such." Finally, cases of special difficulty are dealt with. These may be classified under the following heads: 1. Similar instincts in unallied animals; 2. Dissimilar instincts in allied animals; 3. Instincts apparently detrimental to the species which exhibit them; 4. Instincts performed only once during the lifetime of an animal; 5. Instincts of a trifling or useless character; 6. Special difficulties connected with the instinct of migration; 7. Sundry other instincts presenting more or less difficulty to the theory of natural selection.

The 'conclusion' gives a summary of the general principles which have been set forth by the whole essay. This, therefore, we shall quote *in extenso*:—

"We have in this chapter chiefly considered the instincts of animals under the point of view whether it is possible that they could have been acquired through the means indicated on our theory, or whether, even if the simpler ones could have been thus acquired, others are so complex and wonderful that they must have been specially endowed, and thus overthrow the theory. Bearing in mind the facts given on the acquirement, through the selection of self-originating tricks or modification of instinct, or through training and habit aided in some slight degree by imitation, of hereditary actions and dispositions in our domesticated animals, and their parallelism (subject to having less time) to the instincts of animals in a state of nature; bearing in mind that in a state of nature instincts do certainly vary in some slight degree; bearing in mind how very generally we find in allied but distinct animals a gradation in the more complex instincts, which shows that it is at least possible that a complex instinct might have been acquired by successive steps, and which, moreover, generally indicates, according to our theory, the actual steps by which the instinct has been acquired, inasmuch as we suppose allied instincts to have branched off at different stages of descent from a common ancestor, and therefore to have retained, more or less unaltered, the instincts of the several lineal ancestral forms of any one species, — bearing all this in mind, together with the certainty that instincts are as important to an animal as their generally correlated structures, and that in the struggle for life under changing conditions slight modifications of instinct could hardly fail occasionally to be profitable to individuals, I can see no overwhelming difficulty on our theory. Even in the most marvellous instinct known, that of the cells of the hive-bee, we have seen how a simple instinctive action may lead to results which fill the mind with astonishment.

"Moreover, it seems to me that the very general fact of the gradation of complexity of instincts within the limits of the same group of animals, and likewise the fact of two allied species placed in two distant parts of the world and surrounded by wholly different conditions of life, still having very much in common in their instincts, support our theory of descent, for they are explained by it; whereas, if we look at each instinct as specially endowed, we can only say that it is so. The imperfections and mistakes of instinct on our theory cease to be surprising: indeed, it would be wonderful that far more numerous and flagrant cases could not be detected, if it were not that a species which has failed to become modified and so far perfected in its instincts that it could continue struggling with the co-inhabitants of the same region, would simply add one more to the myriads which have become extinct.

"It may not be logical, but to my imagination it is far more satisfactory, to look at the young cuckoo ejecting its foster-brothers, ants making slaves, the larvae of the Ichneumonidae feeding within the live bodies of their prey, cats playing with mice, otters and cormorants with living fish, not as instincts specially given by the Creator, but as very small parts of one general law leading to the advancement of all organic bodies, — Multiply, vary; let the strongest live and the weakest die."

DR. GRINEWETZKY'S CROSSING OF NOVAIA ZEMLIA.

ON the $\frac{1}{14}$ November, Dr. Grinewetzky described, before the Geographical society of St. Petersburg, his travels on this island. He first started on foot on the $\frac{5}{17}$ August, with Kriwoskeya and a Samoyede (a few of whom are found near Karmakuly). The weather was beautiful, the thermometer 5° C.; but soon after reaching a mountain with a very extensive view, where they passed the night, they were overtaken by a violent snow-storm, and compelled to return. In April, 1883, the Samoyede Hametz crossed the island to the south-east coast, and found Samoyede *chums* (tents). Hearing of this, Grinewetzky, accompanied by Hametz and another Samoyede, set out in sleds drawn by dogs. They had scarcely any food for the dogs, but were assured they would find plenty, as wild reindeer were abundant. This proved not to be the case; and on the fifth day the poor dogs were near starving, when a large herd of reindeer was met. Many shots were fired without effect, due to the difficulty of seeing distinctly, as the men's eyes were much affected by the reflected sunlight, and, in addition, their hands were benumbed by the cold (— 20° to — 25° C.). At last two were killed, and the dogs saved. At first a number of very steep parallel ridges, principally of black slate, were encountered. At some places, hard and exceedingly steep snow-drifts had to be avoided by ascending the surrounding hills. Excepting these drifts, there was but little snow, as, if loose, it was swept away by the strong east-south-east wind prevailing. After the water-shed between the west and east coasts is passed, the country becomes a low plateau, and the snow softer and rather deep and regular. On the $\frac{30 \text{ April}}{12 \text{ May}}$, with the temperature at — 27° C., they prepared to return, as they had already proceeded two days farther than was intended, and no chums were in sight; and, although one of the Samoyedes said the chums were only three miles distant, they began the return.

This expedition is important as the first crossing of Novaia Zemlia by civilized man. According to information collected by Tjagin (1878–79), Pakhtus-

sow, Ziwolka, and Moisseew (1832–39), and a few notes by Höfer and Nordenskiöld, and from his own observations, Grinewetzky gives the following sketch of the south island of Novaia Zemlia. It may be divided into three parts. The northern lies between Matotschkin Shar on the north and the Pukowaja River on the south: this part has the highest mountains (four thousand feet), forming isolated groups rather than ranges. The central part, extending to the Karelka and Belushia Rivers, has five or six parallel ridges, running generally north and south; black slate is common; and the watershed is about seventeen miles from the west coast. The southern part is a rather low plateau: the Goose Land (Gusiwaya Zemlia) is included in this part, which is free from snow by the end of June, and in July has a rather rich vegetation, especially on the gently sloping ground.

Dr. Grinewetzky also expressed the opinion that the wild reindeer of the northern island belong to a totally distinct sub-species from those of the southern island.

LOSS OF NITROGEN FROM ARABLE SOILS.

THE renewed attention of agriculturists has of late been drawn to the question of the nitrogen supply of cultivated soils. On the one hand, Schulz, in Germany, claims to have brought about a gain of nitrogen on a sandy soil by means of the cultivation of lupines, and manuring with kainit. On the other hand, Lawes, Gilbert, and Warington,[1] in England, have published results which show that a very considerable annual loss of nitrogen occurs in the drain-water of cultivated fields; and experiments by Dehérain,[2] in France, show, according to his interpretation of them, an alarming decrease in the total nitrogen of the soil in the course of a few years, and in spite of abundant manuring.

Schulz's experiments have added nothing to our knowledge of the natural supply of nitrogen to the soil, and it is not proposed to consider that topic here. The results of Lawes, Gilbert, and Warington, and of Dehérain, however, have attracted much attention. If they are to be accepted without reserve, they lead to the conclusion that the fertility of our cultivated fields, so far as it depends upon their nitrogen, is being removed in the drainage-water, or in other ways, at a comparatively rapid rate.

The instigation to Lawes, Gilbert, and Warington's experiments was given by the observation, that, in the field-experiments carried on for a series of years at Rothamsted, scarcely a third of the nitrogen of the manure was found in the crop under the most favorable conditions, while, in those cases in which no mineral manures were applied, the deficit was much greater. The most obvious conclusion was, that there must be a great loss of nitrogen in the drainage; and experiments were instituted to test this idea. Their earlier experiments were with three lysimeters. Excavations were made under and around an area of a thousandth of an acre. The mass of soil thus isolated was supported by perforated iron plates, and surrounded by masonry, thus leaving the soil with its natural structure. The quantity of water percolating through this soil has been determined since 1870; and since May, 1877, its content of nitrates has been also determined. The soil was uncultivated and free from vegetation. Numerous interesting facts are disclosed by these determinations, but that which now interests us chiefly is the quantity of nitrogen found in the drain-water. This amounted, in the average of four years, to 46, 36, and 44 pounds per acre, at depths respectively of 20, 40, and 60 inches.

Subsequently the same experimenters have determined the nitrates in the drainage-waters from their experimental wheat-field, each plot of which is drained by a single lateral at a depth of 24 to 30 inches. Having no means of measuring the drainage, the authors take, as the basis of their calculation of the loss of nitrogen, the amount of drainage-water yielded by the 60-inch deep lysimeter at the same time. On this assumption, the annual loss of nitrogen varied from 15 and 16 pounds per acre, on unmanured plots, to as high as 74 pounds per acre.

It is greatly to be regretted that the authors were not able to measure the drain-water in these experiments; for the method which was adopted to supply the deficiency leaves much to be desired. The soil in the lysimeter was uncultivated and bare of vegetation: that of the wheat-field was cultivated, and bore crops of wheat varying considerably in amount. Both these circumstances affect the amount of drainage-water. Cultivation, especially of a clay soil such as that at Rothamsted, may affect very markedly the ease with which water passes downward through it, the amount of water which it can retain in its interstices, and the rapidity of evaporation from its surface. The growth of vegetation exerts a still greater effect on the movements of water in the soil. It has been shown by numerous observers, that much more water evaporates from a soil covered with vegetation than from a bare soil, and that consequently much less of the rainfall percolates through the soil. The diminution of the drainage-water in this way has also been directly proved by Wollny. Furthermore, the various plots in these experiments carried unequal quantities of vegetation, so that the amount of evaporation due to this source must have been unequal also. It appears, then, in the highest degree improbable, that the quantity of drainage-water actually was the same for each plot as was assumed, and unlikely that it was as great as was assumed. When we add to these considerations the fact, that it is uncertain whether the soil of the lysimeter represented an average of the soil of the field, and, further, that all errors of the lysimeter are multiplied a thousandfold when the results are expressed per acre, we are forced to the conclusion that the figures given for the total amount of drain-water, and consequently those also for the total loss of nitrogen in this way, can be, at best, only approximations, and are most likely too large.

[1] *Journ. roy. agric. soc.*, xvii. and xviii.
[2] *Annales agronomique*, viii. 321.