

and that, in the processes of smoothing, the horizontal movement is required to force the abrasive grains against the sides of the cavities. From actual tests it is found that the rate of abrasion is directly proportional to the pressure and to the relative speed of translation.

JAMES WEIR FRENCH.

Annie'sland, Glasgow, October 13.

The Breeding of the King Penguin.

THE Zoological Park at Edinburgh has had the good fortune to possess, almost from its inception, a small group of king penguins. Three of the birds were received in January, 1914, from South Georgia, a second consignment, of which three survived, arriving in the spring of 1917. A hope was excited that they might breed when two of them were observed to be mating in the autumn of 1915, but nothing further occurred at that time. In the late summer of 1917 one of the birds became broody, and sat in the posture of incubation for about a month, but no egg was apparently laid, nor was this bird one of the two which had been observed to be paired. It was not until 1918 that the paired birds really settled down in earnest, and much interest was aroused when, on July 8 of that year, one of them was found to have an egg.

The king penguin, like its near relative the emperor penguin, makes no nest, but carries the single egg on its feet, where it is held in place and covered for warmth and protection by a fold of the skin and feathers of the abdomen, which, being furnished with a constricting muscle, grips the egg tightly. The brooding penguin can not only travel about with the egg in position, but even scratch its head with one foot while still holding the egg securely. Both sexes share in the work of incubation, the transfer of the egg having been observed on the second day. The parental instinct is very strong in the king penguin, not only in mated, but in the unattached birds as well. The group at this time contained three other birds, and their presence, or perhaps nothing but the very obvious conflict of desire for simultaneous possession of the egg between the husband and wife, may have been the cause of the misfortune which followed; at any rate, it was disappointing to find, after about two weeks, that the egg had been broken and that its custodian was believed to be relieving the tedium of duty by occasionally sipping its contents.

The floor of the enclosure consists of shelving rock, and to reduce the risk of breakage if an egg were produced this year, a large bed of sand was laid down. The next incident was again disappointing, for in July an egg was laid, but within an hour or so it had disappeared. As none of the birds showed any disposition to incubate it, I formed the opinion that it had been laid by one of the unmated birds, and this seemed to be confirmed when, on September 1, the female of the pair was found to have an egg. The other three birds were at once removed from the enclosure so that they should not interfere, and for two days all went well, the male bird taking the egg at night and the hen during the day. On the third day, however, the calling of one of the other birds—the third of the three originally imported—seemed to disturb the male, and he left his wife, refused to have anything more to do with the egg, and spent the day (and probably the night) in calling to the third bird and trying to get to it. After some days, as the female seemed to be suffering from the unrelieved care of the egg, and neither bird would feed, it was decided to put the third bird back. When this was done they all settled down together, and the male

resumed his share in the labour, the third bird usually standing near.

The time during which each bird had the egg varied from a day to a week or more. The female when she had the egg always remained in the same place, where she made a slight hollow in the sand, but when the male had it he occasionally went for a walk round the enclosure, shuffling along with the egg on his feet. He even descended from one ledge of rock to another by turning round and working himself down backwards—a performance which led to several narrow escapes for the egg.

As the period of incubation elapsed the result was awaited with some anxiety, and it was in no small degree gratifying to find, on October 22, that the egg was chipped and the chick inside alive. It was not, however, until two days later that the chick was clear of the shell, the period of incubation thus being seven weeks and four days. The chick when hatched was comparatively small, and the skin was bare, but in a few days it increased considerably in size. The young bird, like the egg, is kept between the feet of the parent and covered by the fold of skin; it is fed at frequent intervals with semi-digested fish disgorged by the parent. As in the case of other birds which feed their young by this method, the chick places its head in the parent's mouth and takes the food from the gullet.

Apart from accident, there seems every likelihood that the young bird will be reared. It may be claimed which feed their young by this method, the chick king penguin has bred outside those islands of the Antarctic seas on which it has its home, and the record is a unique one. T. H. GILLESPIE.

Zoological Society of Scotland, Edinburgh,

October 29.

A Helium Series in the Extreme Ultra-Violet.

It has been shown that the helium series first discovered in a terrestrial source by Fowler can be represented by the formula

$$V = 109750 \left(\left(\frac{n_1}{2} \right)^2 - \left(\frac{n_2}{2} \right)^2 \right),$$

where n has the value 3 or 4 (Evans, *Phil. Mag.*, vol. xxix., p. 284, 1915).

If n be given the value 2, and n_2 the successive value 3, 4, and 5, lines result at wave-length 1640.1, 1214.9, and 1084.7. My previous investigations of the helium spectrum did not afford much evidence as to the existence of these lines (*Astrophys. Journ.*, vol. xliii., p. 92, 1916); a recent search, however, has been more successful. With a powerful disruptive discharge in helium, a sharp, fairly strong line appears at 1640.2; no trace of it is found in hydrogen under the same electrical conditions, and it does not occur in helium when the discharge circuit is free from capacity. Under the same violently disruptive condition the line at 1216, always present in helium and hydrogen, develops a satellite on its more refrangible side; this satellite is not well resolved, but its wave-length appears to be about 1215.1. The region that should be occupied by 1084.7 is obscured by a strong pair at 1085, probably due to an impurity.

Owing to the difficulties of vacuum spectroscopy, it is perhaps unwise to claim that the evidence in this case is conclusive. I regard it as very probable, however, that two members of this series in helium have been found in the extreme ultra-violet.

THEODORE LYMAN.

Harvard University, October 25.