oscillation of Nordenskjöld's "glory" in dependence on the seasons. Another, diurnal oscillation, according to which the auroral belt would slowly advance towards the north (for Godthaab) during the night, seems very probable. It would explain—M. Tromholt says—the greater intensity of auroræ towards midnight, as well as the greater frequency of northern auroræ among those which were observed at Godthaab during the morning; but this last phenomenon, of course, might depend also upon some diurnal variation of the intensity of the "common arc." In any case, these conclusions are to be considered as provisory ones, and must be submitted to the further test of observations carried on at points more favourably situated than Godthaab for the study of these oscillations. Such is also the opinion of M. Tromholt himself.

Of course, the fifteen years' observations at Godthaab do not include a period of time sufficiently long for enabling us to deduce from them the laws of periodicity of auroræ. But still they allow of several interesting conclusions which may serve as a guidance for further researches. Thus, it appears from them—contrary to what was said as to the auroræ being more frequent during the most cloudy days—that the number of observed auroræ is directly proportionate to the brightness of the sky. This dependence appears not only for different years or months, but also for separate days. If all the days when auroræ were observed are classified according to their brightness, which is expressed by the figures 1 to 4, and the brightness compared with the average number of auroræ observed during the days thus classified, we see that while the quantity of clouds was 1·6, 1·7, 1·8, 1·8 ... 3·2, 3·3, 3·4, and 3·5, the average corresponding number of auroræ was 7·0, 7·0, 5·0, 5·0 ... 2·9, 2·7, 3·5, and 1·5, the decrease being altogether very regular, so as to leave little doubt as to the accuracy of the law.

The following data have some bearing on the 11⅑ years' period of auroræ which was deduced from observations in more southern latitudes, and which is considered as depending upon the amount of solar spots. Reckoning the years from August to May, so as to comprise in each year all autumn, winter, and spring auroræ (during the bright nights of the summer they are not observable), the yearly number of auroræ during the years 1865-66 to 1879-80 is given by M. Tromholt as follows:—97, 112, 65, 84, 45, 61, 32, 47, 73, 97, 97, 104, 69, 100, and 75, that is, rather irregular. Nevertheless, it is easy to perceive in these figures a certain periodicity with three maxima corresponding to the years 1866-67, 1876-77, and 1878-79. By introducing a correction which depends upon the brightness of the sky, and reducing the observed number of auroræ to an average cloudiness, M. Tromholt finds another series which is more in accordance with the number of solar spots as given by Wolf. Both series for the years 1865-66 to 1879-80 (August to May), appear as follows:—

Number of auroræ, with correction for brightness of sky

86·2, 91·3, 67·4, 80·9, 51·7, 56·5, 32·0, 46·0, 78·4, 97·0, 95·0, 102·0, 73·0, 85·2, 83·3

Number of solar spots

23·5, 6·1, 18·3, 60·1, 107·0, 133·5, 98·6, 89·4, 51·7, 32·1, 11·6, 13·5, 6·8, 2·2, 16·3

It would seem from these two series, that instead of being proportionate to the number of solar spots, the number of auroræ is rather *inversely* proportionate to this number, the two maxima of auroræ corresponding with the two minima of solar spots, and the minimum of auroræ arriving one year later than the maximum of solar spots. The same appears still better from the observations at Stykkisholm in Iceland, which run through the years 1846-47 to 1872-73. Both curves for this place (auroræ and solar spots), although showing several irregularities, nevertheless display a marked connection between the two phenomena; both inflexions of the auroræ curve towards a maximum correspond very well with the minima of solar spots, and *vice versâ*. The result for Godthaab and Stykkisholm is thus the inverse of what was found in more southern latitudes; and, to explain this contradiction, the author admits that the "auroral belt" is subject in its oscillations to a period of about eleven years, during which it advances more towards the north at the time when the number of solar spots reaches a minimum, and returns back towards the south during the maximum period of solar spots.

As to the number of auroræ observed respectively during the evening and during the morning, the observations at Godthaab fully confirm the fact already noticed at other places, namely, that auroræ are more frequent during evening hours. But it still remains to investigate in how far this difference depends upon the hours of observation, the observer usually taking notice of nearly all auroræ which appear before midnight, and not noticing those which appear during the first six hours after midnight.

Such are the questions discussed in M. Tromholt's memoir. As will be seen, they are rather indicated than definitely solved; but we must be thankful to the author for having raised them, and express a hope that the observations of auroræ which are now made to such an extent in Norway and Greenland, may be extended to the polar parts of Siberia and North America; we earnestly hope that the Meteorological Commission of the Russian Geographical Society, which already has done so much useful work, will soon extend its network of observations over this new field, which becomes every day more and more important. P. K.

ILLUSTRATIONS OF NEW OR RARE ANIMALS IN THE ZOOLOGICAL SOCIETY'S LIVING COLLECTION[1]

VIII.

20. THE MULE DEER (*Cariacus macrotis*).—While the Virginian Deer (*Cariacus virginianus*) is widely distributed all over the continent of North America, it is necessary to go far to the west before we arrive within the limits of the range of the two other species of the same group—the Mule Deer (*C. macrotis*), and the Black-tail (*C. columbianus*). Of these western deer, the latter, of which the Zoological Society had living specimens some years ago,[2] is confined to a narrow strip of land along the Pacific coast. But the Mule Deer has a larger distribution, being found on both sides of the Rocky Mountains, and extending eastwards of the main range, far into the prairies of Missouri.

The Mule Deer was discovered by Lewis and Clarke during their expedition to the Rocky Mountains in 1804, on the Missouri River, in about 42° N.L., and was so named from the excessive development of the ears, which at once distinguishes it from its fellows. Its most natural home is the mountainous region which flanks the main range of North America on both sides, though, as already stated, it extends hundreds of miles into the great plains drained by the Mississippi and its affluents. It is also met with in Oregon and British Columbia, though rather superseded in numbers in this quarter by the Black-tailed Deer.

The antlers of the Mule Deer, which, as in most other deer, are borne only by the male, are of the same peculiar type as those of the Virginian Deer. All the normal tines have a posterior projection, and the beam, after casting off the basal snagg, curves gradually forward and inward, until the extremities remotely approach one another. The tines thus stand mostly upright when the head is carried in its usual position, but when the head

[1] Continued from vol. xxv. p. 610.

[2] See Wolf and Sclater "Zoological Sketches," vol. i. pl. 20, for figures of the Deer.

is bowed in battle, the tines become nearly horizontal, and offer formidable weapons of offence. Five points is about the usual number carried by the adult male, though six or seven are not uncommon, and heads are said to have been obtained with even eleven and twelve tines.

The size of the Mule Deer is rather larger than that of the Virginian, and it is also more strongly built. Individuals are said to attain a weight of 250 pounds, but this is the extreme size. The most marked characteristic of the species, however, is certainly the long, broad, and thick ears, which are well covered with hair on both sides, and somewhat resemble those of a donkey or mule.

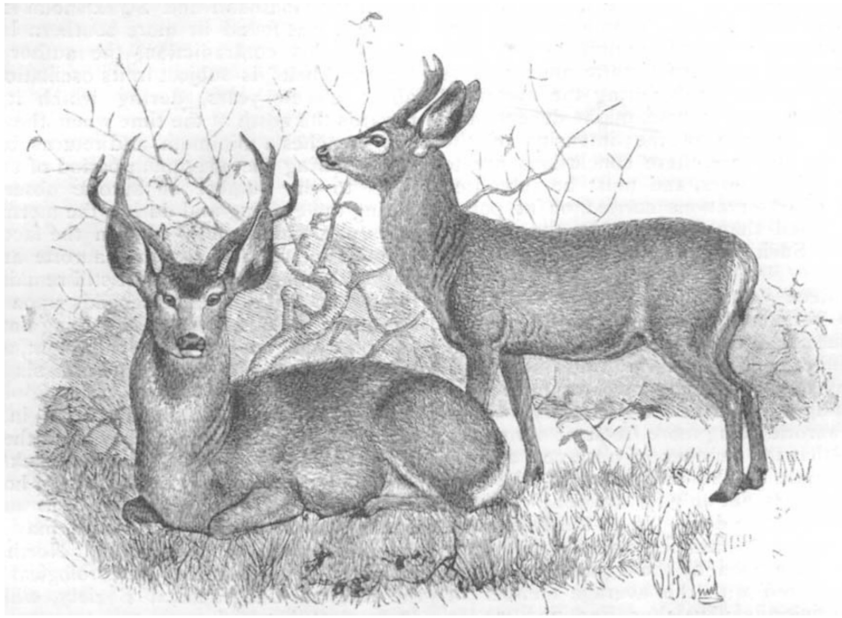

FIG. 20.—The Mule Deer.

For their living examples of this fine animal, Fig. 20 (the first, it is believed, ever received in Europe), the Zoological Society are indebted to one of their Corresponding Members, Dr. John Dean Caton, of Ottawa, Illinois, U.S.A., author of an excellent volume on the Antelope and deer of North America.[1] Males of the species were

FIG. 21.—The Chilian Deer.

[1] "The Antelope and Deer of North America." by John Dean Caton, LL.D. New York: Hurd and Houghton, 1877 1 vol. 8vo.

safely imported some years ago, but it is only a few months since that Dr. Caton, after several previous unsuccessful attempts, succeeded in supplementing his gift by transmitting to England an adult female. There is now therefore for the first time some prospect that the Mule Deer may be added to the list of acclimatised species propagating its young in this country.

21. The Chilian Deer (*Furcifer chilensis*).—The Chilian Deer also belongs to the American group of the Cervidæ, but has some special peculiarities, and together with an allied form—the Andean Deer (*Furcifer antisiensis*)—constitutes a small and distinct section of the American Deer, remarkable for the simple character of the bifurcated antlers.

The Chilian Deer is generally known to the natives of Chili as the "Guemul," and, though but slightly deviating from the ordinary deer in general appearance, has been strangely misunderstood by some of the older authors. Molina, in his work on the Natural History of Chili, classed it as a horse (!) under the name *Equus bisuleus*, while Hamilton Smith has referred it to the Llamas, and other authors to the Camels! Gay, in his "Fauna Chilena," published in 1847, first gave a clear account of this animal, and figured the female in the accompanying "Atlas," from a specimen in the Museum of Santiago. Gay tells us it is rare in Chili, being only met with in the Cordilleras of the southern provinces. Mr. E. C. Reed, who sent a skin and skull of the "Huemul" for exhibition before the Zoological Society in 1875,[1] tells us that several specimens of it have of late years been procured by the Chilian vessels engaged in exploring the Chonos Archipelago, and that it extends throughout Patagonia down to Sandy Point, in the Straits of Magellan.

The Chilian Deer is of about the size of a large roe-deer, but much stouter and thicker in its limbs. The antlers of the male, as will be seen by the illustration (Fig. 21), are very simple in character, consisting of a

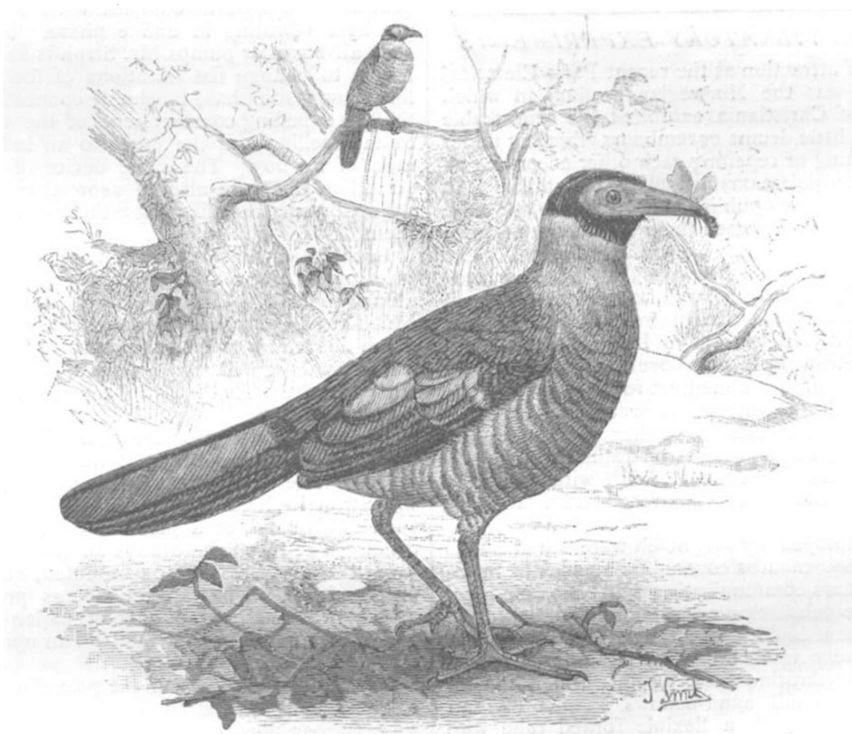

FIG. 22.—The Radiated Ground-Cuckoo.

well-developed beam provided with a single anterior snag or brow antler, which curves rapidly upwards, and attains nearly an equal length with the beam itself.

The example of this rare deer in the Zoological Society's collection was received from the Jardin d'Acclimatation of Paris in December last, and is believed to be the only individual of the species ever brought alive to Europe.

22. The Radiated Ground-Cuckoo (*Carpococcyx radiatus*).—To the minds of most people the name cuckoo conveys only the idea of a tree-loving bird of strong flight, that utters a well-known cry and drops its eggs in other birds' nests. But the Cuckoo family (Cuculidæ) of naturalists is an extensive group, containing many birds which not only have neither cuckoo-like call nor parasitic habits, but differ greatly from our familiar summer visitor both in structure and in manner of life. No better instance can be given of this truth than the very remarkable bird which we now figure (Fig. 23) from an example living in the Zoological Society's "Insect House." Though a "cuckoo" in all the essential points of its conformation, it is a purely terrestrial bird with a pair of long and strong legs, and in its general gait and actions much more nearly resembles a pheasant or a rail than the ordinary cuckoo of this country, with which it claims relationship.

The Radiated Ground-Cuckoo was first made known to science in 1832, by Temminck, who described and figured it in one of the *livraisons* of his "Planches Coloriées," published in that year from a specimen in the Leyden Museum. This, he tells us, was received from M. Diard, a well-known Dutch collector, who had obtained it at the settlement of Pontianak, in Western Borneo. A ticket attached to the foot of the bird called attention to its singular structure and habits, and contained the remark that it differs from the Malkoha Cuckoos (*Phœnicophai*) also found in the same district, in keeping constantly on the ground in search of worms, and in avoiding danger by rapid running, whereas the Malkohas are always met with flying about amongst the trees in search of insects.

[1] See *Proc. Zool. Soc.*, 1875, p. 44.

Our great countryman, Mr. Wallace, who, we believe, met with this ground-cuckoo in Sarawak, also speaks of its terrestrial habits, and states that its mode of life resembles that of the pheasants of the genus *Euplocamus*. Little else appears to have been recorded respecting this cuckoo, which is certainly one of the most peculiar forms of bird-life that have of late years been exhibited in the Zoological Society's aviaries.

On examining the specimen in question, which, when it first arrived, had only a half-grown tail, but is now in excellent plumage, it will be at once observed that the naked space round the eye has been incorrectly coloured in Temminck's figure of this species. Instead of being of a red colour as there represented, it is of a nearly uniform pale green, as is likewise the bill. Few non-professional ornithologists, indeed, would recognise a cuckoo in the pheasant-like ground-loving bird with large bright bill, which is labelled in the Zoological Society's Gardens "The Radiated Ground-Cuckoo."

MR. STROH'S VIBRATORY EXPERIMENTS

A CENTRE of attraction at the recent Paris Electrical Exhibition was the Norwegian section, in which Prof. Bjerknes of Christiania exhibited his remarkable experiments with little drums or tambours vibrating under water, and attracting or repelling each other according as the phase of the pulsations was like or unlike. An account of his results was published in NATURE, vol. xxiv. p. 361, and the analogy between them and the well-known effects of magnetism was there drawn attention to. The field opened up by Prof. Bjerknes has been entered by Mr. Augustus Stroh, a well-known member of the Society of Telegraph Engineers and of Electricians, who recently delivered a lecture on his researches. Mr. Stroh has gone over the experiments of Dr. Bjerknes in air as a medium for propagating the pulsations of the drums instead of water, and has advanced beyond his predecessor in further experiments on the same line. The beauty of the apparatus and methods devised by him, and the exquisite skill with which he manipulated them, elicited the unanimous admiration of his hearers.

The drums employed by Mr. Stroh were small shells of wood having their mouths covered by an elastic membrane and their rears communicating with a flexible pipe, through which the pulsating air was communicated to the membrane, so that it could cause the latter to bulge out or collapse at every wave of air. The source of the vibrations was a vibrating reed, against which the air was forced by a small hand-bellows shaped like an accordion. By employing a flexible forked tube with arms of equal length, each fitted with a drum at the end, the vibratory air-blast from the reed could be conveyed to the drums so as to set them vibrating in like phase; and when one of the drums was mounted on a vertical axis, and free to rotate round it like the pole of a balanced magnetic needle, the approach of the other drum to it resulted in an attraction between them which was very pronounced. In this case the drums were vibrating in like phase, that is to say, they both bulged out and bulged in simultaneously. The mechanical explanation of the attraction is that there is a rarefaction of the air between the drums produced by the simultaneous advance and recession of the membranes toward each other. This rarefaction occasions a difference of pressure between the front and backs of the drums, causing them to move towards each other.

When, however, the vibrations are in opposite phase, that is to say, when one drum bulges out while the other bulges in, there is a repulsion between the drums corresponding to a condensation of air in the space between them. This condition of things is ingeniously obtained by means of an electromagnetic air-pump or bellows devised by Mr. Stroh. It consists of an iron armature placed between the poles of two double electromagnets, and free to move alternately towards either electromagnet. This to-and-fro motion of the armature is kept up by making and breaking the battery circuit in the coils of the electromagnets alternately. The armature carries a cross-arm or lever-rod fixed at right angles to its axis, and the ends of the rod are attached to two leather diaphragms, which act as partitions across the interior of two boxes. Each of these two boxes communicates with the external air by two pipes or orifices, one on each side of the leather partition. Now when this diaphragm or partition stretching across the box oscillates, air is expelled from one compartment of the box, and at the same time air rushes into the other through the orifices provided. It follows that if the orifices communicate with two drums one drum will collapse whilst the other is inflated. Now the oscillations of the armature keep the diaphragm oscillating, and hence the two drums communicating with opposite compartments of the air-chamber are kept vibrating in unlike phase. By employing two such air-boxes or pumps Mr. Stroh is able at a moment's notice to change the vibrations of the two drums from like to opposite phase by simply connecting the drums to the two expelling compartments of the two boxes, or one to an expelling and the other to an indrawing compartment of the box. The same device of a pivoted drum served in this case also to show that when the drums were vibrating in unlike phase there was repulsion between them.

In the science of magnetism we are taught that like poles repel and unlike poles attract; but in the experiments we are considering it is the drums in like phase which attract and those in unlike phase which repel. Mr. Stroh does not attempt to theorise upon his results; but if the analogy with magnetism hold good our ideas of what constitute like poles in a magnet will suffer a considerable change.

The aërial analogy for the attraction which always takes place between a piece of soft iron and a magnetic pole, whether it be a north or a south pole, was illustrated by Mr. Stroh in holding quiescent or non-vibrating bodies, such as his hand, or a piece of cardboard, near to either drum. The result was always an attraction of the drum towards the passive surface presented, whatever the phase of the drum. This attraction was prettily shown by means of a small round disk of paper attached to the end of a delicate lever pivoted on an upright stand like a magnetic needle.

The dying oscillations of the pole of a magnetic needle, when brought to rest in front of a disturbing magnet, were further illustrated by Mr. Stroh, in presenting the free drum a little apart from the pivoted one, and observing the latter shift round and oscillate before the other, until it came to rest face to face with it. This of course happened when the two drums were vibrating in like phase. When they vibrated in opposite phase, the pivoted drum moved away from the free one, and came to rest further off.

Until this point Mr. Stroh had been occupied with repeating Dr. Bjerknes' experiments in air; but beyond this he makes a new departure on his own account. The object of his further experiments was to ascertain what goes on in the air between the vibrating drums; and by inclosing a pair of the drums in an air chamber communicating wiih a capillary tube containing a column of spirits of wine to act on a pressure guage he showed that when the vibrations were of like phase, the spirit fell, indicating that the air was expelled from between the drums, and on the contrary, when the vibrations were of unlike phase, the spirit rose in the tube, indicating that air had been drawn into the space between the drums, and the pressure thereby raised.

The most valuable part of Mr. Stroh's results was now