genus under consideration; and if it differs in two genera so nearly allied as *Tragulus* and *Moschus*, which many modern zoologists consider only species of one genus, what right have we to assume that it is similar in all the genera of *Bovidæ* and *Cervidæ*, more especially as the placenta of very few species of the large group of Antelopes and Deer is known.

Dr. Sclater proposes to divide the *Ruminantia unguligrada* with placenta polycotyledonaria into *pedes didactyli* and *pedes tetradactyli*; but this character will not separate *Antilocapridæ* from *Bovidæ*, unless he proposes to arrange several animals which have been called Antelopes, and which have simple horns with a permanent horny sheath, and which therefore do not agree with his other characters of the group, in the family *Antilocapridæ*; for the genera *Nesotragus* and *Nanotragus*, and one species of the genus *Calotragus* are as destitute of false hoofs as the genus *Antilocapra*. Dr. Sundevall considers the absence of this false hoof of so little importance that he places two species in the genus *Calotragus*, one having large and the other being entirely without false hoofs. Dr. Sclater must have overlooked this fact when he says, "two other points in which the Pronghorn differs from all the other *Bovidæ*," and proceeds, "in the absence of the 'false hoofs,' as the stunted terminations of the rudimental second and fifth digits of each foot are termed."

LIX.—*On the Vision of Fishes and Amphibia.* By Félix Plateau*.

The eyes of animals have formed the subject of a great number of investigations, which, however, have been almost always directed to a purely anatomical end. In studying the physiology of vision, observers have, so to speak, confined themselves to man, and the question of the vision of animals, interesting as it is, has only been lightly touched upon; moreover physiologists have generally proceeded by analogy, very rarely supported by experiment. There are especially two groups of living creatures which, differing so much in their habits from man, merited investigation from the point of view of their vision, namely the Fishes and Amphibia; and it is these which I determined specially to examine.

In order to show to what kind of investigations and experiments I have subjected the eye of these animals, let us conceive for a moment an ideal typical eye of a fish. Its cornea will be perfectly flat, its crystalline spherical, and the aqueous and

* From the Mém. Cour. et Mém. des Savants Etrang. de l'Acad. Roy. de Bruxelles, tome xxxiii. Communicated by the Author.

vitreous humours of the same density as water and in small quantity. Let us place this eye successively in water and in the air, and examine what will be the course of the rays traversing the organ in these two different media. In water, whatever be the form of the cornea, as the aqueous and vitreous humours have, by hypothesis, the same density as this fluid, the cornea will play the part of a transparent lamina with parallel faces bathed with water on both sides; it will therefore by no means serve to render the luminous rays convergent or less divergent, and the crystalline alone will remain to combine in one point upon the retina the rays of each bundle. It must therefore be very convex and of relatively considerable density.

Will this eye, organized for distinct vision in water, be unfitted for distinct vision in the air? By no means. Let us suppose, in the first place, a bundle of parallel rays falling upon the anterior surface of the eye; these rays will arrive at the crystalline retaining their parallelism, as the two surfaces of the cornea are flat and parallel, and it will be seen that, both in air and water, it is solely to the crystalline that is deputed the function of picturing the image at the bottom of the globe of the eye.

Let us suppose, further, that the axis of the eye is of the proper length for the vision of objects sufficiently distant to allow the rays composing each bundle to be regarded as parallel. A fish furnished with a visual apparatus constructed on the above plan would see as distinctly in air as in water objects situated at a great distance, of course assuming the water to be of perfect transparency.

Let us now examine the case of near objects. Although Fishes in general have very large eyes, the orifice of the pupil never presents a very great diameter; hence, supposing the object looked at to be near the eye (a few centimetres from it for example), the cones of rays emanating from each point of this object would still present a very small base in comparison to their length, and the rays constituting them will form but very small angles with the axes of these same cones. From this it follows that, even if we ascribe to the axis of our typical eye a length corresponding with the distinct vision of objects at a few centimetres' distance, this vision will still be as distinct in air as in water, except that the distance of the object must be rather less in the air. There, in fact, the slight divergence of the rays emanating from one point of the object will be necessarily somewhat diminished as they penetrate into the aqueous humour, and consequently, after their refraction by the crystalline, they will converge at a point somewhat nearer the cornea than if the object were in water. It will therefore be necessary to diminish slightly the distance of the object in order to give the rays a greater divergence and thus compensate the slight refraction produced at their entrance into the eye.

As I shall show hereafter, the actual eye of Fishes closely approaches our ideal type, so that we are entitled to conclude theoretically that these animals can see distinctly in the air, and that their distance of distinct vision must be nearly the same in this medium and in water. Although Fishes, with the exception of some privileged species, such as the Eel, the *Chironectes*, and the climbing Perch, have hardly any need for combining the faculty of seeing distinctly in water with that of seeing distinctly in the air, this double faculty is evidently indispensable to the Amphibia.

It will be easily understood that if we suppose the eye of these latter animals to be constructed exactly like that of animals living exclusively in the air, their vision in water will be confused. In fact, as I have already said, when once the eye is immersed in water neither the cornea nor the aqueous humour has any action, and the crystalline remains alone; but, as in the supposition which we have just made its curvature would be slight, it would no longer suffice to cause the rays to converge upon the retina, or, in other words, its focus would be far behind this. This, as is well known, is what happens in the eye of a man, for example, when diving in the water.

Have the Amphibia so great a power of adaptation as to render their crystalline spherical? This appears, *à priori*, to be doubtful.

It is, on the other hand, very easy to assume that the eye of the Amphibia is organized exactly, or very nearly, like that of creatures living exclusively in water, since in that case the distance at which the animal sees distinctly without effort of the eye must be pretty nearly the same in water and in air.

The purpose of my investigations is to show that the eye of Fishes closely approaches our ideal type, and that that of the Amphibia is almost exactly like it, and, finally, to prove experimentally that distinct vision takes place at sensibly equal distances in air and in water, and with the same perfection in both media, in all the animals under consideration.

I therefore, in the first place, examine what is the exact form of the cornea in Fishes. By simple examination, by the reflection upon this membrane of a dark rectilinear object standing out from a luminous ground, and the image of which, when the eye is looked at from the side, is incurved by the curvature, and, finally, by the actual measurement of the radius of this curve upon a model of the eye taken immediately after the death of the animal, I find that the cornea of Fishes, although rather variable as regards its projection upon the surface of the head, is always flat, or at least much flattened in front of the crystalline and over a space equal to the diameter of that lens, whilst the lateral portions may be much curved. As to the crystalline, I have always found it very nearly a sphere, as, indeed, is well known. Lastly, Cuvier and Monro long since proved that in Fishes the humours of the eye may be assimilated to water. In other words, I prove, by a sufficient number of measurements detailed in one of the tables of my memoir, that the eye of Fishes is always constructed evidently on the plan of the ideal type which I have described above, even in those species which some authors have indicated as exceptional.

I subject the eyes of the Amphibia (that is to say, of the animals which must make use of their organs of vision indifferently in water and in air) to the same investigations, and I show that in all, Mammalia, Birds, Reptiles, Batrachia, &c., the eyes, with the exception of some slight differences, exhibit a structure identical with that of these organs in Fishes. As regards Insects, whether terrestrial, aquatic, or amphibious, they all, according to modern researches, possess eyes with flattened corneæ and the crystallines very convex, at least on the inner surface. Here the anatomical portion of my investigation terminates; and then follows the experimental part, in which I determined the distances of distinct vision of ten species of Fishes of different genera, and of some Batrachia, in air and in water.

The method which I have employed is, in few words, as follows, supposing we have to do with a fish, and the process is the same with other animals. After rapidly killing the individual to be experimented on, one eye is carefully removed from its orbit without alteration of its shape, and then fixed by means of pins and of the fragments of the conjunctiva and muscles upon a plate of cork, in such a manner that the cornea shall be vertical. A suitable aperture is then made at the bottom of the eye, by removing with fine scissors a portion of the sclerotic and retina, and in this aperture is fixed a small glass cup slightly roughened, upon which the image of an external object may be depicted as upon an artificial retina. The object employed is the extremity of a fine iron wire thrown out by the flame of a lamp. The experiment must of course be made at night, or in a room with closed shutters, and the image of the iron wire on the hinder part of the eye is observed by means of a lens. By varying the distance from the iron wire to the cornea, we may always at last attain a position in which the image is distinct. The experiment is repeated a certain number of times to give a mean, and is performed successively in air and water; in the latter case, of course, the iron wire is also immersed in the water. I need hardly add that this liquid is contained in a little box, of which the anterior and posterior surfaces are made of thin glass.

The numbers which I have obtained in the same medium and for the same individual are very close, which justifies our having confidence in the results of experiments so delicate; but, moreover, as may be seen from the table which I give in my memoir, the distances of distinct vision in the air and in water are always very nearly the same. Fishes, therefore, as I have already said from the consideration of the structure of the eye, see as well in the air as in water.

Hence, also, the vision of Amphibia finds a natural explanation, as the visual organs of those animals resemble those of Fishes. Nevertheless, as a confirmation of the theory, I have subjected to the same experiments the eyes of some Batrachia; and in these also the distances of distinct vision in air and in water are, so to speak, identical. I shall only remark, in concluding this analysis, that, in the Amphibia, distinct vision, which is necessarily very short in water in consequence of the imperfect transparency of that medium, must, on the contrary, be able to extend itself in the air to very variable distances, which necessitates the existence of a faculty of accommodation; and accordingly the presence of the ciliary muscle, the chief agent of that faculty, has been recognized in their eyes.

LX.—*Description of a new Siluroid Fish from Ceylon.* By Dr. Albert Günther.

[Plate XV.]

A small collection of freshwater fishes, made by the Rev. Bancroft Boake in Ceylon, and kindly submitted to my examination by F. Layard, Esq., contained two Siluroid fishes of the genus *Arius*, which are of great interest, inasmuch as they prove that the peculiar habit which I have described in an American species, *A. fissus* (Fish. v. p. 173), viz. the mode in which the parent fish takes care of its progeny, is not confined to South-American species, but exists also in the East-Indian ones. The mature ova are of the same large size in all these fish; and in all it is the male which carries them in the spacious cavity of its mouth. According to Mr. Boake, who has published an account of the habits of these fish, they are called *Angaluwa*. Three specimens were in the collection, belonging, however, to two very distinct species, new to science. Two of these, a male and a female, 14 inches long, are *Arius Boakii*, so named by Mr. W. Turner, who also had received examples, and read an account of them at the last meeting of the British Association. We may there-