

been created. Agassiz's success in this way was remarkable. He obtained under the most discouraging circumstances, even in the darkness of the war, large sums of money from the Legislature of Massachusetts, and his appeal to individuals was always irresistible.

It seems pertinent, in view of the analogous relations of the New York museum to the Legislature of the State and private benefactors, to quote Marcou's expressive description of Agassiz's methods. Agassiz's biographer writes: "The amount of scientific diplomacy he made use of is something astounding; for instance, he would detail with great clearness the working of the institution, and make it clear that the museum is an element of education even in the most elementary school of commonwealth, and that in the future generations there would not be a child who would not have the opportunity of understanding the scheme of creation as thoroughly as he understood his multiplication table. He had the tact to adapt his explanations and his description of the absolute poverty of the institution to the listener and his official position in the State. Then, after weeks of such preparatory work at the State House, came the annual visit of the whole legislative body, with the Governor at its head, to the museum. Everything was in readiness for the reception when the six or ten street cars, filled with legislators, arrived at the University grounds. Agassiz conducted them at once into the various exhibition halls, showing the treasures of each and briefly describing the departments. Afterwards in the lecture room, in an informal conversation, he detailed the methods and needs of the institution. He always succeeded in winning to his side farmers, tradesmen and politicians. After such a visit the Legislature always voted a new appropriation of public money; it was only necessary for the President of the Sen-

ate and the Speaker of the House to make speeches in its favor, and the resolution would easily pass the three readings without further debate."

Celebrated collections of the Old World, constant accessions from the new, were pouring into the museum at Cambridge. In 1869 Professor Agassiz reported that though the income of the British Museum and the Jardin des Plantes was more than ten times that of the Museum of Comparative Zoology, yet the last "in certain departments, such as corals and fishes, was superior to both, and that in activity of research and publication it yields to neither, while the increase of its collections since its existence, and the prominence it has attained among the museums, are such as no like establishment has reached in the same time and with the same means."

It was with anxious eyes that the naturalists of New York and those citizens of the great metropolis that were devoted to the advancement of its intellectual interests noted this rapid progress. The formative period closed, and the crystallization of an idea, so definitely recognized, quickly succeeded in those years, which included the incorporation of the American Museum of Natural History.

L. P. GRATACAP.

AMERICAN MUSEUM
OF NATURAL HISTORY.

SCIENTIFIC BOOKS.

Publications of the Japanese Earthquake Investigation Committee. Nos. 5 and 6. Tokyo. 1901.

These two volumes are continuations of the series of publications in foreign languages of the investigations of the Imperial Japanese Seismological Committee, the earlier numbers of which received a somewhat extended notice in the columns of this journal some time ago. They are written by Dr. Omori, a member of the Committee in immediate charge of the investigations, and they contain horizontal pen-

dulum observations of earthquakes during 1898 and 1899, together with a detailed description of the horizontal pendulum seismographs used and some discussion of the results.

In the 'compound,' or park, at Hongo, Tokyo, in which the buildings of the Japanese Imperial University are located, there has been erected an 'earthquake-proof' house in which two of the large horizontal pendulums are placed. They are of rather unusual dimensions, the vertical distance from the point of suspension to the point of support being nearly three meters. The pendulum is excellently planned for stability and convenience of adjustment, and is capable of a vibration period of as long as three minutes, being, therefore, extremely sensitive. When adjusted to a period of two minutes it will show an index displacement of about 1 mm. for a change of level of about one two-hundredth of a second. Two of these seismographs, exactly alike, are mounted, one to give the N. and S. component of the disturbance and the other E. and W. component. They are designed, of course, for the registration of very feeble but often long-continued disturbances whose seismic origin is remote from the point of observation. Concerning the transmission of such disturbances many extremely interesting observations have been made, only a few of the most important of which can be referred to here.

Broadly speaking, the motion of an earthquake may be divided into three successive stages, which are always more or less well defined; the *preliminary tremor*, consisting usually of vibrations of small amplitude and short period; the *principal portion*, the active and often destructive part of the earthquake, during which the amplitude is much greater and the period usually longer; the *end portion*, which is the feeble, small amplitude finishing of the disturbance. The first of these is again usually quite sharply divided into two stages, which may be designated as the first preliminary tremor and the second preliminary tremor, and the *principal portion* is also made up of three tolerably distinct phases, of which the last, designated as the *quick-period phase*, is of the greatest importance in the present discussion.

Several seismologists have already pointed

out the fact that the duration of the *preliminary tremor* of an earthquake increases with the distance of the seismic center from the place of observation, and this proposition is not only confirmed by Dr. Omori's observations, but from them and some others he has been able to deduce an equation which represents the relation between duration and distance with astonishing closeness. Sometimes the total duration of these disturbances, due to distant earthquakes, is as long as four hours, but the equation here given is based upon first preliminary tremors varying in duration from five minutes to eleven minutes. It is as follows:

$$x = 17.1y - 1360$$

in which x is distance in kilometres (on the surface of the earth along the arc of a great circle passing through the two points) and y is the duration of the *first preliminary tremor* in seconds. This equation is based on long-distance observations of several earthquakes, three of which, occurring respectively in Alaska, Smyrna and Japan were observed in Japan, while others originating in Japan were observed in Potsdam and Italy. The agreement of the calculated values of x with the actual values is shown in the following table:

Earthquake.	Actual Distance.	Calculated Distance.
Alaska,	6,100	6,500
Smyrna,	4,800	4,560
Java,	9,200	9,240
Japan,	8,999	8,840
Japan,	9,580	9,540

Perhaps the most interesting subject discussed in these volumes is the transmission velocities of the various phases of an earthquake disturbance. Dr. Omori has given much attention to this important question, considering it in considerable detail in the light of his own and other recent observations. It has long been known that all seismic waves did not travel with the same velocity, and it was long ago suspected that different phases of the same disturbance might be transmitted at very different speeds. During the past few years the development of 'long-distance seismology,' as it may be called, has added greatly to our knowledge of velocity of transmission, and at the same time it has materially increased the difficulties by which the subject is surrounded.

Dr. Omori has compared the time of the arrival of the beginning of three of the phases mentioned above, namely the *first preliminary tremor*, the *second preliminary tremor*, and the *quick-period* phase of the *principal portion*, and he has assumed, as he is quite justified in doing, that they originated simultaneously at the seismic origin. He has compared the velocities of transmission of these three phases between Italy and Japan, in ten earthquakes, with results which agree among themselves in the most remarkable way.

The means are, for the *first preliminary*, 12.8 km. per second; the *second preliminary*, 7.2 km. per second, and for *quick period* of the *principal portion* 3.3 km. per second. The latter quantity, it will be observed, is what is usually thought of in speaking of the velocity of an earthquake wave.

Now no known rock has a modulus of elasticity high enough to transmit a wave, of either compression or distortion, with the speed of the *first preliminary tremor* as shown above, and it seems impossible to avoid the conclusion that this disturbance must be transmitted along some shorter path within the earth's crust, while the *principal portion* undoubtedly travels along the earth's surface. This question is greatly complicated, however, by the fact that the duration of the *first preliminary* at a given observation station is very nearly simply proportional to the *surface* distance from the origin of the disturbance.

It is impossible to close even so brief a notice as this must be, without again congratulating Dr. Omori and his colleagues of the Earthquake Commission upon the splendid way in which they are making use of the rare opportunities which they enjoy for seismological study. The indirect results of this study, especially as they are related to the general subject of terrestrial physics, promise to be of the greatest importance, and the Japanese seismologists may well feel assured that they are practically in control of a field worthy of their highest efforts.

The general form and style of these publications is so excellent that it may be worth while to call attention to the existence of a few blemishes, doubtless due to careless proof-reading. One is tempted to especially mention one of

these, which is the frequent appearance of *Alasca* or *Alaskan*, in which form alone, indeed, is found the name of the territory, or whatever it may really be, known to us who own it as Alaska.

T. C. MENDENHALL.

Beitrag zur Systematik und Genealogie der Reptilien. By MAX FÜRBRINGER. Abdruck aus der *Jenaische Zeitschrift für Naturwissenschaft*, XXXIX. Bd. (N. F. XXVII.). Jena, Verlag von Gustav Fischer. 1900. Pp. 1-91.

The paper to which the attention of all who are interested in the class of reptiles is here called is only a portion of an extensive memoir, a summing up of the results of studies detailed in the twenty-seventh volume of the *Jenaische Zeitschrift* and occupying over four hundred pages of that journal. In view of the author's important contributions to zoological literature, especially of his great work on the morphology of birds, anything that he may have to say on the kindred group of reptiles must attract attention.

The author first discusses the position of the most primitive Reptilia and the origin of the Sauropsida (I.); then a survey is made of the systematic and genealogical relationships of the various orders (II.); and finally, these are grouped into subclasses, and their genealogical relation to the other Tetrapoda is treated (III.).

I. Of the living reptiles the Lacertilia and the Rhynchocephalia are regarded as the most primitive; of the latter a single representative exists; of the Lacertilia about 1,600. Contrary to what is generally held, the author does not regard *Sphenodon* as the most primitive reptile, although it possesses many primitive features. A just appraisal of all its characters places it lower than the highest Lacertilia, but higher than the lowest representatives of the latter. The author contends that in the primitive reptiles the quadrate bone was movable (streptostylic), and that its fixed (monomostylic) condition is the result of secondary modifications. Some of the earlier Rhynchocephalia, as *Patteohatteria*, were probably the lowest of known reptiles. Notwithstanding their differences, the Lacertilia and the Rhynchocephalia had a common ancestor.