in such a steel by slow cooling from the tempering temperature, and is revealed by a low absorption of energy in the single-blow impact test on notched bars. The author has found that wide differences in the impact figure with almost identical tensile test results can be produced by suitable heat treatment. He has also found that whereas, after hardening, every tempering treatment involving a final rapid cooling from 600° C. or above produced good impact figures, a final slow cooling produced a considerably lower, and often a bad, impact figure; further, that in any given steel the degree of brittleness which can be produced by a given condition of tempering depends on the original hardening temperature. The higher this is, the lower is the impact figure. He has also found that reheating to about 520° C. produces brittleness, whatever the subsequent rate of cooling, and that this can be removed by reheating to between 600° C. and 670° C. and cooling rapidly.

These results can be explained on the assumption that a critical temperature or temperature range exists in the neighbourhood of 550° C., above which the tough, and below which the brittle, condition is stable. Quick cooling through this temperature retards this change, and the unstable tough condition is retained. Slow cooling results in the production of the stable brittle condition. If the tough material is heated to a temperature rather below the change point, the rate of change to the brittle condition is at a maximum, and brittleness results. The rate diminishes rapidly with fall of the temperature, and below 450° is negligible. Provided, therefore, the critical temperature is not exceeded, the rate of cooling after this reheating is immaterial. Mr. Greaves does not show any cooling or heating curves of his steel. Those published by Messrs. Andrew, Greenwood, and Green on a steel of approximately the same composition indicate that the carbon-change point on cooling occurs between about 490° and 465° C. The character of the curve obtained depends upon the initial temperature from which the steel is cooled.

H. C. H. C.

CEPHALODISCUS AND THE ARCHICHORDATES.[1]

THE history of Cephalodiscus, dredged at 245 fathoms in the Strait of Magellan by the *Challenger*, and at first taken for an Alga, and then for a compound Ascidian, goes back only three dozen years. Moreover, the sole species (*C. dodecalophus*) held the field for twenty-one years before the other species made their appearance; but now, with Dr. Ridewood's memoir before us, the total number of species reaches from twelve to sixteen, though further research may reduce that number. It is noteworthy that whilst the majority group themselves around the South Pole, four occur in the Indian and Pacific Oceans.

In the present memoir Dr. Ridewood, already known as an authority on the subject, keeps to the classification adopted previously, the group Pterobranchia (Aspidophora of Allman) having three subgenera of Cephalodiscus, viz. Demothecia, colony branched, with a continuous cavity throughout the cœnœcium; Idiothecia, colony branched, but each aperture leading into a tube occupied by one zooid and its buds; and Orthothecus, in which the colony is cake- or cone-like, each aperture entering a tube holding a zooid and its buds. The author first treats of the structure of the zooids, the similarity of which throughout the whole series is noteworthy; only in the reduced male zooids of *C. sibogae*, Harmer, is there a divergence. This fact alone would give differences due to variations in the cœnœcium less weight.

Amongst other features of interest are the enlargements at the ends of the tentacles, for instance, in the original species, which the author terms "end-swellings with refractive beads," and it is curious that no special function has been assigned to them. Similar enlargements at the tips of the branchial filaments are prominent features in Filograna and the so-called Salmacina, and great weight has been placed on them specifically, and even generically, by certain observers. In all probability they are sense-organs in both groups, since they are not connected with secretion, nor do they perform the function of opercula in Filograna (a Serpulid), in which form they are present or absent with puzzling indifference, for the plasticity of the species is phenomenal. The changes in the character of the epithelium on the dorsal and neural surfaces of the arms, and on the two surfaces of the post-oral lamellæ, are probably due, as in other forms (*e.g.* the Serpulids), to differences in function. The length of the testis is thought by the author to be a specific character, but that of the ovary is not.

Details are given of a new species, *C. evansi*, a branched form, in which each ostium leads into a tube ending blindly in the middle of the branch. The other three species procured in the expedition were formerly known, viz. *C. nigrescens*, Lankester, *C. densus*, Andersson (which the author considers to be a variety of the next), and *C. hodgsoni*, Ridewood. Thereafter a discussion on the Demothecia occurs, the species being extremely difficult to distinguish either by cœnœcium or zooids, and it is possible that future observers may reduce the number of species, since the variations of both cœnœcium and zooids in a single species are considerable.

No new feature is given in connection with reproduction and development further than that the author thinks there is no certain relation between the number of arms and the sex, as Andersson did, and that in *C. hodgsoni* the short stalk of the egg spreads over the egg-shell. Males, females, and hermaphrodites are found in *C. hodgsoni, C. aequatus, C. nigrescens, C. solidus*, and *C. densus*, whilst no males have yet been found in *C. dodecalophus, C. levinseni*, and *C. gracilis*. In *C. sibogae* and *C. agglutinans* only males are known, and in *C. gilchristi* and *C. evansi* both sexes frequent the same colony.

The author makes no allusion to the systematic position of Cephalodiscus in zoological classification, or to the homologies of the organs which have received the attention of many zoologists in connection with that classification. Dr. Masterman's Archichordata (Trimetamera), therefore, stands as before, with its two classes (1) Hemichordata (*e.g.* Balanoglossus) and (2) Diplochordata (*e.g.* Phoronis, Cephalodiscus, and Rhabdopleura), though not without dubiety in certain aspects, which even the labours of Spengel, Weldon, Cori, Fowler, De Selys-Longchamps, Lankester, Harmer, Gilchrist, Ridewood, Schepotieff, Davidoff, Hill, Gravier, Pixell, and Roule have not quite elucidated. Much of the dubiety is connected with the notochord and the gill-slits. Dr. Harmer thought that the proboscis-vesicle and "heart," with the notochord, essentially agreed with the condition in Balanoglossus, as described by Mr. Bateson; but Dr. Masterman, keenly working at Actinotrocha, Tornaria, Phoronis, and the young forms of Cephalodiscus, held that the primitive types had a double notochord, and his beautiful and accurate drawings speak for themselves whatever interpretation may be put

[1] "British Antarctic (*Terra Nova*) Expedition, 1910. Cephalodiscus. By Dr. W. G. Ridewood. With 12 text-figures, 5 plates, and a map (Published by the Trustees of the British Museum (Natural History), 1918.) Price 12*s*.

on them. Dr. Harmer's notochord, proboscis-vesicle, and heart are Dr. Masterman's subneural gland, subneural sinus, and preoral sac respectively, and Masterman has demonstrated that the subneural gland of Cephalodiscus and the "Eicheldarm" of Balanoglossus occupy entirely different relationships from the surrounding organs in each case, and therefore cannot be homologous. In both Balanoglossus and Actinotrocha there is a large subneural sinus. The presence of pleurochords in Cephalodiscus, of lateral grooves in Tornaria, and of pharyngeal pleurochords in Rhabdopleura, terminating (as in Tornaria) in oral grooves, which Morgan has shown grow outward into serial pouches, are points of interest in connection with Dr. Masterman's view. Besides, in Balanoglossus there are other chordoid parts in addition to the notochord of Bateson and Harmer. Larval Enteropneusta, again, have a pharynx with simple, paired pleurochords terminating in lateral grooves. It has to be borne in mind that Davidoff describes the notochords and nervous system in certain Tunicates as arising from paired rudiments, and the same observation has been made by Brooks in Salpa. In any case, as Masterman shows, Roule's view that Actinotrocha is a trochophore cannot be held, since the cavity of the latter is a hæmocele, whereas the hæmocele of Actinotrocha is restricted to a small space between the cœlomic sacs. The whole subject is a complex one, yet it may be that further research will weld these diverse views into harmony. Meanwhile, Masterman's opinions have much in their favour.

The memoir concludes with a useful synopsis of the species of Cephalodiscus, and the five plates are excellently drawn and lithographed, the map at the end showing at a glance the distribution of the various species, the whole forming a worthy tribute to the methodical and patient industry of the author, who, along with Dr. Harmer, of the same great museum, has done so much to extend our knowledge of this very remarkable group.

W. C. M.

THE ITHACA AGRICULTURAL EXPERIMENTAL STATION.[1]

AGRICULTURAL experts visiting the United States always include the Ithaca Experimental Station in their programme if they can possibly manage to do so, for it is one of the finest and largest in that country of large institutions. Incidentally also, it appeals to all who read and loved Fenimore Cooper in their younger days, for it is situated in the lake country, and still preserves some of the waterfalls and woods associated with his heroic, if somewhat mythical, warriors.

The reports before us are bulky volumes, each of a thousand or twelve hundred pages; they are in keeping in point of size with the whole institution. The list of the staff occupies four closely printed pages, and includes nearly two hundred names. The number of printed copies of bulletins, reports, etc., sent out during one year only was 3,014,000. The State grant was 450,000 dollars in 1913; it rose during the war to 779,401 dollars for the year 1917–18. An Englishman reading these figures, and realising how greatly the income of this one institution exceeds that of all English agricultural colleges and experimental stations put together, begins to gasp when he finds the acting Dean declaring:—"The greatest single need of the college at the present time is more funds for research"; and again, "In common with other colleges in the University, the College of Agriculture is suffering because of the inadequate salaries which members of the staff are receiving."

The investigations cover the whole field of agriculture, but as no summaries are given it is not easy to find one's way through them.

A large number of the bulletins deal with diseases and pests of farm and garden crops, devoting special attention to practical methods of coping with them. In this type of work the American investigator excels; we have scarcely begun to make provision for field-work in plant pathology in Great Britain, although a promising start has been made with the more fundamental investigations. An extended series of observations on the nodule organism (*Bacillus radicicola*) of soybean is given in Bull. 386; the general result is that nodule formation can be considerably checked or stimulated by the presence or absence of certain salts and by variations in the amount of soil-moisture. Chlorides, phosphates, calcium salts, and certain organic compounds such as sugars, starch, oxalic, lactic, and citric acids, increase the amount of nodule formation; increases in moisture-content had a notable effect also. On the other hand, nitrates, ammonia compounds, and sulphates reduce it, though they do not kill the organism.

The direct assimilation of certain carbohydrates by green plants is discussed in Memoir 9 (1916). Saccharose, glucose, maltose, and fructose are directly absorbed and utilised by plants (green maize, Canada field pea, timothy, radish, vetch, etc.); moreover, they produce a characteristic branched-root system. It is suggested that the absorbed sugar is largely utilised in the root itself, but little migrating to the stems and leaves; this diminishes the downward migration of the sugar produced by photosynthesis and leads to increased top growth. Certain plants, such as radishes, vetch, and Canada field pea, are able to utilise lactose, although this sugar has not been found in the vegetable kingdom. Curiously enough, however, galactose is toxic to green plants, although it is utilised by various fungi. The bearing of the results on the old question of the source of carbon for plants is obvious, and the author concludes, as Laurent did in 1904, that the organic matter of soil plays a direct part in the nutrition of green plants, and in certain circumstances, notably in glass-house work, this part may be very important.

The soil surveys of Oneida County (Bull. 362) and of Orange County (Bull. 351) are typical of this kind of work as done in America. They form interesting reading, and would be helpful to a young man wishing to settle on the land but uncertain to which part of the country to turn.

Costs of production of farm crops form the subject of an important investigation (Bull. 377, 1916). In 1912 and 1913 the average costs of producing oats per acre in New York State were respectively 23·51 dollars and 22·34 dollars per acre, *i.e.* 4*l.* 18*s.* and 4*l.* 13*s.* respectively. It is interesting to compare these figures with the Rothamsted data, where the cost in 1913 was 6*l.* 4*s.* per acre. In both cases one of the largest single items is labour; in New York State it was 3·60 dollars per acre (15*s.*), at Rothamsted 21*s.* 4*d.* per acre, although the rate of wages paid in New York was double that paid in this country. The New York yield was 33·5 bushels per acre, that at Rothamsted 48 bushels.

Bull. 338 contains an interesting study of fertile and infertile soil otherwise similar in character; it was found that the former more readily accumulated nitrates than the latter. The most obvious cause was the difference in compactness of the soil, the fertile being less compact and having a smaller volume-weight than the less fertile one. An extensive bacteriological

1 Reports of the Agricultural Experimental Station, Ithaca, New York, for the Years 1914–17.