

Worcestershire by Professor Ramsay; since the prevalence of similar conditions, only slightly modified, would give rise to results in some respects different from those upon which Professor Ramsay has based his conclusions. The angularity of the fragments of the Dumfriesshire breccias, and the circumstance that in some instances these fragments have been derived from distant localities, must be regarded as features sufficient to induce us to seek for the agency of that power which, so far as we know, is alone capable of transporting fragments without depriving them of their angular nature.

There are other features in connection with these breccias which appear to support this influence. In the lower portion of these rocks, where they are seen coming in contact with the underlying sandstones, the breccias often exhibit an abrupt commencement, such as would result from the stranding of an ice-raft bearing fragments of rock on a sandy shore.*

Some of the sandstones which overlie the breccias also manifest some features in support of this conclusion. Sometimes, in these, we have detached angular blocks lying in the midst of the stratum of these sandstones in the same manner as we have masses of rock occurring in the boulder clays.

The several circumstances, therefore, which we find in connection with these breccias of the vale of the Nith, justify the inference of Professor Ramsay as to the prevalence of arctic conditions during the Permian period.

Observations on British Zoophytes. By T. STRETHILL WRIGHT, M.D., Fellow of the Royal College of Physicians, Edinburgh.†

Description of Plates.

PLATE I.

Atractylis and Eudendrium.

- Fig. 1. Medusoid of *Atractylis ramosa*.
 2. Same at third month developed into *Bougainvillea Britannica*.
 3. Tentacle of peduncle of do. further enlarged.
 4. *Atractylis repens*.
 5. Medusoid of do.

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PLATE II.

Fig. 1. Male polyp of *E. rameum* with double sperm sacs—*a*, *b*, ectoderm of unripe sperm sacs—*c*, process of endoderm—*d*, ripe sperm sac with spermatozoa, endoderm absorbed.

2. Female polyp of *E. rameum*—*a*, ovarian sac containing single ovum surrounded by *c*, *c*, process of endoderm.

On Atractylis (new genus).

On a former occasion I read to the Society a description of two Hydroid Zoophytes, which I placed in the genus *Eudendrium*, on account of the similarity which their polyps bore to those of the *Eudendrium ramosum* of Van Beneden ("Memoirs of Brussels Academy, vol. xvii., Plate IV."), the *Tubularia ramosa* of Dalyell, although at that time I doubted, with Johnston ("British Zoophytes," vol. i. p. 47), whether Van Beneden's zoophyte did not belong to a distinct genus. Since the publication of my paper, I have received the opinion of two of our most eminent authors, that my zoophytes were not Eudendria, and have been requested to place them in a new genus. The *Eudendrium ramosum* of Van Beneden, and *Eudendria repens*, and *sessile*, described by myself, differ from the *Eudendrium ramosum* of Johnston, in having their polyps destitute of the cup-shaped proboscis, the body fusiform instead of globular, and in the absence of the very large and distinctive thread-cells which occur on the body and within the polypary of Eudendrium. I can discover no other permanent difference between Eudendrium and Atractylis (*ἀτρακτυλῖς*, from *ἀτρακτος*, a spindle), as I propose to call the first-named zoophytes. It is true, that nothing can be more dissimilar than the large-branched *Eudendria rameum* and *ramosum*, with their globular bodies, opaque from the excessive deposit of red granules in the endoderm, and the delicate polyps of the smaller species of Atractylis; but I have on more than one occasion observed an equally minute creeping species of Eudendrium, which could only be identified as belonging to the latter genus by the shape of its proboscis and thread-cells.

The last systematic writer on zoophytes, Mr Gosse, describes Eudendrium as "Inclosed; Corallum fibrous, rooted, erect, branching; Polyps protruding from tips of the branches, not retractile." This description is, however, incorrect and in-

sufficient, as it does not notice the proboscis, and moreover, Eudendrium is not uniformly erect or branched. The reproductive system is also unnoticed. The following description will, I believe, give the characters of the genus:—

Eudendrium.—Polypary sheathed, creeping, or erect and branched. Polyps not retractile, globular, fleshy, with an alternating row of numerous filiform tentacles; proboscis cup-shaped, fleshy; endoderm of body dark; thread-cells on tentacles minute, on body large, bean-shaped, containing simple style apparent. Dioecious. Ovaries single sacs, developed from polyps or polypary. Spermaries arranged in moniliform series on pedicles, which arise beneath tentacles of polyps, or on separate stalks from the polypary.*

The characters of *Atractylis* are:—

Atractylis.—Polypary sheathed, creeping, erect, or branched. Polyps fusiform, incompletely retractile, with transparent filiform alternating tentacles (mouth closed by a dense muscular ring). Thread-cells inconspicuous. Reproduction by medusoids.

Atractylis ramosa (Van Beneden, Dalyell).—Polypary sheathed, erect, and branching; stem composed of many minute sub-parallel tubes; ends of branches dilated. Medusoids springing from branches and polyps; umbrella sub-globose; peduncle with four undivided capitate tentacles; marginal tentacles eight, in four pairs, each pair springing from a bulb having two eye-specks; auditory sacs absent.†

* *Note on the reproduction of E. rameum*.—Mr Alder, in his "Catalogue of Zoophytes of Northumberland and Durham," says, "according to Sir J. Dalyell the reproductive capsules of this species are of two kinds (probably sperm and ovi-capsules). Those I have met with form a cluster round the base of the tentacles, and are arranged in a linear or moniliform series, two or three on each pedicle." *The double sperm sac* consists of two ectodermic sacs placed end to end (Plate II., fig. 1, *a*, *b*), permeated by a tubular process of endoderm (*c*), and containing the spermatogenic gelatinous plasma. As the spermatozoa first ripen in the distal sac (*d*), the endoderm in that sac is absorbed and withdrawn. The same process afterwards takes place in the proximal sac (*e*). *The ovarian sac* (fig. 2, *a*), contains a single yellow ovum (*b*), which at an early stage is encircled by a looped tubular process of the endoderm (*c*); subsequently this loop is absorbed, and the ovum becomes a ciliated larva filling the sac. Its further change has been described by Dalyell.

† *Note on the development of Bourgainvillea Britannica from Atractylis ramosa*.—In August last I found *Atractylis ramosa* growing in great profusion on the Bimer Rock and on Inchgarvie, both near Queensferry, Firth of Forth. When taken, the specimens were in high condition, each branchlet possessing its terminal polyp; but after being kept in one of my tanks for a few days, I found that a great change had taken place; the polyps were all absorbed, or undergoing the process of absorption, and in their place, and also from the branches themselves, a great number of medusa buds were put forth, which

Atractylis repens (mihi).—Polypary creeping, sheathed; polyp-stalks erect, single, or bifurcate (wrinkled); ends of stalks dilated or not. Medusoids springing from polyp stalks, mitre-shaped; peduncle quadrangular; tentacles four, two very long, two rudimentary. Eye-spots and auditory sacs absent.

Atractylis sessilis (mihi).—Polyps sessile on creeping polypary, or scarcely stalked, sheathed up to the tentacles. Medusoids developed from creeping fibre, similar in shape to those of *Atractylis repens*.

were rapidly developed into the *Medusa ocilia* of Dalyell. The zoophyte had in fact assumed its reproductive phase. It had changed from a creeping hydra-bearing zoophyte, to a multitude of free and actively swimming medusæ. It is well known that the Aphis, as long as its pasture is good and the weather is fine, will produce a continued succession of wingless and sexless individuals by internal gemmation. It will continue its phase of nutrition. But should its circumstances fall adverse—should Flora and Jove become unpropitious—then it undergoes its last change, and becomes a winged and egg-bearing creature. It assumes its phase of reproduction. So the gluttonous caterpillar, taken yet unsatisfied from his cabbage leaf and shut up in a box, becomes prematurely a chrysalis. And so, too, the medusa-bearing zoophytes, exchanging the open sea for the confined water and poor fare of a tank, become, so to speak, winged medusæ, and, instead of a continued succession of polyps, produce eggs.

The medusa of *Atractylis ramosa*, when first given off from the zoophyte, is identical with the *Medusa ocilia* of Dalyell. The orange-coloured alimentary polyp or peduncle has four unbranched tentacles, capitate at their extremities with bundles of thread-cells. The orange tentacular polyps are each furnished with two tentacles, and a black eye-speck at the root of each tentacle. In this stage a large number, then about a month old, were brought to Edinburgh. They fed on the minute Entomostracea (which swarmed in the tank), with avidity, and increased in size. But, to my surprise, I found that a further development was taking place in them. The tentacles of the alimentary polyp (peduncle) became first once, and afterwards twice, dichotomously divided, and each of the tentacular polyps put forth additional successive tentacles, until the greatest number observed amounted to six, each additional tentacle being accompanied by an additional eye-speck at its root. At the same time, genital lobes were developed, springing from the peduncle, which passed for a short distance along the lateral canals of the sub-umbrella, and ultimately contained spermatozoa. In other specimens, given off by *Atractylis ramosa* in the spring, but which never arrived at so late a stage of development, ova were found situated in four masses within the walls of the peduncle. This medusa, at its latest stage of development observed by me, bears a strong resemblance to the *Hippocrene* or *Bourgainvillea cruciata* of Forbes, and also to his *Bourgainvillea Britannica*, which I am disposed to consider as different sexes and stages of development of the same medusa. I am the more emboldened to hold this opinion, as Professor E. Forbes has already considered the *Medusa duodecilia* of Dalyell (which represents, as I have observed, one of the stages of that I am now describing) the same with his *Bourgainvillea Britannica*. (*Monograph of British Naked-eyed Medusæ*, p. 68.)—Nov. 22, 1858.

*On the fixed Medusoids of Laomedea dichotoma.**Description of Plate.*

PLATE II.

- Fig. 3. Summit of reproductive capsule (female) of *L. dichotoma*—*a*, four-lobed endodermal or nutritive process of ovarian sac—*b*, ectoderm of do.—*d*, umbrella or marsupium—*e*, ectoderm of ovary ruptured, ova having escaped into the cavity of the marsupium.
4. Summit of male reproductive capsule of *L. dichotoma*.
5. Alimentary polyp of Siphonophorous Zoophyte (*Agalmopsis punctata*), and
6. Tentacular polyp of same, compared with
- 7 and 8. The same organs in *Sarsia*.
9. False medusoid (ovary with rudimentary umbrella) of *Hippopodius Neapolitanus* (Kölliker).
10. False free medusoid of *Diphyes* (Huxley).
- 11, 12, 13, 14. Development of false medusoid or marsupium in *Sertularia fallax*.

Under the title of *Laomedea dichotoma*, Johnston has described as varieties two very distinct zoophytes. One (the Sea-thread Coralline, *Ellis*, Corall. 21, No. 18, Plate XII., fig. *a*, A), a magnificent production, attains a height of twenty-four inches, its slender stem and branches hidden by thousands of snowy polyps, the whole forming a pyramidal mass, which sways to and fro with every movement of the waves; while from the axillæ of the branches the reproductive cells pour forth shoals of flapping medusoids, which fill the water around with a cloud of living beings. Many of these beautiful trees are joined together by anastomosing lines of creeping fibres, which wander over the rocks, and unite them as a single living being. The other variety (*the Sea-thread Coralline* of *Ellis*, plate xxxviii.) is very different from the last. It is a shrubby Zoophyte, of robust habit, the imperfect medusoids of which remain fixed to the top of the reproductive cells, where they serve as *marsupial* pouches for the development of the ova.

The reproductive cells are developed from the axillæ of the branches, and are at first traversed by a fleshy column, which occupies the axis of the cell, and, being dilated at its summit, closes the orifice. This column differs in no respect from the ordinary alimentary polyp at an early stage of development, and must be considered as a polyp in which development has been arrested, in order to render it subservient to the function of reproduction.

In the female (Plate II., fig. 3) we find a number of sacs developed from the reproductive polyp, each of which consists of,—1st, An ovarian sac formed of two layers, a four-lobed endodermal process or layer (*a*), and an ectodermal layer (*b*), between which are contained one or more ova; and 2dly, Of an investing capsule, which becomes converted into the umbrella, with lateral canals and tentacles of an imperfect medusoid (*d*), of which the ovarian sac is the peduncle. After the medusoid has issued from the top of the cell, the ova still remain in the peduncle or ovarian sac, but the outer membrane or ectoderm of the sac presently bursts (*e*), and the ova are discharged into the umbrella of the medusoid (*f*). There they become developed into ciliated larvæ, and are afterwards discharged, to swim away, and, after attaching themselves, become transformed into arborescent zoophytes.

The male capsules (fig. 4, first described by Lister) resemble those of the female, but the medusoid is in a still more rudimentary state. Its tentacles are very short and few in number, the lateral canals are not to be detected (Schultze and myself), and the peduncle and umbrella are imperfectly differentiated.

The reproduction in this zoophyte has been already described by Lister, Loven, and Schultze, but the anatomy of the different parts has not been well distinguished. I have brought this subject before the Society to point out the distinction between the ovarian sac and the other parts of the medusoid, organs which have been lately confounded together by Professor Allman in his papers on the Reproduction of Zoophytes, and as to the homology of which he appears to me to have arrived at inaccurate conclusions. Wherever the medusoid form of generation exists, the umbrella, with its canals, will always be found not homologous with, but superadded parts to, the ovary; which last, when single, as in the present instance, represents the peduncle of the medusa. Where several ovaries exist, as I have shown in *Campanularia Johnstoni*, and shall show in *Laomedea geniculata*, these organs are developed from the lateral canals, distinct both from peduncle and umbrella, or as bands between the tissues of the peduncle.

The umbrella of a completely developed gymnophthalmatous

medusoid, with its canals, is the homologue of the swimming organ of the Siphonophora. The Siphonophora are compound medusæ of the gymnophthalmatous type, in which an aggregation of peduncles (alimentary polyps), tentacles with their bulbs (tentacular polyps), and reproductive polyps, are joined together by a tubular polypary, the whole being buoyed up, as in *Forskalia Edwardsii* (Kölliker), by a swimming organ composed of numerous conjoined umbrellas, each with four lateral canals. In this animal the umbrellas are altogether segregated from the ovaries. In *Hippopodius Neapolitanus* and others, in addition to the common swimming organ, each ovary is associated with a minute rudimentary umbrella, as in fig. 9. In *Diphyes*, again, the ovary (fig. 10), furnished with a large umbrella, a serviceable swimming apparatus, becomes freed from the polypary, and floats away as a locomotive reproductive organ, like the Hectocotylus of the Cephalopod. So, also, the fixed false medusoid of *C. dichotoma* is nothing more than an ovary with an umbrella, which last, however, exercises—not the function of a swimming organ, but rather, as does the gelatinous envelop secreted by the ovarian sacs of *Sertularia pumila*, *Laomedea lacerata*, &c. (see p. 113)—that of a marsupium.

We have another instance of an umbrella-shaped sac being employed as a marsupial chamber in the reproductive cell of

Sertularia fallax.

In this zoophyte (as I described to the Society, April 1857) the summit of the ovary puts forth four thick lobes, consisting of endoderm and ectoderm covered by corallum; these are gradually developed (as shown in Plate II., figs. 11, 12, and 13,) until they form an umbrella with four or eight canals, (as in fig. 14.) The ova, after leaving the ovary, are received into the cavity of the umbrella, which, on their attaining a more mature stage, opens at the top, and allows them free exit.

On the Reproductive organs of Laomedea geniculata.

PLATE II.

Fig. 15. Medusoid of *Laomedea geniculata*—*a*, ovaries.

On a former occasion I described the existence of ovaries

and ova in the lateral canals of *Campanularia Johnstoni*, and the production of the young zoophytes. On examining, in like manner, the medusoids of *L. geniculata*, immediately after their exit from the capsule, I discovered their ovaries with the contained ova. In some of the medusoids the ovaries were situated in close proximity to the peduncle, in others, midway between the peduncle and the marginal canal (as at fig. 15).

Laomedea lacerata.

Description of Plate III.

- Fig. 1. Male polypary, with polyps and sperm-cells—*a*, unripe sperm sac—*b*, ripe do.
2. Unripe ovarian cell—*a*, reproductive polyp—*b*, sac inclosing ovary—*c* endoderm of ovary—*d*, ectoderm of do.
3. Ripe ovarian cell, ovary emerging from top of cell and enveloped in gelatinous marsupium.

This zoophyte was described by Johnston ("British Zoophytes," 2d edition), under the title of *Campanularia lacerata*, as having "cells on short stalks, ovato-conical, the upper half cleft in six lanceolate segments," the cells arising from a creeping tube. In August 1852 ("Annals of Nat. Hist."), the Rev. T. Hincks removed it from the genus *Campanularia* to that of *Laomedea*, and described it as follows:—"Stem filiform, ringed throughout; cells on short pedicles, ovato-conical, the upper portion divided into a number of deep convergent segments." He stated that the stems, which did not exceed the *sixteenth of an inch* in height, rose from a creeping fibre, and bore their cells on pedicles composed of four or five rings, somewhat irregularly disposed. And further, that this *Laomedea*, *in its young state*, was identical with *C. lacerata* of Johnston. He had not observed its mode of reproduction. Mr Hincks' description, also, is taken from an immature state of the zoophyte. *L. lacerata* may be found in profusion at Morrison's Haven, Firth of Forth. It attains a height of an inch and a quarter, slender and lax, but is generally about half an inch high, and bushy. Both varieties are covered with ovarian or spermatic cells in the spring. Plate III., fig. 1, exhibits a male specimen taken with the *Camera lucida*. The polyps resemble in shape those of *C. syringa*,

have fourteen to sixteen alternating tentacles, and are capable of extending themselves to more than twice the length of the cell.

The reproductive cells are ovate, and are shortly pedicled, like the alimentary polyp cells, of which I consider them an *in-development-arrested* form. Each reproductive cell grows in close proximity to a polyp cell.

The female cell (fig. 2.) consist of a reproductive polyp (*a*), from the side of which buds a single ovarian sac inclosed within a layer of the ectoderm (*b*) of the polyp. The endoderm of the ovary (*c*) is branched or lobed, and is moulded, as it were, on and between the ova which lie between it and the ectoderm of the ovary (*d*). As development proceeds, the ovarian sac (its endodermic lobes having been previously absorbed) rises up to, and issues from, the top of the cell (fig. 3), and becomes surrounded by a thick gelatinous mass, secreted from the surface of the ectoderm. The ectoderm of the ovary now bursts, leaving the ova in the gelatinous *marsupium*, where, as in *Sertularia pumila*, &c., they become developed into ciliated larvæ.

The male cell resembles the female cell. Instead of an ovary, a spermatic sac buds from the reproductive polyp. At first a transparent gelatinous plasma is secreted between the branched endoderm and the ectoderm, as at (*a*), fig. 1. In this plasma the spermatic cells, and subsequently spermatozoa, are developed. Meantime, the sperm-sac rises to the top of the cell, is extruded (*b*), and bursts.
