features. The greatest height reached was 20·2 km. on September 9; pressure 43 mm.; temperature −59° C. The lowest temperature, −62°, was recorded at 14·1 km. All the balloons travelled easterly, but as several were lost owing to the proximity of lake or forest, the station had to be moved from Toronto to Woodstock, about eighty miles to the westward. The kite station is at Agincourt, about fourteen miles from Toronto; Dines's kite and meteorographs were used, and good records of pressure, temperature, humidity, and wind direction have been obtained; the highest flight was 7900 ft. above sea-level.

BIRD NOTES.

IN the November number of *The Zoologist* Mr. Harvie-Brown, in completing his account of the southern extension of the breeding range of the fulmar which has been in progress for many years, points out that these essentially Arctic birds had established themselves in St. Kilda at least 250 years ago. In 1838 or 1837 they were observed for the first time in the Faroes, nesting on the cliffs of Qualboe in Suderoe, and by 1849 they had colonised Skuor and Great Dimon. From these islands the fumar has invaded, as a breeding species, the Shetlands, the Scottish mainland, and the west coast of Ireland.

To Notes from the Leyden Museum, vol. xxxiv., Nos. 3 and 4, Dr. Van Oort contributes further records of the recapture of birds marked in Holland during 1911 and 1912. Among the species mentioned is the spoonbill, of which one example was taken at Reculvers, Kent, while four others were killed in north-western France. The total number of birds ringed in 1912 is considerably in excess of those marked in 1911.

An article on the haunts of the spotted bower-bird (*Chlamydodera maculata*), contributed by Mr. S. W. Jackson to the October number of *The Emu*, is illustrated by excellent photographs of the "runs," nests, and eggs of these birds. In addition to certain implements purloined from the writer's camp, the objects in one of the bowers included ribs and vertebræ of sheep, toe-bones of emus, fragments of coloured glass, stoppers of sauce-bottles, metal clippings, screws, metal bottle-capsules, a cartridge-case, and numerous pods and seeds. The birds nest high up in leafy trees, but select as look-out stations leafless branches or trees.

In vol. ii., No. 1, of the University of California Publications in Zoology Mr. H. C. Bryant bears testimony to the utility of birds as destroyers of grasshoppers. In July last it appears that grasshoppers were doing considerable damage to alfalfa and vegetables at Los Banos, Merced County, California. An average of about fifteen grasshoppers to a square yard is harmful, but in this instance there were from twenty to thirty. Several kinds of birds were observed to be feeding on the insects, and it was noticed that the local contingent of the former was reinforced from the neighbourhood. The author is led to conclude that although birds cannot be regarded as a trustworthy means for controlling all infestations of grasshoppers, yet they are efficient in preventing many. They can be depended on to protect crops by their war against the grasshoppers. "The failure of birds to check an insect outbreak is evident to all. Their success in preventing insects from becoming abnormally abundant is not so apparent but is no less real." Many birds in this particular case changed their normal feeding habits, and took to preying on grasshoppers, and species usually considered harmful to the agriculturist were commended for their utility.

The food of the pheasant in the Scottish grouse moors forms the subject of a note by Mr. P. H. Grimshaw in *The Scottish Naturalist* for November. Examination of the contents of the crop of a bird killed in Argyllshire, where the heather-beetle (*Lochmoea suturalis*) was unusually abundant during the summer, showed that these consisted chiefly of insects. These included 2286 flies (*Bibio lepidus*), 508 heather-beetles, and six other insects. This leads to the conclusion that the pheasant, like the blackcock, may be reckoned of importance in checking the ravages of the heather-beetle.

Another paper on the food of birds is published as Bulletin No. 44 of the Biological Survey of the U.S. Department of Agriculture. This report, which is drawn up by Mr. F. E. L. Beal, relates to the fly-catching species of North America, referable to the genera Sayornis, Empidonax, Muscivora, Myiarchus, Tyrannus, &c. The contents of the stomachs, or crops, of seventeen species were examined, and it was found that "of thirteen of these species Hymenoptera are the largest element in the diet. Of one species Orthoptera (grasshoppers and crickets) are the leading food; in another Lepidoptera (moths and caterpillars) are the favourites; and in two others Diptera (flies) stand at the head. Hemiptera (bugs) are eaten extensively by some, but naturally the ones taken are the larger flying species. Plant-lice and scales [Coccidæ] have not yet been found in the stomach of any fly-catcher, though one bird was shot on a plant covered with lice, with which its bill was filled."

Several of these birds have been charged with devouring honey-bees, but the accusation is not sustained by the examination of their food; comparatively few of these insects being devoured, and those chiefly drones. The real harm done by these birds is the destruction of predaceous and parasitic Hymenoptera which wage war on injurious insects. R. L.

STOCK DISEASES AND THEIR SUPPRESSION IN SOUTH AFRICA.[1]

MODERN knowledge of trypanosome disease and others of a similar nature can be usefully applied to some of the problems which are in my particular line of research, viz. to diseases of our domesticated animals. I shall mention but two, known probably to you all, and which are of great economical importance—horse-sickness in equines, and blue-tongue in sheep. Long before any expert came in contact with him, the observant farmer quite rightly classed these two diseases in one group. He even went so far as to say they were identical, but here is an opinion which we are not able to support. There are, nevertheless, more similarities than differences in the two; they resemble each other in nature of the cause, both being due to micro-organisms of infinitesimal minuteness, so small that none of our modern microscopes can detect them.

The theory of our modern microscope teaches us that there is a limit to visibility beyond which objects can no longer be recognised. The so-called ultra-microscope, which makes use of a different principle of illumination, and allows the detection of objects varying in the magnitude of a molecule, has in these two diseases failed to enable us to demonstrate an organism so far. It must be there, nevertheless, and we conclude this from the experiment that we are able to transmit the disease by inoculation with blood from a sick to a healthy animal, in which latter, after a definite incubation time, it appears, thus showing

[1] From the Presidential Address delivered before the South African Association for the Advancement of Science, at Port Elizabeth, on July 2, by Dr. Arnold Theiler, C.M.G.

that a development must have followed. It having been demonstrated that the malady was inoculable, it formed the subject of much speculation to explain the observations which the farmers had been collecting ever since they knew it, and which principally apply to the climatic and tellurical conditions under which it appears. You have probably all heard that the farmer interpreted his observations to the effect that the dew is the cause. There is nothing ridiculous in this theory. Remember that our knowledge of micro-organisms as causes of disease is practically only a science of yesterday; remember that the English translation of the name "malaria" for the disease of that name means "bad air," and it is only a few years back that science admitted of such a theory as the probable cause; that is just as our farmers have done and are still doing for horse-sickness.

The observations of the farmer are correct in details. We give them the right interpretation when we sub titute for the name "dew" the name "blood-sucking night insect." Under the conditions under which dew is formed horse-sickness and blue-tongue appear most frequently, and these conditions are most favourable for the breeding of mosquitoes and other blood-sucking insects. This being so, the question might be put to us, "But are there any direct proofs to this effect?" If we had all the proofs, we would no longer speak of a theory, and we must speak of a theory until the actual blood-sucking insect has been demonstrated and until the experiments have been made under such conditions that no doubts are left any longer. Indirectly, the theory has been so well founded that the only missing link is the insect itself. The reason why this link has not been demonstrated yet is the fact that we do not know sufficient of all the nocturnal blood-sucking insects of South Africa, of which various genera and many species exist; we do not yet know how to breed and handle them for such delicate experiments as are required to bring the proofs with horse-sickness and blue-tongue. Notwithstanding this, the theory has its practical value, inasmuch as it shows in which way protective measures can be adopted, and what has been said about the destruction of mosquitoes in connection with human malaria applies equally well to the diseases under discussion.

The theory goes still further. Seeing that flying insects must be accepted as being the transmitting agencies, we conclude that there also must be a reservoir somewhere from which these insects obtain the virus. This is perhaps the most interesting point. The horse alone in the case of horse-sickness, and the sheep in the case of blue-tongue, are not sufficient to represent that reservoir. When recovered, the blood of these animals no longer contains any virus. Furthermore, horses, when introduced into a wild country where before there had never been any equines, are liable to contract the disease. Again, the almost "explosion-like" expansion when climatic conditions are suitable does not allow us to conclude that the sick animal alone is responsible, and we naturally ask, "Where does the virus come from?" By analogy with tsetse and human malaria we accept the existence of a reservoir in the shape of a different species of animal, harbouring the parasite of the disease in its blood. Such an animal may be cold-blooded or warm-blooded, a bird or a mammal.

Here, again, we have not yet been able to make further progress. We enter on a different branch of research. It will be interesting work for our zoologists to point out to us the geographical distribution of any such animals, coinciding with the distribution of the disease. Then we might have more hope of proving the theory than there is at present, where we have to work more or less in the dark. It is this theory which justifies the hope that within the districts of the reservoir those diseases will be suppressed one day. Recently an assistant of mine, Mr. Walker, found a parasite in the blood of young ostrich chicks known under the name of *leucocytozoon* and related to the trypanosomes. Whatever the practical outcome of this discovery will be, one conclusion we are entitled to make now, and that is the parasite is transmitted by insects; and should it prove to be the cause of the mortality observed in chicks, the way to combat it is indicated by this conclusion.

Whilst on the subject of suppressing disease, I wish to refer to some other well-known observations made by farmers, the correct interpretation of which has led to important applications. They are in connection with immunity. When horses or sheep recover, they are said to be salted against the disease, viz. to be immune. We expected this to be so by comparison with other diseases of a similar nature, but caused by visible organisms. To this latter group belong those against which modern science introduced methods of preventive inoculation, and by analogy we were entitled to anticipate that a similar possibility would exist in connection with those under discussion. It proved to be the case, and on recognised principles, methods of inoculation for mules as well as for sheep were worked out, which proved to be successful. In the case of horses, however, great difficulties were experienced, inasmuch as these animals showed a much higher susceptibility than mules, a fact which can only be explained by inherited immunity from their sires, which, although susceptible to the disease, have, at least in my experience, never been found to die. The methods in use for mules proved useless for horses. Here the observation of the farmers came to the rescue; they led to deductions which proved to be applicable in the practice.

Long ago farmers had the experience that the so-called salted horses may break down in immunity. They called these relapses, or "*aanmanings*." Subsequently our experience proved the same observations to be correct. Some of the mules and horses which were undoubtedly immune broke down when exposed to natural infection. The virus from such cases was collected, and in several instances it was shown that breakdown in immunity could be produced in almost any salted animals. The experiments showed that there was no actual loss of immunity in the animal affected, but the relapse was due to the different nature of the virus. This means from a biological point of view, the ultravisible micro-organism will also follow the laws of other organisms, viz. that of variability or mutability, but which can show itself to our eyes only by a different virulency in the animal it attacks.

Accordingly more than one variety of horse-sickness organisms exist, and although from a pathological point of view we only recognise one disease, yet there are as many diseases as there are varieties of ultra-visible organisms. At one time we thought that the variation was simply due to the influence of environment, but, based on a number of experiments, we came to the conclusion that the cause of the variability of a particular strain lies in the horse from which it is collected. The host represents, so to say, its environments. The passage through a horse determines whether there will be a decrease or an increase in virulency. This fact established, the further conclusion was made that there must be certain strains or varieties of which the virulency would not be so pronounced, and accordingly that a greater number of animals would recover when infected. This, indeed, proved to be the case. The variability of the organism has now been made use of for the inoculation of horses in connection with the method as applied to mules. The method was introduced into practice last year, and only in the experimental manner; it has not yet stood the brunt of the severe tests of the practice.

The experience just now alluded to teaches us that under the conditions of the practice breakdown in immunity will occur. It remains to be seen to what extent they do occur, or, in other words, what percentage of inoculated horses will be protected against the naturally acquired disease. The same principle was made use of in the preparation of the blue-tongue vaccine, and again recently in the method of inoculation against anaplasmosis of cattle, a disease generally known as gall-sickness. This latter was found to be caused by parasites attacking the red corpuscles of the blood. The remarkable observation was made that two different varieties of organisms could be distinguished under the microscope, and the tests proved that whereas one species was very virulent, the other one was very much less so, and this latter protected an animal to a great extent against the former. The vaccines used against the various diseases therefore represent by no means anything artificial; they are specially selected germs producing the disease in a milder form, which give a great amount of immunity, but by no means a complete one, owing to the existence alongside of still stronger varieties of the same species or genus.

A cure or an inoculation against a disease always appeals to the mind of a layman, and more credit is attached to such an inoculation than to other methods of prevention or controlling the disease which perhaps are more rational but more tedious and cumbersome. A good illustration of this is afforded by red-water, which, as many of you will remember, was introduced into the Cape Colony many years ago. In those days measures were taken to stop its spread, but they were of no use, because the cause of the plague was not then known. Only in the beginning of the 'nineties of the last century was it found in America that it was due to a parasite which lived in the red corpuscles; the parasite developed in the body of a tick, and was transmitted by these to new cattle.

This was as much an epoch-making discovery as Bruce's that the trypanosoma disease was carried by winged insects. The statements of the American men of science were subsequently verified in Cape Colony, and when the attention of South African workers was directed to the presence of similar parasites in the blood of South African stock suffering from various other ailments, then it was only natural to conclude that in their propagation ticks also must be responsible. The conclusion proved to be correct. It was further proved that there also existed the theoretical reservoir; it was found that it was the recovered animal itself which remained infected. This fact, so paradoxical as it appears for healthy animals to spread a disease, explains the permanency of infection on our pasture; although they are immune, they maintain the contamination.

The investigations by Lounsbury into heart-water; a disease caused by an invisible organism which at one time rendered the rearing of cattle and small stock almost an impossibility, more particularly in this neighbourhood, proved definitely that also here ticks were responsible. Once these facts were well established, it was a natural conclusion to expect that the destruction of the ticks would mean the eradication of the disease, just as the destruction of mosquitoes meant the disappearance of malaria. This conclusion at one time had only appealed to a limited number of farmers, and it is even at the present time not sufficiently appreciated. Perhaps it is not scientific enough, or there is not enough mystery about it.

When the terrible disease, East Coast fever, was introduced into South Africa, the presence of a parasite found in the blood corpuscles was soon recognised, and the conclusion had to be drawn that here again ticks were responsible. This also proved correct. After the species of tick which transmitted the disease had been traced, and their life-history was fully understood, and once it had been realised that in this disease, unlike the other caused by intracellular parasite, the immune animal did not represent the reservoir for the virus, it became possible successfully to combat it. In the course of time the most powerful remedy proved to be the dipping tank, which was decidedly the salvation of the Natal farmer, all other methods of stopping the spread in that Colony having failed. For the destruction of the ticks as the root of many evils in stock, the dipping tank must be considered to be the best and most practical means, and its introduction into South Africa is a great scientific attainment.

Not only in the world of micro-organisms, but also in that of higher developed parasites, we shall find our example for demonstrating the utility of the adoption of biological research. I refer to one of the most important farming industries, viz. the breeding of ostriches. We know that one of the main drawbacks are internal parasites, and although the farmer is able to help himself temporarily in a rough and ready way, yet he feels that, in order to combat these pests more successfully, more scientific knowledge is required about the life-history of these worms. As soon as this is established—and I can tell you that good progress has already been made in this connection—practical deduction will be possible in order to build up a rational hygiene for the rearing of the chicks.

So far I have selected my examples in scientific research and practical application out of a group of diseases due to parasites visible to the naked eye, by microscope, or those that can be traced by means of inoculation experiments. We have, so to say, the cause of the diseases in our hands, and can produce and reproduce them at will. This is the one and perhaps the main reason why in the past, in a considerably short time, good progress was made; we were dealing with problems similar to many others already solved. I will now have to mention a subject where the use of the microscope and all transmission experiments into animals failed. It is the disease "Lamziekte" in cattle, to which, in recent years, so much attention has been given by the public, the Press, and Parliament. It has caused terrible destruction, and even threatened to ruin the newly-developed north-western districts.

The investigations carried out so far in conjunction with Mr. Burtt-Davy, the Government agrostologist and botanist, show that we have to deal with toxins which are present in grasses of certain areas. This is at least our theory, and it is well founded; it is, however, by no means new, as it has its analogies in other parts of the world, and explains the observations made by farmers in various parts of South Africa; indeed, it represents the views of many farmers, although not precisely expressed. It is that grasses on certain soils and under certain climatic conditions develop a poison of an accumulative character which only shows its effects on cattle after they have partaken of such grasses for a prolonged period. Actual feeding experiments which have been started on various experimental stations will bring the proof one of these days. The influence of climate and soil has also recently been brought home by experiments undertaken in Natal. Some of you will remember that Mr. Robertson, of Grahamstown, proved in an unmistakable way that the plant *Senecio latifolia*, collected in that part of the country, was found to be very fatal when fed to horses and cattle. The experiments in Natal, carried out on the same class of animals with the same plant, proved harmless.

You will grasp the complexity of these subjects when you remember that, in order to understand and explain them fully, a combination of a number of sciences is necessary, viz. pathology, geology, botany, chemistry, climatology, meteorology, and physiology. Better subjects could scarcely have been found to illustrate how comprehensive investigations may become in a matter which at first sight seems purely and simply a problem for the veterinarian. This point brings me back to some remarks raised before. It is only possible for an applied science, such as that for investigating into the cause of the disease, to progress when the other sciences on which the applied one is based are advancing at the same time or, still better, are ahead of it. This applies strikingly to the case in point. Of the physiological effect of grasses and plants under the various conditions of climate and soil in South Africa we know nothing as yet. I am glad to state that the Minister of Agriculture, to whom I have explained the necessity of such investigations, has promised to add a branch of physiological research on to the laboratory under my control. But an investigation of this nature must be thoroughly undertaken, and in order to be fruitful it must go hand in hand with chemical and biological investigations of the nature of the soil as well.

The necessity for such investigations has frequently been pointed out. Prof. Pearson some years ago advocated the erection of botanical gardens in South Africa in areas representing the various conditions of climate and soil, and one of his strong arguments was the economical importance such establishments would have. Our recent investigations bear him out, and should bring home the value of such institutions. For many years Dr. Juritz preached the necessity of a systematic and thorough chemical survey of the soil of this subcontinent. The conclusions I put before you in connection with the disease caused by plants show you the necessity in the first instance of scientific research into soil and vegetation. But a good deal is required if we intend to make further progress in the understanding of the disease as already described, and of many more not touched at all. The necessity for a general biological survey of all South Africa becomes obvious. Particularly the geographical distribution and seasonal occurrences of plants and animals, the connection of climate and soil with flora and fauna, will have to be thoroughly studied. Hand in hand with this will go the interpretation of the presence and absence of the cause of certain stock diseases.

Fortunately, in the past a great deal has been done by a good many enthusiastic workers. More has yet to be done. Dr. Muir, in his presidential address in Cape Town two years ago, touched on this question, and he pointed out the necessity of a systematic cooperation in which the museums of South Africa could perform the leading duties. I fully agree to this, and I am of the idea that these institutes, similar to the one under my charge, should be centralised, and the work should be undertaken in a definite and well-planned manner, preventing overlapping, and securing complete specialisation in the various branches. We require more: we want a centre for scientific investigation, a central university for South Africa, where research is the leading idea. I speak with emphasis, that South Africa should not wait any longer before establishing such an institute. We men engaged in the application of science feel the want of it in all our undertakings; we require it for advice or assistance in the many problems the solution of which is entirely outside the scope of a single man, who is not always able to keep in line with the new discoveries, and outside his own sphere of work. Nowadays, it is no longer a genius who will only be capable of solving knotty problems; I venture to say that the methods of investigation and research are so far developed that any scientifically trained man with the necessary critical mind, and endowed with patience and perseverance, can tackle these investigations with every prospect of solving them, provided the sciences he has to make use of are sufficiently far advanced to be of assistance to him.

In conclusion, I wish to come back to one of my remarks; that the South African tends to the practical side of scientific problems. If I can give him, after so many theoretical discussions, practical advice, it will be: foster by all means the pure sciences; they are, in the hands of experts, the medium of solving the many economical problems of South Africa.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

IN the issue of NATURE of December 5 last attention was directed to the action which the general council of the University of Edinburgh had taken to bring before members of Parliament and others interested in higher education the serious danger with which the universities of Scotland are threatened by the recent interference of the Treasury with their freedom of internal administration. From further information which has reached us, we find that the question of whether or not Scottish universities are to establish composite or inclusive fees is regarded by the council as relatively unimportant. The vital question is whether the Scottish universities, which have hitherto been free so far as their internal administration is concerned, are now to be subject to a State department. The council is not asking that the universities of Scotland should be freed from the responsibility of accounting for their use of public money, but it is desired that the autonomy which has hitherto been a greatly valued characteristic of the Scottish university system should not now be withdrawn.

THE Bulletin of the Massachusetts Institute of Technology for December, 1912, takes the form of "a catalogue of the officers and students, with a statement of the requirements for admission, and a description of the courses of instruction." One of the most interesting of the very complete arrangements of the institute is the opportunity for research afforded in all the laboratories devoted to the more advanced branches of instruction, as well as in the three separately organised research laboratories for physical chemistry, applied chemistry, and sanitary science. We notice also that by a gift in 1909 special research in seismology and other branches of geophysics was provided for. On January 1, 1912, the Hawaiian Volcano Research Association cooperated with the institute to establish an observatory and laboratory at the volcano Kilauea. Work was begun at once, and a suitable building has been constructed with laboratories, a seismograph cellar, water supply, and facilities for physico-chemical investigation of volcanic process. Investigations are carried on by a resident staff, and properly qualified investigators will be received at the observatory for special studies.

IT is announced that a group of some of the largest coal owners of South Wales has decided to start a mining school for the training of colliery officials. Treforest House, Treforest, has been acquired for the purposes of the school, and the post of director of