to the possibility of determining the sun's parallax by means of the transit of an inferior planet. He has been showing methods of finding the parallax of a planet by comparison of observations made at different parts of the earth upon the position of the planet compared with that of a star. He then takes, in place of a fixed star, another planet, the two being in one line, as seen from the earth. The application of this to the case of Mercury or Venus and the sun, was obvious.

But Halley was the first to see clearly what a powerful means of determining the sun's parallax an observation of contact really is. So far as I can discover, he first mentions the method in a letter to Sir Jonas Moore, written at St. Helena in 1677,* just after having seen a transit of Mercury. The exactness with which he believed the time of contact to be determinable, led him frequently afterwards to urge his countrymen to make every effort to utilise the method on the occasion of the transits of 1761 and 1769, when he should be dead.† And thus, in addition to his celebrated prediction of a comet, he left a second legacy to his successors, who, as Englishmen, might be entitled to be proud of his foresight though he could not live to reap the glory of it.

It is a matter of some difficulty to show, in an elementary manner, the way in which the value of the sun's parallax can be found from observations of contact. We will try, however, to put it in a light which anyone, with a little attention, will understand.

1. It must be thoroughly understood, from what has already been said, that if we know the amount of the sun's parallax we know its distance. In other words, if we know the angle subtended by any known distance on the earth's surface at the distance of the sun.

2. We know that the relative positions of the earth, Venus, and the sun, are given by supposing the earth to go round the sun in 365 days, and Venus in 224 days. Or, if we please, we may take no account of the earth's revolution, but suppose it fixed, in which case the revolution of Venus *relatively* to the earth (*i e.* the synodical revolution) is 584 days.

3. If, then, Venus moves round the sun through 360° relatively to the earth in 584 days, she moves through $\frac{1}{584}$ of that in one day, and through $\frac{360}{584 \times 24}$ of a degree in one hour; which is at the rate of about $1\frac{1}{5}$ seconds of arc in a minute of time.

Now we are ready to understand Halley's reasoning.

Let A (Fig. 10) be the position of an observer on the earth at the time of 1st internal contact. S is the sun, and V_1 is now the position of Venus. This observer sees the contact earlier than a hypothetical observer at the earth's centre would see it, by the time Venus takes to move over V_1V_2. If we knew by calculation the instant when an observer at E would see it, and the observer at A saw it 8 minutes sooner, then, since Venus moves over $1\frac{1}{5}''$ in a minute, she has moved over $8 \times 1\frac{1}{5}$ or $9\frac{3}{5}''$ of arc in this time, and hence we learn that the angle A S E = $9\frac{3}{5}''$.

Suppose that by the time of the last contact the point A on the earth's surface has been carried by her rotation to B: the time of the last contact will now be too late by 8′; since the whole duration of the transit as seen by this observer is 16′ too long, and the angle moved over by Venus in 16′ is the sum of the sun's parallax as seen from A and from B.

But we cannot calculate with absolute accuracy the duration a transit would have when seen from E, because we should require to know more accurately than we do the values of Venus' and the sun's diameters.

Halley got rid of this by taking another station which should be in the position A at the beginning of the transit. In the case we have been considering the time of the first contact would here be too late by 8 minutes; and if this place had reached B′ by the end of the transit, the time of contact would be too soon by 8 minutes. Hence in this case the whole duration would be shortened by 16 minutes; but in the former case it was lengthened by 16 minutes. Hence 32 minutes is the time taken by Venus to pass over an angle equal to the sum of the parallaxes in the four cases considered. This difference of duration, whether it be 32 minutes or anything else, is a quantity which can be observed. Now Venus moves over about $1\frac{1}{5}''$ of arc in a minute, or $38\frac{2}{5}''$ in these 32 minutes. Hence one-fourth of $38\frac{2}{5}''$ or $9\frac{3}{5}''$ would appear, from the above hypothetical observation, to be the value of Venus's parallax.

It must be noticed that we have here supposed that the transit takes exactly twelve hours, whereas the longest transit cannot exceed 8 hours. We have also supposed that two stations had been selected which were exactly situated so as to bring out the full effect of parallax at the time of each observation. These suppositions have been introduced only to simplify the understanding of the method. Anyone who has followed the above explanation will see how the method may be applied to actual cases that may occur.

Halley saw (what many people fail to see even now) that the great accuracy of the method consists in this, that in one second of time Venus moves over about 0″·02; and if we can determine the time of contact, with an error of no more than a second, we are measuring the sun's parallax with an error of no more than ·02 of a second of arc.

Halley even pointed out the best stations for observation. We may consider the earth to be at rest if we suppose Venus to move with the velocity she has relative to the earth. He supposed that the planet would cross near the sun's centre, and that the transit would occupy about eight hours. An observer in India would see the commencement of the transit four hours before mid-day, and the end of the transit four hours after mid-day. But, in the meantime, the part of the earth where he is has been moving from west to east, and Venus has moved from east to west, hence the duration of transit will have been shortened. But at Hudson's Bay the transit begins just before sunset and ends just after sunrise, that part of the earth having moved in mean time from east to west so as to lengthen the transit; and thus at one place the duration of transit is lengthened, and at the other shortened, and the difference of time depends upon the parallaxes of Venus and the sun * at the two stations, and after finding these parallaxes we can calculate the equatorial horizontal parallax.

GEORGE FORBES

(*To be continued.*)

* Hooke's "Lectures and Collections," 1678.

† "Catalogus Stellarum Australium;" also "Phil. Trans.," 1694 and 1715.

THE LECTURES AT THE ZOOLOGICAL SOCIETY'S GARDENS

I.

ON Tuesday, April 14, Mr. P. L. Sclater, F.R.S., gave the Introductory of the twelve lectures which are to be continued during the spring. His remarks on that occasion were chiefly confined to the subject of Zoological Gardens in general. After an interesting account of the most important continental gardens, including those of Paris, Amsterdam, Antwerp, Berlin, and Hamburg, he

* This lengthening or shortening of the time of transit will be rendered more evident by an analogy. A person standing still sees a carriage pass between him and a distant house. The carriage will take a certain time to pass the house. But if he be also moving, and in the same direction with the carriage, the transit of the carriage will take longer; but if he move in the opposite direction to the carriage, the transit will take a shorter time. If, then, two persons be seated at opposite sides of a merry-go-round, so that at the time the carriage seems to be passing the distant house, one observer is moving with the carriage and the other in the opposite direction; then one observer will see the time lengthened, and the other shortened. Now, the world is such a merry-go-round, and the positions of these two people correspond to the positions of India and Hudson's Bay, as pointed out by Halley.

went on to speak of the different animals which thrive best in captivity, taking each order of each of the great classes of the vertebrata separately, and pointing out that whilst some, as the Carnivora, thrive well in confinement, others, as the Insectivora, can hardly be kept in a menagerie at all.

On the following Friday Mr. Sclater commenced the first of four lectures On the Geographical Distribution of Mammalia. A fauna constituting the animals inhabiting a country, and a flora its plants, the lecturer went on to illustrate the fundamental law that the animals and plants found in far distant countries are usually different, and that those of near countries closely resemble one another. We find the animals in France much like those in England, those in Ceylon much less so, and those in Australia as different as possible. It might at first sight be thought that difference of climate caused the differences that are observed in geographical distribution, but that such is not the case is proved without difficulty by taking different countries in the same latitude and with a similar climate and comparing them. For instance, on and near the equator we have Borneo, part of Africa, and the country bordering the Amazons; nothing can be more different than their faunas, and yet they are similarly circumstanced, so far as temperature and climate are concerned. So the polar seas of the northern and southern hemispheres are very different as regards their animals, although nearly identical in climate. The auks and seals of the one are replaced by the sea lions and penguins of the other. The faunas of the Himalayas and of the Andes, mountains both in hot countries, are very different also.

The meaning of the terms "specific area" and "generic area" was then explained. A species, the aggregate of similar individuals, has an habitat or area of distribution which is definitely circumscribed. In some animals this area is large, as in the case of the lion; in others, as in the case of the aye-aye of Madagascar, it is extremely limited. Among birds this limitation, strange as it may appear, is sometimes extreme; on each of the two nearly adjoining mountains of Pichincha and Chimborazo there are species of humming-birds found, which occur nowhere else. The area which includes all the areas of the species of a genus forms a generic area. These areas are continuous, or were so at one time; physical changes having sometimes intervened to produce an apparent interval.

From these observations it is evident that the locality in which an animal is found is as important a fact in estimating its individuality as are its internal structure and general configuration. This point is frequently but too little taken into account.

The lecturer, having said thus much on the general subject, proceeded to show how the class of Mammals was to be distinguished from the other classes of Vertebrates, and stated that for geographical purposes the mammalia, or those animals which suckle their young, might be most conveniently divided into terrestrial and aquatic. Our knowledge respecting the former of these sections is, as might be imagined, much greater than of the latter; nevertheless, within the last few years the aquatic mammalia have received considerable attention, and have become much better known.

(*To be continued.*)

NOTES

THE magnificent bequest of 10,000*l*. has been made by the late Mr. E. R. Langworthy to the Owens College, Manchester, for the purpose of developing the chair of Experimental Physics. A splendid opportunity is thus afforded to the Professor of Physics in Owens College not only to advance original research in connection with that subject, but also of teaching the students of his class in the only effectual way by which physics can be taught. Physics, in short, can now be placed on the same footing in that University as chemistry. The terms in which the bequest is made are so forcible and clear that they deserve to be quoted here:—"I bequeath to the trustees of the Owens College ten thousand pounds, and I desire that the same may be applied by them as they may think best in order to establish in connection with that institution a professorship of Experimental Physics. It being my wish that students may be instructed in the method of experiment and research, and that Science may be advanced by original investigation. And I also desire that the professor from time to time appointed may be selected on account of his knowledge having been especially obtained by original investigation, and that his appointment shall be contingent upon the continuance of such investigation. And I declare that the above desire shall not be construed as a trust and bind the trustees to establish a professorship; but in case it shall be deemed advisable such money may be applied in such other way as the trustees for the time being may think fit, provided such money is only used for the purpose of promoting Science." The late Mr. Langworthy deserves credit not only for his liberality, but for the sound and advanced views he held as to how Science should be taught, and as to the necessity of encouraging original research in connection with the chairs of Science in our Universities. Mr. Langworthy has also bequeathed 10,000*l*. each to the Salford Library and Museum, and to the Manchester Grammar School, in the latter case for the purpose of founding twenty scholarships.

THE Chair of Chemistry in the University of Glasgow is vacant. We hope the Home Secretary in filling up the vacancy will, in the spirit which urged the late Mr. Langworthy to make the magnificent bequest above referred to, show by the appointment he makes the appreciation in which he holds original research. It is now high time that it should be distinctly understood that no man deserves to be appointed to a Chair of Science in any of our Universities unless he has shown that he has that knowledge of his subject which can only come from original investigation.

THE Professorial Chair of Physiology in University College, London, has become vacant by the resignation of Dr. Sharpey, who has held it since the year 1836.

SIGNOR L. M. D'ALBERTIS, the distinguished Italian traveller, who has lately penetrated into the mountains of New Guinea, and discovered the remarkable Bird of Paradise which bears his name (*Drepanornis albertisi*), has just returned to this country from Sydney, *viâ* San Francisco, bringing with him his large collection in every department of natural history which he formed during his expedition.

WE would call attention to the Swiney Course of Lectures on Geology which are at present being delivered by Dr. W. B. Carpenter, F.R.S., in the Middle Class School, Cowper Street, Finsbury. The course was commenced last Thursday, and will be continued on Mondays and Thursdays at 8 P.M.; there will be twelve lectures in all. We are sure that many of our London readers, on being made aware that such a course of lectures is being delivered by such an authority, will be glad to take advantage of the opportunity, especially as the lectures are free to the public.

THE first of the course of lectures at the Zoological Gardens given in pursuance of the provisions of the Davis Trust, was delivered on Tuesday the 14th, by Mr. P. L. Sclater, being an Introductory Lecture on the animals in the Gardens, of which he gave many particulars that seemed greatly to interest the audience. Last Friday Mr. Sclater gave the first of his course of four lectures On the Geographical Distribution of Mammals, in which he dealt with the general laws of the distribution of animals on the globe. Both lectures were well attended, the picture gallery being nearly full.