In a new edition pages 18, 19 and 20, in so far as they discuss air density, might be slightly modified to advantage. Here "air holes" are spoken of as places of low air density.

An aeroplane entering one of these low density regions from the air of higher density around it, will suddenly fall without any warning, merely because the pressure has enormously decreased, and the aeroplane has not had time to attain the requisite velocity of support in this lighter medium.

Enormous differences in pressure must cause enormous changes in the barometer, but such sudden changes are never found in the open, and, besides, it can be shown that the movement (whirl) of the atmosphere necessary to produce a change of pressure amounting to one tenth of the total would be of most destructive violence.

But this is a small fault to find with a book so generally helpful.

Elementary Aeronautics. By Albert P. Thurston. Whittaker and Co., 126.

This is a non-mathematical but clearly written account of the action of air upon moving surfaces, plane and curved, and the application of these principles in the design and operation of aeroplanes.

While both elementary and brief, it seems to be free from errors, and can be recommended to those who wish some reliable information about the general action of aeroplanes, but have not the time to make a real study of them. W. J. Humphreys

A Manual of Philippine Silk Culture. By Charles S. Banks, Department of the Interior, Bureau of Science, Manila, 1911.

Mr. Banks has been engaged, among his other duties, in a study of the possibilities in the way of profitable silk culture in the Philippines ever since the Bureau of Science was started, and this manual puts into convenient shape the results of his investigations. It is a royal octavo pamphlet of about fifty pages, with 18 good halftone plates and diagrams of rearing house and reel. He gives directions for the care of the domestic mulberry silkworm, and announces a cross between the Bengal-Ceylon and Japanese silkworms which he terms "the Philippine race of silkworms." He also announces the successful introduction of the Eri or Castor silkworm (*Attacus ricini* Boisd.) from Ceylon. He thinks that the silk produced from this insect will be popular not only among the Christian Filipinos, but also among the mountain tribes and the Moros, and further that it will find a sale among the Americans and Europeans for hangings, upholstery and even for heavy dress goods. He concludes that, with both the mulberry and the Eri silkworms, the industry can be carried on in the Philippines under conditions as favorable as those which obtain in the best silk-producing countries in the world, with the added advantage that no disease has appeared as yet. That every effort is being made to prevent the introduction of disease is shown by the act of August 14, 1907, prohibiting the importation of silkworms, either eggs or cocoons, into the Philippine Islands except by the Bureau of Science.

L. O. H.

SPECIAL ARTICLES

FOSSIL HOLOTHURIANS

Few classes of animals have a less satisfactory geological record than the holothurians and every fragment that can be gathered is therefore of unusual interest and importance. The known records occur in two forms, impressions of the whole animal or much more commonly, nearly or quite microscopic calcareous particles imbedded in fine shales and limestones and resembling more or less nearly the similar calcareous particles found in the body-wall of most living holothurians. Ludwig[1] has well summed up the phylogenetic value of these fossil particles:

Solche Reste aus dem Kohlenkalk, dem Jura, der Kreide und dem Tertiär vorliegen, aber keine sichere Bestimmung nach Art, Gattung und Familie gestatten: nur die eocänen Synaptidenreste . . . machen davon eine Ausnahme, da sie sich mit einiger Sicherheit auf die Gattungen Synapta, Chiridota (oder Trochodota) und Myriotrochus beziehen lassen.

[1] 1892, "Die Seewalzen," p. 446.

If then we are to secure satisfactory paleontological knowledge of the history of holothurians we must look for it in the impressions (or possibly casts) of the entire animal. As yet evidence of this sort is very rare and highly unsatisfactory. Rüppell[2] long ago described what he thought was a fossil holothurian from the Solenhofen limestone but there is little about either his description or figure that warrants his conclusion. Zittel[3] suggested that the object might perhaps be a cephalopod, but that is also little more than a guess. Giebel[4] has given an account, accompanied by three good figures, of fossils from the same limestones for which he proposed a genus "Protholoturia." Zittel (*l. c.*) refers casually to this genus but considers the specimens "problematische körper." Probably he was not familiar with the appearance of living holothurians, particularly when eviscerating; otherwise it is hard to see why he was so doubtful about Giebel's specimens. Ludwig (*l. c.*) quotes Zittel but apparently without having examined Giebel's figures, which are deserving of careful consideration. Study of these figures and their accompanying text has satisfied me that the objects really are the impressions or casts of holothurians. Giebel found calcareous particles in the outer body layer (or on the surface of the object), thus confirming the impression made by the striking resemblance of the outline and surface, to contracted specimens of the smaller species of Holothuria. It seems to be impossible, however, to point out any characters by which "Protholoturia" may be distinguished from Holothuria and the name is no doubt a synonym, but it is odd that it is not listed in Scudder's Index (either as Protholoturia, Proholothuria or Protoholothuria) nor in the later generic lists of the "Zoological Record." Even Spandel and other writers on fossil holothurian remains seem to have overlooked or forgotten Giebel's work. Simonelli[5] figures a peculiar fossil, *Lorenzinia,* which he suggests may be part of a holothurian allied to *Pelagothuria.* The material is such that no real identification is possible and the probability of its having anything to do with holothurians is very remote.

The Solenhofen specimens of Giebel therefore appear to be the only fossil holothurians known (not counting, of course, isolated calcareous particles) and obviously their phylogenetic value is slight, as they simply show that holothurians apparently like those of the present day existed in the Jurassic Seas. It was, therefore, a matter of extraordinary interest when Dr. Walcott recently announced the discovery of a notably diversified holothurian fauna in the Middle Cambrian rocks of British Columbia.[6] Through the greatly appreciated courtesy of Dr. Walcott and the kindly assistance of Mr. Austin H. Clark, I have recently had the privilege of examining the material upon which this report is based and I will say at once that Dr. Walcott's published figures leave almost nothing to be desired. Excepting only two specimens, examination of the originals showed nothing not revealed by the figures and equally important is the fact that the figures show nothing which is not equally distinct in the specimens. This is most satisfactory, as it will enable any one familiar with the fundamental characteristics of the class to form an intelligent opinion as to whether Dr. Walcott's fossils represent holothurians or not. The two cases in which I have taken exception to the figures are found on plates ten and thirteen. In Figure 1, Plate 10, the illustration does not quite do justice to the specimen; the knobs shown above the central ring (*CR*) are more distinct in the specimen, two of them showing not only definite outlines but some indications of their structure. In Figure 2, Plate 13, on the other hand, the terminal mouth

[2] 1829, "Abbildung und Beschreibung einiger . . . Versteinerungen . . . von Solenhofen."

[3] 1876–80, "Handbuch der Paläontologie," Bd. 1, Abt. 1.

[4] 1857, *Zeitsch. f. die Gesammten Naturw.*, Bd. IX., pp. 385–388.

[5] 1906, *Bologna Mem. Acc. Sc.*, 1905, series 6, Vol. 2, pp. 263–268.

[6] 1911, "Cambrian Geology and Palæontology," II., No. 3, Middle Cambrian Holothurians and Medusæ, *Smithsonian Misc. Coll.*, Vol. 57, No. 3.

surrounded by a jointed or notched ring is distinctly shown; in the specimen, I was unable to make out these points satisfactorily; there seems little doubt about the terminal mouth, but the surrounding ring is ill-defined and I failed to see the joints.

Dr. Walcott names and describes four genera, each with a single species, of what he believes to be holothurians. He apparently has not seen Giebel's figures for he says (p. 42) that his specimens record "for the first time, with the exception of some scattered calcareous spicules and plates, the presence of this class of organisms in any geological formation." That he feels no serious doubts as to the fossils being holothurians is shown by the statement (p. 43) that they establish "the very ancient origin of the Class Holothurioidea and the fact of its great differentiation in Middle Cambrian time," and the assertion (p. 45) that "The Holothuriidæ is represented by *Laggania cambria* and *Louisella pedunculata* and the Synaptidæ by *Mackenzia costalis*. The Pelagothuridæ is indirectly represented by *Eldonia ludwigi*." It is not clear what is meant by the Pelagothuriidæ being "indirectly represented" by *Eldonia* since that genus is subsequently made the foundation of a new family, the Eldoniidæ, especially as Dr. Walcott later shows that his new genus has almost nothing in common with Pelagothuria.

The material upon which *Eldonia* is based is abundant and much of it seems to be very well preserved, but of *Laggania* and *Louisella* there are single specimens only, while of *Mackenzia* there are but two specimens and they differ from each other greatly. Of *Laggania*, Dr. Walcott says the mouth was "ventral, near the anterior end and surrounded by a ring of plates." "It is not practicable to make out the arrangement of the plate-like structure surrounding the mouth, as the calcareous plates, if ever present, have disappeared." "Traces of tube-feet occur on the ventral surface" but "the body of the animal is so completely flattened that the tube-feet are obscured." I have sought in vain both in the figure and on the specimen for anything that could be called a tube-foot, without an excessive use of the imagination. Moreover the "ring of plates" surrounding the mouth does not remind one of the calcareous ring of a holothurian, but it does suggest to me the radiating folds surrounding the partially contracted oral disk of certain actinians and worms. Dr. Walcott calls attention to the surface markings of "indistinct concentric bands, each one of which is crossed by fine longitudinal lines." This can be easily seen in the figure (at least in certain spots) with the aid of a lens. I do not recall any holothurian with such a surface, but it is suggestive of certain worms, and even some actinians have a somewhat similar exterior. On the whole it does not seem to me that *Laggania* can be positively assigned to any invertebrate phylum. I see nothing beyond the probable form of the body, and the terminal mouth, to suggest a holothurian, and these characters are equally suggestive of actinians.

The specimen of *Louisella* seems to show more structure and Dr. Walcott says of it:

> With numerous tube-feet or podia in two longitudinal rows, and what may be papillæ on two peltate extensions at the posterior end. . . . The ventral sole is beautifully outlined by the marginal row of podia on each side.

Examination of the specimen (or figure) shows of course what Dr. Walcott has called the "ventral sole" and "marginal rows of podia," but neither is suggestive of any known holothurian excepting some of the bizarre Elasipod forms like *Scotoplanes*, to which Dr. Wolcott refers. None of the podia are sufficiently defined to enable one to make out even the form, let alone the structure, whereas if they were really like those of *Scotoplanes* and other Elasipods, their rigidity would have caused them to be as well defined as any part of the body-outline. Dr. Walcott considers *Louisella* a genus of the Holothuriidæ, but the size and arrangement of the supposed podia are entirely unlike anything known in that family. If *Louisella* is a holothurian at all, its "ventral sole" and big podia (?) would suggest the Elasipods as its nearest allies, and the two extensions of the posterior end might be considered confirm-

atory evidence. But as there seems to be no really characteristic holothurian structure shown by the fossil, I fail to see why it should be considered a holothurian.

The small specimen of *Mackenzia* is very suggestive of a synaptid without its tentacles, but the most searching examination fails to show a single character which gives positive support to this view. The mouth and its associated structures are not distinctly indicated. As stated above, I could not distinguish any separated or definite parts in the raised ring which seems to surround the mouth, and there is nothing in it to me suggestive of the calcareous ring of a synaptid. The longitudinal markings of the body-wall are more numerous and closer together than they should be if they indicate the longitudinal muscles of a holothurian. On the whole, these longitudinal markings, the appearance of the body surface and of the oral end, and the form of the animal all seem to me suggestive of certain actinians, although I do not assert that the fossil really represents that group. The larger specimen, referred to *Mackenzia* by Dr. Walcott, shows practically no structure and in my judgment can not be assigned positively to that or any other genus.

Turning now to *Eldonia,* of which the material is plentiful and its condition such that the structure can be made out with a fair degree of completeness, we find an animal so medusoid in outer form that Dr. Walcott uses the terms "exumbrella," "subumbrella," "lobation" and "lappets" and says "the system of radial canals is very striking and medusa-like." I do not recall any medusa with a canal system like *Eldonia's,* with a small central ring, but I think most of us will agree that the general appearance of the animal is that of a free-swimming Cœlenterate, except for the apparently distinct and extraordinary alimentary canal. It is upon the interpretation given this structure and upon the importance attached to it, that our final decision as to the position of *Eldonia* must depend. Dr. Walcott at first thought it might be a commensal worm but later decided it was really the alimentary canal of the animal itself, and upon the strength of its partially spiral form, he based his decision to call *Eldonia* a holothurian. He has, however, pointed out the essential differences between *Eldonia* and *Pelagothuria,* the only known free-swimming holothurian, making it plain that they are not at all nearly allied. Emphasis should be placed on the fact that except for the expansion of the oral disk as a swimming organ, *Pelagothuria* is not an extraordinary holothurian, its internal anatomy being like that of many other members of the class. Its alimentary canal is in loops (a long drawn out spiral) and the mouth is surrounded by the usual circle of tentacles. The alimentary canal of *Eldonia* is not in loops as in a holothurian but seems to have been more nearly in a single plane like one half of the canal of a sea-urchin. The appearance of the tube thus seems to me more echinoid than holothurioid. The mouth of *Eldonia* has on either side a large tentacle; neither Dr. Walcott nor I have been able to find more than two and the whole appearance of the oral region indicates two as the normal number. The tentacles are described by Dr. Walcott as "peltato-digitate" but they have almost nothing in common with the sort of tentacles to which that term has hitherto been applied.[1] On the other hand they seem to me suggestive of the marginal clusters of tentacles in *Lucernaria* and its allies. Perhaps even the oral tentacles of some Rhizostomous Medusæ are not fundamentally different. In some of the specimens, notably the one shown in Fig. 1, Pl. 10, bits of the tentacles show some slight indications of their finer structure. In the figure referred to, small lobes or knobs above the central ring (*CR*) are noticeable and these, in the specimen, show, under the lens, a remarkable resemblance to clusters of nettle-cells. I am not sure that these lobes are part of the tentacles but if they are, as they seem to be, my opinion that the tentacles are more medusoid than like anything known among holothurians would be confirmed. *Eldonia* shows absolutely no trace of pen-

[1] See Ludwig, 1892, "Die Seewalzen," p. 97; Pl. VII., Fig. 5.

tamerous symmetry, no trace of calcareous structure, no longitudinal muscles and no podia. The radial canal system is utterly unlike the water-vascular system of any known Echinoderm and it is perfectly inconceivable how the fundamental, circumoral ring of a holothurian could disengage itself from the esophagus and migrate to the opposite end of the body.

If *Eldonia* is a holothurian, it becomes virtually impossible to define the class, except in terms of the alimentary canal. Indeed if *Eldonia* is a holothurian, the Echinoderms themselves can be defined in no other terms, for *Eldonia* lacks every single character which justifies the customary view that holothurians are Echinoderms. It is far less of a strain on my credulity to believe that *Eldonia,* whose extraordinary nature I have no inclination to deny, is some sort of a Cœlenterate with a commensal worm inside or under the subumbrella, or even that it represents a hitherto unknown phylum, than to believe that it is a holothurian or is connected, save in the remotest way, with the Echinoderms.

As a final result of my examination of the evidence, I am forced to conclude that there is no sufficient justification for the belief in a Cambrian holothurian fauna. The external form of *Louisella* and *Mackenzia* and the supposed alimentary canal of *Eldonia* can not be considered adequate basis for such a belief. There is no good evidence, either in Dr. Walcott's material or elsewhere, to show that holothurians existed before the Carboniferous. But as wheels, which are certainly of a Chiridota-like form, occur in the Zechstein of Europe, and animals closely allied to our modern Holothuria are found in the Solenhofen limestone, it is not improbable that the holothurians were differentiated about as early as the other classes of Echinoderms, excepting the Pelmatozoa. Evidence however in support of such a probability is still conspicuous by its absence.

Hubert Lyman Clark
Museum of Comparative Zoology,
Cambridge, Mass.,
January 12, 1912

Biology of Miastor and Oligarces

The general availability of *Miastor,* at least for laboratory work, justifies the following summary account of the biology of this interesting form and the allied, possibly sometimes associated, *Oligarces.*

Distribution.—Miastor is probably world-wide in distribution, having been recorded from Europe, Australia, North and South America. We have found this genus ranging in New York from the upper austral Hudson valley to the transition or boreal Adirondack region. These peculiar larvæ have also been found in Connecticut and Indiana.

Oligarces has been recorded only from Europe and North America, Albany and adjacent Nassau, N. Y., being the only American localities at present known. This species is probably widely distributed though presumably rarer or less easily detected.

Larval Habits.—The moist inner bark of various trees in the incipient stages of decay are likely places for *Miastor* larvæ. Chestnut rails, ties, stumps, the moist bark of maple, oak, birch, beech and hickory indicate no closely restricted food habits. In addition to some of the above, European report *Miastor* larvæ from elm, ash, ironwood and sugar-beet residue.

We have found *Oligarces* only in decaying elm bark, possibly because the larvæ are not so readily detected in nature.

Distinguishing Characters.—Large colonies of *Miastor* larvæ are easily recognized by the masses of more or less adherent yellowish or whitish larvæ, and especially by the occurrence here and there of motionless individuals with poorly indicated segmentation and elongate, transparent areas, the developing embryos, or containing young so well developed as to be easily distinguished with a hand magnifier, even the form of the head and the fuscous ocular spot being visible. The head of these larvæ, whether small or large, is flattened, triangular with diverging antennæ and quite different from the strongly convex, usually fuscous head of *Sciara* larvæ. *Miastor* larvæ have transverse incisurial bands of