Elliptical Temple produced strictly comparable results. The Conical Tower of Zimbabwe was also attacked with the consent of the Rhodesian Government; a tunnel was driven through from side to side, exposing a width of 3 ft. to 4 ft. to bed rock. It was found to rest without any preparation whatsoever on 6 ft. 6 in. of sandy yellow subsoil similar to that under the Maund ruins. The first find was a beautiful early stone implement. The soil was sieved, but all that it produced was a small iron band, a minute gold bead, traces of wire bangle, and a small sherd of the usual black polished pottery. The workmanship is haphazard, the foundations have not been levelled, and hence to counteract a fall of 1·9 ft. in a diameter of 18 ft. 4 in., the upper courses have had to be thickened.

As regards dating, a larger number of beads has been obtained than ever before, possibly owing to the use of the sieve. Although a full report on them has not yet been received, they include types from southern India, definitely considered to be not later than A.D. 900. Others are found in ruins of villages in Malaya and Borneo, and are assigned to a period between A.D. 600 and A.D. 1100. Dr. Randall-MacIver's evidence from objects of foreign origin gave comparable dates ranging to the sixteenth century. The evidence of the two investigations may be regarded as complementary; one fully substantiates the other. As to the Semitic origin of the ruins, there can be no question, in Miss Caton-Thompson's view, that they are typically Bantu. This, however, does not eliminate their interest. As the author said in the remarks with which she concluded her report: "Instead of a degenerate offshoot of a higher Oriental civilisation best studied in its homeland, you have, I believe, a vigorous native civilisation, unsuspected by all but a few students, showing national organisation of a high kind, originality, and amazing industry. It is a subject worthy of all the research South Africa can give to it; South African students must be bred to pursue it."

The Chilean Earthquake of 1922.

IN studying the great Chilean earthquake of Nov. 10, 1922, Prof. Bailey Willis has been led to some interesting conclusions with regard to the origin of the great earthquakes of Chile and Peru. Invited by the Carnegie Institution to study the earthquake, he spent seven months in Chile, five of them in the province of Atacama, in which the earthquake attained its greatest strength. The results of his work are described in a volume of unusual interest and value.[1]

The northern part of Chile consists of the desert region of Atacama. In climate and topography it closely resembles southern California. It is a region of interior basins, of salt plains and sterile mountains, one of the most arid districts of the world. Both countries are similarly situated with regard to the deep ocean basin of the Pacific and the high cordilleras to the east. In Chile, however, there is no great longitudinal river system as there is in California. The rivers flow from the Andes direct to the sea in channels that are in places divided by mountain ranges of considerable altitude.

In the last four centuries, from 1543 until 1922, the province of Atacama has been visited by 22 destructive earthquakes, the last but one, on Dec. 4, 1918, especially strong at Copiapó. During the month preceding the earthquake of 1922, from Oct. 4 until Nov. 8, there was general activity throughout the entire length (1500 miles) of the earthquake zone of Chile and south Peru, no fewer than eight earthquakes of unusual strength, though of limited incidence, having occurred within it. Then came the great earthquake at about 11.45 P.M. on Nov. 10 (4h. 32m. 33s., A.M., Nov. 11. G.M.T.).

The earthquake was remarkable more for the extent of its area of disturbance than for its intensity at any point within it. From some rough estimates made by Prof. Willis, it would seem that the maximum acceleration was about 3000 mm. per sec. per sec., and it nowhere attained so high a value as 4800 mm. per sec. per sec. In other words, the shock was about as strong as that of the Japanese earthquake of Sept. 1, 1923. But while the disturbed area of that earthquake does not appear to have exceeded 166,000 square miles, the Chilean earthquake was violent over a zone not less than 300 miles in length, from La Serena to Potrerillo; it was fairly strong within an area reaching from Iquique to Concepcion (1250 miles); it was readily perceptible over an area of about two million square miles, including Buenos Aires to the east and the island of San Felix to the west. A disturbed area so extensive points, of course, to an unusual depth of origin.

Within the central area there were wide and rapid variations of intensity, the destruction, as usual, being greatest on marshy ground and least on rocky spurs. But part of the irregularity was also due to the occurrence of fault-lines, along which the shock was most violent, possibly from the occurrence of secondary shocks. It was found impossible to draw isoseismal lines, not only because records of intensity were scanty, but also because there was no central region surrounded by zones of decreasing strength. Copiapó and Vallenar, for example, are 87 miles apart and they are built on similar subsoils. At both places the intensity was very great and approximately the same, while between them are villages, built of essentially the same materials, that suffered little or no damage.

In California, the earthquake-faults are vertical planes. The movements that have given rise to earthquakes are partly upwards and partly horizontal, but while the total uplifts are to be measured in hundreds of feet, the horizontal shifts are to be reckoned in miles. In Chile, Prof. Willis could find no proof of the existence of such faults. He therefore supposed, as Mr. R. D. Oldham had supposed thirty years before,[2] that the earthquake might be connected with a compound structure consisting of a great major thrust at a depth of some miles with minor thrust-planes running up to the surface. In his search for such a structure, he found that the whole district from La Serena to Potrerillo is a zone of minor thrust-faults, fourteen of which were found to run nearly parallel to one another at distances of from 2½ to 12 miles apart. The total width of the faulted zone in the latitude of Copiapó is about 100 miles, but the zone may extend westwards beneath the ocean and eastwards among the mountains. The outcrop of the great major thrust was not seen by Prof. Willis, but its existence has been recognised by other geologists along the eastern base of the Andes.

Prof. Willis thus concludes that the earthquakes of Chile are of tectonic origin and are independent of

[1] "Studies in Comparative Seismology: Earthquake Conditions in Chile." By Bailey Willis. With Contributions by J. B. Macelwane, Perry Byerly, Johannes Felsch, and H. S. Washington. (Publication No. 382.) Pp. xi+178+75 plates. (Washington, D.C.: Carnegie Institution, 1929.) 5.50 dollars.

[2] India, *Geol. Surv. Mem.*, vol. 29, 1899, pp. 164-179.

volcanoes. They are due, he thinks, to extensive movements along a major thrust or thrusts, which originate beneath the Pacific Ocean basin and rise gently to their outcrop. These surfaces of rupture are of vast extent; it is possible that their area may amount to hundreds of thousands of square miles. There may also have been movements along the minor thrust-faults, for the shock was strongly felt at many places along their outcrops, but, so far as Prof. Willis was able to observe, there do not seem to have been any displacements left visible at the surface.

C. DAVISON.

Dibranchiate Cephalopods of Japanese Waters.[1]

A STUDY of the late Dr. Sasaki's monograph is a sufficient reminder that the death of this accomplished specialist was a serious loss to systematic zoology. The writer of this review wishes to take the opportunity of expressing his feeling of personal loss and his appreciation of Dr. Sasaki's courtesy and kindness.

This monograph is devoted to the cephalopods of Japan and the area between Bering Straits and the Bonin Islands and Formosa. It embodies the results of a study of no less than 10,000 specimens, which must be the largest collection of cephalopods ever handled by a single investigator. The cephalopods of Japan have been studied in the past by able systematists such as Appellöf, Wülker, and Stillman Berry. We have, however, for a long time required a critical study of this fauna.

The chief importance of Dr. Sasaki's work lies in the fact that it provides this intensive and critical study. The author deals with 125 species referable to 52 genera. Each species is very exhaustively described, and the author does not confine his attentions to the external parts, 'gladii', etc., which have been usually the principal objects of taxonomic study. In many instances he describes internal structures (radula and reproductive organs) which have been too often neglected. He supplies valuable tables of measurements by which the variation of the species may be assessed, and the copious and admirably clear text-figures are a noteworthy feature of the volume. This is work of a kind that is always needed and is perhaps too little forthcoming in the study of a group like the cephalopods. Concurrently with the output of descriptions of new species, etc., we require a constant critical taxonomic revision, a deeper exploration of anatomical features and a fuller analysis of variation, in order that our genera and species may as nearly as possible reflect the divergences in the natural populations from which our material is abstracted.

In his treatment of the broad outlines of classification, Dr. Sasaki does not depart from the lines laid down by earlier workers, and one could have wished that he had discussed decapod phylogeny and classification to some extent. He does not accept Naef's threefold division of the Decapoda, but retains the older and unsatisfactory Myopsida and Egopsida. He divides the Octopoda into Pinnata and Apinna, which are exactly equivalent to Grimpe's earlier Cirrata and Incirrata. Sasaki's names, however, may eventually prove more appropriate, as Berry's *Lœtmoteuthis* (in most respects a 'cirrate' form) seems to be devoid of cirrhi.

Sasaki's amplified account of the rare octopod *Watasella* is a very welcome addition to our knowledge of an interesting group intermediate between the Decapoda and Octopoda. He does not, however, discuss the highly important question as to whether the 'filaments' of *Watasella* are homologous with the arms. Finally, he makes valuable additions to our knowledge of the structure and classification of the Pacific octopods, though it is a pity that by an inadvertence which, had he been able to correct the proofs, he would doubtless have remedied, he includes in his definition of *Polypus* (= *Octopus*) "Nor (*sic*) cartilaginous stylets present internally". The "cartilaginous" (chitinous) stylets of *Octopus*, last vestige of the shell, have been figured in several species.

G. C. R.

[1] *Journal of the Faculty of Agriculture*, Hokkaido Imperial University, Sapporo, Japan. Vol. 20, Supplementary No.: "A Monograph of the Dibranchiate Cephalopods of the Japanese and adjacent Waters". By Madoka Sasaki. Pp. v+357+30 plates. Tokyo: Maruzen Co., Ltd., 1929.

Copals and Damars.

AT a recent meeting of the Royal Society of Arts an interesting paper on East Indian copals and damars was presented by Mr. A. F. Suter, which has appeared in *Jour. Roy. Soc. Arts*, vol. 77, April 19. The distribution of resiniferous plants is world-wide. Of the resins known to commerce the two chief groups are the copals and the damars. This division of the major resins is somewhat arbitrary, being based upon the difference of their physical characteristics, but is, however, quite a useful one.

There are eight commercial copals, their names indicating the country of origin, namely: Macassar or Manilla, Kauri, Congo, Zanzibar or Lindi, Mozambique or Inhambane, Sierra Leone, Angola (Benguela), and Demerara. The first two are obtained from species of *Coniferæ* (*Agathis*), whilst all the others come from leguminous species of trees. The damar-producing trees all belong, so far as present known, to the order *Dipterocarpaceæ*. They are largely collected in the Federated Malay States, Sumatra, and Borneo.

Considerable confusion has existed in the past on the subject of copals and damars. Mr. Suter states that the name copal, which is the Mexican for resin, is unknown in the East, where both copals and damars are known as damar, the Malay name for resin or a torch made of resin. In Europe, in the trade, both groups have been erroneously called gums, on account of their physical similarity to true gums. The author's paper mainly concerns copals, and deals chiefly with Macassar or Manilla copal which is obtained from *Agathis alba*, where it occurs most commonly in the Dutch East Indies; the tree is also found in the Celebes, the Moluccas, Borneo, Sumatra, and New Guinea. It is also present in the Philippines, where it is exploited, and in the Federated Malay States, where the resin is not as yet collected. The *Agathis* has characteristics in common with the Araucaria, and Mr. Suter deals at length with the tree and its habitat, the nature of the resin, and the methods of tapping the trees.

The various types of Macassar copal known in the trade are (*a*) hard or fossil copal, of unknown but often very great age, and very hard, (*b*) half-hard copal, less hard and much younger, (*c*) soft or spirit-soluble copal. The first is found either in the crotches of branches in old trees or else dug from the ground under old trees or where trees at one time existed; the other two are of recent origin, and are obtained by tapping the trees. Mr. Suter directed attention to the very efficient Dutch Forestry Department, which has studied the copal business and industry with great thoroughness.