irrigation water is given in the table in parts per million, while for the leaves and fruits the boron is reported in parts per million of the dry weight of the material, and also it is expressed in terms of milligrams of boron in each fruit and as the equivalent of boric acid ($H_3BO_3$) in the individual fruit and in the peel and pulp of the individual fruit.

These results show that there is a direct relation between the boron content of the irrigation water and that of the leaves, and that the same relationship holds with respect to the fruit, both for the peel and pulp.

The proportion of boron to dry weight is much lower in the fruit than in the leaves and the differences are much less. But it seems clear that not all the boron taken up by the orange tree from the soil solution is deposited in the leaves.

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# THE NATIONAL ACADEMY OF SCIENCES. II

*The band spectrum of ozone in the visible and photographic infra-red:* OLIVER R. WULF (introduced by C. G. Abbot). Photographs of the spectrum of ozone have been taken over the range 10,000 Å to 4,000 Å, using a 33-meter absorption path and ozone-oxygen mixtures of low ozone concentration at one atmosphere pressure. The visible bands exhibit regularities but are diffuse and show no tendency to form heads. In the infra-red a new series of weak bands has been found.

*Significance of recent cosmic ray experiments:* R. A. MILLIKAN and I. S. BOWEN. The experiments reviewed are (1) those of Millikan on the influence of nuclear mass on the absorption coefficients of cosmic rays; (2) those of Millikan, Bowen and Chao on the absorption coefficient of monochromatic Th C″ rays; (3) those of Regener and of Millikan and Cameron on the absorption coefficient of cosmic rays at great depths in water; (4) those of Millikan and Cameron on the absorption coefficients of cosmic rays at great altitudes, and (5) those of Bothe and Kolhörster on the absorption coefficients of the beta rays accompanying cosmic rays. There have been but three possible ways suggested for accounting for the foregoing results. The enormous energies demanded by them are obtained (1) from cosmic electrical fields, (2) from the annihilation of matter, (3) from the building up of the heavy elements out of the light. The requirements of each of these theories are discussed and experiments suggested to decide between them.

*Prediction of trans-Neptunian planets from the perturbations of Uranus:* E. W. BROWN. The prediction of the place of a trans-Neptunian planet by Percival Lowell is shown to be due mainly to a mathematical relation which depends on the number of years during which the planet Uranus has been observed. This fact is brought out by a new analysis of the work of Lowell published in 1915. It is shown that this relation has the effect of giving a prediction of the place of an unknown planet whether the planet has any real existence or not. If the same methods had been used with the additional observations of Uranus which have been made since Lowell completed his work, the predicted place in the sky would have been changed by some twenty-five or thirty degrees. In calculating the disturbance of the motion of one planet by another, the astronomer has to use a measuring rod, the shape, size and position of which can be changed to fit the observations. The reason for this is that he does not know the exact shape, size or position of the orbit of the disturbed planet until he has obtained them from the observations. If the planet has been observed for a long time, the discovery of a new body which alters its motion will affect the measuring rod very little. But if the period of observation covers less than two revolutions of the planet round the sun, it may alter it considerably. Uranus had been continuously observed up to the time Lowell completed his work for about 130 years. In this interval it made only one and a half revolutions round the sun. Consequently, the measuring rod could be so adjusted that the apparent effect of an exterior planet during that time is very small, although the planet may be quite large. A small planet will produce little effect in any case. Thus small deviations of Uranus during that time may mean the existence of an exterior planet or no such planet at all. If we assume that a large planet exists it is shown, without any further use of the observations, that it will be predicted as nearest to or furthest away from Uranus in the middle of the interval, that is, about 1848. The same assumption gives a prediction that the planet will be nearest to or farthest away from the sun near the same date. These are almost exactly the dates found by Lowell and they give the chief factors in the predicted place. The result would be the same, however small the mass. Hence, it gives no indication as to whether the planet exists. The rest of Lowell's prediction depends on a few unreliable observations which were found in astronomical records made before it was known that Uranus was a planet and not a star. We already know that the planet is too small to satisfy these early observations, whether they are good or bad. It follows that the discovery of a new planet near the predicted position must be regarded as accidental, or perhaps as the first of others to be found beyond the orbit of Neptune. Although it seems impossible to give Lowell the credit of having predicted a new planet, his work undoubtedly stimulated a search for one. The value of a scientific hypothesis is not to be judged by its truth but by the impulse which it gives to the search for truth.

*Note on the preceding paper:* D. BROUWER (introduced by Ernest W. Brown).

*Relative value of physiographic and paleontologic criteria in Pleistocene correlations:* FRANK LEVERETT. The physiographic criteria embrace certain persistent and practically uniform conditions, such as rainfall, stream gradient and character of formation, which produce a given result in the modification of a land surface in a given time. Thus each glacial formation of the several which are present in glaciated districts shows a degree of erosion and weathering consistent with its age. So also do the Pleistocene marine terraces of the Atlantic and Gulf coastal plains. It is evident to a person who has studied both the glacial and the marine terraces that the Pensacola marine terrace which has a shore line in Florida at about 33 to 35 feet is no older than the late Wisconsin drift, but the higher marine terraces, Tsala Apopka and Newberry, are evidently of greater age than the Wisconsin drift. Turning now to the paleontologic criteria, it appears that the remains of many species of extinct vertebrates are found on the Pensacola terrace, some of them in close association with remains of man. From studies elsewhere it had been inferred that certain species had become extinct as early as Middle Pleistocene time. On this basis the terrace would be given a much greater age than is consistent with its freshness of contour, and the human remains if contemporary with those of the extinct animals would be given very great antiquity. This naturally raises the question of the value of paleontologic criteria in comparison with physiographic criteria. It is evident that the extinction of a species of either animal or plant life is due to factors of uncertain and varying character, which can not be predicted and which do not of necessity have time limitations. A given species may suffer extinction in one district long before it does in some other district in which conditions are more favorable for its continuation. The physiographic criteria may thus be made a basis for correlations where paleontologic evidence is of conflicting character. The physiographic criteria can be depended upon, however, only as a measure of age of relatively young formations. In older formations than the Pleistocene the paleontologic criteria are likely to be preferable to the physiographic. Neither set of criteria has the definiteness in determination of the age of an old formation that is possible in the determination of the age of a Pleistocene formation.

*Some new fossils from the Middle Cambrian Burgess shale of British Columbia:* RUDOLF RUEDEMANN. The Middle Cambrian Burgess shale of British Columbia afforded, some twenty years ago, to Dr. C. D. Walcott the richest and most varied Cambrian fossil association yet discovered. It consists of seaweeds, sponges, cystids, holothurians, medusae, annelids, crustaceans and merostomes. The material is preserved in a fine-grained shale to the finest details, as the intestinal canal and the hepatic caeca of the crustaceans, and its continued study is expected to throw a flood of light on the phylogeny of various classes of invertebrates. A hitherto unstudied portion of this collection, considered as probably consisting of graptolites, was turned over to the writer and furnished some most interesting additions to the Burgess shale flora and fauna. A fossil similar to the graptolite Dictyonema proved a seaweed with a reticulate system of strengthening ribs of the thallus, which alone remain on maceration. Another fossil is a hydrozoan, belonging to the Hydroid Coelenterata, with distinct thecae. A small, black, leaf-like fossil was found to be a cystid of such primitive structure that it may be near the roots of the phylum of echinoderms. A fossil looking like a well-known branching graptolite is instead a crustacean with enormously developed many-branched swimming limbs, that in appearance is an overgrown nauplius of the present crustaceans, thereby indicating its ancestral character. Finally the fossil Marrella that was considered a bizarre crustacean with two pairs of gigantic horn-like appendages of the carapace was recognized as a freshly moulted trilobite neolenus. Its dorsal tests are still so thin that the delicate structure of the underside of the body is visible. These finds indicate that treasures are still buried in the ancient Burgess shale.

*Bearing of Titanothere researches on the principles of mechanical evolution* (to be printed in SCIENCE): HENRY FAIRFIELD OSBORN.

*The third dimension in Yellowstone Park* (illustrated): ARTHUR L. DAY.

*Iron-bacteria in silicified bog-iron deposits of Cambro-Ordovician age:* DAVID WHITE. Specimens of silicified limonite from the Jonesboro formation, of Cambro-Ordovician age, in Virginia, are found, when examined by means of thin sections under the microscope, to be petrified bog ore deposits in which several kinds of bacteria and algae are present in rather remarkable preservation. Among the plants, which appear golden yellow in the section, are forms closely resembling bog-iron depositing bacteria of the present day, such as *Siderocapsa* and *Crenothrix*, together with a representative of a low order of algae. The petrographic character of the deposit, which presents some notable crystallographic features, has been described by Dr. M. I. Goldman.

*The peptide linkage in proteins:* WILDER D. BANCROFT. The simplest way in which two amino-acids can condense gives the group —CONH—, which is known as the peptide linkage. Emil Fischer assumed that this was the most important linkage in the proteins and did an immense amount of work in synthesizing polypeptides. We have found that a solid containing the peptide linkage will apparently always add hydrogen chloride gas stoichiometrically to form the group —CONH(HCl)—. We have also found that hydrogen chloride gas is not taken up stoichiometrically by any of the nitrogens in zein, from which it appears to follow that there are no peptide linkages in zein. If there are no peptide linkages in zein, it becomes an interesting question as to what percentage of peptide linkages there may be in other proteins such as edestin and gliadin. The first question to tackle is, of course, what the nitrogen linkages are in zein.

*The structure of some sodium and calcium aluminosilicates:* LINUS PAULING (introduced by A. A. Noyes). With the use of the set of structural principles recently developed, the structures of the minerals natrolite, $Na_2Al_2Si_3O_{10} \cdot 2H_2O$, the scapolites (of which the end members are marialite, $Na_4Al_3Si_9O_{24}Cl$, and meionite, $Ca_4Al_6Si_6O_{24}(SO_4, CO_3)$), and davynite-cancrinite, $(Na, Ca)_4Al_3Si_3O_{12}(CO_3, SO_4, Cl)$, have been determined. In each case the crystals consist of a framework of $AlO_4$ and $SiO_4$ tetrahedra joined by the sharing of oxygen ions at tetrahedron corners. Within the framework there are cavities which are occupied by sodium or calcium ions, large negative ions and water molecules or other groups, which can be removed or replaced by other ions or molecules without destroying the framework. The structures account for the characteristic phenomena of base exchange and of dehydration and rehydration (of zeolites) shown by the substances.

*Synthesis of d-mannoketoheptose:* C. S. HUDSON and EDNA M. MONTGOMERY.

*Isolation of four forms of d-mannoheptose:* C. S. HUDSON and EDNA M. MONTGOMERY.

*Interaction of nitrogen trichloride and nitric oxide at −150°; further evidence for the formation of nitrogen dichloride and of mono-oxygen-di-nitrogen-dichloride:* WILLIAM ALBERT NOYES. In a paper published two years ago it was shown that at −80° two mols of nitric oxide react with one mol of nitrogen trichloride, giving one mol of nitrosyl chloride, one of nitrous oxide and one atom of chlorine. This was explained by assuming that the primary reaction gives nitrosyl chloride and nitrogen dichloride and that the latter immediately combines with nitric oxide to give mono-oxygen-di-nitrogen-dichloride, ON—$NCl_2$. The reaction has now been carried out at −150°, the boiling-point of nitric oxide. At this temperature, three mols of nitric oxide react with the trichloride, giving two mols of nitrosyl chloride, one of nitrous oxide and one atom of chlorine. The simplest explanation of this result seems to be that the mono-oxygen-di-nitrogen-dichloride is sufficiently stable at −150° to permit a third mol of nitric oxide to take from it one atom of chlorine. Either at that temperature or on warming up, the mono-oxygen-di-nitrogen-monochloride decomposes to nitrous oxide and chlorine.

*Diazocamphene from bornylamine and from neobornylamine:* WILLIAM ALBERT NOYES and ULRICH HEUBAUM. Forster and others have shown that two bornyl amines are formed by the reduction of camphor oxime, normal bornyl amine and neo-bornylamine. These are optical isomers, because of the asymmetry of the carbon atom to which the amino group is attached. From these amines the two urethanes and their nitroso derivatives have been prepared. By the action of sodium methylate on the nitroso derivatives of the urethanes, at a low temperature, the corresponding diazo compounds have been made. These compounds are even more unstable than the diazo compounds prepared by Kendall and Noyes. Their specific rotation and rotary dispersion were determined, approximately, however. They have a high rotation and an extraordinary rotary dispersion, with a maximum in the green, similar to those obtained by Kendall for the diazo compounds from the aminocamphonanic acids. It has not been possible to show a difference in the specific rotations of the two compounds, probably because of the difficulty of exact measurements with such unstable, colored compounds. Mr. Ray, of Grinnell, has, however, shown that the two diazo compounds prepared by Kendall give different decomposition products, demonstrating that the carbon atom combined with the diazo group is asymmetric.

*The effect of low temperatures on the sensitivity of radiometers:* SINCLAIR SMITH (introduced by George E. Hale). The sensitivity of a radiometer at the temperature of liquid air was compared with that of the same radiometer at room temperature. Curves were derived for both temperatures which show the change in sensitivity with pressure for the same radiometer in hydrogen, helium and air. In these gases, at the lower temperature the maximum sensitivity is increased and shifted towards lower pressures. The form of the pressure-sensitivity curve remains unchanged.

*The crystal clock:* W. A. MARRISON (introduced by F. B. JEWETT). A quartz crystal may be used as the rate controlling element in an accurate clock. From the standpoint of stability, crystalline quartz has some inherent advantages over all other materials for this use. A clock system based on a short period vibration such as is obtained from a quartz crystal oscillator has many advantages over conventional systems for making time comparisons. These include means for intercomparing separate systems, means for measuring short time intervals accurately and means for producing time signals electrically as accurately as the absolute time can be determined. The dial setting and the rate of a crystal clock may be changed by continuous adjustments without in any other way affecting the time-keeping qualities of the system. The rate of the crystal is not affected by magnetic fields or changes in g, and to only a small extent by earth vibrations. Clocks may be operated at different rates from the same rate controlling element. In particular a mean solar clock and a sidereal clock can be operated from a single crystal and rated so that the error in the ratio of the rates is less than one second in a century. Accurate mean solar and sidereal seconds timing pulses may be obtained electrically from the respective mechanisms.

*Analysis of the growth curve of man:* FRANZ BOAS. Our knowledge of growth is based essentially upon measurements of groups of children of varying ages. The following observations are based on the study of individual growth curves. The acceleration of rate of growth of boys during adolescence occurs at varying times, between eleven and seventeen years. Boys who show the

most rapid rate of growth at an early time pass through the whole developmental period with greatest rapidity. They have a higher rate of growth at this period than any other group, and their total increase during a period beginning three years before and ending three years after the period of most rapid growth is greatest. The material available at the present time does not show any appreciable influence of the difference in period of most rapid growth upon the average stature of the adults. Even those who have their maximum rate of growth at the same time vary in the extent of the growth period; among some it closes soon after the period of maximum rate of growth; among others it extends over several years. It is probably due to this fact that the variability of stature of slowly maturing groups of boys is greatest. The increase of variability, which is characteristic of growing boys taken *en masse*, disappears for the group whose maximum rate of growth is between thirteen and fourteen years. For all the others the increase of variability is much reduced. The data available at the present time also suggest that adults who have developed slowly are more variable than adults who have developed rapidly. This may be an expression of a more intensive influence of environmental conditions favoring or inhibiting growth.

*An archeological research and its ramifications:* A. V. KIDDER and S. G. MORLEY (introduced by John C. Merriam). In order to interpret in terms of history the archeological data emanating from investigations by Carnegie Institution of Washington in the Maya field, it is necessary to call upon botanists, zoologists, geologists and meteorologists for information regarding environmental factors, and upon medical men and physical anthropologists for information as to biological aspects of man. Cooperations have been established with workers in certain of the above sciences and enlistment of aid from others is contemplated. Work accomplished to date reveals problems of special interest to individual sciences and of general significance to larger groups. The interrelation of the studies is considered, and it is pointed out that coordinated effort not only is necessary for solving the complex questions of human history but also serves as a practical method of forming contacts between diverse branches of natural science.

*Concentration of remnants of Indian tribes in northwestern California:* C. HART MERRIAM. Probably no part of the United States is so little known from the standpoint of its aboriginal inhabitants as a small area in the mountains of northwestern California—an area restricted to the drainage basins of the Salmon and New Rivers with adjacent parts of the main Trinity and its South Fork. Within a radius of forty miles from Hoopa Valley there were in whole or in part the home lands of nineteen tribes of Indians, representing eight linguistic stocks. It is doubtful if in any other part of the world there are in so small an area so many tribes speaking different languages. Most of these tribes are fairly well known, but during the mining days of the fifties and early sixties several of them were practically exterminated by the onrush of gold seekers and the troops called in to help. Indeed, so complete was the destruction that in the case of four of the tribes the few survivors succeeded so well in remaining hidden from inquisitive eyes that not even the names of the tribes were ascertained by anthropologists.

*A remarkable case of word borrowing among California Indians:* C. HART MERRIAM. Work among the Shoshonean tribes on both sides of the Nevada-California boundary south of the latitude of Mono Lake has brought to light a surprising if not unique case of the borrowing of words, particularly the names of animals. These names as used by the Monache of Owens Valley, on the east side of the Sierra, disagree almost wholly with the names used by their relatives only a short distance farther north—the "Northern Piute" bands of Mono, Walker and Pyramid Lakes. Further study has shown that the un-Shoshonean names of the Owens Valley Monache are in current use among the several derivative Monache tribes on the west side of the Sierra. These names, that differ from those of the "Northern Piute," agree essentially with those of an unrelated stock, namely, the Yokut, of San Joaquin Valley. In other words, a series of tribes of Shoshonean stock have set aside the animal names in common use among their near relatives and have replaced them by the names used by several tribes of a widely different linguistic stock—the Yokut. So far as I am aware, no parallel is known.

*The theory of specific skills in musical training:* C. E. SEASHORE. The theory that success in musical performance, either vocal or instrumental, is conditioned upon the early mastery of a few fundamental skills was advanced. Methods of developing these skills by instrumental aids in intensive training were illustrated and the instruments needed for such training were shown. Among these were the rhythm meter, the tone dynamometer, the tonoscope, the projectoscope and the piano camera, all instruments designed and built in the psychological laboratory of the University of Iowa.

## BOOKS RECEIVED

BEERY, PAULINE G. *Stuff: The Story of Materials in the Service of Man.* Pp. xiii + 504. Illustrated. Appleton. $5.00.

CLARK, AUSTIN H. *The New Evolution: Zoogenesis.* Pp. xiv + 297. Illustrated. Williams and Wilkins. $3.00.

GARRETT, HENRY E. *Great Experiments in Psychology.* Pp. xvii + 337. 11 plates. 35 figures. Century.

JASTROW, JOSEPH. *Piloting Your Life.* Pp. xvi + 372. Greenberg. $3.50.

PARSONS, T. R. *The Materials of Life:* A General Presentation of Biochemistry. Pp. 288. 8 illustrations. Norton. $3.00.

SCOTT, GEORGE G. *The Science of Biology:* An Introductory Study. (Revised edition.) Pp. xx + 633. 390 figures. Thomas Y. Crowell. $3.75.

WORSNOP, B. L. *X-Rays.* Pp. ix + 101. 36 figures. Dutton. $1.10.

YOUNG, JOHN W. *Projective Geometry.* The Carus Monograph Series. No. 4. Pp. ix + 185. 65 figures. Open Court.