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CONTENTS OF VOL. I.

No. I.—JANUARY, 1861.

REVIEWS.

ORIGINAL ARTICLES.

BIBLIOGRAPHICAL NOTICES.

No. II.—APRIL, 1861.

REVIEWS.

ORIGINAL ARTICLES.

BIBLIOGRAPHICAL NOTICES.

No. III.—JULY, 1861.

REVIEWS.

ORIGINAL ARTICLES.

BIBLIOGRAPHICAL NOTICES.

No. IV.—OCTOBER, 1861.

REVIEWS.

ORIGINAL ARTICLES.

BIBLIOGRAPHICAL NOTICES.

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Reviews.

I.—Flora Brasiliensis: Edidit Carolus Fred. Phil. de Martius. Fasc. xxv. et xxvi. Santalaceæ et Myristicaceæ. Exposuit Alph. de Candolle, 36 pp., 8 plates. Apocynaceæ. Exposuit Joan. Müller, Argoviensis, 180 pp., 53 plates, folio.

This great work is proceeding slowly, but steadily, under the editorship and superintendence of Dr. von Martius. When first that distinguished traveller and botanist undertook, in conjuction with the late Dr. Endlicher of Vienna, the preparation of a complete Flora of the Brazilian Empire, he hoped to have contributed a great proportion of it himself; and, accordingly, one of the first parts published—the "Anonaceæ"—was entirely his own. But he soon found, that if carried through on the scale he contemplated, it was far beyond the work of a single man; and he applied himself to the obtaining the collaboration of the most active among modern systematic botanists. Upon this plan, the different natural orders are undertaken by different monographists, each one availing himself of the materials supplied by Dr. von Martius, and of such others as could be obtained from the herbaria accessible to each,—Dr. von Martius reserving for his own share such revision of the MSS. as may be necessary to put them in conformity with the general plan, the superintendence of the printing and engraving, and in many instances the preparation of the drawings. This course has insured the more careful working out of the different parts than could be obtained by any other means, and was perhaps the only feasible plan. But it necessarily entails a want of unity of principle, which will be a great obstacle to the deduction of general conclusions from the work when completed. The uniformity secured by the editor's labours can be external only; for the systematic views of the different contributors are as different as the materials they have to work upon. Thus, the Solanaceæ, carefully described by an apparently judicious appreciator of species, might have been doubled in number in the hands of the monographists of the order in the Prodromus. The Myrtaceæ, elaborated with all the industry, and zeal, and perhaps haste of a young botanist, might have been reduced by one-fourth by the close scrutiny of botanists more accustomed to appreciate the variations of species or of individuals. The principles upon which genera are made or adopted are also as different in different monographs as the estimation of species. In one portion of the Flora large natural genera are left *intact*, and endeavours have been made to group the smaller ones established on individual or uncertain characters; whilst in other parts (e. g. Acanthaceæ or Cyperaceæ) the great object seems to have been to multiply long-winded, harsh-sounding generic names, with or without characters.

As to the materials at the disposal of the various monographists, as no part of the Flora is worked up in the country itself, they can only consist of dried specimens, preserved in herbaria, with the memoranda accompanying them, and are chiefly made up of collections made in Brazil by German, French, or English travellers. Among the most important of them, the original and most complete sets are deposited in different capitals of Europe. Those, for instance, of Langsdorff and Riedel, are at St. Petersburgh; of Sellow, at Berlin; of Pohl, Schott, and Mikan, at Vienna; of Martius and Prince Neuwied, at Munich; of Blanchet, Salzmann, and Vauthier, at Geneva; of A. de St. Hilaire, Claussen, Gaudichaud, Guillemin, and Weddell, at Paris; of Gardner and Spruce, at Kew, &c. The large herbaria in each of these towns contain also, it is true, more or less perfect sets of duplicates from all the others, as well as of the less general collections of Pœppig, Luschnaht, Lhotzky, Regnell, and others; and for the purposes of this Flora, specimens have been lent from several herbaria; yet it is only in the towns above mentioned that access can be had, respectively, to the explanatory memoranda accompanying the original sets. Very few, therefore, of the contributors have been in circumstances which allowed them the full use of all, or even of the greater number, of these complete collections. Most have worked upon one or two complete ones, with duplicates from others. Dr. von Martius has sent the Munich specimens at his disposal, with his valuable memoranda, to, we believe, all his collaborators. The Russian materials have been very liberally lent to several who had applied for them; the Sellowian and Pohlian materials have been available to most of the German contributors; everything that Geneva could supply has been lent to those who were at the same time working up corresponding monographs for the Prodromus. Paris and Kew have at different times lent largely for this and other works; but these herbaria have now acquired so much importance and value, that it has been found necessary, in both establishments, to make it a rule no longer to suffer unique or authenticated specimens to be removed, even for a short time; and visits to Paris and Kew are now almost indispensable to the systematic botanist who would make his monograph at all complete. The great diversity in respect of the specimens available for the monographists of the "Flora Brasiliensis" may be well illustrated by the contrast between the Acanthaceæ and the Verbenaceæ, both of them worked up in Germany at about the same period,—the one with the assistance of almost every one of the collections above named; the other without any aid from the English, French, or Russian herbaria, nor yet, it would appear, from all the German ones. The difference in the use made of their materials by these two monographists is also great, but rather in an inverse than a direct ratio of their copiousness.

The present part has been wholly worked up, at Geneva, in the herbarium and library of De Candolle—the herbarium, one of the most extended and varied that exists, the botanical library, a very complete one in itself, and peculiarly adapted for practical use by the habit regularly adopted by the elder De Candolle, and continued by his son, of extracting from every new work received, references to genera newly established or modified, to be regularly entered into an alphabetical register kept for the purpose, and to species or structural observations entered on separate slips of paper, and duly distributed into the covers or cases kept for the different natural orders. Thus any monographist is at once directed to the whole literature relating to the order or genus he takes in hand. With such resources, and considerable assistance from other quarters, Alph. de Candolle was enabled to give a very complete monograph of the Santalaceæ and Myristicaceæ in the Prodomus, of which the articles on these families in the Brazilian Flora may be considered as an amplification in respect of the very few species indigenous to that country,—2 species of Thesium, and 26 of Myristica. To these the editor has added a digression on the use and cultivation of the nutmeg, and on the history—no very edifying one—of the almost abortive attempts hitherto made to introduce it into Brazil. The great bulk, however, of the part consists of the Apocynaceæ by Dr. T. Müller of Argovie, curator of the Candollean herbarium. This order, monographised for the Prodromus, in 1844, by Alph. De Candolle, is here worked up afresh, as far as regards the South American, and especially the Brazilian, species, after a comparison of the types of the Prodromus with the materials accumulated in the Candollean herbarium, or borrowed from Munich, Petersburgh, Berlin, Vienna, and Paris, but without any aid from British collections, beyond a good duplicate set of Spruce's plants, in Martius's herbarium, and a tolerably fair one of Gardner's, in the Vienna Museum. The result is a detailed and apparently accurate description of 274 species, distributed into 32 genera, and illustrated by 53 plates. These plates are well engraved, and accompanied by ample dissections, sufficiently magnified to express clearly what they are intended to show, without that exaggeration of size which renders the plates in some of our modern works or memoirs almost unintelligible to unaccustomed eyes. The synonymy and stations are detailed after the general plan of the work; and, for some peculiarities in terminology—such as the substitution of "rostellum" for "radicula"—it is probable that here, as in other instances, the editor, not the author, is responsible.

The generic characters are very long,—that of the first genus, for instance, Allamanda, occupies 54 lines, and contains details which cannot be essential to the genus, nor can have been verified in the majority of species; such, for instance, as "Rostellum . . . circa quintuplo cotyledonibus brevius," when the seeds have only been seen in three out of ten species. It is true that imperfectly known species must often be referred to a genus without verifying all its characters, subject to a subsequent removal, if found to differ in essential points; but it surely cannot be intended that any species the radicle of whose embryo should be $\frac{1}{3}$rd, instead of $\frac{1}{5}$th the length of the cotyledons, should on that account alone be generically separated from other Allamandas.

Practically, however, these generic characters must be taken as descriptive, rather than diagnostic; and the inconvenience of their great length for distinctive purposes is, in the present work, obviated by an excellent synoptical table of genera, remarkably clear, both as to matter and type. But no such assistance is afforded in the case of species. In the larger genera, even after their subdivision into groups, there remain series of ten, twelve, or more species, without any contrasted characters, to guide the reader, but such as he can glean from so-called diagnoses, which, far from being confined to the Linnean limits of twelve words, have an average length of twelve to fourteen lines, and are, in fact, detailed descriptions in the ablative case, of almost all characters, except colour and dimensions, which, in true orthodox style, are specially reserved for a separate paragraph in the nominative case. This is a growing evil in almost all modern systematic works, and for which we see no remedy but a rigid return to the Linnean rule, accompanied by repeated sectional subdivisions, or a total abandonment of the system of technical diagnoses, substituting synoptical tables, followed by detailed descriptions.

In the generic arrangement of the Brazilian Apocynaceæ, Dr. Müller appears to have much improved on his predecessors. The general division of the order into two main groups, founded on the structure of the anthers, is, we believe, new. It appears natural; and, if duly verefied on the Asiatic, as well as on the American genera, is in every way satisfactory. The tribes are, in other respects, nearly those of the Prodromus. We are glad to see, also, that several genera which we had already set down as not natural, are here suppressed. Collophora (Mart), and Hortsmania (Miq.), are identified respectively with Couma (Aubl.), and Condylocarpon (Desf.), Peschiera and Bonafousia (A.DC.), are reduced to Tabernæmontana; Robbia (A.DC.), to Malouetia, and Thysanthus (Benth.), to Forsteronia. On the other hand, eight new genera are proposed, besides three more South American, but not Brazilian genera, which the author has described at the same time, and published in Mohl and Schlechtendahl's Botanische Zeitung, 1860, p. 21. Of these eleven genera, Elytropus, founded on a Chilian plant, appears to be very distinct. Zschokkea, allied to Ambelania, Couma, and Hancornia, must be maintained, so long as the three latter are kept distinct, although it is not improbable that on a careful comparison of all the species of truly baccate Carisseæ, from the Old as well as the New World, some further generic consolidation may simplify the system. The other nine genera, Heterothrix, Macrosiphonia, Amblyanthera, Mesechites, Rhodocalyx, Rhabdadenia, Stipecoma, Prestoniopsis, and Urechites (the two last extra-Brazilian) would all have formed part of the old genus Echites. Their establishment as separate genera may have been rendered necessary by the adoption of those already severed from Echites by Alph. De Candolle and others; and the numerous species appear to us to be better grouped here than in the Prodromus; yet we cannot but regret that, in some instances, the course had not been preferred of maintaining larger genera, divided into sub-genera and sections.

With regard to species, as far as we have investigated them, we consider Dr. Müller's appreciation of their value as very fair. As was to be expected, several which had been previously proposed, upon single specimens, have, on the comparison of more copious collections, proved to be varieties of variable types; and a considerable number of old Echites, especially belonging to the genera Odontadenia, Dipladenia, Amblyanthera, &c., admitted into the Prodromus and other works, are here judiciously reduced. Future investigations may even suggest still further consolidations: *Forsteronia Benthamiana* (Müll.), will, for instance, probably prove to be but a very slight variety of *F. Schomburgkii*. But, upon the whole, we can neither class Dr. Müller with the modern wholesale species-makers, nor yet charge him with inconsiderate amalgamation.

Besides the 274 species of Apocynaceæ enumerated in the present work, Dr. Müller has published annotations or descriptions of sixty more American, but not Brazilian species, in the 30th vol. of the Linnæa, pp. 387 to 454.

II.—Outlines of British Fungology: containing Characters of above a Thousand Species of Fungi, and a complete List of all that have been described as Natives of the British Isles. By the Rev. M. J. Berkeley, M. A., F. L. S., author of "Introduction to Cryptogamic Botany." London: Lovell Reeve. 1860.

Mr. Berkeley's work is a most valuable addition to the botanical literature of this country. To a great extent (although, from its professedly limited scope, not entirely) it fills up a gap which has long existed. None of the recent works on the British Flora profess to deal with the Fungi, nor would it be convenient that they should do so; for the subject, from its nature and magnitude, requires to be treated separately. Mr. Berkeley's work contains descriptions, accompanied in many instances by figures, of all such British Fungi as require nothing more than a common lens for their examination; and, in addition, it contains the characters of the genera of all other known British Fungi, with a list of the species of each genus, and references to the places where the species are described. This list is of great utility, inasmuch as the latest systematic account of British Fungi is dated in 1832, being comprised in the second part of the fifth volume of Sir E. Smith's "English Flora." Since 1832, vast numbers of species, new to this country, many of them also new to science, have been discovered and described; but the student in search of them was driven to a roving expedition through the successive volumes of the "Annals of Natural History," and of one or two other works, before these additional species could be ascertained. By the references given in Mr. Berkeley's book, taken in connexion with the explanation at page 305, which we think would have been better placed in the Preface, or in one of the early chapters, any species may now be readily referred to.

The book is divisible into two parts, viz., the introductory portion, consisting of 13 chapters, and the systematic arrangement. The former part contains a concise account of the different divisions of the whole tribe, as well as of the nature and habitats of Fungi in general, and their geographical distribution. This is followed by an account of their mode of growth, structure, and method of propagation, as well as of the variations of form which they assume. The uses of Fungi, and the diseases caused by them, are then described; and some remarks are added, showing what has been done with regard to their cultivation, and the manner in which they should be collected and preserved. The whole of this introductory matter is admirably adapted for guiding the student, who will give his energies to the subject, to an acquaintance with this most interesting branch of botanical science.

The work being professedly intended for popular use, any lengthened discussion of intricate mycological questions would have been out of place; but one or two such questions come to the surface here and there, upon which we have a few comments to offer.

In speaking of the genus Boletus, the author refers to the singular fact of the instantaneous change which takes place in the colour of the flesh, when broken, from white or yellow to dark blue; and he adds that this change, after being long a source of perplexity, is now known to depend upon the action of ozone upon the juices. Mr. Berkeley seems to adopt the opinion of M. Schoenbein,* who examined the question in 1856, with reference to *B. luridus*. Schoenbein discovered a resinous matter like guaiacum, which, like that substance, turned blue when in contact with ozone. Since that time, it has been thought that Schoenbein's investigations have not exhausted the subject; and the Belgian Academy lately proposed the following question for a prize essay:—"Determiner par des recherches a la fois anatomiques et chimiques, la cause des changements de couleur que subit la chair des bolets en general, et de plusieurs russules quand on la brise on qu' on la comprime." M. Kickz, one of the referees, in a report made to the Aca-

* Ueber die nachste Ursache der spontanen Blaüung einiger Pilze. München, 1856.

demy, observes, with reference to M. Schoenbein's views,—1st. That *blue* is not the only colour which the Boleti assume; 2ndly. He asks, Why does not the change of colour take place spontaneously in the plant itself, since all the elements which produce the phenomenon are produced by the plant? 3rdly. How is it that simple pressure often produces the same effect as rupture? And, 4thly, Why do not all Boleti change colour in the same manner? Mons. Kickz suggests a scheme of inquiry with the view of more fully determining the question.* He considers that, before the point can be looked upon as settled, it will be necessary that the anatomical structure and chemical composition of the Boleti which change colour, should be examined and compared with the structure of those which do not change, and that this comparison should be made at different periods of the growth of each species; that care must be taken to observe the difference of colour of the flesh of the pileus and of the hymenium in the same species, and to ascertain in which organs the colouring matter resides; that inquiry must be made whether similar colouring matter exists in other Fungi in which similar changes have been observed, and whether any relation subsists between the change of colour which takes place in the Boleti and that which has been observed to occur in the milk of certain Lactarii. This inquiry is, doubtless, sufficiently extensive: if any mycologist should be willing to undertake it, we believe the prize of the Belgian Academy is still open. It has been suggested that the colouring matter consists of aniline, and this idea has been brought forward again in the "Comptes Rendus" (16th July, 1860(, where M. Phipson remarks:—

"The colouring matter which exists in these Boleti in a colourless state is soluble in alcohol, not easily miscible with water, and becomes resinous in the atmosphere. It possesses the properties of aniline, and, under the action of oxydizing agents, produces the same colours as aniline and its saline compounds."

M. Martens† has objected that the matter is not likely to be aniline, because aniline, he says, has not been found in any vegetable, forgetting apparently that it exists largely in Indigo.

Amongst the different divisions of Fungi, of which a concise general account is given in the work before us, reference is made to a very remarkable group (the Myxogastres), to which considerable biological interest attaches—an interest, moreover, in which the zoologist and the botanist are equally concerned. The peculiarities of the group are very great, as will be seen by the following extract:—

"A large group of Fungi, containing multitudes of the most exquisite microscopic objects, is distinguished by the early condition being creamy or mucilaginous. They differ in many respects from other Fungi, and especially because they seem often quite independent of the substance on which they are developed. One species, for instance, was discovered by Schweinitz, in America, growing on iron which had been red-hot only

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* See "Bulletins de l'Acad. Roy. de Belgique," 2nd Ser, vol. viii., p. 365.
† See "Bull. de l'Acad. Roy. de Belgique," 2nd Ser., vol. viii., p. 372.

a few hours before. . . . . I have seen specimens, again, of another species growing on a leaden cistern at Kew, from which it could derive no nutriment. Another was found by Sowerby on cinders on the outside of the dome of St. Paul's."

Until lately, no question has been raised as to the organisms belonging to this group having been rightly placed amongst the Fungi; but in the "Botanische Zeitung" for 1858 (t. xvi., p. 357), Dr. De Bary expressed an opinion that they are animals, and he has since maintained this view in an elaborate essay in Siebold and Kölliker's "Zeitschrift für wissens-chaftliche Zoologie." His argument is founded partly upon the peculiarities of growth above referred to, but more particularly upon the nature of their component substance, which he considers almost identical with sarcode.

He also lays some stress upon the fact, that the Myxogastres, at an early stage of their growth, exhibit in the substance of their bodies solid matter taken in from without, such as cells of algæ, spores of fungi, &c. He says that if these *ingesta* can be considered to be *food*, the fact would establish the animal nature of the Myxogastres, because, if an organism *eats*, it must be an animal. He admits, however, that there is no proof that the *ingesta* are *food*, and that the solid bodies in question may have gained admittance accidentally.

Mr. Berkeley, in combating De Bary's views, observes:—"A sufficient answer is the fact, that some of the species contain spiral vessels, and have their spores surrounded by a distinct sac."

The latter objection is strong, and is one which De Bary has not met, having contented himself with simply calling in question some observations on the genera Badhamia and Enerthenema, in which Mr. Berkeley and other observers allege (as we believe correctly) that such a sac exists. With regard, however, to the spiral vessels, we think Mr. Berkeley states their existence too confidently. It is true that all the species of Trichiæ contain threads, sometimes short and fusiform, sometimes of great length, and forming almost a net-work, all of which threads bear spiral *markings*; but the nature of these markings is still a subject of controversy, and the determination of the question is dependent upon microscopical investigation, and, like the question as to the markings on the valves of the Diatomaceæ, will probably long continue undecided. De Bary, it may be observed, adopts unhesitatingly the opinion expressed in the "Microscopical Journal" (vol. iii., p. 15), according to which the spiral markings of the Trichiæ are not produced by the existence of a spiral fibre, but are an optical effect arising from an arcuate elevation of the cell-wall, following a spiral direction from one end of the threads to the other.

In commenting upon De Bary's observations, M. Tulasne has called attention to a fact in support of his views, viz., the existence in the external covering of the Myxogastres of a white calcareous salt, which effervesces in sulphuric acid. "I am surprised," says M. Tulasne,* "that M.

* See "Ann. des Sciences Nat.," 4 Ser., vol. xi., p. 150.

de Bary makes no mention of this important element in the organisation of the Myxomycetes. He might have seen in it a further analogy between the latter and the testaceous Rhizopods, such as the Difflugiæ and Polythalamia, to which he compares them."

There is this further peculiarity in the Myxogastres, and by which they are (as far as present observations have gone) distinguished from all other Fungi, viz., that their spores in germinating produce bodies of a similar nature to the zoospores of Algæ. This fact, however, does not aid the argument in favour of their being animals, as it would be equally applicable to prove the animal nature of Zoospores in general, and would thus prove too much.

In the chapter devoted to the habitats of Fungi, Mr. Berkeley refers to the curious moulds which are found upon dead fish.* He says, p. 29:—

"I am not at liberty to reckon as Fungi the curious moulds which grow on dead fish, making them conspicuous, as they float on the surface of the water, by the foggy halo which surrounds them. These productions differ so essentially in their mode of reproduction from Fungi in general, that at present it would be rash to speak too positively about them; but, inasmuch as their peculiar characters seem to depend entirely upon the degree of moisture to which they are exposed, there is some reason to hesitate, and to wait for further information. I have no doubt that the mould which is so common on flies in autumn, oozing out, as it were, between their abdominal rings, is a mere condition of one of these anomalous productions."

And, again, at p. 53:—

"If those moulds which infect fish or aquatic vegetables, as Leptomitus, Saprolegnia, &c., when immersed in water, be truly Fungi, we should have a more perfect type of impregnation than is presented by the supposed Antheridia—at least, one more nearly resembling that in animals; but we are not at liberty to assume their affinity to Fungi, and for the present they must be left amongst the Algæ, to which they approximate closely as regards their reproductive organs."

From these extracts we infer that Mr. Berkeley is unwilling to resign Saprolegnia and its allies to the algologists, and that he entertains some hope of their being reclaimed for the Fungi. And yet, if Pringsheim's observations are correct,† it is difficult to see how these productions can be looked upon otherwise than as Algæ. The process of impregnation, which has been traced with great accuracy, corresponds in its phases so exactly with that occurring in undoubted algæ, such as Vaucheria, Sphæroplea, and Coleochæte, that the nature of the Saprolegnieæ seems hardly any longer doubtful. De Bary's observations, although confessedly not so complete as those of Pringsheim, tend, as far

* We may observe that these moulds affect living as well as dead fish, especially when the former are kept in a confined space. Without vouching for the remedy, we may state, that we were informed, this summer, by a working gardener, that he had treated the diseased fish successfully by administering carbonate of soda internally.

† "Beiträge zur Morphologie und Systematik der Algen." Die Saprolegnieen, Jährbücher für wissenchaftliche Botanik. Vol. i., p. 284.

as they go, to confirm Pringsheim's account.* We should like also to know the grounds of Mr. Berkeley's opinion, that the mould on flies is only a condition of one of the Saprolegnieæ. Cohn, Lebert, Braun, and Fresenius, all treat it as an admitted Fungus.† We believe it to be the fact that the bodies of flies, when immersed in water, have not been observed to produce the mould, whereas, in such a situation, they frequently do produce species of Saprolegnia, but this is hardly sufficient evidence to establish any necessary connexion between the mould and the algæ.

Amongst the diseases caused by Fungi (including, amongst others, dry-rot, the vine mildew, the potato murrain, and many others), ergot holds a prominent place. It affects grains of rye, barley, wheat, and many other grasses, rendering the ears, to use a popular term, "spurred." A good deal has been written, from time to time, on the nature of this disease, and very different opinions entertained; but there is now hardly any doubt that the so-called "ergotted grains" are, in fact, of the nature of a sclerotium, that is to say, that they consist of compact fungoid mycelium. It is not, perhaps, clear whether the individual grains of ergot are purely fungoid, or whether any portion of the albumen of the seed remains intermixed with the mycelium. It would seem that Mr. Berkeley inclines to the latter view, for he speaks (p. 73) of the *white substance of the seed* being converted by the fungus into a firm mass; but we understand Tulasne's opinion to be,‡ that the seed is entirely displaced by the fungus, and that the grains (so to speak) of ergot are altogether foreign bodies, occupying the place of the seed. M. Tulasne was the first to notice the fact that the grains of ergot give rise eventually to a species of Cordyceps, and that the growth of the Cordyceps may be brought about by sowing the grains of ergot in common garden mould, or keeping them in damp moss. There are still some doubtful points connected with the mode in which the ergot attacks the cereals, and relative to the growth of the Cordyceps from the ergot, which require further observation. Tulasne seems to be of opinion that there is a difference between the ergot which attacks rye, and that which affects other grasses, such as the ergot of the common reed. There is, no doubt, considerable difference in size and appearance between the ergot of rye and the ergot of Phragmites; and there is as striking a difference between the species of Cordyceps, which is *usually* produced by ergot of rye, and that which is usually produced by ergot of Phragmites. But then this difficulty arises:—observations subsequent to Tulasne's§ have

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* "Einige neue Saprolegnieen, Jährbücher für wiss. Bot.," vol. ii., p. 169.

† See Cohn in "Nov. Act. Acad. Nat. Cur." 1855; "Fresen. Bot. Zeit.," December 1856; Lebert in "Virchow's Archiv.," vol. xii., Heft. 1, and in "Neue Denkschriften der allg. Schweizerischen Ges. für die ges. Naturwissenchaften," band v., 1857; Fresenius in "Abhandl. der Senckenbergischer Nat. Gesellschaft," band xii., 1858, p. 201; "Braun Algæ unicellulares, Lips." 1855, p. 105.

‡ "Ann. des Sc. Nat.," 3rd Ser., vol. xx., p. 11.

§ See "Bot. Zeitung," Feb. 2, 1855, and "Quart. Journ. of Microscopical Science," vol. v., p. 133.

shown that the ergot of Phragmites produces not only its own peculiar species of Cordyceps (*Cordyceps microcephala*), but also occasionally the same species which is usually produced by ergot of rye, viz., *Cordyceps purpurea*. M. Westendorp, moreover, has lately found ergot of rye producing, instead of *Cordyceps purpurea*, a totally different fungus, viz., *Agaricus papillatus* (Batsch).* It has been attempted to explain M. Westendorp's observations by the suggestion of the accidental presence of the spores of the Agaric; and this explanation might have been accepted, if a stray specimen or two only of the Agaric had appeared; but the ergot in question produced a continuous crop of the Agaric for several weeks, pointing to more than an accidental connexion between the two. Upon the question as to the nature of the supposed spermatia observed by Tulasne in the early stage of ergot, some remarks of Bonorden, in the "Botanische Zeitung," for April 9, 1858, should be considered. They tend to show that the spermatia in question are not sexual organs, but of the nature of spores.

We have but little space to comment upon the systematic portion of Mr. Berkeley's work. His extensive and intimate acquaintance with the whole tribe of fungi affords a sufficient guarantee for its completeness. The arrangement of the orders and genera is according to the author's plan in Lindley's "Vegetable Kingdom," and the "Introduction to Cryptogamic Botany." As far as the Hymenomycetes are concerned, the system is nearly that of Fries, as given in the "Epicrisis Systematis Mycologici." The plan of the "Systema Mycologicum" itself would, perhaps, have afforded greater facilities for students, but the adoption of it would have been a step backwards. At the same time, we should strongly recommend beginners to use the present work in conjunction with the former treatise, in the fifth volume of the "English Flora." The genera propounded in the "Epicrisis," although perfectly natural, and in most cases easily recognized by practised mycologists from difference of habit, are exceedingly difficult to identify from their written characters. Taking, for instance, the genera Agaricus and Russula, a very little practice will enable a student to distinguish the two; but if he were driven to the written characters, he would find the main distinction to reside in the structure of the trama, a difference which cannot be made out without careful microscopical investigation.

Mr. Berkeley admits Fries' genus Nyctalis amongst the Hymenomycetes, calling attention to De Bary's observations as to what the latter considered a secondary form of fruit.† Since the publication of De Bary's paper, Tulasne has written upon the subject, first in the "Comptes Rendus" (January 2, 1860), and subsequently, at greater length, in the last number of the "Annales des Sciences Naturelles."‡ He unhesitatingly denies the correctness of De Bary's observations; and his re-

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* "Bulletin de l'Acad. Royal. de Belgique," vol. vii., p. 80.
† See "Botanische Zeitung," 1859, pp. 385, 393.
‡ 4 Ser., vol. xiii., p. 5.

marks are so important and interesting, that we subjoin a portion of them. M. Tulasne says—

"The type of the genus Nyctalis is *Agaricus parasiticus* of Bulliard, a Fungus which very frequently nourishes in its parenchyma another Fungus, parasitic upon it, viz., *Asterophora agaricicola* (Cord.), *Asterotrichum Ditmari* (Bonord.). Its appearance is then so altered, as to have led to its being mistaken by Bulliard himself, who called it by a name different from its former one, viz., *Agaricus lycoperdoides*. This error has been repeated by Ditmar, and aggravated by Fries, who has imagined that he has found in *Agaricus lycoperdoides* (Bull.) matter for many different species. More recently, however, Vittadini, Corda, Klotzsch, Berkeley, and other authors, have recognised two different vegetable entities in *Agaricus lycoperdoides* (Bull.), and we have adopted their opinion.* M. De Bary, on the contrary, not only revives Bulliard's view in distinguishing *Ag. lycoperdoides* (Bull.) from *Ag. parasiticus* (Bull.); but he maintains that the Asterophora (Asterotrichum, Bonord), the presence of which, in our opinion, constitutes the only difference between the first and the second, so far from being a foreign production or vegetable parasite, is nothing less than a secondary reproductive apparatus proper to *Ag. lycoperdoides* (Bull.) (*Nyctalis asterophora*, Fr., Bary). In support of his opinion, he alleges that *Ag. parasiticus* (Bull.) also possesses an analogous apparatus, and that both in the one and the other Agaric this subsidiary fructification is extremely constant, and always similarly arranged. He admits, however, that the latter excludes the normal or reproductive apparatus, very frequently in *Ag. lycoperdoides* (Bull.), and always, it would seem, in *Ag. parasiticus* (Bull.). He admits also that the secondary spores may well be compared to those of certain fungicolous Fungi, such as Sepedonium, the autonomy and parasitic nature of which he does not venture to doubt. Further, M. De Bary does not deny that it is generally very difficult to make out with certainty, even by the most minute microscopic investigation, the portions of the tissue which belong respectively to the parasite and to its host. This uncertainty, and still more the many reasons to be derived from analogy, weaken the conclusions of M. De Bary. If *Asterophora agaricicola* (Cord.) so much resembles Sepedonium, may it not, like Sepedonium, be an autonomous parasite, rather than an integral portion of *Agaricus lycoperdoides* (Bull.); and may not the supposed reproductive apparatus of *Ag. parasiticus* (Bull.) constitute another kind of Sepedonium? It has been objected that the organisms in question are always developed in the same place and at the same time, and that they are not met with upon other Agarics; but are not these very characters the distinguishing marks of many admitted Agaricine parasites—for instance, of *Sphœria lateritia* (Fr.), which is only produced on the hymenium of *Ag. deliciosus* (L.), where it causes an almost entire abortion of the gills? Moreover, the supposed secondary fructification of *Ag. parasiticus* so nearly resembles on the one hand that of Asterophora, and on the other that of certain Sepedonia, common parasites of the Boleti, as to destroy all our faith in M. De Bary's hypothesis. In our opinion, the proof of the existence of a double fructification in the Agarics must be sought for elsewhere.

"Numerous observations have convinced us that Asterophora, Sepedonium, and Mycogone are the conidioid condition of species of Sphœria of the genus Hypomyces (Fr.)."

If M. Tulasne's views are correct, Sepedonium must be struck out of the genera of fungi, as also Trichoderma, which he considers to be only an imperfect state of *Hypocrea rufa*.

Some few other genera admitted by Mr. Berkeley—for instance, Micropera, Isaria, Helminthosporium, Piggotia, Coniothecium, Aposphœria, and some others, will probably eventually share the same fate; but, in the present state of our knowledge, Mr. Berkeley could hardly

* See "Ann. des Sc. Nat." 3rd Series, t. xx. (1853), p. 27, note 2.

have omitted them, and this is not the place to discuss their autonomy. Some observations upon these matters will be found in the works referred to below.*

We do not find in Mr. Berkeley's work any account of the genus Pilobolus, of which two species, *P. crystallinus* and *P. roridus*, have been found in this country. The omission is, we presume, accidental, for there has never been any question as to the Piloboli being true Fungi.

III.—The Mammals of Amoorland.—Reisen und Forschungen im Amur-lande in der Jahren 1854–6, im Auftrage der Kaiserl. Akademie der Wissenschaften zu St. Petersburg, ausgeführt und in Verbindung mit mehreren Gelehrten ausgegeben von Dr. Leopold von Schrenck. Band I., Erste Lieferung. St. Petersburg, 1858.

Had the recent mutiny in India resulted in the expulsion of the British from the peninsula, little, it has been said, except an unfinished railway or two, would have remained to bear witness that they had ever been there. Whatever change the present system of administration may have made in other respects, we have failed to learn that greater encouragement is likely to be afforded to the investigators of the natural products of India by its new government. Our nearest Continental neighbours have not been so long in possession of the wild country which forms the southern shores of the Mediterranean, yet the "Exploration Scientifique d'Algerie" is, we believe, a *fait accompli*, and affords, at any rate, a good basis for future workers in the same field. Our transatlantic cousins have still more recently annexed California and Texas; but a goodly row of Reports upon the zoology, botany, mineralogy, and meteorology of these countries have already appeared under the auspices of their enlightened government; and were these countries to revert to barbarism to-morrow, would remain to prove that the civilized races who temporarily held them had not neglected the opportunity of adding to the general stock of knowledge of mankind.

Now, it is impossible to value too highly the labours of Hardwicke, Hodgson, Blyth, Hooker, Thompson, Jerdon, Tennent, Cantor, and a host of others, too numerous to mention, who have worked long and laboriously in investigating the different branches of Indian zoology and botany; but we think we have a right to complain that no encouragement has been given on the part of our Indian rulers to any general work, such as might embrace the results thus arrived at, and show what has really been effected towards the working out of the Fauna and Flora of a country which we hold "in trust for the benefit of mankind."

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* "Quart. Jour. of Mic. Science," vol. iii., p. 263; vol. iv., p. 192; vol. v., p. 126.
"Annales des Sciences Nat.," 3rd Ser., vol. xx., pp. 130–171.
Ib., 4th Ser., vol. v., p. 108, and vol. viii., p. 35.
"Philosophical Transactions," 1857, p. 543, et seq.

One-tenth part of the sums of money lately squandered away in support of a mission, conducted by certain well-known foreigners, who were fortunate enough to secure the patronage of the magnates of Leadenhall-street, would have sufficed, if judiciously employed, to have more than wiped off this national reproach.

These remarks may seem somewhat out of place when our subject is the Fauna of Amoorland, not of Hindostan; but it should not be concealed that the conduct of the rulers of a nation often termed barbarous—and whose efforts to occupy "a more enlarged sphere of usefulness" in Eastern Europe are still regarded with fear and trembling, and were but recently opposed by the force of arms—contrasts, in some respects, most favourably with that of our own enlightened government. It is not long ago that the name of the Amoor first became known to British ears. The fame of the Rnssian successes in that quarter has but lately reached us. Yet the first-fruits of the several expeditions despatched to explore the natural products of the new acquisitions are already presented to the world; and we have little doubt that the publication of the Fauna and Flora of Amoorland will be completed ere that of British India is commenced.

Herr von Middendorf's expedition to South-eastern Siberia* had extended our knowledge of the natural productions of Northern Asia as far as the Sea of Ochotsk and the upper confluents of the Amoor, so that the exploration of the countries traversed by the lower portion of this magnificent river was considered by the Imperial Academy of Sciences of St. Petersburg as the next requisite step. Herr von Schrenck was accordingly selected for this purpose, and, accompanied by his scientific staff, embarked in the autumn of 1853 in an imperial frigate, specially appointed to convey him to his destination. After a voyage round Cape Horn, the following June found him in Kamtschatka, whence a corvette was directed to convey the expedition to its final destination. On the 18th of August, 1854, they were accordingly landed at what was then the military post of Nicolajewsch, at the mouth of the Amoor; but what, we believe, is now the flourishing capital of the new government of Amoorland. We need not follow Herr von Schrenck during the two years which he devoted to the exploration of every part of Amoorland, including the adjoining island of Sagalin. Suffice it to say, that he returned to St. Petersburg overland, reaching that capital in January, 1857, in safety, with his collections, after encountering many perils and hardships in the winter's voyage up to the Amoor, which, from Nicolajewsch to Nertschinkoi Sawod—the point where the navigation ceases, and the land-journey begins—lasted more than five months.

Besides the materials thus obtained for the investigation of the Fauna of Amoorland, Herr von Schrenck has availed himself of the col-

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* See Reise in der äusserten Norden und Osten Siberiens, &c., 4 Bde, St. Petersburgh, 1847-59.

lections made by two other travellers, Herr Maximowicz,* a botanical collector in the employ of the Imperial Botanical Gardens of St. Petersburg, who was also travelling in that country, from 1854 to 1856; and Herr Maack, who made an expedition from Transbaikalia, in 1855, to the mouth of the Amoor, and back.

We shall now proceed to consider the species of Mammals thus ascertained to be inhabitants of Amoorland, in the order in which Herr von Schrenck has arranged them in the first volume of his work, adding a notice of the most important facts which he has recorded concerning each of them. In some cases, it will be observed, the names have been inserted on the faith of Pallas and older explorers, and the results arrived at are purely of a negative character.

1. *Ursus arctos.*—The bear of the Amoorland is referable to the *varietas Beringiana* of Middendorf, which occurs on the coasts of the Sea of Ochotsk, but is not specifically separable from the European *Ursus arctos.* Temminck's statement that the bear of Jesso and Sachalin is *U. ferox* (the Grizzly Bear of North America) is erroneous.

2. *Ursus maritimus.*—The Polar Bear, *Ursus maritimus,* was not recognized by the natives as found on the coast of the continent, or of the island of Sachalin, though Siebold has stated that he received indications of its occasional occurrence on the shores of the Japanese province Jetsigo.

3. *Meles taxus.*—A darker and more yellowish variety (*amurensis*) of the Badger of Amoorland, was found to be connected, on an examination of a series of eight examples, with the European *Meles taxus.* Von Schrenck thinks that the Japanese *Meles anakuma* of Temminck is probably nothing more than a further variety of the same species.

4. *Gulo borealis* presents the same variation of coloration as in Europe.

5. *Mustela zibellina.*—The Sable is much sought after here, as elsewhere, for its fur, but is still met with in all parts of Amoorland. Von Schrenck suspects that Temminck's *M. brachyura* is only a variety of this very valuable animal, founded upon an imperfect skin.

6. *Mustela martes.*—Pallas' statement ("Spicilegia Zoologica," xiv., p. 57) of the occurrence of this Marten in Amoorland was not confirmed.

7. *Mustela sibirrica,* Pallas.—Spread over the whole country.

8. *Mustela erminea.*—Also common over the whole of Amoorland.

9. *Mustela vulgaris.*—Only one example obtained, and certainly much rarer than the ermine.

10. *Lutra vulgaris.*—The otter is found throughout the country, but nowhere common, being much sought after by the natives for its fur, which is highly prized by the Mandshurians and Chinese. *Lutra chinensis,* Gray, *L. indica,* Gray, and *Lutra nair,* F. Cuvier, are suspected to be only varieties of the same species.

* The results of this gentleman's expedition are published in the Memoirs of the Imperial Academy, under the title "Primitiæ Floræ Amurensis," vol. ix., p. 1, *et seq.*

11. *Lutra aterrima.*—Pallas' Otter-like animal, described by the great traveller as *Viverra aterrima,* is conjectured to have been a variety of the common otter, *Lutra vulgaris.*

12. *Enhydris marina.*—The Sea-otter, which is stated by Siebold to occur occasionally in Japan, appears to be known to the inhabitants of the southern coast of Sachalin, but to be far from commonly met with.

13. *Canis lupus.*—The wolf of Amoorland is considered by Von Schrenck to be quite identical with the European *Canis lupus.* Temminck's *Canis hodophilax,* under which title the authors of the "Fauna Japonica" separate the Japanese wolf, is believed to be likewise undistinguishable from the same species.

14. *Canis alpinus.*—Only one example of this little-known mountain-wolf, first discovered by Pesteref in 1794, was obtained by Von Schrenck's expedition. Its specific validity is fully recognized.

15. *Canis vulpes.*—The Fox, in all its many varieties of colouring, is very common in Amoorland. Its fur is a regular article of traffic with the natives, next in importance to that of the Sable and Otter.

16. *Canis lagopus.*—No traces of the Polar Fox were met with even in Sachalin; and it is suspected that Siebold's notice of this species inhabiting the Japanese Kuriles is incorrect.

17. *Canis procyonides.*—A very extended notice and elaborate description is given of this singular species of *Canis,* which was only previously known from the insufficient accounts of Gray and Temminck. Herr von Schrenck shows that the names *Canis procyonides* (*!*) and *Canis viverrinus* are really referable to one and the same species, which varies much in summer and winter *pelage,* and is of opinion that the differences in the dentition are not such as to necessitate the generic separation of this animal from the true *Canes,* as has been proposed by Temminck.*

18. *Canis familiaris.*

19. *Felis lynx.*—The true *Felis lynx* of Europe is found throughout the wooded districts of Amoorland.

20. *Felis tigris.*—The existence of the Tiger, popularly supposed to be confined to the hot jungles of India, as a permanent resident on the Amoor, is one of the most remarkable facts known in geographical distribution. Near the mouth of the Ussuri (in north latitude 48°), the Tiger is "not only not a scarce visitant, but an *ordinary resident* in the land in summer and winter, commonly met with, and frequently destructive to mankind, and to cattle." It has even crossed the ice further north, in latitude 52°, and penetrated into the island of Sachalin, although here only to be considered as an occasional intruder.†

21. *Felis irbis.*—The Ounce is not so common as the Tiger near

* In Tijdschr. voor natuurl Geschied. v., p. 285, as *Nyctereuxes viverrinus.*

† *Confer* Brandt's "Untersuchungen ueber die geographische Verbreitung des Tigers," &c. Mem. Acad. Sc. St. Petersburg, 6me ser., vol. viii.

the mouths of the Ussuri and in other parts of Amoorland. It extends into the island of Sachalin. In many districts it is not distinguished by the natives from the Tiger.

22. *Felis domestica.*

23. *Erinaceus europæus.*—A single skin obtained near Anjun, on the Amoor, proved to belong to *E. europæus,* or a variety *amurensis,* and not to the Siberian long-eared species *E. auritus.*

24. *Erinaceus auritus.*—Not observed, though probably a more northern species, and to be met with on the upper branches of the Amoor.

25. *Sorex vulgaris* is the commonest Shrew in Amoorland.

26. *Sorex pygmæus* is also found on the Amoor, and extends into Sachalin.

27. *Vespertilio* (*Vesperus*) *borealis.*—One example of this bat was obtained.

28. *Vespertilio mystacinus.*

29. *Vespertilio daubentonii.*—Herr von Schrenck appears to doubt the real specific difference between these closely-allied species of *Vespertilio,* of both of which examples were obtained on the Amoor.

30. *Plecotus auritus.*—One specimen obtained agrees with European examples.

31. *Pteromys volans* is found in the wooded districts of Amoorland, and extends over the interior of Sachalin, where it resorts to the Birch-trees (*Betula ermanni*).

32. *Sciurus vulgaris.*—Common in Amoorland, varying much in summer and winter *pelage,* being dark grey in winter, and dark brown, sometimes nearly black in summer. Temminck's *Sciurus lis,* from Japan, is considered a questionable species, as *S. vulgaris* extends all over Sachalin.

33. *Tamias striatus.*—Very common.

34. *Tamias uthensis,* of Pallas, is suspected to be a black variety of *T. striatus.*

35. *Spermophilus eversmanni.*—Three specimens were obtained in Amoorland of this *Spermophilus,* which appears to replace *S. citillus,* of Europe, thoughout North-eastern Asia.

36. *Artomys bobac* was not observed in Amoorland, but an example was obtained by Herr Maack, on the upper Amoor.

37. *Mus decumanus.*—The "Hanoverian Bat," as Mr. Waterton delights to call it, has occupied the whole of the Amoorland, and already extended itself into the upper portion of the territory. It probably arrived by ships on the coast first, and penetrated thence, as it is not known in Siberia, though frequent in Japan and China.

38. *Mus musculus* has followed its larger brother in its invasion of Amoorland.

39. *Arvicola* (*Hypudæus*) *Amurensis* nov. sp.—Of this new Vole one example was obtained by Herr von Schrenck, at Nicolajewsck, in September, 1854. The nearest ally seems to be *A. glareolus,* of Europe, of which it may be considered as the eastern representative.

40. *Arvicola rutilus*, Pallas.—Several examples of this North-European species of Vole were obtained on the Amoor.

41. *Arvicola amphibius.*—A single specimen of this European Vole, obtained by Herr Maximowicz, belongs to the short-tailed variety, *A. terrestris*, which is considered by De Selys, and other authorities, as a separate species. Herr von Schrenck himself observed others of the same species.

42. *Arvicola saxatilis*, Pallas.—Full and accurate details are given of this Vole, which has not been recognised since the time of its describer, Pallas, from a single example obtained by Herr Maximowicz on the Amoor. Pallas gives Transbaikalia and Mongolia as its habitat.

43. *Arvicola maximowiczii* nov. sp.—This new species of Vole is also due to the researches of Herr Maximowicz, whose name it bears. A single specimen only was obtained in October, 1856, on the Upper Amoor. *Arvicola maximowiczii* belongs to the typical group of the genus, as arranged by Blasius, being allied to *A. arvalis* (Pall.), and *A. campestris* (Blasius), and more nearly still to *A. subterraneus* of De Selys, though having rather longer ears.

44. *Siphoneus aspalax*, Pallas.—A single example of this singular animal, obtained on the Upper Amoor, agrees well with Pallas' Siberian species. No trace of it was met with on the Lower Amoor.

45. *Castor fiber.*—No traces of the beaver were met with on the Amoor or its confluents, though it is said that the Russo-American Fur Company obtained a skin in 1853–4, at their temporary station at the south end of Sachalin.

46. *Lepus variabilis.*—The Polar Hare is very common in Amoorland and Sachalin, adopting in winter the pure white dress (with the exception of the black ears), as in the typical European form.

47. *Lagomys hyperboreus.*—A pair of *Lagomyes*, obtained by Herr Maack in Amoorland, are considered to belong to this little-known Pallasian species. A comparison of examples from other parts of northern Asia seems to show that there are several varieties in the colouring of this animal, which appears to be the only Pika inhabiting this district.

48. *Sus scrofa.*—The wild hog of the Amoor seems specifically identical with the European *Sus scrofa*. No difference to speak of was found between two skulls of young individuals from Amoorland and others from the Caucasus. Brownish-black examples are spoken of as having been observed; but this colour is also sometimes to be seen in European specimens.

49. *Ovis* (*Œgocerus*) *montana.**—No traces could be found of this

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* We are very much disposed to question the fact of this *Ovis* being identical with the *Ovis montana* of North America. It is *Ovis nivicola* of Eschscholtz. Middendorf gives the spruce partridge of Canada (*Tetrao canadensis*) as occurring in Northern Asia; but his examples, on further investigation, were proved to belong to quite a different species (*Tetrao falcipennis*). The forms of the higher northern latitudes of the eastern and western hemispheres, though very similar, are, except in the polar regions, usually specifically distinct.

wild sheep, which, according to Middendorf ("Sibirische Reise," p. 116), occurs in the coast-mountain chain of the Sea of Ochotsk, and might therefore be naturally supposed to inhabit also the ranges of Amoorland.

50. *Ovis aries.*—In domesticity.

51. *Antilope crispa.*—A pair of horns, obtained from the natives on the Lower Amoor, seem to belong to this Japanese species, which is said to occur in the coast-chain of Amoorland.

52. *Bos taurus.*—In domesticity.

53. *Moschus moschiferus.*—The Musk-deer is found in the mountainous regions of Amoorland, and occurs also in Sachalin.

54. *Cervus capreolus.*—Dr. von Schrenck agrees with Middendorf, after comparing examples of the Roe from Siberia and Amoorland with those of Europe, in considering Pallas' *Cervus pygargus* as merely a variety inseparable specifically from the European *C. capreolus.*

55. *Cervus tarandus.*—The Rein-deer occurs wild in the northern parts of Amoorland, and commonly in Sachalin, and is also a domestic animal among the nomadic Tungusians.

56. *Cervus elaphus.*—The Red deer of Amoorland is rather larger in size than the European, and of brighter and gayer colouring in summer and in winter. As is the case with the Roe deer, it does not appear to extend into the island of Sachalin.

57. *Cervus alces.*—The Elk is most common on the Lower Amoor, resorting to the dense marshy thickets. It likewise does not seem to occur in Sachalin.

58. *Equus caballus.* } In domesticity.
59. *Equus asinus.* }

60. *Trichecus rosmarus.*—The teeth of the Walrus, received from the north, are an article of commerce among the natives.

61. *Phoca nummularis.*—This Japanese seal is common on the coast, and ascends the mouths of the Amoor.

62. *Phoca barbata*, Müll.

63. *Phoca ochotensis* (Pallas).—These two seals are also found on the coast. The little *P. ochotensis* very seldom enters the mouths of the river.

64. *Phoca equestris*, Pall.—A skin of this scarce seal was also obtained in the Gulf of Tartary; and full details concerning this little-known animal are furnished from four examples, obtained by Herr Wosnessenski on the eastern coast of Kamschatka.

65. *Otaria ursina.*—Pieces of the skin of this animal were often seen in the hands of the natives. It occurs on the coasts of the southern half of Sachalin, and on those of the seas of Ochotsk and Tartary.

66. *Delphinapterus leucas* (Pall.)—Ascends the Amoor regularly, upon the breaking up of the ice, and penetrates to a distance of 400 wersts up the stream.

67. *Balæniptera longimana.*

68. *Balæna australis.*—These two cetaceans are probably those which occur on the coast.

Having excepted out of these sixty-eight species the domestic animals, and those concerning which the evidence is of a negative character, there remain about fifty-eight, which we may consider to be the number belonging to the "Mammal-fauna" of Amoorland, as far as we are at present acquainted with it. Let us see, therefore, what deductions we can make as to the general character of the Fauna of this country from these elements. As Dr. Von Schrenck himself observes, our first remark will be one of surprise at the ill-assorted neighbours which, in some instances, seem to be brought together in Amoorland. A Bengal tiger, even with so limited a knowledge of the geographical distribution of animals as we might suppose such a carnivore to possess, must be rather surprised at finding himself, as he swims across the Amoor, brought face to face with the northern seals, *Phoca nummularis*, and *P. barbata*, and the White-fish of the arctic seas (*Delphinapterus leucas.*) Neither can his wonder be diminished, when, on crossing the narrow strait which separates the island of Sachalin from the main, he is compelled to subsist nearly entirely upon the flesh of the rein-deer (*Cervus tarandus*), a beast only found wild in Europe in the extreme north, and which will not *live* in our Zoological Gardens, but which on this side of the great Continent descends to the latitude of Paris. The little Polar Pika, or tailless hare, is also met with in Amoorland, down to the latitude of 48°, while the wild boar ranges northward beyond latitude 52°. But putting these apparent anomalies aside for a moment, it is very instructive to observe how similar in general characters the Fauna of Amoorland is to that of Europe. The difference, taken at it greatest amount, is hardly more than that of species. Out of the whole number of fifty-eight mammals of Amoorland, as above recorded, no less than thirty-four seem to be identical with European species; and most of the others belong to genera which have European representatives. The nineteen species not found in Europe appear to be the following:—

Mustela sibirica,
Enhydris marina,
Canis alpinus,
,, procyonides,
Felis tigris,
,, irbis,
Spermophilus Eversmanni,
Arvicola amurensis,
,, saxatilis,
,, maximowiczii,
Lagomys hyperboreus,
Antilope crispa,
Moschus moschiferus,
Phoca nummularis,
,, barbata,
,, ochotensis,
,, equestris,
Otaria ursina,
Balæna australis.

Of these, *Enhydris*, *Moschus*, and *Otaria*, belong to genera common to the polar regions of Asia and America, and so perhaps show some relationship of the Fauna of Amoorland to that of the more northern parts of the New World. Of this, it must be recollected, Japan furnishes us with further and more remarkable instances,—a second species of the singular talpine genus *Urotrichus*,* having lately been discovered in

* *Urotrichus gibbsii*, Baird. Examples of this highly interesting Insectivore have

North America, and the nearest ally of the celebrated *Sieboldia*, or so-called gigantic salamander of Japan, being undoubtedly the *Protonopsis horrida* of the United States.* The antilope (*A. crispa*), is also probably more nearly allied to the American *Haplocerus americanus*, than to any other form of the group. With these exceptions, and that of *Canis procyonides*—an animal, according to Herr Von Schrenck's elaborate investigations, hardly differing from *Canis* in its dentition sufficiently for generic separation, but certainly belonging to a different sub-group, and remarkably abnormal in general external *facies*—the forms show, certainly, very great resemblance to those of Northern Europe. Amoorland, in fact, is inseparable from that great zoological region to which the rest of Northern Asia, Europe, and Africa, north of the Atlas, alike belong, and to which the name "Palæarctic" has been appropriately applied, as it embraces the whole northern portion of the Old World. Agassiz's ingenious parallel,† in which he attempts to prove that the races of mankind correspond in their variations with those of the zoologies of the countries occupied by them, completely fails in this instance. Though we might perhaps admit the existence of a circumpolar zoological region, occupied by a race of men ethnologically distinct, the areas tenanted by two very different races—the Caucasians of the west, and the Mand-choos of the east—will admit of no separation on zoological grounds. This has already been abundantly shown to be the case, as regards the classes of birds and reptiles.‡ Temminck and Siebold have long ago enlarged on the similarity of the Fauna of Japan to that of Europe. Waterhouse's Tables for the geographical division of the Rodents, which he has worked out so laboriously, bring Europe and Northern Asia together. Von Schrenck's evidence, we maintain, as given in the present work, tends altogether in the same direction.

It remains, in conclusion, that we should call attention to the excellent way in which Herr von Schrenck has worked out the materials he has collected. The descriptions given of the new and doubtful species are in all cases very full, and descend to the most minute particulars. Great care has been devoted to tracing the range of each individual species throughout Northern Asia, where facts were ascertainable, upon which such deductions could be drawn. The native names applied to the animals by the different tribes are all stated, and many interesting details are given concerning their habits. In short, the volume appears to be no less creditable to the author than it has already been shown to be to the Government to whose fostering care science is indebted for this very acceptable contribution to our knowledge of geographical zoology.

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lately been obtained by the engineers surveying the boundary-line of British Columbia, and are now deposited in the British Museum.

* The relations between the *Floræ* of N. E. Asia and America are, we believe, much more intimate.

† See the introduction to Nolt and Gliddon's "Types of Mankind."

‡ Sclater in "Journ, Proc. Linn. Soc. Zool.," ii, p. 134; Günther, in "Proc. Zool. Soc.," 1858, p. 373.

IV.—Naturgeschichte der Daphniden* (Natural History of the Daphnidæ). By Prof. Franz. Leydig. Reviewed by J. Lubbock, Esq.

From the time of Leeuwenhoek to the present, no group of Crustacea has excited more interest, or been more studied by naturalists, than the genus Daphnia, or, perhaps, to speak more precisely, the Family Daphniidæ. So far, however, from exhausting the subject, these investigations have, in the present case, as in all other matters of science, opened out a still more interesting field for future labours, and suggested more questions than they have answered.

In the present memoir, Prof. Leydig gives a description of all the known species, and an interesting essay on their anatomy and embryology, the whole being illustrated by excellent figures. We are also made acquainted, for the first time, with several new species, and especially with a very curious new form, called by Prof. Leydig, *Bythotrephes longimanus,* and found by him in the stomach of *Coregonus Wartmanni,* of which, indeed, it appears in some localities to form the chief nourishment. And yet, though it must be so abundant, Prof. Leydig was unable to obtain a single specimen from the lake itself; but as the Coregonus is generally found at considerable depths, he infers that perhaps the Bythotrephes also seldom comes to the surface. The female only has as yet been discovered. The animal has the large antennæ, and the large eye as in Polyphemus, but the latter has longer lenses. The receptacle for the eggs is almost spherical, and so distinctly separated from the rest of the body, that it much resembles the abdomen of some spiders. There are four pairs of legs: the first is very much elongated, double as long as the rest, and five-jointed; the other three are not unlike those of Polyphemus. The abdomen also is very remarkable, and ends in a spine, half as long again as the rest of the body; and which, with the long anterior legs, the large eye, and the spherical receptacle, gives the whole animal a most peculiar appearance.

Since I have had the advantage of reading Professor Leydig's work, I have had no opportunity of again examining the animals, and am therefore not now in a position to offer any new observations of my own with reference to those points as to which we differ; it seemed to me, however, that it was right to put my name to this review, because it will be necessary for me to refer more than once to my paper on Daphnia (Phil. Trans. 1857); and because, while fully admitting the great value and interest of the present work, I shall still be compelled to differ from Prof. Leydig on one or two important points.

Prof. Leydig adheres to the opinion that the agamic eggs of Articulata are internal buds, or as he would perhaps prefer to call them "germs" (Keime), and not to be confounded with true eggs; although he admits that in the Polyzoa and Rotatoria the so-called buds agree

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* 4to. Tubingen, 1860, pp. 252.

in all essential particulars with the ordinary eggs of other animals. This, however, he denies to be true of the agamic eggs in the Aphidæ, Coccidæ, and Daphniidæ, in all of which he denies that any Purkinjean vesicle exists. In the "Philosophical Transactions" for 1857, however, I have clearly described and figured the Purkinjean vesicle, both in the agamic, or so-called summer eggs, and also in the ephippial, or, as they are called, the winter eggs, of Daphnia. In the "Linnean Transactions" for 1858, vol. xxii., part iii., Professor Huxley has given an excellent account of the agamic egg of Aphis, and has figured a cell, which is evidently the Purkinjean vesicle, with its macula; though with his usual caution he does not actually so call it, but merely says that it "corresponds with the germinal vesicle and spot of an ovum," and that "it is not distinguishable from a germinal vesicle." As regards Coccus, Prof. Leuckart* and I† independently described the Purkinjean vesicle and spot. And as regards most of the other insects in which agamic reproduction has been observed, the Purkinjean vesicle has been observed by Prof. Leuckart in Chermes and Psyche, and by me in Cynips.‡ Moreover, it is arguing in the very narrowest of circles, to maintain—1stly, that the agamic eggs are buds, and not true eggs, because they contain no Purkinjean vesicle or spot; and 2ndly, that the vesicle and spot which they do contain are not a true Purkinjean vesicle and spot, because the reproductive body is a bud, and not an egg. We have, however, I think, a crucial case in the hive-bee, and some other Hymenoptera and Lepidoptera, in which the eggs are capable of developing either with or without impregnation—a fact which must surely convince even the most sceptical that, though as a matter of convenience it is desirable to adopt Prof. Huxley's name "pseudovum," there is no necessary distinction between a pseudovum and an ovum, or true egg.

Prof. Leydig does not, therefore, I think, express the present state of our knowledge, when he asserts that the agamic eggs of Daphnia, Coccus, and Aphis, possess no Purkinjean vesicle. It is, of course, open to Prof. Leydig to dispute the accuracy of the observations made by Leuckart, Huxley, and myself; but it is, I think, to be regretted that he should have referred only to his own previous and incorrect observations, and have ignored all which has since been written on the subject. Prof. Leydig is so eminent a naturalist, that if he still adheres to his old opinions, we should be much interested to know the reason why; but such a supposition seems scarcely reconcilable with other passages of his work. Thus, in the description of *Dida crystallina* (p. 100), he says—"Die Eier bilden sich vom spitzen, umgeknickten Ende her; dort sind die kleinsten Eikeime, bestehend aus dem Keimblaschen mit solidem Keimfleck, und einer hellen, das Keimblaschen einschliessenden

* Untersuchungen zur Naturlehre, 1858.

† "Phil. Trans.," 1858.

‡ I have already pointed out that, as regards Coccus, Prof. Leydig appears to have generally examined his specimens in dilute acetic acid. This destroys the Purkinjean vesicle, and is, therefore, probably, the cause of his mistake.

Umhüllungsmasse." Again, speaking of *Daphnia pulex*, he describes the youngest eggs as consisting "aus dem Keimblaschen sammt heller Umhüllungsmasse," he uses almost the same words with reference to the young eggs of *D. magna;* and in speaking of the agamic eggs of *D. longispina*, he expressly states that he has been unable to ascertain what becomes of the germinal spot after the vitelline mass has quitted the ovary.

These statements seem almost to justify the inference that, after writing the general chapter on the reproduction of Daphnia, he had altered his opinion as to the absence of the Purkinjean vesicle, but had forgotten to modify his statement.

Of course, as we find that some eggs must be impregnated before they can produce an embryo, while others can do so without requiring any external influence, it is clear that these two sorts of eggs cannot be in all respects alike, since identical bodies must have identical properties. Pseudova, however, share all the known essential characters of true eggs; and it would therefore be very interesting to determine, if possible, on what difference of structure this difference of power depends. This, however, is not the only interesting question which we have to solve, since in some cases,—as, for instance, in the hive bee, as just mentioned,—although the egg is capable of development without impregnation, still impregnation exercises an important difference in it (in this case changing the sex of the resulting embryo), and it would be in the highest degree interesting to ascertain how this change is effected.

According to Prof. Leydig, each brood of agamic eggs forms in the ovary one great mass, which is only divided into separate eggs after its entry into the receptacle. It seemed to me, on the contrary, that each egg was produced separately, round a separate Purkinjean vesicle, although no chorion being at first present, and the egg masses being to a certain extent pressed together, the boundary of each egg cannot always be defined.

In Daphnia he describes a vitellarium separate from the germinarium, the former occupying the anterior, the latter the posterior part of the ovary. This is, however (p. 100), not the case in *Sida crystallina;* and although, as I had already mentioned, the ephippial egg (I believe) always, and the agamic ones very often, arise at the posterior part of the ovary, still I did not observe any separation of the ovary into two parts, so distinct from one another as they are described to be by Prof. Leydig. The various parts constituting the yolk always seemed to me to be developed round the Purkinjean vesicle, as is usual in Crustacea; and we can divide the yolk into "Bildungsdotter" and "Nahrungsdotter" only in the limited sense in which this division holds good for the yolk of all animals.

In *Daphnia longispina,* Pr. Leydig has made the interesting observation, that from the yoke emerge small vesicles, which he considers to be homologous with the so-called "Richtungsbläschen" so generally present in the development of Mollusca and other animals. This fact, if correctly interpreted, is very interesting, since the occurrence of the directive vesicle in groups so essentially distinct would tend to prove that it is a structure of importance, and not a mere particle of the yolk excluded to give more space to the rest. It is also important, because it forms another bond of union between two groups so widely separated as are the Mollusca and the Articulata.

Another point of great importance is the determination of the presence of yolk-division in the egg. Up to the present time, this process had been satisfactorily determined, so far as the Crustacea were concerned, only in certain Cyclopidæ and Ergasilidæ, to which, apparently, we may now add *Daphnia brachiata* and *Polyphemus oculus*, both of which species seem, from the transparency of their yolk to be specially well adapted for embryological examination.

From finding many empty eggshells in the receptacles of specimens, which also contain healthy embryos, Prof. Leydig infers that, as a rule, many of the agamic eggs perish during their development; but the observation need not lead to any such conclusion, since the eggshells are always cast off at a very early stage; and the embryos, when first hatched, have, from their oval form, been already, by many observers, confounded with the true agamic eggs.

Prof. Leydig brings no farther evidence to bear on the curious fact, confirmed by all my experience, that all the young of each brood are of the same sex. On this point I have accumulated a good deal of information. Not only did I carefully watch the origin and development of many broods in the summer of 1856, but between the 1st June and the 11th December, 1858, I obtained nine generations of Daphnia, all of which, except perhaps the first, were indubitably produced from agamic eggs. As this experiment is of much interest, I may perhaps be permitted to give the details.

On the 22nd of June I took two young Daphnias, the mother of which had been born by a specimen isolated in a tumbler. Neither these, nor their mother, nor grandmother, had ever been in a glass with a male; but I have not kept the date of their birth.

On the 4th of July these had young ones, some of which I put in another glass. These, therefore, formed the fourth generation without impregnation.

On the 21st of July these again bore young ones; and again on the 29th, some of which latter I isolated.

On the 19th of August these again produced young, which I isolated.

On the 3rd of September, ditto, ditto.

On the 1st of October, ditto, ditto.

On the 1st of December these again had young ones, which died without breeding.

During this experiment I carefully examined all the young ones produced; and as the males are, even directly after birth, easily distinguishable from the females, I think I can undertake to say that not one of the latter was produced during the whole time. This series of observations, therefore, apart from the more obvious object which I had in view, tends to confirm the opinion, that all the young of the same brood are of one sex; and this, again, if established, increases the evidence, that, in the above experiment, no single male may, by chance, have been present, and have escaped observation. This is, indeed, however, scarcely possible, because I examined each brood when they were at most a day or two old, and then isolated two or three specimens, all of which were indubitably females; and, indeed, except the last pair, they all proved fertile.

Considering, also, how much rarer the males are than the females, it is a strong fact in the same direction, that the only time I satisfactorily proved the formation of a male from an agamic egg, the whole brood, eighteen in number, were of that sex.

The fact is, therefore, to my mind, certainly established, that, at least as far as nine generations, the females of Daphnia can continue the species without the intervention of the male; but I by no means believe that the power is then exhausted. It must, indeed, be confessed that the last two generations of my Daphniæ were smaller and weaker than those that had gone before; but I am inclined to attribute this partly to the season (December), but principally to the fact, that certain small algæ, which had flourished all the summer in my tumblers, and had furnished an abundant and suitable supply of food to the Daphni, had died out, and thus left them without sufficient food.

As a general rule, I found that in the heat of summer young Daphniæ laid eggs for the first time (though, under the circumstances, "laying" their eggs is scarcely a suitable expression), when they were about three weeks old, and before they are full grown, or even sometimes a few days earlier; and after this they produced a fresh brood about every seven or eight days.

Although, however, they breed with so much rapidity, they live in confinement a considerable time; I even kept one large specimen by itself in a tumbler from the 21st of January to the 20th of May, when it died; and as it was full-grown at the earlier date, it must have lived for at least five months, and even then it may have died from disease, rather than from old age.

With reference to the homologies of the inner ephippial case, Prof. Leydig expresses no opinion. The explanation of it given by me has, however, lately been called in question by M. F. A. Smitt;* he confirms, indeed, in all respects, the accuracy of my descriptions; and, as also does Prof. Leydig, agrees with me in admitting the correctness of Straus' views as to the nature of the outer valve. I am happy to think also that the apparent difference between us has arisen entirely from his misunderstanding the perhaps too brief description of the structure given by me.

The valve of a Daphnia, being a projection of the skin, consists, of

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* Nova Acta Reg. Societ. Scient. Upsal., Ser. 3æ., vol. iii.

course, of a central layer of corium, surrounded on all sides, except at the line where it joins the body, by a chitinous envelope. When the animal is about to shed its skin, the corium secretes around itself, and between itself and the old chitinous layer, a new layer of chitine; and if an ephippium is being formed, the outer case is produced by the external part of the old layer of chitine, while the chitine which clothed the inner surface of the valve (inner, with reference to the receptacle, though still, of course, in reality, an external skin), is modified into the inner capsule of the ephippium, and the new layer of chitine takes, therefore, no share in this process.

As a proof that this view was correct, I cited the fact, that on removing the outer valve of a Daphnia, which was about to change its skin, the animal swam away, and the inner ephippial valve remained in the receptacle. M. Smitt seems to doubt whether there is not some mistake in this statement, since he says, "Il doive déjà étonner, que les œufs, la mère changeant de test, ne soient pas considérablement dérangés, et que la carapace nouvelle, qui les separe du test exterieur de l' éphippie, ne les emporte pas avec soi;" but I never said that the eggs were not disturbed; it requires some practice and much steadiness of hand to remove the old carapace, even from a large specimen, without injuring the animal; but I never said that it could be done without deranging the eggs.

I consider that the external and internal layers of the shell (both of which are formed of epidermis, and are secreted by the corium or chitinogenous layer which lies between them), constitute the outer and inner valve of the ephippium, but M. Smitt understands me to suppose that the inner layer of the ephippium is formed by the corium itself; and he adds, that in this case it is impossible to understand in what manner the new shell is produced. He suggests, indeed, that as the outer valve of the ephippium is formed of the old shell, so the inner valve may be formed by the new one; but he admits that this explanation cannot apply to those cases in which the Daphnia survives the removal of the ephippium.

I must admit that M. Smitt has conclusively disproved the theory which he supposes that I propounded; and I gladly take this opportunity of thanking him for the courteous manner in which he has done so. I trust, however, that, though the relation of the parts is somewhat intricate, the present description is sufficiently precise; and that, on a second examination, M. Smitt will feel justified in adopting the explanation which I have offered. M. Smitt has also made the curious observation, that in *Daphnia sima* the ephippium contains only one egg. This fact, if it hold good generally, and was not merely the result of accidental circumstances, is certainly very interesting. In *D. Schæfferi*, which alone I examined with much care, two ephippial eggs were always produced simultaneously, one in each ovary. Since reading M. Smitt's paper, I have provided myself with some specimens of *D. sima;* but have not yet succeeded in meeting with any ephippia.

Professor Leydig has observed the male organs in several species.

In *Daphnia* (*Moina*) *rectirostris* he saw, not without astonishment, that the spermatozoa resembled the star-formed seminal bodies of the higher Crustacea. In other species of Daphnia—as, for instance, in *D. magna*, *D. sima*, and *D. longispina*—they are small, rod-like, or conical bodies. It must, however, be remarked, that *Daphnia rectirostris* is considered by Dr. Baird as belonging to a different genus, and this great difference in the spermatozoa is an additional argument in favour of the separation.

The testis is simple and tubular; it generally lies along the intestine, in the same position as that occupied by the ovary, and opens, after a short *vas deferens*, immediately on the upper side of the terminal hooklets.

In *D. rectirostris*, indeed, it seemed to terminate in the rectum, which, therefore, acts as a sort of cloaca; but this is so unlike what takes place in other species, that it requires confirmation before it can be received as an undoubted fact.

Prof. Leydig considers that the recent investigations into the morphology of the arthropods have shown that their body consists of four parts—head, thorax, abdomen, and post-abdomen. This division, which was proposed by Erichson for the Crustacea, has not, however, been adopted by our greatest authorities on the subject. Zaddach, in his admirable monograph "Die Entwickelung des Phryganiden-Eies," divides the body into five parts: "Vorderkopf, Kopf, Brust, Leib, und Hinterleib," though it seems unnecessary to divide the head into two parts. With these exceptions, however, the opinion on this point is remarkably unanimous. Siebold and Stannius, (Anat. Comp., 1850); Milne Edwards, (Annales d. Sci. Nat., 1851, vol. xvi.); Dana, in his great work on Crustacea, 1852; Owen, (Lectures on Comparative Anatomy, 1855); and Huxley, (Memoir on Aphis, Linnean Trans., vol. xxi, 1858), all divide the body of the Crustacea into three parts—head, thorax, and abdomen (the two former having more or less completely coalesced into a cephalothorax). Most, however, if not all, of these eminent naturalists admit that the five posterior thoracic segments of Crustacea are homologous with certain segments which in Insects form part of the abdomen. To apply the word "thorax," however, in two groups so nearly allied as the Insects and the Crustacea, to two different parts of the body, is manifestly very confusing, and contrary to the first principles of nomenclature. The three thoracic segments of insects correspond, according to Erichson, whose views are generally adopted, to the three segments which in Crustacea bear the three pairs of maxillipeds; and the five segments, which carry the legs in decapods, belong in consequence to the abdomen. We ought, therefore, to alter our nomenclatures as regards the Crustacea, however inconvenient such a change may be; and we must for this group of arthropods, if at least we wish to keep the head and thorax distinct, add a fourth division—the post-abdomen—to the three generally admitted. It will no doubt be better, as a matter of convenience, to divide the insect body also, theoretically, into four parts, although practically there are but three, as in decapods.

Although, therefore, the body of decapods and that of insects agree in consisting, theoretically of four, and practically of three, segments, there is this difference, that in the decapods the head and thorax have coalesced, while in insects it is the abdomen and post-abdomen which form a continuous series. It seems to me to be of great importance that we should use the words "thorax" and "abdomen" in one sense only; but when our nomenclature is thus corrected, it is a matter of little importance whether, with most naturalists, we divide the body of Articulata into three parts, with Leydig into four, with Zaddach into five, or whether, with Erichson, we consider the body of the insect as falling into three divisions, and that of the Crustacea, in which the abdomen is not continuous, into four.

Indeed, these divisions, though convenient, are still artificial, since the breaks which occur do not occupy the same place in all Articulata; and, even in the limits of one class, as for instance of the Crustacea or of the Insects, we find segments which in some families lose their usual attachments, and become more or less firmly united to one of the other two divisions.

In order, therefore, to make our nomenclature self-consistent, I should propose to confine the use of the word "thorax," in Crustacea, to the three segments which bear the maxillipeds (and which are homologous with the three thoracic segments of Insects); and to call the five leg-bearing segments of the higher Crustacea the "abdomen," since they correspond to the first five abdominal segments of Insects.

Prof. Leydig adopts the idea first suggested by Gruithuisen, and confirmed by Zaddach, that the valves of Daphnia are homologous with the anterior wings of insects; and as regards the mode of origin of the "cuticle," or outer chitinous membrane, he adheres to the view expressed by him in his article on Argulus (Zeitsch f. W. Zool, 1850, vol. ii., p. 325). According to this view, the outer chitinous investment is a secretion from the subjacent cellular (?) layer; and as most naturalists are agreed on this point, we may regard it as being pretty well established. M. Leydig, however, in 1855, expressed a decided opinion, that the chitinous skin of Articulata was to be considered as chitinised connective tissue. This is apparently a diametrically opposite statement; and we cannot wonder that most naturalists (see, for instance, M. Baur's interesting paper in Müller's Arch., 1860, pt. i.*), should have looked upon Leydig as having abandoned his previous idea. However this may be, it is satisfactory to find that the best authorities are now agreed in considering that the chitinous outer skin of Articulata is thrown off from the underlying cellular layer, although Leydig refers this layer to the class of tissues known as connective tissue, while Kolliker, Häckel,

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* M. Baur, however, refers to MM. Kölliker and Häckel as being the first to regard chitine as an excretion from the subjacent cellular layer, rather than a modification of pre-existing tissue. M. Baur, like other continental naturalists, seems to have overlooked Mr. Huxley's article (in Todd's "Cyclopædia") on Tegumentary Organs, in which this theory is propounded.

Baur, and others, look upon it as being a layer of epithelial cells. It is admitted, says M. Baur, that the chitinous inner membrane of the intestine is secreted by the surrounding layer of epithelial cells, and passes without any line of separation into the ordinary outer layer of chitine. But, on the other hand, M. Leydig urges that the chitinous, spirally-thickened lining of the tracheæ, which also is continuous with the outer skin, is clearly formed by the connective tissue.

Under these circumstances, we naturally ask for a definition of the terms "epithelium" and "connective tissue." If with Baur we define the former to be a layer of cells, or nuclei, clothing a free surface, it is evident that the chitinogenous layer of the skin would be an epithelial structure. But it may be asked, what is a free surface? Before the spiracles are formed, and the tracheæ thus provided with an external opening, the cells which secrete the chitinous inner membrane are certainly connective tissue; when, however, the trachea is complete, they clothe an outer surface just as much as the chitinogenous cells of tendons, which may indeed be regarded as tracheæ, in which the chitine fills up the cavity, instead of lining it. In this case, however, the cells themselves have undergone no change whatever, not even of position. It seems to me, therefore, that we are not able to draw any satisfactory line of separation between epithelium and connective tissue; nor can we look upon them as essentially distinct, although it may be convenient to retain the names as expressing different forms of the same tissue.

The accessory eye-spot does not appear to be so rudimentary an organ as has been generally supposed; and Prof. Leydig was able to detect in it several distinct though small bodies, of high refractive power. He thinks that it is a mistake to suppose that this spot belongs to the period of embryonal life, since, in all species in which he found it present in the embryo, it also occurred in mature specimens. The sense of hearing resides, he believes, as in other Crustacea, in the anterior antennæ; these organs are provided with a large nerve, which, in the middle of the antennæ, forms a small ganglion. From this ganglion, again, nerve-filaments, more or less separate, pass to the group of auditory hairs, generally from five to ten in number, which form a tuft at the end of the antenna.

No organ of smell has as yet been satisfactorily proved to exist in Daphniidæ. The so-called shell-canals of the Entomostraca are regarded by Prof. Leydig as homologous with the equally enigmatical "green glands" of the higher Crustacea, and these again with the projecting green organ in the embryo of Asellus. This curious structure was first discovered by Rathke, who supposed it to act as an embryonal gill. Prof. Leydig's reasons for considering it as homologous with the above-mentioned organs are, that he can suggest no other homologue for it, and that it occupies a similar position; and that, whereas the "green glands" are found in all other aquatic Crustacea, no other homologue for them has been detected in Asellus. In none of these cases has the organ any external orifice.

The blood in Daphnia consists of a fluid which is either colourless, or slightly yellow; in some few cases, even with a bluish or greenish tint. The blood-cells are generally colourless, and their number varies according to the richness or poverty of food. In some species, however, as, for instance, in *Polyphemus oculus*, the blood-cells appeared to be very few in number, or even almost entirely absent.

I subjoin a list of the genera proposed by Prof. Leydig, with their principal characters:—

SIDA.

Six pairs of legs. The large antennæ with two branches, one of them two-jointed; the other three-jointed.

HOLOPEDIUM.

Characters of Sida. The large antennæ not branched.

LATONA.

Characters of Sida. The large antennæ with three branches.

DAPHNIA.

Five pairs of legs. The large antennæ with two branches; one three-jointed, the other four-jointed.

MACROTHRIX.

Legs and general characters as in Daphnia. The plumose hair of the first segment of the three-jointed branch of the large antennæ is the longest, and its second segment is toothed like a saw.

ACANTHOCERCUS.

Characters generally as in Daphnia. The four-jointed branch of the large antennæ has only three plumose hairs; the three-jointed branch has five, the one belonging to the first segment being the longest.

PASITHEA.

Characters generally as in Daphnia. Both branches of the large antennæ have five setæ. Post-abdomen peculiar; the part lying before the anus small, the posterior portion elongated.

BOSMINA.

Five pairs of legs. Large antennæ two-branched; the one branch with four segments, and three bristles; the other with three segments, and five bristles. The head is produced in front into two long horns.

LYNCEUS.

Five pairs of legs. Stem of the large antennæ short, with two three-jointed branches. Accessory eye large.

POLYPHEMUS.

Four pairs of legs, projecting beyond the carapace, which serves only as a receptacle for the eggs. Head separated from the thorax. The bristles on the large antennæ plumose. Post-abdomen produced behind as a long, cylindrical process, with two terminal setæ.

BYTHOTREPHES.

General characters as in Polyphemus, but the anterior legs much longer than the others. The post-abdomen terminating in a single, very long spine.

PODON.

General characters as in Polyphemus, but the post-abdomen ending in two long spines.

EVADNE.

General characters as in Polyphemus, but with the head and thorax united. Post-abdomen very short; the tail bristles quite small. The receptacle of the eggs very large, and produced into a point.

Although this classification suppresses several of the unnecessary genera which had been proposed by previous writers, it may be doubted whether the list ought not to undergo a still farther diminution. The number, arrangement, and size of the hairs on the antennæ afford, in Entomostraca, excellent specific differences; but they are surely not of sufficient importance to be used as generic characters. Although I think few naturalists now regard genera as being more than a convenient *memoria technica*, it is evidently desirable that the characters used to separate genera should, throughout the animal kingdom, be as nearly as possible of equal importance, and, to borrow a mathematical expression, of a higher "order" than those by which species are distinguished. Of course this rule can only be applied in a very rough manner, since it is almost impossible to estimate the relative value of different characters; but it must, I think, be admitted that, if applied, for instance, to the genus Acanthocercus, it would not justify the generic separation of *A. rigidus* from the species of the preceding genus.

In the same manner, the groups Macrothrix and Pasithea, so far as the characters given are concerned, are scarcely entitled to rank as separate genera.

On the other hand, we must add to the list two genera proposed by Prof. Dana, in his great work on Crustacea. A third, Ceriodaphnia, is scarcely distinct enough from Daphnia. I subjoin the characters given for all three, as many other naturalists may, like Prof. Leydig, have been unable to obtain Prof. Dana's book.

PENILIA.

Pedes foliacei numero duodecim. Antennarum posticarum rami ambo 2-articulati. Caput breve, infra elongato-productum, antennas anticas obsolescentes versus apicem gerens.

CERIODAPHNIA.

Pedes foliacei numero decem. Corpus fere globosum, capite brevi. Antennæ anticæ minutæ (raro elongatæ ?). Testa cellulis hexagonis et pentagonis subtilissimè areolata.

PLEOPIS.

Caput grande, oculis repletum. Pedes numero octo. Corpus postice, non deflexum, fere rectum; abdomen crassum extremitate furcatum, setis nullis. Testa postice rotundata. Rami antennarum posticarum 3-articulati.

The whole family I should propose to divide into three sub-families, according to the number of the legs, almost in the manner suggested by Prof. Dana. Firstly, Sidinæ, with six pair of foliaceous legs, and containing the genera Sida, Holopedium, Latona, and Penilia. Secondly, Daphninæ, with five pairs of legs, and divided into the three genera, Daphnia, Bosmina, and Lynceus. And, thirdly, Polypheminæ, characrized by four pairs of legs, and an immense eye. The latter subfamily would comprise Polyphemus, Bythotrephes, Podon, Evadne, and Pleopis.

Prof. Dana is, however, wrong in describing the head of Polypheminæ as "oculis repletum," the part thus occupied being, as Prof. Leydig correctly points out, only the anterior part of the head.

On the whole, Prof. Leydig's monograph is worthy of the reputation of its author. The specific descriptions are drawn up with care, and in much detail; the drawings are clear and good: and though I have not hesitated freely and frankly to indicate the points on which, in my opinion, his views are incorrect, or his arguments inconclusive, I am glad to take this opportunity of thanking him for what is undoubtedly a valuable work on a very interesting subject. There still remain, however, unsolved, many most important questions with reference to the anatomy and development of Daphnia; and especially an examination into the embryology of the ephippial, as compared with that of the ordinary eggs, would, doubtless, well reward any one who would undertake it. In a natural condition, indeed, the ephippial egg is so opaque, that its internal condition cannot satisfactorily be ascertained; but it is probable that this difficulty might be overcome by the use of glycerine, or some other chemical re-agents. The light which is in this manner thrown upon tissues is most surprising; and it is probable that the future progress of histology will depend, at least, as much on the judicious use of chemical agents, as upon that of the microscope itself.

V.—On the Natural Position and Limits of the group Protozoa.

1.—Die Klassen und Ordnungen des Thier-richs, wissenschaftlich dargestellt in wort und Bild. Von Dr. H. G. Bronn, Professor an der Universität Heidelberg. Erster Band, Amorphozoen. Leipzig und Heidelberg, 1859.

2.—Grundzüge der Vergleichenden Anatomie. Von Dr. Carl Gegenbaur, Professor der Anatomie zu Jena. Leipzig, 1859. Erster Abschnitt, Protozoa.

3.—A Manual of the Sub-Kingdom Protozoa, with a general Introduction on the Principles of Zoology. By Joseph Reay Greene, B.A., Professor of Natural History in the Queen's College, Cork. London, 1859.

4.—An Essay on Classification. By Louis Agassiz. London, 1859.

5.—Palæontology; or, a Systematic Summary of Extinct Animals, and their Geological Relations. By Richard Owen, F. R. S., &c., &c. Edinburgh, 1860.

Two authors, of high reputation, having recently expressed themselves, in a somewhat remarkable manner, on the nature of the Protozoa, we have been induced to bring forward the following general comments on the constitution of the group in question.

The Protozoa form one of the primary departments, or sub-kingdoms, into which the animal world is divided; that, in short, to which the lowest forms of animal life belong.

At the time of Cuvier, our knowledge of the humbler animal organisms was not sufficient to enable that naturalist fully to appreciate the importance and extent of this division. The Infusoria, (exclusive of the Rotifers,) and the Sponges, (then placed among the Polypes,) may be said to have constituted, in the Cuvierian arrangement, the germ of the sub-kingdom Protozoa, as it now stands.*

An early step towards the attainment of right views on the present subject was made by Milne-Edwards, who, in his modification of the system of Cuvier, sub-divided "Les Zoophytes" of that author into two great sections: Radiaires, and Sarcodaires. In the latter division he included the two classes of Infusoria and Sponges.

The name Sarcodaires had obvious reference to the researches of another French naturalist, Dujardin, who introduced the term "sarcode"†

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* The term Infusoria is older than the time of Cuvier, and appears to have been first made use of by Wrisberg, in his "Observationum de Animalculis Infusioriis Satura," 1765, although the German equivalent of the same word had, two years before, been introduced by Ledermüller. The Sponges received their earliest scientific treatment in the works of Aristotle. The words "σπόγγος," "σφόγγος," and "σπόγγια," occur in several of the older Greek authors.

† See his "Histoire Naturelle des Infusoires," 1841, p. 35, *et seq.*

to designate the peculiar semi-gelatinous substance composing the body of these simple organisms. In the year 1835,* it was announced by this observer, that the animal inhabitant of certain microscopic shells termed Foraminifera by D'Orbigny,† though by him placed among the Cephalopoda, agreed essentially in organization with the Amæba, or Proteus animalcule and other fresh-water forms allied thereto. It then became desirable to separate these, as a group, from the true Infusoria; and accordingly they were soon united into a class, under the name of Rhizopoda, a term first introduced by M. Dujardin, but employed by him in not quite so extended a signification.‡

At length, in the year 1845, Von Siebold founded the modern subkingdom, Protozoa, which he divided into two classes, Infusoria and Rhizopoda§. No mention, however, is made by him of the Sponges.

Previously, in the year 1838, the name of Polycystina‖ had been given by Ehrenberg to a group of microscopic siliceous-shelled creatures, evidently allied to the Foraminifera. Ehrenberg, it is true, entertained very peculiar views of their affinities, and even sought to place them in the neighbourhood of his Bryozoa.

So early as 1828, Dufour had established the genus Gregarina¶ for the reception of certain minute parasitic organisms found by him in the bodies of insects. In the year 1841, J. Müller described, under the title of Psorospermiæ**, the contents of small rounded cysts occurring in the cellular tissue of the muscles of a young pike's eye. Ten years afterwards, the existence of a curious relationship between these Psorospermiæ and the Gregarinæ of Dufour was ingeniously demonstrated by Leydig.†† Doubts soon arose as to the position of these parasitic forms. Creplin‡‡ had suspicions of their vegetable nature; the hasty observation of some phenomena in their development, which simulated the conjugation of the lower Algæ, appeared, at first, to countenance this conjecture. Bruch§§, Leydig, and a number of other observers, regarded them as Helminthes, or, at least, as transitory stages in the life-history of these animals. But Kölliker, in a paper of great value,‖‖ brought forward arguments which went far to prove, (1), that the Gregarinæ were true animals; (2), that no good evidence had been produced to

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* "Observations nouvelles sur les prétendus Céphalopodes microscopiques," par M. Dujardin, Ann. d. Sci. Nat., Ser. 2, tom. 3.—Zool., pp. 108 et 312.

† In his "Tableau Méthodique de la Classe des Cephalopodes," Ann. d. Sci. Nat., tom. 7. 1826. The much older term, Polythalamia, dates at least as far back as 1732. See Breyn, "Dissertatio Physica de Polythalamis, nova Testaceorum Classe," 1732.

‡ "Infusoires," p. 240. Also, "Recherches sur les Organismes inférieurs," Ann. d. Sci. Nat., tom. 4, 1835; and "Observations sur les Rhizopodes et les Infusoires," Compt. Rend., 1835.

§ Lehrbuch der vergleichenden Anatomie, Wirbellose Thiere, 1845.

‖ See Abhand. d. Berlin Acad., 1839.

¶ Ann. d. Sci. Nat., tom. 13, 1828, p. 366, et Ser. 2, tom. 7, 1837, p. 10.

** Müller's Archiv., 1841, p. 477.

†† Müller's Archiv., 1851, p. 221.

‡‡ Wiegmann's Archiv., 1842, p. 61.

§§ Siebold und Kölliker's "Zeitschrift," 1850, p. 110.

‖‖ Siebold und Kölliker's "Zeitschrift," 1848, p. 1.

show that they were not perfect animals; and (3), that their exceedingly simple structure differed much from that of the Helminthes. Kölliker, indeed, considered the simple Gregarinæ as unicellular animals. Without assenting to the theory which this expression involves, we may, in the absence of more valid testimony, agree with the general tenor of his observations, and view the Gregarinæ as indubitable members of the group Protozoa. The recent careful investigations of Lieberkühn* appear to strengthen this position.

In the same year wherein Leydig published his researches on the Gregarinæ, Professor Huxley described, under the name of Thalassicolla,† a singular genus of marine animals, manifesting affinities both with the Sponges and Foraminifera. It would appear, however, that Meyen, seventeen years before, had noted the existence of some of these forms.‡

The nature of the Thalassicollæ was, subsequently, further elucidated by the late J. Müller, who arranged these organisms under four genera: Thalassicolla proper, Physematium, Sphærozoon, and Collosphæra.§ He, at the same time, called attention to an allied group of Protozoa, previously unnoticed, which he proposed to term Acanthometra. These observations are, perhaps, the more interesting, since they form the subject of the last communication made to science by this great anatomist.||

One other addition to the Protozoa yet remains to be noticed. There can be now little doubt that the Noctiluca¶ of Surriry, well known for its power of imparting a phosphorescent appearance to the sea, and erroneously referred by De Blainville to the Diphydæ, rightly belongs to this sub-kingdom. From the observations of Professor Huxley,** its affinities would seem to be nearest the Infusoria, though, by Doyère, Van Beneden, and others, it has been placed with the Rhizopodous members of the group.

Thus, then, there exists an extensive group of organisms of very humble structure, but equivalent in Zoological importance to the Vertebrata, Mollusca, and other primary divisions of the animal kingdom. This department, or sub-kingdom, of Protozoa contains:—

1. Rhizopoda, including *Foraminifera.*
2. Polycystina.
3. Thalassicollida.
4. Acanthometra.
5. Spongidæ, or Porifera.
6. Gregarinida, including *Psorospermiæ.*
7. Infusoria.
8. Noctilucida.

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* Evolution des Grégarines, Mem. de l'Acad. de Belg., tom. 26, 1855.
† Ann. Nat. Hist., 1851, p. 433.
‡ Nov. Act. Acad. Car. Leop., 1834, xvi., Supp. I., p. 159.
§ Monats-Ber. der Acad. zu Berlin, 1855, pp. 229 and 671: ibid., 1856, p. 474.
|| Abhand. d. Berlin Acad., 1858.
¶ Guerin. Mag. d. Zool., 1836, p. 1.
** "Quart. Jour. Micr. Sci.," 1855, p. 49.

These organisms are true animals. Recent observations,* it may be said, throw some doubt over the nature of a few of the simple Rhizopods, but they are far from proving their supposed affinities with plants. And, until further researches compel us to alter our belief, we see no sufficient reason for dissenting from the generally-received opinion, that Amæba and Actinophrys perform all the necessary functions of undoubted animals. With regard to Infusoria, if the possession of a mouth be demanded as an essential condition in all future definitions of this group, we at once get rid of the hosts of Rhizopods and vegetable forms, which some, following Ehrenberg, still associate with the Infusoria properly so called. It yet remains to distinguish these latter from the numerous embryonic forms of higher animals, more particularly of Annulloida, with which, in all probability, they are in many cases confounded.

A good classification of the Protozoa is still a desideratum. Much has yet to be done towards the attainment of a more perfect knowledge both of their structure and development, before even the data necessary for such an object can rightly be perceived. How far, in the present state of inquiry, we seem justified in indicating the outlines of a natural arrangement, may be inferred from the following considerations.

Some of the Protozoa possess, others are destitute of, a mouth. The former are termed Stomatoda, the latter, Astomata.† The Stomatoda include all the Infusoria proper, and the solitary genus Noctiluca. Under Astomata are placed all remaining Protozoa. Whether the six groups of *Protozoa Astomata,* recognized in the above list, be precisely equivalent to one another, must remain an open question. By J. Müller‡ the term Rhizopoda has been extended, so as to include the Polycystina, Thallassicollidæ and Acanthometra. To these three groups he applies the collective designation of *Rhizopoda radiolaria.* Lachmann, and Claparède,§ the latest systematic writers on this subject, have, with some few restrictions, adopted the views of Müller, and arranged the Rhizopoda as follows :—

RHIZOPODA.

			Orders.	Families.
No calcareous shell, with numerous, porous, chambers.	Pseudopodia rarely becoming fused with one another.	No siliceous spicules, or yellow cells.	PROTEINA.	1. Amæbina. 2. Actinophryria.
		Siliceous spicules and yellow cells.	ECHINOCYSTIDA.	1. Acanthometrina. 2. Thalassicollina. 3. Polycistina.
	Pseudopodia forming very numerous, confused, agglutinations.		GROMIDA.	1. Gromida.
A shell, usually calcareous, most frequently divided into several chambers, each of which, though entire, has its walls pierced with very many pores.			FORAMINIFERA.	1. Monothalamia. 2. Polythalamia.

* Hartig, in "Quart. Jour. Micr. Sci.," 1855. p. 51; Carter, in "Ann. Nat. Hist.," 1857, p. 259 ; A. de Bary, in Siebold und Kölliker's "Zeitschrift," 1859, p. 88; Dickson, in "Quart. Jour Micr. Sci.," 1860, p. 7.

† Huxley, "Lectures on Gen. Nat. Hist.," in "Med. Times and Gaz.," May 24, 1856, p. 507.

‡ Müller's Archiv., 1858, p. 104.

§ Etudes sur les Infusoires et Rhizopodes, 2me livraison, p. 434.

Other writers go farther, and propose to unite the Sponges with the Rhizopoda; nor can we hesitate to admit that many facts are in favour of such a conclusion. But, on the other hand, the possession of so remarkable a morphological element as their fibre, which, even when siliceous, as in Dictyochalis, still exhibits its characteristic reticulated arrangment, must, apart from their aquiferous system, and the comparatively large size which many of them attain, be duly estimated in all attempts to lower the independent value of this group.

The Gregarinida, at first sight, appear to depart most in structure from the ordinary type of an Astomatous Protozoon. Yet even these, as Lieberkühn has shown, give rise, in the course of their development, to bodies which very closely resemble Amæbæ. Thus intimately are these humbler organisms allied to one another.

We are, therefore, disposed to conclude that the time has not yet come for adopting any very definite sub-division of the Protozoa. Those, however, who are not content with the simple enumeration of groups given above, may adopt such a provisional arrangement as the following:—

PROTOZOA.

ASTOMATA.	STOMATODA.
1. Rhizopoda.	1. Infusoria.
2. Spongida.	2. Noctilucida.
3. Gregarinida.	

Such characters as appear to be common to all the Protozoa are, for the most part, purely negative. They do not present that differentiation into distinct layers, which, at so early a stage of development, is manifested by the members of the remaining sub-kingdoms. Those who prematurely seek for a definition of the Protozoa must remember that, in beings of the simplest plan of animal structure, the presence of positive anatomical features, similar to those which distinguish groups of a higher grade of organization, is not to be expected.

We look forward, then, with hope to the result of further investigations, for a solution of those difficulties which yet stand in the way of a right knowledge of the Protozoa. Nevertheless, a writer so eminent as Professor Agassiz has, in a recent work, declared that the very existence of this division, as a distinct animal sub-kingdom, must henceforth be ignored. We quote, *verbatim*, the passages in which he professes to have arrived at so iconoclastic a conclusion:—

"As to the Protozoa, I have little confidence in the views generally entertained respecting their nature. Having satisfied myself that Colpoda and Paramecium are the brood of Planariæ, and Opalina that of Distoma, I see no reason why the other Infusoria, including in Ehrenberg's division Enterodela, should not also be the brood of the many lower worms, the development of which has hitherto escaped our attention. Again, a comparison of the early stages of development of the Entomostraca with Rotifera might be sufficient to show, what Burmeister, Dana, and Leydig, have proved in another way, that Rotifera are genuine Crustacea, and not worms. The vegetable character of most of the Anentera has been satisfactorily illustrated. I have not yet been able to arrive at a definite result respecting the Rhizopods, though they may represent, in the type of Mollusks, the stage of yoke-segmentation of Gasteropods. From these remarks it should be inferred that I do not consider the Protozoa as a distinct branch of the animal kingdom, nor the Infusoria as a natural class."

"With reference to the Protozoa, first, it must be acknowledged that, notwithstanding the extensive investigation of modern writers upon Infusoria and Rhizopoda, the true nature of these beings is still very little known. The Rhizopoda have been wandering from one end of the series of Invertebrata to the other, without finding a place generally acknowledged as expressing their true affinities. The attempt to separate them from all the classes with which they have been so long associated, and to place them with the Infusoria in one distinct branch, appears to me as mistaken as any of the former arrangements; for I do not consider that their animal nature is yet proved beyond a doubt, though I have myself once suggested the possibility of a definite relation between them and the lowest Gasteropods.* Since it has been satisfactorily ascertained that the Corallines and Nullipores are genuine Algæ, which contain more or less lime in their structure, and since there is hardly any group among the lower animals and lower plants which does not contain simple locomotive individuals, as well as compound communities, either free or adhering to the soil, I do not see that the facts known at present preclude the possibility of an association of the Rhizopods with the Algæ. This would almost seem natural, when we consider that the vesicles of many Fuci contain a viscid, filamentous substance, so similar to that produced from the body of the Rhizopods, that the most careful microscopic examination does not disclose the slightest difference in its structure from that which mainly forms the body of Rhizopods. The discovery by Schultze of what he considers as the germinal granules of these beings by no means settles this question, since we have similar ovoid masses in Algæ, and since among the latter locomotive forms are also very numerous." In a note it is added, that "the recent investigations of Ehrenberg and J. Müller indicate a very close affinity between the Thalassicolæ, the Polycystinæ, and the Rhizopods; and the more I examine these enigmatical bodies, the more do they impress me as being allied to the lower Algæ and to the Sponges, rather than to any type of the animal kingdom."

"With reference to the Infusoria, I have long since expressed my conviction, that they are an unnatural combination of the most heterogeneous beings. A large number of them—the Desmidiaceæ and Volvocinæ—are locomotive Algæ. Indeed, recent investigations seem to have established beyond all question the fact, that all the Infusoria Anenterata of Ehrenberg are Algæ. The Enterodela, however, are true animals, but belong to two very distinct types; for the Vorticellidæ differ entirely from all others. Indeed, they are, in my opinion, the only independent animals of that group; and, so far from having any natural affinity with the other Enterodela, I do not doubt that their true place is by the side of the Bryozoa, among the Mollusks, as I shall attempt to show presently. Isolated observations, which I have been able to make upon Paramecium, Opalina, and the like, seem to me sufficient to justify the assumption that they disclose the true nature of the bulk of this group. I have seen, for instance, a Planaria

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* Allusion is here made by Prof. Agassiz to the following passage, which occurs in a Paper on the Principles and Classification of the Animal Kingdom, published in the "Proceedings of the American Association for the Advancement of Science," Charleston, March, 1850:—

"Again, the position of the Foraminifera seems to me no longer doubtful. They are neither microscopic Cephalopoda nor Polype, as of late it has been generally thought best to consider them, but constitute a truly embryonic type in the great division of Gasteropoda, exemplifying, in the natural division, in a permanent condition, the embryonic state of development of common Gasteropoda, during which the bulk of the yolk passes through the process of repeated divisions."

lay eggs, out of which Paramecia were born, which underwent all the changes these animals are known to undergo up to the time of their contraction into a chrysalis state; while the Opalina is hatched from Distoma's eggs. I shall publish the details of these observations on another occasion. But if it can be shown that two such types as Paramecium and Opalina are the progeny of worms, it seems to me to follow that all the Enterodela, with the exception of the Vorticellidæ, must be considered as the embryonic condition of that host of worms, both parasitic and free, the metamorphosis of which is still unstudied. In this connexion I might further remark, that the time is not long past when Cercaria was also considered as belonging to the class of Infusoria, though at present no one doubts that it belongs to the cycle of Distoma; and the only link in the metamorphosis of that genus which was not known is now supplied, since, as I have stated above, the embryo which is hatched from the egg laid by the perfect Distoma is found to be an Opalina."

"All this leads to the conclusion that a division of the animal kingdom to be called Protozoa, differing from all other animals in producing no eggs, does not exist in nature; and that the beings which have been referred to it have now to be divided, and scattered, partly among plants, in the class of Algæ, and partly among animals, in the classes of Acephala, (Vorticellæ,) of Worms, (Paramecium and Opalina,) and of Crustacea, (Rotifera); the Vorticellæ being genuine Bryozoa, and therefore Acephalous Mollusks; while the beautiful investigations of Dana and Leydig have proved the Rotifera to be genuine Crustacea, and not worms."

In these passages it will be observed that much which cannot be accepted is blended with statements of facts long since admitted to be true, and thus a certain degree of plausibility conferred upon the whole.

Few, indeed, will deny that the Desmidia, Volvocinæ, and several other organisms referred by Ehrenberg to his Polygastrica, are true Algæ. That many of the Enterodela may yet prove to be embryonic forms seems also highly probable. To conclude, however, that all the Infusoria, with the exception of the Vorticellidæ, may thus readily be disposed of, appears at best a somewhat hasty mode of removing difficulties, the solution of which must depend on a long series of patiently conducted embryological inquiries. Because two or three forms of supposed Infusoria are shown to be stages of development in the life-history of certain worms, it by no means follows that all remaining Infusoria are to be likewise so regarded. Nor does the careful examination of such a genus as Pedicellina, which of all the Bryozoa most closely approaches Vorticella in form, strengthen the opinion entertained by Prof. Agassiz of their mutual relationship, but is rather decidedly opposed to it.

The assertion that Rhizopoda have not yet found "a place generally acknowledged as expressing their true affinities," would scarcely lead the reader to suppose that Brown, Carus, Gegenbaur, Siebold, Vogt, Van Beneden, Gervais, and many other zoologists, agree in referring them to the type of Protozoa. And he who reads with care the memoirs of Carpenter and Williamson on the shelly structure of the Foraminifera, will scarcely be disposed to call in question their animal nature, or liken the highly complex frame-work of Peneroplis or Polystomella to the stony frond of a Melobesia, in every essential respect so different. Still less does the sarcode substance of the Rhizopods and Sponges resemble, in its vital endowments, the viscid contents of the vesicles of Fuci. Lastly, it is incorrect to state that the Protozoa, as a group, are distinguished from other animals in producing no eggs, since, even so far back as 1851, the existence of true ova was conclusively demonstrated in the genus Tethya.

Those who refuse to admit the Protozoa within the animal kingdom are bound legitimately to solve the question which they have raised as to their true systematic position. Professor Agassiz, as we have seen, adopts the ready expedient of banishing the majority of the group to the vegetable kingdom. Botanists, however, refuse to acknowledge the outcasts thus summarily thrust upon them for protection. Our great anatomist, Professor Owen, has proposed to cut short the difficulty, by establishing for their reception a third primary division of the organic world. By him we are informed that—

"The two divisions of organisms called 'plants' and 'animals' are specialized members of the great natural group of living things; and there are numerous beings, mostly of minute size, and retaining the form of nucleated cells, which manifest the common organic characters, but without the distinctive super-additions of plants and animals. Such organisms are called 'Protozoa,' and include the Sponges or Amorphozoa, the Foraminifera or Rhizopods, the Polycystineæ, the Diatomaceæ, Desmidiæ, Gregarina, and most of the so-called Polygastria of Ehrenberg, or infusorial animalcules of older authors."

The "common organic characters" here alluded to have, in a preceding paragraph been defined as follows :—

"Organisms, or living things, are those which possess such an internal cellular or cellulo-vascular structure as can receive fluid matter from without, alter its nature, and add it to the alterative structure. Such fluid matter is called 'nutritive,' and the actions which make it so are called 'assimilation' and 'intra-susception.' These actions are classed as 'vital,' because, as long as they are continued, the 'organism' is said 'to live.'"

Professor Owen then goes on to distinguish between plants and animals thus .—

"When the organism can also move, when it receives the nutritive matter by a mouth, inhales oxygen, and exhales carbonic acid, and developes tissues, the proximate principles of which are quaternary compounds of carbon, hydrogen, oxygen, and nitrogen, it is called an 'animal.' When the organism is rooted, has neither mouth nor stomach, exhales oxygen, and has tissues composed of 'cellulose' or of binary or ternary compounds, it is called a 'plant.'"

To do justice to these definitions, we shall, without alteration of the author's language, present them in the form of the four following propositions :—

1. The *animal* can move; the *plant* is rooted.
2. The *animal* receives nutritive matter by a mouth; the *plant* has neither mouth nor stomach.
3. The *animal* inhales oxygen, and exhales carbonic acid; the *plant* exhales oxygen.
4. The *animal* developes tissues, the proximate principles of which are quaternary compounds of carbon, hydrogen, oxygen, and nitrogen;

the *plant* has tissues composed of cellulose, or of binary and ternary compounds.

With these may be compared the subjoined parallel considerations:—

1. The Corynidæ, Sertularidae, and many other undoubted animals, are fixed to foreign supports, that is, rooted, just as Laminaria and most sea-weeds are rooted. The common Duckweed is not rooted: is it, therefore, not a plant (?)

The Tœniadæ and Acanthocephala have neither mouth nor stomach. The males of Rotifers are in a similar predicament. Are such organisms plants?

3. Plants exhale oxygen, it is true; but they also, like animals, exhale carbonic acid. The experiments of Saussure are conclusive upon this point.

4. Every plant contains nitrogen in its tissues. According to the analysis of Chevandier, wood yields from 0·67 to 1·52 of nitrogen. And in an approved Manual of Chemistry we read,

> "That certain of the azotised principles of plants, which often abound, and are never altogether absent, have a chemical composition and assemblage of properties which assimilate them in the closest manner, and, it is believed, even identify them, with the azotised principles of the animal body: vegetable albumen, fibrin, and casein, are scarcely to be distinguished from the bodies of the same name extracted from blood and milk."

And in the tests of Ascidians, a deposit of cellulose takes place, precisely after the manner of its formation in the tissues of plants.

So much, then, for Professor Owen's distinctions between the animal and vegetable kingdoms. They prepare us to understand his implied definition of the organisms included in his new kingdom of Protozoa. These "manifest the common organic characters," or, in other words, perform the vital act of nutrition, "but without the distinct super-additions of plants and animals." It follows, therefore, as a necessary inference from the quotations above made, that the anomalous beings in question neither move nor are rooted, but remain in some peculiar physical condition yet to be explained; that they do not receive nutritive matter by a mouth, and, at the same time, differ from organisms which have neither mouth nor stomach; that they neither inhale nor exhale oxygen; and that neither binary, ternary, nor quaternary compounds enter into the composition of their tissues. Such, according to Professor Owen, are the distinctive characteristics of the organic kingdom, Protozoa.

We conclude, however, that a line of demarcation exists between the animal and vegetable kingdoms, and that the Protozoa, rightly so called, have their place on the animal side of the line. The unprejudiced reader of Lieberkühn's careful memoirs can no longer remain in doubt as to the animal nature of the Sponges. And it is for him who disputes the vegetability of the Diatoms and Desmids to set aside the long series of observations inaugurated by the positive discoveries of Thwaites and Ralfs. The difficulty of expressing, by definition, the distinctions between plants and animals rests, be it remembered, more on our ignorance than our knowledge. Those who ignore the animality of the true Protozoa may choose between the rival systems of Professors Agassiz and Owen.

[To the courtesy of the author we are indebted for a copy of his paper "On the Distinctions of a Plant and an Animal, and on a Fourth Kingdom of Nature. By John Hogg, M. A., F. R. S., F. L. S., etc. (From the 'Edinburgh New Philosophical Journal,' 1860.)" In this communication, Mr. Hogg gives a general support to the proposition of Professor Owen, to establish a fourth kingdom of nature for those "primary organic beings" whose systematic position is doubtful, qualifying, however, his assent by the statement, that he is not yet "quite convinced of the immediate necessity of doing so, or that it will ever remain —notwithstanding the progress which we hope will continue to be made in physical science—impossible for man to determine whether a certain minute organism be an animal or a plant;" while, at the same time, he ventures to dispute the propriety of the term Protozoa as a designation for a group of beings whose animality is obviously inadmissible. He, therefore, in its stead suggests "the title of the Primigenal Kingdom,

REGNUM
PRIMIGENUM,
(continens)
PROTOCTISTA,
i. e.,

PROTOPHYTA et PROTOZOA."

Mr. Hogg endeavours still further to illustrate his meaning by the addition of a diagrammatic figure, brilliantly coloured. In this graphic representation, the animal and vegetable kingdoms are respectively denoted by "two lofty pyramids," one *blue*, the other *yellow*, arising from a common base of a subdued *green* tint, his allegorical chromatic embodiment of the "Regnum Primigenum;" the whole reposing on a more or less undulating substratum of pale *brown*, which places before the eye, in one bold panoramic projection, the widely extended domain of our great inorganic parent, Earth, the mother of us all.]

Original Articles.

VI.—On Sphærularia Bombi.—By John Lubbock, F. R. S., F. L. S., F. G. S. (With Plate I.)

This very curious creature was first discovered by Leon Dufour, and described by him in the "Annales des Sciences Naturelles" for 1836. He at first supposed that it was a dipterous larva, but soon saw that it belonged to the Entozoa; and as it certainly could not be referred to any other genus, he gave it the appropriate name of Sphærularia.

Von Siebold is, I believe, the only other naturalist who has recorded any personal observations on the subject; and as the remarks of both these excellent observers are very much to the purpose, and at the same time very short, I may, perhaps, be permitted to quote them in full.

M. Léon Dufour's description is as follows:—

"SPHÆRULARIA BOMBI.*

"Teres, albido-pellucida, mollis, filiformis, haud annulata, undique sphærulis vesiculæformibus granulata, antero posticeque obtusa subrotundata.

"Hab. in abdomine Bombi terrestris et B. hortorum. Long., 6-8 lin. J'ai vainement cherché a rapporter ce singulier Entozoaire a quelqu'un des genres consignés dans l'ouvrage de Rudolphi; j'ai cru pouvoir en constituer un nouveau sous le nom de Sphærulaire qui exprime sa structure extérieure. Je l'avais d'abord pris pour une larve de Diptere, mais l'absence de toute segmentation et sa forme cylindrique, me ramenerent a un Entozoaire. Il n'est pas tres greles, puisque sur six a huit lignes de longueur il en a pres d'une de largeur. Il n'offore aucune distinction ni de tête ni de queue, et il est obtus ou même arrondi par un bout ou par l'autre. Toute la surface de son corps est couverte, soit au dessus, soit au dessous, de granulations spheroidales semblables a des vesicules subdiaphanes.

"Je l'ai rencontré plusieurs fois dans la cavité abdominale des especès preciteés de Bombus, en dehors du tube digestif et toujours libre. En Juin, 1833, j'en trouvai deux ensemble dans le meme individu du *B. hortorum*, et cette circonstance me fortifie encore dans l'idée que c'est un Entozoaire."

V. Siebold says ("Müller's Archiv.," 1838):—

"Who would not be surprised at the appearance of the *Sp. bombi*, figured by Léon Dufour, and ask himself in which of the five orders of Helminths this bee-worm should be placed. I have been fortunate enough to find this worm in the cavity of the body of *B. terrestris*, *muscorum*, and *sylvarum*, together with completely formed young ones, and have made out from the form and manner of development of the latter that this parasite can be nowhere better placed than among the Nematoids. Besides which, the formation of the female generative organs corresponds exactly with those of Filaria; but, on the other hand, the rest of the worm presents some peculiarities: its digestive appa-

* Léon Dufour, Ann. Sc. Nat. 1836, 2nd Ser., vol. vii.

ratus differs remarkably from that of the Nematoids, and I could remark no trace of movement in any individual,—all of which were females,—however fresh I examined them: the young ones, on the contrary, moved about in a lively manner. In this animal the interesting occurrence takes place, that the young are entirely unlike the full-grown animal, their skin being quite smooth, while that of the mother animal is studded with vesicular projections, giving to it a very pretty appearance."

The only other original notice of this extraordinary creature which I have met with is a note to Siebold and Stannius' "Anatomie comparée." They say:—

"On ne trouve ni bouche ni anus chez la *Sphærularia Bombi*, et le canal intestinal est remplacé par une série d'utricules allongées, adherentes ensemble, et autour desquelles s'enroulent les organes genitaux."

Except that the series of large cells is double, instead of single, and that one end of the worm is easily distinguishable by the presence of the vulva, these statements are all, I believe, perfectly correct; they still, however, leave a great many points to be ascertained, and it was with a hope of supplying the deficiency that I undertook the subject. My good fortune has been smaller than my hopes; but, though the present memoir is lamentably incomplete, it may not, I hope, be found entirely without interest.

M. Léon Dufour and Von Siebold met with Sphærularia in the four species of humble bees—namely, *Bombus terrestris, hortorum, sylvarum*, and *muscorum*. I have found it in the females of *B. terrestris, lucorum, pratorum, lapidarius, subterraneus, hortorum*, and *muscorum*, which increases to eight the number of species in which Sphærularia is known more or less frequently to reside. The proportion of specimens attacked is, however, very different in the different species, and the parasite appears to be most common in *B. terrestris, lapidarius*, and *lucorum*. Out of thirty-three specimens of *B. terrestris* examined by me in the months of May and June, no less than nineteen—that is to say, more than one-half—contained these parasites. The following table shows the number of bees examined, and the proportion which were affected:—

	No. of large Females examined in May and June.	No. which contained Sphærulari.
Bombus terrestris	33	19
,, lucorum	21	7
,, muscorum	16	1
,, hortorum	13	1
,, lapidarius	12	6
,, pratorum	6	2
,, subterraneus	4	2
Apathus vestalis	7	0

I have not had any opportunity of examining *B. sylvarum*; and it will be observed that *B. muscorum* and *hortorum*, in which the parasite was found by V. Siebold, have only supplied me with a single infected specimen each, out of twenty-nine which I examined.

Neither Léon Dufour nor Siebold say anything about the sex of the infected specimens. All, however, that have come under my notice were large females, and I have never seen a single Sphærularia in a worker or a male.

The worms lie free in the cavity of the body, and are somewhat curled up. The largest number of full-grown females which I ever found in a single bee was eleven, but the usual numbers were from five to eight. The two infected specimens of *B. pratorum*, however, contained only one specimen of the parasite apiece.

Anatomy of Sph. bombi.

FEMALE.

Von Siebold was quite correct in asserting that all the specimens observed by him were females; the males being, as mentioned below, very much smaller in size, and quite different in form and appearance. The full-grown females, as they are met with in May, June, and July, are nearly an inch long, more or less curled up, white in colour, sometimes opaque, sometimes more or less transparent, and of equal thickness from one end to the other, being everywhere about $\frac{1}{15}$th of an inch in diameter. The whole surface is covered with button-like projections, Pl. 1, Fig. 1, from which the very appropriate generic name is derived. These buttons are situated at equal distances from one another, and are of more or less equal size; each one is from $\frac{4}{1000}$ths to $\frac{7}{1000}$ths of an inch in diameter, and the intermediate spaces are a little smaller. There are, therefore, 10 longitudinal, and about 80 transverse rows, making, in all, about 800 of these projections; and each of them projects from $\frac{4}{1000}$ths to $\frac{6}{1000}$ths of an inch above the general surface of the body.

Generally these spherules are nearly as transparent as the rest of the skin; here and there, however, some of them are rendered quite opaque by the presence of innumerable, minute, greenish, elliptic bodies, each about $\frac{1}{3200}$th of an inch in length, by $\frac{1}{10000}$th of an inch in breadth. These darkened spherules are comparatively few in number, only one here and there being affected in this manner, except round the vulva, where from eleven to fourteen were generally in this condition. No other Nematoid worms have wart-like projections so much developed; many species, however, have, on particular parts, and especially in the male sex, buttons, much less than, but doubtless homologous with, those which are so much developed in Sphærularia, and have suggested for it a name so characteristic. Léon Dufour and Siebold considered the Sphærulari from the different sorts of humble bees, as belonging to one species; and all the specimens which have come under my notice have been very similar to one another, and have presented no differences of specific value. One specimen, however, was a little narrower than the rest, and more transparent; the buttons, also, were smaller than usual, and the body tapered a little towards the end which contains the vulva.

In turning to the internal anatomy, one can, with reference to some highly important organs, and systems of organs, only parody Van Troil's celebrated chapter on the snakes in Iceland, and say simply that there are in Sphærularia, no muscles, no nervous or circulatory systems, and no intestinal canal.

A priori it would seem almost impossible that an animal could exist without these organs. Muscles, however, would be useless, or even destructive. So long as the Sphærularia remains quiet, the Bee does not seem incommoded by its presence, which perhaps produces scarcely any abnormal sensations; but if the parasite, being so large in proportion to its victim, were to move about, it would probably so affect and disarrange the viscera of the Bee, that the poor insect would be quite unable to pursue its usual avocations, and would quickly perish. The female Sphærularia being thus, when full-grown, reduced to a merely vegetative existence, the nerves of motion and of sensation must, of course, be useless, and would soon become atrophied. Under these circumstances, however, it might have been expected that the digestive organs and their nerves would have been highly developed. That, on the contrary, these organs are also absent, is probably to be explained by the fact that the animal is bathed on all sides by the blood of the bee, and thus lives in a medium which is highly organized, and requires, probably, scarcely any further elaboration.

Moreover, although this absence of certain important parts is carried to an extreme in the present animal, we find in other Nematoids a considerable approach to the same condition. Indeed, until within the last few years, we had scarcely any reliable knowledge of the nervous system in any of the Nematoids; lately, however, it has been figured and described at length in several genera, as, for instance, in Strongylus, Ascaris, Oxyuris, Gordius, and Mermis; but even in Van Beneden's Prize Memoir, "Sur les Vers Intestinaux," the nervous system is scarcely so much as mentioned; and it seems very doubtful whether the filaments referred to by Meissner in Mermis as nerves, do not rather belong to the muscular system; while the so-called supra-œsophageal ganglion is asserted by Schneider to be really the œsophagus.

In the Nematoids generally the intestinal canal is a straight tube, reaching from one end of the body to the other. In Mermis and Gordius,* however, we meet with a totally different and very abnormal type, which it is unnecessary for me here to describe. It is sufficient to say that, whereas in these two genera there is no stomach, and that, while in Mermis the œsophagus is small, and in Gordius quite rudimentary, I have in the mature female Sphærularia been unable to detect any trace of them at all.

The same is the case with the muscular system. I have often opened the body along one side, and then stretched out the skin. In this manner it may be examined with a high power; but I have never been able to see any structure in the least like muscular filaments. The entire absence of motion confirms this view.

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* The intestinal canal is quite short also in some other worms, as, for instance, in Nemertes.

In fact, the interior of the body is wholly occupied by two relatively enormous organs—the double series of secretory cells, and the ovary.

The former of these extends in a straight line from one end of the body to the other, being attached at the extremities, but otherwise lying loose in the interior. The cells lie side by side, and thus form a double series. Some of them are very large indeed, being even as much as $\frac{1}{11}$th of an inch in length by $\frac{1}{33}$rd in breadth. Others, however, are not above half as long, though they do not differ much in width. They are not arranged with any regularity as to size, so that often a long one lies by a short one, in which case, however, there is no gap; but the series becomes more or less alternate, until, perhaps, another difference brings each two cells again nearly opposite to one another.

Each of the large cells contains a thick fluid, and about seven or eight transparent nuclei, which are of tolerably even size, and about $\frac{8}{1000}$th of an inch in diameter.

A very similar organ to this has been described by Meissner in *Mermis albicans*, where also it consists of a double series of large cells, with nuclei. The large cells, however, are full of oil globules, and the nuclei contain crystals. In *Mermis nigrescens* and in Gordius the fat-body consists of a large number of much smaller cells. In the last-named genera this fat body is continuous, with a very short œsophagus; and I have therefore examined the two ends of it, to see whether the same was true for Sphærularia. I never, however, found anything in the least like the narrow œsophagus and peculiar stomachal sacs of Mermis, nor the small mouth and short œsophagus of Gordius. It seems, however, that this *corpus adiposum* must be considered as homologous with the intestine of the Nematodes, although no central cavity has been formed in it.

The ovary is about four inches and a half in length; it commences near one end of the body, as a fine tube about $\frac{1}{1000}$th of an inch in diameter, and gradually increases to about $\frac{1}{120}$th, after which it slightly diminishes, then again expands into an uterus $\frac{1}{40}$th in diameter, and then finally contracts to about $\frac{1}{90}$th, and opens externally at the extremity of the other end of the body. It lies perfectly free in the general cavity, but near the vulva is connected with the large fat-cells. The female generative organs of Sphærularia differ therefore considerably from those of Mermis and Gordius, both of which have a double ovary connected with the vulva by a short oviduct.

According to Claparède,* in all Nematoidea, the Purkinjean vesicle is the first-formed part of the egg:—

> "Il parait certain," he says, "que chez tous les Nematoides la vésicule germinative est l'élément primaire de l'œuf. Le blastogene n'ayant chez *l'Ascaris mucronata* qu'une largeur d'environ $0^{m}\cdot013$, ne peut comprendre plus que deux vésicules germinatives dans sa largeur. Ces vesicules s'entourent d'une mince couche d'une substance glutineuse et incolore. C'est là le premier rudiment du vitellus. Nous n'avons pas rencontré d'individus chez lesquels les œufs eussent atteint un developpement plus considérable."

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* De la Formation et de la Fecondation des Œufs chez les Vers Nématodes, p. 38.

Leuckart, also, expresses himself in a very similar manner. Meissner, however, as is well known, has given a different, and very remarkable account of the development of the eggs in Mermis. According to him, the eggs commence as a cell with a nucleus; the nucleus divides, and the new nuclei become the germinal vesicles, while the old cell-wall is gradually produced into follicles, into each one of which a germinal vesicle enters. Finally, the follicles are, by gradual constriction, separated from one another; and in this manner a whole festoon of eggs, besides several abortive follicles, originate directly from the modification of a single cell.

Sphærularia offers so many points of agreement with Mermis, that the development of the eggs naturally became specially interesting; and although my observations are very incomplete, I can at least say, that, if the account given by Meissner is correct, there is in this respect, at least, no similarity between the two genera.

At the extreme end of the ovary I found a large cell with a nucleus. Following this cell are a great number of small vesicles, which much resemble true nucleated cells. They occupy the whole cavity of the ovary, and each of them is about $\frac{1}{3000}$th of an inch in diameter. These are at first transparent, but gradually become more and more opaque on their inner side, from the deposition of minute yolk globules. The Purkinjean vesicle is also distinctly visible, but I could see no macula. As the ovary widens, the eggs gradually become wedge-shaped, the outer, larger portion remaining clear, so that in this part of the ovary there is a transparent border, with an opaque central axis. This axis, which is known under the name of "rachis," becomes gradually smaller and smaller, being absorbed into the growing egg, which becomes more and more opaque, and assumes a round shape, the Purkinjean vesicle remaining for some time visible in it, and containing a single macula.

When, however, it has entered the wide part of the tube, which we may probably call the uterus, it has again become elongated, and has lost the Purkinjean vesicle, and the yolk has begun to undergo segmentation. Pl. I., *f* 11, represents a very common state of the egg at the beginning of this process: the first two yolk-spheres, each with its nucleus, lie at the two extremities of the egg; and the central part is occupied by a mass of yolk, divided into an uncertain number of irregular masses, which however contain no nuclei, and are not regular spheres of segmentation. Farther down the uterus we find eggs in all stages of segmentation (Pl. I., *f.* 13); and in several instances I could distinctly see the nucleus dividing, as in Pl. I., *f.* 12, in preparation for the next division of the yolk. The segmentation is already far advanced when the egg is laid, but I never found in the uterus any eggs with a fully developed embryo.

I noticed a few specimens in which all the eggs near the vulva were broken up into irregular masses, and in one specimen this was even carried so far, that it began when the eggs were only about half grown. In normal eggs, the development of the young takes place in the manner usual among Nematoids.

The young animals are born soon after the eggs are laid. They are about $\frac{1}{60}$th of an inch in length, and $\frac{1}{2500}$th in diameter at the broadest part. They are very active; the skin has the appearance of being ringed. The head is pointed; the tail ends more abruptly, and makes a sudden curve. The anterior end of the body is transparent; but the rest is darkened by minute, round, strongly-refracting globules. As soon as the Humble Bees come out in spring, young Sphærulari may be found together with old ones, in some of them. I have met with them from the beginning of May till the middle of July, and the whole abdominal cavity of the humble bee often swarms with these little worms. In order to ascertain roughly what the number might be, I washed out the inside of a bee, and then collected all the young Sphærulari together. I then put them into a measuring bottle, and after shaking up, poured away half of the contents. Repeating this process, until only about a hundred were left, it was easy to calculate what the number must have been, if half had been removed a given number of times, though, of course, no great accuracy was thus obtainable. I repeated this experiment five times, and thence concluded that one specimen contained about fifty thousand young Sphærulari, three about sixty thousand, and one even over a hundred thousand! It seems almost inconceivable that a bee should live with such an immense number of parasites in its body; and still more so, that it should, meanwhile, go about its daily duties as if nothing was the matter.

These experiments, however, give but a faint idea of the number of young to which a single female Sphærularia might give birth. In every case the whole ovary was full of eggs, in various stages of development; and, considering the minuteness of the eggs, and the size of the ovary, the number present must be enormous. If the young worms can in any manner leave the bee without destroying it, there seems no reason why nearly all of these should not succesively come to maturity, and be hatched; but, even supposing that this is not the case, and that in the preceding experiment I have ascertained the greatest, or nearly the greatest number of young Sphærulari which can be produced in a single bee, still the chances against any one of them attaining to maturity must be very great; for it is evident that if the sexes of a given species are equal in number, and if the species is neither increasing nor diminishing, the chances against any given young one attaining to maturity may be obtained by halving the average number of young ones produced by each female.

It would seem, at first sight, that the history of the young Sphærularia was very simple. We might suppose that the infected bees would die in their nests; and that the young worms would then leave them, and immediately eat their way into other bees. This view would also be supported by the fact, that, at least as far as my experience goes, each infected bee contains, on an average, five or six Sphærulari. Two reasons, however, inconsistent though they may appear, militate against this supposition. The first is, that too large a proportion of the young Sphærulari would live; and the second is, that the whole race must soon perish. For, if their history were so simple, there seems no reason why a large proportion of young might not survive; and the species would then continually increase in numbers, which is impossible. This argument is, however, far from conclusive, because the increase may be prevented by disease, or by some enemy. On the other hand, there would, under this theory, be no means by which the parasites could pass from bees of one nest to those of another; so that in each species we should have one race infested by Sphærulari, and another free from them; in which case, it can hardly be doubted that the former race would, in the struggle for existence, gradually be supplanted by the latter, and thus, in time, the Sphærulari would all perish.

That the young Sphærulari can live some time after leaving the body of the bee, and without entering any other animal, I ascertained satisfactorily. On the 25th of last May I took some from the body of a *B. lucorum* and put them in water, where some of them remained alive until the 9th of August, though, during the latter part of the time, they were far from lively. In this case, therefore, they lived in water for more than ten weeks. Whether they would have lived as long in damp earth, I cannot say, but it seems not improbable; and as we know that humble bees often crawl about on the earth under leaves and grass, they may, in this manner, give the young Sphærulari an opportunity of entering them. I tried to solve this question, by wetting humble bees with water containing young Sphærularias; but, partly owing to the difficulty of keeping these insects in confinement alive for more than a few days, and partly, perhaps, from the difficulty of detecting a single young worm in the abdomen of a bee, my experiments were quite unsuccessful.*

I had hoped to have thrown some light upon this question, and also upon the metamorphosis, by obtaining some specimens in autumn and winter. Up to the present time, however, I have only found them in May, June, and July. This is partly, perhaps, owing to the fact, that large females are most easily obtainable in these months; and it is unlucky for me that the last two years have been very unfavourable to bees—1860, indeed, so much so, that it is said (Zoologist, September, 1860), to have been the worst year for Hymnoptera since 1828.

I have, however, examined eight large females of *B. lucorum* in August, and three in October; two of *B. terrestris* in August, two in September, and two in October; if, therefore, at this season, the Sphærulari were as numerous and as large as in spring and summer, I should almost certainly have found some. If, on the other hand, they were quite small, they may easily have been overlooked.

From all these facts, I am inclined to think that humble bees, when infested with Sphærularia, live for a while as if nothing were the matter; and that only when the young Sphærulari, or the majority of them,

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* I found the best plan was to put the bees in a glass with moist sugar. They seemed also to live longer if put in the dark, probably from the soothing effect upon their nerves. In this manner I kept one bee alive for more than a month.

are hatched, the parasites appropriate to themselves so much of the nourishment belonging to the bee, that the latter becomes seriously incommoded by their presence. As from the misappropriation of its blood the bee became weaker and weaker, it would, probably, feeling its end approaching, crawl into some long grass, or other place of concealment.

As soon as the bee was dead, the young Sphærulari probably work their way out of it, and immediately begin to look out for a new victim. Those who are so fortunate as to meet with a large female, or queen, may enter it, as young Gordii have been seen to enter other insects, but do not, in all probability, increase much in size at first. This I infer, firstly, because I have not found Sphærulari in autumn, but principally because they would in this case be much less injurious to the bee than if they immediately began to increase in size. When the spring commences, the female Sphærularia probably begins to grow rapidly, and soon lays eggs. I am inclined to think that young Sphærulari also occur in workers, and that I have overlooked them on account of their minuteness; since there seems no reason to suppose that the young Sphærulari have sufficient intelligence to distinguish Queen Bees from workers, or even from other insects.

M. Fabre, who has so graphically described (Ann. des Sc. Nat., 1858) the extraordinary series of adventures through which the young of Meloë attain to maturity, found that, though their only chance of life was to attach themselves to Anthophora, or to its parasites Melectes and Cœlioxys, yet they were equally ready to spring on other insects, or even on pieces of straw, if brought within reach, though, curiously enough, they seem, according to M. Fabre, to gain wisdom by experience, and not to be so easily duped a second time:—

"Il est vrai," says M. Fabre, "qu'arrivés sur ces objets inanimés, ils reconnaissent bientot qu'ils ont fait fausse route, ce que l'on voit aisément á leurs marches et contremarches désesperées, et a leur tendance à revenir sur la fleur s'ils en est encore temps. Ceux qui se sont aussi jetés étourdiment sur un bout de paille, et qu'on laisse retourner sur la fleur, se reprennent difficilement au même piége. Il y a donc aussi pour ces points vivants une mémoire, une experience des choses!"

I have not myself had any opportunity of repeating these experiments; but some months ago, being on a geological excursion in a sandpit, where there were few, if any flowers, I was surprised to see on a herbaceous plant several yellow *flowers* with which I was quite unacquainted. On gathering one or two, however, my surprise was increased, when the supposed flower broke up, and ran away, turning out to consist entirely of small, yellow larvæ. Unfortunately I had neither bottle nor pillbox with me, and was unable to carry any specimens home; but it occurred to me at the time that they were young Meloës; and that, in the absence of any flowers near them, they had in this manner attempted to supply the deficiency. I was certainly completely taken in; and as I think that my eyes are better than those of most bees, I have little doubt that they also would have fallen into the trap.

MALE.

All the specimens met with by V. Siebold, and all the large ones which I have seen, were females. I observed, however, in the second specimen which came under my notice, that there was a small nematoid worm attached to the large female, Pl. 1, *f.* 1, A, near to the end in which lies the free extremity of the ovary. This minute worm was apparently overlooked both by Léon Dufour and V. Siebold; or, if they saw it at all, they probably mistook it for one of the ordinary young ones. It is always, however, in very close connexion with the female, the skins of the two being firmly attached to one another; and, if the small worm is torn away, there is a sort of rent at the spot where the attachment takes place. On the other hand, we know that in many nematoid worms the male is much smaller than the female, and the two are, during copulation, closely connected together; in *Syngamus trachealis*, indeed, this is so much the case, that the pair have been mistaken for a single animal. Moreover, although the small attached worm in Sphærularia is not altogether exactly like the ordinary young ones, still, in size and general appearance, it remarkably resembles them; and, lastly, unless we may regard it as being the male, that sex is, as yet, entirely unknown. Although, therefore, I have not been able to distinguish any generative organs, or trace of spermatozoa, I think that I am justified in considering that in Sphærularia the male is far smaller than the female, and that the two are fastened together in a certain definite manner and position. The shape of tail is also quite different from that of the larva; in Pl. 1, *f.* 6, I have represented one of the young worms; and in *f.* 7, one of the attached specimens; and it will be seen that the tail is quite dissimilar, being straighter, and more pointed in the latter. Of what nature, then, is this minute worm, and what are its relations to the large female Sphærularia? Three possibilities only occur to me, viz.: that it might be the larva, a parasite, or the male.

There is, however, no instance in the Nematoidea of any such mode of metamorphosis; and the little creature, though quite motionless, looks too fresh and transparent to be merely the shrivelled-up skin of the young. The difference of shape just alluded to, also, militates against this view, which is, I think, quite untenable.

Nor is the parasitism of the little creature a more probable supposition. In the first place, the almost, if not quite, invariable presence of the little worm speaks against it; and, secondly, the mode of its attachment is almost equally conclusive, as no Nematoid worms are external parasites.* Moreover, it is evident that this little worm must perish at the same time as, or soon after, the Sphærularia, and it is equally clear that in the month of July this latter has not long to live; if, therefore, the

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* It might, however, be said, that as this law arises from the necessity that the external surface should be bathed by animal fluids, the present case might be an exception caused by the fact that the little worm, though external to the female Sphærularia, was internal as regards the Bee.

small worm was a different species, we ought to see in it eggs in course of development, which, however, I have never found to be the case.

The extraordinary disproportion in size between the sexes, though an extreme case, is not entirely without analogy in the animal kingdom. Nordmann first ("Micrographische Beitrage," Pt. 2—see also Huxley's Lectures, "Medical Times and Gazette," August 22nd, 1857, p. 187), discovered that in certain Crustacea the males are much smaller than the females. This is the case, principally, in the genera Actheres, Brachiella, Chondracanthus, and Anchorella, in which the minute male may generally be found attached to the female in the neighbourhood of the vulva. The minute and "complemental" males, discovered by Mr. Darwin in the genera Scalpellum and Ibla, afford cases in point from among the Cirripedia.

In spite, however, of analogies pointing in the same direction, one cannot but be astounded at the existence of a species in which, as in the present, the male is more than twenty-eight thousand times smaller than the female, which, if we may so say, *belongs* to it.

I was not able very satisfactorily to ascertain the manner in which the two are fastened together; but it seemed as if the large worm had a small sac-like depression of the skin, Pl. 1, *f.* 14, into which a corresponding projection of the small one closely fitted. The inner contents of the body passed into the projection, but I could not perceive any penis or spermatozoa, nor was the ovary of the female connected with the place of attachment. The two creatures adhere together more closely than this condition, taken by itself, could account for; and, as in the somewhat similar case of Syngamus the union is effected by the presence of a sort of cement, it was natural to suppose that the same might be the case here. Neither Mr. Busk, however, who was kind enough to look at the junction, nor I, could see any trace of cement; and it is evident, therefore, that if the two skins are not continuous, they are, at least, perhaps by long contact, very closely united to one another.

Considering all these facts, there seems every probability that in this little creature we have the male Sphærularia; but until the Spermatozoa and the transformations are known to us, the fact cannot be regarded as being conclusively established.

It only remains for us to consider the natural position and affinities of Sphærularia, though it will not be possible to come to any satisfactory conclusion until we know more of the anatomy and development of the young. It is, of course, evident that Léon Dufour was right in placing it among the Nematodes; but when that order was limited by the separation of the Gordiacei, it is not so clear that it is correct to leave Sphærularia in its former position. The principal differences between the two orders (Siebold, "Anat. comp.," t. i., p. 113), as given by Siebold, are that the true Nematodes possess an anus and an organ for copulation, while in Gordiacei the one is always, and the other sometimes, wanting. According to both these characters, Sphærularia would belong to the latter order, in which, accordingly, it is correctly classed by Diesing and Meissner, although V. Siebold, Rudolphi, Owen, and other helminthologists, class it with the true Nematodes. The absence of an organ is, however, not generally so important a character as its structure: thus, for instance, we see in insects, that the absence of wings is less significant than are the differences in their structure, so that we have wingless representatives of all the large orders. The characters which induce us to separate Sphærularia, Gordius, and Mermis, from the Nematodes being principally negative, are not to my mind quite satisfactory. Schneider differs also so much from Meissner as to the anatomy of Gordius and Mermis, that it will be necessary to say a few words on this subject, before considering the affinities of Sphærularia. The so-called supra-œsophageal ganglion of Mermis he denies to be a portion of the nervous system at all, and considers it rather to be an œsophageal bulb, homologous with what is found in many Nematodes. If this be granted, the principal argument in favour of the nervous nature of the so-called peripheral nerve-system falls to the ground, and with it one of the principal differences between Sphærularia and Mermis. While, however, we know nothing about the nervous system of Sphærularia, and are in such a state of uncertainty as to that of Gordius and Mermis, it is evident that we cannot avail ourselves of it for the purposes of classification. Meissner's extraordinary account of the digestive organs in Mermis is well known. According to him, the œsophagus is open along one side, thus constituting a trough rather than a tube, which sends out from time to time lateral branches, each of which terminates in a spherical cavity, which he calls a stomach-cell. According to Schneider, however, the œsophagus is a closed tube, and the "stomach-cell" is only a round, firm body, containing a nucleated structure, but without any central cavity, or any communication with the fat-body. This "fat-body" is probably homologous with the intestine of ordinary Nematodes, but no cavity has been developed in it; and while Meissner describes thirty connecting tubes between it and the œsophagus, Schneider denies that any such junction takes place; the two organs lie side by side, but have no communication with one another.

Schneider exemplifies this by the case of *Ascaris rigida, R.*, in which the œsophagus opens, not at the anterior end, but at the side of the intestine. If, he says, this condition were exaggerated, and the lateral connexion removed, we should have exactly the case of Mermis. In *Mermis albicans* the fat-body consists of two rows of large cells, as in Sphærularia; but in Gordius the cells are much smaller and more numerous, still, however, solidly filling the tube; while in *Mermis nigrescens* the cells are smaller, and only clothe the outer tube, and leave a large central cavity; thus completing the series, and giving us a most interesting gradation, connecting the *corpus adiposum* of Sphærularia with the ordinary intestine of any common Nematode. This *corpus adiposum*, therefore, is homologous, not with the whole intestinal canal of Nematodes, but only with the intestine; and we find, in fact, that in Gordius the œsophagus is very short, and opens at once into the anterior end of the *corpus adiposum;* so that, to pass from this genus to Sphærularia, it would only be necessary to shorten the œsophagus a little more, and then the wall of the *corpus adiposum* would be immediately attached to that of the body. So far, therefore, as concerns the *corpus adiposum* and the œsophagus, Sphærularia agrees neither with Gordius nor Mermis, nor indeed with one more than the other, since, if it agrees with *Mermis albicans* in the double series of large fat-cells, it has no œsophagus, and in this respect more nearly resembles Gordius.

Sphærularia agrees with Gordius in the possession of a terminal vulva, but differs both from that genus and from Mermis in having only a single ovary. As regards the development of the young, Sphærularia resembles Gordius in undergoing a metamorphosis; but with this remarkable difference, that whilst the former begins with the filiform or Nematoid condition, the latter ends with it. Mermis, on the other hand, undergoes no metamorphosis; in all stages of development this worm, like the embryo of Sphærularia and the adult of Gordius, is filiform and Nematoid; so that we may say of the three genera, that the metamorphosis is progressive in Gordius, absent in Mermis, and retrogressive in Sphærularia.

On the whole, it is, I think, evident that Sphærularia constitutes a group equivalent to Gordius or Mermis, and indeed farther removed from them than they are from one another. Omitting, then, those points as to which, from the imperfection of our knowledge, no conclusions are at present attainable, we shall get the following as the principal characteristics of the three genera:—

Mermis albicans.—Skin partially covered with papillæ. Œsophagus long, contained in an outer tube, within the outer membrane of which is a series of nuclei, at sub-equal distances. No intestine or anus. Organs of excretion three in number, and occupying the ventral and lateral lines of the body. Ovary double; vulva opening at the middle of the body. No metamorphosis, the young being filiform. Males of moderate size, free. Spiculæ two in number.

Gordius.—Skin smooth, or in part provided with short spines. Œsophagus very short. *Corpus adiposum* containing several series of cells. No intestine nor anus. Ovary double; vulva terminal. Metamorphosis progressive, the young not being filiform. Males of moderate size, free. No spiculæ.

Sphærularia.—Skin covered with spherules. Œsophagus wanting. *Corpus adiposum* consisting of a double series of large cells. No intestine nor anus. Ovary single; vulva terminal. Metamorphosis retrogressive, the young being filiform. Males very minute, attached to the females. No spiculæ.

Thus, then, we see that Gordius and Mermis differ very materially from one another, while Sphærularia departs even more from the common type, and indeed agrees with the other two in little except the absence of an anus, and the very peculiar *corpus adiposum*. M. Schneider is therefore, no doubt, right in proposing to divide the Gordiaceæ into two families, to which we must now add a third—Sphærulariaceæ, for the genus Sphærularia. For the present we must leave the characters of these families to be the same as those of the genera. The arrangement of the cells constituting the corpus adiposum, the relative size of the males, and the position of the vulva, will probably, however, be found somewhat variable, and are perhaps characters of not more than generic importance; in which case the arrangement of the nervous system, the presence or absence of an œsophagus, the presence of a single or double ovary, and the development of the young, will, with the absence of the anus, remain as the principal family characters.

I shall endeavour to get some humble bees in the course of this winter, in order if possible to determine some of the many points which yet remain to be ascertained; and I should feel very grateful to any one who would send me even a single specimen of any species of Bombus between the months of December and April. In the meantime, Sphærularia still remains, as it was when Diesing wrote the "Systema Helminthum," a "genus inquirendum."

DESCRIPTION OF PLATE I.

1. *Sphærularia bombi* × 15. A. Small male.
2. Part of corpus adiposum × 10.
3. Free end of ovary × 250.
4. Two young eggs with rachis × 250.
5. Portion of ovary × 250.
6. Outline of young × 60.
7. Outline of male (?) × 60.
8. Head of male × 60.
9. Tail of do. do.
10. Ovary ×
11. Egg, showing the commencement of segmentation, × 250.
12. Do., in a more advanced stage, × 60.
13. Young egg, still more advanced, × 250.
14. Place of union of male and female × 250. *a.* Part of the body of male. *b.* Part of skin of female. *c.* Projection of male fitting into sac-like depression of female.

VII.—On an Organ in the Skate which appears to be the homologue of the Electrical Organ of the Torpedo. By Robert M'Donnell, M. D., F. R. C. S. I., Lecturer in the Carmichael School of Medicine, Dublin.

In the eyes of those who look without prejudice on the theory of descent with modification, the tracing out of homologies has, in recent times, been invested with a new interest. On this theory, the comparative anatomist no longer, in following out the homological relations of parts and organs, pursues an object, captivating, but fruitless, as fascinating as the solving of a puzzle, but barren as to general results.

On the other hand, the candid inquirer must admit, that when in some creatures well-developed special organs exist, while in their immediate kinsfolk (if I may use the term) no trace of kindred structures has been discovered, there herein exists a grave objection to any theory of unity of type resulting from community of descent. This difficulty appears to have been more obvious to Mr. Darwin than to most of the reviewers who have undertaken to criticize his views, or at least has been more clearly and fairly stated by the former than by the latter; and he speaks of the case of the electrical organs of fishes as one of special difficulty.

The presence of modified, atrophied, or rudimentary organs, constitutes one of the strongest arguments in favour of Mr. Darwin's theory; for the supposition is as unsatisfactory as it is improbable, that such organs are the result of what would seem a whimsical exercise of creative power in framing an organ merely for the sake of symmetry. The total absence, however, of any trace of even an altered or rudimentary organ representing a structure known to exist in certain members of a group, would afford good testimony against the theory of descent; as it would be at least in the highest degree improbable that such a structure should not have its homological representative existing in some form in the immediate members of the same family.

Considering, therefore, that on the theory of Mr. Darwin it was in the highest degree improbable that the electric organs of the Torpedo were totally absent in the Skates, I undertook a careful search, with the view of following out their homologies, determining to do so by tracing the nerves corresponding with those which go to supply the batteries of the Torpedo. I have thus been led to make out the bodies which I conceive to be the true homologues of the Torpedo's wondrous organs; and the anatomical position and peculiarities of which I shall briefly point out. If the skin be removed from the fore part of the back of a common Skate, the following parts will be readily found, a short distance behind the temporal orifice:—1st. That band of the so-called muciferous tubes which runs inwards and a little backwards from a point external and anterior to the gills; 2nd. The dorsal aspect of the branchial chambers; and, 3rd. The little snout-muscle, which ends in a long delicate tendon, running forwards. Let the little fleshy belly of the snout-muscle be raised and drawn outwards, and the band of tubes dissected up and drawn forwards, in the angle between them will be found the body sought for; it will not, however, be very apparent to the naked eye; but if brushed over with some tolerably strong acetic acid, it will become quite distinctly visible. It will be found to be more than an inch long in an ordinary sized fish, wedged in between the occipital muscles internally and the gills externally, covered superficially by the snout-muscle and tubes already mentioned, and dipping down so as to reach the branches of the vagus going to the branchial arches. Its upper surface is triangular, the apex behind the base in front, in contact with one of the large jaw muscles. When made evident by the aid of acetic acid, this little body is seen to consist of a number of quadrangular and pentangular masses, of minute size and rather irregular form, packed closely together like a mosaic work, arranged vertically, and somewhat resembling a small conglobate gland in appearance. Examined microscopically, it is found to consist for the most part of an abundant, soft, yellowish substance, composed of minute round granules, nearly all equal in point of size, and apparently devoid of nuclei. This granular matter is entangled in an abundant areolar texture, in which, when washed several times, there are to be discovered peculiar nucleated bodies, large, and varying considerably in dimensions, which are at first obscured by the granular matter, and seem to be more or less intimately connected with the small nervous ramifications. Neither when viewed by the naked eye, nor by the aid of the microscope, does this organ in the least resemble the tail electric organ discovered by Stark. Unless the peculiar nucleated bodies already mentioned (and which form indeed a very small part of the mass) be regarded as a modified condition of it, nothing like the "tissue electrique" of Robin exists in the body I have described, while the tail-organ is almost entirely made up of this tissue (Kölliker's Schwamm-Körper).

The nerves supplying the little body which I have described are, first, minute filaments derived from the branches of the vagus going to the gills; and, secondly, a larger one, derived from the posterior branch of the fifth pair, which takes the following course:—If the large branch of the fifth, which is found under the skin immediately behind the temporal orifice, be followed backwards, it will be seen, that after escaping from the cranial cartilage, it gives a branch backwards, which enters the muscle behind it, and, supplying this muscle with several twigs, passes through it to reach the body in question, which it supplies, also giving a little twig to the snout-muscle which covers it.

On carefully inspecting this large division of the fifth pair, the difference of colour is quite obvious between that portion which is destined to go to the ampulla, from which the so-called muciferous tubes take rise, and that portion destined for the muscles; nor is it uninteresting to observe, that the branch going to the supposed homologue of the electric organ is derived from the latter. I need not say that it would be quite impossible to trace so minute a nerve so as to find out whether, at its origin, it may be related to the anterior or posterior columns of the cord; but the fact mentioned tends to support the view that it is related to the motor tract.

As the lateral line system exists in the torpedo and other electric fish, in a rather remarkable condition of development, the opinion held by some authors may be set aside, that it in other fishes represents the electric organs; the same may be said for the so-called muciferous system of rays and sharks (which Geoffroy St. Hilaire conceived to represent the torpedo's batteries), inasmuch as this system also co-exists in the torpedo with the electric organs.

That the tail-organs already spoken of, as discovered by Stark, and since so well anatomised by Goodsir, Robin, Leydig, Ecker, Remak, and Kölliker, and more recently by Max Schultze, are not the true homologues of the electric organs of the torpedo, their position, their structure, and nervous supply, lead me to suppose. Indeed, in so far as this last is concerned, it indicates rather an homological relation with the batteries of the gymnotus, which further research may more fully establish. In alluding to the tail-organs of the skate, I may observe, that in the dog-fish I have found, both in the embryo and the adult, what I conceive to be those organs, in an atrophied condition. They give rise to slight eminences, prolonged from near the vent to the tail; and, on transverse section, are seen like narrow chinks in the corion, quite separated from the muscles.

It may occur to some, as it did at first to myself, that the organ which I have described in the skate may represent the "appareil folliculaire nerveux," noticed by Savi, and by him stated to exist only in the electric rays. I think, however, that this apparatus is clearly an appendage of the so-called muciferous tube system; and, agreeing with the views of Leydig, that these appurtenances of the fifth pair are tactile organs, it does not appear that there is any sufficient reason to consider that any homological relation exists between the "appareil folliculaire nerveux" and the bodies in question. In the electric rays which I have examined, I have not found the body which I regard as the homologue of the electric organ; this fact, indeed, taken along with the consideration of the sources from which the nerves of the organ are derived, are the chief points on which the notion rests, that it may be the homologue of the electric organ at all; but one also cannot help observing in its position, with reference to the band of muciferous tubes, the lateral line, the temporal orifice, and the posterior branch of the fifth pair, evidence in support of the same idea. In stating, however, that the organ is absent in the electric rays (or, at least, only represented by their batteries), I should say that I cannot positively assert this; for the torpedos which have come into my hands have all been partially dissected, and it is possible that the body alluded to may have been removed. I may beg of naturalists who have opportunities of doing so to determine this point with certainty.

VIII.—Notes on the Anatomy of the Alimentary System of the Axolotl (Siredon Mexicanum). By E. Perceval Wright, A. M. Dub. and Oxon., M. B., F. L. S., Lecturer on Zoology, University of Dublin (with Plate II.).

The earlier investigators of the anatomy of the axolotl appear to have regarded it as a larval form. This, some of them, as Rusconi, did, judging merely from its external appearance; others, as Cuvier, even after a somewhat minute investigation into its anatomy.

Hunter, it is true, was convinced that they were adult forms, and merited but little the censures passed upon him by Rusconi, who, from constantly studying the salamanders and their metamorphosis, dogmatically refused to believe in the existence of a persistent larval form among the Amphibia. I think, however, it is more than probable that Cuvier's memoir on "Doubtful Reptiles," published in Humboldt's Recueil d'Observations de Zoologie,* was seen by Rusconi, or at least heard of by him, as it was read before the French Institute, as early as January, 1807; and this great anatomist insists so strongly on axolotl being a larval condition of some salamander, and saw so many things in its anatomy that he says strengthened him in this opinion, that it is really no wonder the Italian salamander-observer, feeling himself so strongly supported, indulged in a rather contemptuous laugh at our great English anatomist. Cuvier's account of the visceral anatomy is so short, that we venture to subjoin it here; it will be found at page 109 of the work referred to, and is illustrated with several plates. With the greatest deference to the memory of one of the greatest of modern anatomists, and the author of the "Memoirs of the Mollusca," a work which exhibits a wonderful skill in minute dissection, yet I have never met with an anatomical description which seems so decidedly written to prove a foregone conclusion. Cuvier thought axolotl a larval form; through the kindness of Humboldt, he was given specimens, from the anatomy of which much was to be proven; and yet we read such statements as that the "spleen is very small, and in the middle of the mesentery;" that the "oviducts were so very delicate, that one could perceive them with difficulty;" with what justice these facts, tending to prove an immaturity of condition, are stated, will be seen a little further on:—

"In axolotl," writes Cuvier, "the œsophagus is short, plicated longitudinally, and is continuous with the stomach; this latter is large, membranous; the forepart is a little plumpish, but towards the pyloric orifice, it is much contracted. I found it full in the two specimens (examined) of small fresh-water crustacea, strongly resembling our native ones. The animals had swallowed these without masticating them; and their legs were found undigested down as far as the rectum.

"The intestinal tract is tolerably large; more especially the portion nearest the liver, and tolerably long; it consists of two principal loops, and is furnished neither with a cœcum nor internal valve of any kind.

"The liver is rectangular, and without any deep lobes. I could not detect the presence of a gall-bladder.

"The spleen is very small, and is placed in the middle of the mesentery; this latter is as we find it in the ordinary salamanders. Indeed, all the intestines are just those of a salamander.

"The ovaries are very small, flabby, and contained hardly a trace of ovæ. They occupied the same place, and are furnished with the same greasy appendages that are found in the common salamanders. Again, the oviducts are so delicate (si frêles) that one can scarce perceive them.

"From all these marks of immaturity, and that intimate resemblance which all the viscera bear to those of the salamander and their larva, I conclude that the Mexican axolotl is but the larva of some huge salamander, perhaps the same that is alluded to by Michaux."

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* "Recueil d'Observations de Zoologie et d'Anatomie comparée faites dans l'Oceán Atlantique, dans l'intérieur du Nouveau Continent et dans la Mer du Sud, pendant 1799, 1803." Par Al. de Humboldt et A. Bonpland. 1er volume. 1811.

Before proceeding to treat of the alimentary canal, I may take this opportunity to refer to a paper by Sir Everard Home, in the Philosophical Tranactions for 1824, "On the Generative Organs of the Mexican Proteus." The paper itself, so far as anatomy is concerned, contains little that is noteworthy. The specimens dissected were discovered by Bullock, in a lake three miles above Mexico—this lake being some 8000 feet above the sea level, and of 60° of temperature. Those taken at Lesenco are brought by the peasantry to the Mexican markets in thousands, in strings of from sixty to seventy each. This paper, however, is illustrated, and the artist has done his work, and done it well; and his master has given names to the different parts figured. From a careful comparison of the plates representing the organs of generation in the male and female axolotl, with my own preparations, I am prepared to acknowledge the very general correctness of these fine drawings. The organs in the female, in an immature state, are likewise figured; and the ovaries are neither so small, even in an unimpregnated condition; nor the oviducts so delicate as to afford any difficulty in seeing them, to an ordinary investigator; even the kidneys and urinary bladder (?) are quite perceptible to the most careless observer.

On opening the walls of the abdomen, from the junction of the pectoral muscles to the curious cloacal aperture, and turning back the muscles, the following viscera are seen (*vide* Pl. II., fig. 1),—First, the large and well-marked liver, slightly divided into two lobes by the entrance of the suspensory ligament; next the convolutions of the intestines, ending in the strongly-marked straight rectum; on each side of which we find two glandular bodies—the supposed Cowper's glands of Sir Everard Home; above these, and below the coils of intestine, the apices of the kidneys are to be seen. If we now remove the left lobe of the liver, we will discover the stomachal portion of the alimentary canal of an elongated shape—the œsophageal portion, as Cuvier says, a little plumpish and enlarged, and the pyloric end much contracted. But we also have no difficulty in finding a glandular organ, closely attached to the middle-third of the stomach, and tied down to it by a mesenteric attachment (*vide* Fig. 2), which is the spleen—said by Cuvier to be placed in the midst of the mesentery, and to be very small. In Fig. 2 it is represented of the natural size. At a short distance below the junction of this gland with the stomach, the intestine contracts, and twists upon itself. There is no true pyloric valve, but this turn in the intestine to all intents and purposes acts as one. The intestine next proceeds towards the liver. This organ is large, its upper surface concave, its lower convex; it is divided by the suspensory ligament, which attaches it to the walls of the abdomen, into two lobes; in the adult male it is of a dark brownish colour, mottled; it overlaps the stomach and portions of the small intestine. The right lobe is the larger, and is slightly notched on its outer free margin, to receive the well-developed gall-bladder, which, though not mentioned in the text by Cuvier, is very imperfectly figured in one of the Plates;* when inflated, it is pyriform; in the empty condition, it assumes the outline of the liver (see Plate II, Fig. 3). The biliary ducts open into the intestine, just where it is connected with the liver, by a common duct.

The small intestines make two principal convolutions, and are kept in their place by a well-developed mesentery. I could detect no trace of a pancreas. As the intestine approaches the rectum, it becomes excessively narrow, and at last ends almost by intussusception (Fig. 5); the wide and capacious rectum ends in the cloaca. Before examining the internal structure of these parts, it may be well to compare them with similar organs occurring in the salamanders. For this purpose I have selected *Triton cristatus* and *Salamander maculosa*. So far as the œsophagus and stomach are concerned, the relative size and proportions are nearly similar. The stomach is more pear-shaped in *S. maculosa*. In Triton, the spleen is a small, flat, oval gland, attached to the right side of the stomach by a loose fold of mesentery, but by no means closely so; in Salamander,† it is a long, narrow, ribbon-like body, closely attached to the right side of the stomach. In Triton, the liver is small, but divided into lobes; the gall-bladder is well developed. In Salamander, the liver is rather small in proportion, not much divided, and the gall-bladder is also small. In both Triton and Salamander, the small intestine is very well developed, and in both does it contract as it approaches the rectum, which here, as in Siredon, is much wider than the rest of the intestinal canal.

In the axolotl the œsophagus is short, the mucous surface is longitudinally and finely striated, the external muscular fibres are circular, and act as a sphincter; in the stomach, the mucous membrane is continuous with that of the œsophagus, but here it is thrown into deep folds. The fine striæ of the œsophageal portion are continued; and at what may be considered as the cardiac orifice, these folds of the mucous surface are brought into such close apposition, their dimensions at this spot, too, are so greatly increased, forming four or five little protuberances; as to take the place of a valve and effectually prevent any regurgitation into the mouth. Though there are a few file-like teeth in the upper jaw, yet they serve more for organs of prehension, and cannot be of much use in mastication; and, undoutedly, the process of comminuting the food is mostly accomplished in the stomach.

In this organ, as I have said, the mucous membrane which lines the

* Loc. cit., Plate 12, Fig. 4.

† Here I would observe, that I cannot agree with Schneider, who, in his Natural History of Amphibia, has united the aquatic (Triton) with the land (Salamander) Salamanders; although in both genera the ovæ are impregnated before being laid, yet in the one (Triton), we have the eggs deposited on aquatic plants; the young Tritons, when hatched, retaining their branchiæ for a longer or shorter length of time; in the other (Salamander) we have the oviducts large and capacious, the ovæ are hatched in them, making their exit into the world almost miniatures of their parent. Surely such embryological distinctions point to at least a difference in the general—in the ordinary acceptation of this word—of these creatures.

whole alimentary tract is thrown into a series of very deep folds, which appear to be a continuation of the longtitudinal mucous folds of the œsophagus; they wind to and fro in such a manner, bending backwards and forwards, and interlacing with each other, as strongly to resemble the appearance presented by the gizzard of a fowl (see Fig. 4, Pl. II.); and when acting under the control of the muscular coats of the stomach, must form a very effective triturating apparatus. Four or five of these folds enter into the intestine, and here, for about a quarter of an inch, they become but very slightly elevated; as they approach that peculiar semiflexion in the intestine referred to above, they increase in number, and also in depth (Fig. 4), and, from their very close and compact appearance, I am led to suspect that this portion of the intestine, between the pyloric orifice of the true stomach and the orifice of the biliary ducts, is more than an ordinary duodenum, and acts somewhat as a secondary stomachal cavity. This idea is strengthened by the additional fact, that the true stomach is lined with a series of minute pores, thickly scattered over the mucous surface, and covering both the raised folds of the mucous membrane and the intestines between them. These small pit-like indentations are minute glandular bodies, secreting the gastric juice; they commence just below the cardiac orifice of the stomach, and are continuous to the entrance of the biliary ducts. While every part of this portion of the intestine is supplied with these crypts, of course they are most numerous when the mucous membrane is thrown into a series of folds; this occurs in the secondary stomachal portion alluded to, which, in every anatomical particular, is a miniature of the larger one.

The mucous surface of the small intestine becomes much smoother after it has received the contents of the liver. But in no one spot throughout its length do we find it absolutely smooth; it is always arranged, more or less, in a series of delicate, longitudinal folds; and, as we approach the rectal portion, these folds assume a slightly twisted appearance, but not at all distinct enough to be alluded to as a spiral valve. When the small intestine joins the large rectal cavity, the gut, as above-said, contracts very much, and the mucous membrane is packed up into two or three little eminences, which act the part of a valve. In the rectal portion, the lining membrane is thin, and very smooth. In this, as well as in its large diameter, in comparison with the small intestine, it remarkably resembles the same parts in the Tritons and Salamanders.

From a survey of the details thus glanced at, it will be seen that there is nothing in the alimentary canal of the axolotl to predicate of it that it is a larval form; though it may resemble the same parts in an adult Salamander and Triton, yet it differs from these more than was at first thought, and more than one would imagine from the only account that I have found attainable, namely, that of Baron Cuvier. The osseous system has been too well described by Cuvier, and the reproductive by the paper and illustrations of Sir Everard Home, to need further allusion to at my hand.

At the conclusion of my observations on the alimentary canal of the axolotl, I received a copy of Professor Luigi Calori's paper, entitled "*Sulla Anatomia dell' Axolotl,*" published in the memoirs of the Academy of Science, Bologna.* This elaborate paper leaves but little to be said in addition on the anatomy of this animal; and yet, perhaps, the publications of this Academy—highly valuable though they be—may be as little accessible in Britain as those of our own Royal Society appear to be in Italy. Were the latter otherwise, Dr. Calori would have known of the paper of Sir Everard Home, referred to by us, "On the Reproductive Organs of Axolotl," and not have claimed priority for his discovery and very careful details of these same structures, so unaccountably passed over by Cuvier. This thought, and the fact that, though Dr. Calori's paper is illustrated with five plates, not one represents the viscera *in situ*—nor is there a correct representation of the spleen, or of the gall-bladder—makes us not hesitate to give the result, as detailed in the previous paper, of the dissections of two fine specimens, male and female, of the axolotl (for which we are indebted to the kindness of Dr. Dickie, late Professor of Natural History, Queen's College, Belfast, now of Botany, at Aberdeen); while, in justice to the important paper in the Bologna memoirs, we now append a brief abstract of the portions that more especially treat of the alimentary tract. The osseous and blood system are equally painstakingly investigated; but for these we will refer to the work itself:—

"The interior of the stomach is lined with a dry scaly epidermoidal-like stratum, which is also met with in the pharynx and œsophagus,—a net-like structure, with wide meshes, occurs, seemingly depending from the blood-vessels. In these meshes are a large number of small, regularly disposed cells, probably a smaller vascular net-work, not easily perceived without the assistance of high powers. Within the meshes of this smaller net, the (mucous) glands of the stomach open,—they are very numerous, tubular, and quite microscopic.†

"The muscular coating of the stomach is rather thin, composed of longitudinal fibres, and is continuous with the muscular coats of the œsophagus, and likewise of the intestinal tract. The transverse fibres are more abundant towards the pyloric orifice, and here the coats of the intestine are somewhat thicker; there is no lack of an intermediate cellular membrane between the muscular and mucous coats, but it is very thin.

"The serous investment is very thin, and, having enveloped both sides of the stomach, it is prolonged into two folds: one, the right and lower, going to the liver, forms the gastro-hepatic ligament: the other, the left and higher, goes to the spleen, not placed as Cuvier thinks, in the centre of the mesentery, but against the left side of the stomach.

"The œsophageal orifice is larger than the pyloric one; this latter is very narrow, is slightly twisted, and a series of folds in the lining membrane almost completely closes it. These folds are prolonged into the first portion of the small intestine. These folds in the pyloric orifice take the place of a valve; it is externally marked by a constriction, inferior to which the duodenum commences; this is at first very narrow, and descends in

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* Memoire dell' Accademia delle Scienze dell' Instituto di Bologna. Tomo iii. 1851, pp. 269-361.

† It will be seen by reference to our remarks on the internal structure of the stomach, that Dr. Calori has not rightly comprehended this portion, but his specimen was a very young one: contrast his fig. 9, plate XXIII., with ours, fig. 4, plate II. The general outline of this viscus is likewise very much exagerated in fig. 8a, x., Plate XXIII., of Calori.

the same general direction as the stomach, it next crosses from left to right, twisting slightly; it then enlarges, and reaches the liver, with which it becomes united by a fold of the peritoneum; receiving the contents of the biliary ducts, it bends downwards towards the right side,—is prolonged into the small intestine, which, preforming some convolutions, ends in the large rectal portion almost by intussusception. The rectum is twice as wide as the small intestine, but short and straight, ending in the cloaca, open externally through a longitudinal fissure with swollen lips.*

"The intestines are, for the most part, membranous; the first portion of the duodenum has, however, very thick coats, and internally has longitudinal plaiting, which occupies almost all its cavity; in this it repeats the arrangement of the mucous membrane of the œsophagus. This disposition of the fibres leads me to suppose that this part of the intestine has the power of enlarging itself; between these folds there appears a glandulous net-like structure, without doubt of great importance in digestion; this is also observed in the Salamanders.†

"In the small intestine, we find a few longitudinal plaits: but these are scarcely visible, and disappear as the intestine approaches the rectum; there is, also, a very minute net-like vascular structure, visible to the microscope. Meckel says, there is some villosity present in the small intestine of Salamanders; but in Axolotl, at least, I could find nothing of the kind. No valve intervenes between the small intestine and rectum,—this latter does not exhibit any longitudinal foldings, unless indeed in its lower extremity, close to the external orifice of the cloaca, where many are seen rising like crests; there are here, besides, four little bodies, like carunculæ. In this cloaca open the urinary and genital organs, and the bladder,‡ not much developed; however, the small intestine, equally with the rectum, is furnished with a fine stratum of longitudinal and transverse fibres, but very delicate and microscopic, and is attached to the vertebral column by a thin band of mesentery.

"Salivary glands are totally wanting; there also seems to be a total absence of pancreas, but this gland is wanting in other Saurobatrachii—in Hypochthon, for example; when existing, it is usually very small, and quite rudimentary. Cuvier does not refer to its existence. The spleen is found; its position I have already alluded to; it is four times as broad as it is thick: it ends in an obtuse point at both extremities. I found it full of rather conspicuous corpuscles, and of black pigment.

"The liver is rectangular, of a yellowish-red colour, with many black spots; its under surface is convex, its upper, concave: the first is connected by the falciform ligament to about the anterior half of the middle line of the lower soft coats of the abdomen, and is divided by it into two unequal portions—these form the two lobes of the liver, the right being the larger. On the under surface, the same division is made, here in a notch extending inwards through about four-fifths of the substance of the liver, enters the umbilical vein, also the biliary ducts and the blood-vessels of the portal system.

"The thin border of the right lobe is notched to receive the small biliary bladder, which, being inflated with air, rises up from the posterior hepatic border, of which it is free. Cuvier says, in the text of his paper, that he was not able to see it; but in the plate accompanying it, it is delineated, though confusedly and incorrectly. It is pyriform, but there is nothing remarkable in its structure; it empties itself, with the bile ducts, united to it, into the duodenum, not far from where the latter is attached to the liver."

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* The external appearance of this fissure differs much in the two sexes—in the male it is, as described by Calori, with swollen and corrugated lips: in the female the orifice is simple, as in many of the Amphibia.

† We think many portions of the intestinal tract act the part of a kind of secondary stomach. In the Salamanders, as in Triton, we have found, even below the liver portion of the duodenum, widenings of the intestine, to all appearance having the function of second stomachs; perhaps this portion might be regarded as an additional stomach, regarding as duodenum that portion only where it is continuous from it to the liver.

‡ In the plate the bladder is represented so as to lead one to suppose it is on the right side; its right position is, as figured by Home, towards the left; its shape varies somewhat in different specimens.

Such are the more salient points of Dr. Calori's paper, a translation of which I have thought it better to lay before the reader. There remains no longer any necessity to discuss the question whether this amphibia is a larval form; but still there is much to be done in reference to its organs of respiration in its early life. From finding the lungs in the young axolotl in a complete state of acatylectesis, while the tissue is beautifully developed in those of adult form, I am led to believe that branchial respiration is that of young life, while the older animal becomes as equally dependent for respiration on its lungs.

IX.—On the Zoological Relations of Man with the Lower Animals. By Professor Huxley, F. R. S.

As the biological sciences have grown in breadth and in depth, and as successive generations of naturalists have succeeded in penetrating further and further into the arcana of nature, the questions—In what relation does the thinker and investigator stand to the objects of his inquiries? What is the tie which connects man with other animated and sentient beings?—have more and more forcibly pressed for a reply.

Nor have responses been wanting; but, unfortunately, they have been diametrically opposed to one another. Theologians and moralists, historians and poets, impressed by a sense of the infinite responsibilities of mankind, awed by a just prevision of the great destinies in store for the only earthly being of practically unlimited powers, or touched by the tragic dignity of the ever-recurring struggle of human will with circumstance, have always tended to conceive of their kind as something apart, separated by a great and impassable barrier, from the rest of the natural world.

On the other hand, the students of physical science, discovering as complete a system of law and order in the microcosm as in the macrocosm, incessantly lighting upon new analogies and new identities between life as manifested by man, and life in other shapes,—have no less steadily gravitated towards the opposite opinion, and, as knowledge has advanced, have more and more distinctly admitted the closeness of the bond which unites man with his humbler fellows.

A controversy has raged between these opposed schools, and, as usual, passion and prejudice have conferred upon the battle far more importance than, as it seems to me, can rationally attach to its issue. For whether, as some think, man is, by his origin, distinct from all other living beings, or whether, on the other hand, as others suppose, he is the result of the modification of some other mammal, his duties and his aspirations must, I apprehend, remain the same. The proof of his claim to independent parentage will not change the brutishness of man's lower nature; nor, except to those valet souls who cannot see greatness in their fellow because his father was a cobbler, will the demonstration of a pithecoid pedigree one whit diminish man's divine right of kingship over nature; nor lower the great and princely dignity of perfect manhood, which is an order of nobility, not inherited, but to be won by each of us, so far as he consciously seeks good and avoids evil, and puts the faculties with which he is endowed to their fittest use.

Important or unimportant in its final results as it may be, however, there can be no doubt that the controversy as to the real position of man still exists; and I have therefore thought that it would be useful to contribute my mite towards the enrichment of the armoury upon which both sides must, in the long run, be dependent for their weapons, by endeavouring to arrange and put in order the facts of the case, so far as they consist of the only matters of which the anatomist and physiologist can take cognizance—I mean facts of discernible structure and of demonstrable function. If any one assert that there are other orders of facts which enter into this question, but which are distinguished by being neither demonstrable nor discernible, all that can be replied is, that science is incompetent either to affirm or deny his proposition, confined, as she is, to the humble, if safe, region of observation and of logic.

No one denies, I believe, that there are multitudes of analogies and affinities of structure and function connecting man with other living beings. Man takes his origin in an ovum similar in form, in size, and in structure to that whence the dog or the rabbit arise. The physical process which determines the development of the embryo within that ovum; the successive stages of that development; the mode in which the human fœtus is nourished within the maternal organism; the process of birth; the means provided by nature for the due supply of nutriment after birth: are essentially alike in all three cases. Compare the bony frame-work, the muscles, the great vessels, the viscera, of man, the dog, and the rabbit, and the demonstration of a pervading unity of plan in all three is one of the triumphs of modern science.

The most certain propositions entertained by the human physiologist, those upon which the scientific practice of the healing art depends, are largely, or wholly, based on the results of experiments on animals. The poison which hurts them does not leave us unscathed; and we share with them two of the most terrible diseases with which mortal beings are afflicted, glanders and hydrophobia. Nor can any impartial judge doubt that the roots, as it were, of those great faculties which confer on man his immeasurable superiority above all other animate things, are traceable far down into the animal world. The dog, the cat, and the parrot return love for our love, and hatred for our hatred. They are capable of shame and of sorrow; and though they may have no logic nor conscious ratiocination, no one who has watched their ways can doubt that they possess that power of rational cerebration which evolves reasonable acts from the premises furnished by the senses—a process, be it observed, which takes fully as large a share as conscious reason in human activity. There is a unity in psychical as in physical plan among animated beings; and the sense of this unity has been expressed in such strong terms by Professor Owen, that his words may form a fitting climax to these introductory sentences.

"Not being able to appreciate or conceive of the distinction between the psychical phenomena of a chimpanzee and of a Boschisman, or of an Aztec, with arrested brain-growth, as being of a nature so essential as to preclude a comparison between them, or as being other than a difference of degree, I cannot shut my eyes to the significance of that all-pervading similitude of structure—every tooth, every bone, strictly homologous—which makes the determination of the difference between *Homo* and *Pithecus* the anatomist's difficulty."*

That there are a great number of points of similarity between ourselves and the lower animals, then, appears to be clearly admitted on all hands. It is, further, universally allowed that the Vertebrata resemble man more nearly than do any invertebrates; that among vertebrates the Mammalia, and of these the Quadrumana, approach him most closely. Lastly, I am aware of no dissentient voice to the proposition, that in the whole, the genera *Troglodytes*, *Pithecus*, and *Hylobates*, make the closest approximation to the human structure.

The approximation is admitted unanimously; but unanimity ceases the moment one asks what is the value of that approximation, if expressed in the terms by which the relations of the lower animals one to another are signified. Linnæus was content to rank man and the apes in the same order, Primates, ranging in terms of zoological equality, the genera, *Homo*, *Sima*, *Lemur*, and *Vespertilio*. Among more modern zoologists of eminence, Schreber, Goldfuss, Gray, and Blyth, have followed Linnæus, in being unable to see the necessity of distinguishing man ordinally from the apes.

Blumenbach, and after him, Cuvier, conceived that the possession of two hands, instead of four, taken together with other distinctive characters of man, was a sufficient ground for the distinction of the human family as a distinct order—*Bi-mana*.

Professor Owen goes a step further, and raises *Homo* into a subclass, "*Archencephala*," because "his psychological powers, in association with his extraordinarily developed brain, entitle the group which he represents to equivalent rank with the other primary divisions of the class *Mammalia*, founded on cerebral characters."†

M. Terres‡ vindicates the dignity of man still more strongly, by demanding for the human family the rank of a kingdom equal to the Ani-

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* Prof. Owen on the Characters, &c., of the Class Mammalia, "Journal of the Proceedings of the Linnæan Society of London," vol. ii., No. 5, 1857, p. 20, note. It is to be regretted that this note is omitted in the "Essay on the Classification of the Mammalia," which is otherwise nearly a reprint of this paper. I cannot go so far, however, as to say, with Prof. Owen, that the determination of the difference between *Homo* and *Pithecus* is the 'anatomist's difficulty.'

† Professor Owen on the Characters, &c., of the Class Mammalia, l. c., p. 33.

‡ L'homme ne forme ni une espèce ni une genre comparable aux Primates. L'homme à lui seul constitue un regne à part—le Regne humain."—Resumé des Leçons sur l'Embryologie Anthropologique, Comptes Rendus, 1851.

malia or Plantæ; while, finally, a countryman of our own arrogates to his fellows so high a place in the aristocracy of nature as to deny that mankind can be thought of zoologically at all.

From the conception of man as a genus of *Primates* to the refusal to conceive of him as a subject of zoological investigation, is a wide range of opinion—so wide, indeed, as to include all possible views; for in the present state of science, no one is likely to propound the idea that man is only a species of some genus of ape. Ingenious and learned men have held all the doctrines which have been mentioned; great men have held some of them; and, therefore, it is more than probable that the question at issue, if we put the problem in this way, is in reality more one of opinion as to the right method of classification and the value of the groups which receive certain names, than one of fact. But, after all, it is the latter question which really interests science; and, therefore, it seems to me, that some service may be done by setting about the inquiry in a different way—by endeavouring, in fact, to answer the question—What is the value of the differences observed between man and the lower animals, as compared with the differences between the lower animals themselves? Are the differences between man and the apes, for example, as great as those between the ape and the fish? or are they rather comparable to those between the ape and the bird; or, to take a less range, to those between the ape and the Marsupial; or, to occupy a lower stand still, to those presented by the ape, and, say, the Pachyderm: or, after all, are the differences no greater than those which obtain between different genera of the Quadrumana?

These are questions which can plainly enough be settled independently of all theoretical views. Differences of structure can be weighed by the mind, as definitely as differences of gravity by the balance; nor can any dialectic skill refine them away. It will save trouble, if the attempt be made to answer the last question first—Are the structural differences between man and the Quadrumana no greater than those between the extreme genera of the Quadrumana? If, as I shall endeavour to show, this question can be demonstrably answered in the affirmative;—if it can be proved beyond doubt, that whether we consider the skeleton, the muscles, the brain, or the other viscera, man is far less distant from *Troglodytes* or *Pithecus*, than these apes are from the Lemur, and still more from the *Galeopithecus* or the *Cheiromys*, the other queries will need no separate solution. I have hardly any new facts to bring forward, nor any need to advance such. Thanks to the researches of Duvernoy, Tiedemann, Isidore St. Hilaire, Schrœder van der Kolk, Vrolik, Gratiolet, Professor Owen, and others, all the elements of the problem have long since been determined. It is only necessary to range the admitted facts side by side, in order to show that there is no escape from the conclusion.

And, first, with respect to the differential characters presented by the brains of the chimpanzee and orang from that of man on the one hand, and those of the lowest quadrumana on the other. I begin with this question, because it was my misfortune, at the last meeting of the British

Association, to find myself compelled to give a diametrical contradiction to certain assertions respecting the differences which obtain between the brains of the higher apes and of man, which fell from Professor Owen; and in the interest of science, it is well that the real or apparent opposition of competent inquirers, as to matters of fact, should be put an end to as soon as possible, by the refutation of one or the other. Happily, it is unnecessary that I should trust to my memory of what took place on the occasion to which I refer; for the assertions alluded to were already familiar to me, inasmuch as their substance occurs in two of Professor Owen's latest works—the paper "On the Characters, Principles of Division, and Primary Groups of the Class Mammalia," read before the Linnæan Society on February 17th, and April 21st, 1857; and the essay "On the Classification of the Mammalia," delivered as a lecture before the University of Cambridge.

I quote from the former essay, as that intended for an audience of experts, and hence, in all probability, to be regarded as more strictly scientific:—

"In man, the brain presents an ascensive step in development, higher and more strongly marked than that by which the preceding sub-class was distinguished from the one below it. Not only do the cerebral hemispheres (figs. 5 & 6 A) overlap the olfactory lobes and cerebellum, but they extend in advance of the one, and further back than the other (fig. 6, C). Their posterior development is so marked, that anatomists have assigned to that part the character of a third lobe; *it is peculiar to the genus Homo, and equally peculiar is the posterior horn of the lateral ventricle, and the 'hippocampus minor,' which characterise the hind lobe of each hemisphere.* Peculiar mental powers are associated with this highest form of brain, and their consequences wonderfully illustrate the value of the cerebral character; according to my estimate of which I am led to regard the genus *Homo* as not merely a representative of a distinct order, but of a distinct sub-class of the Mammalia,* for which I propose the name of '*Archencephala*' (fig. 6)."

It might be a grave question whether, granting the existence of the differences assumed to distinguish the human brain, they would justify the establishment of a sub-class for the genus *Homo;* but that difficulty is not worth discussing, inasmuch as I shall endeavour to demonstrate, in the course of the following pages, the accuracy of the three counter statements which I made to the audience assembled in Section D, viz.:—

1. That the third lobe is neither peculiar to, nor characteristic of man, seeing that it exists in all the higher Quadrumana.

2. That the posterior cornu of the lateral ventricle is neither peculiar to, nor characteristic of man, inasmuch as it also exists in the higher Quadrumana.

3. That the *Hippocampus minor* is neither peculiar to, nor characteristic of man, as it is found in certain of the higher Quadrumana.

I support the first two propositions by the evidence of every original observer who has written upon the subject, including Professor Owen

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* Here occurs the note which I have already quoted at p. 69. The italics in the above extract are my own.

himself, and by my own personal observations. The third rests upon the evidence of Messrs. Schrœder van der Kolk and Vrolik, and of an eminent countryman of our own, Dr. Allen Thomson, to whom I am indebted for unpublished observations made with express reference to these very points.

1. *The third lobe or posterior lobe of the cerebrum.*—Many anatomists divide the cerebral hemispheres of man into only two lobes, the anterior and the posterior, separated from one another by the fissure of Sylvius; but it is more usual to speak of three lobes,* an anterior, a middle, and a posterior, the latter, or 'third lobe,' being the posterior, inasmuch as it consists of the hinder part of that, which those who divide the cerebral hemispheres into two lobes, call 'posterior.' It is in this sense that Cuvier, Meckel, and Tiedemann use the term third, or posterior lobe. It is generally admitted that no very strict line of demarcation is traceable between the middle and posterior lobes; anatomists being content to accept Cuvier's curt definition:—

"La partie du cerveau située au-dessus du cervelet est ce qu'on nomme le lobe postérieur du cerveau."†

So far as I am aware, the terms "third" or "posterior lobe," have never been applied in any other senses than those which I have indicated. Under these circumstances, it is utterly incomprehensible to me how any one competently informed, either with respect to the literature or to the facts of the case, can assert that the hind lobe "is peculiar to the genus *Homo*;" for not only will the inspection of any ape's brain convince one of the contrary, but the facts were originally ascertained and published by a most competent authority, and have never been doubted for nearly forty years.

Tiedemann's "Icones Cerebrorum Simiarum," published in 1821, in fact, ought to be familiar to every student of mammalian anatomy. On turning to his first Plate, one finds the first figure to be a representation of the brain of "*Simia nemestrina*." The explanation of the figures says: "*a*,

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* It is not a very easy matter to determine with whom these divisions originated. Vesalius (Humani Corporis Fabrica, libri septem, MDCXLII.) speaks neither of lobes nor of special 'prominentiæ' in the cerebral hemispheres, though he describes them very accurately, explaining particularly that the under surface of these hemispheres is adapted to the 'tubera' of the cranial bones.

"Varolius (Anatomiæ sive de Resolutione Corporis Humani, libri iii., MDXCI. p. 131) says, in his letter to Hieronymus Mercurialis: 'De nervis opticis multisque aliis præter communem opinionem in humano capito observatis;'

"Sunt autem tres cerebri prominentiæ: anterior, media, et posterior . . . . . postrema cerebri prominentia replet cavitatem productam á superiori parte occipitii à posteriori ossis sincipitis et ossis petrosi.'

This looks like the origin of the division into three lobes, while Willis seems to have originated the division into two.

"Porro in homine cui cerebrum præ ceteris animalibus capax et amplum est, utrumque hæmisphærium rursus in duos lobos nempe anteriorem et posteriorem subdividitur: inter quos arteriæ carotidis ramus, utrinque instar rivi limitanei productus eos veluti in binas provincias distinguit"—Willis, Cerebri Anatome, 1664.

† Leçons d'Anatomie Comparée, 2de ed., tome iii., p. 44.

lobus anterior paullulum acuminatus; *b*, lobus medius; *c*, lobus posterior, "*cerebellum obtegens.*" Fig. 2, represents the brain of "*Simia rhesus*;" and the explanation of the figures says: "*a*, lobus anterior; *b*, lobus medius; *c*, lobus posterior." Fig. 3, a figure of the brain of *Simia sabœa*, and fig. 4, of "*Simia capucina*," have the same lettering, and the letters have the same signification.

And, to permit of no mistake, Tiedemann, at page 48 of the same work, tells us expressly:—

"Cerebrum simiarum quoad magnitudinem et divisionem in lobos ad humanum proxime accedit: dividitur enim per fissuram mediam longitudinalem in duo æqualia hemisphœria *quorum utrumque rursus in tres lobos partitur. Lobi posteriores uti in homine faciem superiorem cerebelli obtegunt.* In cæteris a nobis dissectis quodrupedibus encephali hemisphæria sunt magis plana et brevia. Lobi posteriores quamvis breviores quam in Simiis tantommodo in Phoca occurrunt, in reliquis Feris in Leone, Fele, Nasua, Lotore, *et ipso Lemure* ac Bradypode cerebellum fere nudum vel ab hemisphæriis haud obtectum conspicitnr."

In 1825, Tiedemann, describing the brain of the orang (Hirn des Orangs mit dem des Menschen verglichen), particularly states that each hemisphere is, as in man, divided into three lobes—an anterior, a middle, and a posterior; and that the ovate cerebral hemispheres cover the cerebellum almost entirely, though they do not, as in man, project beyond its posterior margin.

In the third volume of the second edition of the "Leçons," Cuvier expressly affirms, in speaking of the apes:—

"Their hemispheres are also prolonged backwards, as in man, to form the posterior lobes, which repose on the cerebellum.

"The cerebellum is almost wholly covered by the hemispheres in the seal and otter.

"In the dolphin, a large proportion of the cerebellum is covered."—pp. 84–86.

And, in the "Regne Animal," he gives as part of the definition of the order Quadrumana: "Le cerveau a trois lobes de chaque côté, dont le postérieur recouvre le cervelet."

In his elaborate essay "On the brain of the negro, compared with that of the European and the orang outang," published in the Philosopical Transactions for 1836, Tiedemanns's zeal for the cause of the oppressed black has occasionally led him into something very like special pleading; and yet he does not dream of hinting the absence of the posterior, or third lobe, present in the negro's brain, from that of the orang. His summary, at p. 518, runs thus:—

"The brain of the monkey and the orang outang differs, as follows, from the human brain:—

"1. The brain is absolutely and relatively smaller and lighter, shorter, narrower, and lower than the human brain.

"2. The brain is smaller, in comparison to the size of the nerves, than in man.

"3. The hemispheres of the brain are, relatively to the spinal marrow, medulla oblongata, the cerebellum, corpora quadrigemina, the thalami optici, and corpora striata, smaller than in man.

"4. The gyri and sulci of the brain are not so numerous as in man."

I do not think that any valid objections can be raised as to the accuracy of the statements already cited; but in case such should be brought forward, I will now produce one authority which I am sure Professor Owen will regard as irrefragable. This is the third volume of the Catalogue of the Hunterian Collection, where, at p. 34, I find the following passages:—

"1338. The brain of a baboon (*Papio mormon*, Cuv.) The cerebral hemispheres are of greater proportionate size than in any of the preceding specimens, and they are developed so far backwards as to cover the cerebellum. The posterior lobes exhibit anfractuosities characteristic of the brain in the higher simiæ, as the baboons and orangs.

"1338A. The brain of a chimpanzee (*Simia troglodytes*, Linn.) This brain, in the relative proportions of the different parts, and the disposition of the convolutions, especially those of the posterior lobes, approaches nearest to the human brain. It differs chiefly in the flatness of the hemispheres, in the comparative shortness of the posterior, and the narrowness of the anterior lobes."

In the year 1842, Dr. Macartney read a paper "On the Minute Structure of the Brain of the Chimpanzee, and of the Human Idiot, compared with the perfect Brain of Man," before the Royal Irish Academy; and the essay, accompanied by two plates, is published in the 19th volume of the Transactions of that Academy. At p. 323, Dr. Macartney says—"The proportions of the cerebellum to the cerebrum were exactly as in man." "The parts in the lateral ventricles corresponded very nearly with the same in man." The figure of the upper surface of a plaster cast of the brain of this Chimpanzee, in Plate I., distinctly exhibits the posterior cerebral lobes projecting beyond the cerebellum.

The "Verhandelingen over de Natuurlijke Geschiedenis der Nederlandsche overseesche Bezittingen," pp. 39–44, contains a valuable memoir,* by Dr. Sandifort, on the anatomy of the orang, in which, at p. 30, I find the following distinct statement:—

"The base of the brain is divided into three lobes (lobi), of which the most anterior is short; the middle one descends remarkably below the foremost and hindmost; while the hindermost not only covers the cerebellum, but extends still further backwards than it. In vertical sections of the skulls of full-grown specimens, the bony frame-work showed that such is always the case, so the cerebral lobes appear to extend more backward over the cerebellum as age advances. In the brain investigated by Tiedemann, which belonged to a young orang, the cerebral lobes covered the cerebellum, but did not extend further back than it."

Vrolik, in the valuable article, "Quadrumana," contributed by him to "Todd's Cyclopædia" (1847), expressly affirms (p. 207), that, in the orang, the cerebral hemispheres "are protracted behind the cerebellum." And M. Isidore Geoffroy S. Hilaire ("Seconde Mémoire sur les Singes Americanes," Archives du Musèum, 1844) draws particular attention to the fact, that in the Saimiri, *Chrysothrix* (*Saimiris*, I. G. St. H.) *ustus*, a platyrhine monkey, and therefore far more distant from man than the

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* "Ontleedkundige Veschouwing van een Volwassen Orang-oetan (*Simia satyrus*, Linn.), van het Mannelijk Geslacht."

tailless catarrhine apes of the old world, the cerebral hemispheres project far back beyond the cerebellum, though the latter is very well developed —in fact, as the cerebral hemispheres project nearly a centimetre behind the cerebellum, while the whole brain is only 5½ centimetres long, the backward projection of the third lobe is, in this monkey, relatively greater than in man.

The "Transactions of the Royal Netherlands Institute at Amsterdam for 1849" contain one of the most valuable memoirs on the cerebral organization of the higher apes that has yet been written, entitled, "An Anatomical Investigation of the Brain of the Chimpanzee," by Schroeder van der Kolk and Vrolik. In their two plates they represent the brains of a chimpanzee, an orang, and a new-born child, and, in all, the letter *c* is applied to the same part—the posterior or third lobe, which they term "achterhoofds-kwab," "occipital lobe," in the explanation of the plates, or frequently in the text, "achter-kwab," "posterior lobe"; nor among the heads of their careful enumeration of the differences between the brain of man and the higher apes does any one of the three differential characters whose existence I have denied find a place.

Finally, in the preface to the most elaborate special memoir that has yet appeared upon the conformation of the brain in the higher Mammalia—the "Memoire sur les plis Cérébraux de l'Homme et des Primatés," by M. P. Gratiolet,—I find the following passage (p. 2):—

> "The convoluted brain of man and the smooth brain of the marmoset resemble one another in the fourfold character of a rudimentary olfactory lobe, *a posterior lobe, which completely covers the cerebellum*, a well-marked fissure of Sylvius, and lastly, *a posterior cornu to the lateral ventricle.* These characters are met with in combination only in man and in the apes."

M. Gratiolet's beautiful original figures of the brain of the chimpanzee (Pl. vi), and of the orang (Pl. vii), show quite clearly that the hinder margin of the cerebral lobes in these animals, when the brain is in its natural condition, overlaps the hinder margin of the cerebellum.

Many months ago, having learned that my friend Dr. Allen Thomson had at one time occupied himself with the dissection of the brain of the chimpanzee, I applied to him for information, and he has very kindly allowed me to print the following extracts from his letters. Of the first brain he examined—that of a young female chimpanzee, seven or eight months old,—this eminently careful anatomist and physiologist says (under date of May 24, 1860):—

> "There is, very clearly, a posterior lobe, separated from the middle one by as deep a groove between the convolutions on the inner side of the hemispheres, as in man, and equally well marked off on the other side. I should be inclined to say, that the posterior lobe is little inferior to that of man, excepting, perhaps, in vertical depth. The cerebral hemispheres completely covered the cerebellum, as seen from above. I took pains to observe this while the brain was still within the cranium, looking down upon it at right angles to the longtitudinal axis of the cranial cavity, and I found the posterior extremity of the cerebral hemispheres projected a little beyond the vertical line, passing the back of the cerebellum."

Thus, every original authority testifies that the presence of a third lobe in the cerebral hemisphere is not "peculiar to the genus Homo," but that the same structure is discoverable in all the true Simiæ among the Quadrumana, and is even observable in some lower Mammalia; and any one who chooses to take the trouble to dissect a monkey's brain, or even to examine a vertically bisected skull of any of the true Simiæ, may convince himself, on the still better authority of nature, not only that the third lobe exists, but that it extends to the posterior edge of, if not behind the cerebellum.

2. *The posterior cornu.*—In the "Icones," already referred to, Tiedemann not only described but figured the posterior cornu of the lateral ventricle in the *Simiæ* (Tab. 2°, Fig. 3[a]), as "*e.* scrobiculus parvus loco cornu posterioris;" and when giving an account of the brain of the seal (Tab. 3[a]), he says: "*e.* cornu descendens s. medium. Præterea cornu posterioris vestigium occurrit."

Tiedemann's statements are confirmed by every authoritative writer since his time. According to Cuvier* (Leçons, T. iii., p. 103), "the anterior or lateral ventricles possess a digital cavity [posterior cornu] only in man and the apes. This part exists in no other mammifer. Its presence depends on that of the posterior lobes. In the seals and dolphins alone, in which the posterior part of the hemisphere is considerable, the lateral ventricle, at the point where it descends into the temporal tuberosity, bends a little backwards, thus exhibiting a sort of vestige of the digital cavity of the human brain."

Vrolik (Art. Quadrumana, Todd's Cyclopædia), though he carefully enumerates the differences observable between the brains of the Quadrumana and that of man, does not think of asserting the absence of the posterior cornu. And lastly, Schrœder van der Kolk and Vrolik (op. cit., p. 271), though they particularly note that "the lateral ventricle is distinguished from that of man by the very defective proportions of the posterior cornu, wherein only a stripe is visible as an indication of the hippocampus minor;" yet the figure 4 in their second Plate shows that this posterior cornu is a perfectly distinct and unmistakeable structure, quite as large as it often is in man. It is the more remarkable that Professor Owen should have overlooked the explicit statement and figure of these authors, as it is quite obvious, on comparison of the figures, that his wood-cut of the brain of a Chimpanzee (l. c., p. 19), is a reduced copy of the second figure of Messrs. Schrœder van der Kolk and Vrolik's first Plate.

As M. Gratiolet (l. c., p. 18), however, is careful to remark, "unfortunately the brain which they have taken as a model was greatly altered (profondément affraissé), whence the general form of the brain is given in these plates in a manner which is altogether incorrect." Indeed, it is perfectly obvious, from a comparison of a section of the skull of the Chimpanzee with these figures, that such is the case; and it is greatly to

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* Leuret, Longet, and Stannius, agree with or, perhaps, only repeat Cuvier.

be regretted that so inadequate a figure should have been taken as a typical representation of the Chimpanzee's brain.

3. *The Hippocampus minor.*—But even supposing that the posterior cornu of the lateral ventricle and its appendage, the hippocampus minor, were absent in the apes, and "peculiar to the genus Homo," what classificatory value would the distinction possess? This, of course, depends upon the constancy of the supposed distinctive character; but it so happens that, as every anatomist knows, the posterior cornu and the hippocampus minor, are precisely those structures which are most variable in the human brain. This is by no means a novel discovery. The work of the brothers Wenzel* has now been published nearly half a century, and it contains (pp. 144–146) the following account of the special researches of these observers on the posterior cornu and the hippocampus, which they call simply "Tuber":—

"*Tuber in cornu posteriore ventriculorum lateralium*:—Non semper plerumque tamen adest, et quidem utroque in latere sive in utroque cornu. Inter quinquaginta et unum, eo specialiter fine a nobis examinata cerebra diversæ omnino ætatis atque utriusque sexus, tria tantum reperiebamus in quibus tuber illud in utroque latere et duo in quibus uno in latere desiderabatur. Quam constans autem, in universum tuberis istius præsentia, tam varians est magnitudo illius, non in diversis tantum subjectis, sed etiam in uno eodemque absque omni prorsus et ætatis et sexus discrimine. Quandoque admodum longum, interdum latum nonnunquam valde angustum est. Magnitudo illius in universum spectata, sequitur magnitudinem posterioris cornu ventriculorum lateralium: hæc quam maxime diversa est, quin et in uno eodemque cerebro et utroque latere. Quandoque enim cornu istud fere usque ad posteriorem cerebri marginem pertingit, sæpe terminus prope initium est, sæpe contingit ut in minore cornu magis, in majore minus sit tuber, id quoque eodem nonnunquam in cerebro evidentissime animadvertitur. Rarius in hoc tubere est quod sicut hippocampus ad finem suum crenas sive sulcos habeat quod superficies ejus duo in tubera superius atque inferius, divisa sit; plerumque autem in medio latissimum est et crassissimum, in terminis angustius: sed et hoc quoque varium est.

"Situs illius atque interior structura semper sunt eadem. Semper juxta interius latus cornu videtur, ideoque superficiei cerebri prope adjacet, idque cum interiore ejusdem structura cohæret, quae, ut sectio in transversum ducta clare demonstrat, eadem omnino est ac in gyris cerebri. Constat videlicet ex interiore in laterales ventriculos continuato, sive prolongato pariete cujus gyri in superficie cerebri siti, qui inflectitur, ac deinde interiori de parte exteriorem versus ad superficiem cerebri rediens in alium gyrum transit. Paries ist intra cornu medullosa, quœ cornu ipsum vestit, lamina obducitur; paries ipse autem ex cinerea, in ambitu cerebri sita, ubique conspicua substantia constat, quæ hoc loco neque latior est, neque alium colorem exhibet ac in quovis alio cerebri gyro.

"Inter utrumque tuberis parietem spatium invenitur, quod vasculosa cerebri æque explet ac sulcum inter duos alios gyras in superficie cerebri sitas.

"Si in superficie cerebri eo, qui eminentiæ isti opponitur loco membrana cerebri media et interior detrahitur, tuber illud evanescit, ut quamprimum cerebri superficies extenditur, in planum mutatur.

"Discrimen ergo, hoc tuber inter et processum cerebri lateralem in eo consistit, quod illud verum absolutum, gyris in exteriore cerebri superficie sitis omino simile, quoad interiorem vero structuram plane æquale, in interiore cerebro sive in aliqua ventriculorum ejusdam parte existens gyrus sit; quod e contrario hippocampus, si cum gyris in superficie cerebri existentibus comparatur, tantummodo gyri alicujus pars, non autem absolutus atque integer gyrus sit, cujus initium in interiore cerebro, aut in aliqua ventriculorum parte existit."

* Jos. et Car. Wenzel, "De penitiori structura Cerebri Hominis et Brutorum. Tubingæ, MDCCCXII.

The brothers Wenzel figure in their excellent plates the various conditions of the posterior cornu and hippocampus minor to which they refer; and it is remarkable that the brain which they have selected as exemplifying the absence of the hippocampus minor on both sides, Tab. v., Fig. 1, is said to be "ex triginta annorum æthiope," while the most remarkably developed hippocampus, Tab. vii., Fig. 3, is "ex septem annorum puero."

The work whence these extracts are taken is contained in the libraries both of the College of Surgeons and of the Royal Society; but, even if it were inaccessible, a well-known and more modern writer fully bears out the doctrine it contains. I refer to Longet,* who states that, in the human brain, "the posterior cornu is found of very different lengths and breadths. I have found brains in which it extended up to within a few millimetres of the surface of the posterior lobe, and others in which it ended at more than three centimetres therefrom."

The same excellent authority, in describing the posterior cornu of the lateral ventricle, says:—

> "Its inner and lower wall is raised by a convolution which forms a more or less distinct, and at times, double projection into the cavity itself. This projection (Hippocampus minor, eminentia unciformis, calliculus, unguis, calcar avis) was well described by Morand, and after him was called the 'Spur of Morand'—'Ergot de Morand.'
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> "The Hippocampus minor exhibits differences in its form and circumference, as Greding has stated; usually it is bent on itself, arched forwards and outwards, sometimes narrow and long, sometimes broader. Very frequently it is smooth, at other times it exhibits many fissures and small enlargements, especially posteriorly; or it may be divided by a longitudinal cleft into two halves, the upper of which is almost always larger than the lower. Its dimensions are by no means directly proportional to the development of the posterior lobe. In the same subject it may be very distinct upon the one side, and yet be hardly perceptible upon the other. For the rest I can certify that, in spite of Meckel's† assertion to the contrary, it is not always present. My own observations agree with those of Wenzel, who, among fifty-one subjects that he examined with express reference to this point, found three in which the hippocampus was absent upon both sides, and two in which every trace of it was absent upon one side only."

To allow a structural character totally absent in six per cent. of the members of any group to stand as part of the definition of that group, *considered as a sub-class*, would be a very hazardous proceeding. But, is it true that the hippocampus minor is altogether absent in the highest apes? I suspect that Tiedemann is responsible for the not unfrequently admitted doctrine that it is; for, in the "Icones" he writes:—

> "Pedes hippocampi minores vel ungues, vel calcaria avis, quæ a posteriore corporis callosi margine tanquam processus duo medullares proficiscuntur, inque fundo cornu posterioris plicas graciles et retroflexas formant, in cerebro simiarum desunt; nec in cerebro aliorum a me examinatorum mammalium occurrunt. *Homini ergo proprii sunt.*"

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* German edition, by Hein, under the title, Anatomie und Physiologie des Nervensystems des Menschen und der Wirbelthiere, 1847, Bd. i., p. 463.

† Dr. Hein here adds: "What Meckel says is that he himself never failed to find the hippocampus minor, but that he by no means wishes to throw doubts on Wenzel's statements;" and on reference to Meckel's work, I find this to be quite correct.

However, the citation from the Memoir of Schroeder van der Kolk and Vrolik, given above, proves that in their opinion a rudimentary hippocampus minor does exist in the Chimpanzee, and Dr. Allen Thomson adds his valuable testimony in a still more decided manner to the same effect. In the letter which I have already quoted, he says:—

"I found an eminence in the floor of the posterior cornu and towards its inner side, which I regarded as the hippocampus minor, and I found it produced exactly in the same manner as in man, by the bulging into the ventricles of a portion of the brain, by a very deep groove between the convolutions."

In another letter (the 11th of November, 1860), replying to further troublesome inquiries of mine, Dr. Thomson writes:—

"I thought it best for my own satisfaction and yours, to open the lateral ventricle from above, in a second brain which I possess. This brain, which was extracted from a young animal in Africa, was placed in rum there, and it was both much discoloured and not so well preserved as I could have wished. The appearances are, however, sufficiently distinct to enable me to confirm entirely what I think I stated to you before, viz.: 1. The prolongation of the cavity of the posterior cornu, to a considerable distance beyond the plane of the posterior edge of the corpus callosum (which, I presume, may be taken as the best measure of the position of the parts); and, 2. The existence on the inner side, and partly in the floor of that posterior cornu, of an eminence corresponding in all respects with the hippocampus minor. . . . . Just as I was setting about the examination of this point, I found an opportunity, in my dissecting-room, of looking at a fresh human brain, and I thought it might be more satisfactory to examine the two brains together. It so turned out, that the brain I cut in upon presented an example (not uncommon) of great deficiency in the extent of the posterior cornu. I think it is worth sending you a sketch of it, for it is really scarcely more developed than that of the chimpanzee in this respect."

Having now, as I trust, redeemed my pledge to prove that neither the third lobe of the cerebrum, nor the posterior cornu of the lateral ventricle, nor the hippocampus minor, are structures distinctive of and "peculiar to the genus *Homo*," I may leave it to the reader to decide the fate of the "sub-class *Archencephala*," founded upon the supposed existence of these three distinctive characters.

And here I might fairly leave the question; but, essential as I have felt it to be to my personal and scientific character to prove that my public assertions are entirely borne out by facts, I am far from desiring to deal with this important matter in a merely controversial spirit. Therefore, although the differences hitherto referred to are certainly non-existent, I proceed to inquire whether there are any other marked and constant characters by which the human may be distinguished from the Simian brain.

Without doubt such characters are to be found; and in all probability, as in the case of any other two distinct genera, the more carefully and minutely our inquiries are carried out, the greater will be the number of these differentiæ. So far as my knowledge goes, the most prominent and important are the following:—

1. In the anthropoid apes the brain is smaller, as compared with the nerves which proceed from it, than in man.

2. In the anthropoid apes the cerebrum is smaller, relatively to the cerebellum, than in man.

3. In the anthropoid apes the sulci and gyri are generally less complex, and those of the two cerebral hemispheres are more symmetrical, than in man.

4. The hemispheres are more rounded and deeper in man than in the anthropoid apes, and the proportions of the lobes to one another are different. Furthermore, certain minor gyri and fissures, present in the one, are absent or rudimentary in the other.

The evidence of the first of these differences has, I believe, been universally admitted since the time of Sœmmering. The second and fourth clearly result from the observations of Schroeder van der Kolk and Vrolik, and those of Gratiolet (Mem. sur les plis cerebraux des Primatès, 1854), as will appear from the following extracts. The first citation is taken from the work of the first-named authors, which seems to be so little known in this country, that I make no apology for length of the extract :—

"According to very precise investigations which the first named of us has carried out with reference to this point, the difference between the brains of the higher apes and that of man is to be sought, not only in the smaller size of the hemispheres, but also in a totally different relation of the lobes. Relatively, the under surface of the first lobe of the cerebrum, in the chimpanzee, is much larger than in man; while, on the other hand, the distance from the most anterior point of the middle lobe to the hindermost point of the posterior lobe is much smaller. In our chimpanzee the distance from the root of the olfactory nerve to the anterior margin of the brain is about 44 millimetres, from the point of the middle lobe to the extreme end of the posterior lobe, 69 mm. In the adult man, according to measurements which the first of us has instituted, and which wholly agree with those of the ninth plate of Foville, the first named measurement is 57 mm., the second, 145 mm. In the brain of a new-born child, examined by us, the first dimension amounted to 33 mm., the second to 70 mm. The length of the base of the anterior lobe was thus to the distance from the point of the middle lobe to the end of the posterior lobe, in the chimpanzee, as 1 : 1·52; in the adult man as 1 : 2·54; in the child, as 1 : 2. Hence it appears that the relative proportions of the lobes of the child's brain hold just the mean between the chimpanzee and the adult man; and that in the course of the growth of the child to manhood, the posterior and middle lobes increase more in length than the base of the anterior lobe. In the orang, the same proportion obtains as in the new-born child, or 1 : 2, a result which is certainly remarkable, and proves that, in this respect, the brain of the orang stands higher than that of the chimpanzee. The second point to which we would direct attention is, that in comparing the brain of man with that of animals, and especially in determining in what manner the cerebellum becomes covered, we too exclusively attend to the posterior elongation of the cerebral hemispheres, while the varying size of the cerebellum itself ought to be taken into account. On comparing the perpendicular section of the brain of the new-born child (pl. ii., fig. 3.) with fig. 1, the brain of the three-year-old chimpanzee, and with fig. 2, that of the orang of a like age, it is at once apparent that the cerebellum of the orang, and especially of the chimpanzee, is much larger than that of the child; so that, supposing one could place the cerebellum of the chimpanzee behind the medulla oblongata of the child, it would be even less covered.

In fact, the distance from the anterior edge of the most anterior part of the cerebellum, close to the corpora quadrigemina, to its posterior margin, measures, in the chimpanzee, 38 mm.; in the orang, 35 mm.; in the child, 22 mm. If we compare the measurements with the whole distance from the anterior to the posterior lobe of the cerebrum, we obtain, according to measurements taken by the first named of us,—

Chimpanzee,	38 : 101 mm.	=	1 : 2·66.
Orang,	35 : 96	=	1 : 2·74.
Human child,	22 : 96	=	1 : 4.36.
Adult man,	50 : 157	=	1 : 3·1.

Hence, it is clear 1°, that the cerebellum in the Chimpanzee and in the Orang are proportionally larger than in man; 2°, that the Orang in this respect approaches man more closely than does the Chimpanzee."—"Anatomical Investigation," &c., l. c. pp. 265–7.

The authors go on to remark that the same large proportion of the cerebellum to the cerebrum is characteristic of the lower Mammalia, as Soemmering had already observed, and that, consequently, the uncoveredness of the cerebellum arises as much from the disproportionately large size of the latter, as from the defect of the posterior lobe of the cerebrum. They further show that the human cerebellum is proportionally still smaller in a six-months' fœtus (1 : 4·7); and that, while in the adult the cerebellum has more than double the size it had in the new-born child (50 : 22), the cerebrum of the adult is only $1\frac{1}{2}$ times as large in the adult as in the new-born child (157 : 96). At the same time the cerebellum attains its full size by the end of the third year—a fact which indicates very interestingly the relations of the cerebellum with the locomotive power.

M. Gratiolet commences his description of the cerebral convolutions of man thus:—

"The form of the human brain is well known. Its singular height, the width of the frontal lobe, whose anterior extremity, instead of narrowing to an acute point, is terminated by a surface whose extent corresponds to that of the frontal bone; the large angle which the two orbital fossæ form, the depression of the fissure of Sylvius, the richness and complications of the secondary convolutions, at once distinguish this brain from that of all the Primates. But these differences, great and characteristic as they may be, yet consist with the existence of such analogies between the brain of man and that of apes, that the same general description serves both equally well. There are the same principal divisions, the same lobes, the same convolutions; all the parts are not the same, but they are homologous."—L. c., pp. 57, 58.

M. Gratiolet then goes on to point out what the differences of these homologous parts are; but I cannot give them in detail here, without entering upon a full explanation of his terminology, which would occupy too much space.

There is no lack, then, of real differences enough between the brain of man and those of the highest Quadrumana, though they are not those which have been asserted to exist. The question, what is the value of these differences? could only be satisfactorily answered, if the extent of variation exhibited by the brain among the different races of mankind had been carefully determined. We are greatly in want of knowledge on this important subject; but what little is known tends distinctly to the conviction, that no very great value can be set upon these distinctions, inasmuch as the differences between the brains of the highest races and those of the lowest, though less in degree, are of the same order as those which separate the human from the simian brain. I am well aware that it is the fashion to say that the brains of all races of mankind are alike; but in this, as in other cases, fashion is not quite at one with fact.

Soemmering and Tiedemann are directly at variance with respect to the relative proportions of the size of the nerves to the brain in the higher and in the lower races of mankind; and, as respects the relative proportions of the cerebrum and cerebellum, the ratios deducible from Tiedemann's measurements give so small a difference, that though it is rather in favour of the existence of a larger proportional size of the cerebellum in the lower races, I do not think it can be depended upon.

But, with regard to the third especially Simian cerebral character mentioned above, Tiedemann's observations (though, as the negro's advocate, he endeavours to explain them away) are definite, and to the point:—

"The only similarity between the brain of the negro and that of the orang outang is, that the gyri and sulci on both hemispheres are more symmetrical than in the brain of the European. It remains, however, to be proved whether this symmetry is to be found in all negro brains, which I very much doubt."—L. c., p. 519.

One would like to know the ground of Professor Tiedemann's doubts, because the only other observation he details, bearing on this subject, leads him to precisely the same conclusion. Thus, at p. 316 of the same memoir, I find the express statement:—"This [symmetry] is particularly visible in the brain of the Bosjes woman." Indeed, the fact must at once strike every one conversant with the ordinary appearance of a European brain, who glances at Pl. XXXIV. of Tiedemann's Memoir, in which a view of the Bosjesman brain referred to is given.

Fortunately, M. Gratiolet has also particularly described and carefully figured this brain (which is that of the "Hottentot Venus;" who died in Paris, and had the honour of being anatomized by Cuvier), and his remarks upon the subject are exceedingly important and instructive:—

"This woman, be it premised, was no idiot. Nevertheless, it may be observed, that the convolutions of her brain are relatively very little complicated. But what strikes one, at once, is the simplicity, the regular arrangement of the two convolutions which compose the superior stage of the frontal lobe. These folds, if those of the two hemispheres be compared, present, as we have already pointed out, an almost perfect symmetry, such as is never exhibited by normal brains of the Caucasian race. . . . . This regularity—this symmetry, involuntarily recall the regularity and symmetry of the cerebral convolutions in the lower species of animals. There is, in this respect, between the brain of a white man and that of this Bosjesman woman a difference such that it cannot be mistaken; and if it be constant, as there is every reason to suppose it is, it constitutes one of the most interesting facts which have yet been noted."—L. c., p. 65.

"The antero-superior curve is less convex than in the white man: lastly, the orbital fossæ are more concave; and there may be observed at the level of the anterior extremity of the temporo-sphenoidal lobe, a very marked constriction, which results from a very remarkable predominance of the supraciliary lobe. This disposition appears to result from the less development of the superior divisions. The brains of fœtuses belonging to the white race present it at the maximum, when the operculum of the fissure of Sylvius does not yet cover the central lobe; it is still quite apparent at birth; but it becomes slowly effaced with age, and in the adult it has completely disappeared. The brain of the Hottentot Venus is, then, in all respects, inferior to that of white men arrived at the normal term of their development. It can be compared only with the brain of a white who is idiotic from an arrest of cerebral development."—p. 66.

Finally, with respect to the fourth difference, Tiedemann observes (p. 515) of the negro's brain:—

"The anterior part of the hemispheres is something narrower than is usually the case in Europeans. This is particularly remarkable in the brain of the Bosjes woman."

Thus, the cerebral hemispheres of the Bosjesman (and to a certain extent of the negro), so far as the evidence before us goes, are different from those of the white man; and the circumstances in which they differ—viz., the more pointed shape of the cerebral hemispheres, the greater symmetry of their convolutions, and the different development of certain of these convolutions,—are all of the same nature as most of those which distinguish the ape's brain from that of man. In other words, if we place A, the European brain, B, the Bosjesman brain, and C, the orang brain, in a series, the differences between A and B, so far as they have been ascertained, are of the same nature as the chief of those between B and C.

The brains of the lowest races of mankind have been hardly at all examined; and it would be a matter of great interest to ascertain whether, in these races, there is any trace of the external perpendicular fissure, any diminution of the lobule of the marginal convolution, and any increase of the proportional size of the nerves to the cerebral mass. Medical men living at the Cape of Good Hope, in Australia, and within reach of the Hill-men of India, will, it is to be hoped, some day solve these problems for the zoologist.

Let it be admitted, however, that the brain of man is absolutely distinguished from that of the highest known apes—

1st. By its large size, as compared with the cerebral nerves;

2nd. By the existence of the lobule of the marginal convolution;*

3rd. By the absence of the external perpendicular fissure—

And then let us turn to the other side of the argument, and weigh these differences against those which separate the brains of *Pithecus* or *Troglodytes* from those of the lowest Quadrumana.

The brain of *Lemur mongos* is well figured, and constantly referred to by Tiedemann in the "Icones" so often referred to. The few gyri; the shortness of the cerebral hemispheres, in the region of the third lobe, which leave fully half the cerebellum uncovered; the large size of the vermis superior; the prominence of its flocculus; the great size of the olfactory nerves, which rather deserve the name of olfactory lobes; the singleness of the corpora candicantia; the comparatively small and flat pons varolii; the presence of corpora trapezoidea; and, in

* The second and third differences are mentioned by Gratiolet, to whose Memoir I must refer for a statement of their nature.

the internal structure of the brain, the large size of the optic thalami in relation to the corpora striata, and the total absence of a posterior cornu to the lateral ventricle*—are all characters which are perfectly obvious, and which separate the brain of the *Lemur* as completely from that of *Pithecus* or *Troglodytes*, as from that of man.

The description of the brain of *Stenops tardigradus*, by Vrolik, tells the same story even more strikingly; and the brains of *Perodicticus* and other Prosimiæ, exhibited in the Hunterian Museum, fully bear out the conclusion, that the vast differences noted obtain throughout the Prosimian division of the Quadrumana.

M. Gratiolet, in fact, has been so struck by the immense discrepancy between the Simiæ and Prosimiæ in cerebral structure, that he proposes to consider the latter as forming a part of the order Insectivora. In this view he is at variance with all the other zoologists; but, in order to meet all possible objections, I will, for the moment, suppose that he is right, and that the order Quadrumana should be restricted to the Simiæ. Even on this supposition, the force of my argument remains unchanged; for the brains of the lower true apes and monkeys differ far more widely from the brain of the orang than the brain of the orang differs from that of man. Not only do they differ from the orang (and to a greater degree) in most of those respects in which the orang differs from man, but they present the absolute distinction, that while the orang, like man, has two corpora candicantia, the lower apes, like the other Mammalia, have only one.

In respect of their cerebral characters, therefore, I hold it to be demonstrable that the Quadrumana differ less from man than they do from one another; and that, hence, the separation of *Homo* and *Pithecus* in distinct sub-classes, while *Pithecus* and *Cynocephalus* are retained in one order, is utterly inconsistent with the principle of any classification of the Mammalia by cerebral characters.

On a future occasion I propose to take up the question, whether, on other grounds, there is any reason for departing from the Linnean view, that man is to be regarded as a genus of the same order as that which contains the Quadrumana.

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* "Cornu posterius in Simiis et Phocis brevissimum et vix conspicuum est: in cæteris mammalibus plane desideratur."—Icones, p. 54.

Bibliography.

[In commencing the Bibliographical Record, it has been thought advisable to begin with the year 1860. With respect to works dated prior to that period, the *Bibliographia Zoologiæ et Geologiæ* of the Ray Society, which comes down to 1847–54, and the very valuable *Bibliographia Zoologiæ* of Professor V. Carus and W. Engelmann, of which the first volume has just appeared, which is brought down to the end of 1859, will, as regards Zoology at least, afford the required information.

In future, it is intended to supply the Bibliography of a single quarter only in each Number of the Review; but on the present occasion, as the greater part of a year is embraced, the quantity of materials has been found too large to admit of the insertion of the whole. A portion only, therefore, is now given, consisting of:—

1. A list of the Natural History periodical publications at present in existence, which will be amended and added to in future Numbers of the Review, as occasion may arise. In this list the publications are arranged according to the countries to which they belong; and under each of these heads they will be disposed in alphabetical order of the abbreviated titles placed in the left hand margin of the page, and by which titles, for the sake of brevity, it is intended to distinguish each periodical when cited in the Bibliography.

2. The Botanical Bibliography for the first nine months of 1860, so far as it has been collected.

In the April Number the entire Bibliography will, if possible, be brought down to the end of 1860. And at the end of the Annual Volume of the Review, it is proposed to give an alphabetical list of Authors' names, with references to the page or pages upon which his works appear in the classified catalogues of each quarter.

The readers of the Natural History Review will thus, at the end of each year, be furnished with a Classified list of Works or Papers in every department of Biological Science, as well as with an alphabetical list of Authors. Whilst, at the beginning of each year, any additions to, or removals from, the List of Periodical Publications, will be duly noted.]

X.—Periodicals.

1. America.

Am. Phil. Soc. T.—Transactions of the American Philosophical Society. 4to. Philadelphia.

Bost. N. H. S.—Proceedings of the Boston Society of Natural History. 8vo. Boston.

New York Lyc.—Annals of the Lyceum of Natural History of New York. 8vo.

Phil. Acad. Journ.—Journal of the Academy of Natural Sciences of Philadelphia. 8vo. Philadelphia.

Phil. Acad. Proc.—Proceedings of the Academy of Natural Sciences of Philadelphia. 8vo. Philadelphia.

Sillim. Journ.—The American Journal of Science and Art. Conducted by Professor Silliman. 8vo. New Haven.

Smiths. Cont.—Smithsonian Contributions to Knowledge. 4to. Washington.

St. Louis Trans.—Transactions of the Academy of Science of St. Louis. 8vo. St. Louis.

2. Great Britain, Ireland, and the Colonies.

A. N. H.—Annals and Magazine of Natural History. 8vo. London.

B. Ass. Rep.—Reports of the British Association for the Advancement of Science. 8vo. London.

Berw. N. C.—Berwickshire Naturalist's Club.

Can. Journ.—Canadian Journal of Industry, Science, and Art.

Can. Nat.—Canadian Naturalist and Geologist. 8vo. Montreal.

Dubl. Geol Soc.—Proceedings of the Geological Society of Dublin. 8vo. Dublin.

D. U. Z. B. A.—Proceedings of the Dublin University Zoological and Botanical Association. 8vo. Dublin.

Dubl. R. S.—Journal of the Royal Dublin Society. 8vo. Dublin.

Ed. Bot. S.—Proceedings of the Botanical Society of Edinburgh.

Ed. R. Phys. S.—Proceedings of the Royal Physical Society of Edinburgh. W.

Geol.—The Geologist. 8vo. London.

Geol. Journ.—Quarterly Journal of the Geological Society of London. 8vo. London.

Ibis.—Ibis, the Magazine of General Ornithology. 8vo. London.

Linn. Proc.—Journal of Proceedings of the Linnean Society. 8vo. London.

Linn. Trans.—Transactions of the Linnean Society of London. 4to. London.

Liverp. L. & P. Soc.—Proceedings of the Literary and Philosophical Society of Liverpool. W.

Lond. Ent. Soc. T.—Transactions of the Entomological Society of London. 8vo. London.

Manch. L. & P. S.—Memoirs of the Literary and Philosophical Society of Manchester. W. 8vo.

Mic. Trans.—Transactions of the Microscopical Society of London. W.

Newc. N. H. S.—Transactions of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne. W.

Phil. Journ.—The Edinburgh New Philosophical Journal. 8vo. Edinburgh.

Phil. Mag.—The London, Edinburgh, and Dublin Philosophical Magazine. 8vo. London.

Phil. Trans.—Transactions of the Royal Society of London. W. and N.

Q. J. M. S.—Quarterly Journal of Microscopical Science. 8vo. London.

R. I. A. Trans.—Transactions of the Royal Irish Academy. 4to. Dublin.

R. I. A. Proc.—Journal of Proceedings of Royal Irish Academy. 8vo. Dublin.

R. S. E. Proc.—Proceedings of the Royal Society of Edinburgh. 8vo. Edinburgh.

R. S. E. T.—Transactions of the Royal Society of Edinburgh. 4to. Edinburgh.

R. S. Proc.—Proceedings of the Royal Society. 8vo. London.

Vict. Trans.—Transactions of the Philosophical Society of Victoria.

Zool. Proc.—Proceedings of the Zoological Society of London. 8vo. London.

Z. Trans.—Transactions of the Zoological Society of London.

Zool.—Zoologist (The). A monthly magazine of popular natural history.

3. France.

Ann. S. N.—Annales des Sciences Naturelles. 8vo. Paris.

Arch. d. Mus.—Archives du Muséum d'Histoire Naturelle. 4to. Paris.

Bourd.: Soc. Lin.—Actes de la Société Linnéenne de Bourdeaux. 8vo.

Bull. Soc. Botan.—Bulletin de la Société Botanique de France. 8vo. Paris.

C. rend.—Comptes rendus hebdomadaires des Séances de l'Academie des Sciences. 4to. Paris.

C. biol.—Comptes rendus de la Societé de Biologie. 8vo. Paris.

J. de Physiol.—Journal de Physiologie de l'Homme et des Animaux. 8vo. Paris.

L'Inst.—L'Institut. 4to. Paris.

Lyons, Soc. Lin.—Annales de la Société Linnéenne de Lyons. 8vo.

Rev. & Mag. de Z.—Revue et Magazin de Zoologie. 8vo. Paris.

Savoie Mem.—Mémoires de la Société Academique de Savoie. Chambery.

Soc. d'Acclim.—Bulletin de la Société Zoologique d'Acclimatation. 8vo. Paris.

Soc. Entom. Ann.—Annales de la Société Entomologique de France. 8vo. Paris.

Soc. Géol. Bull.—Bulletin de la Société Géologique de France.

Strasb. Mus.—Mémoires de la Société du Muséum d'Histoire naturelle de Strasbourg. 4to. Strasbourg.

4. Germany.

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Berl. E. Z.—Berlin Entomologische Zeitung. 8vo. Berlin.

Berl. Monats.—Monatsberichte der kön. Preuss. Ak. d. Wissenschaft. 8vo. Berlin.

Bonn. Verhand. d. N. H. V.—Verhandlungen der Naturhist. Vereines der Preussischen Rheinlande und Westphalens. 8vo. Bonn.

Bot. Z.—Botanische Zeitung. 4to. Berlin.

D. G. Z.—Zeitschrift der Deutsches Geologisches Gesellschafft. 8vo. Berlin.

D. N. H. Zeit.—Allgemeine Deutsche Naturh. Zeitung. Herausg. v. Drechsler. 8vo. Dresden.

Flora.—Flora oder Allgemeine botanische Zeitung. 8vo. Ratisbon.

Freib. Ber.—Berichte ueber die Verhandl. d. Naturf. Gesellsch. zu Freiburg. 8vo. Freiburg.

Giess. Ber.—Berichte der Oberhessichen Gesellschaft fur Natur-- und Heilkunde zu Giessen. 8vo. Giessen.

Halle Abh.—Abhandlungen der Naturf. Gesellsch. zu Halle. 4to. Halle.

J. f. Orn.—Journal für Ornithologie. 8vo. Cassel.

Leips. Abh.—Abhandlungen der Kön. Sächsischen Gesellschaft der Wissensch. 4to. Leipsic.

Leips. Ber.—Berichte über die Verhandlungen der Kön. Sachs. Gesellschaft d. Wissensch. zu Leipzig. 8vo. Leipsic.

L. and B. Jahr.—Jahrb. neues, für Mineralogie, Geognosie, Geologie, &c. Herausg. von K. C. von Leonhard u. H. G. Brorn. 8vo. Stuttgard.

Linnea.—Linnea Journal für Botanik Herausg. v. Schlechtendal. 8vo. Brunswick.

Linn. Ent.—Linnæa Entomologica; Zeitzschrift d. Entom. Vereins, Stettin. 8vo. Leipzic.

Leop.—Leopoldina; Organ der Akademie d. Naturforscher. 4to. Jena.

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Meckl. Arch.—Archiv der Vereines der Freunde der Naturgeschichte in Mecklenberg. 8vo. New Brandenburg.

Mun. Abh.—Abhandlungen der kön. Bayersche Akademie der Wissensch. 4to. Munich.

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6. Spain and Italy.

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7. Russia.

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Botanical Bibliography.

XI.—Phanerogamia.

Alefeld, Dr.—*Hypechusa*, novum genus Viciearum ("Botanische Zeitung," 1860, p. 165). Founded upon a few species of *Vicia* (*V. hybrida*, *lutea*, and others).

——— *Ueber Pisum* ("Bot. Zeit.," 1860, p. 204–5). Dr. Alefeld considers all the forms of Pea which have been specifically distinguished to belong to *P. sativum*, of which he regards *P. elatius* (M. Bieb.) as the parent stock. *Pisum frigidum* (*Lathyrus frigidus*, Sch. and K.), is the second and only other species of *Pisum*. *P. maritimum* is a species of *Orobus*.

——— *Ein Wacholderbaum* ("Bot. Zeit.," 1860, p. 325). The author describes an arborescent female Juniper growing at the village of Niedernhausen, near Darmstadt, about 30 feet in height, with a circumference near the base of about 20 inches.

Archer, William.—On the value of Hairs, as a character in determining the limits of subordinate groups of species, considered in connexion with the genera *Eurybia* (Cass.) and *Olearia* (Mönch.), of Compositæ.—"Journ. Proc. Linn. Soc." (Bot.), vol. v., p. 17–25. The author groups the species of *Eurybia* and *Olearia*, fifty-two in number, under five sections, based on the form and character of the hairs of the leaves. The characters of the pappus and hairs of the achenes are minutely detailed, and their relation to the foregoing sections indicated by a tabulated Conspectus. Mr. Archer's Sections are:—1. *Dicerotricha*, Foliorum pili T-formes, vel divaricato-furcati. 2. *Astrotricha*, Foliorum pili stellati. 3. *Eriotricha*, Foliorum pili lanati. 4. *Adenotricha*, Folia viscosa, plerumque glanduloso-pilosa. 5. *Merismotricha*, Foliorum pili septati.

Arndt, R.—Ueber *Triticum acutum*, D. C. ("Flora," 1860, p. 481–9). The author points out the distinctions between this plant and *T. junceum*, and remarks on the absence of connecting links with that species. He does not regard it as a hybrid between *T. junceum* and *T.*

repens, nor as a maritime form of the latter. A synopsis is given of the various forms of the species, which are grouped under two series or races; together with descriptions and synonyms.

ASCHERSON, P.—Nachtrag zur Flora von Labrador ("Flora," 1860, 369–70). In a collection of 152 species gathered by Lundberg, near Nain, in Labrador, Dr. Ascherson finds about 36 species of flowering plants and ferns which are not in the lists of Schlechtendal ("Linnæa," 1836, p. 76), or Martens (Mün. Denk. Regensb. Bd. iv. i. 1).

BABINGTON, CHARLES C.—Flora of Cambridgeshire, or Catalogue of Plants found in the county of Cambridge, with references to former catalogues, and the localities of the rarer species.—London, 1860, 8vo., 327 pages. A chapter on the topography of the county, with map, and a tabular summary of the distribution of the species, are prefixed to the catalogue. An appendix contains observations upon several critical species and genera (*Thalictrum saxatile, Papaver dubium, Viola canina, Arenaria serpyllifolia, Rubus, Serrafalcus,* and *Triticum*), a list of species characteristic of the vegetation of the Fens, and another of species believed to be lost to the Cambridge Flora. A short account is also given of the range of Cambridge species in Britain beyond the limits of the county.

BAER, K. E. VON.—Ergänzende Nachrichten über Dattelpalmen am Kaspischen Meere und in Persien.—Bull. Ac. Imp. St. Petersburgh, tom i., p. 35–7.

ANDERSON, THOMAS.—On Sphærocoma, a new genus of Caryophylleæ, from Aden in Arabia Felix.—"Journ. Proc. Linn Soc." (Bot.), vol. v., p. 15–6. With 1 Plate. The nearest ally of this plant is Forsskål's genus *Gymnocarpus*, from which a pair of ovules and the bifid stigma distinguish it.

BAILLON, N.—Recherches Organogéniques sur la Fleur Femelle des Conifères. Presented to the Academy of Sciences, April, 1860. The author bases his views upon an extended organogenic study of the floral organs of the order. The development of the bracts, "scales," and female flowers, is detailed from *Taxus baccata, Phyllocladus rhomboidalis, Torreya nucifera, Thuja, Pinus resinosa, Salisburia,* and *Cupressus.*

In *Pinus resinosa, L.*, the cone presents, in its earliest stage, a cylindro-conical axis, bearing numerous unequal alternate bracts, the development of which is arrested at an early period. These, the author regards as the only appendicular organs of the cone. In the axil of each bract originate minute cellular, vertically compressed, obtuse processes, which eventually become the trilobate flattened "scales," bearing a pair of female flowers upon the lower portion of the lateral lobes. The median lobe, in the process of growth, ceases to be the apparent apex of the scale, becoming, by a partial arrest, a slightly incurved tooth-like projection borne near the middle of its inner side. Dr. Baillon regards the scale as a metamorphosed branch. Each flower originates with the rudiments of a pair of minute carpellary leaves, horse-shoe shaped, and with their concavities turned towards each other. These become connate, forming round the plane receptacle an elliptical enclosure. With the growth of the axial "scale" the position of the rudimentary flower alters—at first with the aperture directed laterally, it afterwards becomes directed slightly downwards. The carpellary leaves elongate, forming, as it were, an ovarian sac, continuous below, and divided above into two styline branches (*branches stylaires*). In the centre, at first free from the surrounding carpellary walls, is developed, in direct prolongation of the floral receptacle, a rounded swelling, which eventually forms the basilar ovule.

In *Cupressus*, the floral axis, which is similar to that of *Thuja* and *Salisburia* bears empty bracts. Above each bract, and at a tolerable distance from their insertion, a dicarpellary pistil originates opposite to their median line. Soon another flower is produced in front of, and below, the first, then two others upon the sides; additional flowers develope exterior to these, and lower en the axis, surrounding them in several irregular circles. Thus is formed a small, centrifugal, axillary inflorescence, in some measure comparable to the axillary glomerules of the Labiatæ, which, as in *Cupressus*, collectively form a kind of spike.

Dr. B. embodies the results of his investigation in the following propositions :—

1. The female flowers of the Coniferæ differ but slightly from each other in essential particulars. They are formed upon one type, and, regarded apart, afford no basis for the division of the Order into Pinaceæ and Taxaceæ.

2. The female flower is either terminal, or borne in the axil of a bract or of a leaf. It is always, however, as Schleiden also remarks, supported upon an axial process, and never upon a bract. As is the case in receptacles, the form of this axis is very variable.

3. As also Mirbel and Spach have regarded it, the flower is not gymnospermous, but possesses a true dicarpellary ovary, without floral envelopes, containing an orthotropal, erect ovule attached to a basilar placenta.

4. The cupule of various consistence and form which surrounds the ovary, and which in several genera has received the name of aril, is a later production, although anterior to fecundation, as is the case of those floral organs resulting from an ulterior expansion of the axis, which have been termed discs.

The Memoir is accompanied by figures, exhibiting the consecutive stages of development of the "scales" and female flowers in *Pinus resinosa*.

Baiträgez.—Pflanzenkunde d. Russischen Reichs.—Part II., plate. Petorsb., 1860, Royal 8vo.

Bentham, George.—Synopsis of Dalbergieæ, a tribe of Leguminosæ.—"Journ. Proc. Linn. Soc.," vol. iv. (Botany, Suppl.), 134 pp. Mr. Bentham, while engaged in editing the Leguminosæ for the "Flora

Brasiliensis" of Von Martius, having found it needful to revise the entire tribe Dalbergieæ, and to compare the Brazilian genera and species with those of the Tropics of the Old World, has been led to draw up a synopsis of the whole tribe, with brief characters of all the species.

The numerous accessions of specimens from all parts of the Tropics since the publication of the author's Memoir in the Annal. Wiener Mus., in 1837, have enabled him to modify the circumscription of many of the genera which were then proposed, and to reduce others which had been based upon insufficient material. To the descriptive portion of this paper is prefixed an introductory chapter, embracing general observations upon the main features of the Dalbergieæ, their economic uses, and geographical distribution. The genera are also severally reviewed. The Rosewoods of commerce are furnished by members of the group. The two best varieties imported from Rio are supplied by the genus *Dalbergia*, chiefly by *D. nigra;* other sorts are afforded by *Machærium*, and in Africa, by *Pterocarpus*. Mr. Bentham observes, that the great majority of species of the tribe occupy but very limited areas. There is not one species common to Asia and America; five or six are common to America and West Africa. Of 200 American species, but 5 extend from northern or central Brazil to the West Indies and Central America. The 286 species of Dalbergieæ here described are distributed in 23 genera, which are grouped under three principal sections, viz. *Pterocarpeæ*, with dry fruit, and leaflets mostly alternate along the petiole; *Lonchocarpeæ*, also with dry fruit, but with the leaflets more strictly opposite; and *Geoffroyeæ*, with a usually drupaceous fruit, and a single pendulous seed.

Beurling, P. J.—Plantæ vasculares seu cotyledoneæ Scandinaviæ, nempe Sveciæ et Norvegiæ, juxta Regni vegetabilis systema naturale digestæ. 8vo. Holmiæ.

Bianca, G.—Flora dei intorni d'Avola. Memorie che contiene la descrizione delle piante comprese nelle classe Diadelphia.—Catan. Acad. Giorn. xiv.

Bibra.—Die Getreidearten und das Brod. 8vo. Nürnberg, 1860.

Boissier, E.—Centuria Euphorbiarum. Lipsiæ et Parisiis: April, 1860. 8vo.

Bolle, C.—Addenda ad floram Atlantidis præcipue insularum Canariensium Gorgadumque. (Continuation) Bonplandia, viii. Jahrg., p. 130–6 (Compositæ) 279–87 (Labiatæ, Verbenaceæ).

Boussingault, M.—De la Terre végétale considérée dans ses effets sur la végétation (Comptes Rendus, 1859).—Ann. des Sciences, Ser. iv., tom. xii., p. 354–72.

M. Boussingault's investigations bear reference to the relations subsisting between the amount of matter of organic origin contained in vegetable soils, and the extent to which this is really available to plants.

Braun, A.—Ueber Polyembryonie u. Keimung v. *Cœlebogyne*. Ein Nachtrag zu der Abhandlg. üb. Parthenogenesis bei Pflanzen. 6 plates. 4to. Berlin, 1860. (Berl. Abh., 1859).

——— and C. Bouche.—Index Seminum in Horto Bot. Berolinensi, 1858. Ann. des Sc. Nat. Ser. iv., tom. xii,, p. 380.

Buchenau, F.—Die Sprossverhältnisse von Ulex.—Flora, 1860, p. 449–56.

Bunge, Alex. de—Letter from, to M. Decaisne. Bull. Soc. Bot. de France, tom. vii. p. 29, 30.

This letter is in reply to one addressed to M. Bunge, prior to his departure for Persia, by M. Decaisne, directing his attention to the investigation of original sources of certain economic plants and products, the collecting of seeds, occurrence of *Chamærops* and the Date Palm in Persia, &c. M. Bunge, in reply states—1. That he was unable to learn anything as to the origin of cereals. 2. The Melon was not indigenous in those parts of Persia which he visited. A *Bryonia* was the only Cucurbitacea. 3. He did not observe the Horse Chesnut (*Æsculus Hippocastanum*), either wild or in cultivation. *Pinus* and *Abies* were absent. *Platanus orientalis* was not met with in the wild state. 4. The Persian Lilac, Apricot, and Peach, were not found wild, neither was any species of *Lilium*, or *Quercus mannifera*. 5. The date occurred only at Teber—in autumn, laden with fruit—and at Chabbis, in spring, in full flower. The dates were quite ripe at Teber by the end of October. No other palms were met with.

Bureall, Ed.—Laboratoire de Botanique à la Faculté des Sciences de Paris. A Letter to Count Jaubert.—Bull. Soc. Bot. de France, tom. vii., p. 5–8.

Caruel, F.—Observations sur la nature et l'origine de la pulpe qui entoure les graines dans certains Fruits.—Ann. Sc. Nat. (Bot.), Ser. iv., tom. xii., p. 72–7.

The author traces the development of pulp in the fruit of various species belonging to the following orders, viz. Cucurbitaceæ, Solanaceæ, Ericaceæ (*Arbutus unedo*), Capparidaceæ, Aurantiaceæ, Cactaceæ, Aroideæ. In most Cucurbitaceæ the tissue of the recurved parietal placentas interposes itself between the ovules, which it encloses in distinct cavities. With maturation of the fruit, this placentary cellular tissue becomes the pulp of varying consistence, in which the seeds are usually found to be embedded. In *Momordica* the placental tissue becomes spongy and orange-coloured; the layer surrounding each seed ultimately separates from the rest of the tissue, and forms around it a distinct closed envelope. Similar arilloid sacs envelope the seeds in *Trichosanthes anguina*, *Bryonia verrucosa*, and, perhaps, *Joliffia Africana* (*Telfairia pedata*, *Hk.*). In Solanaceæ, after flowering, the folds of the endocarp advance towards the interior of the young fruit, eventually uniting with the placentas; at the same time, being interposed between the seeds, they form for each of them a separate niche. In the Tomato (as also in *Arbutus unedo*), the expansions of tissue surrounding the seeds are due to prolongations from the placentas. In the Orange, the pulp originates from the numerous papillæ which, at the time of flowering, cover more or less the walls of the cells of the ovary. These elongate without branching, and entirely fill the cavity of the loculaments. At maturity, the cellular tissue of which they are composed is filled with yellow juice.

In the species of Cactaceæ with pulpy fruits, the pulp is an appendage of the seed, or rather an arillus, or false testa, derived from the funiculus. Many Aroideæ have a pulp consisting of isolated, soft, confervoid cellular filaments originating on the placenta, the funiculus, and around the base of the ovules.

Carrière, M.—Considerations générales sur l'especè.—Rev. Hort., 1860, pp. 383–8, 416–9. (Instances of variation in ornamental trees and shrubs, and in forest trees), p. 443–6. (Instances of variation, and the formation of *races* in animals).

——— Sur quelques Variétés de Yucca. Rev. Hort., 1860, pp. 358–64. Descriptions of six cultivated varieties of *Yucca gloriosa.*

——— Sur la Transformation des végétaux. Refutation de la Transformation spécifique des végétaux par l'effet des milieux dans lesquels ils croissent.—Rev. Hort., 1860, p. 65–71. Relates to Mr. Buckman's experiments on *Glyceria fluitans* and *Poa aquatica,* and to the supposed transformation of *Ægilops* into *Triticum.* No new facts are recorded.

Cesati, J. and T. de Notaris.—Index Seminum Hort. Reg. Bot. Genuensis, 1858.—Ann. Sc. Nat. Ser. iv., tom. xii., p. 381.

Chatin, Ad.—Note sur un cas Teratologique offert par *l'Henophyton deserti.*—Bull. Soc. Bot. de France, tom. vii., pp. 10, 11. In this monstrosity the ovaries were developed into a kind of gall, owing to insect-puncture.

Crepin, Fr.—Manuel de la Flore de Belgique. Bruxelles, 1860. 8vo. pp. 236.

The descriptive portion of this "Flora" is preceded by chapters on Herbaria and Herborisations, the Geographical Botany of Belgium, the "Vegetable Species," and a Glossary of terms. The author bases the four botanical regions of Belgium upon the principal geological divisions of the country. The geological and physical features of these regions are described, and lists given of their characteristic species. Analytical tables of the orders, genera, and species are also furnished. The descriptions are in French.

——— Note sur quelques Plantes rares ou critiques de la Belgique.—Bull. Acad. Roy. Belgique. Ser. ii., vol. vii.

Crüger, Hermann.—Outlines of the Flora of Trinidad.—Appendix L. to "Report on the Geology of Trinidad." By G. P. Wall and J. G. Sawkins. London, 1860. 8vo. pp. 178–95. Embracing a sketch of the vegetation of the forests, mountains, savannas, &c., and of the generally prevailing physiognomic forms. In reference to the botany of the celebrated Pitch Lake, near San Fernando, with an area of 99 acres, H. Crüger states, a Chara and some Confervæ to grow in the water, filling the crevices which intersect the surface of the pitch. About the borders of the lake are a few mosses, lichens, grasses, and sedges; and where the broken, weathered pitch becomes looser, are found *Clusia*, *Chrysobalanus*, *Anona palustris*, Bromeliaceæ, Ferns, &c. A catalogue is given of the genera, both of Phanerogams and Cryptogams, which have been observed by the author in the island.

Daubeny, Charles.—Remarks on the Final Causes of the Sexuality of Plants, with particular reference to Mr. Darwin's Work on the Origin of Species. Oxford, 1860. 8vo. 34 pages. With 1 plate.

Dickie, George.—The Botanist's Guide to the Counties of Aberdeen, Banff, and Kincardine. Aberdeen, 1860. 1 vol. 8vo. 344 pages.

A few observations on the physical features, and a summary of the physical and geological structure of the counties, by Alexander Cruikshank, are prefixed to the list of species. The altitudinal range of the species, and the stations of the less common ones, are given.

Duchartre, P.—Recherches physiologiques, anatomiques, et organogeniques sur la Colocase des Anciens.—Ann. Sc. Nat. Bot. Ser. iv., tom. xii., pp. 232–79. With 4 plates.

The author's observations bear special reference to the remarkable phenomenon of the secretion of water by the minute orifices at the extremity of the leaves. M. Berthelot, at the author's request, analyzed the excreted water, and found it almost absolutely pure; faint traces, only, of chloride of potassium, carbonate of lime, and organic mucilage, were perceptible. M. Duchartre regards the emission of fluid to be directly due to diminished transpiration of the leaves: that transpiration and aqueous excretion stand in inverse ratio to each other, though at the same time they are but different manifestations of the same physiological phenomenon. The author's anatomical investigations were directed mainly to the system of canals in the submarginal nerve-like thickening of the leaves, and to the orifices terminating them, by which the water finds an exit. Examination of the development and structure of the excretory orifices shows them to be greatly altered and enlarged stomata. Minute observations are appended on the development and rate of expansion of the leaf.

——— Note sur deux Fleurs monstrueuses de *Cattleya Forbesii*, *Lindl.* —Bull. Soc. Bot. de France, tom. vii., p. 257.

In one of these flowers the segments of the perianth were reduced to five, the labellum and one of the lateral sepals being united by their margins into a single large segment, the halves of which were distinctly separated, as it were, by a longitudinal thick stripe of bright yellow colour. Each of the united segments retained its characteristic colour, texture, and position; but while the sepal retained its normal breadth, the labellum to which it was united acquired but half its dimensions. Owing to this reduction of the labellum, the unaltered column was entirely laid bare. The two petals were but slightly altered, the most remarkable feature being, that the one next to the monstrous labellum had contracted a close union with the lower half of the column in the direction of its median line. Both retained their normal position. In the upper flower of the

same inflorescence, the inferior sepal, and one of the lateral pair, had undergone no alteration; the other lateral sepal was affected as in the other flower, being united throughout with the semi-labellum. The two lateral petals remained normal and free. Within the compound lobe, resulting from the union of the lateral sepal and labellum was an entire, free, slightly trilobate, second labellum, traversed by a thick longitudinal stripe. The right side of this labellum was nearly flat, and with an undulate margin; a portion of the left side was sharply curved inwards, becoming parallel to the rest of the segment, and between it and the column. Within these was a third and yet smaller, spreading, supplementary labellum, with its back turned to the plane face of the column, and bearing slight traces of a thickened median line. The median line of the large labellum was sensibly turned towards the left, that of the small inner one, toward the right. The three labels were placed nearly in front of each other; the intermediate free one probably representing the normal labellum.

——— L'eau de la pluie qui mouille et lave les organes exterieurs des plantes, est-elle absorbée directement? Recherches experimentales sur cette question.—Bull. Soc. Bot. de France, tom. vii., pp. 86–92.

The detail of eight observations is given upon four species (*Fuchsia globosa*, *Veronica Lindleyana*, China Aster, and *Phlox decussata*). From M. Duchartre's experiments it results, that plants exposed to rain for various intervals up to 12 hours, having the pots containing their roots perfectly closed, acquired no increase in weight; on the contrary, in some cases, a slight decrease was manifest, due to loss by transpiration.

Dufour, Léon.—De la valeur historique et sentimentale d'un herbier 2ème partie. Souvenirs 'd'Espagne.—Bull. Soc. Bot. de France, tom. vii., pp. 103–9.

Engelmann, George.—Systematic arrangement of the species of the genus Cuscuta, with critical remarks on old species, and descriptions of new ones. St. Louis, 1859. (Ext. Trans. Acad. Sciences, St. Louis, 1859, vol. i., pp. 453–523).

——— Two new Diœcious grasses of the United States.—Trans. Acad. Science, St. Louis. 1859, pp. 431–442, with 3 plates.

These grasses are regarded as types of new and distinct genera, both of which, probably, belong to Chlorideæ—*Buchlöe dactyloides*, Engelm. (the Buffalo-grass of the Western Prairies), and *Monanthochlöe littoralis*, Engelm. (from Texas and Florida).

Fenzl, Ed.—Delectus Seminum in Hort. Bot. Univ. Vindobonensis collectorum anno 1858.—Ann. Sc. Nat. (Bot.). Ser. iv., tom. xii., pp. 165–6.

Frauenfeld, Georg.—Ueber exotische Pflanzenauswüchse erzeugt von Insecten.—Verhandlgn. Zool.-Bot. Gesellsch. Wien. Bd. ix., pp. 319–32, with 2 plates.

Relating chiefly to galls and monstrous growths on *Tamarix*, *Deverra*, *Zygophyllum*, and other eastern plants.

Frémy, E.—Recherches Chemiques sur la composition des cellules végétales.—Ann. des Sciences Nat. (Bot.). Ser. iv., tom. xii. pp. 320–353. (Ext. from Comptes Rendus).

M. Frémy's observations relate chiefly to results obtained by the treatment of vegetable tissues with the ammonuret of copper, in which he finds the true cellulose layer of the cell-walls to be readily soluble together with the azotised matter which often occurs in it; while the inner deposits, having pectine as their base, are insoluble, and are left as pectate of copper, retaining the form of the original cells. M. Frémy announces the discovery of a new acid, which he terms "cellulic," comparable to malic acid, and forming soluble compounds with all bases. It is obtained by submitting the carefully washed pulp of fruits or succulent roots to the action of lime, with which it forms a cellulate, and from which it may be separated by oxalic acid. The distinctive chemical characters presented by ligneous and cortical fibrous tissue and pith are detailed. Special chapters are devoted to the chemical examination of cuticle, the composition of the prosenchyma, vessels, and medullary rays of wood; also to the composition and mode of formation of gums in vegetable organisms.

Gasparrini, G.—Ricerche sugli organi assorbente delle radice, et sulle loro escrezioni. Osservazioni sull'origine dell' embrione seminale della Lemna minor.—Napol. Mem. II.

Gray, Asa.—Note on the Species of Nissolia.—Jour. Proc. Linn. Soc. (Bot.), vol. v., pp. 25-6.

Diagnoses are given of *N. Wislizeni*, and *N. Schottii*, A. Gr.

Gris, Arthur.—Observations sur la fleur des Marantées.—Ann. Sc. Nat. (Bot.). Ser. iv., tom. xii., pp. 193–219, with 4 plates.

A minute account is given of the floral structure of species examined by the author in the living state in the Jardin des Plantes, with observations on the function of the staminodia in the process of fertilisation. The structure of the fruit, and especially of the seeds (of *Thalia dealbata*, and other species), is described in detail.

Hammar, O.—Monographia generis Fumariarum. 6 plates. 4to.—Ups. Acta. ii. 2.

Hanstein.—Ueber ein noch nicht bekanntes System schlauchförmiger Gefässe im Parenchym der Blätter. Berl. Mon. 59 (11).

Harvey, W. H.—"Thesaurus Capensis;" or, Illustrations of the South African Flora. Vol. i., Parts 3, 4. 8vo. Plates 51–100.

Pleiospora, a new genus of Leguminosæ, near *Psoralea*; also *Tryphostemma*, a genus of Passifloreæ, with flowers not larger than those of chickweed, are described and figured.

——— and O. W. Sonder.—Flora Capensis; a Systematic Description of the Plants of the Cape Colony, Caffraria, and Port Natal. Vol. 1. (Ranunculaceæ to Connaraceæ).

Hasskarl, J. K.—Hortus Bogoriensis Descriptus. Continuation. Bonplandia. viii. Jahrg., pp. 90–100. Scrophulariaceæ, Solanaceæ (the generic character of *Jochroma* is re-written), Gesneriaceæ, Palmæ, and Smilaceæ.

Henslow, J. S., and E. Skepper.—Flora of Suffolk. London, 8vo.

A catalogue of the plants, indigenous or naturalized, found in a wild state in the county of Suffolk, with the times of flowering, and the localities of the less common species.

Heyer, Karl, and Julius Rossmann.—Phanerogamen-Flora der Provinz Oberhessen, insbesondere der umgegend von Giessen.—Oberhessisch. Gesell. Natur-und Heilkunde. Achter Bericht., App. 96 pages.

Extends to the genus *Lathyrus*. The descriptions are in German. The nature of the habitats, and the special locality of rarer species, are given, also the vulgar name of each species; if only generic, the Latin adjective is translated.

Hildebrand, Dr.—Der Bau der Coniferenspaltöffnungen und einige Bemerkungen über die Vertheilung derselben.—Botanische Zeitung, 1860, p. 149, with 1 plate.

Hoffmann, Hermann.—Vergleichende Studien zur Lehre von der Bodenstetigkeit der Pflanzen.—Oberhessisch: Gesell. Natur-und Heilkunde. Achter Bericht., pp. 1–12, with 2 maps.

In reference to the opposing views as to whether familiar geognostic relations of certain species are dependent upon the physical conditions or the chemical composition of the soil, Dr. Hoffmann states his opinion, based upon special investigations which he has instituted in the neighbourhoods of Giessen and Kissingen, that in the case of the so-called chalk-plants, the presence of a certain proportion of lime has the first influence. Close inquiry into apparently exceptional cases, and analysis of the soil, the author finds to confirm his view. When a "chalk-plant" is found isolated, on sandstone, for example, the number of individuals does not increase, nor does the plant thrive, and its existence is but transitory. Dr. Hoffmann shows, upon small maps of the vicinity of Giessen and Kissingen, having the alluvium, and the basaltic and calcareous formations shaded in, the localities of *Prunella grandiflora* and *Dianthus carthusianorum*. The basalt near Giessen contains from 7 to 12 per cent. of lime.

——— Vegetationszeiten in dem Jahr 1859.—Oberhessisch. Gesell. Natur-und Heilkunde. Achter Bericht., p. 85.

A table of observations made at Giessen, Pfeddersheim, Marburg, and Messel, on the periods of first expansion and full flowering of 37 species, including Horse Chesnut, Laburnum, *Crocus vernus*, Apple, Robinia, Lilac, Vine, winter Wheat, &c.

Hofmeister, W.—Nouveaux documents destinés a faire connaitre la formation de L'Embryon des Phanérogames.—Annales des Sciences Naturelles, (Bot.). Ser. iv., tom. xii., pp. 5–71.

A partial translation of Hofmeister's paper entitled, "Neue Beiträge zur Kenntniss der Embryo-bildung der Phanerogamen" (in Abhdg. Kon. Sachs. Ges. d. Wissensch. vi.).

Hogg, John.—Note on the Tree Mallow.—Jour. Proc. Linn. Soc. (Bot.), vol. v., pp. 51–2.

A specimen grown in the north of England from seeds collected in the south of Ireland, and sown in April, 1858, was killed by the frost of December, 1859. When cut down, the stem measured 2½ inches in diameter, exclusive of the bark. Mr. Hogg directs attention to the value of the fibre of the bark, and the importance of the cultivation of the *Lavatera* on its account.

Hooker, J. D.—Note sur l'origine et le developpement des urnes dans les plantes du genre Nepenthes. Jour. Trans. Linn. Soc., London, 1859.—Ann. Sc. Nat. (Bot.). Ser. iv., tom. xii., pp. 222–31.

——— On *Fropiera*. A new Mauritian genus of Calycifloral Exogens, of doubtful affinity.—Jour. Proc. Linn. Soc., vol. v., pp. 1, 2, with 1 plate.

Founded upon specimens collected in the Mauritius by Sieber, M. Bouton, and others. In habit *Fropiera* resembles some Ilicineæ; but its glandular, entire leaves, with closely parallel, and also intramarginal veins, indicate a relationship with Myrtaceæ, of which order Dr. Hooker is disposed to regard it as an anomalous ally.

——— On *Barteria*. A new genus of Passifloreæ, from the Niger River.—Jour. Proc. Linn. Soc., vol. v. (Bot.), pp. 14–5.

A remarkable and anomalous addition to Passifloreæ, collected by the late Mr. Barter. The stigmas are consolidated into an indistinctly-lobed, capitate mass, exceeding the ovary in diameter. The stamens are numerous, and bi-serial.

——— (The following is a brief notice of a paper read by Dr. J. D. Hooker before the Linnean Society, 21st June, 1860, on the Distribution and Affinities of North Polar Vegetation. This paper will appear in the "Transactions of the Linnean Society of London.")

The Arctic Flora is comprised within a belt of 10° to 14° latitude, N., of the Arctic circle. The number of Phanerògamia hitherto collected within this belt amounts to 806 (Monocotyledons, 218, Dicotyledons, 588). Cryptogams may be approximately estimated at a little over 900. The predominating type in Arctic vegetation is the Scandinavian: Arctic Scandinavia alone containing three-fourths of the species. The Asiatic and American types are very subordinate. The general character of the vegetation is continuous in longitude, without abrupt break, excepting in the meridian of Baffin's Bay, where the contrast between the almost purely European Flora of the east coast, and the American element of the west, is very marked.

Dr. Hooker divides the region of the Arctic Flora into five provinces, viz.:—

			Proportion of Scandinavian species.
Arctic Europe (extending east to the Obi), containing	(about)	607 species,	93 : 100
,, Asia,	,,	218 ,,	86 : 100
,, West America,	,,	349 ,,	72 : 100
,, East,	,,	359 ,,	71 : 100
,, Greenland,	,,	192 ,,	95 : 100

This table conspicuously shows the close affinity of the Flora of the Greenland peninsula with that of Scandinavia, notwithstanding its geographical position. Temperate Greenland, though 400 miles long, adds but 74 species to the comparatively poor Flora of the entire peninsula, and of these, all but two are Arctic Lapland plants.

The poverty and peculiarity of the Greenland Flora, and absence of American types in it, are not explained by the general physical features of contiguous regions, or by aërial or oceanic currents.

Dr. Hooker attributes chief importance to past extensive climatal changes, and to its peninsular form. He assumes—1. The great antiquity of the Scandinavian type. 2. He agrees with Darwin and Forbes, in considering that, prior to the Glacial Epoch, a uniform Flora was more widely extended over the circumpolar area than at the present period; as also—3. That by the increased cold of the Glacial Period the Scandinavian Arctic Flora was driven into lower latitudes, returning northwards with the succeeding warmth of the present period, accompanied by species peculiar to the tracts invaded by it. 4. That many of the species of the Greenland peninsula, cut off by isolation from the general southward migration, were exterminated. 5. That from the species which survived this period in the southern extremity of Greenland, the present Flora is chiefly derived. 6. That from its peninsular form there could be no admixture of American types.

The botanical provinces, and the local distribution of plants within the Arctic circle—also the general distribution of Arctic species over the surface of the globe—are discussed at length. A systematic catalogue is given of all the species hitherto found in Arctic regions, tabulated, to show the distribution of each, both within the circle, and generally over the world.

Irmisch, Th.—Ueber einige Ranunculaceen.—Botanische Zeitung, 1860, p. 221–7, with 1 plate. Pt. iii. *Eranthis hiemalis.* A detailed account of its germination, formation of bulbs, flower, &c.

——— Beiträge zur Morphologie der monocotylischen Gewächse. Part I. Amaryllideen.—Halle. 1860. 4to. 11 plates.

Jankee, V. de.—Adnotationes in plantas adacicas nonnullasque alias Europeas.—Linnæa. Bd. xiv., pp. 549–622.

An enumeration of species arranged in their natural sequence, with observations and descriptions of those which are new, critical, or imperfectly described. On *Festuca nutans* of Wahlenberg, a new genus (*Amphigenes*) is based. An analytical table of the species of *Sesleria* is given.

Junghuhn, F., and J. E. de Vry.—Die Chinakultur auf Java zu Ende des Jahres 1859, kurz beschreiben.—Bonplandia viii. Jahrg, pp. 206–10, 227–42, 254–8, 270–9.

The first section consists of a report, by F. Junghuhn, on the condition of the *Cinchonas* which have been planted, in a botanical and cultural point of view. The second, by Dr. de Vry, refers to the organic constituents of the Java *Cinchonas,* and their chemical characteristics.

KARSTEN, H.—Das Geschlechtsleben der Pflanzen u. die Parthenogenesis.—Berlin, 1860. 4to. 2 plates.

——— Floræ Columbiæ terrarumque adjacentium specimina selecta. Tom. i., Fasc. 2.—Berlin, 1860. Folio. 20 plates.

KEIL, FRANZ.—Ueber die Pflanzen-und Thierwelt der Kreuzkofl-Gruppe nächst Lienz in Tirol.—Verhandlgn. Zool.—Bot. Gesellsch. Wien. Bd. ix., pp. 151–166.

KERNER, A.—Die Formationen immergrüner Ericineen in der Nördliche Kalkalpen.—Bonplandia viii. Jahrg., pp. 210–2, 287–9.

KÖRNICKE, FR.—Ueber *Bidens tripartita*, *L. nodiflora*, *L. radiata*, Thl. und *platycephala*, Oer.—Bonpl. viii. Jahrg., pp. 222–7.

KOTSCHY, THEODOR.—Die Eichen Europa's und des Orients.—Liefg. v., with 5 plates.

LEHMANN.—Index Seminum in Horto. Bot. Hamburgensi, 1858.—Ann. Sc. Nat. Bot. Ser. iv., tom. xii., pp. 220–1.

LINDEN, J.—Hortus Lindenianus. Recueil iconographique des plantes nouvelles introduites par l'établissement de J. Linden, au jardin royal de zoologie et d'horticulture à Bruxelles. 2 livr.—Bruxelles, 25 coloured plates. 8vo.

LOWE, R. T.—A list of plants observed or collected at Mogador, and in its immediate environs, during a few days' visit to the place in April, 1859; with notes and observations.—Jour. Proc. Linn. Soc. (Bot.), vol. v., pp. 26–45.

The author remarks the Andalusian or Spanish-European character of the vegetation. Palms, Bananas, Cactaceæ, the Canarian shrubby Euphorbiaceæ and Madeiran Compositæ, Labiatæ, and Cruciferæ, are wanting. Trees are absent from the coast region, which is more or less clothed with *Retama monosperma*, *Pistacia lentiscus*, dwarf *Argania*, &c. *Peganum harmala* abounds on the shore.

A catalogue is given of the 177 Phanerogamous plants observed. Of these, one-fourth are common to Mogador, Algeria, Britain, the Canaries, and Madeira; two-thirds are common to Mogador and Algeria. Critical notes are appended on certain of the species.

MACVICAR.—Vegetable Morphology: its general principles.—Edin. New Phil. Jour., 1860. 20 pages.

MARTIUS, C. F. PH. VON.—Flora Brasiliensis. Fasc. xxv. Santalaceæ and Myristicaceæ, by Alph. de Candolle. Fasc. xxvi. Apocynaceæ, by J. Mueller. Lipsiæ, 1860.

MAXIMOWICZ, C. J.—Primitiæ Floræ Amurensis (Ext. Mem. Ac. Imp. St. Petersbg., t. ix., 1859. 4to. 504 pages. 10 plates and map.

The new genera described are:—*Plagiorhegma* (Berberideæ); *Hylomecon* (Papaveraceæ); *Schizopepon* and *Mitrosicyos* (Cucurbitaceæ); *Eleutherococcus* (Araliaceæ); *Symphyllocarpus*, *Syneilesis* (Compositæ); *Pterygocalyx* (Gentianaceæ); *Omphalotrix* (Scrophulariaceæ).

MEINSHAUSEN, K. F.—Beitrag zur Pflanezengeographie des Süd-Uralgebirges.—Linnæa. Bd. xiv., pp. 465–548, with 1 plate.

The author was engaged, in the summer of 1844, as collector to the Imperial Botanic Gardens in the Southern Ural. This paper contains a general notice of the vegetation of those parts visited by him, with observations on the relations of the Flora of this region. An enumeration of the flowering plants and ferns of the South Ural, with notes on the flowering or fruiting period of most of the species, is appended.

MÉLICOCQ, BARON.—Les Forêts du Nord de la France aux xv[e], xvi[e], et xvii[e] siecles.—Bull. Soc. Bot. de France, tom. vii., p. 11–14.

MIERS, JOHN.—On the Tribe Colletieæ, with some observations on the structure of the seed in the family of the Rhamnaceæ.—Annals and Mag. Nat. Hist. 3 ser., vol. v., pp. 76–95, 200–216, 267–73, 370–81, 482–92.

Mr. Miers prefixes to the descriptive portion of his paper a detailed account of the structure of the seed of *Colletia dumosa*, and of several species of *Rhamnus*, *Frangula*, *Zizyphus*, and *Alphitonia*.

The *Colletieæ* are divided into three sections.—1. *Eucolletieæ*, Flores apetali; fructus capsularis, dehiscens (including *Notophaena*, gen. nov.). 2. *Chænocarpeæ*, Flores petaliferi; fructus capsularis, dehiscens. 3. *Clethrocarpeæ*, Flores petaliferi; fructus nucumentaceus et lignosus aut membranaceus, fere semper indehiscens (including *Scypharia*, gen. nov.). The genera and species (of which 21 are new), are minutely described.

MOHL, H. VON.—Ueber die anatomischen Veränderungen des Blattgelenkes, welche das Abfallen der Blätter herbeiführen.—Bot. Zeitung, 1860, pp. 1–7, 9–17.

Von Mohl details his observations upon the phenomena presented by various species, and particularizes certain exceptional conditions which occurred to him. Generally speaking, the essential structural change which is the immediate cause of the fall of leaves takes place in a transverse layer of the cells of the petiole. The cells of this layer usually soften, become filled with plastic contents, multiply by division, and finally their membranes separate in a determinate plane.

——— Ueber den Ablösungsprocess saftiger Pflanzenorgane.—Botanische Zeitung, 1850, pp. 273–7.

The author investigates the immediate causes which determine the fall of the undeveloped extremities of branches during summer; of flowers, and of floral organs. In the case of the caducous apical buds, their fall is due to the separation from each other of the starch- or protein-containing cells of a transverse divisional plane, in a manner corresponding to that obtaining in the petiole of leaves. The fall of flowers (as in *Æsculus*, male flowers of Cucurbitaceæ, perigonial leaves of *Lilium*, &c.), is consequent on the rounding and mutual separation of the cells of similar divisional planes.

MUELLER, J.—Genera nova tria Apocynacearum extra-brasiliensi-americana.—Botanische Zeitung, 1860, pp. 21–3. The genera are *Elytropus*, *Prestoniopsis*, *Urechites*.

——— Species novæ nonnullæ americanæ ex ordine Apocynearum et observationes quædam in species generis *Echitis* Auctorum earumque distributio in genera emendata et nova.—Linnea Bd. xiv., pp. 387–454.

Münch, Pfarrer.—Mittheilungen über einige Loranthaceen.—Flora, 1860, p. 465.

Diagnoses of *Viscum album*, and *Loranthus europæus*, with observations on their general history, distribution, germination, &c.

Nägeli, C.—Beiträge zur wissenschaftlichen Botanik. Part II.—Leipsic, 1860. 8vo. 192 pages, 8 plates, 4to.

Movements of plants, right and left. Motion of cells and contents. On the alleged occurrence of free or amorphous starch in *Ornithogalum*.

Naudin, Ch.—Revue des Cucurbitacées cultivés au Muséum, en 1859.—Ann. Sc. Nat. (Bot.). Ser. iv., tom. xii., pp. 79–164, with 3 plates.

M. Naudin prefixes to the descriptive portion of this memoir, observations upon the nature and disposition of some of the floral organs of the Cucurbitaceæ, in continuation of a notice previously published by him (Ann. Sc. Nat. (Bot.) Ser. iv., tom. iv., p. 5, *et seq.*).

The so-called calyx-tube of the male flower, M. Naudin regards as a campanulate or tubuliform dilatation of the extremity of the peduncle; in other words, that it is a true receptacle, comparable to that of the rose, in the composition of which the calycine leaves take no part. He states the theory of congenital union or coalescence of the calyx segments to be, in the case of the Cucurbitaceæ, quite inadmissible. There is no trace of sutural lines on the "calyx-tubes" of any known species of the order. The pentagonal form which it sometimes assumes is due to the form of the peduncle, which is also pentagonal, the angles being simply prolonged upon the "calyx-tube," which is but a dilatation or expansion of it.

The true calyx, according to M. Naudin, consists but of the five lobes, which in some species are reduced to imperceptible teeth, and in others are strongly developed. In certain varieties of *Cucurbita maxima* they are entirely wanting, the flower consisting only of corolla and the staminal fascicle. M. Naudin leaves the question open as to whether the tubular lower portion, when present, of the "corolla," may be, in like manner, a modified process of the receptacle, in which case the lobes of the upper portion would answer to the true petals. The author confirms his previously published views on the structure of the stamens in Cucurbitaceæ, by further examination of species of *Luffa*, in which the two complete and bilocular stamens are divided to their base. In these plants the filaments do not alternate with the five corolla-lobes, but are in pairs; the filaments of each pair being collateral, and inserted upon the same point of the receptacle. An additional proof that the bilocular stamens of the Cucurbitaceæ are simple, but complete, is the fact that there exist species having really five stamens, alternating with the corolla-lobes. This return to the usual symmetry is presented by a plant not yet clearly determined, but probably belonging to the genus

Æchmandra, of Arnott. M. Naudin maintains, that in the great majority of the Cucurbitaceæ, the stamens are three in number, two being entire and bilocular, and one reduced to a half, and thus unilocular. Among the nineteen genera enumerated and described in detail in this paper, is the new genus *Peponopsis*, founded upon female plants (of Mexican ? origin), cultivated in the Jardin des Plantes. The embarrassed synonymy of the species known to M. Naudin in cultivation, is fully worked out, and extended observations are appended to those of special interest.

Nees ab Esenbeck, Th. Fr. Lud.—Genera Plantarum Floræ Germanicæ iconibus et descriptionibus illustrata.—Fasc. xxxi. Genera plura Familiæ Caryophyllacearum cum nonnullis Compositorum et Saxifragacearum (by A. Schnizlein).—Bonnæ, 1860, with 20 plates.

Neilreich, August.—Ueber die Vegetations verhältnisse der aufzulassenden Festungswerke Wien's.—Verhandgln. zool.-bot. Gesellsch. Wien. Bd. ix., pp. 167–76.

An enumeration is given of the species growing upon the bastions, glacis, ramparts, and in the moat; those which are abundant, also species of fortuitous and transitory occurrence, &c., are severally indicated.

Nitschke, Dr. T.—Wachsthumsverhältnisse des rundblättrigen Sonnenthaues.—Botanische Zeitung, 1860, pp. 57–61, 65–69.

Drosera rotundifolia propagates itself both by seed, and by the formation of axillary and adventitious buds. The author remarks the great frequency of the latter mode of multiplication. The adventitious buds only develope upon leaves, especially upon old ones which are about to separate, or upon those already fallen, which are kept moist by surrounding Sphagnum. The author's observations apply principally to the development of the internodes, "rosettes," and the resting winter buds.

——— Ueber die Reizbarkeit der Blätter von *Drosera rotundifolia*, L. —Botanische Zeitung, 1860, pp. 229–34, 237–43, 245–50.

The sensibility to irritation, Dr. Nitschke finds common to the entire surface of the leaves and their glandular appendages. When irritated, both the glands and the lamina itself curve towards the source of irritation. The degree of susceptibility of the leaf to irritation is proportionate to the activity of its secretions, and is dependent on the process of assimilation. Old or undeveloped leaves, which do not form glandular secretions, do not either manifest irritability. The author states the leaves to be unaffected by the presence or absence of light—they have no "sleep."

Oudemans, T. A.—Natuurlijke Historie van Nederland.—De flora van Nederland, Parts 7, 8, 9. 8vo. Haarlem, 1860.

Palacky, Dr.—Die Schimper'schen Pflanzen aus Abyssinien, nach der Bestimmung von A. Richard im tentamen Fl. Abyss. zusammengestellt.—Flora, 1860, p. 289–303.

The species are arranged in the sequence of the natural orders, the distribution numbers being quoted.

Palacky, Dr.—Uebersicht der von Miquel in der Flora Indiæ Batavæ bestimmten Cumming'schen Philippinen-Pflanzen.—Flora, 1860, pp. 446–8.

A list of Miquel's names, with Cuming's distribution numbers.

Pancic, Josef.—Die Flora der Serpentinberge in Mittel-Serbien.—Verhandlgn. zool.-bot. Gesellsch. Wien. Bd. ix., pp. 139–50.

In the enumeration of species, those which have been observed by the author on the Serpentine only (about 42 species), are marked by an asterisk.

Parlatore, Filippo.—Flora Italiana, vol. iii., Part 2 (to end of Monocotyledons). 8vo. pp. 161–690. Firenze, 1860.

The Italian species of *Iris* are distributed by Professor Parlatore under the genera *Iris*, *Xiphion*, Parl., *Gynandriris*, Parl., *Hermodactylus* and *Thelysia*, Salisb.

The genus *Bicchia* is founded on *Habenaria albida*, Br., *Gennaria*, on *Peristylus cordatus*, Ldl., *Caldesia*, on *Alisma parnassifolia*, L.

The "Flora Italiana" embraces, according to Professor Parlatore, 245 genera of Monocotyledons, containing 998 species.

Perger, A. R. v.—Studien über die Deutschen Namen der in Deutschland heimischen pflanzen.—Denkschrift. Kais. Ak. d. Wissench. Wien. (Math.-Natur. classe). Bd. xviii., Abth. ii., pp. 41–102.

Personnat, Victor.—Note sur la station de quelques plantes de la Flore de Béziers (St. Céré, Lot.).—Bull. Soc. Bot. de France, tom. vii., p. 8–10.

——— Observations sur quelques plantes du Department du Lot.—Bull. Soc. Bot. de France, tom. vii., pp. 22–4.

Pescatorea.—Iconographie des orchidées de la collection de M. Pescatore, au château de la Celle-Saint-Cloud. Vol. I. 48 coloured plates. Folio. Bruxelles, 1859–61.

Phillippi, R. A.—Excursion nach dem Ranco-See in der Provinz Valdivia.—Botanische Zeitung, 1860, pp. 305–11, 313–18.

The author describes, at length, the vegetation surrounding the Lake, and that of the route from San Juan. The species springing up after the burning of a Valdivian forest are, besides *Funaria hygrometrica*, of annuals, *Oxalis valdiviana*, *Calandrinia axilliflora*, and *Monocosmia corrigioloides*. Soon large bushes and under-shrubs, growing socially, spring up, and form almost impenetrable masses. These are chiefly made up of *Abutilon vitifolium*, *Solanum Gayanum* (*Natri* of the Valdivians), and a species of *Baccharis*. A fourth plant (species of *Chusquea*), affording a valuable fodder for cattle, sometimes covers large tracts to the exclusion of all others, after the burning of a forest. After a lapse of, perhaps, thirty to forty years, a new generation of the former inhabitants of the forest, nursed in the shade of the foregoing species, prevails, and the temporary occupants are suppressed.

——— Flora d. Wüste Atacama (Chili). 6 plates, *vide* Philippi's Reise. 4to. 1860.

Philippe.—Flore des Pyrénées. Tom. ii. Bagnères de Bigorre, 1860. 4to.

Pokorny, A.—Vierter Bericht der Commission zur Erforschung der Torfmoose Oesterreichs.—Verhandlgn. zool.-bot. Gesellsch. Wien., pp. 81–92. With 2 plates by Professor Lorenz, showing the excessive multiplication of adventitious roots from the axils and sheathing bases of leaves below the surface, by which the formation of the turf is essentially promoted.

Puel, T.—Etudes sur les Divisions Géographiques de la Flore Française. Part v.—Bull. Soc. Bot. de France, tom. vii., pp. 94–102.

Quetelet, Ad.—Observations des Phénomènes periodiques. Phénomènes periodiques Naturels. Règne végétale.—Mém. Acad. Sc. Belgique, xxxi.

The observations refer chiefly to the years 1856 and 1857, and were made at Brussels, Amiens, Ostend, Lierre, Namur, Dijon, and Venice, by Schramm, Bommer, and others.

The names of (1) about 112 species are given, arranged alphabetically, with the periods of foliation ; (2) of 230–40 species, with the time of flowering; (3) of 69 species, with period of fruiting ; and (4) of 53 species, with time of defoliation. There are also tables of observations made on the 21st March and 21st October, at the same stations, on the state of foliation, flowering, &c., of certain species. M. de Selys-Longchamps observes, in a note to the Observations for 1857, that the extraordinary temperature of 1857 retarded the fall of leaves. He states, if the number of trees which retained all their foliage be added to those which retained three-fourths (40 and 15) the total but slightly exceeds that of 1855 (26 and 27), but a great difference is shown in the proportion of the two numbers; 1857 presenting 40 species retaining all their leaves, 1855 but 26.

Rauwenhoff, N. W. P.—De anatomische zamenstelling der Schors van *Robinia pseudo-acacia*, in hare opvolgende ontwikkelings-toestanden,—Nederl. Kruidk. Archief. vijfde Deel., pp. 1–28.

Regel, E.—Index Seminum Horti. Bot. Imp. Petropolitani.—Ann. des Nat. (Bot.). Ser. iv., tom. xii., pp. 373–80.

Astemon, Rgl., a new genus of Labiatæ, stated to be near *Colebrookia*, Sm., is founded on a plant raised from seed sent by Cuming from Bolivia.

Reichenbach, L., and H. G.—Icones Floræ Germanicæ et Helvetiæ.—Tom. xix., Dec. 16–19. Lipsiæ.

In continuation of the genus *Hieracium*.

Reissek, S.—Vegetations-Geschichte des Rohres an der Donau in Oesterreich und Ungarn.—Verhandlgn. zool.-bot. Gesellsch. Wien., Bd. ix., pp. 55–74.

The author remarks the extraordinary tenacity with which the Reed (*Phragmites communis*) maintains itself abundantly on the Danube, notwithstanding the apparently unfavourable circumstances of flood, shifting river-bed, &c.

The physiognomy of the vegetation with which the Reed is associated—osiers, willows, *typha, scirpus,* sedges, thistles, &c.—is discussed at length.

Rossmann, Julius.—Ueber die Bezeichnungen für Phanerogamen und Kryptogamen.—Oberhessisch. Gesell. Natur-und Heilkunde, Achter Bericht., pp. 23–4.

Professor Rossmann objects to the terms Phanerogamia and Cryptogamia as applied to flowering and flowerless plants, inasmuch as some of the so-called Cryptogams are, in fact, as to their reproductive processes, more Phanerogamous than any bearing flowers. He proposes to substitute Anthophyta and Sporophyta. The Professor has also a controversy with generic and specific names involving contradiction or nonsense, as in the case of *Sagina apetala, Potentilla sterilis,* and even *Gypsophila,* the species of which are not all "chalk-loving."

——— Die Lostrennung der Blumenkrone bei den Rhinanthaceen.—Botanische Zeitung, 1860, p. 217.

The lower membranous portion of the corolla-tube divides transversely, leaving a small sheathing ring around the ovary.

Rostrup, E.—Om Vegetationen i den udtörrede "Lersö" ved Kjöbenhavn.—Vidensk. Meddels. Nat. For. Kjöbn., 1859.

The Ler or Rör was a small lake about two English miles from Copenhagen, which formerly served for the supply of water to the city. In the spring of 1852 it was commenced draining—an operation which was almost completed when again visited by the author in the autumn of the same year. He was there again in 1854, and in 1857 and 1858 made repeated herborisations, and carefully collected all the native vegetation which had sprung up, amounting to 175 species, including 19 of *Salix.*

One of the most remarkable plants observed was the *Senecio* (*Cineraria*) *palustris,* of which, in 1852, when the lake was half drained, there were only a few scattered individuals. In 1854 the whole bed of the lake was yellow with its blossoms; but in 1857 and 1858 it had so far disappeared, that Mr. Rostrup only succeeded in finding a single specimen. This recalls a similar circumstance observed in Holland in 1853, when the large portion of the lake of Haarlem, which had been drained off the previous summer, was a sheet of yellow with the blossoms of the same *Senecio,* which, we understand, has since nearly disappeared. *Rumex maritimus,* and *Blitum glaucum,* and *rubrum,* which were in the greatest abundance in the drained parts of Lake Ler, in the autumn of the first year, 1852, had also almost disappeared in 1857 and 1858. The paper concludes with some speculations on the probable origin of the present vegetation.

Sachs, Jul.—Physiologische Mittheilungen verschiedenen Inhaltes.—Botanische Zeitung, 1860, pp. 113–9, 121–6. 1. Cultivation of land plants under water. 2. Marble dissolved by the roots of maize. 3. The transpiration of plants. 4. Destruction of plants by cold at temperatures above zero. 5. The exudation of water contained in wood.

Sagot, P.—Etudes sur la végétation des Plantes potagères d' Europe à la Guyane Française.—Journ. Soc. Imp. et Centr. d'Horticult, 1860, tom. vi. 8vo. 22 pages.

In Guiana, with a mean annual temperature of 27° C., and contrasting dry and wet seasons, many of the culinary vegetables of the north cannot be grown at all, while others are uncertain or incomplete in their growth, and none acquire their full and natural development. M. Sagot remarks the short period which seeds appear to retain their vitality in Guiana, compared with the length of time they may be kept in Europe unimpaired. The seeds of the melon or haricot, which in France may be kept six or eight years, do not germinate after five or six months. The behaviour of each of the most common kitchen plants, also of several ornamental garden flowers under the climate of Guiana, is separately detailed.

The cabbage, radish, mustard, cress, haricots (with care), water melons, the aubergine (*Solanum melongena*), chives (ciboules), are successfully and usefully cultivated; while turnips, peas and beans, lentils, cicer, potatoes, tomatoes, asparagus, and the cereals, either altogether refuse to grow, or afford no useful produce. Comparative observations are appended upon the influence of equatorial climate upon man, domestic animals, and plants, brought from cool latitudes. In the opinion of the author, plants submit to climatal change much less readily than man, and man somewhat less so than most introduced animals.

——— Note on Useful woods of French Guiana.—Bull. Soc. Bot. de France, tom. vii., pp. 16–7.

The great proportion of hard and coloured woods belong to Leguminosæ, especially to the tribes Dalbergieæ and Cæsalpinieæ. The valuable cabinet wood "Boco" is afforded by *Etaballia guianensis*, Bth.; "Bagot," by *Cynometra hostmanniana*, Tul.; Gaïac (used for the "gorges" of pullies), by a species of *Dipteryx*. "L'angelique de Cayenne," celebrated for its utility in marine constructions, is *Dicorenia guianensis, Bth.*

Sanio, Karl.—Einige Beobachtungen über den Bau des Holzes—Botanische Zeitung, 1860, pp. 193–8, 201–4, 209–17, with one plate.

1. On the structure of the pits of cell-walls and inter-cellular cavities, 2. The tertiary thickening layer of wood-cells. 3. On Lignine (Holzstoff). 4. On tannin in wood; with observations on tannin generally.

Schacht, H.—Der Baum. Studien üb. Bau u. Leben der höheren Gewächse. 2nd edition. 575 engravings, 227 woodcuts. Berlin, 1860.

Schlechtendal, D. F. L. von.—Ueber eine vielnamige Gartenpflanze. —Botanische Zeitung, 1860, pp. 289–90.

This paper relates to *Stachys germanica*, and its immediate allies.

——— Von anderen Stachysarten.—Botanische Zeitung, pp. 293–5, 297–9, 301–3. (To be continued).

This paper embraces observations upon the various forms, both wild and in cultivation, their synonymy, &c., with remarks on the variability of the species.

Schnitzlein, A.—Iconographia Familiarum Naturalium Regni Vegetabilis.—Heft. xiv. Bonn.

This part contains detailed descriptions of about twenty natural orders or sub-orders, in Latin and German, with figures and elaborate dissections. The illustrations of the orders are not issued in their natural sequence, but indiscriminately, as the author finds material.

——— Einige merkwürdige Formen von Ovula bei Monocotylen.—Flora, 1860, pp. 529–32. These remarks apply to the ovules of *Astelia Banksii* and *Conostylis dealbata.*

In the former the anatropous ovules are provided with a long, curved funicle, which eventually becomes bent at an angle over the micropyle ; opposite to this point a plait or fold is developed, which covers a considerable portion of the outer side of the ovule. In *Conostylis,* Schnitzlein finds the ovules to be orthotropous, with two well-marked integuments. The cells of the outer coat are transverse to the axis of the ovule, and give it a wrinkled aspect. It finally assumes a remarkable appearance, from resting upon a bulbous raised base, as though two ovules were superimposed with a constriction between them. The thickened funicle or support is shorter than the ovule.

Schott, H. G.—Prodromus Systematis Aroidearum. Vindobonæ, 1860. 8vo. 602 pages.

This work comprises descriptions of 960 species, referred to 107 genera, of which 70 have been proposed by the author himself in his various publications.

Schenk, Prof.—Beobachtungen während der Sonnenfinsterniss am 18 Juli, 1860, angestellt in dem botanischen Garten zu Würtzburg.—Botanische Zeitung, 1860, pp. 277–8.

In plants out of doors an alteration in the position of the leaf was observed in species of *Edwardsia, Sophora, Colutea, Caragana, Lupinus, Vicia, Oxalis,* &c. Several others under glass, chiefly Leguminosæ and Oxalideæ, distinctly manifested the phenomena of "sleep." None of the expanded flowers which were observed (*Nicotiana, Mirabilis, Œnothera*), showed any alteration with the diminished light.

Schultz, C. H. (Bipont).—Ueber *Loricaria thyoides.*—Bonplandia viii., Jahrg. pp. 258–60.

——— Ueber die Gattung *Ormenis,* Càss.—Flora, 1860, pp. 433–4.—The geographical distribution of the several species is given.

Sowerby, J. E.—British Wild Flowers : Described, with an Introduction and a Key to the Natural Orders, by C. P. Johnson. 8vo. London, 1860.

Senft, Dr.—Praktische Beobachtungen über das Auftreten der Gramineen im Gebiete der Wälder.—Flora, 1860, pp. 305–14, 321–30, 337–45.

Spruce, Richard.—On the mode of branching of some Amazon trees.—Journ. Linn. Soc. (Bot.), vol. v., pp. 3–14.

Mr. Spruce analyses the "habit" presented by certain natural orders, genera, and by some individual species, which engaged his attention during his lengthened sojourn in Northern Brazil. From the disposition of the branches in the Myristicaceæ, in horizontal whorls of five (or three), the lowest and oldest branches being the largest, a parabolic outline results, which, especially in the case of some nutmeg trees near the mouth of the Rio Negro, was very striking. Monimiaceæ agree generally in their mode of branching with the allied Myristicaceæ. In Anonaceæ, with a similar habit, the branches are solitary, and not whorled. The species in which they spread horizontally resemble the nutmegs, though in some Xylopieæ the outline is more pyramidal. In Lauraceæ there is often a tendency to have the branches verticillate; but as they ascend at various angles, they lack the symmetrical contour of the foregoing. Species of *Eriodendron* are characterised by a dome-shaped crown. Many Tiliaceæ, with horizontal, pinnate branches, offer a close resemblance to Anonaceæ. Mr. Spruce remarks the infrequency of solitary and verticillate branching in the same order; *Diospyros* is the only instance in which he has found both to coexist in the same genus. In certain cymosely branching Rubiaceæ, especially in the "mulatto tree" (*Enkylista spruceana*, Bth.), the outline of the tree approaches to obconical or obpyramidal. Some Cinchoneæ and the Papaws, the primary stem of which constantly elongates at the apex, emitting only annual lateral branches, present a remarkable, palmiform appearance. *Melia Azedarach*, introduced, and now widely spread in Brazil, assumes a similar aspect—it is either unbranched, or the few branches given off from its lower axils elongate like the primary stem, bearing clusters of leaves and flowers at the apex. On the Amazon this tree flowers all the year round. Mr. Spruce's paper further contains observations on the connexion subsisting between cladotaxis, the nature of the inflorescence, &c., and the physiognomy of species.

Stur, Dionys.—Beiträge zu einer Monographie des genus *Astrantia*.—Wien, 1860, 58 p., with 1 map, showing the distribution of species. (V. Ber).

Tchihatcheff, P. de.—Asie Mineure; Description physique, statistique, et archéologique de cette contrée. 3e partie, Botanique. Paris. 1860. 2 vols. 8vo. Atlas, 4to.

Tenore, M.—Indicis Seminum Hort. Reg. Bot. Neapolitani adnotationes.—Ann. Sc. Nat. (Bot.). Ser. iv., tom. xii., p. 78.

Timbal-Lagrave, E., and H. Loret,—L'Herbier de Marchand et Lapeyrouse.—Bull. Soc. Bot. de France, tom. vii,, pp.–17–22, 66–72.

——— Ed.—Des variations que présentent les espèces du genre *Orchis*, et principalement *l' Orchis Tenoreana*, Guss. With woodcuts.—Bull. Soc. Bot. de France, tom. vii., pp. 109–17.

These variations chiefly apply to the lobation and colour of the

labellum. Differences presented by the spur, its relative length, &c., are but slight in *O. Tenoreana;* in some other species, as *O. morio*, the spur is very variable in form. The author considers, with Koch, *Orchis tridentata*, Scop., and *O. variegata*, All., to be specifically identical. *O. Tenoreana*, Guss., he regards as distinct.

TOMASCHEK, A.—Ueber die Entwickelungsfähigkeit der Blüthenkätzchen von *Corylus avellana*, L.—Verhdlgn. K. K. Z.-B. Gesellschft. in Wien. Bd. ix., pp. 3–6.

——— Nachtrag zur Phanerogamen-Flora Cylli's.—Ib. Bd. ix., pp. 35–42.

——— Zur Flora der Umgebung Lembergs.—Ib. Bd. ix., pp. 43–54.

Considerations upon the relations of the vegetation to the character of the soil, and to meteorological conditions.

TREVIRANUS, L. C.—Ueber den Wechsel des Grünen und Rothen in der Lebensäften belebter Körper.—Bot. Zeit. 1860, pp. 281–8.

The author's observations apply, in the vegetable kingdom, chiefly to the red coloration of Algæ, Lichens, and autumnal leaves.

ULOTH, W.—Beiträge zur Physiologie der Cuscuteen. With 2 plates.—Flora, 1860, pp. 257–68, 273–81.

The structure of the seed, its germination, the connexion between the parasite and its prey, &c., are minutely described. The author finds the embryo in *Cuscuta compacta, vulgivaga, chilensis*, and *Cephalanti* (referred by him to *Cuscutina* of Pfeiffer), to bear minute scale-like organs on its summit.

The active growth and increase of the parasite commences with the formation of vascular tissue in the first cord of tissue penetrating the epidermal layers of its prey. When these "suckers" penetrate any part of the parasite itself, as frequently occurs, no formation of vessels takes place. M. Chatin's account (Anat. Comp. des Végét., Livr. iii.) of the parasitism of *Cuscuta*, and his elaborate drawings, appear to be unknown to the author.

TORNABENE, F.—Monografia delle specie di *Asparagus* spontanee sull' Etna. 4to. Catania. 6 plates.

——— Sopra un nuovo albero indigeno sull' Etna del genere *Celtis*.—Catania. 4to.

WALPERS.—Annales Botanices Systematicæ. Tom. v., Fasc. vi. From Taxineæ to end of Monocotyledons; with Index to the volume.

WAWRA, H. and J. PEYRITSCH.—Sertum Benguelense. Aufzählung und Beschreibung der auf der Expeditionsfahrt Sr. M. Corvette "Carolina" an der Kuste von Benguela von Dr. H. Wawra gesammelten Pflanzen. Wien, 1860. (Wien Ber. Vol. xxxviii.) 46 pp.

The "Carolina" touched at Benguela on the return voyage from the Cape, remaining but six days (from 21st to 28th January). On two excursions, made under very unfavourable circumstances, Dr. W. collected 53 species, of which he finds about half to be undescribed. A short account of the town of Benguela, the vegetation of its neighbourhood, and of the Benguelese, is prefixed to the list of species met with. This latter includes diagnoses and lengthened descriptions of 24 novelties, one of which is regarded by M. Peyritsch as the type of a new Passifloreous genus (*Basananthe*, Peyr.), related to *Paschanthus*, Burch., and *Acharia*, Thg.

Weddell.—Chloris Andina. Essai d'une Flore de la Région Alpine des Cordillères de l'Amérique du Sud. Vol. ii., pts. 12 and 13, with ten plates; completing Scrophulariaceæ, Gesneriaceæ, Bignoniaceæ, Labiatæ, Lenttibulariaceæ, Plantaginaceæ, Myrsinaceæ, Ericaceæ, Rhamnaceæ.

Weiss, W.—Beobachtungen über den Pflanzenschlaf mit Rücksicht auf die letze Sonnenfinsterniss.—Bot. Zeit. pp. 321–4. The following species were carefully observed for some days prior to the eclipse, and the hours noted at which their "sleep" commenced, and reached its maximum:—*Mimosa pudica* and *sensitiva*, *Grammanthes gentianoides*, *Arnicia zygomeris*, *Cæsalpinia sepiaria*, *Acacia julibrissin*, and *Porliera hygrometrica*. The author details the result of observations during the eclipse on *Arnicia* and *Grammanthes*, which he selected as showing the greatest susceptibility to light. The leaves of the *Arnicia* under glass with the commencement of the eclipse began to droop, and at the maximum of darkness were half reflexed: at the end of the eclipse, they were again normally expanded. The flowers of *Grammanthes* also, under glass, which were expanded at the beginning of the eclipse, were all closed about the middle. At the end, most of the flowers attempted to open, though with but partial success. The author's numerous thermometrical observations lead him to refer the sleep-phenomena of sensitive plants to the direct thermal influence of the solar rays.

Wendland, H.—Bemerkungen über einige Palmengattungen Amerikas. Bonplandia viii., Jahrg., pp. 100–106, 115–119. The new genera proposed are *Iriartella*, founded on *Iriartea setigera* of Martius; *Catoblastus*, on two New Grenada species, also previously referred to *Iriartea;* and *Dictocaryum*, based on specimens of fruit only, collected by Wagner in N. Grenada.

Willkomm, M.—Bemerkungen über kritische Pflanzen der Mediterranflora. Bot. Zeit. 1860. pp. 129–32. The author establishes a new edition of his genus *Costia* upon three species referred to *Iris*, *I. scorpioides*, *Desf.*, *I. persica*, L., *&* *I caucausica*, M. B.

Woronin, M.—Ueber den Bau des Stammes von *Calycanthus*. Bot. Zeit. 1860. pp. 177–82. With a plate. Referring to the occurrence of woody bundles (four in number), with vessels in the cortical region, and their relation to the nodes, leaves, &c.

Wydler, H.—Kleinere Beiträge zur Kenntniss einheimischer Gewächse. Flora. 1860. pp. 353–366; 371–400; 419–432; 435–445; 457–461; 471–480; 490–510; 513–520; 532–544.

In continuation of previously published communications relating chiefly to phyllotaxis, sprout formation and axial relations, &c. The following orders are discussed:—Cucurbitaceæ, Portulaceæ, Paronychie, Crassulaceæ, Grossularieæ, Saxifrageæ, Umbelliferæ, Araliaceæ, Corneæ, Loranthaceæ, Caprifoliaceæ, Stellatæ, Valerianaceæ, Dipsaceæ, Compositæ.

XII.—Cryptogamia.

1. Ferns (*Filices*).

Bolle.—Notice sur l'asplenium Seelosii Leybold par M. Charles Bolle.—Bulletin de la Société Botanique de France, tom. vii., pp. 72–8, and pp. 82–86.

This paper contains the diagnosis and synonymy of Asplenium Seelosii, together with an account of its discovery and geographical distribution, a full description of the plant, and a few remarks on its culture. It is peculiar to the Alps between the Tyrol and Venetia.

Heufler.—Die Verbreitung von *Asplenium fissum* Kit. mit einer Karte, von Ludwig R. v Heufler, Verhandlungen der kaiserlich-koniglichen Zoologisch-botanischen Gesellschaft in Wien Band ix., p. 309.

Hooker.—Species Filicum.—Descriptions of all known Ferns, by Sir William Jackson Hooker, F. R. S., &c.—Vol. iii., pts. 2, 3, and 4, completing the vol., with plates clxi–ccx.

These parts include the following genera: Sadleria, Woodwardia, Doodia, Asplenium, Allantodia and Actinopteris, with Index.—London, Tamplin.

Mettenius.—Ueber Seitenknospen bei Farnen; par M. G. Mettenius (abhandl. d. Konigl. Sachs. Gesellschaft der Wissenchaft zu Leipzig, vol. vii., 1860, pp. 610–628). Published in a separate pamphlet.

Moore.—Index Filicum.—A synopsis, with characters, of the genera, and an enumeration of the species of Ferns, with synonyms, references, &c., &c., by Thomas Moore, F. L. S., F. H. S., parts 7, 8, and 9. London, Tamplin.

These parts contain figures illustrating the genera Polybotrya, Rhipidopteris, Elaphoglossum, Lomariopsis, Stenochlæna, Olfersia, Soromanes, Neurocallis, Hymenodium, Stenosemia, Pæcilopteris, Anapausia, Acrostichum, Photinopteris, Platycerium, Dryostachyum, Jenkinsia, Lomaria, Blechnum, Blechnidium, Salpichlæna, Sadleria, Monogramma, Diclidopteris, Pleurogramma, Xiphopteris, Hymenolepis, Gymnopteris, Scoliosorus, Holcosorus, Tænitis, Schizolepton, Lomogramma, Drymoglossum, Diblemma, Paragramma, Dicranoglossum, and Tæniopsis.

——— Notice of the discovery of Lastrea remota in England, by Thomas Moore, Esq., F. L. S., F. H. S., Journ. of the Proc. of the Linnæan Society (Botany), vol. iv., p. 192.

Milde, J.—Gefäss-Cryptogamen in Schlesien. 25 plates. 4to. Bonn. 1859.

Reichardt.—Asplennim Heuflcri eine Hybride zwischen Asplenium

germanicum, Weis, und A. Trichomanes L. beschrieben von H. W. Reichardt. mit einer Tafel. Verhandlungen der kaiserlich-koniglichen Zoologisch-Botanischen Gesellschaft in Wien Band ix., p. 93.

2. Mosses (*Musci*).

Arnold, F.—Ueber die Laub-moose des Frankischen Jura. Regensburg Flora, 1860, p. 401–405.

Hampe.—Was sind Laubmoose, und wie ist deren systematische Eintheilung übersichtlich und verständlich. Von Ernst Hampe.—Botanische Zeitung, am 4 Mai, 1860.

The following arrangement is proposed by the author:—

Principium potissimum classificationis est: Calyptra! Muscis frondosis propria.

A. Calyptra irregularites fructu maturo disrupta, inferior pars ad basin thecæ remanens.—Diarrhagomitria. (Musci spurii).

B. Calyptra basi jam juventute tota libera regulariter circumscissa.—Stegomitria. (Musci genuini).

A. Theca omnino clausa.—Cleistocarpi.

B. Theca operculata.—Stegocarpi.

I. Theca in caule primario apicalis.—Acrocarpi.

II. Theca in caule secundario apicalis.—Cladocarpi.

III. Theca radicalis vel lateralis pleurocarpis simillima sed structura interna acrocarporum.—Rhizocarpi.

IV. Theca subsessilis vel longe stipitata in caule secundario lateralis, gemma fructifera sessilis conspicua: folii structura interna trifolici ordine cellulorum prosenchymaticarum.—Pleurocarpi.

V. Theca inter folia equitantia inserta.—Entophyllocarpi.

VI. Theca in pagina inferiore caulis inter tegumenta propria inserta.—Hymenophyllocarpi.

Heufler.—Ueber das wahre Hypnum polymorphum Hedwig's, von Ludwig R. v. Heufler. Verhandlungen der kaiserlich-königlichen Zoologisch-botanischen Gesellschaft in Wien, Band ix., p. 383.

Juratzka.—Zur Moosflora Oesterreichs, i., ii., iii., von J. Juratzka. Verhandlungen der kaiserlich-koniglichen Zoologisch-botanischen Gesellschaft in Wien, Band ix., pp. 97, 313.

Klinggräff.—Zur Sexualität der Moose, von Dr. H. von Klinggräff. Botanische Zeitung, 26th Oct., 1860. The author for eight years had observed a species of Hypnum growing in large quantities, half-immersed in pools of peaty water. In seven years he found only about ten capsules, and was led to consider the moss diœcious. In August, 1859, the author found flowers of each sex growing on different plants, the male and female plants being at a distance from one another. He therefore took male plants, with fully-developed antheridia; and selecting six pools which contained only female plants, he placed male plants in two of them. In the following June he found in the two pools into which the male plants had been introduced, upwards of 100 fully-developed capsules; whilst the remaining four

pools, into which no male plants had been introduced, contained not a single fruit.

The paper also contains some remarks on the different periods of flowering and fructification of a number of different species of mosses.

LINDBERG, S. O.—Den Nordiska Moss-vegetationen. Öfvers, Stockh., 1859.

LORENTZ, P. G.—Beiträge zur Biologie und Geographie der Laubmoose. 4to. München.

MILDE.—Ueber die Moos-Vegetation der Torfsümpfe Schlesiens, von Dr. J. Milde. Botanische Zeitung, 16th March, 1860.

——— Ueber Bryum (Cladodium) fallax Milde, von Dr. J. Milde. Botanische Zeitung, 6th April, 1860.

——— Hypnum Mildeanum W. Ph. Schpr. in liter., beschrieben von Dr. J. Milde. Botanische Zeitung, 25 Mai, 1860.

MÜLLER, PH. J.—Einige kleine Nachträge zu den Beiträgen zu Ch. Gümbel's Moosflora d. Pfalz. Regensburg Flora, 1860, pp. 81, 83.

MÜLLER.—Australian Musci. Linnæa xiv. 623.

NERVANDER.—Bidrag til Findland's Bryologi Joh. H. Emmanuel Nervander. Helsingfors, 1859. 8vo. 95 pages.

RABENHORST.—Bryotheca Europæa. Die Laubmoose Europa's unter mitwirkung mehrerer Freunde der Botanik ges. u. herausg. v. Dr. L. Rabenhorst. Fasc. vi., n. 251–300. Dresden, 1859. Druck von C. Heinrich. 4.

A list of the species published in this fascicle is given in the "Botanische Zeitung" for Feb. 10, 1860.

SCHIMPER.—Synopsis Muscorum Europæorum præmissâ introductione de elementis bryologicis tractante. Scripsit W. Ph. Schimper. Stuttgartiæ. E. Schweizerbart.

The work is written in Latin, and consists of an introduction, followed by a systematic arrangement.

The Introduction contains the following matters:—The first part relates to the organography and morphology of Mosses, including sections relating to—1. Their different modes of propagation; 2. Their vegetative organs; 3. Their mode of generation, with accounts of their male and female flowers and sexual organs; 4. Their fructification, i. e. the primary origin of the fruit, the evolution of the capsule, the sporangium, and the evolution of the spores; and, 5. The perfect fruit and its constituent parts, including the perfect spores.

The second part contains chapters relating to—1. The mode of life of mosses; 2. The chemical and physical nature of their places of growth, and the effect of their variety in regulating the distribution of mosses on the surface of the earth; 3. The geographical distribution of mosses in Europe; 4. Their distribution with regard to altitude.

The fifth chapter (wrongly headed cap. iv.) contains certain special bryological floras.

The third part of the work sets out the classification of European mosses proposed by Hedwig, the classification of Bridel in his Bryologia Universa, of Müller in his Synopsis, and the author's own system.

Added to the above details, are Tables showing the species which are found in different zones in different regions.

The systematic portion of the work contains a detailed description of each species, accompanied by synonyms and explanatory remarks.

There are eight plates, showing in detail the characters of all the genera, and also a map, exhibiting the zones of altitude.

Schimper.—Icones morphologicæ atquæ organographicæ introductionem synopsi muscorum Europæorum præmissum illustrantes ad naturam vivam delineavit et explicavit W. Ph. Schimper. Tabulæ lapidi incisæ xi. Stuttgartiæ Sumptibus Librariæ E. Schweizerbart. 1860.

This is an atlas of eleven plates, originally intended by the author (together with other figures) to form part of an introduction to the study of mosses generally. The plates are now published in advance of the intended elementary work, with a view of illustrating the introductory portion of the "Synopsis Muscorum."

Spruce.—Mosses of the Amazon and Andes. By Richard Spruce, Esq. Journ. of Proc. of the Linnæan Society (Botany), vol. v., p. 45.

3.—Liverworts (*Hepaticæ*).

Mitten.—Hepaticæ Indiæ orientalis. An enumeration of the Hepaticæ of the East Indies, by William Mitten, Esq., A. L. S.—Journ. of the Proc. of the Linnæan Society (Botany), vol. v., p. 89.

Rabenhorst.—Hepaticæ Europææ. Die Lebermoose Europa's unter Mitwirkung mehrerer nahmhafter Botaniker, ges. u. herausg. v. Dr. L. Rabenhorst. Dec. 13, u. 14, Dresden, 1860. 8vo.

The species published in these Decads are set out in Botanische Zeitung, 18 Mai, 1860.

4.—Lichens.

Arnold, F.—Die Lichenen des Frankischen Jura. Enumeration, with brief observations on the size of spores, &c. Regensburg Flora, 1860, pp. 66–80.

Fries, T. M.—Monographia Stereocaulorum et Pilophorum. 4 plates. 4to. Upsala, 1858.

Haszlinszky.—Beiträge zur Kenntniss der Karpathen-Flora von Friedrich Haszlinszky. Flechten (Lichens). Verhandlungen der kaiserlich-königlichen zoologisch-botanischen Gesellschaft in Wien, Band ix., p. 7.

Koerber.—Parerga lichenologica. Ergänzungen zu Systema Lichenum Germanicæ, von Dr. G. W. Koerber. Erste Lieferung Breslau, Verlag, von Edward Trewendt, 1859. Zweite Lieferung, 1860.

This work, which is intended to be completed in three parts, has for its object to supply any omissions (as to diagnosis, synonyms, &c.) affecting the species described in the author's "Systema," and also to supply descriptions of the species new to Germany or to science which have occurred since the publication of the latter work.

NYLANDER.—Synopsis methodica Lichenum omnium hucusque cognitorum præmissa introductione lingua gallica tractata; scripsit William Nylander. 1st fascicle, Paris, 1858. 2nd fascicle, Paris, 1860.

The first fascicle consists of two parts—one general, the other descriptive. The first part, written in French, contains an account of the organisation, classification, and distribution of Lichens. The eleven chapters of which it is composed, relate to the following matters:—

1. Definition of Lichens. Lichens (says M. Nylander) are cellular plants; their fructification is borne upon a thallus furnished with gonidia, and has a hymenium containing an amyloid gelatinous substance. They are characterized by a slow and intermittent growth, dependent upon the state of humidity of the atmosphere; and, for the most part, they derive their nourishment from the atmosphere. They differ further from fungi in the fact of their hymenium usually assuming a blue or vinous red colour under iodine.

2. The constituent parts of Lichens—viz., the *thallus*, or vegetative part; the *apothecia*, or thecasporous fruit; the *spermogonia*, which have been supposed to represent male organs; and the *pycnidia*, the nature of which is obscure.

3. The thallus. This assumes four principal forms—the foliaceous, the fruticulose, the crustaceous, and the hypophleodal thallus, which lies concealed under the epidermis of trees, or between the fibres of the wood. The thallus is usually stratified, more rarely formed of a homogeneous tissue. The stratified thallus has three or four layers—the cortical, the gonidial, the medullary, and frequently a hypothalline layer, which sometimes forms a hypothallus, and sometimes rootlets or root-like fibrils. Homogeneous thalli are only met with in the lower Lichens.

4. Apothecia. These form sometimes a disc, sometimes a rounded nucleus. They consist of the combination of three layers, viz., the hypothecium, or perithecium, or conceptacle, which corresponds to the hypothallus; 2, the thecium, which is analogous to the gonidio-medullary layer of the thallus, and which is formed of a mass of paraphyses and thecæ; 3, the epithecium, corresponding to the epithallus, or cortex; 4, the spermogonia; these are generally very small, round, or oblong nucleiform organisms, sometimes lodged in particular tubercles, but more frequently immersed in the superficial layers of the thallus, and having the appearance of small papillary elevations, or simple ostioles, sometimes black or brownish, sometimes of the same colour as the thallus itself. They are composed of a conceptacle, quite analogous to that of the apothecia—of sterigmata, which are cellules with delicate walls, usually elongated, which grow on the internal surface of the conceptacle, and which are erect and simple, or slightly branched—and, lastly, of spermatia, borne by the sterigmata, and which are very minute acicular, ellipsoid, or oblong bodies,

constituting (the author considers), with great probability, the male organs of the Lichens. 5, the pycnidia, which Tulasne considers to be supplementary sporiferous organs, which resemble the spermogonia in form, in their conceptacles, and in the mode of insertion of the organs called stylospores, which they produce, but which latter are less numerous than the spermatia, of a much larger size, and capable of germination.

The seventh chapter contains a recapitulation of the anatomical elements of Lichens; the eighth chapter treats of their chemical properties and uses; the ninth, of their specific characters; and the tenth, of their classification.

M. Nylander divides the Lichens into three families: the Collemacei, the Myriangiacei, and the Lichenacei. The Collemacei are distinguished by their heavy, dark colour, and by the structure of their thallus, which is rarely cellular, and is usually gelatinous, containing gonimic granules, scattered or in rows. The Myriangiacei comprise only two species of the genus Myriangium. They resemble the Collemacei in their external form and colour, but in their thalline tissue and thalamial tissue are nearer the Lichenacei. Their spheroidal thecæ are always arranged irregularly, and are sometimes superposed in two or three rows. The Lichenacei are divided into six series: 1. the Epiconiodei, in which the spores, when they have escaped from the thecæ, accumulate like powder on the surface of the hymenium; 2, the Cladoniodei, or Lichens with a stipitiform thallus, usually fruticulose, and furnished with squamules or folioles, with lecideine and convex apothecia (*apothecia cephaloidea*); 3, the Ramalodei, or Lichens with a fruticulose thallus, compressed or cylindrical, without squamules, and with fruit generally lecanorine and flat; 4, the Phyllodei, or Lichens with a foliaceous thallus, and usually lecanorine apothecia, with jointed sterigmata; 5, the Placodei, or Lichens with a crustaceous thallus and lecanorine lecideine, or lirelliform apothecia; 6, the Pyrenodeæ, or Lichens with a peltate thallus or a crustaceous thallus, sometimes without any thallus, with pyrenocarpous apothecia, either immersed in the thallus, or more or less naked. A table of the families, series, tribes, and genera, is added.

The eleventh chapter treats of the geographical distribution of Lichens. After this follows the systematic portion of the work, written in Latin, containing descriptions and synonyms of species, with indications of their geographical distribution.

The two fascicles already published include the Collemacei and the Myriangiacei, and the first four series of the Lichenacei, with the exception of the tribes Gyrophorei and Pyxinei, which, with the series Placodei, which includes the tribes Lecanorei, Lecidinei, Xylographidei, and Graphidei, are to be dealt with in the forthcoming concluding parts.

There are eight plates accompanying the two fascicles already published, giving illustrations of the genera, and of a certain number of species.

THE

NATURAL HISTORY REVIEW:

A

QUARTERLY JOURNAL OF BIOLOGICAL SCIENCE.

Reviews.

XIII.—A History of Infusoria, including the Desmidiaceæ and Diatomaceæ, British and Foreign. By Andrew Pritchard, Esq., M. R I. Fourth edition. Enlarged and revised by J. T. Arlidge, M. B., B. A. Lond.; W. Archer, Esq.; J. Ralfs, M. R. C. S. L.; W. C. Williamson, Esq., F. R. S.; and the Author. Illustrated by Forty Plates. London: Whittaker and Co., Ave Maria-lane. 1861.

When to the means already within his reach for the investigation of living nature, man's intelligence first led him to add a new instrument, the Microscope, who could have foretold the rich rewards that awaited him in the hitherto unseen world of minute organization, or the glimpses, which, by its aid, he has since been enabled to obtain, of marvels each day occurring within the busy house of life?

The varied knowledge so gained admits, to some extent, of being arranged under two principal heads; namely, histology in general, and the study of the entire structure of those numerous beings, whose size is such as to preclude the possibility of their being discriminated, or, it may be, even seen, by the naked eye.

The time during which our acquaintance with these last has been gradually augmenting may, in like manner, be divided into two natural periods. The beginning of the first we shall not attempt to define. The end of the second period is yet to come. But the junction between the two is clearly marked by the appearance of the great work of Ehrenberg: Die Infusionsthierchen.

There are some who, of late years, have not paid that meed of respect to the name of the veteran microscopist of Germany, which his eminent services in the cause of biology may justly claim. Not that we are of the number of those who unduly venerate authority in matters of observation, even though it be vested in the person of Professor Ehrenberg, whose real merits we wish fully to acknowledge, but to whose many shortcomings we are, nevertheless, not blind. Science is the religion of fact; a religion without an orthodoxy, which knows no altars, save those of truth and freedom. It becomes, then, her priests, as a most sacred duty, to deprecate all prejudice, false praise, and personal idolatry. But, on the other hand, she does not withhold merit where merit is due. Nor do we find among the detractors from the fame of Ehrenberg the names of those discoverers whose investigations offer the sole refutation we possess of not a few of his declared opinions. It is against the cowardly abuse of this great man by a host of empty authors, parasites on the scientific substance of others, and who of themselves could never have pointed out one error in the writings of him whom they assail, that we now desire to raise our voice. Of such praise as it is in our power to give, Professor Ehrenberg does not stand in need. His works fix an epoch in science. From them he may appeal to the scanty knowledge of microscopic beings which existed before his time, and point to what it has since become. His best witnesses are his candid opponents. They know the armoury wherein their most successful weapons have been forged.*

Furthermore, we should not forget, what a glance at systematic treatises is, indeed, sufficient to show, that our views as to the nature and relations of the "Infusoria" are even now in the midst of a complete revolution; a revolution, too, which, to speak metaphorically, has seen its deposed monarch, its Girondists, its Men of the Mountain, but whose all-victorious despot is yet to come.

The dismemberment of the vast assemblage of diverse beings somewhat hastily brought together by Ehrenberg under the common title of Infusoria, has proved, indeed, no light task to those naturalists by whom it has been attempted. Now, however, we may fairly conclude that all these organisms fall under one or other of two very dissimilar sections, the animal and the vegetable.

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* A curious analogy may be traced between the contributions of Ehrenberg to our knowledge of minute organisms, and the researches of Schleiden and Schwann in the still wider field of general histology.* The great works of both were published about the same year, 1838. Both rendered services of the utmost value to science, though the fundamental "conceptions of structure" of Ehrenberg, as of Schleiden and Schwann, have since been proved to be erroneous. The writings of both have not so much an actual as an "historical value." In one respect, indeed, Schleiden and Schwann show an advantage over their illustrious contemporary. They always appeal with sure confidence to the study of development, and lose no opportunity of urging its primary importance. Had Ehrenberg more frequently sought the aid of this all-potent test, he would not have permitted Cohn, by his brilliant application of it in the case of *Protococcus pluvialis*, to offer one of the most striking proofs of the insufficiency of a purely anatomical method of reseach which has, perhaps, ever appeared.

* For a concise criticism of these last, see an Essay by Mr. Huxley, in Brit. & For. Med.-Chir. Rev., Oct., 1853.

The vegetable Infusoria include the Diatoms, the Desmids, and certain other organisms which most botanists regard as low forms of Algæ. All these Infusoria are sometimes spoken of collectively as constituting a single group, termed Protophyta.

But what are Protophyta? The word itself seems suggestive of a vegetable group, holding a position among plants akin to that which Protozoa occupy in the animal kingdom. Such an answer must, however, be regarded as inconsistent; for no botanist has yet proposed to elevate the Protophyta to the rank of a sub-kingdom, while the Protozoa form one of the five primary departments of the animal world. True it is that botanists are slow to acknowledge the systematic value of the several groups which constitute the great division of Cryptogams; and it may even be questioned whether these last do not bear to Phænogams a relation somewhat similar to that between Invertebrate and Vertebrate animals. This, at least, must be admitted, that the Cryptogams differ much more *inter se* than do the Phænogams; and it is difficult to mention any positive anatomical feature common to all the members of the former sub-kingdom. Their reproductive organs are often not homologous. And, assuredly, the "spore" of a Moss by no means corresponds with what is called the spore of a Fern. With regard to the Protophyta in particular, all that can be said is, that they constitute a sub-group of the large class of Algæ; but whether equivalent to the Chlorospermeæ, or to all the thalloid Algæ taken together, it is, at present, not easy to determine. To define the Protozoa as unicellular animals, and the Protophyta as unicellular plants, not merely requires the assumption of a theory which is, at best, very far from proven, but contradicts directly the plain testimony of observed facts, both in the structure and development of these highly diversified forms.

As to the animal Infusoria, they consist of—

1. Rhizopoda,
2. Infusoria proper,
3. Doubtful embryonic forms, and
4. Rotifera.

The Rotifera now form part of the Annulose sub-kingdom. The Rhizopoda and Infusoria have been placed by Siebold in the sub-kingdom Protozoa.

A copy of the "Infusionsthierchen" lies before us, while we pen the present page. It forms a huge folio volume of 550 pages, with an atlas of sixty-four coloured plates. The characters of the several groups are in three different languages, Latin, German, and French. It is impossible to consult this (in every sense) great work, without some feeling of admiration for the prodigious industry which, in the year 1838, and with inferior instruments, could accumulate so many hundred figures and descriptions of living beings, all of minute size, and many for the first time made known to science by their distinguished investigator.

But there was wanting some interpreter, some medium, by whom this vast mass of knowledge might be made available to the microscopists of Britain. Such a medium science has found in Dr. Pritchard, whose history of the Infusoria is, to some extent, an English re-issue of the classical work of Ehrenberg.

The fourth edition of Dr. Pritchard's book, which has just made its appearance, is, however, much more than this. It contains copious statements of the views which modern observers entertain in opposition to Ehrenberg's doctrines; and the Infusoria of that writer are by no means regarded as constituting one great natural assemblage.

If this be so, some one may ask, why has Dr. Pritchard included in a single treatise descriptions of living forms acknowledged to differ thus widely from one another? The reply is, that all these forms, however dissimilar in structure, agree, with but few exceptions, in their extremely minute size and community of aquatic habit. Hence they are liable to be studied in succession by the same investigator, who naturally desires to find as much information as possible concerning them within the compass of one volume.

Yet we do not coincide with Dr. Pritchard in his proposal to retain the term Infusoria, as a convenient collective designation for the various groups in question. Would it not be more appropriate to restrict the application of this word to the stomatode Protozoa? These, with a few other forms, are by Dr. Pritchard distinguished as "Ciliata." But it might be questioned whether all the true Infusoria present conspicuous cilia. Is not the possession of a mouth the only constant feature whereby they may definably be separated from other Protozoa?

The several divisions of Dr. Pritchard's work together form one thick octavo volume of nearly a thousand pages. Its entire contents are arranged under two principal parts: the first being a *general*, and the second, a *systematic* history of "Infusoria."

The first part contains five sections. Section I. treats of the Bacillaria of Ehrenberg, including the Diatoms, Desmids, and a third group separated from the latter under the name of Pediastreæ. In section II. are discussed certain other low vegetable forms, mostly locomotive, and furnished with whip-like cilia. These are termed Phytozoa, and correspond to the group denominated Flagellata by Cohn, and Volvocineæ by Henfrey. To us this employment of the word Phytozoa appears objectionable, conveying, as it does, an erroneous view of the nature of the organisms so entitled. It is, moreover, merely an inversion of the old term Zoöphyta, already used in so many different significations.

The remainder of the first part is devoted solely to animal forms: section III. treating of Protozoa; section IV. of Rotifera; and section V. of Tardigrada.

The section on Protozoa gives a general account of the fresh-water Rhizopods, Gregarinida, Infusoria proper, and Noctilucida. The Ichthydina are noticed as a special sub-group,—the author being, we think, justified in his exclusion of these anomalous creatures from the well-marked division of Rotifera. But we are not disposed to agree with his statement that Dysteria "occupies a position in the zoological scale above the Ciliata," or to conclude with Mr. Gosse "that it is an annectent form between the Rotifera and the Infusoria (*i. e.* the Ciliata), with a preponderance of the characters of the former class." Without waiting to discuss the doctrine of affinity implied in the last sentence, we may be permitted to express our surprise that any doubt could have been entertained as to the true relationship of Dysteria with the uncinate Infusoria.

The survey taken in this section of the ciliated Infusoria may be considered as, upon the whole, a satisfactory review of our knowledge of the organization of these animals previous to the appearance of the systematic works of Stein, Lachmann, and Claparède; works, it must be remembered, which are not yet brought to a conclusion. With Siebold, the author continues to regard the Opalineæ and Peridineæ as a subgroup of the Infusoria proper. Such a view of their affinities seems to us far from satisfactory. But in a subsequent paragraph on the "Nature of Opalineæ," it is rightly stated that "the observations of microscopists in general concur to prove that these simple beings are not independent, but the mere embryonic or transitional phases of other animals." And the vegetability of the Peridineæ is, we venture to suggest, less improbable than many naturalists suppose—the wreath of cilia which surrounds the bodies of these creatures not being, of necessity, at variance with it.

The short notice of the Gregarinidæ and Psorospermia in the same section briefly reviews the principal memoirs which treat of these forms.

The shelly structure of the Rhizopoda is discussed only in general terms, the Spongida, Echinocystida, and other marine Protozoa, not being described in any detail. The brief history given of the Foraminifera, so far as it goes, is good, and a translation of Schultze's proposed arrangement of these animals has here been appended.

In the section on Rotifera the researches of Ehrenberg, Dujardin, Cohn, Leydig, Huxley, Vogt, Williamson, Gosse, and others, are each in turn explained; and the reader is led to conclude, we think rightly, that the systematic relations of these animals are less with the Crustacea than with the Worms. The close resemblance between some adult Rotifers and the larval forms of various Annuloida appears to leave but little room for doubt on this question.

The last section of the first part comments on the structure of the Tardigrada, a group which the author, following Kaufmann, is induced to consider "the lowest section of the Arachnida, by the side of the Pychnogonida and the Acarina."

In the systematic division of the work, minute descriptions are given of the families, genera, and species of the Bacillaria, Flagellata, Tardigrada, Rotifera, Amœbea, and Ciliata, so far, at least, as they are provisionally definable. A full review of this part would involve us in a lengthened series of discussions on the constitution of each of the groups whose classification is attempted therein.

The author and his several coadjutors may fairly be said to have performed with credit the task they have undertaken. The result has been a treatise more useful than profound, partaking less of the nature of a grammar than of a dictionary. It would be false criticism, therefore, to complain of the copious introduction of long quotations from various writers, in the place of condensed statements of their more general conclusions. Lastly, it should be understood that original matter is by no means wanting, especially in those portions of the work which treat of vegetable forms.

The number of plates has been largely increased in the present issue, and most of the numerous new illustrations appear to have been selected with considerable judgment.

To the purchasers of Dr. Pritchard's book there is one word in conclusion, which we do not wish to leave unsaid. While eminent success has attended English naturalists in their investigation of the lower forms of vegetable life, they have almost wholly abandoned to their Continental brethren the widely extended field of research which the great group of animal Infusoria so accessibly affords. Cordially congratulating our French and German fellow-workmen on the rich contributions made by them to this last department of inquiry, we feel, nevertheless, that many more observers are yet wanting to complete what has been already so happily begun. The Quarterly Journal of Microscopical Science has just entered on a new series. We heartily wish it success, and hope often to find throughout its pages ample records of future British discoveries in the structure and life-history of the true Infusoria.

XIV.—Primitiæ Floræ Amurensis. By C. J. Maximowicz, Traveller to the Imperial Botanical Garden of St. Petersburgh. 4to. (Separately printed from the ninth volume of the "Mémoires présentés à l'Académie Impériale des Sciences de St. Pétersbourg par divers Savans.")

In our last Number we adverted to the prompt liberality of the Russian Government in the publication of the results of their scientific expeditions, as exemplified in the accounts of their explorations of their newly acquired Amurland, of which we then reviewed the zoological portion. No less activity was displayed in the botanical department. The collectors returned to St. Petersburgh in the spring of 1857; and by the end of 1859, very full sets of their specimens were deposited in several of the principal national herbaria of Europe, including those of Paris and Kew; and early in 1860, all that could be known on the botany of the country was published in the shape of the large quarto of 500 pages now before us, accompanied by ten plates and a map, the whole issued at a price (about 16*s.* 6*d.*), which places it within reach of the working botanist. And this is not, as is but too frequently the case after similar expeditions, a hasty catalogue of the plants gathered by the collector himself, describing as new all that cannot be readily identified, but a complete enumeration of all the species known to grow in the country, as far as could be made out from the materials deposited at St. Petersburgh by different collectors, or from the few works already published; the whole carefully compared, when possible, with specimens from adjoining countries, and followed by general essays on the physical aspect, climate, and vegetation of the territory, chiefly drawn up from personal observation and data collected during a two years' residence there.

M. Charles John Maximowicz* was in July, 1854, botanical collector to the Petersburgh Botanical Garden, on board the frigate Diana, which, in the course of a scientific voyage round the world, was then lying in the Bay of Castries, off the coast of Mantchuria, near the lower Amur. In consequence of the outbreak of the war with England, he there left her, and remained in the Amur district till the autumn of 1856, spending the long winters at Mariinsk, on the river, 300 versts (225 miles), above its mouth, but separated from the Bay of Castries only by a very narrow chain of hills. His explorations in 1854 were chiefly along the coast between Castries and Nicholaefsk, at the mouth of the river. In the summer of 1855 he ascended the Lower Amur and its southern affluent, the Ussuri, to the mouth of the Nor, in lat. 47°. In 1856, he was detained late at Mariinsk by the arrangements preparatory to an anticipated attack from the English; and the season was far advanced when he ascended the whole length of the river on his return to St. Petersburgh. His own collections are therefore nearly limited to the plants of the Lower Amur and Ussuri; but his enumeration includes those gathered by M. Maack, traveller to the Russian Geographical Society, who, in the spring and early summer of 1855, descended the river from its commencement to its mouth, and by Dr. L. v. Schrenck, traveller to the Imperial Academy of Sciences, who ascended it early in the following summer. Use has also been made of the smaller and more local collections of M. de Turczaninoff, Dr. Weyrich, and M. C. von Detmar.

The basin of the Amur, which appears to have received the name of Amurland, forming hitherto part of Northern Mantchuria, lies to the north of the high snowy mountain range of Shan-alin (lat. about 42°). The river commences by the junction of the Schilka and the Argun, in lat. 53°, at the point where they enter the mountain chain bounding the high table-land of their upper course; and after pursuing its way for some time through a still elevated hilly land, and taking a more southerly direction, it enters, at the mouth of the Dreja, into a broad plain, traversed near to the southern bend of the river, in lat. 47° 30′, by the rugged transverse ridge of the Bureja mountains. The Amur now turns again towards the north-east and north, runs along the foot of a mountain chain parallel to the coast, until by a sudden turn to the east it breaks through the hills, and empties itself into the straits of Tartary in lat. 53°. The whole basin, from the Chingan mountains on the west to the

* Cz pronounced like *ch* in *church*.

sea on the east, thus occupies about 20° of longitude, and about 12° of latitude, from the Shan-alin range on the south to the Stanovoi mountains on the north.

The climate is by no means a genial one: under the latitude of London, the river is frozen over six months in the year. The mean monthly temperature, taken from the averages of two years' daily observations (three times each day at 6, 7, or 9, A.M.; at 2, or 3, P.M.; and at 9, or 10, P.M.), at Mariinsk was – 11° R. (about 8° Fahr.) in January, and –14° R. (0° Fahr.) in February; and still lower at Nikolaciosk, with a minimum at Mariinsk of – 31° R. (about – 38° Fahr.) At the southern bend of the river there is some improvement; the river may not freeze over till after the middle of November, and breaks up very early in May, or in the end of April; but further south again, at Girin, on the Ssunguri, at the foot of the Shan-alin range, the thermometer frequently falls in winter to – 30° R. (– 35° Fahr.) The whole territory, in short, belongs to that coldest of all regions in proportion to latitude, North-eastern Asia; and it is only when the high snow-clad mountains of Southern Mantchuria are passed, and we descend their southern declivity towards Pekin, that a sudden rise of temperature is experienced,—the mean monthly temperature in that capital, on an average of thirteen years, being, –2° 74′ R. (about 26° Fahr.), for January; and –0·9′ R. (about 31° Fahr.) for February, with a minimum of – 8° R. (14° Fahr.) The narrow coast-line, separated from the lower Amur by a ridge of pine-clad mountains rising in most places rapidly from the shore, may be somewhat milder; but even here the moderating influence of the sea is felt less than in most maritime countries, probably from the intervention of the long mountainous island of Sachalin, running parallel to the coast from lat. 46° to 54° 30′, in some parts only at a few miles' distance.

Under these circumstances, the Flora must be expected to be of a very northern character; and all the peculiar plants of the country which have as yet been introduced into the St. Petersbugh Botanic Garden appear to bear well the winters of that place (in lat. 60°), without protection. During the short summers, however, the heat on the southern and lower Amur is considerable, without long droughts; vegetation is rapid and luxuriant, including more southern species than we should have expected, protected perhaps in winter by the great mass of snow, which accumulates habitually to the depth of several feet. In the Upper Amur, the climate in this respect, as well as the Flora, partakes more of that of Nertchinsk, in Dahuria, where, in lat. 51° 19′, with an average January temperature of – 23° 67, R. (about – 21° Fahr.), and a minimum of – 36° R. (– 49° Fahr.), there sometimes does not fall the whole year round sufficient snow for the use of sledges.

The geographical distribution of the Amur Flora is treated of by M. Maximowicz with great detail, and considerable ability, under various points of view as to species, genera, and orders, taking in many respects for his guide the principles laid down in A. de Candolle's 'Géographie Botanique raisonnée,' and exhibiting the relations to climate and physical conditions, as well as to the vegetation of adjoining regions, as far as his materials permitted, and comparing them with the vegetation of Dahuria (the trans-Baikal Flora), Eastern Siberia, North China (Pekin), Japan, and North America. As was to be expected, a large number of the species are Siberian, and European and North Asiatic natural orders are the prevailing ones; yet, if we compare the Flora generally with that of the Altai, for instance, there is a considerable change in its character; the Cruciferæ, Astragali, Umbelliferæ, Pedicularidæ, and other groups constituting so marked a feature in the herbaceous Flora of the latter region, are but sparingly represented in Amurland, where Euphorbiaceæ, Cyperaceæ, Filices, Ribes, Evonymus, &c., become more prominent, showing a tendency, as remarked by our author, towards the North American proportions of groups. We enter indeed here, especially in the southern Amur and Ussuri valley, into the curious band of vegetation which connects the United States with the Himalaya through Japan, South Mantchuria and North China, and much more so than M. Maximowicz appears to have been aware of. Dr. A Gray's interesting review of the Japanese Flora had not yet reached St. Petersburgh, and our knowledge of the vegetation of temperate eastern Asia was, and is still, lamentably scanty. Yet every addition we receive to it, and the work now under review as much as any one, shows more clearly the remarkable phytogeographical connexion first pointed out by Dr. Gray.

M. Maximowicz's enumeration, after deducting a very few cultivated plants, comprises 904 species, of which 527 are common to the trans-Baikal or Dahurian Flora, 293 to north-east Siberia. For the concordance with the Japanese Flora he can give no precise figures; but, although the number is probably less than either of the above, it is considerable, and must include, as he correctly observes, several of the species here first described as new. A list is given of 143 endemic species, hitherto only known in Amurland, and 56 more only extending to Pekin; but amongst them it has already been ascertained that *Actinidia kolomitka* is the *A. callosa*, Lindl., extending from the Himalaya to Japan; *Caulophyllum robustum* is certainly not different from several Japanese and N. American specimens of *C. thalictroides*. *Adenocaulon adhærens* is the Himalayan *A. himalaicus*, Edgw.; *Youngia chrysantha* is the Chinese and Japanese *Ixeris ramosissima*, A. Gr.; *Phyllanthus ussuriensis* is the widely-spread south and east Asiatic *P. anceps; Smilacina hirta* is *S. japonica*, A. Gr.; *Maximowiczia chinensis* is the Japanese *Sphærostemma japonica*, A. Gr.; and the majority of the new species will probably be hereafter found to be identical with, or closely allied to N. Chinese and Japanese, or even Himalayan or North American forms. And we may here remark that, amongst other links afforded by the southern Amur Flora, connecting the chain of North American and Asiatic vegetation, we have *Phryma leptostachya*, which had so long been considered as an isolated instance of a plant common to the eastern United States and to the Himalaya, without its occurring in any intermediate stations. It is very abundant in North China, and on the lower and southern

Amur. It is, however, still unknown in Japan; and, like several other species of the same geographical group, it appears to be entirely wanting in Western America.

Among the weeds of the southern Amur we are surprised to see a few southern forms, such as *Myriogyne*, *Phyllanthns*, *Acalypha*, *Pilea*, &c., which find time to run through their annual course in the short but hot summers.

The new species described by Maximowicz amount to above 120, including a few that had been shortly mentioned in the Bulletin of the Academy of St. Petersburgh by Ruprecht or Maack. Some, indeed, have since proved to be identical with previously described Japanese or more southern species, and others may have been established on grounds which we might scarcely consider sufficient; but the majority of those we have seen are such as we should be inclined to adopt, and we highly appreciate the pains taken by the author in the descriptions, synonyms, and other systematic details of his work. We cannot, however, as readily concur in the twelve new genera proposed by himself or Dr. Ruprecht, all except one monotypic. If, indeed, as is a very prevalent opinion among modern botanists, any two species which show appreciable differences in their floral or reproductive organs, not in essential structure only, but even in number, form, or relative proportion, *must* belong to distinct genera, we might acquiesce in the adoption of every one; but if, as we believe, a genus should be a group of species having certain characters or resemblances in common, collected under one name for the convenience of study and comparison; and if monotypic genera should be avoided as useless, except where the character of a species are such that it cannot be connected with others without disturbing the arrangement and principles of distribution of the other genera of an order, tribe, or group, we fear that the Amurland will have supplied few, if any, that have really a right to stand as genera *per se*. Taking this view, we will proceed to examine such of them as we have materials for judging of, either from specimens or from the well-executed outline plates of the work.

1. *Maximowiczia*, Rupr.—This plant, which, as above noticed, has been published as a *Sphœrostemma* by A. Gray, is intermediate, as it were, between some species of the latter genus and *Schizandra*. It belongs to a small distinct group of Magnoliaceæ established under the name of Schizandraceæ, and consisting now of thirteen species, which are readily separable into two groups upon characters derived from the gynœcium and fruit. *Kadsura*, with the carpels crowded in a globular head, has seven species; the other six species have them loosely arranged in an elongated spike. These six differ considerably from each other in the andrœcium, and, if that character be relied on, must be split up into four, at least, if not five genera, of which *Maximowiczia* would be one; or they may be all grouped into one genus, under the original name of *Schizandra*. We should prefer the latter course, as being more simple, and more in conformity with our principles of systematic distribution;

whilst, at the same time, sectional divisions are amply sufficient for calling attention to the greater importance of some of the specific distinctions as compared with others.

Plagiorhegma, Maxim., is, under our view, a second species of *Jeffersonia*, with which it forms a very well characterized natural genus. The undivided leaves and more oblique dehiscence of the capsule than in the original *J. diphylla*, are excellent specific distinctions, but would not, in any other instance, be admitted as generic. The flowers are unknown; for the two loose ones picked up from the ground, and described by Maximowicz, were found not to tally with the appearances of the young capsule, and consequently were at first concluded to be abnormal, but afterwards admitted (p. 460), to have probably belonged to some other plant. We mention this as a caution to travelling collectors against a not uncommon practice of hastily concluding that flowers or fruits picked up under a tree or herb must have fallen from it—a source of many an error in descriptive botany.

Hylomecon, Maxim., "has the habits and flowers of *Stylophorum*, with the fruit of *Chelidonium*." This fruit, however, the author had not himself seen, but states it, on the authority of the natives, to be two inches long, and slender—a very insufficient authority for establishing a genus, when there is nothing in the enlarged ovary (as correctly figured) to indicate this elongation; for, might not the natives have confounded it with the true *Chelidonium majus*, stated to be very common in the country? It is true, that in *Hylomecon*, as well as in the nearly allied *Dicranostigma*, Hook. and Thoms., from the Himalaya, the ovary is 2-merous, whereas in the two American species of *Stylophorum*, it is usually 3-4-merous; but even in these, the carpels are sometimes reduced to 2; and by uniting the Himalayan as well as the Mantschurian plants with the American, we have a natural and well-characterized genus of four species.

Phellodendron, Rupr. belongs to a group allied to *Xanthoxylon*, but differing chiefly in the opposite leaves, the scarcely imbricate or sometimes valvate corolla, and the superposed ovules. There are several south and east Asiatic species, which, from having been usually compared with *Xanthoxylon* only, have been proposed as genera under the names of *Lepta*, *Boymia*, *Philagonia*, and *Megabotrya;* but which, on a general review, show that there is nothing in character or habit to separate them (as well as the opposite-leaved species published as *Xanthoxyla*), from the old-established genus *Evodia*, with which no one seems to have thought of comparing them.

Maackia, Rupr. differs from the North American *Cladrastis*, Raf., in its small crowded flowers, with a shorter calyx, more obtuse at the base, and rather shorter pod; the other characters, the foliage and habit, are nearly the same; and although a very distinct species, we cannot see sufficient grounds for separating it generically from the N. American plant. The stamens are figured as monadelphous; they are, however, in a flower we examined, free as described.

Schizopepon, Maxim., a cucurbitaceous plant, cannot well be judged of in the present state of confusion into which that order has been thrown by the excessive multiplication of genera, especially in the Bryonia group. *Mitrosicyos*, Maxim., belonging to the same order, is a very distinct genus, of which two species are described. A third, however, had been previously published in Griffith's "Notulæ," under the name of *Actinostemma*, which must prevail over Maximowicz's *Mitrosicyos*.

Eleutherococcus, Maxim., is well distinguished from *Hedera*, with which, following only the arrangement of the Araliaceæ of De Candolle and Endlicher, it might have been technically, but improperly associated. In the re-arrangement of the order sketched out by Decaisne and Planchon in the "Revue Horticole" for 1854, with which Maximowicz was probably unacquainted, this plant would probably range under *Panax*, sect. *Acanthopanax*.

Symphyllocarpus, Maxim., is a small composite weed, closely allied to *Myriogyne* in character, and to *Thespis* in appearance, but separated from both by a purely artificial character, the value of which we are not able to judge of, not having seen any specimen.

Syneilesis, Maxim., is also composite; the genus is created for the *Cacalia aconitifolia*, Bunge, which has the habit and general characters of *Cacalia*, as limited by modern authors. Our specimens have no ripe fruit; and we are unable to say whether the remarkable union of the two cotyledons by one edge is of sufficient constancy to separate it even as an artificial genus.

Pterygocalyx, Maxim., appears to us in nowise to differ as a genus from *Crawfurdia*, although, as a species, it differs from all the other known ones by the obtuse lobes of the corolla.

Omphalotrix, Maxim. is distinguished from *Odontites* by characters derived from the placenta and the size of the embryo, which appear to us to be of very little importance. The habit is said to be very different; but to our eyes it is not far from that of *O. lutea* and *O. granatensis*, differing chiefly in the longer and more slender pedicles.

M. Maximowicz's chapters on the area occupied by the principal gregarious trees of Amurland, and on the cultivated and economic plants of the country, are of high interest; and on the latter subject, especially, we should be glad to see more attention bestowed than is usual with botanists resident for a time in little-known countries. We can also highly commend the map, as giving, from the most authentic available sources, the prominent physical features of the territory in a clear and conspicuous form.

Original Articles.

XV.—ON THE SPECIES AND GENERA OF PLANTS, CONSIDERED WITH REFERENCE TO THEIR PRACTICAL APPLICATION TO SYSTEMATIC BOTANY. By George Bentham. (Extracted from a Paper read before the Linnean Society of London, Nov. 15, 1858.)*

I SAY *Species and Genera*, rather than *Genera and Species;* for the whole system of classification depends, in the first instance, on a right understanding of what is meant by species.

The *Species*, in the ordinary traditional acceptation of the word, designates the whole of the individuals supposed to be descended from one original plant, or pair of plants. But this definition is practically useless—for we have no means of ascertaining the hereditary history of individual plants—and is considered theoretically incorrect by those who deny the original creation of a certain number of individuals, or pairs of individuals, forming each a parent stock, from which as many constantly distinct races have descended. It has, therefore, been proposed entirely to reject descent as an element in the definition of species, and to consider as such any set of individuals which present, either in their external form, or in their internal structure, or in their biological phenomena, any common character, or combination of characters, distinguishing them from all others. But in nature there are no two individuals exactly alike in every respect. In all collections of individuals, even when the immediate offspring of one parent, peculiarities will be found common to some, and not to all. The species or collection of individuals thus defined, becomes, therefore, as arbitrary as the genus or collection of species, and reduces the rules of classification in the one case, as in the other, to little more than rules of convenience.

Believing, however, as I do, that there exist in nature a certain number of groups of individuals, the limits to whose powers of variation are, under present circumstances, fixed and permanent, I have been in the habit of practically defining the species as *the whole of the individual plants which resemble each other sufficiently to make us conclude that they are all, or* MAY HAVE BEEN *all, descended from a common parent.* Their variations would be such only as we observe among individuals, which we

* The great length to which this paper, read at three different meetings of the Society, extended, prevented its immediate publication, and the subsequent appearance of Mr. Darwin's work rendered obsolete the short allusions I had made to the theories advanced on the origin of species. The present extract, however, is purely practical, relating to species as they now exist, and have existed within historical periods, quite independently of their theoretical origin.

know or believe to have had such a common descent. The specific identity of two or more individuals admits, therefore, but very rarely of positive proof; we must judge of it by inductive evidence, selecting by the careful consideration of what characters are known, especially in allied species, to remain permanent generation after generation, unaltered by change of soil, climate, or other circumstances, and what are the variations occasioned by causes which we can appreciate, or which are known to occur without assignable cause. The conclusions to be derived from such evidence will not, indeed, always be decisive, and different persons will often form different judgments; but that is an unavoidable consequence of the imperfection of the human mind.

My own attention was first directed to the variations to which plants of the same species are liable, under different circumstances, in the year 1820. I had then become tolerably familiar with the common plants of France, in the West, in Upper Languedoc, and in the central Pyrenees; and, settling for some years in the neighbourhood of Montpelier, I was struck with the different aspect assumed by several of the same species in this very different soil and climate. In the first instance, I did indeed believe that many of these were representative, not identical species; but I could not but observe even then that, in many cases, species really the same underwent considerable modifications, through the influence of soil and climate. In 1823 I collected, with my friend, Dr. Arnott, a considerable number of Scotch specimens, which, two years later, after our Pyrenean tour, we had the opportunity of comparing with a similar vegetation grown in mountains of twice or thrice the elevation of the Scotch ones, but under a difference of latitude of 12 to 13 degrees; whilst, on the same Pyrenean chain, we were several times struck with the differences exhibited by plants of the same species growing in the cool northern, or the hot southern valleys. In 1821, on my father's estate near Montpelier, a considerable extent of the botanically rich waste lands, called *garrigues*, was walled in, to allow the natural wood to grow up; and, during the few succeeding years, I could observe a gradual, but in many instances very striking, change take place in the character and aspect of the wild plants protected by the enclosure. In 1837, when at Trieste, I visited a similar enclosure, on a larger scale, and of many years' standing, at Lippiza, near that town, and observed very marked differences in the individuals of some species, when growing within or without these walls. From the time, indeed, when I first began to collect notes on the vegetation of Southern Europe, some of which I embodied in my "Catalogue des Plantes des Pyrenées et du Bas-Languedoc," published in 1826, my attention has been much directed to the modifications of specific types, in all my herborisations in various parts of Europe, and, more especially, in the mountains of Scotland, the Pyrenees, Central France, and Tyrol; in the lower hills and plains of France, Britain, Sweden, Germany, Italy, and Sicily; and on the coasts of Britain, Western and Southern France, and various parts of the Mediterranean, Adriatic, and Black Seas. The preparation of large collections for distribution has given me opportunities of studying many American, African, and Asiatic species in large masses of specimens. In some of the more important monographs I have worked up, I have been enabled to compare the materials of the principal herbaria of Europe; and, since my working-stock has been transferred to Kew, the daily consultation of such a collection as that of Sir William Hooker has contributed very much to confirm my ideas as to the variability and limitation of species; and nothing more so than the extensive and highly instructive series brought from India by Drs. Hooker and Thomson, and the numerous accurate and judicious notes and memoranda so liberally communicated by Dr. Hooker. When, therefore, I speak of having observed a series of specimens collected in various parts of the geographical area of a species, I do not mean (as has been hinted) the examination of a few single specimens from different localities deposited in a herbarium, but the observation of a species in a living wild state in different countries, or the comparison of numerous specimens, either promiscuously collected, or selected, with notes, for the purpose of illustrating variations.

And here I would observe, that the use of herbaria in determining the extent of variability of species requires the greatest caution. Not only are the specimens preserved generally unaccompanied by any notes on the comparative frequency of the form gathered, and others closely resembling it, or on any other local circumstances affecting the question, but they are very likely to lead the botanist astray in these particulars. A collector is naturally struck by a plant differing in aspect from the generality of its species, and gathers it in preference to the forms more familiar to him. The consequence is, that it frequently happens that an accidentally abnormal variety, which may occur only once in the way in nature, having been cut up into a number of specimens, and distributed without notes to various botanists, has, from its presence in so many herbaria, all the appearance of a form abundant in the locality cited.

The experience I have thus obtained has gradually produced in my mind a conviction of the truth of the following axioms:—

Every species has certain determinate limits of variation, which it only exceeds under exceptional circumstances.

The exceptionally abnormal forms thus produced are few in individuals, and are not reproduced; or their race becomes gradually extinguished, when the causes which produce them cease.

Within these limits of variation, a species will, in some countries, or under certain circumstances, produce an indefinite number of individual, or more or less permanent varieties, often passing into each other by almost imperceptible gradations; whilst, in other countries, or under other circumstances, a certain number of these varieties or races will remain, generation after generation, marked by positive, distinctive characters, having at first sight the appearance of real species.

Plants of the same species often breed freely together, the crossbreeding of different individuals sometimes producing a more vigorous offspring than those sprung from a single flower, and being, perhaps, occasionally even necessary in plants apparently hermaphrodite. In other species, cross-breeding between individuals or races is rare and exceptional, and apt to be unfruitful.*

Plants of distinct species breed together only under exceptional circumstances.

The hybrids thus produced are constitutionally more or less imperfect. They seldom produce a second generation, unless fertilized by an individual of one of the parent species, to which they then gradually return. They, therefore, do not establish permanent races, but disappear in nature, unless reproduced by a fresh cross-breeding between the parent species.

Setting aside, in the first instance, these hybrids, and accidentally abnormal extreme variations, monstrosities, and diseases, the variations of a species may be generally referred to two classes.

1. Variations resulting from the direct influence of soil, climate, food, or other external circumstances, such as luxuriance from a rich soil, fleshiness from a maritime exposure, &c. These act upon the individual; they may disappear in that individual when the exciting causes are removed, or they may become so engrafted on the constitution as to last through life, after removal of the causes; they may even become more or less hereditary through one or more generations. Seeds of a plethoric kitchen-garden vegetable, originally the result of a peculiar treatment in a rich soil, will, even under a different and uncongenial treatment, to a certain degree reproduce the same variety for some generations.

2. Variations which, arising from causes unknown to us, we consider as constitutional,—variations in the colour of the flower, in the form of particular parts, in the production or non-production of wings or other appendages to fruits, seeds, peduncles, &c. These, like variations in the features of animals, are often hereditary, and in plants under cultivation will last, or may be made (by selection of seed, &c.) to last almost indefinitely; and, in a wild state, they may, in particular localities, result in apparently permanent races. These races, however, generally breed readily with the typical forms of the species, and, although permanent and distinct in some localities, will generally, in some part of the area of the species, or under certain circumstances, be

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* Since the above was written out, and when on the point of reading it to the Society, I observed in the "Gardener's Chronicle" of the 13th Nov., 1858, a very important communication from Mr. Darwin, in which he states his conviction that this cross-breeding between different individuals of the same species is universal. I admit readily that the vast number of curious observations he has made, most of them hitherto unpublished, tend to show that this cross-breeding is very much more general than we had supposed, and perhaps indispensable in certain species, or, at any rate, under certain climatological conditions; but I think there are numerous facts which argue strongly against its universality. On the other hand, Naudin, in a still more recent number of the "Annales des Sciences Naturelles," in which he gives an account of some highly instructive experiments connected with hybridity, may have been led too far in his doubts as to the frequency of cross-fecundation in some of the genera he has experimented upon.

found to break out occasionally into a return to the typical form, or to be connected with it by numerous intermediates. Generally speaking, such of these aberrant races as have spread to the limits of the geographical area of the species, or have become introduced into distant countries, and have thus been adapted to a change of condition, will there be found more disposed to maintain their peculiarities, or even to diverge still more from their types. It is where the species is most at home, where it accommodates itself most readily to a variety of soils and exposures, where the stations it affects show a most ancient domicile, that the connecting links between the varieties it has produced must generally be sought for. And this is one great reason why permanence of form is so little conclusive as evidence of specific difference, unless observed in a considerable portion of the area of the species.

The investigation of the connecting links between two forms, with the view of determining whether they are distinct species or marked races of one species, is attended with great difficulty in the due appreciation of what are intermediates—of the difference between one or two definitely limited, though apparently intermediate species, and a chain of intermediate forms connecting the two extreme varieties of one species. The Allsike clover, in the colour of its flowers and mode of growth, has been looked upon as intermediate between the Dutch and the common red clover (*T. repens* and *pratense*), and some such idea suggested to Linnæus the name of *T. hybridum*. Yet the evidences of its specific distinctness from both are very strong. I have observed it with care in a living state over a great part of its natural area in Sweden and Central Europe. From *T. pratense* it is separated by characters among the most constant in the genus, without, in this instance, any tendency to variation. It is nearer to *T. repens;* and Professor Buckman, at the meeting of the British Association at Cheltenham, in 1856, stated that he had found it degenerate into that species. I cannot but think, however, that here there must have occurred one of those mistakes so common in botanical and experimental gardens—that a plant or its seeds have accidentally perished, and its place has been taken by some ubiquitous species, so nearly allied as to escape observation when young, such as, in this instance, *T. repens.* I never could detect, either in those places where I have seen *T. hybridum* wild in the greatest abundance, nor yet in the fields where it is cultivated, any tendency to assume the creeping stems, the peculiar inflorescence, and other characters of *T. repens.*

Take, again, *Hypericum linariifolium.* The cursory inspection of a few herbarium specimens of this plant, of certain varieties of *H. perforatum,* and of *H. humifusum,* might suggest the idea that the former constituted a connecting link between the two latter. In this instance the characters are less decided, and of a less constant nature than in that of the three Clovers above quoted; yet, so far as my experience goes—and I have observed *H. linariifolium* living in parts of Western France, where it grows in the greatest abundance, besides numerous dried specimens from the greater portion of its area, and the two others living in a great variety of stations and countries—I have seen no real tendency of *H. linariifolium* to pass into *H. humifusum,* still less into *H. perforatum.*

On the other hand, a very good example of really intermediate forms, erroneously (in my opinion) considered as constituting a distinct species, is afforded by the Daisy. In my early botanical days I was familiar with the two extreme forms—the large-flowered, long-leaved *Bellis sylvestris* of the south of France, of which I dried rather largely, selecting (as is usual with collectors), the most characteristic specimens, and our common, much smaller-flowered, and broader-leaved *B. perennis,* which I never particularly examined, and which is reckoned too common a plant to be frequently preserved in herbaria beyond a single specimen. The difference between the two was striking; and I adopted, without hesitation or consideration, their established specific distinctness. I subsequently received from Prof. Gussone his *B. intermedia,* which I laid in, on his authority, as a distinct species, the single specimen being quite insufficient to enable me to form any independent opinion on the subject. But when, in the autumn of 1846, I saw the neighbourhood of Constantinople abounding in daisies of various sizes, usually fully as large as the Montpelier ones, but sometimes much more like our northern ones, and equally variable in the form of their leaves, I felt much puzzled as to which species I should refer them to. In the following spring, in my Sicilian herborisations in Gussone's own country, I paid particular attention to these plants. The three supposed species there appeared to me to pass most gradually the one into the other, the intermediates being more abundant than either of the extremes; and since that time, in other parts of Europe, I have observed that where either of the extremes grows alone, its distinctive characters are not nearly so constant as they are supposed to be. I have thus been irresistibly led to the conviction that *Bellis intermedia* and *sylvestris* are mere varieties of *B. perennis.*

In the above instances, the evidences of specific diversity in the two first, and of identity in the third, are to my mind conclusive; and, as further examples of cases where a conviction of specific identity has, as it were, been forced upon me in opposition either to the views I had at first entertained, or to those of a large number of modern botanists, I would refer to *Fumaria officinalis, Cerastium vulgatum, Rubus fruticosus,* &c., which have all been the subject of long-contined observation, and endeavours to maintain as distinct species forms which I have, in my Handbook, reunited under the above names. There are, however, a number of cases where the evidences, as hitherto collected, are so insufficient or so conflicting, as to render any satisfactory decision hopeless, until carefully conducted experiments and observations shall have made us better acquainted with the hereditary permanence of certain apparently positive, but minute and unimportant characters.

It may be observed, in the first place, that there are frequently two nearly allied forms, of nearly the same geographical range, which are found more or less in company with each other, retaining over the whole of that range certain distinctive characters, of no great importance in their respective genera, yet apparently constant in that particular case. Such are, for instance, *Viola odorata* and *hirta*, *Lychnis vespertina* and *diurna*, *Ulex Europæus* and *nanus*, *Sonchus oleraceus* and *asper*, *Senecio jacobœa* and *erucæfolius*, *Orchis maculata* and *latifolia*, *Juncus articulatus* and *obtusiflorus*, and a number of others. In some of these cases, the balance of evidence has appeared to me to be in favour of their specific distinctness, in others of their identity, and I have so recorded them in my Hand-book, but often with great hesitation; and it is not improbable that further observation and experiment may induce a change of opinion in regard to some of them.

Again, there are sometimes two, three, or more forms, having every appearance of really distinct species, all common over an extensive area, or spreading into distant regions, and everywhere retaining their characters; and yet we are occasionally startled by the appearance of intermediate forms of various degrees, suggesting in some minds the specific identity of the whole series, in others a progressive development from one species to another; and in others, again, natural hybrids; whilst in some instances the observer may have been deceived by accidentally abnormal specimens, carefully preserved and occupying a conspicuous part in the herbarium, without any record of the attending circumstances which might have accounted for their production, but which forms in nature are very rare, and of mere temporary existence. Such occur, for instance, among some of the common species of *Rumex*, *Mentha*, &c. It is also frequently a matter of great nicety to determine what constitutes an intermediate form; for two plants, to be really intermediate, should not be so in one character only, but in general habit and aspect, in a combination of all the characters which separate the two species it stands between. The species of *Carduus* (including *Cirsium*) for instance, have been artificially divided into species, with their leaves decurrent or not. When, therefore, a specimen of one which has usually sessile leaves is met with having them slightly decurrent, it has been, on that account alone, set down as intermediate between that and some other species to which it shows no approach in any other point; and thus figures in books as a hybrid, or a distinct species, according to the tendency of its describer.

One source of deception as to the real permanency of an abnormal form, even when observed without variation in a wild state in the greatest abundance, arises from the facility with which certain perennials, or shrubs, multiply by runners, suckers, bulbs, or other modes of division, especially in cool, moist, and comparatively sunless climates like our own. Individual peculiarities are thus propagated naturally in a wild state, as we do artificially in gardens, spreading over the country in such numbers, as to be mistaken by the cursory observer for races, if not for species. Seedling brambles, mints, creeping-rooted weeds, &c., are rare in our climate; the bulbiferous *Alliums*, the viviparous grasses, many introduced plants, such as the *Periwinkles*, *Hypericum grandiflorum*, &c., seldom produce any seed. *Carduus arvensis* may often be observed in great numbers for hundreds of yards along a roadside, all of one sex, evidently all from suckers, originating, perhaps, many years back in a single individual. In like manner, an individual bramble will, in the course of years, spread through a whole wood; a fragment of coltsfoot or couch grass infest large fields; or *Elodea Canadensis* fill our canals, though not a single seedling be raised.

One of the greatest difficulties in arriving at a just conclusion as to the value to be attached to intermediate forms, is owing to the doubts which still hang over the question of hybridity. The existence of hybrids in the vegetable kingdom, less perfect in their nature than true species, analogous to the mule among animals, has at all times been a popular notion; and wild plants, having some resemblance to cultivated or useful ones, but less perfect in respect of the qualities sought from them, have in most countries been stigmatised as *bastards*. Linnæus corrected many of these popular errors which had crept into the scientific nomenclature of the day; but he still gave his sanction to the idea of the hybrid origin of certain species, by adopting the term as the specific name in certain cases, without, however, probably having given the matter much consideration. Since his time it has been shown that his *Chelidonium hybridum*, *Vicia hybrida*, *Campanula hybrida*, *Chenopodium hybridum*, &c., are genuine, substantive species; and the existence of hybrids in a state of nature has been denied by several botanists, and admitted only with great reservations by some even of the most distinguished ones of the present day. Others, on the contrary, of our most acute observers, having acquired convincing evidence of natural hybridity in a few cases, have generalized their conclusions; they have supposed natural hybrids to be of constant and frequent occurrence; and they have ascribed to this cause alone the majority of variations from the supposed typical forms of species, or even attributed to original hybridisations the multitude of nearly allied, but constant species, in several of the largest genera.

That wild hybrids do exist, I had already convincing evidence from personal observation during the years 1825 and 1826, when my attention was specially directed to the search after them in the Pyrenees and the South of France; and the proofs brought forward by other observers are not to be resisted. But the cases are very few, and it requires great caution before we can attribute to this cause the appearance of individuals of a species showing some approach in their characters to some other species. In Western Europe, there are but six genera in which I have myself been able to collect satisfactory proofs of natural hybrids, viz., *Cistus* (including *Helianthemum*), *Geum*, *Saxifraga*, *Gentiana*, *Verbascum*, and *Digitalis*. We are also bound to admit on the authority of other observers, at least four more, viz., *Epilobium*, *Carduus* (including *Cirsium*), *Salix*, and *Narcissus*, and perhaps also *Centaurea*, *Erica*, *Rumex*, and *Polygonum*. The supposed hybrids in *Viola*, *Medicago*, *Primula*, if cross-breeds at all, are probably between varieties of one species, not between two species. The cases adduced in *Serapias*, *Aceras*, and *Orchis*, require much farther investigation, especially now that it is known how singular are the anomalies which occasionally break out in the flowers of some Orchideæ, where hybridity is quite out of the question. The wild hybrids described in *Dianthus*, *Galium*, *Hieracium*, and *Stachys*, appear to me to be exceedingly doubtful; and in the single alleged instance among Gramineæ, that of the hybrid between *Ægilops* and *Triticum*, one of the parents at least is in a cultivated state. We must also bear in mind the observation of C. F. Gaertner, how numerous are the genera, where several nearly-allied species grow together in the greatest abundance all over Europe, and are never known to hybridise. Such are *Ranunculus acris*, *repens*, and *bulbosus; Brassica Sinapistrum* and *nigrum; Stellaria Holostea* and *graminea; Geranium molle*, *pusillum*, and *rotundifolium; Potentilla argentea*, *verna*, *reptans*, and *anserina*, &c., &c.

Admitting, however, that in the extensive and diversified Flora of Europe, wild hybrids have been observed in some twenty to twenty-five genera, if we consider that the species in those genera which will hybridise are but few; that the individuals raised are always very few, and often isolated; that they are either not reproduced in a second generation, or their offspring is a further approach to the parent species; and that even two individuals sprung directly from the same two parent species generally differ quite as much from each other as from one of their parents; we shall find it very difficult to believe in the permanent establishment of wild hybrid intermediate races, distinguished by positive characters; and we cannot but reprobate the modern practice of introducing into Floras and systematic works so-called hybrid species, races, or varieties, with a pretended diagnosis, which are, in fact, nothing but descriptions of individuals. The reader is thus misled; for the chances are that the diagnosis will not apply to any fresh individual he may find of the same hybrid. A mere indication in the Flora or other work, under each parent species, of the existence or suspected existence of hybrids with such and such other species, is always sufficient for all legitimate purposes.

None of the above observations apply to artificial hybrids, the subject of so much careful experiment on the part of W. Herbert, C. F. Gaertner, A. Braun, Naudin, and others, whose labours have done much towards elucidating the physiology of hybrids in general. But the plants thus experimented upon were placed in exceptional circumstances; and the results obtained bear but indirectly on the evidences of wild hybridity, or are often indeed calculated in some measure to mislead. The fact that artificial impregnation between certain species can be effected with great facility, is no proof that these species, or others allied to them, are the more apt to produce hybrids in a wild state. It is well known, for instance, how numerous are our garden hybrids in the genus *Erica*. When I worked up that genus for the Prodromus, I had before me wild specimens from various collectors of almost every Cape species, and often in considerable numbers, including the original specimens of Masson, Niven, and others, from whom were obtained the majority of our garden forms; I examined them all with great care, as well as nearly complete sets of our then cultivated varieties, pure or hybrid, from four of our largest living collections, and thus acquired a tolerable idea of the characteristic features assumed by hybrids in this genus. Yet among the wild plants there was only one, in an old collection of Roxburgh's, that had the slightest appearance of a hybrid; and among European ones, the only instance I am aware of, is that mentioned by Hewett Watson, of the Cornish hybrids, between *E. ciliaris* and *E. Tetralix*. So in the genus *Dianthus*, according to C. F. Gaertner, artificial hybrids are very readily produced, and are more fertile than those of almost any other plants, and yet wild hybrids are very rare. Lecoq, it is true, speaks of hybrids between *D. Monspessulasnus* and *D. Seguieri* as being very abundant in the Montdore, and certainly these two species are, in that locality, very variable, but not more so than I have observed them in the Pyrenees, Provence, &c., when growing separately.

The apparent permanence given by cultivation to abnormal or intermediate races has afforded a plausible argument against the supposed constancy of the limits assigned to species in nature. The manner in which the Cape *Pelargoniums*, the South American *Verbenas* and *Petunias*, &c., have produced varieties without end, blending the original species together in inextricable confusion, is well known; and gardeners reckon with tolerable certainty on reproducing, by seed, the numerous varieties of our kitchen-garden annuals. But, as in the case of artificial hybrids, these plants are then placed in an anomalous condition, in which they are maintained by cultivation only. Restore them to the conditions of a wild growth, leave them exposed to all those obstacles which nature opposes to their multiplication, and they will soon yield to the more hardy or more favoured genuine forms, and gradually perish without being reproduced. This temporary character, when wild, may be observed in all the extraordinary aberrations from the common form, however healthy the individuals may appear, such as *Orchis pyramidalis* with spurless flowers, or *Linaria vulgaris*, with five spurs; *Helianthemum vulgare*, or *Narcissus juncifolius*, with linear or divided petals; or *Stellaria Holostea*, with no petals at all, &c.; they are none of them perpetuated; they cannot resist the immense chances there always are against the offspring of any one individual plant ever coming to perfection.*

To sum up the foregoing remarks:—When a plant is observed apparently allied to some known species, but differing in one or more characters hitherto unobserved or unrecorded in that species, before deciding

* As a familiar instance of the disproportionate chances against the success of any individual seed in a wild plant, take the *foxglove* (*Digitalis purpurea*). It will often ripen 200 capsules, and even above twice that number have been counted on one plant, and the number of good seeds I have found in one capsule have varied from 800 to 1200. Taking, however, the average number of good seeds shed by every plant as only 100,000; as the average number of foxgloves in a given district remains the same year after year and century after century, we have only one plant coming to perfection

whether it be a distinct species or a mere variety, the points to be considered, independently of direct experiment, will be chiefly the following:—

Are the distinctive characters such as can be accounted for by station, climate, or other known influences, of which I have enumerated several in my Handbook? (Introd. p. 31 and 32.)

Are the circumstances under which it was growing, and its general aspect, such as to suggest its being a hybrid between the allied and some other species?

Are the distinctive characters such as are known to occur in mere varieties of other species, more especially of such as are systematically allied to the one in question?

Is the plant in question, an isolated individual (including in the same category any number of individuals naturally propagated from a single one by runners, suckers, bulbs, &c.); or has it been observed in more or less abundance in any variety of stations over any considerable independent geographical area, or in any important part of the area of the allied species?

Is the distinctive character relied on confined to a single organ, or is it more or less accompanied by differences in other organs of the plant; and, if so, how far does the plant retain all the characters in all the different stations and localities where it has been observed?

Have intermediates between the plant and its allied species been sought for in any considerable portion of the area of the latter, and especially in those countries where it is most liable to variations? And, if such intermediates exist, what is their relative number, and how far do they vary, or pass one into another in all, or any, and which, of the points in which the plant in question differs from its allied species?

It is only in proportion as the evidence on all these points is full, satisfactory, and reliable, that our decisions on the value of a species can be fair, independently of any want of tact, experience, powers of observation or judgment, which we are all liable to; and not to mention the cases of but too frequent occurrence where ignorance, a false pride, vanity, a love of controversy, a desire of flattering, or even mercenary motives, have influenced the reckless splitting or over-hasty reunion of species.

With regard to direct experiment in aid of inductive reasoning, it has been said that cultivation is a sure and easy test of the identity or distinctness of species; and nothing is more common than to find as an argument in support of a "critical" species, that it has been growing for many years in a garden, always retaining its distinctive characters.

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for every 99,999 that perish either as seeds or young plants. It is often very curious to observe the luxuriant crops of crowded seedlings of various plants in autumn, which totally disappear before the following flowering season; and year after year, an attentive examination of the moors and heaths in many parts of Western England will disclose a profusion of seedling oaks, one, two, or three years old, not one of which ever attains the size and age even of a bush.

But the results thus obtained are liable to very great fallacies, unless the experiment is followed out in all its bearings, with many precautions rarely attended to; and what is supposed to furnish irresistible proofs of permanency of character, when inquired into, will often be found to add nothing at all to the arguments derived from observation.

In the first place, it is a very common practice, in thus testing by cultivation the permanency of character in a plant, to remove it bodily to a garden, and there to propagate it by suckers, cuttings, or other modes of division—an experiment which may, indeed, show the immediate effects of soil, climate, or other extraneous influences on the individual—but, as a test of value between species and variety, it can be of no avail. It is the very method adopted by gardeners for perpetuating individual variations. The only mode in which the test can really bear upon the question, is by sowing the seed, and observing the results in future generations. And in this proceeding it is not enough to raise a few plants in one spot, for two or three generations; for such a course would prove our varieties of kitchen-garden annuals to be all distinct species, which we all know is not the fact; the cultivation must be on a large scale, under circumstances of soil, climate, &c., as varied as the plant will bear, and for many generations; and, after all, the proofs of distinctness can scarcely be absolute, for they consist, as it were, in proving a negative. The object is not to show how long a particular form *can be made* to endure, but that it *will* always endure, in spite of external influences or other accidents—that it will not vary under any circumstances, or at any time. The cultivation must be that of the gardener, whose object is to raise new varieties—not of the curator, desirous of keeping his botanic garden usefully cropped, and correctly named—still less of the botanist, who seeks to uphold a species he has set up. The former sows extensively in different localities, in order to have the greater chance of accidental aberration; he carefully watches his seedlings as they grow up, and selects his seeds for the next generation from such plants as show the slightest tendency to vary in the wished-for direction. The curator, on the contrary, anxious to keep his types true, if he selects the seed at all, takes it from the most healthy, normal, and characteristic individuals.

To illustrate the very slender grounds upon which botanists of considerable and well-deserved reputation will occasionally adduce the results of cultivation as convincing proofs of specific distinctness, let us select from Grenier and Godron's Flora an instance taken from a genus worked up with great care, by one of the most accurate observers of individual varieties and local races, and whose views as to their reception as a species M. Grenier entirely adopts. Under *Galium spurium*, he says, "Cette espéce se produisant invariablement de graines sans perdre aucun de ses caractères, ne saurait être confondue avec le *G. Aparine*." To justify so sweeping and positive an assertion, we must suppose that he, or some one on whose exactness he has implicit reliance, has sown in several successive years each of the three varieties he mentions of *G. spurium*, besides the smaller forms of what he considers the true *G.*

aparine; that he has raised them in considerable quantities; that he has each year selected his seeds from such of his own seedlings as have shown any tendency to variation; and that this process has been carried on in different soils, in different situations, in different climates, and at different seasons. It is scarcely to be imagined that this has been done for so very uninteresting a plant; and yet, if any one of these precautions has been neglected, it cannot be said to be proved that the plant will never lose any of its characters. And, after all, what are these characters, so invariably reproduced? Not the want of hairs at the nodes, nor the narrowness of the leaves, for these he admits to be variable in his *G. tenerum*—besides, that such hairiness is often scarcely perceptible in the stoutest specimens of *G. aparine*—nor yet the glabrous or hispid fruit, for that is admitted to occur in both his species. There remain, first, the size of the plant, not more than a foot in *G. spurium*, often above three feet in *G. aparine;* but to which would he refer the numerous specimens occurring in some localities from 1 to 2 feet high? 2ndly. The articulations, swollen in *G. aparine*, but not in *G. spurium*, a mere result of the luxuriance of the former. 3dly. The size of the fruit, 4 to 5 millimetres in *G. aparine*, 3 or 4 times smaller, consequently 1 to $1\frac{1}{2}$ millimetres, in *G. spurium*. To verify this character, I have measured the fruits of numerous specimens, living and dried, of both forms, and I have never found the diameter quite so little as 2 millimetres; but from that size I have measured every intermediate from half to half millimetres, up to 5 millim., the largest I have met with. And 4thly. The hairs of the fruit, rising from a small tubercle in *G. aparine*, and no such tubercles in *G. spurium*. As to this point, if we take the hairy-fruited varieties of each form, I confess myself unable to discover any difference but what depends on size; the larger the fruit, and the larger the hairs, the more prominent are the tubercles at the base. Upon the whole, as far as my own experience goes, the results of cultivation constitute an item, but one item only, and that often a fallacious one, among the evidences on which the permanency of character is to be judged by inductive reasoning.

Even the proof of specific identity by cultivation is often liable to error. Such experiments are often several years in carrying on; it is not to be expected that they can be daily watched during the whole of that period, and all who have had the charge of gardens must be aware of the mishaps which may occur during a short absence, without being directly noticed—such as labels accidentally or intentionally destroyed or misplaced, or the sown seed failing, or the seedling perishing, and replaced accidentally by some common allied species or variety. The abnormal circumstances in which a plant under cultivation is placed, may also induce an apparent approach to some other species, without any real alteration of essential character. I have already instanced the *Trifolium repens* and *hybridum*, as one in which the supposed proof of identity by cultivation, notwithstanding my confidence in the experimenter, produces no conviction in my mind; and it is only with great hesitation that I have admitted the specific identity of the Primrose and the Cowslip, although several experimenters are stated to have raised the one from the other. In all cases, proof by cultivation seems to require some confirmation by the observation of wild nature.

With regard to genera and orders, I need not here repeat the views I laid before the Linnean Society on a former occasion ("Journ. Linn. Soc. Bot.," v. ii., p. 31), on the importance of maintaining, for the convenience of language and study, large genera and orders, in preference to breaking them up into small independent ones. But the opinions I have on that and other occasions expressed, that genera, as such, have no independent existence in nature, have been in some measure misunderstood. Far be it from me to deny that groups of species exist in nature, resembling each other more than they do the species of any other group—that some of these groups, consisting of two, three, or any number of species, are in nature distinguished from all others by a number of well-marked characters, or that a single species may be so isolated; whilst others can only be separated by single or unimportant or variable characters—that these groups may be collected into groups of a higher order, consisting in like manner of two, three, or any number of smaller ones, similarly distinguished in nature by more or less marked or important characters—that this synthetical process, always following natural indications, may be carried on till we arrive at the two or three great primary divisions of the vegetable kingdom—and that in all the stages very great differences exist in nature in the definiteness of the groups established, and in the relative importance of the characters distinguishing them; but that, generally speaking, the characters of a large group are more important than those which only distinguish its minor subordinates; for on these principles,—on a nice appreciation of affinities (or calculation of resemblances and differences), and of the importance of characters, as indicated in nature,—depends the whole value of a natural classification. What I meant to assert was, that nature has not assigned everywhere precise definite limits to the groups she has indicated; nor has she fixed upon two stages in the synthetical process more definite than any others, to be marked out, the one for genera, the others for orders. These are often selected and limited, arbitrarily, though necessarily, for the convenience of system, language, and reference. The characters of plants are, indeed, very different in importance; but such differences are relative, not absolute; we cannot say that certain characters are of ordinal importance, whilst certain others are only of tribual, generic, or sectional value. Nor does any one character retain the same importance throughout the vegetable kingdom. There is no test by which we can determine whether two groups formed in different parts of the field of classification are co-equal in value, or whether the one be of a higher grade than the other.

It becomes, therefore, necessary to consider what constitutes the relative importance in characters, how far we can safely be guided by it in the formation of genera, orders, or other groups, and when it is that we run the risk of being led astray by the too close adherence to the rules laid down.

The most important character, in plants, will always be that which in the greatest number of species (or groups of species) is the most constantly accompanied by the greatest general resemblances among those species, and differences from all others—that which collects into the same group species showing the greatest general conformity in the structure and economy of all their parts, and which may, therefore, be supposed to be the most uniformly influenced by or acting upon the specific constitution of plants.

This question of the relative importance of characters has been frequently discussed, especially by French botanists; and by none has it been so clearly put as by the elder De Candolle, in his admirable "Théorie Élémentaire." He there lays it down as a rule, that the value of a character is *in the compound ratio of the importance of the organ it is derived from, and of the point of view in which that organ is considered.*

But, in regard to the first element, how are we to determine the relative importance of organs? De Candolle indicates two modes: *à priori*, by the consideration of the functions they perform, or the part they take in the vital phenomena; *à posteriori*, by the observation of the extent to which they prevail, the number of species in which they exist. The former mode has been the one eagerly pursued or attempted by the greater number of generalizing botanists; the latter is that which, after all, has practically led to the best classifications; and though characterized by De Candolle as "très ingénieux mais peu applicable," is really that which he has himself followed in the best parts of his systematic works.

These two modes of argument correspond to those arguments from final causes, and from observation of facts, which have divided zoologists. But in plants we are much less able even than in animals to trace the modifications of form and structure to any final causes. The animal goes after, and selects his food; and the whole economy of his structure is modified according to the nature of that food, and where and how it is to be obtained. The plant is stationary and must take what food comes within its reach; and that food, and the mode of absorbing it, is very similar in all species; nor can we discover any other final cause why one set of plants, for instance, should always have alternate and another opposite leaves—why in *Digitalis purpurea* there should be on an average 1200 seeds fecundated and ripened for every two pair of stamens, whilst in several Acacias there should be 10,000 stamens to every head of flowers, which sets and ripens some half-dozen or a dozen seeds only. And yet characters like these are, in some instances, so constantly accompanied by so many general resemblances as clearly to distinguish natural groups of several thousand species.

The importance of organs, also, in another way, admits of two distinct qualifications, not always concurrent: physiological importance and systematic importance. The compounding these two applications of the word is apt to lead into some fallacies. De Candolle, for instance, after showing the impossibility of establishing any comparison of relative importance in the functions of the organs of reproduction and those of vegetation, but explaining why it is that the former practically supply better characters than the latter, lays down the following scale of progression in the importance of these reproductive organs:—

1. L'embryon qui est le but de tout;
2. Les organes sexuels, qui en sont le moyen;
3. Les enveloppes de l'embryon;
4. Les enveloppes des organes sexuels;
5. Les nectaires ou organes accessoires.

But, in the first place, the embryo in its perfect state can no longer be called an organ of the parent plant. Until it is fully formed, it supplies no characters. When once formed, it has no function to perform till it commences life as a new independent being. And this is the great reason of the importance of the characters it then supplies. It is a whole plant, not an organ of a plant.

Secondly, the same arguments which show the impossibility of comparing the importance of the functions of the reproductive and vegetative organs, would apply to the flower (or 'les organes sexuels') and the fruit (comprised in 'les enveloppes de l'embryon')—the apparatus for producing the embryo and the apparatus for bringing it to perfection—and, again, in the flower, between the male and the female organs; for all these are equally essential for completing the series of vital phenomena which continue the species. It is true that, exceptionally, embryos may be formed and brought to perfection without normal fertilisation, but so also the whole series may be dispensed with, and plants are reproduced by buds without passing through the embryo state; but in all phanerogamic species, for their normal reproduction, the whole series, the male organs, the female organs, and the organs of maturation, are equally essential.

Perhaps all that can be said of the relative importance of organs with reference to their functions is this: That the so-called essential organs, the sexual organs, and the organs of maturation among the reproductive, and the perfect leaves or foliaceous surfaces, and the root-fibres among the nutritive, stand first; the protective organs, such as floral and fruit envelopes, bud-scales, &c., occupy the second rank; and accessory organs, including epidermal scales, are the lowest. But here again the relative importance of these organs is not proved by *à priori* arguments, derived from the necessity of their presence for performing those functions, but from the observation of the degree of constancy of their being so employed. Cryptogamic plants have sometimes none, sometimes not all, of the organs of the first degree; yet nutrition, fertilisation, and reproduction, take place, but by other means, with another class of organs. And had we observed that, in phanerogamous plants, fertilisation of the ovule never took place unless the sexual organs were enclosed in floral envelopes, we should have classed the latter among the essential organs of the first class.

The importance of characters, in as far as derived from the importance of the organs they relate to, would follow the same gradation,—observation (not theory) teaching us, however, to place those derived from the reproductive organs of each degree before the corresponding ones derived from the nutritive organs; and those derived from the embryo or young plant, more especially at the moment of germination, above all.

But the second element in the ratio of value of characters, the point of view in which the organs are considered, is one which experience shows to be often far more important than the nature of the organ itself, and the neglect of which contributes more than anything to the degeneracy of an apparently natural classification into a purely artificial one. The principal characters which an organ, or set of organs, can thus supply, and their relative importance, are admirably expounded by De Candolle, in his Taxonomie, div. I., chap. 3. He there establishes the following scale of gradation, in which I have ventured to make some slight modification in expression, but which I think should never be lost sight of by the systematist who has any pretension to establish natural groups.

1. The real presence or absence of organs (parts of organs, or sets of organs), independent of adherence or accidental abortion.

2. Their arrangement, or relative position, and numbers, as affecting or indicating the general plan upon which the plant is constructed.

3. Their external form, relative size, continuity or articulation, &c., all subordinate to the preceding class, only acquiring importance when indicative of a result from general arrangement.

4. Their functions and sensible qualities,—the results, rather than the causes, of the preceding modifications.

By combining this scale of relative importance with that derived from the nature of the organs themselves, it might be possible to frame a general scale of relative importance of characters, which, with other rules suggested by the observation of the comparative prevalence of particular characters, might assist in judging of the expediency of describing as a new genus or order any newly-discovered plant which does not come precisely within the limits previously fixed for any known genus or order. But, in the grouping together any number of species or genera already known, the relative value of the characters relied upon should be tested, at every step, by a comparison with all the other features of the plants. The blind adherence to a pre-established scale, in distributing into genera the species of a large order, renders such a classification purely artificial. It had been ascertained that the relative arrangement of the radicle and cotyledons in the embryo of *Cruciferæ*, the relative prominence of the ribs of the fruit, and the number and arrangement of the vittas in *Umbelliferæ*, the various modifications of the pappus in *Compositæ*, were in many cases remarkably constant, not only in species, but in many very natural genera. But by taking these characters as absolute, and considering every slight modification of them as of generic importance, many of the most natural groups in those orders have been broken up, and split down almost to single species, classed into purely artificial tribes and sub-tribes. So, also, a character generally important may, in some instances, separate a single species from a large order with which it may agree in every other respect. The dismemberment of such exceptional species from that order,—as, for instance, that of *Phryma* from Verbenaceæ,—becomes then purely artificial, and contrary to all principles laid down for natural classification.

This introduction of artificial arrangements, under the disguise of a strict adherence to the rules of the natural system, is much promoted by a tendency to which we systematists are all very liable. It has happened to most close observers to have on some occasion brought forward some character till then comparatively neglected, but which has proved to be eminently useful for establishing natural groups in particular genera, orders, or classes. Such a character is then apt to assume an undue importance in the observer's mind, and to be applied by him indiscriminately throughout the vegetable kingdom. The arrangement of the parts of the floral whorls with relation to the main axis of inflorescence, the æstivation of the floral envelopes, the relative attachment of the floral whorls, and consequent modifications in form of the torus, disk, or floral receptacle; the numbers absolute and relative of the parts in the several floral whorls, the position of the ovary with relation to the rest of the flower, that of the ovules with relation to the ovary, the structure of the fruit, and even the most important of all, the relation of the embryo to the seed, and, the seat of deposit of starch for supplying the first nutriment to the growing embryo—whether as albumen around it, or in its cotyledons, or in the intermediate point (the collet) between the radicle and cotyledons—all characters which more or less generally mark out large and highly natural orders, have nevertheless, each in their turn, on some occasion or other, been applied too strictly, so as to dissever groups otherwise most natural.

On the other hand, however closely we follow natural indications, our system must be to a certain degree artificial. A purely natural method of arranging species and genera is impossible; at least, none has ever been brought forward. The affinities and cross-affinities of plants are so complicated and intertwined, that we have no method of representing them either by a linear series, or by mapping them out on a plane surface. Many of the most natural groups have no definite limits; and yet, to form any clear idea of them for the purpose of study, we must assign limits. The truly German idea of taking one species or genus as a normal type of a genus or order, and grouping others around it as more perfect, or reduced, or collaterally aberrant forms, leads to no practical results. However well it may read in chamber speculations, it produces nothing but confusion when applied to the actual grouping of species. There is no plant which arguments like those usually brought forward may not show equally well to be an aberrant form of almost any number of different types. The absurdity of such a system appears to me never to have been so fully exemplified as in an elaborate work received whilst writing out these pages, in which, for instance, Begoniaceæ, Melastomaceæ, Gesneriaceæ, Burmanniaceæ, and Orchideæ, are collected into one series, whilst Memecyleæ, Bignoniaceæ, and Irideæ, are far removed from them.

It appears to me, therefore, that whilst in an artificial or analytical system for finding out the name of a plant, one prominent character is selected to mark out each division; in a natural or synthetical system, on the contrary, for the arrangement and study of plants, the affinities according to which they are grouped should be judged of by the combination of as many and as constant characters as possible, derived from all parts of the plants ; but that, in both cases, characters *must* be assigned. "Character non facit genus," it is true; but a genus without a character is of no assistance to the mind of the naturalist.

XVI.—On the Serial Homologies of the Articular Surfaces of the Mammalian Axis, Atlas, and Occipital Bone. By John Cleland, M.D., Demonstrator of Anatomy in the University of Edinburgh.

[Read before the Royal Physical Society of Edinburgh, Nov., 1860.]

In works on human anatomy it has been customary to compare the articular surfaces of the atlas, and the superior articular surfaces of the axis, with those of the oblique processes of other vertebræ, as if they were homologous, notwithstanding the apparently anomalous manner in which, according to that view, the first and second spinal nerves must be considered as emerging from the spinal canal. The circumstances which have led to this comparison being made, are merely the rapid diminution in size of the intervertebral discs from the thoracic region up to the axis, and a general similarity of appearance between the articular surfaces of the atlas and axis and those of succeeding vertebræ : and though the impropriety of this comparison has been exposed in very explicit terms by Prof. Henle,* there is still room for a few remarks as to the precise parts of other vertebræ to which the surfaces in question correspond.

In order to arrive at a just conclusion upon this subject, we shall find it advantageous to examine the atlas in the bird. In it we find on the posterior aspect a pair of true oblique processes passing backwards, to articulate above the intervertebral foramina with a corresponding pair of processes of the axis, similar to those of succeeding vertebræ; while inferiorly there is a cartilaginous surface which forms, with the body of the axis and its odontoid process, a joint similar to those between the succeeding bodies of vertebræ. On the anterior aspect of the

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* Henle, Handbuch der Syst. Anat. des Menschen, I., p. 42.

atlas there are no articular processes like the posterior pair; and there is presented for articulation with the condyle of the occipital bone, a single surface, exactly corresponding in extent with that which articulates with the body of the axis. As regards the occipital condyle, its constitution will be best understood by looking at the quite similar condyle of the occipital of the turtle. In it the middle and lower portions are formed by the basi-occipital, in precisely the same manner as the body of a vertebra is formed principally by the centrum, but has its superior angles derived from the arch. Thus, there can be no doubt that the atlo-occipital articulation in birds, as well as the inferior atlo-axoid articulation, belongs to the same series as those between the bodies of the succeeding vertebræ.

It remains for us to show that they also correspond to the atlo-occipital and atlo-axoid articulations in mammals: and that they do so will readily appear, on making a more careful examination of the anterior articular surface of the atlas of the bird in the recent condition. It presents the form of a cup perforated by a small foramen, through which a ligament passes from the tip of the odontoid process to the occipital condyle, and the part of the cup which lies above the foramen is formed by a transverse ligament. This transverse ligament corresponds to those which pass from side to side of the bodies of other vertebræ and are attached to the superior angles of their anterior aspects—those angles which are derived from the arches.* Now, in mammalia, not only is the function of the tranverse ligament of the atlas the same as in birds; but in many of them the heads of the ribs of opposite sides are united above the intervertebral discs by transverse ligaments (ligamenta conjugalia costarum), which very obviously correspond to the ligaments just mentioned on the vertebræ of the bird; for, though they do not, like them, pass from angle to angle of the bodies of the vertebræ, they are attached to structures interpolated between these angles. It appears, therefore, that the transverse ligaments of the atlas and other vertebræ in birds, and the ligamentum conjugale costarum, and transverse ligament of the atlas in mammals, are all homologous structures: and, in that case, the only difference between the atlo-occipital articulation in the mammal and in the bird is, that while in the latter it is single, in the former it is divided into two lateral parts. But this is not an important distinction; for in the atlo-axoid articulation, we find the arrangement in many mammals, as in the human subject, similar to that of the atlo-occipital; while in others, as in the sheep, a single joint extends across the middle line exactly as in the bird.

The serial correspondences of the vertebral articulations are very well illustrated in the human fœtus. The articular surfaces of the oblique processes are situated immediately behind the transverse processes, and

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* I have described and figured the ligament here referred to in a paper "On the Structure, Actions, and Morphological Relations of the Ligamentum Conjugale Costarum," in the Edinburgh New Philosophical Journal, April, 1859.

in the cervical region the arches are bulged outwards at the points where they are placed (Fig. 5). The axis is shaped altogether like one of the succeeding vertebræ, except only that the odontoid process is superadded to the centrum: and the bulging of the arch on each side behind the transverse process is well marked, and bears the inferior articular surface on its under side. On the other hand, the superior articular surface is placed partly on the odontoid process, but principally on the most anterior part of the arch, viz. that part which, in all the succeeding vertebræ, forms the posterior angle of the body (Fig. 3). So also on the anterior extremity of the arch are placed the articular surfaces (both superior and inferior) of the atlas (Fig. 4); and also, in the dorsal region, the surfaces for the heads of the ribs. The occipital condyles are placed upon the most anterior parts of the arch of the occipital bone, and to a small extent upon the centrum.

The foregoing examination of vertebral articulations leads us to observe, that, when surfaces for a synovial joint are present upon the body of a vertebra, however little of the body they may cover, they are never absent from those angles which are formed by the arches.

The synovial articulations between the bodies of vertebræ in mammals are arranged in the following manner: In the dorsal region are the synovial capsules for the heads of the ribs, which always occupy the angles of the bodies, but are also, in many animals, united across the middle line between the intervertebral disc and the conjugal ligament; while in some cases, as in the horse and the sheep, a small line of cartilage is stretched along the superior margin of the posterior of the two vertebræ concerned in each joint. In the cervical region in the human subject, the minute joints described by Luschka,* are situated between those parts of the bodies which are formed by the arches. Lastly, in the atlo-axoid and atlo-occipital articulations, the principal parts of the articular surfaces are placed upon those parts of the arches which correspond to the angles of the bodies of succeeding vertebræ, while the intervertebral discs have disappeared.

I may here remark that, if the odontoid process be regarded as the centrum of the atlas,—a view which seems to be supported by its very large comparative size in the young condition, long before the anterior tubercle of the atlas makes its appearance—then we must recognise in the odontoid ligaments the terminal member of the series to which the transverse ligament of the atlas and the ligamenta conjugalia belong: and indeed the arrangement of their fibres, some of which are continuous from side to side, is favourable to this supposition, and reminds one of the ligamentum conjugale in the sheep.

Note.—Since writing the above, my attention has been called to Rathke's work "Ueber die Entwickelung der Schildkröten," in which (page 77), the view that the odontoid process is the centrum of the atlas is strenuously urged, and strong evidence brought forward in its favour.

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* Luschka, Die Halbgelenke des Menschlichen Körpers, 1858, p. 71, and Tab. I., fig. 1.

See also "Owen, On the Homologies of the Vertebrate Skeleton," page 93. Rathke points out that the ligamentum suspensorium, which, in the birds and higher reptilia unites the odontoid process to the occipital condyle, is the serial representative of the intervertebral discs behind. He found that in most chelonians it consisted of true cartilage, and that in certain birds it was composed of fibro-cartilage. This view of the ligamentum suspensorium is quite consistent with the suggestion which I have offered, that the ligamenta alaria are homologous with the transverse ligament.

The large portion of the cup on the anterior aspect of the chelonian atlas, which is formed by the expanded inferior extremities of the arch, illustrates very well the unity of plan upon which the articular surfaces of the atlas are formed in animals having one occipital condyle, and those which have two. This will be seen by comparing the woodcuts below.

When, in the human subject, a process of bone passes up from the arch of the atlas, to meet the superior articular surface and convert the groove for the nerve and vertebral artery into a foramen, the process in question is a true oblique process. If, in addition, we were to imagine the tip of the transverse process thickened and projecting upwards to meet the superior articular surface, we should then have presented to us the condition of parts found in the pig and the sheep.

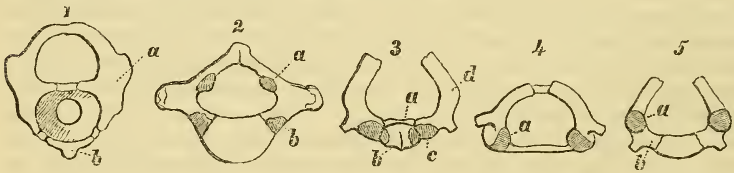

Fig. 1. Atlas of a young *Chelonia virgata*—after Rathke. *a*. The arch. *b*. Osseous centre of the tubercle.

Fig. 2. Dorsal vertebra of a young seal, for comparison with the following figures: *a*. Oblique process. *b*. Articular surface for head of rib.

Fig. 3. Superior aspect of the axis of a human fœtus. *a*. The centrum. *b*. Odontoid process. *c*. Superior articular surface. *d*. Bulging of the arch in the situation of the inferior articular surface.

Fig. 4. Inferior aspect of the atlas of the same subject. *a*. Articular surface.

Fig. 5. Cervical vertebra from the same subject. *a*. Oblique process. *b*. Part of the arch entering into the composition of the body of the vertebra.

XVII.—On the Crania of the Most Ancient Races of Man. By Professor D. Schaaffhausen, of Bonn. (From Müller's Archiv., 1858, pp. 453. With Remarks, and original Figures, taken from a Cast of the Neanderthal Cranium. By George Busk, F. R. S., &c.

In the early part of the year 1857, a human skeleton was discovered in a limestone cave in the Neanderthal, near Hochdal, between Düsseldorf and Elberfeld. Of this, however, I was unable to procure more than a plaster cast of the cranium taken at Elberfeld, from which I drew up an account of its remarkable conformation, which was, in the first instance, read on the 4th of February, 1857, at the meeting of the Lower Rhine Medical and Natural History Society, at Bonn.* Subsequently Dr. Fuhlrott, to whom science is indebted for the preservation of these bones, which were not at first regarded as human, and into whose possession they afterwards came, brought the cranium from Elberfeld to Bonn, and entrusted it to me for more accurate anatomical examination. At the General Meeting of the Natural History Society of Prussian Rhineland and Westphalia, at Bonn, on the 2nd of June, 1857,† Dr. Fuhlrott himself gave a full account of the locality, and of the circumstances under which the discovery was made. He was of opinion that the bones might be regarded as fossil; and in coming to this conclusion, he laid especial stress upon the existence of dendritic deposits with which their surface was covered, and which were first noticed upon them by Professor Mayer. To this communication I appended a brief report on the results of my anatomical examination of the bones. The conclusions at which I arrived were:—1st. That the extraordinary form of the skull was due to a natural conformation hitherto not known to exist, even in the most barbarous races. 2nd. That these remarkable human remains belonged to a period antecedent to the time of the Celts and Germans, and were in all probability derived from one of the wild races of North-western Europe, spoken of by Latin writers; and which were encountered as autochthones by the German immigrants. And 3rdly. That it was beyond doubt that these human relics were traceable to a period at which the latest animals of the diluvium still existed; but that no proof in support of this assumption, nor consequently of their so-termed *fossil* condition, was afforded by the circumstances under which the bones were discovered.

As Dr. Fuhlrott has not yet published his description of these circumstances, I borrow the following account of them from one of his letters. "A small cave or grotto, high enough to admit a man, and

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* Verhandl. d Naturhist. Vereins der preuss. Rheinlande und Westphalens., xiv. Bonn, 1857.

† Ib. Correspondenzb. No. 2.

about 15 feet deep from the entrance, which is 7 or 8 feet wide, exists in the southern wall of the gorge of the Neanderthal, as it is termed, at a distance of about 100 feet from the Düssel, and about 60 feet above the bottom of the valley. In its earlier and uninjured condition, this cavern opened upon a narrow plateau lying in front of it, and from which the rocky wall descended almost perpendicularly into the river. It could be reached, though with difficulty, from above. The uneven floor was covered to a thickness of 4 or 5 feet with a deposit of mud, sparingly intermixed with rounded fragments of chert. In the removing of this deposit, the bones were discovered. The skull was first noticed, placed nearest to the entrance of the cavern; and further in, the other bones, lying in the same horizontal plane. Of this I was assured in the most positive terms by two labourers who were employed to clear out the grotto, and who were questioned by me on the spot. At first no idea was entertained of the bones being human; and it was not till several weeks after their discovery that they were recognised as such by me, and placed in security. But, as the importance of the discovery was not at the time perceived, the labourers were very careless in the collecting, and secured chiefly only the larger bones; and to this circumstance it may be attributed that fragments merely of the probably perfect skeleton came into my possession."

My anatomical examination of these bones afforded the following results:—

The cranium is of unusual size, and of a long-elliptical form. A most remarkable peculiarity is at once obvious in the extraordinary development of the frontal sinuses, owing to which the superciliary ridges, which coalesce completely in the middle, are rendered so prominent, that the frontal bone exhibits a considerable hollow or depression above, or rather behind them, whilst a deep depression is also formed in the situation of the root of the nose. The forehead is narrow and low, though the middle and hinder portions of the cranial arch are well developed. Unfortunately, the fragment of the skull that has been preserved consists only of the portion situated above the roof of the orbits and the superior occipital ridges, which are greatly developed, and almost conjoined so as to form a horizontal eminence. It includes almost the whole of the frontal bone, both parietals, a small part of the squamous and the upper-third of the occipital. The recently fractured surfaces show that the skull was broken at the time of its disinterment. The cavity holds 16,876 grains of water, whence its cubical contents may be estimated at 57.64 inches, or 1033.24 cubic centimetres. In making this estimation, the water is supposed to stand on a level with the orbital plate of the frontal, with the deepest notch in the squamous margin of the parietal, and with the superior semicircular ridges of the occipital. Estimated in dried millet-seed, the contents equalled 31 ounces, Prussian Apothecaries' weight. The semicircular line indicating the upper boundary of the attachment of the temporal muscle, though not very strongly marked, ascends nevertheless to more than half the height of the parietal bone. On the right superciliary ridge is observable an oblique furrow or depression, indicative of an injury received during life.* The coronal and sagittal sutures are on the exterior nearly closed, and on the inside so completely ossified as to have left no traces whatever, whilst the lambdoidal remains quite open. The depressions for the Pacchionian glands are deep and numerous; and there is an unusually deep vascular groove immediately behind the coronal suture, which, as it terminates in a foramen, no doubt transmitted a *vena emissaria*. The course of the frontal suture is indicated externally by a slight ridge; and where it joins the coronal, this ridge rises into a small protuberance. The course of the sagittal suture is grooved, and above the angle of the occipital bone the parietals are depressed.

	mm.†	
The length of the skull from the nasal process of the frontal over the vertex to the superior semicircular lines of the occipital measures, .	303 (300)	= 12·0″.
Circumference over the orbital ridges and the superior semicircular lines of the occipital, ...	590 (580)	= 23·37″ or 23″.
Width of the frontal from the middle of the temporal line on one side to the same point on the opposite, .	104 (114)	= 4·1″ – 4·5″.
Length of the frontal from the nasal process to the coronal suture, .	133 (125)	= 5·25″ – 5″.
Extreme width of the frontal sinuses,	25 (23)	= 1·0″ – 0·9″.
Vertical height above a line joining the deepest notches in the squamous border of the parietals, . .	70	= 2·75″.
Width of hinder part of skull from one parietal protuberance to the other, ...	138 (150)	= 5·4″ – 5·9″.
Distance from the upper angle of the occipital to the superior semicircular lines, ...	51 (60)	= 1·9″ – 2·4″.
Thickness of the bone at the parietal protuberance, ...	8.	
—— at the angle of the occipital, .	9.	
—— at the superior semicircular line of the occipital, ...	10	= 0·3″.

Besides the cranium, the following bones have been secured :—

1. Both thigh-bones, perfect. These, like the skull, and all the

* A remark with respect to this depression will be found in the Remarks.

† The numbers in brackets are those which I should assign to the different measures, as taken from the plaster cast.—G. B.

other bones, are characterized by their unusual thickness, and the great development of all the elevations and depressions for the attachment of muscles. In the Anatomical Museum at Bonn, under the designation of "Giant's-bones," are some recent thigh-bones, with which in thickness the foregoing pretty nearly correspond, although they are shorter.

	Giant's bones. mm.	Fossil bones. mm.
Length, ...	542 = 21·4″ .	438 = 17·4″.
Diameter of head of femur, . .	54 = 2·14″ .	53 = 2·0″.
,, of lower articular end, from one condyle to the other,	89 = 3·5″ .	87 = 3·4″.
,, of femur in the middle,	33 = 1·2″ .	30 = 1·1″.

2. A perfect right humerus, whose size shows that it belongs to the thigh-bones.

	mm.
Length, ...	312 = 12·3″.
Thickness in the middle, . .	26 = 1·0″.
Diameter of head, ...	49 = 1·9″.

Also a perfect right radius of corresponding dimensions, and the upper-third of a right ulna corresponding to the humerus and radius.

3. A left humerus, of which the upper-third is wanting, and which is so much slenderer than the right as apparently to belong to a distinct individual; a left *ulna*, which, though complete, is pathologically deformed, the coronoid process being so much enlarged by bony growth, that flexure of the elbow beyond a right angle must have been impossible; the anterior fossa of the humerus for the reception of the coronoid process being also filled up with a similar bony growth. At the same time, the olecranon is curved strongly downwards. As the bone presents no sign of rachitic degeneration, it may be supposed that an injury sustained during life was the cause of the anchylosis. When the left ulna is compared with the right radius, it might at first sight be concluded that the bones respectively belonged to different individuals, the ulna being more than half an inch too short for articulation with a corresponding radius. But it is clear that this shortening, as well as the attenuation of the left humerus, are both consequent upon the pathological condition above described.

4. A left *ilium*, almost perfect, and belonging to the femur; a fragment of the right *scapula;* the anterior extremity of a rib of the right side; and the same part of a rib of the left side; the hinder part of a rib of the right side; and, lastly, two short hinder portions and one middle portion of ribs, which, from their unusually rounded shape, and abrupt curvature, more resemble the ribs of a carnivorous animal than those of a man. Dr. H. v. Meyer, however, to whose judgment I defer, will not venture to declare them to be ribs of any animal; and it only remains to suppose that this abnormal condition has arisen from an unusually powerful development of the thoracic muscles.

The bones adhere strongly to the tongue, although, as proved by the use of hydrochloric acid, the greater part of the cartilage is still retained in them, which appears, however, to have undergone that transformation into gelatine which has been observed by v. Bibra in fossil bones. The surface of all the bones is in many spots covered with minute black specks, which, more especially under a lens, are seen to be formed of very delicate *dendrites.* These deposits, which were first observed on the bones by Dr. Mayer, are most distinct on the inner surface of the cranial bones. They consist of a ferruginous compound, and, from their black colour, may be supposed to contain manganese. Similar dendritic formations also occur, not unfrequently, on laminated rocks, and are usually found in minute fissures and cracks. At the meeting of the Lower Rhine Society at Bonn, on the 1st April, 1857, Prof. Mayer stated that he had noticed in the museum of Poppelsdorf similar dendritic crystallizations on several fossil bones of animals, and particularly on those of *Ursus spelæus,* but still more abundantly and beautifully displayed on the fossil bones and teeth of *Equus adamiticus, Elephas primigenius,* &c., from the caves of Bolve and Sundwig. Faint indications of similar *dendrites* were visible in a Roman skull from Siegburg; whilst other ancient skulls which had lain for centuries in the earth presented no trace of them.* I am indebted to H. v. Meyer for the following remarks on this subject:—

"The incipient formation of dendritic deposits, which were formerly regarded as a sign of a truly fossil condition, is interesting. It has even been supposed that in diluvial deposits the presence of *dendrites* might be regarded as affording a certain mark of distinction between bones mixed with the diluvium at a somewhat later period and the true diluvial relics, to which alone it was supposed that these deposits were confined. But I have long been convinced that neither can the absence of *dendrites* be regarded as indicative of recent age, nor their presence as sufficient to establish the great antiquity of the objects upon which they occur. I have myself noticed upon paper, which could scarcely be more than a year old, dendritic deposits, which could not be distinguished from those on fossil bones. Thus I possess a dog's skull from the Roman colony of the neighbouring Heddersheim, *Castrum Hadrianum,* which is in no way distinguishable from the fossil bones from the Frankish caves; it presents the same colour, and adheres to the tongue just as they do; so that this character also, which, at a former meeting of German naturalists at Bonn, gave rise to amusing scenes between Buckland and Schmerling, is no longer of any value. In disputed cases, therefore, the condition of the bone can scarcely afford the means for determining with certainty whether it be fossil, that is to say, whether it belong to geological antiquity, or to the historical period."

As we cannot now look upon the primitive world as representing a wholly different condition of things, from which no transition exists to

* Verh. des Naturhist. Vereins in Bonn, xiv., 1857.

the organic life of the present time, the designation of *fossil,* as applied to *a bone,* has no longer the sense it conveyed in the time of Cuvier. Sufficient grounds exist for the assumption that man coexisted with the animals found in the *diluvium;* and many a barbarous race may, before all historical time, have disappeared, together with the animals of the ancient world, whilst the races whose organization is improved have continued the genus. The bones which form the subject of this Paper present characters which, although not decisive as regards a geological epoch, are, nevertheless, such as indicate a very high antiquity. It may also be remarked that, common as is the occurrence of diluvial animal bones in the muddy deposits of caverns, such remains have not hitherto been met with in the caves of the Neanderthal; and that the bones, which were covered by a deposit of mud not more than four or five feet thick, and without any protective covering of stalagmite, have retained the greatest part of their organic substance.

These circumstances might be adduced against the probability of a geological antiquity. Nor should we be justified in regarding the cranial conformation as perhaps representing the most savage primitive type of the human race, since crania exist among living savages, which, though not exhibiting such a remarkable conformation of the forehead, which gives the skull somewhat the aspect of that of the large apes, still in other respects, as for instance in the greater depth of the temporal fossæ, the crest-like, prominent temporal ridges, and a generally less capacious cranial cavity, exhibit an equally low stage of development. There is no reason for supposing that the deep frontal hollow is due to any artificial flattening, such as is practised in various modes by barbarous nations in the Old and New World. The skull is quite symmetrical, and shows no indication of counter-pressure at the occiput, whilst, according to Morton, in the Flat-heads of the Columbia, the frontal and parietal bones are always unsymmetrical. Its conformation exhibits the sparing development of the anterior part of the head which has been so often observed in very ancient crania, and affords one of the most striking proofs of the influence of culture and civilization on the form of the human skull. The Abbé Frère,* whose collection of crania belonging to the different centuries of our epoch is now placed in the Anthropological Museum of the Jardin des Plantes in Paris, came to the conclusion that, in the most ancient crania, the occipital was the most, and the frontal region the least developed; and that the increase in the elevation of the latter marked the transition from barbarous to civilized man. Blumenbach, also, met with an old Danish skull, whose facial angle was no greater than it is in the Negro. In the sepulchral mounds near Ambery in the Upper Palatinate, at Witterswyl in Switzerland, and in other places in Germany, crania have been found exhibiting a surprisingly slight development of the frontal region.† Hyrtl describes a

* Serres. Gaz. Méd de Paris, 1852, No. 31.

† Jahresber. d. Sinsheim. Gesellsch. z. Erforsch. d. vaterl. Denkmale d. Vorzeit von K. Wilhelmi, 1831–46.

Celtic skull found at Hallstadt as dolichocephalic and orthognathic, with the incisor and molar teeth entirely worn down, and the frontal bone much inclined backwards.* The crania found in Lower Austria, near Grafenegg, and afterwards at Atzgersdorf, with depressed foreheads, were regarded as those of Avares; but their very abnormal form, resembling that of the Peruvian skulls, and which may also be traced in the fragments of cranial bones from the Crimea, described by v. Rathke and K. Meyer,† has been produced by artificial means.‡ In many instances, also, in which human bones, taken as the oldest traces of the existence of our race on the earth, have been found intermixed with those of extinct animals, they have exhibited an undeveloped primitive form of the cranium. Among the crania collected by Schlotheim in the gypsum caves near Köstritz, Link found one with a remarkably flattened forehead. In a bone-cavern in Brazil, Lund discovered human crania mixed with the bones of extinct animals, in which the forehead receded on a level with the face—a formation which is also represented in ancient Mexican pictures. In the rocky caverns of the Peruvian Andes, Castelnau discovered, under the same conditions, human crania of a similar strongly retrocedent, elongated form. A cranium found, together with fossil bones of animals, in the cavern of Engis, near Lüttich, is described by Schmerling as being elongated, with a slightly elevated and narrow frontal bone, and a form of the orbits more approaching that of the Negro than of the European. In the cavern of Chauvaux, near Namur, among numerous fragments of human bones, the half of a cranium was found, in which the forehead was so retrocedent, and the alveolar arches so prominent, that the facial angle was not more than 70°. Rasoumovsky's statements respecting the supposed fossil skulls of the Mount Calvary, near Baden, which have been compared sometimes with that of the Negro, sometimes with the Caribbean skull, have been corrected by Fitzinger, who agrees with Hyrtl in regarding the crania, according to Retzius' description of the Czechen-skull, as Sclavonic.§

In a report of the meeting of German naturalists and physicians, held at Tübingen, in 1853, published in the German and foreign periodicals, Fraas is reported to have exhibited a petrified human skull from the Swabian Alps, of an elongated form, with prominent jaw, worn teeth, retrocedent forehead, large frontal sinuses, and strongly developed

* Jahrb. d. K. K. Geologischen Reichanstalt., Wien, 1850. I., p. 352.

† Müll. Arch., 1850, p. 513., taf. xiv. and xv. [*Vid.* also, on the subject of these macrocephalic skulls, a recent, learned memoir by K. E. v. Baer: "Die Makrokephalen im Boden der Krym und Osterreichs," &c. (In Mém. de l'Acad. de St. Petersbourg, tome ii. No. 6. 1860.)]

‡ Fitzinger, Sitzungsb. d. K. Ak. d. Wissensch. Math. Naturer. Kl. vii., B. 1851., p. 271.

§ Denkschr. d. k. Akad. d. Wissensch. Wien, 1853. V.

muscular processes.* This report, however, was erroneous, and arose in a mistake. On the occasion in question, some ancient skulls from the Celtic graves of Sigmaringen were exhibited, after which the discussion fell upon the supposed fossil human teeth, from the iron mines of Melchingen, in the Swabian Alps.

There is no reason whatever for regarding the unusual development of the frontal sinuses in the remarkable skull from the Neanderthal as an individual or pathological deformity; it is unquestionably a typical race-character, and is physiologically connected with the uncommon thickness of the other bones of the skeleton, which exceeds by about one-half the usual proportions. This expansion of the frontal sinuses, which are appendages of the air-passages, also indicates an unusual force and power of endurance in the movements of the body, as may be concluded from the size of all the ridges and processes for the attachment of the muscles or bones. That this conclusion may be drawn from the existence of large frontal sinuses, and a prominence of the lower frontal region, is confirmed in many ways by other observations. By the same characters, according to Pallas, the wild horse is distinguished from the domesticated, and according to Cuvier, the fossil cave-bear from every recent species of bear; whilst according to Roulin, the pig, which has become wild in America, and regained a resemblance to the wild boar, is thus distinguished from the same animal in the domesticated state, as is the chamois from the goat; and, lastly, the bulldog, which is characterised by its large bones and strongly developed muscles from every other kind of dog. The estimation of the facial angle, the determination of which, according to Professor Owen, is also difficult in the great apes, owing to the very prominent supra-orbital ridges, in the present is case rendered still more difficult from the absence both of the auditory opening and of the nasal spine. But if the proper horizontal position of the skull be taken from the remaining portions of the orbital plates, and the ascending line made to touch the surface of the frontal bone behind the prominent supra-orbital ridges, the facial angle is not found to exceed 56°.† Unfortunately, no portions of the facial bones, whose conformation is so decisive as regards the form and expression of the head, have been preserved. The cranial capacity, compared with the uncommon strength of the corporeal frame, would seem to indicate a small cerebral development. The skull as it is holds about 31 ounces of millet-seed; and as, from the proportionate size of the wanting bones, the whole cranial cavity should have about 6 ounces more added, the contents, were it perfect, may be taken at 37 ounces. Tiedemann assigns as the cranial contents in the Negro 40, 38, and 35 ounces. The cranium holds rather more than 36 ounces of water, which corresponds to a capacity of 1033.24 cubic centimetres.

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* *Vid.* the figure given in the Leipsic Illust. Journ. of Nov. 26, 1853.

† Estimating the facial angle in the way suggested, on the cast I should place it at 64° to 67°.—G. B.

Huschke estimates the cranial contents of a Negress at 1127 cubic centimetres, of an old Negro at 1146 cubic centimetres. The capacity of Malay skulls estimated by water equalled 36, 33 ounces, whilst in the diminutive Hindoos it falls to as little as 27 ounces.

It is, of course, a matter of the greatest interest to inquire whether a similar conformation has been before noticed; whether it is probable that it exists only in skulls to which a high antiquity must be assigned; and whether in any instance of the kind observations may not have been made tending to supply what is wanting in the results of the investigation above detailed, and to confirm or to contradict the conclusions drawn therefrom. Large frontal sinuses, it is admitted, are occasionally noticed in skulls; but these instances afford only faint indications of the remarkable conformation which gives the cranium we are considering its brutal expression. In the museums of the College of Surgeons in London, the Jardin des Plantes at Paris, of the Universities of Gottingen, Berlin, and Bonn, there is nothing which can be compared with it. Neither do the ancient northern crania, described by Retzius, Eschricht, &c., show any conformation of the kind. But it is remarkable, and important in the explanation of this form, that a prominence, though in much less degree, of the supra-orbital ridges has been observed chiefly in the crania of savage races, as well as in those of great antiquity. Thus Sandifort* figures the skull of a North American from an ancient burial-place on New Norfolk Sound, as *cranium Schitgagani*, with a similar though far less considerable projection of the supraorbital ridges. In Morton's works† an unusual development of the same part may be seen in the Peruvian (tab. 6), the Mexican (tab. 16, 17, 18), the Seminole (tab. 24), and in the skulls of other races (tab. 25, 34, 35, 36, 37, 52, 57, 63, and 66), some of which were taken from ancient burial-places. Lucæ‡ gives a figure of a very brutal Papu skull in the Senkenbergian collection, having strong, coalescent superciliary arches. Even Bory St. Vincent assigned as characters of the Celtic race an elongated form of the skull, a forehead somewhat depressed towards the temples, a deep depression between the forehead and nose, strongly developed supra-orbital ridges, and worn teeth. Eschricht examined the skulls from the Hünengräbern (Giants' Graves) of the Island of Moen;§ they are remarkably diminutive, especially in the facial part, the occiput very short, the orbits unusually small, whilst the supra-orbital ridges, on the contrary, are very large; the nasal bones project strongly in front, and a depression exists between the supra-orbital arches and the nasal bones, deep enough to receive the forefinger of an adult; the attachments of the facial muscles are strongly marked, the alveolar margins projecting, and the teeth worn off obliquely. Subsequently Eschricht obtained from the same

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* Tabulæ craniorum, Lugd. Bat., 1838.
† Crania Americana. London, 1839.
‡ Zur Organischen Formenlehre. Frankf., 1844. Taf. xi.
§ Bericht üb. d. 22te Versamm. deutsch. Naturf. u. Aerzt. in Bremen, 1844.

locality skulls of an entirely different form, of considerable length, flat, and compressed, with a projecting occiput, and small facial development.

One cranium of this kind, from the Danish Island Työr, presents on the occiput a bony spine; the thigh-bones belonging to the same subject, $20\frac{3}{4}$ inches long, indicate a height of 6 feet 3 inches. Prichard has figured a round skull, with prominent supraorbital ridges, in the museum of the College of Surgeons, as a Cimbric cranium.* A skull found in an ancient grave at Nogent les Vierges, Oise, exhibits, as does a similar cranium from Auduze, an elongated form, the forehead depressed towards the temples, strong supraorbital ridges, and worn teeth.† The ancient British brachycephalic skull from Ballidon Moor, described by Davis,‡ has large frontal sinuses, prominent supraorbital ridges, and well-developed muscular impressions on the facial bones. The prominence of the orbital border is less considerable in the ancient British skull, which is also brachycephalic, described by Retzius. An ancient rounded Irish skull also exhibits large supraorbital ridges projecting in front of the frontal bone, and meeting in the middle, and a depressed forehead.§

As, in speaking of the aboriginal inhabitants of Scandinavia, Nilsson describes a more ancient brachycephalic, and a more recent dolichocephalic type of cranial conformation, from the circumstance that the long oval skulls of the one type have been found in graves containing metallic implements, whilst the others have occurred in ancient burial-places, together with implements of stone and bone, so D. Wilson asserts the existence of two races in Scotland antecedent to the Celts; the Fifeshire skull described by him as elongated and narrow, corresponding with the dolichocephalic Scandinavian type, whilst that from Montrose is round, with a better frontal development, both exhibiting large frontal sinuses.‖ The skulls, two of which were sent to me by the kindness of Dr. Veiel, disinterred some years since in Cannstadt, near the Uffkirche, and which were found in Germanic graves, together with earthenware vessels, weapons, and ornaments, none of which articles presented any trace of Roman art, are orthognathic, of an elongated form, with a much projecting occiput, large orbits, particularly from above downwards, the supraorbital ridges prominent, and the root of the nose hollowed. Five ancient Germanic skulls, from Selsen, preserved in the Romano-Teutonic Museum at Mayence, two of which are prognathic, present similar prominent supraorbital ridges; as is the case also with a very ancient cranium in the same collection, found at Oberingelheim, deep in the earth, and unaccompanied by any weapons; and also with a skull of Germanic origin,

* The Nat. Hist. of Man. Lond., 1845, p. 206. Pl. VIII.

† V. Leonh. und Bronn, Jahrb. für Mineralogie, &c., 1853, p. 370.

‡ Maury, Indig. Races of the Earth. London, 1857, pp. 297.

§ Retzius, Kroniologisches, in Müll. Arch., 1849, pp. 554 and 571.

‖ Maury, op. c., p. 294.

recently found near Engers on the Rhine, in an ancient burial-place long well known. In the Museum at Poppelsdorf is a cranium, on which, in the handwriting of Goldfuss, are the words "from volcanic Tufa," nothing further, however, being noticed with respect to its derivation. It is of the considerable length of 198^{mm}. (7.8″) from the *glabella* to the projecting occiput; the forehead is short, and somewhat retreating, the supraorbital ridges large and continuous, the orbits very wide, the upper jaw prognathous, the muscular attachments on the facial-bones strongly marked; of the sutures, only the sagittal is ossified; the bones are thin, partially calcined, and adhere strongly to the tongue; the lower jaw is wanting. It is also to be noticed that several Germanic skulls found near Sigmaringen, belonging to the Prince's collection, and which have been placed in my hands by Dr. Fuhlrott have strongly developed supraorbital ridges; but, together with this, they possess a greater or less frontal development, and a good facial angle. The Sinsheim skulls contained in the Stuttgart collection, also, present a noble Caucasian form. It is certain that even in ancient times the various Germanic stocks, according as they retained their purity of race, or became blended with the remains of a primitive population, or even with Roman blood, and in proportion as they led a savage or more civilized mode of life, differed in corporeal constitution, as well as in the formation of the face and head.

The difference as regards the cranium is most marked in the greater or less development of the anterior part of the head, and in the position of the muzzle, which is occasionally rather prominent, as is the case even at the present time in some of the German races, as, for instance, in Hesse and the Westerwald. Huschke* describes a skull found, together with several others of the same peculiar form, under the Stadtkirche at Jena, as Cimbric; it resembles that of the Negro, except that the jaws and forehead are vertical; the supraorbital region projects but slightly, the semicircular temporal line ascends to within an inch of the sagittal suture. The length of the cranium is 196 mm, (7·7″). Retzius† describes some skulls taken from very ancient Scandinavian graves, dating to a period of a thousand years back, as of a long-oval form, with much elongated occiput, good forehead, upright teeth, and corresponding in almost all respects with Swedish crania of the present day. An ancient Norwegian and an Icelandic skull had the same form. Subsequently,‡ Retzius described the small rounded skulls from very ancient burial-places containing stone implements as those of Iberians. With these he places the skulls found by Eschricht and Nilsson in ancient sepulchral barrows; and also the supposed fossil Irish cranium figured by Wilde, which occurred in the neighbourhood of Dublin, as

* E. Huschke, Schädel, Hirn und Seele des Menschen und der Thiere. Jena, 1854.
† Müller's Archiv., 1845, p. 84.
‡ Ib., 1847, p. 499.

well as two others found in the same locality. To the same category he also refers the skulls disinterred, together with stone implements, near Meudon and Marly, in the year 1845, by M. Serres. Retzius, also, in his memoir on the form of the cranium of the northern populations, states that the supraorbital eminences are strongly developed in the existing Swedes, Slaves, and Finns; Huech says the same with respect to the Esthonians. In the Lapps this prominence is absent, or very slightly marked, as is the case also with the natives of Greenland. In the latest catalogue of the collection formerly belonging to Dr. Morton,* the following skulls are enumerated as presenting a remarkably developed supraorbital region:—No. 21, that of an English soldier of Celtic type; No. 1200, of a Norwegian; and No. 1537, of a Finn, both from casts by Retzius; lastly, No. 1512, the skull of an aboriginal American, found by Davis and Squier in the valley of Scioto, Ohio, in a rude stone sepulchre; this cranium is of a rounded form, with high vertex;† No. 1533, the skull of a Calmuc; and No. 1558, that of an Esquimaux.

Now, when it is found from these numerous examples, that a marked prominence of the supraorbital region, traces of which can be perceived even at the present time, occurs most frequently in the crania of barbarous, and especially of northern races, to some of which a high antiquity must be assigned, it may fairly be supposed that a conformation of this kind represents the faint vestiges of a primitive type, which is manifested in the most remarkable manner in the Neanderthal cranium, and which must have given the human visage an unusually savage aspect. This aspect might be termed brutal, inasmuch as the prominent supraorbital border is also characteristic of the facial conformation of the large apes, although in these animals the prominence in question is not caused by any expansion of the frontal sinuses. These sinuses have been found by Owen to be wholly wanting, as well in the Gorilla, as in two Tasmanian and an Australian skull,‡ a circumstance which is in accordance with the weak bodily constitutions of these savages.

The reports which have reached us from Latin and Greek writers respecting the bodily constitution and manners of the barbarous populations of ancient Europe, receive an unexpected light from the discovery of crania of this kind. Even of the Germans, Cæsar remarks that the Roman soldiers were unable to withstand their aspect and the flashing of their eyes, and that a sudden panic seized his army.§ Of the Gauls,

* Aitken Meigs, Catalogue of Human Crania in the Collection of the Acad. of Nat. Sc. of Philadelphia. 1857.

† [The cranium of a Red Indian figured by us. Pl. V., figs. 1 and 2, appears to belong to the same type.]

‡ In the Gorilla the frontal sinuses are of large size, although they do not altogether constitute the large supraorbital eminences.

§ Cæsar, in the passage cited, does not say that his troops were actually frightened by the aspect of the Germani. All that he states is that, while delayed for a few days at also, Ammianus Marcellinus says: "They are frightful from the wildness of their eyes." But the ancient Britons and Irish, the Belgians, Fins, and Scythians are described as of far more savage aspect. According to Strabo, the Irish were voracious cannibals, and considered it praiseworthy to eat the bodies of their parents; and they are noticed in similar terms by Diodorus. St. Hieronymus states that, even in Gaul, the *Scoti* had been seen eating human flesh. Tacitus relates with respect to the Fins, that they live in a state of astonishing savageness, their food being wild herbs, their clothing skins, their arrow-heads made of bone, and that the children and old people had no other protection from the weather than wattled huts. Adam of Bremen relates that, so late as in the eleventh century, the so-termed *Jotuni*, the most ancient population of Scandinavia, dwelt in the mountains and forests, clad in the skins of animals, and uttering sounds more like the cries of wild beasts than human speech. Their conquest and extermination are celebrated in the poems of the Skalds.* Isigonus of Nicæa, quoted by Pliny,† says that a Scythian people dwelling ten days' journey northwards from the Dnieper was addicted to cannibalism, drank out of human skulls, and carried the hairy scalps of the slain on their breast. As in the German traditions and tales, many traces of the mode of life of our ancestors have come down to us from heathen times, so also may the tradition respecting cannibalism, which, from Grimm's researches, though it appears as early as Homer in the history of Polyphemus, is also widely diffused in the legends of the Fins, Tartars, and Germans, have originated in the actual remembrance of that abominable practice.‡

The considerations which have led us to compare the Neanderthal cranium with those of the most ancient races are still farther confirmed

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Vesontio, on his march against Ariovistus, reports were spread by the Roman inhabitants of the country, and by the Gauls and traders, of the "incredible valour, expertness in arms, and gigantic stature of the Germani;" and that these *reports* (which were, probably, not altogether unintentionally made) caused a sudden panic, chiefly, however, among the volunteers who had followed him, and the inexperienced soldiers. He seems to have had little difficulty in quelling the commotion, and in removing some of the dread instilled into his troops, by reminding them that the Germani had been often beaten without difficulty by the Helvetii.

* J. C. Prichard, Natural History of Man.

† Plinii, Sec. Hist. Nat., vii. 2.

‡ [To these references might be added, perhaps, some lines of Sidonis Apollinaris in describing the Huns, quoted by V. Baer (Die Makrokephalen, &c., p. 36:)—

"Gens animis membrisque minax: ita vultibus ipsis
Infantum suus horror inest. Consurgit in arcem
Massa rotunda caput: geminis sub fronte cavernis
Visus adest oculis absentibus: arcta cerebri
In cameram vix ad refugos lux pervenit orbes,
Non tamen et clausos: nam fornix non spatiosa,
Magna vident spatia, et majoris luminis usum
Perspicua in puteis compensant puncta profundis."]

by the discovery, about to be related, of skulls exhibiting a yet closer correspondence with it than do those already mentioned.

At the meeting of the Lower Rhine Society, on the 9th July, 1857, Herr Nöggerath stated that, in the Transactions of the Imperial Russian Mineralogical Society of St. Petersburgh, of the year 1842, an account was given by Dr. S. Kutorga, of two human skulls from the Government of Minsk, and that one of the skulls there figured presented a great similarity with that found in the Neanderthal. Both these skulls were discovered near Bobruysk. One was found in the sandy bottom of a hollow, apparently an ancient river-bed, in a locality where numerous human bones had been occasionally met with for a very long period; and tradition said that a town formerly stood there, which was destroyed by an inundation. Of this cranium only the frontal and two parietal bones remain. The frontal is strongly depressed, the supraorbital ridges, including the border of the orbit, form prominent elevations; the two halves of the frontal bone are unequal, and the sagittal suture manifestly flattened. Dr. Kutorga considers it very probable that this conformation was brought about by artificial compression; but the figure which he gives does not convey the decided characters of an artificial deformity. The other skull, taken from an ancient sepulchral mound in the same region, exhibits a well-developed forehead; but both the frontal and parietal bones are still more unsymmetrical than in the former skull. On the right side is a very well developed *tuber frontale,* which is wholly wanting on the left; the left parietal bone, also, is smaller than the right.

Shortly afterwards, in September, 1857, my attention was directed by Herr L. Lindenschmit to the cast of a frontal bone having exactly the same conformation, in the Romano-Teutonic Central Museum, at Mayence. This cast had been taken from a skull found near Plau, in Mecklenburg. At the meeting of the Association of German Naturalists and Physicians, at Bonn, in the same month, these peculiar cranial forms were exhibited in plaster casts, the difference between them and the crania of other lower races pointed out, and the opinion again expressed that this hitherto unknown form of skull probably belonged to a primitive race, settled in North Europe before the Germanic immigration. Having made application on the subject to Dr. Lisch, Keeper of the Archives in Schwerin, where the crania are preserved in the Grand Duke's collection, I was furnished with precise information respecting the discovery of the remains at Plau; and the portions of the skulls, together with similar relics found in Schwaan and other places in Mecklenburgh, were most readily sent to me. Thus were afforded the materials for a brief report upon the subject, which was read at the sitting of the Lower Rhine Society, held on the 3rd February, 1858.* The particulars are as follows:—A human skeleton in a squatting, or almost kneeling posture, together with implements made of bone, a battle-axe

* Verhandl. des naturh. Vereins des preuss. Rheinl. u. Westphal., 1858. xv.

of stag's-horn, two boar's-tusks, which had been cut off, and three incisor-teeth of a stag perforated at the root, was found near Plau,* in siliceous sand, six feet below the surface. A very high antiquity was assigned to this grave, as it was wholly unprotected by any masonry, and afforded no trace of cremation having been practised, nor any implements of stone, clay, or metal. Dr. Lisch, who had been struck with the unusual prominence of the supraorbital border, the wide root of the nose, and the strongly retrocedent frontal, accompanied the account of the finding with this remark:—"The formation of the skull indicates a very remotely distant period, at which man presented a much lower degree of development. Probably this grave belongs to the autocthonous population." I succeeded, with some trouble, in putting together the skull, which, as well as the skeleton, had been broken to pieces by the labourers, from the twenty-two fragments transmitted to me. Notwithstanding the great similarity in the form of the forehead between this skull and that from the Neanderthal, the prominence of the supraorbital ridges in the latter is more marked, and they are completely continuous with the orbital-margin, which is not the case in the former. But the skulls are essentially distinguished by their general form, which in the one is long-elliptical, and in the other rounded. In the skull from Plau, a portion of the upper jaw with the teeth, and the entire lower jaw, have been preserved; it is orthognathous. The bones are thick, but very light, and adhere strongly to the tongue. The muscular impressions on the occiput above the mastoid process are very strongly developed; the sutures are wholly unossified; the last upper molar on the right side has not yet come through the alveolus; the teeth are worn away, the entire crown in some of the molars having disappeared; the lower canine teeth are far larger than the incisors, and project in front of the row of teeth; the *foramen incisivum* in the upper jaw is very large, exceeding 4^{mm} in width. The wide and short ascending ramus of the lower jaw rises at a right angle. The muscular impressions on the lower jaw are also well marked. On the right parietal bone is an elongated indentation, apparently caused by a blow. The dimensions are as follows:—

	mm.
Circumference over the supraorbital ridges and the superior semicircular lines of the occiput, . . .	445 (17.7″)
From the root of the nose over the vertex to the superior semicircular lines, ...	320 (12.7″)
From the root of the nose over the vertex to the foramen magnum, ...	380 (15″)
Length from the glabella to the occiput, ...	168 (6.5″)
Breadth of frontal, ...	107 (4.1″)
Height from a line connecting the squamous borders of the parietals to the middle of the sagittal suture,	80 (3.2″)

* Jahr. d. Vereins für Mecklenburg. Geschichte und Alterthumskunde, herausg. von G. S. F. Lisch, Schwerin, 1847, xii., p. 400.

	mm.
From the foramen magnum to the same point, . . .	122 (4.8″)
Width of occiput from one parietal protuberance to the other, ...	138 (5.5″)
Width of base from one mastoid process to the other,	155 (6.25″)
Thickness of the frontal and of the parietal bones in the middle of each, ...	9

The cranial contents, estimated in millet-seed, amount to 36 ounces, 3½ drachms, Prussian apothecaries' weight.

Another instance of a similar cranial form has occurred in Mecklenburg; and the circumstance under which the skull was found again point to a high antiquity. In the year 1852, a human skeleton, with a bronze sword, was found in a sepulchral mound, termed "the Herberg," under a stone cairn, covered with an earthern mound. The skull presented a regular Caucasian form. Beneath a stone foundation, upon which the body lay extended, were found eight skulls lying in the same direction, the faces looking towards the west; beneath these were innumerable bones lying one upon another, the arm-bones appearing above the thigh-bones, as if in this spot eight bodies had been placed side by side in the ground in a crouching or squatting posture. The bones were so rotten, that only a few of them could be preserved. A frontal bone, which was also sent to me by Dr. Lisch, presented in the great prominence of the supraorbital ridges, the low retreating forehead, and the broad root of the nose, a great similarity with the Plau cranium; but the projection was far less considerable; and the thin bone with the ossified coronal suture appeared to belong to a young or female cranium; it adhered to the tongue, like the Plau cranium. The assumption that the eight bodies placed in the foundation belonged to a more ancient period than the principal corpse, is not justified by the more decayed condition of their bones, which obviously depends upon the way in which they were buried; it is far more probable that these eight bodies were those of slaves, sacrificed at the interment of the warrior. That the *Germani*, when they immigrated into Germany, met with an indigenous population, is indubitable from historical and linguistic indications. The position in a crouching or squatting posture is not Germanic, it indicates a higher antiquity; but the custom may have maintained itself even into the time of the *Germani*, together with the remnants of the aboriginal population. As among the Esquimaux and Greenlanders, and several American tribes, the dead are placed in the graves in a sitting posture, so, according to Nilsson,* human skeletons in a squatting posture occur only in the more ancient graves in Scandinavia, as, for instance, in the Axevalla-Haide. These primitive graves are covered with great stones, and they never contain any objects of metal, nor any indication of cremation having

* Jahrbuch. der Vereins f. Mecklenb. Gesch. u. Alterthumskunde. 1849, xiv., p. 301.

been practised, affording only implements made of bone and stone. The skulls of these bodies are said to be divided by the coronal suture into two equal parts, of which the posterior is broader than the anterior. They are remarkably small, globular, and almost round; the upper jaw and the nasal bones project considerably in front. They are chiefly distinguished from the skulls of other races by the low and much depressed forehead. Eschricht, as stated before, describes the skull from the Hünengräbern of Denmark in similar terms. A. G. Masch refers to a skull of this character, found in an ancient grave in the Island of Moen, which is figured in the "Dag," a Danish newspaper of the 15th September, 1835, as well as to a skull found near Fehrbellin,* which would appear to possess all the characters of that from Plau, and had probably been used as a drinking vessel. J. Ritter† also gives an account of a large barrow near Plau, in which the skull lay a foot higher than the rest of the skeleton, and it appeared as if the body had been placed in the sitting posture. The forehead of this cranium is described as remarkably flat. Human skeletons in the squatting posture have been found in ancient graves in France and Germany, as well as in Scandinavia. Tschudi, it is well known, brought mummies of this kind from Peru; and Trogon observed the same thing in the most ancient burial-places in the Canton Wallis. The skulls from Plau and the frontal bone from Schwaan, which present a conformation resembling that of the Neanderthal cranium, bear, however, but a distant resemblance to the two frontal bones from Pisede, also preserved in the Grand Duke's collection at Schwerin. One of these frontal bones is thick, with protuberant supraorbital ridges, a low retreating forehead, and the temporal ridge rises very high, reaching the sagittal suture; in the second frontal bone, the supraorbital ridges are level, but the *glabella* is remarkably prominent, and the forehead rather more arched. An ancient cranium in the same collection, found at some depth in the moor of Sülz, and of which I have been furnished with a plaster cast by Dr. Lisch, is of an abnormal and very peculiar form; it is small and elongated, and, when viewed laterally, remarkably round; the forehead is narrow, but well arched, the supraorbital ridges small, but protuberant; the sutures open, and the line of the sagittal suture raised into a sort of keel, as in the so-termed "boat-shaped" skulls; the occiput is very projecting, with a long pointed spine.

In conclusion, the following propositions may be regarded as the result of the foregoing researches :—

The fragments of crania from Schwaan and Plau, on account both of their anatomical conformation and of the circumstances under which they were found, may probably be assigned to a barbarous, aboriginal people, which inhabited the North of Europe before the *Germani;* and, as is proved by the discovery of similar remains at Minsk in Russia,

* Jahrb. d. Vereins f. Mecklenb. Geschichte, &c., 1844, ix., p. 361.
† Ib., 1846, xi.

and in the Neanderthal near Elberfeld, must have been extensively spread—being allied, as may be presumed from the form of the skull, with the aboriginal populations of Britain, Ireland, and Scandinavia. Whilst at Schwaan the bones were deposited in a Germanic grave of stone, and consequently are brought into relation with the historical period, the bones from Plau, on the contrary, were merely laid in the sand, together with implements of bone of the rudest kind. The Minsk skull, in like manner, was found in the sand of an ancient river-bed. But the human bones and cranium from the Neanderthal exceed all the rest in those peculiarities of conformation which lead to the conclusion of their belonging to a barbarous and savage race. Whether the cavern in which they were found, unaccompanied with any trace of human art, were the place of their interment, or whether, like the bones of extinct animals elsewhere, they had been washed into it, they may still be regarded as the most ancient memorial of the early inhabitants of Europe.

Remarks.

The fact of the geological antiquity of Man, or, to use other words, of his having been cotemporary with extinct animals whose remains are universally regarded by geologists as "fossil," has apparently been fully established, though rather, perhaps, from the discovery of his works than of his actual remains, under certain geological conditions. It has become a matter, therefore, among others, of extreme interest to determine how far it may be possible, from the scanty remains of his bones as yet discovered, to ascertain whether, and in what respects, the priscan race or races may have differed from those which at present inhabit the earth.

Although the materials as yet in our possession are far too scanty to allow of any satisfactory solution of this difficult question, they are sufficient, perhaps, to allow of its being entered upon. It is with this view that we reproduce the interesting paper by Professor Schaaffhausen, which incidentally treats upon the question at large, and contains a considerable amount of information respecting it.

The human remains there described were discovered under circumstances which, though not altogether demonstrative of their real geological position, leave no doubt of their enormous antiquity, and of the probability of their having belonged to what has been termed the quaternary period. The conformation of the cranium, moreover, in this instance is so remarkable, as justly to excite the utmost interest, approaching as it does in one respect that of some of the higher apes. It remains, consequently, a subject of the deepest importance for future discoveries to determine whether the conformation in question be merely an individual peculiarity, or a typical character. The peculiarity consists in a remarkable prominence or projection of the superciliary region of the forehead; for the enlargement in this part is so great, that it can hardly be described as limited to the superciliary ridges. Dr. Schaaffhausen appears to regard this extraordinary conformation as due to an expansion of the frontal sinuses. In this we are not disposed altogether to agree with him; but as we have had an opportunity, through the kindness of Sir Charles Lyell, of examining only a plaster cast of the cranium, in which the interior is not shown, we, of course, are able to speak but doubtfully on the subject. A main reason for our disagreement with Professor Schaaffhausen arises from the circumstance that a considerable elevation of the same part is often observed in recent crania, more especially, as he states, in those belonging to savage and barbarous races, in which no extraordinary expansion of the sinuses is found to exist;* and, secondly, because the frontal sinuses rarely, we believe, extend beyond half the length of the supraorbital border; whilst in many cases—and this is particularly evident in the Neanderthal cranium—the elevation is continued to the outer angular process of the frontal bone, which, in that cranium, is very remarkably thickened.

The lateral extent of the frontal sinus, in cases where the superciliary borders are much elevated, is usually imperfectly indicated by an opening or depression, through which the frontal nerve passes; and this depression is very manifest, especially on the right side, in the fossil cranium, in which it is regarded by Professor Schaaffhausen, we believe erroneously, as indicative of an injury received during life. In the mature Chimpanzee and Gorilla, the supraorbital ridges are, as is well known, remarkably developed: in the former case, we are not aware that the enlargement is accompanied with any expansion of the frontal sinuses, which in fact do not exist in that ape, but it is due simply to a projection of the margin of the orbit, which cavity is larger in proportion to the skull behind it, than it is in the human subject, and is thus in accordance with the greater development of the face generally. In the old Gorilla, on the other hand, although the bone itself is enormously thickened in the monstrous projection above the orbit, there are very large frontal sinuses.† However this may be, the protuberance in question must be regarded as showing a very savage type; and, in the extent to which it exists in the Neanderthal cranium, it affords a character in which that skull approaches that of the Gorilla and Chimpanzee.

Dr. Schaaffhausen appears to have taken considerable pains to in-

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* It may be observed also that a considerable development of the sinuses may coexist with only a moderate elevation of the superciliary region. This is the case in the fragment of a cranium represented in Pl. V., fig. 6.

† In order to render the apparent resemblance between the Neanderthal cranium and that of the higher apes the more evident, we have given the outline of a corresponding portion of the skull of a Chimpanzee, in which the third molars are just appearing, and which will serve to show the remarkable similarity in contour, at any rate, between the two. The human cranium, it is hardly necessary to say, is represented half the size of nature, whilst that of the Chimpanzee is but slightly reduced, so as to bring it to the same comparative scale.

quire whether a similar conformation, or one approaching it, has been observed in other instances of ancient or modern skulls, but without success. He describes and figures a brachycephalic cranium from Plau (Pl. V., fig. 8), in which there is a considerable protuberance of the supra-orbital ridges, but not to anything like the extent of that presented in the Neanderthal skull. We have added figures taken from the cranium of a Red Indian, which was procured from an ancient burial-place in Tennessee, and in which, of all the crania in our possession, the supraorbital prominence is most marked (Pl. V., figs. 1 and 2). This skull also affords a striking instance of the existence of irregular depressions of the same nature as those which are seen, more especially on the right side, in the Neanderthal cranium.

To these figures we have also added others of some very ancient fossilized crania from different localities, with the view, simply, of showing that considerable diversities of form existed among even the earliest races of mankind inhabiting the West of Europe. These are: 1.* The figure of a cranium discovered in a submarine, or rather subterranean peat bog or forest, 30 feet below the present level of the sea, at Sennen, near the Land's End, Cornwall, for which we are indebted to Mr. Jonathan Couch, through the kindness of Prof. Warington Smyth. This cranium, it may be remarked, bears some resemblance to the Engis cranium of Dr. Schmerling.†

2. A cranium, probably of a female, found, together with less perfect skulls and numerous other bones belonging to six or seven individuals of different ages, from 60 or 70 down to 3 or 4 years, in a narrow fissure in a limestone quarry at Mewslade in Glamorganshire, and not improbably of the same period as the bones of animals, &c., found in the neighbouring caverns in Gower, which have been described by Dr. Falconer and others. This cranium is obviously of a wholly distinct type from that of the others, though still in some respects peculiar. In the Museum of the College of Surgeons are several crania taken from an ancient (British?) burial-place in Anglesea, in which the same conformation exists. And it also resembles very closely a cranium found deep in an ancient peat-bed in Northamptonshire, which has been placed in our hands by Mr. Prestwich, who regards it as belonging to a very remote period.

3. A small portion of another cranium,‡ found in a limestone quarry near Plymouth, at a depth of about six feet below the present turf, exhibits a different form; it is chiefly remarkable for the retreating forehead and the projection, without much thickening, of the supra-orbital ridges, the margin of the orbit being very acute.

4. In the human skull discovered by Dr. Schmerling in the Cavern of Engis, and which, we believe, is regarded by Sir Charles Lyell as undoubtedly cotemporary with the cave Elephant, Rhinoceros, and Carnivora, there is some reason, from the drawing of the longitudi-

* Pl. V., fig. 9. † Pl. V., figs. 3, 4. ‡ Pl. V., fig. 6 and 7.

nal outline, for surmising that the superciliary ridges may have been prominent. But as we have had no opportunity of inspecting either the skull itself, which is in a very shattered condition, or a cast of it, and as the drawing given of the front view does not support the surmise, we must be content with simply throwing it out,—leaving the point to be determined by future examination. As the Engis cranium, from its undoubted geological antiquity, is of particular interest, and perhaps the most interesting relic of ancient humanity in existence, we give reduced copies of Dr. Schmerling's figures,* which may be the more acceptable, as his work is not very generally accessible in this country.

With respect to the relationship between the *prisca gens* to which these cave-bones belong, and any of those which, since their time, have inhabited Western Europe or are anywhere found living, no satisfactory opinion can at present be offered. Dr. Schmerling, it is true, fancied that he perceived some resemblance between his cranium and that of the Negro, but it must be confessed that his figures or measurements give no support to this notion. Dr. Schaaffhausen, enters pretty fully into the question of this relationship; and we have, therefore, little need to say more upon such an obscure and difficult matter. At the same time, we cannot avoid insisting upon one important point, viz.: that none of the crania above noticed, unless it be, perhaps, that from Plau, belong to the brachycephalic type; that is to say, the breadth in all is less than $\frac{8}{10}$ths of the length; they cannot, consequently, be referred to the short-headed race or races, which there is much reason to believe constituted the earliest of the existing European stocks.

Description of Plates.

PLATE IV.

Fig. 1. Various views of the Neanderthal cranium (taken from a plaster cast in the possession of Sir Charles Lyell), one-half size of nature).

2. Side view of the cranium of a young Chimpanzee (one-ninth less than nature).

PLATE V.

Fig. 1. Side view of the cranium of a Red Indian.

2. Front view of the same.

3. Side view of the Engis cranium (reduced one-half from Dr. Schmerling's figure).

4. Front view of the same.

5. Longitudinal view of the Mewslade cranium.

6, 7. Cranium from limestone quarry near Plymouth.

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* Pl. V., figs 3, 4.

8. Outline of Dr. Schaaffhausen's figure of the cranium from Plau.
9. Side view of the cranium from a submarine forest at Sennen, near the Land's End.

[The figures, with the exception of the Chimpanzee skull, are all reduced to the same scale, or to half the natural size. They are all, excepting the front view of the Engis cranium, placed as nearly as possible in the same position, so that they admit of direct comparison. The position selected is that in which a line drawn from the junction of the sagittal and coronal sutures to the middle of the external auditory openings would be vertical.]

XVIII.—The Sensory and Motor Functions of Nerves. By G. H. Lewes.

When once a doctrine has been generally accepted, and confidently taught, it necessarily calls forth a strong conservative principle of resistance against every effort to change it. That very reluctance to change of mental attitude which made the public deaf to the voice of the original teacher, now serves to close the ears of the public against the opponents of that teacher. Bell had trouble enough to get his discovery of the sensory and motor nerves accepted; but now that the contest has long been ended, and Bell is crowned victor, all the conservatism which embittered his efforts is employed to maintain his triumph. Not only is he declared victor, but "victory along the whole line" is claimed, and his errors are consecrated with his truths.

I have already paid my small but hearty tribute to Bell's genius, and to the unimpeachable validity of his *anatomical* discovery; but, conceiving that he had founded on that discovery a *physiological* induction which was erroneous, I laid before the British Association,* and the public,† certain critical strictures, the purport of which was to show that there was no *essential* distinction between the two nerves: both being sensory *and* motor, though in varying degrees. In these strictures there may be a fundamental error; and if so, I should be glad to see it pointed out. The discussion is one which cannot be without service; and if any champion of Bell's doctrine will do me the honour to descend into the arena, he may be assured that the harder he hits (without foul blows), the more welcome he will be.

Ever since the time of Galen, it has been suspected that there were "nerves of motion," and "nerves of sensation." Latterly we have had "nerves of secretion." The question to be settled is: Are these nerves different in *kind?* or are they the same in kind, but different in *function,*

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* Aberdeen Meeting, 1859. † Physiology of Common Life, vol. ii.

or use? Flexor, extensor, and sphincter muscles are not held to be different kinds, but the same kind applied to different uses; the peculiar property of muscles, Contractility, is found in all three, but this property is put to different uses, when the anatomical connexions of the muscles differ. In like manner, as I conceive, the nerves which are distributed to sensory surfaces, to muscles, and to glands, are all of the same kind, and have the same properties; but differ in their uses, as they are different in their anatomical connexions.

The champion of Bell must prove, first, that the motor nerve is of such a structure as to be *incapable of transmitting a stimulus to a sensitive centre;* or he must prove, secondly, that its anatomical distribution is such that *no sensitive centre can be reached by it.* One of these two conclusions must be established. No other alternative is possible. Let us examine both points.

It is admitted that motor and sensory nerves are of the same structure. The conclusion, therefore, that they must be identical in property seemed to me self-evident, the more so as, to guard against superficial objections, I added the qualification, "under similar conditions." If any one chooses to maintain that two substances identical in structure, under identical conditions, *can* have different properties, I must leave him to the indulgence of his "right of private judgment;" meanwhile, the axiom remains, that identity of structure implies identity of property. There is, indeed, another avenue of attack. It has been said, "You do not know that the two nerves *are* identical; there may be differences important, yet too minute for appreciation at present. Of two bars of steel, one may have a magnetic property, and the other none, yet you cannot on mere inspection detect any difference in their structure. Of two tissues, one may be dead, and the other living, yet you cannot detect a difference." We do not know that two muscles, or two secreting cells, may not be so different in structure as to have different properties; but until this is *proved*, we are not warranted in assuming it. All we do know of the nerves points to their identity: they have the same physical, electrical, and chemical properties; and, till the contrary be proved, we must assume them to be identical in all their properties. The two bars of steel *have* precisely similar properties, according to their similarities of structure; but, *over and above* these, one of them possesses a magnetic property, in consequence of its having been submitted to peculiar conditions; under the like conditions, the second bar of steel would be magnetic. The same may be said of dead and living tissues; they have in common, structure and property, and as long as they are under similar conditions there will be no difference between them; but under the group of conditions known as "life" and "death," there will of course be differences.

Cut off the leg of a frog, and resect its sciatic nerve, the muscles will for some time retain their property (Contractility), and will contract on being stimulated. The nerve also retains its property (Neurility), and on being stimulated, it will excite the muscles to contraction. We know that muscles will contract without the intervention of nerves, and that glands will secrete without the intervention of nerves. It is also probable that the sensorium may be stimulated without the direct intervention of nerves. But it is not less certain that the ordinary stimulus which awakens the activity of muscles, glands, and nerve-centres, is the stimulus of nerves. *How* this is effected we cannot say. *What* the peculiar property of the nerves may be, baffles science. It may be electricity; it may be a correlation of that force; it may be a special "nerve-force," something *sui generis.* To avoid every hypothesis, and yet to secure a specific name, I proposed the term Neurility, as corresponding with the terms Sensibility and Contractility; the term, having met with some acceptance, may be used throughout this paper.

In the course of investigation, it appeared to me that many of the vexed questions of nerve-physiology would rapidly receive answers, if the perplexing ambiguities of phraseology were to give place to a more rigorous nomenclature. For example, it is difficult to come to an understanding respecting the motor and sensory nerves, so long as we continue to *talk* as if we believed that "motility" resides in the spinal chord, and that the posterior roots are "sensitive." Motor force no more resides in the spinal chord, than explosive force resides in the lighted match; the motor-force is in the muscles, the explosive force is in the gunpowder; and when eminent physiologists are at great pains to detect the "seat of motility" (*siège de la motricité*) in the grey matter of the chord, they are perplexing a subject already difficult enough. I do not assert that competent physiologists ever *believe* that the seat of motility is elsewhere than in the muscles; what they mean is, doubtless, that the centre, from which the stimulus issues which will excite the muscles, is in the spinal chord. But how easily the ambiguous language leads to ambiguity of conception may be seen in a hundred examples; and it may be, to a great extent, avoided by rigorously demarcating the phenomena of Sensibility, Neurility, and Contractility, as the actions of three different organs: nerve-centres, nerves, and muscles.

Müller puts this question:—"Is the nervous principle, or force of the motor fibres, different in its quality from that of the sensitive fibres? or are what are here called the motor and sensitive principles, actions of the same nervous principle, differing only in direction—being centrifugal in the motor, and centripetal in the sensitive fibres?" Put into the language of the essay, this question will run thus:—Are there two Neurilities, one motor, and the other sensory (with the possibility of a third—the secretory)? Or does the Neurility in each nerve act only in one direction, *from* a centre along the motor nerve; *to* the centre along a sensory nerve?

That there are two Neurilities is extremely improbable, nor is there a shadow of evidence in its favour. *Neither motions nor sensations belong to the nerves themselves,* but to the muscles and centres, *stimulated* by the nerves. It is only in the looseness of unsystematized phraseology, that we speak of "sensitive impressions" being "conveyed to the brain;" and of "motor-impulses" being "conveyed to the muscles;" it is the stimulated nerves which excite the activity of brain and muscles, as the spark excites the explosive activity of gunpowder. We do not need three kinds of Contractility for flexors, extensors, and sphincters; nor do we need three kinds of Neurility for muscles, centres, and glands. One property serves for the three functions. The differences in the functions do not depend on the organs themselves, but on the *connexion* of these organs with others; the same organ (nerve) which, in connexion with a muscle, produces motion, in connexion with a gland would produce secretion.

The idea of different Neurilities must, therefore, be rejected. The two nerves having similar structure must have similar properties; but these properties may be put to different uses. My critic in the *British and Foreign Medical Review* seems to have wholly misunderstood me; and thinks that had I been "longer engaged in the study of physiology," I should be "less inclined to rest upon an apparent similarity of structure as justifying an inference of identity of property." Perhaps his longer study will enable him to enlighten me on this point; at present my conviction is, that if the similarity were only apparent, it would amply justify *the inference;* whereas, if the similarity were real, and not apparent only, it would carry a *demonstration.* My critic seems to think otherwise; and he is kind enough to say that my "dogmatism on this point, indeed, is absolutely confounding to those who have been accustomed to look with marvel at the diversity of *operations* performed by elementary parts which present no appreciable structural differences." One naturally feels a little perplexed at having confounded others by one's dogmatism, when the point in question is so excessively simple as the discrimination between *properties* and *uses.* I would, therefore, submit that the *operations* performed by means of chain cables, tenpenny nails, marling spikes, and grappling irons, though various enough, are not generally held as evidence that the iron of which they are all composed has different *properties* in each. I never denied that different nerves had different functions, but only that they had different properties. If any one conceives that the anterior roots send forth nerves having a Neurility as widely opposed to that of the nerves issuing from the posterior roots as Motion is to Sensation, let his evidence be produced. If he conceives that the anterior nerves will only act in *one* direction, and the posterior in *another* and contrary direction, so that the motor nerve *cannot* excite a centre, and the sensory *cannot* excite a muscle or a gland, let him produce his evidence. Meanwhile, I will suggest the evidence against such a notion.

It has been proved by Schiff, and others, that the nerve *will* conduct *both* ways; not only will it conduct electricity, it will conduct its own proper stimulus. In other words, it has been shown experimentally that Neurility will act both in the centripetal and centrifugal directions. I will now call attention to a still more striking fact, one which has strangely enough been overlooked, probably because investigators were seeking only the phenomena of sensation and motion; a fact which disproves the fundamental position of the established doctrine that a sensory nerve conducts only *to* a centre, never *from* it. Let any one follow the distribution of the Fifth Pair. Of the three trunks, into which this nerve is divided as it issues from the posterior root, two are called sensory, and the third is called "mixed," because, after its emergence from the Gasserian ganglion, it is joined by the nerve from the motor root. No fibres whatever from this anterior (motor) root join the two first trunks; and these two trunks are, therefore, considered on every ground of anatomy and experiment to be purely sensory. Now, I think it demonstrable by anatomy and experiment that these so-called sensory nerves have the distinguishing characters of motor nerves; that is to say, one of these nerves can be proved to transmit Neurility *from* the centre *to* an organ; and the other will *not* transmit a "sensitive impression" *to* its centre.

The first trunk is the ophthalmic. Among the parts it supplies there is one deserving particular notice—the lachrymal gland. This is the secreting organ, which is innervated solely from a branch of the ophthalmic, and a twig of the superior maxillary—that is to say, from the two purely "sensory" trunks. Yet that these nerves have a part to play in the *mechanism* of secretion is proved beyond a doubt by the great diminution of the secretion which follows division of the trunk. It is true that division of the trunk does not wholly suspend the secretion; but that is because the influence of a nerve upon the gland is only that of a *stimulus.* Let the part played by the nerves be never so small, the fact that *some* influence over the secretion is exercised by them, proves that they transmit a stimulus *from* the centre *to* the organ—they act centrifugally; which is precisely the character claimed for a motor nerve. What the *nature* of the influence may be which nerves exercise on glands is still a mystery; nor is it necessary for the present argument that anything more than the fact of a transmitted stimulus be admitted; but that fact is conclusive. All the argument needs is that a sensory nerve will act centrifugally; that proved, it follows that, if properly connected with a muscle, it would act upon the muscle as it acts upon the gland, viz., it would *stimulate* it.

Müller seems to have been on the point of adopting this view, but was held back by another consideration. "The affection of the nervus lachrymalis," he says, "under the influence of certain passions and ideas, is apparently an instance of the transmission of nervous influence in a centrifugal direction in a decidedly sensitive nerve; and this would be decisive proof that sensitive nerves can propagate nervous action in the centrifugal direction, if it were certain that the lachrymal nerve is not, like other branches of the fifth, accompanied by branches of the sympathetic. But it is probable that the lachrymal nerve receives grey fibres."* It is to be regretted that this great physiologist did not pursue the investigation, and assure himself of the actual facts. Had

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* Müller, Physiology, I., 726.

he done so, I believe he would have seen that *no* grey fibres mingle with this lachrymal branch. I have sought in vain for any connexion between the sympathetic and this branch; and Hirschfeld states that it is only the filaments of the sympathetic which accompany the artery in the gland, to which the secretion may be due, after division of the fifth. "La branche lachrymale du nerf ophthalmique de Willis, et un filet lachrymale de la branche orbitaire du nerf maxillair supérieur, se distribuent dans la glande lachrymale et tiennent en grande partie sous leur dépendance la sécrétion des larmes; car celle-ci diminue considérablement après la section de la cinquième paire, mais sans cesser, toutefois, complétement. Ce qui a fait supposer que les filets du grand sympathétique qui accompagnent les artères de la glande lachrymale avaient aussi une certaine influence sur la sécrétion."* Observe that not only has the presence of the grey fibres in the lachrymal nerve to be demonstrated as a fact, but I think their presence might be admitted without damage to my argument; for an examination of the connexion which *does* exist between the sympathetic and the fifth pair, will show that division of the fifth would not interfere with the action of the sympathetic filaments joining it from the carotid. Granting, therefore, that one part of the nervous stimulus reaches the gland through the sympathetic, we have still the greater part reaching it through the lachrymal nerve. In other words, a sensory nerve acts centrifugally.

The second point to which I referred, in the functions of the fifth, is the "insensibility" of the nasal branch; but this must be noticed presently, in connexion with the analogous "insensibility" of the motor nerves.

If there is any difference between sensory and motor nerves, it is not a difference of kind, but of use. Each nerve is *capable* of serving either function, provided it be properly distributed. If nerves are distributed through the substance of muscles, they will be motor—if distributed through glands, they will be secretory—if distributed to the surfaces, they will be sensory. There will probably be little objection raised to this statement. But we must go farther, and ask whether the skin-nerve is ever motor, and whether the muscle-nerve is ever sensory? To answer this, we must first settle one or two points of physiology and anatomy. A nerve is sensory because it stimulates the Sensibility of its Centre, and not because its termination is in the skin. It is not the nerve which is sensitive, but the centre. Stimuli, which reach the nerve through the skin, affect the centre. It is to the centre, therefore, that we must look. So much for physiology; now for anatomy. "There is no difference," says Dr. Todd, "between a motor and sensory nerve as regards structure. We can attribute the difference of endowment of the fibres to *no other cause but to the nature of their peripheral and central connexions. The same nervous force is propagated by the fibres of each kind;* but whether that force is to excite motion or sensation, must depend on

* Hirschfeld, Névrologie, p. 250.

the connexion of the fibres with muscles in the one case, and with the centre of sensation in the other."* The principle here laid down is irreversible; but it is an error to suppose that only *one* of the nerves is in connexion with the centre of sensation. I pointed out the fact, which had been universally disregarded, that the anterior (motor) roots were quite as unmistakeably in anatomical connexion with the ganglionic substance of the spinal chord, as the posterior roots were; and the conclusion seemed irresistible, that if one nerve in connexion with a centre will stimulate the activity of that centre, another nerve precisely analogous in structure, and endowed with an analogous property (propagating the same nervous force), if *also* in connexion with that centre, must *also* stimulate its activity. Modern microscopic researches have rendered the direct connexion of the anterior roots with the ganglionic substance, a fact beyond dispute. To resist the conclusion I have drawn, it will be necessary to prove: 1st. That the ganglionic substance with which the anterior roots is connected has not the same property as the ganglionic substance of the posterior roots; or, 2nd. That nerves are only capable of stimulating in one direction. But it has been proved by Schiff that there is no difference between the properties of the anterior and posterior horus. And it has also been proved that nerves conduct in both ways.

If, therefore, Sensibility is the property of Nerve-centres awakened by the stimulus of Neurility—if both nerves are in direct anatomical connexion with their centres—and if there be not two different kinds of Neurility, acting in very different ways upon the centre—there is no alternative but to accept the conclusion that both nerves have a sensory function.

In vindicating the *essential similarity* of the two sets of nerves, we are not overlooking their *specific diversity*. The functions of various nerves, that is to say, the uses they serve in the mechanism, depend upon their anatomical connexions. A nerve that is not distributed to a muscle cannot be expected to have a *motor* function; a nerve that is not distributed to a gland cannot be expected to have a *secretory* function; a nerve that is not distributed to an organ of sense cannot be expected to have a function of special Sensation.

Bell's discovery that the anterior roots ministered to motion, and the posterior to sensation, may be interpreted thus: the anterior nerves are muscle-nerves, the posterior are skin-nerves. My critic in the *British and Foreign* demurs to this. "It is known to every anatomist," he says, "that it is a pure assumption on the part of Mr. Lewes to assert that the fibres of the anterior roots are distributed exclusively to the muscles, and those of the posterior roots exclusively to the skin. How, we would ask, is it possible anatomically to separate the fibres of the anterior and the posterior roots in any nerve of mixed endowments? and on what basis, save that of physiological experiment, can any positive statement

* Todd, Physiol. of Nervous System, in Cyclopæd. of Anat. and Phys.

be made as to their peripheral distribution?" An experiment will convince my critic that it is not only "possible" to separate the fibres, but that my "assumption" is easily demonstrated. Let him divide the anterior roots of the nerves supplying one of the extremities of a frog, and he will find that *all* the fibres in the muscles of that extremity degenerate, but *none* of those distributed over the sheath or to the skin. A more absolute proof could not be required. I would further remark that it is not enough for a nerve to pass through or along a muscle, its filaments must *terminate in the substance* of the muscle, if its function is to be motor.

My critic is also inaccurate in stating that I attribute the difference of function of the two nerves *entirely* to their peripheral distribution. He should have said *mainly;* the difference in their central distribution is insisted on, as one of the reasons why the muscular sensations differ from the skin sensations. Both nerves are directly connected with the spinal chord, and "both must, therefore, have a similar functional relation to it." The critic should not have passed over the emphatic sentence of the next paragraph,—"Observe, I say the relation is *similar*, not the *same*. It requires but a moderate acquaintance with microscopic anatomy to be aware that the anterior and posterior roots differ in their distribution over the spinal chord; indeed, it is partly on this difference that I explain the different *forms of Sensibility* excited by each root. But, underlying this diversity, there is a fundamental agreement. Hence they may be called similar, though not the same. The form of sensibility excited by the anterior root is as unlike the form of sensibility excited by the posterior, as the sensation of sound is unlike the sensation of light, which are nevertheless similar, in being both sensations."

I endeavoured to prove by experiment that it was through the anterior nerves that the "muscular sense" was excited. The evidence cannot be reproduced here; but, perhaps, for the sake of argument, the reader will admit the point as proved, and we may then show that the *one* objection which is always raised against the sensory function of the anterior nerves falls to the ground. When both anterior and posterior roots are divided, an irritation of the central ends of the anterior, produces none of the ordinary signs of sensation; but the irritation of the posterior produces unequivocal signs of pain. This is held to be conclusive against the sensory functions of the anterior root. But is it so? On the supposition that the anterior root serves the muscular sense, we have no right to expect anything than what we find. The muscular sensations are as *special* as those of sight or hearing, and every special sense responds only in its special form: the optic nerve, when irritated, produces sensation of light, but no pain; the auditory nerve a sensation of sound, but none of temperature, light, or pain. In like manner, the irritation of a muscle-nerve will produce the sensations habitually produced by that nerve, which are not those of pain. My assertion that muscular sensations are not those of pain has been scornfully rejected, and a reference made to the agonies of cramp. But cramp, I must maintain, with Schiff and others, is *not* a muscle-pain ; it is produced by pressure on the nerves of the muscle-sheath, or of some neighbouring nerve.* And I have proved that no sign of pain is elicited by burning or pricking the muscle itself.

Now, if we are justified in attributing muscular sensibility to the anterior nerves, it is obvious that these nerves, when irritated, can *only* excite muscular sensations—no others. It is further obvious that the *signs* of such sensations must be very different from those of other sensations. Irritation of the root can only produce that sensation which precedes or accompanies adjustment of the muscles, or one of the vague diffusive sensations which the muscles contribute to the general consciousness. The direct *response* to such a sensation would be an adjustment of the muscles to which the particular nerves were sent; but *this* cannot take place, because the connexion between the nerves and the muscles is cut off. None, therefore, of the ordinary signs could be manifested. But is this a proof that the muscle-nerves are not sensory? To say so, would be to say that the optic nerve is not sensory, because it may be divided without the animal's manifesting any sign.

A few paragraphs back, allusion was made to the fact, that one of the nerves of the fifth pair has an "insensible branch"—will *not* transmit sensitive impressions (as the phrase is usually understood) more than a motor nerve will. Claude Bernard says: "Examinant chez le chien le nerf naso-palatin qui va à la membrane muqueuse du nez nous avons eté très surpris de le trouver *en apparence complétement insensible*, tandis que la branche principale, la sous orbitaire, nous offrait tous les signes d'une sensibilité vive." Here are two branches of the same nerve (both sensory), yet one of them completely without response to the stimulus which excited the others. Did Bernard thence conclude that the naso-palatine was not sensory? By no means. "Cette insensibilité d'un rameau appartenant à la cinquiéme paire porterait à penser qu'elle renferme des filet de *sensibilité spéciale;* Majendie ayant prouvé que les nerfs de sensations speciales sont *complétement insensibles aux irritations mécaniques.*"†

That all nerves *may be,* and that most *are,* double in function, the muscle-nerve being predominantly motor, because distributed to motor organs, whereas the skin-nerve is only distributed to the minute muscles of the skin, may be inferred from the anatomy of the invertebrata, in whom no double roots exist. Let us examine the ventral chord of a bee. From each ganglion *one* nerve-trunk issues, to supply both skin and muscles of each side. The first time I made a preparation of the bee's nervous system, I was forcibly arrested by this unity of motor and sensory nerves. But as I then believed in the classical doctrine, the explanation quickly suggested itself that, in the bee, there had not yet taken place that specialization into motor and sensory, which was found in vertebrata. True enough: but what *is* the specialization? Is it the introduction of a new kind of nerve, or only the assignment of one

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* Schiff Lehrbuch. der Physiol., I., 158.

† Bernard, II., 95.

set of nerves to muscles, and of another to the skin? Clearly the latter; for there is nothing in the nature of the nerve tissue itself to prevent its serving both functions, as we see in the animal which has only one nerve for both: this nerve is not, as in vertebrata, split up into two, having two different origins, and two different peripheral terminations, but is one nerve, with one origin, sending off branches, here to muscles, and there to surfaces.

In his memoir on the Haliotis, M. Lacaze-Duthiers notices that the optic nerve has two kinds of branches, "les uns, que l'on pourrait nommer *tégumentaires*, et les autres *oculaires* proprement dits. Les premiers se distribuent aux téguments et aux tissus contractiles de nature musculaire qui forment les parois du tubercle; évidement ils apportent et la sensibilité et la motilité à ce support de l'organe de la vision." He notices as remarkable, that from the very trunk of a nerve of special sense, branches are given off, which are nerves of general sensibility and nerves of motion. But he contents himself with the supposition that there may be sensitive and motor fibres in this trunk, separate at their origin, though combined together in the trunk. This is, however, irreconcileable with microscopic observation of the molluscan nervous system; for when there *are* fibres, they are nothing but linear arrangements of the granular mass filling the neurilemma, which enter the ganglion together, and not from separate parts corresponding to anterior and posterior horns.

I will not extend this paper further, by any attempt to assign more definitely the functions of the nerves. The question at issue is: Are we justified in denying a sensory function to the anterior nerves, and a motor function to the posterior nerves? Is the difference between them one of property, or of function?

XIX.—General Results of the Study of Typical Forms of Foraminifera, in their relation to the Systematic Arrangement of that Group, and to the Fundamental Principles of Natural History Classification. By William B. Carpenter, M.D., F.R.S., F.L.S., F.G.S.

Having been for some time engaged in the study of a series of typical representatives of several of the chief natural divisions of the Foraminifera,* and finding that the general results of my inquiries are fully borne out by the study of other types prosecuted on the like method by Messrs. Rupert Jones and W. K. Parker, I think it desirable to draw the attention of naturalists to them, not merely as fixing the principles

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* See my Researches on Foraminifera, first and second Series, in the Philosophical Transactions for 1856; third Series, op. cit., 1859; fourth Series, op. cit., 1860.

which must be taken as a guide in any attempt to frame a natural classification of that group, but as having an important bearing upon some of those higher questions relating to the origin and value of differential characters generally, which have recently been brought prominently under consideration. In so doing, it is my desire to confine myself purely to the scientific and practical aspect of these questions; seeking in the first place to determine, on the legitimate basis of induction, what general principles may be educed from the comparison of the large body of facts which I have brought together as regards the classification of Foraminifera; and then briefly inquiring how far the results of similar comparisons, made upon other types of organized structure, justify the extension of the same principles to the Animal and Vegetable Kingdoms at large.

It may be well for me to advert *in limine* to certain peculiar features in this inquiry, that render the group to which it relates singularly adapted for a comparison at once minute and comprehensive amongst a wide range of individual forms. The size of the greater part of these organisms is so small, that many hundreds, thousands, or even tens of thousands of them, may be contained in a pill-box; and yet it is usually not too minute to prevent the practised observer from distinguishing the most important peculiarities of each individual by a hand-magnifier alone, or from dealing with it separately by a very simple kind of manipulation. Hence the systematist can easily select and arrange in series such of his specimens as display sufficient mutual conformity, whilst he sets apart such as are transitional or osculant; and an extensive range of varieties may thus be displayed within so small a compass, that the most divergent and the connecting forms are all recognizable nearly in the same glance. I am not acquainted with any other group of natural objects in which such ready comparison of great numbers of individuals can be made; and I am much mistaken if there be a single species of plant or animal, of which the range of variations has been studied by the collocation and comparison *under one survey* of so large an assemblage of specimens as have passed under review in the course of these investigations.

The general fact which I desire to bring prominently forward as the result of my investigations into this group, is, that in all the types possessing a wide geographical distribution which have been specially studied by myself, or by others, the range of variation has also been very wide; so that not only what have been considered as *specific*, but such as have been regarded as *generic*, and in some cases even as *ordinal* differences, present themselves among organisms, which, from the intimacy of the mutual relationship that is evinced by the gradational character of those differences, as well as by the variation presented in the several parts of one and the same organism, must in all probability have had a common origin.*

* I have the authority of M. Deshayes for the belief that the excessive multiplication of generic and specific distinctions, which so greatly impairs the value of the late M.

And it appears to me a justifiable inference from this fact, that the wide range of forms which this group contains, is more likely to have come into existence as a result of modifications successively occurring in the course of descent from a small number of original types, than by the vast numbers of originally distinct creations which on the ordinary hypothesis would be required to account for it.*

The greater part of my first memoir was devoted to the investigation of a single type, *Orbitolites;* and I there showed, that not only as regards the size, shape, and other external characters of the organism as a whole, but even as regards the size and form of its elementary parts, in which greater constancy might be expected, is there so great a variation (the most marked diversities being apparent even in different parts of the same specimen), that all attempts to found specific distinctions upon such variations are utterly futile. But further, I showed that a distinction on which almost any naturalist would feel justified in relying, as of specific if not of generic value, that between the *simple* type in which all the cells are arranged on only one plane, and the *complex* type in which there are two superficial planes more or less strongly differentiated from the median, is no less invalid. For although these types are usually distinguishable the one from the other without the least difficulty, yet they are often combined in the same individuals, and this in such a variety of modes, that the transition from the simple to the complex may be clearly seen, by the comparison of a sufficient number of specimens, to be by no means attributable to a mere advance of age. Further, having been furnished (by the kindness of Mr. H. J. Carter) with specimens of the Scindian fossil which presents the characters ascribed by M. D'Orbigny to his genus *Cyclolina*, I find, as I had anticipated, that this genus is founded upon a mere variety of *Orbitolites*, in which the character of the surface-marking is more than ordinarily cyclical. Not merely, however, does the range of variation of this type confound the ordinary distinctions of systematists in regard to species and genera; it extends also to that difference in plan of growth which has been assumed by M. D'Orbigny of such fundamental importance, as justly to constitute the essential difference between his two orders *Cyclostègues* and *Helicostègues*. For, as I have shown, although *Orbitolites* is typically cyclical from its commencement, yet specimens frequently present themselves in which its early development has taken place so completely on

D'Orbigny's labours upon this group, was due to his having based these distinctions upon specimens selected for him as *typical*, and to his having disregarded the *transitional* forms which any large collection of these organisms is sure to contain in abundance; thus, to use the admirable discrimination of the Prince of Canino, "describing *specimens* rather than *species*."

* In order to avoid misapprehension, I would here remark that the production of any organism seems to me just as much to require the exertion of Divine Power, when it takes place in the ordinary course of generation, as it would do if that organism were to be called into existence *de novo;* the question being, in reality, whether that exertion takes place in the way of continuous exercise, according to a settled and a comprehensive plan, or by a succession of disconnected efforts.

the helical plan, that if such had been collected before their assumption of the cyclical mode of growth, their essentially *Cyclostègue* character would not have been suspected.

Again, I have shown (2nd series) that a parallel variation is displayed by the genus *Orbiculina*, whose ordinarily helical plan of growth has caused M. D'Orbigny to range it among his *Helicostègues*, notwithstanding that in fully developed specimens its mode of growth is not unfrequently cyclical. The occasional exchange in this type of one plan of increase for the other, at an advanced period of life, is a fact of very high interest; for when an *Orbiculina* has undergone this change, the outer or cyclical portion of its disk can in no way be distinguished from that of *Orbitolites;* and the only difference between these two types which has any semblance of validity is the absence in *Orbitolites* of those successive encasings of the central nucleus, the presence of which seems to be a constant feature in *Orbiculina.*

It is to be observed, however, that these successive encasings are due entirely to the extension of the later whorls of the spire over the earlier, and that they are no longer found in *Orbiculina* when the helical mode of growth gives place to the cyclical. Hence it seems not unfair to surmise that if the helical growth of an aberrant *Orbitolites* were to continue until its spire had made several turns, instead of stopping before the completion of one, its nucleus would receive successive investments from successive whorls, just as in the typical *Orbiculina*, and the only difference between these two types would thus vanish.

On the other hand, if the helical growth of an *Orbiculina* were to give place to the cyclical at an unusually early period, the central nucleus would receive no investment, and would present the flatness by which that of *Orbitolites* is characterised as compared with that of the typical *Orbiculina.* Hence the idea of the derivation of *Orbitolites* and *Orbiculina* from the same original must be admitted to be scarcely less probable than that of the derivation of the helical and the cyclical forms of *Orbiculina*, or of the simple and complex types of *Orbitolites*, from a common parentage.

Let us now apply the same mode of inquiry to *Alveolina.* I have shown (2nd series) that this organism is closely allied in every other respect than its geometrical plan of growth to the types we have just been considering; the structure of the shell and its relations to the contained body, and the relations of the segments of that body to each other, and to the external world, being essentially the same in them all.

Now however improbable it may seem at first sight that an *Orbitolites*, which extends itself as a flat or bi-concave disk by successive concentric growths, and an *Alveolina* acquiring a fusiform shape by successive turns round a progressively elongating axis, should have a common original, yet, when the intermediate links are duly studied, a continuous gradation is found to be established. For, as has just been shown, a longer continuance of the helical mode of growth in which *Orbitolites* often commences, would really produce an *Orbiculina*, with its centre so invested by successive whorls as to form a vertical linear axis; and we find this axis in *Orbiculina,* sometimes equalling in length the diameter of the spire, so that this organism at an early stage of its growth may be nearly spheroidal. Now among the various types of fossil *Alveolina,* there are some whose shape, instead of being fusi-form, like that of the recent type I have described, is almost identical with that of a spheroidal *Orbiculina;* and the general structure of two such organisms will be so nearly identical, that I cannot see any difficulty in referring them to a common original. And when we examine a series of such fossil types, we see that they present a wider and wider divarication from the *Orbiculina* type in this one particular alone, that whilst the later growth of *Orbiculina* tends to liken it to *Orbitolites,* that of *Alveolina* tends to the continual elongation of its vertical axis—a difference which all analogy would indicate to be one of far too small account in this group to be justly taken as a ground of original distinction.

In the assemblage of forms which I have thought myself justified in re-assembling under the designation *Peneroplis* (3rd series), we encounter other remarkable series of variations, the principal of which have given occasion to the formation of the two additional genera *Dendritina* and *Spirolina.* With an exceedingly close conformity in the texture and in the superficial markings of their shells, as well as in their general plan of growth, we observe a marked diversity in the form and proportions of the spire, especially in the later stages of its growth, and a still greater divergence in regard to the form and disposition of the septal apertures. For in the type to which M. D'Orbigny restricts the generic designation *Peneroplis,* we usually find the spire rapidly widening and becoming proportionally compressed in each succeeding convolution; whilst in that which he distinguished as *Dendritina,* the spire widens but slowly whilst increasing rapidly in turgidity. Further, in the one type, as in the other, the later extension is often in a straight line, instead of continuing to follow the spiral course; and on this variation alone, which (as will presently appear) is of no account whatever among Foraminifera, has been erected the genus *Spirolina.* Now, in the typical *Peneroplis,* the septal plane presents a single linear series of minute rounded pores, whilst in the typical *Dendritina* we find in their place a single large orifice with radiating extensions, the difference between these two modes of communication being as great as we find between almost any two types of Foraminifera whatever. Yet I believe that no one who will go through the details of the evidence I have collected from the study of transitional forms, will have any doubt that *Peneroplis* and *Dendritina* may have had a common progenitor, and that the peculiarity in the mode of septal communication that characterises each is intimately related to the compressed or turgid form of the spire in each case; whilst the different forms of *Spirolina* type, among which we find the most remarkable transitional conditions of aperture, are so obviously related to one or other of the foregoing, that no reasonable doubt can exist of their derivation from these. Now, the geographical distribution of the two fundamental types is so far different, that where one prevails, the other is either absent altogether, or presents itself under a modified form; and thus we seem justified in the belief that whether either has been derived from the other, or both have been derived from some intermediate form (such as that which seems common alike to the *young* of both), the modifications which have given rise to the marked differences they now exhibit, are mainly due to diversities in the external conditions under which they have been respectively propagated.

But to what other type does *Peneroplis* itself present the closest approximation? By systematists in general, the intimate relationship which I have shown it to possess to the helical type of *Orbiculina* has been so slightly regarded, that it has been considered as at least equally related to the *Operculina* type; and yet, as I shall presently show, these two types are removed from each other in all the most essential features of their structure, as far as any two polythalamous Foraminifera can be. And the idea of the derivation of *Peneroplis* from the same stock with *Orbiculina* seems justified by the fact that the young forms of the two are frequently so alike as not to be distinguishable by external characters alone, whilst their internal difference consists only in the presence or the absence of the secondary or transverse septa—a character which I have shown reason to regard as variable in this group.*

Notwithstanding, therefore, the apparently wide divergence of the cyclical *Orbitolites*, the helical *Orbiculina*, the fusiform *Alveolina*, and the simply-chambered *Peneroplis* and *Dendritina*, these several types must be regarded as most intimately related to one another; and that relationship seems to me much more likely to have arisen from a common ancestral descent, than from the original creation of independent types, capable of graduating into each other so continuously as almost to assume each other's characters.

It is very important to remark that they all possess that peculiar texture of shell, which is designated by Professor Williamson as *porcellanous;* presenting an opaque white hue when seen by reflected light, but a rich brown or amber colour, when seen by light transmitted through thin natural lamellæ or artificial sections. This substance is entirely structureless, and possesses no great density or tenacity. Moreover, in all the foregoing types, each of the septa intervening between the chambers consists of only a single layer; and the passages of communication between them are, for the most part, so large and free, that the segments of the sarcode-body are but very imperfectly isolated from each other; and, as might be anticipated from this incompleteness of separation, it is here that variations in the mode of communication between the chambers seem to be of least account. It is in this type that we re-

* My statement on this point is fully confirmed by Messrs. Parker and Rupert Jones, who state that, not "unfrequently, feebly-developed Peneropliform varieties, as well as good-sized Adunciform specimens, occur, in which the long narrow chambers are at times simple and undivided, being occupied by transversely-elongate lobes of sarcode, instead of numerous minute, sub-cubical blocks." See Ann. of Nat. Hist., March, 1860, p. 180.

cognize the nearest approximation towards such forms as *Thalassicolla,* which seem to connect *Orbitolites* with *Sponges;* while the relationship which *Orbiculina* and *Peneroplis* have been supposed to bear to the ordinary *Hélicostègues*, being dependent only on plan of growth, and being utterly at variance with the essential characters of the two groups, must be regarded as one of analogy, not affinity. Looking to the evidence I have adduced in regard to the prevalence of particular modifications of *Orbitolites* in particular localities, and to the influence of the geographical distribution of the *Peneroplis* type upon the modifications it presents, we seem justified in extending the same view to those larger (though not more essential), differentiations which these types must have undergone on the hypothesis of their derivation from the same original. The following may be suggested as the mode in which the existing forms might thus have diverged from each other, and from their primary type.

ORBICULINA TYPE,

Diverging into

PENEROPLIS.	ORBICULINA.
Dendritina, Peneroplis, Dendritina, Spirolina, Peneroplis.	Alveolina, Orbiculina, Alveolina, Orbiculina, Orbitolites.

Passing on, now, to an essentially different group, of which *Operculina* may be taken as the type, I have shown that the relation of the discoidal *Cycloclypeus* and the helicene *Heterostegina* is of essentially the same nature with that of *Orbitolites* and *Orbiculina;* the minute structure of the shell and the physiological condition of the sarcode-body being essentially the same in the two organisms, and the only important divergence between them being in their plan of growth. From the rarity of *Cycloclypeus,* all the specimens of which yet known have been brought from one locality, I have not yet had the opportunity of ascertaining whether it ever presents in an early stage any approximation to the helical mode of growth; but such a deficiency of affirmative evidence is obviously not equivalent to a disproof of what has strong analogy in its favour.

The variations which I have described (3rd series) among the different forms of *Operculina,* although limited to the form of the spire, and the character of the surface-markings, would be amply sufficient to justify the erection of numerous species, were it not for the connexion established between the most divergent forms by intermediate links, and the necessity for an almost indefinite multiplication of hypothetical originals which the adoption of such a method would involve. The existence of such a large extent of variation among the specimens collected in the same locality must be admitted as valid evidence of the facility with which differential characters develope themselves in this type; and a strong probability is thus afforded in favour of the varietal character of larger differences among individuals whose conditions of existence are very diverse. Hence the analogy of *Operculina* affords good grounds to surmise that many of the reputed species in the nearly-allied genus *Nummulites* have no real title to that rank; the differences among many of them being not nearly so great as those we have met with among the varieties of *Operculina;* whilst those presented by many others do not exceed what might be reasonably expected to occur under a greater variety of modifying agencies. But I have shown that it may be fairly questioned whether there is adequate ground for upholding the generic distinctness of *Operculina* and *Nummulites;* the characteristic by which the latter has been asserted to be specially distinguished, being not unfrequently observable as a varietal difference in the former. The form which I have described under the designation of *Amphistegina Cumingii,** bears a striking resemblance to the ordinary Nummuline type in the early part of its growth, and to the ordinary Operculine in the later; and may be regarded as in many respects a connecting link between the two.

There appears, then, strong reason for considering *Cycloclypeus, Heterostegina, Operculina, Nummulites,* and *Amphistegina* as related to each other in the same manner and degree as the leading forms already enumerated under the Orbiculine group. And it is very curious to observe the perfect analogy which prevails in regard to the forms under which these two great types of structure—essentially different as they are—tend to develope themselves. As I have already pointed out, the relation of *Cycloclypeus* to *Heterostegina* is exactly that of *Orbitolites to Orbiculina.* So, if the transverse or secondary septa of *Heterostegina* were undeveloped, we should have an *Operculina, Nummulina,* or *Amphistegina* (these three types being, in my view, essentially one and the same), just as the like deficiency actually occurring in *Orbiculina* gives to it all the essential characters of *Peneroplis.* And the parallelism seems to be completed by the existence in *Fusulina*† of the same metamorphic condition of this type, that *Alveolina* is of the Orbiculine. The accordance of all these in the highly elaborated texture of the shell, in the relation which this bears to the segments of the sarcode-body, and in the presence of an intermediate skeleton with its canal system, is extremely close. The substance of the shell is very dense, and of almost vitreous transparence where it is not perforated by the minute closely-set tubuli, which usually pass direct from the interior of the chambers towards the external surface. Each segment of the body has its own proper envelope, so that the septa between the chambers are composed

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* It is questioned by Messrs. Parker and Rupert Jones whether this is a true *Amphistegina*, chiefly on account of its bilateral symmetry (Ann. of Nat. Hist., Feb., 1860, p. 111). But I have met with perfect bilateral symmetry in specimens warranted as *Amphistegina* by those excellent judges of that type.

† I have not yet been able to satisfy myself as to the precise affinities of *Fusulina*, the metamorphic condition of its shell interfering with the minute study of its structure; but my view of its nature essentially corresponds with that of Messrs. Parker and Rupert Jones. (See Quart. Journ. of Geol. Soc., Nov., 1860, p. 458.)

of two distinct laminæ, which diverge from each other where they give passage to the canal system, and which are often further separated by the intervention of a portion of the intermediate skeleton. The passages of communication between the chambers are so narrow, that segments of the body are much more isolated from each other than they are in the type already described; and the proper walls of the chambers seem, as it were, to be moulded upon the segments, instead of merely filling-up the interspaces, between them, as they there do. This filling up, in fact, is the office of the intermediate skeleton, which gives a solidity to the whole aggregation that it would otherwise want; and special provision, as we have seen, is made in the canal system for its nutrition. Altogether this type is the one in which the Foraminiferous structure attains its highest development, and which is most completely differentiated from every other. And the morphological variations it is known to undergo seem to me fully to justify the inference that such further variations as have been shown to occur in the Orbiculine type might be regarded as the probable source of the divergence from some common ancestral stock of the several forms whose intimate relationship I have demonstrated. The analogy of that type would suggest *Heterostegina* as presenting the nearest existing approximation to such a common original; and the stages of differentiation may be thus expressed:—

HETEROSTEGINE TYPE,

Diverging into

OPERCULINA. HETEROSTEGINA.

Amphistegina, Nummulites, Operculina. Heterostegina, Cycoclypeus.

From my imperfect acquaintance with *Fusulina*, I do not feel justified in expressing its exact relationship to either of the forms included in this scheme; and, for the same reason, I abstain from connecting *Orbitoides* with *Cycloclypeus*, to which it has some features of close relationship.*

After this detailed examination of the general relations of the principal modifications of two of the most strongly-marked types to be found in the whole group of Foraminifera, it seems needless for me to do more with respect to the other forms whose structure I have investigated, than to inquire how far the peculiar characters by which they are respectively distinguished show evidence of a like variability. Thus I have shown (4th series) that *Calcarina* is essentially distinguished from *Rotalia* by the extraordinary development of the *intermediate* or *supple-*

* The figure given by Prof. Ehrenberg, in his remarkable memoir already referred to, "Ueber den Grünsand und seine Erläuterung des organischen Lebens," Plate IV., fig. 8, and by him designated as the internal cast of *Orbitoides javanicus*, will be seen on comparison to present a most remarkable correspondence with figs. 10, 11, 12, of Plate XXIX., illustrating my description of *Cycloclypeus*.

mental skeleton, and by the extension of this into radiating prolongations. But the number, forms, and proportions of these prolongations are subject to very considerable variations; so that, whilst they are sometimes so greatly multiplied and prolonged as to constitute the principal feature of the organism, they are so little developed in other instances, that the contour of the disk is scarcely interrupted by them. Further, I have shown that the development of this supplemental skeleton is, in a great degree, independent of that of the spire; hence, if this last be the essential component of the organism (as all analogy indicates), the supplemental skeleton must be regarded as a feature of minor importance. On the other hand, the development of radiating out-growths is an occurrence not unfrequent among other helicine Foraminifera, even in species whose typical form is altogether destitute of them (as Professor Williamson has pointed out in *Polystomella crispa*); and such forms differ much less widely, as regards this character, from the simpler forms of *Calcarina,* than these last do from the very complex forms with which they are connected by a continuously-gradational series. Hence, I cannot regard the remarkable development of the supplemental skeleton in *Calcarina* as affording any disproof of its genetic relationship to *Rotalia,* with which its affinity in every other particular is most intimate.

If, again, we inquire into the import of that remarkable development of the *canal-system,* which seems to be the distinctive feature of *Polystomella* (4th series), we find that if we base our judgment upon a sufficiently wide foundation of facts, its non-essential character becomes apparent. For although the large *P. craticulata* of the tropical and Australian seas presents the most symmetrical and extensive distribution of the canal-system that I have anywhere met with, the little *P. crispa* of our own seas exhibits but feeble traces of it; yet of the intimacy of their relationship no doubt can be fairly entertained. I have shown (3rd series) that a parallel difference exists between the gigantic *Amphistegina Cumingii* and the comparatively diminutive *A. gibbosa;* as also (4th series) between the two forms of *Tinoporus,* where its presence or absence is obviously associated with the presence or absence of the radiating prolongations, and of the supplemental skeletons from which these proceed.

In considering the import of the canal-system as a character for the systematist, the mode of its formation must not be left out of view. I have shown that the passages which altogether go to make up this system are not true *vessels,* but are mere *sinuses,* left in some cases by the incomplete adhesion of the two contiguous walls which separate adjacent chambers, and in other cases apparently formed by the incomplete calcification of the sarcode which forms the basis of the solid skeleton; certain portions of that substance remaining in their original condition, so as to maintain a communication between the contents of the chambers and the parts of the shelly casing most removed from them, just as the fissures or pores which communicate between the chambers, and between the last chamber and the exterior, are mere unconsolidated portions of the septa, occupied in the living state by commissural portions of the sarcode body. Hence it is readily conceivable how a canal-system may be formed with considerable regularity in an organism in which the intermediate skeleton attains a considerable development, whilst it may be wholly or partially deficient in another, in which that supplemental deposit of calcareous matter has taken place to a much smaller extent. And it is to be specially observed that all those forms in which it is at present known to attain its greatest completeness, are those tropical or semi-tropical types, in which the influence of warmth, abundance of food, and other external agencies in promoting development, appear specially to favour the largest growth and the most specialized evolution of the Foraminiferous type.

The relations of the forms belonging to the family *Miliolitidæ* have recently been investigated by Mr. W. K. Parker;* and his results are in perfect accordance with my own. Thus in each of the genera *Cornuspira, Hauerina*, and *Vertebralina*, Mr. Parker reduces all the reputed species to one; while he shows that even their generic differences are really but of small account. And he not only in like manner reduces all the reputed species of the genus *Miliola* to the level of varieties, but brings down to the same rank the reputed genera *Spiroloculina, Biloculina, Triloculina*, and *Quinqueloculina;* the differences between which, arising from asymmetrical growth, and from variations in the form and number of the chambers, cannot be regarded as even of specific value, the Milioline plan of construction being preserved throughout. In the large group of *Nodosarinæ* which has been carefully studied by Messrs. T. Rupert Jones and W. K. Parker,† those gentlemen have felt themselves justified, on the like grounds in reducing a multitude of reputed genera and species to a single type. Between the nautiloid *Cristellariæ* and the straight moniliform or rod-like *Nodosariæ*, which agree in essential characters of structure and mode of growth, they find such a continuous series of connecting links, that no line of demarcation can be anywhere drawn, the straight, the curved, and the spiral forms passing gradationally one towards another; and the extreme forms being thus brought together, the various intermediate grades which have been distinguished by systematists under the generic names *Glandulina, Lingulina, Dentalina, Rimulina, Vaginulina, Planularia, Marginulina, Dimorphina, Flabellina*, and *Frondicularia*, necessarily fall into the same category.

The same general doctrine having thus been shown to hold good in regard to all the chief natural subdivisions of the Foraminiferous group, it is not my purpose at present to prolong the inquiry in this direction. The systematic study of this tribe needs to be prosecuted far more extensively than my own time and opportunities have admitted, to enable even an outline scheme to be framed, which should represent an approach to the true relations of its principal families. But I think I

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* Transactions of the Microscopical Society for 1858 (New Series, vol. vi.), p. 53.

† Annals of Natural History, Nov., 1859, p. 477; and Quarterly Journal of the Geological Society, August, 1860, p. 302 and November, 1860, p 454.

have made it clear that such a scheme will be most likely to approach the truth, when its basis is laid in a thorough knowledge of the nature and extent of those variations which every chief modification of this type shows itself so peculiarly disposed to exhibit, and when in building it up the idea of *natural affinity* is accepted as expressing not only degree of mutual conformity, but actual relationship arising from community of descent more or less remote. For the endless gradational departures from any types which we may assume as fixed, and the occurrence of links of connexion between such as present the best marked differentiations, seem to me to point unmistakeably to this as the only escape from that difficulty of indefinite multiplication, which attends the application of the doctrine of distinct specific creations to a group in which scarcely any two individuals are alike.

The present aspect of this inquiry, in fact, may be not inappropriately compared with that of the oft-debated question as to the Races of Mankind. In the one case, as in the other, the direct evidence of descent affords cogent evidence as to the possible extent of modification within the limits of particular races; and when that evidence is brought into relation with analogous facts in regard to the yet greater variations of which we have direct evidence in the case of domesticated animals, it points to conclusions of higher generality, which physiologists find no difficulty in accepting. Now the modifications which any single type of Foraminifera must have undergone, to give origin to the whole series of diversified forms now presented by that group, *are not greater in comparison with the modifications of which we have direct evidence,* than are those which the advocate for the specific unity of the human races has no hesitation in assuming as the probable account of their present divergence.

This view of the case derives great force from the fact that there is strong reason to regard a large proportion of the existing Foraminifera as the direct lineal descendants of those of very ancient geological periods—a doctrine first advanced by Professor Ehrenberg in regard to a considerable number of Cretaceous forms, and since fully confirmed and extended as regards the Tertiary fauna by the admirable researches of Messrs. Rupert Jones and Parker, as well as by my own comparison of the recent and fossil types of *Orbitolites*, *Orbiculina*, *Alveolina*, *Operculina*, and *Calcarina;* and shown to be applicable also to the Secondary fauna, as far back as the Triassic system, by the remarkable results of the investigations of the same gentlemen in regard to a well-preserved sample of it. Following out, by laborious and extended comparison, the method of inquiry I have so much insisted on, they have found ample evidence that a like range has prevailed through the whole succession of geological periods to which their researches have extended. "Our own experience of the wide limits within which any specific group of the Foraminifera multiply their varietal forms, related by some peculiar conditions of growth and ornamentation, has led us to concur fully with those who regard nearly every species of Foraminifera as capable of adapting itself, with endless modifications of form and structure, to very different habitats in brackish and in salt water; in the several zones of shallow, deep, and abyssal seas; and under every climate, from the poles to the equator. In arranging our synoptical tables of the Mediterranean Rhizopoda, recent and fossil, and in comparing their numerous specific and varietal forms one with another, we have not confined ourselves to our collections from this region, but have necessarily made comparisons of forms from almost every part of the globe; from the Arctic and the Tropic Seas; from the temperate zones of both hemispheres; and from shallow, as well as deep sea-beds. Geologically, also, we have reviewed the Foraminifera in their manifold aspects, as presented by the ancient Faunas of the Tertiary, Cretaceous, Oolitic, Liassic, Triassic, Permian, and Carboniferous times; finding, to our astonishment, that scarcely any of the species of Foraminifera met with in the Secondary Rocks have become extinct; all, indeed, that we have yet seen have their counterparts in the recent Mediterranean deposits. This is still more clearly found to be the case with regard to the Chalk of Maestricht and the Tertiaries"*. And the same excellent observers, in summing up their description of the Foraminifera of the blue clay met with in the alabaster pits at Chellaston, near Derby, belonging to the Upper Triassic series, thus express themselves:—"Having thus pointed out that, judging from these specimens obtained at Chellaston, the minute *Nodosarinæ* and other Foraminifera of the Triassic period have continued to exist through the intermediate ages to the present day, without losing any of their essentially specific features, we will observe that the *Nodosariæ* are present in rocks of still greater age than the Trias,—namely, the Permian and Carboniferous, and probably even the lower Silurian. *Nodosariæ* and *Dentalinæ* abound in some of the Permian limestones of Durham and the Wetterau, in company with *Textulariæ*. *Nodosaria* occurs also in the Carboniferous limestone of Ireland, according to M'Coy; and the green sand of the lower Silurian series, near St. Petersburg, has yielded to Ehrenberg casts of chambers something like those of *Dentalina*, together with unmistakeable casts of Testularian and Rotalian shells. We may remark, too, that the *Fusulina* of the Russian, North American, and Arctic Mountain-limestone carries back the pedigree of the *Nonionina* group to the Palæozoic periods; and that it is accompanied with other Foraminifera of known types, amongst which *Nummulina* is not absent. This last-named type has rare representatives in the Lias and Oolite; it acquired great potency in the Tertiary seas, and is not extinct now. Altogether we have here some remarkable instances of the persistency of life-types among the lower animals. Though the specific relations of the Palæozoic Foraminifera require further elucidation, we feel certain that the six genera, represented in this Upper Triassic clay of Chellaston by about

* "On the Rhizopodal Fauna of the Mediterranean, compared with that of the Italian and some other Tertiary Deposits," in the Quarterly Journal of the Geological Society for August, 1860, p. 294.

thirty varieties, stand really in the place of ancestral representatives of certain existing Foraminifera, that they put on their several subspecific features in accordance with the conditions of their place of growth, just as their posterity now do; and that although we have in this instance met with only the minute forms of a 700-fathoms mud-bottom, yet elsewhere the contemporaneous fuller development of these specific types may be found by careful search in other and shallower deposits of the Trias period"*.

It can scarcely, I think, be questioned that such a continuity of the leading types of Foraminifera maintained through so long a series of geological periods, and the recurrence of similar varietal departures from those types, is a result of the facility with which creatures of such low and indefinite organization adapt themselves to a great variety of external conditions; so that, on the one hand, they pass unharmed through changes in those conditions which are fatal to beings of higher structure and more specialized constitution; whilst on the other, they undergo such modifications, under the influence of those changes, as may produce a very wide departure from the original type.

Thus we have found strong reason for regarding temperature as exerting a most important influence in favouring, not merely increase of size, but specialization of development; all the most complicated and specialized forms at present known being natives either of tropical or of sub-tropical seas, and many of these being represented in the seas of colder regions by comparatively insignificant examples, which there seems adequate reason for regarding as of the same specific types with the tropical forms, even though deficient in some of their apparently most important features. The depth of the sea-bottom seems also to affect the prevalence of particular types, and to modify the forms under which they present themselves; so that Messrs. Jones and Parker feel themselves able to pronounce approximately as to the depth of water at which a deposit of fossil Foraminifera may have been formed, by a comparison of its specific and varietal types with those characterizing various depths at the present time. And it is specially worthy of note, that in the greatest depths of the ocean from which Foraminifera have been brought by deep-sea soundings, these belong almost exclusively to one type, *Globigerina*.

Now it may be at once conceded that no other group in the Animal kingdom affords any thing like the same evidence, on the one hand, of the derivation of a vast multitude of distinguishable forms from a few primitive types, and on the other, of the continuity of those types through a vast succession of geological epochs. A somewhat parallel case, however, as regards the first of these points, is presented by certain of the humbler groups of the Vegetable kingdom, in which it is becoming more and more apparent, from the careful study of their life-history, not

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* "On some Fossil Foraminifera from Chellaston, near Derby," in the Quarterly Journal of the Geological Society for November, 1860, p. 458.

only that their range of variation is extremely wide, but that a large number of reputed genera and species have been erected upon no better foundation than that afforded by the transitory phases of types, hitherto known only in their states of more advanced development.*

But it would be very unreasonable to put aside these cases as so far exceptional, that no inferences founded upon them can have any application to the higher forms of animal and vegetable life. For it is only in the *degree* of their range of variation, that Foraminifera and Protophyta differ from Vertebrata and Phanerogamia; and the main principle which must be taken as the basis of the systematic arrangement of the former groups,—that of ascertaining the range of variation by an extensive comparison of individual forms,—is one which finds its application in every department of Natural History, and is now recognized and acted on by all the most eminent botanists and zoologists. It will be sufficient for me here to refer to the views recently advanced by Dr. J. D. Hooker, in his introduction to the Flora of Australia; the results of his extensive experience in the comparison of the Floras of different portions of the globe having led him to conclusions regarding the probable origin of the diversities they present, with which my own deductions from the study of the Foraminifera are in complete accordance. And I am authorized by Mr. T. Davidson, whose profound knowledge of the *Brachiopoda* enables him to speak as the highest authority upon all that relates to that most interesting group (which, like that of Foraminifera, is traceable through the entire series of fossiliferous rocks) to state that in proportion to the increase of his knowledge of its modifications of type, does he find reason to regard many of them as possessing so wide a range of variation, that he feels justified in making a large reduction in the number of specific types hitherto accounted distinct; whilst in the same proportion he finds himself able to trace with considerable probability the same specific types through a succession of geological periods,—certain Oolitic *Terebratulida*, for example, being the probable ancestors of existing forms; and even the *Lingula* of the Wenlock Silurian being specifically undistinguishable from the *Lingula anatena* of our present seas.

The following are the general propositions, which it appears to me justifiable to base on the researches of which I now give a *résumé* :—

I. The range of variation is so great among Foraminifera, as to include not merely the differential characters which systematists proceeding upon the ordinary methods have accounted *specific*, but also those upon which the greater part of the *genera* of this group have been founded, and even in some instances those of its *orders*.

II. The ordinary notion of *species*, as assemblages of individuals marked out from each other by definite characters that have been genetically transmitted from original prototypes similarly distinguished, is

* See especially on this subject the valuable researches of Dr. J. Braxton Hicks, "On the Development of the Gonidia of Lichens, in relation to the Unicellular Algæ," in Quart. Journ. of Micr. Science, October, 1860, and January, 1861.

quite inapplicable to this group; since even if the limits of such assemblages were extended so as to include what would elsewhere be accounted genera, they would still be found so intimately connected by gradational links, that definite lines of demarcation could not be drawn between them.

III. The only natural classification of the vast aggregate of diversified forms which this group contains, will be one which ranges them according to their mode and degree of divergence from a small number of principal family types; and any subordinate groupings of genera and species which may be adopted for the convenience of description and nomenclature, must be regarded merely as assemblages characterized by the nature and degree of the modifications of the original type which they may have respectively acquired in the course of genetic descent from a common ancestry.

IV. Even in regard to these family types, it may be fairly questioned whether analogical evidence does not rather favour the idea of their derivation from a common original, than that of their primitive distinctness.

V. The evidence in regard to the genetic continuity of the Foraminifera of successive geological periods and of those of the later of these and the existing inhabitants of our seas, is as complete as the nature of the case admits.

VI. There is no evidence of any fundamental modification or advance in the Foraminiferous type from the Palæozoic period to the present time. The most marked transition appears to have taken place between the Cretaceous period, whose Foraminiferous Fauna seems to have been chiefly composed of smaller and simpler types, and the commencement of the Tertiary, of which one of the earliest members was the Nummulitic limestone, which forms a stratum of enormous thickness, that ranges over wide areas in Europe, Asia, and America, and is chiefly composed of the largest and most specialized forms of the entire group. But these were not unrepresented in previous epochs; and their extraordinary development may have been simply due to the prevalence of conditions that specially favoured it. The Foraminiferous Fauna of our own seas probably presents a greater range of variety than existed at any preceding period; but there is no indication of any tendency to elevation towards a higher type.

VII. The general principles thus educed from the study of the Foraminifera should be followed in the investigation of the systematic affinities of each of those great types of animal and vegetable form, which is marked out by its physiological distinctness from the rest. In every one of these there is ample evidence of variability; and the limits of that variability have to be determined by a far more extended comparison than has been usually thought necessary, before the real relations of their different forms can be even approximately determined.

VIII. As it is the aim of the physical philosopher to determine

" what are the fewest and simplest assumptions, which being granted, the whole existing order of nature would result,"* so the aim of the philosophic naturalist should be to determine how small a number of primitive types may be reasonably supposed to have given origin, by the ordinary course of "descent with modification," to the vast multitude of diversified forms that have peopled the globe in the long succession of geological ages, and constitute its present Fauna and Flora.

XX.—On the Affinities of the Brain of the Orang Utang. By George Rolleston, M. D., F. L. S., Linacre Professor of Anatomy.

As an opportunity has quite lately been afforded me of dissecting an Orang Utang, and as the University Museum possesses a considerable number of preparations which illustrate "the Zoological Relations of Man with the Lower Animals," it is less presumptuous in me than it otherwise would have been, to write upon a subject which has met with such able, as well as such recent, handling in the pages of this Journal. The great attention which the Paper to which I allude has attracted, renders it unnecessary for me either to recapitulate the views it propounds, or to specify in detail the points in which I agree, or those in which I feel myself compelled to differ, with the writer of it, whose authority I should be little likely needlessly to dispute.

In this Paper it will be with Human rather than with Simious Brains that I shall contrast and compare the Brain of the Orang Utang; incidentally, however, I shall institute comparisons between the Brain of the Asiatic Ape, and that of the smaller of the two most anthropoid African Apes, the Chimpanzee.

Tiedemann and Buffon exemplify, respectively, the two most opposite views which it is possible to entertain as to the questions of the actual anatomical truth, on the one hand, and of the possible anthropological bearings of the former of these two comparisons, on the other. Buffon, writing in 1766, speaks of the Brain of the Orang in much the same language as Tyson, in his "Anatomy of a Pygmie," had more than sixty years previously, applied to the Brain of the Chimpanzee. Between these Brains and that of Man there was, according to these writers, actually no difference at all—"Le Cerveau† est absolument de la même forme et de la même proportion." And the doctrine of the immateriality of the soul was, in the estimation of these authors, not merely compatible with, but a corollary of, these not wholly correct anatomical premises. Though the Brain in each is the same—in the one the power of thought exists, in the other it is absent. Thought,

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* Mill's Logic, 3rd ed., vol. i., p. 327.

† Histoire Naturelle, tom xiv., p. 61. Paris, 1766.

therefore, cannot be a product of the Material Organism—"Il ne pense pas—y a-t-il une preuve plus evidente que la matière seule, quoique parfaitement organisée, ne peut produire, ni la pensée, ni la parole qui en est la signe, à moins qu' elle ne soit animée par un principe supérieur?"

The modern Idealist may avoid his predecessors' anatomical errors; but, if he be true to his principles, he will feel no anxiety to repudiate their metaphysics. He may make his strong position yet stronger, we believe, by adducing biological evidence in disproof of the usually granted assumption, that mental capacity stands always in a certain relation to cerebral development; but holding, as he does, the existence of an essential difference between mind and matter, he makes himself but a materialist for the nonce, if he express any repugnance to such statements as those just quoted on account of any conclusions to which they could lead *him*. For even if they were wholly, as we believe they are nearly, true to the facts, he could draw from them, if he remained true to his principles, no other conclusions than did Buffon and Tyson.

Reasoners of the kind to which we allude will do well to imitate the logical consistency of the materialistic author of the "Icones Cerebri Simiarum." Tiedemann, at all events, had no half-hearted faith in his creed. He plights his faith to the scalpel and callipers, and betrays no anxiety as to any possible upsetting of his conclusion by such data as consciousness or the history of psychical phenomena could furnish—"Parvus* ergo encephalus Orang Utangi rationem physicum et certam prodit ubi jam celeberrimus Soemerring monuit cur animi facultatibus tantopere ab homine distet. In homine prævalere cerebrum summumque hominis bonum rationis usum, ab ipsa maxima encephali evolutione pendere haud dubitari potest. Præcipua et essentialis ergo differentia quæ ipsum hominem et reliqua animantia intercedit in cerebro posita est."

Having indicated our opinion that the dealing with such views as those just quoted from Tiedemann's thirty-second Corollary is to be safely, though by no means of necessity, delegated to the metaphysician, we may proceed forthwith to lay before the reader the anatomical details which will enable him to decide for himself, whether the Heidelberg anatomist, or the French natural historian, was the nearer the truth in a matter of fact.

Multitudinous as are the differences which a detailed comparison of any two brains will disclose, they yet admit of being arranged under four heads. Under the first of these heads we may class those differences, which the observant anatomical eye would detect without the assistance of any anatomical instrument, and could express without being necessitated to employ any technical anatomical language.

Our second class of differences comprehends such as the scales and the callipers reveal.

For the power of describing, and one might almost say, for the

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* Icones, Cor. xxxii., p. 54.

power of discovering the third class of differences, we are indebted to M. Gratiolet's masterly analysis of the cerebral convolutions. Previously to the appearance of the "Memoire sur les Plis Cerebraux de l' homme et des Primatès," it was all but impossible to express in words the differences which the eye detected in the arrangement in two different brains of what has been called "the chaos of the convolutions." What was previously all but an impossibility, M. Gratiolet's philosophy has made an easy task. No apology can be necessary for adopting his phraseology, as the right of naming the country he has conquered, is a prerogative never denied to one, who has succeeded in subduing a territory which few before him had even thought of invading.

Under our fourth head we shall arrange those points of difference which a dissection of the brain alone can reveal.

These four heads correspond, it is obvious, to the successive stages of an anatomical investigation; and they possess, consequently, the merit not merely of colligating conveniently the results, but also of corresponding accurately to the several processes of an accurate anatomical investigation.

The orang dissected was a young male (*Simia Morio*). The first two molars had just come into use in both jaws; the weight of the entire body was but 16 lbs. 12 oz.; the height was 2 feet 7 inches. None of the internal viscera presented any appearance of disease. The lungs, which were both but unilobar, were crepitant throughout, free from congestion, collapse, or tubercle. The callosities on the backs of the fingers, which have been held, and with some show of probability, to indicate the existence of a state of debility, were absent.

The roof of the cranium was removed by a circular incision, intersecting the foramen magnum posteriorly. Before the removal of the dura mater, the cerebral hemispheres were seen to cover the superior surface of the cerebellum entirely, and even to project a very little way beyond it, posteriorly. After the removal of the dura mater, a small segment of cerebellar surface became visible on each side, posteriorly to the tips of the occipital lobes. It is well known* that the antero-posterior dimensions of the corpus callosum are very different in a brain whilst contained and supported within its case, and when removed from the skull,—the forward swaying of the hemispheres upon their supporting stems, the crura, flattening the previously arched commissure. That it was the weight of the hemispheres, working similarly, which produced the alteration just noted in the relations of the cerebrum to the cerebellum was seen thus.—*A wider segment of cerebellar surface was visible on the left side than on the right, the animal lying over towards its right side.*

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* "Bei der Messung der Lange des Balkens muss man wohl im Auge behalten dass man ihn Misst so lange die Hemisphären ihre Lage noch in Schädel haben; am herausgenommenen Gehirn dehnt er sich sehr betractlich in die Lange aus und verliert seine Wolbung." Huschke. Schaedel, Hirn und Seele, p. 110.

The greater width of the semilunar segment exposed on the left side was, no doubt, owing to the gravitation of the cerebral lobes, but the greatest width of this segment was only three lines. The relations thus described are well shown in Pl. iii., fig. 3. The view of the base of the brain, as given in fig. 2, will enable us to complete our observations as to the relations of the cerebellum to the posterior lobes of the cerebrum. On looking at that figure, it will be seen that no cerebral surface comes into view on the outside of the lateral boundaries of the cerebellum. In a view of the base of the human brain, some cerebral substance is invariably seen in this situation; but the same is the case with a second orang's brain, with a chimpanzee's brain, and with the brains of several *Cercopitheci*, and an *Inuus*, in the Series belonging to the Christ Church Museum. The cerebellum does not project so far laterally as to cover the cerebral lobes in a basal view of any brain in Tiedemann's Icones which is above the rank of the *Lemuridæ*. Two figures* of the brain of the Gibbon given by M. Sandifort, which present a relation of the cerebral lobes to the cerebellum, much resembling that which I have described in the brain of the first of the two orangs in our museum, M. Gratiolet regards with suspicion, whilst he himself records the existence† of a similar relation of the two parts of the encephalon in the gorilla. M. Gratiolet gives the figure of the brain of the chimpanzee as drawn by Tyson, only to express a strong opinion as to its worthlessness; and as he condemns it, as well as the two figures of M. Sandifort, on grounds quite independent of the view they give of the cerebellum and its relations, we may, perhaps, be justified in disregarding any evidence which might be based upon these three figures, and in considering the condition and relation of the parts in the subject of this paper as an individual, rather than a specific, peculiarity.

The roof-like exterior of the skull of the gorilla would prepare us for meeting with quite another relation of cerebellum and cerebrum than that which we find in the subglobular skulls of the smaller anthropoid apes. For, though the transverse diameter in these latter skulls taken from one parietal protuberance, or rather from one spot homologous with such protuberance to the other, is only subequal to the transverse diameter, as taken from one supramastoid region to the other, it is yet never markedly inferior, as is the case with the gorilla, to a degree for which no development of mastoidal air-cells can account.

The evidence, then, for the lateral predominance of the cerebellar lobes rests upon the single instance, the subject of this paper, and upon the three representations which M. Gratiolet sees, upon other grounds, good cause for condemning. Against it, is to be set the evidence based upon the examination of several other simious brains as above specified, upon the unanimous assent of every one of the plates given by M. Gratiolet in his Mémoire sur des Plis Cerebraux, and upon Tiedemann's

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* Gratiolet, Memoire sur les Plis Cerebraux. Planche iv., fig. 1 and 2.

† Comptes Rendus, Avril, 1860, p. 803.

figures of the brains of the *Simia Rhesus, Simia Nemestrina, Simia Sabœus,* and *Cebus Capucinus.* If the weight of this latter mass of evidence is not sufficient to make us consider the relations of the parts as seen in our specimen, fig. 2, as mere individual peculiarities, it is at all events sufficient to justify us in denying them, not merely all classificatory, but also all physiological value.

For arrogating importance to any projection or predominance backward of the cerebellum, still less justification exists. For so doing no other colour can be brought forward than such as our own figures can afford, for which we have adduced a sufficient explanation—or such as certain confessedly imperfect figures,* taken as they were from a confessedly badly preserved brain, may be thought to furnish, when weighed against the all but unanimous verdict to the contrary, which is obtained by the examination of authentic representations, and of well-preserved specimens. In every specimen, save the single one the subject of this paper, of a simious brain above the grade of a lemur, contained in our Museum, the cerebellum is as much covered posteriorly by the cerebral lobes as we have already shown it to be laterally. The same remarks apply to every one of M. Gratiolet's own figures; the only exceptions to the rule which his plates offer being those which the imperfect figures of Tyson and Sandifort furnish. Tiedemann's Icones of the lower apes are unanimous on the same side, but the figures which he gives of the brains of the orang and chimpanzee, in his work on the Brain of the Negro,† represent the cerebellum uncovered, on both sides, to a somewhat greater extent than it is in our figures 3 and 4, on one side‡.

A careful study, however, of our figures, coupled with an examination of the skulls of several anthropoid apes, will lead to the belief that the cerebral hemispheres of the apes bulge less laterally than do those of man; that they are not merely more boat-shaped, and tapering anteriorly and posteriorly, but that they are more wall-sided, and less protuberant laterally.

Though we may be inclined to consider the diminution in lateral expanse, and in backward growth of the posterior lobes, D, of which

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* Schrœder van der Kolk et Vrolik, citt. Gratiolet, Mem. p. 49, Planch vi. 5 and 6.

† Citt. ap. Wagner's Icones Zootomicæ Taf. viii., figs. 2 and 3.

‡ Since the above paragraphs were written, casts have been taken of the interior of the skulls of our second orang and of the chimpanzee with the following results. The cast of the orang's skull approximates more nearly to the proportions of the brain we have figured than does the prepared brain it represents; the relative extent of the space occupied by the mass corresponding to the cerebellum, being somewhat greater than that occupied by the cerebellum itself, in the specimen. Still, in such a view of the cast as that given in fig. 3 of the first of our brains, no cerebellar surface at all comes into view; though a little less cerebral surface comes out laterally than in the preserved brain in a similar view to that in fig. 2. The cast of the chimpanzee's skull represents the cerebral hemispheres as overlapping the cerebellum to a greater extent, posteriorly, than they do in the preparation, the hemispheres having in this, as in certain figured preparations, fallen apart laterally somewhat, and lost thus in antero-posterior, what they have gained in lateral, extent.

our figures speak, as an individual rather than as a specific peculiarity, we are compelled to assign greater importance to the curtailment in downward growth to which they, as well as other similar figures, testify. A line drawn along the edge of the cerebral hemisphere in Fig. 1, where that hemisphere overlies the cerebellum, will be seen to be much less nearly horizontal than a line is which holds the same relation in a human brain. It seems as if the cerebellum had encroached upon the cerebral lobes which roofed it over.

The same figure shows that a similar stunting has befallen the upward growth of both the frontal and posterior lobes, a line bounding the superior edge of the hemispheres from D forwards to A, describing a much more even curve than is usual in man.

Less ambiguously does the vertical direction of the fissures of Sylvius, F, and of the convolution 6, 6, 6′; parallel with, and immediately below the lower lip, 7, 7, 7, of that fissure, speak of diminished relative antero-posterior growth of the frontal lobes.

The greater relative thickness of the nerves is well seen in Fig. 2.

These nine points of greater or less discrepancy between the human and the Simious brain may be arranged under our first head: they consist, in the ape, of diminution in downward, lateral, upward, and antero-posterior growth, first, of the posterior; secondly, of the frontal lobes; and to these, based on consideration of diminution, we have to add the ninth, based upon a consideration of increase, that, viz., of the size of the nerves. What is the value of these points as differentiating characteristics? Two canons may be laid down, to assist us in estimating the value of such characteristics as means for settling the relative rank of rival organisms. The first of these may be thus expressed:—If certain structures, or certain relations of certain structures, are found to exist in animals confessedly lower in the scale of life than those which are the subjects of comparison, the presence of such structures, or of such relations of structures, cannot *by itself* be held to be a mark of serial elevation. Cumulatively it may have weight, absolutely it can have none. The second canon is but a converse of the first; and, expressed in similar language, it may run thus:—If certain structures, or certain relations of certain structures, are found to exist in animals confessedly higher in the scale of life than those which are the subjects of comparison, such structures, or such relations of such structures, cannot *by themselves* be held to be marks of serial degradation. Cumulatively, they may be of weight; absolutely, they are not. These canons have been, perhaps necessarily, expressed in complex language; in themselves, however, they are sufficiently simple and self-evident, and, being so, are compatible with either view of the origin of species.

The first of these canons we have already applied, in our comparison of the overlapped cerebellum of the lower monkeys with the partially unoverlapped cerebellum of our orang. The even curve described by the boundary line of the superior surfaces of the Bushwoman's brain, as given by M. Gratiolet in the first plate appended to his often-quoted work, and the anteriorly and posteriorly tapering ends of the hemispheres there figured, enables us to apply the second canon to the several marks of degradation spoken of, as diminution of upward and of lateral growth in the frontal and the occipital lobes. The even regular curve,* indeed, of the skull, and its narrowing tapering frontal and occipital regions, as seen in the lower races, would have led us to anticipate some such cerebral conformation as the unhappily all but unique specimen of such a brain as the one just referred to actually discloses to us.

The foramina for the nerves in the skulls of the lower races of mankind have been said by certain ethnologists to present larger diameters than the similar foramina in the basis of the skull of higher races; and if this be really the case, our first canon will come to apply to our ninth point of difference, the larger relative size, namely, of the nerves in the simious brain.

The three points of diminution in downward development of the posterior lobes, and in both downward and in antero-posterior development of the frontal, remain unaffected by the application of either canon. Of their value our figures will enable the reader to judge for himself.

After comparing our single brain of the chimpanzee with the two of the orang we possess in our Museum, we cannot see that the African ape contrasts in any one of these nine points to disadvantage with the Asiatic.

Under our second head—that, namely, of the differences which weighing and measuring enable us to enucleate as existing between the several subjects of our comparison—we have eight points of difference to enumerate. When it is not otherwise specified, the measurements of the human brain were taken from a brain of a German of average intelligence, the brain having recently been brought to the museum and presenting nothing peculiar, in the way either of under or of over development, to render it unfit to serve as a standard of comparison to the brain of the orang. Both sets of measurements were taken at the same time.

The entire weight of the orang's body being 16 lb. 12 oz., the weight of the brain was 12 oz. The relation of the weight of the brain to that of the body was, therefore, as 1 : 22.3.

I find recorded by Huschke† a set of observations analogous to these. They were made upon a child of six years of age. The child was a girl, dying emaciated of pleuro-bronchitis—

Weight of body, ... 13,377 grammes or c[a] 29 lb.
Weight of brain, . . . 1215 grammes or c[a] 2 lb. 10 oz.

The brain : the body = 1 : 11.

* Hunterian Osteological Catalogue, 5346, 5755. See, also, Symbolik der Menschlichen Gestalt., von. C. G. Carus, p. 170, fig. 34.

† Schaedal Hirn und Seele. 1854, p. 112.

The state of emaciation in which this child is reported to have died makes it the fairer to take it as a standard in this comparison. The child's dentition may very well have been in the same state as that of our orang; its age, however, was in all likelihood much further advanced; but as the brain would have been growing rapidly during those years, whilst the weight of the body was not increased proportionally, the excess of years may not in reality have caused in this case any diminution in the relative disproportion of the child's brain to its body, as it does in cases of healthy development.

On the other hand, we must recollect that the proportion subsisting between the adult brain in man and the body has been put as low as 1 : 50;* and that though this proportion is lower by as much as 15 than most authorities would rate it, some such disproportion must have prevailed in those cases in which the brain of an adult Negro is recorded as reaching no greater weight than 753 grammes† or 1 lb. 10.59 oz.

The weight of the body of a nearly adult female chimpanzee is given by Professors Sharpey and Ellis, on the authority of Professor Owen, as 61 lb. The relation of weight between such a body and the brain of our orang which weighed 12 oz. would be 1 : 81.3.‡

Let us suppose that the Negro, the weight of whose brain, as given by Tiedemann, amounted to no more than 26 oz., weighed altogether as much as 8 stone, or 1792 oz. The proportion between his brain's weight and his body's would then have stood as 1 : 68.9, as against a proportion taken between analogous weights in the apes of 1 : 81.3. It will be seen from this that the absolute weight of the human brain is a more sharply differentiating characteristic than is its relative weight.

It will be convenient to give the following measurements and their mutual relations in a tabular form, using, for the sake of economy of space, the letters of the alphabet to denote each particular measurement:—

a. The length from the root of the olfactory nerve to the anterior extremity of the brain.

b. The length from the point of the middle lobe to the posterior extremity of the brain.

c. The length of the cerebellum.

d. The breadth of the cerebellum.

e. Length of cerebral hemispheres.

f. Length of corpus callosum.

$$a : b \begin{cases} \text{In Orang} & = 1\tfrac{3}{4} \text{ inch.} : 2\tfrac{7}{8} \text{ inch.} = 1 : 1{\cdot}64. \\ \text{In Man} & = 2\tfrac{5}{8} \text{ inch.} : 5\tfrac{1}{8} \text{ inch.} = 1 : 1{\cdot}95. \\ \text{In Chimpanzee§} & = 44 \text{ mm.} : 69 \text{ mm.} = 1 : 1{\cdot}56. \end{cases}$$

* Huschke, l. c., p. 60.
† Tiedemann, citt. Huschke, p. 73.
‡ Quain's Anatomy, by Sharpey and Ellis, vol. ii., 433, note. 1856.
§ Schrœder van der Kolk et Vrolik, citt. Nat. Hist. Review, No. I., p. 80.

$c : d$	In Orang	$= 1\frac{1}{4}$ inch.	: 3 inch.	$= 1 : 2{\cdot}40.$	
	In Man	$= 1\frac{1}{2}$ inch.	: $4\frac{1}{8}$ inch.	$= 1 : 2{\cdot}75.$	
	In Chimpanzee*	$= 15{\cdot}5'''$	: $32{\cdot}5'''$	$= 0{\cdot}48 : 1.$	
$e : f$	In Orang	$= 4\frac{1}{4}$ inch.	: $1\frac{7}{8}$ inch.	$= 1 : 0{\cdot}44.$	
	In Man	$= 6 - 7$ in.	: $3 - 4$ in.	$= 1 : 0{\cdot}50$,	or $1 : 0{\cdot}42.$
	In Chimpanzee†	= 99 mil.	: 43 mil.	$= 1 : 0{\cdot}43.$	

The following six measurements of height, breadth, and length of the human cerebral hemispheres, are the three maximum and the three minimum measurements given by Husche, at the ninety-ninth page of his work, already referred to.

Maximum height in Chinese	= 155 mil.	Minimum in	Hindoo Fakir	= 124 mil.
,, breadth in Inca	= 173·3 ,,	,,	Croat	= 103 ,,
,, length in Croat	= 200 ,,	,,	Inca	= 151 ,,

From these measurements, it is evident that the variations of height oscillate within narrower limits in the human brain than the variations either of length or of breadth. The measurement of height, therefore, would seem to possess greater serial importance than either of the other two measurements. Yet the following measurements will show that it is precisely in this dimension that the brain of the apes stands in the greatest relative inferiority to that of man.

Length of hemispheres in Orang : length in Man	$= 4\frac{1}{4}$ in.	: 6 – 7 in.	= 1 : 1·4 or 1 : 1·64.
,, Chimpanzee : ,,	= 99 in.	: 6 – 7 in.	= 1 : 1·54 or 1 : 1·79.
Breadth of ditto in Orang : breadth in Man	$= 3\frac{1}{4}$ in.	: 4 – 7 in.	= 1 : 1·23 or 1 : 2·15.
,, Chimpanzee : ,,	= 95 m.‡	: 4 – 7 m.	= 1 : 1·08 or 1 : 1·88.
,, ,, ,,	= 87 m.§	: 4 – 7 m.	= 1 : 1·17 or 1 : 2·06.
Height of ditto in Orang : height in Man	$= 2\frac{1}{8}$ in.	: 5	= 1 : 2·35.
,, Chimpanzee : ,,	= 54 m.‡	: 5	= 1 : 2·38.
,, ,, ,,	= 64 m.§	: 5	= 1·2.

Of all the differences of measurements and their relations as yet adduced, the difference between the relative heights of the human and the simious brains seems the most important.

Small as the difference in the two measurements of corpora callosa may seem, we must yet record that posteriorly to the posterior bourrelet or rounded edge of that body in the orang, the corpora quadrigemina came into view when the brain was removed from the skull. This observation will be seen later to have, when coupled with certain others, considerable value, as showing the greater relative shortness of the corpus callosum. It was noticeable that the anterior pair of corpora quadrigemina were less sharply marked off from the posterior than in man.

The central notch of the cerebellum was much shallower relatively

* Schrœder van der Kolk? citt. Huschke, l. c., p. 82.
† Idem, Ibid., p. 129.
‡ Schrœder van der Kolk ap. Huschke, p. 129.
§ Gratiolet, Memoire, p. 54.

than in man, a point to be recollected in connexion with the relations stated to exist between the transverse *d* and antero-posterior diameters *c*, of the cerebellum.

It is under our third head, that, namely, of the differences which M. Gratiolet's work has enabled us to describe, and we might almost say to discover, that the most important points of our comparison will be found. Under this head will fall the points which were mentioned in the last number* of this Journal, as the second and third points of difference, absolutely distinguishing the brain of man from that of the ape; and under it also may be ranged those which M. Gratiolet† lays stress upon, as indicating a relative inferiority in the African to the Asiatic ape.

To begin with "the external perpendicular fissure." This fissure or a part of it is visible in Fig. i., below *a*; in Fig iii., between *a* and *a*. It is well represented in most of the simious brains figured by M. Gratiolet; it may be seen in Fig. i., Fig. ii., Fig. iii., Fig. vi., at *f*, in Tab. i. of Tiedemann's Icones of the brain of the Simia Nemestrina, Simia Rhesus, Simia sabæa, and Cebus capucinus. It will be seen a little later that it is not beside the purpose to remark that it may also be better seen in Tiedemann's‡ figure of the brain of an Orang on one side than it is on either side of his representation of the brain of a Chimpanzee; and that it is very well-marked on both sides, in a drawing of a brain of a young orang given by Professor Wagner, in a work§ written with express and constant reference to M. Gratiolet's labours. Lastly, this fissure is very well seen in the representation of the brain of the Chimpanzee given by Professor Owen in his paper in the Linnæan Society's Proceedings, Jan. 21, 1857, Fig. iv., p. 19, and in his Reade Lecture, Fig. vii., p. 25.

The inward prolongation of this fissure is never filled up, see 16, Fig. iv. It is upon the degree to which its outward prolongation is filled up or not filled up, bridged or not bridged over, that the absence or presence of an external perpendicular figure, the existence or non-existence of an "operculum," depends.

In the figures referred to, and to some extent in those appended to this paper, the anterior edge of the occipital lobes is seen to rise wave-like as it were against the table-land of the fronto-parietal lobes. The wave-like edge is the "operculum." Along the middle line on each in Fig. i., Fig. iii., and Fig. iv., the wave-like edge, speaking of disruption of continuity between the occipital lobes and the mass of brain anterior to them, is absent; a convolution, *a*, *a*, passes across what would else be a chasm. This convolution is the "premier pli de passage" of Gratiolet; it comes according to that authority thus to the surface, and thus bridges the chasm in Man, in the Orang, and in the Ateles, but in no other ape. Our first canon can be immediately applied in the estimation of the value

* Nat. Hist. Rev., i., p. 83. † Memoire, pp. 51, 62.

‡ Tiedemann ap. Wagner, Icones Zoot., Taf. viii., figs. 2 and 3.

§ Vorstudien zu einer Wissenschaftlichen Morphologie und Physiologie des Menschlichen Gehirns als Seelenorgan. Von Rudolph Wagner. Gottingen. 1860.

of this structure upon the data thus put before the reader upon the authority of M. Gratiolet. Leaving the task of so applying it to the reader, I shall proceed to show that the superficial position of this bridging convolution is by no means an universally present characteristic either of the human brain, or of the Orangs; and, thirdly, that it is sometimes both present and superficially visible in the brain of the Chimpanzee.

Of seven human brains at present in the University Museum, three possess this bridging convolution on both sides entirely superficial in position; in the fourth we find it wanting on one side, two spurs thrown out from the declivity of the occipital representing what is a perfectly continuous chain on the other side; in the fifth it is concealed on one side by the overhanging edge of the occipital lobes; in the sixth it does not quite reach, on the left side, the level held by the occipital and parietal lobes which it connects; in the seventh, a deep chasm is visible on both sides; but on the left the convolution, which seems to fail to bridge the fissure, does really cross it and fill it up, though at a distance of as much as an inch from the longitudinal fissure; whilst on the right side the connecting convolution dips vertically downward, and leaves a deep valley between the occipital and parietal lobes. This seventh brain belonged to a man who, by trade a gardener, was possessed of more than an average share of intelligence, and whose brain was carefully preserved for this reason, as well as on account of its great size, and the development of its convolutions. This last of the seven brains will allow us to apply our second canon to test the value of the absence of this structure in the particular relation of superficial position as a mark of serial degradation.

But a structure which exhibits so much variability, as to conform to the rule in but three, and to diverge more or less from it in four, out of seven brains chosen at haphazard for examination, as being all at that moment which a particular museum contained, will scarcely seem to merit a high place as a zoological differentia. With reference to the "premier Pli de Passage" in the orang, a careful comparison of the relations of the parts lettered *aa*, in fig. 3, with the same relations in fig. 4, will show that this convolution is by no means superficial in its entire extent on the left side of that brain. And, secondly, in our second specimen of an orang's brain, this convolution is concealed on both sides within the fissure; and the cerebral hemispheres in this specimen present, in consequence, as perfectly wave-like an opercular edge as in any other monkey. In confirmation of this, I would appeal to Tiedemann's* and Wagner's† figures, already referred to, as giving typical representations of an external perpendicular fissure in the brain of orang utangs, in which, according to M. Gratiolet, it should be invariably half-filled up by his "premier pli de passage."

Lastly, with reference to the chimpanzee: one specimen possesses

* Wagner, Icones Zoot., viii., 3.

† Ap. Wagner, Icon., taf. viii., fig. 2.

on its right side a well-marked, superior bridging convolution, coming for a considerable part of its length nearly or quite to a level with the lobes it connects. Tiedemann's figure of the chimpanzee's brain leads us, by its imperfectly-marked operculum, to the same conclusion as its sharply drawn one did in the case of the orang. The law of correlation of forms is a safe guide to us, when we have to predict what will be found in the lower organisms of well-marked families; it loses its inflexibility, and becomes but a leaden rule, when we come to examine the most perfectly evolved species in such families. In the higher species of the order, apes, as in the higher varieties of the species, man, we find variability the rule, uniformity the exception; in the lower species, as in the lower varieties of man, the reverse condition obtains. The variability which we have seen to exist in the species chimpanzee, is no inconsiderable proof of its high relative rank in its own order.

But there is a second connecting bridge passing between the occipital and the parietal lobes. This convolution is invariably present, and invariably superficially placed in man; it is as invariably absent in both the anthropoid apes. In man it is always a large, easily recognizable structure; and in cases such as those which our fourth human brain may be taken to exemplify, or exaggerate, it will often be found to send a branch, as it were, in aid of the weakened superior bridge. The vacuity which in the apes corresponds to what is invariably a convolution of importance in man, may be seen in fig. 1, immediately posteriorly to 6; and in fig. 3, immediately below *a*. But this convolution, the "deuxième pli de passage" of Gratiolet, absent without exception in the Old World apes, and present equally invariably in man, is found also in two New World monkeys, the cebus capucinus* possessing it without, the ateles possessing it in company with its fellow.†

There is yet a third structure — "the Lobule of the Marginal Convolution" — to be treated of. In man it lies above the upper end of the fissure of Sylvius; and it may not unfairly be represented in our figure 1, by the convolution which lies immediately to the spectator's left of 5. Of it M. Gratiolet speaks in the following language:—"Cet lobule est particulier à l'homme et ne se trouve pas‡ ni dans l'orang ni dans le chimpanzee." But I find nowhere in M. Gratiolet's work any repetition of this striking statement: indeed it loses a good deal of its force, when we find the qualifying words "souvent assez grand" applied to this peculiarly anthropic lobule in the sentence immediately preceding the one we have quoted. And in the coloured diagrams, which speak so plainly, by their various hues, of the varied relations in extent and arrangement which may obtain among different brains, I find no separate colour assigned to this peculiarly separable lobe—no such distinction is awarded to them as there is to the bridging "plis de passage;" which, nevertheless, are not asserted to be exclu-

* Gratiolet, Memoire, p. 78. † Ibid., p. 76. ‡ Ibid., p. 60.

sively anthropic. These considerations make me suspect that more weight has been attached to M. Gratiolet's words, as above quoted, than he would have wished them himself to carry; and anatomical investigation seems to me but to strengthen the argument based upon these literary considerations. For this "lobule of the marginal convolution" is very frequently asymmetrical on the two sides of the same brain, and its development in any two human brains taken at haphazard is pretty sure to present the very greatest differences. Varying, as it does most widely, in absolute size, it varies also showing "rien* de constant" in its relation to certain other parts; its value can hardly be high, therefore, as a serial characteristic.

The convolution numbered 4 in Fig. 1 and Fig. 3, the "premier pli ascendant" of Gratiolet, is separated by a vertical more or less interrupted fissure from the horizontal-lying frontal lobes 2 and 3. Now, a line drawn down the long axis of this fissure would fall a considerable way in front of the commencement of the fissure of Sylvius. Such a line in the human brain falls always far behind the commencement of that fissure, joining it, indeed, some way behind the angle where the fissure of Sylvius makes its bend horizontally backwards. The forward position of this line speaks more strongly than can the vertical direction of the fissure of Sylvius, of stunted antero-posterior growth of the frontal lobes, and it deserves more attention than it has as yet received.

The convolutions, No. 3, the superior frontal convolutions, are of all the convolutions those in which by symmetry and simplicity, both alike sure marks of degradation, the orang's brain contrasts to the greatest disadvantage with man's. But this fourth and this fifth point we shall leave to be elucidated by the reader for himself from an examination of our figures. We will state, however, the details which an examination of the chimpanzee's brain, instituted with a view of seeing whether its convolutions were really more symmetrical and more simple than those of the orang, elicited, in confirmation of M. Gratiolet's views.

In the orang, and in the chimpanzee, both the frontal, 1, 2, 3, the 4 and 5 ascending parietal, and the superior bridging convolutions *aa*, are asymmetrical on the two sides of the brain. The occipital D, the temporo-sphenoidal B, and the convolutions *b*, *b*, *b*, named "pli courbe" by M. Gratiolet, are symmetrical in the chimpanzee, but asymmetrical in the orang. The occipital lobe is both more simple and more symmetrical in the chimpanzee than in the orang, but it is not larger in size. Both ascending convolutions are a little more simple in the chimpanzee than in the orang. But the sum total of advantage accruing to the orang from this comparison is, on M. Gratiolet's own principles, but slight.

Having arrived at our last head—that, namely, of such differentiæ as are detectible by dissection only—we will proceed to lay them before

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* Memoire, l. c.

the reader in the shape of a short account of the dissection which disclosed them.

The right cerebral hemisphere was removed down to the level of the corpus callosum, as seen in Fig. 4. At a point relatively much further distant from its posterior edge, 14, than is the case in man, we see the internal perpendicular fissure, 16. Posteriorly again to this fissure, and running nearly parallel with it, we see a second, 17, the "scissure des hippocampes" of M. Gratiolet. Corresponding with this indentation, we have within the cavity of the ventricle an eminence, 19, the lesser hippocampus, bounded by an arm or creek running up, 18, along its outer surface from the central ventricular expanse. This arm or creek was called, by another metaphor than those we have used, the third *cornu* of the lateral ventricle, in the phraseology of the old anatomists. The large smooth headland into which the hippocampus swells at 19, justifies the expression we find at page 19 of M. Gratiolet's work—"L' anfractuosité d' ergot . . . *qui est plus evidente encore dans les Singes que dans l' Homme.*" In the brain of a cercopithecus now before us, its proportions are very much larger. The width of this third cornu was at its commencement three-eighths of an inch; and the similar cavity in a human brain examined at the same time was of the same width. But the cavity narrows much more rapidly in the orang than in man; and before reaching its termination, at a distance of one inch from its commencement, it becomes almost a linear cavity; but, as our figure shows, the distinctness of its limiting walls and the continuity of its lining membrane were unambiguously visible up to its very extremity. The length of this third cornu is as great absolutely, and relatively, therefore much greater in the cercopithecus, than in the orang. In the human brain it was but half an inch longer than in the orang, scooped out though it was in a posterior lobe relatively very much longer. Neither in the cercopithecus, nor in the orang, does the bourrelet or posterior rounded edge of the corpus callosum extend nearly so far back as to allow us to take it as "the best measure of the position" of the third cornu;* indeed, when we find Tiedemann speaking of the pedes hippocampi minores as "Processus† duo medullares qui a posteriore corporis callosi margine proficiscuntur," it is easy to understand how he came to overlook their existence altogether, "in cerebro Simiarum desunt," being so far in error as to their relations to neighbouring parts.

This relation of the posterior edge of the corpus callosum to the commencement of the third cornu is of importance, not merely as a guide to the discovery of that fissure, but also as, when coupled with the relations which the corpus callosum holds to the internal occipital figure 16, laterally, and to the corpora quadrigemina posteriorly, speaking unambiguously of great diminution of the antero-posterior diameter of the simious corpus callosum.

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* Nat. Hist. Rev., l. c., p. 79. † Icones, p. 51.

The hippocampus major presents several well-marked corrugations on its expanded lower extremity, "quæ huic parti tanquam figuram digitorum pedis tribuunt;"* but as they are on its posterior, not on its anterior edge, we are not compelled to contradict Tiedemann's twenty-first corollary, which relates to the hippocampus major, in the same way as our figures compel us to differ from his twenty-second, quoted above, with reference to the hippocampus minor.

It is for the sake of illustrating yet further the important principle, that variability of arrangement is to be expected, rather than wondered at, in organisms as high as those of these apes, that I add the following observations as to the convolutions on the internal aspect of the hemispheres. There is scarcely any indication of a lobulus quadratus, the structure representing it resembles but little the figure of it as given by M. Gratiole in his third plate; whilst, as if in compensation, the superior marginal convolution, spoken of by him as "très simple et à peu près lisse" dans l' Orang (page 49 in his Mémoire), presents, in our specimen, abundant and rich convolutions.

The internal anatomy of the simious brain does not furnish us, then, with those sharply differentiating characteristics which have been supposed to put it into a position of such marked inferiority to that of man.

As to the external anatomy, whilst too little importance has perhaps been assigned to the points of difference which the very widely-differing heights of the hemispheres, the very widely-differing antero-posterior diameters of the corpora callosa, and of the frontal lobes, and the very widely-differing absolute weights of the two brains, constitute, too much seems to have been given to the "absence of an external perpendicular fissure," to the "presence of a lobule of the marginal convolution," and to the lesser relative size of the nerves in the human brain. Upon most other points, I find myself in agreement with most other writers, both as to facts and to inferences; the cumulative weight of the many minor points of agreement and difference, the reader will be best able to appreciate, by massing each order of facts together for himself.

The principles of the idealist teach him that the difference which exists between the soul of man and the life of the beast which perishes, is not one which can be weighed or measured, be drawn or figured, be calculated in inches or ounces. He fearlessly acknowledges that the anatomical truth in this matter lies on the boundary line of the conterminous positions taken up by Buffon and Professor Huxley, respectively; for he feels that yet higher truth is expressed in the golden words but recently rescued from long oblivion—

"On earth there is nothing great but man;
In man there is nothing great but mind."

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* Icones, p. 51.

Description of Plates.

These four views of the brain of the orang are copies of photographs taken of it by Messrs. Hills and Saunders, of Oxford. The brain had been carefully hardened in spirit for as much as two months before it was thus photographed. The figures are numbered in the order in which the photographs were taken. The numbers placed upon the convolutions on the exterior surface of the brain will be found to correspond with those similarly employed by M. Gratiolet in his invaluable Mémoire sur les Plis Cérébraux de l' Homme et des Primatés, so often referred to.

Fig. 1, is a lateral view of the brain of the orang. It shows the following points :—

- i. The even curve described by the superior boundary line of the hemispheres.
- ii. The vertical direction of the fissure of Sylvius, F.
- iii. The failure of the posterior lobes to cover the cerebellum entirely.
- iv. The diminished downward growth of the posterior lobes, as shown by the obliquity of a line drawn along their surface where it lies upon the cerebellum, C.
- v. The presence of the outer part of the lateral vertical fissure, which outer part is always filled up in man, even when the inner may not be so, as the inner is in the orang.

Fig. 2 is a basal view of the same brain. It shows the following points :—

- i. The great relative thickness of the nerves to the mass of the brain.
- ii. The absence of any marked excavation of the orbital lobes.
- iii. The lateral and posterior development of the cerebellar hemispheres.

Fig. 3 represents the brain of the orang as seen from above. It shows the following points :—

- i. The greater extent to which the cerebellum has come into view on the left side than on the right.
- ii. The want of symmetry between the two sides of the cerebrum. The longitudinal fissure seems on the left to be bounded by a continuous vertically unindented table-land, on the right by a table-land indented at two points. The posterior of these two points corresponds to the external vertical fissure, the first or superior pli de passage *a*, *a* being partially concealed under the operculum, and allowing us thus to mark off the occipital from the principal lobes nearly as sharply as in the Chimpanzee. The three frontal convolutions, 1, 2, 3; the two ascending parietals, 4, 5, and the lobule of the second ascending convolution, 5′, are asymmetrical on the two sides of the brain.

iii. The absence of the second pli de passage is well seen on both sides of the brain; and the wave-like anterior edge of the occipital lobes constituting the "operculum" is especially well marked on the right side.

Fig. 4. Brain of orang dissected, so as to show the lateral ventricle of the right side, its three cornua and the hippocampus minor, 19. It shows, besides, the different relations which the bourrelet of the corpus callosum holds in the ape and in man:—

i. To the commencement of the third cornu, 18.
ii. To the internal perpendicular fissure, 16.
iii. To the hemispheres which it connects.

1. Inferior frontal convolution.—"Étage frontal inférieur" of Gratiolet.
2. Middle frontal.—"Étage frontal moyen."
3. Superior frontal.—"Étage frontal supérieur."
4. First ascending parietal.—"Premier pli ascendant."
5. Second ascending parietal.—"Deuxième pli ascendant."
5'. Lobule of second ascending parietel.—"Lobule du deuxième pli ascendant."
6 and 6'. Convolution running below, and parallel with the lower lip of the Sylvian fissure.—"Pli courbe."
7. Lower lip of Sylvian fissure.—"Pli marginal inférieur."
10. Superior occipital convolution.—"Étage superieur du lobe occipital."
11. Middle occipital convolution.—"Étage moyen."
12. Inferior occipital convolution.—"Étage inférieur."
13. Corpus striatum.
14. Posterior edge of corpus callosum.
15. Fornix.
16. Internal occipital fissure.
17. "Scissure des hippocampes."
18. Third cornu of lateral ventricle.
19. Hippocampus minor.

A. Anterior lobes.
B. Middle temporo-sphenoidal lobe.
C. Cerebellum.
D. Occipital lobes.
E. Medulla oblongata.
F. Fissure of Sylvius.
G. Pons.

a. Convolution connecting the superior occipital convolution (10), to the lobule of the 2nd ascending parietal 5'.

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1. PERIODICAL PUBLICATIONS.

I. Additions to the list of existing Periodicals.

2. ZOOLOGICAL.

II. General and mixed works relating to Zoology and the geographical distribution of animals.
III. Mammalia, including Anthropology.
IV. Aves.
V. Reptilia and Amphibia.
VI. Pisces.
VII. Annulosa. Subdivided under the heads of—

1. General and mixed.
2. Crustacea.
3. Arachnida and Myriapoda.
4. Insecta.
5. Annulata. Consisting of—
    - *Annelida.*
    - *Suctoria.*
    - *Annuloida.* The last group containing the—
        - *Scolecida.*
        - *Rotifera.*
        - *Echinodermata.*

VIII. Mollusca. Subdivided into—

1. General and mixed.
2. Cephalophora.
3. Acephala. Including the—
    - *Lamellibranchiata.*
    - *Brachiopoda.*

4. Molluscoida. Including—

Polyzoa.
Tunicata.

IX. Cœlenterata. Consisting of—

1. Hydrozoa.
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X. Protozoa.
XI. Physiology, &c. Subdivided into—

1. General and mixed.
2. Nervous System, and Organs of Sense.
3. Respiratory and Sanguineous Systems.
4. Digestive, Assimilative, and Glandular Systems.
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6. Histology and Human Anatomy.

XII. Palæontology.

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XIII. Phanerogamia.
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The author admits of three primary groups of animals:—

The Binary of M. de Blainville, the Radiate, and the Homogeneous. These groups represent three terms of a very regular series; and their essential characters admit of being brought under geometrical and arithmetical considerations.

From the *first* to the *last*, *similarity* is manifested more and more strongly, whilst the mode of *co-ordination* becomes simplified. Thus in the first group, to take the geometrical character, the co-ordination of the similar parts takes place in relation to a *plane*, or more generally to a *surface;* in the second, in relation to a *line;* and in the third, to a *point*, *spine*, *axis*, or *centre*. In the first division, moreover, the corresponding parts are repeated in pairs; in the second, in groups of *several* to *several;* and in the third, in *a very great or*

indefinite, if not infinite number. Or, in other words we find, *duality,* definite multiplicity, and indefinite multiplicity, or *indefinity.*

With respect to man, the author admits twelve races. Of these the four principal are the *Caucasian, Mongolian, Ethiopian,* and *Hottentot.* The Caucasian race is distinguished essentially by the predominance of the *superior region* of the *head* over the *face;* the Mongolian, by the predominance of the *middle region;* and the *Ethiopian,* by that of the *inferior region,* which projects in front. The most remarkable characteristic of the Hottentot resides in the predominance of both the middle and inferior region, that is to say, of the entire face, which is at the same time broad and prognathous. In other words, the Caucasian race is *orthognathous,* the Mongolian *eurygnathous,* the *Ethiopian prognathous,* and the Hottentot both *eurygnathous* and *prognathous.* In addition to this very important character, which ranks the Hottentot, in fact, in the series of human races, in a place diametrically opposite to the Caucasian, we find in the Hottentot race a peculiar mode of insertion of the *hairs,* a special disposition of the *toes,* which decrease gradually, like the reeds in a Pan's-pipe, from the inner to the outer; the development of the *nymphæ,* and various osteological,* and encephalic peculiarites, which have already been well studied by different authors. Between these four cardinal groups are placed the other races, which are modified and intermixed in so many ways as to constitute a sort of network, uniting more or less intimately all the varieties of the human type.

The races regarded by M. G. St. Hilaire as sufficiently distinct are the following:—

1. Races with smooth hair:—Caucasian, Alleghanian, Hyperborean, Malay, American; Mongolian, Paraborean, Australian.

2. Races with woolly-hair:—Ethiopian, Caffre, Melanian; Hottentot.

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The author points out that Agassiz and Vogt detected the heterocercality of the adult Salmonidæ (Anat. des Saumones, 1845), and coincides generally with the views on this subject more recently put forward by Heckel and by Huxley. He admits three degrees of heterocercality: perfect (*Acrolepis, Pygopterus, Acanthodes, Catopterus, Amblypterus, Palæoniscus*): internal (*Lepidosteus, Amia, Salmo, Esox, Cyprinus*): imperfect, *Polypterus*, and probably many others with imperfectly lobed tails.

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,, *stylifera.*
Staurocephalus rubrovittatus.
Phyllodon macroceros.
,, *punctifera.*
,, *albo-vittata.*
Syllis variegata.
,, *zebra.*
Sylline rubropunctata.
Spiophanes Kroyeri.
Heterocirrus frontifilis.
Cirratulus tenuisetis.
Clymene leiopygos.
Maldane globifex.
Terebella cretacea.
,, *turrita.*
,, *spiralis.*
,, *zostericola.*
,, *gracilis.*
,, *rosea.*
,, *pustulosa.*
,, *flexuosa.*

Amphicteis grœnlandica.
,, *invalida.*
,, *brevispinis.*
,, *acutifrons.*
Polycirrus aurantiacus.
Sabella brevibarbis.
Serpula galeata.
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THE

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Reviews.

XXVIII.—COLONIAL FLORAS.

1. Flora of the British West Indian Islands. By A. H. R. Grisebach, M.D., Professor of Botany in the University of Göttingen. Published under the authority of H. M. Secretary of State for the Colonies. Parts I.-III.
2. Flora Capensis: being a Systematic description of the Plants of the Cape Colony, Caffraria, and Port Natal, by William Henry Harvey, M.D., F.R.S., Professor of Botany in the University of Dublin, &c. and Otto Wilhelm Sonder, Ph. D. of Hamburgh. Vol. I.
3. Enumeratio Plantarum Zeylaniæ: an Enumeration of Ceylon Plants, with descriptions of the little known Genera and Species, observations on their habitats, uses, native names, &c. by G. H. K. Thwaites, F.L.S., Director of the Royal Botanic Garden, Peradenia, Ceylon. Parts I.-III.
4. Flora Hong-Kongensis: a description of the Flowering Plants and Ferns of the Island of Hong-Kong, by George Bentham, Esq., V.P.L.S., with a Map of the Island. Published under the authority of H. M. Secretary of State for the Colonies.

The object of this communication is to give publicity to the steps now being taken, partly under the authority of the Secretary of State for the Colonies, partly under that of some of the Colonial Governments, and in some cases by private individuals, to procure a series of good, but inexpensive, scientific works on the Vegetable productions of the British Colonies.

Up to the present time, it is believed, that there are (with the exception of three unfinished Floras, to which we shall hereafter refer) but three of our foreign possessions whose plants have been published in a cheap systematic form, available equally to the traveller, the man of science, and the settler; these are Aden, Gibraltar, and

Hong-Kong!—all of them military stations rather than colonies, absolutely without exports of any kind but sick troops, incapable of feeding their own population, and enormously expensive to the mother country. Of the first of these, an excellent Florula, containing about 100 species, has been lately communicated by Dr. Anderson (Acting Director of the Calcutta Botanic Garden) to the Linnæan Society, and printed in its Journal. Of the Gibraltar Flora, a very full enumeration, with notes and habitats, was published in 1846 by the late Dr. Kelaart, an intelligent surgeon in the army; and the Hong-Kong Flora is the first to be completed of that series of Colonial Floras published under Government authority, whose rise and progress will be here reviewed. This retrospect is not a very encouraging one, considering the extent, population, wealth, resources and products of England's boasted colonial possessions, the number of Botanic Gardens they support, of Government botanists who have been attached to them, of scientific expeditions that have explored them, and of unpublished collections that have been accumulating from them, in our Herbaria, for upwards of a century.

It is true that the Botany of several other colonies has been published, including some of the more important, as that of British North America, 30 years ago, in the "Flora Boreali-Americana," and more recently of Tasmania, New Zealand, and the Falkland Islands, in the "Botany of Sir James Ross' Antarctic Voyage;" but these are all of them very expensive, illustrated, quarto works, too cumbrous and costly for the traveller, colonist, or man of science, and too scientific for general use; moreover they were not projected exclusively or primarily for the benefit of the colonies, but were ordered for publication by Government, on the recommendation of the Admiralty or Colonial Office, as national contributions to abstract science, and appendages to costly scientific expeditions, whose results, in discoveries and collections, reflected honour on the country that sent them forth.

In the colonies themselves, the want of suitable Floras, which, like those of Great Britain, should be accessible to all, thoroughly trustworthy in a scientific point of view, and yet not so exclusively scientific in method and language as to be useful to the professed man of science only, has long been felt; and has been commented upon by Governors and colonists in official despatches and in various other ways. Nor has the want been less felt in the mother country, whence alone, in the present state of matters, can any information be obtained by the colonist. Hence, owing very much to the incessant demands made on the Director of the National Gardens at Kew, for the names and uses of colonial plants, that officer has been led (as well no doubt for his own sake, as for that of the countries to which the garden and museum at Kew owe so much) warmly to espouse these representations to the Home Government, and to urge that the first steps should be taken in this country, in which only can anything effectually be done, to provide the colonies with the means of ascertaining all that is known of their vegetable productions. In his annual Reports to Parliament on the progress of the Garden and the utility of the Museum, Herbarium and Library, as well as in his correspondence with various Secretaries of State for the Colonies, the Director of Kew Gardens has officially called attention to his opinion (an opinion that has never been disputed) that it is a duty of the department under his control, to provide all materials and facilities for conducting such works efficiently; adding, that the want of them is the chief obstacle towards developing the productive resources of the colonies, and furthering a scientific knowledge of their vegetation and taste for its study; and that they are indispensable for supplying that fixed nomenclature for their plants, without which it is impossible for himself or the colonists to carry on a correspondence on these and kindred subjects.

Nor are other reasons wanting; as the colonies increase in extent and wealth, an upper class of settlers is evolved, whose intelligence and education alike stimulate them to obtain a knowledge of the plants of their native or adopted country, and who, appreciating the value of a scientific training in developing the reasoning and observing faculties, desire that their children should possess the means of being thus trained in nature's school. Further, as the attractions of these new provinces increase, and facilities for visiting them become greater, many well educated men, travellers, tourists, and Government servants, leave our shores for a temporary sojourn in the colonies, and desire to take with them a suitable Flora. Nor are practical illustrations wanting of the loss we have suffered through ignorance of our colonial productions, for it is a fact well known to exhibitors and jurors, that a large proportion of the new and little known vegetable products of the British foreign possessions, which were sent to the Great Exhibition of 1851, were almost valueless, solely from the want of any means of procuring reliable information concerning them, or of giving them names by which they had already been recognized, or could again be known. With regard to the timbers especially, of which the Indian and Colonial series were magnificent, the same wood had sometimes many names in one country, and in the case of the Australian woods, many had a different name in each contiguous colony, or from each exhibitor in the same colony. In many cases the names given were purely arbitrary, originating in a whim or blunder, or in a mistaken idea of the resemblance of the tree producing it to some better known timber tree.

Something more, however, was required to move the Government to consider the subject, than the officially unsupported representations of a single scientific man; whose exertions would have met with little success but for the happy accident of a gentleman of scientific attainments, in fact an excellent botanist, holding, for a short period, the office of Parliamentary Secretary to the Colonies. This was Mr. J. Ball, than whom no one better knew how much was wanted, and how much might be effected by a little timely aid from Government, and who warmly took up the subject, so successfully representing to Mr. Labouchere, then Secretary of State for the Colonies, the expediency and utility of such undertakings, that Sir W. Hooker was desired to name a colony of which he thought it desirable to publish a Flora, the extent of the work required, and the author he would recommend to conduct it. After full deliberation the British West Indian Islands were selected for the experiment, for the following reasons. The materials in Herbaria were pretty complete and good; Government Botanic Gardens exist at Jamaica and Trinidad, for whose efficiency such a work was indispensable; great efforts were being made by the Governors of Jamaica, St. Kitts, Dominica, and Trinidad, and by many intelligent colonists, to develop the productive resources of those islands; and lastly, in a scientific point of view, the Flora was well worth working out, for since the publication of Swartz's "Flora Indiæ Occidentalis" in 1806, and M'Fadyen's never completed Flora of Jamaica, no attempt had been made, even to enumerate, the plants of any British West Indian Island.

The botanist, who, for his scientific attainments and special knowledge of the vegetation of the Spanish Main, was selected as author, is Dr. Grisebach, Professor of Botany in Goettingen, a gentleman personally well known and highly esteemed amongst English Botanists, who has published on Carribean plants, and possesses so perfect a command of English, as to be able to write the Flora in that language. Three parts of Dr. Grisebach's Flora have already appeared, and the fourth, nearly completing the Dicotyledonous orders, is now in the press. The materials have hitherto been most carefully and conscientiously worked up and described. The older Herbaria of Patrick Brown, Sloane, and Swartz have been studied, the result of which has been the fixing of many doubtful synonyms, and the reference of numerous obscure and imperfectly known species to better known ones, while much light has been thrown upon various obscure and interesting plants. In various cases Dr. Grisebach has established excellent reforms in generic characters, has reduced (judiciously in most cases) a number of doubtful and bad genera to subgenera and synonyms, and, in short, has left the orders he has completed in a very satisfactory state in a systematic and descriptive point of view. The defects of the work are, the arrangement of the natural orders, in which Dr. Grisebach follows a sequence which is peculiar to himself, and presents, as a whole, no advantage over those current amongst Botanists; but which is confusing to the beginner, who in all cases must have learnt botany by some other method, and troublesome to the professed botanist, who has to consult the index to find the place of every Dicotyledonous genus or order. The typographical arrangements too, are not so good as they might be, the type being too small and crowded, and the contractions too numerous. These latter, however, are blemishes for which the author is not altogether responsible, as they arose from a desire to reduce the price of the work to the smallest possible sum at which a publisher would undertake to print and sell it; a price unfortunately fixed in the prospectus, before the amount of materials could be accurately ascertained. In other respects, the Flora of the British West Indian islands is highly creditable to its author and the Government.

Soon after this, a second Colonial Flora—the "Flora Capensis" of Drs. Harvey and Sonder, which will embrace the plants of all Africa south of the Tropic of Capricorn—was begun on the same general plan, but under very different auspices, and without any certain prospect of Government aid. This was also brought about by the representations of Sir William Hooker, who urged its prosecution on its originator, Dr. Harvey, Professor of Botany at Dublin University, and keeper of the Herbarium there, as a work of great utility, which he was well qualified to undertake from his general attainments and personal familiarity with the Flora of the Cape.* Dr. Harvey's principal objection arose from the want of authentic specimens, some of the most complete and best published South African collections being on the Continent; this was fortunately easily overcome, for Dr. Sonder, of Hamburgh, the possessor of the best of these collections, a good botanist, and author of several valuable memoirs on Cape plants, gladly accepted Dr. Harvey's offer to share the authorship with himself. Dr. Harvey undertook to print and publish the Flora at his own risk and cost, trusting chiefly to colonial subscriptions for a repayment of the outlay. These were liberally accorded, and thanks to the exertions of the Governor, Sir George Grey, and the Colonial Secretary, Rawson Rawson, Esq. a Parliamentary grant was made by the Colony towards the expenses of the first volume, and hopes were held out of its being continued to the succeeding ones.

The first volume of the Flora Capensis appeared in 1860, containing all the Thalamifloral orders and the Calycifloral, down to *Connaraceæ;* thus including some of the largest and most difficult Cape genera, *Pelargonium* (containing 163 species), *Oxalis* (108), *Agathosma* (97), and *Hermannia* (70), all apparently skilfully elaborated, much improved by expunging bad species and reducing others to varieties, and rendered comparatively easy of study by good analytical tables. The volume includes about 1200 species, so that, as extratropical South Africa is said to contain at least 12000, the work will be a very extensive and laborious one: and but for the timely assistance of the Colonial Government it could not have been proceeded with, the authors having put a price on the volumes so low as to fall below the cost of their production.

The scientific and typographical arrangements of the Flora Capensis are for the most part excellent; though in respect of loose-

* Dr. Harvey held the office of Colonial Secretary of the Cape Colony between 1837 and 1840, during which time he published, at Cape Town, his "Genera of South African Plants," a work now out of print.

ness of type and prodigality of paper, it tends to run to the opposite extreme to the West Indian Flora, which, considering the number of volumes to which the work will extend, is certainly an evil. The system of De Candolle is followed, the principal orders and genera are preceded by analytic keys to their contained genera and species, and the volume is prefaced by an excellent compendious introduction to Botany, and a glossary of terms, which are rigidly adhered to throughout. Some defects are inevitable in a work carried on by authors residing far apart and using different Herbaria for general purposes: thus, in the treatment of genera and species which are not endemic to the Cape; Dr. Harvey, who is a great traveller, and possesses means of consulting larger Herbaria and more copious suites of specimens, from more varied climates, than Dr. Sonder, naturally tends to take broader views of their variations and distribution. Other defects, common to both, are the partial quotation of numbered collections (the numbers of which should be always quoted or always omitted), and the want of any geographical guide to the localities so profusely referred to for the rarer species, or any division of the enormous area whose plants are described, into naturally or artificially bounded districts. This is the more inexcusable, as excellent divisions of this kind have been made by E. Meyer and Drege in their "Zwei Pflanzengeographische Documente," distinguished by physical boundaries, geographical and climatal, which illustrate well many botanical features of South Africa. As it is, the impossibility of finding in any Gazetteer or map, the villages, streams, hills, and kraals quoted in the Flora Capensis, diminishes its value for all higher purposes of botanical geography. Much might have been done by indicating under the generic character, the general range of the species, and we hope that the authors will accompany the second volume with a sketch-map of the country, divided into districts, and indicate under each species, by a letter or number, the district to which it belongs.

Before concluding the subject of Dr. Harvey's labours in Colonial Botany, it is only right to add that he is publishing, at his own cost, fascicles of outline lithograph plates, drawn on stone by himself, and descriptions of new, rare, and little known South African plants, of which a volume with 100 illustrations has already appeared.

Another, also unaided, effort to develop a knowledge of the plants of our Colonies, is the "Enumeratio Plantarum Zeylaniæ" of Mr. Thwaites, the accomplished Director of the Peradenia Botanic Garden. On Mr. Thwaites' appointment to Ceylon in 1849, he found the want of any guide to the indigenous plants of the island a most serious drawback, to himself especially, who had no previous knowledge of tropical botany; moreover, he arrived about the time when those energetic measures were being adopted by the Government and the settlers, which have resulted in Ceylon rapidly rising to the position of the most prosperous of our Eastern possessions. With the exception of Moon's indescribably bad catalogue of Ceylon plants (containing not half the indigenous plants, and fully half of these wrongly named) no work on the plants of the island had appeared, since the days of Burmann and Linnæus, nor were there any means of studying its Flora, except by aid of the expensive and always incomplete Indian Floras, or the more voluminous general systemata of all known plants. Fortunately a partially named, but incomplete, Ceylon Herbarium had been formed at the Botanic Garden by Mr. Thwaites' predecessors, Moon and Gardner; this the new Director at once commenced to arrange, to increase by collecting himself and sending out collectors, and to study with diligence, analysing the genera and communicating valuable papers on them to the Journal of Botany. He also numbered and distributed the duplicates, sending the first set to the Kew Herbarium, where they were named, and the corresponding names returned to him. After eight years' labour, Mr. Thwaites commenced with these materials, his "Enumeratio," which contains the names, with references to authorities, of all Singhalese plants, their localities, synonymy, native names and uses, notes where required, and descriptions of all little known or new genera and species. The MS. is sent as prepared, to Kew, and is printed and published in London. The first number appeared in 1858, and the fourth, concluding the Dicotyledons, is now in the press; these are extremely carefully and well done, especially considering that the author works so far from the Libraries and Herbaria of Europe. It is to be hoped that it will be speedily followed by a full Flora of Ceylon, on the plan of that of the Cape of Good Hope, under the authority of the Home or Colonial Government.

For the Australian Continent, much has been done by Dr. F. Mueller, Director of the Botanic Gardens of Victoria, an able botanist and distinguished traveller, the companion of Gregory in his famous journey across tropical N.E. Australia, and himself the explorer of the Victorian Alps. Dr. Mueller's works not having appeared in a systematic form, can only be cursorily alluded to here; they consist chiefly of descriptions of new genera and species, official Reports on the botanical results of his own travels and those of other travellers, and miscellaneous papers scattered through many Colonial and European Journals. He has also commenced an elaborate "Flora of Victoria," in quarto, with numerous plates, full of analyses, executed in the Colony; of this a few sheets and plates have been privately communicated, judging from which it promises to be a work of great elaboration and excellence. It is much to be wished that Dr. Mueller's copious writings were reduced to a systematic form, for at present, owing to the number of periodicals (many of them ephemeral or insignificant) through which they are dispersed, it is impossible to consult them satisfactorily.

Latterly a proposition has been laid by Sir William Denison (the enlightened Governor, lately of Australia, and now of Madras), before the Secretary of State for the Colonies, for the publication of a series of works illustrating all branches of Colonial Science—geography, geology, mineralogy, meteorology, magnetism, zoology, and botany —and quoting as an example the "Historia fisika e politica de Chili" of the Chilian Government. It was proposed that the Home and Colonial Governments should share the expenses, the former finding collectors, observers, and collections, &c. and the latter undertaking the plates, letter-press, publication and authorship. Sir W. Denison's suggestion was referred by the Secretary for the Colonies to the Royal Society, the Directors of the Geological Survey and of the Royal Gardens, and to the Superintendent of the Natural History Collections of the British Museum, to be reported upon by them. The Botanical Report is the only one with which this paper is concerned; it fully admitted the excellence and utility of the general plan, but foresaw many insuperable obstacles to the achievement of the botanical portion, on the proposed scale of a quarto or folio work, illustrated with beautiful coloured plates, to which alone the Australian Colonies would be disposed to contribute: these were, that the expense would be enormous, Australia alone containing about 8000 species of plants; the time required would not fall short of half a century; the earlier volumes would be antiquated before the middle and later appeared; there was no prospect of securing the services of a succession of scientific botanists and artists who would co-operate in producing a work, of which the scientific results would be small compared with the labour and anxiety of superintendence; no publisher would undertake the series, except the Government were at the whole cost of producing it; the price and bulk would place it beyond the reach of any but a few wealthy individuals and public libraries: and, what appears a stronger objection than all these, is that the inexpensive, portable, practical Floras, which should be precursors to such magnificent works, would be indefinitely postponed. The Director of Kew Gardens, therefore, concluded by again urging on the Home Government the prosecution of the Colonial Floras, which would meet the principal object Sir William Denison had in view, as far as botany was concerned, proposing that it be left to the wealthy colonies themselves to provide the "ouvrages de luxe," whose extent, scope, and practicability could not even be estimated in the present rude condition of Colonial Botany. The expediency of this middle course was at once recognized by his Grace the Duke of Newcastle, who immediately gave instructions that a definite plan should be submitted to him, embracing Floras of all the Colonies, stating what had been done towards each, and what remained to be done, together with the probable expenditure of time and money, which their preparation would occupy.

The reply embodied much curious information regarding the state of Colonial Botany, and many suggestions as to the best means of securing to the public the uniformity, cheapness, and completeness of the Floras. These were considered under the three heads of *collection of materials*, *authorship* and *publication*. With regard to the first, it was shown that ample materials existed for very good practical Floras of the largest colonies, but that it would be necessary to send collectors to others, or wait till they were better explored by settlers or travellers. In the matter of authorship it was proposed, that the authors should be paid at a uniform rate, according to the amount of work contained in the Flora undertaken; the remuneration to include all expenses of authorship and correcting the press, and to be paid on the publication of each volume. Lastly, with regard to publication, after consulting some of the most eminent London publishers, it was found that no one would undertake to issue and advertise the series at a cheap rate, except a sale of at least 100 copies were guaranteed on the day of publication; and it was therefore proposed that these should be subscribed for by Government, for its own use, under the conditions that the selling price to the public did not exceed 20*s* a volume of 500 8vo. pages, containing about 1000 to 1200 species of plants. It will be observed that, under these terms, the author and publisher are entirely independent, each responsible to Government alone, and that complication of pecuniary interests is avoided, which has proved fatal to various publications patronized by Government.

The above calculations were irrespective of illustrations; these however, of a plain useful character, might be issued independently of the letterpress, at a cheap rate, in 8vo. provided they were executed in outline lithograph; they would cost about 20*s* each, for artist's work, to Government, and be sold at 1¼*d* each, without loss to the publisher, who would provide printing, paper, binding, &c. It was proposed that 50 such should accompany each volume, or be sold separately at the option of the purchaser.

Then followed a list of the Colonies, with the probable number of flowering plants they contain, which are nearly as follows:

1.	South Africa, including Natal, 12,000 species (now publishing by Drs. Harvey and Sonder, under the auspices of the Colonial Government.)	
2.	Australia, including Tasmania	8000
3.	British North America, (Canada, Newfoundland, Nova Scotia, and British Columbia)	3000
4.	West Indian Islands (now publishing by Dr. Grisebach)	2500
5.	New Zealand	1000
6.	Ceylon	2500
7.	Hong-Kong (published by Mr. Bentham)	1000
*8.	Mauritius and the Seychelles	1000
*9.	British Guiana	2500
*10.	Honduras	1500?
*11.	West African Colonies	2000
*12.	Ionian Islands, Malta, Gibraltar	1500
13.	Ascension, St. Helena and Tristan d'Acunha	150

(Heligoland, the Falkland Islands, and Labuan were not included.)

These could easily be comprised in thirty 8vo. volumes of about 500 pages each, and the total cost to Government would be only £150. per volume, without plates, and £200. with plates, exclusive of the purchase of copies for its own use; the price to the public would be 15*s* to 20*s* each volume, without plates, and 20*s* to 25*s*, with plates.

The Colonies marked with a star, all require to be explored by collectors previous to the publication of their Floras; the others might be commenced forthwith.

To secure uniformity of plan, and due attention on the part of the authors to the convenience of the public and requirements of the Colonies, the following instructions for their guidance were drawn up at Kew, and after being submitted for approval to several experienced Botanists, have been adopted with regard to the only Flora hitherto published, that of Hong-Kong.

"The Floras of the British Colonies are to contain concise and "characteristic descriptions of all Phænogamic plants and Ferns "known to inhabit the several Colonies. These descriptions to be "drawn up in English, from the actual examination of all available "specimens, by the authors severally selected for the purpose.*

"Each Flora to commence with an analytical table of the Natural "Orders it comprises, containing the most prominent differential cha-"racters only, as exemplified in the species representing the order in "that particular Flora.

"Under each Natural Order, after a concise ordinal character, "drawn up with special reference to its representatives within the "Flora, there shall follow a note of its distribution and such observa-"tions as may be necessary to facilitate its recognition, or to under-"stand its limits and affinities; and following these, an analytical "table of its contained genera, when more than one.

"In like manner, under each genus, the generic character and dis-"tribution, &c. will be followed by an analytic table of the species, "when more than one.

"Under each species will be given,

"1. The description above mentioned.

"2. A select synonymy, with especial reference to works already "published on the Colony, and to one work where the general syno-"nymy, or a more detailed account of the species may be found.

"The localities of the species, in more or less detail, according to "the extent of the country it inhabits, together with the name of its "discoverer or collectors when of unusual occurrence.

"An abstract of the extra-colonial range of the species.

"A notice of its economic value in arts, manufactures or medicine, "where necessary. A general list of such useful species with their "nature and colloquial names, when of sufficient importance, will be "appended to each Flora.

"The plants to be arranged under the Natural Orders contained

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* In the case of certain genera or even families, it may be found desirable that they should be described by Botanists eminent for their knowledge of that particular group, rather than by the author of the special Flora in which they occur. In all such cases the selection of an author must be authoritatively sanctioned.

"in an enumeration with which each author will be supplied, and "in the sequence there given. Should a genus be removed from the "order in which it is placed in the works of De Candolle or Endlicher, "it is to be referred to under the order from which it is removed.

"The form, size, type, paper, punctuation, &c., are to be uniform "throughout the series, with that adopted for the first Flora, pub-"lished under the above regulations; Mr. Bentham's Flora of Hong-"Kong.

"A short compendium of Systematic and Descriptive Botany, in-"cluding a Glossary of necessary technical terms, for the instruction "of the Colonists, as well as for the guidance of the authors, will be "issued with each Flora and be applicable to them all.* No tech-"nical terms are to be employed in the Floras, but such as are "contained in this Glossary, nor are they to be used in any other "sense than what is there indicated.

"On the completion of each Flora a brief introduction is to be ap-"pended by the author, and to contain a full acknowledgment of the "kind and amount of assistance received during its preparation; an "abstract of the labours of previous authors on that Flora; a notice "of the principal collectors who have explored the Colony, and of "the parts of it most requiring further examination.

"It will be at the option of each author, to add any general "matter on the nature of the Flora, with reference to its peculiarities, "and to those of other countries. All such matter must be officially "sanctioned before publication, and must not so add to the extent of "the volume as to raise its price above that determined upon by "Government.

"All the plants of the several Colonies that exist in the Herbaria "of Kew, are to be examined, and this, and when necessary other "Herbaria, are to be referred to under each species. A reference to "the name adopted, and to the page of the Flora, will also be added to "each species so examined in the Kew Herbarium.

"The authors will be further required to consult such public or "private Herbaria during the preparation of the Floras, as shall be in-"dicated by the Director of the series previous to its commencement."

Such have been the steps taken and means employed to induce the Government to undertake a work of acknowledged public utility, and whose desirability is vouched for by the concurrent testimony of the Home Government, Colonial Governors and Colonists, independently of men of science; one too, the total expense of which could never exceed two or three hundred pounds a year, and this for a very limited period. It will, however, surprise no one at all acquainted with the working of our public departments to hear, that though the final plan above detailed, was called for and approved upwards of a year and

* This has been prepared by Mr. Bentham, and is issued with the Hong-Kong Flora; Dr. Harvey's Cape Flora contains one that has been revised by Mr. Bentham, and hardly differs from it in practical application.

a half ago, the only result has been the aforesaid Flora of Hong-Kong, and that this would not have been produced, but for the following very exceptional circumstances. That Flora happens to be scientifically, (though not in any other respect) very interesting, and has long been a favourite study of our most eminent systematist, Mr. Bentham; who published much upon it several years ago in the Kew Journal of Botany. Since that period it has been largely increased by various collectors, and especially by the naturalists of the American Exploring Expedition, whose collections were sent to Mr. Bentham for elucidation; these were worked up by him, together with all others, into a general catalogue, with numerous notes and descriptions, and sent for publication to the Smithsonian Institution of Washington, in the United States of America, for lack of any means of publishing them in this country. On this fact becoming known to the projector of the Colonial Floras, he at once represented the facts to the Secretary of State for the Colonies, through J. F. Elliot, Esq., the Assistant Under-Secretary, a gentleman who has throughout most actively interested himself in this undertaking. He pointed out that Hong-Kong was one of the series indicated in his Report, and strongly urged the propriety of requesting Mr. Bentham to recal his manuscript, and embody it in a Colonial Flora, which would thus form the first of the series. Happily this suggestion was acceded to, the Smithsonian Institution most generously gave up the MS., though two sheets had been printed, and in six months afterwards the Flora of Hong-Kong appeared, in which the general plan detailed above is carried out in all particulars.

Very lately, the propriety of continuing the series was again represented to the Government, and the Duke of Newcastle placed in the estimate for his department, the small sum necessary to proceed with the Australian Flora, for which it was most desirable to secure Mr. Bentham's services; but the Lords Commissioners of the Treasury refused the grant, on the ground of the Australian Colonies having shown a sufficient sense of their interest in science and commerce, to warrant the execution of their Flora being left to their own enterprize. We are not so surprised at this reply, when we consider the magnificence of the proposal on the part of the Australian Government in regard to illustrated works; but, on the other hand, this answer applies to two only of the seven Australian Colonies, and considering how largely the mother country is benefited by developing the resources of its dependencies, it appears undignified to withhold the trifling contribution required for the purpose. In the meantime, steps are being taken to induce the Australian Colonies themselves to sanction the Flora, and there can be no doubt but they will do as much, at the very least, as the Cape Government has done.

As the matter now stands, however, the Hong-Kong Flora is the only result of this "Mons parturiens," whose labours it is to be hoped are only begun.

XXIX.—Course of Lectures on the Physiology and Pathology of the Central Nervous System. Delivered at the Royal College of Surgeons of England, in May, 1858, by C. E. Brown-Sequard, M.D., F.R.S., &c. &c. London. Williams and Norgate. 8vo. pp. 276, 1860.

"These Lectures contain the results of the work of almost all my life, since I began to study medicine," so says Dr. Brown-Sequard in his preface: those, therefore, who have studied the numerous memoirs of this able Physiologist, will expect to find little absolutely new in the pages of this book. That large class of readers, however, whose varied occupations prevent them from following such investigations through the reports of societies and the pages of periodicals, will be glad to find embodied in one volume, the most important results of the labour of Dr. Brown-Sequard's life. Since the year 1838, Dr. Brown-Sequard, has devoted all his disposable time to the study of the great questions connected with the physiology of the nervous centres. How vast, during this period, have the changes been in the aspects of many of these questions; how different the views put forward both as to the minute structure and functions of the nervous centres; how discordant the opinions of the ablest microscopists; how inconclusive the reasoning of various physiologists! All this shows, at least, the amazing intricacies and difficulties which surround the subject, and when we look to the records of the past, and contemplate the alterations which we are now forced to make concerning opinions and views, which some twenty or thirty years ago were regarded as perfectly established, we indeed perceive the folly of attempting to dogmatize upon such questions. If we turn to the 'Report on the Physiology of the Nervous system,' presented to the British Association at its Cambridge meeting in 1833, by Dr. W. C. Henry, of Manchester, we find that although this was the work of a most careful and accomplished gentleman, many theories were assumed by him as having been at that time unquestionably proved, which are now overturned. In the concluding recapitulation of that report, as among the "most important facts that have been *fully* ascertained in the physiology of the nervous system," the author asserts, that the function of the spinal cord is simply that of a *conductor* of motive impulses from the brain to the nerves supplying the muscles, and of sensitive impressions from the surface of the body to the sensorium commune; and that these two vital offices reside in distinct portions of the spinal medulla, the propagation of motion in its anterior columns, the transmission of sensations in its posterior columns. How changed upon this subject are the ideas of to-day!

Before entering upon an analysis of the opinions of Dr. Brown-Sequard, on the physiology of this nervous centre (the spinal cord), it may not be amiss to state what other views have been put forward, and what generally accepted, since Sir Charles Bell propounded that which was adopted, as *fully ascertained*, by Dr. Henry in the report just alluded to. We need not do more than mention in the most cursory way the experiments of Fodera, who on dividing one posterior column of the spinal cord, in the cervical region, produced loss of feeling in the opposite side, and loss of movement in the same, and who on repeating the same experiment in the lumbar region obtained results diametrically opposite: or those of Backer, who on cutting across the posterior columns observed a destruction of both feeling and motion in the posterior limbs; or of Schoeps, who, on repeating the same experiment, thought that he found sensibility persisting and motion destroyed, in the posterior extremities.

The views of Bellingeri, that the anterior columns of the spinal cord are a bundle of nerve fibres animating the flexor muscles, and that the posterior columns contain the nerve fibres animating the extensor muscles, are more deserving of a critical investigation, because, in these later times, they have been, to a certain extent, adopted by a person of acknowledged ability, the learned Professor Valentin. The now modified notions of M. Moritz Schiff, who holds that the grey matter transmits along the cord painful impressions, while simple tactile impressions are conveyed along the posterior columns, must not be forgotten. Nor can we pass over in silence the statements of Professor Schroeder van der Kolk, that, in his opinion, the grey matter in the spinal cord serves solely for motion, the posterior, rather for reflex action and the co-ordination of movements, whilst sensation is transmitted upwards through the posterior and lateral medullary columns. The opinion of the last named Professor is the more deserving of criticism, in as much as his work is universally in the hands of British readers; yet we confess, that we are quite at a loss to understand the reasoning on which his opinions are founded: he, indeed, draws his conclusions especially from the phenomena produced by strychnia in a dog, but his line of argument appears to us so entirely inconclusive, that we are almost forced to infer that there is some typographical error in the expression of his opinion as above stated. If it be not so, then indeed a very useful lesson is to be drawn from the deductions of the learned Professor; we are taught how very dangerous it is to hang physiological theories upon a framework, such as the anatomist sees, or fancies he sees, in the structures of the nervous centres. But it will become our duty further on to analyse the reasonings of Prof. Schroeder van der Kolk, when comparing them with those of Brown-Sequard.

Passing from these, as we may call them, subordinate theories concerning the precise functions of the various tracts of the spinal cord, we come to the two great rivals, which have for some time struggled, with varying success, for acceptance before the leading Physiologists of Europe, viz. that of Sir Charles Bell, as modified by M. Longet, which had been generally adopted in France and England,

and that for the most part admitted in Germany, and, with many minor modifications, adopted by Van Deen, Valentin, Stilling, and others.

The theory of Sir Charles Bell, as modified and completed by Longet, has been, until quite recently, so generally accepted in this country, and is so universally known that it is hardly necessary to state it. In brief, upon this theory, the spinal marrow is regarded at once as a nervous centre enjoying an activity of its own, and as a conductor intended to place the muscles, the surface and various organs in connexion with the encephalon; this double function is considered as due to the two kinds of substance which enter into its composition. As a centre, it is a producer of reflex phenomena, which property is due to the grey matter, a substance supposed to be devoid of the power of conveying either sensitive impressions, or mandates of the will, to muscles; the conducting faculty resides entirely in the white substance of the columns of the cord; the posterior columns are regarded as being destined exclusively for the transmission of sensitive impressions to the encephalon, while, on the contrary, the anterior and lateral columns are the sole channels through which the influence of the will is conveyed to muscles. In other words, the posterior columns and their corresponding nerve roots are regarded as centripetal conductors; the anterior and lateral columns, with the anterior nerve roots, as centrifugal conductors, while the grey matter is the dynamical, or force generating, element of this nervous centre. The human mind loves systems, and it found in this theory something so simple and so seductive as to be almost irresistible. Yet now it must be set aside, and recorded in the history of physiology with many other brilliant, but deceptive, doctrines.

Van Deen has propounded, and Valentin, Stilling, and others have, with various modifications, adopted, a theory in one respect fundamentally differing from the foregoing; they assign to the grey matter the function of conducting impressions. According to Stilling, whose beautiful researches in anatomy, physiology and pathology have done so much for science, the posterior half of the grey substance of the spinal marrow is the channel for the transmission of sensitive impressions to the encephalon. Moreover, according to his theory, there is no determinate and invariable course for sensitive impressions, which may pass equally well by either lateral portions of grey matter already indicated. Indeed, Stilling holds that a very small portion of the grey matter is still sufficient to permit the transmission of sensitive impressions coming from parts situated behind the lesion. Although this theory cannot at the present time be accepted as exact, yet it will be found that it contains important elements of truth, in assigning to the grey matter conducting power.

It is a remarkable instance of how much may be done by bold assertion, even when altogether unsupported by facts, that it has been so generally believed that the grey matter is devoid of the power of conducting impressions, and that its true function is dynamical—that it is destined to produce nerve force. A moment's reflection serves to show that every nerve, after separation from the cerebro-spinal axis, nevertheless contains in itself the elements necessary to originate the *vis nervosa*, or neurility, as it has been very well named, for this force may be called into being by the excitation of ever so small a portion of such a nerve by electrical, chemical or mechanical stimulation. On the other hand, however much the minute anatomist may have failed to point out precisely what becomes of the roots of the nerves; whatever discrepancies may exist among the researches of Hannover, Stilling, Eigenbrodt, Blattmann, Kölliker, Wagner, Lockhart Clarke, Schilling, Gratiolet, Owsjannikow, Schroeder van der Kolk, Bidder, Remak, Kupfer, and others; the great majority of these anatomists, at least, agree that a great number of the fibres from the posterior nerve roots pass directly into the grey substance. In this fact alone, we have good anatomical evidence that the grey matter is connected with the transmission of sensitive impressions. We find likewise strong presumptive evidence to the same effect, in the circumstance that so many most skilful experimentalists, engaged in investigations quite independently of each other, and differing in some respects widely from one another, have nevertheless agreed in attributing to the grey matter some share in the transmission of sensitive impressions: the hypothesis of Marshall Hall has nothing in it directly at variance with such a supposition; that of Todd and Bowman assumes that all nerves are implanted in the grey matter, and do not pass beyond it, and that the segments of the cerebro-spinal axis are connected with each other through the continuity of the grey matter; while Bellingeri, Valentin, Schiff, Van Deen, Volkmann, Stilling, and other physiologists, are led by their experiments, however contradictory in other respects, to grant to the grey matter conducting power.

The greater part of Dr. Brown-Sequard's lectures are devoted to an attempt to determine with scientific precision, what are the exact channels in the spinal cord and medulla oblongata through which sensitive impressions are transmitted and through which the influence of the will is conveyed to muscles; in making this attempt, Dr. Brown-Sequard has recourse to experimental investigation on animals, while he also tries to corroborate the conclusions thus arrived at by reference to pathological cases; and even those who may not regard his arguments as in all respects conclusive, we venture to assert, will not peruse his book without admitting that he gives a masterly analysis of the pathological cases bearing upon these questions, which he has collected from the most varied sources, with so much labour and so much care. As an experimentalist, he has disproved the assertion of one of the most eminent physiologists that these islands has ever produced, that "direct experiments afford no aid in determining the functions of the columns of the spinal cord." We freely admit that attempts to expose this organ either in living or dead animals are surrounded with difficulties, which embarrass the experimenter, and weaken the force of his inferences. The depth at which the spinal cord is situated in most vertebrate animals, its extreme excitability, the intimate connections of its various parts with one another, so that one can scarcely be irritated without the others being affected, the proximity of the roots of its nerves to each other, the difficulty of stimulating one portion of the cord itself without affecting either the anterior or posterior roots, are great impediments to accurate experiments: and when we consider these difficulties, we see a sufficient explanation of the discrepancies which are apparent in the recorded results of experiments, undertaken by so many able observers.

But these difficulties, great though they unquestionably are, are not insurmountable; they reflect, indeed, great honour upon him who has done so much to overcome them, but they also teach how slow we ought to be in admitting proofs upon this subject, drawn from experimental sources; and with what caution and care we should examine the tests to which such experimental enquiries have been submitted, before we can accord to their results, as stated by any investigator, our sanction and belief. The tests to which the fundamental experiments of Dr. Brown-Sequard have been submitted have been of the most trying nature; his ideas as to the channels through which sensitive impressions and motive commands pass, came before a sceptical public, saturated with very different notions, and his experiments have been repeated before large audiences of such persons at various places in these islands. The more sceptical of his hearers (ourselves among the number) have made careful autopsies of the animals upon which he had operated, previously hardening the spinal cords in spirit; and not a few have, like ourselves, repeated his experiments with success. Physiologists whose theoretic views do not harmonize with those of Dr. Brown-Sequard, and who therefore, may have been presumed to have undertaken them in a critical, if not an antagonistic, spirit, have had the candour to confess that their ideas have been modified by a repetition of these experiments:* and, moreover, his principal assertions and experiments have passed with approval, through the severe ordeal of a commission, appointed by the Societé de Biologie, and composed of MM. Cl. Bernard, Bouley, P. Broca, Giraldés, Goubaux, and Vulpian. At page 42 of his lectures Dr. Brown-Sequard himself observes in a note,

"I must say, that it is absolutely impossible to know, *while* we make a section of parts of the spinal cord, what is the precise depth of the injury; it is mere guess work. But if we study well the phenomena, and then after having killed the animal, if we put the spinal cord in alcohol, we render it hard, and we can ascertain exactly

* Compare Schroeder van der Kolk, On the minute structure and functions of the spinal cord—translated from the original. Sydenham Society, 1859, page 51, note.

what is the extent of the lesion. This is the means that I always employ in my experiments, and it is also the means employed by the Committee appointed by the Societé de Biologic, for the investigation of my researches on the spinal cord."

We think then, that notwithstanding the great and admitted difficulties which surround experimentation on the spinal cord, much weight must be given to testimony derived from results tested by so rigid a process. In his second lecture, Dr. Brown-Sequard details the experiments by which he hopes to prove that the transmission of sensitive impressions in the spinal cord, takes place chiefly in its central part, *i.e.* in the grey matter; and in the following discourse, he enters upon those which show that the conductors of sensitive impressions from the various parts of the trunk and limbs, make their decussation in the spinal cord, and not in the encephalon, as had been generally supposed. He commences by proving that the theory of Longet, with regard to the posterior columns of the cord being the conductors of sensitive impressions, is no longer tenable; he carries on the work of destruction commenced by Sir Charles Bell himself, vigorously urged on by the serious objections brought up against this hypothesis by Dr. R. B. Todd, supported more recently by the beautiful anatomical researches of Stilling and Lockhart Clarke, and now completed by his own experiment, showing that a transverse section of the posterior columns, *far from being followed by any loss of feeling is accompanied by the very reverse effect.* So far as the posterior columns are concerned, this single experiment annihilates the fascinating theory of Longet, which won its way so speedily into full notoriety, and was so charmingly seductive, because "it was so orderly a plan and made people remember." But it had no facts to rest upon.

If, says our author, the transmission of sensitive impressions does not take place along the posterior columns, it remains to be found what is the channel of their transmission. Is it the grey matter, or some part of the lateral or anterior columns, or all, or several, of these constituents of the spinal cord? When the anterior columns alone are divided there is no marked alteration of sensibility. Transverse section of the two lateral columns, in the dorsal region, does not diminish, but increases, sensibility in the posterior limbs, while sensibility is lost in these parts when the entire spinal cord, with the exception of one lateral column, is divided transversely; hence, it seems that sensitive impressions are not transmitted through these channels. It is quite different with regard to the grey matter.

A transverse section of the posterior half of the spinal marrow is attended with diminished sensibility in the posterior extremities, but as we already know that this loss of sensibility is not attributable to the division of the posterior, and the portions of the lateral, columns thus unavoidably divided, it seems necessarily to be due to the division of the grey matter. Again, transverse section of the anterior half of the spinal cord is also attended with diminished sensibility; but, since we know that this loss is not attributable to the division of the anterior columns and of the portions of the lateral columns, it seems again that it must be due to the division of the grey matter. Lastly, if the anterior, lateral and posterior columns are divided transversely, at a little distance from each other, sensibility persists behind the sections, the grey matter being the only channel which remains for its propagation towards the encephalon. As, in this experiment, it is impossible not to divide some of the grey matter, sensibility is found diminished, but not destroyed. If one can feel thoroughly satisfied as to these facts, there can be no doubt respecting the inference, that sensitive impressions pass, principally, along the grey matter in the spinal cord. Dr. Brown-Sequard, however, does not negative the notion of Calmeil and Nonat, that the anterior columns have a share in this function, for he has found, that when the entire spinal cord has been cut across, leaving only the anterior columns, sensibility, which is at first lost, after a time reappears, and many hours afterwards evidently exists everywhere, though in a slight degree only; he therefore concludes that these columns have a share, but only a slight one, in the transmission of sensitive impressions to the sensorium.

It is not our intention here to enter into any analysis of the many and interesting, pathological cases adduced by Dr. Brown-Sequard in his fifth, sixth, seventh and eighth lectures, in support of the views which experimental enquiry has led him to adopt. There is one, however, which bears so pointedly upon the question of the conducting power of the grey matter for sensitive impressions that we cannot forbear giving it at full length:—

Case 22. A man, aged 44, after having had cramps, formication and weakness in the lower limbs, and paralysis of the upper limbs, for a long period, was admitted at *La Charité*. Sensibility existed everywhere. On the evening of November 1st he was able to walk, but aided by some one. Sensibility continued everywhere to the last moment before his death on the 3rd of November at 3 A.M.

Autopsy. Encephalon normal. There was induration of the spinal cord from its upper extremity to the third dorsal vertebra, and from the sixth dorsal to the lower extremity. The tissue of the cord in these parts being cut, was shining, looking like porcelain, hard and difficult to be crushed. The grey matter was also a little harder than normally, but of its usual colour. The anterior and posterior roots seemed normal. In the space between the third and sixth dorsal vertebræ, the cord was softened, pultaceous, resembling a whitish, or rather, slightly rose, pulp, punctuated in some places. When placed in water many parts became disintegrated and formed a kind of emulsion. This alteration existed only in the white substance. The grey, on the contrary, seemed to have preserved its normal consistence. The microscope showed that the grey matter in both the softened and indurated parts contained normal cells and fibres, and normal blood-vessels, while the white substance in the softened region, contained but rare fibres, which were altered, containing an oily matter and granulations. There was also a quantity of granulated corpuscles of inflammation, with many capillaries, oily drops and amorphous matter; in the indurated white substance, there was less alteration and the fibres were more normal and numerous. (Laboulbène in the *Mémoires de la Societé de Biologie*, 1855.) The author of the report of this case adds that he has ascertained that sensibility to pinching, pricking, touching, tickling, feeling of heat and cold, and that due to the muscular spasm caused by galvanism persisted in this patient, although the white matter, *i. e.* the posterior and antero-lateral columns had but few and altered fibres remaining."

It is obvious from what has been already brought forward, that various physiologists have had, for a long time past, a tendency to adopt the two propositions so clearly enunciated, and so well discussed by Dr. Brown-Sequard. The slow accumulation of well observed pathological cases, careful microscopic investigation and experimental researches (which although often contradictory, yet on the whole tended in the same direction), have paved the way for the general acceptance of these conclusions: viz., that sensitive impressions *do not* pass along the posterior columns, but that the grey matter is the main channel for their transmission to the encephalon. It would be foreign to our purpose to enter into any critical discussion of the views of those who, at the present time, dissent from those propositions, but we conceive that it is right to do so with regard to one author, because his opinions come before the British public with much prestige, and because not only the justly great reputation of the author as a microscopical anatomist, but also the fact of his work having been selected (and very rightly so) for publication, by the Council of the New Sydenham Society, give in the eyes of many readers very great, perhaps undue weight and authority to his opinions.

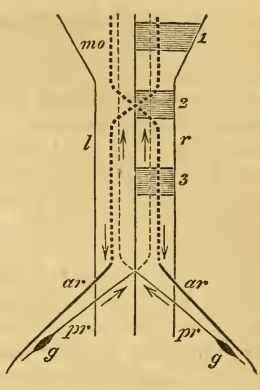
"In my opinion," says Professor Schroeder van der Kolk, "the grey matter in the spinal cord serves solely for motion, the posterior rather for reflex action, and the cöordination of movement, while sensation is transmitted upwards exclusively through the posterior and lateral medullary columns. That such is the case I inferred especially from the phenomena produced by strychnine in a dog; in slighter attacks the hind feet acted first, and subsequently continued more rigid, the animal standing upon them, with the body inclined obliquely forward. Not only during these convulsions, but even when the animal lay more than once upon the ground, with its feet stretched out in tetanic rigidity, it had not lost consciousness, of which my audience were witnesses with me; thus when a white cloth was accidentally drawn from one side of the apartment to the other, the dog followed it with his eyes and head, while it appeared from all that occurred that he did not experience the least pain. We also know that after excessive doses of strychnia, the patients without feeling anything, are suddenly seized with abnormal movements and convulsions. After the death of the dog I examined the spinal cord and brain, chiefly with a view to discover any congestion which might have existed in the several parts; in the brain I met no unusual degree of congestion, but I was particularly struck with a remarkable condition of the grey matter of the lumbar bulb; it presented in fact, numerous small effusions of blood, while in the *medullary portion* (?) nothing abnormal was found. In another dog, killed under the influence of strychnine, I found, in the grey matter of the lumbar portion, aneurismal dilatation of the capillary vessels, which were, in consequence, on the verge of bursting. Perhaps similar effusions had taken place in this instance, but that in the sections I prepared I had not met with them. In both cases, however, the two horns of grey matter were most beautifully injected with blood, as was evident after the sections were dried and placed under Canada balsam. Hence it would appear that, after the administration of strychnine, great congestion and irritation take place in the grey matter, which in the situations where they are most fully developed, as in the loins, may pass into effusion or dilatation of the blood-vessels, and still all this occurs without any sensations, without any pain. Were the grey matter in the spinal cord sensitive, or did the sensitive nerves penetrate into the grey matter, such congestion or irritation, as excites in a sensitive nerve itself the most intense pain, could not be conceived to exist without occasioning some sensation. Hence it follows also that reflex movements cause no pain nor sensation in the spinal cord, so that, by this observation, the *direct ascent of the sensitive nerves* in the spinal cord—of which I possess the most satisfactory preparations—is physiologically or pathologically, if we will, confirmed."

Any one who carefully peruses the foregoing passage will perceive in itself, without reference to other contradictory portions of the book, the insufficiency of Professor Schroeder van der Kolk's argument as regards the physiological properties of the spinal marrow. In the main it comes to this; the grey matter is itself not sensitive, it is therefore inconceivable that it can conduct sensitive impressions: or again, a nerve which conveys sensitive impressions is itself very sensitive to pain, the grey matter is not sensitive to pain, therefore it cannot convey sensitive impressions. There is not the least ground for admitting such an inference; to be sensitive to pain and to be capable of conveying sensitive impressions are distinct functions, not of necessity co-existing in the same parts of the nervous system; because they co-exist in the nerves of the trunk and limbs, it does not follow the same should necessarily be the case in the grey matter; it certainly cannot be granted as an assumption, indeed several considerations lead one to the very reverse conclusion. We know for instance that the optic nerve, which undoubtedly conveys impressions received from light, is itself not sensitive when cut or punctured, or at least, if sensitive at all, very slightly so: we have ourselves known of a case in which the optic nerve was, by a curious accident, punctured; there was instant loss of vision, but no pain referrible to the optic nerve, nor was the sensation of a flash of light, said to follow the lesion of this nerve, perceived by the individual. Until, therefore, Professor Schroeder van der Kolk adduces some facts in support of his assumption, his argument cannot be admitted to have any real value.

With reference to the decussation of sensitive impressions in the spinal marrow and the determination, with precision, of the exact seat of this decussation, we think the experiments of Dr. Brown-Sequard lead to conclusions, if possible more definite, than any of his other researches. It has been known, indeed, for centuries, that the conductors of sensitive impressions, as well as those of the impulses of the will to muscles, decussate somewhere in the cerebro-spinal centres, but Sir Charles Bell seems to have been the first physiologist who undertook the attempt to determine the real situation of the decussation of sensitive conductors; though he gives no experimental proofs whatever of his idea, which was that the crossing took place in the floor of the fourth ventricle, above and very close to, the decussation of the anterior pyramids. Sir Charles Bell was so fond of making systematic plans for himself, that he seems to have been thus led to adopt, on very insufficient grounds, an idea which suited his imaginary scheme. He found good anatomical reasons and pathological facts to support the belief, that the voluntary motor fibres of the trunk and limbs make their decussation at the lower part of the medulla oblongata, and that the anterior pyramids are, for the most part, formed by these conductors after their decussation. He could not have given his assent to the view of Foville and Valentin, that there are, in the medulla oblongata, two sets of motor columns, one the anterior pyramids, the other the olivary columns, the fibres of which last they conceived to decussate all along the pons varolii. Sir Charles wished to balance the notion of the decussation of the motor fibres in the crossing of the anterior pyramids (for which idea he had good foundation) by the idea of a similar decussation of the sensitive fibres at a somewhat corresponding point posteriorly (for which he had no foundation at all.) Many physiologists, feeling dissatisfied with a baseless, purely speculative theory, made this important question of the precise place of decussation for sensitive impressions, the subject of careful experiment; and some of them came very near to making the discovery, whose accomplishment was, however, reserved for Dr. Brown-Sequard, and which is not only one of the most conclusive, of his demonstrations, but is an addition to science of great practical importance.

1stly. The spinal cord of a mammal is laid bare at the level of the two or three last dorsal vertebræ, and a lateral half of this organ, (including the posterior, the lateral, and the anterior columns, and all the grey matter on one side,) is divided. (See diagramatic figure, 3.) The animal is left at rest a little while, and then it is ascertained that sensibility seems to be much increased in the posterior limb, on the side of the section, while it seems to be lost, or extremely diminished, in the posterior limb on the opposite side. There seems to be therefore *hyperæsthesia* behind and *on the same side as*, a transverse section of a complete lateral half of the spinal cord, while on the contrary, there seems to be *anæsthesia* behind and *on the opposite side* to the section. With reference to motion it is the reverse; power of movement is lost on the side of the section, but persists on the uninjured side: see the diagramatic view, in which suppose the lesion marked number 3 to be made in the dorsal or lumbar region, and let *a r.* represent the anterior or motor nerve root, continued on by a dotted line to its decussation in the anterior pyramid, while *p r.* represents the posterior, sensitive, nerve root, also continued through its supposed decussation by a dotted line. For the present let us disregard the increase of sensibility, a phenomenon which we shall subsequently consider, and we have the following results of a complete section of one half of the spinal cord in the dorsal or lumbar region.

On same the side as the injury.	*On the opposite side to the injury.*
Power of movement is lost, sensibility continues.	Power of movement continues, sensibility is lost.



2ndly. If after having made first, a section of a lateral half of the spinal cord in the dorsal region on the right side, and after having ascertained that the right posterior limb is quite sensitive, the left lateral half of the spinal cord is divided in the cervical region, then the right posterior limb loses its sensibility. This experiment shows that the sensitive impressions coming along *pr.* (after the lesion at 3) had first crossed to the other side of the spinal cord, along which they were transmitted until interrupted by the 2nd section, not represented in the diagram.

3rdly. The spinal cord is laid bare in the whole lumbar region, and a careful division of the entire extent of the part of the organ, giving origin to the nerves of the posterior limbs, is made directly along the middle line, so as to separate the two lateral halves of the organ one from the other. If this experiment could be executed perfectly, nothing would be divided in the cord, except the commissures which unite the right and left sides, and all the longitudinal elements of this centre would be left uninjured; but it is impossible not to cut more or less on either side. However, when the operation has succeeded, *i.e.* when the two lateral halves have been very little injured, a striking result is obtained. Voluntary movements still exist in the hind limbs, but sensibility is entirely lost in them. The animal has the use of his two hind limbs; he moves about pretty freely. The loss of sensibility, therefore, must depend on the division of the commissures of the spinal cord, or in other words on the elements of this organ which cross each other in the median line, or rather, in the median plane.

If on comparing the results of these three experiments, and if, after considering the many great difficulties already spoken of, which attend all such experiments, the reader admits (as we ourselves assuredly do) that the results may be accepted, then the inferences from them are clear and undeniable; so that it is unnecessary here to point out how completely the third experiment disproves the notion of some German physiologists, that the grey matter has the power of transmitting impressions in every direction.

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* Diagramatic representation of the decussation of the conductors for voluntary movements, and of those for sensation. *Ar.* anterior roots continued by dotted lines in the spinal cord, where they decussate; *pr.* posterior roots and their decussation; *g.* the ganglia; *mo.* the medulla oblongata; *r.* the right, and *l.* the left side. 1, 2, 3 represent supposed lesions of one lateral half of the medulla oblongata and the spinal cord; 1 above, 2 at the level of the decussation of the voluntary motor conductors, and 3 at some part below this decussation, say in the dorsal or upper lumbar region. The arrows indicate the direction of the nervous action in the motor and sensitive conductors.—(Copied *from Dr. Brown-Sequard's work.*)

The fourth lecture commences by the expression of the author's hope that he shall be able to show, that the various sensitive impressions of *touch*, of *pain*, of *temperature*, of *muscular contraction*, &c. are transmitted by conductors which are quite distinct from one another, and so much so, that the conductors of painful impressions, for instance, are no more able to convey other kinds of impressions than to transmit the impulses of the will to muscles. It is to be regretted that Dr. Brown-Sequard has not, in these lectures, given very fully all his reasons for adopting this view. The kinds of sensitive impressions which he believes to be furnished with distinct and separate conducting fibres, are the sensations of touch, tickling, pain, heat, cold, and the peculiar sensation which accompanies muscular contraction. It is obvious that in seeking to interrogate nature upon points so delicate and refined as these, experimentation upon the lower animals can give no satisfactory answer; pathological cases, scrutinised with truthfulness and care, can alone yield accurate information upon these topics. Hence it is that Dr. Brown-Sequard, with an earnest desire to obtain light from every source, with a view to the elucidation of these important problems, appeals to the many medical men who may peruse his book, and who have yearly opportunities of seeing numbers of patients, whose cases may throw important and often decisive, light upon the questions discussed in his paper. Those persons whose interest in science and love of mankind dispose them to respond to this appeal, and not to allow to pass unrecorded such cases, as may be the means of tending to settle what is yet undecided in these questions, may add a thousand fold to the interest and value of such cases as they may describe, by adopting one simple means of estimating, with precision, the comparative capability possessed by different parts, of appreciating the sensations of tickling, pricking, touch, heat, &c. In the normal state, different portions of the surface are very variously susceptible of these sensations; the tickling sensation, produced by light brushing of the surface with a camel's hair pencil, is more felt around the mouth, than over the nose; along the front of the forearm, than in the palm, or along the fingers: the feeling of a light shock or impulse, like the pulsation of an artery, is much more distinctly perceived by the tips of the fingers than by the knuckle, the lips or the tip of the tongue; thus, if a thin tube of vulcanised indian-rubber be quite filled with water and tied at both ends, an impulse, produced by letting a little hammer fall on one end, is felt at the other by the finger, when the same cannot be appreciated by the lips, tongue, and other parts; if, on the contrary, the whole hand be held under water and a gentle current be made to pass from a pipe through the water, the striking of the current on the hand is felt at a greater distance from the pipe, by the back of the hand, than by the palm. If ether, or spirit, be applied to the surface and a draft of air made to play upon the parts, the cold produced will be felt very differently by different parts of the body; if a needle or pin be made to pass through a small disk of cork so that a very little of the point projects, the pricking with this small point will be more delicately appreciated in some parts than in others, and if the front of the forearm be irritated by the application of a sinapism for a few minutes, we can easily satisfy ourselves, by comparison with the other forearm, that, so far as regards pricking, the sinapism has produced hyperæsthesia. These obvious facts place within our reach means, at once ready and tolerably precise, for making comparisons between symmetrical and other parts of the surface; but for measuring the degree of tactile sensibility, perhaps the best method of all is that indicated by Dr. Brown-Sequard in his "Experimental Researches." The curious facts discovered by E. H. Weber, respecting tactile sensibility are well known. He found that if the blunted points of a pair of compasses are applied simultaneously on the skin, there is, according to circumstances, either the sensation of one or of two points. When the points are both inside of certain boundaries, they are felt as one only, when they are outside of these boundaries, both are felt. These boundaries vary exceedingly in different parts of the skin, but, for a given part, the differences between various individuals are not considerable. The compasses may be made use of for measuring the degree of tactile sensibility in diseases: in a case of considerable anæsthesia of the lower limbs, the patient only felt a single impression on one leg, although the points of the compass were ten, fifteen, or even twenty centimetres apart, whilst, on the other leg, he could distinguish them at a distance of twelve centimetres. The normal limit for that limb is generally from three to five centimetres. In another case where anæsthesia was slighter, the limit of the discriminating power was at from nine to sixteen, centimetres. In two other cases, in which the diminution of sensibility had not been discovered by other means of diagnosis, the compass indicated a very slight and beginning anæsthesia; the limit being at from six to seven centimetres.

These facts demonstrate that, by the help of a pair of compasses, a physician can with tolerable precision determine: 1st, whether there may be slight anæsthesia or not. 2nd, what is the degree of anæsthesia. 3rd, what changes occur from day to day in the amount of anæsthesia as regards tactile sensibility.

The same is true for cases of hyperæsthesia. In a case of paraplegia of motion, the patient felt the two points of the compasses on his feet, even at the distance of five millimetres, whilst a healthy person feels the two points only when they are at a greater distance than twenty-five millimetres. For success in such experiments the two points should be blunted and applied simultaneously.

To how great a degree this tactile sensibility is capable of improvement by education, is known to every one who has visited institutions for the reception of blind persons; yet, in making comparative experiments on different individuals, or even different parts of the same person, it should not be forgotten how much its delicacy may depend upon the condition of the skin itself, quite independently of the nervous system.

We have dwelt at some length on this subject, because we fancy that a close investigation of cases at the bed-side, with subsequent pathological scrutiny, can alone set at rest this question. Although we admit that Dr. Brown-Sequard deals with it, as with all the topics treated of in his Lectures, with great subtlety, acuteness, and ability, yet we cannot at present accept as proved, his idea that the nerve fibres employed in the transmissions of sensitive impressions of *touch, tickling, pain, &c.* are as distinct, one from the other, as they all are from the nerve fibres employed in the transmission of the orders of the will to the muscles. Just as we must require of phrenologists to determine psychologically what are, or what are not, the fundamental faculties of the mind, before, as physiologists, we can venture to assign to each its local habitation, so, before we can assign different conductors to each variety of sensitive impression, must we determine what are the various sensitive impressions which are fundamentally distinct from one another. We may incline to admit the general truth of Dr. Brown-Sequard's view with reference, for instance, to the appreciation of weight through muscular action, as distinct from the feeling of heat, while we regard touch, tickling, ordinary pain, as mere phases of one more general sensation, depending perhaps in their varieties upon the texture of the skin, the hair, &c. It is certain, however, that the analysis of cases given by Dr. Brown-Sequard lends considerable weight to his idea:

Thus, case 24 is reported as having lost the feeling of pinching, pricking and muscular sensibility; sensibility to cold and tickling remaining.

Case 23, loss of the feeling of tickling or contact; persistence of the feeling of pain.

Case 13, loss of tactile sensibility; increased sensibility to painful impressions.

Dr. Budd's case, (*Medico-Chirurgical Transactions*), in which contact was felt while heat was not perceived.

Ollivier's case: loss of feeling of pain on pinching; diminished sensibility to cold, heat, and touch.

It has been ingeniously suggested that the appreciation of harmonic sounds by the auditory nerve, the peculiar and agreeable thrill, for instance, produced by notes which are the octaves of each other, bears the same relation to ordinary hearing, that tickling does to ordinary tactile sensibility: the notion of Dr. Brown-Sequard seems to lead to the supposition that distinct nerve fibres may exist for each variety of auditory sensation; and analogy might lead to the supposition that the optic nerve contained distinct conductors for every colour of the spectrum, so that colour-blindness and absence of "ear" would find their explanation in deficiency or absence of the conductors of these sensitive impressions; these speculations, however, touch on subjects of so delicate a nature, that we fear they are likely to remain for ever merely hypothetical.

Although, therefore, it appears to us that Dr. Brown-Séquard's view wants further evidence for its complete substantiation, we wish to state what exactly are his notions on this subject. It seems to him that the conductors of the various sensitive impressions pass along distinct fibres, which decussate in the spinal cord: that none of them go up to the brain along the posterior columns. It remains, in his opinion, to be known where the decussation takes place for the nerve fibres conveying different sensitive impressions, but he conceives that for all sorts of sensitive conductors save one, there is evidence that their place of decussation is in the immediate neighbourhood of the entrance of the posterior roots into the spinal cord; the conductors of the kind of sensitive impressions which originate in muscles when they contract, —impressions which, on being felt, guide our movements,—perhaps form an exception and decussate very high in the spinal cord: in support of which, Dr. Brown-Sequard cites the fact that in most of the cases of alteration of a lateral half of the spinal cord which he has reported, the voluntary movements are said to have been unimpeded on the opposite side of the body, which would not have been the case if the "*guiding sensation*" had not been felt. In one of these cases, however (case 37), the patient *had* lost that peculiar muscular sensibility which guides voluntary movement, as she could not hold her child in her arm when she did not look at that arm. But as the precise seat of alteration in this case was not known, no positive conclusion can be drawn from it: it would only seem to show that the fibres of muscular sense do not decussate, along with those for muscular motion, in the decussation of the anterior pyramids. Before passing on to the consideration of the very important discoveries of modern physiologists, concerning vaso-motor nerve fibres, we may observe that even though it be assumed by some that there are distinct conductors for various sensitive impressions, yet it appears certain that such conductors do not run in distinct bundles, along definite tracts of the spinal cord, any more than do the nerve fibres seem to run in groups or distinct bundles, from the surface supplied by them, to the brain. Were it so, and admitting that sensitive impressions are mainly propagated along the grey matter, it would follow that certain injuries done to the grey matter, but not dividing it completely, would be followed by loss of some particular variety of sensation, or, in the other instance, by anæsthesia in particular patches of the surface from which the divided bundles of nerve fibres would have come. But this is not what occurs; after lesion of the spinal cord, engaging more or less of the grey matter, sensibility is not completely destroyed in certain places, remaining perfect in other parts: but sensibility is diminished and apparently, equally diminished, in all parts posterior to the lesion, and this diminution of sensibility continues to become more marked, the more the grey matter is divided, until, when the anterior columns alone remain, anæsthesia is established. Thus, while one is certainly induced to believe that the grey matter of the cord conducts sensitive impressions as a whole, and not, as a nerve, by separate conductors coming from particular points—it is evident that the conductors in the spinal cord are not so arranged, as to follow distinct channels, running in bundles, in continuation of the nerve roots, nor does it seem probable that such is true for the conductors of pain, touch, tickling, &c. Indeed this, among other things, would incline one much more to regard the spinal cord as a nerve tubule on a very large scale, than as a large nerve composed of many independent conductors, as has been the view of many: looked upon as a gigantic nerve tubule, the spinal cord may be considered as having, in its investing membrane, a structure analogous to the tubular membrane of a nerve fibre; and in the white structure of the columns, anterior, lateral and posterior, the structure represented by the white substance of Schwann; while the grey medullary substance takes the place of the axis cylinder. Of course this comparison merely serves to point out an ideal similitude; nevertheless, as it seems probable that the axis cylinder, encased and insulated as it is by the surrounding tunics, can be the means of conveying sensations produced by divers means of irritation, so it seems that there is some reason to suppose that the grey matter conveys all sorts of impressions, and even also the orders of the will to muscles.

If we divide transversely, in the dorsal region, the whole posterior half of the grey matter and a part of the lateral columns, besides the posterior columns, we find that the voluntary movements are much diminished in the abdominal limbs. If the division be carried further, so that the whole of the central grey matter be divided, the animal can hardly move its abdominal limbs, and if we add to this section that of the anterior horns of grey matter, the loss of movement seems to become complete, although the anterior columns continue undivided. Hence it seems that, not only is the grey matter the conductor of sensitive impressions, but that also the commands of the will to muscles in a great degree pass along it: nay, more, that in making a gradual division of the grey matter, power of voluntary movement is by degrees diminished more and more, until it is entirely lost in the abdominal limbs, while yet the anterior columns remain undivided.

In the fifth, sixth, seventh and eighth Lectures, Dr. Brown-Sequard enters upon an analysis of pathological cases, bearing upon the views which he has elucidated, by experimental research in the preceding discourses. We have already said that it is not our intention to enter here upon the consideration of the pathological portion of Dr. Brown-Sequard's work: we shall therefore content ourselves with saying upon this subject, that although, after a careful perusal of these chapters, we cannot in all respects coincide with the deductions drawn by the accomplished author from the cases he details, yet that it is obvious throughout, that he never seeks to coerce phenomena and symptoms into harmony with any definite scheme of his own creation; that his only object seems to be the discovery of truth, not the framing of a systematic but baseless fabric. We pass then directly to the latter chapters, in which the functions and relations of the vaso-motor portion of the nervous system are considered, or, in other words, leaving behind what relates to voluntary movements and sensibility, we come to the consideration of the influence of the nervous system on nutrition, animal heat, secretion, &c.; and, first, of the physiological and morbid actions due to the great sympathetic nerve.

There is perhaps no department of physiology in which, within a recent period, two or three discoveries have afforded so comprehensive an elucidation of a large number of comparatively isolated facts, as in that connected with the vaso-motor nervous system. It was probably for the want of these discoveries that the observations of the thoughtful Whytt and of the profound Prochaska, were so long neglected and apparently forgotten, or, at all events, that their real importance was by no means understood. The expression of Prochaska with reference to the capability of sensorial, being reflected into motor impressions, sufficiently proves that the mind of this great physiologist had grasped the idea which Le Gallois and Mayo, Marshall Hall and Müller did so much to develop subsequently. But even the facts accumulated by the latter observers hung together but loosely, until their connexion and value were indicated by the more recent researches of Claude Bernard, Brown-Sequard, and others.

Professor Claude Bernard published the results of his first researches on the effects of division of the cervical sympathetic nerve, in 1851 and the beginning of 1852. The great fact announced in these publications was, that this section was constantly followed by a considerable afflux of blood to the parts of the head supplied by the sympathetic. Along with the greater afflux of blood and accompanying dilatation of the blood-vessels, the temperature becomes elevated, hyperæsthesia is noticed, and the vital properties of the parts generally become increased.

Dr. Brown-Sequard, with Dr. Tholozan, had before this, performed an experiment which, taken in connexion with the preceding, prepared the way for what was to be expected from galvanisation of the cervical sympathetic, after sections of it had first given rise to the above phenomena. The experiment alluded to is one of prime and fundamental importance, and was undertaken with the intention of trying whether Dr. W. F. Edwards was right in his assertion, that if the temperature of one part of the body be raised or lowered, a corresponding rise or fall takes place, more or less, in all other parts of the body, according to circumstances. This assertion is found quite true in one sense, yet in exactness to bear an interpretation quite different from that put upon it by Edwards.

Drs. Brown-Sequard and Tholozan found that if one hand was plunged in water at tne temperature of its freezing point, a very strong lowering action was exercised on the temperature of the other hand, while a thermometer placed in the mouth indicated but slight diminution of heat: thus, in one case, the hand kept in the atmosphere lost, in seven minutes, 22° Fahrenheit, while the temperature of the mouth was not diminished more than the fifth of a degree. We therefore cannot hesitate to admit that this cooling of the hand in the atmosphere was produced by a contraction of the blood-vessels, due to an action in the nervous system, and not to general loss of temperature affecting the blood of the system generally. Besides, it was observed that, the greater the pain produced in the arm immersed in the cold water, the more the temperature was diminished in the hand left in the air. But other proofs are not wanting that the action of the nervous system is, in this way, sufficient to diminish the calibre of blood-vessels. We have ourselves performed the following modification of the foregoing experiment. A bat is placed upon a small piece of board and fastened with both wings fully expanded, so that one, say the right, can be readily inspected with a microscope. As the web of the bat's wing is generally too much darkened with pigment to admit of very precise observation of the blood-vessels, it is necessary to peel off some of the epidermis, which is easily done by seizing a portion of it with a pair of forceps over one of the metacarpal ribs of the wing and so tearing gently off a small portion: in the portion thus denuded an artery and accompanying vein are to be sought, and the former accurately measured with an eyepiece micrometer. If then a small muslin bag of snow, or powdered ice and salt, be applied to the other wing, in a short time, we may observe the artery under observation diminishing very remarkably in calibre, and indeed, under favourable circumstances, becoming almost entirely closed; as we have seen in a bat which had been flying about in a small room, the upper part of which was very warm in consequence of the burning of gas in it; the animal was consequently warm and its circulation very active at the moment of the commencement of the experiment.

On the announcement, therefore, of Bernard's discovery on section of the cervical sympathetic, Brown-Sequard was prepared to expect that the irritation of the divided sympathetic by galvanism would probably be followed by constriction of the blood-vessels and the very reverse phenomena of those observed to follow the section; and he, in America, and a couple of months later, Bernard, in Paris, announced this important discovery to the scientific world, while Dr. Augustus Waller, though ignorant of the publications of either of the former experimenters, communicated the same discovery to the " Acadèmie des Sciences."

There is no doubt that the knowledge of the effects of paralysis and of irritation of the sympathetic nerve, thus obtained, opened a new and most important field for physiological investigation, indeed, it is one in which many labourers have already toiled with success. The immediate connexions and relations of the sympathetic to the cerebro-spinal axis had, it is true, been already tolerably well investigated by anatomists, but the presiding influence exercised over the heart, blood-vessels, and indeed over involuntary muscular fibre generally, by the nervous system, had not been studied with success by physiologists: the vast importance of the sympathetic system in its union with the cerebro-spinal axis had not been fully recognized: nor had any real attempt been made to explain many of the principal phenomena connected with nutrition, secretion, animal heat, &c. which are now regarded as being under the control of the vaso-motor system of nerves. It would be impossible, within the limits of an article such as this, to give even a résume of the many important facts, the discovery of which has given a sanction to the views of many eminent physiologists, which, it must be confessed, was needed: and indeed, it is not possible to do more than allude to some of the leading hypotheses which have of late been put forward, with reference to the influence of the entire nervous system upon blood-vessels, or (as we have already stated in more general terms), upon involuntary muscular fibre, whether in the heart, blood-vessels, intestines, or elsewhere.

One of the hypotheses in question appear to us as novel and startling, as it does speculative and untenable, and were it not that it is associated with the name of one of the most eminent experimental physiologists in Europe, it would hardly call for even a passing mention. Professor Bernard has imagined, that the dilatation of the blood-vessels in many of the circumstances influencing secretion, &c. is an active phenomenon; he fancies, in fact, that the capillaries have two properties, contraction and dilatation, and, if we understand him aright, he conceives the latter to be no less an active phenomenon than the former, each being put into play by a distinct set of nerves. On the other hand, to say that the blood-vessels dilate in consequence of a greater attraction for arterial blood developed in the tissues of the part, conveys to our mind no distinct meaning, but is merely putting into other, and less simple, terms the expression of what takes place when the small arteries are observed to become dilated. The view advocated by Pflüger, (Ueber das Hemmungs Nerven-system), must be admitted as exceedingly ingenious, and as giving a very adroit explanation of many of the phenomena in question; but we cannot but agree with Mr. Joseph Lister, that the supposition, that there is a certain set of nerve fibres, the so-called inhibitory system of nerves (Hemmungs Nerven-system) whose sole function is to arrest, or keep a check upon, action, seems a very startling innovation in physiology, and one which we must be very cautious about accepting, so long as the same phenomena may be accounted for by the supposition of a more simple, comprehensive and uniform action in those nerve fibres, which seem to preside over the movements of involuntary muscles. Indeed, we cannot help looking forward to a further development of the notions shadowed forth by Lister, that the peripheral expansions, (ganglia and nuclei, &c.) of the nervous system are in all cases essential to these contractions of vessels, &c. and while capable of independent action, are nevertheless susceptible of being stimulated or checked by the governing influence of the central nervous system; the so-called inhibitory influence being due to the more or less energetic operation of the same nerve fibres, and bearing a remote analogy with that almost, if not entirely, passive condition of the nervous system, which gives rise to muscular tonicity.

But to pass from the realms of hypothesis, it appears tolerably certain that the sympathetic nerve is, first, essentially, though not exclusively, a motor nerve of blood-vessels; secondly, that it originates chiefly from the cerebro-spinal axis; thirdly, that its paralysis is characterised by a dilatation of blood-vessels and afflux of blood, and by the results of this afflux; and fourthly, that its excitation, whether direct or reflex, is characterised by a contraction of the blood-vessels, and the results of this contraction. The origin of the cervical sympathetic has been indicated by Augustus Waller and Budge, as taking place between the sixth cervical and fourth dorsal vertebræ, and it is probable that it has an origin even more extended. As regards the other fibres of the sympathetic, Dr. Brown-Sequard believes, that those going to the blood-vessels of the various parts of the head, come out mainly from the spinal cord by the roots of the last cervical, and first and second dorsal nerves. Their real place of origin he thinks to be partly the spinal cord, and partly the higher portions of the encephalon, but chiefly the medulla oblongata and the neighbouring parts of the encephalon. In the other parts of the body, the nerves of the blood-vessels seem to come chiefly from the cerebro-spinal centre as well as the cervical sympathetic.

On division of a lateral half of the spinal cord in the dorsal region, we find in the lower limb on the same side, most of the effects of a section of the sympathetic in the neck, viz. dilatation of the blood-vessels, increase of heat and sensibility, and of the general vital properties of the parts. Hence it seems to follow that the vaso-motor nerve fibres follow, in the spinal cord, a course similar to, if not identical with, the fibres for the propagation of commands of the will to muscles; so that, referring again to our diagram, a section of the spinal cord in the dorsal region, suppose at 3, would be followed, on the same side as the injury, by paralysis of motion and the symptoms of paralysis of the vaso-motor nerves, *i. e.* dilatation of the blood-vessels, &c. In this fact, we find some means of accounting for the hyperæsthesia on the side of the lesion; for the dilatation of the blood-vessels is, as we know, accompanied by an increase in the vital properties of the part, hence we find increase of heat and increase of sensibility. Whether this explanation is one altogether satisfactory we shall consider afterwards. As the dilatation of the blood-vessels, resulting from paralysis of the vaso-motor nerves, has been experimentally shown in the head of the rabbit, after section of the cervical sympathetic, and in the lower limb on the same side, after section of a lateral half of the spinal cord, so the constriction or spasm of these vessels has been made obvious as the result of galvanic and other stimulation. The discovery of Dr. Brown-Sequard as to the contraction of the vessels of the ear on galvanisation of the cervical sympathetic after section, was a prime step in this direction. We regard likewise the researches of Mr. Joseph Lister* "On the parts of the nervous system regulating the contractions of the

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* Philosophical Transactions, Part ii. 1858; also "On the early stages of Inflammation," by the same author, in the same volume.

arteries," as of great value, and as having done much to explain the discrepancies upon this subject found between the experiments of Schiff, Wharton Jones, Waller, and others. The constriction, says Lister, of the arteries of the frog's webs, on irritation of the cord, may be well demonstrated in the following simple manner. The head of the frog being depressed, so as to stretch the ligament between the occiput and the first vertebra, a sharp knife is carried across the spinal canal, immediately behind the head, so as to divide the cord from the brain; the toes may now be tied out and any observation made upon the web, without the inconvenience generally produced by voluntary struggles on the part of the animal, while at the same time the use of chloroform is avoided, which is desirable, on account of the irritating effect of its vapour on the web, and the constant care required for its administration. If the webs be examined, immediately after the operation, they will be found exsanguine from the extreme constriction of the arteries, but in a few minutes this state will give place to dilatation, with free flow of blood. If now a fine needle, curved at the end, be introduced through the wound in the spinal canal, so that its point may penetrate a short distance into the cord, while the eye of the observer is kept over the microscope, the arteries will be seen to become constricted to absolute closure, and to dilate again, after withdrawal of the needle. The experiment may be repeated as often as may be desired, until the cord becomes disorganised. Pflüger, in operating upon the large edible frog, succeeded in applying the galvanic stimulus to the anterior roots of the sciatic nerve within the spinal canal, with the effect of producing complete constriction of the arteries of the webs. Division of the same roots, on the other hand, was followed by full dilatation of the vessels. From this experiment it appears that the vaso-motor nerve fibres pass along with the motor nerve roots.

(*To be concluded in our next.*)*

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* It appears so desirable to complete the Bibliography of 1860 in the present number, that we have determined, however unwillingly, to defer the publication of the remainder of the Review of Dr. Brown-Sequard's labours, in order to allow space for the excess of bibliographical matter.—[Eds.]

XXX.—The Fauna of Equatorial Africa.

Such interest has been excited concerning the merits of M. Du Chaillu's discoveries in Western Equatorial Africa, and so much discussion has taken place upon the subject, that, although that gentleman's volume of "Explorations and Adventures," has perhaps no great claim to be considered a scientific work, we have been induced to devote some pages of this Journal to its examination, and to take the opportunity of making a few general remarks on the present state of our knowledge of the Mammals and Birds of the Gaboon country, and of the adjacent portions of Western Africa.*

As M. Du Chaillu himself tells us, he formerly resided at the French fort on the Gaboon river, as a trader, and there "gained his first knowledge of Africa, and his first acquaintance with the Gaboon tribes." During this period, however, which was antecedent to that spoken of in the narrative of his adventures, M. Du Chaillu was not altogether idle in the cause of Natural History. By reference to the pages of the "Proceedings of the Academy of Natural Sciences of Philadelphia," it will be found, that a collection of birds was received from him during the year 1855. Mr. John Cassin † has given us an account of the new species contained in this series, and at the same time, has taken the opportunity of remarking that M. Du Chaillu's "discoveries in Zoological and Geographical Science were in a high degree important and interesting." As Mr. Cassin's name may be not so well known to all classes of our readers, as it is to those who have paid particular attention to Ornithology, it may be, perhaps, as well to mention, that his reputation stands deservedly high amongst those of living naturalists, who have devoted their chief attention to the class of Birds, and that, in the particular subject of West African Ornithology, his authority ranks next to that of Dr. Hartlaub of Bremen, the title of whose masterly work on this subject, we subjoin.

On his return to America in 1855, it appears that M. Du Chaillu received such encouragement, as induced him to determine to continue his explorations in the Gaboon country. On turning to page 410 of

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* We shall have occasion to refer, chiefly, to the following works:—

System der Ornithologie Westafrica's, von Dr. G. Hartlaub, Bremen, 1857.

Catalogue of Birds collected on the Rivers Camma and Ogobai, Western Africa, by Mr. P. B. Du Chaillu, in 1858, with notes and descriptions of new Species. By John Cassin. Proceedings of the Academy of Natural Sciences of Philadelphia for 1859, pp. 30, 91, 133, 172.

Descriptions of new Mammals from Western Equatorial Africa. By P. B. Du Chaillu. Proceedings of the Boston Society of Natural History, Vol. vii. pp. 296 and 358.

Explorations and Adventures in Equatorial Africa. By Paul B. Du Chaillu. London, 1861.

† See Proceedings of the Academy of Natural Sciences of Philadelphia, 1855, p. 324.

the volume of "Proceedings" for 1855, which we have already quoted, we find that at the meeting of the Academy held on the 16th October of that year—

"Mr. Cassin announced that Mr. Du Chaillu was about to return to Western Africa for the purpose exclusively of geographical exploration, and the collection of objects of Natural History. Arrangements have been made to secure, for the Cabinet of this Society, the collection of Birds especially, and also of some other objects. Mr. Cassin explained the general design of the exploration, which was to pass from Cape Lopez, 1° S. lat. towards the supposed source of the Congo river, with the intention of attempting to reach its source.

"Mr. Du Chaillu had already penetrated farther into the interior of this part of Africa than any other white man. The coast is unknown farther inland than from twenty to twenty-five miles, except to slavers, there having been no exploration of that part of Africa. Mr. Du Chaillu had been on the Rivers Moonda and Mouni, had traced the latter to its source, and had ascertained the existence of high mountains, probably a continuation or spur of the Atlas range, and much further south than is to be found in any published maps.

"Another fact ascertained by him, is the existence of a very populous nation, of marked Negro character, known as the Powein Nation, which he estimates at from five to seven millions. Their country extends across from the sources of the Moonda, probably to the sources of the Nile, and the nation is probably that mentioned by Bruce, as occasionally descending the Nile. It is a warlike and cannibal nation, engaged in agriculture, not wandering, resembling in this respect the Ashantees and Dahomeys. It displays the highest degree of civilization yet observed among the true Negroes, presenting an analogy to the Feejées among the Oceanic nations. Mr. Du Chaillu possesses peculiar advantages as an explorer. He has lived long in the country, is entirely acclimated, speaks well two of the languages, and understands thoroughly the Negro character. He proposes to proceed merely with convoys of natives from each tribe successively to the next.

"At the suggestion of Dr. Leidy, a Committee was appointed to solicit contributions from the Members of the Academy to aid the expedition."

Such appears to have been the origin of M. Du Chaillu's second expedition, of which he has given us an account in his much-canvassed "Explorations and Adventures." From them we gather that our explorer left America in October 1855, the very same month in which Mr. Cassin made the above given communication to the Academy; and that he remained in Africa until the 8th of June 1859, so that he appears to have been absent on this expedition, upwards of three years and eight months.

Our opinion on the merits of the volume, which contains the record of M. Du Chaillu's adventures during this period, may be stated very simply. We have read M. Du Chaillu's pages with great interest, and have derived much instruction from them. We believe his narrative to be true, or as true as the narrative of any traveller of M. Du Chaillu's stamp—drawn up as it has probably been from rough and imperfectly kept notes, assisted by the efforts of a rather vivid imagination and a not very perfect memory—is ever likely to be. M. Du Chaillu has no doubt made a chaos of his dates. The birds discovered during the Cape Lopez expedition, which, according to his book, appears not to have taken place until 1857, were certainly safe in the stores of the Academy of Natural Sciences of Philadelphia, on the other side of the Atlantic, in October 1856; and were worked out and described by Mr. Cassin, before the end of the following December.*

M. Du Chaillu has no doubt "borrowed" many of his illustrations, and has committed the additional error of not acknowledging his debts in this respect. This, we think, may be easily explained by the fact of his having employed an American artist, who was not in the habit of drawing pictures of beasts and birds, and found it more easy to copy Mr. Wolf's and other originals, than to invent attitudes of his own.

As we have already suggested, M. Du Chaillu can lay no claim to the title of a scientific Naturalist. He who speaks of "Humming-birds" (p. 37), Deer (p. 71), Vampires (p. 112), and Anacondas (p. 273) in Africa; who calls a Hornbill (*Toccus camurus*) a Toucan (p. 170); who kills "venomous" snakes "a little over thirteen feet long" (p. 57); who terms *Bos brachyceros* "a new and hitherto undescribed species of Buffalo" (p. 175), while he uses a name given to it twenty-five years ago; who "feels the breath of a serpent against his face" (p. 273); and who "turns turtles" in fresh water lakes, and then classifies them among the Mammalia in his list of newly discovered species, is no doubt a vigorous voyager and a lively narrator, but wants the knowledge and the sobriety of a man of science. And we are not at all surprised, therefore, at his making out his mammals to be new species, when certainly the greater number of them have been described long ago. "Every man thinks his own geese to be swans," and the error of describing old species as new, is one of such ordinary occurrence, that we fear there is scarcely a living Naturalist, who could wash his hands and say that he was innocent of the offence.

M. Du Chaillu cannot even fairly claim to be a scientific traveller, for he took no observations, either astronomical, barometrical, meteorological or thermometrical; he determined neither heights nor distances; and did not even keep his Journal with sufficient accuracy to prevent his making such errors in the dates of his book, as, we have been informed by one of his critics in *The Athenæum*, have led him to cram four Julys into three years.

On the other hand, it must be evident, that such errors as we have last described, are of the very kind that any one, intentionally deceiving, would most surely avoid. And we consider M. Du Chaillu, in spite of all these, not inconsiderable, shortcomings, to be an energetic and active explorer, who has entered a region never before discovered by civilized man, who has seen and hunted the GORILLA in his native wilds, and brought back a mass of information concerning this interesting "anthropoid," and his kith and kin among the apes. And we wholly repudiate the theory of those who broadly hint, that

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* See "Catalogue of Birds collected at Cape Lopez, Western Africa, by P. B. Du Chaillu in 1856, with notes and descriptions of new Species. By John Cassin." Proc. Acad. Philad. 1856, p. 316.

his whole story is a myth, that his most positive statements cannot be depended upon, and that he probably passed his three years and eight months vegetating on the coast, and obtained his natural history specimens by barter with the natives at different ports! It is, we fear, owing to the somewhat over-zealous way in which he has been taken up and made a "lion" of, that M. Du Chaillu has provoked such severe criticisms upon his performances; such, indeed, as, in our opinion, ought not to have been put forward, until the most positive and satisfactory evidence of the untruth of his statements had been obtained.

So much for M. Du Chaillu's volume of adventures. Now let us take a glance at some of the more noticeable among the Mammals and Birds that inhabit the countries he has discovered. To begin with the *Quadrumana.* "That monstrous and ferocious ape," as our author calls the *Troglodytes gorilla*, seems to be confined to a narrow belt of forest land, immediately under the Equator. We shall not fill our pages with extracts of what M. Du Chaillu has to say about this animal, but beg of our readers, most of whom have probably done this without waiting for our request, to turn to the original. With regard to M. Du Chaillu's two supposed new species of *Troglodytes*, which he has described in the "Proceedings" of the Boston Society of Natural History, and named *T. calvus* and *T. koulo-kamba*,* neither the characters, as there given, nor the inspection of the skulls lying on the tables in the Royal Geographical Society's Library have as yet quite convinced us of their specific difference from the Chimpanzee (*T. niger*). We may, however, remind our readers that a high authority—Professor Duvernoy, in one of his elaborate Memoirs on the large Anthropoid Apes, which have been published in the "Archives du Museum d'Histoire Naturelle,"† has already discriminated a *Troglodytes Tschego*, founded upon a skeleton obtained by M. Franquet during his residence as Chief Medical Officer on the Gaboon Station, and that it is by no means impossible that one of M. Du Chaillu's supposed new Apes may be referable to this species.

Besides the genus *Troglodytes*, two other genera of highly organized Quadrumana occur in Equatorial Africa: *Colobus*, represented by Mr. Waterhouse's *C. satanas*, of which M. Du Chaillu has obtained several examples, and *Cercopithecus*—a numerous group of Monkeys, quite confined to and characteristic of, the Æthiopian Fauna. Of the latter genus we have noticed among M. Du Chaillu's trophies, skins of *C. erythrotis*, *C. Campbellii*, and *C. pogonias*, and of *C. collaris*—belonging to the subgroup *Cercocebus*. It appears to be the *C. pogonias* (described from Furrier's skins by the late Mr. Bennett in 1833) that M. Du Chaillu has inserted amongst his "new species" under the specific name "*nigripes*."‡ Another scarce and interesting Monkey

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* See Journ. Boston S. N. H. vii. pp. 296-358.
† See Archiv. du Museum d'Hist. Nat. vol. viii. p. 1 et seq. (Paris, 1855-6.)
‡ See also Proc. B. S. N. H. vii. p. 360.

obtained by M. Du Chaillu, is Dr. Gray's *Presbytes albigena*, described and figured in the Zoological Society's "Proceedings"* for 1850, from an example formerly living in the Society's Menagerie. The typical specimen was, as far as we know, previously unique, and the exact locality uncertain, so that in this, as in other cases, M. Du Chaillu has done us good service in increasing our knowledge of previously known species of Mammalia, although he may not have been so fortunate as to have discovered many new to science. Now that its African habitat is fully established, a more accurate examination will probably show the necessity of removing this Monkey from the Asiatic group *Presbytes*, with which it has been hitherto arranged. M. Du Chaillu has also described as new a Lemur from this country, (*Otolicnus apicalis*) which will require further investigation.

Among the Carnivora, the Leopard appears, according to M. Du Chaillu's narrative, to be tolerably abundant in the Gaboon country. We observe also in his collection skins of a Jackal (*Canis mesomelas?*) and several Genets (*Genetta poensis* and *G. pardina*), upon one of which M. Du Chaillu has probably established his *Genetta fieldiana*. There are likewise skins of an Otter (*Lutra*), and of a little Otter-like animal, which we believe to be really new to science, and which M. Du Chaillu has described† as *Cynogale velox*, with the sub-generic name *Potamogale*, attached in case of necessity. The skull and teeth being absent, it is impossible to determine the true position of this interesting Mammal in the natural series, without accurate examination and comparison; but, if M. Du Chaillu's account of its habits *and teeth* are correct, he is perhaps not far out in his views as to its natural affinities.

He tells us (Proc. B. S. N. H. vii. p. 362):—

> "This extraordinary animal is found in the mountains of the interior, or in the hilly country explored by me north and south of the Equator. It is found along the watercourses of limpid and clear streams, where fish are abundant; it hides under rocks along these streams, lying in wait for fish. It swims through the water with a rapidity which astonished me; before the fish has time to move, it is caught; on account of the rapidity of its movements I have given it the specific name of *velox*. The animal returns to land with its prey almost as rapidly as it started from its place of concealment. The great motive power of the animal in the water seems to be in its tail."

With regard to M. Du Chaillu's Antelopes, we cannot but agree with Dr. Gray in recognising Mr. Ogilby's *Antilope euryceros* in the *Tragelaphus albo-virgatus*, but M. Du Chaillu certainly has the merit of having obtained the first tolerably perfect example of this animal. Among the smaller species of this genus, we observe four species of the genus *Cephalophus*, amongst which are *C. sylvicultrix*, *badius*, *Ogilbyii*, and a fourth, very probably new. There are likewise skins of the only representative of the Musks (*Moschi*) in the Æthiopian Fauna—the *Hyomoschus aquaticus*. Can M. Du Chaillu give us any information as to the reputed aquatic habits of this animal, for the

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* See P. Z. S. 1850, p. 77, pl. xvi.

† Proc. B. S. N. H. vii. p. 361.

late Earl of Derby has remarked of his specimens in captivity, that they "take no notice of the water?"*

The typical Bovine of Western Equatorial Africa seems to be *Bos brachyceros*, a name pertinaciously misspelt by M. Du Chaillu, who also gives us a good deal of queer information concerning its wildness and ferocity when attacked. We cannot compliment M. Du Chaillu's artist on his representation of this animal (p. 175), nor is the picture (p. 204) of a native tossed by one of them, more creditable. For correct figures of the head and skull of this *Bos*, we must refer our readers to the "Bijdragen tot de Dierkunde," published by the Society "Natura artis magistra," of Amsterdam, where an interesting notice of it will also be found from the pen of H. S. Pel, formerly Dutch Resident on the Gold Coast, and discoverer of many fine novelties in Natural History.

Among the numerous Artiodactyles of West Africa we find, in M. Du. Chaillu's volume, frequent reference to the *Hippopotamus*. There appears to be no doubt that the ordinary species is here spoken of; but we may remind our readers, that a few degrees further north of the Equator is Liberia, the home of the *Chœropsis liberiensis* of Dr. Leidy, the only known, second, recent species of this formerly more extensive, genus of Pachyderms. It would be interesting to know whether its range extends thus far south, but we have no doubt that the officers of the Institution, who are the fortunate custodians of the *only known examples* of this scarce animal, did not forget to remind M. Du Chaillu of the importance of obtaining additional specimens if they were to be had.

The characteristic Pig of these latitudes is the *Potamochœrus penicillatus*, now well known in England from the species having lived and bred for these last few years in the Zoological Society's Gardens.† Some slight deviations in character from the ordinary type have induced M. Du Chaillu to give this animal a new name (*P. albifrons*). His artist has also perpetrated an execrable figure of this beast, which Mr. Murray ought to have been ashamed to publish, after Mr. Wolf's inimitable portraits of the living animal.‡

M. Du Chaillu's Rodents embrace some half a dozen specimens of Squirrels, (*Sciuri erythrogenys*, *Stangeri*, *pyrrhopus*, *&c.*) most, if not all, already known from Western African skins, and two species of the singular African type *Anomalurus*, namely, *A. Fraseri*, and *A. Beecrofti*. It appears to be the latter, which has been described under a new name as *A. Beldeni*, and the figure given (p. 455), is, as has been already pointed out by Dr. Gray, an unacknowledged copy of Mr. Wolf's drawing of the same animal in the Zoological Society's "Proceedings," with merely the ears a little sharpened.

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* See Knowsley Menagerie, p. 22.

† See P. Z. S. 1861, p. 62.

‡ See Proceedings of the Zoological Society, with Illustrations, 1852, pl. xxxiv: and Wolf and Sclater's Zoological Sketches, (London, 1861) pl. 29.

Nor do we see any reason to consider M. Du Chaillu's Manatee as new to science. It may be either *M. senegalensis* or *M. Vogelii*—if these are really different. But in this, as in other cases, careful comparison and much study are requisite for the accurate determination of the species, and we recommend M. Du Chaillu to place his specimens of Mammals in the hands of some competent Zoologist, who may be able to bring the question, as to whether he has really discovered anything new, to a satisfactory determination. A carefully drawn up list of the Mammals obtained by M. Du Chaillu in this country, with notes of their habits, based upon his *personal* observation, would form a very acceptable addition to our knowledge of the African Fauna.

We must now say a few words with regard to the Birds of the Gaboon country. The greater part of this branch of M. Du Chaillu's collections has become part of the magnificent series, belonging to the Academy of Natural Sciences of Philadelphia—a collection which in respect of its number of stuffed specimens, and its possession of rare types, probably rivals, if it does not surpass, that of our own National Museum. It is, therefore, quite true, as some of M. Du Chaillu's critics have observed, that among the skins exhibited by him at the Geographical Society's rooms, there will be found but few species new to science. But those who will take the trouble to consult Mr. Cassin's papers in the Philadelphian Academy's "Proceedings," and Dr. Hartlaub's standard work on the Ornithology of Western Africa, may easily convince themselves that, in this branch of Natural History, the success of M. Du Chaillu's researches has been undeniable. Upwards of fifty new species, first brought to light during his travels, have been described by the eminent Ornithologist whose name we have first quoted above, and their authenticity has been further guaranteed, by the examination of the greater part of them, by the second. The names of these species will be found altogether, in the list of "Birds discovered by P. B. Du Chaillu," printed at p. 472 of his work, and we much regret that some differences, which, we believe, arose between the Philadelphian Academy and M. Du Chaillu, after his return to the United States, should have induced the latter to withhold the acknowledgment, certainly abundantly due to Mr. Cassin, for the labour he has devoted to this subject. We cannot conclude this notice better than by giving one or two extracts from M. Du Chaillu's book, which afford us some information concerning several of the rarer species.

Gyphohierax angolensis is usually classed with the Vultures. Dr. Hartlaub, upon the authority of Pel, states its habits to be those of the "Fishing-Eagles," and this is confirmed by what M. Du Chaillu says, (p. 131.)

"We continued to skirt the sea-shore, our aim being to gain a Shekiani village, where we proposed to stop the night. I shot a beautiful black and white fishing eagle (the *Gyphohierax angolensis*), which sat on the very top of a huge cotton-wood tree, looking gravely down into the blue sea below, meditating its finny prey.

The beautiful Guinea-fowl (*Numida plumifera*), discovered by M. Du Chaillu, is not found in the forests near the sea-shore, but is first met with, as he afterwards ascertained, about fifty miles east of Sangatanga.

"It is very shy, but marches in large flocks through the woods, where the traveller hears its loud voice. It utters a kind of "quack," hoarse and discordant, like the voices of other Guinea fowls. It avoids the path left by travellers; but its own tracks are met everywhere in the woods it frequents, as the flock *scratch* and tear up the ground wherever they stop. It is strong of wing, and sleeps by night on the tops of high trees, a flock generally roosting together on the same tree. When surprised by the hunter they do not fly in a body, but scatter in every direction. Thus it is a difficult bird to get, and the natives do not often get a shot at it."

Another very remarkable bird is the *Phasidus niger*—remarkable as being the nearest approach, in the Æthiopian Fauna, to anything like a true *Gallus* or *Phasianus*. The typical form of the *Gallinaceæ* in Africa is the Guinea-fowl, *Numida*, near which also must be placed the singular type *Agelastes* of Temminck. But *Phasidus* seems really, not only in structure but in habits, to come nearer the true *Galli*, and its plumage forcibly reminds one of *Gallophasis Horsfieldi* and its allies.

"When," says M. Du Chaillu, "I saw the *Phasidus niger* for the first time in the woods, &c. I thought I saw before me a domestic chicken. The natives have noticed the resemblance too, as their name for it shows: *couba iga*, signifying wild-fowl. *Wild* they are, and most difficult to approach; and also rare even in the forests where they are at home. They are not found at all on the sea coast, and do not appear until the traveller reaches the range of fifty or sixty miles from the coast. Even there they are so rare that though I looked out for them constantly, I killed but three in all my expeditions. They are not gregarious, like the Guinea-fowl, but wander through the woods, a male and one, or at most, two females in company. They are very watchful, and fly off to retreats in the woods at the slightest alarm."

Another remarkable type, for the discovery of which we are indebted to M. Du Chaillu's exertions, is the *Alethe castanea*, of which we find the following notice (p. 273.)—

"Hunting in the rear of the village, on the 15th, I shot a curious bird, the *Alethe castanea*—a new species. It is said by the natives to have a devil in it—for what reason I could not discover; probably for none. But its habit makes it singular. They fly in a small flock, and follow industriously the bashikouay ants in their marches about the country. The bird is insectivorous; and when the bashikouay army routs before it the frightened grasshoppers and beetles, the bird, like a regular camp-follower, pounces on the prey, and carries it off. I think it does not eat the bashikouay."

In conclusion we must advert to the fact that the French collectors, Franquet, Aubry-Lecomte and Fosse, are also entitled to great credit for the discoveries they have made in the Zoology of the Gaboon. The numerous new species and splendid specimens which have been received, from time to time, by the well-known house of Verreaux in Paris have, we believe, been mainly the product of these diligent collectors.

Dr. Franquet's exertions have furnished the materials upon which MM. S. Geoffroy St. Hilaire and Duvernoy have founded a series of elaborate articles upon the Osteology and Anatomy of the Anthropoid Apes, and his labours have been rightly commemorated in the specific title of a new Bat—the *Epomophorus Franqueti*—the largest and finest member of this peculiar group of African frugivorous *Chiroptera*, which has lately been described and figured by Mr. R. F. Tomes in the Zoological Society's Proceedings,* and dedicated to its discoverer.

Original Articles.

XXXI.—On the Brain of a Young Chimpanzee. By John Marshall, F.R.S.; Surgeon to the University College Hospital, London.

The Chimpanzee, whose brain is described in the ensuing pages, came into my possession within twenty-eight hours of its death; and the cranium having been opened without delay, and the brain placed immediately in strong spirits, the state of preservation of this organ is very perfect.

The animal was a young male, in excellent condition, and apparently free from disease. From the vertex to the heel, it measured 2 feet 4 inches; from the vertex to the ischial tuberosities, 1 foot 6 inches. The fore hand was $5\frac{1}{2}$ inches, and hinder hand $5\frac{3}{4}$ inches in length: the fingers were nearly as long as the palm; the toes were not webbed at their base. The distance from the vertex to the chin was $6\frac{3}{4}$ inches; from the vertex to the auditory meatus, $2\frac{1}{2}$ inches; the circumference of the cranium, just above the ears, was $14\frac{1}{4}$ inches; the length of the ears, which strikingly projected away from the sides of the head, was $2\frac{1}{2}$ inches. The temporary teeth were all present, much discoloured, and much worn, but not even the incisors were loose. In the lower jaw, the first permanent molar was well through the gum on the left side, but that tooth was still partially covered on the right: the corresponding teeth of the upper jaw were still beneath the swollen gum; so that, whatever the fact may be worth, the same lateness of eruption of the upper teeth in comparison with the lower, as is observed in man, obtained in this animal. The hair was a brilliant black, and the colour of the iris a bright hazel. The total weight of the recent animal was 16 lbs. and 8 oz. avoirdupois.

Weights of the Encephalon and its parts. The entire brain, including a portion of the medulla and cord, extending $\frac{12}{10}$ inch below the pons, together with the pia mater and cerebral arachnoid, but

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* See P. Z. S. 1860, p. 42, pl. lxxv.

excluding the pituitary body and pineal gland, weighed, immediately after its removal from the cranium, exactly 15 oz. Deducting the weight of the membranes afterwards removed (about ½ oz.) and allowing for the blood which these would contain, as well as for the short piece of the spinal cord attached to the medulla, I calculated that the nervous mass of the encephalon, in the quite recent state, weighed at least 14 oz. This is an absolute weight, greater than that of the brain of the young orang, described by Dr. Rolleston in the last number of this Journal (p. 207), which weighed only 12 oz. It also surpasses the absolute weights ($9\frac{3}{4}$ oz. and $13\frac{1}{4}$ oz.) of the brains of a half grown male and of a female Chimpanzee, as given on the authority of Professor Owen.* The brain of this young animal is, so far as I am aware, the heaviest Simian brain yet on record. It is, however, light indeed, in comparison with the weight of the human brain in a child at about a corresponding period of dentition, which would average at least 38 oz.†

The ratio between the weight of the entire brain (14 oz.) and the body (264 oz.) in our Chimpanzee, both taken in the recent state, and without any sign of emaciation in the animal, is very nearly as 1 to 19, so that the brain was relatively heavier than in Dr. Rolleston's young orang, in which the ratio was as 1 to 22·3. Fitting such a brain to the body of the nearly adult female Chimpanzee, stated by Prof. Owen,‡ to weigh 976 oz., the proportion would be as 1 to 70. The actual proportions observed in the female Chimpanzee mentioned above, whose body weighed 680 oz., were 1 to 51. But much as this, unusually heavy, young Simian brain raises previous estimated ratios, it still remains far below the human proportion, taken at a corresponding age. In Huschke's case of the child of six years, the ratio was 1 to 11; and the proportion in the human adult, is usually given as 1 to 36, or as 1 to 40, in cases of persons killed or dying suddenly, whilst the body is in a healthy state.‡ This, however, refers to European brains. In regard to other races our information is defective.

At the end of several months, the entire brain of our Chimpanzee, hardened and shrunk from the action of the spirit on its watery, saline, and fatty ingredients, weighed only 9 oz. and a few grains. In dissecting its right half, care was taken to weigh the fragments of the cerebral hemisphere, and to ascertain the weight of the right half of the cerebellum, and that of the pons, with the medulla. The weight of the left half of the brain, which still remained undissected, was also recorded. With these elements, and assuming that every part of the brain had equally lost weight from the action of the spirit upon it, it was easy to estimate approximately the separate weights of the cerebrum, cerebellum, and pons, with the medulla, in

* Quain's Anatomy by Sharpey and Ellis. Vol. ii. 433, note, 1856. Trans. Zool. Soc. Jan. 1846.

† See a table drawn up many years ago by myself, for Dr. Sharpey. Loc. cit. p. 431.

‡ Quain's Anatomy, ut antea, p. 433.

the recent state. The weights of these three portions of the hardened encephalon, respectively, were 7·5 oz. avoirdupois, 1·3 oz. and ·2 oz.; so that the recent cerebrum would have weighed 11·66 oz., the cerebellum 2·02 oz., and the pons and medulla ·31 oz.

According to these calculations, the cerebrum in the young Chimpanzee is to the cerebellum, as 5·75 to 1 nearly. In the adult man it was found by Dr. John Reid to be about 8·5 to 1; and in the new born child it appears from Huschke and others, to be at least 13 to 1. In a child five years of age the ratio would probably be somewhere between these. By the test of weight then, which I am not aware to have been applied before, to the separate parts of the Simian brain, the cerebrum of the Chimpanzee is found to be much smaller, in proportion to its cerebellum, than is the case in man.

To carry still further this mode of comparison, we may next contrast the relative weights of the cerebrum and body, and then of the cerebellum and body, in man and the Chimpanzee, by which double contrast, we see, at once, the relative superiority in size of the cerebrum, in man, and of the cerebellum, in the ape. Assuming the ratio of 1 to 40, between the brain and the body in an adult healthy man, and of 8·5 to 1, between his cerebrum and cerebellum, then the proportion between his cerebrum and his body will be 1 to 44·7 and between his cerebellum and his body 1 to 380; whilst in our Chimpanzee, the proportions as estimated above would be 1 to 22·6, and 1 to 131. It is desirable that many more observations on the weights of these separate parts of the encephalon in the several races of men, and in animals, as compared with their bodies, should be collected: they would yield neater results than those arising from *measurements*, for reasons which will presently be abundantly illustrated.

General form, dimensions, and relative position of the parts of the Encephalon. Notwithstanding the care with which the Chimpanzee's brain had been placed, with its upper surface resting on a bed of cotton wool, in the spirit in which it had been preserved, a marked distortion of its shape had taken place, by the time it was perfectly hardened. Such a deformation must occur, to a greater or less extent, in every brain removed from its cranial case, and placed in a similar position. Its effects are surprising to those who are not familiar with them, and cannot be correctly estimated, without comparing the so altered brain with a cast of the interior of the cranial cavity, from which this soft, pulpy, organ has been extracted. It influences the form of the encephalic mass in all three of its cubical dimensions. The general results are, a slight lateral bulging of the cerebral hemispheres, opposite the parts tied together by the corpus callosum; a more marked falling asunder of the hemispheres at each extremity, but especially behind; a moderate elongation of the hemispheres; and lastly, a very marked, compensating flattening, on both the upper and under surfaces, but especially, on the former, so that its characteristic convexity is completely lost. Moreover, the cerebellum, together with the pons and medulla, drag on the cerebral peduncles, so as to make these latter assume a position nearly parallel to the under surface of the brain, instead of descending obliquely from it; hence, the cerebellum falls backwards further than in its natural state, presses somewhat aside the posterior ends of the cerebral hemispheres, and so modifies the proper relative position of these parts of the encephalon. Besides this, the general subsidence of the cerebral hemispheres, the falling asunder of the points of the middle lobes, and the sinking in of the cerebellum between the hinder portions of the cerebrum, diminish the concavity of the orbital surfaces, injure the concave outline of the lower border of the posterior half of the hemisphere, and convert its natural overhanging curve into a nearly even, oblique border, passing backwards and upwards, above the cerebellum. All these changes, which must be still more marked in brains already partially decomposed, will be better appreciated by comparing the photographic illustrations of our Chimpanzee's brain given in Plate VI. figs. 2 and 4, with the outlines, figs. 1 and 3, (also taken from photographs) of a plaster cast, which I made of the interior of the cranium of the animal, before the dura mater was removed from the bone, and in which, the divided tentorium was first carefully stitched up, on both sides.

A comparison of these figures is of great interest, for it will not only serve to elucidate a subject of controversy, just now of importance, but it will demonstrate conclusively, that no proper estimate of the *general form* of the encephalon, either of man or of brutes; no exact *measurements* of its parts; and no correct idea of their *mutual positions*, can be obtained, unless by hardening the brain before it is removed, or by correcting the notions derived from an examination of this otherwise flaccid organ, by constant reference to the internal form of the cranial cavity in which it was contained. M. Gratiolet has been well aware of this fact and has availed himself of it in his valuable researches; but he has left an abundant field for future observation. The internal forms of the crania of the different races of mankind, especially, need to be systematically investigated and measured in a similar manner.

The illustrations which accompany this Paper will enable the reader to follow me, in the critical examination which I here feel called on to make, of the various original representations of the Chimpanzee's brain given by Tyson,* Tiedemann,* Macartney,* Schroeder van der Kolk and Vrolik,* and Gratiolet.* Tested by a comparison with the brain and cranial cast in my possession, or (as the reader must do) with the faithful facsimiles of those objects taken by aid of photography, the figures given by these authors will all be found to exhibit, unmistakeably, the Chimpanzee characters; but they differ materially in value.

Tyson's figures are useless for modern science—in the main, owing to their want of artistic rendering; the basal view, as shown by the position of the curved supra-orbital borders, is taken too much

* In the works already cited by Professor Huxley and Dr. Rolleston in this Review. I am not aware of any other original figures of this brain.

from the front, so as completely to disturb the real relative positions of the cerebrum and cerebellum; and the cerebral arachnoid and pia mater have not been taken away. The internal dissection is almost unintelligible.

Tiedemann's two, more carefully drawn, figures represent an apparently, well preserved, specimen, then, and probably now, in the Hunterian Collection. From its small size, and from the imperfect development of the convolutions, this brain was, most likely, taken from a very young animal; the cerebral membranes have been removed; the vertex is somewhat flattened; the orbital surfaces have lost their characteristic concavity; the middle lobes have sunk asunder; and the cerebellum has, undoubtedly, been a little displaced backwards.

Macartney's two figures were drawn from plaster casts of the brain, taken before the cerebral arachnoid and pia mater were removed—at least this is evident enough in regard to the basal view. In size, these figures exactly correspond with the brain in my possession. Owing, probably, to the unavoidable pressure and disturbance in the casting, there is, in spite of the support afforded by the cerebral arachnoid, even more subsidence of the parts at the base, than appears in Tiedemann's corresponding figure. The orbital surfaces, though tolerably concave, are too wide across their base; the points of the middle lobes have fallen asunder; and the cerebellum has, clearly, slid backwards from the hollow of the cerebrum, into which it would naturally fit: moreover, the convolutions are somewhat conventionally drawn and, in certain parts, imperfectly and inaccurately represented.

In the various figures given by Schroeder van der Kolk and Vrolik, the brain is shown, entirely divested of its membranes; the convolutions are carefully and artistically rendered; but all the above-mentioned results of subsidence of the entire encephalic mass, both laterally and from vertex to base, and the consequent distortion and displacement of its parts, are particularly noticeable; so that, on a question of form and relative position, these now famous representations must come to be regarded as wholly unsafe guides. Barring a certain primness of style, these figures are most carefully executed, and they bear a critical comparison with our photographed views, figs. 2, 4 and 5; but, the very closeness of resemblance between the basal and lateral views and our figs. 2 and 4, shows that all have equally been copied from nearly similarly sunken, or flattened, brains. The width and evenness of the orbital surfaces, the severance of the points of the middle lobes, the dragging back of the cerebellum, and the sinking in of this last-named part between the hemispheres; or, viewed in its effect from above, the sliding of the posterior extremities of the hemispheres, forwards and sideways, over the cerebellum, are all very obvious. One can note, especially, that owing, doubtless, to circumstances connected with the state of the brain, or its mode of preparation, suspension, or support, the unnatural lateral separation of the cerebral hemispheres behind, is greatly exaggerated; as must be admitted by any one who contrasts the figure 2, Plate I., of Sch. van der Kolk and Vrolik, not merely with the accompanying photograph, fig. 5, but even with Tiedemann's and Macartney's figures. Hence, the enormous surface of the cerebellum seen in the upper view of the encephalon, in the Dutch anatomists' representation. We shall examine hereafter the merits, or defects, of their representation of the interior of the lateral ventricle.

Lastly, M. Gratiolet's figures of the Chimpanzee's brain, which are at once the latest and most trustworthy, were taken from a specimen preserved in the Museum at Paris, the form being restored (*restituées*) by constant reference to that of the cranial cavity, from which it had been removed. The general shape of the entire brain, the relations of its several parts, the position of the cerebellum, the various convolutions and all their surface markings, are most conscientiously reproduced, and, so far as the external anatomy of the brain is concerned, leave little room for improvement. The multiplication of accurate data on such a subject is, however, most desirable, and in the face of the very different statements just now made, as to matters of fact, in the anatomy of the Simian brain, new materials for consideration cannot but be welcome to all parties. More particularly it has seemed to me that, on the one hand, our figures 2, 4, and 5, so clearly demonstrate the defects of Schroeder van der Kolk's and Vrolik's representations, and, on the other, all the figures establish, so satisfactorily, the accuracy of M. Gratiolet's restorations, that their publication will be useful to science. The view of the lateral ventricle is also as complete as could well be obtained. In no case has anything been altered or restored.*

In proceeding to describe the brain, from which these photographs have been taken, I must observe that I have studied it side by side with an average human brain, belonging to an adult, of whose cranial cavity I also took a plaster cast, to serve as a standard of correction in all questions of form, size and relative position. Wherever, in the course of the following description, any comparison is made between the human and Chimpanzee's encephalon, it must be understood to refer to this particular human brain.

The general form of the *cerebrum* of the Chimpanzee, when viewed from *above*, is not so much pyramidal, as Tiedemann indicates, but rather, as Gratiolet figures it, it is a short, wide, ovoid, having its larger end turned backwards, somewhat pointed behind, and considerably so in front. It contrasts markedly, with the long ovoidal shape of the human cerebrum, viewed on the same aspect. Placed side by side, the difference between them is seen to consist, chiefly, in the greater length and more equal width, in man, of the anterior portion,

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* I am greatly indebted to my friend Mr. Herbert Watkins, for his pains and skill in securing photographs of the natural size of the parts, from which the accompanying figures are reductions. Complete sets of ten full-sized photographs will be supplied by him, or by the Publishers of this Journal.

which is almost square in front, instead of being pointed, as in the ape. By adding on, as it were, a broad piece in front, the Simian brain would assume, in this aspect, a nearly human shape. But the posterior part of the hemispheres must, also, be somewhat lengthened and widened; and the lateral, or parietal, regions be likewise expanded. In this view, no trace of the cerebellum is visible at the sides, or behind, in either brain.

In the *profile* view, figs. 3 and 4, one is struck, in the Chimpanzee's cerebrum, as compared with man's, first, with its semi-globular shape; or rather, with its almost hemispherical outline above,—the vertex being comparatively low, and situated only a little behind the middle point, between its anterior and posterior extremities; the curve descending only a little more abruptly behind, than in front. In the human cerebrum, the vertex is extraordinarily high and is placed further back; so that the fall of the outline behind, is necessarily more sudden, and the depth of the posterior region is very characteristic. In the ape again, the shortness and shallowness of the anterior portion makes the curve of that part of the cerebrum more abrupt, and more equal to the hinder curve, than it is in man, in whom the elongated and deep, frontal region produces a much more gradual curvature from the vertex forwards, than exists backwards. The remaining points of contrast, in this aspect, are the singular, recurved, beak-like termination of the frontal lobe—its very deeply hollowed interior, or orbital surface—the great downward projection of the point of the so-called middle lobe—and the more marked obliquity and concavity of the lower border of the cerebrum from that lobe, upwards and backwards, in the Chimpanzee; as compared with the flatter orbital surface—less prominent middle lobe—and more nearly horizontal and straighter, lower border of the cerebrum behind that part, in man. In M. Gratiolet's side view, the hinder part of the cerebrum is a little more depressed, than it is in our specimen, and therefore a little less like the human shape. On this lateral aspect, the *cerebellum* of the Chimpanzee appears to bear about the same proportion, measured vertically and from before backward, to the cerebrum, as it does in man: though, in reality, these proportions of the cerebrum, are a little less in the ape, than in man, in whom the cerebellum looks rounder in profile. In the ape, the cerebellum is overlapped by the cerebrum, to the extent of $\frac{5}{10}$ths of an inch, and, in the human brain, by $\frac{6}{10}$ths of an inch, in other words, by about $\frac{1}{9}$th of the total length of the cerebrum in the Chimpanzee, and by only about $\frac{1}{11}$th of that measurement in man. So that the relative amount of overlapping is *greater* in the Chimpanzee. Lastly, in the ape, the direction of the medulla oblongata is a little more oblique, than it is in man. In M. Gratiolet's lateral view, the cerebellum, indicated in outline, is represented as too deep, and the direction given to the medulla oblongata is too nearly horizontal, so that the position of the cerebellum is not quite true: still, it is covered by the cerebrum. In our own photographic view, fig. 4, and in

Schroeder van der Kolk's and Vrolik's corresponding view, in both of which the characters of the lateral aspect of the Chimpanzee's brain are entirely lost: the cerebellum and medulla are pressed horizontally backwards, so that the former is tilted up and projects too far behind, and converts the naturally concave lower border of the cerebrum, from the middle lobe backwards, into an even oblique line. The same criticism must apply, we think, to the lateral view of the Orang's brain, given by Dr. Rolleston, the obliquity which he notices in his paper (p. 206) being evidently the result of displacement from pressure.

The comparison of the Chimpanzee's brain, as seen in *front* and *behind*, with the human brain, does little more than confirm the observations already made. Anteriorly, in the ape, the want of depth and width of the frontal region, and the hollowing of the orbital surfaces; and, posteriorly, the want of height in proportion to the width, and the smoothing down of the parietal regions, as contrasted with the towering height and width of those parts in man, are chiefly noticeable; so that the Chimpanzee's brain has a more compact, rounded, form. We do not observe, in this animal, the wall-sided shape of the lateral regions, mentioned by Dr. Rolleston as characteristic of the Orang, the sides of the cerebrum being very evenly convex. In the posterior view, the cerebellum of the Chimpanzee appears very wide in proportion to the cerebrum; but it is shallow and less full and rounded, than in man; it is distinctly overlapped by the cerebral hemispheres, on each side, but rather less so, than in the human brain.

On the *base* of the Chimpanzee's brain, (see figs. 1 and 2,) the deficient length and width, and the pointed character of the frontal region, anteriorly, as compared with man's, are very evident: the orbital surfaces are extremely concave, and the median ridge, on each side of the longitudinal fissure, disproportionately prominent. The under surfaces of the cerebral hemispheres, from the point of the middle lobes to the hinder extremities of the cerebrum, are relatively shorter, and appear more incurved, or kidney-shaped, than in the human brain. The line of greatest width of the base of the brain, in the Chimpanzee, is half an inch nearer to the posterior, than to the anterior end of the hemispheres, lies just in front of the widest part of the cerebellum, and passes across just behind the pons Varolii; whereas in man, it is placed proportionately further back, namely, $1\frac{1}{2}$ inch nearer to the occipital, than to the frontal, extremity, lies considerably in front of the widest part of the cerebellum, and passes across a little behind the pons. The cerebellum itself appears flatter, and is much wider, in proportion to its length, from before backwards, and also, in proportion to the extreme width of the cerebrum, in the Chimpanzee, than in man, in whom it is more protuberant, and though absolutely wider, less so in proportion to its other dimensions, or to the width of the cerebrum. The greater relative size of the cerebellum in this ape, depends therefore, mainly, on its greater relative *width*,—as shown by measurements taken in its natural state and position, not when it is disturbed and displaced,—a statement somewhat differing from that usually made. In the Chimpanzee, proportionally less of the under surface of the cerebrum is seen on each side of the cerebellum, than in man; but posteriorly, though the area of cerebral surface seen, is less in this animal than in man, yet the antero-posterior measurement of the surface is, in proportion to that of the entire brain, greater in the Chimpanzee, being about $\frac{1}{9}$th of the total length of the cerebrum, and, we may add, $\frac{1}{7}$th the distance from the point of the middle lobe to the posterior end of the cerebrum, instead of $\frac{1}{11}$th and $\frac{1}{8}$th respectively, as in man. As to the medulla oblongata, it is less fore-shortened in this basal view of the Chimpanzee's brain, than in man's, because it inclines a little more backwards. In harmony with Sœmmerring's law, the width of the medulla at its base is, proportionately to that of the cerebrum, wider in the Chimpanzee's, than in the human, brain.

If, finally, we take as a sort of arbitrary *central point for the entire cerebral mass*, the centre of its common stalk, the medulla oblongata, where it intersects the pons; and imagine lines drawn thence to the extreme occipital, frontal, parietal and vertical points of the cerebrum, we find that, in the Chimpanzee, the actual lengths of those *cerebral radii*, as they might be called, are respectively, 23, 29, 26, and 29 tenths of an inch, whereas, in man, they are 33, 43, 39 and 46 tenths of an inch. These numbers show, not only, the absolutely, far greater size of the human cerebrum, but taking *its* size as the standard, they show that the deficiency of the Chimpanzee's cerebrum, is most marked in the vertical radius, next in the parietal, then in the frontal, and least of all, in the occipital. In other words, the superiority of development of the human cerebrum follows the same order, as to regions,—being greatest in the vertical and parietal combined, next in the frontal, and least of all, in the purely occipital regions. The numerical ratios of these and other measurements will be found in the following Tables. In Table I. the ratios are given in reference to the human measurements as units; a plan which I cannot but think is preferable to that of making every separate animal's brain a separate unit of comparison with man's.

Table I.

Measurements of the parts of the Encephalon in Man and the Chimpanzee, given in $\frac{1}{10}$ths of an English inch, with the ratios between them, taking the human measurements as units.

Cerebrum.

a. Extreme breadth . . .	in Man	50,	in Chimpanzee	37	=	1 to ·74
b. 〃 length	〃	65	〃	44	=	1 to ·68
c. 〃 height	〃	45	〃	29	=	1 to ·65
d. Length of orbital surface . .	〃	23	〃	15	=	1 to ·65
e. Extreme depth of frontal lobe .	〃	35	〃	20		1 to ·57

f.	From point of middle lobe to hinder end of the brain . . .	in Man	48,	in Chimpanzee	34	=	1 to ·7
g.	Cerebral radii, occipital . .	〃	33	〃	23	=	1 to ·7
h.	〃 frontal . . .	〃	43	〃	29	=	1 to ·67
i.	〃 parietal . .	〃	39	〃	26	=	1 to ·66
j.	〃 vertical . . .	〃	46	〃	29	=	1 to ·63
k.	Projection of cerebrum beyond cerebellum	〃	6	〃	5	=	1 to ·83

Cerebellum.

l.	Extreme breadth	in Man	36,	in Chimpanzee	30	=	1 to ·73
m.	〃 length	〃	24	〃	16	=	1 to ·66
n.	〃 depth	〃	14	〃	8	=	1 to ·57

Table II.

Ratios between the dimensions of different parts of the Encephalon, in Man and in the Chimpanzee.

Cerebrum.

a to *b*	in Man	1 to 1·3,	in Chimpanzee 1 to 1·2
a to *c*	〃	1 to ·9	〃 1 to ·74
c to *b*	〃	1 to 1·44	〃 1 to 1·5
d to *f*	〃	1 to 2·03	〃 1 to 2·26

Cerebellum.

m to *l*	in Man	1 to 1·5,	in Chimpanzee 1 to 1·83
m to *n*	〃	1 to ·57	〃 1 to ·5
n to *l*	〃	1 to 2·57	〃 1 to 3·75

Cerebrum and Cerebellum.

m to *b*	in Man	1 to 2·75,	in Chimpanzee 1 to 2·7
n to *c*	〃	1 to 3·2	〃 1 to 3·6
l to *a*	〃	1 to 1·39	〃 1 to 1·23

Medulla and Cerebrum.

Breadth of Medulla oblongata to that of cerebrum . . .	in Man	1 to 7,	in Chimpanzee 1 to 5·7

N.B.—All the above measurements, except those of the medulla, were taken by aid of the intra-cranial casts. They necessarily differ from those taken from the brain itself by various anatomists. Such measurements as relate to internal parts will be given hereafter.

The *Fissures, Lobes and Convolutions.* The *Sylvian fissure*, more vertical than in man, even in the preserved Chimpanzee's brain, fig. 4, S, appears still more so in the cast, fig. 3; but in the cast of the human brain it is, also, somewhat more upright than in the preserved specimens, though not so much as in the Ape. The *fissure of Rolando*, figs. 4, 5, R, is very distinct in the Chimpanzee's brain, passing obliquely forwards from the longitudinal fissure, in a zigzag line, and separating the first ascending convolution, fig. 5,[4,4'] from the second ascending convolution [5,5']. The V-shaped figure which the two fissures of Rolando make, where they unite with the longitudinal fissure, is a very striking feature in the upper aspect of both the Quadrumanous and the human brain; but, in the Chimpanzee, the point of the V is situated a little in *front* of the transverse axis of the hemispheres, whilst in man it is, to a still greater extent, *behind* that axis. Suppose the whole length of the hemispheres to be represented by 100, then from the fore-part of the brain to the point of the V, would measure, in the Chimpanzee, 49, and, in man, 57. It is obvious, on further examination, that whereas nearly one-half of the upper surface of the cerebrum lies in front of the fissures of Rolando in man, a very little more than one-third is so placed in the Chimpanzee. In the Orang's brain, figured by Dr. Rolleston, the proportion appears to be mid-way between the two. There can be no reasonable doubt, that the part of the hemispheres situated in front of these remarkable fissures in man, the Orang and the Chimpanzee, and we may add, in still lower Quadrumana, are homologous parts, in the truest sense of that term. The anterior cornua of the lateral ventricles project into them, passing beyond the first ascending convolution on each side. The *external perpendicular,* or vertical, *fissure,* figs. 4, 5, V, is particularly well developed in the Chimpanzee's brain; it is not bridged over, on the upper surface of the hemispheres, by any superficial convolutions, so that its posterior border, named by M. Gratiolet the *operculum,* is smooth and uninterrupted. It is continued, on the internal surface of the hemisphere, as a distinct *internal perpendicular fissure.* In the particular human brain which we have dissected for the purposes of this paper, the external perpendicular fissure is obliterated, but it can be unmistakeably traced on the internal surface of the hemispheres, within the longitudinal fissure, as the internal perpendicular, or vertical, fissure. In the ape, this fissure cuts off 23 parts, posteriorly, out of 100 of the length of the hemispheres as visible above; in man, the corresponding portion represents 20 parts out of 100; in the Orang figured by Dr. Rolleston, the proportion seems to be intermediate. There can be as little doubt here, as in regard to the parts in front of the fissure of Rolando, that the portions of the hemispheres behind the perpendicular fissure, in man, the Orang, and the Chimpanzee, as well as in the lower apes, are strictly homologous parts of the cerebrum. We shall see that the posterior cornua of the lateral ventricles extend into them. Between the fissure of Rolando on each hemisphere, and the perpendicular fissure, is an equally homologous region which, in the Chimpanzee, occupies the remaining 28 parts out of 100, of the total length of the cerebrum; whilst, in man, it constitutes 23 parts, *i. e.* as seen directly from above; but this particular region, and also the part behind the perpendicular fissure, it must be remembered, are just those which gain so much in their vertical dimensions, in the human brain. If, in fact, we measure longitudinally over the vertex, the relative spaces occupied by these three regions, which may be distinguished as frontal, parietal and occipital, though they do not exactly coincide with the margins of those bones, we find that the proportionate dimensions in the Chimpanzee would be 46, 28, 26, instead of 54, 23, 23, out of 100, as in man.

Turning next to the outer side of the cerebral hemisphere, fig. 4, the so-called *parallel fissure*, situated parallel with and behind, the Sylvian fissure, is rather more complicated in our specimen than in M. Gratiolet's figure. On the inner surface of the hemisphere, besides the internal perpendicular fissure, there is seen a longitudinal *fissure*, surmounting the convolution of the corpus callosum. And lastly, on the under surface, rather than on the internal surface, of the hinder part of the hemisphere, is seen, very well marked, the *fissure of the hippocampus*, commencing, as described by Gratiolet, along the outer or lower border of the fimbriated convolution, and passing backwards in a curved direction, towards the hinder extremity of the hemisphere. The corresponding fissures plainly exist in the human brain dissected by us, *pari passu* with that of the Chimpanzee.

Now, whatever grounds of definition as to the leading sub-divisions of the cerebral hemispheres may be adopted, it is at once apparent that all those sub-divisions of the human cerebrum, called *lobes*, are present in the Chimpanzee. In the phraseology of the older anatomists, the *anterior* and *middle lobes* are well distinguished by the fissure of Sylvius, which, however, is comparatively not quite so deep as in man. At the bottom of this fissure, is plainly seen the *insula*, or island of Reil. Looking at the Chimpanzee's brain, it is quite indifferent whether we choose the usual arbitrary definition of the limits between the middle and *posterior* lobe, viz., a line drawn in front of the cerebellum, or whether we select the one more recently laid down, according to which the posterior lobe signifies that part "which covers the posterior third of the cerebellum and extends beyond it";* for, in either sense, the posterior lobe exists in our Chimpanzee's brain, inasmuch as the cerebrum projects half an inch beyond the cerebellum in its natural and undisturbed position, whilst the human cerebrum, under the same conditions, projects only a tenth of an inch more.

If, however, we reject these arbitrary modes of distinguishing the various lobes, and follow a more philosophical method, for example, the one suggested by Gratiolet, a corresponding conclusion is forced upon us, viz., that all the great masses in the human brain have their anatomical representatives, or homologues, in the Chimpanzee. The *frontal* lobe (figs. 4 and 5) F, together with the *parietal* lobe P, marked off by the first ascending convolution $^{4,4'}$, which is included in the latter, lie above the Sylvian fissure, and in front of the vertical or perpendicular fissure; the *temporo-sphenoidal* lobe, T, lies below the Sylvian fissure; the *central lobe* is the island of Reil; and the *occipital lobe*, O, is the part behind the external vertical fissure. Though this latter fissure is broken across by convolutions, its place can

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* Professor Owen. Annals and Mag. of Nat. Hist. June, 1861, p. 457.

usually be recognized in the human brain, by tracing outwards from the longitudinal fissure, the internal vertical fissure, which is always present, though thrust backwards at its upper end by the enlargement of the parietal lobe, so as to be somewhat oblique instead of vertical. On the internal surface of the hemispheres of the Chimpanzee, the *fronto-parietal* and *quadrate* lobes are seen to occupy the space in front of this fissure, a small *internal occipital lobule* lies behind it, and the *temporo-occipital lobe* is at once distinguishable, below the anterior portion of the fissure of the hippocampus. As thus defined, it is impossible to escape from the conviction that all the above-named parts exist in the Chimpanzee, as well as in man; and that, amongst others, the little occipital lobules at the posterior extremity of each hemisphere, in the former, are the homologues of those in the latter. We shall see that this conclusion is fully supported by the closest scrutiny of the convolutions, and of the internal structure of the cerebrum.

As to the *convolutions* in the Chimpanzee's brain, one can hardly pay a better tribute to M. Gratiolet's general accuracy, than to adopt his description of them, whilst referring to our own specimen. After pointing out the general characters of the frontal, parietal and occipital lobes, a remarkable notch which interrupts the border of the orbital surface, (seen in our fig. 4), the large size of the occipital or posterior lobe, and the even or perfect edge of its operculum, figs. 4, 5, in front of 10,10′, he proceeds thus, p. 50:—

"The convolutions of the frontal lobe are very large, even larger and wider than those of the Orang. The *superior frontal* convolution* (figs. 3, 3′, 4 and 5,) is subdivided into two parts, of which the highest is marked by secondary sulci.

"The *middle frontal* convolution, 2, is well marked. The *inferior frontal* or supraciliary convolution, 1,1, is very large, and broadly designed, so that the frontal lobe is well developed in all its parts.

"The *first ascending* convolution, 4,4, is slender, flexuous, and only slightly inclined backwards: it presents no marginal notches, and its surface is absolutely smooth.

"The *second ascending* convolution, 5,5, is equally simple and smooth; it passes up by the side of the preceding one, forming parallel flexuosities with it; but having reached above the bent convolution, 6, (pli courbe), it forms an elbow, and spreads out into a large lobule, 5′5″, which is prolonged back to the external perpendicular fissure. This lobule, [named by M. Gratiolet *the lobule of the second ascending convolution*] is very elegantly subdivided by a rather complicated sulcus, which serves to separate two distinct convolutions, one external, 5′, the other internal, 5″. The external convolution pursues a very simple course; but the internal one is folded several times upon itself, an arrangement which is tolerably constant.

"The commencement of the *bent convolution* (pli courbe), 6,6′, is remarkable. In the Orang and in the Gibbon, it begins at the top of the Sylvian fissure. *In the Chimpanzee, it arises in front of the summit of that fissure by a large extremity,* fig. 4, *and describes a very extensive curve around it.*

"As to the descending part, 6′, of the bent convolution, it is very slender, scarcely flexuous, and rather long, * * * *

"The convolutions of the temporal lobe, are very simple, * * * *. [They are

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* We substitute here the references to our figures, for those given by M. Gratiolet to his. The italics are in the original. My own additions are between brackets[].

named the *superior temporal* or *marginal*, 7,7, the *middle temporal*, 8,8, and the *inferior temporal*, 9. The *convolution of the hippocampus major* is marked * in fig. 2. The Island of Reil has five shallow convolutions.]

"We have already stated that the occipital lobe, O, is very large. It presents several parallel sulci, amongst which the one which separates the *middle occipital* convolution, 11, from the *superior occipital convolution*, 10,10′, predominates. The *operculum*, [viz. the border in front of 10,10′], is entire and well developed.

"But the chief ground of distinction between the brains of the Chimpanzee and Orang is the absence [in the Chimpanzee] of the *superior* connecting convolution (le premier pli de passage).

"Thus, *the first or superior connecting convolution is absolutely wanting.* [This, if present, would pass across the operculum opposite to 10, fig. 5].

"*The second connecting convolution is hidden under the operculum.* [This lies opposite to 10′].

"*The third,* fig. 4, C, *and fourth,* D, *connecting convolutions are superficial.*"

From the foregoing quotations, it will be seen that the arrangement of the convolutions in our specimen, coincides remarkably with the description of M. Gratiolet. It must be noted, however, that all those on the vertex, are considerably *broader* and flatter than in the *restored* figure given by that author; but they resemble in this respect, very strikingly, those represented in Schroeder van der Kolk's and Vrolik's plate. This flatness, evidently the result of pressure, affords a special confirmation of the view that the brain figured by the Dutch anatomists, like our own specimen, had been deformed during its preservation.

Of the convolutional characters which, in M. Gratiolet's opinion, distinguish the Chimpanzee, viz., the great size of the occipital lobe, the neatness of definition of its operculum, the mode of origin of the bent convolution, the absence of the first connecting convolution, and the hidden position of the second, all are strictly fulfilled upon the left cerebral hemisphere of our specimen; but, on the right or dissected side, of which a photograph is preserved, there was a rudimentary superior connecting convolution, of very small size, passing from the outer margin of the lobule of the second ascending convolution, outwards, and then, bending inwards and backwards, across the perpendicular fissure, to join the occipital lobe. The presence of this superior connecting convolution in the Chimpanzee, and on one side only, is another example of that variety and want of symmetry, as regards these connecting convolutions, noticed by Dr. Rolleston in his interesting paper (p. 212). Nevertheless, vary as they may, the several connecting convolutions are evidently, as M. Gratiolet first pointed out, the traces, or homologues, of much more highly developed, but corresponding, parts of the brain in man. On the whole, too, the evidence is still in favour of this particular connecting convolution being less developed in the Chimpanzee, than in the Orang. As to the second connecting convolution, it existed on both sides of the Chimpanzee's brain, concealed under the operculum, but of good size. In reference to what M. Gratiolet describes as a very remarkable feature in the Chimpanzee's brain, viz., the broad origin of the bent convolution (pli courbe) in front of the top of the Sylvian fissure, instead of at its summit, as in man and the Orang, I feel disposed, from a comparison of the parts in the Chimpanzee with the human brain, to consider this, so-called, unusually broad and forward origin of the bent convolution, 6, as in reality the homologue of the so-named "lobule of the superior marginal convolution," which is regarded by Gratiolet as peculiar to man: on such a supposition the bent convolution would arise in man's, the Orang's, and the Chimpanzee's brains, all at the same point; and if Dr. Rolleston's supposition be correct (l. c. p. 212), all these would possess a "marginal lobule," which, however, like the connecting convolutions, would be far more highly developed in man. On the interesting question of the relative superiority of the Chimpanzee's and Orang's brain, our specimen, on the whole, is in favour of the claims of the latter. The Chimpanzee's convolutions are more symmetrical. But the subject of the cerebral convolutions is too prolific a one to be discussed at length here.

It is utterly impossible to follow M. Gratiolet's analysis without coinciding with him, entirely, as to the correspondences of his essential subdivisions of the cerebral masses. One general fact he illustrates very fully, viz., that uniformity and symmetry of arrangement are marks, so far as they go, of inferiority of cerebral development. Now, this is not merely true in regard to different species of animals, or different individuals of the same species, but in any one brain, even in the human brain, there are certain convolutions which are more uniform and more symmetrical than the rest, and these very same convolutions vary less in different, though allied, groups of animals. The convolutions which are thus characterized in the Quadrumana and in Man, are those which belong to Foville's first order, those which form as it were the extreme rim or circumference of each cerebral hemisphere, viz., the convolution of the corpus callosum, on the inner side, and the convolution which surrounds the Sylvian fissure, on the outer side. The various fissures, or sulci, which separate these primary convolutions from those which occur next to them, also partake of the same comparative simplicity; whilst the further one recedes from them, on to the external surface of the hemisphere between them, the greater complexity and variety one meets with, both in the convolutions and in their intervening sulci. In accordance with this rule, the under surface and the internal surface, of the hemispheres are more simple than their external, or convex, surface; and hence, whilst the detection of corresponding parts becomes more and more difficult in certain portions of the latter region, as we ascend in the scale of organisation; in the two former the necessary landmarks continue very clearly recognisable. This is certainly the case in regard to the internal and under surfaces of the posterior part of the hemispheres; and if any one will examine the series of basal views of Quadrumanous brains in Gratiolet's work, in which the cerebellum has been removed, so as to show the under surface of the back part of the hemispheres, he will be able to trace in one of the more or less simple, yet elegant, curved lines, proceeding backwards from the outer side of the corresponding cerebral peduncle, an evidently homologous fissure, present in many, otherwise most varying, brains. This fissure is the *fissure of the hippocampus*. Its extension backwards to the tip of the occipital lobe is seen in all; and it serves at once to identify parts which, on the upper surface of the hemisphere, cannot so easily be compared. It is at the bottom of the middle half of this fissure, that the cerebral substance is tucked in, in the form of two deep hidden sulci, to constitute the hippocampus minor and eminentia collateralis, in the posterior cornu of the lateral ventricle, where that prolongation of the great internal cavity of the brain exists. But supposing that prolongation did not exist in any particular brain, still the presence of even a *rudimentary* fissure occupying the above-described characteristic position, would suffice to justify the conclusion that the surrounding parts of the cerebrum were homologous parts. Now, a careful comparison of these parts in the human brain, in the brain of our Chimpanzee, and in the brain of a common Green Monkey, has satisfied me that the fissure of the hippocampus and its two deep hidden sulci, are present in all three.

Internal structure of the Brain. The cerebral convolutions of the Chimpanzee's brain are very large on the outer surface of the hemispheres, where indeed, as is seen in fig. 5, the sulci are, proportionately, quite as deep as in the human brain. On the frontal lobe, they are also bold; but in the occipital lobe the convolutions are smaller, and the sulci for the most part shallower, though both are still very numerous, so that the smoothness of this part of the brain is not owing to an *absence* of convolutions, but to their diminutive size and depth. The superior occipital convolution is, however, almost devoid of any surface-markings. This part of the brain is smoother than in the Orang. It certainly would seem as if it were behind the rest in development, at least in the young Chimpanzee. We may remark, as suggestive of a similar idea, that these posterior convolutions were found to be more tender than those of the parietal or frontal regions; and, as is recognisable in fig. 5, that the grey cortical layer is thinner in them than elsewhere. In the human brain, also, the occipital convolutions are not so bold as those on the sides and fore part of the hemispheres; but the difference is not nearly so marked as in the ape. The average thickness of the grey matter is about $\frac{3}{30}$ths of an inch, in the Chimpanzee, as compared with $\frac{4}{30}$ths, in man. In proportion to the size of the brain, it is curious that the quantity of white matter in the centre of the hemispheres seems smaller than in man.

Of the various *commissures* of the cerebrum in the Chimpanzee, we will speak first of the *corpus callosum*. This is both shorter and thinner in proportion than in man, as the following measurements, in 30ths of an inch, taken in each case from the *hardened* brain, will show. In the ape, the length, the greatest thickness, the least thickness, and the average thickness of the corpus callosum divided along the middle line, are respectively 51, 6, 2 and 4·5 thirtieths of an inch; in man the corresponding quantities are 93, 16, 6 and 13. The sectional area of the longitudinally divided corpus callosum in the Chimpanzee, is therefore $\frac{230}{900}$ths of a square inch; whilst in man it is $\frac{1209}{900}$ths of a square inch. Comparing these numbers with the area of the internal surface of one of the cerebral hemispheres, in the Chimpanzee's and in the human brain, we find them to be as 1 to 28·5 in the ape, and 1 to 12·5 in man; so that the corpus callosum is more than twice as large, proportionally to the size of the brain, in man, as it is in the Chimpanzee. We may add, that the corpus callosum in our specimen is exactly of the same length as in Schroeder van der Kolk's figure, whilst the brain itself is a little longer. As in man, the corpus callosum of the ape, is thickest behind. The section of the *anterior* commissure is not so round as in the human brain, but it is proportionally as large. The *posterior* commissure also exists, but it is small. The so-called *soft* commissure is large. On the whole then, the system of *transverse* commissural fibres is defective in the Chimpanzee, as compared with man; and as the section of the medulla oblongata, in the former, is even larger in proportion to the cerebrum, than in the latter, it would seem as if the relative deficiency of white substance within the hemispheres, already noticed, is, to a great degree, owing to the fewness of these, as well as other, commissural fibres. Of the *longitudinal* system of commissures, the fornix is thin; the tænia semicircularis is only just recognisable; and the striæ longitudinales are slender.

Of the middle and fifth *ventricles*, nothing is to be remarked. The fourth is very wide, corresponding in this respect with the cerebellum. The *lateral ventricle*, examined on the right hemisphere, proved to be a very large cavity. It consisted, as in man, of a body (fig. 5), ** and three cornua; an anterior cornu *, a descending cornu (of which only the commencement is seen); and a very obvious, posterior cornu. * * * The body measured 12/10ths of an inch long, the anterior cornu 6/10ths, the posterior cornu nearly 5/10ths, and the descending cornu 20/10ths; whereas in the human brain, these parts measured respectively, 21/10ths, 14/10ths, 12/10ths and 26/10ths of an inch. Comparing these dimensions with the lengths of the two brains, (44/10ths, and 65/10ths of an inch) we get as ratios for the Chimpanzee, ·207, ·103, ·18 and ·45 to 1, and for man, ·32, ·21, ·184 and ·4 to 1. From this we perceive that the lateral ventricle was proportionally longer in the human brain, except as regards the descending cornu; and that the posterior cornu was only fractionally longer. It is worthy of note, as may be seen by comparing the dissected with the undissected side of fig. 5, that, in the ape, the body of the lateral ventricle corresponds almost exactly with the parietal lobe of the hemisphere, P, whilst the anterior cornu projects into the frontal lobe, F, and the posterior runs, beyond the vertical fissure, into the occipital lobe, O: the descending cornu of course occupies the temporo-sphenoidal lobe, Fig. 4, T. In the human brain, the same relations are observed, together with a coincidence in the measurements of the parts. In our Chimpanzee's brain, the posterior cornu begins at a line, midway between the hinder end of the corpus callosum and the internal perpendicular fissure. The widths of the cornua of the lateral ventricle vary according as their sides are held asunder, but they are large cavities. About the same proportionate quantities of corpus striatum and optic thalamus are seen in the anterior cornu and body of the ventricle, as in man. In fig. 5, the thin curved margin of *the fornix*, with the rounder commencement of the *hippocampus major*, are seen entering the descending cornu. On the inner side of the floor of the posterior cornu is a convex eminence, *the hippocampus minor*. Between the bend of the hippocampus major and the hippocampus minor is a triangular eminence, also prolonged into the posterior cornu; this is a small *pes accessorius* or *eminentia collateralis*. All the parts to be found in the human posterior cornu are thus represented in the Chimpanzee, in proof of which we may refer to the irrefragable evidence of the photograph, fig. 5. A comparison of the natural parts with Schroeder van der Kolk's and Vrolik's figure, 4, Plate II.,—which is so differently interpreted just now, being equally quoted* to show the *presence* and the *absence*, in the Quadrumanous brain, of the same parts, viz. the *posterior lobes*, the *posterior cornu*, and the *hippocampus minor*, has compelled me to the conclusion that, although those anatomists have had to dissect a displaced and deformed posterior lobe, and have removed its substance rather freely, still the eminence figured, and marked *e*, by them, is really a *hippocampus minor*. To make this clear we may refer to the annexed sketch, fig. A., drawn by myself from nature, in which the parts are shown of their true size.

Fig. A.

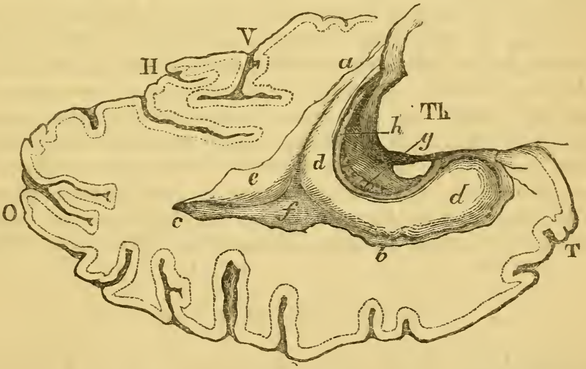

Fig. A. O, occipital lobe. T, temporo-sphenoidal lobe. Th, back of thalamus opticus. V, internal perpendicular fissure. H, part of fissure of hippocampus. *a*, hinder part of body of lateral ventricle. *b*, descending cornu. *c*, posterior cornu. *dd*, hippocampus major. *e*, hippocampus minor. At *f*, the small eminentia collateralis; both of the latter extend into the posterior cornu. *g*, fascia dentata. *h*, continuation of fornix or corpus fimbriatum.

* By Professor Huxley, in this Journal, p. 76; and by Professor Owen, in the recent No. (June 1861) of the Annals and Mag. of Nat. History, p. 456.

The hippocampus minor, as in man, corresponds, on the surface of the Chimpanzee's brain, with the upper of the two deep hidden sulci at the bottom of the fissure of the hippocampus; and the eminentia collateralis with the lower of those sulci. Hence, as already deduced from other considerations, even the presence of this fissure, without its sulci and the corresponding projections into a posterior cornu, would suffice to identify corresponding parts of the cerebral hemisphere. The remaining points, which seem worthy of notice, are the following. The hippocampus major corresponded to a thick rolled convolution and sulcus; its lower end, fig. A, *d'* was much expanded, and, what I shall call, to avoid confusion, its *convex* border was twice, though feebly, indented. The fascia dentata was quite distinct. Of the corpora quadrigemina, the upper pair were the larger, but the less prominent. The pineal body was large, soft, and contained no gritty particles. The habenulæ were distinct. The pituitary body was large, and wider than deep. The corpora albicantia were beautifully seen, quite distinct from each other, and connected, as in man, with the anterior pillars of the fornix. On the medulla oblongata, the corpora olivaria were neatly defined and of good size; and the decussation of the pyramids was very prettily seen. In some of these points Macartney's description is not quite correct.

Lastly, all the parts of the cerebellum, so far as I have yet examined them, are the same as in the human encephalon; only the lateral hemispheres are wider and flatter. I have still preserved this and also the left half of the brain, on which I propose some day to follow the arrangement of the fibres.

I may be permitted to add, in conclusion, that my sole object in this paper has been to record the results of an anatomical investigation. I have no theory, zoological, or physiological, to support; I have no leaning towards any of the developmental hypotheses of the origin of species. But, on the question of facts, and the interpretation of those facts, my results, as to the existence of a posterior lobe, of a posterior cornu, and of a hippocampus minor, in the Chimpanzee, will be found to harmonize with the investigations and conclusions of Prof. Huxley and of Prof. Allen Thomson, already published in this Review.

Description of the Figures in Plate VI.

N.B.—Nearly all the figures are, as nearly as may be, two-thirds the linear dimensions of the objects.

Fig. 1. Under view of a plaster cast of the interior of the Chimpanzee's skull, taken before the membranes were removed from the base; (from a photograph.) F F, frontal lobes of the cerebrum; T T, temporo-sphenoidal lobes; O O, occipital lobes; V, pons Varolii; M, medulla oblongate; C C, cerebellum.

Fig. 2. Under view, or base of the Chimpanzee's brain, hardened in spirit, with the pia mater and arachnoid taken away. Intended to show the displacement of the parts, especially of the cerebellum, from their natural positions; (from a photo-

graph.) The capital letters as in fig. 1; 8, the external inferior temporal convolution; 9, the middle inferior temporal convolution; * the convolution of the hippocampus major.

Fig. 3. Left side view of the plaster cast shown in fig. 1. Intended to show the natural rounded form of the brain, and the position of its parts; (from a photograph.) The capital letters the same as in figs. 1 and 2, except P, which indicates the parietal lobe of the cerebrum.

Fig. 4. Photographic view of the left side of the Chimpanzee's brain. F, P, O, T, frontal, parietal, occipital and temporal, lobes of the cerebrum; R, fissure of Rolando; V, external perpendicular, or vertical fissure; S, Sylvian fissure; C, cerebellum; as in fig. 5: 1, inferior frontal convolution; 2, middle frontal convolution; 3, 3′, superior frontal convolution; 4, 4, first ascending parietal convolution; 5, 5, second ascending parietal convolution; 5′, 5″, lobule of the second ascending convolution; 6, 6′, bent convolution (pli courbe); 6′, its descending part; 7, 7, superior external temporal or marginal convolution; 8, 8, middle external temporal convolution; 9, inferior temporal convolution; 10, superior occipital convolution; the operculum is the anterior border of this convolution immediately behind the vertical fissure V; 11, middle occipital convolution; 12, inferior occipital convolution; c, third external connecting convolution (pli de passage): D, fourth external connecting convolution.

Fig. 5. Photographic view of the upper surface of the Chimpanzee's brain; the right half being dissected to show the lateral ventricle and its cornua. Most of the letters generally as in fig. 4. L, the longitudinal fissure. On the left side, 5′, 5″, are the external and internal convolutions of the lobule of the second ascending convolution; 10, 10′, the superior occipital convolution,—the operculum being the edge in front of 10, 10′. The first connecting convolution (pli de passage) is absent; its seat, when present, is a little to the left of 10. The second connecting convolution is hidden under the operculum, in front of 10′; * is opposite to the anterior cornu of the lateral ventricle, * * level with the body, and * * * with the posterior cornu. In the latter, are seen, to the inner side or left-hand, the hippocampus minor; in front of this is the bent end of the hippocampus major entering, with the fornix, into the descending cornu; between them is a small triangular portion of the small eminentia collateralis. Compare with the woodcut A, in which the whole extent of the hippocampus major is shown.

XXXII.—Anatomical Notes.—By Professor Hyrtl of the University of Vienna.

[Professor Hyrtl has kindly promised to favour me, from time to time, with the communication of a series of his Anatomical Notes; some of which will be found in the future proceedings or transactions of the K. K. Akademie der Wissenchaften, Wien. But as these are not published at any fixed periods, it will very generally happen that the epitome of such papers given in these pages, will have some months priority over the more detailed descriptions given in the Publications of the Academy. Some few, perhaps, will be familiar to those learned in German Bibliography, but will probably still be new to most readers; others, again, will be printed here for the first time. It is but justice to Professor Hyrtl, well known to be an excellent English scholar, that I should hold myself responsible for the English of these notes, and I trust that the sense, at least, of what my friend would say, will always be given, even though

I may not have succeeded in translating into very terse or elegant language, some of the more complex of the compound German words.—E. P. W.]

1.—*On Anangious Retinas.*

In the xxxiii. volume of the "Sitzungsberichte der naturwiss. Classe der kais. Akademie der Wissenchaften zu Wien," I published a treatise on hearts devoid of nutritive blood-vessels. (Ueber gefässlose Herzen). I there demonstrated, by microscopical investigations, that the heart, in all the Amphibia, presents the remarkable peculiarity, that the Arteria coronaria, which arises from one* of the first branches, into which the Bulbus arteriosus splits, and at some distance from the heart, supplies only the Bulbus arteriosus itself; and that not the smallest arterial branch enriches the muscular substance of the Ventriculus, or of the Atrium cordis.

I have likewise demonstrated, that the heart of Sauria, Ophidia, and Chelonia, is also partially deprived of blood-vessels; in them, the outermost layer of the muscular stratum of the heart, possesses, like all the other muscles, a capillary network, but still, the greater part of the heart-mass is entirely destitute of nutritive blood-vessels. This is the case, too, with all the osseous Fishes, while the more highly organised Rays and Sharks have, like warm-blooded animals, the coronary arteries distributed to the whole muscular coat of their hearts. In the paper, alluded to, I have stated the reason why such an apparent anomaly is, in these several cases, quite in accordance with physiological principles; and I need not further allude to the matter here. My reason for referring to it at all is that I have now met with the same exclusion of all nutritive arteries, in a different organ, and not only is the organ one of similar importance, but it also presents so constantly this state of *anangia* (α priv.—αγγεῖον), that the latter becomes almost an anatomical characteristic of certain classes of Vertebrata.

The retina of all Birds, Reptiles, Amphibia and Fish, osseous and cartilaginous, contains not the slightest trace of blood-vessels, so that the vascularity of the retina occurs only in the Mammalia. I communicated a short notice of this interesting anatomical fact to the Academy of Sciences in February, which will not, however, be printed until towards the end of the year (1861), as there are many prior papers for publication. Hence, I have thought, that a note of the existence of these anangious retinas would not be without interest for the readers of the Natural History Review. I trust, that those engaged in optical inquiries, will see the importance of this discovery, for the assertion of physicists, that the blood-vessels of the retina must absorb some of the rays of light, and so cause certain

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* Arteria carotico-lingualis; *mihi.*

imperfections in the vision of minute objects, cannot hold as true for all eyes, now that the existence of bloodless retinas is an established fact.

The retina then, of four classes of vertebrate animals is *not* nourished by the direct intervention of the circulatory system, and can be preserved in health and vigour, only by some endosmotic process.

And here I may mention, that this endosmotic action is limited in birds to the *choroid* surface alone. In the other three classes, Reptiles, Amphibia and Fish, absorption, on the contrary, may take place both from it and from the hyaloid membrane. This latter membrane, as I was the first to show, many years ago,* is in some reptilia and amphibia a highly vascular one, and late investigations of mine have made it evident, that the hyaloidea of all fishes perfectly resembles that of the reptiles alluded to, in the richness of its supply of blood-vessels. The result of these investigations I reserve for a special treatise on the vascularity of the hyaloidea of fish. This subject is one well worth further investigation.

2. *On some peculiarities of the gills of Lutodeira Chanos* Forsk.

I have had an opportunity of investigating the anatomy of this very rare and most valuable fish, and have discovered the following modifications to exist in its respiratory apparatus, which though partially found in some other clupeid and salmonoid fish, yet are most fully developed only in this genus.

Attached to the gills there is an accessory respiratory organ, presenting the form of a tube, partly membranous, partly cartilaginous; this tube is twisted upon itself like a helix, one and a half-times, and is of equal calibre throughout: its length is one inch and three quarters and its diameter is two lines. It is situated above the fourth

* I do not care much to claim the right of priority in scientific questions. That some new fact has been demonstrated, is well; it matters not who was the happy demonstrator; but I may infer, as a proof of the feeble renown of Austrian science, that my discovery of the blood-vessels in the hyaloidea of reptilia and amphibia, made when I was a young man (Med. Jahrbücher des Osten. Staater, Band 15) had not reached England when Mr. J. Quekett wrote his "Observations on the vascularity of the Capsule of the Crystalline Lens, especially in certain Reptilia." (Trans. Microscop. Soc. of London, Vol. III. 1850).† I made the first injection of the Hyaloidea of Coluber and Rana in the year 1831. The preparations are now in the Anatom. Museum of our University, and duplicates were sent in 1832 to Prof. Retzius in Stockholm, and 1837, to Prof. T. Müller in Berlin.

† In a note to me, Prof. Hyrtl adds, that in all the Saurians and Chelonians there is no vascular hyaloidea, and that even among the amphibia, the Sozura—(Salamander, Triton, Amphuima, &c.) have a bloodless hyaloid. Professor Quekett erred in mistaking the hyaloidea for the capsule of the lens. In the frog the lens is very large, and the vitreous humour very small, so that in spirit specimens it almost disappears, and then the hyaloid membrane embraces the posterior portion of the lens so as to be easily mistaken for a capsule.

branchial arch, whose *epibranchial segment* (Owen) is expanded into a broad triangular plate; the accessory organ lies upon this plate in such a manner, that the axis of its spiral canal keeps a perpendicular direction throughout.

The right and left organs communicate by a common aperture with the roof of the pharynx, immediately behind the toothed pharyngo-branchial segments (Owen, pharyngiens superieurs Cuv.) The lining membrane of these organs is very vascular, and fine injection proved beyond contradiction, that their arteries are but prolongations of those which bring the venous blood to the gills. Their veins unite with the root of the aorta, and must, therefore, contain arterialised blood. On the inner border of the twisted tube there is a double row of fringes, of the consistency of cartilage, and a groove lies between the two rows, but there is no interspace* like a branchial cleft.

Our great anatomist Johannes Müller, threw out a hint of the existence of this organ in his admirable work "Bau und Grenzen der Ganoiden," p. 74 et seq.; but the specimen which he had for dissection was probably so defective as to cause him entirely to overlook its peculiar snail-like convolution, and he only speaks of the above mentioned double series of fringes, which he declared to be a *true biserial gill.* Careful investigation of well injected preparations, has, however, satisfactorily convinced me, that the *biserial gill* of Müller is not a *respiratory gill*, but simply a continuation of the peculiar horny fringes, which are attached to the concave border of the branchial arches in many Clupeid and Scomberoid fish, and which serve as combs, or gratings, to intercept any solid particle swallowed, which if forced through the interspaces of the branchial arches would, most certainly, injure the very delicate vascular net-work, supported by the slender and compressed processes of the gill fringes.

A very large branch of the pneumogastric nerve supplies the inner side of this organ (to which I give the name of Cochlea branchialis), and it strikes me that its mucous membrane may be capable of receiving some special sensation. The organ is surrounded by a strongly developed muscular coat, so that the water contained in it can, by the contraction of the muscles, be easily expelled through the same orifice by which, on dilatation, it enters.

On a former occasion† I have pointed out that some of the true clupeid fish, as *Meletta*, *Chatoessus*, *Clupanodon*, *Gonostoma*, &c.

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* In a note Prof. Hyrtl says—The branchial clefts are very long and narrow in all clupeid fish, and the fringes on the convex border of the branchial arches are of so delicate an organization and possess such an extremely fine capillary net-work, that all the clupeid fish die the instant they are taken out of the water. Prof. Hyrtl suggests that hence the origin of "As dead as a herring."

[The only objection to this explanation which occurs to us is that, as all who have seen herrings caught, know very well, the fish do *not* die the instant they come out of the water; nor indeed sooner than many other fish.—Eds.]

† Denkschriften der K. K. Akademie der Wissenschaften, Wien. 10 Bd. pag. 47, "Ueber die accessorischen Kiemenorgane der Clupeaceen."

are also provided with a *cochlea branchialis*, to which, the organ described in *Lutodeira*, is, in its form, structure and uses, quite similar.

I may add that a few genera of the Salmones (Cuv.) or rather Characini (Müll.) viz. *Prochilodus* and *Citharinus*, also possess an accessory respiratory organ, well supplied with nerves from the Vagus; it is situated above their gill chambers, and is either a straight blind chamber, or has a curved sac-like form, in both cases receiving venous blood from the heart, and returning red blood to the base of the aorta. My friend, Professor Kner, a short time since, showed me the same organ in *Anodus*.

The following peculiarities in the structure of the gills of *Lutodeira* are unique, no other clupeoid or characine fish affording a trace of them:—

1st. Each interspace between the branchial arches is divided into a superior and inferior compartment by a short, strong and non-elastic ligament, which unites the articulations of the basi- and cerato-branchial bones (Owen) of each arch, with the like articulations of the same bones, opposite to them. The branchial arches therefore cannot be divaricated from one another, and their interspaces, the branchial clefts, cannot be so much dilated as in other fish, but they remain permanently in a state of extreme narrowness, and the current of water which passes through them, must necessarily be very small.

2nd. The cartilaginous combs, or fringes, attached to the concave borders of the branchial arches, are set in two rows on each arch; these two rows are likewise divergent, so that the tips of the fringes of the outside row of one arch, meet the tips of the fringes of the inside row of the next one. The tips of each pair of fringes firmly coalesce and cannot be separated without breaking them. Each branchial cleft is therefore bridged over by a succession of gothic arches, equal in number to the cartilaginous filaments in every fringe, and there is no free passage for the current of water. The water is, therefore, it may be said, filtered through the coalesced fringes, whose tips are directed towards the mouth, and, whatever may be the amount of heterogenous particles in the water, they must be with certainty caught between the pallisades, just as a fish is caught in a net; the surprising length, fineness and delicacy of the respiratory branchial lamellæ on the convex edges of the branchial arches, and the excessive richness of their capillary net-work of vessels, are such as fully to account for all these elaborate guards against mechanical injury to so frail an organism.

3. *On a peculiar arrangement of the Gill chamber in Polyacanthus.*

This fish, one of the Labyrinthidæ, presents a very peculiar arrangement of its gill chambers.

The first five vertebræ are each furnished with four ribs instead of two; this is quite a unique arrangement in the osteology of fishes. These supernumerary ribs are attached to the sides of the neural-spine (Owen) far above the neural arch. They are somewhat shorter than the true ribs, which are articulated to the bodies of the vertebræ. But they are so curved, that the inferior end of each reaches to its corresponding true rib, and articulates with the latter near its head. The first supernumerary rib is the longest, and the others gradually decrease until the last, which is the shortest.

A dense fibrous membrane lines the spaces which intervene between these ribs, so that there exists, on each side of the dorsal spine, and covered over by the superior muscles of the vertebral column, a long conical cavity, whose apex is directed upwards and backwards, and whose base opens downwards into the branchial cavity. In this cavity is lodged a good deal of the branchial labyrinth of the fish.

The labyrinth of *Polyacanthus* is not of the complicated nature of that of *Anabas*, *Helossoma*, or *Osphromenus*, but, in the simplicity of its structure, more resembles that of *Ophiocephalus;* it is composed of but three heliciform lamellæ, which, however, make up in length, what they want in the sub-division of their lamelliform surfaces, and are so long that they cannot be sufficiently protected by the upper portions of the tympano-maxillary and humero-scapular arches.

An organ like the labyrinth of this fish, with such important functions to perform, could not well be lodged in the trunk, where it would be in the way of powerfully acting muscles, but it is quite securely situated, under the rib-like protection of this kind of thorax, formed by the five pairs of accessory ribs.

No other known Labyrinthoid fish (I have them all in abundance) presents a similar anomaly.

4. *Some results of isolated Arterial Injections.*

Isolated arterial injections are in many respects very instructive; by "isolated injection" I mean the injection of the minute arteries, not of those supplying an extremity, or other large portion of the body; these latter will never give the same clear idea of the province which belongs to each small arterial branch, whilst the isolated injection of the minute arteries shows the boundaries of the territories, which are irrigated by certain sets of blood-vessels. When an organ receives several arteries, then the isolated injection of each with differently coloured injections, will show, in a most satisfactory manner, what portion of the organ is supplied by each branch. So far as the nervous system is concerned, anatomists have marked out the districts over which the ultimate nervous ramifications spread;

the same might be done for the arterial system by means of these isolated injections, and most beautiful and instructive preparations can be obtained by injecting, with differently coloured materials, the arteries of the conjunctiva, the mucous membrane of the nostrils, or the lining membrane of the mouth, pharynx, urinary bladder, &c.

The following results of a long series of such injections may merit attention, as some of them are of high practical importance.

Coronary Arteries.

When a single coronary artery of the heart is injected, the other (say the right) remains empty, showing that there is no anastomosis between the primary, or secondary, ramifications of these two arteries, in the circular and longitudinal grooves of the surface of the heart, as all anatomists say they have observed. When the injection passes from one artery to the other, it is always through the intervention of the capillary system that the communication takes place; never through the *non*-capillary system; hence it follows, that the right and left hearts are, to this extent, independent as far as regards their arterial circulation.

Arteria lingualis.

The same is likewise the case with the right and left lingual arteries. When the right lingual artery is injected with colouring matter, only one-half of the tongue becomes coloured, the other half remaining as it is. If the assumed anastomosis really existed between the two arteries (forming an arch in the top of the tongue) the injection of the one artery would certainly fill that of the opposite side.

Arteria laryngea superior.

When the Arteria laryngea superior is separately injected, it is necessary to put a ligature on the Art. thyreoidea inferior of the same side, because there is a very extensive anastomosis between the former and the laryngeal branch of the latter; this anastomosis will be found in the interior of the larynx (between the thyroid and cricoid cartilages); perhaps this fact admits of the following interpretation: The superior laryngeal artery is not exposed to muscular compression, but the inferior thyroid, which gives a branch to the larynx, may occasionally be compressed by vehement contraction of the muscles under which it wends its way. The intra-laryngeal anastomosis of both is so arranged, that the necessary supply of blood cannot be stopped by such compression.

Uterine Arteries, &c.

In the uteri of children, of which I have several well injected preparations, the right and left arteries appear to be as independent as those of the heart. An injection of the arteries of one side is always followed by the perfect filling of the vessels of that side, and the absence of injection in the other. However, in the vagina, and more especially in the bladder, there are large anastomoses between the right and left arteries of these organs, a circumstance which is of some importance in the development of certain pathological changes. When, in man, there are two, three, four, or even (as sometimes) five renal arteries, you may inject one, and yet none of the others will be filled, every one of these arteries having a distinct province of its own. It is the same case in other Mammalia, when their kidneys have more than one artery entering at different portions of their surface; for instance, when an injection of the horse's kidney is made, one can spare the injected matter, by selecting any small artery which enters the external surface of the organ (not in the hilus). A minute injection of a very limited portion of the cortex is thus obtained, and there is no risk of wasting the injected material by filling other parts, not required for the preparation.

Meningea media.

An isolated injection of the middle meningeal artery makes it evident, that this artery is not only destined to be the nutritive artery of the cranium, but also, that very numerous off-sets of the diplöetic branches pass out to the external surface of the calvariüm and ramify freely throughout the pericranium. When a well injected preparation of this artery is exposed to the action of weak hydrochloric acid, the destruction of the earthy matter gives to the skull (after being well dried and saturated with turpentine) such a degree of transparency, that the perforating branches of the diplöetic arteries can be distinguished with the greatest facility.

Arteria occipitalis.

It happens very often, that the occipital artery seems to send a branch through the mastoid foramen; it is very commonly believed that this branch appertains to the dura mater, and is an accessory nutritive artery (Art. meningea externa accessoria). Now, when a series of isolated injections of the occipital artery are made, it is easy to show that, in many instances, the artery which passes into the mastoid foramen does not pass through it, and that it is, therefore, no meningeal artery. The hammer and chisel, or the help of muriatic acid, will prove that the before-mentioned arterial branch ramifies through the diplöe, reaching as far as the parietal bone. I have, for this reason, called it the *Art. diplöetica magna*, and I consider it to be an attempt of nature to reproduce, in man, the great diplöetic artery which some years ago I discovered in the large Edentata,* as a branch of the very large occipital artery, and which, in these animals, penetrates the very dense diplöe of the bones of the cranium as far as the lamina cribrosa of the ethmoid, when it escapes, and is lost, with the olfactory nerves, in the mucous membrane of the nose.

Even when, as is sometimes the case, this branch of the human occipital artery passes right through the mastoid foramen, and actually reaches the dura mater, yet a comparison of the diameter of the artery as it enters, with that of the artery as it makes its exit through the foramen, will show a very striking difference in size; the artery, as it makes its appearance at the inner side of the mastoid foramen, not having half the diameter that it possessed on its entrance into the foramen, and, even in these cases, it sends a very considerable off-shoot to the diplöe.

Ligamentum teres.

It is said in most works on anatomy, that this ligament serves to conduct nutritive blood-vessels to the head and neck of the femur. I venture to doubt this general assertion, on the strength of isolated injections of the arteria obturatoria, under the pectineus muscle. These injections have proved, that all the capillary vessels in the ligamentum teres are, at the point where this latter is inserted into the oval depression on the head of the femur, reflected back again into veins, forming a large number of fine capillary loops, which form a very interesting object. When a vertical section of this ligament is made, no arterial vessel can be singled out, passing from the ligament to the bony substance of the head of the femur; but if you inject the perforating artery, of which the nutritive artery of the femur is a branch, you will obtain a very satisfactory microscopical injection of the interior of the bone; and, in a vertical section of the injected femur, one may trace the vessels to the very insertion of the ligamentum teres itself, without finding a trace of even the minutest branch passing into it. Further there is *no* anastomosis between the vessels of the round ligament and those of the medullary cavity, which must have been the case were the blood-vessels of the former destined to nourish the frame-work of the reticulated interior of the head of the femur.

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* Vide "Ueber das Gefässystem der Edentaten." Denkschriften der Kais. Acad. Wissenchaft. Wien. vol. vi. 1854.

Arteria auditoria interna.

Perhaps the most important result which I have obtained from a long series of isolated injections, has been yielded by injecting the internal auditory artery in man and other mammals ; but this artery is so very small that it is quite impossible to introduce into it even the smallest injection tube, so that it is necessary to proceed to inject it in another way.

Place a ligature round the basilar artery, immediately in front of the origin of the internal auditory, just behind which the basilar artery may be easily fitted with an injection tube of tolerable dimensions; the injection being then prevented by the ligature from penetrating far into the basilar artery, must pass along into the auditory branch with all the requisite force. Next inject, in the same subject, the middle meningeal artery, with a differently coloured injection; both these injections must be composed of very fine materials. The investigator will now perceive that the labyrinth is supplied by the auditory artery, while the surrounding substance of the petrous bone is supplied by branches of the meningeal.

I shall not now enter into more details; these I reserve for another occasion ; but, I may state that this independence of the circulations of the labyrinth and of the petrous bone, will account for the very interesting observations made by several French surgeons, and proved by many convincing pathological preparations, in my osteological collection, that a *caries temporum* may corrode away almost the whole of the petrous bone, without destroying the sense of hearing; and that the cochlea of a human ear, together with the vestibulum, may be exfoliated through a like caries, just as if prepared by the skilled hand of the anatomist, because the two having separate and independent circulations, each may preserve its integrity apart for a long time.

I have in my possession a very neat looking cochlea, which was taken out, with a forceps, from the external auditory meatus of an otorrhoic patient by a friend of mine, who is Surgeon to a suburban district in Prague.

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(1860, continued.)

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——— Descriptions of Three new Species of Uniones, from Mexico. Phil. Acad. Proc. 1860, p. 305.

——— Descriptions of Seven new Species of Unionidæ, from the United States. Phil. Acad. Proc. 1860, p. 306.

——— Descriptions of Six new Species of Unionidæ from Alabama. Phil. Acad. Proc. 1860, p. 307.

——— Descriptions of Three new Species of Exotic Unionidæ. Phil. Acad. Proc. 1860, p. 307.

MÜLLER, FRITZ.—Beschreibung einer Brachiopodenlarve. (plate.) Arch. Anat. 1860, p. 72. Ann. N. H. 3 ser. vi. p. 310.

PRINCE, TEMPLE.—Descriptions of new Species of *Cyrena* and *Corbicula*, in the Cabinet of the Academy of Natural Sciences at Philadelphia. Phil. Acad. Proc. 1860, p. 80.

Römer (E.) Beschreibung neuer Venus-arten. Mal. B. iv. p. 148.
Voit, Carl.—Anhaltspunkte für die Physiologie der Perl-Muscheln. Z. W. Z. x. 470.
Vrolik.—Rapport sur le Taret. A. S. N. xiii.

4. *Molluscoida.*

Aplin, C. D'Oyley, H.—Freshwater Polyzoa, in Australia. A. N. H. 3 ser. vi. p. 454.
Busk, Geo. —List of Marine Polyzoa, collected by George Barlee, Esq., in Shetland and the Orkneys, with Descriptions of the new Species. Rep. Brit. Assoc. 1859. Trans. Sect. p. 144.
——— Descriptions of new Species of Polyzoa, collected by George Barlee, Esq., in Shetland. Q. J. Mic. Sc. (Zoophytology), viii. p. 123, 143, 213.
——— Catalogue of the Polyzoa, collected by J. Y. Johnson, Esq. at Madeira, in the years 1859 and 1860. Q. J. Mic. Sc. (Zoophytology), viii. p. 280.
Claparède, Ed.—Beiträge zur Fauna der Schottischen Küste. Z. w. Z. xx. p. 401.
Contain: 1. On the Sexual propagation of Medusæ by Medusæ.
2. On the "Haus" of *Appendicularia.* M. Claparède noticed this structure universally in *Appendicularia Cophocerca*, taken abundantly in Lamlash Bay. He describes it as resembling a very transparent bivalve shell of an oval form. That it is not a nidamental organ, as suggested by Allman, is shown by its occurrence, in M. Claparède's experience, only in males.
3. "Die hutförmige Larve." A microscopic creature, shaped like a French officer's cap, the concavity and lower border are covered with cilia. The lower border is toothed and marked with reddish granules. From the middle of the concavity projects a bundle of about 40 long setæ, which the animal has the power of spreading out or closing together. Each seta is bulbous at the free extremity and beset with short spines. M. Claparède thinks it probable that the creature represents an Annelid Larva.
Hincks, Thos.—Descriptions of new Polyzoa, from Ireland. Q. J. Mic. Sc. (Zoophytology), viii. p. 275.
Houghton, W.—Note on *Fredericella Sultana*, being found in the winter. Ann. Nat. Hist. 3 ser. vi. p. 389.
Huxley, T. H.—Observations on the Development of *Pyrosoma.* Ann. N. H. 3 ser. ii. p. 29, (Abstract of Observations laid before the Linnean Society, Dec. 1, 1859).
——— On the Anatomy and Development of *Pyrosoma.* Linn. Trans. xxiii. p. 193.
Keferstein, W., and Ehlers, E.—Anatomie und Entwickelung von *Doliolum.* Wiegm. Arch. I. 1860. p. 334. (from Gött. Nachr. 1860—No. 23, 25-26.)
M'Gillivray, P. H.—Notes on the Cheilostomatous Polyzoa of Victoria and other parts of Australia. (plates). Vict. Trans. 1860, p. 159.

Müller, Fritz.—Das Kolonialnervensystem der Moosthiere, nachgewiesen an *Serialaria Coutinhii*, n. sp. Wiegm. Arch. I. 1860. p. 311.

Murray, A.—Notice regarding the Branchial Sac of the simple Ascidiae. R. S. E. Proc. 1860, p. 271.

——— On Darwin's Theory of the Origin of Species. R. S. E. Proc. 1860, p. 274.

Wallich, G. C.—On the Siliceous Organisms found in the digestive cavities of the *Salpæ*, and their relation to the Flint Nodules of the Chalk Formation. Transactions Mic. Soc. in Q. J. Mic. Sc. viii. p. 36.

XXXIV. Cœlenterata.

1. *Actinozoa.*

Danielsen.—Om.—*Virgularia elegans*, n. sp.
„ „ *Pennatula aculeata*, n. sp. ?
„ „ *Cerianthus borealis*, n. sp.
„ „ *Sipunculus pyriformis*, n. sp.

Edwards, H. Milne.—Histoire naturelle des Coralliaires, ou polypes proprement dits. Vol. iii. 8vo. Paris. Plain, 8*s* ; col. 10*s* 6*d*

A complete monograph of the *Zoantharia, Rugosa* and *Alcyonaria.* All the species and genera of these groups known to the author are fully described. There is a general introduction on the organization of the Polypes. These form the class *Coralliaria*, divided into the sub-classes *Cnidaria* and *Podactinaria.* The *Cnidaria* include two orders, *Alcyonaria* and *Zoantharia.* Of *Alcyonaria* are distinguished three families, *Alcyonidæ*, *Gorgonidæ*, and *Pennatulidæ.* In this order Prof. Milne Edwards establishes a new genus, *Haimeia*, in honour of his recently deceased colleague. The single species, *H. funebris*, has a further interest in being the only recorded example of a solitary Alcyonarian. The *Zoantharia* are arranged under three suborders: *Malacodermata*, *Sclerobasica*, and *Sclerodermata.* All the *Malacodermata* are divided into two families, the *Actiniadæ*, with tentacles alternate, and the *Cerianthiidæ*, having two rows of opposite tentacula. This portion of the work is, perhaps, the least perfect in its systematic details. Of *Sclerobasica* there is but one family, *Antipathidæ.* The numerous families of *Sclerodermata* fall under five principal sections: *Aporosa*, *Perforata*, *Tubulosa*, *Tabulata*, and *Rugosa.* The sub-class *Podactinaria* is equivalent to the family *Lucernariadae* of other authors.

A short chapter is added on the geographical distribution of the Polypes.

There are, also, three fasciculi of Plates, representing some of the forms described in the text.

Ehrenberg, C.—Beiträge zur Beurtheilung der wunderbaren japanischen Glaspflanze, der Sogenannten Corallenthier-Gattung *Hyalonema*, und der Familie der Hyalochætiden. Berl. Monats. 1860, p. .

Gosse, P. H.—Actinologia Britannica: a History of the British Sea Anemones and Corals.

The recent British *Actinoida* (= *Zoantharia* s. *Helianthoida*) are here minutely described, and illustrated by numerous coloured figures. The author distinguishes seventy-five species, and adds definitions of the principal varieties of each. All the species receive English names. A tendency is shown to multiply unduly the number of genera and families. A detailed account is given of the anatomy of the *Actiniæ*, which contains some new facts, especially with regard to their stinging apparatus. The most valuable part of the work is that which treats systematically of the non-adherent forms. Under the name of 'conchula' a curious organ is described, which appears to be a modification of the oral extremity of the single gonidial groove in some of these creatures.

A table is appended, showing the distribution of the species, so far, at least, as at present known, around the different parts of our coast.

Gray, J. E.—Revision of the Family Pennatulidæ, with Descriptions of some new species in the British Museum. With figures. A. N. H. 3 ser. v. p. 20. Jan. 1860.

Dr. Gray divides this family into five tribes: *Funiculineæ* (Junciformes), *Pennatuleæ* (Penniformes), *Kophobelemnonieæ* (Claviformes), *Veretilleæ* (Veretilloids), and *Renilleæ*. The memoir of Herklats (Bidj. t. d. Dierkunde, part vij. 1858) is made "the basis of this communication." Two plates are added, representing *Sarcoptilus simosus, S. Gurneyi; Sarcobelemnon Australasiæ*, and *Renilla sinuata*.

——— On the Genus *Hyalonema*. A. N. H. 3 ser. v. p. 229.

Dr. Gray, following Brandt, regards *Hyalonema* as a Zoantharian, and not, as he first supposed, a genus allied to *Gorgonia*. He believes that the living *Hyalonema* finds its proper habitat in a peculiar kind of Sponge, within the substance of which one end of the coral is firmly embedded. He thinks also that the two species of *Hyalonema*, and one of *Hyalochæta*, described by Brandt, may, possibly, be varieties of the same form.

——— Notice of some new Corals from Madeira, discovered by J. Y. Johnson, Esq. Ann. N. H. 3 ser. vi. p. 311.

These Corals are: *Corallium Johnsonii*, allied to *C. rubrum; Antipathes gracilis*, a fan-like branching species, about six inches high; and *A. setacea*, which has a straight elongate corallum, covered with numerous short conical spinules. Its length is 18 inches. A variety of this last (*β. occidentalis*), which may prove a distinct species, has also been received from Turk's Island,

West Indies. This curious form has a slender whip-like corallium more than nine feet in length.

GRAY, J. E.—Description of a new Species of *Distichopora* from New Caledonia. Proc. Zool. Soc. 1860, p. 244.

A palmated Coral, which differs from *D. violacea* in its bright red tint, and the more compressed, broader, form of its stem and branches; their shelving edges giving the species "a rather sword-like appearance." The much smaller cells, and narrower lateral cell grooves also distinguish it.

HORN, G. H.—Descriptions of new Corals in the Museum of the Academy. Phil. Acad. Proc. 1860, p. 435.

MÜLLER, FRITZ.—On *Philomedusa Vogtii*, a parasite on Medusæ. A. N. H. 3 ser. vi. p. 432. (From W. Arch. 1860, p. 57.)

This is a free Zoantharian allied, we think, to *Peachia* of Gosse. It was first found "adhering singly to the lower surface of the disc in *Olindias* (nov. gen. *Eucopidarum*), and afterwards in plenty upon *Chrysaora*, in which it dwells on the arms, in the sexual cavities, and in the stomach and its sacs." None of the specimens contained ova or spermatozoa. Rows of minute orifices, leading into the grand cavity, were distinctly seen to radiate from the hinder end of the body.

VALENCIENNES, A.—Observations sur les espèces de Madrépores en corymbes. Compt. rend. Tom. l. pp. 1008-9. Ann. N. H. 3 ser. vi. p. 79. (Figures.)

M. Valenciennes here reviews some of the species of *Madrepora*. The American forms of this genus, though sufficiently distinct, he considers analogous with those found under corresponding latitudes in the Eastern hemisphere.

2. *Hydrozoa*.

ALDER, JOSHUA.—Description of a Zoophyte and two species of Echinodermata, new to Britain. (With Figs.). Ann. N. H. 3 ser. v. p. 73.

The Zoöphyte here described is *Campanularia fastigiata*, a minute parasitic species allied to *C. syringa*, from which it chiefly differs in the curious form of the lid closing the orifice of its hydrotheca, or polype-cell. This, "when closed, slopes down on each side like the roof of a house, the two opposite angles forming the gables. When the operculum is fully open, the folds disappear, and the edges unite into a continuous rim round the top of the cell."

ALLMAN, GEO.—On the Structure of *Carduella cyathiformis*. A contribution to our knowledge of the Lucernariadæ. Q. J. Mic. Soc. viii. p. 125.

The structure of this species (= *Lucernaria cyathiformis*) is detailed, and compared with that of a gymnophthalmatous Medusid. The author does not fully estimate the closer affinity of the *Lucernariadæ* to the *Steganophthalmata*.

Allman, Geo.—Note on the Structure and Terminology of the Reproductive System in the *Corynidæ* and *Sertulariadæ.* Ann. N. H. 3 ser. vi. p. 1.

A re-statement of the views contained in the author's previous papers on the same subject, and a reply to certain objections urged against part of his terminology by Prof. Huxley.

——— Note on *Carduella cyathiformis.* Ann. N. H. 3 ser. vi. p. 40.

Prof. Allman distinguishes three genera of *Lucernariadæ:*—*Lucernaria,* Müller; *Carduella,* Allman (= *Calicinaria,* Milne Edwards); and *Depastrum,* Gosse.

——— On *Dicoryne stricta,* a new Genus and Species of the Tubulariadæ. Rep. Brit. Ass. 1859. Trans. Sect. p. 142.

This form resembles *Hydractinia* in habit, and in the structure of its proliferous stalks, or gonoblastidia, around the bases of which are clustered the reproductive buds. But one specimen, a male, was dredged at Orkney, from a depth of about three fathoms.

——— On *Laomedea tenuis,* n. sp. Rep. Brit. Ass. 1858. (Trans. Sect. p. 143.)

A delicate species akin to *L. lacerata,* from which it differs in having branches equal to the main stem in thickness, and in the form of its reproductive capsules, which give rise to free medusiform gonophores.

——— On the Structure of the Lucernariadæ. Rep. Brit. Ass. 1859. Trans. Sect. p. 143.

Boeck, Chr.—Beskrivelse over en Tubularie fra Belsund paa Spitzbergen—*Tubularia regalis.* Forh. Vid. Selsk. (Aar. 1859) 1860, p. 114.

Claus, C.—Ueber *Physophora hydrostatica* nebst Bemerkungen über andere Siphonophoren. Z. w. Z. x. p. 295.

The structure of the swimming organs (nectocalyces), with their curiously convoluted canals, and of the tentacular apparatus, receives the author's special attention.

Gegenbaur, K.—Neue Beiträge zur näheren Kenntniss der Siphonophoren. 7 plates. 4to. Jena, 1860.

Gosse, P. H. — On the *Lucernaria cyathiformis* of Sars. Ann. N. H. 3 ser. v. p. 480.

Mr. Gosse makes of this form a new genus, *Depastrum,* which he considers identical with *Carduella* of Allman, and claims, therefore, priority for his own term. But see Allman, above.

Greene, J. Reay.—On *Sertularia tricuspidata.* Ann. N. Hist. 3 ser. v. p. 431.

This name, given by Mr. A. Murray to a Californian Sertularian, had previously been applied by Mr. Alder to a British form of that genus. Mr. Murray has since corrected his misnomer, and called his new species "*S. Greenei.*" (See Murray).

Jäger.—Ueber das spontane Zerfallen der Süsswasserpolypen nebst

einigen Bemerkungen über Generationswechsel. Plate. Vien. Sitz. 60.

Three specimens of *Hydra* were isolated in small vessels. One of these, which did not produce buds, died. The two others, furnished with buds, spontaneously broke up into fragments which, after the expiration of a month, were observed to move like Amœbæ, and even multiply by self-division, while some passed into a state resembling the encysted condition of certain *Infusoria*. Thus, it is conjectured, they may remain throughout the winter, and, in spring time, become changed into perfect Hydræ.

HOUGHTON, W.—On the *Hydra rubra* of Mr. Lewes.

KEFERSTEIN, W., and EHLERS, W.—Auszug aus den Beobachtungen über die Siphonophoren von Neapel und Messina, angestellt im Winter 1859-60. Wiegm. Arch. I. 1860. p. 324. (from Gött. Nachr. 1860. No. 23-25-26.

LEWES, G. H.—On a new British Species of *Hydra*. Ann. Nat. Hist. 3 ser. v. p. 71.

Hydra rubra only differs from *H. vulgaris* in its colour, which, according to Mr. Lewes, it retains in captivity for weeks, and transmits to its numerous free buds.

MURRAY, AND.—Description of new Sertulariadæ from the Californian coast. (With Figs.) Ann. N. H. 3 ser. v. p. 250.

The three species of *Sertularia*, and two of *Plumularia*, described in this paper, were taken in the Bay of San Francisco. With one exception, they closely approach some British forms of the same genera.

——— On *Sertularia tricuspidata (Greenei)*. Ann. Nat. H. 3 ser. v. p. 504.

PRICE, JOHN.—On the Genus *Cydippe*. Rep. Brit. Ass. 1839. Trans. Lect. p. 155.

Mr. Price tells us that he has kept the delicate *Cydippe pileus* in captivity for thirteen months. The fact is note-worthy, and should be taken advantage of by those who wish to study the structure of these animals.

VAN BENEDEN.—On the Strobilation of the Scyphistomata. Ann. N. H. 3 ser. v. p. 504. From Bull. Ac. Roy. Belg. 2me ser. vii.

A confirmation of Sar's well known observations, with which, hitherto, Van Beneden had not been disposed wholly to agree.

SARS.—Udtog af en Anhandling om Ammeslægten *Corymorpha* og dens Arter Samt de af disse opammende Meduser. Forhand. Vedensk. Selskabet, Aar. 1859, (1860), p. 95.

XXXV.—PROTOZOA.

CLAPARÈDE, E. et J. LACHMANN.—Études sur les Infusoires et les Rhizopodes. (Tome 1er en 3 livraisons.) Tom. I. Parts 1, 2. 24 plates. 4to. Geneva, 1860.

Engelmann, F. W.—Ueber Fortpflanzung von *Epistylis crassicollis, Carchesium polypinum, &c.* Plate. Zeitschr. w. Z. x. 2.

Lecoq, H.—Observations sur une grand espèce de Spongille du Lac Pavin (Puy de Dôme). Compt. rend., Tom. l. pp. 1116-21 and No. 26, June 25, pp. 1165-70.

These observations relate chiefly to the colour, spicules, and sarcode substance of what is believed to be a new species of fresh-water sponge. Little is said of the reproductive bodies.

Lemaire, N.—Sur le rôle des Infusoires et des matières albumineuses dans la fermentation, la germination, et la fécondation. Comp. rend. LI. p. 536, 627.

"I think, (says M. Lemaire), that the Infusoria so abundantly diffused in nature, and which have been proved to occur in the seminal fluid of almost all known animals, and in the male organs of nearly every plant, constitute the *primum movens* of the phenomena of fermentation, of germination, and of fecundation, but that, for their action to manifest itself, contact (réunion) with albuminoid matters seems indispensable."

Parker, W. K., and Jones, T. R.—On the Nomenclature of the Foraminifera. Ann. N. H. 3 ser. v. p. 98-174, 285-466, vi. p. 29, 337.

A continuation of a series of papers in previous departments of the same subject. The species mentioned by Fichtel and Moll, Lamarck and Denis de Montfort, are here reviewed.

Pritchard, A.—History of Infusoria, including Desmidiaceæ and Diatomaceæ, British and foreign, 4th ed. enlarged and revised by J. T. Arlidge, W. Archer, J. Ralfs, W. C. Williamson and the author. 40 plates. 8vo. 1860. coloured, 50*s*; plain, 36*s*.

A notice of this work appeared in the last number of the Natural History Review, p. 121.

Retzius, A.—Ueber Trompetenthierchen als Röhrenbewohner. L. Nat. 1860.

Schultze, Max.—Die Gattung *Cornuspira* unter d. Monothalamien, u. Bemerkungen über d. Organisation u. Fortpflanzung d. Polythalamien. Wiegm. Arch. 1860. I. pp. 3-287.

——— Sur une nouvelle espèce d'éponge (*Hyalonema*) prise pour une polype. Compt. rend., Tom. L. pp. 792-3.

M. Max Schultze differs from M. Brandt and Dr. Gray as to the nature of *Hyalonema*, which he regards as a true sponge, not a polype parasitic on sponges.

Stein (F.) der Organismus der Infusionsthiere nach eigenen Forschungen in systematischer Reihenfolge bearb. Vol. I. Allgemeiner Theil u. Naturgeschichte der hypotrichen Infusionsthiere. 14 plates. Folio. Leipz.

Valenciennes, A.—Note sur les Spongiaires envoyés des côtes de l'Attique, par M. Albert Gaudry. Comp. rend. LI. p. 579.

The name *Adythia* is proposed for a genus of Sponges, characterized by the ready solubility of their entire substance in

weak alkaline ley, and by the absence of a reticulated structure. One species of *Adythia* has been obtained from Attica, another from the Morea, and a third from the Red Sea.

XXXVI.—Physiology and Human Anatomy—including Histology.

1. *General and Mixed.*

Adrian, A.—Ueber Diffusions-geschwindigkeit und Diffusions æquivalente bei getrockneten Membranen. Eckhard's Beitrag. Z. An. u. Phys. ii. p. 186.

Beale, Lionel S.—Some points in support of our belief in the permanence of Species, and on the very limited application of the doctrine of their Origin by Natural Selection. Phil. Journ. xii. p. 233.

Bischoff.—Ueber eine Arbeit von Voit: Die thierischen Kraftäusserungen in ihrem Zusammenhange mit dem Stoffwechsel. Mun. Sitz. 1860, II.

Bois-Reymond, Emil. du.— Untersuchungen über thierische Elektricität. Vol. ii. part 2, 8vo. plate. Berlin.

Boudin, M.—On the Non-Cosmopolitanism of the Human Races. Jour. Physiol. 1860, p. 363.

Bree, C. R.—Species not transmutable, nor the result of secondary causes. 8vo.

Brière de Boismont.—Recherches sur l'unité du genre humain, au point de vue de l'éducation et des croisements pour l'amélioration des races. 8vo. Paris.

Broca, P.—Études sur les animaux ressuscitants. Rapport lu à la Société de biologie. Plates. 8vo. Paris.

——— On Hybrid Phenomena in the Human Race. (Conclusion). Jour. Physiol. 1860, p. 392-439.

Budge, J.—Lehrhuch der speciellen Physiologie d. Menschen. 8. gänzlich umgearb. Aufl. Part i. 5 plates. Royal 8vo. Weim. 1860.

Chauveau, A.—Theorie des Effets physiologiques produits par l'electricité transmise dans l'organisme animal, à l'etat de courant instantané et à l'état de courant continue. Arch. d. Sc. Phys. et Nat. ix. p. 410. Journ. d. Physiol. 1860, pp. 52, 274, 300, 458, 472.

Collingwood, Cuthbert.—On Homomòrphism. Liverpool Lit. and Phil. Soc. Proc. No. xv. 180, 216.

——— On Recurrent Animal Form, and its Significance in Systematic Zoology. Ann. N. H. 3 ser. vi. p. 81.

Crisp, Dr. E.—On the Causes of Death of the Animals in the Society's Gardens, from 1851 to 1860. Proc. Zool. Soc. 1860, p. 175, 190.

Czermak.—Kleine Mittheilungen aus d. physiol. Inst. zu Pest. Abth. 2, 3. Vien. Sitz. 60.
Dalton, J. C.—Treatise on Human Physiology, designed for the use of Students and Practitioners of Medicine. 8vo. New York, 1861.
Davy, John.—Miscellaneous Observations on the Tadpole; the albumen of newly-laid Eggs; the growth of Birds, their specific gravity; and on the Stomach of Fishes in relation to Digestion. Edinburgh New Phil. Jour. 1860, xi. 252, 271.
Eckhard, C.—Beiträge zur Anatomie und Physiologie. Vol. 2, Pt. 2. plate. 4to. Giessen.
——— Ueber Diffusions-geschwindigkeit durch thierischen Membranen (Fortsetzung). Ib. p. 159.
Edwards, H. Milne.—Leçons sur la Physiologie et l'Anatomie comparée de l'homme et des animaux, faites à la Faculté des Sciences de Paris. Tome v. Part 2, and Tome vi. Part 1. 8vo. Paris.
Funke, O.—Lehrbuch der Physiologie f. akademische Vorlesungen. 3rd edition. 3 vols. 8vo. Leipzig, 1860.
Gervais, P.—De la métamorphose des organes, et des générations alternantes dans la série animale et dans la série végétale. 8vo. Montpellier, 1860.
Giraudet, E.—Exercices anatomiques et physiologiques, 8vo. Paris, 1860.
Guerry, M.—Cas d'hypnotisme chez des oisseaux décrits des 1646, par le P. Kircher. Compt. Rend. L. p. 166.
Henle u. Meissner.—Bericht üb. die Fortschritte der Anatomie u. Physiologie, 1859. 3 parts, 8vo. Leipzig, 1860.
Jeffreys, J. Gwyn.—On the Origin of Species. Ann. N. Hist. 3 ser. vi. p. 152.
Inman, Thomas.—Adaptability to altered circumstances, an attribute of life. Liverpool Lit. and Phil. Soc. Proc. No. xiv. p. 63, 77.
Jürgensen, Theod.—Ueber die Bewegung fester, in Flussigkeiten suspendirter Körper unter dem Einfluss des Elektrischen Stroms. (with reference to cyclosis in plants). Arch. Anat. 1860, p. 673.
Kirkes, W. S.—Handbook of Physiology. 4th edition. 8vo. London, 1860.
Köstlin, O.—Ueber die Unveränderlichkeit der organischen Species. 4to. Stuttgart, 1860.
Lehmann, L.—Zur Würdigung der physiol. Wirkung der sitzbäder. Moleschott's Untersuchungen. vii. 3.
Controversial papers on the same subject by Radicke and Böcker in the same work, vii. 5.
Lewes, George Henry.—The Physiology of Common Life, in two volumes. W. Blackwood and Sons.
——— Studies in Animal Life. Cornhill Mag. Vol. i.
Liebermeister, Dr.—Physiologische Untersuchungen über die quantitativen Veränderungen der Wärmeproduction. Arch. Anal. 1860, p. 520-589.

LONGET, F. A.—Traité de Physiologie, deuxieme edition, revue, corrigée et augmentée. T. II, avec 70 figures dans le texte et 3 planches in taille-douce. 8vo. Paris.

LUDWIG, C.—Lehrbuch der Physiologie d. Menschen. 2nd edition. Vols. i. ii. 8vo. Leipzig, 1850-60.

PANUM, P. L.—Untersuchungen über die Entstehung von Missbildungen, zunächst in den Eiern der Vögel. 12 plates. 8vo. Berlin, 1860.

ROLLETT, AL.—Ueber die Eiweiss Körper des Bindegewebes. Moleschott's Untersuchungen, vii. 2.

ROUGET, CHARLES.—Notes on several questions of Anatomy and Physiology. 1. On the Movements of the Iris—2. Action of Nicotine on the Heart—3. On the Gubernaculum Testis. Jour. Physiol. 1860, p. 568, 571.

VIERORDT, K.—Grundriss der Physiologie d. Menschen. 192 Engravings. roy. 8vo. Tubing. 1861.

WALLER, AUGUSTUS.—Researches on the influence of certain agents with regard to the rapidity of Cutaneous absorption. Jour. Physiol. 1860, p. 443, 448.

2. *Nervous System and Organs of Sense.*

ARNOLD, FRED.—Icones Nervorum Capitis. Ed. altera atque emendatior. 4to. Heidelberg, 1860.

BAXTER, H. F.—On Nerve Force. Phil. Jour. xii. p. 22.

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BEZOLD, ALB. v.—Untersuchung über die Einwirkung des Americanischen Pfeilgiftes (Curare) auf das Nervensystem. 2te Abhandl. Arch. Anat. 1860, pp. 168, 387.

BOIS-REYMOND, E. du.—Anmerkung an dem Aufsatz von J. Budge "Ueber den Stillstand des Herzen durch Vagusreizung." Arch. Anat. 1860, p. 261.

——— Abänderung des Stenonschen Versuches für Vorlesungen. Arch. Anat. 1860, p. 639.

——— Ueber d. angebliche Fehlen d. unipolaren Zuckung bei dem Schliessungs-induktions Schlage. Arch. Anat. 1860, p. 857.

BROWN-SEQUARD.—Experimental Researches on the Physiology of the Medulla oblongata. Jour. Physiol. 1860, p. 151-157.

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His, Prof.—Beiträge zur Kenntniss der zum Lymphsystem gehörrigen Drüsen. Z. W. Z. x. p. 295.

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In all these organs, as has been long known, the essential glandular parenchyma is constituted in a similar manner. It is subdivided by connective-tissue dissepiments into more or less numerous portions, which are sometimes only imperfectly separated. The walls of these *alveoli*, *acini*, or *follicles*, support the larger arterial and venous vessels, which send off fine capillary

branches into the interior of the spaces, and which by their anastomoses constitute a rather loose plexus, in the midst of which in some cases a central space is left. Among these capillaries and in connection with them, and with the connective tissue of the septa, is found an extremely close, but at the same time very delicate network composed, if not exclusively, yet for the most part of anastomosing cells; and in the meshes of this plexus the well known forms of Lymph-corpuscles are lodged.

This fine network, was supposed by Eckhard to represent a system of serous canals communicating directly with the blood vessels. But Heidenhain, was unable to trace any communication of the kind by means of injection, and Prof. His, has fully satisfied himself, after numerous observations, that no such connexion really exists.

A minute account of the structure of the Thymus gland is given, and the results of the author's and of Friedleben's observations respecting its functions are stated. Prof. His considers that lymph-corpuscles are continually formed by the division of the cell-like bodies contained in the capsules of the *acini*, and that these corpuscles gradually find their way into the central canal, and are conveyed by special canals into the lymphatics, and ultimately into the blood where they are converted into red corpuscles.

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The author concludes:

1. That the chorda dorsalis does not exist in the first and half of the second days of the formation of the embryo of birds.

2. That the "secondary line" which has been personified under that name, represents a free interval lying between the internal borders of the primitive folds; the line being inflected with the folds in the formation of the cephalic hood.

3. That this secondary line, or the interval of the primitive folds, should not be regarded as the rudiment of any body whatever, since light traverses it readily when viewed under the Microscope.

4. It follows, therefore, that if the *chorda dorsalis* does not exist in the first day of the formation of the embryo, *it is not, nor can be, the axis around which the primitive parts of the fœtus are subsequently formed.*

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——— Des Espéces perdues et Races qui ont disparu des lieux qu'elles habitaient primitivement, depuis ou avant notre existence. Soc. Geol. Bull. xvii. p. 262.
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Taylor, J.—Fossil Fruit from the Upper Coal Measures, near Bolton. Geol. 1860.

Trautschold, H.—Ueber Petrefakten vom Aralsee. (Fig.) Mosc. Bull. 1859, p. 303.

Unger, F.—Die Pflanzenreste der Lignit-Ablagerung von Schönstein. Vien. Sitz. 60.

——— Die versunkene Insel Atlantis. Die physiologische Bedeutung der Pflanzencultur. 8vo. Vien.

Verneuil, de Collomb, Triger, et Cotteau.—Sur une partie du pays Basque Espagnol, suivie d'une Description de quelques Echinodermes. (Fig.) Soc. Géol. Bull. xvii. p. 333.

——— et Caux.—Sur des ossemens fossiles et des silex taillés trouvés dans la sabliére de Precy (Oise.) Soc. Geol. Bull. xvii. p. 555.

Vibraye, Marquis de.—Sur la decouverte d'un nouveau gisement de vertebres à Chitenay (Loix et Cher.) Soc. Géol. Bull. xvii. p. 413.

——— Sur les Ossemens fossiles et une mâchoire humaine trouvés dans les grottes d'Arcy sur Yonne. Soc. Geol. Bull. xvii. 462.

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Wagner, A.—Neue Beiträge z. Kenntniss der fossilen Säugethier. Ueberreste von Pikermi. 17 plates. Mem. Abh. Acad. viii. 1.

——— Neue Beiträge z. Kenntniss der urweltlichen Fauna d. lithographischen Schiefers (Saurier.) 6 plates. Mem. Abh. Acad. viii. 1.

——— Monographie der fossilen Fische des lithographischen Schiefers. Mün. Gel. Anz. xlix. p. 9.

——— Ueber einige im lithogr. Schiefer neu aufgefundene Schildkröter und Saurier. Mün. Gel. Anz. xlix. p. 553.

——— Die Griffelzähner (*Stylodontes*). Mün. Gel. Anz. l. p. 81.

——— Das Vorkommen eines fossiles Fisches, im Jura-dolomite. Mün. Gel. Anz. l. p. 102.

——— Charakteristik der Gattungen *Sauropsis* und *Pachycormus* nebst ihren Verwandten. Mün. Gel. Anz. l. p. 209.

——— Vergleichung der urweltlichen Fauna des lithographischen Schiefers von Cirin mit den gleichnämigen Ablagerungen im Frankischen Jura. Mün. Gel. Anz. l. p. 390.

——— Ueber die Verschiedenheit der Arten von *Ichthyosaurus.* Mün. Gel. Anz. l. p. 412.

——— Ueber die Arten von Fischen und Sauriern welche im untern wie im obern Lias zugleich vorkommen sollen. Mün. Sitz. 1860, p. 36.

Wagner, A.—Ueber fossile Fische aus einem neuentdeckten Lager in der Südbayerischen Tertiärgebilden. Mün. Sitz. 1860, p. 52.

——— Ueber fossile Säugethierknochen am Chimborazo. Mün. Sitz. 1860, p. 330.

——— Die fossilen Ueberreste von nackten Dintenfischen aus dem lithographischen Schiefer und dem Lias des süddeutschen Juragebirges. (Fig.) Mün. Abh. viii. p. 749.

Wallich, G. C.—On Siliceous Organisms found in *Salpa*, and their relation to the Flint Nodules of the Chalk. Q. J. M. S. viii. p. 36.

Weld, F. A.—Egg of Dinornis and Human Skull. Phil. Journ. xi. p. 164.

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Wood, H. C. Jun.—Contributions to the Carboniferous Flora of the United States. Phil. Acad. Proc. 1860, p. 236.

——— Catalogue of Carboniferous Plants in the Museum of the Academy of Natural Sciences, with corrections in Synonymy, descriptions of new species, &c. Phil. Acad. Proc. 1860, p. 436.

Woods, J. F.—On some Tertiary Rocks in the Colony of South Australia. With notes on the Fossil Polyzoa and Foraminifera, by G. Busk, T. R. Jones, and W. R. Parker. Geol. Journ. xvi. p. 253.

Woodward, S. P.—An Ammonite with operculum in place. Geol. Ap. 1860.

Wright, Thos.—On the subdivisions of the Inferior Oolite in the South of England, compared with the Equivalent Beds of that formation on the Yorkshire Coast. Geol. Journ. xvi. p. 1.

——— On the Zone of *Avicula contorta*, and the Lower Lias of the South of England. Geol. Journ. xvi. p. 374.

Zeuschner, L.—Palaeontologische Beiträge zur Kenntniss des weissen Jurakalkes von Inwald bei Wadowice. 4 plates. Prag. Abh. x.

——— Die Brachiopoden d. Stramberger Kalkes. L. and B. Jahr. 1860. 6.

Zigno, Achille de, and Bunbury, C. J. F.—Some Observations on the Flora of the Oolite. Geol. Journ. xvi. p. 110.

Zimmermann, K. G.—Die Tertiar-Versteinerungen am Brothener Strande bei Travemünde. Jahrb. f. Mün. 1860. 3.

Botanical Bibliography,

1860.—*(Continued.)*

XXXVIII.—Phanerogamia.

Ambrosi, Fr.—Flora del Tirolo Meridionale. Vol. ii. Parts 3 and 4. 8vo. pp. 321-820.

(Dipsaceæ (pars), Compositæ, Campanulaceæ, Rubiaceæ.)

Species occurring in the North of Italy, but absent from South Tyrol, are also described in Appendices.

Brachyaster is substituted for the generic name *Bellidiastrum*.

ANDERSON, THOMAS.—Florula Adenensis. A systematic Account, with Descriptions, of the Flowering Plants hitherto found at Aden. Linn. Proc. v. (Suppl.) pp. 71. With 6 plates.

The descriptive portion of this paper is preceded by a short essay on the physical features and climate of Aden; some of the peculiarities of its flora, its general relations, and the geographical distribution of the species. The total number of natural orders found at Aden is 42; of genera, 80; species, 95. The proportion of species to natural orders, 2·29:1. But eleven of the 95 species are monocotyledons, and of these nine are grasses. Fourteen species are endemic. Dr. Anderson unites all the described species of *Fagonia* with the Linnæan F. *cretica*.

ARDOINO, HONORÉ.—De l'Annexion du Comté de Nice à la France au point de vue de la Botanique. Bull. Soc. Botan. Tom. vii. pp. 317-320.

With a list of 40 species found in Nice and Monacho, and not occurring in the 'Flore de France' of Grenier and Godron.

BAILLON, H.—Études sur la Structure et le développement de la fleur des Philésiacées. Rec. d'Obs. Bot. 1860, Oct. pp. 44-49.

——— Remarques sur l'Androcée des *Asarum* et sur les appendices qui tiennent la place des pétales dans *l'A. europaeum*, pp. 55-57.

BALL, JOHN.—Notes sur quelques Crucifères. Bull. Soc. Botan. Tom. vii. pp. 227-231, 247-252.

Mr. Ball observes that the more the genera of Cruciferæ are studied with ample suites of specimens, the less possible does it become to base their classification upon positive characters.

Apropos of this paper M. Cosson observed that characters derived from the relative position of the radicle and the cotyledons, and the form of the latter, are less constant than has been generally conceived.

BEDDOME, R. H.—Report on the Vegetable Products of the Pulney Hills. (Extract from Madras Journal). pp. 40.

BENTHAM, GEORGE.—Notes on Ternstrœmiaceæ. Linn. Proc. v. pp. 53-65.

Consisting, in part, of critical observations on the "Mémoire sur les Ternstrœmiacées et les Camelliacées" published by M. Choisy in 1855; in part, the result of a recent revision of the genera for the "Flora of Hong-Kong," and the "Genera Plantarum," in course of preparation by the author in conjunction with Dr. Hooker.

The separation of Ternstrœmiaceæ from Camelliaceæ, as proposed by Choisy, Mr. Bentham objects to as unnatural and not sustained by any positive character.

Saurauja with the allied genera *Actinidia* (referred by Dr. Lindley to Dilleniaceæ) and *Stachyurus*, are appended to Ternstrœmiaceæ as a small separate tribe. *Scapha*, Ch. and *Draytonia*, A. G. are united with *Saurauja*. *Thea*, as modified by Seemann, is regarded as a section of *Camellia* rather than as generically distinct. *Haploclathra*, a new genus founded on opposite-leaved species of *Caraipa*, and *Marila*, are referred to Bonnetieæ as anomalous members. *Visneaceæ*, Ch. is incorporated with Ternstrœmiaceæ. *Pentaphylax* is appended to the same tribe.

Ixionanthes and *Ochthocosmus*, Mr. Bentham excludes from the order. He considers them allied to Saxifrageæ. Marcgraaviaceæ, Juss. are included in Ternstrœmiaceæ proper ;—the genus *Antholoma*, which has been associated with this group, De Labillardière's figure would indicate to be a *Bassia*.

Tristylium, Turcz. is reduced to *Cleyera*, and *Kowalewskia*, published as Ternstrœmiaceous by the same botanist, is a Mexican *Clethra*. Descriptions of the species of *Caraipa*, and of four new Ternstrœmiaceæ, collected by Mr. Spruce, are appended to this paper.

Bentham, George.—Notes on Anonaceæ. Linn. Proc. v. pp. 67-72.

Referring especially to the American species. Mr. Bentham, with Dr. Hooker, proposes to suppress the tribe *Anoneæ*, uniting it with *Xylopieæ*. *Oxymitra*, *Phæanthus* and *Monodora* are included in the modified tribe *Mitrephoreæ*.

Guatterieæ takes the name of *Unoneæ*, the American genus *Guatteria* belonging to the *Uvarieæ*, which are characterized by petals imbricate in æstivation. The Asiatic species which have been referred to *Guatteria* are reduced to *Polyalthia*.

Guatteria heteropetala, Benth., allied to *Phæanthus*, is separated as the type of a new genus—*Heteropetalum*, as is also *Uvaria brasiliensis*, Vell., under the name *Cymbopetalum*.

New species of *Trigyneia* and *Bocagea* are described from South America and a *Monodora* from the Niger. The ovary of the latter genus Mr. Bentham finds to consist of numerous carpels, as indicated by its longitudinal furrows and the curvatures or lobation of the peltate centrical stigma.

——— Botanical Memoranda. Linn. Proc. v. pp. 73-8.

1. Involucre of *Anemone*. Regarded as a single amplexicaul leaf divided to the base into distinct segments.

2. Stigmas of *Papaveraceæ*. In *Romneyeæ* and in *Hypecoum* the stigmatic summits of the carpels remain distinct and alternate with the placentas, indicating an approach to the apocarpous structure of Ranunculaceæ. In the rest of the order the stigmas, or even the summit of all the carpels are more or less confluent, as may be traced in gradation from *Stylophorum* through *Bocconia*, *Sanguinaria*, *Chelidonium*, *Argemone*, *Meconopsis* and other genera to *Papaver*, in which the radiating stigmas answer to the stigmatic margins of the summits of the carpellary leaves, and are consequently over the placentas.

3. The species of *Ventilago*, a genus of Rhamnaceæ. Mr. Bentham reduces the Indian species, of which sufficient material has been received, to three, of which diagnoses are given.

4. The *Memecyla* of Cuming's collections, with the synonymy of four species.

5. A Chinese species of *Calogyne*, a genus of Goodeniaceæ. Curious as the second species of the order, apart from the maritime *Scævolas*, found out of Australia. It was collected near Amoy.

Bentham, George.—On *Fissicalyx*, a new genus of Dalbergieæ. Linn. Proc. v. pp. 78-9. From Venezuela, Fendler's Coll. No. 2223.

Berg.—Charackteristik der für die Arzneikunde und Technik wichtigsten Pflanzengattungen in Illustrationen. Liefng. viii.-ix. Berlin, 1860.

Berg, O.—Ueber die Knollen des Sturmhuts (Aconite). Bonpl. viii. Jahrg. pp. 352-5.

Bergsma, M.—Sur le Phénomène dit Fonction de la Respiration des Plantes. L'Hortic. Univ. 1860, pp. 278-281.

Boott, Francis.—Illustrations of the genus *Carex*. Vol. i. part 2. Fol. London, 1860. With plates.

With detailed descriptions of 262 species. A plate of each is furnished; in the case of *C. baccans*, *C. Bengalensis*, *C. indica*, and the more variable types, a series of figures is given. Seven species are described for the first time.

Borszczow, El.—Die Aralo-Caspischen Calligoneen. Petersb. Mém. Tom. iii. No. 1. 45 pp. with 3 plates.

Contains observations on the history and literature of the genus *Calligonum*, Linn. (with which the genera *Pterococcus*, Pall. and *Calliphysa*, F. et M. are united), its *modus crescendi*, physiognomy, development, geographical distribution and statistics, properties and uses.

The total number of species is reckoned at 25, all of which are exclusively Asiatic, with the exception of *C. comosum*, which extends from Persia, across North Africa to the Canaries. The majority of species—at least 14—are peculiar to the Aralo-Caspian basin. Many of the species of *Calligonum* afford a gummy product, as observed by Pallas, which flows from wounds both in the branches and older stems; in very hot weather exuding from herbaceous parts of the plant. The commonest species, *C. Pallasia*, besides serving as a good fuel, furnishes the food of the Steppe-mice *(Cricetus, Meriones)* which live under its bushes. Most of the species are capable of affording a dye, which has not, however, been investigated. Twenty Calligonums are described; eleven of them, discovered by Herr Borszczow on his journey in 1857-8, as new.

——— Die pharmaceutisch-wichtigen Ferulaceen der Aralo-Caspischen Wüste, nebst allgemeinen Untersuchungen über die Abstammung der im Handel vorkommenden Gummiharze,

Asa-fœtida, Ammoniacum und Galbanum. With 8 plates. St. Petersb. Mém. iii. 40 pp.

A description, with figures, is given of a new *Ferula*, (near *F. soongarica*, Pall.), called "Schaïr" by the inhabitants, the milk-sap of which possesses the characteristics of Galbanum, which latter is stated to be obtained from *Ferula rubricaulis*, Boiss.

Brown, Robert.—Phanerogamous Plants and Ferns of Caithness. Trans. Bot. Soc. Edinb. vi. pp. 328-9.

A list of species new to the "North Highland" province of Watson's "Cybele Britannica" is given.

Buckley, S. B.—Descriptions of several new species of Plants. Phil. Acad. Proc. 1860, p. 443.

Buhse, F.—Aufzählung der auf einer Reise durch Transkaukasien und Persien gesammelten Pflanzen in Gemeinschaft mit Dr. E. Boissier in Genf bearbeitet. Nouv. Mém. Soc. Imp. Nat. Moscou. xii. pp. 246. With 10 plates and a map.

Nearly seventy pages are devoted to Dr. Buhse's itinerary, including extended notices of the vegetation and physical features of his route, which extended by Erivan (1847) and the Caucasus through Tabriz and Ardebil to Teheran (1848), thence to Asterabad, Jesd (1849) and Ispahan; returning by the Caspian. One of the most interesting plants collected was a new *Ferula* (*F. galbaniflua*, sp. nov.) affording Gum Galbanum. It was frequent about the Demavend mountains to the north-east of Teheran, at an elevation of from 4 to 8000 feet. Many new species are described, including 17 of *Astragalus*.

Buignet, H.—Recherches sur la matière sucrée contenue dans les fruits acides, son origine, sa nature et ses transformations. 59 pp. 4to. Paris, 1860.

Cantoni, Gaetano.—Nuovi principi di fisiologia vegetale applicati all' agricoltura. 24 pp. 8vo. Milan, 1860.

Carriere, M.—Considérations générales sur l'espèce. Exemples de variation et de formation des *races*, &c. Rev. Hort. 1860. pp. 555-559, 613-616, 639-643.

——— Robinier faux-acacia monophylle, l. c. pp. 629-632. With figures.

A variety of *Robinia pseud-acacia* raised by a French nurseryman, usually developing but terminal leaflets, which acquire a length of 5 to 6 inches.

Caruel, Th.—Prodromo della Flora toscana. 8vo. pp. 127. Florence, 1860. Paris, Baillière.

Caspary, Robt.—Einige Pelorien (*Orchis latifolia*, L., *Columnea Schiedeana*, Schldl., *Digitalis purpurea*, L.) Königsb. Phys. Ges. Schrift. 1860. pp. 59-65.

——— *Bulliarda aquatica*, DC. l. c. pp. 66-91.

An account of its structure, history, and distribution.

——— Ueber Sonnenrisse. l. c. pp. 92-4.

Observations by Hr. Busolt on cracks in the bark and cambium-layer of the Lime, occasioned by exposure to the sun.

CASPARY, ROBT.—Flora des Kölner Doms. Bonn. Verhand. d. N. H. V. 1860. pp. 331-2.

A list of fifteen Phanerogamia collected on a terrace of the unfinished south-west tower of Cologne Cathedral, at an elevation of 177 feet, on two visits in Sept. 1857 and May, 1858. Of these Privet, Dog-Rose and Violet have probably been planted in soil carried up for them.

CHABOISSEAU, L'ABBÉ.—Observations sur douze espèces de *Rubus* du Département de la Vienne. Bull. Soc. Botan. Tom. vii. pp. 265-9.

CHAPMAN, A. W.—Flora of the Southern United States, containing an abridged description of the Flowering Plants and Ferns of Tennessee, N. and S. Carolina, Georgia, Alabama, Mississippi, and Florida. The Ferns by D. C. Eaton. 1 vol. 8vo. New York, 1860.

An Introduction includes a brief sketch of the Elements of Botany, a Glossary of Terms and an Analysis of the Natural Orders. Synopses of the genera are given in the larger Orders.

CHATIN, A.—Ordre des *Thesiacées* ou *Santalacées*, Rapports de leur structure anatomique avec leur classification. C. Rend. Oct. 16, 1860.

CHOISY, PROF.—Du genre *Discostigma* (Hassk.) appartenant à la Famille des Clusiacées. Gen. Mem. xv. pp. 434-9. With 2 plates.

Founded on the plant distributed by Zollinger under No. 3276. A supposed second species of the genus figured (Zoll. No. 1192) is apparently Rubiaceous.

COHN, F.—Ueber contractile u. irritable Gewebe d. Pflanzen. Virch. Arch. xxii. p. 405.

COLDSTREAM, W.—Experiments with Anæsthetic Agents on Sensitive Plants. Trans. Bot. Soc. Edinb. vi. pp. 390-7.

A true anæsthesia was most decided in experiments on the irritable stamens of *Berberis*, exposed to the action of Chloroform, Amylene, Sulphuric and Chloric Ether. Immediately after exposure to the vapour, the stamens sprung towards the pistil, returning slowly to their former position. They were then found to be destitute of irritability. Their irritable condition was usually restored by exposure to the sun.

COSSON, E.—Note sur le *Gagea Bohemica.* Bull. Soc. Botan. Tom. vii. pp. 212-13.

Near Nemours this species appears to multiply itself principally by bulbils which detach from the bulbs of the parent plants; the fertilization of the ovules being imperfect. M. Cosson is satisfied that G. *saxatilis*, Koch, and G. *bohemica*, Schult. are specifically identical.

——— Sur les hybrides de l'herbier de M. de Franqueville (obtenus

artificiellement par K. F. Gaertner). Bull. Soc. Botan. Tom. vii. pp. 343-4.

A list of the parent species of 40 hybrids is given, belonging to the following genera, viz.:—*Dianthus*, *Lychnis*, *Silene*, *Œnothera*, *Lobelia*, *Nicotiana*, *Verbascum*, *and Digitalis*.

Costa, A. C.—Index Seminum in horto botanico Archigymnasii Barcinonensis. Ann. S. N. ser. iv. (Bot.) Tom. xiii. pp. 103-5.

Crüger, H.—Die Entwickelung der Blume von *Napoleona imperialis*, Beauv. Bot. Z. 1860, 361-6. With figures.

The double corona and the discoid ring surrounding the pistil originate subsequent to the development of the staminal whorl; the inner corona is adnate below with the filaments. The affinities of *Napoleona* are discussed.

——— Einiges ueber die Gewebsveränderungen bei der Fortpflanzung durch Stecklinge. Bot. Z. 1860, 369-374. With 1 plate.

Crocker, C. W.—Notes on the Germination of certain species of Cyrtandreae. Linn. Proc. v. pp. 65-7. With 1 plate.

The cotyledons of *Streptocarpus polyanthus* at first equal, become in a few days after germination remarkably unequal, the larger continuing its expansion until it attains frequently a foot in length, constituting usually the only leaf of the plant. A similar development of one cotyledon is exhibited by *S. Rexii* and *S. biflorus*. Mr. Crocker's observations agree with those previously published by Dr. Caspary.

Cuzent, G.—Tahiti. Recherches sur les principales productions végétales de l'île. 8vo. pp. 275. Paris, 1860. V. Masson.

Darach, Dr.—Plants flowering in the neighbourhood of Philadelphia during the months of July, August, September and October. Phil. Acad. Proc. 1860, pp. 511-515.

Delavaud, C.—Fleurs soudées et péloriées de *Linaria striata*. Bull. Soc. Botan. Tom. vii. pp. 174-5.

Dickson, Alexander.—On some Bisexual Cones occurring in the Spruce Fir *(Abies excelsa)*. Trans. Bot. Soc. Edinb. vi. pp. 418-423.

The lower portion of these cones was covered with stamens, the upper producing bracts and scales as in normal female cones. Dr. Dickson found the bracts of the terminal portion to be serially continuous with the stamens of the lower part.

Dippel.—Ueber die Entstehung und den Bau der Tüpfel. 1. Die Tüpfel der Holz und Geiässzellen. 2. Die Tüpfel in den Querwänden dikotyler Gefässzellen. Bot. Z. 1860, pp. 329-336. With 2 plates.

The development of the "pits" or "pores" on the wood-cells and vessels, takes place in a similar manner in all plants provided with them, which were examined by the author. He selects *Pinus* as especially suited for their study, from the large size of the pits, and its ready accessibility. The "pit" (Tüpfel), which is a closed pore widened at its base, is first formed by a folding-

in of the primary cell-wall all round. Its further formation results, in part, from the extension of this projecting fold, in part from the deposition of thickening layers around it. The original membrane dividing two opposed pores, becomes absorbed when the adjacent cells contain air, and persists in those which continue to be filled with fluid.

Dresser, C.—The Morphological Import of certain Vegetable Organs. Trans. Bot. Soc. Edinb. vi. pp. 321-2.

——— The Stem or Axis as the Fundamental Organ in the Vegetable Structure. l. c. pp. 432-4.

Duchartre, P.—Note sur le Lilas blanchi par la culture forcée. Bull. Soc. Botan. Tom. vii. pp. 152-4.

Dufour, Léon.—De la valeur historique et sentimentale d'un herbier. Souvenirs d'Espagne (Suite). Bull. Soc. Botan. Tom. vii. pp. 146-151, 169-173.

——— Diagnoses et Observations critiques sur quelques plantes d'Espagne malconnues ou nouvelles. Bull. Soc. Botan. Tom. vii. pp. 221-7, 240-7, 323-328, 347-352.

Engel, L. C.—Influence des climats et de la culture sur les propriétés médicales des plantes. 35 pp. 4to. Strasburg, 1860.

Fermond, Ch.—Note sur les fruits et l'écorce du *Sapindus divaricatus* du Brésil. Bull. Soc. Botan. Tom. vii. pp. 214-219.

A detailed account is furnished of the fruit, seed, and bark of this *Sapindus*, sent from Brazil as the produce of a tree called the "*Savonnier*" or "*Arbre-à-savon;*" the "Pao-de-Sabao" mentioned by M. Guibourt in "Hist. Nat. des Drogues."

Frémy, E.—Recherches sur la matière colorante verte des Feuilles. Ann. S. N. Ser. iv. (Bot.) Tom. xiii. pp. 45-53.

M. Frémy resolves the colouring matter of chlorophyll into blue and yellow elements by treatment with a mixture of ether and dilute hydrochloric acid. The blue substance he calls *phyllocyanine;* the yellow, *phylloxanthine.* The latter is the more stable element, and is found in autumnal as well as nascent leaves, from which phyllocyanine is absent.

Garcke, A.—Ueber die Stellung von *Plagianthus* and *Hoheria* in Natürlichen Systeme. Bonplandia, 1860, pp. 365-7.

Confirms the relation of these genera to Malvaceæ by the structure of the pollen granules, which are dotted with the warts characteristic of this Order: not smooth as in Sterculiaceæ.

Gay, J.—Le Printemps de 1860, comparé a celui de 1859, dans son effet sur la floraison de quelques plantes observées a Paris. Bull. Soc. Botan. Tom. vii. pp. 307-8.

Flowering was retarded in the case of the nine species (of *Ajax*, *Narcissus*, and *Syringa intermedia*) observed from 12 to 31 days.

——— Nouvelles observations sur la Couronne des Narcissées. l. c. pp. 309-16. With woodcuts.

From an examination of some partially double flowers of *Nar-*

cissus poeticus collected in the south of France, M. Gay concludes that the corona is not a special organ nor an appendage comparable to stipules, but that it is formed by the marginal union of the dilated connectives of three metamorphosed anthers.

Gaudin, Ch. T.—Sur la végétation contemporaine de l'homme primitif. Arch. Sc. Phys. et Nat. Aug. 1860, p. 280.

Göppert, H. R.—Ueber die Anordnung der Alpenpflanzen im botanischen Garten zu Breslau. Flora, 1860, pp. 561-8.

Arranged with a view to afford popular instruction in the character and general relations of the Floras of high latitudes and elevations.

Grenier, Ch.—Recherches sur le *Posidonia Caulini*, Kön. Bull. Soc. Botan. Tom. vii. pp. 362-6.

An account of notices of the species from the time of Homer, with its synonymy.

Gris, Arthur.—Note sur une plante qui constitue probablement un nouveau genre de la Tribu des Marantées. Bull. Soc. Botan. Tom. vii. pp. 320-322.

This plant, allied to *Phrynium*, is described under the name of *Marantochloa Comorensis*. Ad. Br.

——— Note sur l'origine et le mode de Formation des Canaux périspermiques dans la Graine des *Marantées*. Ann. S. N. Ser. iv. (Bot.) Tom. xiii. pp. 97-102. With 2 plates. Also Bull. Soc. Botan. Tom. vii. pp. 237-9.

The canals, which are branches of the chalaza, are due to the curvature of the axis of the nucleus. Their formation may be traced as the ovule assumes its campylotropous form, from, at first, slight depressions to the long narrow blind canals, which were considered by R. Brown to be due to aborted embryos.

Grisebach, A. H. R.—Flora of the British West Indian Islands. Sect. i. pt. 3. Leguminosæ (*Teramnus*) to Loranthaceæ. With Index to Section I.

New genera described are *Prioria* (Leguminosæ, near *Copaifera*); *Anamomis* (Myrtaceæ); *Eurychænia*, *Chænopleura*, Crüg., *Pleurochænia*, *Octopleura* (Melastomaceæ); *Cionandra*, *Cionosicys* (Cucurbitaceæ); *Triacis* and *Tribolacis* (Turneraceæ).

A synoptical key is given to the West Indian genera of Melastomaceæ, 29 in number. Several of the generic descriptions are re-written.

——— Erläuterungen ausgewählter Pflanzen des tropischen Amerikas. 58 pp. 4to. (Ext. Bd. ix. Abhn. K. G. Wissen. Göttingen), 1860.

This *brochure* was published simultaneously with the first volume of the author's "Flora of the British West Indian Islands," and serves to explain the grounds upon which certain changes, chiefly affecting generic or ordinal circumscription, were introduced into that work.

Phytolaccaceæ. The genus *Agdestis*, Moc. Sess., referred by De Candolle to Menispermaceæ, and by Prof. Grisebach to Phytolaccaceæ, as suggested by Mr. Bentham, is described in detail.

Amarantaceæ. *Woehleria*, a new genus from Cuba, is described.

Euphorbiaceæ. Critical observations upon the affinities of the Order and its subdivision into Tribes and Subtribes. The West Indian genera are grouped under the following sections, viz. :—

A. Ovarii loculi 2-ovulati.

Trib. I. *Buxeæ.* Capsula loculicida, dissepimentis connexis. Semina ecarunculata.

Trib. II. *Phyllantheæ.* Capsula in coccos divisa v. baccata. Semina sæpius ecarunculata.

Subtrib. 1. *Drypeteæ.*
Subtrib. 2. *Euphyllantheæ.*

B. Ovarii loculi 1-ovulati.

Trib. III. *Crotoneæ.* Capsula in coccos divisa, raro baccata.

Subtrib. 1. *Iatropheæ.*
Subtrib. 2. *Ricineæ.*
Subtrib. 3. *Eucrotoneæ.*
Subtrib. 4. *Ditaxideæ.*
Subtrib. 5. *Acalypheæ.*
Subtrib. 6. *Hippomaneæ.*
Subtrib. 7. *Euphorbieæ.*

The genera *Acidocroton*, Gr., *Mettenia*, Gr., *Adelia*, L., *Bernardia*, P. Br., *Lasiocroton*, Gr. and *Leucocroton*, Gr. (gen. nov.) are described at length.

Bixineæ. The following tribes are proposed, viz. :—

1. *Bixeæ.* Capsula sicca, medianicida. Stamina hypogyna, indefinita.

2. *Flacourtianeæ.* Pericarpium carnosum. Stamina disco libero inserta.

3. *Prockieæ.* Pericarpium carnosum, indehiscens. Stamina disco perigyno inserta.

4. *Samydeæ.* Pericarpium dehiscens. Stamina perigyna.—Pedicelli articulati.

Diagnoses are given of the genera *Samyda*, L., *Guidonia*, Gr., *Casearia*, Iq., *Casinga*, Gr. (nov. gen.), and *Sadymia*, Gr.

Malpighiaceæ. *Henlea*, is a new genus, founded on a Cuban plant of Rugels.

Rutaceæ. Prof. Grisebach adopts, as subtribes,

1. *Pilocarpeæ.* 2. *Zanthoxyleæ*, and 3. *Simarubeæ.*

Juglandeæ. The character of the group is modified to admit *Picrodendron*, Pl., which is described from additional and more complete material.

Melastomaceæ. Critical observations on the structure of the seed, embryo, and anthers, with a review of the West Indian genera, (vide supra.).

Grisebach, A. H. R.—Plantæ Wrightianæ e Cuba Orientali (Polypetalæ et Apetalæ). Smith. Contr. viii. pp. 153-192.

Determinations of Mr. C. Wright's plants collected from 1856 to 1860, with the distribution numbers.

Phlebotænia (Polygaleæ), *Ditta* (Euphorbiaceæ), *Carpodiptera* (Bombaceæ), *Rheedia* (Guttiferæ), *Gyrotænia* (Urticaceæ), *Linodendron* (Thymeleæ), are the new genera described.

Hallier, Ernst.—Bewegung der Pflanzen gegen verschiedene Lichtquellen, beobachtet und gemessen an *Ornithogalum caudatum*, Ait.-Flora, 1860, pp. 689-694.

Herr Hallier found the scape more susceptible to reflected than to direct solar light. It was similarly affected by artificial light, the stem bending rather towards a sheet of white paper than to the taper illuminating it.

Hanstein, Johannes. — Versuche über die Leitung des saftes durch die Rinde und Folgerungen daraus. Pringsheim's Jahrbücher für Wiss. Botanik. Bd. ii. pp. 392-467.

The subject is discussed under the several heads of, (1.) Can the roots nourish themselves? or whence and in what manner do they receive assimilated nutrient matter? (2.) Can leaves alone assimilate nutriment? or what is required besides them to effect this? (3.) By what channel does the plastic sap ascend to its destination? (4.) What has the bark to do with the passage of re-dissolved substances which have been in reserve, and of assimilated sap? (5.) Which are especially the sap-conducting tissues of the bark? Among the general results of the author's enquiries are the following. Both roots and leaves together, must effect the assimilation of the various nutrient elements which they each take up; neither can, apart from the other, assimilate. The sap is conveyed from the root to the leaves by the wood, the bark alone serves as the return channel for the assimilated matter. In uninjured plants the bark directly conveys, both upwards and downwards, the plastic sap derived from the leaves, and without the supply of this channel neither are the leaf-buds developed, the fruits matured, or the elements of the wood duly thickened. The bark also appears to be concerned in re-conveying to the buds dissolved reserve-nutriment. The unthickened bundles of liber-cells (*Baströhren*) probably serve as the principal special cortical system, conveying the plastic sap; the cambium layer itself would seem to take as little part in the descent of formative sap as it does in the upward flow of the wood-sap.

Hartinger, Ant.—Oesterreich's u. Deutschland's wildwachsende od. Gärten gezogene Giftpflanzen. Nothwendiger Atlas zu Adf. Nitsche's Giftpflanzenbuch u. Giftpflanzen-Kalender, in naturgetreuen Abbildgn. 1. Lfg. gr. Fol. (4 chromolith. Blatt.) Wien, (Wallishausser's B.)

Heer, Oswald.—Untersuchungen über das Klima und die Vegetationsverhältnisse des Tertiären landes. (Separatabdruck aus Bd. iii. d. tertiären Flora der Schweiz). Winterthur, 1860.

Henry, Aimé.—Ueber die Bildung der Wurzelfasern von *Sedum Telephium*, *S. maximum* und *S. Fabaria*. With 2 plates. Bonn. Verhand, d. N. H. V. 1860, pp. 1-12.

A description of the internal structure, (1st.) of the stems of the above species, which offer no peculiarity—and (2nd.) of the root and root-fibres, which become thickened and tuberiform. After passing into the root, the circle of woody tissue which, in the stem, is interposed between the pith and bark, resolves itself into two to six distinct rings or bundles which traverse the greatly developed, starch-abounding parenchyma of the tuber, and ultimately, in approaching the extremity of the root converge, reuniting to form a single central mass. The author compares this structure in *Sedum*,—the independent woody bundles of the tubers—to certain abnormal *liane* formations figured by Gaudichaud from a certain South American *Sapindacea*.

Hoffmann, Rh.—Jahresbericht über die Fortschritte der Agriculturchemie mit besonderer Berücksichtigung der Pflanzenchemie und Pflanzenphysiologie. Vol. II. 1859-60. 8vo. Berlin, 1861.

Hooker, J. D.—Illustrations of the Floras of the Malayan Archipelago, and of Tropical Africa. Linn. Trans. xxiii. pp. 155-172. With 9 plates.

The new genera described are *Disepalum*, *Sphærothalamus* (Anonaceæ); *Pachynocarpus* (Dipterocarpeæ); *Irvingia* (Simarubeæ); *Pentaspadon*, *Haematostaphis*, *Parishia* (Anacardieæ); *Trigonochlamys*, *Triomma* (Bursereæ); *Hemiandrina* (Connaraceæ). Figures are given of most of these.

——— An account of the Plants collected by Dr. Walker in Greenland and Arctic America, during the expedition of Sir Francis M'Clintock, R.N., in the yacht "Fox." Linn. Proc. v. pp. 79-89.

The principal interest of Dr. Walker's collection attaches to an herbarium of 46 flowering and 58 cryptogamic plants gathered at Port Kennedy, in the Peninsula of Boothia, the flora of which was previously unknown. The Port Kennedy Florula appears to be poorer than that of the surrounding islands, although favoured by the absence of snow for about four months each year, and ample variety of surface. Tables are given by Dr. Hooker of 20 species occurring in Melville Island, which are wanting at Port Kennedy; of 6 species found at the latter absent from Melville Island; of 5 species of Port Kennedy plants absent from the Western shores of Baffin's Bay, (Pond's Bay to Herne Bay), and 7 absent from the Western Islands. Catalogues are appended of the collection: The *Musci* and *Lichens*, by Mr. Mitten, the *Algae*, by Dr. Dickie, and the *Fungi*, by Mr. Berkeley. Observations on temperature, &c. at Point Kennedy, are added by Dr. Walker.

Hooker, W. J. and G. A. Walker-Arnott.—The British Flora. Ed. viii. London, 1860.

Hooker, W. J.—Curtis's Botanical Magazine. Ser. iii. vol. xvi. London, 1860.

Including *Begonia frigida*, DC. bearing occasionally flowers with superior carpels; *Narthex Asafœtida*, Falc. and *Cocos plumosa*, Hk.

Howard, J. E.—Illustrations of the Nueva Quinologia of Pavon. Parts 5 and 6, with 6 plates. Fol. London, 1860.

Huet, A.—Sur diverses plantes découvertes dans le Départment du Var. Bull. Soc. Botan. Tom. vii. pp. 344-6.

Jamain, Alex.—Sur une excursion scientifique aux environs de Cherbourg en Juin 1859. Bull. Soc. Botan. Tom. vii. pp. 157-164.

Jardin, Edel.—Supplément au Zephyritis taitensis de Guillemin. Mem. Soc. Sc. Nat. Cherbourg, vii. pp. 239-244.

Karsten, H.—Floræ Columbiæ Terrarumque adjacentium specimina selecta. Tom. i. Fasc. 3. Berlin, 1860. Folio. 20 plates.

Marssonia, a new genus of Primulaceæ with the habit of Cyrtandreæ, is described.

Karsten, Hermann.—Zur Parthenogenesis. Bot. Z. 1860, 387-8.

Observations on a criticism of Schleiden's upon Dr. Karsten's omitting to notice the persistence of the stigma in his remarks upon the occurrence of normal fertilization in *Coelebogne* (in 'Das Geschlechtsleben der Pflanzen und die Parthenogenesis').

Kerner, A.—Niederösterreichische Weiden. Vien. Z. B. V. 1860. Separatabdruck, pp. 160.

Chamitea, g. n. is founded upon *Salix reticulata*.

——— Die Formationen immergrüner Ericineen in den nördlichen Kalkalpen. (Schluss.) Pt. 3. Bonpl. viii. Jahrg. pp. 305-8.

Kirschleger, Fr.—Observations sur la dernière livraison des annotations à la flore de France et d'Allemagne de M. C. Billot. Bull. Soc. Botan. Tom. vii. pp. 375-381.

——— Flore d'Alsace. 3e volume. 2e partie. Guide du botaniste herborisateur à travers l'Alsace et les montagnes des Vosges. 12mo. Strasbourg, 1860.

Klotzsch, Fr.—Linné's Natürliche Pflanzenklasse *Tricoccæ* des Berliner Herbarium's im Allgemeinen und die natürliche Ordnung *Euphorbiaceæ* insbesondere. Berlin, 1860. 4to. pp. 108. (Aus Abh. K. Ak. Wissen.).

Under the head of 'Tricocca,' Linnæus, in 'Philosophica Botanica' (1751) grouped, on the ground of their close natural affinity, a number of genera for which A. L. de Jussieu, in his 'Genera Plantarum' (1791) proposed the name *Euphorbiæ*, and which constitute, with the additions since made to them, the *Euphorbiaceæ* of most recent writers.

Prof. Klotzsch, with his colleague Dr. Garcke, proposes to break up the group into six 'natural orders,' viz. (uni-ovulate) Euphorbiaceæ, Peraceæ, Acalyphaceæ, (bi- rarely uni- ovulate), Buxaceæ, Phyllanthaceæ, Antidesmaceæ.

His Order Euphorbiaceæ, based upon the genus *Euphorbia* as commonly received, *Pedilanthus* and *Anthostema*, is to consist of 19 genera, the section Euphorbieæ, Kl. and Gk. including 15, viz. (A. Anisophyllæ—Involucri lobi membranacei, basi callo variiformi (glandula) instructi). *Anisophyllum*, Haw., *Alectoroctonum*, Schlecht, *Tricherosterigma*, Kl. and Gk., *Eumecanthus*, Kl. and

Gk., *Tithymalopsis*, Kl. and Gk., *Dichrophyllum*, Kl. and Gk., *Leptopus*, Kl. and Gk., *Adenopetalum*, Kl. and Gk., (B. Tithymalæ, —Involucri lobi exteriores supra callo carnoso (Glandula) toti tecti), *Euphorbia*, L., *Medusea*, Kl. and Gk., *Arthrothamnus*, Kl. and Gk., *Tithymalus*, Scop. (to which belong most of the British species), *Sterigmanthe*, Kl. and Gk., *Euphorbiastrum*, Kl. and Gk., *Poinsettia*, Grah.

Section Pedilantheæ, Kl. and Gk. includes *Pedilanthus*, Neck., *Hexadenia*, Kl. and Gk. and *Diadenaria*, Kl. and Gk. ;—Anthostemeæ, Kl. and Gk., the genus *Anthostema*, Juss.

Besides nearly ninety pages devoted to a systematic enumeration of species, &c. the essay contains a historical sketch of the Tricoccæ, the treatment of the group by various authors, critical remarks on M. Baillon's work on Euphorbiaceæ, and observations upon the changes proposed by the author.

Körnicke, Fr.—Monographiæ Marantearum Prodromus. — Nouv. Mèm. Soc. Imp. Nat. Moscou. Tom. xi. pp. 297-362. With 8 plates.

The author's investigations on the structure of the flower in Marantaceæ are based upon species cultivated in the St. Petersburg Botanic Garden and upon herbarium specimens. He regards the corolla as tripetalous, and the staminodia as biserial. In *Maranta* (and *Phrynium*) there are two staminodia in the outer series; in *Calathea*, *Thalia*, and *Ischnosiphon*, but one; while in *Monostiche*, *Marantopsis*, and *Distemon*, they are entirely wanting. The three staminodia of the inner series are either all present,—one bearing the fertile anther-cell,—or (in *Distemon*) one is abortive.

The structure of the several whorls of the flower in various genera is described in detail, as also that of the fruit and seed.

The distinctions between Cannaceæ and Zingiberaceæ are summed up as follows. In Cannaceæ, it is the inner circle of staminodia, which, by preference, is developed, while the outer always remains incomplete. The fifth staminodium is petaloid and bears the fertile half-anther.

In Zingiberaceæ, it is especially the outer circle of staminodia which becomes developed, the inner always remaining imperfect. The fertile stamen is the sixth of the series. It is symmetrical and bears a perfect anther.

A synopsis and critical descriptions of the genera of *Maranteæ* (adopted as a Tribe of Cannaceæ) is given. *Ischnosiphon* and *Monostiche* are genera founded by the author on South American and West Indian species. The characters of the last genus are not contrasted in the synoptical key owing to the allied genus *Calathea* being described, through a *lapsus*, as destitute of an outer staminodium. The species are not described.

—— — Ueber *Calathea fasciata*, Rgl. et Kör. und einige andere bunt-

blättrige Maranteen.—Mitthn. Russ. Gartenb. Ver. 1860. Heft 2. pp. 81-97.

Landerer, Dr.—Botanische Mittheilungen aus Griechenland. Flora. 1860, pp. 705-713. Referring chiefly to economic products.

Lange, Joh.—Pugillus plantarum imprimis hispanicarum. 82 pp. 8vo. Copenhagen, 1860. (Ext. Nat. Videns. Med. 1860.)

Lawes, J. B., J. H. Gilbert, and E. Pugh.—On the Sources of the Nitrogen of Vegetation, with special reference to the question whether Plants assimilate free or uncombined Nitrogen. (Abstract.) R. S. Proc. 21 June, 1860. pp. 16.

The experiments of the authors with certain Graminaceæ and Leguminosæ did not indicate the assimilation of free nitrogen by plants.

Further investigations are required upon the question, and also as to the sources whence *combined* nitrogen may be derived by vegetation.

Lawson, George.—Contributions to Microscopical Analysis:—*Celastrus scandens*, L., with Remarks on the Colouring Matters of Plants. Trans. Bot. Soc. Edinb. vi. pp. 362-8.

Referring to the histological character of the colouring substance of the cells of the arillus, which occurs in the form of minute, elongated, and straight or curved granules of a bright scarlet colour.

Le Jolis, Aug.—Plantes vasculaires des environs de Cherbourg. Mem. Soc. Sc. Nat. Cherbourg. viii. pp. 245-360.

An account of the climate and general character of the vegetation of the environs of Cherbourg is prefixed to the Catalogue of Species,—954 in number,—which are arranged in conformity with the 'Flore de France' of Grenier and Godron.

Lindley, John.—Descriptions of Coniferæ sent from Japan, by J. G. Veitch. Gard. Chron. 1861, pp. 22-3.

Livingstone, J. S.—On the Anæsthetic effects of Chloroform, Ether, and Amylene, on Sensitive Plants. Trans. Brit. Soc. Edinb. vi. p. 325.

The anæsthetic influence was found always to proceed from above downwards. The most marked effects were produced by amylene.

——— Experiments on the Effects of Narcotic and Irritant Gases on Plants. Trans. Bot. Soc. Edinb. vii. pp. 380-7.

Details are given of the effects of Sulphurous and Hydrochloric Acid, Chlorine, Sulphuretted Hydrogen, Nitrous and Carbonic Oxide, and Coal Gas, on Laburnum, Balsam, and a *Psoralea*. As regards their action on plants, the author distinguishes the two classes of narcotic and irritant gases. Plants exposed to the former until the leaves begin to droop, although the colour remains unchanged, inevitably perish. In irritant gases the action is more local, affecting first the tips of the leaves, which become disco-

loured. If the stem be not attacked, the plant recovers when removed.

LOWE, R. T.—Some Account of the "Chaparro" of Fuerteventura, a new species of *Convolvulus*, A. N. H. ser. 3. vi. pp. 153-6.

The 'Chaparro' (*Convolvulus Caput-Medusæ*) is a dwarf, woody, spinose plant, growing in dense convex masses on the sterile seaward slopes of the western shore of Fuerteventura. The root and wood are reported to possess a fragrance rendering it commercially valuable: this property Mr. Lowe was unable to confirm. The plant is, however, readily inflammable, while green or even growing.

MALY, J. K.—Flora von Deutschland, nach der analytischen Methode. Wien. 1860, pp. 585.

MARTIUS, C. F. PH. VON.—Mun. Sitz. 1860. Heft iii. pp. 308-330.

A critical and detailed *seriatim* examination into the value of the characters upon which certain genera (*Ladenbergia* and *Remijia*) have been based, at the expense of the Linnean genus *Cinchona*. Herr v. Martius proposes to reunite these.

MAXIMOWICZ, C. J. —Nova Genera Cucurbitacearum. Ann. S. N. Ser. iv. (Bot.) Tom. xiii. pp. 95-6.

Descriptions of *Schizopepon* and *Mitrosicyos* from the author's 'Primitiæ Floræ Amurensis.'

METTENIUS, G.—Beiträge zur Anatomie der Cycadeen. Leipsic, 1860.

MICHALET, EUGÈNE.—Sur la conservation dans le sol des graines de diverses plantes. Bull. Soc. Botan. Tom. vii. pp. 334-338.

In pools in alluvial deposits bordering the Jura, which, according to a custom of the country, are drained at intervals and cultivated, M. Michalet notes the re-appearance of certain species after the intervals (sometimes extending to 12 or 15 years) of submergence and exposure. Among the species springing up on the drained surface, and which are rare or infrequent in the district generally, are *Carex cyperoides*, *Scirpus Michelianus*, *Rumex maritimus*, *Potentilla supina*, *Bidens fastigiata* (Michal.).

On the occasion of the construction of a road in which gravel was employed, brought from a pit excavated in a sterile field, *Galium anglicum*, a rare plant near Chaussin (Jura), sprung up wherever the gravel had been deposited and in the pit from which it was obtained. This was five years ago, and the *Galium* has since disappeared.

Tripolium filiforme, L. (*T. micranthum*, Viv.), a plant affecting the coast and valleys of the large rivers, was found in plenty by heaps of gravel used for road-making near Dôle. As an example of a species presenting instances of almost instantaneous diffusion, the author mentions *Phelipæa cœrulea*, which usually occurs very sparingly. In 1851 and 1852, it was found in enormous quantity by the Doubs. The following year none was to be found. The unwonted abundance of *Phelipæa* he attributes to the seeds having

been just previously disturbed by the breaking up of the surface of the pebbly soil for planting; the same circumstance favouring the increase of *Achillea millefolium*, upon which it is parasitic.

Miers, John.—On the Calyceraceæ. A. N. H. Ser. 3, vi. pp. 174-190, 279-288, 350-356, 396-404.

A general account of the floral structure of the group precedes the descriptive portion of the Memoir. The tubercle crowning the ovary in Calyceraceæ, Mr. Miers regards as an epigynous disk, adnate more or less with the base of the style within, and with the corolla-tube outside. The five glandular areolæ alternating with the stamens probably appertain to the disk. The genus *Amomocarpus* is founded upon seven Chilian species. Fifteen new species of Calyceraceæ are described.

Miquel, F. A. W.—Flora Indiae Batavæ. Supplementum primum. Prodromus Floræ Sumatranæ. Amsterdam, Van der Post, 1860, pp. 160. With 2 plates.

With chapters on the geognosy, climate and meteorology of Sumatra, its cultivated and wild food and economic plants. A list of species hitherto found in the island is given, with localities.

Mueller, F.—Notes on the Plants collected during Mr. John M. Stuart's recent Expedition into the North-west interior of South Australia. Trans. Phil. Inst. Victoria, iv. pp. 183-8.

Müller, Hermann.—Nachträge und Bemerkungen zu Karsch's Phanerogamenflora der Provinz Westfalen. (Mit Beiträgen von Beckhaus und Ascherson.) Bonn. Verhand, d. N. H. V. 1860, pp. 179-198.

Müller, Karl.—Der Pflanzenstaat, oder Entwurf einer Entwickelungsgeschichte des Pflanzenreiches. Leipzig. Förstner, 1860.

Murray, A.—Notes on Californian Trees. Trans. Bot. Soc. Edinb. vi. pp. 330-353, 369-370.

Neisler, H. M.—Notes on the Habits of the Common Cane (*Arundinaria macrosperma*, Mich.) Sillim. Journ. xxx. (1860), pp. 14-16.

Neubert, W.—Fähigkeit der Pflanzenwurzel feste oder gebundene Stoffe aufzulösen. Württ. Nat. Jahr. xvi. p. 50.

Oliver, Daniel.—*On Sycopsis.* Linn. Trans. xxiii. pp. 83-9. With 1 plate.

Sycopsis is a new genus of *Hamamelideæ* near to *Distylium*, S. and Z. An account is given of the geographical distribution of the *Hamamelideæ*, and of the histological character of the wood-cells of the order.

Philippi, R. A.—Florula Atacamensis seu Enumeratio plantarum in itinere per desertum Atacamense observatarum. pp. 62. Tabb. vi. 4to. Appended to 'Reise durch die Wüste Atacama. Halle, 1860.

The new genera described are *Stichophyllum*, *Microphyes*, *Diazia*, *Silvæa* (Portulaceæ), *Eulychnia* (Cactaceæ), *Eremocharis*,

Domeykoa (Umbelliferæ), *Urmenetea*, *Chondrochilus*, *Gypothamnium*, *Oxyphyllum*, *Jobaphes*, *Polycladus*, *Brachyandra*, *Vazquezia*, (Compositæ), *Varasia* (Gentianæ), *Rhopalostigma*, *Waddingtonia* (Solanaceæ).

PUEL, T.—Spécimen d'un Catalogue des Plantes vasculaires de France. Bull. Soc. Botan. Tom. vii. pp. 269-273.

——— Revue critique de la Flore du Département du Lot. Bull. Soc. Botan. Tom. vii. pp. 373-5.

RAMOND, A.—Sur le *Brassica* des falaises de Normandie, Bull. Soc. Botan. Tom. vii. pp. 339-342.

REGEL, E.—Beobachtungen ueber *Viola epipsila*, Ledeb. Moskau, 1860, 4 pp.

REGEL, E. and H. TILING.—Florula Ajanensis. Aufzählung der in der Umgegend von Ajan wildwachsenden Phanerogamen und höheren Cryptogamen, nebst Beschreibung einiger neuer Arten und kritischen Bemerkungen über verwandte Pflanzen-Arten.—Nouv. Mem. Soc. Imp. Nat. Moscou. Tom. xi. pp. 1-137.

Ajan is a factory of the Russo-American Company, on the sea of Ochotsk, 56° 28′ N. lat. 138° 29′ E. long.

This Florula is based upon collections made by Dr. Tiling in the immediate neighbourhood of the factory during the five years (from 1846-1851) he was stationed there as medical officer.

It was the intention of the late C. A. Meyer to have worked up these materials in conjunction with Dr. Tiling; in consequence of his decease, however, they have been elaborated by M. Regel.

An introductory essay by Dr. Tiling on the physical features of Ajan and neighbourhood, is prefixed to the descriptive portion of the work. The phanerogams of this Florula belong to 58 Natural Orders, of which Compositæ furnishes the largest number of representatives. Then follow Ranunculaceæ, Cruciferæ, Rosaceæ, and Cyperaceæ. The species of these five Orders amount to more than one-third of the total. Sixteen Orders are represented by solitary species. The new genera described are *Tilingia* (Umbelliferæ, near *Cnidium*) and *Kruhsea* (Smilaceæ) founded on *Smilacina streptopoides*, Ledb. 354 species are enumerated, including Ferns and Lycopods.

REINSCH, PAUL.—Morphologische Mittheilungen (Schluss). Ueber die dreierlei Arten der Blätter der *Sagittaria sagittæfolia*, L. Ueber die Bildung der Triebe an dem stamme der *Draba aizoides*, L. Flora, 1860, pp. 740-3.

——— Morphologische Mittheilungen. Flora, 1860, pp. 721-726. With 1 plate.

1. Notice of the occurrence of *Fagus sylvatica*, with three cotyledons. 2. Florets formed by the union of two hermaphrodite ones in the female capitula of *Petasites officinalis*. 3. An abnormal example of *Cirsium lanceolatum*.

SACHS, JULIUS.—Physiologische Untersuchungen über die Abhän-

gigkeit der Keimung von der Temperatur. Pringsheim's Jahrbücher für Wiss. Botanik. Bd. ii. pp. 338-377.

The author's inquiries, conducted chiefly in the winters 1857-8 and 1858-9, were instituted with a view to determine the extremes of temperature at which the seeds of various species would germinate, the rate of development of the organs as affected by diverse or constant temperatures, and the effect of a fixed temperature on the different stages of development of germinating plants. The results of experiments (upon Maize, Barley, Wheat, *Phaseolus multiflorus*, Pea, Bean, *Cucurbita Pepo* and other species) are detailed — (1) on the change in the rate of extension of germinating rootlets and ascending organs under like temperatures: (2) the temperature most favourable to rapid development of the germ: (3) the minima and maxima at which germination takes place: and (4) the dependence of ulterior development on temperature.

A criticism upon A. DeCandolle's theory of the relation of vegetation to temperature, (Bibl. Genève, Mars, 1860, and 'Geog. Bot.' i. 51), and a proposed formula for the expression of the empirical relation of temperature to vegetation, are added to the above details.

Savi, Pietro.—Nota sulla morfologia e micrografia degli organi delle Cicadacee. Il Nuovo Cemento, xii. 1860. Ext. pp. 8.

Schacht, H.—Der Baum. Studien über Bau und Leben der höheren Gewächse. 2nd edition, 4 plates and 227 wood engravings. 8vo. Berlin, 1860.

——— De Maculis in plantarum vasis cellulisque lignosis obviis. An. Sc. Nat. Bot. xiii. pp. 218-235.

Schaffner, Dr. — Zur Entwicklungsgeschichte des Embryos und Samens von *Leucojum vernum*. Flora, 1860, 577-582. With 1 plate.

Appendages of delicate membranous texture are described, developed from the germinal vesicle and projecting beyond the apex of the embryo sac. They are lost when the embryo is matured.

Schenk, Prof.—Ueber Parthenogenesis im Pflanzenreiche. Würz. Nat. Z. Bd. i. pp. 85-9.

The result of experiments, chiefly upon *Cannabis sativa* and *Mercurialis annua*. No female flower, which had been cut off from the access of pollen, perfected fruit.

Schlechtendal, D. F. L. v.—Nachtrag zur Geschichte der Sonnenblume (*Helianthus annuus*, L.) Bot. Z. 1860, pp. 349-350.

——— Abnorme Weizenähren, Bot. Z. 1860, 381-3.

Schlotthauber, Dr. — Zunahme der Temperatur in der unteren Region der Atmosphäre, sowie Erklärung und Einfluss dieser Erscheinung auf die Vegetation. Bonplandia, 1860, pp. 371-3.

Schoenefeld, W.—Sur le mode de Végétation de l' *Aldrovanda vesi-*

culosa en hiver et au printemps. Bull. Soc. Botan. Tom. vii. pp. 389-391.

The floating hibernal buds of this plant were found to vegetate, in cultivation, without first sinking to the bottom, as is believed usually to be the case in nature.

SCHULTZ, C. H. (BIPONT.)—Ueber die Catanancheen. Bonplandia, 1860, pp. 367-71.

With description, analysis of species, history and distribution of the group. *Piptocephalum*, gen. nov. is described.

SEEMANN, BERTHOLD.—Synopsis Crescentiacearum: an Enumeration of all the Crescentiaceous Plants at present known. Linn. Trans. xxiii. pp. 1-22.

With amended character of Crescentiaceæ, and diagnoses of the genera and twenty-six species composing the group. Dr. Seemann adopts the Tribes *Tanæcieæ* (*Calyx persistens, regularis, 5-merus*) and *Crescentieæ* (Calyx deciduus, irregularis—spathaceus vel bipartitus). No new genera are founded. *Schlegelia* and *Tripinnaria* are suppressed, being identical with *Tanæcium* and *Colea* respectively. *Periblema*, DC. is excluded from the Order. The Crescentiaceæ chiefly prevail in the islands of East Africa, whence further additions are probably to be received. Two species occur in Asia, ten in America.

SENDTNER, O.—Die Vegetations-Verhältnisse des bayerischen Waldes nach den Grundsätzen der Pflanzengeographie geschildert. 8 plates, 8vo. Munich, 1860.

STURM, J. W. and A. SCHNITZLEIN.—Verzeichniss der Phanerogamen und gefässkryptogamischen Pflanzen in der Umgegend von Nürnberg und Erlangen. Ed. ii. Nürnberg, Schmid. 1860.

TCHIHATCHEFF, P. DE—Asie mineure. Description physique, statistique et archéologique de cette contrée. 3e partie. Botanique. Atlas of 44 plates. Roy. 8vo. Paris, 1860.

THWAITES, G. H. K. and J. D. HOOKER.—Enumeratio Plantarum Zeylaniæ. Part 3, 1860.

Compositæ (*Elephantopus*) to Labiatæ (*Leucas*).

New genera described are *Dasyaulus* and *Dichopsis* (Sapotaceæ), *Dædalacanthus*, T. Anders, and *Ptyssiglottis*, T. Anders, (Acanthaceæ).

TIMBAL-LAGRAVE, E.—Essai monographique sur les espèces, varietés et hybrides du genre, *Mentha*, L., qui sont cultivées ou qui croissent spontanement dans les Pyrénées centrales et dans la partie supérieure du bassin sous-pyrénéen (Haut-Garonne). Bull. Soc. Botan. Tom. vii. pp. 231-6, 254-261, 328-334, 352-358).

TODARO, AGOSTINO.—Nuovi Generi e nuove Specie di Piante coltivate nel real Orto botanico di Palermo. Fasc. 2°. pp. 21-38. Palermo, 1860. 8vo.

Biancæa, n. g. (Leguminosæ, sub-order, *Cæsalpinieæ*), with new species of *Duranta*, *Hermione*, and *Oxalis* are described.

TRAUTVETTER, E. R. VON.—Enumeratio Plantarum Songaricarum a

Dr. Alex. Schrenk annis 1840-1843, collectarum (continuabitur). —Mosc. Bull. 1860, pp. 65-162.

From *Ranunculaceæ* to *Caryophyllaceæ*. *Diptychocarpus*, a new genus of Cruciferæ, is described.

Trémeau de Rochebrune, A. et A. Savatier.—Catalogue raisonné des plantes phanérogames qui croissent spontanément dans le département de la Charente. 8vo. pp. 294. Paris, Baillière.

Treviranus, L. C.—Ueber die Frucht von *Chimonanthus*, Bot. Z. 1860, p. 337.

At the narrowed extremity of the fruits were formed five reflexed organs, which observation of their development showed to be persistent, elongated and thickened filaments.

——— Ueber *Melampyrum pratense* mit gold-gelben Kronen. Bot. Z. 1860, pp. 337-8.

——— Weitere Bemerkungen über monströse Blätter von *Aristolochia macrophylla.* With 1 pl. Bon. Verhand, d. N. H. V. 1860, pp. 327-330.

With an account of the progressive stages in the development of abnormal cup- and trough-shaped appendages on the under surface of the leaves.

Verlot, B.—Voyage de la Société botanique de France à Grenoble et dans les Hautes-Alpes en 1860. Rev. Hort. 1860, pp. 521-531.

Itinerary, with record of the interesting species collected.

Wagner, Rudolf.—Ueber den Oelgehalt einiger forstlicher Samen. Würz. Nat. Z. Bd. 1 pp. 161-2.

Giving the percentage of oil obtained from the seeds of Beech, Hazel, species of *Pinus*, &c.

Wartmann, Élie.—Note relative à l'influence de froids excessifs sur les graines. Arch. Sc. Phys. et Nat. Aug. 1860, p. 277.

Walker-Arnott, G. A.—Note on *Hypericum anglicum*, A. N. H. Ser. 3. vi. pp. 362-6.

Watson, H. C.—Part First of a Supplement to the 'Cybele Britannica.' Lond. 1860. (Privately distributed).

Containing two tabulated lists of British plants, showing, together, the distribution of each species through the subprovincial areas adopted by Mr. Watson in the 4th vol. of the 'Cybele.' The subprovinces, 38 in number, are denoted by figures.

Weber, C. O.—Beiträge zur Kenntniss der Pflanzlichen Missbildungen. With 2 plates. Bonn Verhand. d. N. H. V. 1860, pp. 333-388.

Weddell, M.—Rapport sur un Mémoire relatif au *Cynomorium coccineum* (Brongniart, Tulasne, and Decaisne, Commissaires). C. Rend. Aug. 1860.

Welcker, H.—Notiz ueber das Ausspritzen des Saftes beim Zerreissen saftiger Pflanzentheile. Pringsheim's Jahrbücher, für Wiss. Bot. Bd. ii. pp. 468-9.

Wydler, H.—Kleinere Beiträge zur Kenntniss einheimischer Ge-

wächse (Fortsetzung). Flora, 1860, pp. 547-559 (Compositæ): 593-600 (Campanulaceæ, Vaccineæ): 609-617 (Ericineæ, Pyroleæ, Monotropeæ): 625-631 (Ebenaceæ, Oleaceæ, Jasmineæ, Asclepiadeæ, Apocyneæ), 673-685 (Boragineæ).

——— Kleinere Beiträge zur Kenntniss einheimischer Gewächse.—Berichtigungen und Zusätze zu der NN. 2-43 dieses Jahrganges.—Flora. 1860. pp. 753-765.

Zetterstedt, J. E.—Vegetations-skizzer från Pyreneerna. Overs. Svensk. Handl. (Stockholm, 1860), pp. 23-51. Sect. 1. Jemförelse mellan Superbagnères och Cazaril. ii. Excursion till Venasque och Castenèse. iii. Excursion till Pic du Midi, Marboré och Brèche de Roland.

——— l. c. pp. 407-424.

Botanisk resa till medlersta Norges fjelltraker under Sommarren, 1858.

XXXIX.—Cryptogamia.*

1. *Filicales.*

Bergeron, Georges.—Sur l'existence de trachées dans les Fougères. Bull. Soc. Botan. Jour. vii. pp. 338-9.

M. Bergeron finds unrollable spiral vessels in the bulbils of *Diplazium poliferum*, *Cœnopteris fœnicula*, *C. Thalictroides*, *Asplenium, proliferum*, &c. They also occur in very young leaves of the first named species. They become eventually replaced by scalariform, annular or reticulated vessels.

Bolle, Carl.—Zur Vegetationsgeschichte Beschreibung Cultur, &c. des *Asplenium Seelosii*. Bonpl. 1861, pp. 18-23.

Braun, A.—Revisio Selaginellarum. A. S. N. xiii.

Crüger.—Zur Kenntniss der Hymenophyllaceen von H. Crüger. Botanische Zeitung, 9 Nov. 1860.

This paper contains some observations, accompanied by figures, on the fructification of the genera Trichomanes and Hymenophyllum.

Duval-Joure, J.—Sur une particularité que présente l'*Equisetum hiemale*, L. Bull. Soc. Botan. Tom. vii. pp. 164-7.

The author's observations were made in the neighbourhood of

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* For convenience of reference it is intended to divide the Bibliography of Cryptogamic Botany into five portions, viz., Filicales, Muscales, Lichens, Fungi and Algæ. Under the head Filicales will be included works relating to the following orders, namely, Filices, Ophioglossaceæ, Equisetaceæ, Marsiieaceæ and Lycopodiacæ. Under "Muscales" will be found the works relating to the orders Ricciaceæ, Marchantiacæ, Jungermanniæ, and Musci. Works on the Characeæ will be placed under "Algæ."

Strasbourg where this *Equisetum* grows very abundantly, and is collected for market. He finds the toothing of the sheaths to be very variable, even upon the same stem or upon stems from the same rhizome.

EATON, DAN. C.—Filices Wrightianæ et Fendlerianæ, nempe Wrightianae Cubenses et Fendlerianæ Venezuelanæ (nonnullis Panamensibus, etc. ex coll. A. Schott et S. Hayes interjectis), enumeratæ novæque descriptæ. Mem. Ac. Am. Sc. et Ant. 1860. N. S. vol. viii. pp. 193-220.

HASZLINSKY.—Beiträge zur Kenntniss der Karpathen-Flora. Lebermoose. Wien. Z. B. V. Band x. p. 315.

About 50 species of Ricciaceæ, Marchantiaceæ and Jungermanniaceæ are here given as belonging to the Flora of the district, but the author admits that the account is probably incomplete. No new species are described.

JURATZKA.—Zur Moosflora Oesterreichs. Vien. Z. B. V. Band x. pp. 121, 367, 673.

These are three short papers on the mosses of Austria. They are almost entirely of local interest, but the second contains some remarks on " Neckera Sendtneriana" of the Bryologia Europæa. The author has lately discovered the plants in fruit, the occurrence of which is very rare. The plant is diœcious, and he describes its male and female flowers, and gives reasons for retaining it in the genus Neckera instead of placing it in Omalia, as proposed by Lobarzewski and Schimper.

LOWE, E. J.—Ferns, British and Exotic. Vol. viii. 108 plates. 8vo. London, 1860.

MOORE.—Index Filicum. Part 10. London. William Pamplin.

This part contains figures of the following genera: Vittaria, Lindsæa, Schizoloma, Dictyoxyphium, Adiantum, Hewardia, Adiantopsis, Cheilanthes, Hypolepis, Cassebeera, Plecosorus and Onychium.

REGEL, E.—Ueber Farn und deren anzucht aus Sporen. Mitthn. Russ. Gartenb. Ver. 1860. Heft 2, pp. 97-105.

REINSCH, PAUL. —Morphologische Mittheilungen. (Schluss).

Weitere Beobachtung des Ueberganges getrennter alternirender Wirtel in eine Spiralwindung an einem unfruchtbaren Stengel von Equisetum Telmateia, nebst Bestätigung der in einem früheren Aufsatze (Flora, 1858) gegebenen Erklärung dieser Erscheinung. Flora, 1860, pp. 737-740.

2. *Muscales.*

HEUFLER.—Untersuchungen über die Hypneen Tirol's, von Ludwig Ritter von Heufler (aus den Verhandlungen der k. k. Zool. bot. Gesellschaft in Wien (Jahrgang 1860, Abhandlungen) besonders abgedruckt.)

Of the 143 European species, 83 are described as Tyrolean, and the synonymy of each species is given. The systematic part of the work is preceded by some general remarks on the soil, on the influence of light, warmth, moisture, &c., on the difference between North and South Tyrol with regard to the presence of certain species, on the relation of the Tyrolean Moss-Flora to that of other countries, and on the probability of the discovery of further species.

LORENTZ. — Beiträge zur Biologie u. Geographie der Laubmoose. Eine Abhandlung zur Erlangung der philosophischen Doctorwürde von Paul Günther Lorentz. München, 1860. 4.

This work contains details of the ranges of altitude of upwards of 300 Mosses observed by the author in Bavaria, the Black Forest, the Austrian Alps, and in Switzerland, with notices of the chemical nature of the soil in many localities. The author also speaks of the changes which different mosses undergo under different circumstances.

NOTARIS (J. de) Musci Napoani, sive Muscorum ad flumen Napo in Columbia a clariss. Osculati lectorum recensio. Tur. Mem. xviii.

——— Appunti per un nuovo censimento delle Epatiche italiane. Tur. Mem. xviii.

RABENHORST.— Hepaticae europaeae. Die Lebermoose Europa's unter Mitwirkg. mehrerer namhafter Botaniker gesammelt u. hrsg. Decas 13 u. 14. gr. 8. (20 Bl. m. aufgeklebten Pflanzen.) Ebd. 1860, cart.

REICHARDT.—Ueber das Alten der Laubmoose von Dr. H. W. Reichardt. Wien. Z. B. V. Band x. p. 589.

The following is a short account of the contents of this paper. Botanists acknowledge two methods of determining the age of a plant. 1st, the anatomical, founded upon peculiarities of structure, as in the case of annual rings. 2ndly, the morphological, founded upon the nature of the growth of the plant, especially the regular succession of certain axes, as in the case of the scars on the rhizome of Convallaria Polygonatum. The second method alone is applicable to mosses. The age of a moss is always determinable when there is a regular succession of axes, each of which has a limited growth lasting for a year; otherwise there is no certainty. Therefore the age of the stems of acrocarpous mosses is determinable, but not that of pleurocarpous mosses.

The author gives five methods of arriving at the age of the stem of the acrocarpous moss.

1. By observing the number of whorls of branches standing one above another, a method applicable to most acrocarpous mosses which grow in thick tufts.

2. By observing the number of capsules. This method is applicable in cases where the growth of the stem is carried on, year by year, from axillary buds beneath the terminal fruit, and where the new stem-growth pushes aside the fruit of the preceding year, and forms an apparent continuation of the principal

axis, as may be observed in Bartramia Halleriana Hedw. and in many Dicrana.

3. By observing the number of shoots, where several are united together, and form what the author calls a Sympodium. Some mosses produce horizontal subterranean runners, which eventually appear above ground, and produce leaves and fruit. At the point where each runner bends upwards, a bud is developed in the axil of a leaf. This bud forms a second subterranean runner, and at last appears above ground like the former one. This process is repeated yearly, so that by counting the number of shoots which appear above ground, the age of the moss is arrived at. Minum undulatum Hedw., Climacium dendroides W. and M., and Thamnium alopecurum Schpr. may be examined in this way.

4. This method applies to Polytrichum only, and depends upon the fact of the growth of the stem in that genus being carried on *through* the inflorescence.

5. The 5th method (an uncertain one) is by observation on the size of the leaves. The early spring leaves are the smallest, and those produced as the year advances become gradually larger and larger. With the following spring the small-sized leaves reappear. Thus each point of commencement of the small-sized leaves marks the commencement of a year. In Leucobryum and in many Dicrana this plan may be used.

In the pleurocarpous mosses, the fruit not being terminal, the growth of the principal axis is not limited, and it is in most cases not possible to fix the age of the stem. An exceptional case exists in *Hylocomium splendens* Schpr. where new axes of growth are formed at regular intervals.

The age of moss stems determined in this manner is found to vary between 3 and 10 years, but this does not represent the *duration of the whole period of vegetation* of a moss. As the moss grows, the older portions of the stem decay by degrees, and in order to determine the length of the whole period of vegetation, it is necessary to examine instances where the decay is arrested. This may be done in the case of Sphagnum where the old portions have formed peat, or where, as sometimes happens, the lower parts of a moss have become incrusted with carbonate of lime.

We have not space to go into the details of the author's remarks upon this part of the subject, but he arrives at the conclusion that mosses attain an age equal to that of the oldest trees.

Roze, Ernest, and E. Bescherelle.—Note sur quelques Mousses rares ou nouvelles, récemment trouvées aux moirons de Paris. Bull. Soc. Bot. vii. pp. 433-4.

3. *Lichens.*

Massalongo.—Catagraphia nonnullarum Graphidearum Brasiliensum (ex herbario Heufleriano) auctore A. D. B. Massalongo. Wien. Z. B. V. Band x. p. 675.

This paper contains a description, accompanied by figures, of the apothecia and fruit of seven new Lichens from Brasil. The description is preceded by a short "Conspectus Graphidearum." Two of the plants described belong to the genus Opegrapha, one to Pyrrhographa, two to Arthothelium, and one to Thecographa. The seventh constitutes a new genus, Creographa, allied to Medusula.

Nylander.—Prodromus expositionis Lichenum Novæ Caledoniæ, scripsit Wm. Nylander. Ann. des Sc. Naturelles, tome xii. pp. 280-283.

This paper contains an account of a small collection (twenty-six in number) of Lichens made in New Caledonia, by D. D. Vieillard and Paucher. Six of the species are European, the rest Polynesian, Japanese and Australian. The author remarks that of the species which are found in New Zealand more than half are European.

——— Dispositio Psoromatum et Pannariarum, scripsit Wm. Nylander. Ann. des Sc. Naturelles, tome xii. p. 293-295.

The author remarks that, so far as regards the distinction between these genera, it is sufficient to say that the thallus of Psoroma has true gonidia, and that of Pannaria only gonimic granules, a distinction, he adds, analogous to that which exists between Nephroma and Nephromium, and Sticta and Stictina. The author divides Psoroma into two sections, separated by the nature of the margin of the apothecia, and Pannaria into two sections, the first having lecanorine, and the second biatorine apothecia.

——— De Stictis et Stictinis adnotatio. Regensburg Flora, 1860, pp. 65, 66.

——— Conspectus Umbilicariarum. Regensburg Flora, 1860, pp. 417, 18.

Payod, V.—Flore de Chamounix. Famille des Lichens. Bulletin de la Soc. Vaudoise des Sciences naturelles. Tome vi. p. 421. An account of the Lichens of Chamounix.

Rabenhorst, L.—Lichenes Europæi exsiccati. Die Flechten Europa's unter Mitwirkung mehrerer nahmhafter Botaniker. Ges. u. herausg. v. Dr. L. Rabenhorst, Fasc. xviii.; Dresden, Druck v. C. Heinrich. 8vo.

A list of the species published in this fascicle is given in the Botanische Zeitung for June 29, 1860.

——— Cladoniae Europaeae. Die Cladonien Europa's. Unter Mitwirkg. mehrerer Freunde der Botanik gesammelt u. hrsg. Fol. (12 S. u. 39 Bl. m. aufgeklebten Pflanzen). Ebd. 1860. In Carton.

Senft, Dr.—Die Flechten im Dienste der Natur. Regensburg Flora, 1860, pp. 193-199.

Schwendener, S.—Untersuchungen über den Flechten-thallus. Von Dr. S. Schwendener. Erster Theil, Die Strauchartigen Flechten; mit 7 lithogr. Tafeln. Leipzig, Engelmann, 1860.

The author commences with the genus Usnea, describing the structure of the thallus, the division into medullary and cortical tissue, the nature of that tissue, the gonidia, the soredia, and the mode of attachment of the thallus to its support, and adds some remarks upon the nature of some species or varieties of the genus. He then treats of some other fruticulose Lichens, viz., Bryopogon, Cornicularia, Cetraria, Ramalina, Evernia, Hogenia, Sphærophorus, Roccella, Thamnolia, Cladonia, Stereocaulon, and Lichina. The Part concludes with a collection of the genera, and a description of the plates.

Stenhammer.—Exsiccater af Svenska Lafrar. Ofvers. Stockholm, 1859.

4. *Fungi.*

Bail.—Ueber die Myxogasteres Fr. (Myxomycetes Walbroth), von Dr. Th. Bail, mit einer Tafel. xxi. Vien. Z. B. V. Band ix. p. 31.

The author observed the process of development of *Lycogala miniatum*, *Physarum columbinum*, and *Æthalium septicum*, and arrived at the following conclusions: That the Myxogastres have no true mycelium; that the fruit capsules do not consist of a true membrane, and are not composed of cells, but are formed by the confluence of sarcode threads, and by the hardening of the mucilage; that the spores are not produced on basidia, or in asci, or in mother-cells, properly so called; that the spores, when placed in water, do not emit germ-filaments, but the primordical utricle escapes from the ruptured spore in the form of a contractile ciliated motile organism.

He concludes that De Bary has rightly considered the Myxogastres as belonging to the Rhizopoda.

Barla.—Descriptions et figures de quatre espèces de champignons, par J. B. Barla, de Nice, M. de l'Acad. de Nat. Cur. Nov. Act. Vol. xix. (Jenae, 1860).

This paper contains descriptions, accompanied by coloured plates, of a new Agaric of the tribe Flammula, two new Boleti, and a new Clavaria.

Bary, A. de.—Die Mycetozoen. 5 plates. Z. w. Z. x. 1.

—— Ueber Schwärmsporenbildung bei einigen Pilzen. Sep. Abdk. a. d. Ber. Nat. Ges. Freiburg, 1860.

This paper relates to the discovery by the author of Zoospores in Fungi. The species to which the observations relate are Cystopus candidus, Cystopus cubicus, and Peronospora devastatrix.

A translation of the paper, with illustrative figures, has appeared in the Annales d. Sciences Naturelles.

Berkeley.—Outlines of British Fungology, containing characters of above a thousand species of Fungi, and a complete list of all that have been described as natives of the British Isles. By the Rev. M. J. Berkeley, M.A., F.L.S., Author of "Introduction to Cryptogamic Botany." London: Lovell Reeve, 1860.

(This work is noticed, *sup*. p. 5.)

BONORDEN.—Zur Kenntniss einiger der wichtigsten Gattungen der Coniomyceten und Cryptomyceten, von Dr. Bonorden, mit drei colorirten tafeln. Halle. Schmidt, 1860.

BOUSSINGAULT.—Observations relatives au developpement des Mycodermes. C. Ren. LI. p. 671.

COEMANS.—Notice sur le Pilobolus crystallinus; par Eug. Coemans. Bull. de l'Acad. Roy. de Belgique, 2nd Ser. vol. viii. p. 199.

This paper contains observations on the structure and development of the vegetative portion of *P. crystallinus*, as also on the structure of the sporangium, and of its covering membrane, and of the cause and mode of its projection from the plant.

——— Recherches sur la genese et les metamorphoses de la Peziza Sclerotiorum Lib., par M. Eugène Coemans. Bull. de l'Acad. Roy. de Belgique. 2 ser. vol. ix. 1860, p. 62.

The first state of the fungus (periode nematoide ou sphacelienne) consists of a system of filaments which produce acrogenous spores. After a few weeks these filaments become condensed and form a rounded or irregular mass, and a black epidermis is formed from the extremities of the filaments. In this state (l'etat sclerotien) the fungus lives through the winter. In spring the epidermal cellules swell and become elongated, and produce a rounded stem which bears a cinnamon-coloured cup. The plant is then in the perfect state (l'etat pezizoide) and the fungus recognizable as Peziza Sclerotiorum Lib.

The author describes at length the three different stages above mentioned. He notices the production during the Sphacelioid state of three sorts of spores, viz. small oval spores, large cylindrical or fusiform spores, and rounded spores, but no true spermatia. A section is devoted to the different parasites observed to grow in company with the sphacelia. In the Sclerotioid state M. Coemans observed an exudation similar to that mentioned by Tulasne in Sclerotium Clavus. The author then describes his experiments with the Sclerotium. He did not succeed in rearing the Peziza from Sclerotia suspended in bottles, but those sown in pots, in mould, produced an abundant crop. M. Coemans entertains no doubt of the Sclerotium being the Mycelium of the Peziza, there being, he says, no ground for suspecting parasitism, as in the cases of Agaricus tuberosus and Ag. stercorarius. The Sclerotia from which the Peziza was produced varied much in appearance, answering to the forms described as species under the names varium Pers., compactum D.C. tectum Fr., bullatum D.C. and sphæriæformis Lib.

FERMOND, CH.—Sur une prolification de l'*Agaricus edulis*. Bull. Soc. Bot. vii. pp. 496-8.

Fries.—Calendrier des champignons sous la latitude moyenne de la Suède, par M. Elias Fries, Professeur de Botanique à l'Université d'Upsal. Ann. S. N. tome xii. pp. 296-319.

This memoir is a translation of a communication read by M. Fries to the Academy of Sciences, at Stockholm, on the 13th May, 1857. It contains, in addition to some introductory remarks, an account of the Fungi which appear at different times of the year, which the author divides into twelve periods:—1. The glacial period (*mensis glacialis*, L.), including January and February, or the greater part of it. 2. The period of thaw (*mensis regelationis*, L.), from the end of the February to the 15th or 21st of April. 3. The period of sowing, or of the flowering of the Amentaceæ (*mensis germinationis*, L.). 4. The period of the opening of leaves (*mensis frondescentiæ*, L.), from the middle of May to the second week in June. 5. The period of the solstice (*mensis florescentiæ*, L.), corresponding to the three latter weeks of the month of June. 6. Midsummer, comprising the greater part of the month of July. 7. The period of hay-harvest (*mensis maturationis*, L.), including the last week of July and the first two weeks of August. 8. Harvest-time (*messis*, L.), extending over the latter half of August and the first eight days of September. 9. The end of summer (L'arrière-été, Efter sommaren) (*mensis disseminationis*, L.), from September 8 to the end of the month. 10. The fall of the leaf (*mensis defoliationis*, L.), commencing with the first nights of intense frost, usually at the end of September or the beginning of October. 11. The period of frost (*mensis congelationis*, L.), when mild days alternate with frosty nights, corresponding usually with November. 12. The period of snow, or the time when snow lies, being usually December.

Hoffmann.—Untersuchungen über die Keimung der Pilzsporen von Hermann Hoffmann. Jahrbücher für wissenschaftliche Botanik Band ii. Heft 3. Berlin, 1860. Hirchswald.

This paper contains figures of the spores of 48 species of Fungi belonging to different families; the figures in most cases, though not in all, exhibiting also the mode of germination of the spores. In some instances the germinating thread or the contents of the spore were observed to assume a blue colour under iodine, or iodine and sulphuric acid, and the same reaction was observed in the asci of Bulgaria inquinans and Peziza vesiculosa. In speaking of the germination of Hymenogaster Klotzschii Tul. the author expresses an opinion that the hyaline sac spoken of by Tulasne as enclosing two spores, is not really a sac but an inversion of a very wide basidium. The second part of the paper contains an account of the author's apparatus and mode of observation; some general remarks upon the development, structure and composition of spores, their mode of dispersion and germination. The effect of light, of different degrees of temperature, and of various chemical substances upon germination is also discussed, and the details of a number of observations upon these points are added.

Hoffmann.—Beiträge zur Entwickelungsgeschichte und Anatomie der Agaricinen von Hermann Hoffmann. Bot. Z. 21 Dec. and 28 Dec. 1860.

——— Mycologische Studien über die Gährung, von Hermann Hoffmann. Botanische Zeitung, 3rd Feb. 1860, and 6th Feb. 1860.

——— Index Mycologicus. Sistens Icones et specimina sicca fungorum Europæorum et exoticorum imprimis nuper (inde a publicatione Friesiani systematis mycologici, et quoad species germanicas—Rabenhorstii manualis floræ germanicæ cryptogamicæ) edita, ordine alphabetico composita, cum synonymis. Autore Hermann Hoffmann.

This Index is in the form of a supplement to the Botanische Zeitung, 1860.

Hofmeister.—Ueber die Entwickelung der Sporen von Tuber æstivum Vittad. Pringsheim's Jahrb. für wiss. Bot. vol. 3, pt. 3, 1860.

Maisonneuve.—Note sur le Sphœria militaris, Ehrh. considéré comme parasite de la chenille processionaire du Pin (*Bombyx pityocampa*, Fabr.), communiquée au Congrès des délégués des sociétés savantes en Avril, 1859; par M. Durieu de Maisonneuve.

(A pamphlet in 8vo. of eight pages, without date or indication of its origin, extracted, it would seem, from the proceedings of the meeting).

In the department of the Gironde, the caterpillar, which devours the leaves of the young shoots of firs, had made such ravages in the year 1858, that the proprietors were alarmed for the fate of their woods. This fact was followed by the appearance, in immense quantities, of *Sph. militaris*, Ehrh., one of the club-shaped species of Sphœria parasitic on the larvæ of insects, and which is remarkable for its golden red colour. M. Durieu de Maisonneuve, having visited the woods in December, 1858, observed at once several individuals of this Sphœria parasitic upon the caterpillar, which was enclosed in its cocoon, not having yet passed into its chrysalid condition. In all the other parts of the woods which he visited, he observed the same Fungus, attached to the same caterpillar, dead, and buried in the ground. M. Tulasne has observed that the perfect state of *Sph. militaris* is much more rare than its secondary or isarioid condition; and that this latter is more rare than its primary or byssoid state; and inasmuch as the *perfect* plant occurred in such quantities that the ground round the diseased trees was covered with it, the quantity of caterpillars destroyed by this Sphœria in all stages of its growth must (in the author's opinion) have been prodigious.

Müggenburg.—Beiträge zur Pilzkunde von St. Schulzer v. Müggenburg. Wien. Z. B. V. Band x. p. 321 and 807.

The first of these two papers contains an account of a new fungus supposed to be a species of Ditiola, to which the author gives the name of Ditiola mucida. He calls attention to the conflicting accounts given by mycologists of the fructification of Ditiola, and inclines to Bail's opinion that the genus is really ascigerous. The first paper also contains some observations upon the structure of Dacrymyces stillatus, tending to show that a true hymenial layer sometimes exists in that plant.

The second paper relates to the Sclerotium of Agaricus tuberosus Bull. and to the fungus produced by it. The author considers that the Sclerotium and the Agaric have each a special individuality, and that they stand to each other in the same relation as Hydnum auriscalpium does to the fir-cones upon which it grows. He observes that the Agaric when withered revives in water, and that therefore it is rather a Marasmius than a Collybia, notwithstanding the nature of its stem. This latter paper also contains an account of an Agaric supposed to be a variety of Agaricus horizontalis Bull. It is described at length and well-figured. It has cinnamon spores, and would belong to the series Derminus, but its consistence is that of a Marasmius. This leads the author to suggest that it might be advisable to extend the genus Marasmius, so as to include all central stemmed persistent Agaricini, whether the spores be white or coloured. The writer is in error in supposing that Agaricus horizontalis has not been observed since the time of Bulliard. It occurs occasionally (although rarely) upon elm-trees in this country. (See B. and Br. Notices of British Fungi, No. 391, and Berkeley's Outlines of Fungology.)

Niessl.—Zweiter Beitrag zur Pilzflora von Nieder-Oesterreich von G. v. Niessl. Vien. Z. B. V. Band ix. p. 177.

Pasteur, L.—Recherches sur le mode de nutrition des Mucedinées. C. rend. LI. p. 709.

Rabenhorst.—Fungi Europæi exsiccati (Klotzschii herbarii vivi mycologici continuatio). Editio nova, series secunda. Centuria ii. Curâ Dr. L. Rabenhorst. Dresd. MDCCCLX. Typis Caroli Heinrich, 4.

The species published in this century are set out in Botanische Zeitung, 11 Mai, 1860.

Ravenel, H. W.—Fungi Caroliniani exsiccati: Fungi of Carolina illustrated by natural specimens of the species. Fasc. i.—v.

Richter.—Commentatio de favo ejusque fungo. Dissert. inaug. pathol. bot. quam cons. grat. medicor. ord. in univers. Viadrina d. xxiii. m. Junii, etc., publ. def. auctor Bertholdus Richter, Silesius, etc. Adjectæ sunt tabulæ duæ lithographicæ. Vratislaviæ typ. Boehmeri et Minuthii. 8, 63, s.

Tulasne.—De Quelques Sphéries fongicoles a propos d'un memoire de m. Antoine de Bary sur les Nyctalis par MM. Tulasne. Ann. des Sc. Nat. T. xiii. (Botanique), p. 6. 4 ser.

This paper is noticed at some length in the review of Mr. Berkeley's work (*sup.* p. 12). In addition to the matter there referred to, it contains a monograph of the genus Hypomyces,

and some remarks upon the identity of *Trichoderma viride* with *Hypocrea rufa*, and upon the conidia of *Hypocrea delicatula*, Tul. (a new species), and of *Cordyceps ophioglossoides*, Pers.

WESTENDORP.—Sixieme notice sur quelques Cryptogames inédites ou nouvelle pour la Flore Belge; par G. D. Westendorp. Bulletin de l'Academie Royale de Belgique. 2 ser. vol. vii.

This paper is a continuation of others, which have appeared in the 12th, 18th, 19th, and 21st vols. of the first series, and in the 2nd vol. of the 2nd series of the Reports of the Belgian Academy. It describes (besides some Mosses and Lichens from Luxembourg and Hainault), a number of Pyrenomycetes, including a new species of Cordyceps, eleven new species of Sphæria, two new species of Pestalozzia, two new species of Macroplodia; two new species of Staurosphæria; and two new species of Phoma. Some observations on the nature of ergot will be found at p. 80.

5. *Algæ*.

ARCHER.—On the occurrence of Zoospores in the family Desmidiaceæ, by William Archer. Natural Hist. Review, and Quarterly Journal of Science, July, 1860. Quarterly Journal of Microscopical Science, October, 1860.

ARNOTT.—On Cyclotella, by G. A. Walker Arnott. Q. J. M. S. October, 1860. Vol. viii. p. 244.

BRADY, GEO. S.—A Catalogue of the Marine Algæ of Northumberland and Durham. Tynes. Trans. iv. p. 266.

BRIGHTWELL.—On some of the rarer or undescribed species of Diatomaceæ. Part II. By T. Brightwell, F.L.S. Q. J. M. S. Jan. 1860. Vol. viii. p. 93.

CROUAN, FRÈRES.—Liste des algues marines découvertes dans le Finistère depuis la publication des algues de ce département en 1852. Bull. Soc. Botan. Tom. vii. pp. 367-373.

——— Notice sur le genre Hapalidium, par MM. Crouan frères, Pharmaciens. Ann. S. N. Vol. xii. p. 284. 4 ser.

The wish (say the authors) to elucidate the characters of the genus Hapalidium, of which the fructification has hitherto been unknown, has induced us to study it; and we are happy to be able to rectify the characters of the genus, and to make known the two kinds of fructification, as well as to publish three new species.

Genus Hapalidium Kutz.—Phyc. gen. p. 385. Sp. Alg. p. 698. Crouan M. S. char. reform.

Frond calcareous, formed of capillary dichotomous articulate filaments, or of little lobes or flabelliform disks, fixed horizontally, and adherent by all their parts; stratum simple, formed of cellules, arranged in lines radiating towards the periphery, square or rectangular, furnished in the centre with a rosy nucleus, and surrounded by a cretaceous border, forming a net-work. Ceramidia not opaque, of two sorts, the one sort enclosing, in the lower part, a mass of elliptical or pyriform sphærospores, straight, divided transversely into four spores, and fixed to a reticulate placenta; the other containing, in the interior, a mass of round spores, immersed in the middle of a filamentous tissue.

CROUAN.—Notice sur quelques espèces et genres nouveaux d'algues marines de la rade de Brest, par MM. Crouan frères, Pharmaciens. Ann. S. N. Vol. xii. p. 288. 4 ser.

Ulvella Crouan, (gen. nov.)

Frond green, lentiform, 1-2 mill. in diameter, horizontal, adherent by the whole inferior surface; formed in the centre of its surface of round, oval, or angular cells, embedded in a sub-gelatinous substance, reticulated, and containing some sporidia in their interior. Towards the periphery they become ovoid or rectangular, are much smaller, separated from one another, and disposed in radiant lines, simple or forked at their extremities. A vertical section of the frond exhibits the central cellules, arranged in almost perpendicular series, and filled with endochrome.

This genus (the authors say) resembles, at first sight, under the microscope, the first state of development of the sporidia of Enteromorpha; but its uniform size at all seasons of the year, its structure, and sporidia, point to its being a new genus of the Ulvaceæ.

Cruoriella Crouan (gen. nov.)

Frond horizontal, 1-2 centimetres in diameter, adherent by the whole of its inferior surface, of a deep purple, having the appearance of a Peyssonelia, composed of filaments, plunged in and held together by gelatine; the surface exhibiting the lines of the spherical cellules radiating towards the periphery in the form of a fan. *Nemathecæ* numerous, scattered over the frond, very slightly prominent, formed of simple articulated filaments, the lower joints very large, spherical, or square, then becoming 1½ times as long as broad, and 3-4 times as long as broad at the summits, which are attenuated, cystocarps immersed in the middle of the nematoid filaments, at the spot where their diameter becomes abruptly diminished, bearing round or square spores, joined end to end, and resembling little heaps, in a simple or dichotomous series, fixed together by gelatine. Sphærospores oblong, crucial, attached to the summit of a long articulated pedicel, and immersed in the middle of forked and fibrillose filaments constituting the Nematheca.

This plant, the authors observe, differs in fructification and structure from all known Squamariæ.

Rhododiscus Crouan (gen. nov.)

Frond, 3-8 mill. in diameter, disciform, of a beautiful rose-carmine, adherent by the whole of its inferior surface, a little thickened in the centre, which is sometimes lifted up and detached from its support; fining off towards the periphery into a very delicate, fan-shaped, lobed membrane, sometimes laciniated, and presenting on its surface dichotomous series of ovoid or angular radiating cellules; sphærospores numerous, internal, obovate, crucial, occupying the summit of the perpendicular series of cellules.

This plant is classified by the authors in Trib. II. of the Squamariæ (J. Ag.), for which they establish a new section.

The above paper contains also descriptions of a new species of Callithamnion, and a new species of Calothrix. It is accompanied by 2 plates, containing 44 figures.

Dippel.—Versteinerte algen. Regensburg Flora, 1860, p. 207.

Donkin.—On the marine Diatomaceæ of Northumberland, with a description of several new species. By Arthur Scott Donkin, M.D., L.R.C.S. Quart. J. M. S. New series, pt. 1.

Druce.—On the reproductive process in the Confervoidæ. By T. C. Druce, Esq. Q. J. M. S. April, 1860. Vol. viii. p. 71.

Famintzin.—Beitrag zur Kenntniss der Valonia utricularis von A. Famintzin. Botanische Zeitung, Oct. 26, 1860.

From the results of his observations, the author draws the conclusion that the groups of cells of Valonia must be considered, not as colonies of unicellular individuals, but as multicellular plants, composed of stem, root, and branch cells. He considers that Valonia, in its structure, growth, and mode of junction of its cells, as well as in the development and structure of its zoospores, is clearly allied to Cladophora, from which it differs in the want of apical growth and irregular ramification of its thallus, and particularly in the fact of each cell (except the root-cells) being capable of throwing out branches from any point of the surface.

Greville.—On Campylodiscus, &c., by R. K. Greville, L.L.D., F.R.S.E., &c. Q. J. M. S. Jan. 1860, vol. viii. p. 29.

——— A monograph of the genus Asterolampra, including Asteromphalus and Spatangidium, by R. K. Greville, L.L.D., F.R.S.E., &c. Q. J. M. S. April, 1860, vol. viii. p. 102.

Grunow.—Ueber neue oder ungenügend gekannte Algen. Erste Folge Diatomaceen, Familie Naviculaceen. Wien. Z. B. V. Band x. p. 503.

This paper contains some general introductory remarks upon the structure of diatoms, followed by a new arrangement of the order (making eleven families and 73 genera), founded principally upon the system of Kützing. Smith's arrangement is objected to, as having the effect of separating closely allied genera, and of breaking up of other genera and even species. The author gives a detailed account of the family Naviculaceæ, which he arranges in 13 genera, including a new one, Scoliopleura, formed for the reception of Navicula Jenneri, convexa and Westii of Smith, and of two new species discovered by the writer. The genus is distinguished from Navicula by the fact of the median line not being always sigma-shaped, and by the relative position of the valves, which, when seen from above, do not cover, but cut one another at an acute angle.

Harvey.—Index Generum Algarum; or, a Systematic Catalogue of the Genera of Algæ, Marine and Freshwater, with an alphabetical key to all the names and synonyms, by W. H. Harvey, M.D., F.R.S., &c. London, John van Voorst, 1860.

——— Dr. W. H.—Phycologia Australica; or, a History of Australian Sea Weeds, 1860. London, L. Reeve. Vol. iii. and iv. fasc. 31, 32. Tab. cxxi.-cxcii.

Hicks.—On the amæboid condition of Volvox globator, by J. Braxton Hicks, M.D., Lond., F.L.S., &c. Q. J. M. S. April, 1860. Vol. viii. p. 99.

——— Contributions to the knowledge of the development of the gonidia of Lichens in relation to the unicellular Algæ, &c., by J. Braxton Hicks, M.D., Lond., F.L.S., &c. Fasc. I. Q. J. M. S. October, 1860. Vol. viii. p. 239.

——— Contributions to the knowledge of the development of the gonidia of Lichens in relation to the unicellular Algæ. By J. Braxton Hicks, M.D. Lond., F.L.S. Fasc. II. Quart. J. M. S. New Series, part I.

Hohenacker, Dr. R. F.—Algæ marinæ siccatæ. Eine Sammlung europaischer u. auslandischer Meeralgen in getrockneter Exemplaren, mit einem kurzen Texte versehen von Prof. Dr. Kätzing. Achte Lieferung, 50 Arten enthaltend. Herausgegeben von Dr. R. F. Hohenacker Kirchheim u. T., Königreich Wurtemberg, 1860, fol.

Johnstone and Croall.—The nature-printed sea-weeds: a history, accompanied by figures and dissections, of the Algæ of the British Isles, by William Grosart Johnstone and Alexander Croall. Nature-printed, by Henry Bradbury. Vols. 2, 3, 4. London, Bradbury, 1859-60. Roy. 8vo. Vol. 2. Rhodospermeæ. Vol. 3. Melanospermeæ. Vol. 4. Chlorospermeæ.

Karsten.—Berechtigung zu Pringsheim's Nachtrag zur Kritik und Geschichte der Untersuchungen über das Algengeschlecht von Dr. Hermann Karsten Botanische Zeitung, Dec. 14, 1860.

This paper refers to a matter (of opinion) in dispute between the author and Dr. Pringsheim as to the mode of impregnation in Vaucheria. The bitterness of feeling which it exhibits, and the uncourteous manner in which the author speaks of his opponent, are much to be regretted, and are of a nature rarely to be met with in a scientific discussion. It is surprising that the editors of the Botanische Zeitung should have admitted such personalities into their columns.

Kutzing, Fr. T.—Tabulæ phycologicae od. Abbildgn. der Tange. Vol. x. 100 plates. Roy. 8vo. Nordh. 1860. col. plates.

Lawson, Geo.—On the structure and development of *Botrydium Granulatum*. Ed. Bot. Soc. Trans. vi. 424-431. With 1 Pl.

Lobb.—On the self-division of Micrasterias denticulata by Mr. Lobb. Q. J. M. S. New Series, No. 1.

Lowe, John.—On *Sarcina ventriculi*, Good. Ed. Bot. Soc. Trans. vi. 371-7.

LUDERS.—Einige Bemerkungen über Diatomeen-Cysten und Diatomeen-Schwarmsporen von Joh. E. Luders. Botanische Zeitung, 30 November, 1860.

The author, after referring to the observations of Smith (British Diatomaceæ, Vol. 2, p. xv.) and of Hofmeister (Bericht über die Verhandl. der Königl. Sachs. Gesellschaft der Wissensch. zu Leipzig, 1854, i. p. 28), and to the remarks of De Bary in the Supplement to the Bot. Zeitung for 1858 (p. 62) gives an account of his own observations upon Synedra radians, Cocconema, and Gomphonema, which he says show clearly that the cysts are formed by Amœbæ. He also describes the production of infusoria in the cells of Podosphenia Lyngbyei, Achnanthes longipes, Melosira Borrerii, Amphora ovalis, Gomphonema constricta, acuminata and intricata. He considers it probable that these infusoria or some allied productions have given rise to the notion of the existence of zoospores in the Diatomaceæ, but adds that he has never yet succeeded in finding true zoospores in that tribe of plants.

NORMAN.—On some undescribed species of Diatomaceæ by George Norman, Esq., of Hull. Quart. Journ. of Mic. Sc. New Series, Part 1.

PRINGSHEIM.—Nachtrag zur Kritik und Geschichte der Untersuchungen über das Algengeschlecht von N. Pringsheim ; Jahrbücher für wissenschaftliche Botanik, Band ii. Drittes Heft, p. 470.

This paper relates to the reproductive process in Vaucheria, and is devoted to a refutation of Dr. Karsten's objections to the author's published observations on that phenomenon.

PRITCHARD.—A History of Infusoria, including the Desmidiaceæ and Diatomaceæ, &c. By Andrew Pritchard, M.R.I. Fourth edition, enlarged and revised by J. T. Arlidge, W. Archer, J. Ralfs, W. C. Williamson, and the author. 40 plates, pp. 968.

RABENHORST, Dr. L.—Die Algen Sachsens, resp. Mittel-Europa's. Unter Mirwirkg. der H. H. Ardissone, de Bary, Bulnheim, etc. gesammelt u. hrsg. Decade 97-100. gr. 8. (à 10 Bl. m. aufgeklebten Pflanzen u. Alphabet. Verzeichniss 16 S.) Dresden, 1860, (am Ende.) cart.

REINICKE, F.—Die Bewegung der Oscillarien besonders der Spirulina. Beiträge zur neuern Mikroskopie, zweiter Heft. 8vo. Dresden.

The first part of this paper contains some remarks upon the movements of the Oscillariæ, with reference to the observations of Adanson, Brown, Saussure, Karsten, Mayer, and d'Alquen ; but the principal portion is devoted to the author's observations on the movements of a new species of Spirulina (*Spirulina gracillima*, Rabenhorst, Algen Sachsens, resp. Mittel-Europas, No. 895). He gives, as the result of his observations, the following facts : that in this species the spiral is sometimes left- sometimes right-handed ; that each spiral can revolve on its axis, either to the left or to the right; that if the direction of the turn of the spiral and of its revolutions on its axis coincide, the plant moves forwards; if the contrary, backwards: that for each revolution on its axis, the plant progresses or retrogrades to the extent of one turn of the spiral; that one revolution lasts generally from one to five seconds; that each plant has a revolving pendulum motion* (Kreispendel-Schwingung), which may take place either at one end or both; that one such revolution coincides in time with one revolution of the plant on its own axis; that the revolving pendulum motion may take place either to the left or to the right; that the direction of the pendulum motion in left-handed spirals is always to the left, in right-handed spirals, sometimes to the left and sometimes to the right.

The second part of the paper is devoted to an inquiry into the probable causes of the motion, the result of which is summed up as follows, viz.: that special causes of motion, such as cilia, &c. do not exist; that external influences, such as light, heat, currents of water, &c. are not the cause; that the origin of the motion must be sought for in the plant itself, and stand in some relation to its vital condition; that the movements observed in the higher plants (which are also unexplained) cannot be compared with those of the Oscillariæ; that endosmose affords no sufficient explanation; that the resemblance in many respects to animal motion is undeniable, but that there is no sufficient proof to establish the animal nature of the alga or of its movements.

Roper, F. C. S.—On Triceratium arcticum. Q. J. M. S. vol. viii. p. 55.

Smith.—Notes on Diatomaceæ, found near Gambia, O. By Professor Hamilton L. Smith, of Kenyon College, Gambia, O. Q. J. M. S. vol. viii. p. 33.

Stizenberger. — Dr. Ludwig Rabenhorst's Algen Sachsens resp. Mittel-Europa's Decade I—C. Systematisch geordnet (mit Zugrundelegung eines neuen Systems) von Dr. Ernst Stizenberger. Dresden, 1860. Heinrich.

Venturi.—Beobachtungen über die Fructifications-organe der Florideen von Dr. Gustav Venturi. Wien. Z. B. V. Band x. p. 583.

This paper relates to the discovery, by the author, of certain organs in Wrangelia penicellata, Polysiphonia elongata, and Callithamnion versicolor, which have the appearance of being antheridia. True spermatozoa have not been seen, although in Callithamnion versicolor the upper cells of the antheridia contained minute cellules in which slight movements were observed. From the author's account we suspect this motion was only molecular.

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* That is to say, the motion of a pendulum, when the extremity of it can move in any plane, and is so set in motion as to cause its extremity to describe a circle or an ellipse.

Figures of the antheridia in each of the three species accompany the paper.

WALLICH.—On the development and structure of the Diatom-valve. By G. C. Wallich, M.D., F.L.S. Q. J. M. S. April, 1860. Vol. viii. p. 129.

——— On the Siliceous Organisms of the digestive cavities of the Salpæ, and their relation to the flint nodules of the chalk formation. By Surgeon G. C. Wallich, M.D., Retired List H. M. Indian Army. Q. J. M. S. January, 1860. Vol. viii. p. 36.

——— Descriptions of Desmidiaceæ from Lower Bengal. A. N. H. 3 ser. v. p. 184.

WEISE, J. F.—Les Diatomacés du limon d'Arensbourg de Haspal et de Staraïa-Roussa. Petersb. Mem. I.

WEST.—Remarks on some Diatomaceæ, new or imperfectly described, and a new Desmid. By Tuffen West, F.L.S. Q. J. M. S. July 1860. Vol. vii. p. 147.

——— Remarks on some new Microscopic Algæ, collected by Thos. Atthey. Tynes. Trans. iv. p. 321.

6. *Miscellanea of Cryptogamic Botany.*

BERTOLINI. — Flora Italica cryptogama, Fasc. ii. Bononiæ, 1859. 8vo. pp. 129-256. Wien, Sallmayer and Co.

BISCHOFF.—Allgemeine Uebersicht der Organisation der phanerogamen und kryptogamen Pflanzen. 3911 lithographirte Abbildungen auf 77 Tafeln mit organologischen, systematischen und Namen-register (Abdruck aus dem Handbuche der botanischer Terminologie und System-kunde) 2. Abtheilungen. Neue wohlfeile Ausgabe. Leipsic. Schrag. 4.

1. Phanerogamen-kunde mit 2200 Abbildungen auf 47 Tafeln, 23 pp.
2. Kryptogamen-kunde mit 1712 Abbildungen auf 30 Tafeln, 19 pp.

BREUTEL.—Flora Germanica exsiccata Cryptogamica. Centuria I. 2te Auflage. Fol.

A collection of dried cryptogamic plants, of which this first century contains 8 species of vascular cryptogams, 8 species of liverworts, 66 species of mosses (including 10 of Sphagnum), and 18 species and varieties of Algæ, chiefly from the Baltic.

CICCONE.—De la nature des globules ovöides dans les vers à soie, par M. A. Ciccone.

The author remarks that it is beyond a doubt that the ovoid corpuscles play an important part in the prevalent malady of silkworms, but that it remains to be proved what those corpuscles are. Are they, he asks, crystals, or psorosperms, or hæmatozoids, or unicellular algæ, or panhistophytons, or merely organic elements of the worm? The author decides that the globules in question are organic elements of the silk-worm, and are a modified form of certain small globules found in the body of the worm.

GENNARI, DR.—Cryptogamæ vasculares Ligusticæ. Mem. Acc. di Torino, 1859.

GLASER.—Blicke in die Cryptogamenwelt der Ostseeprovinzen. 2. Abtheilung, (Aus den Archiv für die Naturkunde Liv.-Ehst-und Kurland's abgedruckt.) Dorpat, 1859. 8vo. (54 pp.) (Glaser.)

MONTAGNE.—Huitieme centurie de plantes cellulaires nouvelles tant indigènes qu'exotiques, par Camille Montagne, D. M. Decades IX et X. Ann. S. N. Tom. xii. pp. 167-192. 4 ser.

This paper contains descriptions of some new Algæ, Lichens, and Fungi, including some vegetable productions, found in the mineral waters of Gazost, St. Honoré, Valdieri, Ems and Louèche. The author also calls attention to the mode of growth of the pro-embryonal filaments of *Gymnostomum calcareum*, which were found forming a green velvety layer on the stone-work of a bath. It will be curious (says the author), to know whether this development is normal or exceptional, or dependent upon locality; and especially whether the plant, under such circumstances, would perfect its development.

POETSCH.—Neue Beiträge zur Kryptogamen-flora Nieder Oesterreichs, von J. S. Poetsch. Wien. Z. B. V. Band ix. p. 127.

POKORNY.—Beitrag zur Flora des ungarischen Tieflandes von Dr. A. Pokorny. Wien Z. B. V. Band x. p. 283.

RABENHORST.—Cryptogamæ vasculares Europeæ. Die Gefass. Kryptogamen Europa's, unter Mitwirkung mehrerer Freunde der Botanik gesammelt und herausg. v. Dr. L. Rabenhorst. Fasc. III. No. 51-75. Dresden, 1860. Druck v. Heinrich.

The species published in this fascicle are set out in the Botanische Zeitung for July 20, 1860.

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Reviews.

XL.—Course of Lectures on the Physiology and Pathology of the Central Nervous System. Delivered at the Royal College of Surgeons of England, in May, 1858, by C. E. Brown-Sequard, M.D., F.R.S., &c. &c. London. Williams and Norgate. 8vo. pp. 276, 1860.

(*Concluded from page* 287.)

For a considerable time past physiologists have been familiar with the influence of reflex actions on secretion and nutrition. Since the publication of Müller's Manual of Physiology, Stilling's Treatise on Spinal Irritation, and Henlé's various works, no treatise on physiology, or general pathology, has appeared which has not fully recognised the reflex phenomena of nutrition and secretion, as something well known. This makes it the more surprising, that, shortly before his death, Dr. Marshall Hall announced, as a new discovery, the supposed existence of an excito-secretory and secretory nerve system. Dr. Campbell of Georgia, U. S., claimed priority of this discovery, which Marshall Hall in a great measure conceded to him: but the truth is that neither one nor the other adduced one single fact to show the existence of any such distinct system of nerves. Admitting the vast importance of the influence exercised over secretion and nutrition by the vaso-motor nervous system, admitting that many phenomena hitherto inexplicable, find, in the effects produced upon the blood-vessels by paralysis and excitation, whether direct or reflex, of this system, a complete explanation; still the question comes, can we explain *all* the phenomena, normal and pathological, showing the direct or reflex influence of the nervous system on nutrition and secretion by deduction from the above truths, concerning the effects of paralysis or excitation of the sympathetic nerve on blood-vessels? We entirely concur with the answer given to this question by Dr. Brown-Sequard, that facts discovered by Ludwig, by Czermak, and especially by Claude Bernard, seem to have solved the question in the most positive manner, and that it seems absolutely certain that there is some agency of the nervous system, which is not simply an influence on the constricting muscular fibres of blood vessels, in the normal, or pathological, phenomena of secretion and nutrition. Professor Bernard has pointed out, how that, instead of contracting, the blood-vessels of the salivary glands become enlarged, when certain nerves are excited. To explain this and other, apparently contradictory, facts, we must seek for some theory embracing a wider generalization than any hitherto propounded. As we have already said, the notion of Dr. Brown-Sequard that this enlargement in the blood-vessels must be due to a greater attraction of the arterial blood by the tissue of the gland, seems to us a mere change of terms, explaining nothing. Indeed it leaves physiology as regards these phenomena in very much the same position as did Prochaska, whose observations on "the action of nerves on vessels and their fluids" are both interesting and instructive.

"Another function of the nerves," says this most acute observer, "consists in a certain power over the blood-vessels, and specially the capillaries, in virtue of which, when the nerves are stimulated (?) they excite, in that part in which they are distributed, a much more copious accumulation of blood than would have taken place in the normal condition of the circulation. Stahl termed it the tide of the microcosmic sea, or the ebb and flow of the blood—one cause of it is a stimulus of the nerves. Innumerable phenomena of daily occurrence shew this. Thus a stimulus to the nerves is the cause why the cheeks, ears and nose become intensely red and a sense of heat is felt, when exposed to a cold wind in winter. No one is ignorant how much the stimulus of sinapisms and blisters causes derivation to the stimulated part; an acrid smoke, or fine powder, getting into the eyes excites a copious flow of tears, and the vessels of the conjunctiva, previously invisible, become distended with blood. The smoke of tobacco or any other acrid aroma, retained in the mouth, excites a copious flow of saliva, &c. &c. But the same thing happens when the nerves are excited *not directly* but *indirectly* through the brain. We know that the face is suffused with the blush of modesty; grief causes a copious flow of tears, congestion of the vessels of the conjunctiva, and redness and swelling of the whole face. The sight of agreeable food provokes the flow of saliva; it is not unusual for some persons to vomit, or be purged, by only seeing a medicine, &c. &c. Does not the *vis nervosa*, increased by a stimulus, render the force of attraction of the fluids circulating through the vessels greater, so that by this means the fluids are attracted from every side to the centre of stimulation, as occurs, for example, when sealing wax is gently rubbed on a piece of cloth, and made electrical, and attracts sand and particles of various kinds."

Modern physiology will hardly be content to answer this question in the affirmative; to us it would seem as unsatisfactory as the supposition of *active* dilatation of the blood-vessels. . . . Although to our mind the solution given to the question, how a reflex action may produce or stop a secretion, how it may produce an atrophy or an hypertrophy, an inflammation or some other change in nutrition, by Dr. Brown-Sequard, is in some respects not more satisfactory than that offered by Prochaska, yet we freely admit that he puts forward his view remarkably clearly and well. Let him speak for himself:—

"In the preceding Lecture (Lecture ix.) we have said that there are two modes of action of the nervous system upon the production of the phenomena of nutrition and secretion. By one of these actions the nervous system determines an increase in the attraction of blood by the living tissues, and in this case the phenomena are accompanied by a dilatation of the blood-vessels, while the reverse exists when the nervous system, instead of acting upon the *parenchyma* of the tissues, acts upon the walls of the blood-vessels, and produces a constriction. In the first case, the quantity of blood passing through the part on which the nervous system has acted, is increased, while in the second case it is diminished; in the first case the secretions are increased, in the second diminished. In the first case, nutrition is more active, and there is a tendency to hypertrophy and an augmentation of the vital properties of nerves and muscles; in the second case, nutrition is not active, and there is a tendency to atrophy, and a diminution of the vital properties of nerves and muscles; lastly, in the first case, there is an augmentation of temperature, while in the second there is diminution. There is therefore the most complete difference between these two nervous influences.

"Let us now employ the knowledge of these two modes of action of the nervous system, to explain what occurs in some cases of secretory, or nutritive, reflex phenomena. Suppose, for instance, a calculus in one of the ureters: it irritates the centripetal nerve fibres of this canal, the irritation is transmitted to the spinal cord, which reflects it upon the muscular coat of the blood-vessels of the two kidneys, and produces a contraction, in consequence of which there is much less blood passing through these organs, so that the urinary secretion is stopped or much diminished. Suppose a worm in the bowels irritating their centripetal nerve fibres: the irritation is propagated to the spinal cord, which reflects it upon the roots of the cervical sympathetic nerve, by which it reaches the blood-vessels of the retina, produces their contraction, and, as a consequence of this cause of diminution in the amount of blood, an amaurosis. If instead of the reflex action on the blood-vessels, there is an action on the tissues, as in the case of the experiments of Czermak and of Prof. Bernard, the blood-vessels dilate and more blood passes through them. The cornea, for instance, is irritated: its centripetal nerve fibres transmit the irritation to the pons varolii, which reflects it upon the retina, the lachrymal gland, the conjunctiva, &c., more blood is attracted by all these parts, their blood-vessels dilate, and the consequences of a greater amount of blood become manifest—increase of tears, photophobia, &c.

"The two kinds of effects produced by the nervous system on nutrition and secretion, may co-exist or follow each other, and we have instances of such a combination or alternation in cases of neuralgia, of worms, &c."

Whatsoever physical explanation may be adopted for the many interesting facts concerning the sympathy existing between remote parts of the body, it will be admitted that the subject is one of amazing importance, and considering its importance, it is surprising that so little has been done by physiologists and practitioners to develop its manifold relations in health as well as in disease. Although more than once regretting that his space does not allow him "to enter in greater developments" on this subject, Dr. Brown-Sequard deals with it at considerable length, and in some respects treats it with great originality. In speaking of the morbid changes in the nutrition of the brain, of the spinal cord, and of the organs of sense, produced by an irritation of some centripetal nerve, he shows that insanity, epilepsy, chorea, catalepsy, extasis, hydrophobia, hysteric and other varieties of nervous complaints, may be the result of a simple, often slightly felt irritation of some centripetal nerve. He brings what we conceive to be very ingenious and, at the same time, valid, arguments in support of his novel view, that it is, occasionally, by a reflex action of one part of the cerebro-spinal axis on another part of itself, through the nerves going to the blood-vessels, that irritation of one portion of the nervous centre acts in modifying, or altering, the nutrition of another portion of itself. In this way he offers an explanation of the attacks of epilepsy and epileptiform seizures, resulting from organic lesion of the nervous centres.

The researches of Dr. Brown-Sequard concerning the etiology and nature of epilepsy are known to all the world, while his production of artificial epileptiform attacks in animals as the result of lesion of the spinal cord, and the very remarkable discovery that the offspring of animals thus rendered epileptic frequently acquire, by hereditary descent, the same affection, are facts no less interesting to the naturalist than to the physiologist. But this subject which, with that of rotatory convulsions, is discussed in his two final lectures, it is not our intention to enter upon: we shall content ourselves with observing that they are lectures of great practical value, and show, in every line, the extraordinary importance of studying, in all their varied aspects and complex forms, the phenomena of reflex excitability. In reviewing the principal of such phenomena, we cannot but admit that the best physical explanation of them hitherto given, seems to be that through the action of the vaso-motor nerves on the blood-vessels of the nervous centres. Donders and his pupil Van der Beke Callenfels, have shown the influence of these nerves directly on the vessels of the pia mater; and the experiments of Kussmaul and Tenner, although coming from a different direction, are strongly confirmatory of Brown-Sequard's views, and seem to those able experimenters to justify them in asserting "that epileptic convulsions can be brought about by contraction of the blood-vessels induced by the vaso-motor nerves." A great number of observers have, of late, added new facts to the physiology of the vaso-motor nervous system. But can we regard the characteristic phenomena of epilepsy, or the still more subtle forms of disease met with in insanity, vertigo, hallucinations, &c. as entirely explicable by any such physical changes? Must we not at least still recognise the humoral views of Todd and such notions as have been put forward by the original and ingenious Dr. C. B. Radcliffe, as having their element of truth as a "vera causa" in some cases? When we see a large snake struck across the tail with a rod, and instantly, in the twinkling of an eye, seized with a paralysis as complete as death, which yet, after a time, passes off again, can we attribute such a condition to the constriction of the blood-vessels of the cerebro-spinal axis? We think not, because we know that among these animals, the cerebro-spinal system does not (even after the evacuation of the blood of the body) speedily cease to exercise certain functions, and perform movements: and, moreover, we have proved experimentally, that even after decapitation, a blow across the tail stops for a while all the movements which, under ordinary circumstances, persist for a considerable time. The effect, therefore, cannot be attributed to disturbance through the blood-vessels; it appears rather to be due to an altered molecular condition of the nervous centres resulting from the blow, and more or less persistent. We have heard a well known and very accomplished physician observe that he believes in an "immaterial pathology." No doubt the term pathology implies the notion of some change of structure recognisable by the senses, and hence the phrase "immaterial pathology" is a contradiction in terms: it nevertheless, to our mind, conveys the idea intended; it seems to us to imply that, in many diseases (and we would specify particularly those of the nervous system where peculiar psychical conditions are accompanied by spasm, as in the "Tanzwuth," chorea, hysteria, "Revivals," &c.) symptoms may arise, from changes in the molecular arrangement, or from altered polarity of the nervous centres, or of the nerves themselves, and which are so far material changes; while they must be regarded as immaterial, in so far as such changes must be for ever and completely beyond the range of the perception of the human senses. That a shock conveyed to the central nervous system through its peripheral nerves, should, with the instantaneousness of a lightning flash, lock in insensibility and motionlessness the entire frame of the creature, cannot, to our satisfaction, be accounted for through the action of the vaso-motor trunks upon the blood-vessels, any more than the opposite class of phenomena detailed in the following case:—

"Case 44. On rising in the morning, a lad 14 years old was heard by his father making a great disturbance in his bed-room, who, rushing in to know the cause, found his son in his shirt, violently agitated, speaking incoherently, and breaking to pieces the furniture. Mr. —— caught the lad in his arms and threw him back on the bed, when he at once became composed, but did not seem conscious of the mischief he had done. He said that on getting out of bed he had felt something odd, but that he was very well and thought that he might have had a frightful dream, although he could not recollect it. I was immediately sent for, and the lad ordered to remain in bed until I had seen him. About five hours after I found the lad lying in bed, reading some amusing book; his tongue clean, pulse regular, countenance calm and cheerful. He said he was quite well and wished to get up, but that his father had ordered him to remain in bed until I had seen him. I was informed before I went up to his bed-room, that the lad had never before been heard to complain of disturbed dreams, or walked in his sleep, or exhibited any epileptic symptoms, and that his general health had been good and all his functions regular. Finding the patient free from any apparent disease and that he had eaten with good appetite, and no disturbance, his usual breakfast, I desired him to get up. When sitting up in his bed he drew on his stockings; but on putting his feet on the floor and standing up, his countenance instantly changed, the jaw became violently convulsed, and he was about to rush forward when I seized and pushed him back on his bed. He was at once calm, but looked surprised and asked what was the matter with him. He assured me that he had felt no pain, had slept well, but that he felt odd when he stood up. I found that he had been fishing on the preceding day and having entangled his line had taken off his shoes and stockings and waded into the river to disengage it; but he said he had not cut his feet or met with any other accident. To ascertain this point I made him draw off his stockings and examined his legs minutely. Not the slightest scratch or injury could be seen; but on holding up the right great toe with my finger and thumb to examine the sole of that foot, the leg was drawn up and the muscles of the jaws were suddenly convulsed, and on releasing the toe these effects instantly ceased. I then closely inspected the toe. The nail was perfect; there was not the least swelling or redness in the surrounding parts, nor any tenderness or uneasiness felt when I compressed the toe laterally, or moved it, held thus, in any direction; but on the bulb of the toe nearly at the point where the circumgyrations of the cuticle centre, there was a very small elevation, as if a bit of gravel less than the head of a small pin had been there pressed in beneath the cuticle. There was not the least redness on this spot nor any sensation or effect produced by passing my finger over its surface; but on compressing it with my finger and thumb against the nail very cautiously, a slight convulsion instantly ensued. I asked the patient if anything pricked him? He said "No, but something made him feel very odd." On examining this part well with a pocket lens, no scratch or puncture of the cuticle could be discovered. I then with a pair of scissors included and snipped away the slightly elevated part, but not so deeply as to denude the cutis beneath. In the bit of cuticle thus removed I expected to find some point of a thorn or particle of sand, but could not detect anything of the kind. I then pressed the toe in every direction; the strange sensation was gone and never returned. I do not know that any member of patient's family had ever been under treatment for insanity, but two of his uncles, and I believe an aunt, were suicides, and the patient himself many years afterwards was "found drowned" by the cautious verdict of an inquest."

Every physician has probably from time to time met with kindred, although much less remarkable cases, resulting from reflex irritation; we have ourselves, more than once, seen cases of hiccup, which had for several days, resisted all the ordinary remedies, stopped at once and permanently, by making an incision for the evacuation of a small quantity of pus from the sole of the foot; we have also witnessed an instance in which a patient suffering from erysipelas in the lower limb, was suddenly, at midnight, seized with violent, maniacal delirium, shouting so as to disturb the neighbourhood, and plunging and kicking so as to be with difficulty restrained. An incision made along the side of the tibia, of which the patient was apparently unconscious, gave exit to some grumous pus; instantly the sufferer became composed, and in less than half an hour was sleeping soundly; the delirium did not return. But the question is, how are such reflex phenomena to be accounted for? does not the contemplation of the theories now generally adopted as to the forces acting in the inorganic world, induce us to suppose that, in the living organism, analogous molecular changes, altogether independent of the blood-vessels, may give rise to many of the phenomena in question? In such cases, we confess, that analogy is an unsafe guide, but, on the other hand, it is difficult, if not impossible, not to be led some little way by it.

In an appendix, which forms a goodly portion of the volume, Dr. Brown-Sequard considers the objections to the opinions which he has advanced, and upon whose full discussion he had not been willing to enter in the lectures themselves; while in a subsequent portion of the same, he deals with the application of some of the facts and views expounded in his lectures, to the treatment of disease. Of the latter portion it is not our duty here to speak; and to the former it is in a great degree unnecessary to advert, in as much as the "examination of objections" contained in it has for a long time been before the scientific public, in Dr. Brown-Sequard's "Experimental and Clinical Researches on the Physiology and Pathology of the Spinal Cord," published in 1855.

In a notice like the present, it would be quite impossible to deal with the many secondary questions which are touched upon in Dr. Brown-Sequard's eminently suggestive work. There are, however, two of these which we cannot refrain from mentioning: 1st, as to the muscular sense, *i. e.* the appreciation of the feeling which accompanies muscular contraction, and which, in its exaggerated condition, constitutes the excruciating suffering which attends cramp and various muscular spasms; and 2ndly, as to the hyperæsthesia which follows the section of a lateral half of the spinal cord in the posterior limb, on the same side as the lesion.

Magendie discovered, in 1839, that irritation of the anterior or motor roots of the spinal nerves causes pain, and further, that when these roots are divided, irritation of the distal extremity only gives pain; while if the posterior roots of the corresponding spinal nerves be next cut across, pain no longer results from the irritation just mentioned. On these facts Magendie founded his hypothesis of recurrent sensibility. Now what may be the cause of the pain resulting from an irritation propagated, thus centrifugally along a motor, and then centripetally along a sensitive nerve? To this question Dr. Brown-Sequard gives a most ingenious answer. Although Matteucci and Dubois Reymond differ as to the explanation of the phenomena, yet all agree that if a so-called rheoscopic frog's leg be prepared and laid on an insulating plate, and a second leg be laid across it, so that the nerve alone of the second is in contact with the muscles of the first, a contraction produced in the first leg, by galvanic or other stimulus, is followed by a secondary (or *induced?*) contraction in the second, and so for three or four limbs under favourable circumstances. This is due to some change in the galvanic state of the muscle, which by its contraction thus excites the nerve lying on it. Now Dr. Brown-Sequard supposes that this change in the galvanic state of a muscle is, in the natural condition, perceived by the sensitive nerves of the muscle; and the delicate perception of this galvanic change accompanying muscular contraction, however slight, gives to us a correspondingly delicate appreciation of the feeling of weight, which is one of the most striking phases of the so-called "muscular sense." The more violent the contraction, the more marked is the disturbance of the galvanic equilibrium, and consequently the more distinct and strong the impression conveyed to the central nervous system. Normally these contractions are unaccompanied by pain, but if the muscular contraction be very violent, or if the centripetal nerves of muscle be in a hyperæsthetic condition, pain results, and hence that accompanying spasm and cramp. In support of this view Dr. Brown-Sequard gives the following experiment:

"If we fix a thread to the tendon of a muscle of a frog and attach to this thread a weight, capable of entirely preventing the contraction of the muscle, which is fixed by its other extremity, we find that every time the muscle *tends* to contract, there is an excitation of the nerve lying upon it, and a contraction of the muscle to which this nerve is distributed. Hence it is not necessary for muscle to contract in order to produce in nerves in contact with it a galvanic excitation. I repeat that it is sufficient that they tend to contract. Now I have found that the greater is the resistance to the contraction of the muscle the greater is the galvanic excitation that it gives to nerves in contact with its tissue. On the contrary, if there is no resistance at all, as already shewn by Prof. Matteucci, after the section of the tendon, then the galvanic excitation of the nerves in contact with the contracting muscle no longer exists."

In this manner Dr. Brown-Sequard attempts to explain, with what, as we have already said, appears to us singular ingenuity, the pain accompanying contracted muscles, cramps, spasms, contraction of the uterus, &c. &c.

What is to be considered as the true cause of the *increase* of sensibility which follows a division of a lateral half of the spinal marrow, and is observed to take place on the same side as the lesion? Hyperæsthesia (or at least such augmentation of sensibility as we can discover in animals by pricking, pinching, &c.) seems to result from two distinct conditions, viz. increased vascularity of the surface, and also increased vascularity of portions of the cerebro-spinal centres. Of the first we have a familiar example, in the great sensitiveness of a portion of the skin irritated by the application of a sinapism; the peripheral expansions of the nerves seem to become, in consequence of the greater supply of blood, more acutely sensitive to impressions made upon them, to undergo, in fact, an exaltation of function. Of the second we have an illustration in the increased sensibility, which forms so striking a symptom of the early stages of cerebro-spinal meningitis; in this case, the increased vascularity of the central nervous system is accompanied by an increase of sensibility of the surface. We know that when the sympathetic nerve is divided in the neck of a rabbit, the ear, on the same side, becomes warmer, more vascular, and more sensitive than the other, and that the same consequences are met with, on the same side as the section, in the posterior limb, after division of a lateral half of the spinal cord. We are therefore, at first, naturally led to suppose that in each experiment the vaso-motor nerve fibres being divided, and the blood-vessels paralysed, the increased vascularity consequent upon this gives rise to the increase of sensibility. An exceedingly interesting experiment of Dr. Brown-Sequard's proves that in the latter instance, at all events, there is another cause for the hyperæsthesia to be sought for. In his paper entitled "Experimental Researches on various questions concerning Sensibility," read before the Royal Society in May, 1860, he says that in a rabbit, all the parts of one of whose hind limbs were amputated, except the nerves, and in which the toes are, after a time, about losing their sensibility, in consequence of all circulation of blood being at an end in the limb, there is nevertheless a rapid and very notable return of sensibility on dividing the posterior columns of the spinal cord in the dorsal region. It is obvious that this return of sensibility cannot be due to any cause connected with the vessels of the partially amputated limb ; we must attribute it rather to the increased vascularity of the spinal cord, which must more or less extensively result from the injury done to it. So also it would appear that, after division of a lateral half of the spinal cord, the increased vascularity which unavoidably attends such an experiment may be, in some degree, a cause of the hyperæsthesia already alluded to in a previous part of this article.

In concluding the present imperfect notice of Dr. Brown-Sequard's work, we wish merely to add that we have perused it with the greatest possible pleasure ; and that wherever we have ventured to differ from the learned author, we have tried to do so with all the respect due to a man who has devoted much of his life to the successful investigation of the truths of natural science, and who has, with extraordinary industry and ability, sought to solve some of the most difficult problems in Physiology.

XLI.—Mémoire sur la tribu des Hystérinées de la famille des Hypoxylées (Pyrenomycetes), par M. le Pasteur Duby, Docteur-és-Sciences. Genève, Jules-Gme. Fick, 1861.

This Memoir, now published separately, first appeared in the "Mémoires de la Société de Physique et d'Histoire naturelle de Genève." (Tome XVI.) It will be of great service to Mycologists, relating as it does to a subject upon which a monograph was much wanted. Monsieur Duby has for some time been occupied in preparing a work on the Hypoxyleæ, or Pyrenomycetes, as Fries terms them, and the present account of one of the most important tribes of that family is published, by way of Prodromus to the larger work.

After a few introductory remarks, the author divides his work into four sections. The first contains some general observations on the family of the Pyrenomycetes, and especially on the tribe of the Hysterineæ. The second section relates to the particular characters of the Hysterineæ and the relative value of such characters. The third section contains a systematic exposition of genera and species, and the fourth, some remarks on the application to the family of the Hypoxyleæ of the principles laid down in the previous part of the work.

The position of the Hysterineæ amongst the Fungi has given rise to some difference of opinion. Fries in the "Systema Mycologicum" placed them in the Pyrenomycetes, but in his later work, the "Summa Vegetabilium Scandinaviæ," he has transferred the greater portion of the tribe to the neighbourhood of the Pezizas in the Discomycetes. He retains, however, *Lophium*, *Actidium*, and *Ostropa* amongst the Pyrenomycetes, mainly upon the grounds that in these three genera the perithecia never open, and that the spores only escape by rupture of the walls, which he considers to be more fragile in these genera than in other Hysterineæ. Mons. Duby contends that this classification is founded upon a double error. He remarks that in *Lophium* the walls are not more fragile than in many of the *Hysteria*; upon this point we think he is quite correct, and that the same remark might be extended to *Actidium*. He adds that in *Ostropa* the walls are more persistent than in most plants of the tribe.

The question as to the escape of the spores is one which can only be determined by a careful examination of specimens in a living state. Mons. Duby alleges that the lips of the perithecia in the genera in question, although closed when dry, open when the plant becomes moist, and that the spores escape through the fissure. This would certainly be more in accordance with what might be expected from our knowledge of the process in closely allied species: at the same time, the great authority of Fries, especially in observations upon living Fungi, would lead one to suspend judgment in the matter, with a suspicion, however, that Mons. Duby will prove to be in the right.

Mycologists in general will probably concur with Mons. Duby in keeping the Hysterineæ apart from the Pezizas, for which he gives, as it seems to us, sound and sufficient reasons. The absence of gonidia affords a strong, if not a conclusive argument in favour of separating them from the Lichens; a separation which could not, we think, be justified upon the other grounds brought forward by the author, viz. the absence of a thallus, the structure of the paraphyses and of the hymenium, and the insensibility of the latter to the action of iodine. With regard to the last point especially, so many fungi are now known* in which the test of iodine discloses the existence of starch, that the presence of this substance can no longer be looked upon as a mark of distinction between Lichens and Fungi.

Mons. Duby divides the Hysterineæ into two sections, Lophieæ and Hysterieæ, the former having the perithecia more or less erect, the latter having the perithecia horizontal. Each of these sections is divided into two sub-sections, according to a difference in the nature of the asci. We are not aware that this difference has been previously noticed, and we therefore translate the author's account of it. He says—

"The asci of the Hysterineæ are constructed upon two totally different systems. Those of the one system are true sacs, enclosing 8 spores (exceptionally 4 or 6 only) of different forms, varying from ovoid-globular to cylindrico-linear. Those of the other system, which at first resemble the former, excepting that they are cylindrical and much more elongated, are in reality composed of 8 hyaline filiform spores, containing a number of little globules or sporules. When ripe, the spores separate at

* See Ann. d. Sc. nat. Ser. IV., Vol. 3, p. 148. Proceedings of the Royal Society of London, 1858, p. 119. Pringsheim's Jahrbücher für wiss. Bot. Vol. ii. p. 275, et seq.

their upper ends, and become detached, more or less, completely from one another, being often entirely bent backwards or twisted in different directions. They are so like paraphyses that their true nature has often been mistaken. . . . . I thought at first that these spores must, before their separation, be united by a membrane, but, although I have used different microscopes, different magnifying powers, different sorts of light, and different chemical tests, I have never succeeded in discovering the slightest trace of an enveloping membrane. The Hysterineæ, therefore, have two very different sorts of asci, viz. *dehiscent asci* (those formed by long spores which become detached from one another), and *closed asci* (those which contain spores of different sorts within a closed membrane)."

Now upon this we would remark that a consolidation of 8 filiform spores without an enveloping membrane cannot with any accuracy be called an ascus; if (as Mons. Duby is convinced) no membrane be present, the fructification would be somewhat analogous to the bunches of spores borne on the lips of the paraphyses of *Patellaria*, and must, we think, be looked upon as basidiosporous or stylosporous, and not as ascigerous. This would not interfere with Mons. Duby's classification, but would only necessitate a change in definitions.

In the third section of his Memoir, which contains, as we have said, a systematic exposition of genera and species, two substantial new genera are proposed. There is a third, "*Aporia*," which, however, is only a refuge for some plants of uncertain affinity, and which is designated by the author as "anomalum et ambiguum." Of the two others *Ostreichnion* is founded upon *Lophium unguiculatum* of Wallroth, and will probably be adopted. The other, *Mytilinidion*, represents *Hysterium aggregatum* of De Candolle, and differs somewhat from *Ostreichnion* in the shape of the perithecium, and materially so in the spores.

The fourth and last section contains some useful observations on the value of the stroma and of the form of the spores for purposes of classification in the Hypoxyleæ generally. With most of these observations we entirely concur, but we entertain great doubt as to the character of dehiscence ascribed by the author to the fruit of *Sph. acuminata*, *rubella*, and *disseminans*. We have not had an opportunity of examining the latter species, but with regard to the two former we have never had any doubt as to the existence of an enveloping membrane, or true ascus, and if this be so, Mons. Duby's principle of classification would not be applicable.

XLII.—Blackwall's Spiders of Great Britain and Ireland. Published by the Ray Society.

All naturalists must feel much indebted to the Ray Society, and to Mr. Blackwall more especially, for the publication of this volume. It must, we think, be admitted that Insects, particularly the Coleoptera and Lepidoptera, have of late years nearly monopolized the attention of Entomologists; and even Mr. Stainton might see without jealousy some part of the "collecting power" of this country diverted from the Microlepidoptera, and "turned on" to the other groups of Annulosa. Owing to the enormous variety of insects, the entomologist is always in danger of merging the philosopher in the collector, and of devoting to particular groups the labours which would produce a richer harvest if spread over a wider field.

Partly perhaps for this reason, entomologists are a class too much separated from and too little appreciated by their fellow naturalists. Their delight is to wander, net in hand, in the woods and fields, collecting specimens and watching the habits of their favourite insects. To do this successfully, it is necessary to know by sight and name a great many species, and this is done to a wonderful extent. But any group in which the species are difficult to name and to preserve, is almost certain to be neglected,

This has been hitherto the case with the Spiders; but, as far at least as Mr. Blackwall's work goes, the former difficulty is now much diminished, copious descriptions being given, with excellent coloured* figures of almost every species.

We hope, therefore, that the appearance of this work will stimulate our naturalists to cultivate the field thus thrown open to them.† How much there is to be done may be judged of from the fact, that though Mr. Blackwall is careful to record the names of those who have captured specimens of any rare species, he only mentions fourteen persons, three of whom are ladies. Moreover, of these fourteen, five appear only once. Mr. Blackwall himself, Mr. Cambridge, Mr. Clark, Mr. Meade and Mr. Hardy have indeed been indefatigable, but so few labourers could do but slight justice to such a plentiful harvest. The art of collecting insects is brought to a high pitch of perfection; and Mr. Stainton's list in the Entomologist's Annual informs us that there are more than 1400 entomologists in the kingdom. By far the greater number are ardent collectors, as may be shown by the collateral evidence that a penny weekly paper, the "Entomologist's Intelligencer," which circulates entirely among insect collectors, has more than 600 subscribers. Yet not a month passes without adding some new insect to our lists; and we may

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* Mr. Blackwall most liberally defrayed half the charge of the colouring, which was all done by hand, and was therefore a considerable expense.

† In Carus's recent "Bibliotheca Zoologica," twenty pages suffice for the Arachnida, while the Insecta occupy more than two hundred.

therefore fairly conclude that the present catalogue of British Spiders must be very incomplete.

Mr. Blackwall's present volume comprises seven families: the Mygalidæ, Lycosidæ, Salticidæ, Thomisidæ, Drassidæ, Ciniflonidæ and Agelenidæ, comprising twenty genera. The author, however, gives no complete family characters, and the generic descriptions, in which he generally follows Walckenaer and other authorities, are far from being satisfactory. It would have been a great boon to anatomists if Mr. Blackwall had given a tabular arrangement of the genera, like those in the Histoire Naturelle des Crustacés. This we will attempt in some measure to supply; taking Mr. Blackwall's own words, and treating his last five families as one great group.

Eight genera, named *Lycosa*, *Hecaerge*, *Dolomedes*, *Sphasus*, *Eresus*, *Salticus*, *Textrix* and *Cœletes* have the eyes unequal; and four, *Lycosa*, *Sphasus*, *Eresus* and *Salticus* may be recognised by the relative position of these organs; though we may observe that in the several figures of *Lycosæ* the posterior row is made too large, and that this is the case even in the enlarged figure, specially intended to show the arrangement characteristic of the genus. In *Hecaerge*, *Dolomedes*, *Textrix* and *Cœlotes* the eyes are in two rows, both of which are straight in *Cœlotes*, while the posterior at least is curved in the other three genera. In *Hecaerge* the lip is small, triangular and truncate at the extremity, while in *Textrix* and *Dolomedes* it is nearly quadrate. These two genera in Mr. Blackwall's arrangement belong to altogether different families; and an analysis of genera in this manner often gives a very unnatural arrangement; indeed the principal object of it is to separate allied groups.

In *Dolomedes* the maxillæ are straight, while in *Textrix* they are curved towards the lip. Of the remaining genera in which the eyes are more or less equal in size, three, namely, *Ciniflo*, *Ergatis* and *Veleda*, forming the Ciniflonidæ, have a comb on the hind legs. Two of the remainder, *Thomisus* and *Philodromus* are characterised by having the legs extended laterally. In *Drassus*, *Clubiona*, *Agelena* and *Argyroneta* the two eye rows are parallel. In *Tegenaria* the posterior row is described as being concave in front, and the anterior row nearly straight, but in the figure given (Pl. XII. fig. 107), which is, we believe, correct, this description is by no means verified. Walckenaer has fallen into exactly the same inaccuracy, though he has selected a different species (*S. domestica*) for illustration. *Sparassus*, which has the anterior row convex in front and the posterior row straight, has only one English species, which is brightly coloured.

The single English species of the genus *Argyroneta* will offer no difficulty to the Naturalist. *Agelena* has the eye rows concave in front* and the maxillæ short. In *Drassus* and *Clubiona* the maxillæ are long; being in the former curved towards the lip, and in the latter straight.

* This curvature is unfortunately reversed in several of the figures.

While however we admit that Mr. Blackwall has in most instances merely followed earlier authorities, and must be acquitted of any great multiplication of genera on his own account, we may be permitted to doubt whether all those which he has adopted are sufficiently characterised. We will take, for instance, *Thomisus* and *Philodromus*, placing the characters side by side, as follows:

Thomisus.	Philodromus.
Eyes disposed on the anterior part of the cephalothorax in two transverse rows, forming either a crescent or a segment of a circle whose convex side is in front; they do not differ greatly in size.	*Eyes* disposed on the anterior part of the cephalothorax in two transverse, curved rows, forming a crescent whose convex side is in front; they do not differ greatly in size.
Maxillæ inclined towards the lip, and pointed at the extremity.	*Maxillæ* inclined towards the lip, and convergent at their extremities.
Lip either triangular or oval, but obtuse at the apex.	*Lip* either triangular or somewhat oval.
Legs so articulated as to be extended laterally; the first and second pairs are longer and more robust than the third and fourth pairs.	*Legs* so articulated as to be extended laterally; they are long, and vary in their relative length in different species.

Comparing together the above characters, it must be at once evident that if there is any difference it is not one which can fairly be considered of generic value. According to Walckenaer, indeed, in *Philodromus* the legs are equal in length, while in *Thomisus* the two posterior pairs are shorter than the others, but this statement is quite incorrect, as a glance at the figures will show.

Other similar examples might be given, and therefore we cannot but think that the classification of the Araneidæ is very unsatisfactory, and that many of the genera must be abandoned, unless better characters can be given. Mr. Blackwall has probably taken a step in the right direction, in attributing much importance to the comb of hairs characteristic of the Ciniflonidæ. Perhaps also the spiders with three tarsal claws might be generically separated from those with two. Mr. Blackwall might, we think, have advantageously shortened his specific descriptions, by putting some of the points common to the genus either in the generic description, or, at least, in the general remarks on the group. For instance, in all the 28 species of *Thomisus* and *Philodromus*, except one in which the point is overlooked, he remarks that each tarsus is terminated by two claws. In his remarks on the family Thomisidæ he does indeed observe that each tarsus is usually terminated in this manner, but the fact is that all the English species, with perhaps one exception, have this character.

The total number of species described is 120. Only seven species are recorded as having presented varieties; two in *Lycosa*, and one respectively in *Dolomedes*, *Eresus*, *Salticus*, *Thomisus* and *Ciniflo*. The number is therefore insufficient to give results of any value, but it tends to confirm the usual slightly greater variability of large genera. Four cases are also recorded in which the eyes were abnormal; namely, a specimen of *Lycosa campestris*, in which the lateral anterior eyes were deficient, one of *L. cambrica* in which the right intermediate eye was wanting, a female of *Thomisus bifasciatus* had the right posterior eye much smaller than usual, and in a female of *Ciniflo atrox* the left intermediate eye of the posterior row was entirely wanting. Mr. Blackwall has only met with one other case of monstrosity; namely, a short but perfectly formed supernumerary tarsus connected with the base of the tarsal joint of the right posterior leg; this occurred in a female of *Lycosa campestris*. Thus four cases of monstrosity out of five occurred in the large genera, and in the female sex.

Mr. Blackwall mentions that *Thomisus pallidus* and one or two of its congeners have "the power of changing the colour of the anterior intermediate pair of eyes from dark red brown to pale golden-yellow by a very perceptible internal motion," but it does not seem clear in what manner the movement produces this effect.

As regards the manners and customs of our spiders, it is almost unnecessary to say that they are all insectivorous. *Alypus sulzeri*, like many foreign Mygalidæ, excavates a subterranean gallery, in which it spins a tube of silk; the Lycosidæ and Thomisidæ are hunters, and some species of the former are semi-aquatic, running fearlessly on the surface of the water, and even sometimes descending beneath it; the Salticidæ take their prey by surprise, frequently springing on it from a distance; the Drassidæ "conceal themselves in silken cells, "which they construct among the leaves of plants, in the crevices of "rocks and walls, and under stones, and the exfoliating bark of aged "trees; they run actively in pursuit of the insects which constitute "their food, or take them by surprise; but one species, the *Argy-* "*roneta aquatica*, lives habitually in the water of ditches and pools;" finally, the Cinifloridæ and Agelenidæ catch their prey by means of curious and complicated nets.

In the well-known circular nets of the Epeiræ, the concentric lines only are adhesive; they are composed of an elastic spiral line, thickly studded with minute globules of liquid gum, and Mr. Blackwall has calculated, that an ordinary net fourteen or sixteen inches in diameter, would contain 120,000 of these globules, in spite of which the *Epeira* will complete its snare in less than an hour, if it is not interrupted.

"Many intelligent naturalists," says Mr. Blackwall, "entertain the opinion that spiders can forcibly propel or dart out lines from the spinners: but when placed on twigs set upright in glass vessels with perpendicular sides, containing a quantity of water sufficient to immerse their bases completely, all the efforts they make to effect an escape uniformly prove unavailing in a still atmosphere. However, should the individuals thus insulated be exposed to a current of air, either naturally or artificially produced, they immediately turn the abdomen in the direction of the breeze, and emit from the spinners a little of their viscid secretion, which being carried out in a line by the current, becomes connected with some object in the vicinity, and affords them the means of regaining their liberty. If due precaution be used in conducting this experiment, it plainly demonstrates that spiders are utterly incapable of darting lines from their spinners, as they cannot possibly escape from their confinement on the twigs in situations where the air is undisturbed, but in the agitated atmosphere of an inhabited room, they accomplish their object without difficulty. Similar means are frequently employed by spiders in their natural haunts, for the purposes of changing their situation and fixing the foundation of their snares."

The habits of spiders however are little known. The subaqueous habitation of the water spider (*Argyroneta*) indeed is well known from the descriptions of Dr. Bell and others, and according to Mr. Blackwall—

"The following remarkable physiological facts in connection with *Tegenaria civilis* (one of the house spiders) have been ascertained by observation and experiment; namely, that both sexes change their integument nine times before they arrive at maturity, once in the cocoon, and eight times after quitting it; that a leg of a young individual, detached at the coxa (hip) six times consecutively, may be reproduced at each succeeding change of integument after the infliction of the injury; that the life of the species extends through a period of four years; that the sexual organs of the male are connected with the digital joint of the palpi; and that the female, after impregnation, is capable of producing nine sets of prolific eggs in succession, without renewing her intercourse with the male, more than two years elapsing before all are deposited, and ten months nearly intervening sometimes between the deposition of two consecutive sets."

It is well known that spiders are essentially insectivorous and like other animals of prey they can go a long while without food. A female *Theridion quadripunctatum* has been known to exist for eighteen months without nutriment in a phial closely corked.

Though unsocial and voracious, many spiders have, in their affection for their young, at least one redeeming feature. They lay from thirty to two hundred eggs at once, and "usually spin silken cocoons "for their reception, which exhibit much diversity of form, colour, "and consistency, and are placed in various situations, according to "the economy of the species, by which they are fabricated. Many "spiders abandon their cocoons so soon as they are completed; "others manifest great attachment to them, watching over them with "the utmost solicitude; and some, connecting them with the spin-"ners by silken lines, or grasping them with the falces and palpi, "transport them whenever they move." In some species the young spiders on leaving the cocoon attach themselves to the body of their parent, who carries them about until they are able to provide for themselves.

With reference to the senses of the Arachnida, Mr. Blackwall says:—

"Nothing is known with certainty concerning the organs of smell and hearing in spiders. As regards taste, the choice which these animals make of their food sufficiently indicates that it exists, and it is probable that the organ is situated at the entrance of the pharynx. Numerous circumstances tend to prove that spiders are endowed with considerable delicacy of touch, but the instruments more especially adapted to bring them into relation with surrounding objects are the legs and palpi. The presence of eyes, which are of the kind termed simple, in opposition to those of insects and crustaceous animals, which are denominated compound, leaves no doubt relative to the sight of spiders, though, in all probability, they see objects distinctly at short distances only."

They appear to be less subject to parasites than many other animals, but *Polysphinata carbonaria*, one of the Ichneumonidæ, lays its eggs in the bodies of young Spiders, which when thus infested never come to maturity.

Mr. Blackwall's present volume, however, being devoted to the description and classification of Spiders, their anatomy and habits are only mentioned incidentally, and he refers to his Memoir in the Transactions of the British Association for 1844. As regards the function performed by the palpi of the male, his subsequent investigations have confirmed him in the belief that these "organs are the only efficient instruments employed by male spiders in the propagation of their species." It is, however, unnecessary to observe that the spermatozoa do not originate in this position; the testes are, as is well known, situated in the abdomen, and Treviranus has shown, that the vas deferens of the male opens in the same position as that of the female. It would appear, therefore, though Mr. Blackwall has not noticed the fact, that the semen must pass externally into the palpi, and be there retained until it is required. Nor is this incredible, since after the extraordinary facts which have been observed in certain Cuttlefishes and Centipedes, no mode of impregnation ought to stagger us.

In conclusion, it may perhaps be well to say a few words about the irregularity in the appearance of the Ray Society's Volumes. Neither the fact, nor the inconvenience, can be denied, but the remedy is not so plain. The arrangements have always been made three or four years in advance, the books have been promised by the authors, the authors have been applied to from time to time, and it is difficult to see what more the Council could have done.* Neither can we throw much blame on the authors. No one for instance will accuse Mr. Huxley or Mr. Blackwall of idleness; the delay has been mainly caused by their wish to render their works as perfect as possible, and so much excellence may well atone for some little unpunctuality.

We understand, however, that Mr. Currey's translation of Hofmeister is in a forward condition, and that it will be published within the year, and we hope that this may be the beginning of greater regularity; but at any rate the large number of subscribers shows that the publications of the Ray Society are well appreciated by naturalists, and that the members, even if they not unnaturally grumble a little, still take for their motto, "better late than never."

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* In the present case indeed much delay was caused by the fact that it was found necessary to colour the plates by hand.

XLIII.—Recent Contributions to the Literature of the Sub-kingdom Cœlenterata.

1. Beiträge zur Kenntniss Wirbelloser Thiere. Von Dr. H. Frey, und Dr. R. Leuckart: Braunschweig, 1847.
2. Lectures on General Natural History. By Thomas H. Huxley, F.R.S. &c., &c. (Published in the *Medical Times and Gazette*, 1856-7.) Lectures IV. and V.
3. Icones Zootomicæ. Mit Originalbeiträgen der Herren G. J. Allman, C. Gegenbaur, Th. H. Huxley, Alb. Kölliker, H. Müller, M. S. Schultze, C. Th. E. Von Siebold, und F. Stein. Herausgegeben von Julius Victor Carus, Professor der Vergleichenden Anatomie in Leipzig. Leipzig, 1857. Tafel II.-IV.
4. Histoire Naturelle des Coralliaires ou Polypes proprements dits. Par H. Milne Edwards, Membre de l' Institut, &c. Paris, 1857-60.
5. Grundzüge der Vergleichenden Anatomie. Von Dr. Carl Gegenbaur, Professor der Anatomie zu Jena. Leipzig, 1859. Zweiter Abschnitt. Cœlenterata.
6. The Oceanic Hydrozoa; a Description of the Calycophoridæ and Physophoridæ observed during the voyage of H.M.S. "Rattlesnake," in the years 1846-50. With a General Introduction. By Thomas Henry Huxley, F.R.S., &c., &c. London: printed for the Ray Society, 1859.
7. Die Klassen und Ordnungen des Thier-reichs, wissenschaftlich dargestellt in Wort und Bild. Von Dr. H. G. Bronn, Professor an der Universität Heidelberg. Zweiter Band, Strahlenthiere: Actinozoa. Lief. I.-VI. Leipzig und Heidelberg, 1859-60.
8. A Manual of the Sub-kingdom Cœlenterata. By Joseph Reay Greene, B.A., Professor of Natural History in the Queen's College, Cork, &c., &c. London, 1861.

The sub-kingdom Cœlenterata has not yet been acknowledged as such in the writings of several Zoölogists. Some have endeavoured to convince themselves of its supposed unsuitability. Others, and these the greater number, slow to appreciate the facts and arguments brought forward by recent enquirers or, it may be, unduly impressed with the belief that all classification is, at best, but provisional, have rejected it, less from conviction, than from an indolent or prejudiced adherence to the systems usually adopted in the older treatises on Zoölogy.

The Reviewer, therefore, proposes to take a brief survey of the leading views which, during the present century, have prevailed with reference to the systematic relations of the animal forms in question. A knowledge of such views, in itself sufficiently desirable, becomes necessary for those who wish to consult, with ease and advantage, the numerous memoirs which have, from time to time, treated of Cœlenterate organisms, under whatsoever designation.

In comparing Zoölogical systems it is requisite, in the first place, to select some well known classification which may serve for a convenient standard of comparison. For this purpose that of Cuvier[1] is above all others to be preferred; first, by reason of its intrinsic merits, and, secondly, on account of its historical value, strongly contrasting, as it did, with the arrangements of his predecessors, and forming, so to speak, the basis on which the greater number of succeeding systems have been reared. We shall, accordingly, proceed to indicate the place which Cœlenterate animals held in the classification of Cuvier, and then notice the gradual changes of opinion which have led modern investigators to adopt the more accurate view of their affinities now entertained.

Of the four primary branches, or sub-kingdoms, into which the entire animal kingdom was divided by Cuvier, the lowest, Zoöphyta[2] or Radiata, included five classes, viz.:—

1. ECHINODERMATA.
2. INTESTINA.
3. ACALEPHÆ.
4. POLYPI.
5. INFUSORIA.

In thus bringing together a number of animal forms having few characters in common save a certain vague resemblance in outward aspect, and an inferiority, real or supposed, in the details of their organization, Cuvier lost sight of the principle, so important in biological classification, which no one has more happily defined than its first and clearest enunciator, Von Baer.[3] In the year 1828 this most philosophic of naturalists drew attention to the distinction between the *grade of development* of an animal and the *type of its organization*. The grade of development of an animal he defined as consisting "in the greater or less heterogeneity of its elementary parts and of the separate divisions of a complex apparatus; in a word, in its greater histological and morphological differentiation:" the type as "the relative position of the parts." And since no real agreement in type, or plan of structure, exists among the several divisions of Cuvier's Zoöphyta, it follows that this sub-kingdom can no longer be regarded as constituting a truly natural group.[4]

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[1] Le Règne Animal. Nouvelle édition. Paris, 1829-30.

[2] For some account of the several senses in which this term has been used see, especially, De Blainville, Manuel d'Actinologie, p. 1; Johnston, History of British Zoophytes, second edition, passim; and Dana, Structure and Classification of Zoophytes, p. 7. The word Phytozoa is of more modern construction, and may be found in the work of Goldfuss, cited below.

[3] See the English translation (by Mr. Huxley) of selections from the works of Von Baer, in Taylor's Scientific Memoirs, Natural History, 1853. p. 195.

[4] "We believe, in fact, (writes Von Baer), that Cuvier has penetrated most deeply into the relations of animal organisms. But he does not satisfy us in this; that he requires in the Mollusca and Articulata not only the type of their organiza-

It should be remembered, however, that much which is now known of the structure of the lower animals had, at the time of Cuvier, been very imperfectly acquired, and that many of the improvements in classification for which he had prepared the way waited only to be revealed by the clearer light of subsequent anatomical discoveries.

Thus many investigators have agreed to transfer the class Intestina to the Articulate sub-kingdom (preferably known as Annullosa). Here, also, have been placed the Rotifera, by Cuvier associated with the Infusoria.[5]

So, likewise, the class of animals now known as Polyzoa or Bryozoa, whose several forms Cuvier had distributed among the Polypi, has been since removed to the sub-kingdom Mollusca.[6]

The Sponges were by Cuvier regarded as animals and classed with the Polypes, a view of their affinities which some Zoölogists still continue to hold.[7] Most, however, are disposed to place the Sponges, Infusoria, and other organisms of like structure subsequently discovered, in a group distinct from the remaining Zoöphyta. Thus Milne Edwards (first excluding the Intestina, Rotifera, and Polyzoa) has arranged the other Zoöphyta under two groups,[8] as follows:—

ZOOPHYTES.

	Classes.
Radiaires ou A. rayonnes.	ÉCHINODERMES ACALÈPHES POLYPES.
Sarcodaires.	INFUSOIRES SPONGIAIRES.

The Sarcodaires are now more generally considered as a distinct sub-kingdom, under the name of Protozoa.[9] So that the sub-kingdom

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tion, but also a certain degree of development,—a condition which can only be required of the single classes. The consequence is, that all the animals of low organization are thrown among the Radiata, although very many of them are by no means radiate in their structure. The boundaries under these circumstances could only be drawn arbitrarily."

[5] Milne Edwards, in 1838, clearly pointed out the necessity for effecting these changes. Vid. Ann. S. N., Ser. 2, Tom X. p. 194.

[6] For a concise account of the several steps of this transference consult Allman, Fresh-water Polyzoa, p. 2 ; and Busk, A. N. H., 1852, Ser. 2, Vol. X. p. 352.

[7] Van Beneden et Gervais, and R. Leuckart, writing in 1859, appear to give it their sanction.

[8] Cours Élémentaire d' Histoire Naturelle—Zoologie.—The above has been copied from the eighth edition, 1858.

[9] Siebold, Lehrbuch der vergleichenden Anatomie—Wirbellose Thiere—1845. But the term Protozoa may be found in the works of older writers, and appears to have been first used by Goldfuss, in his Handbuch der Zoologie, 1820.

Radiata, as restricted in recent works, includes but three classes:[10]—

1. ECHINODERMATA.
2. ACALEPHÆ.
3. POLYPI.

It has been shown, however, by Frey and Leuckart[11] that the Polypi and Acalephæ, while possessing in common a plan of structure peculiar to themselves, differ, on the other hand, both as to type and grade of organization, from the members of the group Echinodermata. They have, therefore, proposed to associate the two former classes in a separate sub-kingdom, under the name of Cœlenterata,[12] *i.e.*, animals having a well marked body-cavity, freely communicating with that portion of it which may be concerned in the discharge of the digestive functions. The propriety of this arrangement has been acknowledged by some of our most trustworthy living observers.

Thus far with reference to the sub-kingdom Cœlenterata as a whole; next, as to its classes and orders. It has been said that this group includes the two classes termed Acalephæ and Polypi in the system of Cuvier, the Sponges and Polyzoa being no longer associated with the latter.

Cuvier thus divided the Acalephæ and Polypi into orders:—

Les Acalèphes.	*Les Polypes.*
Ordre 1. A. SIMPLES.	Ordre 1. P. CHARNUS.
Ordre 2. A. HYDROSTATIQUES.	Ordre 2. P. GÉLATINEUX.
	Ordre 3. P. à POLYPIERS.

Few zoölogists, however, adopted these divisions. Eschscholtz,[13] in 1829, suggested a re-distribution of the Acalephæ which soon met with very general approval, and, in many of its features, is still

[10] For example, Edward Forbes, so far back as 1840, recognizes the propriety of employing the term Radiata in the above limited sense. See the introduction to his History of British Star-fishes.

[11] Op. s. cit., pp. 37-8.

[12] What then, it may be asked, becomes of the class Echinodermata? To this question the answer is, that not less than four different views are at present maintained as to the systematic position of these animals:—

1. That of those naturalists who refuse to acknowledge the Cœlenterata, and regard the Echinodermata as a class of the sub-kingdom Radiata.

2. That of R. Leuckart, Gegenbaur, J. V. Carus, and others, who place the Echinodermata in a sub-kingdom by themselves, distinct from the sub-kingdom Cœlenterata.

3. The intermediate view of Milne Edwards who, retaining the old group of Radiata, considers the Echinodermata and Cœlenterata as constituting its two primary, equivalent sub-divisions.

4. Lastly, it has been proposed by Huxley, who acknowledges the sub-kingdom Cœlenterata, to refer the Echinodermata, as a class, to the Annullose sub-kingdom, with certain forms of which (the Intestina and Rotifera of Cuvier) they constitute a very natural assemblage, best known under the name of Annulloida.

[13] System der Acalephen, Berlin, 1829.

well worthy of notice. His arrangement, compared with that of the French naturalist, De Blainville,[14] whose nomenclature of the Acalephæ several English writers have followed, is indicated in the subjoined table.[15]

ACALEPHÆ.

Eschscholtz.		*De Blainville.*
Order I. CTENOPHORA.	=	CILIOGRADA.
Order II. DISCOPHORA. 1. Phanerocarpæ. 2. Cryptocarpæ.	=	PULMOGRADA.
Order III. SIPHONOPHORA.		
Family 1. DIPHYIDÆ.	=	DIPHYDA.
Family 2. PHYSOPHORIDÆ.	=	PHYSOGRADA.
Family 3. VELELLIDÆ.[16]	=	CIRRHIGRADA.

The Pulmograda and Cirrhigrada form the only two orders of a class to which De Blainville gave the name of Arachnodermata. The remaining Acalephs he associated with the Entozoa and Infusoria in a group of uncertain constitution, which he defined as "faux, mais animaux à tort rapportés aux Zoophytes." His vague and erroneous statements as to the affinities of these organisms, present a striking contrast to the tersely accurate scientific descriptions, wherein, no less than in his incomparably richer stores of knowledge gained by observation, Eschscholtz appears superior to his French contemporary.

More recently, Edward Forbes,[17] followed by Lutken,[18] and Gegenbaur,[19] gave greater definiteness to the leading groups of Discophora, introducing various improvements into the limitation of the several families. Other modes of sub-dividing the Acalephæ had, it is true, long before been proposed by Péron et Lesueur,[20] Brandt,[21] and Lesson,[22] but never having been generally received, and presenting no advantages over the classifications mentioned above, they do not call for any detailed consideration.

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[14] Article "Zoophytes" in Dictionnaire des Sciences Naturelles, 1830, and Manuel d'Actinologie ou de Zoophytologie, 1834.

[15] With various slight modifications De Blainville's names have been adopted by Carpenter, E. Forbes, Grant, Rymer Jones, and Owen.

[16] The families of the two preceding orders have, for obvious reasons, been excluded from this table.

[17] A Monograph of the British Naked-eyed Medusæ, 1848.

[18] Videns. Med., 1850, p. 15.

[19] Versuch eines Systems der Medusen, &c. Z. W. Z., 1857, Band. 8, p. 202.

[20] Annales du Muséum, 1809.

[21] Prodromus, &c., Petersb. Mem., 1833.

[22] Acalèphes, in Nouvelles Suites à Buffon, 1843.

Of the Polypi, three principal arrangements have prevailed, those of Ehrenberg,[23] Milne Edwards,[24] and Johnston;[25] the first being chiefly adopted by German, the second by French, and the third by English naturalists. Ehrenberg, whose classification has precedence in point of time over those of his predecessors, conferred upon this class the name of Anthozoa,[26] which Johnston[27] subsequently adopted.

ANTHOZOA.

Ordo I. ZOOCORALLIA.	Ordo II. PHYTOCORALLIA.
Tribus 1. Z. POLYACTINIA.	Tribus 4. P. POLYACTINIA.
„ 2. Z. OCTACTINIA.	„ 5. P. DODECACTINIA.
„ 3. Z. OLIGACTINIA.	„ 6. P. OCTACTINIA.
Hydrina.	„ 7. P. OLIGACTINIA.
Tubularina.	
Sertularina.	

The arrangements of Johnston and Milne Edwards, first published contemporaneously,[27*] may be thus exhibited:—

POLYPES. *Milne Edwards.*		ANTHOZOA. *Johnston.*
I. SERTULAIRIENS.	=	I. HYDROIDA.
II. ALCYONIENS.	=	II. ASTEROIDA.
III. ZOANTHAIRES.	=	III. HELIANTHOIDA.[28]

The first of these groups corresponds to the Zoocorallia Oligactinia of Ehrenberg; the second to his Z. Octactinia, Phytocorallia Octactinia, and P. Oligactinia; while the third includes all remaining tribes of his two orders.

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[23] Beiträge zur physiologischen Kenntniss der Corallenthiere im allgemeinen, und besonders des rothen Meeres, &c., Berl. Abh., 1834, p. 225.

[24] Audouin and Milne Edwards, in Lamarck, Hist. Nat. des An. sans Verteb. ed. 2, Tom. II., p. 105, 1836.

[25] Magazine of Zoology and Botany, Vol. I. p. 447.

[26] As distinguished from Bryozoa, the two groups being collectively denominated Corallia. At a later period, the Zoocorallia oligactinia were separated by Ehrenberg from the Anthozoa to form a third class, which he named Dimorphœa.

[27] History of British Zoophytes, 2nd edition, 1847. This work and the Manuel of De Blainville, may be consulted by those who wish to obtain information concerning the older and more obscure arrangements of these organisms.

[27*] It should be remembered, however, that at p. 18 of their Résumé des Recherches sur les Animaux sans vertèbres, faites aux îles Chausey, Ann. S. N. 1828, the classification of Polypi afterwards adopted by M.M. Audouin et Milne Edwards is partly sketched out.

[28] These three equivalent divisions are by Johnston termed *orders;* by Milne Edwards, *familles.* The name Helianthoida has been taken by Johnston from Latreille.

So much, then, for the old classes, Acalephæ and Polypi, groups by no means susceptible of accurate definition. The Acalephæ of Cuvier and Eschscholtz differ, indeed, much more among themselves than do many of them from the Polypi, presenting little mutual agreement save in their Cœlenterate organization, gelatinous texture, and oceanic habit. Yet more difficult is it to point out such anatomical features as are common to the various forms of Polypi, excepting, of course, those which justify their being placed in the same sub-kingdom. It is not correct to say that, like the Acalephæ, they observe a certain similarity in their mode of life, considerable differences in this respect prevailing even among closely allied genera. But, were it otherwise, so purely physiological a tendency would avail the systematist little. For since the same *essential* may coexist with very different *adaptive* characters, community of habit, apart from resemblance in plan of structure, affording no safe ground for classification, it is plain that the two groups of Cœlenterata to which reference has been made can no longer be regarded as natural. What others, then, have been substituted in their stead?

To Professor Rapp, of Tübingen, must be ascribed the merit of having first pointed out the way towards a right solution of the difficulty now under consideration. In a small quarto treatise,[29] published at Weimar in 1829, this zoölogist laid down with great clearness and precision, the limits of two primary sections of the class Polypi, bearing the names of Exoarii and Endoarii. The Exoarii contained those Polypes which developed their generative elements within external processes of the body wall; the Endoarii those whose reproductive organs were lodged in the interior of the general cavity. This last division corresponded to the second and third orders in the arrangements of Johnston and Milne Edwards.

At a much later period both Dana[30] and Milne Edwards,[31] acknowledged two groups of Polypi equivalent in systematic value to those of Rapp. Previously both Owen and Ehrenberg had raised these divisions to the rank of classes; the Exoarii being designated Hydrozoa,[33] while the term Anthozoa, first applied by Ehrenberg to all the Cœlenterate Polypes, was restricted to the Endoarii.

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[29] Ueber die Polypen im Allgemeinen und die Actinien insbesondere.

[30] Report on Zoophytes, U. S. Exploring Expedition, 1846.

[31] In the Introduction to their Monograph of the British Fossil Corals, published by the Palæontographical Society, 1850, Milne Edwards and Haime divided the Polypi into two equal sub-classes, Corallaria and Hydraria. The Corallaria correspond to the orders Zoantharia and Alcyonaria in the earlier arrangement of Milne Edwards, the Hydraria to his Sertulairiens.

[32] Lectures on the Invertebrate Animals, 1843, p. 86.

[33] In addition to the Hydrozoa of Owen, Rapp included among his Exoarii a small group of Polypes, to which he gave the name of Milleporen. It is not easy to determine the precise sense in which the latter is used, but, obviously, Rapp meant not thereby to designate the forms now placed in the family of Milleporidæ.

The arrangements of Rapp, Ehrenberg, Owen and Dana are compared in the following table:—

POLYPI.			ZOOPHYTA.			
Rapp, 1829.		*Ehrenberg*, 1836.		*Owen*, 1843.		*Dana*, 1846.
Section 1.		Class.		Class.		Order I.
Exoarii.	=	**Dimorphœa.**	=	**Hydrozoa.**	=	**Hydroidea.**
Section 2.		Class.		Class.		Order 2.
Endoarii.	=	**Anthozoa.**	=	**Anthozoa.**	=	**Actinoidea.**

Thus diminished in extent, the class Anthozoa has since been adopted by more than one writer, and answers to the group so termed by J. V. Carus and Kölliker;[34] to the class Polypi in the systems of Vogt, Gegenbaur, Agassiz and others; and to the recently established class Coralliaria of Milne Edwards.

The Hydrozoa, on the other hand, have been enriched by the addition of all, or nearly all, the forms included under the Acalephæ of Eschscholtz and Cuvier; the Discophora and Siphonophora of the last mentioned writer being now no longer separable, as members of a distinct class, from the fixed Hydrozoa (Corynidæ and Sertularidæ), which in structure they have been proved to resemble.

The removal of the Discophorous Acalephæ to the class Hydrozoa may be viewed as the chief systematic result of the researches of numerous observers on the so-called phenomena of "alternate generation," as occurring among Cœlenterate forms.

First, it has been shown by Sars, Siebold, Steenstrup, Reid, Dalyell, Desor, Van Beneden, and others that the ova of *Aurelia*, *Cyanea* and *Chrysaora*, three of the best known and most widely distributed genera of Phanerocarpæ, become developed into fixed polype-like organisms, or "Hydra-tubæ;" these, in their turn, by transverse fission, producing a succession of free floating forms similar to those which gave them birth, and which, under the vulgar name of jelly-fishes, are familiar, in outward appearance, to almost every sea-side resident. These investigations, it must be admitted, refer only to the Monostome family of the Phanerocarpæ. But

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[34] The Cœlenterata and Bryozoa are by Kölliker retained in one division, named Radiata Molluscoidea, (as distinguished from R. Echinodermata), and arranged under six groups, as follows:—

First group: HYDROIDEA. — Divided into H. sessilia (= Hydra) and H. nechalea, (including all the Siphonophora except the Velellidæ, which are doubtful).

Second group: HYDROMEDUSIDA.—Here are placed the Corynidæ, Sertularidæ, Velellidæ, (?) and Cryptocarpæ.

Third group: DISCOPHORA.—(= Phanerocarpæ.)

Fourth group: CTENOPHORA.

Fifth group: ANTHOZOA.

Sixth group: BRYOZOA.

Vid. p. 77, of Kölliker's "Die Schwimmpolypen oder Siphonophoren von Messina," 1853.

Busch, Ecker, Frantzius and Gegenbaur have since ascertained that a like series of transformations would seem to mark the life-history of the two Rhizostomatous genera, *Cephea* and *Cassiopeia*.[35]

Still more extended inquiries have proved that many forms of Corynidæ and Sertularidæ bud forth free-swimming reproductive bodies closely resembling, in every anatomical feature, not a few of the apparently perfect animals which constitute the division of Cryptocarpæ.

To appreciate such facts aright the student must ever bear in mind the existence of a most perfect and wonderful series of transitional structures, connecting those highly differentiated "Zoöids" with the simple reproductive processes occurring in a few genera of Hydrozoa; processes which may truly be said to differ in their contents alone from any other portion of the body-wall.[36] As a supplement to the preceding remarks it may seem strange to add that the observations just noticed, though highly valuable in themselves, were not needed to demonstrate the necessity for uniting into a single class forms so closely resembling one another in structure as the Discophora and fixed Hydrozoa. An appeal to anatomical evidence, had such been carefully made, ought of itself to have sufficiently shown the desirability of such an arrangement. The study of their development, however, affords a new and striking proof of the true morphological relations which unite together the organisms in question, while, at the same time, it discloses the existence of a still more intimate genetic connection subsisting between them.

Perhaps no special department of Morphology has of late years brought to light results at once so complete and satisfactory as that which proves the close nature of the relationship between the plant-like Corynidæ and Sertularidæ on the one hand, and the oceanic Siphonophora on the other;[37] a relationship which their obvious dis-

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[35] Consult, in addition to the English translation of Steenstrup on the Alternation of Generations, Ray Society, 1845, the essay of Gegenbaur—Zur Lehre vom Generationswechsel und der Fortpflanzung bei Medusen und Polypen, 1854, for references to the works of the various authors mentioned in the above paragraph.

[36] On this subject the recently-published memoirs of Allman are of primary importance. See his paper—On the Structure of the Reproductive Organs in certain Hydroid Polypes, R. S. E. Proc. 1857-8. Additional Observations on the Morphology of the Reproductive Organs in the Hydroid Polypes, ibid, 1858; and Notes on the Hydroid Zoophytes, A. N. H. 1859-61, passim.

[37] In the Ann. S. N. for 1841 (tom. xvi.), an excellent memoir on the structure of Stephanomia appeared from the pen of Milne Edwards. For the student of the history of zoölogy this paper possesses a considerable interest, as being by far the best and most complete account of a Siphonophorous Acaleph which had, up to that time, been published. It was followed by the essays of Mr. Huxley, read before the Royal and Linnean Societies in 1849. In these the true nature of the Siphonophora, and their affinity to the fixed Hydrozoa and Medusidæ, received very complete elucidation; yet, owing to certain delays on the part of the Linnean Society, the views of Mr. Huxley were at first but imperfectly announced and remained comparatively unknown until the year 1851, when the same observer, contemporaneously with Leuckart, again directed attention to the curious morphological problem which the organi-

similarity in outward form and habit had long kept concealed from the notice of observers apparently by no means wanting in patience or ingenuity. A peculiar feeling of pleasure, therefore, attends the perusal of the works of those investigators, whose skilful use of such opportunities as lay within their reach, first led them to form right conjectures as to the proper affinities of the Siphonophora.

Like most Corynidæ and Sertularidæ, these creatures are, in general, of composite structure, presenting a hollow stem, or cœnosarc, by which numbers of digestive zoöids (polypites) are connected. Generative bodies, agreeing in all respects with those of the fixed Hydrozoa, are also borne on the same stem. Thus the mode in which both groups of organisms discharge the two great processes of nutrition and reproduction, save as to a few comparatively unimportant matters of detail, is precisely similar. It is otherwise with the functions of relation. For in the Siphonophora, the entire compound mass, not, as in the Corynidæ and Sertularidæ, permanently fixed by one of its extremities to some fragment of rock, shell, sea-weed, or other foreign support, is free and endowed with the power of executing a variety of graceful movements, due, for the most part, to a very simple arrangement of contractile tissues, and further assisted, in many cases, by the addition of special organs which are at once seen to bear a close resemblance to the swimming-bells (nectocalyces) of the Cryptocarpæ. But, while in the members of this group, a single digestive zoöid is, in a manner, suspended from the roof of its swimming-bell and thus brought into immediate connection with the canal system of the latter,—in the Siphonophora the polypites and nectocalyces are attached independently to different parts of the common trunk, through which alone a distant communication between their cavities is maintained. Besides the reproductive organs, polypites, and swimming bells, (these last being sometimes absent) many other appendages may arise from the cœnosarc of the Siphonophora. In one large section of the group its anterior extremity forms a float-like expansion, or pneumatophore, within which a hollow air-vesicle, the pneumatocyst, is lodged. Such forms have now been placed in a separate order, Physophoridæ, as distinguished from another division of equivalent value, the Calycophoridæ, in which there is no air-vesicle, while swimming bells are constantly present.

Thus the dismemberment of the old classes, Acalephæ and Polypi, may now be regarded as complete. But with reference alike to the precise limits and nomenclature of those primary groups of Cœlente-

zation of the Siphonophora presented. Another interval of two years elapsed, when the chief difficulties of the subject were finally set at rest by the nearly simultaneous publication of three memoirs on the part of Vogt, Kölliker and Leuckart, respectively, wherein the structural features of several genera of Siphonophora were reviewed in detail and illustrated by numerous figures. Both Leuckart and Gegenbaur, in the course of the following year (1854), made further valuable contributions to the same department of zoöphytology. (For a full citation of all the works and papers here referred to, vid. the bibliography given by Huxley, op. s. cit.)

rata which should be substituted in their stead, naturalists still hold different opinions. These discrepancies, happily, exist less in appearance than in reality, and for the most part, as will presently be made clear, are of a secondary or non-essential character.

Under the name of Hydromedusæ[38] Vogt,[39] Sars, Leuckart, Gegenbaur and J. V. Carus acknowledge a very natural class, including the Hydroid Polypes (*Hydra*, Corynidæ and Sertularidæ) together with the Siphonophora and Discophora. Bronn,[40] however, separates the Hydromedusæ into two classes; Hydræ and Medusæ, of which the first contains but one genus, *Hydra.*

Milne Edwards, also, has recently assigned *Hydra* to a separate class. The same distinguished zoölogist[41] further suggests the restoration of the old term Acalephæ to designate a group including, besides the Hydromedusæ of Vogt, the well-marked order Ctenophora, or, in other words, all the Acalephæ of Eschscholtz, together with the Hydrozoa of Owen. Such, too, is the opinion of Agassiz.[42] But while this naturalist considers all these "Acalephæ" as forming a single class, Milne Edwards does not hesitate to divide them into, at least, three distinct classes,—"Les Médusaires, les Siphonophores et les Hydraires."

In the accompanying table, the latest views of Milne Edwards, both as to the systematic position and primary divisions of Cœlenterate animals are exhibited in a compendious form.

EMBRANCHEMENT DES ZOOPHYTES.

SARCODAIRES. RADIAIRES.

ECHINODERMES. CŒLENTÉRÉS.

Classe 1. CORALLIAIRES. ACALÈPHES.

Classe 1. HYDRAIRES. *Classe* 2. SIPHONOPHORES. *Classe* 3. MÉDUSAIRES.

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[38] Leuckart (Bericht in Wiegmanns's Arch.) terms the class *Hydrasmedusæ;* and Gegenbaur (Op. s. cit), *Hydromedusida.* See note [34] p. 423.

[39] In his Zoologische Briefe, 1851, the group Hydromedusæ, as established by Vogt, does not include the Siphonophora, of which he makes a separate class. But, in 1853, he fully recognizes their true affinities, regarding them as but an *order* of his *class* Hydromedusæ. (Gen. Inst., Tom. I., p. 144).

[40] Op. s. cit. pp. 78 & 85. Bronn arranges the Cœlenterata under four classes Polypi, Hydræ, Medusæ, and Ctenophora.

[41] Op. s. cit. p. 4. Here no special mention is made of the Ctenophora, but there can be little doubt that Prof. Milne Edwards considers them as constituting a subdivision of his class Médusaires. A perusal of pp. 301—306 of the fifth volume of his Leçons sur la Physiologie, published in 1859, appears further to confirm such a conclusion.

[42] Essay on Classification, 1859, p. 294.

The class Coralliaires Milne Edwards divides into two equal sections, in one of which, Cnidaires, are placed all the Actinoid polypes (Zoantharia and Alcyonaria), while the second division, Podactinaires, includes but the genus *Lucernaria* of older authors (family Lucernariadæ of Johnston). The true position of this curious form and its immediate allies is a question of much interest to the systematic zoölogist, involving as it does, to a certain extent, the determination of those first principles which should guide him in the recognition of natural groups among the Cœlenterata. Ehrenberg, Dana, Johnston, and the greater number of those who, since the time of Cuvier, have written on *Lucernaria*,[43] associate this genus with the Actinoid polypes, not far from *Actinia* itself. But a growing idea of its dissimilarity in structure to the true Polypes has of late years become impressed on the minds of several zoölogists. Thus, in 1850,[44] Milne Edwards referred it to an order equivalent to Zoantharia or Alcyonaria, and in 1857,[45] as has been shown, he regarded it, from a systematic point of view, as on a par with these two orders taken collectively; so that, while placing it in one class with the polypes proper, he, nevertheless, removed it to the greatest possible distance from these organisms, consistent with such an estimate of its affinities. But others, at a much earlier date, had gone still further. Lamarck, in 1816,[46] had hinted at the relationship of *Lucernaria* to the Discophora; and twenty-four years later, in one of the notes appended to the posthumous edition of his principal work, a similar opinion is still more explicitly urged by Dujardin.[47] Greater definiteness was soon after given to this view of the nature of *Lucernaria* by Frey and Leuckart,[48] who, in the same treatise wherein they first called attention to the existence of the sub-kingdom Cœlenterata, instituted a direct comparison between the organization of *Lucernaria* and *Pelagia*, tending to show that the four-lipped alimentary proboscis of the former is truly the homologue of the prehensile nutrient organ depending from the swimming disc of the latter; this disc, moreover, which bears round its margin a number of long slender tentacles, corresponding in its structural relations to the cup-like body-wall of *Lucernaria*, which, though usually fixed, is, at times, capable of performing the function of natation. In the following year, the systematic position of *Lucernaria* was reconsidered by Leuckart, who still, however, hesitated to remove it from the class of Polypi, though,

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[43] In the second edition of the Règne Animal, *Lucernaria* is placed after *Actinia* and *Zoanthus;* in the first edition (1817) a nearer view is taken of its relationship to the Discophora.

[44] Edwards and Haime, in Monograph of British Fossil Corals, Introduction, p. lxxxv.

[45] Op. s. cit. Tom. I. p. 94.

[46] "Les *lucernaires* commencent à donner une idée des médusaires."—Hist. Nat. des An. sans Vertèb., Tom. II., p. 473.

[47] Second ed. of Lamarck's Hist. Nat. des An. sans Vertèb., Tom. 3, p. 58.

[48] Beiträge, p. 10, and Pl. I. figs. 3 and 4.

like Milne Edwards, he regarded it as the sole representative of a primary division of this group, for which he proposes the name of Cylicozoa.[49] And this opinion he appears still to hold. But the question as to the Medusan affinities of the Lucernariadæ was not permitted to rest. In 1856, Professor Huxley[50] again discussed their close resemblance in structure to the Discophora Phanerocarpæ of Eschscholtz, more particularly to those so-called larval forms of this group, which, since the appearance of Dalyell's work, have become familiar in elementary treatises under the name of *Hydræ tubæ.* In both *Lucernaria* and *Hydra-tuba* a true digestive zoöid, or polypite, is seen to project from the centre of the free extremity of the animal. In both, likewise, this polypite is surrounded by a variously-shaped cup or disc, bearing the marginal tentacles, and formed by an expansion of the body-wall, homologous with the natatorial organ, or umbrella, so conspicuous in most "jelly-fishes." Again: the space intervening between this umbrella and the sides of the central polypite is, both in *Lucernaria* and *Hydra-tuba*, divided into a number of sinuses, which must by no means be confounded with the body-chambers of *Actinia*, seeing that the partitions which separate them present an anatomical arrangement very different to that of the mesenteries in the last-mentioned genus and its allies. And, in both genera, the position of the reproductive organs is strikingly dissimilar; for while, in *Lucernaria*, they are lodged within four equi-distant folds, which descend along the body of the polypite, in *Actinia*, as is well known, they are situate below the gastric sac, on the free edges of numerous mesenteric plates.[51] Guided by these considerations, Professor Huxley suggested the union of the Lucernariadæ and Phanerocarpæ into a single order, bearing the name of

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[49] Or *Becherpolypen.* See his essay—Ueber die Morphologie und die Verwandtschaftsverhältnisse der wirbellosen Thiere, 1848, p. 20. The name he afterwards changed to Calycozoa. Leuckart, who includes the Sponges among the Polypi, divides this class into three groups, Calycozoa, Anthozoa, and Porifera. (Vid. Bericht in Wiegmann's Arch.)

[50] Lectures (sup. cit.), pp. 566-7, June 7, 1856.

[51] In a valuable memoir by Professor Allman on the structure of *Carduella*, (Q. J. M. S. 1860), a genus closely allied to and previously confounded with *Lucernaria* proper, the precise relations of the body-partitions, polypite, and reproductive organs are very carefully illustrated and described. Professor Allman, however, is of opinion that the Lucernariadæ rank nearer to the Gymnophthalmatous (Cryptocarpæ) than to the Steganophthalmatous division of the Discophora. But those parts of the umbrella in *Carduella* which he considers to be the homologues of the nectocalycine veil of the Cryptocarpæ, namely, the marginal lobes reflected inwards so as to roof in its four outer canals, ought surely to be rather regarded as corresponding with structures of a like nature, surrounding the open edge of the disc in many free-swimming forms of Phanerocarpæ. The development of the umbrella of *Lucernaria* has not yet, it is true, been made the subject of direct observation, but its structural identity with what appears to be the corresponding organ in *Hydra-tuba*, whose development is so well known, leaves little room for doubt that the one is indeed homologous with the other, both being alike dissimilar to the swimming-bell of the Cryptocarpæ, the formation of which takes place in so obviously different a manner.

Lucernariadæ, as distinct from such of the Cryptocarpæ as may hereafter seem worthy of being placed in an ordinal group, to which may be applied the title of Medusidæ.

The position of the Lucernariadæ being thus defined, a few words may now be said concerning another group of Cœlenterata, as to the nearest affinities of which much needless uncertainty and difference of opinion still seems to prevail; namely, the Ctenophora. Many years ago, De Blainville,[52] followed by Quoy et Gaimard,[53] suggested that their true place was in the Molluscous sub-kingdom, of which, in 1851, Vogt[54] constituted them a class, in close proximity to the Tunicata. But this view of their affinities met with little encouragement. Nevertheless, it contained one slight element of truth, in so far as it denied the close relationship of these animals to the Siphonophora and Discophora, with which most zoölogists, misled by their transparent gelatinous aspect and free oceanic mode of life, have long continued to associate them. Preferable seems the opinion of Leuckart, J. V. Carus, Gegenbaur, and Sars, who elevate the Ctenophora to the rank of a distinct class of Cœlenterata, equivalent to the Polypi and Hydromedusæ. For, in truth, the Ctenophora, as Frey and Leuckart[55] plainly hinted in the year 1847, come nearer to the first of these two classes than to the latter. These writers compare the structure of *Pleurobrachia* with that of *Actinia*, indicating the existence of some fundamental points of similarity between them. But these excellent suggestions were permitted to remain unheeded until, in 1856, they were restated by Huxley,[56] who, clearly perceiving the strong arguments in favour of such a step, united the Ctenophora and Polypes into one class, to which he gave the name of Actinozoa. A brief anatomical comparison of the genera mentioned above, selected as accessible representatives of the two groups thus brought together, may serve to place in its proper light the intimate nature of the systematic relationship subsisting between them.

First, on comparing the nutrient systems of *Actinia* and *Pleurobrachia*,[57] "the digestive sacs of the two organisms are clearly seen "to correspond; in form, in relative size, and mode of communication "with the somatic cavity. The funnel and apical canals[58] of *Pleuro-* "*brachia*, though more distinctly marked out, are the homologues of "those parts of the general cavity which in *Actinia* are central in "position, and underlie the free end of the digestive sac. So, also,

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[52] Manuel, &c. pp. 143 and 641.
[53] Zoologie, Voyage de l'Astrolabe, Tom. 4, p. 36.
[54] Zoologische Briefe, Band I. p. 254.
[55] Beiträge, &c. *passim*.
[56] Lectures, p. 621, June 21, 1856.
[57] *Cydippe* of Eschscholtz (1829) and of most subsequent writers; but the name *Pleurobrachia*, proposed by Fleming in 1828, has the priority.
[58] The two short canals opening directly from the funnel.

"the paragastric[59] and radial[60] canals may be likened to those lateral "portions of the somatic cavity of *Actinia* which are not included "between the mesenteries. Lastly, the ctenophoral[61] canals of "*Pleurobrachia* and the somatic chambers of *Actinia* appear to be "truly homologous, the chief difference between the two forms being "that, while in the latter the body-chambers are wide and separated "by very thin partitions, they are in *Pleurobrachia* reduced to the "condition of tubes; the mesenteries which intervene becoming very "thick and gelatinous, so as to constitute, indeed, the principal bulk "of the body."[62] Between the tentacles of *Actinia* and *Pleurobrachia* there exist, as Professor Huxley has stated, no greater differences than those which distinguish the same organs in *Diphyes* and *Hydra:* moreover, in some Ctenophora tentacles are absent.

The oceanic habit of the Ctenophora may be paralleled in certain genera of Zoantharia closely allied to *Actinia*, while their apical canals are to some extent represented by the posterior somatic opening in *Peachia* and *Philomedusa*, or even by the multiple pores of *Corallium*. The prolongation of the somatic cavity into a number of tubes is seen in several Alcyonaria, with which order the Ctenophora further correspond in the numerical proportion of their parts. The Ctenophora may, therefore, fairly be viewed as an ordinal group of Actinozoa, from the other members of which class their curious locomotive bands, thick gelatinous outer layer, nervous system and organ of sense, readily serve to distinguish them.

If the view here taken of the systematic position of the Ctenophora be accepted, all Cœlenterate forms admit of being arranged under two classes, of which one is equivalent to the Hydromedusæ of Vogt, together with the Lucernariadæ, while in the other may be placed the true Actinoid polypes (Zoantharia and Alcyonaria) and the Ctenophora. For the first of these groups, the name Hydrozoa, as suggested by Mr. Huxley,[63] seems preferable in many ways to the terms Hydromedusæ or Hydroidea, which some have endeavoured to establish in its stead. For the second class, the parallel designation of Actinozoa,[64] proposed by the same writer, may with equal propriety be adopted.

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[59] The two canals which, issuing from the funnel, run parallel to the sides of the digestive sac.

[60] The canals which, with their branches, serve to connect the funnel and the ctenophoral vessels, next mentioned.

[61] The eight longitudinal canals whose courses coincide with those of the eight rows of locomotive combs.

[62] Greene, op. s. cit. p. 146.

[63] Lectures, sup. cit. Rymer Jones, in 1847, restricts this term to a sub-class containing only the genus Hydra; in 1855, he extends it so as to include in one group all the Acalephæ of Eschscholtz, together with the Hydrozoa of Owen.

[64] Bronn, op. s. cit. applies this name to all the Radiata (Cœlenterata Echinodermata), following De Blainville, who used the same term in a somewhat similar signification.

The class Hydrozoa (*i. e.* animals whose type is the genus Hydra) will include seven orders, viz.—

Order 1. HYDRIDÆ (= Hydrina of Ehrenberg).—*Hydra* itself is the sole representative of this division.

Order 2. CORYNIDÆ or TUBULARIDÆ (= Tubularina of Ehrenberg).—Here are placed those fixed Hydrozoa which want "hydrothecæ," or polype cells, the distinctive structural feature of

Order 3. SERTULARIDÆ (= Sertularina of Ehrenberg).

Order 4. CALYCOPHORIDÆ.—In this order, the name of which was first suggested by Leuckart, are placed such of the Siphonophora as do not possess an air-vesicle and float, the presence of which distinguishes the members of the next group,

Order 5. PHYSOPHORIDÆ.

Order 6. MEDUSIDÆ.—Such Cryptocarpæ (for example, *Cunina*)[65] as appear to be the direct offspring of forms resembling themselves, together with many others whose genesis is unknown—*i. e.* which have not yet been proved to be merely the free reproductive buds of other Hydrozoa—may for the present find their best place in this order.

Order 7. LUCERNARIDÆ.—The family Lucernariadæ of Johnston, in addition to the Phanerocarpæ of Eschscholtz, belongs, as above stated, to this group.

The second class, Actinozoa (*i. e.* animals typified by *Actinia*), divides itself into four orders:—

Order 1. ZOANTHARIA.—This group includes all the Polypes so designated by Milne Edwards, save those which are placed in the following order.

Order 2. RUGOSA.—The four extinct families of Sclerodermic Corals, associated under this name by Milne Edwards with the Zoantharia proper, may on just grounds be elevated to the rank of a separate order, distinguished by the tetrameral arrangement of their (in general well developed) septal system from the members of the preceding division, whose septa and tentacles are usually some multiple of five or six. In the numerical proportion of their parts, therefore, the Rugosa differ from the Zoantharia, and resemble the two remaining orders of Actinozoa.

Order 3. ALCYONARIA.—A sharply-defined group, the polypes of which always present eight pinnate tentacula.

Order 4. CTENOPHORA.

Sub-kingdom CŒLENTERATA.

Animals whose alimentary canal freely communicates with the somatic cavity.

Substance of the body made up of two foundation membranes,

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[65] For a very recent addition to our knowledge of the life-history of this genus, see Fritz Müller on *Cunina Köllikeri*, n. s., in Wiegmann's Arch. 1861, p. 42.

an outer or ectoderm, and an inner or endoderm, which correspond, in mode of growth, with the primitive layers of the germ.

No distinct neural and hæmal regions. A nervous system absent in most.

Peculiar urticating organs, or thread cells, usually present.

Class 1.	*Class* 2.
HYDROZOA.	ACTINOZOA.
Cœlenterata, in which the wall of the digestive sac is not separated from that of the somatic cavity, and the reproductive organs are external.	Cœlenterata, in which the wall of the digestive sac is separated from that of the somatic cavity by an intervening space, subdivided into chambers by a series of vertical partitions, on the faces of which the reproductive organs are developed.
Order 1.—HYDRIDÆ [66]	*Order* 1.—ZOANTHARIA[70]
„ 2.—CORYNIDÆ [66]	„ 2.—RUGOSA
„ 3.—SERTULARIDÆ [66]	„ 3.—ALCYONARIA[71]
„ 4.—CALYCOPHORIDÆ [67]	„ 4.—CTENOPHORA.[72]
„ 5.—PHYSOPHORIDÆ [67]	
„ 6.—MEDUSIDÆ[68]	
„ 7.—LUCERNARIDÆ.[69]	

[66] Exoarii, *Rapp*, 1829; Zoocorallia oligactinia, *Ehrenberg*, 1834; Dimorphœa, *Ehrenberg*, 1836; Sertulairiens, *Audouin et Milne Edwards*, 1836; Hydroida, *Johnston*, 1836; Nudibrachiata, *Farre*, 1837; Polypiaria, *Gray*, 1842; Hydrozoa, *Owen*, 1843; Hydroidea, *Dana*, 1846; Hydraria, *Milne Edwards*, 1850 and 57; Hydriformia, *Van der Hoeven*, 1856; Hydræ, *Bronn*, 1859.

[67] Acalèphes Hydrostatiques (with *Porpita* and *Velella*), *Cuvier*, 1830; Siphonophora, *Eschscholtz*, 1829; Physogrades, Diphyes, et Chondrogrades, *De Blainville*, 1834; Schwimmpolypen or Hydroidea nechalca (besides *Porpita* and *Velella*), *Kölliker*, 1853.

[68] Cryptocarpæ, *Eschscholtz*, 1829; Gymnophthalmata, *Forbes*, 1848; Craspedota, *Gegenbaur*, 1857.

[69] This order is divided into three families: Lucernariadæ, Pelagidæ, and Rhizostomidæ. The synonyms of Lucernariadæ (*Johnston*) are as follow:—Cylicozoa or Calycozoa, *Leuckart*, 1848; Podactinaria, *Milne Edwards*, 1850 and 57. The two other families correspond to Phanerocarpæ of *Eschscholtz*, 1829; Medusidæ and Rhizostomidæ, *Brandt*, 1833; Rhizostomeæ, *Lesson*, 1843; Steganophthalmata, *Forbes*, 1848; Discophora, *Kölliker*, 1853; Acraspeda, *Gegenbaur*, 1857; Discophora, *Agassiz*, 1860.

[70] Helianthoida (minus Lucernariadæ), *Johnston*, 1836; Zoantharia (minus Rugosa), *Milne Edwards*, 1836; Actinaria, *Dana*, 1846.

[71] Alcyonaria of *Milne Edwards*, also of *Dana*; Zoophytaires ou Cténocères, *De Blainville*, 1834; Octactinia, *Ehrenberg*, 1834; Asteroida, *Johnston*, 1836.

[72] Ctenophora of *Eschscholtz*, 1829; Béroës ou Ciliobranches (Ciliograda), *De Blainville*, 1834.

XLIV.—Contributions to the Natural History of the United States of America. By Louis Agassiz. Vol. III. Boston, 1860.

The third volume of Professor Agassiz' great work, or rather series of works, on the Natural History of the United States, not many months since issued to its numerous subscribers, contains the commencement of his "Second Monograph," which treats of the Class of Acalephs.

On the title-page it is stated that the contents of this Monograph will be arranged under five Parts, viz.:—1. Acalephs in general.—2. Ctenophoræ.—3. Discophoræ.—4. Hydroidæ.—5. Homologies of the Radiata; the whole to be illustrated with forty-six plates.

In the volume before us the First of these Parts is brought to a conclusion; the second, nearly so. From a perusal of the table of contents alone, it might appear that this Part, likewise, had been entirely finished, but, in the text, Professor Agassiz alludes, more than once, to various observations of his own on the development of the Ctenophora, the promised details of which are not given. But it may be that the author intends to notice these, not at the end of the Second Part, but rather in the course of the Fifth, when the homologies of all the Radiata come to be finally considered. We propose, therefore, for the present, to postpone our remarks on Part II., hoping, in a future number, to discuss in some detail the writings, not only of Professor Agassiz, but also of various other naturalists, on a group so worthy of special treatment as the Ctenophora, the study of whose structure and development has yielded, within the last ten years, results of greater value to the skilled investigator than those which he could boast of having gained, up to that period, from the time that Zoölogy became a science.

The First Part of the Second Monograph, with its 152 quarto pages, includes two chapters, of which the first is entitled "History of our Knowledge of the Acalephs," while the second treats of "Acalephs as a Class."

The subject-matter of the first chapter, containing but 35 pages, is discussed under the five following Sections:—

Section 1.—Period of Aristotle and the Roman Naturalists.
„ 2.—The naturalists of the sixteenth and seventeenth centuries.
„ 3.—The naturalists of the eighteenth century.
„ 4.—The systematic writers and anatomists.
„ 5.—Embryological researches upon Acalephs.

Its contents will be read with much interest, especially by those who are not well versed in this department of Zoölogy, to whom the large amount of historical information which it embodies is presented in a form at once pleasing and instructive, while the numerous bibliographical citations scattered throughout its notes cannot fail to prove useful for reference, even in the hands of experts.

But the second chapter, on Acalephs as a Class, more fully demands our attention. The nine Sections into which it is divided are named as follows:—

Section 1.—Mode of determining the natural limits of the class.
„ 2.—The different animals referred to the type of Radiata.
„ 3.—The classes of Radiata.
„ 4.—Morphology and nomenclature.
„ 5.—Individuality and specific difference among Acalephs.
„ 6.—Natural limits of the class of Acalephs.
„ 7.—Gradation among Acalephs.
„ 8.—Succession of Acalephs.
„ 9.—Classifications of Acalephs.

We have quoted the names of these Sections at length, not because it is our intention to notice each, seriatim, but from a desire to afford the reader, who is not already in possession of Professor Agassiz' work, a faithful transcript of its general contents. This having been done, we shall, without following to its extremest details the arrangement which he has laid down, choose from the entire chapter such portions of its contents as seem best fitted for comment, selecting alike those on which we agree with, or are constrained to differ from, their distinguished author.

First, then, we find that Professor Agassiz is in direct opposition to those naturalists who, following Frey and Leuckart, have proposed to place in a distinct sub-kingdom, under the name of Cœlenterata, those so-called Radiate animals in which a well marked body-cavity communicates freely with the digestive sac, whensoever the latter appears distinct. He maintains "that it is an exaggeration of their affinities to unite, as Leuckart has done, and as most German naturalists now do, the Polyps and Acalephs in one and the same great division under the name of Cœlenterata."—"I shall presently show [he adds] that all the true Polyps and all the true Acalephs may naturally be grouped with the two characteristic representatives of their respective classes, alluded to in the preceding section; and that, in connection with the Echinoderms, they constitute one of the four great types of the animal kingdom, characterized by a peculiar plan of their structure, founded upon the idea of radiation; and that the anatomical differences exhibited by the Echinoderms do not justify us in considering them as a distinct type. The latter are, in reality, only another class of Radiata, as a comparison of any of the flat Echinoids, such as the *Echinarachnius*, with an ordinary Medusa, say the *Aurelia*, readily shows; *Echinus* being, as it were, a Medusa, the soft disk of which is charged with limestone particles."* And, in

* Pp. 40-1.

the following paragraphs, he more fully exhibits his views on the same subject:—

"In uniting the Acalephs and Polyps into one primary division distinct from the Echinoderms, Leuckart has overlooked the general homologies which unite the Echinoderms with the Acalephs and Polyps, and has paid no attention to the Acalephian character of the embryo of a large number of Echinoderms. There is no feature more striking in all these animals, in the Polyps and Acalephs on the one side and the Echinoderms on the other, than the radiated arrangement of their parts. A comparison of *Echinarachnius* with *Polyclonia* and *Æquorea*, and of the latter with *Actinia*, can leave no doubt upon this question; and since all Polyps can easily be reduced to the type of *Actinia*, as well as all Acalephs to that of *Æquorea*, and all Echinoderms to that of *Echinarachnius* or of *Asterias*, it must be admitted that the plan of structure is the same in all these animals. They are built upon the idea of radiation; that is to say, all their organs are arranged around a centre, at which the mouth is placed, and diverge towards the periphery, to converge again at an opposite pole. But this is not the whole: all the organs of this structure are homologous. The chambers between the radiating partitions of the *Actinia* correspond to the radiating tubes of *Æquorea*, and these, again, to the ambulacral system of the Echinoderms; and the marginal tentacles of the *Actinia* correspond to the marginal tentacles of the Acalephs, and appear as ambulacral tubes in the Echinoderms, under the various forms of seeming gills around the mouth of Echinoids, or of seeming gills in the rosette of *Clypeaster*, or of branching tentacles and ambulacral suckers in the Holothurians. The identity of all these parts I shall have an opportunity of showing hereafter.

The central cavity, in open communication with the radiating chambers in Polyps, is closed in Acalephs, and communicates only through narrow openings with the radiating tubes; while in Echinoderms there arises a distinct alimentary canal, which is, however, still in direct communication with the ambulacral system through a network of anastomoses, about which I shall also have more to say hereafter. The ocelli at the base of the tentacles, which in Polyps are mere pigment cells, appear like modified tentacles in the higher Medusæ, while they are still connected with real tentacles in the lower ones; in Echinoderms they appear again, in the same relation with the ambulacral system and the terminal odd ambulacral sucker, as they are with the tentacles in Acalephs. The sexual organs are upon the sides of the radiating cavities; that is, upon the edge of the partitions in the Polyps, upon the sides of the radiating tubes in the Acalephs, and alternating with the ambulacra in Echinoderms,—everywhere in a homologous position and relation." *

* P. 65.

Again and again throughout the course of the same chapter Professor Agassiz insists strongly against the evils which must accrue to systematic zoölogy from a confusion between the fundamental differences in plan of structure observable amongst animals, and those minor differences having reference to the various modes in which the execution of the same plan may be carried out. But of what avail is it to enunciate this general proposition, the truth of which all intelligent naturalists, familiar with the principles of Von Baer, have long been accustomed to admit, if, at the same time, he fail to perceive the true import of those great anatomical features, which distinguish the group of Cœlenterata? If these be not enough to constitute a distinct plan of structure, and not merely a variation in the mode of execution of some other plan, it may be asked what amount of morphological peculiarity can be considered sufficient for this purpose? Or do sub-kingdoms exist only in the imaginations of Cuvier and his successors, and ought the entire animal kingdom, as in the time of Linnæus, to be resolved at once into classes? In thus refusing to acknowledge so natural an assemblage as the Cœlenterata, Professor Agassiz, as he himself with characteristic candour admits, entertains views adverse to those of many German, and, we may add, of many English naturalists. Even Professor Milne Edwards, who, occupying as he does, the distinguished position of successor to Cuvier, might well be excused were he to cherish a prejudiced and too literal adherence to the system of his great predecessor, though he does not elevate the Cœlenterata to the rank of a sub-kingdom, goes so far as to regard them, with their several classes, on a par with the single class of Echinoderms, the two groups, being constituted, in his recent arrangement, equal and primary divisions of the Radiata.*

But it should not be forgotten that the definition of the sub-kingdom Cœlenterata includes another clause in addition to that specified by Frey and Leuckart. It is now many years since the body-substance in all these animals has been shown by Professor Huxley, (who, we believe, first drew attention to the fact), to be resolvable into two foundation membranes, an outer and an inner, for which he proposed the names of ectoderm and endoderm. The subsequent researches of many naturalists have tended more and more to confirm this generalization. And if, by the light of our present knowledge, we carefully peruse the works of those older writers who acquired by patient investigation the useful faculties of seeing only what they ought to have seen and recording only what they saw, we shall not fail to perceive that they too were not without their own presentiment of a truth which appears to us of such importance. In their thread-cells, also, the Cœlenterata, exhibit another structural peculiarity, not unworthy of consideration.

To all this, however, Professor Agassiz replies that there is a

* Histoire Naturelle des Coralliaires, Tom. I., 857, pp. 3-4.

plan of structure, namely, the radiate, common to the Polypes, Acalephs, and Echinoderms, and that all anatomical differences which may exist between the two first of these classes, on the one hand, and the Echinodermata, on the other, are of a wholly subservient character to the fact of their common radiation.—"There is no feature more striking in all these animals, in the Polyps and Acalephs on the one side and the Echinoderms on the other, than the radiated arrangement of their parts." Yet it may be doubted if even the Echinodermata are truly radiated. However, this is a point on which at present we shall not dwell, but proceed at once to question the propriety of applying the name Radiata to many Cœlenterate organisms. The mode of attachment of the appendages in various genera of Siphonophora is most assuredly not radiate.* Of the bilateral symmetry of the Actinoid Polypes and Ctenophora, Professor Agassiz himself reminds us. This, however, cannot be said to admit of more than distant comparison with those indications of right and left symmetry in certain Echinoderms, which have been pointed out by J. Müller and Sars.†

The resemblance, in outward aspect, between the adult forms of the Ctenophora and the free-swimming larvæ of most Echinoderms, must be considered as wholly superficial and delusive in its character, and as presenting in no wise that deep morphological significance which Professor Agassiz would fain assign it. Elsewhere‡ he has expressed his regret that Johannes Müller, while prosecuting his famous researches on the life-history of the Echinoderms, did not avail himself of such excellent opportunities for tracing out, in complete detail, the likeness between their larval forms and the Beroid Medusæ. But the great anatomist of Berlin had too much real work on his hands to find time for the pursuit of what to him must have appeared no better than the vain shadow of a chimæra. Even in the arrangement of its locomotive bands the young Echinoderm is seen to contrast markedly with the Ctenophorid; and in all other essential features, such as histological differentiation of the body-substance, structure of the digestive canal, and relation thereto of the general cavity, the differences between the two organisms are so great as almost to preclude the possibility of instituting a comparison between them.

Nor have we read without surprise the statement of Professor Agassiz, that the chambers between the radiating partitions of *Actinia* and the radiating tubes of *Æquorea* correspond to the ambulacral vessels of the Echinoderms. The apparatus last mentioned would appear to be without homologue among the members of the Cœlenterate sub-kingdom, while the radiating vessels of *Æquorea*,

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* See Huxley's Oceanic Hydrozoa, p. 8.

† Consult the abstract of a recent memoir, by Sars, given in A. N. H., August 1861, p. 190.

‡ Trans. Amer. Acad. May 1849, p. 366.

or body-chambers of *Actinia*, parts of the general cavity in these animals, truly correspond with the perivisceral cavity of the Echinoderms, within which the nutrient fluid circulates. And in stating this conclusion, supported alike by the facts of structure and development, we find our own opinions in complete accordance with those entertained by all who have occupied themselves in any careful degree with such considerations. The erroneous view formerly held on this subject, and which unhappily yet lingers in some elementary works, was altogether of an opposite character, mistaking, as it did, the ambulacral apparatus of the Echinoderms for a true sanguineous system. Parts really homologous to ambulacral vessels must be sought, not among the structures of the Cœlenterata, but in the canals of the water-vascular system of the Rotifera and Worms. The assertion that "the central cavity, in open communication with the radiating chambers in Polyps, is closed in Acalephs, and communicates only through narrow openings with the radiating tubes" conveys, by implication, an exaggerated view of what is, in truth, a very feeble difference of degree; all the parts here mentioned being, as we have already said, but portions of the same great body-cavity. The alimentary canal of an Echinoderm cannot, with strict propriety, be considered homologous to any organ performing a like function among the Cœlenterata, seeing that its mode of development and relative position to the general cavity are so essentially dissimilar.

The following is the arrangement of Radiata adopted by Professor Agassiz. The names of the several orders and classes, as we have sought here to present them, follow one another in what he considers to be their gradation, or relative rank, the highest appearing first in the descending scale.*

Sub-kingdom . . **RADIATA.**

Class I.—ECHINODERMATA.

Order 1.—Holothuroidæ.
„ 2.—Echinoidæ.
„ 3.—Asterioidæ.
„ 4.—Crinoidæ.

Class II.—ACALEPHÆ.

Order 1.—Ctenophoræ.
„ 2.—Discophoræ.
„ 3.—Hydroidæ.

Class III.—POLYPI.

Order 1.—Halcyonoidæ.
„ 2.—Actinoidæ.

As the Echinodermata are but incidentally alluded to in the

* In compiling this table we have availed ourselves of the author's Essay on Classification, in the first volume of these Contributions.

present Monograph, it is not necessary that we should stay to notice them. Turning to the Acalephæ, we find, first, an order Ctenophoræ equivalent to the group so termed by Eschscholtz. The second order, Discophoræ, corresponding to the Phanerocarpæ of the same writer, has been adopted, as such, from Kölliker. The third order, Hydroidæ, includes not only the forms so termed by Johnston, but likewise the Cryptocarpæ and Siphonophora of Eschscholtz, together with the genus *Lucernaria*. The sub-divisions of the class Polypi require here no comment.

In regarding the Ctenophoræ as a group of equal importance to the Discophoræ, Professor Agassiz expresses his dissent from the views of Milne Edwards, one of the most eminent among original investigators of this group, which, nevertheless, in his recent arrangement of the Acalephs, occupies a somewhat subordinate position. So that the opinion of Professor Agassiz on the systematic value of the Ctenophoræ may be viewed as intermediate between that of the French naturalist, and those who, like Leuckart, Gegenbaur, and Sars, would consider these animals as a distinct class of Cœlenterata. In the Section on 'Gradation among Acalephs' it is added that "the Ctenophoræ, as the highest order in the class of Acalephs, correspond to the Echinoderms, and especially to the Holothurioids, the highest order of the highest class among Radiates." In a previous Section, Professor Agassiz contends against the recommendation of Quoy and Vogt, to remove these organisms to the sub-kingdom Mollusca. But the close affinity of the Ctenophoræ to the true Polypes, as suggested in 1847 by Frey and Leuckart, is not thought worthy of detailed discussion.

The recognition of the Phanerocarpæ as a separate order cannot but be received with satisfaction by those who, like ourselves, have sought duly to estimate the essential nature of the characters which distinguish these forms from the Cryptocarpæ. Such characters, for the most part purely morphological, would hold equally good even if those singular genetic phenomena, which unite together many of the Cryptocarpæ and the Hydroids, yet remained to be discovered.

With pleasure, also, we find Professor Agassiz supporting the opinion that *Lucernaria* is not a true polype, but rather, allied to the Acalephæ. He places the genus in his third order, Hydroidæ. But its nearer relationship to the Phanerocarpæ does not altogether escape his notice, for he expressly adds that "their resemblance to the young Medusæ is very great, especially during the incipient stage of their Strobila state of development."

The last order of Acalephæ in the system of Professor Agassiz forms a group of very considerable extent, in our opinion of more than ordinal value. In addition to the genus *Hydra*, the fixed Hydrozoa, the Siphonophora, the Cryptocarpæ, and Lucernaria, it includes the Tabulate, Tubulose, and Rugose Corals, which Milne Edwards and most other zoölogists have hitherto associated with the Polypi. With reference to the systematic position of the Rugosa

Professor Agassiz has not yet finally decided, but he entertains little doubt that the large group of Tabulata ought no longer to be kept apart from the Hydroids proper. This view, apparently so heterodox, is, according to Professor Agassiz, sufficiently sustained by the results of some recent observations which he has made on the soft parts of the living *Millepora*. The details of these researches have not yet been communicated at length, so that the important enquiry which they suggest to the systematic zoölogist cannot now be more than referred to. We may add, however, that the figures of the animal of *Millepora alcicornis*, which Professor Agassiz has here given, less closely resemble Actinoid polypes than the polypites of *Hydractinia*, to which genus he deems the Tabulata to be most intimately related.

In accordance with recent investigations, Professor Agassiz does not dispute the possible existence of a group of Medusid forms, distinct from those Cryptocarpæ which have been shown to be but the free reproductive bodies of the Hydroida. But to the systematist whose mind has been fully made up on the fundamental principles of his science, the existence of such a group makes comparatively little difference, howsoever significant it may justly seem to the student of animal development.

"Since the free Medusæ known to originate from Hydroids all belong to the type of the *Discophoræ Cryptocarpæ* of Eschscholtz, the *Gymnophthalmata* of Forbes, or *Craspedota* of Gegenbaur, there is presumptive evidence that the final investigation of the true affinities of these Medusæ will lead to a natural association of all those which are really and closely related to one another, to the exclusion of the possible foreign admixtures now left in this group, and that such a natural group will in the end embrace all the Medusæ originating from Hydroids. It is also possible, however, that such a natural group of Medusæ may embrace genera undergoing a direct metamorphosis from the egg to the perfect Medusa without intervening Hydra stock, as we already know that there are higher Discophoræ, such as *Pelagia*, which reproduce themselves without passing through the Strobila state. But this would not alter the case of the affinity of such Medusæ: it would only show that the natural group to which they belong exhibits a wider range in its modes of development. The systematic position of any Medusa must be determined by an investigation of its special structure, and if there are any Medusæ, not arising from Hydroids, but growing up directly from eggs to their permanent form, and presenting the same special structure as those that arise from Hydroids, there is no reason why they should be separated. Upon this view we shall hereafter consider the affinities of the Æquoridæ, the mode of development of which is not yet fully ascertained, and those of the Æginidæ, some of which are known to undergo a direct metamorphosis."*

"Considering the mode of reproduction of the Acalephs in general, the highest Hydroids would, of course, be those in which the medusoid elements prevail, and the lowest, those in which the hydroid elements are most prominent. We have, therefore, to inquire, first, whether there are any genuine naked-eyed Medusæ which do not originate from Hydræ, in order to answer a question already raised respecting the true limits of the order of Hydroids, and the true position of the Æquoridæ and Æginidæ.

"There are Æginidæ, unquestionably, which undergo a direct metamorphosis, and it is probable that this is the case with all of them. But are the Æginidæ genuine naked-eyed Medusæ, or a low type of Discophoræ allied to the Charybdeidæ? My knowledge of this family is too limited to enable me to speak confidently upon that point; but I am inclined to consider them as belonging rather to the Discophoræ proper than to the Hydroids. In the first place, the Æginidæ have no radiating chymiferous tubes, as all true naked-eyed Medusæ have; but instead of them there arise broad, flat pouches from the main cavity, extending towards the margin of the disk, as in *Ephyra*, the young of *Aurelia* and *Cyanea*, and as in the adult of the latter, and of many other genera of Discophoræ proper. The Æginidæ have no circular chymiferous tube, as all true naked-eyed Medusæ have. Again, the tentacles of the Æginidæ are not strictly marginal, and, in the absence of a circular tube, cannot be closely connected with it as is the case in all true naked-eyed Medusæ, but are in direct communication with the radiating pouches of the main cavity, as in *Pelagia* and *Cyanea*. If, then, for these reasons the Æginidæ should be associated with the higher Discophoræ, instead of occupying a place among the naked-eyed Medusæ, the importance attached by Gegenbaur to the marginal seam of the umbrella, as a distinctive character of the lower Discophoræ would be greatly lessened; and I rather think rightly so, for many of the higher Discophoræ, and among them our common *Aurelia*, have the margin of their umbrella not only very thin, but turned inward and downward as in all Craspedota, and their tentacles arise between indentations of the disc, at some distance from its margin, as is the case in the Æginidæ.†

"As to the Æquoridæ, I have no doubt that they are genuine Hydroids, though I have not been able to trace with certainty the origin of the *Æquorea* of our coast to any true Hydroid. But the structure of *Æquorea*, in its adult Medusa state, is so strictly homologous to that of all other naked-eyed Medusæ, that, even if it were

* P. 108.

† In his recently discovered genus *Tamoya*, closely allied to *Charybdea*, the presence of a veil is pointed out by Fritz Müller. (Halle, Abh. 1859.)

ascertained that it undergoes a direct metamorphosis from the egg to the perfect Medusa, I would not hesitate to consider it as a member of the order of Hydroids, since it has simple radiating chymiferous tubes, a circular tube, and marginal tentacles closely connected with it, and provided with mere pigment specks upon their base."*

With the above statements, in so far as they tend to refute the widely-prevalent error that the affinity between these Acalephs and the fixed Hydroids rests solely on embryological evidence, we desire fully to concur.

In the Section on Morphology and Nomenclature,† Professor Agassiz introduces certain new terms, explanatory of his peculiar views on the Radiata in general, and the class Acalephæ in particular. To the entire body-wall of a radiated animal he applies the designation of *spherosome*, for "it requires [he says] no formidable stretch of the imagination to reduce any single Polyp, or any Acaleph, or any Echinoderm, to a spheroidal form. Indeed, the sphere is the essential form of all Radiates,—not the mathematical sphere, but the organic sphere, loaded in different directions, according to the peculiarities of the subordinate groups of this type." "Considering the plan of their structure, we have already seen that there exists in all of them one axis and centre of radiation, around which all their parts are symmetrically arranged in a radiating and concentric order, even though that axis or centre of structure be not the centre of figure or form. At one end of this axis we invariably find the so-called mouth or *actinostome*, while the opposite end of the alimentary canal may have an excentric position." That side or pole of the sphere at which the actinostome occurs is termed *actinal;* the opposite side or pole, *abactinal.* For the "homological segments," or "identical elements," which together make up the spherosome, the title of *spheromeres* is appropriated.

The names *Planula*, *Hydra*, *Scyphostoma*, *Strobila*, *Ephyra*, and *Medusa*, taken from Sars and others, are suggested as well suited for distinguishing the principal forms of simple Acalephs, at the several stages of their growth. The term *Hydra*, after the manner of Dalyell, is also used as a synonym of the common nouns polype and polypite. When a composite community of Acalephs consists of a number of such Hydræ united by a connecting stem, the whole mass constitutes an *Hydrarium.* Should bunches of Medusæ be budded forth either by any of the Hydræ or their common trunk, each of these groups becomes a *Medusarium*, and the compound organism which results, including both Hydræ and Medusæ, "may be called a *Hydro-Medusarium.*"

* Pp. 119-20.

† The distinction between Nomenclature and Terminology, insisted on by Dr. Whewell and others, is not acknowledged by Professor Agassiz.

From the above brief summary of his terminology, we proceed without abrupt transition, to record what Professor Agassiz has said on "the question of individuality among Acalephs." Animal individuality, he considers, may be manifested after one or other of four principal modes, differing in degree or kind. Of these the first is termed *hereditary individuality*, or "that kind of independent existence manifested in the successive evolutions of a single egg, producing a single individual, as is observed in all the higher animals." After this, "*derivative*, or *consecutive individuality*, that kind of independence resulting from an individualization of parts of the product of a single egg." "Next, we must distinguish *secondary individuality*, which is inherent in those individuals arising as buds from other individuals, and remaining connected with them. This condition prevails in all the immovable Polyparia and Hydraria, and I say intentionally in the immovable ones; for in the movable communities, such as *Renilla*, *Pennatula*, etc. among Polyps, and all the Siphonophora among Acalephs, we must still further distinguish another kind of individuality, which I know not how to designate properly, unless the name of *complex individuality* may be applied to it. In complex individuality a new element is introduced, which is not noticeable in the former case. The individuals of the community are not only connected together, but, under given circumstances, they act together as if they were one individual, while at the same time each individual may perform acts of its own."*

The Section on Individuality contains further, indeed is almost wholly occupied with, a number of iconoclastic paragraphs, in which Professor Agassiz puts forward, with much boldness and vigour of language, his objections to the arguments in Mr. Darwin's recent work on the Origin of Species. These portions of Professor Agassiz's volume having been elsewhere† reprinted in full, and in a very accessible form, we prefer, on the present occasion, to pass them by, rather than, within our limited space, render them a maimed or too imperfect notice. We do this with less reluctance, since our readers may now peruse for themselves the excellent and impartial essays on Mr. Darwin's theory by Professor Asa Gray, in which the criticisms of his illustrious colleague, together with those of other "American reviewers," receive due consideration.‡

The last Section of the First Part, on Classifications of Acalephs, embodies a detailed abstract, accompanied with a critical commentary, of the several systems proposed by Lamarck (1801-16), Péron et Lesueur (1809), Cuvier (1817-30), Schweigger (1820), Goldfuss (1820), Chamisso and Eysenhardt (1821), Latreille (1825), Esch-

* P. 97.

† A. N. H. September, 1860, p. 219.

‡ Reprinted from the Atlantic Monthly for July, August, and October, 1860. London, Trübner and Co. 1861.

scholtz (1829), De Blainville (1830-4), Oken (1835), Brandt (1833), Lesson (1843), Forbes (1848), Lutken (1850), Vogt (1851), Kölliker (1853), Leuckart (1854), Gegenbaur (1856-9), McCrady (1858), and Huxley (1859), for the arrangement of these animals and their sub-divisions. Here, as in other parts of the work, the care taken by Professor Agassiz to master the very extensive bibliography of his subject has produced results calculated, in some measure, to diminish the necessity for the repetition of the same labour on the part of future investigators.

The beautiful plates which served to illustrate Professor Agassiz's former memoirs on the North American Acalephæ,* must be in the memory of some of our readers. Those which accompany the present volume, twenty-six in number, are issued in a style no less worthy of imitation, and, with scarcely an exception, by the same artist, Mr. Sonrel. He, also, as we are informed in the preface, executed directly from nature most of the preliminary drawings, in some cases receiving the assistance of Professor H. J. Clark, who has, in addition, enriched the text with some special contributions of his own, which much enhance its value. A number of outline cuts are interspersed throughout the body of the volume. Of the twenty-six plates, three only, those on the Ctenophora, have particular reference to the subject-matter of the third volume; an inconvenient arrangement, whereby the reader who desires to consult future sections of the same Monograph must, of necessity, have this volume lying open before him. We doubt not that it has arisen from a praiseworthy desire on the part of Professor Agassiz and his publishers to justify, by their liberality, the cordial support which the work has received from its American subscribers. Trusting that an early opportunity may be afforded us of noticing the fourth volume of these 'Contributions,' we now bring to a conclusion our notice of the third. Whatever comes from the pen of Professor Agassiz shall receive our welcome and attentive perusal. And if, at times, we venture to differ from his conclusions, may we do so with all simplicity and good faith, in the free spirit of that science which he has cultivated with so much zeal. Truly the very shortcomings of a writer possessing his honesty and ability may bear comparison with the excellencies of ordinary men.

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* In Trans. Amer. Acad. 1849.

XLV.—Zoological Sketches. By Joseph Wolf. Made for the Zoological Society of London, from Animals in their Vivarium. Edited, with Notes, by Philip Lutley Sclater, M.A., F.R.S., &c., Secretary to the Society.

Under the above title has recently been issued the first volume of a series of plates, representing some "of the most rare and interesting animals which have appeared, or may appear, in the Vivarium of the Zoölogical Society of London."

Fifty coloured lithographs, of folio size, are comprised in the thirteen parts, which together make up the volume. Each is devoted to a single animal species, of which, however, in some cases, two or more figures have been introduced. The following is a list of the several subjects:—

MAMMALS.

1. The Chimpanzee (*Troglodytes niger*).
2. The Pluto Monkey (*Cercopithecus pluto*).
3. The Lion (*Felis leo*).
4. The Leopard (*Felis leopardus*).
5. The Painted Ocelot (*Felis picta*).
6. The Eyra (*Felis eyra*).
7. The Clouded Tiger (*Felis macrocelis*).
8. The Serval (*Felis serval*).
9. The Egyptian Cat (*Felis chaus*).
10. The Caracal (*Felis caracal*).
11. The Red Caracal (*Felis caracal*).
12. The Canadian Lynx (*Felis canadensis*).
13. The Cheetah (*Felis jubata*).
14. The Bassaris (*Bassaris astuta*).
15. The Patagonian Skunk (*Mephitis humboldtii*).
16. The Grey Fox (*Canis azaræ*).
17. The Syrian Bear (*Ursus syriacus*).
18. The Walrus (*Trichecus rosmarus*).
19. The Wapiti Deer (*Cervus canadensis*).
20. The White-tailed Deer (*Cervus leucurus*).
21. The Eland (*Oreas canna*).
22. The Persian Gazelle (*Gazella subgutturosa*).
23. The Leucoryx Antelope (*Oryx leucoryx*).
24. The Punjab Sheep (*Ovis cycloceros*).
25. The Thar Goat (*Capra jemlaica*).
26. The Alpaca (*Lama pacos*).
27. The Hippopotamus (*Hippopotamus amphibius*).
28. The South African River Hog (*Potamochoerus africanus*).
29. The Red River Hog (*Potamochoerus penicillatus*).
30. The Great Anteater (*Mymecophaga jubata*).
31. The Thylacine (*Thylacinus cynocephalus*).
32. The Tasmanian Wombat (*Phascolomys wombat*).

BIRDS.

33. The Saker Falcon (*Falco sacer*).
34. The Greenland Falcon (*Falco greenlandicus*).
35. The Iceland Falcon (*Falco islandicus*).
36. The Angolan Vulture (*Gypohierax angolensis*).
37. The Chinese Pheasant (*Phasianus torquatus*).
38. The Japan Pheasant (*Phasianus versicolor*).
39. Horsfield's Kalecge (*Gallophasis horsfieldii*).
40. The Caspian Snow-Partridge (*Tetraogallus caspius*).
41. The Painted Spur-Fowl (*Galloperdix lunulosa*).
42. The American Rhea (*Rhea americana*).
43. The Mooruk (*Casuarius bennetti*).
44. Mantell's Apteryx (*Apteryx mantelli*).
45. The Great Bustard (*Otis tarda*).
46. The Mantchurian Crane (*Grus montignesi*).
47. The Australian Mycteria (*Mycteria australis*).
48. The Black-necked Swan (*Cygnus nigricollis*).
49. The Ashy-headed Goose (*Chloephaga poliocephala*).

REPTILES.

50. The Green Boa (*Xiphosoma caninum*).

The skill and patience which Mr. Wolf has displayed in his efforts to render these drawings faithful copies of their living originals deserve the highest commendation. In selecting characteristic attitudes of the birds and mammals, carefully preserving the relative proportions of their different parts, and depicting, with minute detail, the most striking peculiarities of each, he has here, as in his previous works, been eminently successful.

On the utility of the entire collection it would be a waste of words to dwell. Some of the species have never been represented before; of others, no better figures are known to us than such as have been filled up from the imperfect outline sketches of travellers, too often executed in haste, and under circumstances which rendered accuracy impossible, or, still worse, the would-be restorations on paper of Museum specimens already far gone in the last stage of denaturalisation: ill-killed, ill-skinned, ill-kept, ill-stretched, and finally, ill-stuffed. If we except the "Knowsley Menagerie," prepared many years since under the auspices of the late Earl of Derby, no work has ever been published in Britain at all comparable in its aim or mode of execution to that before us.

Every plate is accompanied with a page of explanatory letterpress, prepared for the purpose by our colleague, Mr. Sclater. His object has been to present, in this brief space, a selection of the more remarkable facts touching the history of the animals figured, their distribution, economic value, and suitability for acclimatisation. The various means by which the specimens were obtained for the collection of the Society, with a few particulars as to their habits in a state of captivity, have, where such information seemed necessary, been duly recorded.

Students of the higher Vertebrata, who have had the privilege of consulting this series, will not be slow on future occasions to turn again to its pages, whenever their studies demand the employment of an aid so pleasing in the work of identification. But to a far more extended class than these it cannot fail to commend itself; to all, in short, who, with feelings of gratitude, can admire those qualities of hand and mind which have enabled the artist to embody, in a form available to others, his own genial appreciation of the finished productions of Nature.

Original Articles.

XLVI.—Report on Vegetable Parthenogenesis.

The question as to the existence of parthenogenesis in vegetables has latterly been the subject of much discussion, but it is by no means of modern origin. It has been studied at different times by numerous botanists for pretty nearly 100 years, and after the lapse of a century the point in dispute seems as far from being decided as ever. In England the subject has attracted little attention, although the most important of all the apparent instances of parthenogenesis, that namely of *Cœlebogyne ilicifolia*, was first noticed in this country. A short time since it would have been a work of some labour to have given any readable account of the question at issue, but the difficulties in the way of doing so have been to a great extent removed by Dr. Regel's publication in the Memoirs of the Academy of St. Petersburg.* The latter author has given at some length the history of all the important observations preceding his own, and in the outset of the present report we wish to acknowledge the assistance we have derived from Dr. Regel's Memoir.

For some years prior to 1767 the observations of physiological botanists had been directed to prove the existence of sexes in plants, and we find the names of Grew, Camerarius, Linnæus, and Köhlreuter conspicuous amongst the writers upon this subject. In the year above mentioned (1767) we come upon the writings of Spallanzani, with whose experiments the question of parthenogenesis, as it exists at the present day, may be considered to have originated.

In May, 1777, Spallanzani selected two young female plants of hemp (*Cannabis sativa*), the sex of which was only just distinguishable. These were placed in a room facing the south, twenty days before their flowers opened, and kept enclosed between two window frames. As a further test, two of the flowering branches of one of the plants were enclosed in a glass flask, the mouth of which was hermetically sealed, and all the branches of the latter plant, with the exception of those in the flask, were cut off. The window frames were kept closed, and all the plants were carefully examined from time to time, without a single male organ being detected. After all these precautions the plants in question, and the particular branches enclosed in the flask, produced seeds, which afterwards germinated.

A second experiment was made, in which the female plants were brought into flower six weeks before the time of flowering of the hemp in the open fields, and similar results were obtained.

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* Mémoires de l'Académie Impériale des Sciences de St. Petersbourg, VII· Série Tome I. No. 2.

De Marti* repeated the above experiment, and considered Spallanzani's observations imperfect. He was of opinion that male blossoms must have existed, which were overlooked by Spallanzani. Volta† also was unable to procure any perfect seeds from plants from which the anthers had been carefully removed.

In 1837, Ramisch published some observations upon *Mercurialis annua*, with which he had been occupied for four successive years. The results were inconclusive, for although Ramisch procured seeds, both with and without embryos, he admits that in some of the female plants upon which he experimented male blossoms were present, and he attempts to exclude the operation of the pollen in these hermaphrodite flowers by suggesting that the anthers had only been opened for a very short time.

Bernhardi's experiments with *Cannabis* are given in "Otto u. Dietrich's Allgemeine Gartenzeitung, 1839." These experiments were continued for six years, and each year with the same result. The plants were sown in April in the open air; the male plants which appeared were destroyed, and two female plants only allowed to stand, which were carefully examined every two days, in case any male blossoms should be overlooked. Each year seeds were ripened, from which both male and female plants were raised. Bernhardi was satisfied that at the time of the experiments no male plants were in flower near the spot where they were carried on, and consequently that accidental impregnation by pollen grains carried by the wind, or by insects, was out of the question.

Gärtner's observations on *Delphinium Consolida* are important as showing the great care which must be taken in order to guard against deception. For some years he had taken what he considered sufficient precautions, and nevertheless had always obtained perfect seeds, apparently without any previous impregnation; but in the year 1838, when he cut off the male organs at an earlier period, and examined the plants several times daily, removing individual anthers at each examination, he found that the plants upon which he experimented produced no seeds.

We now come to the case of *Cœlebogyne ilicifolia*, the famous Euphorbiaceous plant, the great stumbling block of the opponents of parthenogenesis. This plant is diæcious, and the female one forms a low evergreen shrub, with pale green oval leaves, toothed like the holly. The female flowers are situated at the apex and on the side of small branches, and form short spikes of five or more flowers. The ovary is trilocular, and the stigma three-lobed. Each flower has on its calyx and bracts large wart-like glands, which at the time of flowering secrete a watery fluid. Three female plants were sent by Cunningham from Moreton Bay to Kew, where they flowered for the

* Experimento y Observaciones sobre los sexos y fecondation de los plantas. Vol. i. Barcelona, 1791.

† Memoires de l'Acad. de Mantoue, i. 226.

first time in 1839. In 1841 Mr. John Smith, of the Royal Gardens at Kew, published, in the Transactions of the Linnæan Society, an account of his observations on this plant. He stated that he had never been able to find male flowers or pollen of any sort, but that nevertheless perfect seeds were produced each year, from which young plants were raised resembling the parent plant in every respect. Mr. Smith suggested the possibility of the existence of a fertilizing power in the fluid secreted by the glands above mentioned. We shall have to return to the case of *Cœlebogyne* in a later part of this report, but there are some other intermediate observations which first require attention.

In the "Annales des Sc. Nat." Ser. III. Vol. V. Gasparini asserts that the cultivated fig produces seeds without the intervention of pollen. It bears (he says) two kinds of fruit, the one kind appears in spring and ripens early, the other appears in summer and ripens in autumn. In the former, male flowers are seldom found, and those which exist cannot serve for impregnation, as they do not appear until the stigma has withered. In these early fruits Gasparini never found perfect seeds. In the summer fruit he never found male flowers, and yet most of the ovaries produced seeds capable of germination. In order to prevent impregnation from without, Gasparini closed the opening of the young fruit of the cultivated fig with gum, or some other glutinous matter, and yet procured numerous perfect seeds. He never found in the fruits thus experimented upon any anthers or pollen-bearing organs. To these observations of Gasparini it has been objected—1st. That from time immemorial the cultivated fig has been impregnated artificially by the wild fig, an operation which would have been a waste of trouble if perfect seeds were produced without such process; 2ndly, that the impregnation cannot be watched with the necessary care, inasmuch as it takes place within the receptacle of the fruit; and 3rdly, that some observers have noticed peculiar organs in the ovule of the cultivated fig, which are called pollinidia, the nature of which is not yet understood.

The next observations at which we arrive are those of M. Naudin.* He experimented with Hemp, *Mercurialis*, *Ricinus*, *Bryonia*, and *Ecbalium*. He found that female plants of Hemp planted in a place surrounded by high walls, and others cultivated in pots and placed in a greenhouse in a garden, also surrounded by high walls, produced a quantity of perfect seeds, although no male plants were near, and although the females were subjected to careful examination with a view to the detection of possible male organs. Female plants raised from these unimpregnated seeds were set apart in the house of M. Decaisne, and so protected that M. Naudin considers it altogether impossible that any pollen could have reached them; and although they were carefully examined by himself and M. Decaisne, no single male flower was ever discovered amongst the females. His observations

* Comptes rendues, Vol. 43 (1856).

on *Mercurialis* were conducted in a similar manner and with similar results. The *Bryonia* was kept in a room in the Museum at Paris, entirely isolated from all male plants, and yet for three years successively it produced a few perfect seeds. A young plant raised from one of these seeds also produced perfect seeds without apparent impregnation, and the number of them when counted, was found to be about the same as that produced by a female plant exposed to the influence of pollen. This result M. Naudin considers to be opposed to the supposition of impregnation by the aid of insects, which however he thinks may possibly have been the case with the *Bryonia*.

The plants of *Ricinus* and *Ecbalium* produced no perfect fruit, and M. Naudin is of opinion that diœcious plants are more apt to produce fruit without impregnation than monœcious ones. In 1857, Radlkofer published some remarks upon the present subject in Siebold and Kölliker's "Zeitschrift fur. wiss. Zoologie." He assumes the certainty of the absence of male organs in the female plants of *Cœlebogyne.* He examined the young embryo-sacs, in which he found three germinal vesicles, of which sometimes one, sometimes two, or even all three, became true embryos. He concludes that a true parthenogenesis exists in *Cœlebogyne;* and he considers this conclusion fortified by the fact (previously noticed by Smith) that the stigma remains fresh until just before the ripening of the seeds, whilst in ordinary cases it withers shortly after impregnation. He states that, although the stigma in Hemp and in *Mercurialis* withers soon after impregnation, he had noticed its persistence in one of the female Hemp plants experimented upon by Naudin, and in a female plant of *Mercurialis annua* which had been kept by M. Thuret apart from the male.

Braun's elaborate essay on parthenogenesis appeared in 1857 in the "Transactions of the Berlin Academy." After referring to the accounts of previous observers, which, before *Cœlebogyne* was known, had rendered the existence of parthenogenesis probable, he states that the latter plant is one which fulfils the necessary conditions. The observations made at Berlin agreed with those at Kew, as to the fact of the production by female plants of perfect seeds without any process of impregnation. He considers it to be against all probability that any abnormal mode of impregnation, as by the glands, observed by Smith, should exist, and notices in detail some observations made at his request by M. Deecke, as to the mode of origin of the embryo in *Cœlebogyne,* the result of which was to show that the process differed in no way from ordinary embryo-formation as observed by Hofmeister, Tulasne, and Radlkofer. After noticing that Radlkofer's observations differed from Deecke's only in the fact that the former found three and the latter only two embryonic vesicles, Dr. Braun remarks, "These observations lead to the result, that in "*Cœlebogyne* the germs of new individuals are developed within a "normally constructed female organ of generation without any "previous influence of pollen, and consequently a true partheno-"genesis exists."

Further on, Dr. Braun alludes to the fact of the persistence of the stigma (upon which, as we have mentioned, Radlkofer relies), as showing the absence of impregnation. In Cryptogams a remarkable instance of apparent parthenogenesis occurs in *Chara crinita.* In all the Characeæ, with the exception of this species, the male and female organs are equally common, sometimes on the same, sometimes on separate plants. After noticing the distinctive features of the species, its geographical distribution, and the certainty that in many localities the female plant alone exists, Dr. Braun gives it as his opinion that, at least in certain places, *Chara crinita* has the capacity of producing, without the operation of any male organ, normal spores capable of germination, and consequently that it affords an instance of veritable parthenogenesis.

In 'Bonplandia,' for 1857 (p. 209), Klotzsch suggested that the so-called embryo in *Cœlebogyne* is in fact not an embryo at all. He says that all the Euphorbiaceæ, without exception, have anatropal ovules, and a highly developed straight embryo with the radicle turned to the micropyle, whilst the large flat cotyledons which enclose the plumule are directed to the chalaza. In *Cœlebogyne*, on the contrary, no freely developed embryo is perceptible, nor is there any trace of a radicle turned towards the micropyle, or of cotyledons turned towards the chalaza. Instead of the above, there is found an elliptical body within a fleshy, *not albuminous*, envelope, and consisting of a convoluted leaf-like mass, firmly attached on the inside of the seed to the chalaza by a discoid foot. From these facts Klotzsch arrives at the conclusion that the supposed embryo is a bud formed within the seed.

Ruprecht* has objected that Klotzsch has given no figure of the perfect seed, and without this he seems to consider Klotzsch's observations open to doubt, at the same time expressing no opinion either for or against parthenogenesis.

Radlkofer's second essay on parthenogenesis relates to some matters of opinion in dispute between himself and Braun. He discusses the nature of the germinal vesicle before impregnation, and considers that in that stage it must be looked upon, not as the germ of the future plant, but as a rudimentary body capable of becoming a germ; a distinction somewhat subtle, and not very easily appreciable. He also enters upon the question of the analogy between the embryo-sac and the spore of the higher cryptogams. These matters, however, have no bearing upon the practical question as to the existence or non-existence of parthenogenesis in vegetables, and we refrain therefore from any further details with regard to them.

In 1859, Regel's paper, "Die Parthenogenesis im Pflanzen-reiche,"

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* Ein Beitrag zur Frage über die Parthenogenesis bei Pflanzen, im Bulletin de l'Acad. Imp. de S. Petersbourg, 1858, p. 274, No. 378.

was published in the Memoirs of the Academy of St. Petersburg, (VII. Ser. Tome I. No. 2.) He considers that Spallanzani's experiments are the only ones which have been well conducted, and admits that if he (Regel) could have procured perfect seeds by operating as Spallanzani did with the Hemp and the Water-melon, the doctrine of parthenogenesis might be considered established. Regel attempts to get rid of Spallanzani's authority, by suggesting either that his observations were not carefully conducted, or that Spallanzani did not speak the truth. The latter accusation appears to have no sort of foundation; at least the grounds for it given by Regel are of the weakest description.

In the course of a series of experiments on hybridization, Regel observed that the anthers of many plants are fully formed and contain perfect pollen some time before the opening of the flowers; from which he concludes that it is necessary, in all experiments on parthenogenesis, to cut off the anthers at a very early period, or otherwise impregnation may have taken place without the observer having any suspicion of it. He considers monœcious and diœcious plants to be especially likely to have led to deceptions, because sufficient care was not taken to examine each individual flower—a precaution which is necessary on account of the frequent occurrence of accidental anthers in the female flowers, and because monœcious and diœcious plants produce a greater quantity of pollen than hermaphrodites, and consequently accidental impregnation by wind or insects is highly probable. He considers the Hemp-plant, which has been so much employed for these experiments, to be especially ill-suited for them, on account of the abundance of its easily dispersible pollen, and of its universal cultivation. As therefore (he says) these precautions have not been taken by any trustworthy observer, and as his own observations have afforded only negative results, he considers it certain that the formation of a true embryo can only take place under the influence of impregnation.

Regel then proceeds to give an account of his observations upon the Cycadeæ, and especially upon *Ceratozamia*, and the result that he arrived at was, that no embryo can be formed without the influence of a pollen-tube, but that the growth of the embryo-sac and the production of endosperm, as also the formation of corpuscula in Gymnosperms, may take place independently of impregnation. The case of the Cycadeæ he considers very conclusive, as showing that the development in the embryo-sac can only proceed up to the point at which the stimulus to the commencement of the formation of an embryo must be given, and that where this stimulus is wanting, the germinal vesicle, even in vigorous seeds, exhibits no further development.

Regel subsequently proceeds to detail his experiments on *Mercurialis annua*, from which he concludes that the previous observers who have imagined that they have procured perfect seeds without impregnation, have overlooked the very frequent occurrence of anthers in the so-called female flowers; and with regard to the persistence of the stigma, upon which Radlkofer places so much reliance, as proving the fact of non-impregnation, a figure is given (after Nees) of the young *fruit* still surmounted by the perfect stigma; and it is stated that the stigma is not only persistent, but even increases in growth after impregnation—a circumstance which (it is added) has often been observed by Klotzsch in the Euphorbiaceæ.

Experiments upon *Spinacia oleracea*, similar to those just mentioned upon *Mercurialis*, led the author to the conclusion that *Spinacia* is, in point of fact, an hermaphrodite plant, which can produce no perfect seeds when impregnation is really prevented, but that such prevention is a most difficult task, it being next to impossible to remove the male flowers at so early a stage and with so much care, as to be certain that impregnation has not taken place.

Lastly, Regel entered upon the same investigations with female plants of *Cannabis sativa*. He cut the plants down to a few branches, so that he might be able to examine with a lens the numerous flowers which were daily produced, and so that the whole vegetative force of the plant might be directed to those few branches, and thus favour the formation of fruit. He kept these plants in favourable situations until the month of October, up to which time none of the ovaries produced seeds; but all of them, without exception, withered and dropped off. He then put these plants, and another female plant subsequently reared, but not cut down like the former, into a room with a male plant. The heat of the room and other circumstances he considered to be unfavourable to fructification. Nevertheless, the female plants which had been cut down produced and ripened seed, whilst the other female plant did not fructify. The results are thus recapitulated by the author.—Two plants cut down so that the whole vegetative power was directed to the formation of seeds, placed under favourable circumstances, vigorous in their growth, and having daily access to fresh air, produced no fruit so long as impregnation was withheld. The same plants under unfavourable circumstances, in a close hot room, and when the days were shortened, produced and ripened seeds as soon as they were subjected to impregnation. A plant *not* cut down like the above, and impregnated under the (unfavourable) circumstances just mentioned, produced no seeds.

Regel states that he has not had the opportunity of examining *Cœlebogyne*, and can therefore give no decided opinion as to that plant. He suggests the possibility of the future discovery of sessile anthers between the bracts or near the glands, or that individual pollen-grains may be developed in the interior of the embryo; the latter suggestion arising from the fact of Deecke having seen in *Cœlebogyne* a pollen-tube which had penetrated to the embryo-sac, although neither he nor Radlkofer could discover pollen-grains upon the stigma.

Since the publication of Regel's paper, Dr. Braun has returned to the subject in a communication made to the Berlin Academy, and published in their Transactions for 1859. This essay, which has since appeared separately, is of enormous length, occupying about 150 quarto pages. Only a small portion of it, however, relates directly to the simple question of the existence, or non-existence, of fructification without impregnation. The author expressly contradicts the theory advanced by Klotzsch as to the nature of the body within the seeds of *Cœlebogyne.* He says: "I can confidently re-" affirm, and prove at any time by sections of seeds in my possession, " that the embryo-formation of *Cœlebogyne* which I have observed " and described, fulfils all the conditions necessary to constitute a " veritable embryo, and agrees in its essential features with that of " the other Euphorbiaceæ." In a later part of the essay some remarks are given under the head "Weitere Zeugnisse für die Parthenogenesis," of which the following is a short account. Some observations on individual plants given by Ruprecht, Tenore, Lecoq, and Jacquemont are noticed, the author stating that he was unwilling to pass them over entirely, although (he adds), as merely special instances, little importance may be attached to them. Dr. Braun then refers (as bearing upon the question of parthenogenesis) to those cases of fructification called by Gärtner *Fructificatio spuria*, in which *fruit* is formed, and even seeds also; the latter being apparently perfect, but containing no embryo. Instances of this occur in *Datisca*, *Adelia*, the Cycadeæ, and the Coniferæ; and give rise to the question, whether the unimpregnated germinal vesicle disappears without undergoing any development; or whether the development progresses to a certain extent, and is then arrested. Dr. Braun considers this point deserving of investigation, as, in his opinion, it is not improbable that, besides perfect parthenogenesis, there may exist *indications of parthenogenesis*, as has been observed in the animal kingdom. The above question, he adds, is connected with the further ones; 1, whether or not, speaking generally, the formation of seeds and fruits depends upon the development of the germinal vesicle into an embryo; and, 2, whether, when impregnation occurs, it acts directly only upon the development of the germinal vesicle into an embryo, and thus indirectly upon the formation of the surrounding parts; or whether impregnation acts upon the entire ovule, or even upon the ovary itself. Observations, he says, are wanting as to the well-known cases of fructification without seeds which occurs in certain cultivated varieties of *Citrus*, *Pyrus*, *Cydonia*, *Vitis*, *Artocarpus*, *Musa*, and *Ananassa.* It should be ascertained in what stage of development the ovules fail, and whether the formation of these seedless fruits is in all cases independent of impregnation.

Having regard to the cases in which parthenogenesis has been noticed in the animal kingdom, Dr. Braun observes that it might be expected to play a more important part amongst cryptogamic, than amongst phænogamic plants. He adds, however, that this question is surrounded by many difficulties, and that he can do no more than make a few suggestions on the subject. He alludes, in the first place, to the ferns, in which he considers that the constant reappearance of individual peculiarities, and even of monstrosities, points to the existence of zelotypical* reproduction, and consequently of parthenogenesis. He then refers to the mosses, and mentions that in some of them male blossoms are not even known, whilst in others, although known, they occur but seldom, and yet in both cases fruit is produced plentifully, at least in some localities. For example, the male blossoms of *Dicranum undulatum* are entirely unknown, and yet it is a moss which forms an abundance of fruit. In *Sphagnum molluscum* the male plants are known, but yet the species fruits freely in places where no trace of them is to be found; and the same thing occurs in *Camptothecium lutescens*. *Atrichum undulatum* bears a male flower only in the first year; from which, in the second and subsequent years, innovations are produced bearing female flowers. Patches of this moss are often found bearing fruit, but having no first-year male plants in or near them. *Fissidens incurvus* bears the male flowers at the apex of a lateral innovation of the second year, but it produces fruit in the first year of its growth. Dr. Braun then refers to the Algæ, and dismisses the Florideæ and Fucoideæ as exhibiting no satisfactory proofs of parthenogenesis. He then mentions the Conjugatæ; and, adopting De Bary's theory that the process of copulation is a peculiar modification of sexual reproduction, he considers that the exceptional cases where the spores in the Conjugatæ are formed without copulation must be looked upon as instances of parthenogenesis; at least, if it may be assumed (what he admits is not yet proved) that such spores agree with the others in their structure and mode of germination.

In a note at pp. 117 and 118 of his essay, Dr. Braun refers to some experiments of Schenk, made, during the three previous years, in the botanical garden at Wurzburg, and also to some observations of De Bary made at Freiburg. Schenk directed his attention to *Cannabis sativa*, *Mercurialis annua*, *Ricinus communis*, *Momordica elaterium*, and *Cucurbita Pepo*. De Bary speaks of *Cannabis sativa* alone. Both observers obtained only negative results, and the same was the case with some later observations upon *Cannabis sativa* and *Mercurialis* made by Schenk, and reported in the "Wurzburg Nat. Zeitschrift," Bd. 1. pp. 85-89.

The last publication which we have to mention is Karsten's treatise, entitled "Das Geschlechtsleben der Pflanzen und die Parthenogenesis," published at Berlin in 1860. He asserts that anthers are not unfrequently developed at the base of the calyx of the female flowers of *Cœlebogyne*; that he has himself observed this in the botanical garden at Berlin; that if *Cœlebogyne* be carefully

* "Zelotypic" and "Idiotypic" are words coined by Radlkofer in his treatise on the relation of parthenogenesis to other modes of reproduction. In sexual reproduction, the new individual, although retaining the peculiarities of the species, may vary to some extent from the original type. This is called by Radlkofer "idiotypical" reproduction. In asexual reproduction, the new individual is, so to speak, a copy of the old one: this Radlkofer calls "zelotypical" reproduction.

examined, a succession of hermaphrodite flowers may be observed at intervals throughout the whole summer, from the beginning of May to the end of August; and that, in fact, about every fifth flower is hermaphrodite.

With these observations of Karsten the present report comes to a close; and the readers of it, being now in possession of the evidence on both sides, may form their own opinion whether or not parthenogenesis exists in the vegetable world. It is no part of the duty of the writer of a report to give his own views upon the subject to which it relates, although we ventured a statement at the outset that the point in dispute was far from decided. Setting aside the case of *Cœlebogyne*, it appears to the writer that, although some of the facts might lead to a *suspicion* on the subject, there is really no *proof* whatever of the existence of parthenogenesis, at least, in phænogamic plants; and with regard to the Cryptogamia, the discovery of their sexual organs is of such comparatively recent date, and the examination of them is surrounded by so many difficulties, and is in the hands of so few observers, that it would be rash in the extreme to found any theory upon the results hitherto obtained. *Cœlebogyne*, however, still remains a striking instance of the apparent possibility of reproduction without impregnation; for, although the value of the evidence afforded by this latter plant is doubtless shaken by Karsten's observations, it is quite impossible to assume, with him, that parthenogenesis is yet disproved. It cannot be supposed that the observations of Smith, Radlkofer, Deecke, and Braun have been so imperfectly and carelessly conducted as must be the case if, as Karsten would lead us to suppose, every fifth flower in every plant of *Cœlebogyne* is hermaphrodite. We do not at all intend to deny the correctness of his observations, but we think it highly improbable that, if the stamens of *Cœlebogyne* were of such frequent occurrence, they would have escaped the notice of so many other equally able observers.

In conclusion, it is hardly necessary to remark, that further observations by competent botanists, as to the anatomy of the inflorescence of *Cœlebogyne*, are much to be desired; and that further inquiries into the reproductive process in cryptogamic plants may hereafter throw additional light upon the subject. For the present, all that can be said is that vegetable parthenogenesis is *not proven*.

XLVII.—On the Systematic Arrangement of the Rhizopoda. By William B. Carpenter, M.D. F.R.S., &c.

Notwithstanding that, by the general consent of zoologists, the group of *Rhizopods* is now admitted to take rank as a class in the sub-kingdom Protozoa, and although there is little or no difference of opinion as to the extent of range which it comprehends, scarcely anything has yet been done towards the determination of the principles on which its various forms should be classified into Orders and Families; so that among the writings of recent systematists there is a complete disaccordance as to the relative places assigned to them. Having been recently led to inquire into this subject with some care, for the purpose of determining the relations of the *Foraminifera* to the other members of the class, and having been encouraged to believe that my results may be deemed worthy of acceptance by other Naturalists, I avail myself of the pages of the "Natural History Review" to bring them in a concise form under their consideration; referring to my forthcoming "Introduction to the Study of the Foraminifera," shortly to be published by the Ray Society, for a fuller exposition of them.

It is not a little singular that Dujardin, who first discovered the true "idea" of the Rhizopodous type,* and to whose original account little of importance has subsequently been added, should have so limited his definition of it as actually to exclude some of what we now regard as its most characteristic examples. In his "Histoire Naturelle des Zoophytes Infusoires" (Paris, 1841), he ranks the *Amibiens* as the second family of his INFUSOIRES, the *Rhizopodes* as the third, and the *Actinophryens* as the fourth; but he distinctly states that the structure of the animal is essentially the same in the first two cases, and that the *Rhizopodes* are differentiated from the *Amibiens* solely by the enclosure of their bodies in a testaceous envelope, varying in consistence from a simple flexible membrane to a thick calcareous shell, either solid or porous. He does not, however, regard the differences in the texture of the envelope as equal in importance to those presented by the form of the pseudopodian extensions of the sarcode-body, according to which the *Rhizopodes* may be divided into two sections; of which the first (corresponding to Ehrenberg's family *Arcellina*) includes only the *Arcellæ* and *Difflugiæ*, whose pseudopodia are short, thick, and rounded at their extremities; whilst the second comprehends all those whose pseudopodia are filiform and much attenuated towards their extremities. This second section was subdivided by Dujardin into three tribes; the first composed of the genera *Trinema*, *Euglypha*, and *Gromia* (all discovered by himself), which are distinguished from *Difflugia* only by the attenuation of their pseudopodia; the second is composed of the single genus *Miliola*, which agrees with the ordinary *Foraminifera* in the possession of a calcareous shell, whilst it corresponds with *Gromia* in having but a single large aperture from which the pseudopodia extend themselves; and the third includes the *Foraminifera* proper, all of which were supposed by Dujardin to be furnished (like the few observed by himself) with porous shells for the passage of pseudopodia from the general surface of the body.

Now this arrangement, imperfect though it was, is based (as it

* "Observations sur les *Rhizopodes* et les *Infusoires*;" in Comptes Rendus, 1835, p. 338.

seems to me) on a truer perception of the value of characters than most of the classifications that have been since proposed. For Dujardin distinctly recognized the fact that *Arcella* and *Difflugia* are nothing else than testaceous Amœbans; and in separating these from those Rhizopods which are characterized by the possession of filiform, tapering, or ramifying pseudopodia, he laid the foundation of a truly natural grouping of the latter. Had he recognized the fact that his group of (testaceous) Rhizopods is related, on the one side, not less closely to *Actinophrys* than it is, on the other, to *Amœba*, and that *Trinema* and *Euglypha* are really formed on the Actinophryan type, whilst *Gromia* is the representative of the Foraminiferous, he would have marked out, upon a sound basis, what appear to me to be the fundamental divisions of the class. Even in separating *Miliola* from the ordinary Foraminifera, he adopted a principle which I believe to be perfectly correct, though his limited acquaintance with the group misled him in the application of it; for, as I shall hereafter show, *Miliola* is the type of a large group of Foraminifera in which the body is inclosed by an imperforate shell, so that there is no exit for its pseudopodial extensions except by the apertural plane, in which there is sometimes (as in *Miliola*) a single large orifice, whilst in other cases it is replaced by a multiplicity of distinct pores. The differentiation between this group and the one in which the shell, being everywhere perforated with pores more or less fine, allows the passage of pseudopodia from every part of the surface of the body, I hold, with Dujardin, to be of essential importance.

These considerations have been altogether passed over, not only by M. D'Orbigny, who adopted Dujardin's rectification of the position of the Foraminifera in the zoological series, without in any way modifying the classification of the group which he had previously devised under the notion that the animals by which these shells are formed are minute Cephalopods, but also by Prof. Schultze, who, having applied himself to the study of the Foraminifera and their allies in the living condition, might be expected to have gained more insight into their true relations as indicated by the characters furnished by their sarcode-bodies. Yet he shows himself to be so completely under the influence of views of systematization based on the characters of the shell, and to have so little regard even to the most important structural and physiological differences anywhere presented by the animals of this class, as to associate in his family *Lagynidæ**—for no other reason than that they agree in the possession of a unilocular test, *Arcella* and *Difflugia*—whose animals are of the Amœban type, *Trinema* and *Euglypha*—whose animals are Actinophryan in character, *Gromia*—whose animal is the type of that of the imperforate-shelled Foraminifera, *Squamulina*—which has an imperforate calcareous shell of the Milioline type, and *Ovulina*—whose shell is

* See his treatise, "Ueber den Organismus der *Polythalamien* (Foraminiferen) nebst Bermerkungen über die *Rhizopoden* in allgemeinen." Leipzig, 1854.

perforated. Any arrangement more truly unnatural can scarcely be conceived:—to me it appears a sort of *reductio ad absurdum* of the principle that the unilocularity or multilocularity of the shell should be held of primary account in the systematic arrangement of the organisms in question.

An important step in the classification of the RHIZOPODA was made by the late Prof. Johann Müller, in his admirable memoir (Transactions of the Berlin Academy, 1858), "Ueber die *Thalassicollen*, *Polycystinen*, und *Acanthometren* des Mittelmeeres;" these three groups, whose mutual affinity he showed to be very strong, being associated by him into a distinct sub-class, which he distinguished as RHIZOPODA RADIOLARIA. He failed, however, to perceive what appears to me to be the essential relationship between the *Acanthometrina* and *Actinophryna;* an *Acanthometra*, as we shall presently see, being nothing else than an *Actinophrys* furnished with a siliceous skeleton. And in drawing a strong line of demarcation between the simple and the composite forms of *Thalassicolina*, he endeavoured to establish a distinction which seems to me untenable among animals that multiply by gemmation, between the simple and the composite forms. Taking the group of RADIOLARIA as a whole, however, it may be considered an eminently natural one; and I adopt it as one of the primitive sub-divisions of the class, adding to it the family *Actinophryna*, which includes *Actinophrys* and its immediate allies, for reasons which will be presently apparent.

More recently an attempt has been made to frame a natural classification of the RHIZOPODA as a whole, by two distinguished pupils of Prof. Müller, MM. Claparède and Lachmann ("Études sur les *Infusoires* et les *Rhizopodes*," Genève, partie 2ième, 1859); and it is with some diffidence that I venture to express a divergence of opinion from observers who have been trained in so excellent a school, and who have given such ample proofs in their published writings of practical familiarity with the several forms whose relations they discuss. The following is the scheme proposed by them (l. c. p. 434):—

				Orders.	*Families.*
RHIZOPODES.	No calcareous test. No multiple-porous chambers	Pseudopodia rarely uniting	No silicious spicula. No yellow cells	PROTEINA	1. Amœbina. 2. Actinophryna.
			Silicious spicula. Yellow cells	ECHINOCYSTIDA	1. Acanthometrina. 2. Thalassicollina. 3. Polycystina.
		Pseudopodia forming very numerous junctions	. . . .	GROMIDA .	Gromida.
	A usually calcareous test, most frequently multilocular: even when there is but a single chamber, its parietes are traversed by a multitude of pores		. . . .	FORAMINIFERA	1. Monothalamia. 2. Polythalamia.

Now on this I have to remark, in the first place, that the two families *Amœbina* and *Actinophryna*, which are associated in the order PROTEINA, differ essentially from each other in several particulars which seem to me of great physiological importance; whilst I cannot trace any such peculiar bond of union between them, as would be required to justify their separation from all other Rhizopods and their association into a separate order. Again: the foregoing arrangement follows that of Prof. Müller in dissociating *Actinophryna* from *Acanthometrina*, to which they are much more nearly allied than they are to *Amœbina*. And thirdly, the ordinal separation of GROMIDA from FORAMINIFERA seems to me to be altogether unwarranted by any essential difference, since the condition of the animal in these two groups is in every respect the same; while the diversity in the material of the envelopes which they respectively form can no more be admitted as a valid ground of separation in this group than in the family *Amœbina*, of which *Arcella* exudes a chitinous test like that of *Gromia*, whilst *Difflugia* forms its test by the cementation of foreign particles, as do several genera among *Foraminifera*.

It is, as it seems to me, in the structural and physiological conditions of the *animal* alone, that we should look for the characters on which our primary subdivisions should be constituted; and notwithstanding that the extreme simplicity and apparent vagueness of those conditions at first sight appear almost to forbid the attempt to assign to them a differential value, yet a sufficiently careful scrutiny will make it clear that, under their guidance, lines of demarcation may be drawn, as precise as in any other great natural group, between three aggregations of forms which assemble themselves round three well-known types, *Amœba*, *Actinophrys*, and *Gromia*,—the sarcode-bodies of these three types presenting three distinct stages in the differentiation of the protoplasmic substance of which they are composed, and exhibiting, in virtue of that differentiation, three very distinct modes of vital activity.

I.—The lowest stage of this differentiation is seen in *Gromia* and its allies, among which may be particularly specified a remarkable naked form, which has been described by MM. Claparède and Lachmann under the name of *Lieberkühnia*, and which seems either identical with the *Pamphagus* of the late Prof. Bailey (U.S.), or very closely allied to it. In this type the whole substance of the body and of its pseudopodian extensions is composed of a homogeneous, semi-fluid, granular protoplasm, the particles of which, when the animal is in a state of activity, are continually performing a circulatory movement, which has recently been likened by Prof. Schultze (and, as it seems to me, with great justice) to the circulation of the particles in the protoplasmic network within the cell of a *Tradescantia*. The entire absence of anything like a membranous envelope is evinced by the readiness with which the pseudopodian extensions fuse together whenever they come into contact, and with which the principal branches subdivide into finer and yet finer threads, by whose continual inosculations a network is produced that might be almost described as an animated spider's web. Any small alimentary particles that may come into contact with the glutinous surface of the pseudopodia are retained in adhesion by it, and speedily partake of the general movement going on in their substance. This movement takes place in two principal directions; from the body towards the extremities of the pseudopodia, and from these extremities back to the body again. In the larger branches a double current may be seen, two streams passing at the same time in opposite directions; but in the finer filaments the current is single, and a granule may be seen to move in one of them to its very extremity, and then to return, perhaps meeting and carrying back with it a granule that was seen advancing in the opposite extremity. Even in the broader processes, granules are sometimes observed to come to a stand, to oscillate for a time, and then to take a retrograde course, as if they had been entangled in the opposing current,—just as is often to be seen in *Chara*. When a granule arrives at a point where a filament bifurcates, it is often arrested for a time until drawn into one or the other current; and when carried across one of the bridge-like connections into a different band, it not unfrequently meets a current proceeding in the opposite direction, and is thus carried back to the body without having proceeded very far from it. The pseudopodian network along which this "cyclosis" takes place is continually undergoing changes in its own arrangement; new filaments being put forth in different directions, sometimes from its margin, sometimes from the midst of its ramifications, whilst others are retracted. Not unfrequently it happens, that to a spot where two or more filaments have met, there is an influx of the protoplasmic substance, which causes it to accumulate there as a sort of secondary centre, from which a new radiation of filamentous processes takes place.

Now, the entire absence of differentiation in the protoplasmic substance, the freedom of the mutual inosculation of its pseudopodian extensions, and the active cyclosis incessantly going on between these and the body, are three mutually related conditions, which not only serve to characterize the group of animals that exhibits them, but, as we shall presently see, to differentiate that group from others. There is, moreover, a negative character of much importance, which is naturally associated with the absence of differentiation,—namely, the deficiency of the "nucleus" and "contractile vesicle" that occur both in *Actinophrys* and in *Amœba*. So far as is yet known, there is a perfect agreement as to all these characters between the *Foraminifera* and the *Gromida;* and I regard *Lieberkühnia* as standing in the same relation to the chitine-covered *Gromia* or to the calcareous-shelled *Foraminifera*, that *Actinophrys* does to the chitine-covered *Euglypha* or to the siliceous-shelled *Polycystina*. The entire group thus constituted may (as it appears to me) be appropriately termed Rhizopoda Reticularia; the ordinal designation being meant to express that reticulose arrangement of the pseudopodian extensions which is its distinguishing characteristic.

II.—In *Actinophrys* and its allies there is a degree of definiteness in the form and arrangement of the pseudopodia, which contrasts strongly with the entire indefiniteness which prevails throughout the Reticulose order. These organs are, for the most part, simple filaments, tapering gradually from base to point, usually maintaining their isolation throughout, and extending in a radiary direction from the body of the animal. It is obvious that they are of much firmer consistence than in GROMIA and its allies, since they neither subdivide themselves by ramification into finer filaments, nor do they show any readiness to coalesce when they come into mutual contact. Still it is equally certain that they can be retracted into the general mass of the body, and fused (as it were) into its substance; and such a fusion takes place when food is being entrapped by their means. A careful examination of the substance of the *Actinophrys* serves to explain this apparent inconsistency; for it thence appears that the body and its pseudopodian extensions are far from having the homogeneousness of those of *Lieberkühnia*, but that there is an incipient differentiation of their substance into two dissimilar constituents, the outer layer being least granular and of firmer consistence, whilst the contained portion approaches more nearly to the character of a liquid, as may be seen by the freer movements of the granular particles which are suspended in it. These two constituents have been appropriately designated by Dr. T. Strethill Wright as the "ectosarc" and the "endosarc." There is no definite line of demarcation between them; but the one graduates insensibly into the others. It seems to be, however, from the ectosarc alone that the pseudopodia are put forth; the granular endosarc not extending itself into them. A movement of granules along their surface may indeed be discerned by careful observation; but these appear to be merely particles which have been entrapped by adhesion to the surface of the pseudopodia, and are being transmitted to the body; and there is nothing like that regular circulation from the body to the extremities of the pseudopodia, and back again, which is so remarkable a feature in the Reticularia. With the incipient differentiation of the protoplasmic substance, there seems to be associated the presence of a "nucleus;" which, however, is not so strongly marked in *Actinophrys* as it is in *Amœba*, and may easily escape notice. The "contractile vesicle," on the other hand, is always discernible, and its actions are very regular. Its presence may be considered as superseding the necessity of the general protoplasmic circulation; since it can scarcely be doubted that its function is to maintain a continual movement of nutritive fluid among a system of channels and vacuoles excavated in the substance of the body, some of the vacuoles which are nearest the surface being observed to undergo distention when the vesicle contracts, and to empty themselves gradually as it refills.

The general characters of *Actinophrys*, with a more or less complete limitation of the pseudopodia to one portion of the body, necessitated by its enclosure within a membranous or chitinous envelope, are presented by the genera *Trichodiscus*, *Plagiophrys*, and *Euglypha*, which are associated with it by MM. Claparède and Lachmann in the family *Actinophryna*. But they seem to me—so far as I can judge by the published descriptions of these animals, which I have not myself had the opportunity of examining in their living state*—not less unmistakeably exhibited by the *Acanthometrina* and the *Polycystina*, which may be regarded as higher or more specialized forms of the same type. The radiating pseudopodia of *Acanthometra* correspond precisely in all their characters with those of *Actinophrys;* having the same rod-like tapering form, the same regularly radiating arrangement, the same mutual isolation, and the same slow movement of particles along their surface: some of them, however, are enclosed in tubular siliceous sheaths, which appear to be secreted from their surface; and the union of the expanded bases of these sheaths forms a sort of framework, that supports the protoplasmic substance of the body. In this substance the differentiation of endosarc and ectosarc has obviously proceeded further than in *Actinophrys;* and the endosarc contains a number of cell-like bodies resembling those of the *Thalassicollæ*. The animal of the *Polycystina* seems to correspond with *Acanthometra* in all essential particulars, the difference being only in the disposition of the siliceous envelope; and that of the *Thalassicollina* appears to be only a more composite aggregation of the like structural components. For details of the evidence of the relations of the last-named groups to each other and to the preceding, I must refer to the memoir of Prof. Müller already cited; and his designation RADIOLARIA I adopt as that of the group to which he applied it, with the addition of the family *Actinophryna*. That family, as I have endeavoured to show, really supplies the typical form of the Order; the naked *Actinophrys* bearing the same relation to the testaceous *Polycystina* (for example) that the naked *Amœba* does to the testaceous *Arcella* and *Difflugia*, or the naked *Lieberkühnia* to the testaceous *Gromida* and *Foraminifera*.

III.—From the Actinophryna and the other Rhizopods of the order Radiolaria, the *Amœbina* seem to me to be very definitely distinguished by the more complete differentiation of the containing and the contained portion of their sarcode-bodies, and by the entire difference (as regards, at least, the typical forms of each group) in the character of their pseudopodial extensions. The distinction between the ectosarc and the endosarc is far more clearly marked in *Amœba* than in *Actinophrys;* the latter being much more fluid, whilst the consistence of the former is much firmer. It is through the endosarc alone that those coloured and granular particles are

* I am not aware that *Acanthometræ* have yet been seen upon our coasts. They seem, however, to abound in the North Sea, and should therefore be looked for upon our eastern shores, especially when the wind blows towards them. The *Acanthometra echineides*, which abounds on the western coast of Norway, is discernible by the naked eye as a crimson red point.

diffused, on which the hue and opacity of the body depend; its central portion seems to have an almost aqueous consistence, the granular particles being seen to move quite freely upon one another, with every change in the shape of the body; but its peripheral portion is more viscid, and graduates insensibly into the firmer substance of the ectosarc. The ectosarc, which is perfectly pellucid, forms an almost membranous investment to the endosarc; still, it is not possessed of such tenacity as to oppose a solution of its continuity at any point, for the introduction of alimentary particles, or for the extrusion of effete matter; and thus there is no evidence, in *Amœba* and its immediate allies, of the existence of any more definite orifice, either oral or anal, than exists in other Rhizopods. It is asserted by MM. Claparède and Lachmann, however, that an oral orifice does exist in *Podostoma*, a peculiar modification of the Amœban type; and they think it not impossible that such an aperture may exist even in *Amœba*, of which the lips might be exactly applied to one another, as in *Amphileptus*, so as only to open for the ingestion of food. The more advanced differentiation of the ectosarc and the endosarc of *Amœba* is made evident by the effects of re-agents. If, as Auerbach has shown, an *Amœba radiosa* be treated with a dilute alkaline solution, the granular and molecular endosarc shrinks together and retreats towards the centre, leaving the radiating extensions of the ectosarc in the condition of cœcal tubes, of which the walls are not soluble, at the ordinary temperature, either in acetic or mineral acids, or in dilute alkaline solutions; thus agreeing with the envelope noticed by Cohn as possessed by *Paramecium* and other ciliated *Infusoria*, and with the containing membrane of ordinary animal cells. A nucleus is always distinctly visible in *Amœba*, adherent to the inner portion of the ectosarc, and projecting from this into the cavity occupied by the endosarc; when most perfectly seen, it presents the aspect of a clear flattened vesicle surrounding a solid and usually spherical nucleolus; it is readily soluble in alkalies and first expands and then dissolves, when treated with acetic or sulphuric acid of moderate strength; but when treated with diluted acids it is rendered darker and more distinct, in consequence of the precipitation of a finely granular substance in the clear vesicular space that surrounds the nucleolus.

In all these particulars, therefore, the *Amœbina* present a nearer approach to Infusoria than is discernible among other Rhizopods; and hence it was not without good reason that Prof. Müller designated them "Infusorial Rhizopods." They tend towards Infusoria, also, in their higher locomotive powers, obtaining their food by actively going in search for it, instead of entrapping it and drawing it into the substance of their bodies by the agency of their extended pseudopodia. In fact, the pseudopodia are here very different organs from those of either Reticularia or Radiolaria, being rather lobate extensions of the body itself, than appendages proceeding from its surface-layers. They are few in number, short, broad, and rounded;

and their outlines present a sharpness which indicates that the substance of which their exterior is composed possesses considerable tenacity. No movement of granules can be seen to take place along the surface of the pseudopodia; and when two of these organs come into contact, they scarcely show any disposition even to mutual *cohesion*, still less to a *fusion* of their substance. Sometimes the protrusion seems to be formed by the ectosarc alone, but more commonly the endosarc also passes into it, and an active current of granules may be seen to pass from what was previously the centre of the body, into the protruded portion, when the latter is undergoing rapid elongation; whilst a like current may set towards the centre of the body from some other protrusion which is being withdrawn into it. It is in this manner that an *Amœba* moves from place to place; a protrusion like the finger of a glove being first formed, into which the substance of the body itself is gradually transferred; and another protrusion being put forth, either in the same or in some different direction, so soon as this transference has been accomplished, or even before it is complete. The kind of progression thus executed by an *Amœba* is described by most observers as a "rolling" movement, this being certainly the aspect which it commonly seems to present; but it is maintained by MM. Claparède and Lachmann that the appearance of rolling is an optical illusion, for that the nucleus and contractile vesicle always maintain the same position relatively to the rest of the body, and that "creeping," or reptation, would be a truer description of their mode of movement. On this view, these animals have their ventral constantly differentiated from their dorsal surface, it being from the former alone that the pseudopodian extensions proceed; and thus a transition would seem to be indicated towards the testaceous *Amœbina* (*Arcella*, *Difflugia*, &c.) in which the dorsal surface is invested by a shell, and the pseudopodia are strictly limited to the ventral region. It is in the course of its movement from place to place, that the *Amœba* encounters particles which are fitted to afford it nourishment; and it appears to receive such particles into its interior through any part of the ectosarc, whether of the body itself or of any of its lobose expansions, insoluble particles which resist the digestive process being got rid of in the like primitive fashion.

The Amœban, like the Actinophryan, type shows itself in the testaceous as well as in the naked form; and it is of importance to notice, that whilst the "test" of *Arcella* is formed by a membranous (probably chitinous) exudation from the animal itself, that of *Difflugia* is chiefly made up of grains of sand, fragments of shell, or other foreign particles, cemented together. The resemblance of the animals of these two genera is so close, that no systematist has ever proposed to separate them by more than a generic distinction; and if the dissimilarity of the material of *their* "test" be not admitted as a differential character of grave importance, I can see no reason for attaching more weight to the distinction between the chitinous test of *Gromia* and the calcareous shell of the ordinary *Foraminifera*, especially as this last is often replaced, either partially or completely, by an envelope formed by the cementation of sandy particles.

Thus, then, *Amœba* and its allies are distinguished from the *Actinophryna*, by the yet higher manifestation of that tendency to differentiation of the homogeneous protoplasma, which marks so definite a distinction between the *Actinophryna* and the *Gromida;* and the distinction is indicated in the former case, as in the latter, by the nature of the pseudopodian expansions, the lobose form of which seems so characteristic of all the typical *Amœbina*, that they may be appropriately ranged under the ordinal designation Lobosa. It is quite true that these distinctions do not hold good in every instance; as there are osculant forms (such as the *Amœba porrecta* of Schultze) whose characters are so intermediate between those of the typical *Amœba* and of the typical *Actinophrys* that it is difficult to say to which type they are most nearly allied. And in like manner, judging from the characters of the pseudopodia in Schultze's genera *Lagynis* and *Squamulina*, it may be doubted whether the true place of those genera is in association with the *Foraminifera*, or whether their relation is not really more intimate with the *Actinophryna*. But the existence of such osculant forms by no means invalidates the principle of our classification, since their presence only serves to supply, between the Orders into which I propose to divide the Rhizopoda, the link which is necessary to their completeness as natural groups.

It is an interesting exemplification of the intimacy of the relation between the form of the pseudopodia and the properties of the sarcode-body of the Rhizopoda, that any small separated portion of that body will behave itself after the characteristic fashion of its type; thus, if the shell of an *Arcella* be crushed, so as to force out a portion of its sarcode, and this be detached from the rest, it will soon begin to put forth lobose extensions like those of an *Amœba;* whilst if the like operation be performed upon a *Polystomella*, or any other of the Foraminifera, the detached fragment of the protoplasm will extend itself into delicate ramifying and inosculating pseudopodia, resembling those of *Gromia*. And this fact seems to me to afford an additional justification of the employment of the characters furnished by the pseudopodia as the basis of a systematic arrangement of the class. The characters of the three Orders into which I propose to distribute its various forms may be concisely summed up as follows:—

I. Reticularia. The body composed of homogeneous granular protoplasm, without any distinction into ectosarc and endosarc; neither nucleus nor contractile vesicle; pseudopodia composed of the same substance as the body, extending and multiplying themselves by minute ramification, and inosculating completely wherever they come into contact; a continual circulation of granular particles throughout the viscid substance of the body and its extensions. This Order consists of the *Foraminifera* and the *Gromida*, whose mutual relations will be presently examined.

II. Radiolaria. Incipient differentiation of the protoplasmic substance into endosarc and ectosarc, the former semi-fluid and granular, the latter more tenacious and pellucid ; a nucleus and contractile vesicle; pseudopodia rod-like, usually tapering from base to point, composed of the same substance as the ectosarc, exhibiting little disposition either to ramify or to coalesce, having a more or less regular radiating arrangement, and not showing any constant circulation of granules in their substance, although a movement of particles adherent to their exterior is often to be distinguished. The type of this order is *Actinophrys*, constituting, with its immediate allies, the family *Actinophryna ;* but the Order also includes the *Acanthometrina*, *Polycystina*, and *Thalassicollina*, by the last of which this group is connected with the Sponges.

III. Lobosa. More complete differentiation of the protoplasmic substance into endosarc and ectosarc, the former being a slightly viscous granular liquid, and the latter approaching the tenacity of a membrane: a nucleus and contractile vesicle; pseudopodia few and large, being in reality lobose extensions of the body which neither ramify nor coalesce, having well-defined margins, and not exhibiting any movement of granules on their surface, the circulation in their interior being entirely dependent on the changes of form which the body undergoes as a whole. This Order is composed of but a single family, the *Amœbina ;* and it is the one which presents the nearest approximation to the classes Infusoria and Gregarinida.

Having thus explained what I conceive to be the true relations of the Foraminifera to other Rhizopods, I purpose now to state the views to which I have been led by the same mode of enquiry, in regard to the classification of that group. And in the first place, it is requisite to examine what is the physiological value of the separation of the *Monothalamous*, or *Unilocular*, forms from the *Polythalamous*, or *Multilocular*,—a separation which has been hitherto adopted by all systematists as one of primary importance, although Professor Reuss has lately expressed himself doubtfully as to the correctness of its principle.

There can be no doubt that, in common with all the lower forms of animal as well as vegetable life, the Rhizopoda tend to multiply by a separation of continuously-growing parts of their bodies, which may take the form either of *fission* or of *gemmation*, according as the original body undergoes subdivision, or as it puts forth an extension which eventually detaches itself. Among the Foraminifera proper, whose bodies are enclosed in unyielding shells, multiplication by fission cannot take place, except in that early stage of existence in which the shell is not yet consolidated ; but extension by gemmation may go on without limit, the successively-formed gemmæ usually remaining in connection with each other and with their stock. The progressive growth of the sarcode-substance causes a portion of it to project beyond the aperture of the shell ; and this projecting portion possesses all the attributes of the body of which it is an extension, and can maintain its existence with equal readiness, either in a separate state or in continuity with the stock of which it is an offset. Although, therefore, there are certain types of Foraminifera in which such offsets appear invariably to separate themselves before the consolidation of the shell, so that the original body never adds to the number of its segments, and the shell remains "monothalamous,"—whilst there are others in which they ordinarily remain in connection with the original stock, so as progressively to augment the number of the segments and of the chambers of the "polythalamous" shell, often to an indefinite extent,—I cannot see any such difference between the physiological conditions of the newly-formed segment in the two cases, as would be required to justify the erection of the *Monothalamia* into a distinct order. Moreover, we find that each of these groups, as ordinarily constituted, contains forms which *in principle* should rank with the other. Thus the continuous spiral shells which are known as *Spirillinæ* or *Cornuspiræ*, having their cavities undivided by septa, are always ranked among Monothalamia; but as they have the capacity for indefinite extension, which is characteristic of the *Polythalamia*, they need nothing but segmental division to turn them into *Rotaliæ* or *Spiroloculinæ*. Hence, such shells though *actually* monothalamous, are *potentially* polythalamous; and to rank them with *Gromiæ*, *Lagenæ*, or *Orbulinæ*, whose increase can only be effected by the complete detachments of the superfluous segments of sarcode, and by the formation of new and independent envelopes for these,—the enlargement of their shells being forbidden by their shape, would be antagonistic to the very principle on which the differentiation is based. I have recently been investigating another type, not until lately ranked among Foraminifera, which presents a condition of precisely the converse nature. In *Dactylopora* and *Acicularia* (as I shall more fully explain in my forthcoming Monograph), we have composite organisms of definite form made up by the aggregation of chambers which have no internal communication with each other, each being as distinct from the rest as the chambers of a heap of *Lagenæ*, and being only united by external adhesion. Such organisms, therefore, although *actually* polythalamous, are *essentially* monothalamous; since the sarcode-body, contained within each chamber, is as independent of the bodies enclosed in the neighbouring chambers, as it would have been if these chambers had been altogether disconnected. Again, there are certain Polythalamia, the successive chambers of whose shells, although formed by continuous gemmation the one from the other, are so slightly connected as to be easily separable by accidental violence, and of which the animals can maintain their lives just as well when they are thus broken up into distinct segments as when retaining their original continuity; such, again, may be regarded as *potentially* Monothalamous; and the fact that the segments of sarcode, as they were successively budded off from the stock, formed their shelly investments before, instead of after, their detachment from it, can scarcely be admitted by the Physiologist as alone justifying an ordinal differentiation, which is not borne out by other structural or physiological diversities.

Having shown in my former paper how completely fallacious is the assumption of M. D'Orbigny that *plan of growth* affords the key to the natural arrangement of Foraminifera,—any classification that is founded upon it necessarily bringing together generic types which are physiologically most distinct, and separating such as are physiologically most nearly allied,—I shall now confine myself to a concise exposition of what appear to me the principles on which Natural Classification should be founded.

Looking at the Order Reticularia as a whole, the only great physiological distinction at present known to exist among the multitudinous forms of animal life which it includes (our acquaintance with the mode in which the generative function is performed in this group being as yet so imperfect, that no differential characters can be founded upon it), is that presented by the two modes in which the pseudopodia originate, viz.:—either from the surface of the body generally, or from a limited portion of it. The animals of the former type, of which *Rotalia* may be taken as an example, have a shell whose surface is everywhere perforated with numerous closely set pores; and through these, as observation shows, the pseudopodia extend themselves freely from each of the segments that occupies the subjacent chambers. In those of the latter, of which *Miliola* may be taken as the type, the walls of the chambers are entirely imperforated; so that the pseudopodia can only issue from the single or multiple aperture, which leads to the last-formed chamber alone. The fundamental importance of this distinction was perceived (as I have already pointed out) by Dujardin; and my own enquiries, which have been pursued on a basis altogether independent of his, have led me most fully to recognize the merit of that far-sighted perception, which would have been more likely to attract the notice it deserved, if its author had been aware that, instead of being isolated from the true Foraminifera by the characters in question, the *Miliolæ* are really the representatives of that large group of Foraminifera which are distinguished by the *porcellanous* texture of their shells.

Taking our stand, then, upon the limitation or diffusion of the origin of the pseudopodia—manifested in the imperforation or the perforation of the testaceous envelope,—as a distinction of fundamental importance, we find that the Order Reticularia may be subdivided by this character into two sections; and as it is convenient to base our systematic arrangement of the Foraminifera upon the characters furnished by the *shell* (though always bearing in mind that these are of value only in so far as they may be taken as exponents of the characters of the *animal*) these two sections or sub-orders may be respectively designated Imperforata and Perforata.

In the sub-order Imperforata, the testaceous envelope presents itself under three very different conditions, the *membranous*, the *porcellanous*, and the *arenaceous;* and upon this difference we may group together the whole aggregate of "imperforate" genera under the three families *Gromida*, *Miliolida*, and *Lituolida*. The family *Gromida* presents in *Lieberkühnia* the nearest approach to a naked representative of this Order; the membranous envelope of its sarcode-body being reduced to such extreme tenuity, as only to be distinctly visible where it surrounds the pedicle, from which the pseudopodia are given off; but it is not a little remarkable, and is very significant of the physiological value of the character, that notwithstanding the absence of any shelly wall to limit the extension of the sarcode-body into pseudopodia, these are just as much restricted to one region as if the body had been entirely shut up within an envelope pervious only at one spot. In *Gromia*, the membranous envelope is of greater firmness, and presents a wide aperture; and the physiological condition of its animal so closely corresponds, except as regards the segmentation of the body, with that of the animal of *Miliola*, that I cannot see any ground for separating (as M.M. Claparède and Lachmann have done) the Gromida from the Foraminifera proper. Thus I am led to regard *Gromia* as the unilocular type of the imperforate series; holding the same place in it that *Lagena* and *Orbulina* do in the perforated.

The family *Miliolida* includes an extensive range of generic forms, from the simple undivided *Cornuspira* (the *Spirillina foliacea* of Prof. Williamson) to the highly complex and minutely-subdivided *Orbitolites*. But all these forms are so intimately united with each other, as to constitute an extremely natural assemblage. They all agree in the possession of an imperforate calcareous shell, the substance of which is "porcellanous," being opaque-white by reflected light, and brownish-yellow when sufficiently thin for light to be transmitted through it. The wall of this chamber is simply joined on to that which preceded it, so that the septa between the cavities of adjacent chambers are *single*, being composed merely of the portions of the walls of the older chambers, which are embraced by the newer. The communications between the successive chambers, and between the last chambers and the exterior (whether formed by a single large aperture as in *Miliola*, or by the multiplication of smaller pores as in *Peneroplis*,) are very free; having to give passage not merely to stolons which are subservient to the multiplication of segments, but to bands of sarcode-substance large enough to transmit with facility, to the segments that are furthest removed from the exterior, the nutrient materials obtained by the pseudopodia which issue from the last alone. Neither "intermediate skeleton," nor "canal-system" for its nutrition, presents itself in the Foraminifera of this family; although a sort of representation of it exists in the most complex form of that very aberrant type *Dactylopora*, which, in addition to the aggregate of separate chambers, has a deposit of solid shell-substance, traversed by a regular system of passages that has no communication with the chambers, but seems to have been in connection with a sarcode-body *outside* of them.

We occasionally find among the *Miliolida* that the surface of the shell is formed of arenaceous particles; but these are embedded in a cement formed of the proper shell-substance, which is never wanting; and the close accordance in every other character between shells which are thus superficially altered and such as conform to the ordinary type, forbids our regarding the former as more than *varietally* distinct from the latter. The case is very different, however, with regard to certain genera in which the power of forming a proper shell seems to be altogether wanting; the testaceous envelope being essentially composed of substance directly derived from without, the only material furnished by the animal being the organic glue that holds them together. Their substance is generally composed of a very fine cement in which coarser particles are imbedded; the former sometimes predominating, so that the shell is smoothed off on the surface; whilst if the latter be in excess, the surface of the shell is rough. Of this family the genus *Lituola* is the most characteristic; and the variety of forms into which it passes, several of them so closely resembling those of other genera as to have been mistaken for them, would not be readily conceived by any but such as have made a special study of them.* In the genus *Trochammina* (Parker and Rupert Jones) we have an instance of a gradational transition from the monothalamous to the polythalamous type; for whilst its lowest form is a continuous vermicular spiral (the *Spirillina arenacea* of Prof. Williamson), this comes to present, in some instances, a degree of segmental division scarcely inferior to that which some of the most vermiculate forms of *Rotalia* are reduced. The genus *Valvulina* forms the transition between this group and the "perforated" series; for whilst the principal part of its "test" is uniformly made up of an aggregation of sandy particles, leaving no such pores for the exit of pseudopodia, as can be readily discerned in the arenaceous *Textulariæ*, this has a basis of true shell-substance in which pores can be distinguished.

In the whole of the sub-order Perforata, the shell is calcareous, and is formed of a dense *hyaline* or *vitreous* substance, which is traversed by tubuli running straight from the cavity of the chambers to the external surface, whose diameter usually ranges from 1-3000th of an inch (as in *Rotalia* and *Planorbulina*) to less than 1-10,000th (as in *Operculina* and *Cycloclypeus*). There can be no question that even the smallest of these tubuli are large enough to transmit the finest threads into which the protoplasmic substance may sub-divide itself: and looking to their remarkable continuity through successive layers of shell substance, when (as in *Operculina*) the earlier whorls are completely embraced by the later, there can, I think, be no reasonable doubt that, through their means, a direct communication is maintained between even the earliest and innermost segments and the surrounding medium.† This, of course, renders the successive

* My knowledge of these arenaceous types has been entirely obtained through the kindness of Messrs. Parker and Rupert Jones.

† The finely tubular shell-substance of *Operculina* and its allies presents a very striking resemblance to dentine in everything except the ramification of the

segments much more independent of one another, than they are in the porcellanous type; and their isolation is marked by these two important peculiarities in the structure of the shell,—first, that each segment has its own complete wall, so that the septa between successive chambers are *double*,—and second, that the apertures of communication through the septa are far smaller than in porcellanous shells, as is seen in comparing a *Vertebralina* or *Miliola* with a *Nodosaria* or *Cristellaria*, or, in the unilocular types, on comparing the aperture of a *Gromia* with that of a *Lagena*. It is in this type alone that we meet with an "intermediate skeleton" nourished by a "canal system" that is connected with the cavities of the chambers; although this feature is wanting in the lower types of the series, yet its presence in the higher, most strongly differentiates them from the forms of the porcellanous type to which they bear the closest resemblance. In certain genera of this as of the porcellanous series, we find the surface of the shell occasionally roughened by the adhesion of arenaceous particles; but these are imbedded in true shell-substance, which is never wanting; and as the very same forms may be altogether free from arenaceous deposit, its presence is obviously not essential but is (so to speak) accidental, and constitutes no ground for even specific distinction.

As the texture of the shell throughout the whole of this series is essentially the same,—the variation in the diameter of its tubuli being the only difference of any mark,—we have not the same easy means of subdividing the Perforated group into families as we possess in the case of the Imperforate; and this division must consequently be based on the aggregate of characters supplied by the coarseness or firmness of the tubuli, the mode of communication between the chambers, and the general plan of growth. To enter into details upon these points would be foreign to my present purpose, which has been merely to set forth the *general results* at which I have arrived; and these I now offer to the criticism of such Naturalists as interest themselves in the study of the group to which they relate.

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tubuli; and it comes to be a very interesting inquiry what relation there may be between these two substances as to the mode of their formation. There is reason to consider the shell-substance of the Foraminifera as an excretion from the protoplasmic mass of which the body itself is composed; just as the cellulose wall of the vegetable cell, which may be consolidated by carbonate of lime (as in Corallines) or by silex (as in Diatoms) is an excretion from the contained endochrome. The new lamellæ of shell successively added to the *external* surface of the preceding, in cases in which the spiral lamina of each new whorl completely invests the old, would block up its pores, if the continuity of the tubuli were not maintained by the extension of the pseudopodia through the freshly consolidating substance, and this, by moulding itself upon the pseudopodia that issue from the orifices of the subjacent surface, will itself be rendered tubular, and will continue to allow the passage of the pseudopodia from the earliest chambers through the last formed layer of shell. And I would suggest it as a subject for inquiry whether in the formation of dentine and other calcified tubular tissues of higher animals, the tubular structure is not really the result of the consolidation of an excretion-substance around filamentous prolongations of the active protoplasmic substratum from which it is exuded.

XLVIII.—On Certain Points in the Anatomy and Physiology of the Dibranchiate Cephalopoda. By Albany Hancock, Esq.

[Read at the Meeting of the British Association, September, 1861.]

I propose, on the present occasion, to give some results at which I have arrived respecting the anatomy and physiology of the Dibranchiate Cephalopods; whose structure I have been engaged investigating for some time past. My observations will be confined almost entirely, to the so-called water system and to the blood system; and on these points I shall speak as concisely as possible, reserving for some future opportunity detailed accounts of them, when I hope to be able to lay before those interested in such subjects a memoir treating on the general anatomy of this order of the Cephalopoda.

First, then, with regard to the so-called water system. In the *Octopodidæ* this consists of five chambers; namely, two large chambers, containing the venæ cavæ; two small lateral ones, which open into the above, and which communicate by long slender tubes with the fifth, the posterior or "genital chamber," which always contains the special genital organ, the ovary or testis, according to the sex.

The two first-mentioned chambers lie along each side of the median line, separated by a membranous partition, and immediately within the abdominal wall. The liver lies in front of, and above, the ovary or testis behind them. Each opens into the branchial chamber by a nipple-shaped orifice placed near to the root of the gill. These two chambers contain the two venæ cavæ, with their glandular appendages. The convoluted or upper portion of the intestine, and a limited portion of the branchial hearts, also project into these cavities. Over all these organs the membranous wall of the chamber is reflected; but on the glandular appendages of the venæ cavæ it is scarcely, if at all, demonstrable. I shall uniformly designate these the "renal chambers," as they always contain the venæ cavæ with their glandular appendages, which latter undoubtedly perform, in whole or in part, the function of a kidney, as is now generally admitted.

Besides the external nipple-shaped openings already specified, there are other two orifices leading into these chambers. These orifices are situated in the dorsal wall of the chamber, close to the base of the nipple-shaped orifices; and establish a communication between the renal chambers and two small, elongated cavities placed between the wall of the former and the lateral walls of the abdomen. These orifices are also somewhat nipple-formed, with the lips opening outwardly, or into the renal chambers, and are placed at the anterior extremity of the small chambers; the other extremity, which is somewhat enlarged, abuts upon the branchial heart, and encloses within it the so-called "fleshy appendage" attached to that blood-propelling organ. The interior of these small chambers is longitudinally and irregularly laminated, with the surface of a glandular appearance, and a long, delicate tube connects each with the chamber containing the genital organ.

The genital chamber contains only the genital organ, whether ovary or testis, which is attached to the anterior wall of the chamber; the wall being reflected over the organ, as is clearly seen at the point of attachment. The membranous wall, however, very soon becomes so completely incorporated with the organ as to be no longer demonstrable. In the female, there are two ovarian outlets from this chamber, as well as the two already noticed as communicating with the small lateral chambers. In the male, there are three outlets only, two leading to the same small lateral chambers, and one into the vas deferens.

Thus it appears that all these so-called aquiferous chambers open externally, through the nipple-formed orifices situated in the branchial chamber. But, as might be expected, they have no direct communication with the blood system; at least, I have hitherto failed to discover any.

In the *Loliginidæ* we find these chambers considerably modified, and reduced to two in number,—the renal and genital. The former is no longer divided into two by a longitudinal median septum, but forms one large continuous cavity—the pericardial of most writers; though it never contains the heart, so far as I have observed. In this group, however, it holds, in addition to the venæ cavæ and their glandular appendages, the hepatic ducts, with their attached pancreatic glands. This is the case in *Loligo sagittata*, *L. media*, *Onychoteuthis Lichtensteinii*, *Sepia officinalis*, *Sepiola Rondeletii*, and *Ommastrephes todarus*. In this last, the lower portion of the intestine and the greater part of the ink-bag, and in *Sepia*, one half of the stomach and the whole of the spiral cæcum, are also lodged within this chamber. And, in all the species, a small portion of the branchial hearts likewise protrudes a little into it. The nipples, which bring this chamber into communication with the branchial chamber, are placed further forward than in the *Octopodidæ*.

The genital chamber is very much increased in dimensions in this group, occupying the whole of the abdomen from the liver backwards to the end of the tail. It contains, besides the testis or ovary, with the single exception above alluded to, the stomach and cæcum; also the branchial hearts and their appendages, a small portion of the hearts only protruding into the renal chamber, as already noticed. The latter organs are placed in two recesses, situated at the sides towards the anterior end of the cavity, and which communicate freely with the chamber.

All these organs are covered with the membrane forming the wall of the chamber, which is reflected over them in the manner of a peritoneum; but it is not easily demonstrable, except at the points where the various organs are attached to the wall, and there it is always seen doubling back upon them. It is thus distinctly visible on the stomach, over which it passes backwards, forming a fold carrying the blood-vessels and nerves, which fold unites this viscus to the anterior extremity of the genital organ. The latter is also attached to the posterior extremity of the chamber by the same membrane in *Ommastrephes* and *Loligo;* but in *Sepia* and *Sepiola* this extremity is free.

There are two oviducts in *Ommastrephes;* all the other species that I have dissected have only one, which is situated on the right side. They open through the lateral walls of the chamber, and lie apparently, between these walls and that forming the boundary of the abdomen. The male intromittent organ, which is always single, is situated on the right side, and the vas deferens communicates with the chamber by a small orifice opening through the wall of the same side.

Besides the genital outlets, there are other two, as in the *Octopodidæ*, which bring this chamber into communication with the renal cavity. Here, however, in the place of long, fine, duct-like tubes, there are short, wide, flattened channels, which pass from the sides of the chamber in front, and dipping downwards and forwards, between the wall of the body and that of the renal chamber, open into the latter immediately behind the nipples that communicate with the branchial chamber. These channels, which open into the renal chamber by slit-formed orifices, remind us of the manner in which the ureters open into the bladder in the higher animals.

There can be no doubt that the genital chambers in the two groups are homologous. The fact that, in both, they always contain the special genital organ—that the excretory channels of these organs always open into them in the same manner—and that they are always in communication with the renal chamber, sufficiently establishes this relationship.

The two additional, small, lateral chambers in the *Octopodidæ* are nothing more than enlargements on the channels of communication between the two chambers. Indeed, the chamber in the *Loliginidæ* differs from that in the *Octopodidæ* chiefly in the fact, that the former contains, in addition to the special genital organ, the stomach and cæcum; these organs, in the latter, being placed in what M. Edwards, in the "Voyage en Sicile," première partie, p. 123, designates the visceral or abdominal chamber; which in the *Loliginidæ* is either wholly or in part wanting. These digestive organs are therefore developed backwards, and are consequently thrust, as it were, into the genital chamber, bulging in its anterior wall, which becomes reflected over them in the manner we have seen.

The true nature of these chambers is a matter of no little interest. We have seen nothing to warrant the idea that they are directly connected with the vascular system, and certainly nothing to prove that they are for the purpose of receiving water from the exterior; but rather, on the contrary, that they form part of an apparatus for ejecting from the system the effete, nitrogenous, or urinary matters, and along with them the redundant fluids. But we must reserve further remarks on this subject until we have taken a glance at the vascular system.

According to Milne Edwards, the blood system in these animals is incomplete, as it is in all other mollusks. And in proof of this, a large sinus, or lacune, is referred to in the *Octopodidæ*, which is asserted to be the homologue of the abdominal or visceral chamber usually observed in the Mollusca. This sinus is situated on the dorsal region of the body, and extends nearly the whole length of the animal. It is divided by constrictions into three compartments; the anterior, or buccal, the median, or œsophageal, and the posterior, or gastric. With the exception of the anterior portion, which lies in the midst of the fleshy mass forming the base of the arms, this compound sinus is placed between the liver and the wall of the body. The posterior division communicates with the median portion by an orifice, not much wider than is sufficient to allow of the easy passage of the lower extremity of the œsophagus, or crop. It contains the gizzard, the spiral stomach or cæcum, and the hepatic ducts. The gastric organs are suspended in the centre of this chamber by a sort of mesentery, which is perforated, so as to allow the free circulation of the blood which flows in this great sinus. The median division holds within it part of the œsophagus, the crop, the posterior salivary glands, and the aortic trunk. It is much and suddenly constricted in front, on its passage through the nervous collar to join the anterior, or buccal division, within which are found the anterior portion of the œsophagus, the buccal organ, and the anterior salivary glands.

The whole of this great sinus is lined throughout by a membrane, the peritoneal membrane of Milne Edwards, which is reflected upon all the organs it contains; and the mesentery, before alluded to, is formed by a duplicature of this same membrane. It is also seen distinctly forming a sheath to the aorta, which floats freely in the centre of the cavity, and it can be readily traced on all the organs, though it is for the most part incorporated with their tissues, so as to be scarcely, if at all, discernible.

Three branches from the venæ cavæ open into this great blood sinus; two into the posterior, and one into the median portion. The latter opens on the right side of the œsophagus, behind and close to the point where the aorta enters the chamber.

Now, the lining membrane of the sinus is continuous with that forming the wall of these trunk veins: and it is almost impossible to resist the conclusion that the great sinus results from the expansion and fusion of these venous trunks. Indeed, I should have been much inclined to adopt Delle Chiaje's conclusion, alluded to by Milne Edwards, that this is a veritable venous sinus, even had nothing else turned up to elucidate this interesting point: we have evidence, however, which appears sufficient to set this matter at rest.

Milne Edwards says that in the Calmars, or those Cephalopods with ten tentacles, the abdominal sinus has entirely disappeared, and that the lacunary portion of the circulation is in them confined to the head. So far as I have yet examined the genera *Loligo* and *Sepia*, it appears that the abdominal portion of the great blood sinus is really wanting, as is asserted by this distinguished French anatomist; but in *Ommastrephes todarus* this is not the case, the middle portion of the sinus still existing in a modified form. The posterior division has certainly disappeared, and with it the two posterior venous trunks which pass from it to the venæ cavæ. The anterior venous trunk is, however, present, and passes forward by the side of the aorta, and with it ascends until it reaches the dorsal surface of the liver, exactly as it does in the *Octopodidæ*. The two vessels then run along for a short distance by the side of the œsophagus, when the venous trunk suddenly expands, and, enclosing that tube within it, forms for it a wide sheath. In this state, with the aorta imbedded in the wall of the sheath, the œsophagus and vein reach the salivary glands, when the vein or sheath again expands, and forms a pouch for the reception of these organs. The œsophageal sinus thus formed, and carrying within it the œsophagus, salivary ducts, and buccal branches of the aorta, passes through the nervous collar, and becomes continuous, in the usual way, with the anterior or buccal division of the sinus.

Here, then, we have a modified visceral sinus; and so modified, that its true nature is patent enough. In the first place, it cannot be doubted that this is the homologue of the so-called visceral chamber in the *Octopodidæ;* or, rather, of what has been termed the œsophageal or median division of it. It contains the same organs, is situated in the same position, and communicates in like manner with the anterior or buccal division of the sinus and with the left vena cava. I have just said it contains the same organs. The aorta, however, might be supposed to be an exception to this; but as it lies apparently *in* the wall of the sinus, and not merely attached to it, it may be considered to rest virtually within the sinus,—the wall of the sinus itself, as in the *Octopodidæ*, being reflected over it.

This modified visceral sinus lies packed in a rather loose areolar tissue, but can be easily isolated; so that no doubt can exist as to the fact, that its wall is really an expansion of that of the venous trunk, which communicates with the vena cava. And thus we arrive at the conclusion that the so-called visceral chamber in the *Octopodidæ* is a veritable venous sinus, with its own proper wall.

As this so-called abdominal or visceral cavity is the only hiatus in the vascular system, pointed out by Milne Edwards, we might perhaps assume, since we see that this is really a venous expansion, that in these animals we have a completely closed blood system, with proper walls throughout. There is one point, however, which appears still to require elucidation before we can finally adopt this conclusion. The existence of capillaries has not yet perhaps been sufficiently demonstrated. Milne Edwards apparently believes in their presence; but he has not described them, neither are his figures satisfactory on this point. And I am sorry that I cannot myself speak to the fact with sufficient confidence; but as I have succeeded in injecting a minute network of vessels on the stomach in one instance, and that not under the most favourable circumstances, I cannot doubt that the peripheral portion of the vascular system is as complete as the central, and that I shall be able to demonstrate this so soon as I shall obtain suitable and fresh specimens. Neither must we forget that Kölliker (Entwickelungsgeschichte der Cephalopoden), states that he has observed capillary vessels in the embryo of *Sepia*, and that H. Müller describes them. We may therefore, I think, fairly assume, for the present, that the vascular system is throughout supplied with proper walls. And here the question naturally arises, How then does the chyle enter into the circulation?

From whatever point of view we look at this important question, we find it beset with difficulties. Supposing, for instance, that we adopt the opinion of Milne Edwards, that the great dorsal blood sinus is nothing more than a visceral chamber, more or less developed, forming an extensive hiatus in the continuity of the vascular system, it is not easy to see how the chyle could find its way into this reservoir, even were it devoid of walls. In those mollusks which have the intestine floating in the visceral chamber, the chyle may be supposed to exude through the walls of that tube, and thus at once pass into the circulation. But in the *Cephalopoda* the intestine is not so situated. On the contrary, it is placed on the ventral, or opposite side of the body, having the liver above it. It is not, however, in contact with that viscus, but is separated from it by a stout muscular membrane, which entirely cuts the intestine off from all communication with every portion of the so-called visceral chamber. In fact, in most of the *Loliginidæ*, the greater portion of the intestine is placed, along with the great cephalic vein and duct of the ink-bag, in a confined space, bounded above, by this membrane, below, by the external wall of the abdomen, and behind, by that of the renal chamber: in front, the space is closed by the coalescence of the said membrane and the abdominal wall. And here the intestine lies closely packed in juxta-position with the above-mentioned organs; the whole being bound together and firmly attached to the surrounding walls by areolar tissue. In the *Octopodidæ*, the intestine is also to a great extent similarly situated; but the convoluted portion is thrust further back between the wall of the renal chamber and that of the right side of the abdomen. How, then, the chyle is to find its way from the intestine to the so-called visceral chamber it is impossible to say. Milne Edwards does not explain how this is effected: on the contrary, his injections prove that the visceral chamber is bounded by a wall, and is entirely cut off from the space in which the intestine is placed.

The difficulty is not much lessened by assuming the absence of capillaries; for nearly all the viscera, whose veins might be supposed to take up the chyle mingled with the extravasated blood, are confined in chambers which are equally cut off from the space in which the intestine is placed. The venous radicles of the abdominal walls in the vicinity of the intestine might possibly absorb the chyle; but the anatomy of the parts shows nothing to warrant such an opinion.

After weighing this point with much care, I am forced to the conclusion, which must have been generally adopted when the vascular system in the Mollusca was thought to be complete, that the absorption is effected through the instrumentality of the intestinal veins themselves, which are amply provided, and are every way suitable, for such a purpose. There are usually two or more such veins; and in the *Loliginidæ* they are placed symmetrically, on each side of the alimentary tube, and have the portions which lie within the renal chamber covered with glandular appendages, similar to those that garnish the venæ cavæ. They always open into the venæ cavæ, or into the great cephalic vein, close to the point where the latter gives origin to the former, and are richly provided with twigs.

Now, it would seem that it must be through the agency of the capillaries of these vessels that the chyle, or nutritive fluid, finds its way into the circulation. These capillaries probably penetrate to the folds of the mucous membrane that lines the intestinal tube, and there assuming the office of lacteals, in addition to that of veins, take up, by a species of endosmosis, the nutritive products of digestion. Or, it may be that, spreading out over the surface of this portion of the alimentary tube, they there meet with and absorb the exuded chylous fluid.

There is nothing that should startle us in the idea that these veins act in a double capacity, for everywhere throughout the animal kingdom we observe one and the same organ performing several functions, until the division of labour in organic life is fully consummated. And in the embryo of the higher animals the absorption of the nutritive matters is actually effected by the sole agency of the vascular system. Thus, in the embryo of the fowl, the yolk is absorbed by the blood-vessels of the germinal membrane; and the nourishment of the mammalian embryo is accomplished by the aid of the vascular tufts of the umbilical vessels, which likewise absorb the required oxygen from the blood of the parent. So that, in the latter case, these blood-vessels do not only act as lacteals, but also perform the function of lungs.

The chyle, then, in the *Dibranchiate Cephalopoda* appears to be absorbed in this way by the intestinal veins, and to be poured by them, mixed with the blood coming from the intestinal tube, into the venæ cavæ, and there commingled with the blood returning from all parts of the system, to be subjected, on its way through the branchial hearts to the aerating organs, to the action of the renal follicles.

These hearts are of a very peculiar appearance; so much so that their cardiac nature has been denied. Their walls are exceedingly thick, soft and spongy, and are composed, for the most part, of nucleated granular cells. On this account they are considered by some anatomists to be glandular organs,* which undoubtedly they are; but it is erroneous to assert that they "contain no trace of muscular fibres." Such fibres assuredly exist, and are most plentiful, lining the inner surface of the cavity, where they form numerous circular meshes of various sizes, bordering the orifices of the channels, that permeate the substance of the organ in all directions. Fibres, also, pass in every direction through the glandular mass of the walls. There can, therefore, be no question as to their being blood-propelling organs, though they are at the same time glandular.

Attached to these curious compound organs are the so-called "fleshy appendages" before alluded to, the true nature of which is still an enigma. They are usually of a rounded form, smooth externally, with the interior cavernous, wrinkled, and irregularly laminated. They are attached to the heart by a short, constricted peduncle and, on the opposite surface, there is an irregularly-formed opening, leading into the interior. The walls of the organ are composed almost entirely of a soft, tender parenchyma, formed, for the most part, of vascular ramifications, the trunks of which, three or four in number, communicate with the interior of the branchial heart, through the peduncle. The walls of these trunks and of the peduncle are composed of stout, tough membrane. The cavity of the appendage does not communicate with that of the heart, but opens, as we have seen, externally, or into the chamber within which the organ is placed, so that the fluid surrounding it will bathe its inner as well as its outer surface.

On examining microscopically, the membrane lining the inner surface, it is seen to be covered with minute, obtuse, cylindrical papillæ, filled with very small granular cells.

Difficult as it has been to determine the anatomy of this organ, it is still more so to assign to it its proper function, though it is evidently of much importance in the economy of these animals. We have seen, in the *Loliginidæ*, that these appendages lie within the great genital chamber, and are bathed by the fluid therein contained. And where, as in the *Octopodidæ*, this chamber is modified, there is a special apparatus provided, by means of which the appendages are still kept in contact with the fluid coming from that chamber. They therefore appear to have some relation to this fluid, the nature of which it becomes of importance to examine.

But first as to the genital chamber itself, and the others associated with it. In the *Octopodidæ*, as we have seen, there are five of these chambers, and only two in the *Loliginidæ*. These two, however, are homologically equivalent to the five in the former; which are made up by the renal chamber being divided by a septum, and by the two small additional, lateral chambers containing the cardiac appendages, the lateral chambers themselves being nothing more than

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* Anatomy of the Invertebrata, by C. Th. v. Siebold, translated by W. J. Burnett, p. 292.

developments of the passages connecting the genital with the renal chamber.

As the glandular appendages of the venæ cavæ are now generally acknowledged to be of a renal nature, the office of the chamber containing them is, apparently, to receive the urine as it is secreted, and then to expel it through the nipple-shaped orifices situated in the branchial chamber. And the genital, which we have seen communicates with the renal chamber, may be looked upon as an extension of the latter; the same membrane undoubtedly forming the walls of both chambers. In the renal chamber proper this membrane is in part specialized, forming the glandular appendages attached to the venæ cavæ, the blood channels themselves only supplying the vessels that permeate these organs. The effete, nitrogenous and more solid matters of the urine are probably eliminated by these glandular appendages, which take upon themselves the function of the urinary tubules of the kidneys of the higher animals; while the other great chamber, the genital, receives the fluid, perhaps little more than water, that may be supposed to flow from the arterial capillaries of the various organs placed within it. Assuming this to be the case, then this chamber will be related functionally to these capillaries as the capsule of the malphigian tuft is to the capillaries of the tuft itself. The fact appears to be, that the kidney in these, as in most other mollusks, is diffused, or not fully specialized; but nevertheless here, as in the higher animals, the more solid products of the urinary secretion are abstracted by the agency of secreting cells, and the fluids principally by the action of mere capillary blood-vessels.

This, then, is apparently the primary function of these so-called water chambers; but lymph may also be supposed to escape into them during the act of nutrition, and mingle with their fluid contents. This, however, is perhaps more strictly the case with regard to the genital chamber, in which the fluid is probably little else than lymph and pure water; the valvular nature of the orifices connecting this chamber with that containing the glandular appendages preventing the fluids of the latter passing into the former. The deleterious urinary matters are consequently always confined to the renal chamber proper.

Now we have seen that the cardiac appendages are always bathed by this fluid, both externally and internally, however the parts may be modified; that their lining membrane is raised into folds and wrinkles, which are clothed with minute papillæ, thus giving great increase of surface; that the papillæ are filled with granular cells, and are in connexion with a highly vascular parenchyma, and that the trunks of the vessels permeating this parenchyma, open into the branchial hearts. It is therefore evident, from the structure of these enigmatical organs, that they are well calculated for the selection and absorption of fluid matters. I would suggest, then, that we see in these cardiac appendages an apparatus for the return to the system of the extravasated lymph that may have escaped into the genital chamber, and that consequently we have here a rudimentary form of the lymphatic system.

This suggestion is to some extent corroborated by the nature of the branchial hearts, into the midst of the glandular walls of which the lymph is apparently thrown, and there probably undergoes some assimilating influence, on its passage into the circulation, like that which is supposed to be exercised by the spleen, and the other glandular appendages in connexion with the lymphatic system of the higher animals.

It would thus appear that these so-called water chambers form a diffused kidney, having, probably in connexion with it, a rudimentary lymphatic system. It is, however, generally believed that they receive water into their cavities from the exterior; but it is not easy to conceive for what purpose the raw element should be thus admitted to bathe the surfaces of the various delicate organs that lie within these cavities. There is nothing to give colour to such an opinion, except the fact that the renal chamber opens externally; and yet it would have been rather extraordinary if no such orifice had existed to admit of the escape of the urine. And, moreover, it is evident that this opening, which is, so far as my experience extends, always more or less nipple-formed, is ill calculated for the ingress of fluid, while, on the contrary, it is perfectly adapted for its egress. The same is the case with regard to the passages of communication between the renal chamber and the other portions of this so-called water system. This is most strikingly so in the *Loliginidæ*, in which it would seem impossible for the fluid in the renal, to pass in a backward direction into the genital chamber; though the passages are most admirably formed to allow the flow of the fluid in the opposite direction,—the tubes connecting the two chambers opening into the renal chamber, much in the same manner as the ureters do into the bladder of the higher animals.

Neither have I yet been able to satisfy myself of the existence of any water canals, or system of water chambers, opening externally in the neighbourhood of the head or tentacles. Some writers appear to have taken the olfactory openings for orifices leading into such aquiferous passages or chambers, and probably some of the other openings described, are nothing more than mucous pores. But this branch of the subject requires further investigation.

Before concluding, one or two points of detail may be mentioned in connexion with the vascular system. With regard to the heart, I can find nothing deserving the name of pericardium. The renal chamber has been so designated; but, as we have seen that the heart is never placed within it, this is evidently a misnomer. The heart, in some of the *Loliginidæ*, lies within the genital chamber, but is not enclosed in a special receptacle. The membrane, forming the wall of the chamber, is apparently reflected over it, though it is so completely incorporated with the surface of the organ as not to be demonstrable. In the *Octopodidæ* the heart lies in the cellular tissue, between the renal and genital chambers, and is more or less enveloped by the wall of the former: but here, as in the other group, there is no pericardial sac.

The heart itself is strong and muscular, and the fibres are of the striated kind. Those of the branchial hearts are also apparently striated, but the striæ are less distinct, owing perhaps to the state of preservation of the specimen examined. Striated fibre has likewise been observed in these parts by H. Muller.

The ascending aorta, on reaching the cranium, is divided into two nearly equal portions, each of which has, near its origin, a conspicuous bulbous enlargement. Numerous branches radiate from these bulbs, and are distributed to the brain, to the eyes, to the œsophagus, to the salivary glands, to the buccal organ, and to the arms. The branches that go to the buccal organ pass through the nervous collar; and that which supplies the arms goes so far along with them, and then penetrating through the pedal ganglion, passes to its outer surface, and so advances to its destination, giving off, as it goes, branches to the muscular wall of the buccal channel.

The arterial branches supplying the fins in the *Loliginidæ*, exhibit enlargements similar to those of the aortic branches, and the function in both cases is probably the same, though it is not very clear what it is. As they are muscular, however, they are probably for the purpose of regulating the flow of the blood to the respective parts, retarding it or pressing it onward, as occasion may require.

The most interesting point that I have observed in the nervous system is, that the surface of the brain of *Octopus vulgaris* displays distinct inequalities, having a considerable resemblance to the rudimentary cerebral convolutions of some of the lower Vertebrata. I have also, for the second time, observed that the brachial nerves originate in two centres, or rather, that in those species which have the pedal ganglions divided into two portions, these nerves have double roots which can readily be separated for a considerable distance from their origin.

It may also be stated, that, on a due analysis of the parts, the commissures and the ganglions, composing the Cephalopodous brain, can be clearly determined, and their homological relations with those of the lower mollusks ascertained. This being so, the difficulties with regard to the general homologies of these highly organised mollusks do in a great measure disappear. And it is satisfactory to know, that the results, thus obtained, agree with those derived from embryological and other data, as determined by Prof. Huxley.

In concluding these few somewhat hasty and imperfect remarks, on the structure and physiology of the Dibranchiate *Cephalopoda*, it will be well to take a glance at the results at which we have arrived, though in some respects they cannot be considered final.

The results, then, are as follows:—

First.—That the so-called abdominal or visceral chamber, in the Dibranchiate *Cephalopoda*, is a veritable venous sinus, formed by the expansion of venous trunks, and that it is provided with proper walls.

Second.—That, apparently, capillary vessels exist, uniting the arterial and venous branchlets; and that the blood system is composed of vessels and sinuses with proper walls, therefore constituting a closed system.

Third.—That the so-called water system, for the ingress of water from the exterior, does not exist; but that the chambers to which this function has been attributed compose a diffused kidney—the glandular appendages in the renal chamber being for the purpose of eliminating the peculiarly urinary matters, while the fluids pass off through the agency of the capillaries of the various organs that lie in the several chambers.

Fourth.—That a rudimentary absorbent system exists in these animals, the intestinal veins assuming, in addition to their own, the function of lacteals, and the so-called fleshy appendages of the branchial hearts acting, probably, in the capacity of a general lymphatic system.

Fifth.—That there is no pericardium properly so called.

Sixth.—That the muscular fibre of the systemic heart is of the striated variety, as is also apparently that of the branchial hearts.

Seventh.—That the cephalic arteries, and those supplying the fins, are provided with bulbous, muscular enlargements, probably for the purpose of regulating the flow of the blood.

Eighth.—That the surface of the brain of *Octopus vulgaris* exhibits inequalities resembling rudimentary convolutions, and that the pedal nerves arise by double roots; both conditions approximating to the higher standard of the Vertebrata.

Ninth.—That the results of analysis of the nervous system corroborate the deductions derived from embryology as to the homological import of the parts.

XLIX.—On Correlations of Growth, with a Special Example from the Anatomy of a Porpoise, by G. Rolleston, M.D., F.L.S., Linacre Professor of Physiology in the University of Oxford.

Philosophers of other countries have often taken occasion to remark, and in no complimentary terms, upon the utilitarian tendency constantly displayed by the English mind. Our everlasting seeking after hidden purposes, our infantine inquisitiveness after final causes in biological as well as other investigations, has frequently called forth contemptuous comments from foreigners, who happened to be acquainted with Bacon's famous comparison of final causes to vestal virgins. But in these latter days it has come to be acknowledged, even in England, that there are many structures in normal organisms for the existence of which no teleological explanation will suffice; and it is right to say that in no other country, and in no other time than ours, have theories for the explanation of such phenomena been more clearly enunciated. Our natural hankering after hypothesis, our constitutional craving after rationales, has called into use, if not into being, the several theories of adherence to type, of complemental nutrition, of genealogical, yet modified, transmission, and of correlation of growth.

The first of these theories has won with us not a little popularity; its antique dress, striking the eye, diverted the attention from the utter incongruity which exists between Platonic mysticism and modern science; and, appealing to our reverence for the dreams of our youth, it has lived longer, and made more converts than unassisted by the associations of the Academy it ever could have done. Even now it is fairly in the way of developing out of the larva stage of an Idolon Theatri into an Idolon Fori, a more active, elusive, albeit fragile, Imago. But a few years back, the joint empire of final and formal causes, of confederated teleological and morphological considerations, seemed firmly established in a country delighting in compromise; the legitimacy of the one, and the prescriptive right of the other, placed them, when united, in an apparently unassailable position. The appearance of the theory of complemental nutrition in a deservedly well-known work* caused men to accept of a triumvirate of ruling causes. Material causes counted for something as well as final and formal; Wolff's theory could suffice not only for the rationalization of many phenomena which Paley and Oken did explain, but also for the elucidation of some with which their philosophies were incompetent to deal. Mr. Paget's exemplifications of the law of complemental nutrition seem drawn exclusively from a class of cases of what I would call "heterogeneous growth." The evolution of the one structure has rendered possible the evolution of the other, by setting free some residual product which Nature in her economy has worked up into such secondary structure. The perfecting of the plumage contemporaneously with the perfecting of the sexual functions in the pairing bird is one, and may serve as a type of all, of the instances given by Mr. Paget. There is no equality in rank between the two structures, which stand to each other in this relation of complemental nutrition; the one is supported by what the other finds useless, superfluous, or even hurtful; after the production of the one the organism aims and labours, the other is but a "nebenprodukt;" they are heterogeneous in the same sense as the food of the hound and the food of his master, and often in a yet truer sense still.

The instances of Correlated Growths to which I am about to refer, and which from the dissection I shall detail, I hope to elucidate, differ from those classed under the head of Complemental Nutrition, in that both growths draw with equal right, and to an equal extent, upon the same store of nutriment. To the same stock of alimentary matters they stand in the same relation; they share and share alike either as joint consumers or joint elaborators of it. If we may coin a word from but second-hand Greek, and borrow one-half

* Paget Lectures on Surgical Pathology, Vol. 1, Lecture ii.

of our composite from our Anglicised word "tautologous," we would call these growths "tautogeneous." As just hinted, they admit of a two-fold rationale. The blood either needs, as in the case I shall proceed to detail, an excess of some material, or it possesses some material in excess over its requirements; in either case "tautogeneous" growths spring up, in the one case to elaborate, in the other to consume, that excess of material. The history of pathological tumours is but an illustration of the latter of these divisions. The severity of our struggle for existence has called into being so rigid a law of parsimony, as to render it difficult to give illustrations of this class of tautogeneous growths from physiological nutrition. But though difficult, it is not impossible. I proceed to illustrate the former of these two divisions by an account of certain structures observed by me in a recent dissection of a young porpoise.

The animal was a young *Phocæna communis*, but it had attained at least fourth-fifths of its full size, weighing as it did 60 lbs. and being 47¼ inches in length.

On either side the aorta, just where it became free from the diaphragm, on passing into the abdomen, two elongated bodies were to be seen, lying in close contact with the posterior part of its calibre for a length of as much as three inches. Their width was about the fourth of an inch, and this width was maintained for their entire length. Their external surface was smooth, only a little lobulated at their upper end and internal margin. They possessed a readily detachable fibro-cellular capsule. They were reddish in colour, firm to the touch, on section at first homogeneous, but subsequently showing to careful inspection numerous orifices of cut vessels, though very little fibrous stroma. Their upper ends lay behind, and in contact with the posterior half of each supra-renal capsule. This relation will show that the structures in question could not have been abnormally persistent Wolffian bodies, which indeed further particulars will yet further prove.

These structures, when examined by the microscope, were seen to be all but wholly made up of such cells as we get from the Malpighian bodies in the spleen, or indeed from the cortical part of a lymphatic gland, namely, circular nucleated cells with granular contents, of a size somewhat less than that of a red blood corpuscle.

Functionally, these structures may be regarded as identical with lymphatic glands; morphologically, I consider them different; on account, first, of their symmetrically elongated tongue-like shape, all but entirely smooth and unlobulated, and secondly, on account of their encapsulation in an external coat of fibro-cellular tissue, and their want of such supporting elements within their parenchyma.*

* Though my dissection enables me to confirm the views put forth by Mr. Turner, it compels me to dissent from those anatomists who say there is nothing in the Cetacean economy to represent either the Vena Azygos or the Cowper's Glands of Human Anatomy.

There can at all events be no doubt that they were developed from the general formative mass of blastema, which surrounds the aorta in the fœtus, as described by Professor Goodsir;* and that therefore they were morphologically as well as physiologically to be classed with the thymus.† This gland, as well as the thyroid, was largely developed in this specimen, and the arrangement of the two glands coincided very exactly with the description given of them by my friend Mr. Turner.‡

The lymphatic glands generally throughout the body were largely developed; so largely, in fact, at either jaw angle, as to simulate the appearance of a large submaxillary gland.

The spleen was, as has been so often described, curiously multifid.

All of these ductless, all of these lymphatic, glands were richly supplied with blood vessels; all, alike and jointly, laboured at the elaboration of the constituent elements of the vast mass of this cetacean's blood. They enabled it thus to support a high standard of temperature in an excellent conducting medium, and they supplied all the calls for rich and refined aliment which a brain equalling in this case one-sixtieth of the weight of the entire body, made upon the nutritive fluids. They may be taken as illustrations of "tautogeneous growths" of the first of our two classes.

Many of Mr. Paget's instances of complemental nutrition, Mr. Darwin would explain as the results§ of hereditary transmission, with modification, and there can be little doubt that of the two hypotheses the latter will, to many minds, seem to suit the better with such instances as the four rudiments of nails on the fins of the Manatee, or the equally rudimentary teeth in the Ruminant's intermaxillaries, or of the representatives of the Polian vesicles in the *Arenicola.*

But many of Mr. Paget's instances cannot be brought under this head, and constituted as our minds are, we cannot but read them as he has done.

Mr. Darwin, on the other hand, himself‖ admits that there are many instances of correlated growths of which our reason can give no rationale, either as subserving ends, or as confirming to type, or as speaking of parentage, or as working up into structure what would else be waste and excretory; for which in other words it can assign neither final nor formal, nor material cause. I would instance in addition to those he brings forward, the correlations of growth witnessed in Morbus Cæruleus betwixt a malformation of the heart and

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* Phil. Trans. 1846, p. 638.

† In the common Shrew, however, two bodies are to be found, floating loosely in the abdominal cavity, but anchored each by a process of mesentery which is attached just where these bodies in the Porpoise lie fixed; and that they are connected with the lymphatic or rather with the lacteal system, an examination of a Shrew, which has died whilst digesting, will leave no doubt.

‡ Transact. Royal Soc. Edinburgh, Vol. XXII. Part ii.

§ Origin of Species, p. 453-454, 1st edit. pp. 486-487, 3rd edit.

‖ Origin of Species, pp. 145, 197, 1st edit.; pp. 162, 217, 3rd edit.

a clubbed adunque state of the finger nails, and in Morbus Addisoni betwixt disorganized supra-renal capsules and pigmentary skin discolouration. Unable to rationalize, we class such phenomena as these under the wide head of "Correlations of Growth." The very vagueness of the phrase prevents us from even momentarily deluding ourselves with the idea that it amounts to an explanation, and to more therefore than an expression, of facts. It cannot be accused of striving to conceal the flimsiness of its thought by a magnificent display of archaic words, as certain exchequers would fain conceal their bankruptcy from the world by a copious issue of paper money. Herein lies its great merit.

On a future occasion I shall consider the nature of the Hybernating glands, if so they may be called, of certain hybernating and non-hybernating Insectivora and Chiroptera, and the possibility of classing them as growths tautogeneous with the highly developed mesenteric and cervical lymphatic glands found in many of those creatures.

And, before concluding, I would mention yet another class of structures, the existence of which admits of being rationalized upon yet another principle. These structures, fixed and settled in the adult organism, speak of a time when the sex was as yet unfixed and unsettled in the developing embryo, and accessory organs of either kind were, if so we may say, prepared so as to be in readiness to meet either event. The mammary glands, the Weberian organ, and the cysts of Morgagni of the adult male, the round ligament and the canals of Nuck and of Gärtner of the adult female economy, may have the history of their existence thus read.

As more and more *vera causæ* assert their existence and vindicate their rights, the ancient realm of Archetypal Ideas will suffer more and more serious curtailment.* But, like other failing empires, it too will find its advocates to speak of it as being an "essentially conservative power;" though after short campaigns it has, once and again had to resign some of the fairest provinces in the world of thought, its existence will still be said to be necessary for the "preservation of the due balance of power" amongst rival biological principles.

Let us hope that in the interludes of Rhetoric the Logic of Facts may find a moment to make itself heard. It will teach men *mundum quærere non in microcosmo suo sed in mundo majore,* to hold of Nature that her ways are not as our ways, nor her thoughts as our thoughts. The notion of type may help man's weakness, but it by no means therefore follows that it regulates Nature's operations; it may enable us to colligate phenomena, but it may no more for that be the cause of their evolution than the mule's panniers which carry home the grapes are, by virtue of this their function, the cause of the growth of the vine.

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* Even in Mr. Herbert Spencer's "First Principles," we find at page 22, the following sentence. "In Biology we are beginning to progress through a fusion of the Doctrine of Types with the doctrine of adaptations," and Mr. Darwin, in the last page but one to which we have referred in his writings, speaks of "Homology coming into play" as a really efficient physical agent.

L.—The Kjökkenmöddings: recent Geologico-Archæological Researches in Denmark. By John Lubbock, Esq., F.R.S.

Denmark occupies a larger space in the history, than in the map, of Europe. The nation is greater than the country; and even if with the growth of physical power in surrounding populations, she has lost somewhat of her influence in political councils, still the Danes of today are no unworthy representatives of their ancestors. Many a larger nation might envy them the position they hold in Science and in Art, and few have contributed more to the progress of human knowledge. Copenhagen, indeed, may well be proud both of her Museums and of her Professors: and without attempting to compare together things which are essentially incomparable, we may, perhaps, especially point to the celebrated Museum of Northern Antiquities, as being most characteristic and unique.

For the formation of such a collection Denmark offers unrivalled opportunities. The whole country appears to have been, at one time, thickly studded with tumuli: where the land has not been brought into cultivation, several of them are often in sight at once, and even in the more fertile and thickly populated parts, the plough is often diverted from its course by one of these ancient burial places. Fortunately, the stones of which they are constructed are so large and so hard, that their destruction and removal is a laborious and expensive undertaking. As, however, land grows more valuable, or perhaps when the stones themselves become available for building or other purposes, no conservative tradition, or feeling of reverence for the dead, protects them from desecration: and it is estimated that not a week passes without witnessing the destruction of one or more tumuli, and the loss of some, perhaps irrecoverable, link in the history of our race.

Every barrow indeed, is in itself a small museum of Northern Antiquities, and the whole country even may be considered as a Museum on a great scale. The peat bogs, which occupy so large an area, may almost be said to *swarm* with antiquities, and Professor Steenstrup estimates that every column of three feet square contains some specimen of ancient workmanship. All these advantages and opportunities, however, might have been thrown away, but for the genius and perseverance of Professor Thomsen, who may fairly be said to have created the Museum over which he so worthily presides.

After careful study, the archæologists of Northern Europe have divided the history of their country into four great periods, and their collection into as many series. These four ages are known as the Stone, the Bronze, the Iron, and the Christian periods. Of the last I need here say nothing: nor does the Iron age immediately concern us, though it may be well to observe that it certainly commenced before the time of Christ and lasted until the introduction of Christianity into Denmark. The men of this period had long heads, and were, as well as the domestic animals, apparently more powerful than those of the preceding epoch. With the Bronze age we get beyond the reach of history and even of tradition. At first it appears remarkable that bronze should have been discovered before iron: but copper itself is found native, its ores are strongly coloured, and have a metallic appearance, while those of tin are black, very heavy, and easily smelted. On the other hand, iron ore, though very common, is not peculiar either in colour or in weight, and its reduction requires a very high temperature.

Before arriving, however, at a knowledge of bronze, it is evident that mankind must have passed through an age of copper, and the absence in Northern Europe of any evidence of such a fact (though a very few hatchets of copper have been found) is one among several reasons for regarding the acquisition of bronze, not as a discovery made by the men of the Stone period, but rather as introduced into Northern Europe by a new race. In fact, while mankind, during the earlier part, if not the whole, of the Stone period, appear (in Denmark, at least) to have been exclusively hunters and fishermen, with the Bronze age we find evidences of a pastoral and agricultural life, in the presence of domestic oxen, pigs, and sheep. It is probable that the men of the Stone period were conquered and partly replaced, by a more civilized race coming from the East. It is not only the introduction of bronze and of domestic animals which points to such a conclusion. The new people burned their dead and collected the bones in funeral urns. While, therefore, we have many skulls belonging to the Stone age, there is scarcely one, well authenticated, as appertaining to the Bronze: and though this custom of burning the dead deprives us of the assistance of osteology, it is in itself some indication of Eastern origin. The small size of the knife handles belonging to this period shows that, like the Hindoos of the present day, the men had small hands;* and, indeed, they appear to have been decidedly inferior to the Iron race which succeeded them.

On the other hand it must be confessed that the antiquities of Norway and Sweden, of Switzerland and of Ireland, indicate a different progress of civilization in these countries. Thus domestic animals were already known in Switzerland during the Stone age; in Northern Scandinavia bronze appears to have been much rarer and iron to have been discovered earlier, than in Denmark; while in Ireland the custom of burning the dead coexisted, according to Wilde, (though upon this point the evidence is not quite satisfactory), with the practice of interment and belonged to various periods, although in Denmark it appears to be confined to the Bronze and perhaps the commencement of the Iron age. These differences however will

* Mr. Wilde however suggests that these swords may have been used rather as daggers, and have been held by only three fingers. (Catalogue of Antiquities, p. 455.)

appear less surprising when we consider that, in more modern times, coins were struck in the South of England before the commencement of our era, while in Ireland none were made before the tenth century, so that London has had a coinage for more than twice as long as Dublin. For the present however I confine myself to Denmark, reserving the consideration of other countries for a future opportunity.

Two or three battle fields belonging to the Bronze period have been found, and have supplied a great number of interesting objects. It is curious, that besides dice of the common shape, some have been discovered which are elongated and cylindrical, a peculiar form which is still however used in some parts of India. Many of the spears had one or more nails driven into them, in a manner apparently useless, but Professor Thomsen observed the same thing in some spears from India, and ascertained that, in these, a nail was inserted for every enemy killed. Metal was, however, rare and precious, and therefore only used in instruments which could not easily be made from flint. The beautiful flint knives of the Stone period must have been extremely difficult to make. We cannot imitate them now, and even in those days, when they had such wonderful skill in working flint, a flint knife must have been made with great difficulty. Axes, on the contrary, were easily formed, and therefore stone was used for them long after the introduction of bronze, as is shown by the fact that while in the Museum at Copenhagen there are about 300 bronze swords, there are not more than 20 bronze axes. The arrow heads also were made of flint.

A confusion is sometimes made between the bronze of the true Bronze age, and that which is found together with iron. The former, however, is composed of about 9 parts of copper to 1 of tin, while in the bronze, or rather brass, of the Iron period, the tin is generally replaced by zinc, and the composition thus obtained is used only for ornaments; and though sometimes, as for instance in the umbos of the shields, it may form part of a weapon, it is never the cutting or striking edge, which is always formed of iron.

The number of objects belonging to the Bronze age, which have been found in Denmark is very remarkable, and together with the great differences apparent in the workmanship, indicate that the period was of great duration. The same appears to have been the case in Ireland, as in the great museum of the Royal Irish Academy there are six hundred and eighty-six of these weapons, and yet no two of them* were cast in the same mould.

Some of them are merely repetitions, in bronze, of the older stone weapons, as may very well be seen, for instance, in the British Museum; but, at what was perhaps a later period, the art had wonderfully improved, and the bronze instruments are more varied in form and more skilfully made. That they were cast, and

* Wilde's Catalogue, p. 393.

were of Danish manufacture is proved by the discovery of moulds, and in some cases of the "tags" formed in the hole through which the metal was poured.

With the Stone age we arrive at a time when the use of metal was altogether unknown in Denmark. The inhabitants supported themselves by hunting and fishing, and had no domestic animals, except the dog, nor so far as we are aware, any knowledge of agriculture.

Reduced thus to implements of stone, and fortunate in being able to obtain excellent flint, they attained to a rare skill in this art, and some of their flint spears and knives are wonderfully well made. The common form of flint axe, or celt, is represented in Pl. VII. *fig.* 1. These weapons though found elsewhere, are rare, except in Denmark, where they occur in the barrows of the Stone period. A few have been met with in England, principally in rivers, but our specimens seem to be generally narrower, with sloping sides, and arched above and below, while the Danish forms are flatter and with perpendicular sides. They were made by a succession of blows, and then the angles were ground down on sandstone blocks, several of which have been discovered. In this respect they differ from the celts found in the gravel beds at Amiens and Abbeville, which are always left angular. Smaller hatchets of stone are common in and to all countries. Some of the other objects belonging to this first great phase in the civilisation of Scandinavia are represented in Pl. VII. It might at first be doubted whether the triangular flint flake (*fig.* 7) was necessarily artificial. Similar flakes, however, either of flint or obsidian, have been and are still, used by savages in various parts of the world. They were made by taking an oblong stone and continually splitting off the projecting edges. Many obsidian flakes and one of the pieces from which they were struck may be seen in the British Museum, and I have represented in Pl. VII. *fig.* 6, a similar piece of flint from Denmark. The tombs of this period are chambers formed by enormous blocks of stone, so large that it is difficult to imagine how they can have been brought into position. The bodies were placed in a sitting posture, with their backs resting against the stones, and their knees brought up under their chins. When the tomb was intended only for one or two bodies it was small and the height was determined by the size of the stones forming the sides. Sometimes, however, a number were buried together, the tomb having, perhaps, served as a last resting place for a whole family. When this was the case the walls were formed by two rows of stones, and the space enclosed was much larger. In one that we visited the chamber was about 25 feet long by 10 broad, and there was a passage leading from the side to the exterior. The tomb was finally covered over by great slabs, and earth was heaped upon it, so as to form a mound, and a row of stones was placed round the edge. They are, therefore, quite different from the Barrows of the Bronze period which "have no circles of massive "stones, no stone chambers, in general no large stones on the bottom, "with the exception of stone cists placed together, which, however, "are easily to be distinguished from the stone chambers; they consist, as a general rule, of mere earth, with heaps of small stones, "and always present themselves to the eye as mounds of earth, "which, in a few rare instances are surrounded by a small circle of "stones, and contain relics of bodies which have been burned and "placed in vessels of clay with objects of metal."*

It would appear from the remains found near the lake habitations of Switzerland, that, though, during the Stone period, neither the goat, the sheep, nor the domestic ox can be proved to have existed in Denmark, they were already present in Southern Europe, but, even if the lake-habitations do not, as seems probable, belong to a period subsequent to that of the "Kjökkenmöddings," it is easy to believe that in many respects the inhabitants of these more genial countries may have been more civilized than their Northern contemporaries.

In addition, however, to the objects collected from the tumuli and the peat bogs, and to those which have been found from time to time scattered at random in the soil, the Museum of Northern Antiquities contains an immense collection of specimens from some very interesting shell deposits, which are known in Denmark under the name of "Kjökkenmöddings," and which were long supposed to be raised beaches, like those which are found at so many points along our own shores. True raised beaches, however, necessarily contain a variety of species; the individuals are of all ages, and they are, of course, mixed with a considerable quantity of sand and gravel. It was observed, however, in the first instance, I believe by Professor Steenstrup, that in these supposed raised beaches, the shells belonged entirely to full grown, or nearly full grown, individuals: that they consisted of four species which do not live together, nor require the same conditions, and would not therefore be found together alone in a natural deposit: and thirdly, that the stratum contains scarcely any gravel, but consists almost entirely of shells.

The discovery of rude flint implements, and of bones still bearing the marks of knives, confirmed the supposition that these beds were not natural formations, and it subsequently became evident that they were, in fact, the sites of ancient villages, the primitive population having lived on the shore and fed principally on shell-fish, but partly also on the proceeds of the chase. The shells and bones not available for food gradually accumulated round the tents, until they formed deposits generally, from 3 to 5 feet, but sometimes as much as 10 feet in thickness, and in some cases more than 300 yards in length, with a breadth of from 150 to 200 feet. The name Kjökkenmödding is derived from Kjökken, kitchen, and mödding (corresponding to our local word midding) a refuse heap, and it became, of course, evident that a careful examination of these accumulations would throw much light on the manners and civilization of the then population.

* Worsäae's Primeval Antiquities, p. 93.

Under these circumstances a committee was formed, consisting of Professor Steenstrup, the celebrated author of the treatise "On the Alternation of Generations," Professor Forchhammer, the father of Danish Geology, and Professor Worsäae, the great Archæologist: a happy combination, and one which promised the best results to Biology, Geology, and Archæology.

Much was naturally expected from the labours of such a triumvirate, but the most sanguine hopes have been fulfilled. Already several of the deposits have been carefully examined, and many thousand specimens have been collected, ticketed, and deposited in the Museum at Copenhagen. Both in themselves and in their relations to the discoveries made by M. Boucher de Perthes in the Valley of the Somme, these researches are of the greatest interest, and the results have been embodied in six Reports presented to the Academy of Sciences at Copenhagen.*

These reports, however, being in Danish have not received the attention they deserve, but M. Morlot† has published a very excellent abstract of them, to which I would refer all those who take an interest in the subject, and from which I have extracted many of the following details. Having had the advantage of visiting the pits at Amiens and Abbeville with Mr. Busk, Capt. Galton, and Mr. Prestwich, and of inspecting the admirable collection belonging to M. Boucher de Perthes, I was naturally very desirous of having an opportunity of comparing the flint instruments found in France with those which occur in Denmark, and I was so fortunate as to induce Mr. Busk to go with me to Copenhagen, he being specially anxious to study the collection of ancient crania, while my attention was more particularly directed to the contents of the Kjökkenmöddings. During the whole of our visit Prof. Worsäae was absent from the capital, and Prof. Forchhammer was also away for a great part of the time; Professors Thomsen and Steenstrup however were most obliging, and the latter at much personal inconvenience made an excursion into the country to show us the Kjökkenmödding, at Havelse, on the Isefjord, which is one of the most characteristic specimens of these ancient dust-heaps. We had already visited one at Bilidt, close to Fredericksund, but this is one of the places at which it would seem that the inhabitants cooked their dinners actually on the shore itself, so that the shells and bones are much mixed up with sand and gravel. At Havelse, on the contrary, the settlement was rather higher up, and the shells and bones are therefore unmixed with any extraneous substances. We started from Copenhagen soon after six, going to Röeskilde by rail, and then took the steamer down the Isefjord to Fredericksund, from which we drove to Havelse. At this place the Kjökkenmödding is of small extent, and appears to have

* Untersögelser i geologisk-antiquarisk Retning af G. Forchhammer, J. Steenstrup, og J. Worsaae.

† Etudes Géologico-Archéologiques en Danemark et en Suisse. Mèm. de la Société Vaudoise, T. vi. 1860.

surrounded a single tent, being in the form of an irregular ring, enclosing a space on which the tent or tents probably stood, and which is now occupied by a mill. In other cases, where the deposit is of greater extent, the surface is undulating, the greater thickness of the shelly stratum in some places apparently indicating the arrangement of the dwellings. These two settlements were by no means the only ones on the Isefjord; in the neighbourhood of Roeskilde, Kjökkenmöddings occur near Gjerdrup, at Kattinge, and Kattinge Værk, near Trallerup, at Gjershöi, and opposite the island of Hyldeholme; besides several farther north, others have been found on the islands of Fyen, of Moen, and of Samsoe, and in Jutland along Liimfjord, Mariagerfjord, Randersfjord, Kolindsund, and Horsensfjord. The southern parts of Denmark have not yet been carefully examined. Generally it is evident that deposits of this nature were scattered here and there over the whole coast, and that they were never formed inland. The whole country would appear to have been more intersected by fjörds during the Stone period even than it is now. Under these circumstances it is evident that a nation which subsisted principally on marine shellfish would never form any large inland settlements. In some instances indeed Kjökkenmöddings have been found as much as eight miles from the present coast, but in these cases there is good reason for supposing that the land has encroached on the sea. On the other hand, in those parts where Kjökkenmöddings do not occur, their absence is no doubt occasioned by the waves having to a certain extent eaten away the shore, an explanation which accounts for their being so much more frequent on the shores of the inland fjords than on the coast itself, and also deprives us of all hope of finding any similar remains on our eastern and south-eastern shores, though an examination of the western Coast would be very desirable. The fact that the majority of these deposits are found at a height of only a few feet above the sea appears to prove that there has been no considerable subsidence of the land since their formation, while on the other hand it clearly proves that there can have been no elevation. In certain cases, however, where the shore is elevated, they have been found at a considerable height. It might indeed be supposed that where, as at Bilidt, the materials of the Kjökkenmödding were rudely interstratified with sand and gravel, the land must have sunk, but if for any length of time such a deposit was subjected to the action of the waves, all traces of it would be obliterated, and it is therefore probable that an explanation is rather to be found in the fact that the action of waves and storms was greater then than now. At present the tides only affect the Kattegat to the extent of about a foot and a half, and the configuration of the land protects it very much from the action of the winds. On the other hand, on the west coasts of Jutland the tides rise about nine feet, and the winds have been known to produce differences of level amounting to 20 feet, and as we know that Jutland was anciently an archipelago, and that the Baltic was more open to the German Ocean than it is now, we can easily understand that the fluctuations of level may have been greater, and we can thus explain how the waves may have risen over the Kjökkenmödding at Bilidt (which is after all not much more than 10 feet above the water), without resorting to the hypothesis of a subsidence and subsequent elevation of the coast.

In the Lake-habitations of the Stone age in Switzerland, grains of wheat and barley and even pieces of bread, or rather biscuit, have been found.* It does not however appear that the men of the Kjökkenmöddings had any knowledge of agriculture, no traces of grain of any sort having been hitherto discovered. The only vegetable remains found in them have been burnt pieces of wood and some charred substance referred by M. Forchhammer to the *Zostera marina*, a sea plant which was perhaps used in the production of salt.

The four species of shells which constitute the greater portion of these deposits are in the order of their abundance—

The oyster, *Ostrea edulis*, L.
The cockle, *Cardium edule*, L.
The mussel, *Mytilus edulis*, L. and
The periwinkle, *Littorina littorea*, L.

all four of which are still used as food for man. Four other species occur more rarely, namely,—

Nassa reticulata, L.
Buccinum undatum, L. (the whelk)
Venus pullastra, Mont. and
Helix nemoralis (the snail).

It is remarkable that the specimens of these species are very well developed, and decidedly larger than any now found in the neighbourhood. This is especially the case with the *Cardium edule* and *Littorina littorea*, while the oyster has entirely disappeared, and even in the Cattegat itself occurs only in a few places, a result which may perhaps be partly accounted for by the quantities caught. Some oysters were, however, still living in the Isefjord at the beginning of the century, and their disappearance cannot be altogether ascribed to the fishermen, as great numbers of dead shells are still present; but in this case it is attributed to the abundance of starfishes, which are very destructive to oysters. On the whole, however, their disappearance, especially when taken in connexion with the dwarf size of the other species, is evidently attributable in a great measure to the smaller proportion of salt in the water.

Of Crustacea only a few fragments of crabs have hitherto been found. Fish bones, on the contrary, are frequent, the commonest being—

Clupea harengus, L. (the herring)
Gadus callarias, L. (the dorse)
Pleuronectes limanda, L. (the dab) and
Murena anguilla, L. (the eel).

* Troyon, Habitations Lacustres, pp. 43 and 427.

The remains of birds are highly interesting and instructive. The domestic fowl (*Gallus domesticus*) is "conspicuous by its absence." It is less surprising that the two domestic swallows of Denmark, (*Hirundo rustica* and *H. urbica*), the sparrow, and the stork are also missing. On the other hand, fine specimens of the capercailzie (*Tetrao urogallus*) which feeds principally on the buds of the pine, shows that, as we knew already from the remains found in the peat, the country was at one time covered with pine forests. Aquatic birds, however, are the most frequent, especially several species of ducks and geese. The wild swan (*Anas cygnus*, L.), which only visits Denmark in winter, is also found; but perhaps, the most interesting of the birds whose remains have been identified is the Great Auk (*Alca impennis*, L.), a species which is now almost extinct.

During our short visit to Havelse we found perhaps a hundred fragments of bone belonging principally to the following animals:—

The stag (*Cervus elaphus*, L.)
The roedeer (*Cervus capreolus*, L.)
The wild boar (*Sus scrofa*, L.)
The wild bull (*Bos urus* or *primigenius*) and
The seal (*Phoca gryppus*, Fabr.)

These are the commonest species, but the following also occur:—

The beaver (*Castor fiber*, L.)
The wolf (*Canis lupis*, L.)
The fox (*Canis vulpes*, L.)
The dog (*Canis familiaris*, L.)
The lynx (*Felis lynx*, L.)
The wild cat (*Felis catus*, L.)
The marten (*Mustela martes*, L.)
The otter (*Lutra vulgaris*, Erxl.)
The hedgehog (*Erinaceus europæus*, L.)
The water rat (*Hypudæus amphibius*, L.)

The Lithuanian auroch (*Bison europæus*) has been found, though rarely, in the peat bogs, but not yet in the Kjökkenmöddings. The musk ox (*Bubalus moschatus*) and the domestic ox (*Bos taurus*), as well as the elk, the reindeer, the hare, the sheep, and the domestic hog, are all absent. Remains of the two former will probably be ere long discovered. It may perhaps be inferred that the hares were spared in deference to the same superstition which preserved them from the ancient Britons, and which in Lapland and some other countries survives even to the present day.*

Professor Steenstrup does not believe that the domestic hog of ancient Europe was directly derived from the wild boar, but rather that it was introduced from the East, and the skulls which he showed us in support of this belief certainly exhibited very great differences between the two races. It is extremely unlikely that an animal so powerful and so intractable as the Urus appears to have been, can

* It is a curious fact that as Professor Steenstrup informs me, the bones from the Kjökkenmöddings of Jutland indicate as a general rule larger and more powerful animals than those of the Islands.

have been domesticated by these savages, and the condition of the bones themselves confirms the idea that they belonged to wild animals. The sheep and the reindeer being entirely absent, and the domestic cat not having been known in Europe until about the ninth century, the dog appears to have been the only domestic animal of the period; and though it may fairly be asked whether the bones may not have belonged to a race of wild dogs, the question admits of a satisfactory answer.

Among the remains of birds, the long bones which form about one-fifth of the skeleton are, in the Kjökkenmöddings, about twenty times as numerous as the others, and are almost always imperfect, the shaft only remaining. In the same manner it would be impossible to reconstruct a perfect skeleton of the quadrupeds, certain bones and parts of bones being always absent. In the case of the ox, for instance, the missing parts are the heads of the long bones (though while the shaft only of the femur is found, in the humerus one end is generally perfect), the back bone except the two first vertebræ, the spinous processes, and generally the ribs, and the bones of the skull except the lower jaw and the portion round the eyes. It occurred to M. Steenstrup that these curious facts might, perhaps, be referred to the dogs; and, on trying the experiment, he ascertained that the bones which are absent from the Kjökkenmöddings are precisely those which the dogs eat, and those which are present are the parts which are too hard and solid to contain much nourishment. M. Steenstrup called my attention to a diagram of a bird's skeleton, tinted in such a manner as to show at a glance which of the bones occur in the Kjökkenmöddings, and pointed out to me that it coincided exactly with one given by M. Serres to illustrate those portions of the skeleton which were first formed.

Although a glance at, for instance, a femur, and a comparison of the open cancellated tissue of the two ends with the solid, close, texture of the shaft, at once justifies and accounts for the selection made by the dogs, it is interesting thus to ascertain that their predilections were the same in primæval times as at present. Moreover, we may in this manner explain the prevalence of some bones in fossil strata. I have already mentioned that of the skull, the hard parts round the eye and the lower jaw are the only parts left; now, the preponderance of *lower jaws* in a fossil state is well known.

In the "Proceedings of the Geological Society for 1857," p. 277, Dr. Falconer, after describing some of the fossils found by Mr. Beccles at Swanage, says:—"The curious fact that only lower jaws "should have turned up among the Stonesfield mammalian remains "has often been the subject of speculation or remark. The same, to "a certain extent, has held good with the remains found in the "Purbeck beds. . . . . In these minute creatures, unless the bone "be complete, and, supposing it to be a long bone, with both its "articular surfaces perfect, it is almost hopeless, or at any rate very "discouraging, to attempt to make out the creature that yielded it; "whereas the smallest fragment of a jaw, with a minute tooth in it, "speaks volumes of evidence at the first glance. This I believe to be "one great reason why we hear so much of jaw remains, and so little "of other bones." No doubt it is so, but these observations, made by Prof. Steenstrup, afford a farther explanation of the fact, and it is to be regretted that the parts of the long bones which are most important to the palæontologist are also those which are preferred by beasts of prey.

In every case, the bones which contain marrow are split open in the manner best adapted for its extraction, and this peculiarity, which has not yet been observed in bones from the true tertiary strata, is in itself satisfactory proof of the presence of man. No such indirect evidence is, however, required; not only are pieces of burnt wood, and even the stones forming the hearths, of frequent occurrence, but flint implements are far from rare. During our short visit to the Havelse Kjökkenmödding we obtained nine hatchets, of which Mr. Busk and I were so fortunate as to find three each, besides flint flakes and sling stones. These latter (Pl. VII., fig. 12) are so rude, that except for the circumstances under which they are found, there would at first sight seem to be but slight grounds for regarding them as specimens of human art. A more careful examination shows, however, that the flint has been carefully broken in such a manner as to adapt it for a sling, while the sharp edges would considerably increase its power of wounding. The flint flakes are of the ordinary type.

None of the large polished axes have yet been found in the Kjökkenmöddings. A very few carefully formed weapons have been found, but the hatchets are almost invariably rude, though of a well-marked type (Pl. VII., figs. 8 and 9): their angles are not ground down as in the more perfect weapons from the tumuli (Pl. VII., figs. 1, 2, 5), but are left rough, as in the older specimens from Amiens and Abbeville, from which, however, they differ altogether in shape. Small pieces of very coarse pottery have also been discovered.

Some of the bones from the Kjökkenmöddings bear evident marks of a sharp instrument, and several of the pieces found by us were in this condition, one in particular having been fashioned into a pin.

The absence of human remains satisfactorily proves that the primitive population of the North were free from the practice of cannibalism. On the other hand, the tumuli have supplied us with numerous skeletons of this period.* The skulls are very round, and in many respects resemble those of the Laps, but have a more projecting ridge over the eye; in this respect nearly approaching the skull found by Dr. Schaffhausen, and figured by Mr. Busk in our second number. One curious peculiarity was, that their front teeth did not overlap as ours do, but met one another, as do those of the Greenlanders at the present day. This evidently indicates a peculiar manner of eating.

Much as still remains to be made out respecting the men of the

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* Some remarks on this subject by Mr. Busk will appear in our next number. [EDS.]

Stone period, the facts already ascertained, like a few strokes by a clever draughtsman, supply us with the elements of an outline sketch. Carrying our imagination back into the past, we see before us on the low shores of the Danish Archipelago a race of small men, with heavy overhanging brows, round heads, and faces probably much like those of the present Laplanders. As they must evidently have had some protection from the weather, it is most probable that they lived in tents made of skins. The total absence of metal from the Kjökkenmöddings proves that they had not yet any weapons except those made of wood, stones, horns, and bones. Their principal food consisted of shell-fish, but they were able to catch fish, and often varied their diet by game caught in hunting. It is, perhaps, not uncharitable to conclude that, when their hunters were unusually successful, the whole community gorged itself with food, as is the case with many savage races at the present time. It is evident that marrow was considered a great delicacy, and every single bone which contained any was split open in the manner best adapted to extract the precious morsel.

The remains of the wild swan, which is only a winter visitor, and the state in which some of the deer-horns are found, prove that we have not here to do with mere summer quarters, and render it highly probable that the inhabitants resided on these spots all the year round, except, indeed, when obliged to move in search of shellfish, as is the case even now with the Fuegians, whose mode of life (Darwin's Journal, p. 234), gives us a vivid and probably correct idea of what was passing on the shores of the Danish fjords several thousand years ago.

If the absence of cereal remains justifies us, as it appears to do, in concluding that they had no knowledge of agriculture, they must certainly have sometimes suffered from periods of great scarcity, though, on the other hand, they were blessed in the ignorance of spirituous liquors, and saved thereby from what is at present the greatest scourge of Northern Europe.

While one race of men has thus exterminated another, and has in its turn been supplanted by a third, great changes in the vegetation have also taken place. At present the beech woods are the pride of the country, and are considered by the Danes to be the finest in the world. Many of the trees are of great size, and the forests are popularly supposed to have existed from time immemorial. This, however, is a mistake, as is proved by the trees found in the peatbogs. Some of these bogs, which are known in Denmark under the name of Skovmose, are small and deep depressions which have been gradually filled up by the growth of peat, and by the trunks of trees which grew on the edge and fell into the hollow. The lowest portion of the deposit consists, however, entirely of peat, and it is only in the upper part that the tree stems are found. It was at first supposed that these were blown down by the wind, but it has been observed that their heads always lie towards the centre of the moss. When this latter is of small diameter, it sometimes happens that the stems from one side cross those from the other, and the whole depression is as completely choked up with trees as if they were artificially arranged in it.

At the lower part of the deposit, immediately above the peat, the trees are all pines, (*Pinus sylvestris*). They attain a diameter of three feet, and their magnificent size proves how well the country was at that time adapted to their wants, while the proportion of their length to their diameter shows that they were "drawn up" by growing close to one another, though for a long while pines have ceased to grow naturally in Denmark. As we rise nearer to the surface of the peat we find them gradually replaced by oaks, while these latter are succeeded by beeches. No antiquities are found in the lowest amorphous peat, but stone weapons are found amongst the pines: an interesting fact, when coupled with the presence in the "Kjökkenmöddings" of the *Tetrao urogallus*, whose food consists mainly of pine buds.

Articles of bronze have not been found below the oaks: while iron occurs only among the beeches. Thus we find in Denmark three great periods of arborescent vegetation, corresponding to the three great stages of civilization: the Stone period, with the pine forests; the Bronze age with the oaks; and finally, the great beech woods, which must have been already the most striking feature of the country, even before the introduction of iron, as we know that they have continued to be ever since.

It is a question whether the Kjökkenmöddings were not more ancient than the period previously known as the Stone age: and whether, therefore, this earliest age ought not to be subdivided. Certain it is that the Kjökkenmöddings have not yet yielded any of the carefully formed axes and knives, but these weapons were evidently the result of toilsome and skilful workmanship, and we should not expect to find the choicest works of art in a modern dustheap. On the other hand, the barrows of the stone period in which the more elaborate weapons are found, have not yet supplied us with the small and rude axes which occur in the Kjökkenmöddings, but the fact is that, in all probability, these would, until the last few years, have attracted no attention and been overlooked, so that it remains to be ascertained whether, now that their interest is acknowledged, they will not be found, and it is stated that some barrows recently opened have contained rude, as well as well worked, weapons. But even if they should hereafter prove to be absent, still the fact would not be conclusive, as probably only the chiefs and their families were buried in the great barrows, and in this case it might well be argued that the best weapons only would be buried with them.

Possibly it will hereafter be ascertained that while in the older tumuli of the Stone period, weapons of the best workmanship only were deposited, the later ones contain also ruder and less perfect specimens. There is indeed evidence that, even at this early period, religious institutions and customs, at first full of earnest meaning tended to degenerate into mere forms. In the earliest times the warrior was buried with his favorite weapons; gradually the inevitable tendency of ceremonies, or possibly a dim sense that axes and knives were more useful to the living than the dead, caused an alteration of the custom, and small models of the weapons were buried instead of the weapons themselves.

[illegible] same thing has been observed by M. Boucher de Perthes, [illegible] valley of the Somme. He has discovered in the peat some [illegible] places belonging probably to the Bronze age, and he supposes th[illegible] it was customary for every one who attended the funeral, to cast some offering on the grave as a token of respect to the departed. Of these rude flints M. Boucher de Perthes possesses a great collection, and it is evident that they were never intended to be of any actual use. Mr. Franks, of the British Museum, informs me that much of the jewellery found in Etruscan tombs is so thin that it could not have been worn during life; and in Egyptian graves also models occur, instead of the weapons or implements themselves.

M. Worsäae is of opinion that there is sufficient evidence to indicate the separation of the Danish Stone age into two periods. However this may be, the remains found near Amiens and Abbeville, seem to me to justify our doing so, at least as regards France, but we did not see in Copenhagen any Danish flint weapons at all resembling the older forms from the gravels capping the hills on each side of the valley of the Somme, nor have any flint weapons of this type as yet been found in Ireland.

It is manifestly impossible to affix a date in years to the formation of the Kjökkenmöddings, which, nevertheless are, as evidently, of immense antiquity. We have seen that at the time of the Romans the country was, as now, covered by beech forests, and yet we know that during the Bronze age, beeches were absent, or only represented by a few stragglers, while the whole country was covered with oaks. This change implies a great lapse of time, even if we suppose that but a few generations of oaks succeeded one another. We know also that the oaks had been preceded by pines, and that the country was inhabited even then.

Again, the immense number of objects belonging to the Bronze age which have been found in Denmark from time to time, and the great number of burial places, appear to justify the Danish Archæologists in assigning to this period a very great lapse of time. The same arguments apply with even more strength to the remains of the Stone period, as a country the inhabitants of which live by hunting and fishing can never be thickly populated; and, on the whole, the conclusion is forced upon us, that the country must have been inhabited several thousand years before the Christian Era.

On the other hand no flint implements have yet been found in Denmark, which resemble those occurring in the drift near Amiens, Abbeville, and elsewhere. Not only, however, the great differences in the workmanship, but also the absence of any trace of the Elephant or Rhinoceros, with the human remains in Denmark, and their well attested presence in France, in the same strata with the flint implements, tend to prove the greater antiquity of the remains found near the Somme. These flint weapons have been actually found *in situ* by Prestwich, Flower, Gaudry, Pouchet, and others; but even without this satisfactory evidence, the genuineness of the weapons is, as M. Boucher de Perthes and Mr. Prestwich have shown, completely proved by their condition. Those which have lain in siliceous or chalky sands have a peculiar vitreous lustre very different from the comparatively dead surface generally presented by a newly broken flint. Mr. Evans, however, has shown me a flint in which the recently fractured surfaces have a gloss, certainly very much like that of the Amiens and Abbeville specimens, which therefore, though generally a good voucher for antiquity, cannot in all cases be implicitly relied on. More conclusive is the evidence when the flints have lain "in "ochreous sand, by which, especially if argillaceous, they are stained "yellow, whilst in ferruginous sands and clays they assume a brown "colour," and in some beds they become white and porcellaneous. As will be seen, however, in Pl. VII., fig. 11, this alteration of colour is quite superficial, *and follows the outline of the present surface*, whereas if the weapon had been tampered with by the workmen, they would have broken through the outer coating and exposed the dark flint, as has, in fact, been done by the accidental fracture shown in the figure.

Moreover, the great antiquity of these most interesting remains is farther proved by the position of the gravel beds in which they are found. Not only are these strata covered by several feet of sand, containing unbroken though very delicate land and freshwater shells, and this again by brick earth, but they *cap the hills on each side of the Somme valley*, which must therefore have been excavated, in part at least, since they were deposited. The lower parts of the valley are now occupied by peat, in which are found remains referred by M. Boucher de Perthes to the Stone period, and it would seem therefore that we have here, at least, good evidence of two Stone ages, one of which would be much older than the other, and would carry back the origin of the human race to a date, at least, twice as remote as that usually assigned to it. Further, it is evident that man must have originated in a hot climate, and he could not have supported the climate of the North until he had made some steps in civilization; at least, until he had learnt to light a fire and provide himself with a dwelling place.

Intensely interesting, therefore, as are the antiquities of Northern Europe, it is, after all, in a hotter part of the world, and probably in the tropics themselves, that we must look for the true cradle of the human race.

Prof. Steenstrup has promised to send us an account of his recent progress in the investigation of the Kjökkenmöddings; and I hope also, perhaps in a future number of this Review, to compare the early history of Denmark, as indicated by the tumuli and the ancient weapons, with that of other neighbouring countries.

The length to which this article has already extended, prevents me from doing more at present than mention that flint hatchets closely resembling those from Amiens and Abbeville, were found at Hoxne in Suffolk, and described by Mr. Frere, in 1797. Some of the oval form were found in Kent-Hole, near Torquay. In the British Museum is a similar specimen which was found with the skeleton of an elephant in London many years ago, and more recently a few have been discovered near Reculvers by Mr. Leech, Mr. Evans, and Mr. Prestwich, at Biddenham in Bedfordshire by Mr. Wyatt, at Godalming in Surrey by Mr. Whitburn, and at Abbot's Langley by Mr. Evans. We may reasonably hope that the persevering researches of these gentlemen, and especially of Messrs. Evans and Prestwich, will be rewarded by similar discoveries in other places.

Description of Plate VII.

Fig. 1. A flint axe from a tumulus, $\frac{1}{3}$ Nat. size.
Fig. 2. Another form of stone axe with a hole for a handle, $\frac{1}{3}$ Nat. size.
Fig. 3. A flint saw, $\frac{1}{2}$ Nat. size.
Fig. 4. A flint sword, $\frac{1}{6}$ Nat. size.
Fig. 5. A flint chisel, $\frac{1}{2}$ Nat. size.
Fig. 6. One of the "cores" from which the flint flakes are splintered, $\frac{1}{2}$ Nat. size.
Fig. 7. One of the flakes, $\frac{1}{2}$ Nat. size.
Figs 8-9. Rude axes from the Kjökkenmödding at Havelse, $\frac{1}{2}$ Nat. size.
Fig. 10. Flint axe from drift at Moulin Quignon near Abbeville, $\frac{1}{2}$ Nat. size.
Fig. 11. Flint axe from Abbeville, showing that the part stained white is parallel to the present surfaces, and that the weathering has taken place since the flint was worked into its present shape, $\frac{1}{2}$ Nat. size.
Fig. 12. Sling-stone from the Kjökkenmödding at Havelse, $\frac{1}{2}$ Nat. size.

LI.—Report on the Present State of our Knowledge of the Species of Apteryx living in New Zealand. By Philip Lutley Sclater, M.A., Ph. D., F.R.S., and Dr. F. von Hochstetter.

[Read at the Meeting of the British Association, September, 1861.]

There appears to be evidence of the present existence of at least four species of birds of the genus *Apteryx* in New Zealand, concerning which we beg to offer the following remarks, taking them one after the other in the order that they have become successively known.

1. Apteryx australis.

Apteryx australis, Shaw, Nat. Misc. xxiv. pl. 1057, 1058, and Gen. Zool. xiii. p. 71.
" " Bartlett, Proc. Zool. Soc. 1850, p. 275.
" " Yarrell, Trans. Zool. Soc. I. p. 71, pl. 10.

The *Apteryx australis* was originally made known to science about the year 1813, from an example obtained in New Zealand by Captain Barclay of the ship "Providence." This bird, which was deposited in the collection of the late Lord Derby, was afterwards described at greater length in 1833, in the Transactions of the Zoological Society by Mr. Yarrell, and was still, at that date, the only specimen of this singular form known to exist. Examples of *Apteryges* subsequently obtained, though generally referred to the present species, have mostly belonged to the closely allied *Apteryx Mantelli* of Bartlett, as we shall presently show, though specimens of the true *Apteryx australis* exist in the British Museum, and in several other collections.

The original bird described by Dr. Shaw is stated by Mr. Bartlett (Proc. Zool. Soc. 1850, p. 276) to have come from Dusky Bay, in the province of Otago, Middle Island, whence Dr. Mantell's specimen, upon which Mr. Bartlett grounded his observations as to the distinctness of this species from *Apteryx Mantelli*, was also procured.

Dr. Hochstetter was able to learn nothing of the existence of this *Apteryx* in the province of Nelson, in the same island. In fact, the species is so closely allied to the *Apteryx Mantelli* as to render it very desirable that further examples of it should be obtained, and a rigid comparison instituted between the two. For the present, however, we must regard this form of *Apteryx* as belonging to the southern portion of the Middle Island.

2. Apteryx Owenii.

Apteryx Owenii, Gould, P. Z. S. 1847, p. 94.
„ „ Birds of Austr. vi. pl. 3.

Owen's *Apteryx*, which is readily distinguished from the preceding species and *A. Mantelli*, by its smaller size, transversely barred plumage and slender bill, was first described by Mr. Gould in 1847, from an example procured by Mr. F. Strange, and "believed to have "been obtained from the South Island." Since that period other specimens have been received in this country, which have sufficed to establish the species, and from the information obtained by Dr. von Hochstetter, there is no doubt of this being the common *Apteryx* of the northern portion of the Middle Island.

"In the spurs of the Southern Alps on Cook's Strait, in the "province of Nelson," says Dr. von Hochstetter, "that is, in the "higher wooded mountain-valleys of the Wairau chain, as also west-"wards of Blind-Bay, in the wooded mountains between the Mo-"tucka and Aorere valleys, Kiwis of this species are still found in "great numbers. During my stay in the province of Nelson I had "myself two living examples (male and female) of this species. They "were procured by some natives, whom I sent out for this purpose, "in the upper wooded valleys of the river State, a confluent of the "Aorere, in a country elevated from 2000 to 3000 feet above the sea "level. It appears that this *Apteryx* still lives very numerously and "widely spread in the extended southern continuations of the Alps."

3. Apteryx Mantelli.

Apteryx australis, Gould, Birds of Australia, xi. pl. 2.
Apteryx Mantelli, Bartlett, Proc. Zool. Soc. 1847, p. 93.

The characters which distinguish this commoner and better known *Apteryx* from the true *A. australis* of Shaw were pointed out by Mr. Bartlett at the meeting of the Zoological Society, held on the 10th Dec. 1850:—"This bird differs from the original *Apteryx aus-"tralis* of Dr. Shaw," says Mr. Bartlett, "in its smaller size, its

"darker and more rufous colour, its longer tarsus, which is scutel-
"lated in front, its shorter toes and claws, which are horn-coloured;
"its smaller wings, which have much stronger and thicker quills; and
"also in having long straggling hairs on the face."

Mr. Bartlett tells us that, as far as he has been able to ascertain, all specimens of *Apteryx Mantelli* are from the Northern Island, and this is completely confirmed by Dr. von Hochstetter's observations, which are as follows:—

"In the northern districts of the Northern Island this species of
"*Apteryx* appears to have become quite extinct. But in the island
"called Houtourou, or Little Barrier Island, a small island, com-
"pletely wooded, rising about 1000 feet above the sea level, and only
"accessible when the sea is quite calm, which is situated in the Gulf
"of Hauraki, near Auckland, it is said to be still tolerably common.
"In the inhabited portions of the southern districts of the Northern
"Island also, it is become nearly exterminated by men, dogs, and
"wild cats, and here is only to be found in the more inaccessible and
"less populous mountain-chains, that is in the wooded mountains
"between Cape Palliser and East Cape."

"But the inhabitants of the Northern Island speak also of two
"sorts of Kiwi, which they distinguish as Kiwi-nui (Large Kiwi) and
"Kiwi-iti (Small Kiwi). The Kiwi-nui is said to be found in the
"Tuhna district, west of Lake Taupo, and is in my opinion *Apteryx*
"*Mantelli*. Kiwi-iti may possibly be *Apteryx Owenii*, though I can
"give no certain information on this subject."

4. Apteryx maxima.

"The Fireman," Gould in Birds of Australia, sub. tab. 3, vol. vi.
Apteryx maxima, Bp. Compt. Rend. Acad. Sc.
"Roa-roa" of the natives of Southern Island.

The existence of a larger species of *Apteryx* in the Middle Island of New Zealand has long ago been affirmed, and though no specimens of this bird have yet reached Europe, the following remarks of Dr. von Hochstetter seem to leave no reasonable doubt of its actual existence:—

"Besides *Apteryx Owenii* a second larger species lives on the
"Middle Island, of which, although no examples have yet reached
"Europe, the existence is nevertheless quite certain. The natives
"distinguish this species not as a *Kiwi*, but as a *Roa*, because it is
"larger than *A. Owenii* (Roa meaning long or tall).

"John Rochfort, Provincial Surveyor in Nelson, who returned
"from an expedition to the western coast of the province while I
"was staying at Nelson, in his report, which appeared in the 'Nel-
"son Examiner,' of August 24th, 1859, describes this species, which
"is said to be by no means uncommon in the Paparoa elevation, be-
"tween the Grey and Buller rivers, in the following terms:—'A
"'Kiwi about the size of a turkey, very powerful, having spurs on
"'his feet, which, when attacked by a dog, defends himself so well
"'as frequently to come off victorious.'

"My friend, Julius Haart, a German, who was my travelling "companion in New Zealand, and in the beginning of the year 1860 "undertook an exploring expedition to the southern and western "parts of the province of Nelson, writes to me in a letter, dated "July, 1860, dated from ten miles above the mouth of the river "Buller, on the mountains of the Buller chain, which at a height of "from 3000 to 4000 feet, were at that time, it being winter in New "Zealand, slightly covered with snow, that the tracks of a large "Kiwi of the size of a turkey were very common in the snow, and "that at night he had often heard the singular cry of this bird, but "that as he had no dog with him he had not succeeded in getting an "example of it. He had, nevertheless, left with some natives in "that district a tin case with spirit, and promised them a good "reward if they would get him one of these birds in spirits, and send "it to Nelson by one of the vessels which go from time to time to "the west coast."

In concluding this brief report, we wish to call attention to the importance of obtaining further knowledge respecting the recent species of this singular form of birds, whilst it is yet possible to do so. We see that one of them—the *Apteryx Mantelli*—is already fast disappearing, whilst its history, habits, mode of nidification, and many other particulars respecting it are as yet altogether unknown. We therefore trust that such members of this Association as have friends or correspondents in any part of New Zealand will impress upon them the benefits that they will confer on science, by endeavouring to procure more specimens of, and additional information concerning, the different species of the genus *Apteryx*.

LII.—Note upon the northern limit of the Quadrumana in the New World. By P. L. Sclater, M.A., Ph. D., F.R.S.

In looking through the plates and letterpress of Johnston's Physical Atlas and the works of other authorities who treat of the geographical distribution of the Mammalia, I have observed that the northern limit of the range of the Quadrumana in the New World is altogether incorrectly laid down, and that the species assigned to the countries north of the isthmus of Panama are wrongly named. Although I cannot pretend to be able to set this matter quite right, as the correct determination of the species of Quadrumana which inhabit the northern (or trans-panamanic) province of the Neotropical region must remain in abeyance, until more specimens of these animals have been brought to Europe from Central America, and their differential characters more carefully studied, yet I have been able to acquire, through the kindness of some of my correspondents and during visits to several Zoological Museums, some information upon this point which I hope will be sufficient to rectify a not unimportant error in geographical distribution.

Having paid much attention to the birds of Southern Mexico, Guatemala and the adjoining republics of Central America, I have found it a general rule that this northern portion of the great South-American (or Neotropical) region possesses specifically distinct representatives of all the more important groups which characterize the Ornithology of Tropical South America. It not unfrequently happens that these northern outliers of the genus are the finest in colouring and the most outré or exaggerated in form, of the whole group. In illustration of this remark I may adduce the case of the Guatemalan Cotinga *(Cotinga amabilis)*—certainly pre-eminent in coloration even among this lovely brotherhood. The naked-throated Umbrella-bird *(Cephalopterus glabricollis)* of Veragua, the Three-wattled Fruit-eater *(Chasmorhynchus tricarunculatus)* of the same country, and the celebrated Long-tailed Trogon or Quesál of the mountains of Vera Paz *(Trogon paradiseus)* are other instances of the same kind, and the list might be still further extended without much difficulty. When the Quadrumana of the trans-panamanic province are properly worked out, I believe it will be found that each of the leading genera of Tropical America possesses a representative within the limits of this special Fauna.

But first as regards the northern limit of the Quadrumana in the New World. This is given in the plate of Johnston's Physical Atlas by a line across Honduras, which is supposed to mark the northern limit of *Mycetes seniculus*. But I know of no authority for the occurrence of this *Mycetes* in Honduras, and the true limit of the family must be fixed, as I shall presently show, much further north.

The well-known German Naturalist, Deppe, who travelled in Mexico in 1824-7, writes in a letter dated from Xalapa, Feb. 18th, 1825:—

"In Alvarado* we heard that 15 or 18 leagues further south on the St. Martin we should find Monkeys. On Christmas-day we set out in a canoe with Indians to Hacatalpa, and here took horses to go to the mountains eight leagues farther. Having arrived at the appointed spot we were informed to our great sorrow that the Monkeys had deserted this locality three weeks since for a spot where fruit was more abundant. There were three species described to me, (1) a large white one, 4 feet high; (2) a smaller one, 2½ feet high (apparently the same as that which I now send); and (3) a small one quite black. I was told that they would return in the beginning of February in large troops."

Dr. W. Peters, the Director of the Museum at Berlin, who has most kindly supplied me with the above extract, adds,

"Mr. Deppe, who is still alive and whom I questioned about the specimen in our Museum writes to me, 'I bought the *Ateles* alive in Alvarado. It was caught by a Mexican about twenty hours distant from the city. Afterwards, on my journey from Caxaia to Alvarado, I watched, in a forest near Valle Real, a great number of the same

* Deppe remained in Alvarado during December, 1824, and January, 1825.

species for more than six hours together, but having no large shot I was unable to procure any.' Mr. Deppe told me afterwards that this *Ateles* was the only Monkey he got during his whole stay in Mexico from 1824 to 1827.

I have had the opportunity of examining this specimen in the Berlin Museum in company with Dr. Peters. It is an *Ateles* of a species allied to *A. beelzebuth* of Brazil and *A. hybridus* of New Granada, but probably referable to *Ateles frontatus*—*Brachyteles* (*Eriodes*) *frontatus*, Gray, (Voy. Sulphur). However this may be, it indubitably proves the existence of a species of this genus in Mexico, as far north as between 18° and 19° N.L. That this *Ateles* ranges still further north seems amply proved on the evidence of M. Auguste Sallé—the well-known Naturalist and traveller—from whom I have received the following communication relative to this subject:—

"La limite la plus nord ou on trouve des Singes à ma connaissance, est l'Etat de San Luis Potosi, aux environs du 23e dégré de latitude, dans le haut de la rivière de Tampico également. On en trouve une espèce dans les montagnes et lieux très déserts de l'Etat de Veracruz, aux environs de Cordova entre cette ville et Huatusco par le 19°. Je crois que c'est un *Ateles,* je ne sais pas au juste. Quoique très commun je ne l'ai pas vu aux Galeries du Museum, mais je tâcherai de vous en donner le nom; à Cordova on les nomme *Changos.* A la côte entre Veracruz et Tampico il y a de grandes forets ou en trouve. On dit qu 'il y en a deux espèces dans l'Etat de Chiapas."

In Guatemala Mr. Salvin informs me that Monkeys are rather scarce and difficult to be seen, but that three species have been described to him as existing there. Of one of them he has brought home an imperfect skin, which appears to be that of an *Ateles.*

In Nicaragua, M. Sallé states that he found four species of Quadrumana during his travels. Examples of two of these were purchased by the British Museum in 1848 through Mr. Cuming, and are now in the collection. One of the species is an *Ateles* (probably *A. frontatus*), the second is a *Mycetes*, described and figured by Dr. Gray in the Proceedings of the Zoological Society for 1848* under the name *M. palliatus*, and erroneously stated to be from Caraccas.

Further south, in Costa Rica, Dr. Peters informs me that the late Dr. Hoffman, who up to the time of his lamented death, worked vigorously at the Fauna of this interesting region, met with three species of Quadrumana and forwarded examples of all to Berlin, namely,—

1. An *Ateles*, apparently the same as Deppe's Mexican specimen —though varying in colour. "This species," writes Dr. Hoffman, "varies very much in colour from red to grey. It is called *Mono colorado*, and has a flavour like mutton."
2. *Mycetes palliatus*, Gray.
3. *Cebus hypoleucus*, Geoffr., called in Costa Rica *Mono caro biancho.* "It bellows like a dog," says Dr. Hoffman.

The Zoological Society have lately received some living examples of the *Hapale œdipus*, said to have been obtained from Chiriqui, and

* See P. Z. S. 1848, Mammalia, pl. VI.

Mr. Bridges during his residence at David, in the same country, procured a skeleton of a *Chrysothrix*, perhaps *C. sciurea*.

It thus appears evident that species of Monkeys of the genera *Mycetes*, *Ateles*, *Cebus*, *Chrysothrix* and *Hapale* are found northwards of the isthmus of Panama, and that the *Ateles* extends its range up to the 23° N.L.

This is all the information I have been enabled to collect concerning the Quadrumana of the trans-panamanic province. I sincerely trust that Mr. Salvin, who is now returning to Central America in company with Mr. Godwin, for the purpose of making collections in Natural History, will endeavour to render our knowledge of this subject more perfect. The ignorance which prevails concerning it is mainly attributable to the carelessness and negligence Naturalists have hitherto shown as to the record of precise localities.

LIII.—On the Myology of the Orang Utang (Simia Morio).

By William Selby Church, B.A., Lee's Reader in Anatomy, Christ Church, Oxford.

Having had an opportunity of dissecting the muscles of an Orang Utang, and of comparing them with those of the Magot (*Inuus Rhesus*) and of the *Cebus Capuchinus*, I have put together the following remarks on their myology, in the hope of drawing general attention to some points which have usually been overlooked.

I shall endeavour to point out the variations existing in the different species of the Quadrumana, as illustrated by the above-mentioned species, and to show how much closer is the connexion between the myological structure of the Platyrrhine prehensile-tailed *Cebus* and the Magot, than that existing between the latter animal and the Orang; secondly, to furnish parallels between the recorded variations of the muscular system in man and the arrangement of the muscles in the Quadrumana; and thirdly, to show that the Quadrumana differ among themselves in those points in which they differ from man: the distribution of the Flexor Longus Hallucis and Pollicis, for instance, differing as widely in the Orang, from that found in the bulk of the Quadrumana, as it does from that which obtains in man.

Unfortunately, comparative anatomists have almost exclusively confined their investigations to the osteology and nervous system of the Bimana and Quadrumana; and, while they have frequently noticed the approach which the lower races of mankind make to the quadrumanous type in those parts of their organization, few or no inquiries have been made into the myology of these races, and consequently the abnormal variations here mentioned are exclusively obtained from civilized races.

In many of the wild races, the external form of the limbs differs slightly from that of the civilized; and I think it may be fairly presumed that the structure of the muscles would not unfrequently present corresponding modifications.*

In the following remarks, I have first described each muscle as it appeared in the Orang, and I have then compared it with the accounts given of the corresponding muscle in the Magot, *Cebus*, and other Quadrumana, and, lastly, with any similar variations which I have found recorded as occurring in man.

The works to which most frequent reference is made are—Recherches d'Anatomie comparée sur le Chimpansée, par W. Vrolik; M. Duvernoy's Memoir on the Myology of the Gorilla and other Anthropomorphous Apes, Archives du Museum d'Histoire Naturelle, tom. viii.; Encyclopédie Anatomique, traduit d'Allemand par A. J. L. Jourdan, tom. iii.; Mr. J. Hallett's Paper in the Edinburgh Medical and Surgical Journal, 1847; Anatomie Comparée, Recueil de Planches du Myologie, dessinées par G. Cuvier; Prof. Owen, Proceedings of the Zoological Society, vol. i.

I have confined my remarks almost entirely to the muscles of the anterior and posterior extremities, as they are the most subject to variations in the various orders of the Mammalia.

The Orang was a young specimen, and its muscles were but feebly developed, forming a very strong contrast to those of the Magot, which was an old individual, and very muscular. The age of the Orang may perhaps account for some of the differences between my dissections and those of Prof. Owen and M. Duvernoy.

The Muscles of the Anterior Extremity.

The inferior portion of the *Trapezius* arose from ten dorsal vertebræ, and its fibres did not communicate with those of the *Latissimus dorsi*, as they do in the Chimpanzee.†

The *Rhomboidei Major* and *Minor* were fused together, as in the Chimpanzee: in the latter animal this muscle does not reach the occipital bone, but the Orang in this respect resembles the Inui and Cynocephali.

The *Levator Scapulæ*, called *Trachelo-scapularis* by Duvernoy,‡ is inserted into the four anterior cervical vertebræ. This muscle is described by Duvernoy as having one digitation inserted into the occipital bone, another fusing with the sterno-mastoid, and three others into the cervical vertebræ. In the Gorilla, he describes three distinct fascicles; one of which is inserted into the transverse process of the Atlas, the other into the second, third, fourth, and fifth cervical vertebræ. In the Magot, he describes it as I found it in this Orang.

* Mr. Simpson noticed an undue shortness of the thumbs in the western Eskimos, and the absence of calf and flatness of the thighs has been often noticed in wild races by travellers.

† Rech. d'Anat. Comp. sur le Chimpansée, par W. Vrolik, p. 17.

‡ Duvernoy, Archives du Museum d'Histoire Naturelle, tom. viii. p. 74.

The slip to the sterno-mastoid, which Duvernoy found in the Orang, occurs as an accidental variety in man, as is mentioned by Theile.*

The *Clavio-trachélien*, or *Acromio-trachélien*, arose from the clavicle alone, and was inserted into the inner side of the transverse process of the atlas. In the Gorilla, it has the same insertion, but it arises from the acromion.†

The *Latissimus Dorsi* possessed much the same origin as in man, but scarcely reached so far up the back. The fibres which arose from the dorsal vertebræ remained distinct, and did not interlace with those of the inferior portion of the muscle; and, as they curved round the lower margin of the *Teres Major*, they formed a distinct head, separated from the rest of the muscle by a septum of dense tissue, which was inserted partly into the external fascia of the arm, and partly into the humerus, together with the tendon of the *Teres Major*. The larger and inferior portion of the muscle passed on to be inserted by a broad tendon, which curved round the humerus, and was inserted into the inner surface of that bone an inch and a half below the bicipital groove. At the distance of an inch and a half from the point of insertion, a strong muscular slip, called by Duvernoy the *Dorso-epitrochlien*, is given off, which passes down along the inner side of the long head of the *Triceps*, to be inserted into the fascia of the arm and the olecranon process of the ulna.‡

In the Gorilla, the *Dorso-epitrochlien* receives a small slip from the tendon common to the *Biceps* and the *Coraco-brachialis* (Duvernoy, l. c., p. 80.) In the *Cebus*, the tendon of the portion coming from the dorsal vertebræ is not inserted together with that of the *Teres Major*, but close to it. This modification of the *Latissimus Dorsi* appears common to all the Quadrumana, and must greatly relieve the strain thrown on the muscles of the arm and shoulder by the weight of the

* Encyclopédie Anatomique, traduit d'Allemand par A. J. L. Jourdan, tom. iii. p. 124.

† This, the *Acromio-basilar* muscle of Vicq. d'Azyr, is eminently characteristic of the lower Mammalia; so that M. Duvernoy (second edition of Cuvier's Leçons, tome i. p. 371) even says, "On le trouve dans tous les mammifères, l'homme excepté, ce qui semblerait prouver qu'il est une des conditions de la station quadrupède." Its upper attachment varies in the Mammalian series from the lower cervical vertebræ (camel) to the occipital bone (rabbit). The human muscular variety, which appears to make the nearest approach to the development of this muscle, is that observed by R. Wagner (cited in Henle's Handbuch der Systematischen Anatomie des Menschen, Bd. I. 3te. Abtheilung, p. 24) who found an accessory fasciculus of the *Trapezius* inserted into the Mastoid process, and remaining separate as far as the *Acromion*. The numerous dissectors, who will be busy in our medical schools during the ensuing winter, might do good service by attending to the variations of the *Trapezius*; and indeed of all those muscles whose attachments in man differ widely from those presented by the apes—*e.g.* the *Flexor pollicis proprius*, the *Extensor indicis*, and the *Interossei* of the hand: the *Tibialis anticus*, *Extensores digitorum brevis*, *communis digitorum*, *hallucis longus*, *Flexor brevis digitorum*, *Transversus pedis*, and *Interossei* of the foot. We shall be glad to receive and to record examples of such varieties.—[Eds.]

‡ This muscle is clearly represented in Man by the tendinous band which, as Halbertsma has shown (Henle, l. c. p. 183) constantly connects the long head of the *Triceps* with the *Latissimus dorsi*.—[Eds.]

body when the animal is climbing. Corresponding modifications will be found in the posterior extremities.

The *Teres Major* was proportionately a stronger muscle than in man, and its tendon was inserted over a space of one inch and three-eighths: this was partly caused by its receiving a slip, as before mentioned, from the *Latissimus Dorsi*.

The *Teres Minor* differed only in its mode of origin; arising between the long head of the *Triceps* and the *Infra-Spinatus* muscles from the inferior border of the scapula.

The acromial portion of the *Deltoid* was inserted separately into the humerus by a thin tendinous band, while the mass of the muscle was inserted into the deltoid tuberosity, which was situated lower down the arm than in man.

In the Magot, it was divided, as stated by Duvernoy, into three almost distinct portions, which he calls *Claviculaire, Coracodienne, et Sous-epineuse.*

The *Pectoralis Major* arose by three distinct heads; one coming from the clavicle, the other two from the sternum and intercostal cartilages. The upper sternal portion did not, in this instance, reach higher than the third rib. The lower sternal portion arose from the costal cartilages, the ensiform appendage, and the sternum: it received, opposite the fifth rib, some fibres from the external oblique. The muscle was inserted by a broad tendon, extending from the anatomical neck, $2\frac{1}{8}$ inches down the anterior border of that bone. The fibres of the clavicular portion form the lowest and those of the lower sternal portion, the upper part of the tendon, as in man.

In the Chimpanzee (Vrolik, l. c. p. 18), this muscle has only a single sternal and clavicular origin. And Prof. Owen* describes it as formed in the Orang of *sterno-humeralis*, *costo-humeralis*, and *sterno-costo-humeralis* portions—apparently, therefore, in his specimen, the clavicular portion was wanting; neither does Sandifort mention any clavicular portion in the adult dissected by him.

In the Magot, a thin muscular slip, distinct from the *Pect. Major*, and beneath it, was found, which arose from the lower ribs, and terminated in a thin membranous expansion, which appeared to be inserted partly into the aponeurosis of the arm, and partly into the intermuscular septum and the humerus.

In Man, it is by no means unfrequent to find the sternal portion divided into two or more parts; the arrangement met with in the Magot is described in the human subject by Theile;† and Mr. Hallett‡ mentions a very similar one as occurring in man.

The *Pectoralis Minor* presented the same appearance as in man; in the Gorilla, Duvernoy states that it is divided into two portions; one passing in front of, the other behind the laryngeal sac.

The two heads of the *Biceps* remained distinct until they reached

* Proceedings of the Zool. Society, vol. i. p. 19.
† Encyclopédie Anat. tom. iii. p. 202.
‡ Mr. C. J. Hallett, Edinburgh Medical and Surgical Journal, 1847.

the lower third of the humerus. Taking its origin by fleshy fibres alongside of the long head of the *Biceps* and the *Coraco-brachialis*, and receiving fibres from them, was a muscular slip, described as *très mince* in the Chimpanzee (Vrolik, l. c. p. 19), which, after accompanying the long head of the *Biceps* for 2½ inches, leaves it to be inserted into the humerus and intermuscular septum, immediately below the insertion of the *Corecobrachialis*, and alongside of the internal portion of the *Triceps*. This slip is not mentioned by Duvernoy as occurring in the Orang, but he found it in the Chimpanzee and Gorilla: in the latter, it joined the *Dorso-epitrochlien*. It did not occur in the *Cebus* or Magot, and Cuvier* has not figured it in any of his plates.

This slip is a frequent occurrence in the human subject, the *Biceps* being subject to many variations.

The *Triceps* differed from that of man only in having the long head of greater proportionate strength: it had a large insertion, covering a space of one inch and seven-eighths into the inner and lower edge of the scapula.

In examining the muscles which move the hand of the Orang, we find that, whilst the extensor muscles closely correspond with those of man, the flexor muscles are modified, in order to strengthen the hand for grasping, while the capability for varied and delicate movements must be impaired.

The *Supinator Longus* was large, its origin covering a space of 3½ inches on the humerus, and some of its fibres appearing to interlace with those of the long head of the Triceps as it passed downwards.

The *Extensor Carpi Radialis Longior* arose from the external condyloid ridge of the humerus. The lower two-thirds of this muscle were tendinous: it was inserted into the radial side of the metacarpal bone of the index.

The *Extensor Carpi Radialis Brevior* was larger and stouter than the preceding muscle, and had a similar insertion into the metacarpal bone of the middle finger.

The *Extensor Communis Digitorum* presented almost exactly the same appearance as in man. In the Chimpanzee, according to Duvernoy, the portion for the index finger is distinct, from its origin.

The *Extensor Minimi Digiti* arose alongside of the *Extensor Carpi Ulnaris* from the ulna and intermuscular septum, passed through a distinct sheath of the annular ligament, and split into two tendons inserted into the ring and little fingers. In the Chimpanzee, it is inserted into the little finger only. The Gorilla has the tendon strongly connected with that of the *Extensor Communis;* the muscular portion seemed also to form part of the *Extensor Communis.* (Duvernoy, l. c. p. 97.) In the *Cebus*, it formed part of the same muscular belly as the *Extensor Communis*, but soon separated from it, and was inserted as in the Orang. In the Magot, its origin, disposition, and insertion all resembled those in the Orang.

The *Extensor Indicis*, instead of being inserted only into the index, was flattened out, and inserted chiefly into the base of the

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* Anat. Comp. Recueil de Planches de Myologie, dessinées par G. Cuvier.

metacarpal bone of the middle finger, sending a few fibres to those of the index and ring fingers. In two specimens dissected by Duvernoy, he found this muscle performing the office of an *Extensor proprius* of the middle finger only, and in another specimen it was inserted into both the index and middle fingers; see also Cuvier, l. c. pl. 17.

In the Gorilla, according to Duvernoy (p. 97), it goes to the index only, but it is very weak. In the Chimpanzee, according to Vrolik, the tendinous insertion is confined to the index, but the muscle at its origin appears to be fused with the common *Extensor*. In an *Ateles* I found it to terminate by two distinct tendons; one of which was inserted into the index and radial side of the middle finger, the other into the ulnar side of the middle and the ring finger. In the *Cebus* and Magot, the two tendons were inserted severally into the middle and index fingers.*

The *extensor* muscles in the human subject are very liable to variations, and the commonest resemble those arrangements found normally in the Quadrumana. Mr. Hallett says of the *Extensor Minimi Digiti*, "it is occasionally absent, being replaced by the *Extensor Communis;* more frequently split into two tendons, or two muscles even, going to the ring and little fingers." The sending off of a slip to join the tendon of *Extensor Communis* going to the ring finger is described by Vesalius.† Theile‡ mentions the same arrangement as Mr. Hallett. Mr. Hallett also describes a case in which the *Extensor Indicis* was divided into two distinct muscles, the tendon of one of them going to unite with the index branch of the common *extensor*, while the other went to the middle finger: this was the most complete irregularity met with, but many minor grades were noticed. Theile§ mentions the tendon being double, a branch going to the middle finger.||

The want of specialization of this muscle in the Orang must be regarded as a lower organization than that of the Chimpanzee or Gorilla, which, from their myology, I should think are able to point with their finger in the same manner as man.

The *Pronator Teres*, *Flexor Carpi Radialis*, *Palmaris Longus*, and *Flexor Carpi Unaris* presented the closest resemblance to the same muscles in man. But the individuality of the several muscles was less marked; they appeared to have a common origin from the inner condyle of the humerus and intermuscular septum, and owing to the interlacement of their fibres, none of the muscles could be traced out to their individual origins. The same remarks apply to these muscles in the Magot and *Cebus*.

The *Flexor Sublimis Digitorum*. The portion of this muscle

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* The muscles known as *Extensores primi intermodii pollicis, Indicis* and *Minimi digiti*, appear to be mere isolated remnants of the complete second or deep *extensor digitorum* found under various forms in the lower Mammalia.—[Eds.]

† Vesalii Opera, vol. i. p. 258. ‡ Encyc. Anat. tom. iii. p. 230.

§ Wagner, Elements of Comp. Anatomy, translated by Tulk, p. 19.

|| And sometimes this muscle is double and its deeper division gives three tendons, to the 2nd, 3rd and 4th fingers. See Henle, l. c., p. 213.

which supplies the little finger left the rest of the belly, and became tendinous $2\frac{1}{2}$ inches above the origin of the other tendons.

The *Flexor Profundus* arose as in man, but had no tendon going to the index finger; as it passed through the annular ligament, the tendon of the middle finger received a slip from the tendon of the *Flexor Longus Pollicis* (*Indicis*), and gave one to that of the ring finger; the tendon of the ring finger sent no slip to that of the little finger, but the tendons supplying these fingers arose from the same fascicle of the muscle. In the Gorilla, the index tendon is wanting; and in both the Cebus and Magot the *Flexor Profundus* and *Flexor Longus Pollicis* are intimately connected in the palm.

(*To be concluded in the next number.*)

Bibliography.

In the original scheme for this Department of the Natural History Review it was proposed to give, in each number, the Bibliography of all subjects, for the penultimate quarter; and, in the October number, an alphabetical list of Author's names.

It has been found, however, that considerable difficulties oppose the efficient carrying out of this plan with due regularity and accuracy. With the space disposable for the purpose, we have not found it possible to do more than give the Bibliography for the year 1860, and to complete the original programme in the present part, which concludes the volume, with the alphabetical list of Author's names; but we have added an index of the new genera of phanerogamic plants noticed in the Bibliography, which it has been thought would be acceptable to Botanists.

In future the arrangement will be altered, and the Bibliography, disposed under the different heads already adopted, will be distributed in the following manner, in which it is believed that the desirable regularity and accuracy will be more easy of attainment.

The Natural History Review will contain:—

In April: The Bibliography relating to—
- I. Zoology, general or mixed.
- II. The Vertebrata.
- III. The Annulosa.

In July:—
- I. Mollusca.
- II. Cœlenterata.
- III. Protozoa.
- IV. Physiology and Anatomy.

In October:—
- I. Botanical Bibliography—
  1. Phanerogamia.
  2. Cryptogamia.
- II. Palæontology.

In January:—Alphabetical List of Authors.

LIV.—ALPHABETICAL LIST OF AUTHORS.

LV.—PHANEROGAMIA.—BIBLIOGRAPHY.

INDEX TO NEW GENERA DESCRIBED IN THE WORKS ENUMERATED.

INDEX.

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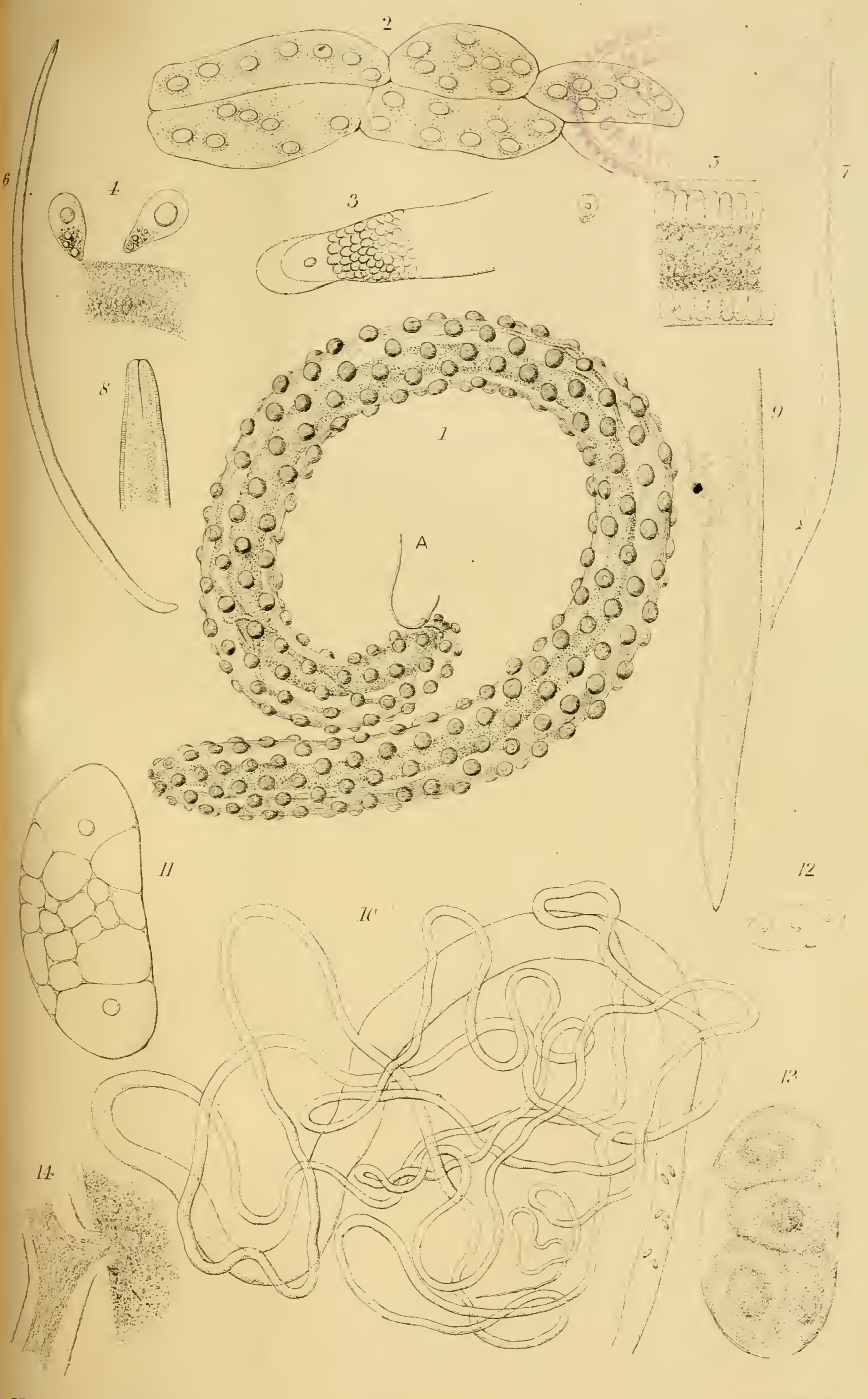

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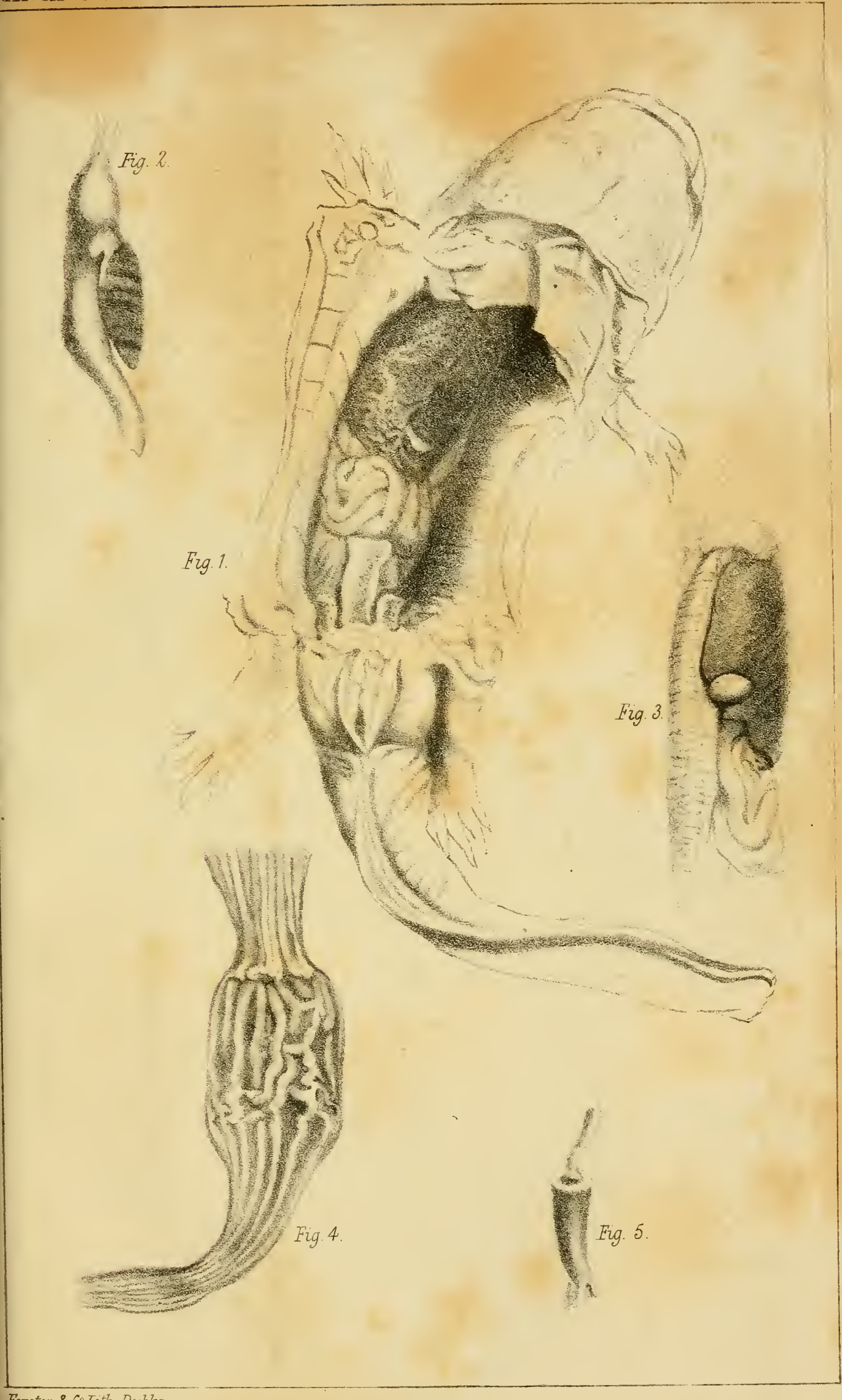

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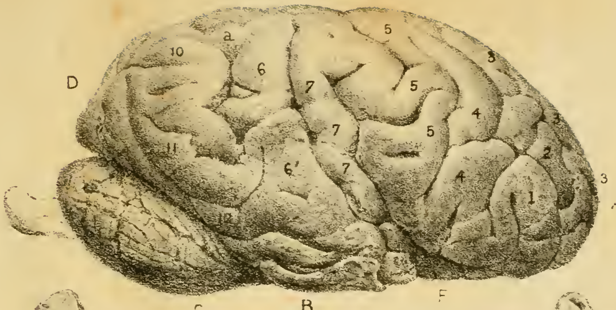

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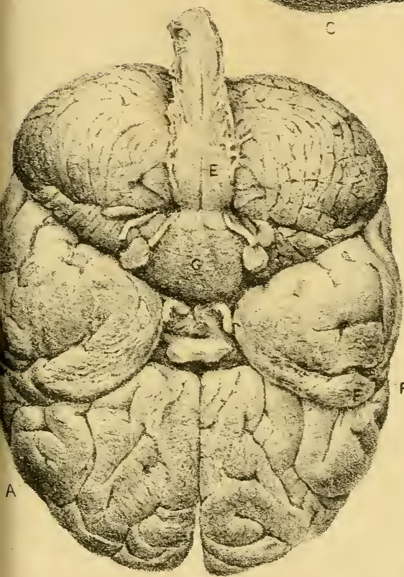

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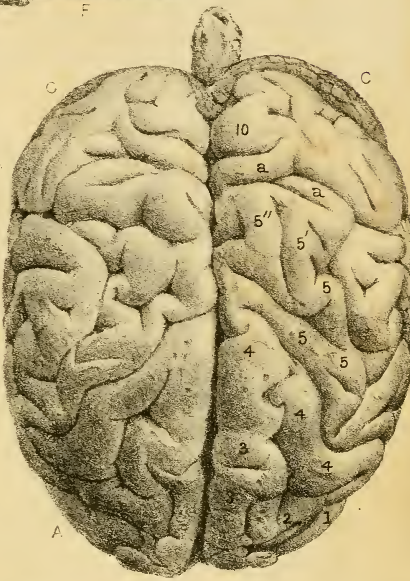

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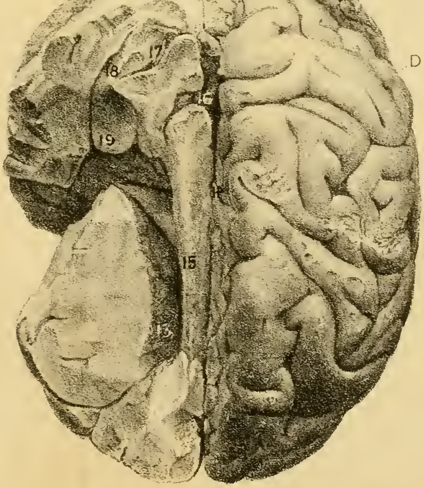

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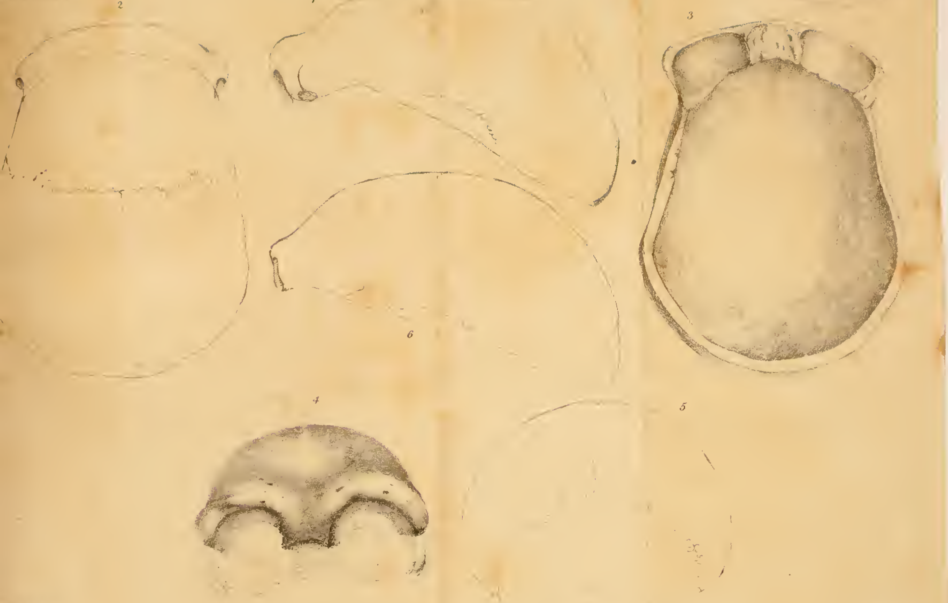
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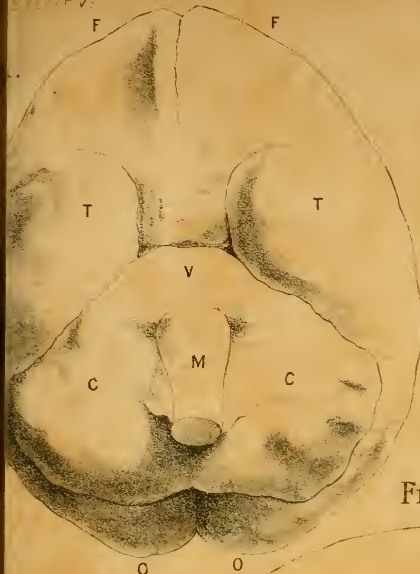

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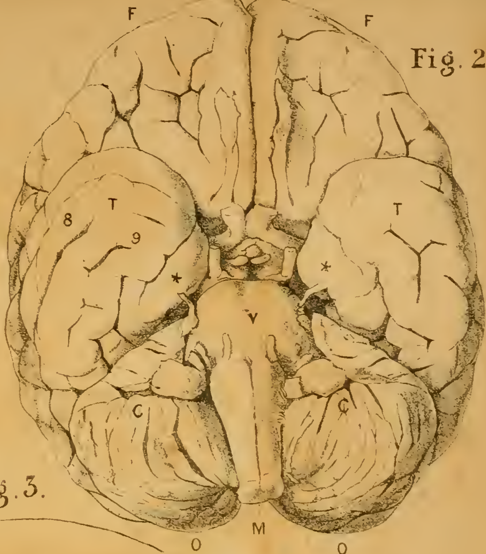

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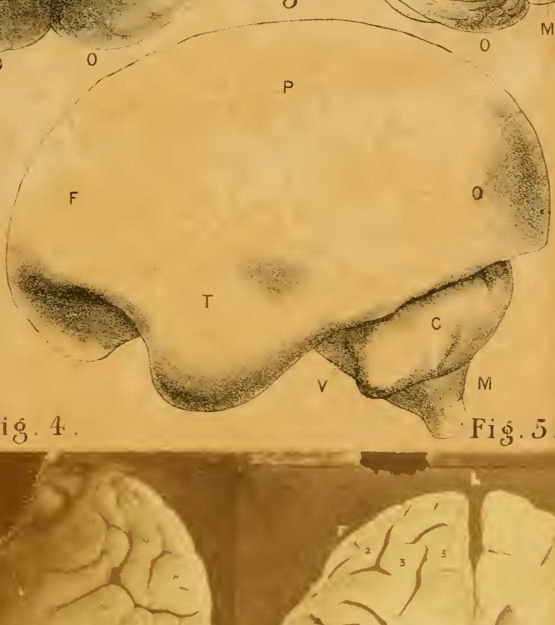

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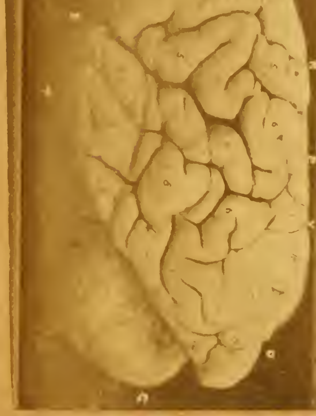

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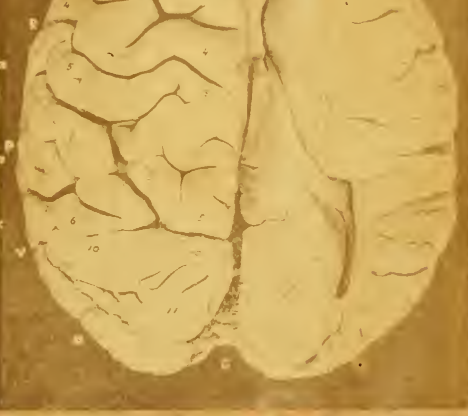

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