die to the ground in winter are rare, as are bulbous plants.

The plant associations of New Zealand, on which Dr. Cockayne has written so extensively,[2] are of surpassing interest; to find an equal variety a continent extending to the tropics would have to be visited. The northern rivers and estuaries display a mangrove vegetation—a unique and unexpected occurrence outside of the tropics. The lowland and montane forests are of the tropical rain-forest type, and are distinguished by the abundance of filmy ferns, tree-ferns, woody climbers, massive perching plants, deep carpets of mosses and liverworts, and trees with buttress-roots. The high-mountain forests are subantarctic in character, and are usually dominated by the southern beech (Nothofagus). Wide areas are covered by shrub heath, fern heath of tall bracken, and moorland with bogs, while grass-land with tussock grasses is a great feature of the volcanic plateau of the North Island and of the east of the South Island; species of Poa and Festuca form the chief tussocks of the lowlands and lower hills, but at higher altitudes species of Danthonia are dominant.

The alpine vegetation contains, excluding lowland plants which ascend to the mountains, about 550 species, most of which never descend below 1500 ft. altitude, while some are confined to the highest elevations. The most beautiful of New Zealand flowers, with but few exceptions, belong to this mountain flora—the great white and yellow buttercups, the marguerite-flowered celmisias, and the variously coloured ourisias, eyebrights, forget-me-nots, and many more. The growth-forms are often striking—cushion-plants, rosette-forming plants, stiff-branched shrubs, mat-forming plants, and other xerophytes are much in evidence, showing the usual xerophilous leaf-characters (hairiness, leathery structure, rigidity, needle-points, &c.).

The floras of the Kermadecs, Chatham Islands, and the Subantarctic Islands (Snares, Auckland, Campbell, Antipodes, Macquarie)—island groups far distant from the mainland—are distinctly part of that of New Zealand. The Kermadecs contain 114 species of vascular plants, only twelve of which are endemic, while seventy-one belong to New Zealand proper; the largest island (Sunday Island) is covered with forest in which *Metrosideros villosa*, a near relative of the pohutakawa (*M. tomentosa*), is the dominant tree. The Chatham Islands have 235 species, twenty-nine of which are endemic, while the remainder of the flora is found on the mainland. The chief plant associations are forest, moor, and heath; on the moors are great thickets of the purple-flowered shrub *Olearia semidentata*, while there are two remarkable endemic genera, Coxiella (an Umbellifer) and Myosotidium (a giant forget-me-not)—both now almost extinct, unfortunately. The Subantarctic Islands have a dense vegetation consisting of 194 species, of which no fewer than fifty-two are endemic, the rest occurring in New Zealand, but chiefly in the mountains. Forest is found only on the Snares and the Aucklands, the dominant trees being an Olearia and a Metrosideros respectively. Very dense scrubs occur on the Auckland and Campbell Islands, and moors are characteristic of all the islands, owing to the enormous peat-deposit and the frequent rain. The Cook Islands, though forming a part of the dominion, have a Polynesian flora quite distinct from that of New Zealand, and are therefore not included in Dr. Cockayne's notice, while, on the contrary, the flora of the Macquarie Islands, though belonging to Tasmania, is a portion of that of New Zealand.

The indigenous flora has been invaded by an important introduced element, consisting of about 540 species, mostly European, which has followed in the wake of settlement. Dr. Cockayne points out that although these aliens are in active competition with the true native plants, the widespread opinion that the latter are being eradicated in the struggle is quite erroneous. Where the vegetation has never been disturbed by man, there are no foreign plants at all, but where man has, by farming operations, stock-raising, and burning, brought about European conditions, the indigenous plants have given way before artificial meadows with their economic plants and accompanying weeds. On the tussock-grass areas, however, invaders and natives have met, and though the original vegetation has changed, there is no reason to consider the one or the other as the victor. On the contrary, it appears likely that both will persist, and in course of time a new flora and vegetation will be evolved.

F. C.

PALÆOZOIC AND OTHER ECHINOIDS.[1]

THE Echinoidea afford probably greater opportunities for accurate phylogenetic study than any other class of animals. This is due to the fact that a fossil Echinoid is, when well preserved, often as complete for morphological, and even ontogenetic, examination as a recent specimen. No work on recent Echinoids could be adequately carried out without reference to the fossil forms, while any classification of the group based on structures other than skeletal would exclude more than half the available material.

There could be no better proof of the absolute interdependence of zoology and palæontology than the volume before us. The work aims primarily at a revision of the known Palæozoic Echinoids, but before the characters and relations of those highly specialised forms can be well understood, an exhaustive general survey of the morphology of the whole class is necessary. Conversely, it is surprising, but none the less gratifying, to find that the fullest account of the lantern of a recent Echinoid yet published is included in a work mainly concerned with Palæozoic types.

In the introduction a valuable summary of the methods of research (based largely on those of Hyatt) is given, together with useful technical hints for the preservation and development of recent and fossil Echinoids.

The first section of the work is devoted to a detailed account of the comparative morphology of the class. Beside the study of the lantern already mentioned, three features stand out preeminently in this part. Teratological and other irregularities of development are here systematised for the first time, and their value in the interpretation of normal conditions is clearly established. The apical system, considered biometrically, is found to yield important evidence of the direction of evolution in species, especially among the regular Echinoids. But perhaps the most noteworthy conclusion reached concerns the actual composition of the test. It is shown that the only parts of the Echinoid skeleton that occupy an interradial position are the genital plates and the braces of the lantern. Each interambulacrum is really composed of two separate halves, each half having its origin in the same ocular plate as the contiguous ambulacrum.

The systematic classification contained in the second section of the work is concerned chiefly with the regular Echinoids. The only striking novelty is found

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[2] See, for instance, the papers reviewed in NATURE, vol. lxxxviii., pp. 51, 590.

[1] Memoirs of the Boston Society of Natural History. Vol. vii., "Phylogeny of the Echini," with a Revision of Palæozoic Species. By Robert T. Jackson. Pp. 491+76 plates. (Boston: Printed for the Society, 1912.)

in the subdivision of the Centrechinoida (*olim* Diademoida). Here the characters of the jaws are used as the guiding features in the separation of three suborders.

The final part of the paper gives a complete survey of all Palæozoic Echinoids hitherto described, and, naturally, includes the description of several new genera and species. The completeness of the revision may be gauged from the fact that figures are given of all but four of the known species. The seventy-six plates accompanying the paper are partly photographic and partly diagrammatic, both alike admirably clear. A full bibliography and an adequate index bring to a fitting conclusion a work that must always remain a classic to echinologists, and a model to workers on other groups. H. L. H.

CHEMISTRY OF THE SUGARS.

PROF. EMIL FISCHER'S latest paper in the final part of the Berlin *Berichte* for 1912 brings another chapter in the chemistry of the sugars to a close. His welcome return to the subject has been attended with the same brilliant experimental dexterity which led to his former successes in this remarkable group of compounds, and it is to be hoped that he will yet succeed in conquering the still unsolved problem of the synthesis of the disaccharides. Fischer now describes the conversion of ordinary glucose into a methyl pentose, and is enabled to clear up the constitutional formulæ of the stereoisomeric methyl pentoses and effect their complete synthesis from the elements.

The methyl pentoses are a somewhat remarkable group of compounds; they represent sugars of the type of glucose in which one hydroxyl group is reduced so that $CH_2.OH$ is replaced by CH_3. At first their occurrence was rare and limited to a few coloured glucosides. Many more of these have been described recently, but the group is most widely represented amongst the seaweeds, the investigation of which we owe to Votoček. As a result of his work, several isomerides of rhamnose, the methyl pentose which was first discovered, are known.

Fischer started from a dibromo-derivative of glucose, discovered by Fischer and Armstrong ten years previously. The one bromine atom in this substance is attached to the carbon atom at one end of the chain of carbons which constitutes the skeleton of glucose; it is easily replaced by methoxyl and a glucosidic compound formed. The position of the second bromine was uncertain; there were reasons for considering it as attached to the other end of the chain. This position is now confirmed by the fact that when the bromine atom is reduced the glucoside of a methyl pentose is formed from which the methyl pentose is in turn obtained. The new sugar proves to be identical with a compound described by Votoček, and receives the name isorhamnose. Its configuration formula must be the same as that of glucose, and it is easy to deduce the formula of rhamnose and other members of the group.

A side issue of the research, which, however, possesses the very greatest interest, is the behaviour of the new glucoside of isorhamnose towards enzymes. Like the β-methyl glucoside, from which it is derived, it is hydrolysed by emulsin, though somewhat more slowly. Apparently the substitution of CH_3 for $CH_2.OH$ is not sufficient to put the compound out of harmony with the enzyme; this is what might be expected in view of Irvine's proof that tetramethyl-β-methyl glucoside is likewise hydrolysed by emulsin. It is therefore all the more remarkable that β-methyl xyloside, which differs only in that the CH_3 group is replaced by H, is not acted on by the enzyme in the very least.

A more striking proof of the selective nature of enzyme action could not well be desired, and the moment is opportune to emphasise this fact, since it is fundamental to the interpretation of vital phenomena. E. F. A.

GYROSTATS AND GYROSTATIC ACTION.[1]

WE are accustomed in daily life to handle non-rotating bodies, and their dynamical properties excite little attention, though it cannot be said that they are commonly understood. It is different, however, with rotating bodies. These, when handled, seem to be endowed with paradoxical, almost magical properties. I have here an egg-shaped piece of wood. I place it on the table and it rests, as we expect it to do, with its long axis horizontal. Our experience tells us that this is the natural and correct position of the body. But I set it spinning rapidly on the table, as you see, with the long axis horizontal, and you observe that after an apparently wobbling motion it erects itself so that its long axis is vertical. It was started spinning about a shortest axis, but the body has of itself changed the spin, and it is now turning about the long axis. In taking this position it has actually raised itself against gravity, through a height equal to half the difference between the lengths of the long and short axes. This seems paradoxical, but the man who is in the habit of spinning tops knows that this is the proper position of the body, that it must stand up in this way when spinning rapidly on a rough horizontal plane.

This experiment may be performed at the breakfast table with an egg as the spinning body. But the egg must be solid within—that is, it must be hard-boiled; a raw or soft-boiled egg will not spin. Perhaps this was why Columbus did not adopt this method for his celebrated experiment; there may, of course, have been other reasons.

It is thus made clear that by causing a body to rotate rapidly we endow it with new and strange properties. Between a top when spinning and the same top when not spinning there is a difference which reminds us of that between living and dead matter; and this will strike us still more forcibly when we consider some more complicated cases of rotational motion. The top, the ordinary spinning-top of the schoolboy, stands on its peg and "sleeps" in the upright position, in contempt of all the laws which govern statical equilibrium.

The experimental study of spinning-tops is carried on by very small boys and a few more or less aged people. Somehow, but I think quite wrongly, a top is regarded as a toy suitable only for a child, and that kind of amusement is scarcely encouraged by the benevolent despots who so completely direct the games of boys at school. Among older boys there used to be a regular game in Scotland of "peeries," and some of you may have read Clerk Maxwell's poetical description of the Homeric contests which distinguished the sport.

The top as a plaything is depised; nevertheless it is a most important contrivance. The earth on which we live is a top, and a considerable range of astronomical phenomena are most easily explained by reference to the behaviour of ordinary spinning-tops. It is a top that directs the dirigible torpedo, that controls the monorail car, which may soon rise from the posi-

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[1] Discourse delivered at the Royal Institution on Friday, February 14, by Prof. Andrew Gray, F.R.S. The motor-gyrostats described are the invention of Dr. J. G. Gray and Mr. G. B. Burnside. The gyrostatic tops and combinations used in the latter part of the lecture are due to Dr. Gray.