original.\* In the second volume of the same work, now passing through the press, these discoveries of the young naturalist are given in detail in the chapter on the "Aeronautic or Ballooning Habits of Spiders."

My first knowledge of these studies was obtained from a printed extract from the life of Jonathan Edwards by Dr. Sereno E. Dwight.† This author appears to have been the first to publish the now famous letter written by Edwards, when a boy of twelve or thirteen years old, to an English correspondent of his father's, in which letter he describes what he has seen of the habits of so-called "flying spiders." The scientific world was made acquainted with the matter as early as 1832 by the editor of Silliman's *Journal*,‡

\* McCook : " American Spiders and their Spinning-work," Vol. i, p. 69.

† "The Works of President Edwards, with a Memoir of his Life," in ten volumes. By Dr. Sereno E. Dwight. S. Converse, New York, 1829, Vol. i, p. 23 *sq.*

‡ *American Journal of Science and Arts*, Vol. xxi, 1832, pp. 109 *sq.* The letter is published as an appendix to Prof. Hentz's monograph, "On North American Spiders," and is entitled "Juvenile Observations of President Edwards on Spiders."

who published in full the above-named letter as printed by Dr. Dwight. The facts, however, as far as recent naturalists are concerned, being thus more than half a century old, were only known to a few specialists in arachnology.

The January number of the *Andover Review* takes up this subject anew, and in a valuable and interesting paper,\* Prof. Smyth covers the whole ground of Edwards' studies, and permits us to look into the operations of the young mind while pursuing his remarkable experiments and observations. An unpublished manuscript is therein edited which appears to have been the original record of the boy's studies, from which record the letter to the English correspondent was probably constructed.

I propose in the present paper to examine, from the standpoint of a specialist, the various facts contained in the letter of Master Edwards; to compare them with the facts as independently observed and published in recent times; to test their value from a strictly scientific view; and to note what credit the young naturalist is entitled to receive on the score of priority.

## II.

It is evident that Edwards had made a rude division of various tribes of spiders which, so far as it goes, is at least sufficiently accurate for all popular purposes. He divides the spiders into four classes: First, "those that keep in houses," which are evidently the Lineweavers (*Retitelariæ*), whose well-known cobwebs of intersecting lines frequently ornament the corners and angles of our homes. Second, "those that keep in forests upon trees, bushes and shrubs;" these are the Orbweavers (*Orbitelariæ*), and are designated beyond a doubt by the subsequent statement that they are "that sort of spider that make those curious network, polygonal webs." A third class he designates as "those that keep in the ground," which is a fair description of the *Citigradæ*, popularly known as the Lycosids, Wolf or Ground spiders. These make burrows in the earth, and are frequently found stalking their prey in the open field. The fourth class is more generally designated as the "sorts which keep in rotten logs, hollow trees, swamps and grass." This description may cover a large class of spiders widely removed from each other structurally, but it may be said generally to characterize those that are known as Tubeweavers (*Tubitelariæ*), whose silken cells and funnel-shaped snares abound in just such localities as Edwards describes.

\* "The Flying Spider: Observations by Jonathan Edwards when a Boy." *Andover Review*, January, 1890, Prof. Egbert C. Smyth.

The lacking of minute detail in such classification as this would of course be notable at the present time, but if one considers that this observation was made perhaps as early as A. D. 1716, when no attention had been given to American spiders, and very little to European, and that the lad making the classification was wholly unacquainted with the subject, and had thus divided the creatures under observation simply from his own knowledge of their habits, it certainly must be regarded as highly praiseworthy. He had, in fact, hit upon the foundation principle of classification of the distinguished Latreille, who, just a century later,\* divided spiders into seven groups, based upon those very habits of which young Edwards notes some, although of course with more careful characterization.

### III.

Turning to the special matter under view, namely, the letter on "The Flying Spider," it is interesting to note how thoroughly the boy had worked out his problem. In the first place (page 6),† he had found that in a dewy morning towards the latter end of August or the beginning of September, one has the best possible opportunity to study spider-webs afield. The particles of moisture deposited thereon during the night then make them conspicuous. There is no sight in nature more striking than this; and familiar as one may be with the matter, he will continually wonder when he sees, on such occasions, the innumerable myriads of webs of various forms that hang upon the foliage of every manner of plant.

I have seen a fir tree literally covered from tip to lowermost branch with dew-laden webs, glittering in the morning sun. Every blade of grass, every head of timothy, every bunch of weeds, all shrubs and flowers and plants are ornamented by this graceful drapery. The hedgerows are sometimes festooned and upholstered with the broad, sheeted, funnel-shaped snare of our speckled Tubeweaver (*Agalena nævia*), every web looking like a fairy platter filled with beaded dew. The round webs of the Orbweavers, great and small, droop under their burden of dew-drops that look like strings of pearl as they hang around the viscid spirals that form the armature of the snare. Even on the plowed fields and barren roadsides, where young spiders have found lodging for the night, the same drapery is observed.

One may sometimes see a like phenomenon in winter. I recall a

\* See Cuvier's "Le Regne Animal," edition 1817, Paris.

† The page references in this article refer to the page numbers in Prof. Smyth's paper, which I use here as more likely to be accessible to the readers of this REVIEW than the one in Silliman's *Journal* or the original in Dwight's "Life."



walk along the shores of the Lake of Geneva on a morning succeeding a Christmas day. The lake had been overhung with mist for several days; a sharp frost had fallen, and as the sunlight appeared above the Alps the piers and ballustrade of the well-known bridge across the lake were shown to be festooned, in some places freely, with threads of spinningwork. I was particularly interested in the appearance of a statue which showed around the entire face and neck these beaded lines. They had an odd effect upon the bronze icon. The threads of the late autumn, or those which had been outspun by some straggling spider attracted forth from winter quarters by an unusually warm day, were stretched from nose to cheek, over eyes and eyebrows, around ears, mouth, chin and neck. There they had remained, perhaps for months, unobserved by any passer-by, until the heavy mist, clinging to the delicate filaments, was hardened into white crystals by the hoar frost—and lo! the unseen drapery was brought to view. I do not know that any of the good Genevans observed this effort of Nature to decorate their bronzes, but if so they probably wondered how it came about in midwinter, and possibly were seized with an itching desire to brush the cobwebs from the face and eyes of their stuated heroes.

Another fact which Edwards had discovered is, that spider-webs which ordinarily are unobserved, may readily be brought into view by putting one's self in such a position that the rays of the sun shall fall upon them against some opaque body. Many times have I practiced this habit, which is the result of long experience in searching for spider-webs, and it is to this alone that I have frequently been indebted for an undeserved reputation for keenness of vision, when walking in the fields during a summer vacation with friends, who would not be persuaded that I had seen spider-webs in certain positions, until I took them up to the object upon which they hung, and thus confirmed my assertion. I have long been in the habit of instructing my assistants to observe in this way, and it is always a revelation to them to find that such a simple trick uncovers to their vision so many unsuspected beauties of araneal spinningwork.

#### IV.

Once more (page 7), the boy naturalist had discovered that the aeronautic habit of spiders is closely associated with those bridge-lines which are continually observed in summer time stretched from tree to tree across roads, between fences and in like positions. The two habits are the result of one method. When a spider wishes to cross a vacant space, it turns in the direction of the wind the points

of its abdomen, upon and within which are located the spinning organs. The apparatus is then set in motion, and immediately a thread, or a series of diverging threads, escapes from the spinning spools, and borne by the wind is carried out until it touches some object with which it entangles. Thereupon the spider pulls upon its output line to see if it be firmly fastened, proceeds to draw it taut, and passes over, "hand over hand" as it were, with body hanging downward. Most of this process Edwards had observed, and alludes to in his letter. By the way, it may not be out of place to notice here that there is a tradition which appears to have some foundation in fact, that the first wire suspension bridge constructed by man was suggested by this habit of the spider to stretch its delicate bridge-line across streams, as it often does.

Once more, Edwards appears to have discovered that the spider, while engaged in casting out these bridge-lines, often swings itself in a little basket of threads held between the bunched feet. In one of his experiments, he speaks of a spider that "let himself down a little, hanging by his web, and presently I perceived a web out from his tail, a good way in the air." Again (page 14), "When they would Go from one tree to Another, or would fly in the Air, they first Let themselves Down a little way from the twig they stand on by a web, and then laying hold of it by his fore feet and bearing himself by that puts Out a web which being Drawn out of his tail with infinite Ease by the Gently moving Air to what length the Spider pleases."

This habit I several years ago described at length in the "Proceedings of the Academy of Natural Sciences of Philadelphia," and supposed at the time that I was the original discoverer; but a subsequent study of Edwards' letter in Silliman's *Journal* convinced me that the credit belongs to the boy naturalist. In no other point is the accuracy of his observations better shown than in this. He illustrates his statement by rude but sufficiently exact figures, which are reproduced by Prof. Smyth in his paper.\*

Edwards is also correct in his statement that two threads, instead of one, issue from the spinnerets of the spider when it is engaged in ballooning (page 7). Indeed, more than two, sometimes a whole cluster of threads, will be thrown out from the spinnerets, and these, as they are elongated by the combined action of the wind and the spider, diverge from one another, thus gradually increasing the buoyancy of this primitive balloon.

\* In Vol. i of my work on American spiders above alluded to, I made *fac similes* of these drawings as they are given in Silliman's *Journal*, supposing them to be accurate. But, in point of fact, Edwards' drawings, as given by Prof. Smyth, are far more accurate than those, particularly in the outline of the spider's body and legs.

## V.

Again, Edwards divined correctly the manner in which the spider's thread is formed. He could make no studies of the interior structure of the animal. It was reserved for the age of the microscope to do this; but this boy, thirteen years old, reasoned that the spinning stuff must be contained in liquid form within certain appropriate organs in the abdomen, from which it is expressed, escaping from the spinnerets as a liquid, and immediately hardening by contact with the air. I quote his language: "Seeing that the web while it is in the Spider, is a certain cloudy liquor with which that Great bottle tail of theirs is filld which immediately upon its being Exposed to the Air turns to A Dry substance, and Exceedingly Rarifies and extends it self" (page 16). "Now if it be a liquor it is hard to Conceive how they should let out a fine Even thread without expelling a little Drop at the End of it but none such Can be Discerned, but there is no need of this." . . . "Indeed, Sir, I never Could Distinctly see them Do this, so Small a piece of web being imperceptible amongst the spider's legs. But I Cannot Doubt but that it is so, because there is a necessity that they should some way or other Separate the web."

There is probably no more beautiful study in the whole realm of histology than the spinning organs of the ordinary orbweaving spider. In the lower or ventral part of the abdomen are located several hundred minute glands, within which are contained various kinds of silk extruded by the spider. With each gland is connected a minute duct, which passes out through a jointed spinning spool seated upon the lower surface of the spinnerets or finger-like organs located just beneath the tip of the abdomen. There are usually six of these spinnerets, and on the surface of each one are situated sometimes as many as a hundred or one hundred and fifty of these minute spools. The silken glands within the abdomen are surrounded by a muscular coating, whose contraction forces the liquid within the glands through the duct, out of the spinning spool, into the air. Several hundreds of these spinning spools will at once be extruding their tiny filaments, and all these unite to form that extremely delicate object known as the spider's web.\* The perfection of the spinning machinery devised by man is not worthy to be spoken of in comparison with such intricate, elegant and delicate spinning structure as this. That a mere lad, wandering among New England fields a century and three-quarters ago, should have entertained a theory which modern histological science has confirmed so completely, is certainly a startling incident.

\* See, for details and illustrations, "American Spiders and their Spinning-work," chapter ii, on the "Spinning Organs."

## VI.

Edwards perceived also (page 11) that the spider had no direction of its frail, aërial vessel, after it had once embarked, but was compelled to go at the will of the wind and to disembark and settle wherever its balloon might find an entanglement. He correctly discerned and explained the theory of equilibrium by which the spider navigates the air (page 12). This is his explanation (page 15): "If there be not web more than enough Just to Counterbalance the gravity of the Spider the spider together with the web will hang in equilibrio neither ascending nor Descending otherwise than as the air moves but if there is so much web that its Greater Rarity Shall more than Equal the Greater Density they will ascend till the Air is so thin that the Spider and web together are Just of an equal weight with so much air."

Again, "Any such time wherein the Air is perfectly Calm, this webb is so easily Drawn Out of the Spider's tail that if the End of it be Once Out, barely the levity of it is sufficient to draw it out to any length, wherefore if it Dont happen that the End of this web Catches by a tree or some other body, till there is so long a web Drawn Out that it(s) levity shall be so Great as more than to Counterbalance the Gravity of the Spider or so that the web and the Spider taken together shall be lighter than such a quantity of Air as takes up equal Space then according to the universall acknowledged laws of nature the web and the Spider together will ascend" (page 15).

This statement substantially expresses the opinion of araneologists at the present day. It is true that the learned editor of *Silliman's Journal*, in his notes added to Edwards' letter in the number above quoted, endorsed the theory of Mr. John Murray, that the ballooning habit depends much upon the electrical condition of the atmosphere, and that the direction of the young aëronauts is dependent more upon the effect of electricity on the silken filaments than upon the current of air.\* But I do not know of any one who is disposed to accept Murray's theory even with such distinguished endorsement. At least, the results of my own observations lead me to the conclusion that the exercise of the habit is dependent, first, upon those mysterious movements of nature by which all living things are made conscious of the right moment for crisis changes of life; and, second, upon the condition of the temperature, which invites spiderlings forth from their retreats to voyage in the air. Further, that the direction, both laterally and vertically, which the balloonists take is dependent upon the course and currents of the wind, and in

\* "Researches in Natural History," second edition, London, 1830.



no appreciable degree upon electricity or any other influence. Thus the theory of the boy naturalist may be considered as substantially correct.

## VII.

This review of Natural History studies by young Edwards will suffice to justify the language used nearly sixty years ago by Prof. Benjamin Silliman, one of the most eminent of America's men of science: "The observations recorded by him present a very curious and interesting proof of philosophic attention in a boy of twelve years, and evince that the rudiments of his great mind were even at that immature age more than beginning to be developed." Even with the more perfect light of the present, few will question the further words of the same distinguished authority, that "had he devoted himself to physical science, he might have added another Newton to the extraordinary age in which he commenced his career; for his star was just rising, as Newton's was going down."\*

It is true that the boy fell into some mistakes, and it would have been marvelous had this not been so; but it is noticeable that his mistakes are more in matters of speculation than observation. For example, he had noted (page 11) the fact that the aëronautic habit of spiders was confined to certain seasons and conditions of temperature and wind. "I never saw them fly," he says, "but when they were hastening Directly towards the sea and (the) time of the flying being so long even from the Middle of August to the Middle of October tho their Chief time here in newengland is in the time as was said before towd the Latter End of Aug., And the beginning of Sept., and the(y) keep flying all that while towards the sea must needs almost all of them Get there before they have Done."

From this observation he deduces the "corollary" that the spiders are flying for their "Pleasure and Recreation." Moreover, he derives a second corollary which he thus expresses (page 12): "Coroll: hence also we may behold and admire at the wisdom Of the Creator and be Convinced from Prvd (Providence) there is exercised about such little things, in this wonderfull Contrivance of Annually Carrying of and burying the Corrupting nauseousness of our Air, of which flying insects are little Collections in the bottom of Ocean where it will Do no harm and Especially the strange way of bringing this About in Spiders (which are Collections of these Collections their food being flying insects) which want wings where by it might be Done; and what Great inconveniencs should we labor Under if there were no such way for spiders and flies are so

\* *Am. Jour. Sci. and Arts*, 1832, p. 110.

Exceeding Multiplying Creatures that If they Only slept or lay benumbed in (Winter?) and were raised again in the Spring which is Commonly supposed it would not be many years before we should be as much Plagued with their vast numbers as Egypt was, and If they Died for good and all in winter they by the renewed heat of the sun would Presently Again be Dissipated into those nauseous vapors of which they are made up of, and so would be of no use or benefit in that (in) which now they are so verry serviceable."

In point of fact, the end of this ballooning habit of spiders, as far as it lies in the purposes of nature, appears to be the distribution of species. The habit is not limited to araneads living along the sea-shore, but is common to those of the interior. It is only the smallest number of these spiderling aëronauts who succeed in reaching the coast. The greater part must be entangled upon the forests, shrubs, grasses, etc., at points quite near to the place of departure.

A brood of spiderlings will sometimes consist of several hundred. These all issue forth at one time in the early spring or balmy days of autumn, and are distributed throughout the surrounding neighborhood by means of the aëronautic habit. The sea voyages are limited to those spiders that are brooded along the shore or within comparatively short distance thereof. When the wind is blowing seaward, as there are rarely any objects along shore to entangle their tiny threads and give them anchorage upon *terra firma*, they are of necessity carried out to sea.

No doubt, as Edwards conjectured, many of them perish in the waters, but in the absence of any obstacles to attract them they often voyage long distances. Darwin, in his famous "Voyage of the Beagle," observed multitudes of these spiderling balloonists entangled upon the rigging of his ship at least sixty miles from shore. A sea-faring friend, the late Captain Dodge, informed me that a like phenomenon had been observed by him and noted when he was at least two hundred miles from shore. Vessels nearer the coast have often had the experience of observing shrouds, masts and rigging covered with immense numbers of ballooning spiders.

In a paper published some years ago, I was able to trace the distribution of a species of Laterigrade, the Huntsman spider (*Heteropoda venatoria*), all the way around the world in the two belts which mark the course of the trade winds, both north and south.\*

It thus appears that the sea voyages of our spider aëronauts do not always prove fatal, but that oftentimes, buoyed up by a steady and long-continued wind, they are dispersed throughout the islands of the ocean and carried sometimes even to another hemisphere.

\* "Proceedings Academy of Natural Sciences of Philadelphia," 1878, p. 138 sq.

Of course, concerning the lad's idea as to the "corrupting nauseousness" of spiders and insects, no remark need now be made, except that the idea was one which prevailed very largely at that period, even among men who had pretensions to scientific position. Even now one may find, at the close of this marvelously enlightened and self-sufficient nineteenth century, a multitude of persons whose only idea of a spider is that it is a horrible, corrupting and dangerous creature, to whom the human race owes no guerdon and for whom there is no mercy! It is even possible that, if in this highly cultivated journal, the writer should assert that spiders are the greatest philanthropists of the world of invertebrate animals; that they are appointed of nature to be a blessing and only a blessing to mankind, and without their kindly service man could scarcely inhabit large portions of the world, unless some similar check upon the growth of insect life were provided, he would be met with skepticism and possibly sneers. Yet, even so it is. How little does the average man know of his true friends, and how often does he deal with them as though they were enemies! In Spider-world, at least, it falls out that the philanthropist, like the prophet, is without honor in his own country. "What fools these mortals be!"

HENRY C. MCCOOK.

PHILADELPHIA.