

directly into the modern Felidæ, the canines having reverted from the almost unique machærodont specialisation to the normal type of carnivorous mammals. The series Dinictis—Nimravus—Pseudælurus—Felis are in direct succession, structurally and geologically."

In the opinion of Dr. Matthew the origin of the cat family cannot be carried back further than the Oligocene sabre-tooth, their supposed derivation through the so-called *Ælurotherium*—which is based on the milk-dentition of a species of the same group—from the Eocene creodont *Palæonictis* being inadmissible.

Mr. R. O. Peterson has, however, just described, under the name of *Daphænodon*, in the Memoirs of the Carnegie Museum at Pittsburg (vol. iv., No. 5), the skeleton of a dog-like carnivore of the size of a large leopard from the Miocene of Nebraska, which, together with the allied but older *Daphænus*, he regards as in a considerable degree intermediate between dogs and cats, although the skull and teeth are essentially dog-like. In many respects *Daphænus*, of which the whole skeleton is known, is very cat-like, especially in the long leopard-like tail, which may, however, have been bushy. A cat-like feature is the partially retractile structure of the claws. In concluding his description, Mr. Peterson observes that the model "is instructive, as it furnishes at least a conception of a primitive form ancestral to cats and dogs." Whether later discoveries in earlier strata will reveal a community of origin for the two groups remains to be seen.

Reverting to the first article, Dr. Matthew replies near the end to critics who have doubted his theory that the sabre-tooths attacked by dropping the lower jaw into a nearly vertical position and stabbing with the upper tusks. After supporting the theory by additional anatomical evidence, he remarks that most of the early large ungulates were of the "pachyderm" type, which were specially suitable to this method of attack, while they would succumb to the mode practised by lions and tigers.

"With the rise and dominance of the large light-limbed ruminants and horses some of the early sabre-tooths were correlatively adapted into the modern type of felines, while other sabre-tooths, as the surviving pachyderm phyla became larger, thicker skinned, and more powerful, became progressively larger, more powerful, and developed heavier weapons to cope with and destroy them. The final extinction of the machærodont phylum was probably largely conditioned by the growing scarcity and limited geographic range of the great pachyderms."

Finally, he protests against the idea that these later sabre-tooths died out as the result of over-specialisation.

Recent conflicting opinions as to the pose of the sauropod dinosaurs are discussed by Dr. Matthew in the September number of the *American Naturalist* (vol. xlv., p. 547). That these reptiles walked, instead of crawling, the author considers fully proved, their limb-structure, as was previously pointed out by Dr. Abel, displaying a remarkable parallelism to that of proboscideans. This "rectigrade" type, in which the whole limb is pillar-like, with the foot short, rounded, and heavily padded, and the toes reduced or rudimentary, is correlated with gigantic bodily size, the movements being mainly restricted to the upper joints, and the foot serving chiefly as a cushion to minimise the shock. A structure of this kind will obviously occur only among animals which habitually rest their weight on the limbs alone.

A limit is, however, soon reached in regard to the weight which even the most powerful limbs are capable of supporting in the case of a purely terrestrial animal, and this limit appears to have been attained among the elephants. But if this be so, we are confronted by the question why the sauropod dinosaurs, with their less perfectly formed limbs, vastly exceed the largest elephants in bulk and stature. The answer, in Dr. Matthew's opinion, is that these reptiles were aquatic, and adapted to wading. "A wading animal has the greater part of its weight buoyed up by the water, and might attain a much larger size without transcending its mechanical limitations, just as the whales and some true fishes attain a much larger size than any land animal."

In 1908 Mr. Lambe described a new genus of crocodile (*Leidyosuchus*) on the evidence of imperfect remains from the Judith River beds of Alberta, Canada. An unusually well-preserved crocodylian skull from the *Ceratops* beds of

Wyoming, recently acquired by the U.S. National Museum, is referred by Mr. C. W. Gilmore (Proc. U.S. Nat. Mus., vol. xxxviii.), in spite of its later geological horizon, to a second species of the same genus, under the name of *L. sternbergii*. A second skull of the same species, from the Hell Creek beds of Montana, which came under the author's notice after the original paper was written, is also described and figured.

Leidyosuchus may now be characterised as a short and relatively broad-skulled crocodile, with the nasals apparently not reaching the nares, the posterior nostrils wholly enclosed by the pterygoids (instead of being behind them, as in *Crocodylus*), the mandibular symphyses short and formed in part by the splenial, the upper teeth more numerous than the lower, the first lower tooth received into a pit, and the third and fourth—which are about equal in size—into notches in the skull. The vertebrae have the cup in front; and there was armour on the lower as well as on the upper surface of the body. Many of these characters connect the genus with *Crocodylus* on one hand and Alligator (including Caiman) on the other, although their preponderance is with the first-named genus. There are also indications of affinity with the Tertiary *Diplocynodon*. The position of the posterior nostrils—intermediate between those of modern and Jurassic crocodyles—is just what might have been expected from the geological horizon of the genus.

Since its original description by Sir R. Owen in 1873 the imperfect skull of the saw-billed bird (*Odontopteryx toliapica*) from the London Clay of Sheppey, preserved in the British Museum, has remained the sole evidence of its genus and species. When complete the specimen probably measured something like 6 inches in length. The discovery is now announced by Mr. B. Spalski, in the second number of the new journal published at Leipzig under the title of *Der Geolog*, of the skull of a much larger species of the same genus in Tertiary strata in Brazil, the total skull-length being no fewer than 53 centimetres. The name *O. longirostris* is proposed for the Brazilian species.

THE INFLUENCE OF RIVER SYSTEMS IN THE EAST.

GLOBUS for September 1, Bd. xcvi., contains an article of some interest on the subject of the influence of river systems in the East, by Herr Ewald Banse. The author deals with the area between 17° and 36° N. lat. and 17° W. and 74° E. long. (which he terms the Orient), where the average annual rainfall is less than 200 mm. (8 inches); this is bordered in the southern Sahara and in the northern part of south-western Asia by a broad zone with an annual precipitation of 600 mm. (23½ inches). In summer this area is the hottest part of the earth's surface. It tends to prevent the intermingling of various flora, fauna, and human races; the Arabian peoples, the one-humped camel, and the date-palm are mainly confined to it. The map accompanying the article shows three main areas, which are drained by no rivers—the Saharan, the Arabo-Syrian, and the Irano-Armenian, the undrained regions amounting to 77 per cent. of the Orient.

The central regions, with their entire lack of hydrographic connection with the ocean, differ essentially from peripheral countries with sea-connection. The formation of level plains is one marked tendency of countries devoid of rivers; wind, which forms the sole connection with the ocean, plays a very important rôle there. These flats are to be regarded as phenomena of disease in the earth's surface, and the fact that three-quarters of the Orient is devoid of river systems will account for its low population and helps to explain its cultural backwardness. It is the watered areas—23 per cent. of the whole—which have produced the cultures of the Orient, e.g. the Sumerian within the Anatolian-Kurdic belt. Higher cultures concentrate where there is flowing water all the year.

Four regions are passed in review, the Atlas countries, the Sahara region, south-west Asia, and western Asia. For each a table is drawn up giving the total area, proportions of permanently river-drained, periodically river-drained, and entirely undrained land, and the density of the population—the last, it may be noted, is in inverse

ratio to the extent of riverless country. These statistical data are summed up in a fifth table. The Sahara region is most intensively characterised by lack of river-systems; no rivers rise there, and those which flow through lose rather than gain during the transit. Eighty-eight per cent. of this region is without off-flow. This huge desert area Herr Banse regards as "the surest bulwark of Islam in Africa."

RECENT PROGRESS IN ELECTRIC LIGHTING.¹

Incandescent Lamps.

THE most remarkable development within recent times is the production of an incandescent lamp with an efficiency approximating to 1 candle-power per watt. The best known of these lamps are of two kinds, one made with tantalum as the material for the filament, and the other with tungsten. There are a great number of lamps under a great variety of different names using tungsten, and the difference between the lamps is largely due to the differences in the processes of manufacture adopted. The most recent development in the construction of tungsten lamps is in the use of wire-drawn filaments (L. Gaster, Cantor Lecture, 1909).

In order to test a statement that has been frequently made as to the bad effect of switching off and on, a series of tests is being carried out in the Electrical Engineering Laboratories at Liverpool in which the lamps are switched off for ten seconds and then switched on again, the process being repeated at intervals of one minute. Although these tests are not complete, the results, so far as they go, have been interesting. In all, twenty lamps, which have been supplied by several makers, are being subjected to this test. The lamps were divided into two groups, and each one was adjusted to have an initial efficiency approximating to 1.4 watts per candle-power; this adjustment was effected by introducing resistance into the circuit of each individual lamp. One set of ten lamps was connected in circuit with an automatic switch driven by a small fan motor at such a speed that a cam switched on the light for fifty seconds and switched it off for ten seconds. The reason for this choice of time was that it appeared that ten seconds was enough to allow the filament to become practically cold, and thus to give the maximum contraction and expansion of the thread. So far as the experiments have gone, the effect of switching does not appear to be serious; the lamps that have been burning continuously have given out to the same extent as those that have been subjected to the continuous switching off and on.

The effective life of these lamps is found by them to be roughly proportional to the 3.65th power of the initial watts per candle-power, a law which corresponds with that found for carbon filament lamps.

We may sum up the position, so far as metallic filament lamps are concerned, by saying that at present there is no difficulty in obtaining a 230-volt metal filament lamp of about 25 candle-power which will give one horizontal candle-power for 1.2 watts, and will burn near this efficiency for more than 1000 hours, probably for a much longer period under ordinary conditions.

Before leaving the subject of incandescent lamps, it may be of interest to make some remarks on the character of the light that is emitted from them. The spectrum obtained corresponds with the spectrum given by an incandescent body, i.e. it is a simple band spectrum. So far as my own observations have gone, there is no evidence of selective emission, and the increase in efficiency of metal filament lamps may be said to be entirely due to the higher temperature at which the lamp filament runs. The wave-length of maximum emission intensity corresponds fairly closely with Wien's law for the radiation emitted by a black body. (It may be of interest to note here how nearly the temperature of maximum emission intensity for the yellow line, D, or centre of the visible spectrum about

6200° C., corresponds with the estimated temperature of the sun.)

The nearer we can approach the temperature of the sun with artificial sources of light, the more nearly will an illumination be obtained which corresponds in all regards with sunlight.

Arc Lamps.

The most notable advance in arc lighting within recent years is the flame arc, but these lamps have been used so extensively for a number of years that the flame arc itself is far from being a recent development.

It is my intention in this paper to lay stress on only two points:—(1) the improvements made in the distribution of light so as to give more uniform illumination over a large area; (2) the actual efficiency or flux of light emitted per watt consumed in a modern lamp.

The attempt to obtain more uniform illumination on the surface has been made in two ways, first by using vertical carbons instead of V carbons, as in the earlier form of flame lamps. As has been pointed out by many people, the candle-power curve required to give uniform horizontal illumination is much more closely approached by the polar curve of light distribution given by a vertical carbon lamp than by any other form.

The second method which has been adopted with the view of improving the light radiation from V carbon lamps is by the use of special globes. The most notable example of this is the use of the dioptric globe.

(2) Actual efficiency of modern arc lamps as measured by the influx of light per watt consumed (see subjoined Table).

Type of lamp	Volts	Current	M. ² S.C.P.	C.-P. per watt
Enclosed flame lamp (clear globe)	58	8.45	2200	4.5
(opal globe)	57.8	8.5	1430	3.0
Open flame arc (slightly obscured globe)	40	7.0	1040	3.72
Singly enclosed arc ordinary carbon	86	8.5	1150	1.6
Midget singly enclosed arc lamp	77	3.2	245	1.0

Vapour Lamps.

The production of light from an incandescent vapour is a method of lighting which has long been familiar, though the only practical examples of it are the mercury vapour lamp and the Moore tube. The two forms of mercury vapour lamp which are being manufactured at present are the quartzite lamp and the silica lamp.

The main characteristic of this lamp is that it produces a large amount of ultra-violet light, to which quartz is transparent, and which is screened off from the exterior by a heavy lead glass cover. If the lamp is left burning without this cover for a few minutes the smell of ozone produced is very strong. It is a matter for discussion whether mercury vapour lamps containing these very strong lines only in the spectrum will not ultimately prove injurious to the sight of those who are obliged to work in it. *A priori*, it would seem to be bound to produce a fatigue of those parts of the retina which respond to the impulses given by the particular rays which the lamp emits.

A lamp of this type has recently undergone test in my laboratory, with the result that the efficiency worked out at 1.73 candle-power (mean hemispherical) per watt. The lamp consumed 688 watts at 230 volts, and gave a mean hemispherical candle-power of 1190.

The mixing of the mercury vapour light with that of the light from tungsten lamps has been tried at Liverpool with quite satisfactory results, the ratio between the amount of light required to produce complete mixing being very easily found by the aid of the globe photometer and two pieces of milk glass, one piece illuminated by a beam of daylight from the outside and the other by the light diffused on the surface of the globe by the two sources of light inside the globe. This method is, of course, not so exact as the colorimeter of Ives, but gives quite satisfactory results.

¹ From a paper read before the Illuminating Engineering Society on December 9 by Prof. E. W. Marchant.