



# Annals and Magazine of Natural History

## Series 5

ISSN: 0374-5481 (Print) (Online) Journal homepage: <http://www.tandfonline.com/loi/tnah11>

### III.—The morphology of *Antedon rosacea*

P. Herbert Carpenter D.Sc. F.R.S. F.L.S.

**To cite this article:** P. Herbert Carpenter D.Sc. F.R.S. F.L.S. (1887) III.—The morphology of *Antedon rosacea*, *Annals and Magazine of Natural History*, 19:109, 19-41, DOI: [10.1080/00222938709460196](https://doi.org/10.1080/00222938709460196)

**To link to this article:** <http://dx.doi.org/10.1080/00222938709460196>



Published online: 12 Oct 2009.



Submit your article to this journal [↗](#)



Article views: 4



View related articles [↗](#)

The peristomes of the cells are also perforated, but the "tubules" in these are more elongate than those of the area.

In one of my specimens the whole length of the cell is exposed on the inner side, and the ends of the "tubules" or porous openings are also exposed on the inner walls, for these seem to have served some special purpose in the economy of the growing cell\*.

Although rather familiar with the closures of Palæozoic, Jurassic, and recent Cyclostomata, I have never noticed similar features to those described above. As we are as yet only in the infancy of our knowledge respecting the developmental features of Cyclostomatous Polyzoa of past ages, all careful observations bearing on this point are valuable, especially because, as Mr. Waters says, "further examination [of species] enables me to state that the position and the character of this diaphragm may be employed as a useful specific character"†.

---

III.—*The Morphology of Antedon rosacea.* By P. HERBERT CARPENTER, D.Sc., F.R.S., F.L.S., Assistant Master at Eton College.

THE 'Traité d'Anatomie Comparée Pratique' by Messrs. Vogt and Yung, which is now in course of publication both in French and in German, is described in the authors' prospectus as designed to aid the student in making an "étude approfondie" of certain selected zoological types, their structure being investigated "couche par couche, organe par organe."

The 'Traité' "sera composé d'une série de monographies anatomiques des types, résumant l'organisation animale toute entière." This is clearly a very high standard; for in the present state of zoological science a monographic description of any known type can only be properly worked out by a very detailed process of investigation, requiring the combination of various methods of research and an intimate acquaintance with the literature of the subject. In the case of those animals which possess a hard skeleton its relation to the soft parts must be made the subject of very careful investigation. The mere cutting of thin sections for histological examination is not a sufficient means of research; but the comparative osteology and the macroscopic characters of the

\* See Busk, Crag Polyzoa, p. 122, and A. W. Waters, "On the Occurrence of Recent Heteropora," Journ. Roy. Micr. Soc. vol. ii. p. 390 (1879).

† Journ. Linn. Soc., Zool. vol. xvii. p. 401.

type form a most essential element in the "monographic" treatment of the subject. In no Invertebrate animals is the relation of the soft to the hard parts more complex than in the Echinodermata; and of all the members of this group the Crinoids are those in which the soft and the hard tissues enter into the most intimate relations with one another.

As this subject has been occupying my attention very closely for the past eleven years, it was with considerable interest that I examined Messrs. Vogt and Yung's anatomical monograph on *Antedon rosacea*, which is the result of their personal investigation of this type; and I regret to state that I find it to contain a very large number of serious errors, both of omission and of commission, many of which would have been avoided if the authors had taken the trouble to make themselves better acquainted with the literature of the subject.

The essential requisite of a work such as theirs, which is intended for the use of students, is the greatest possible accuracy; but it is hardly too much to say that between misprints, misstatements, and absolute anatomical blunders, there are comparatively few pages of the monograph on *Antedon rosacea* in which a correction of some kind or other will not be necessary before the work is put into the hands of the students for whose use it is intended.

The authors' inaccuracy and want of acquaintance with the literature of their subject appears in two instances at the very commencement of their account of the Crinoidea. They give a definition of the group \*, in which the following passage occurs:—"Face orale portant, au centre, la bouche et l'anus dans un espace interradaire." It has been known, however, for over forty years that there are a large number of Crinoids in which the mouth is not central, but excentric, or even marginal. Three instances of this arrangement were figured by Müller † in 1849; while I have myself frequently alluded to it and have figured several disks ‡, together with a sectional view §, in all of which the markedly excentric position of the mouth is very evident. It has been pointed out again and again during the last eight years that this is the essential character of Müller's genus *Actinometra*, and it is given as such in Claus's 'Grundzüge.' This genus contains quite one

\* 'Traité d'Anatomie Comparée Pratique,' livr. vii. p. 514.

† "Ueber die Gattung *Comatula*, Lam., und ihre Arten," Abhandl. d. k. Akad. d. Wiss. Berlin, 1849, p. 245.

‡ "On the Genus *Actinometra*, Müll., with a Morphological Account of a new Species from the Philippine Islands," Trans. Linn. Soc. 2nd ser. (Zool.), 1879, vol. ii. pl. i.

§ "The Minute Anatomy of the Brachiata Echinoderms," Quart. Journ. Micr. Sci. n. ser. 1881, vol. xxi. pl. xii. fig. 14.

third of the species of recent Crinoids, and yet the mouth in this class is described as central by Vogt and Yung, without any indication whatever that this position is not an absolutely constant one in all species of *Antedon*, and does not occur at all in *Actinometra*.

This error may be described as one of omission. The next one which I shall consider is one of commission, and that of a very definite kind, betraying either a most remarkable neglect of Crinoid literature on the part of Messrs. Vogt and Yung, or a deliberate refusal to give British naturalists the credit which is justly their due. On p. 518 the authors describe the young Crinoid as a "larve à forme de *Pentacrine* (Perrier)." It is true that in the year 1884 Professor Perrier\* published the results of his researches into "l'Organisation de l'animal aux trois phases: 1. de Cystidé; 2. de Pentacrine; 3. de Comatule libre, mais non encore adulte," and that he referred to "la phase pentacrinoïde;" but in attributing the origination of this term to Professor Perrier, Messrs. Vogt and Yung must be either totally unaware of, or have deliberately resolved to ignore, the following facts.

So long ago as the year 1836 Dr. J. V. Thompson† furnished to the scientific world "the evidence of *Pentacrinus* being the young of *Comatula*." In 1863 Allman‡ referred to "the fixed *Pentacrinus* stage" of the young of *Comatula*, as described by J. V. Thompson. On the very first page of Sir Wyville Thomson's memoir on the Embryogeny of *Antedon rosacea*§ he referred to the "Pentacrinoid" stage; while eleven pages of Dr. Carpenter's monograph||, published in 1866, are devoted to the "General History of the Pentacrinoid Larva," and the term "Pentacrinoid" recurs again and again, both in this and in his three subsequent papers in the 'Proceedings of the Royal Society,' published in 1876 and 1884 respectively. M. Sars (1839), Greeff (1876), and

\* "Sur le développement des Comatules," *Comptes Rendus*, 1884, t. xcvi. p. 444.

† "Memoir on the Starfish of the Genus *Comatula*, demonstrative of the *Pentacrinus europæus* being the Young of our Indigenous Species," *Edin. New Phil. Journ.* 1836, vol. xx. p. 297. The entire absence of any reference whatever both to this and to the previous memoir of J. V. Thompson's is a very striking omission in Vogt and Yung's monograph. They are not even mentioned in the Bibliography, where, however, place is found for Perrier's preliminary description of a new genus which he withdrew in May 1885!

‡ "On a Pre-brachial Stage in the Development of *Comatula*, and its importance in relation to certain Aberrant Forms of Extinct Crinoids," *Trans. Roy. Soc. Edin.* 1863, vol. xxiii.

§ *Phil. Trans.* 1865, p. 513.

|| *Ibid.* 1866, pp. 726-737.

Ludwig (1877) have all adopted it; while it appears in almost every morphological paper on the Crinoids that I have written in the past ten years, and is also used in the textbooks of Claus, Zittel, and other well-known writers, all published before Perrier's allusion to the "phase de Pentacrine." In fact, so long ago as 1872 Perrier himself\* quoted Sir Wyville Thomson's memoir on the development of the "larve pentacrinoïde," a point which (like many others) seems to have escaped the notice of Messrs. Vogt and Yung; and it was therefore with no little astonishment that I found them attributing this term to the French professor who had imparted to them some of the results of his own observations on *Antedon rosacea* for incorporation in their monograph, his own lengthy memoir on this type not being then ready for publication. In certain cases, however, as we shall see subsequently, Messrs. Vogt and Yung express themselves very guardedly with respect to Professor Perrier's results; while some of the new facts, the discovery of which they attribute to him, should in reality be credited to Dr. Carpenter or to some other of his fellow-workers. Like Perrier† too they persist in employing *Antedon* as a masculine name, although the researches of Mr. Spedding led him to the conclusion, which he published nearly ten years ago‡, that it is really feminine; and it has been repeatedly used in this sense by Pourtalès, Ludwig, Duncan and Sladen, F. J. Bell, J. V. Carus, and myself.

Like most of their predecessors, Messrs. Vogt and Yung recognize an antero-posterior plane in the organization of a Crinoid, which passes through the mouth and anus and along one ray. But in the figure which they give of the *Antedon*-disk on p. 521 they do not place the anal interradius downwards, as is done by Sladen, Bell, and myself, and by almost all palæontologists, *e. g.* Schultze, Meek and Worthen, Zittel, Wachsmuth and Springer, &c.; and the bilateral symmetry of the Crinoid type is thus rendered much less apparent to the student than it really is.

Every writer who has hitherto figured sections of an entire *Comatula* has represented it in its natural position, *i. e.* with the mouth upwards—*e. g.* Müller, Greeff, my father, Ludwig,

\* "Recherches sur l'Anatomie et la Régénération des Bras de la *Comatula rosacea*," Arch. de Zool. expérimentale et générale, vol. ii. 1873, pp. 46, 64.

† Although the feminine gender of *Antedon* (or more correctly *Anthedon*) was determined in 1877, Perrier used it as a masculine noun till as late as 1884, though he has since discovered his mistake.

‡ 'Nature,' vol. xv. 1877, p. 366.

Teuscher, Marshall, and myself. Messrs. Vogt and Yung, however, write as follows on p. 520:—"Dans toutes les descriptions qui vont suivre, nous nous représenterons donc l'animal comme couché sur la face ventrale, le sommet du calice étant tourné en haut. Cette position, inverse de celle qu'affecte la Comatule à l'état de Pentacrine, est la seule par laquelle nous pouvons faire congruer son anatomie avec celle des Stellérides et des Échinides, chez lesquels tout le monde admet cette position comme étant normale, où tous les anatomistes parle de l'intestin montant depuis la bouche, du canal pierreux descendant depuis la face dorsale, etc."

Messrs. Vogt and Yung's vertical sections of the calyx therefore represent the cirri as growing upwards from the centro-dorsal, or "en l'air," to use a military expression. No figure at all is given of the natural position of a *Comatula*, and the student is therefore liable to gain an entirely erroneous idea about the functions and relations of the cirri. On p. 544 the authors speak of "plaçant la Comatule dans sa position anatomique normale, le disque en bas, la coupole avec les cirrhes en haut," and are then obliged to describe the gullet as "se dirigeant obliquement en haut et en arrière, vers l'espace interradianal anal."

The student of comparative anatomy who is advanced enough to use Messrs. Vogt and Yung's monograph, but is unable to understand that a Crinoid is simply an inverted Starfish, and that the gullet *descends* into the stomach instead of *ascending*, must be a somewhat remarkable person. Since the Crinoid is the first type of the Echinodermata which is brought before his notice, it seems a curious plan to tell him that the *Comatula*-sections are all represented upside down, in order to "congruer" the anatomy of a Crinoid with that of other types which he has not yet studied.

To speak of an inverted *Comatula* as being "dans sa position anatomique normale," even as compared with the other Echinoderms, is to use a designation which cannot be better described than by the terms which the authors themselves employ with reference to another anatomical name introduced by Dr. Carpenter, viz. "éminemment impropre."

It will be very interesting to see how far the authors will allow this principle to carry them when they come to deal with the Holothurians, Cirripedes, and above all with man as compared with Vertebrates which do not walk erect. Which is his normal anatomical position? No comparative anatomist has yet represented his human dissections as otherwise than in the erect position. Why should not the Crinoids also be figured in the natural position which they occupied during

life? Would Messrs. Vogt and Yung figure a vertical section of *Pentacrinus* or *Rhizocrinus* with its mouth downwards and its stem "en l'air"?

Another illustration of the authors' want of acquaintance with the recent Crinoid literature which has not emanated from the pen of Professor Perrier is afforded by the following passage on p. 571:—

"Les Comatulides libres (*Antedon*, *Actinometra*) offrent fort peu de différences anatomiques, et sauf quelques détails insignifiants, sont construites absolument sur le même plan que notre espèce type."

My comments on this passage shall be put in the form of a series of questions.

1. Is it a "détail insignifiant" that more than half the arms, with the majority of the pinnules in some forms of *Actinometra*, have neither ambulacral groove, tentacles, nor ventral nerve? This fact was first published in 1876, and has been since noticed over and over again in papers on Crinoids which are included in the bibliography given by Messrs. Vogt and Yung.

2. Is it a "détail insignifiant" that the sacculi which Messrs. Vogt and Yung describe as parasitic "zooxanthelles" are never found in the exocyclic *Actinometra*, even when living side by side with *Antedon* in the same locality, though they occur in three other endocyclic Comatulæ?

3. Is it a "détail insignifiant" that the arms and pinnules of many species of *Antedon* are provided with a very well-defined ambulacral skeleton, consisting of a double row of side plates and covering plates, the former being notched for the reception of the symbiotic "zooxanthelles;" but that side plates and covering plates are entirely absent on the arms and pinnules of *Actinometra*, even in species which have a strongly plated disk? These characters were described in 1880 and 1882 respectively.

4. Is it a "détail insignifiant" that the mouth of *Actinometra* is excentric, and that its alimentary canal makes four coils round the disk instead of one only, as is the case in all the endocyclic Crinoids?

A diagram of this arrangement was given in the Report on the 'Challenger' Crinoidea, which appeared early in the year 1885, and formed the subject of an article by M. P. de Loriol in the 'Archives des Sciences physiques et naturelles,' published in the following April at Geneva, the very town in which Messrs. Vogt and Yung are professionally engaged; while a second notice of the report was given by Professor Perrier in the 'Revue Scientifique' for May 1885.

Singularly enough, however, both these reviews and the volume which suggested them appear to have been altogether unknown to Messrs. Vogt and Yung; for the 'Challenger' Report is not mentioned in the bibliography of the Crinoidea which appeared in the autumn of 1886, eighteen months after its publication\*; and on p. 571 they say with reference to the Stalked Crinoids that "les seuls travaux détaillés sur l'anatomie sont: celui déjà ancien de J. Müller sur le *Pentacrinus caput Medusæ* de la mer des Antilles, et celui plus moderne de M. H. Ludwig sur la *Rhizocrinus lofo-tensis*." Continuing their comparison of the Stalked Crinoids with the typical *Comatula*, they say:—

"Il résulte de ces travaux que les organes du disque, des bras et des pinnules sont disposés en général, sur le type des Comatules. . . . En revanche, il y a des conformations conservées qui ne sont que passagères dans la larve pentacrinoïde des Comatules. Il n'y a qu'un seul pore calycaire, réuni par un sac à un seul tube hydrophore." And after giving other details of the resemblances between the adult *Pentacrinus* or *Rhizocrinus* and the *Comatula* larva, they add:—"C'est un des plus beaux exemples de la conservation de caractères embryonnaires dans des animaux adultes."

Now, although the authors do not state the fact in so many words, they certainly imply that in the Stalked Crinoids, as known from the researches of Müller and Ludwig, there is only one water-pore and only one "tube hydrophore," just as in a certain stage of the *Comatula* larva. I do not know what other meaning can be attributed to the passage which I have italicized. But, according to the descriptions of Professor Perrier†, the developmental stage of *Comatula* in which only one water-pore is present is the "phase de Cystidé," in which the arms are not developed. These do not appear till the "phase de Pentacrine," when there are five water-pores, one in each interradius; and as Ludwig's observations show that this condition is permanent in *Rhizocrinus lofo-tensis*, Messrs. Vogt and Yung would have done better to refer to this later developmental stage rather than to the pre-brachial "Cystid phase" as an illustration of the "conservation des caractères embryonnaires dans des animaux adultes."

Will they name a single Stalked Crinoid which resembles the Cystid phase of *Antedon* in having but one water-pore and water-tube? Do they not know that there are never less

\* It may be well to state here that I was unable to obtain *Livraison 8* of the 'Traité,' which contains the bibliography of the Crinoidea, till Oct. 25, 1886.

† 'Comptes Rendus,' 1884, t. xcvi. pp. 444, 445.

than five, and that *Rhizocrinus* is the only genus which has so few? Are they not aware that forty years ago Müller not only described but also figured a large number of water-pores at the sides of the ambulacra in *Pentacrinus*\*, and that I noted the presence of several pores in *Bathycrinus* and *Hyocrinus* in 1882 †? The same character was described as occurring in *Holopus* and *Metacrinus* in the 'Challenger' Report; and, as a matter of fact, *Rhizocrinus* is the only Stalked Crinoid which at all resembles the *Comatula* larva, and this in having not one, but five water-pores!

Messrs. Vogt and Yung have illustrated their 'Monograph' by a number of woodcuts which admirably represent the structure of *Antedon rosacea*; and I am glad to be able to speak of these figures in terms of unqualified praise. It is unfortunate, however, that their great excellence should be marred by errors and omissions in the lettering and in the explanations of the figures which are given at the bottom of each page. Thus, for example, in the explanation of fig. 266 on p. 525 *q* and *q*<sup>1</sup> are transposed, while *k*<sup>1</sup> is printed *h*<sup>1</sup>; in like manner in fig. 267, on the following page, the *i* indicating the intestine is printed as the *v* marking an ambulacral groove; *p*<sup>2</sup>, which indicates the wall of *p* (cavité buccale), is marked "couche fibreuse de la paroi intestinale;" while an accidental rent, caused by the tearing away of the extensor fibres between the axillary radial and the first brachial, is marked with a sign which may be either *a*<sup>1</sup> or *d*<sup>1</sup> badly printed; *a*<sup>1</sup>, however, stands for the primary radial, and *d*<sup>1</sup> is not explained at all; neither are *t* and *e*<sup>1</sup>.

Figure 268, on page 527, is described as a "Coupe verticale passant par l'axe et la ligne antéro-postérieure, désignée par les orifices buccal et anal." In reality, however, it is not a truly vertical section at all. If it were so its dorsal portion would pass through the central capsule and show its internal chambers, with the origins of the cirrus-vessels and the axial cords of the first radials, just as is seen in fig. 267, on the previous page. This last represents a (nearly) vertical section, *i. e.* one which cuts the median plane in the calyx and is just outside the edge of the peristome on the ventral side; and it is sufficiently near to the median vertical plane to be fairly described as such without exaggeration. But the section represented in fig. 268 is very considerably oblique, for its dorsal portion passes through the extreme outer edge

\* "Ueber den Bau des *Pentacrinus caput-meduse*," Abhandl. d. k. Akad. d. Wiss. Berlin, 1843, p. 49, Taf. ii. fig. 14.

† "Notes on Echinoderm Morphology.—No. V.," Quart Journ. Micr. Sci. new ser. 1882, vol. xxii. p. 383.

of the centro-dorsal piece and through the five bundles of muscular and other fibres, four flexor and one extensor, which effect the articulation between the first and second radials. An artificial rent, caused by the tearing away of the densest part of the bundle of extensor fibres, is marked " $f^1$ , cavités laterales de l'organe cloisonné," namely the chambers marked  $f$  in fig. 267, which are enclosed by the thick nervous envelope of the central capsule, and are in the very middle of the centro-dorsal plate. In fact the chambers of the "organe cloisonné" lie inside what the authors describe as the "anneau nerveux central;" while the space marked  $f^1$  in fig. 268 is on the outer side of this structure, and is separated from it by almost the entire thickness of the first radial. The explanation of fig. 268 contains other serious errors. The two first radials are not specially distinguished, but are simply marked " $a$ , pièces constituant le sommet du calice;" and the authors continue, " $c$ , muscles qui les réunissent." These "muscles," however, unite the first radials not with one another, but with the second radials, as explained above; while the tissue uniting the two first radials laterally is marked " $g^2$ , colonne de l'organe dorsal, effleurée." The extent of the error here involved will be evident from inspection of the (nearly) horizontal section represented in fig. 264 on p. 522. Its centre is occupied by the dorsal organ, marked  $g$ ; while the structure which is marked  $g^2$  in fig. 268 is the outermost edge of what is here marked  $b$  and described as an articular face separating the "pièces calcaires du sommet," in other words the first radials. The authors do not seem to have recognized the fact that a vertical section which passes through the articulation between the first and second radials could not possibly also pass through any part of the dorsal organ at its base, for it is not merely within the nerve-pentagon inside the first radials, but in the very centre of the calyx itself, as shown in their figs. 264 and 267.

Another gross blunder of the same kind appears in the explanation of fig. 276 on p. 550, where the fibres uniting the centro-dorsal to the first radials are described as " $b$ , muscles entre le premier et le second radial." These fibres, though represented in fig. 267, are not referred to in its explanation, and the unwary student would thus be led to infer from fig. 276 that some of the cirrus-nerves pass out from the central capsule directly into the first radials, and that the arm-nerves pass at once into the second radials! If the authors had distinguished the centro-dorsal from the first radials in this figure it would have been some help to the

student; but they are both alike marked "*a*, parties décal-cifiées du squelette."

We have seen that in the explanation of fig. 268 two of the first radials are described as "*pièces constituant le sommet du calice*;" and on p. 529 we read "*les cinq premiers radiaux qui forment le sommet du calice*," &c. But on the page immediately preceding (528) we are told that "*ce sommet est occupé par un seul pièce pentagonale, la plaque centro-dorsale*," a description which is scarcely consistent with the explanation of fig. 268; while we also read that the first radials are "*fusionnées avec la plaque*," although the fibres effecting this fusion are described in the explanation of fig. 276 as the muscles between first and second radials! Various descriptions are also given of the mode in which the first radials are united laterally to one another. The explanation of fig. 264 runs thus:—"a, pièces calcaires du sommet, séparées par des faces articulées, b, dans lesquelles s'engagent les muscles transversaux c, internes; d, muscles se rendant aux bras naissants." But on the next page the same parts are described as follows:—"Les pièces calcaires (a) du sommet du calice sont réunies par de fortes masses musculaires (d) et par des sutures linéaires (b) traversées également par des muscles (c)." Thus then the extensor fibres (d), which on one page are spoken of as uniting the arms to the "*sommet*," are described on the next as joining together the calcareous pieces of the "*sommet*;" and this same "*sommet*" is said on p. 528 to be occupied by only one pentagonal piece, the centro-dorsal!

The authors admit that the section represented in fig. 264 passes "*un peu obliquement sur la plaque centro-dorsale*." Had it been really horizontal they would have seen nothing of the three "*faces articulées*" (b), which are described on the next page as linear sutures between the first radials; while on p. 529 we are told that these same first radials are "*fusionnés ensemble*," and nothing whatever is said about the "*muscles transversaux internes*," which are marked (c) in fig. 264 and described on p. 530 as "*puissantes masses musculaires*"! Do the authors really believe that the first radials were united to the centro-dorsal and to one another by muscles, and that these portions of the calyx were movable on one another? The fibres which effect this union are altogether of a different nature from those forming the great muscular bundles which are attached in the fossæ at the ventral ends of the articular faces of the first radials and of the arm-joints (c of fig. 268, f of figs. 279 and 280). These have the usual histological characters of the muscles in other

Echinoderms, and are very darkly coloured. They are similar in all essential respects to the muscular fibres of the Ophiurids, as figured by Simroth \*; while the fibres uniting the first radials with the centro-dorsal and with one another are of the same nature as those which Simroth described as effecting the various forms of synostosis between different plates in the skeleton of an Ophiurid (p. 435).

Messrs. Vogt and Yung do not give any reason for the presence of muscles between plates which are "fusionnés" with one another, and are therefore immovable, neither do they describe any articular faces on which movement can take place. As a matter of fact the fusion or synostosis is often so close that the calyx will resist prolonged boiling in strong alkali and begin to undergo chemical disintegration without the radials separating from one another and from the centro-dorsal; while any attempt to separate them by a fine knife-blade results in fracture of the whole calyx. Since the ordinary muscles outside the calyx are the very first tissues to be affected by the action of the alkali, the muscles described by Vogt and Yung within the calyx must differ from them altogether in their chemical as well as in their histological features.

It has been mentioned already that the monograph on *Antedon rosacea* which is the subject of this notice is a part of Messrs. Vogt and Yung's 'Traité d'Anatomie Comparée Pratique,' and one would therefore expect to find some notice in it of the comparative morphology of the Echinoderm skeleton. The homology of the basal and radial plates of a Crinoid with the genital and ocular plates of an Echinid is now universally acknowledged; but though Vogt and Yung make plenty of comparisons between the vascular system of Crinoids and those of other Echinoderms, they make no reference whatever to the morphology of the apical system, a point about which there is a much more general consensus of opinion than exists about the vascular system. They give a very good figure of the apical plates of an Urchin, but say not a word respecting their homology with the basals and radials of a Crinoid. In fact they make no reference whatever to the former, which is a somewhat singular omission, considering their morphological importance in the organization of the Crinoid type. The authors do, it is true, speak of the cirrus-vessels as separating from one another "pour se continuer, à

\* "Anatomie und Schizogonie der *Ophiactis virens*, Sars," Zeitschr. f. wiss. Zool. 1876, Bd. xxvii. p. 440, Taf. xxxii. figs. 15-17, 20, 21, Taf. xxxiii. fig. 30.

travers la pièce basale du calice, dans les cirrhes ;" \* but what they call the basal piece here is the substance of the centro-dorsal, which they describe elsewhere as the single piece occupying the "summit" of the calyx. This is a considerable inconsistency ; but it is only the natural result of their inverted mode of figuring and describing the Crinoid, which also leads them to say (on p. 548) that the cavities of the chambered organ "remontaient dans la tige de la larve pentacrinide lorsque celle-ci était encore fixée."

I have some doubts indeed as to whether they are even aware of the existence of basal plates in *Antedon rosacea*.

On p. 529 they say with reference to the first radials that "ils sont fusionnés ensemble et avec une mince plaque treillisée, qui s'interpose entre eux et la plaque centro-dorsale, et qui en est séparée dans la stade pentacrinioïde. Cette partie appelée *rosette* par Carpenter, montre au milieu une excavation pentagonale à angles proéminents et arrondis." Now this rosette was shown by Dr. Carpenter to be developed by the metamorphosis of the basal plates of the early larva ; and Messrs. Vogt and Yung's description of it as being separated from the centro-dorsal and radials during the Pentacrinoid stage is incomplete, to say the least of it, seeing that it is not then existent. Dr. Carpenter described the transformation of the basals into the rosette as commencing after the detachment of the young *Antedon* ; and he gave figures of the calyx both of the advanced Pentacrinoid and of the young *Antedon* in which five separate basal plates are still distinctly visible and the rosette is not yet formed †.

Although the word "Rosette" as employed by Dr. Carpenter for the metamorphosed basals of Comatulæ has been used by all subsequent writers on the subject, *e. g.* Sars, Wyville Thomson, Ludwig, Marshall, Claus, Zittel, Wachsmuth and Springer, Schlüter, Weinberg, Dendy, and myself, Messrs. Vogt and Yung have seen fit to transfer it to another structure, namely a portion of the vascular system belonging to the chambered organ. It is used in this sense on p. 555, and also three times in the last paragraph of p. 548 ; but in the preceding paragraph we read : "La partie centrale du système nerveux (*e*, fig. 264 ; *g*, fig. 276) est en effet située dans le sommet de la coupole au-dessous de la rosette, dont elle est séparée par un mince plafond calcaire, percé au centre par de nombreuses lacunes qui sont en relation avec l'organe cloisonné." I must confess that this sentence puzzles me. The central part of the nervous system which is marked *g* in fig. 276 is

\* *Op. cit.* p. 549.

† Phil. Trans. 1866, p. 744, p<sup>l</sup>. xli. figs. 5, 6, pl. xlii. figs. 2, 6.

not the same as that marked *e* in fig. 264. The latter is rightly described in the explanation of the figure as the "anneau pentagonal du système nerveux central;" but it lies within the substance of the first radials, above the rosette in the natural position of the animal, and not within the "somet de la coupole." On the other hand, the part marked *g* in fig. 276 really is within the centro-dorsal, or summit as the authors call it; but it is represented above the rosette (of Dr. Carpenter) in their (inverted) fig. 276, while the "mince plafond calcaire," which they describe as separating it from the rosette, whatever this may be, is nothing but the rosette of metamorphosed basals, as described by Dr. Carpenter and all his successors. I know of no other thin calcareous plate in the neighbourhood of the chambered organ which at all answers to the description of Messrs. Vogt and Yung. A portion of this calcareous rosette is excellently shown between the ventral surface of the chambered organ (*sensu strictu*) and the inner face of the first radial, and is marked *o* in fig. 276; but *o* is left without notice in the explanation of the figure; and Prof. Carl Vogt has been good enough to inform me by letter that the missing legend should run "*o*, tissu conjonctif aréolaire entourant l'organe dorsal et les cavités *c* de l'organe cloisonné."

Now this very part had been figured in the sections of Ludwig, Marshall, and myself, and in each case had been marked "Rosette" and its real nature properly explained. It was therefore with no small feelings of astonishment that I found one of the authors of a work on comparative anatomy describe a calcareous structure which is universally recognized as homologous with the genital plates of an Urchin, as "areolar connective tissue." This statement helps us to understand why a portion of the centro-dorsal piece in immediate contact with the nervous "anneau central" is lettered "*e*, mésentère."

The authors' want of acquaintance with the mutual relations of the hard and soft parts in the calyx of *Antedon rosacea* is further indicated by their description of the mode in which the great brachial nerves originate from the central nervous organ. On p. 549 they say with respect to their vertical sections:—"On voit sur ces coupes la masse nerveuse comme un gâteau à face dorsale un peu bombée, tandis que la face ventrale est un peu creuse, et lorsque la coupe a bien rencontré, comme sur notre figure à droite, l'axe d'un radial, on peut suivre la continuation immédiate et sans interruption, sous forme de nerf, de l'un des angles du gâteau dans le bras naissant." Now, if the authors had properly studied any one

of the descriptions and figures given by Dr. Carpenter, Ludwig, Marshall, or myself, they would know that a section in the axis of a radial could not by any possibility show an uninterrupted continuation of the nerve-cord direct from one of the angles of the central capsule into the origin of an arm. The arm-nerves start from the angles of the chambered organ, which are interrarial, and they occupy this position on the dorsal surface of the calcareous rosette, where they bifurcate. The left branch of one fork and the right branch of its neighbour enter the same first radial, and a section through the axis of the *radial* would not therefore pass through the primary *interrarial* cord arising from the central capsule. Truly radial sections, such as those figured by Marshall\* and myself†, are not very difficult to obtain, and they show the relations of these primary nerve-cords very clearly; but the right side of Vogt and Yung's fig. 276 is very nearly interrarial, and not radial as they state. If it were in the axis of a radial, as they say, the nerve-cord would not end abruptly, as they figure it, at the level of the "anneau pentagonal;" but it would be seen to pass on beyond this towards the second radial, as is represented on the left side of fig. 267. In like manner the left side of fig. 276, which would be interrarial according to their description, is almost radial. It strikes one of the radial diverticula of the body-cavity into the calyx (axial radial canals), which is enclosed by a radial process of the rosette, the same part which is lettered *o*, but not explained, as I have already stated. Not only have the Swiss authors entirely failed to understand the orientation of their sections through the calyx, but they have altogether neglected to give any account of the remarkable way in which each radial receives nerves from two sources, while all the five double nerves of the rays are connected among themselves by two sets of commissures, interrarial and intrararial, thus forming the great pentagonal commissure which is lodged within the substance of the first radials. It is true that they give a nearly horizontal section through this commissure (fig. 264), and speak of it as the "anneau pentagonal du système nerveux central," but they say not a word about the manner in which it is formed—a somewhat remarkable omission when we consider its physiological importance; while the mode in which they refer to it is calculated to seriously mislead the unfortunate student.

They make the following statement on p. 523:—"L'orien-

\* "On the Nervous System of *Antedon rosaceus*," Quart. Journ. Micr. Sci. new ser. 1884, vol. xxiv. pl. xxxv. fig. 1.

† Trans. Linn. Soc. 2nd ser. (Zool.), vol. ii. 1879, pl. viii. fig. 3.

tation étant donnée, telle que nous l'avons indiquée, nous allons esquisser la situation générale des organes dans le calice, dans le but de faciliter à l'élève l'intelligence de l'anatomie de la Comatule singulièrement difficile à débrouiller. Les coupes dans différents sens constituant les principaux éléments de la dissection, nous avons indiqué, dans les figures 264 à 268, représentant trois coupes horizontales et deux verticales du calice, les mêmes objets par des chiffres identiques." Here are some instances of the way in which this most desirable object is effected:—*c*, in fig. 264, denotes the "muscles transversaux internes," *i. e.* those by which the first radials are "fusionnés" to one another laterally; while in fig. 268 it is appended to the paired muscular bundles by which the first and second radials are articulated together. In figs. 264 and 268 *a* denotes the first radials, while in fig. 267 these are marked *a*<sup>1</sup>, and the centro-dorsal is denoted by *a*. In fig. 264 the figure *e* is appended to the "anneau pentagonal du système nerveux central" which lies within the substance of the first radials on the ventral side of the rosette and altogether outside the inner cavity of the centro-dorsal; but in fig. 267 *e* denotes the dorsal portion of the central capsule or nervous envelope of the chambered organ, which is situated at the very bottom of the centro-dorsal cavity in its deepest part. Do the authors really mean to imply that this is "le même objet" as the pentagonal commissure within the radials? It would seem so; for they refer to it as the "anneau nerveux central," and in fig. 276 they mark the same part *g*, with the explanation "anneau central du système nerveux." But they speak of it two pages before (p. 548) as "sous la forme d'un disque pentagonal à angles arrondis, percé au centre d'une petite rosette pentagonale aussi, et parcourue par des cloisons membraneuses étoilées, qui se réunissent au centre." The result of this indiscriminate application of the term "anneau" to the discoidal nervous centre within the centro-dorsal and to the pentagonal commissure within the radials cannot but be most perplexing to the student; and it was the less excusable since every one of these different muscular and nervous structures, which have been confused by Messrs. Vogt and Yung, were clearly differentiated by myself and distinguished by different letters in the explanations of my figures as long ago as 1879, in a memoir quoted in their Bibliography.

The authors also seem to be altogether unaware, though the fact has been known for the last twenty years, that each radial receives two nerve-cords which enter it separately by large and well-defined openings. They find, as their predecessors

have done, that sections of the second radials show ten nerve-cords, the shape of which varies according to the plane in which they are cut; but on p. 549 these ten cords are described "comme résultat définitif du travail de division accompli dans l'épaisseur des premiers radiaux;" and the authors further proceed to say that these cords correspond to the nerves of the ten arms. As a matter of fact, however, these ten cords in the second radials are really converging, and not diverging from points of division in the first radials, and each of them contributes nerve-fibres to two arms, as explained by Ludwig, Marshall, and myself and not to one only, as implied by Messrs. Vogt and Yung. The real division by which the five (double) nerves within the rays form ten (double) nerves within the arms takes place in the *third* and not in the *first* radials, as has been known for years past. Facts like these may be verified by any one who will take the trouble requisite for accurate section-cutting along particular planes of the calyx, and will further acquaint himself with the characters and arrangement of the internal canals, so that he will not be liable to errors of "orientation" like those into which Messrs. Vogt and Yung have fallen.

Reference has been made already to the axial radial canals which are enclosed between the rosette and the radials of *Comatula*, and sometimes reach the ventral surface of the centro-dorsal. Their character and relations were minutely described by myself in 1879 \*. They were shown in longitudinal and in transverse section, and were clearly distinguished from the five cavities within the central capsule, which were first discovered by Dr. Carpenter †. He gave the name "five-chambered organ" or "quinelocular organ" to the structure which had been described by Müller as a single-chambered heart; for he found it to contain "five chambers clustered like the carpels of an orange round a central axis;" and he described these chambers as being surrounded by a fibrillar envelope, which he regarded as nervous in character. Marshall ‡, again, spoke of the cavity of the centro-dorsal as lodging a sac divided by vertical septa into five radial compartments, and hence called the chambered organ; and he went on to explain how this is surrounded by a thick fibrillar investment known as the "central capsule." Ludwig had previously adopted the same terminology, and, in fact, he was the first to speak of the chambered organ without the nume-

\* Trans. Linn. Soc. Lond. 2nd ser. (Zool.), vol. ii. 1879, pp. 77, 78.

† Phil. Trans. 1866, p. 738; and Proc. Roy. Soc. 1876, vol. xxiv. pp. 218, 219.

‡ *Op. cit.* p. 510.

rical prefix\*; but he never used this expression to denote anything else than the five chambers and their central axis inside the central capsule; while he further described and figured the radial axial canals, the relations of which to the coeliac canals of the rays and arms were subsequently pointed out by myself. Their connection with the body-cavity and their distinctness from the chambers of the so-called heart were clearly recognized by Greeff, both in his figures and in his descriptions; while I am not aware that Teuscher, the only other recent original writer on the subject till the time of Jickeli and Perrier†, ever used the expression "chambered organ" at all, though he often referred to the "Kammern des Gefässcentrums," and he recognized the connection of the radial axial canals with the coeliac canals of the rays.

Messrs. Vogt and Yung, however, have figured not only the cavities within the central capsule, but also the radial axial canals, and the whole system of spaces within the calcareous network occupying the centre of the radial pentagon, together with some accidental cavities within the solid base of the centro-dorsal piece and in the radials, as "cavités dépendantes de la cavité générale, et constituant dans leur ensemble l'organe dit cloisonné"‡.

They say on p. 549, "Ce sont les espaces qu'on est convenu d'appeler, fort improprement, l'organe cloisonné;" and again on p. 530, "C'est la réunion de toutes ces excavations internes, qui sont revêtues de membranes, envoyant de cloisons transversales et dessinant ainsi un système compliqué de lacunes cloisonnées, qui composent ce que les auteurs ont appelé l'organe cloisonné (*Gekammertes Organ*). C'est une dénomination éminemment impropre, vu que ce n'est pas un organe, mais une suite de cavités parcourues par l'organe dorsal avec ses vaisseaux, et formant la continuation de la cavité générale du corps, du cœlôme, qui entoure les intestins." The statements contained in the first passage quoted above and in the first paragraph of the second one are inaccurate, to say the least of it. Messrs. Vogt and Yung do not name the writers who have used the term "chambered organ" in this very improper sense; but it is certainly neither Dr. Carpenter, Ludwig, Marshall, Greeff, Teuscher, Jickeli, nor myself; and with the exception of Prof. Perrier, I know of no other original

\* "Beiträge zur Anatomie der Crinoideen," Zeitschr. f. wiss. Zool. 1877, Bd. xxviii. pp. 315-326.

† So far as I can understand Perrier's preliminary notes, he uses the term "chambered organ" in its original sense, and not at all in that assigned to it by Vogt and Yung.

‡ *Op. cit.* p. 550, fig. 276.

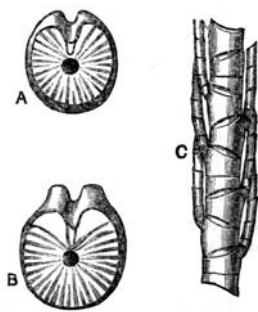
writer on Crinoid morphology who has used the expression "chambered organ" at all. The space represented in the figures to which the Swiss authors refer \* is the radial portion of the body-cavity within the calyx, which is clearly distinguished from the chambers within the central capsule in all the figures given by Ludwig, Greeff, Marshall, and myself; and not one of us has ever regarded this space as a part of the chambered organ, nor, so far as I know, has any other writer on the subject. But from the mode of reference employed by the Swiss authors it would appear that Dr. Carpenter had made a great mistake which had escaped notice for twenty years, until it was rectified by Messrs. Vogt and Yung; whereas in reality they are themselves in error, because they give a meaning to his name which neither he nor any one else who used it ever intended it to bear. The term "(five-) chambered organ," as used by him and by every one of his successors till now, refers exclusively to the cavities within the central capsule, which lie on the *dorsal* side of the calcareous rosette and radial pentagon. But Messrs. Vogt and Yung erroneously interpret it as also denoting the entire system of cavities within the centro-dorsal plate and the ring of radials that rests upon it; and this is certainly not a definite organ, but a part of the general *cœlom*, as stated by the Swiss authors. These facts, however, were perfectly well known both to Dr. Carpenter and to his successors, and I am therefore entirely at a loss to know who the authors can be who have used the term "chambered organ" in the "eminently improper" sense described by Messrs. Vogt and Yung. The Swiss authors seem to have entirely ignored or misunderstood the writings of their predecessors, and have attributed to them a mistake which never was made; but instead of rectifying this supposed mistake they have converted it into a real one, and have perpetuated it both in their text and in the explanations of their figures. Thus in figure 276 the cavities within the central capsule on the dorsal side of the calcareous rosette and the portion of the body-cavity which is on the ventral side of this structure and enclosed by one of its radial processes are marked alike "*c, c, cavités dépendantes de la cavité générale et constituant dans leur ensemble l'organe dit cloisonné.*" No one but Vogt and Yung has used the term chambered organ in this sense; and as they rightly speak of it as "eminently improper," one cannot but regret that it should have been employed in a text-book of comparative anatomy for the use of students.

But Messrs. Vogt and Yung go even further than this. The

\* *Op. cit.* : *f*, fig. 264; *c*, fig. 276.

space on the dorsal side of the central capsule which is marked *f*<sup>1</sup> in fig. 267, and *c* in fig. 276, and is described in the explanation of the former figure as one of these cavities of the chambered organ, is nothing whatever but a rent in the organic basis of the floor of the centro-dorsal piece. These rents often appear in the skeletal tissues when very thin sections are cut, and I have been familiar with them for years; but I have many sections through the calyx, both of *Antedon rosacea* and of other species of Comatulæ, in which there is no trace of them. Three such undamaged sections are figured in my *Actinometra*-memoir\*; and I certainly never expected to find an accidental fracture in the skeletal tissue *outside* the central capsule described as a part of the chambered organ, the cavities of which are entirely *within* this capsule, as explained above. If there really be such a diverticulum of the body-cavity within the calcareous substance of the centro-dorsal piece, as described by Vogt and Yung, *i. e.* between its inner floor on which the central capsule rests and its external surface, its presence could easily be demonstrated by rubbing away the outer surface of the centro-dorsal until this cavity was reached; and I commend this method of proving the accuracy of their anatomical descriptions to the attention of Messrs. Vogt and Yung.

It would be well also if they would use the same method to demonstrate the existence of the "cavité de la syzygie," which they represent in fig. 279 on p. 558. They describe this section as a "coupe transversale d'un bras, frisant une syzygie;" but in reality it is very considerably oblique, and so far as its dorsal portion is concerned would be classed as a bad section, owing to the large amount of skeletal tissue which has been torn away by the knife. It will be apparent from the annexed figure (C) that the plane of each syzygial face is absolutely transverse to the axis of the arm, so that a truly transverse section would pass through all the ridges radiating outwards from the central canal and show no trace of the paired muscular bundles or else show no ridges at all. But



Syzygies in the arm of *Antedon rosacea*.  
A, the epizygial; B, the hypozygial;  
C, dorsal view of an arm-fragment.

\* Trans. Linn. Soc. Lond. 2nd ser. (Zool.), vol. ii. 1879, pl. viii. figs. 3, 4, 7.

Messrs. Vogt and Yung's transverse section "frisant une syzygie" shows the peripheral edge of one ridge and portions of two others ; while two large muscular bundles are the most conspicuous objects in the figure. The brachial nerve is not central as it ought to be, and a large portion of the organic basis of the arm-joint, both between it and the dorsal surface and on each side of it, especially the right in the figure, has been torn away by the knife, leaving a great gap which is marked "*c, cavité de la syzygie.*" Did this cavity really exist in the position figured by Vogt and Yung, it would certainly appear on the dorsal side of the axial cord in a longitudinal section of an arm. But on the opposite page of Messrs. Vogt and Yung's work to that bearing the transverse section is a figure of a longitudinal section in which there is absolutely no trace of this cavity. There could be no better proof than this of the fact that the "*cavité de la syzygie*" is an accidental one, the position assigned to it by Vogt and Yung being within the actual substance of the arm-joint. The same longitudinal section on p. 559 shows two diverticula of the cœliac canal towards the dorsal side with their bases resting against the skeleton. One of them is lettered *c*, and the other with a letter which is apparently meant for *c*, though it looks more like a *t*; and the explanation of the figure runs "*c, c, cavités de syzygies.*" The *t*-like *c*, however, indicates a cavity which is not at a syzygy at all, but is merely the usual diverticulum of the cœliac canal at a muscular articulation between two arm-joints. There is a similar diverticulum at every syzygy, which is represented on the syzygial face by a groove (see woodcut, *suprà*, p. 37, A, B); but it never reaches the arm-nerve, as is well shown in Vogt and Yung's longitudinal section. On p. 560, however, they speak of this diverticulum as enlarging "*vers la syzygie même, en une cavité arrondie, plate, laquelle entoure le vaisseau-nerf central, et est traversée par des canaux, disposés en rayons et formés d'un tissu fibreux en apparence élastique, ou musculaire, dont les insertions sur les teguments donnent à des coupes bien dirigées un aspect de roue.*"

As a matter of fact, however, the position of this supposed "*cavité de la syzygie*" is not anywhere in the syzygial union, but behind it, and it is occupied by the solid substance of the arm-joint, as is shown in Vogt and Yung's longitudinal section.

The authors appear to have some doubt as to the real nature of the fibres which effect the syzygial union; for while in the explanations of figs. 279, 280 they describe these fibres as the "*ligaments de la syzygie,*" they say on the following

page that the fibrous tissue is apparently elastic or muscular ; but lower down on the same page they definitely speak of the "fibres tres fines du tissu élastique," which are "isolées et ne se réunissent pas en faisceaux comme celles des muscles." Their undecided mode of reference to these fibres is a point of considerable interest, for Perrier (whom in general the Swiss authors follow through thick and thin) has described them as forming powerful muscles by which water is expelled from the arm-canals through pores at the periphery of the syzygy. The Swiss authors do not in this case use any such form of expression as "Les recherches de M. Edm. Perrier ont complètement élucidé cette question;" but they merely give a quotation from Perrier's statement of his theory without any confirmatory expressions of their own \*. I have already given my own reasons for not accepting it †, and I am therefore very glad to find that such ardent admirers of Prof. Perrier's researches as Messrs. Vogt and Yung have altogether refrained from expressing their belief in it.

The Swiss authors' description of the vascular system of *Comatula* calls for a much more detailed criticism than would be at all possible at present; but one or two points may be noticed here. Speaking of the structures immediately beneath the ambulacral epithelium, they say on p. 538, "Quelque fois on y voit des écartements qui ont été pris pour l'expression d'un vaisseau dit nerveux, dont nous contestons formellement l'existence." Greeff has figured this cavity in the arm of *Antedon rosacea* ‡; and I have seen it over and over again in both arms and disk of this species, as well as in *Antedon Eschrichti*, *Actinometra nigra*, *A. parvicirra*, *A. pulchella*, and *Pentacrinus decorus*, and in the arms of *Bathyrinus Aldrichianus*. In good sections of the larger types its epithelial lining may be seen, as described and figured by Ludwig in *Antedon Eschrichti* §; and if the Swiss authors had followed his example they would have seen a good deal in the structure of the ambulacra, and more especially in that of the genital tube, which they have failed to make out in the small arms of *Antedon rosacea*.

Considering the very definite character of the intervisceral blood-vessels of this type, those namely which form a plexus interpenetrating the connective-tissue meshwork within the

\* *Op. cit.* p. 561.

† "On some points in the Morphology of the Echinoderms, and more especially of the Crinoids," *Ann. & Mag. Nat. Hist.* 1885, ser. 5, vol. xvi. pp. 110-116.

‡ "Ueber den Bau der Crinoideen," *Marburg Sitzungsberichte*, 1876, no. 1, p. 20.

§ *Op. cit.* p. 267, Taf. xii. fig. 9.

body-cavity, I am somewhat surprised at finding no reference to them, either in the text or in the figures of Messrs. Vogt and Yung's monograph\*. They occupy some of the 'lacunes péritonéales dans le tissu spongieux vasculaire' (p. 554), and are altogether different from the channels within the threads of this tissue that Messrs. Vogt and Yung term "vaisseaux formant de réseaux," a denomination which I cannot now discuss. Their omission is the more surprising as Ludwig has given an excellent description and figure of these inter-visceral vessels in *Antedon rosacea* †; while one of his figures shows their connection with the problematical dorsal organ. I well remember my father directing my attention to these vessels in *Antedon rosacea* before I ever cut any sections of the disk. He had studied them in his minute dissections with a binocular microscope, a method of research which I have often found extremely useful when applied to moderately thick sections of a large *Comatula* or *Pentacrinus*, and I have invariably found these intervisceral vessels in the disk of every *Antedon*, *Actinometra*, *Promachocrinus*, or *Pentacrinus* which I have cut into sections. Their relations to the other portions of the vascular system are fully described in the 'Challenger' report.

I am really very sorry to have been obliged to speak so strongly with respect to a work which is associated with the honoured name of Prof. Carl Vogt, and I should not have noticed it at all had it been a mere students' text-book compiled in the ordinary way; but the prefatory statement that the *Traité* "sera composée d'une série de monographies anatomiques de types, résumant l'organisation animale toute entière," and its publication in two languages so as to bring it within the reach of a larger number of students, necessitate its being judged by a much higher standard than that of the usual 'Lehrbuch.' In a work of this kind descriptive accuracy is absolutely essential, and it will be evident from what I have said above that, altogether apart from mere clerical errors, Messrs. Vogt and Yung's monograph is often sadly defective in this respect. Some of their statements, *e. g.* that respecting the division of the arm-nerves in the first radials, could not have been made by any one who had a proper acquaintance with the literature of the subject which was being treated monographically; while others, such as the description of rents in the skeletal tissues as portions of the system of cavities derived from the coelom, are due to a total misapprehension of the characters of their sections.

\* It is possible that the "vaisseaux coupés" which are lettered *o* in fig. 271 may belong to this system.

† *Op. cit.* p. 323, Taf. xvii. figs. 52, 56; Taf. xviii. figs. 57, 59.

A monograph of *Antedon rosacea* for the use of students has yet to be written; but we must first endeavour to arrive at some general consensus of opinion respecting the character and relations of the vascular system, not merely in the Crinoids, but also in the other Echinoderms; and I am in hopes that the researches of Perrier and Prouho, of Ludwig and Hamann, and of those English naturalists who are attracted by the subject, will soon bring this very desirable end more within our reach than it appears to be just at present.

---

IV.—On the *Rhopalocera* of Northern Borneo.—Part I.

By W. L. DISTANT and W. B. PRYER.

[THE butterflies here enumerated and described were collected by Mr. Pryer at, and in the neighbourhood of, Sandakan, and all notes as to the habits, times of appearance, &c. of the species are contributed by him, and are the results of his own observations. His colleague in the preparation of this paper desires to draw attention to the exceedingly close relationship of this portion of the *Rhopalocera* fauna of Borneo with that of the Malay peninsula, a large percentage of the species being common to both areas, whilst where specific distinction exists it, in most cases, partakes largely of a local and racial character.]

THE district of Sandakan, where a considerable number of the species mentioned were caught, is almost entirely one unbroken forest. Unbroken forest is not at all good collecting-ground for butterflies, which are very rare in its gloomy depths, while its thick leafy cover, rising 200 feet above the ground, is also but little frequented by them. The place where I chiefly resided, Elopura, having been but recently cut out of the virgin forest, the nearest clearing being twenty miles away, it was a long time before butterflies found their way there, consequently my opportunities for collecting were not so good as if I had been in a more cleared part of the country. As all the surrounding district is flat land the sameness of the vegetation causes a sameness of insects; an exploration of the high land in the interior would no doubt bring to light a largely different fauna.

Some distance up the rivers there are many old abandoned village sites in all stages of low regrown jungle, and whenever I found myself in such a locality a fair take of butterflies was always the result. A collector in the tropics,