believes that the post-flagellate phase finds its way back again to the human being, when the bug feeds again, by regurgitation from the intestine. Proof of this is as yet lacking, but he hopes in future experiments to solve this part of the problem once and for all. He states that if the bug takes a fresh feed of blood when the parasites in its intestine are in the flagellated phase, they are all destroyed, and cannot develop further. "Human blood has some body in it which not only prevents the process of flagellation, but also destroys the flagellates. This substance is in all probability the complement, and it is known that it is itself destroyed in about two days, when blood is drawn from the human body. This fact further explains why the parasite only begins its development in the bug on the second day. . . . Though many bugs may become infected, only those which do not feed again till the parasite has passed back to its post-flagellate stage are infective." He believes that only in its "post-flagellate" leishmanial form can the parasite resist the destructive action of fresh blood and re-infect the vertebrate host.

The author's conclusion that a non-flagellate leishmanial stage is the final phase in the development of the parasite in the insect-host is based largely on a comparison with the herpetomonad parasites of insects; that is to say, on an analogy with species which are parasitic in invertebrate hosts alone and have no alternate vertebrate host in their life-cycle. In such species, however, the infection of new hosts is effected (apart from the possible occurrence of "hereditary" infection) by the contaminative method; that is to say, by means of resting, non-flagellate phases, usually encysted, which pass out of the host in the fæces, and are accidentally swallowed by another insect-host. On the other hand, in all known cases where a flagellate parasite has an alternation of hosts, vertebrate and invertebrate, and where the vertebrate host is infected by the inoculative method, that is to say, by the parasite being injected into it through the mouth-parts of the invertebrate in the act of sucking blood; in all such cases that have been investigated accurately up to the present, the final stage of the parasite in the invertebrate host is an active flagellate. Further, it has been frequently observed in, for instance, the development of trypanosomes in their alternate invertebrate hosts that the active, flagellate forms, usually crithidial or herpetomonad in type, may pass temporarily into a resting, non-flagellate, leishmanial phase during hunger-periods, when the ingested blood is digested and absorbed, and become active flagellate forms again when the host takes in a fresh supply of food.

From these considerations the possibility is not to be excluded at present that Captain Patton's observations may be capable of an interpretation different from that which he places upon them. It may well be that his "post-flagellate" stage represents a resting phase upon which the parasite enters when the blood taken up by the bug is digested, and that when the bug feeds again these resting forms will become active once more, and give rise to a final flagellate stage, yet to be discovered, which will be inoculated ultimately into the human being. It must, however, be borne in mind that it has not yet been proved definitely that the parasite passes from the bug into the human being by inoculation through the proboscis; if, as is at least possible, the parasite is destined to pass out of the bug in its fæces, it is then probable in the highest degree that the final stage in the development in the bug would be a resting, non-flagellate phase.

The final decision, however, with regard to the transmission of the parasite of Kala-azar will rest, not upon analogies with other parasites, but upon facts demonstrated with regard to this parasite itself, and if Captain Patton establishes his statements, he will have added a new type of development and transmission to those known already to occur in flagellate parasites of vertebrates transmitted by blood-sucking invertebrates. However this may be, the author is to be congratulated on having brought forward very strong evidence to show that, as suggested originally by Rogers, the spread of this very deadly human disease is to be attributed to the agency of the bed-bug, a discovery of immense practical importance.

E. A. MINCHIN.

NEW ZEALAND VEGETATION.[1]

IN a brief general account, contributed to the "New Zealand Year-book, 1912," Dr. L. Cockayne, F.R.S., who has done so much floristic and ecological work in New Zealand, points out that owing to its long isolation and diverse elements (Malayan, Australian, subantarctic, and endemic), the flora of New Zealand is of special interest.

The vascular plants in this flora—ferns, fern-allies, and seed-plants—number, so far as at present known, about 1700 species, of which about three-fourths are endemic. Of the lower plants—algæ, fungi, lichens, liverworts, and mosses—many hundreds have been described, including many remarkable genera and species, but there can be no doubt that hundreds more remain to be described. The ferns and fern-allies form a striking feature in the vegetation in some areas, but are not of such great relative importance in the New Zealand flora as has sometimes been supposed; still, about 160 species of these plants are known.

Among the seed-plants, the daisy family is the largest, as might be expected, having more than 230 species; the sedge, grass, and figwort families follow with more than 100 species each, while between thirty and seventy species belong in each case to the orchid, carrot, buttercup, bedstraw, epacrid, willowherb, pea, rush, and forget-me-not families.

Among genera which contain many species and are marked by great variability, making them difficult to define and classify, Dr. Cockayne mentions Veronica, Carex, Ranunculus, Senecio, Epilobium, and Myosotis. The genus Veronica, with more than 100 species, is remarkable for its variability and for the almost endless variety of habit assumed by the various species, some of the New Zealand speedwells (mostly endemic and largely alpine in habitat) being small trees, while the majority are shrubby and often dwarf, frequently simulating cypresses and other conifers owing to their reduced and appressed leaves. Apart from variability in the adult plants, about 100 New Zealand species, belonging to different genera, have juvenile forms which are quite distinct from the adult forms, and may retain their juvenile characters for many years; this is seen in various trees, such as lace-bark, lancewood, and ribbonwood.

Among the multitudinous growth-forms, characteristic of diverse life conditions, the more remarkable are the climbers with woody rope-like stems, resembling the lianas of the South American tropical forests; shrubs with wiry interlaced branches forming close masses; the curious cushion-plants, sometimes of immense size, as in the vegetable sheep (species of Haastia, Raoulia, and Psychrophyton); leafless shrubs with round or flattened stems, and so on. The woody plants are almost all evergreen, only some twenty species being deciduous or semi-deciduous; herbs that

1 "The Flora of New Zealand." By Dr. L. Cockayne. Extract from the "New Zealand Year-book, 1912."

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.

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

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

[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.)