been comparatively short, both stations have suffered from "mikroseismische Unruhe" (air tremors?).

At the present moment the most interesting station where world shaking earthquakes are recorded is at Pribram, where on the surface and at a depth of 1100 m. Wiechert's pendulums are installed. From the few records hitherto obtained, it appears that the motion on the surface and that underground have a striking similarity.

DR. GOELDI ON BRAZILIAN DEER.

DR. E. GOELDI has decidedly advanced our knowledge of the deer of South America by a memoir on the antlers of three Brazilian species recently published in the *Memorias* of the museum at Para of which he has charge (*Mem. Mus. Goeldi*, part iii., 1902). All South American deer, it need scarcely be said, differ markedly from the more typical deer of the Old World, the males of the larger species, together with their relatives, the white-tailed and the mule deer of North America, being specially distinguished by the form of their antlers, which branch in a fork-like manner some distance above their base, instead of giving off a brow-tine close to the latter. Hitherto naturalists, in Europe at any rate, have had no definite information with regard to the gradual increase in the complexity of the antlers of the South American species as they are annually renewed. This deficiency in our knowledge has been supplied in the case of the marsh-deer, the pampas-deer, and the one commonly called *Cariacus gymnotis*, in the memoir before us. With great pains, Dr. Goeldi has collected a large series of the antlers of each of the three species belonging to animals of different ages, and in the plates accompanying his memoir has figured a selection which serves to display the gradual evolution from the young to the adult form. In the course of the memoir, it is incidentally mentioned that the aforesaid *C. gymnotis*, which is a near relative of the North American whitetail, has only recently made its appearance in Brazil, its proper home being Colombia and Guiana.

THE PEARL FISHERIES OF CEYLON.[1]

THE celebrated pearl "oysters" of Ceylon are found mainly in certain parts of the wide shallow plateau which occupies the upper end of the Gulf of Manaar, off the north-west coast of the island and south of Adam's Bridge.

The animal (*Margaritifera vulgaris*, Schum. = *Avicula fucata*, Gould) is not a true oyster, but belongs to the family Aviculidæ, and is therefore more nearly related to the mussels (Mytilus) than to the oysters (Ostræa) of our seas.

The fisheries are of very great antiquity. They are referred to by various classical authors, and Pliny speaks of the pearls from Taprobane (Ceylon) as "by far the best in the world." Cleopatra is said to have obtained pearls from Aripu, a small village on the Gulf of Manaar, which is still the centre of the pearl industry. Coming to more recent times, but still some centuries back, we have records of fisheries under the Singhalese kings of Kandy, and subsequently under the successive European rulers—the Portuguese being in possession from about 1505 to about 1655, the Dutch from that time to about 1795, and the English from the end of the eighteenth century onwards. A notable feature of these fisheries under all administrations has been their uncertainty.

The Dutch records show that there were no fisheries between 1732 and 1746, and again between 1768 and 1796. During our own time the supply failed in 1820 to 1828, in 1837 to 1854, in 1864 and several succeeding years, and finally after five successful fisheries in 1887, 1888, 1889, 1890 and 1891 there has been no return for the last decade. Many reasons, some fanciful, others with more or less basis of truth, have been given from time to time for these recurring failures of the fishery; and several investigations, such as that of Dr. Kelaart (who unfortunately died before his work was completed) in 1857 to 1859, and that of Mr. Holdsworth in 1865 to 1869, have been undertaken without much practical result so far.

[1] Abstract of a discourse delivered at the Royal Institution on March 27 by Prof. W. A. Herdman, F.R.S.

In September, 1901, I was asked to examine the records and report on the matter, and in the following spring was invited by the Government to go to Ceylon with a scientific assistant, and undertake what investigation into the condition of the banks might be considered necessary. Arriving at Colombo in January, 1902, as soon as a steamer could be obtained we proceeded to the pearl banks. In April it was necessary to return to my university duties in Liverpool, but I was fortunate in having taken out with me as my assistant Mr. James Hornell, who was to remain in Ceylon for at least a year longer, in order to carry out the observations and experiments we had arranged, and complete our work. This programme has been carried out, and Mr. Hornell has kept me supplied with weekly reports and with specimens requiring detailed examination.

The s.s. *Lady Havelock* was placed by the Ceylon Government at my disposal for the work of examining into the biological conditions surrounding the pearl oyster banks; and this enabled us on two successive cruises of three or four weeks each to examine all the principal banks, and run lines of dredging and trawling and other observations across, around and between them, in order to ascertain the conditions that determine an oyster bed. Towards the end of the time I took part in the annual inspection of the pearl banks, by means of divers, along with the retiring inspector, Captain J. Donnan, C.M.G., and his successor, Captain Legge. During that period we lived and worked on the native barque *Rangasameeporawee*, and had daily opportunity of studying the methods of the native divers and the results they obtained. [These were discussed in the lecture and illustrated by lantern slides.]

It is evident that there are two distinct questions that may be raised—the first as to the abundance of the adult "oysters," and the second as to the number of pearls in the oysters—and it was the first of these rather than the frequency of the pearls that seemed to call for investigation, since the complaint has not been as to the number of pearls per adult oyster, but as to the complete disappearance of the shell-fish.

Most of the pearl oyster banks or "Paars" (meaning rock or any form of hard bottom, in distinction to "Manul," which indicates loose or soft sand) are in depths of from 5 to 10 fathoms, and occupy the wide shallow area of nearly 50 miles in length, and extending opposite Aripu to 20 miles in breadth, which lies to the south of Adam's Bridge. On the western edge of this area there is a steep declivity, the sea deepening within a few miles from under 10 to more than 100 fathoms; while out in the centre of the southern part of the Gulf of Manaar, to the west of the Chilaw Pearl Banks, depths of between one and two thousand fathoms are reached. On our two cruises in the *Lady Havelock* we made a careful examination of the ground in several places outside the banks to the westward, on the chance of finding beds of adult oysters from which possibly the spat deposited on the inshore banks might be derived. No such beds, outside the known "Paars," were found; nor are they likely to exist. The bottom deposits in the ocean abysses to the west of Ceylon are entirely different in nature and origin from the coarse terrigenous sand, often cemented into masses, and the various calcareous neritic deposits, such as corals and nullipores, found in the shallow water on the banks. The steepest part of the slope, from 10 or 20 fathoms down to about 100 fathoms or more, all along the western coast seems in most places to have a hard bottom covered with Alcyonaria, sponges, deep-sea corals and other large encrusting and dendritic organisms. Neither on this slope nor in the deep water beyond the cliff did we find any ground suitable for the pearl oyster to live upon.

Close to the top of the steep slope, about 20 miles from land, and in depths of from 8 to 10 fathoms is situated the largest of the "Paars," the celebrated Periya Paar, which has frequently figured in the inspectors' reports, has often given rise to hopes of great fisheries, and has as often caused deep disappointment to successive Government officials. The Periya Paar runs for about 11 nautical miles north and south, and varies from one to two miles in breadth, and this—for a paar—large extent of ground becomes periodically covered with young oysters, which, however, almost invariably disappear before the next inspection. This paar has been called by the natives the "mother-

paar," under the impression that the young oysters that come and go in fabulous numbers migrate or are carried inwards and supply the inshore paars with their populations. During a careful investigation of the Periya Paar and its surroundings, we satisfied ourselves that there is no basis of fact for this belief; and it became clear to us that the successive broods of young oysters on the Periya Paar, amounting probably within the last quarter century alone to many millions of millions of oysters, which if they had been saved would have constituted enormous fisheries, have all been overwhelmed by natural causes, due mainly to the configuration of the ground and its exposure to the south-west monsoon.

A study of the history of the Periya Paar for the last twenty-four years [given more fully in the lecture] shows that since 1880 the bank has been naturally restocked with young oysters at least eleven times without yielding a fishery.

The 10-fathom line skirts the western edge of the paar, and the 100-fathom line is not far outside it. An examination of the great slope outside is sufficient to show that the south-west monsoon running up towards the Bay of Bengal for six months in the year must batter with full force on the exposed seaward edge of the bank and cause great disturbance of the bottom. We made a careful survey of the Periya Paar in March, 1902, and found it covered with young oysters a few months old. In my preliminary report I estimated these young oysters at not less than a hundred thousand millions, and stated my belief that these were doomed to destruction, and ought to be removed at the earliest opportunity to a safer locality further inshore. Mr. Hornell was authorised to carry out this recommendation, and went to the Periya Paar early in November with boats and appliances suitable for the work, but found he had arrived too late. The south-west monsoon had intervened, the bed had apparently been swept clean, and the enormous population of young oysters, which we had seen in March, and which might have been used to stock many of the smaller inshore paars, was now in all probability either buried in sand or carried down the steep declivity into the deep water outside. This experience, taken along with what we know of the past history of the bank as revealed by the inspectors' reports, shows that whenever young oysters are found on the Periya Paar, they ought, without delay, to be dredged up in bulk and transplanted to suitable ground in the Cheval district—the region where the most trustworthy paars are placed.

From this example of the Periya Paar it is clear that in considering the vicissitudes of the pearl oyster banks we have to deal with great natural causes which cannot be removed, but which may to some extent be avoided, and that consequently it is necessary to introduce large measures of cultivation and regulation in order to increase the adult population on the grounds, give greater constancy to the supply, and remove the disappointing fluctuations in the fishery.

There are in addition, however, various minor causes of failure of the fisheries, some of which we were able to investigate. The pearl oyster has many enemies, such as star-fishes, boring sponges which destroy the shell, boring Molluscs which suck out the animal, internal Protozoan and Vermean parasites and carnivorous fishes, all of which cause some destruction, and which may conspire on occasions to ruin a bed and change the prospects of a fishery. But in connection with such zoological enemies, it is necessary to bear in mind that from the fisheries point of view their influence is not wholly evil, as some of them are closely associated with pearl production in the oyster. One enemy (a Plectognathid fish) which doubtless devours many of the oysters, at the same time receives and passes on the parasite which leads to the production of pearls in others. The loss of some individuals is in that case a toll that we very willingly pay, and no one would advocate the extermination of that particular enemy.

In fact the oyster can probably cope well enough with its animate environment if not too recklessly decimated at the fisheries, and if man will only compensate to some extent for the damage he does by giving some attention to the breeding stock and "spat," and by transplanting when required the growing young from unsuitable ground to known and trustworthy "paars."

Those were the main considerations that impressed me during our work on the banks, and were, therefore, the leading points dealt with in the conclusions given in my preliminary report (July, 1902), which ended as follows:—

"To the biologist two dangers are, however, evident, and, paradoxical as it may seem, these are *overcrowding* and *overfishing*. But the superabundance and the risk of depletion are at the opposite ends of the life cycle, and therefore both are possible at once on the same ground—and either is sufficient to cause locally and temporarily a failure of the pearl oyster fishery. What is required to obviate these two dangers ahead, and ensure more constancy in the fisheries, is careful supervision of the banks by someone who has had sufficient biological training to understand the life-problems of the animal, and who will therefore know when to carry out simple measures of farming, such as thinning and transplanting, and when to advise as to the regulation of the fisheries."

In connection with cultivation and transplantation, there are various points in structure, reproduction, life-history, growth and habits of the oyster which we had to deal with, and some of which we were able to determine on the banks, while others have been the subject of Mr. Hornell's work since, in the little marine laboratory we established at Galle. [Discussed and illustrated by lantern slides in the lecture.]

Turning now from the health of the oyster population on the "paars" to the subject of pearl formation, which is evidently an unhealthy and abnormal process, we find that in the Ceylon oyster there are several distinct causes that lead to the production of pearls. Some pearls or pearly excrescences on the interior of the shell are due to the irritation caused by boring sponges and burrowing worms. Minute grains of sand and other foreign bodies gaining access to the body inside the shell, which are popularly supposed to form the nuclei of pearls, only do so, in our experience, in exceptional circumstances. Out of the many pearls I have decalcified, only one contained in its centre what was undoubtedly a grain of sand; and from Mr. Hornell's notes, taken since I left Ceylon, I quote the following passage, showing that he has had a similar experience:—

"February 16, 1903—*Ear-pearls*. Of two decalcified, one from the anterior ear (No. 148), proved to have a minute quartz grain (micro. preparation 25) as nucleus."

It seems probable that it is only when the shell is injured, as, for example, by the breaking off or crushing of the projecting "ears," thereby enabling some fine sand to gain access to the interior, that such inorganic particles supply the irritation which gives rise to pearl formation.

The majority of the pearls found free in the tissues of the body of the Ceylon oyster contain, in our experience, the more or less easily recognisable remains of Platyelmian parasites; so that the stimulation which causes eventually the formation of an "orient" pearl is, as has been suggested by various writers in the past, due to infection by a minute lowly worm, which becomes encased and dies, thus justifying, in a sense, Dubois's statement that—"La plus belle perle n'est donc, en définitive, que le brillant sarcophage d'un ver" (*Comptes rendus*, October 14, 1901.)

[The lecturer then dealt with the work of Dr. Kelaart (1859), to whom belongs the honour of having first connected the formation of pearls in the Ceylon oyster with the presence of Vermean parasites, Filippi, Kukenmeister, Moebius, Humbert, Garner, Thurston, Giard, Seurat, Jameson, and finally Dubois—bringing the record up to January, 1903.]

We have found, as Kelaart did half a century ago, that in the Ceylon pearl oyster there are several different kinds of worms commonly occurring as parasites, and we shall, I think, be able to show in our final report that Cestodes, Trematodes, and Nematodes are all concerned in pearl formation. Unlike the case of the European mussels, however, we find, so far, that in Ceylon the most important cause is a larval Cestode of the Tetrarhynchus form. Mr. Hornell has traced a considerable part of the life-history of this parasite, from an early free-swimming stage to a late larval condition in the file fish (*Balistes mitis*) which frequents the pearl banks and preys upon the oysters. We have not yet succeeded in finding the adult, but it will probably prove to infest the sharks or other large Elasmo-

branchs which devour Balistes. It is only due to my excellent assistant, Mr. James Hornell, to state that our observations on pearl formation are mainly due to him. During the comparatively limited time (under three months) that I had on the banks, I was mainly occupied with what seemed the more important question of the life-conditions of the oyster, in view of the frequent depletion of particular grounds. It is important to note that these interesting pearl-formation parasites are not only widely distributed over the Manaar banks, but also on other parts of the coast of Ceylon. Mr. Hornell has found Balistes with its Cestode parasite both at Trincomalie and at Galle, and the sharks also occur all round the island, so that there can be no question as to the probable infection of oysters grown at these or any other suitable localities.

There is still, however, much to find out in regard to all these points, and other details affecting the life of the oyster and the prosperity of the pearl fisheries. Mr. Hornell and I are still in the middle of our investigations, and this must be regarded as only a preliminary statement of results which may have to be corrected, and I hope will be considerably extended in our final report.

It is interesting to note that the *Ceylon Government Gazette* of December 22 last announced a pearl fishery, to commence on February 22, during which the following banks would be fished :—

The South-East Cheval Paar, estimated to have 49 million oysters.

The East Cheval Paar, with 11 millions.

The North-East Cheval Paar, with 13 millions.

The Periya Paar Kerrai, with 8 millions—making in all more than 80 million oysters.

That fishery is now in progress, Mr. Hornell is attending it, and we hope that it may result not merely in a large revenue from pearls, but also in considerable additions to our scientific knowledge of the oysters.

As an incident of our work in Ceylon, it was found necessary to fit up the scientific man's workshop—a small laboratory on the edge of the sea, with experimental tanks, a circulation of sea-water and facilities for microscopic and other work. For several reasons [discussed in the lecture] we chose Galle at the southern end of Ceylon, and we have every reason to be satisfied with the choice. With its large bay, its rich fauna and the sheltered collecting ground of the lagoon within the coral reef, it is probably one of the best possible spots for the naturalist's work in eastern tropical seas.

In the interests of science it is to be hoped, then, that the marine laboratory at Galle will soon be established on a permanent basis with a suitable equipment. It ought, moreover, to be of sufficient size to accommodate two or three additional zoologists, such as members of the staff of the museum and of the medical college at Colombo, or scientific visitors from Europe. The work of such men would help in the investigation of the marine fauna and in the elucidation of practical problems, and the laboratory would soon become a credit and an attraction to the colony. Such an institution at Galle would be known throughout the scientific world, and would be visited by many students of science, and it might reasonably he hoped that in time it would perform for the marine biology and the fishing industries of Ceylon very much the same important functions as those fulfilled by the celebrated gardens and laboratory at Peradeniya for the botany and associated economic problems of the land. W. A. H.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. F. C. MCCLELLAN has been appointed to the new chair of forestry and estate management at the Royal Agricultural College, Cirencester.

THE new science buildings of the Colston's Girls' School, Bristol, will be opened on Friday, May 15, by the Right Hon. Henry Hobhouse, M.P.

WE have received a copy of the University of Colorado *Bulletin* for December, 1902. It contains a detailed account of the quarto-centennial celebration held at the end of last year in connection with the University of Colorado, when addresses were delivered by Profs. A. Reed, F. S. Lee, D. C. Jackson, and others.

THE Council of the Manchester Literary and Philosophical Society has appointed Mr. A. P. Hunt, sublibrarian of Balliol College, Oxford, to be assistant secretary and librarian to the Society, in succession to Mr. Charles Leigh, who has been appointed deputy librarian of the Owens College, Manchester.

THE second volume of the Report of the U.S. Commissioner of Education for the year 1900–1901 runs, like the former part, to more than twelve hundred pages. A large portion of the volume is concerned solely with statistics, and these refer to every grade of education. Uninteresting though these masses of figures are likely to prove to ordinary teachers, they will be found of great value by the student of educational problems. The descriptive article which will most directly appeal to men of science is one on instruction in mining engineering. It appears that the first school of mines in the United States was established in New York City in 1863, in connection with the institution which later developed into the existing Columbia University. At the close of 1901 there were thirty-seven institutions offering courses in mining engineering, two of the courses—those in connection with the University of North Carolina and the University of Texas—having been instituted in 1901. The article also contains short accounts of the systems of instruction in mining in each of the thirty-seven institutions holding courses. A chapter is given to consular reports sent home to the United States by its consuls in different parts of the world, and these reports contain many hints likely to be of practical value to the lecturers and others in American colleges. One chapter appears out of place in an educational report, since it is concerned with the introduction of domestic reindeer into Alaska.

THE first part of vol. xiv. of the *Transactions* of the South African Philosophical Society contains an instructive paper by the Rev. Dr. Flint on the legal and economic bases of some colonial teaching universities, which concludes with the local application of the results of the inquiry. The paper summarises the salient facts in the history of the important colonial universities, but it is only possible here to refer to one or two points of interest. The Government of New South Wales voted at its establishment 50,000*l.* for the buildings of Sydney University. An endowment of not more than 20,000*l.*, with an annual sum of 500*l.* for the stipend of the principal, was provided for each college incorporated within Sydney University upon the condition that 10,000*l.* at least shall have been subscribed by its founders, the whole to be voted to the erection of buildings on land granted for the purpose. New Zealand University has also been generously treated by its Government, from which source it receives an annual grant of 3000*l.* But in addition to this the four affiliated colleges have received land grants to the extent of 40,000 acres, and Otago, for instance, receives in rent from lands granted in this way about 6500*l.* per year. Similarly, the University of Adelaide received from South Australia a grant of 50,000 acres. The University of Melbourne appears to receive in Government grants some 13,500*l.* It is well that these examples, which do not by any means exhaust the instances given in the paper, should be brought prominently before the people of South Africa, in view of the growing feeling that a worthy teaching university for the whole of South Africa is much needed.

THE annual discussion before the Washington meeting last January of the American Society of Naturalists dealt with the question: How can endowments be used most effectively for scientific research? The speeches on this occasion are printed in *Science* for April 10. Prof. T. C. Chamberlin advocated the special endowment of chairs of research. There ought no longer, he said, to be a struggle on the part of the capable investigator to free himself from obligations to teach that he may devote himself to creative work. From 20,000*l.* to 40,000*l.* would effectively endow a chair of research, though Prof. Chamberlin argued later that the endowment should be made to the department rather than a specific chair, thus distributing the function of research among the members of the staff according to