THURSDAY, NOVEMBER 22, 1877

DANISH GREENLAND

Danish Greenland; its People and its Products. By Dr. Henry Rink. Edited by Dr. Robert Brown, F.L.S. With Illustrations by the Eskimo and a Map. (London: Henry S. King and Co., 1877.)

THERE is a strange fascination about Greenland, which may be partly owing to the mystery that shrouds its early history,—partly to its being an almost Arctic country, the scanty population of which seems to furnish an example of a nation in the enjoyment of a very primitive culture; and partly because it seems very probable that it was from it started the voyagers who were the first discoverers of what is now called America.

Our knowledge of the early history of Greenland is limited to what we can gather from the Icelandic sagas or popular tales, and from these we find that about the year 986 an Icelander called Erik the Red, who had been outlawed, sailed to the west to look for some land which had some years previously been sighted by Gunbjörn, the son of Ulf Kraku, another Icelander who had once been driven far westward by a very fierce storm. Erik found the land, made a two winters' stay thereon, giving names to many places, and returning to Iceland called this new country Greenland, because, said he, people would sooner be induced to go thither in case it had a good name.

This first colonisation of Greenland seems at the time to have been fairly successful, and several ruins are still to be found which throw a light on the habits of these seafaring people. The present Eskimo station, Igaliko, situated on an isthmus between two fjords, is thought to have been the ancient residence of Erik. One of Erik's friends, named Herjulf, had a son called Bjarni, a promising youth, and very fond of travelling abroad. One year he would spend in Iceland, another with his father in Greenland. Wishing, however, to spend one Yule-tide with his father, he set sail for Greenland, where his father was, with a crew who had never been in the Greenland Ocean before, and the consequence seems to have been that he found himself after many days near a country covered with wood, which was certainly not Greenland, and turning his back upon it to hasten to find his parent, he succeeded in landing at the very spot where his father lived. It is probable that during this voyage he had discovered the tract of country stretching from Connecticut to Newfoundland.

The news of Bjarni's venturesome voyage spread to Iceland and to Norway, and Leif, the son of Erik the Red, bought his ship, and set sail for the new country, on which they landed, and which, from finding on it a species of "fox-grapes," they called Vinland. Returning the next year to Greenland, it was no wonder that Vinland was all the talk, and Thorvald, about 1002, went to settle there and finally had a battle with the natives, in which he was killed. This Vinland was probably the present Massachusetts. Half a century later tidings from the Greenland colonies suddenly became rare, but in 1126 the then pope sent them a bishop, the ruins of whose church are still pointed out, and about 1261 the Greenlanders became subjects of Norway. From this date to 1450 tidings of the colonists, stories of their doings, and records of their misfortunes, came less and less frequently to Europe. The very sailing route passed into oblivion, and the country was only again re-discovered in 1585 by John Davis, whose name will be for ever remembered in connection with the Straits also discovered by him. Another century-and-a-half passed away before the present European stations in Greenland were founded by the well-known Danish missionary, Hans Egede, who in 1721 landed on an island at the mouth of the Godthaab-fjord and founded a regular colony. From then until now, with many a vicissitude; an epidemic of small-pox in 1734, a total interruption with Denmark (1807–1814) on account of the war; the colonies have struggled on. The trade was for some part of the former century made a private monopoly, but in order to keep up the commerce, the government was finally obliged to take it in hand, and since 1774 it has continued to be a royal monopoly. Following the steps of the extending trade, the missionary institutions have gradually incorporated the whole population into Christian communities.

Dr. Rink's book tells us in a very succinct though most interesting manner, of the results of the European transactions thus carried on in Greenland, for now over a century, and he describes the present state, and hints at the future prospects of the population. More than this, he gives us in well-written chapters, an account of the configuration and general physical features of this almost frozen up island, he tells of its "inland ice," and of the origin of the "floating icebergs." We read of the temperature, prevailing winds, the wonderful changeableness of its weather, and we find here a *résumé* of all that is known about its lakes and streams, its mysterious fjords, and of its great fields of drifting ice. Nor is the natural history of the country overlooked, for we have a chapter on its geological and mineral products. Of these latter cyolite appears to be the only one that has become a regular article of trade, about 10,000 tons thereof being exported each year. There are also chapters on its plants and animals, with special ones on the capture of whales and seals, and on the Greenland fisheries.

From an Eskimo point of view the commercial importance of the seal and whale fisheries is very great. The flesh and blubber of these animals not only supply the Greenlander with nutritious food, but also provide him with heat and light. The sealskins too afford material for clothes, boats, and tents, and whaleskin called "matak," yields a favourite article of diet. It may give some idea of the vast numbers of these animals killed yearly to summarise the average annual catch as follows: Of *Phoca fœtida*, 51,000; of *P. vitulina*, 2,000; of *P. groenlandica*, 33,000; of *P. barbata*, 1,000; of *Cystophora cristata*, 3,000; and of narwhals, white whales, and walruses nearly 1,000. The right whale has nearly disappeared and the mean annual catch of the "humpback" whale is scarcely over two.

The most important fisheries in addition appear to be those of the cod fish, the halibut, and the capelin.

Perhaps there was not much to be said about the manners and customs of the people in the olden time; the change in religion seems to have very early modified the social condition of the people, and this portion of Dr.

notably on the Severn, which, according to Mr. Alfred Tylor, F.G.S., is seen to best advantage with a rising sun from Stonebench Inn, about three miles below Gloucester.

1878.	Height above average.	1878.	Height above average.	1878.	Height above average
	ft. in.		ft. in.		ft. in.
Jan. 20 p.m.	0 4	April 17 a.m.	0 8	Sept. 1 a.m.	1 3
,, 21 a.m.	0 7	,, ,, p.m.	0 11	,, ,, p.m.	0 11
,, ,, p.m.	0 9	,, 18 a.m.	1 1	,, 2 a.m.	0 7
,, 22 a.m.	0 10	,, ,, p.m.	1 3		
,, ,, p.m.	0 11	,, 19 a.m.	1 3	,, 26 a.m.	0 1
,, 23 a.m.	0 10	,, ,, p.m.	1 0	,, ,, p.m.	0 7
,, ,, p.m.	0 7	,, 20 a.m.	0 9	,, 27 a.m.	1 0
,, 24 a.m.	0 4	,, ,, p.m.	0 5	,, ,, p.m.	1 4
		,, 21 a.m.	0 1	,, 28 a.m.	1 7
Feb. 18 a.m.	0 5			,, ,, p.m.	1 8
,, ,, p.m.	0 11	May 16 a.m.	0 1	,, 29 a.m.	1 7
,, 19 a.m.	1 4	,, ,, p.m.	0 2	,, ,, p.m.	1 4
,, ,, p.m.	1 5	,, 17 a.m	0 3	,, 30 a.m.	1 1
,, 20 a.m.	1 6	,, ,, p.m.	0 3	,, ,, p.m.	0 9
,, ,, p.m.	1 6	,, 18 a.m.	0 3	Oct. 1 a.m.	0 4
,, 21 a.m.	1 5	,, ,, p.m.	0 2		
,, ,, p.m.	1 3			,, 25 a.m.	0 2
,, 22 a.m.	0 10	July 31 p.m.	0 3	,, ,, p.m.	0 6
,, ,, p.m.	0 4	Aug. 1 a.m.	0 5	,, 26 a.m.	0 10
		,, ,, p.m.	0 7	,, ,, p.m.	1 0
Mar. 18 p.m.	0 3	,, 2 a.m.	0 9	,, 27 a.m.	1 2
,, 19 a.m.	0 9	,, ,, p.m.	0 9	,, ,, p.m.	1 4
,, ,, p.m.	1 3	,, 3 a.m.	0 9	,, 28 a.m.	1 2
,, 20 a.m.	1 6	,, ,, p.m.	0 6	,, ,, p.m.	0 11
,, ,, p.m.	1 9	,, 4 a.m.	0 3	,, 29 a.m.	0 8
,, 21 a.m.	1 9			,, ,, p.m.	0 4
,, ,, p.m.	1 7	,, 28 p.m.	0 1		
,, 22 a.m.	1 5	,, 29 a.m.	0 6	Nov. 24 a.m.	0 1
,, ,, p.m.	1 1	,, ,, p.m.	1 0	,, ,, p.m.	0 3
,, 23 a.m.	0 8	,, 30 a.m.	1 3	,, 25 a.m.	0 4
,, ,, p.m.	0 1	,, ,, p.m.	1 5	,, ,, p.m.	0 4
		,, 31 a.m.	1 5	,, 26 a.m	0 5
April 16 p.m.	0 4	,, ,, p.m.	1 5	,, ,, p.m.	0 3

From the above table it appears that the highest tides of the year will occur on March 20–21 and September 28. The heights will be found probably to exceed those of the Admiralty Tables, as I have employed larger factors in the necessary corrections to the semi-menstrual inequality.

As a London tide table appears to be a desideratum, I have been induced to publish one for next year, in which the "danger" tides will be distinguished in a new, bold, and unmistakable manner.

EDWARD ROBERTS

3, Verulam Buildings, Gray's Inn, November 17

Rainfall in the Temperate Zone in Connection with the Sun-spot Cycle

THIS month's number of the *Nineteenth Century* contains an article on the connection of rainfall with the eleven years' cycle of sun-spots. It takes a carefully-selected area in which such a coincidence, if it existed, would be well marked. The great tract of water spreading southwards from Asia to the southern pole affords an arena for the undisturbed play of solar activity. It may readily be understood that any excess of solar energy has a more direct and uniform influence upon the rainfall gathered from this vast aqueous expanse, than it would have upon smaller areas of water intermingled with tracts of land, and cut off from each other by ranges of mountains, as in the European and American continents. Other reasons exist which would render solar influence a more directly potent factor in the rainfall gathered from the Indian Ocean than in that of the temperate zone. Without doing more than alluding to the fact that sun-spot activity is confined to a belt of considerable thickness on either side of the sun's equator, there are several well-ascertained causes which would render an excess of solar activity more directly felt in the equatorial regions of our earth than in those nearer the poles. While, therefore, I believe that the coincidence of a rain cycle and of a cycle of wind disturbances with the eleven years' cycle of sun-spots, has now been established as regards the Indian Ocean and the Madras rainfall, I am anxious to guard against the conclusion being pushed too far. The article in the *Nineteenth Century* proves much, but it would be a misfortune at this still early stage of the inquiry, if wider inductions were drawn from it than are justified by the evidence which it brings forward.

It seems right, therefore, to state that so far as my investigation of the rain returns of the temperate zone yet enables me to form an opinion, the cyclic coincidence of the rainfall with the eleven years' cycle of sun-spots, seems to shade off in extra-tropical regions until it ceases to exist at all. This opinion is based upon an examination of the returns of between one and two hundred stations in different parts of the world, but only with regard to one-third of them is the evidence sufficiently complete as to raise more than a presumption either for or against the existence of a cycle. Further, I have not yet been able, except in comparatively small groups of stations, to examine the monthly returns or to separate the winter from the summer rainfall. This separation forms one of the first essentials to arriving at a final opinion on the question. Subject to these remarks, I beg to state the facts with regard to the rainfall of the northern extra-tropical zone in India, Europe, and America. It is chiefly with the first and last-named countries that the present contribution will deal.

In my "Cycle of Drought and Famine," printed in India on the commencement of the late dearth, I mentioned that the rainfall which, in periods of minimum sun-spots, passes uncondensed over the Southern Presidency, might possibly "fall in the temperate zone. The excessive rain, if it takes place anywhere, will probably be found in India between the 22nd and 32nd degree of north latitude, to the south of the great Himalayan partition wall." The conjecture was based upon the configuration of the Indian continent, which, in its lower and middle regions, receives the rainfall gathered from a vast ocean, and is provided with a barrier at the upper end to arrest the rain-clouds on their further progress northward. Prof. Archibald's examination of the rainfall in Northern India now throws a clear light on this side of the question. He has published in the leading Calcutta paper, the *Englishman*, a series of carefully-compiled returns from stations within the ten degrees of latitude above mentioned. He shows that the rainfall of the sub-tropical region, from 22° to, say, 30°, is in some respects (but only in some respects) complementary to the rainfall of Southern India, and in a recent letter to me he thus summarises his conclusions:—First, the winter-rainfall of Northern India varies inversely with the sun-spots in a well-marked manner at all the stations. Second, the summer rainfall varies directly with the sun-spots, in a manner well marked in the north-western provinces, by no means marked in the lower provinces of Bengal, but sufficiently well marked when the returns of the several stations are combined.

Let us examine the meaning of these facts. The returns from Madras and Bombay (lately published in NATURE and elsewhere) prove that when the summer monsoon strikes Southern India, its aqueous burden varies directly with the sun-spots. Prof. Archibald's returns now show that the rainfall brought by the summer monsoon to Northern India also varies directly with the sun-spots. But they prove more than this. They show that the rain-clouds which, in years of minimum sun-spots pass over India without dropping their watery burden, are found, on their being stopped by the Himalayan partition wall, to be charged with a more than average surplus (so to speak) of moisture. In Northern India, therefore, the summer monsoon, on its passage up, brings, as in Southern India, a rainfall varying directly with sun-spot activity; but the winter rainfall, *i.e.*, the immediate rebound of the rain-clouds from the Himalayan barrier, varies inversely with sun-spot activity. I say the immediate rebound, for it must not be forgotten that the north-eastern monsoon (October to December), when it strikes Madras in its full development, after collecting its aqueous freight from the Bay of Bengal, follows the same law as the summer monsoon (May to September), and varies directly with the sun-spots.

Passing from the sub-tropical region of Northern India (22° to 32° lat.) to the temperate zone, we find the evidence of a cycle either very faint or altogether wanting. With regard to Europe, I am not yet prepared to offer any new facts. The existing evidence only amounts to this: (1) Mr. Baxendell, from observations for a comparatively short period but very carefully recorded and scrutinised, came to the conclusion that even at an English station, notwithstanding the manifold disturbing influences incident to our insular meteorology, changes take place in the rainfall as well as in the temperature and barometric pressure,

which correspond closely in their maxima and minima periods with those of sun-spots. (2) A more comprehensive survey of the European rainfall has so far failed to establish this correspondence. Dr. Jelinek's examination of fourteen stations, from 1833 to 1869, showed that the coincidence held good in fifty-two cases, but failed in forty-two. While frankly accepting this as evidence against a real coincidence, it should be remembered that a general law such as a common periodicity in sun-spot activity and terrestrial rainfall will be subjected to, and sometimes overruled by, the local surroundings of individual stations. (3) On the other side, Gustav Wex, from the recorded depths of the Elbe, Rhine, Oder, Danube, and Vistula, for six sun-spot cycles (1800–1867), found that the maximum amount of water occurred during periods of maximum sun spots, while the minimum levels were reached in the periods of minimum sun-spots. The evidence, as regards Europe, is, therefore, conflicting; and it is safer for the present to reckon it as against a well-marked common periodicity. I hope at no distant date to submit the results of a new and more exhaustive examination of the European rain-registers.

I now proceed to the North American rainfall. Here, as in Europe, the question is complicated not merely by disturbing meteorological influences, such as the Gulf Stream, but by the uncertain value of the rain-returns. These are causes which even at a carefully supervised station render it difficult to estimate the number of inches yielded by long-continued or very violent snow-storms. At badly supervised stations, or in the case of private gauges where the supervision is apt to be of a still more haphazard character, these difficulties often suffice to render the returns quite worthless. Yet it is the latter class of records on which we have chiefly to depend in an attempt to deal with the American rainfall during a long series of years. Nowhere does meteorology now receive more careful and scientific study than in the Western Continent, but in many of the most valuable series the element of time is still necessarily wanting. The evidence hitherto received from America has, on the whole, been favourable to the existence of a common periodicity. Mr. Dawson, Geologist to the British North American Boundary Commission, found a correspondence, although by no means an absolute one, between the fluctuations of the great lakes and the sun-spot periods. This question has been lately revived and interpreted afresh by a distinguished meteorological observer in Northern India. Prof. Brocklesby's contributions to the *American Journal of Science* also point to a connection between variations in the sun-spot area and annual rainfall.

It was with a knowledge of these statements that I undertook a systematic inquiry into the American rain-returns. I ought at once to say that the result of that inquiry altogether fails to establish the existence of a common cycle, so far as concerns the temperate zone. I divided the American stations into four groups. The first group consisted of eleven stations in east coast or Atlantic States, lying between 40° and 45° N. latitude. The second group consisted of seven stations in Inland States, from 38° to 48°. The third group was intended to consist of stations in the West Coast or Pacific States, but I have obtained the returns (and those for a period altogether too brief) for only a single West Coast Station, San Francisco. I give them, however, for what they are worth. The fourth group consists of three coast-stations in the Southern States, between 30° and 33°; or just above the sub-tropical region with which Mr. Archibald's returns for the Bengal stations deal.

The results of the examination of the four American groups may be summarised thus: (1) Taken as a whole, the returns from the twenty-two stations do not exhibit any common periodicity between the rainfall and the sun-spots; nor do they disclose an eleven year's cycle corresponding to the one which I have shown to exist in the rainfall (at Madras and elsewhere) gathered from the Indian Ocean. (2) That as regards the three northern groups, stretching across the continent from 38° to 48° N. lat., the rainfall, so far as any symptoms of periodicity can be detected at all, tends to vary inversely with the sun-spots; but that it is impossible to discover any real periodicity whatever. (3) On the other hand, that as regards the southern group, between 30° and 33°, there are symptoms of a periodicity tending to coincide with the sun-spot variations; but that these symptoms are not sufficiently uniform in the small number of southern stations which I have examined, to justify any conclusion.

The calculations on which these results are based would occupy many pages, but their general line may be indicated in a few sentences. Thus the mean rainfall at the twenty-two stations during the years of *maximum* sun-spots for which the records have been obtained, was 37½ inches, while during the years of minimum sun-spots it was 39. The years of maximum sun-spots, together with the years immediately preceding, had a mean fall at the twenty-two stations of 40·2 inches; while the minimum years of sun-spots, taken together with the years immediately preceding, had an almost exactly equal rainfall of 40·1 inches. In the northernmost group of eleven Atlantic stations the mean rainfall of the years of maximum sun-spots was 39 inches, against an average of 41 inches in years of minimum sun-spots; in the second group of seven inland stations (38° to 48°) the mean rainfall of the years of maximum sun-spots was precisely equal to that of years of minimum sun-spots, being 33¾ inches in both; in the third group, San Francisco, the mean rainfall years of maximum sun-spots was 21 inches against 23½ inches in minimum years; in the fourth group of three southern stations (30° to 33°) the returns for the minimum and maximum years are broken; but taking these years and the preceding ones together, the mean rainfall of the years of maximum sun-spots with the years immediately preceding was 51 inches, against 48½ inches in the years of minimum sun-spots and immediately preceding ones.

The returns have also been examined by another method. I have shown elsewhere that the rainfall at Madras, and other stations around the Indian Ocean, follows a well-marked cycle of eleven years, with a maximum, minimum, and intermediate period, corresponding with the maximum, minimum, and intermediate period of sun-spots. The American stations not only fail to show such a correspondence, but as regards the three northern groups so far as any symptoms of periodicity exist, they point in the opposite direction. The fourth or southern group of stations, on the other hand, so far as they disclose a periodicity, tend to coincide with the periodical variations in the sun-spots. The following table will show this. The Madras rainfall in the tropics discloses a cycle closely corresponding with the eleven cycle of sun-spots; speaking generally, the American rainfall in the temperate zone discloses no such cycle; but the southern stations begin to furnish symptoms of such a cycle.

Table of Madras and American Rainfall Compared with the Eleven Years' Cycle of Sun-spots

Rainfall and sun-spots shown in the minimum, intermediate, and maximum groups of the eleven years' cycle.	*Minimum Group.* Mean of 11th, 1st, and 2nd years.	*Intermediate Group.* Mean of 3rd, 4th, 9th, and 10th years.	*Maximum Group.* Mean of 5th, 6th, 7th, and 8th years.	Remarks.
Eleven years' cycle of sun-spots (from Wolf's lists)	12·6	43·5	76·8	
Eleven years' cycle of rainfall at Madras	Inches. 40·3	Inches. 49·0	Inches. 53·5	Common Periodicity well-marked.
Eleven years' cycle of rainfall; mean of three stations around the Indian Ocean...	43·4	48·1	52·2	
North American Rainfall.				
Mean of eleven stations in East Coast States, 40° to 45° N. lat....	40·2	41·6	40·1	No common Periodicity.
Mean of seven stations in Inland States, 38° to 48° N. lat.	35·3	35·8	34·6	
San Francisco; West Coast Station, 38° N. lat.	22·9	19·9	22·3	
Mean of three stations in Southern States, 30° to 33° N. lat.	47·0	51·2	49·1	Symptoms of common Periodicity.

NOTE.—The sun-spot figures represent the relative numbers, reduced from Wolf. The rainfall is expressed in inches. The San Francisco returns deal with only twenty-one years, or not quite two complete cycles; much too short a period for any definite conclusion.

The records of the twenty-two American stations extend over brief periods compared with the Madras returns. Several of them disclose breaks or gaps; few of them have been kept with the minute care bestowed by the professional astronomical staff on the rain gauge at the Madras Observatory, and the value of most of the eighteen northern ones is rendered in some degree uncertain by snow-storms. It is probable, moreover, that better and much more complete returns are available to American meteorologists than I possess for the twenty-two stations which

I have examined. They will come to the criticism of my results with fuller materials than are available to me here, but so far as these materials enable me to form an opinion, the result is against the existence of a common periodicity in the sun-spots and in the American rainfall within the temperate zone.

Allanton, Lanarkshire, November 4 W. W. HUNTER

Contribution to the Sun-spot Theory of Rainfall

THE Lucknow Meteorological Observatory has been established since 1868, and regular observations have been recorded since that year under my superintendence.

In NATURE of December 12, 1872, Mr. Lockyer published a notice of Mr. Meldrum's discovery of the coincidence between the maximum and minimum sun-spot periods, and the maximum and minimum rainfall in certain places. After reading it I examined the annual rainfall at Lucknow from 1868 to 1872, and found that there was reason to believe that the rainfall at Lucknow followed the same cycle as that of the sun-spots. The figures were :—

1868	... ...	27·6 inches.
1869	... ...	41·9 ,,
1870	... ...	64·6 ,,
1871	... ...	65·0 ,,
1872	... ...	41·4 ,,

The equal amount of rainfall (41 inches) on both sides of the maximum fall of 1870 and 1871 was very striking, and as there was a rise in the rainfall from 1868 to 1870–71, and after that a decrease, and having just read Meldrum's discovery, I conjectured that the annual rainfall would continue to decrease till it reached its minimum. In my annual abstract, which I submitted to Government in April, 1873, and on the slender evidence of five year's rainfall, I ventured to state that if Meldrum's law be true, we had in Lucknow lately passed the period of maximum rainfall, and were descending towards a minimum, so that during 1877, 1878, and 1879 there would be a scarcity of rain, and in one of those years the minimum rainfall of the cycle would occur. I am now able to give the annual rainfall of almost a complete cycle, and the figures will speak for themselves :—

1867 was a sun-spot minimum period.

1868	... ...	27·6
1869	... ...	41·9
1870	... ...	64·6
1871	... ...	65·0
1872	... ...	41·4
1873	... ...	35·1
1874	... ...	51·4
1875	... ...	43·5
1876	... ...	23·6
1877	... ...	11·7

(Up to date October 22).

Inches of rainfall in Lucknow.

This is October 22, 1877, and the total fall up to date has been only 11·7 inches, about a third of which fell in the months of January, February, and March. The fall during the rainy season of 1877 has been so small that great fear of a famine has been felt. I considered Meldrum's discovery so important that at the end of my annual abstract of meteorological observations for 1872, I inserted a long abstract of Mr. Lockyer's article in NATURE, in order to make the theory more widely known.

I believe meteorologists are on the track of a most important law. I would not expect the maximum and minimum rainfalls in every place to coincide with the sun-spot maximum and minimum so completely as that given above. Possibly in some places the figures might be reversed, owing to a changed direction in the water-bearing currents of the atmosphere; but that the changes occurring in the sun have a direct influence on rainfall there cannot, I think, be any doubt. E. BONAVIA

Lucknow, October 22

The Radiometer and its Lessons

I WISH that Prof. G. C. Foster had been more explicit in his answer to my letter; for as it is I cannot understand to what "variations of density" he refers. So far as I know there are no variations of density in the gas in question except those which arise from variations of temperature; but these variations certainly do not affect the rate at which heat diffuses into and through the gas, for this rate is independent of the density and for the same gas depends only on the degradation of temperature in the direction in which the diffusion takes place.

It is obvious that the law of diffusion holds good only so long as the gas is undisturbed by convection currents. Such currents, which certainly exist, increase the rate at which heat is communicated to the gas, that is to say, the hot surface instead of being exposed to the action of still air is exposed to a wind which tends to increase the rate of cooling. But the velocity of the wind does not increase with the rarefaction, and the cooling effect of a wind of a certain velocity does increase with the density of the air. Hence, as I pointed out in my first paper, the motion of the air will favour the force resulting from the communication of heat less and less as the rarefaction is increased.

As regards Mr. Johnstone Stoney's theory. The post which brought me this week's NATURE brought me also a paper from Mr. Stoney, on which I venture to comment. In doing this, however, I may say that I have no wish to criticise what Mr. Stoney has written. The fact that Mr. Stoney has in no way referred to my work, although I preceded him by some two years, has relieved me from all obligation to discuss Mr. Stoney's theory; and I certainly should not do so now were it not that, as Prof. Foster has instanced his theory as disproving what I believe to be the truth, I feel bound either to show wherein it is wrong or acknowledge my inability to do so.

In the paper which I have just received,[1] Mr. Stoney starts with an assumption that, but for the effect of gravitation, "a flat stratum of gas in contact with a hot surface, A," and "every subject to the same pressure" can exist in a state of equilibrium "except at the limits," without any passage of heat from the hotter to the colder part, although "within the stratum the temperature gradually decreases, from within outwards, from θ_1 the temperature of A to θ_2 the temperature of the surrounding gas."

In support of this assumption I cannot find any proof is offered except that which is contained in the following portion of a sentence :—"We know, from familiar experiments, which show gases to be bad conductors of heat, that after the brief interval of adjustment a permanent state would ensue in which there would be no further change of density, or motion of heat, except by radiation."

Now this assumption and the statement in support of it—in both of which Mr. Stoney seems to have ignored the very existence of diffusion of heat in gases—are contrary to all experience as well as to the deductions from the kinetic theory of gases; for it follows directly from the kinetic theory, and has been abundantly established by experiment, that under no circumstances can there exist a variation in the temperature of a continuous layer of gas without heat diffusing from the hotter to the cooler part.

I think that I need say no more. This assumed condition of gas forms the base of all Mr. Stoney's reasoning, and although in a subsequent part of his paper he appears to me to have arrived at deductions which contradict his fundamental assumption, still this assumption may be held accountable for the anomalies which he has found. OSBORNE REYNOLDS

November 17

I BEG to call the attention of the readers of NATURE to the following passage at the commencement of Mr. Crookes's lecture at the Royal Institution on February 11, 1876, "On the Mechanical Action of Light" :—

"To generate motion has been found a characteristic common, with one exception, to all the phases of physical force." [Illustrations are then given of the production of motion by heat, magnetism, electricity, gravitation, sound, and chemical force.]

"But *light*, in some respects the highest of the powers of nature, *has not hitherto been found capable of direct conversion into motion;* and such an exception cannot but be regarded as a singular anomaly.

"This anomaly the researches which I am about to bring before you have now removed; and, like the other forms of force, *light is found to be capable of direct conversion into motion*, and of being most delicately and accurately measured by the amount of motion thus produced."

I cannot but suppose that Mr. Crookes and Prof. Carey Foster have alike forgotten the existence of this passage. If it does *not* convey an interpretation of the phenomena of the radiometer which is now admitted on all hands to be wrong, and imply a claim to the discovery of "a new mode of force," I am incapable of understanding the meaning of words.

I may add that one after another of my eminent scientific

[1] "On the Penetration of Heat across Layers of Gas," *Scientific Transactions* of the Royal Dublin Society, November, 1877.

friends has assured me that I was perfectly justified in my statement on this point; and it was by one of these, who was present at the lecture in question, that I was informed of the very explicit statement made on that occasion by Mr. Crookes of the views he then held, which were universally understood in their plain common-sense meaning.

November 20 WILLIAM B. CARPENTER

Fluid Films

WITH reference to Mr. Sedley Taylor's interesting note on Fluid Films, allow me to say that if a drop of water, clinging to the outside of a glass goblet, be lightly dusted with lycopodium powder, and a fiddle-bow be drawn across the edge of the glass, the drop will exhibit vortices, rotating in opposite directions.

Highgate, N., November 19 C. TOMLINSON

Tuckey and Stanley.—The Yallala Rapids on the Congo

CAPT. TUCKEY is dead and gone and cannot answer for himself; it may therefore, perhaps, serve to clear his memory in some measure of a doubt about the correctness of his description of the Yallala Rapids in 1816, arising from the very different account of them given by Stanley sixty years afterwards, if I mention one of several facts in connection with American rivers.

The late Sir J. Franklin, in his first and disastrous overland journey to the Arctic Sea in 1821, describes the "Bloody Fall" on the Coppermine River as "a shelving cascade about *three hundred yards* in length, having a descent of ten or fifteen feet."

Between 1848 and 1851 this "fall" was visited five times; on one or other of such occasions the water was either at high spring flood, at low summer level, or at an intermediate elevation, yet under none of these conditions was the "fall" found to be more than *thirty yards long*, if so much, the height being about fifteen feet.

Franklin and the officers with him were most careful and correct observers, so that I can only attribute this wonderful change (from three hundred yards long to thirty) in the form of the cascade to the wearing away of the material forming the bed of the river, by the action of the water, assisted in a great measure by the large masses of ice and the stones carried down with it during the breaking up of the navigation in the course of thirty seasons, only half the interval of time between Tuckey's and Stanley's visits to the Congo.

Supposing a somewhat similar attrition, but in a less rapid manner, to have been going on at the Yallala Rapid, the description given by the former as he saw it may be equally correct as that of the latter when he visited it in its altered shape in 1877.

May I add that a cataract may become a fall or a series of falls, and *vice versâ*, according as the water in a river is in flood or at low level. J. RAE

Scientific Club, November 16

The Future of our British Flora

IT may interest Mr. Shaw to know that the stations given by Lightfoot in his "Flora Scotica, 1777," still exist (as far as I am aware, and I have visited by far the greater number of them) at the present day. Experience has led me to the conclusion that a plant however maltreated, does not become extinct unless the *natural conditions are changed*, as by the draining of a marsh, &c. I have over and over again found plants in stations where they were reported as "extinct years ago." Perhaps if Mr. Shaw visits his station for the "Lizard Orchis" (is this *Orchis hircina*, L.? if so it is, I fancy, new to Scotch botanists) in the course of a year or two he may find it in as large quantity as ever. As regards the maltreatment of plants, I agree with what Mr. Shaw says respecting professors of botany. Each teacher of the science ought to teach his students that it is a crime to exterminate a plant, and that they can best learn botany from the observation of the common plants of their district; there is great room for improvement in this respect.

While a student I was often disgusted by seeing rare plants torn up and then cast away as if they had been a handful of grass, or, worse still, put in the vasculum and forgotten till the next Saturday, when they were thrown away; and all this without a word of remonstrance from those who ought to have exercised authority, "that's villainous, and shows a most pitiful ambition in the man who uses it."

Provided we reform a little, I do not think that, judging of the future by the past we have any reason to expect a large decrease in the ranks of our native flora. I do not suppose any species given by Lightfoot 100 years ago has become extinct even in *his* stations, and on the other hand we have had a considerable number added to it since his time.

Edinburgh A. CRAIG-CHRISTIE

Selective Discrimination of Insects

IN continuation of the interesting observations of "S. B." on selective discrimination of insects in NATURE, vol. xvi. p. 522, permit me to send you the following notes from my journal, made in August last:—

"Watched by the roadside near Kew Bridge Station, several species of Hymenoptera, of the genus *Bombus* principally; one visited thirty flowers of *Lamium purpureum* in succession, passing over without notice all the other plants in flower on the same bank—species of *Convolvulus*, *Rubus*, *Solanum*. Two other species of *Bombus* and a *Pieris rapæ* also patronised the *Lamium*, seeking it out deep in the thicket, thrusting their probosces even into withered cups, although the *Rubus*' flowers were far more accessible and seemed much more attractive, being fresh and well-expanded.

"On the same bank several species of Diptera—*Syrphus* chiefly—were visiting the *Rubus*, ignoring the *Lamium*. On another bank, some distance removed from the first, I observed, however, that the diptera were visiting the *Lamium* (one species was very busy on the convolvulus, applying its proboscis to the external aspect of the anther) while the Hymenoptera, species of wasp, were giving their attention to the *Rubus*."

I am sorry not to be in a position to identify the species of Hymenoptera and Diptera, being unable to capture specimens of either. HENRY O. FORBES

Highgate, N.

The Earth-worm in Relation to the Fertility of the Soil

IN your number of the 8th instant there are some interesting remarks upon the habits, &c., of the common earth-worm. From frequent observations I fully concur with the remark that the worm does not consume living vegetation but only vegetable matter undergoing decomposition.

I am also rather inclined to the opinion that there are (or may be) two reasons for the drawing in to their holes dead leaves, &c., the one being, for use as food, and the other to protect the holes from a too plentiful supply of water.

In this same connection I may mention what I have not before seen mention of, namely, the little mounds of small gravel stones which the worms heap up around the entrance to their holes. These are very curious and may be partly to prevent the entrance of water; and also, as I think, partly for rubbing against the worm's slimy body, as fish do.

It is very remarkable the extent to which loose gravel-stones (some as large as a hazel-nut, and even larger) are removed from a gravel-walk from distances quite beyond a foot, leaving the walk pitted all over. I have never seen a worm in the act of moving these stones and it is difficult to imagine how it is done, but as it generally takes place in wet weather, it may probably be by an adhesion of the stone to the slimy body of the worm.

As regards fertilising effects, it would be interesting to know whether the earthy matter composing worm-casts had passed through the worm's body, as the writer supposes, for in that case it would probably have more fertilising properties than if consisting merely of the natural soil thrown up as by moles.

The remark by one of your correspondents as to his observation of a line of darker soil thrown up by worms from a substratum of ashes deposited a considerable time before, would almost make it appear that the mole-like action above referred to took place. The writer, however, repeats his conviction that the matter composing worm-casts has passed through its (the worm's) body.

31, Stockwell Park Road GEO. H. PHIPPS

Smell and Hearing in Moths

"J. C." seems to draw inferences that moths have not the power of smell but have that of hearing. I feel quite certain they possess the former, but am in doubt about the latter. For the purpose of catching moths I use a preparation of beer and

sugar boiled together, to which (after boiling) is added a little spirit, placing rags several folds thick, saturated in the preparation, upon garden-seats, low branches of trees, &c. I have in one evening taken as many as thirty-six moths (including red, yellow, crimson, underwing, swordgrass, angleshade, &c., &c.). What has attracted them unless smell? or what generally leads them to their food?

With reference to the sound of the glass, is it not the quick motion of the hand which disturbs the moth? E. H. K.

Carnivorous Plants

PROF. SERRANO FATIGATI, of Ciudad Real (Spain), has made some investigations upon two insect-feeding plants which he found during his last excursion to the province of Cordova, and on the general peculiarities of viscous plants during their flowering. The first of these plants is *Ononis natrix;* it grows at Sierra Palacios. The second appears to be *Silene viscosa*, and was found on the hill which connects the village of Belmery with the station. The experiments made upon these plants prove that when alive they were both covered abundantly with a viscous fluid, which in *Silene* was still visible after the specimens had been dried for four months. Prof. Fatigati has observed in several instances that every insect which touches their surface, and remains adherent to them, dies in a very few minutes. Remains of animals in different stages of decomposition may be seen on the plants he possesses.

The microscopical study of these plants has enabled the structure of their secretory glands to be examined. The glands of the plant *Ononis* are at the extremity of hairs composed of cylindrical cells, and are ovoid and multicellular. The protoplasm of the cylindrical cells always forms a parietal coating to the cell-wall. The glands of the *Silene* are simply conical epidermical protuberances, and are divided into two cells at the close of their development.

Prof. Serrano Fatigati has observed that in these species and in *Cistus ladaniferus* the secretion of the viscous fluid increases during their period of flowering; he is studying this matter, in order to ascertain whether this circumstance bears any connection with the production of heat and carbonic acid possessed by plants during the flowering period. FRANCISCO GINEZ

Esparteros 9, Madrid

OUR ASTRONOMICAL COLUMN

MINOR PLANETS.—Mr. J. N, Stockwell, of Cleveland, Ohio, who has had much experience in calculations relating to the small planets, draws attention to a curious circumstance connected with the observations of Gerda, discovered by Prof. Peters at Clinton, N.Y., on July 31, 1872. It had been supposed that this planet was observed again in 1873, 1876, and 1877, but on forming equations of condition for the correction of the elements, Mr. Stockwell found that the observations of 1873 are quite irreconcilable with those of the other oppositions, or that some incompatible conditions had been introduced into the equations. "The discovery of these incompatible conditions," he writes, "has been the occasion of an unusual amount of trouble and annoyance, and will be the source of future mortification, should the explanation at which I have arrived ultimately prove to be erroneous." Mr. Stockwell's conclusion is this, that notwithstanding the planet observed from September 27 to November 12, 1873, was very near the computed place of Gerda, it was really another body that was observed in that year. To decide this point he calculated an orbit upon the observations of 1873, which it appears are very well adapted to furnish reliable results, and finds the following elements, placing the elements of Gerda, as perturbed to the same date, in juxtaposition for the sake of comparison. The epoch is 1873, November 7·0 M.T. at Washington, longitudes from M.Eq. 1873·0 :—

	PLANET OF 1873.	GERDA.
Mean long.	35 4 57	35 47 14
π	213 14 38	208 19 29
Ω	178 53 9	178 56 40
ι	1 36 3	1 36 19
ϕ	1 58 40	2 0 51
μ	613″·6390	614″·3842

It will be seen that four of the elements of the planet of 1873 are almost identical with those of Gerda, while the lines of apsides differ about five degrees. The actual distance of the planets from each other on November 7 would be 0·0188 of the earth's mean distance from the sun. Mr. Stockwell adds, "if there are really two planets moving in orbits so extremely near together, it must happen in the course of time, unless the mean distances are exactly the same, that they will approach each other so closely that their mutual perturbations will cause them to unite and form a single planet."

A similar case of near coincidence between the orbits of two minor planets is that of Fides and Maia, to which attention was first directed we believe by M. Lespiault, of Bordeaux. In 1876 the elements were as follow :—

	FIDES.	MAIA.
Epoch	July 27·0 Berlin M.T.	Oct. 4·5 Berlin M.T.
Mean long.	326 33 33	27 37 21
π	66 27 20	48 8 26
Ω	8 15 15	8 17 1
ι	3 6 49	3 5 40
ϕ	10 11 21	10 4 31
μ	826″·4417	824″·6400

Here, however, the planets are much further from each other than in the case of Gerda and the planet of 1873.

At present Gerda and its companion will not be favourably placed for observation, but in the ensuing year no doubt an effort will be made to decide if there are really two bodies revolving in such near proximity to each other. Questions of much interest may arise if this should prove to be the case.

The discoveries of minor planets during the present year now stand as follow :—

No. 170, Myrrha, January 10, by Perrotin, at Toulouse.
,, 171, Ophelia, January 13, by Borrelly, at Marseilles.
,, 172, Baucis, February 5, ,, ,,
,, 173, ... August 2, ,, ,,
,, 174, ... September 2, by Watson, at Ann Arbor, U.S.
,, 175, ... October 14, by Peters, at Clinton, U.S.
,, 176, ... November 5, by Paul Henry, at Paris.
,, 177, ... November 6, by Palisa, at Pola.
A planet, ... November 12, by Watson, at Ann Arbor.

We adopt Prof. Peters' name for No. 170, instead of the inappropriate one proposed in France.

THE COMET OF 1672.—Mädler has pointed out a distant resemblance between the elements of the comet of 1672 calculated by Halley, and those of the comet of 1812, which has been found to have a period of revolution of about seventy years, and which therefore might have been in perihelion in the former year. The comet of 1672 was observed by Hevelius from March 6 to April 21, and also by Richer off the coast of Africa during his voyage to Cayenne, from March 15 to the end of the month, though he only described its position roughly. The observations of Hevelius are published in the rare volume of his "Machina Cœlestis" (of which, by the way, the British Museum possesses two copies), and we believe in the small special publication issued at Dantzig in the same year, and entitled, "J. Hevelii, Epistola de Cometâ, anni 1672, Gedani observato, ad Henricum Oldenburgium."

Halley's orbit gives for three dates of observation by Hevelius, adopting his corrected times, the following positions :—

	G.M.T.	Right Ascension.	Declination.
	h. m.	° ′	° ′
1672, March 6, at	15 39	353 16	34 57 N.
,, ,, 15, at	7 44	18 2	37 25
,, ,, 29, at	8 8	52 21	30 21 N.

Without attempting an accurate reduction of the Dantzic observations, it may be seen that they agree sufficiently well with the positions deduced from Halley's orbit to render it probable that his elements would not be so far changed by a calculation from the improved places as to bring them materially closer to those of the comet of

1812, the re-appearance of which is shortly expected. We have already mentioned that sweeping-ephemerides have been prepared by Herr Mahn, of Strasburg, and may be found in "Vierteljahrsschrift der Astronomischen Gesellschaft, 12 Jahrgang, 2 Heft."

MR. DARWIN AT CAMBRIDGE

AS we intimated last week, the honorary degree of LL.D. was conferred on Mr. Charles Darwin at Cambridge on Saturday. The occasion was in many ways remarkable, and suggestive of reflections that must occur to all, and which need not be put formally into words. The university seems to have been conscious of the honour Mr. Darwin was doing it, and seldom, it is said, was a more exciting scene seen in the senate-house. To appoint a special congregation of the senate for the transaction of no other business but the conferment of a solitary degree, although it be *honoris causâ*, is only resorted to in exceptional and important cases. The step taken by the university evidently has met with general approval to judge by the tone of the assembly in the senate-house on Saturday. The building was packed, and the inevitable pastime of the undergraduates assumed a form extremely appropriate, however questionable its taste may have been.

The appearance of Mr. Darwin entering the senate-house by a side door, with the Master of Christ's, of which College Mr. Darwin is a member, was the signal for a burst of applause which was evidently the result of genuine enthusiasm, and was certainly thoroughly hearty. At two o'clock the Vice-Chancellor took his seat on the raised dais, and the business of the day began. Standing side by side with Mr. Darwin in the centre of the senate-house, Mr. Sandys, the Public Orator, commenced the delivery of the customary Latin oration. Interruptions from the galleries occasionally interfered with the orator's efforts to make himself heard, but the pleasant manner of his delivery, combined with great tact and judgment, helped to quiet the undergraduates' "chaff," and assisted him materially in getting through his task.

We have been favoured with a copy of the Public Orator's address, which our readers will no doubt read with interest, both on account of the elegance of its Latin, and for its neat summary of Dr. Darwin's work; indeed, in its way, it is somewhat of a literary curiosity.

"ORATIO AB ORATORE PUBLICO HABITA CANTABRIGIAE DIE XVII° NOVEMBRIS A. S. MDCCCLXXVII

"DIGNISSIME domine, domine Procancellarie, et tota Academia:—

"Meministis Horatianum illud, 'fortes creantur fortibus'; vix igitur necesse est commemorare viri huius de rerum natura optime meriti patrem fuisse medicum egregium, avum poetam quoque insignem. 'Doctrina sed vim promovet insitam'; iuvat igitur recordari pueritiam huius fovisse scholam celeberrimam Salopiensem; adulescentiam aluisse non modo Caledonicas illas Athenas, sed in hac etiam Academia Miltoni nostri Collegium. Tanti in laudem alumni, nisi fallor, ipsa paterni fluminis nympha, non immemor hunc primum patefecisse insularum corallinarum originem, illa inquam Sabrina quae Miltoni in carmine vivit,

curalio nitida roseum caput exseret unda,

frontemque tam venerabilem sua praecinget corolla.

"Quanta cum voluptate accepimus insularum illarum circulos, sese e vadis sensim attollentes, quasi florum immortalium palmarumque victricium corona locos illos virides placidosque in Oceani campo designare, ubi priores insulae depressae et sepultae sunt. Quam facete describit, quo modo varios sensuum affectus exprimant indices illi vultus et ipsa tacitorum oculorum eloquentia; quo more apes, dum dulce illud nectar e flore delibant, quod continuandae floris stirpi utile sit, ipsae aliunde referant. Quam venuste explicat, quo modo captet Venus ipsa muscas; quali ex origine sint Veneris volucres, 'raucae, tua cura, palumbes'; quibus cantuum illecebris, quo splendore plumarum, concilientur volucrum amores. Quam familiariter, velut rex ille excellenti sapientia, de tot rebus disserit, quicquid volat, quicquid natat, quicquid serpit humi; quam varia eruditione disputat de fabuloso illo lepadum balanorumque marinorum genere, de montium igneorum miraculis, sed idem de gracili vitis pampino et lentis hederarum bracchiis in apricum enitentium; quanta liberalitate in patrocinium suum vindicat non modo 'aurea pavonum saecla,' sed etiam minus pulchram simiarum familiam. Qua de re quanquam poeta vetus dixit, 'simia quam similis nobis'; nobis tamen, viri Academici, cum oratore Romano, viro Academicae praesertim philosophiae dedito, gloriari licet, 'mores' esse 'in utroque dispares.'

"Illud certe extra omnem controversiam constat, pulchrum esse tantam rerum naturae varietatem contemplari, regiones remotas invisere, silvarum incaeduarum solitudinem penetrare, insularum prope ignotarum recessus perscrutari, varias denique animalium formas comparare inter se et distinguere; pulchrius, haec omnia accuratissime observata aliorum in usum voluptatemque litterarum mandare monumentis; omnium pulcherrimum, infinita talium rerum multitudine ad leges quam paucissimas revocata, ipsum fontem et originem omnium repetere. Quanta igitur laude vir hic dignus est, qui adhuc iuvenis, aliorum magis quam suo commodo, tot terras lustraverit, lustratas feliciter descripserit; qui maturiore aetate, tot generibus animantium et earum rerum quas terra gignit diligenter investigatis, illi praesertim legi constituendae operam dederit, qua docere conatus est, ita e perpetuo prope ad internecionem debellantium certamine aptissimam quamque novae stirpi propagandae speciem vivam victricemque superesse, ut tot species inter se diversae alia ex alia minutatim per immensam annorum seriem generari potuerint.

> 'Usus et impigrae simul experientia mentis
> paulatim docuit pedetemtim progredientes.
> sic unumquicquid paulatim protrahit aetas
> in medium ratioque in luminis erigit oras.
> namque alid ex alio clarescere et ordine debet
> *omnibus*, ad summum donec venere cacumen.'

"Tu vero, qui leges naturae tam docte illustraveris, legum doctor nobis esto.

"Duco ad vos CAROLUM DARWIN."

The conclusion of this oration was greeted with loud applause, and the proceedings ended with the Vice-Chancellor conferring the degree on Mr. Darwin in the usual formal manner.

In the evening the anniversary dinner of the Cambridge Philosophical Society was given in the Hall of Clare College. The president of the Society, Prof. Liveing, occupied the chair, and among the visitors present were Professors Huxley, Ramsay, Tyndall, Parker, Burdon Sanderson, Drs. Günther, Wilks, Pye Smith, Mr. Francis Galton, &c. Prof. Ramsay proposed the toast of the University of Cambridge, and Prof. Huxley responded to that of Mr. Darwin, who was unable to be present. In his speech Prof. Huxley sarcastically spoke of the University as reserving its highest honour till all other distinctions had been heaped on Mr. Darwin, that its own chaplet might crown the whole, and not be covered up. Prof. Huxley spoke of Mr. Darwin as the foremost among men of science, with one exception, since the days of Aristotle.

A special meeting of the Philosophical Society is to be held next Monday in the combination room of Christ's College, to consider the best means of making a permanent memorial of Mr. Darwin in the University. Would not a Darwin Professorship of General Biology be a very suitable memorial?

INTERNATIONAL GEOLOGICAL CONGRESS

AT the late meeting of the American Association for the Advancement of Science at Nashville, Tenn., Dr. T. Sterry Hunt presented a report on the above subject, of which at the time we gave a brief note. The following extracts, which have been sent us, will no doubt be more satisfactory to geologists :—

"The committee to arrange for an International Geological Exhibition and Congress, to be held in Paris in 1878, was appointed by this Association at Buffalo in August, 1876, and consisted of Messrs. W. B. Rogers, James Hall, J. W. Dawson, J. S. Newberry, T. Sterry Hunt, R. Pumpelly, and C. H. Hitchcock, together with T. H. Huxley for England, O. Torrel for Sweden, and E. H. von Baumhauer for Holland. At a meeting of the committee at Buffalo on August 25, 1876, James Hall was chosen chairman, and T. Sterry Hunt secretary. It was then agreed to prepare a circular setting forth the plan of an International Geological Exhibition, which should form a part of the general exhibition to be held at Paris in 1878, and indicating a scheme for the organisation of the geological collections to be sent thereto by the nations taking a part in that exhibition, and moreover, proposing an International Geological Congress to be held at Paris.

"The circular in accordance with this plan was duly prepared, and printed in English, French, and German, and before the end of the year had been sent by the secretary to the principal scientific societies and academies, as well as to the workers in geology throughout the world. The response to this invitation has been most gratifying. The Geological Society of France has formally recognised the great importance of the objects proposed, and promised its hearty co-operation, while private letters from its president to the secretary of the committee, and from Prof. Hébert to Prof. Hall, give cordial assurances of the same kind. Spanish and Italian geologists have translated and published the circular in their respective languages, and have communicated to the secretary their hearty approval of the plan. Prof. Capellini has, in this connection, published an interesting correspondence, calling attention to the fact that in 1874 he had laid the project of a similar International Geological Congress, to be held in Italy, before the Italian Minister of Agriculture, Industry, and Commerce.

"The Geological Society of London and the Geological Survey of Great Britain have also formally signified their approval of our objects, and the co-operation of Norway, Sweden, Russia, and Austro-Hungary, is promised. It is to be regretted that Germany has declined to take a part in the International Exhibition of 1878, but we trust that this will not prevent her geologists from joining in the proposed Congress. The director of the Geological Survey of Japan promises to aid in our work, and we have the same assurance from Brazil, where the circular has been translated into Portuguese. Chili and Mexico have also responded, and promise an ample representation of their geology at Paris next year; while Canada, both through her Geological Survey and in the person of Dr. Dawson, will probably be represented there.

"The Government of the United States has as yet failed to accept the invitation of France to take a part in the Exhibition of 1878, so that American geologists are not certain that they will be able to participate in the International Geological Exhibition of 1878. We are, however, assured that the Government is very desirous to have our country duly represented at Paris; and it is to be hoped that at the approaching extra session of the United States Congress, measures will be taken for accepting the French invitation, and appointing a commission, so that our people may secure a representation in Paris. I am assured, on all sides, that our geologists desire to contribute largely to the International Geological Exhibition, and even at this late day it will be possible to do much. In any event it is probable that several members of our committee will be present at the proposed Geological Congress. The precise date of this has not yet been fixed, though your secretary is now in correspondence with the Secretary of the Geological Society of France upon this point, and believes that with the co-operation of that body a time convenient to all will be agreed upon.

"It is recommended by the Standing Committee of the Association that, in addition to the names of Prof. J. P. Lesley, of Philadelphia, and Prof. A. C. Ramsay, director of the Geological Survey of Great Britain, already added to the International Committee, the presidents for the time being of the Geological Societies of France, London, Edinburgh, and Dublin, of Berlin, of Belgium, Italy, Spain, Portugal, and the Imperial Geological Institute of Vienna, be invited to form part of our Commission. T. STERRY HUNT

"Secretary of the International Committee."

Shortly after the presentation of the above report, the secretary received official notice that the Geological Society of France had, in co-operation with the above plan, appointed at Paris a local committee of organisation for the proposed Congress, constituted as follows :—Hébert, President; Tournouer and Albert Gaudry, Vice-Presidents; Bioche, Treasurer; Jannetaz, Secretary-General; Delaire, Sauvage, Brocchi, and Vélain, Secretaries; with the following: Belgrand Bureau, de Chancourtois, G. Cotteau, Damour, Daubrée, Delafosse, Delesse, Descloizeaux, Desnoyers, Fougué, V. Gervais, Gruner, De Lapparent, Mallard, Milne-Edwards, Pellat, Marquis de Roys and L. Vaillant, Members of the Committee.

A circular issued by this committee bearing date July 31, invites all those interested in geological, mineralogical, and palæontological studies to take part in the approaching congress, and to subscribe the sum of *twelve francs* each, which will give a card of admission to the Congress, and right to all the publications thereof. All those who intend to be present are at the same time invited to send, as soon as possible, a list of the questions which seem to them worthy of general discussion, as well as of the communications which they propose to make touching these questions. They are also invited to indicate the date which appears to them most convenient for the meeting of the Congress.

As regards an International Geological Exhibition, the Paris Committee of Organisation state that the difficulty of finding a suitable locality seems to them an obstacle in the way of realising this part of the programme. They hope, however, that there will be many special collections sent, and beg the exhibitors of such to give the committee due notice of these, in order that a special catalogue of them may be prepared.

The secretary of the International Committee desires, in this connection, to call attention to the fact that his circular did not contemplate the holding of an International Geological Exhibition apart from the universal exhibition, but, in the language of that circular, *the making as complete as possible the geological department of the universal exhibition.* It is certain that, as at all previous similar exhibitions, the different nations will contribute more or less of geological material, and it was conceived that such collections, extended and systematised in accordance with the plan set forth in the circular, would, while forming a part of the universal exhibition, without farther cost meet all the requirements of an International Geological Exhibition. To the accomplishment of this end it will only be necessary for the exhibitors of all nations to send a list of their geological contributions to the Local Committee of Organisation at Paris.

All correspondence relating to the Congress should be

addressed to Dr. Jannetaz, Sécrétaire-général, rue des Grands Augustins, 7, Paris, France; and all moneys sent to Dr. Bioche, at the same address.

THE MODERN TELESCOPE

THE gain to astronomy from the discovery of the telescope has been twofold. We have first, the gain to physical astronomy from the magnification of objects, and secondly, the gain to astronomy of position from the magnification, so to speak, of *space*, which enables minute portions of it to be most accurately quantified.

Looking back, nothing is more curious in the history of astronomy than the rooted objection which Hevel and others showed to apply the telescope to the pointers and pinnules of the instruments used in their day; but doubtless we must look for the explanation of this not only in the accuracy to which observers had attained by the old method, but in the rude nature of the telescope itself in the early times, before the introduction of the micrometer; the modern accuracy has been arrived at step by step.

FIG. 1.—A portion of the constellation Gemini seen with the naked eye.

Let us see what the telescope does for us in the domain of that grand physical astronomy which deals with the number and appearances of the various bodies which people space.

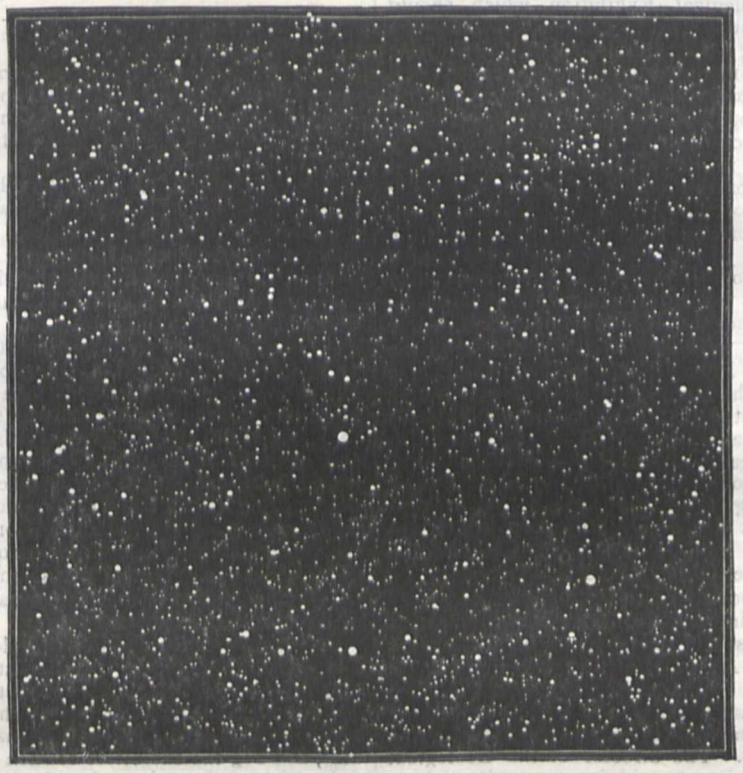

FIG. 2.—The same region, as seen through a large telescope.

Let us, to begin with, try to see how the telescope helps us in the matter of observations of the sun. The sun is about 90,000,000 of miles away; suppose, therefore, by means of a telescope reflecting or refracting, whichever we like, we use an eyepiece which will magnify say 900 times, we obviously bring the sun within 100,000 miles of us; that is to say, by means of this telescope, we can observe the sun with the naked eye as if it were within 100,000 miles of us. One may say, this is something, but not too much; it is only about half as far as the moon is from us. But when we recollect the enormous size of the sun, and that if the centre of the sun occupied the centre of our earth the circumference of the sun would extend considerably beyond the orbit of the moon, then one must acknowledge we have done something [to bring the sun within half the distance of the moon. Suppose for looking at the moon we use on a telescope a power of 1,000, that is a power which magnifies 1,000 times, we shall bring the moon within 240 miles of us, and we shall be able to see the moon with a telescope of that magnifying power pretty much as if the moon were situated somewhere in Lancashire—Lancaster being about 240 miles from London.

It might appear at first sight possible in the case of all bodies to magnify the image formed by the object-glass to an unlimited extent by using a sufficiently powerful eye-piece. This, however, is not the case, for as an object is magnified it is spread over a larger portion of the retina than before; the brightness, therefore, becomes diminished as the area increases, and this takes place at a rate equal to the square of the increase in diameter. If, therefore, we require an object to be largely magnified we must produce an image sufficiently bright to bear such magnification; this means that we must use an object-glass or speculum of large diameter. Again, in observing a very faint object, such as a nebula or comet, we cannot, by decreasing the power of the eye-piece, increase the brightness to an unlimited extent, for as the power decreases,

the focal length of the eye-piece also increases, and the eye-piece has to be larger, the emergent pencil is then larger than the pupil of the eye and consequently a portion of the rays of the cone from each point of the object is wasted.

We get an immense gain to physical astronomy by the

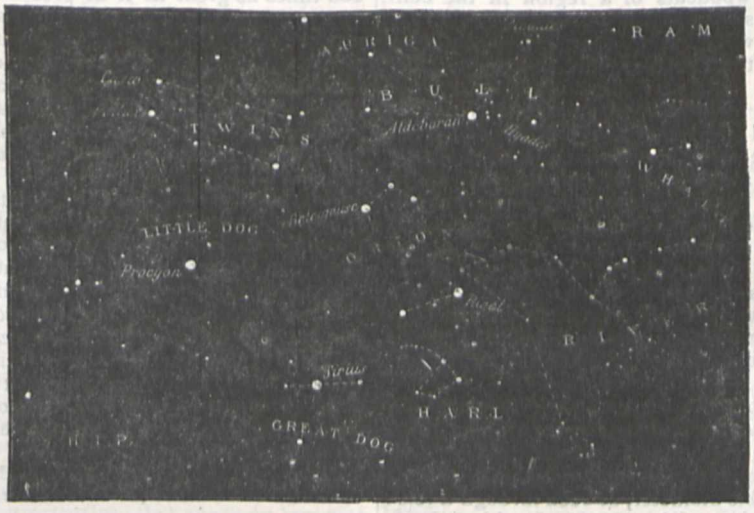

FIG. 3.—Orion and the neighbouring constellations.

revelations of the fainter objects which, without the telescope, would have remained invisible to us; but, as we know, as each large telescope has exceeded preceding ones in illuminating power, the former bounds of the visible creation have been gradually extended, though even now we cannot be said to have got beyond certain small limits, for there are others beyond the region which the most powerful telescope reveals to us; though we have got only into the surface we have increased the 3,000 or 6,000 stars visible to the naked eye to something like twenty millions. This space-penetrating power of the telescope, as it is called, depends on the principle that whenever the image formed on the retina is less than sufficient to appear of an appreciable size the light is apparently spread out by a purely physiological action until the image, say of a star, appears of an appreciable diameter, and the effect on the retina of such small points of light is simply proportionate to the amount of light received, whether the eye be assisted by the telescope or not; the stars always, except when sufficiently bright to form diffraction rings, appearing of the same size. It therefore happens that as the apertures of telescopes

FIG. 4.—The Nebula of Orion, reduced from Lord Rosse's Drawing.

increase, and with them the amount of light (the eye-pieces being sufficiently powerful to cause all the light to enter the eye), smaller and smaller stars become visible, while the larger stars appear to get brighter and brighter without increasing in size, the image of the brightest star with the highest power, if we neglect rays and diffraction

rings, being really much smaller than the apparent size due to physiological effects, and of this latter size every star must appear.

The accompanying woodcuts of a region in the constellation of Gemini as seen with the naked eye and with a powerful telescope will give a better idea than mere language can do of the effect of this so-called space-penetrating power.

With nebulæ and comets matters are different, for these, even with small telescopes and low powers, often occupy an appreciable space on the retina. On increasing the aperture we must also increase the power of the eye-piece, in order that the more divergent cones of light from each point of the image shall enter the pupil, and therefore increase the area on the retina, over which the increased amount of light, due to greater aperture, is spread; the brightness, therefore, is not increased, unless indeed we were at the first using an unnecessary high power. On the other hand, if we lengthen the focus of the object-glass and increase its aperture the divergence of the cones of light is not increased and the eye-piece need not be altered, but the image at the focus of the object-glass is increased in size by the increase of focal length, and the image on the retina also increases as in the last case. We may therefore conclude that no comet or nebula of appreciable diameter, as seen through a telescope having an eye-piece of just such a focal length as to admit all the rays to the eye, can be made brighter by any increase of power, although it may easily be made to appear larger.

Very beautiful drawings of the nebula of Orion and of other nebulæ, as seen by Lord Rosse in his 6-foot reflector, and by the American astronomers with their 26-inch refractor, have been given to the world.

The magnificent nebula of Orion is scarcely visible to the naked eye; one can just see it glimmering on a fine night; but when a powerful telescope is used it is by far the most glorious object of its class in the northern hemisphere, and surpassed only by that surrounding the variable star η Argûs in the southern. And although, of course, the beauty and vastness of this stupendous and remote object increase with the increased power of the instrument brought to bear upon it, a large aperture is not needed to render it a most impressive and awe-inspiring object to the beholder. In an ordinary 5-foot achromatic many of its details are to be seen under favourable atmospheric conditions.

Those who are desirous of studying its appearance, as seen in the most powerful telescopes, are referred to the plate in Sir John Herschel's "Results of Astronomical Observations at the Cape of Good Hope," in which all its features are admirably delineated, and the positions of 150 stars which surround θ in the area occupied by the nebula laid down. In Fig. 4 it is represented in great detail, as seen with the included small stars, all of which have been mapped with reference to their positions and brightness. This, then, comes from that power of the telescope which simply makes it a sort of large eye. We may measure the illuminating power of the telescope by a reference to the size of our own eye. If one takes the pupil of an ordinary eye to be something like the fifth of an inch in diameter, which in some cases is an extreme estimate we shall find that its area would be roughly about one-thirtieth part of an inch. If we take Lord Rosse's speculum of six feet in diameter the area will be something like 4,000 inches; and if we multiply the two together we shall find, if we lose no light, we should get 120,000 times more light from Lord Rosse's telescope than we do from our unaided eye, everything supposed perfect.

Let us consider for a moment what this means; let us take a case in point. Suppose that owing to imperfections in reflection and other matters two-thirds of the light is lost so that the eye receives 40,000 times the amount given by the unaided vision, then a sixth magnitude star—a star just visible to the naked eye—would have 40,000 times more light, and it might be removed to a distance 200 times as great as it at present is and still be visible in the field of the telescope just as it at present is to the unaided eye. Can we judge how far off the stars are that are only just visible with Lord Rosse's instrument? Light travels at the rate of 185,000 miles a second, and from the nearest star it takes some $3\frac{1}{2}$ years for light to reach us, and we shall be within bounds when we say that it will take light 300 years to reach us from many a sixth magnitude star.

But we may remove this star 200 times further away and yet see it with the telescope, so that we can probably see stars so far off that light takes 60,000 years to reach us, and when we gaze at the heavens at night we are viewing the stars not as they are at that moment, but as they were years or even hundreds of years ago, and when we call to our assistance the telescope the years become thousands and tens of thousands—expressed in miles these distances become too great for the imagination to grasp; yet we actually look into this vast abyss of space and see the laws of gravitation holding good there, and calculate the orbit of one star about another.

J. Norman Lockyer

(*To be continued.*)

ZOOLOGICAL GARDENS[1]

THE lists and reports of the various zoological gardens now before us show that much progress has lately been made by these as by other institutions connected with natural history. For though zoological gardens are looked upon by many as a simple form of amusement there can be no question that, when rightly conducted, they are not only instructive in the highest degree, but also tend materially to advance the interests of the higher branches of natural science. All persons, therefore, who take an interest in the progress of science will be glad to see the number of zoological gardens increasing among the dependencies of this country and in other States.

Of the first of the five works on our list we need say but little. The Gardens of the Zoological Society of London, in the Regent's Park, are too well known to most of our readers to require a lengthened notice. The chief additions to their unrivalled menagerie are recorded every week in our columns. The volume now before us contains a catalogue of all the species of vertebrated animals, of which examples have been exhibited during the past fifteen years, arranged in systematic order. The various specimens are distinguished by letters, and the date and mode of acquisition of each individual are added. Thirty-five woodcuts, most of which have originally appeared in the Society's *Proceedings*, illustrate some of the more remarkable forms. The result shows that from the commencement of the year 1861 to the close of 1875, there have been obtained for the collection in the Regent's Park, examples of no less than 2,143 species of vertebrated animals. Of these 570 were mammals, 1,224 birds, 227 reptiles, 39 batrachians, and 83 fishes.

The catalogue of the animals in the newly-established Zoological Gardens at Calcutta, concerning the foundation and progress of which we have written at full length not long since,[2] is next upon our list. It is drawn up after

[1] (1) List of Vertebrated Animals now or lately living in the Gardens of the Zoological Society of London. Sixth Edition. 1877. (London: Longmans).

(2) List of Vertebrated Animals living in the Zoological Gardens, Calcutta, April, 1877. Printed at the Bengal Secretarial Press. 1877. 8vo.

(3) A Guide to the People's Park, Madras, with a description of the Zoological Collection contained therein. (Madras: Higginbotham and Co., 1876.)

(4) The Fifth Annual Report of the Board of Directors of the Zoological Society of Philadelphia. Read at the Annual Meeting of the Members and Loanholders of the Society, April 26, 1877. 8vo. (Philadelphia, 1877.)

(5) Report of the Director of the Central Park Menagerie, Department of Public Parks, City of New York, for year 1876. (New York, 1877: B. M. Lees, Printer, 210, Fulton Street.)

[2] Nature, vol. xvi. p. 28.

the fashion of the preceding, and has been prepared by Dr. John Anderson, the Superintendent of the Imperial Museum at Calcutta. It shows that though so recently in actual operation these gardens have already made considerable progress, and are able to show a good series of the better-known Indian animals for the instruction and amusement of the Calcutta public. Amongst others we may notice the Indian Otter (*Lutra leptonyx*) and the Isabelline Bear, as animals which have not yet reached the Gardens of the Zoological Society of London. Altogether there are 77 species of mammals in the collection, 120 of birds, and 17 of reptiles.

The "Guide to the People's Park" shows that Madras does not intend to be left behind the sister-city of Calcutta, and that she too will have a zoological garden. As its name imports, this little work is more of the nature of a "Guide" than a Catalogue. It appears that Madras is indebted to Sir Charles Trevelyan for the People's Park. Prior to 1859 the plot of ground which it now occupies formed "an immense swamp." In that year the enlightened governor of the day first suggested, and subsequently put into execution, the conversion of it into a park of about 116 English acres. (How glad would be the Council of the Zoological Society of London to have such an area at their disposal!) The collection of animals does not yet, it is true, appear to be very extensive; but space, at any rate, does not fail them, and there is, at all events, plenty of room for additions, which cannot be said of some of the sister institutions.

We must now turn to the western hemisphere, and see what our Anglo-Saxon relatives on the other side of the Atlantic have done in the way of zoological gardens. In this matter, we must say, our usually energetic cousins seem to have moved a little slowly. Such vast and wealthy populations as those of New York and Philadelphia might well have started zoological gardens for the instruction and amusement of their citizens years ago, and they would by this have been in possession of well-organised institutions. But although the subject has been mooted in both these cities for many years, it is only within these last few years, we believe, that anything very practical has been effected.

The Zoological Garden of New York forms a part of the Central Park of that city, and the report now before us is addressed by Mr. W. A. Conklin, the director, to the Board of Commissioners of the Department of Public Parks of New York. It gives us an account of the affairs of the Zoological Garden during the year 1876, and not apparently a very satisfactory one—since a reduction of the sum usually appropriated (by the City of New York, we presume) to the Park was made that year, which rendered it impossible to keep up the Gardens on their usual footing. It was resolved "not to receive any animal for exhibition in the menagerie unless the owner furnished the necessary food." This measure and the diminution of the sum expended in new purchases seem to have caused a sad decrease in the number of animals exhibited in 1876. In spite of this the number of visitors was larger than in any previous year, which, however, is accounted for by the concourse of visitors passing through New York to and from the Centennial Exhibition at Philadelphia.

While the Zoological Garden of New York is kept up out of public moneys that at Philadelphia is, like ours in London, the property of a private society, and appears to be in a much more flourishing condition. Here the "Centennial" told still more largely on the number of visitors than at New York, raising them to a grand total of more than 600,000 for the year ending April 30 last. The extra receipts from this source have not only enabled the society to make many important additions to its menagerie, but also to spend a considerable sum in improvements and new buildings. Amongst the latter we notice "a house for the accommodation of warm-climated (!) hay-eating animals" (qu. zebras and antelopes?) now under construction at an estimated cost of 18,000 dollars, which will apparently exceed in dimensions even the new lion-house of the Zoological Society of London. This is pretty well for a society only now issuing its *fifth* annual report. It is evident that in zoological gardens, as in other scientific institutions, Philadelphia means to "go-ahead" of her more populous neighbour.

NOTES

We take the following from the *Times*:—The Royal Society medals for the present year have been awarded by the President and the Council as follows:—The Copley Medal to Prof. James Dwight Dana, for his biological, geological, and mineralogical investigations, carried on through half a century, and for the valuable works in which his conclusions and discoveries have been published. A Royal Medal to Mr. Frederick Augustus Abel, F.R.S., for his physico-chemical researches on gun-cotton and explosive agents. A Royal Medal to Prof. Oswald Heer, of Zurich, for his numerous researches and writings on the tertiary plants of Europe, of the North Atlantic, North Asia, and North America, and for his able generalisations respecting their affinities and their geological and climatic relations; and the Davy Medal to Robert Wilhelm Bunsen and Gustav Robert Kirchhoff, for their researches and discoveries in spectrum analysis. This is the first award of the Davy medal, which, as will be remembered, was founded by the proceeds of the sale of the service of silver plate bequeathed for the purpose by Sir Humphry Davy. The medals will be presented at the Society's anniversary meeting on the 30th inst.

A few days ago the French Minister of Public Instruction, by a decree which has not yet been published, appointed a Commission to deliberate with the members of the council of the Observatory of Paris, as to the improvements which are possible in the organisation of the establishment without interfering with existing decrees. Among the commissioners are Dr. Janssen, Director of the Meudon Physical Observatory, M. Hervé Mangon, President of the Meteorological Society of France, and M. Marie Davy, the Director of the Montsouris Observatory. M. Yvon Villarceau and M. Loewy have been appointed as councillors. The first meeting of the Commission took place last Saturday, under the presidency of M. Dumesnil, one of the heads of the ministry, representing M. Brunet. M. Yvon Villarceau, the astronomer delegate, read a long and elaborate report on the improvements which it was considered desirable to make in the establishment. The Commission came to no decision, and the meeting adjourned to Saturday, Dec. 1. Some of the members are desirous of separating the meteorological department from the observatory, and either transfer it to Montsouris or establish a Meteorological Institute; to accomplish this long-desired change it would be necessary to suppress the decrees signed by M. Thiers and approved by M. Leverrier. The intentions of the Government are not to alter radically the existing state of things, which works satisfactorily, but to improve it as far as possible. Public opinion is strongly in favour of the organisation consecrated by M. Leverrier's administration.

Two volumes of the French Transit of Venus Reports are now going through the press, and will be distributed in a very few days. The first is a *compte rendu* of the mission in China, commanded by Capt. Fleurian. The second is a *procès verbal* of the sittings of the Transit Commission, which was presided over by M. Dumas. It is known that M. Leverrier abstained from being present at its deliberations, the illustrious astronomer being one of the few opponents of the transit observation. He preferred the opposition of Mars or direct measurements as taken by Cornu in his experiments on the velocity of light.

The French Government intends to send out an expedition to San Francisco in order to observe the next transit of Mercury, which will take place on May 6, 1878.

AT the meeting of the Paris Academy of Sciences, on November 12, M. Faye presented the volume of the "Connaissance des Temps" for 1879. This publication has reached, according to M. Faye, the highest degree of perfection desirable, and the new volume is marked by two important improvements both due to M. Loewy. The first consists in a new method which enables longitudes to be calculated according to occultations of stars by the moon, and that with such facility that sailors will make use of them with great benefit. The second improvement consists in tables which enables the latitude to be obtained by observation of the polar.

THE death of von Baer has made a foreign associateship in the Paris Academy of Sciences vacant, and MM. Bertrand, Fizeau, Becquerel père, Claude Bernard, Dumas, and H. St. Claire Deville, have been appointed a commission to prepare a list of candidates for the vacant "fauteuil."

A PRIZE of 1,000 marks (50*l.*) is offered through Dr. Hermann J. Klein, of Cologne, for the best treatise on "The Development of Monistic Philosophy from Spinoza down to the Present Time." The treatise must be written in the German language, and must contain a complete account of the relation of Spinoza to the Cartesian philosophy, a description of the progress and changes in the monistic theory brought about by Leibniz, Schopenhauer, Lazarus Geiger, and Ludwig Noiré, and a clear definition of the differences between the materialistic and monistic theories. All details can be obtained from Dr. Klein. The term up to which treatises will be received is fixed for July 30, 1878.

BY a recent will, M. Maujean has bequeathed to the French Institute the capital producing a sum of 1,200 francs, designed to form a biennial prize of 2,000 francs, to be awarded alternately by the Académie Française, and by the Académie des Sciences. To obtain it of the latter, it is necessary to have published the work which shall be pronounced the most useful to hygiene, considered in all its branches.

THE Berlin Aquarium suffered, on November 13, the loss of what was certainly, from a scientific and from a financial standpoint, the most valuable zoological specimen in Europe, viz., the famous gorilla Pongo, whose human-like form and playful antics became so familiar to Londoners during the past summer. The visit to England, and stay in its warm moist climate, was regarded as having had the best effect on Pongo's health, when he returned to Berlin on September 21, and there was every prospect of the animal's being able to live through his second northern winter. Five weeks later, a lessening of appetite and sligh diarrhœa were observed, but were not regarded by the physician as of sufficient importance to prevent Pongo's appearance in public. The consternation was great when a few days later, the gorilla died suddenly, without any apparent increase of dangerous symptoms. The loss to the Berlin Aquarium is no small one, as it had lately refused an offer of 2,500*l.* for the animal, and, taken in connection with the late deaths of their orang-outang and chimpanzee, will check somewhat the tendency to invest capital in anthropoidal apes. Not less severe is the loss to the scientific public, for no animal of late years has so attracted the attention of zoologists as Pongo, and theorists were looking forward with no slight degree of interest to the possibilities connected with his growth and education. After a dissection, which will probably reveal the cause of the sudden death, the skin will be handed over to the Berlin Anatomical Museum.

WE have received from Dr. Aguilar the annual volume of the Observatory of Madrid for the last year, 1876. It is a little late in the day, but we may call attention to the long and interesting article on geographical discovery with which the book terminates, seeing that that commences so early, "2400 (?) años A. des J. C. Dispersion de las gentes despues del Deluvio. Del cáos consiguiente á tan immensa catástrofe surgen á poco tiempo los tres grandes reinos de Babilonia, Ninive y Egipto."

ALREADY studied by two geologists, the Crimean peninsula has been recently visited by M. Ernest Favre, of Geneva. M. Hebert presented to the Paris Academy of Sciences, on Nov. 12, the results of this new examination, consisting of numerous sections on a very complete map.

HACHETTE and Co. are about to publish an important work of reference in Chemistry containing such important matter as the coefficients of dilatation, the specific weight of vapours, refrigerating mixtures, numerical documents on qualitative, quantitative, and spectral analysis, &c. We may state that the Smithsonian Institution are about to publish a similar work.

THERE are now "on view" at the Westminster Aquarium four Laplanders—two men and two women—who have with them reindeer, dogs, an Arctic fox, a tent, sledges, and numerous articles of dress of home manufacture. They have been brought to England by Mr. Carl Bock, through the enterprise of Mr. Farini, so well known as the "inventor" of Lulu's "upward bound," Zazel's "lightning flight," and Maraz's "eagle swoop." Any entertainment announced by one whose greatest successes hitherto have been to puzzle the public as to "how it is done" will naturally be looked upon with the same kind of suspicion that was bestowed on the "Egyptians" in the recent Lord Mayor's show. In some cases the public enjoys being puzzled, and this adds a zest to the enterprises of those who devise how to puzzle them. In the case of these Laplanders there does not appear to be the slightest ground for any suspicion as to genuineness. It will be recollected that Mr. Farini's whale at the aquarium was genuine, and when the *post-mortem* was held under the direction of Prof. Flower it was shown beyond doubt that it was not made of vulcanite and kept going by clock-work as was popularly supposed. We draw attention to the visit of these Laps because there is much of interest to be learnt from seeing them, and we do so with all the greater pleasure because the aquarium, looked at from a scientific point of view, has fallen from its high estate. We cannot pretend to make it a complaint that it is in the evening practically a large music hall with a miscellaneous entertainment by comic performers and sword swallowers. The place cannot be kept open without money, and if the public will not pay to go to an aquarium pure and simple, the management must provide what the public will take to, or shut up the place. But what we fear is that the management has been too much neglecting that part of the public, the minority certainly, who do care for an aquarium. Occasionally, especially during the control of Mr. Carrington, the aquarium has been in good order and well-stocked. It is again getting very unsatisfactory, perhaps because Mr. Carrington is in Naples. We gladly mentioned such recent improvements as throwing several tanks into one to make a place for large fish, and the removal of the seals to the whale tank, where their gambols in swimming can be better seen, and we have on several occasions recorded interesting arrivals, and if we could honestly do so we would gladly recommend the tanks generally as affording a good opportunity for studying the habits of the occupants. Though the Laps are not especially connected with aquarium objects the building affords a centrally located home for them. The performance, if it may be so called, through which they go, is an illustration of their quiet life, and happily there is no attempt to make it sensational. They show, among other things, how reindeer sinew is worked into a continuous thread, a process of interest to those who have examined collections from bone caves containing implements which it is believed were used either with such threads or strips of reindeer hide. The size of some of the eyes of the bone needles is more suggestive of thread than strips. Their monotonous singing on the syllables *wa wa wa*, if not

beautiful, has an interest of its own as representing their secular music, especially when contrasted with their capability for singing Lutheran hymns. Schaferius gives the translation of some of their love songs. Have these died out since his time? Mr. Bock says they have no secular songs. We are glad to know that the Zoological Society has given a friendly hand to Mr. Farini in offering a temporary home to five of his reindeer in the gardens. Mr. Bock states that the place from which he brought the party is Kautokeino, N. 69·1, E. 22·56.

A REPORT has recently been presented to the State Board of Health in Massachusetts by Dr. Nichols, regarding the health of people who work with sewing machines. From observations by the medical men engaged it is inferred that a healthy person of average strength who does not make a business of sewing with the machine, may work from three to four hours daily without much fatigue or perceptible injury to health. Among work people, on the other hand, one frequently meets with disorders of digestion, due to sedentary life and bad ventilation, also pains in the muscles of the trunk and the lower limbs, because these latter are always in motion. There occur also congestions of the ventral organs, weakness, and in some rare cases neuralgias of the legs and spinal irritations. It is recommended to the proprietors of works in which the sewing machine is used, to have (1) a good ventilation; (2) a shorter time for work, with periods of rest; (3) another motor force than that of the feet, *e.g.*, a steam engine.

AN Indo-Chinese Society has just been formed in Paris for promoting the study of Transgangetic India and developing the trade of France in that region.

THE Juvenile Christmas Lecture at the Society of Arts will be by Prof. Barff, on "Coal and its Components."

THE *Moniteur Universel* publishes an article on the manufacture of types for printing with hardened glass (*verre trempé*). It appears that the new types have worked admirably on the improved revolving press for continuous paper.

THE death is announced of Mdlle. Henrietta Cerf, who was born in Jamaica in 1810, and died in Brussels on the 22nd ult. Mdlle. Cerf, who for some years resided near Dinant, communicated various articles on the botany of Kent and Belgium to the *Phytologist*.

PRINCE BISMARCK'S study at Varzin has been connected with the Foreign Office at Berlin by a telephonic apparatus. The demand for these instruments is said to be immense in Germany.

A MONK of the monastery of Raigern, between Braun and Vienna, has completed a very curious mechanical work, a self-moving terrestrial globe, fourteen metres in diameter. A combination of wheels effects a revolution similar to that of the earth, and which lasts for three weeks. At the axis of the North Pole there are dials which indicate the days, months, &c.; above this axis is another smaller globe which shows the rotation of the earth around the sun. The large globe is set in motion by a dozen wheels. This ingenious mechanism has cost ten years' labour, and has only been achieved after many experiments. A map drawn upon the globe shows geographical details, and includes the most recent discoveries, routes of steamers, railways, telegraphs, mountain-heights, depths of the sea, &c.

WE have received a reduced photo-electrotype facsimile, by Mr. G. E. Emery, of Lynn, Mass., of the map which accompanied the narrative of the brothers Zeni, published at Venice in 1558. The Zeni it will be remembered made a voyage to the Arctic regions in the fourteenth century, and one of the problems of geography is to identify the places mentioned in their narrative and map. This has already been ably attempted by Mr. Major, and while Mr. Lynn's identifications agree in the main with those of Mr. Major, there are some important differences. "Icaria," *e.g.*, which Mr. Major makes out to be Kerry, Ireland, Mr. Lynn identifies with the Rockall Islands. The lost East Greenland Colony, the latter places on the east of Spitzbergen, apparently on Wiche Land, and most extraordinary of all, Crolandia, he maintains is the recently-discovered Franz-Josef Land. These two last identifications are very daring, and geographers will look with interest for Mr. Emery's reasons, which no doubt he will publish.

INTELLIGENCE has reached the Royal Italian Geographical Society that the Marquis Antinori, heading the Italian expedition of discovery in Africa, is dead. Chiarini, his fellow-traveller, is a prisoner in Abyssinia.

A SECOND edition of Capt. Luigi Gatta's Italian translation of Maury's "Physical Geography of the Sea" has just been published at Rome. It contains extensive and valuable footnotes by the translator. Capt. Gatta is, we understand, engaged in a translation of Lyell's "Principles of Geology."

DR. HARMAND, who has been exploring in Cochin China, has arrived in France, bringing with him, we believe, results of much value.

ON October 18, the first pioneers of the International African Exploration Society, consisting of the two Belgian officers, Capts. Crespel and Cambier, and the naturalist, Dr. Maes, left Southampton for Lake Tanganyika *vid* Port Natal, on one of the vessels of the Union Mail Steamship Company. This Company, with praiseworthy generosity, conveys the first party entirely free, and will make a deduction of twenty per cent. in the fares of all subsequently sent out by the society. The royal auspices under which the society enters upon its field of activity have ensured to it support in a variety of directions. The Sultan of Zanzibar has promised to render the utmost assistance possible, and the commercial house of Roux de Fraissinet and Co., has instructed its widely-spread agencies on the east-coast to second the efforts of the exploring party. There seems to be no lack of funds in the treasury of the society. Among the late subscriptions are 3,000 francs from the Hungarian African Society, while the collections in France amount already to 32,000 francs. Belgium, small as it is, contributed 300,000 francs outright in June last, while yearly subscriptions to the amount of 100,000 were given in addition. There is every prospect that this magnificent united effort will succeed in solving some, at least, of the problems connected with the remaining *terra incognita* of equatorial Africa.

WE regret to record the untimely end of the well-known geologist and African explorer, Dr. Erwin von Bary, whose recent explorations have frequently been referred to in our columns. Dr. v. Bary started in August, 1876, from Tripolis, on his journey into the interior of the Sahara, supported partly by the Karl Ritter Endowment Fund, and partly by the Berlin Afrikanische Gesellschaft. The aim of this expedition was to make a thorough study of these almost unknown regions, with especial reference to topographical and geological questions, more particularly the age and formation of the great desert. The chief results of this first journey were the observations leading to the conclusion that the Sahara was not formerly the bed of an inland sea as hitherto supposed. The traveller returned from this very exhaustive and fatiguing tour to the Berber town of Chat to recruit his impaired energies, and prepare for a more extended trip into the district of the Tuarej Hoggar, which has not as yet been visited by Europeans. Here he met the sad fate of so many African explorers, and died on October 2, from the effects of excessive exposure and privation. Von Bary's varied qualifications and complete devotion to the cause for which he perished, had led to high expectations among his fellow German geologists,

and a general feeling of regret is felt over his early death, away from home and friends. The French geologist, M. Largeau, is at present endeavouring to penetrate into the Tuarej region from the north, and the interest previously centred on von Bary's investigations will now gather about his efforts.

IN the spring of the present year we referred briefly to the attempt being made by Dr. J. M. Hildebrandt, under the auspices of the Berlin Academy of Sciences, to ascend the snow-covered summit of Mount Kenia. The question as to the permanent snow covering of the two equatorial mountains, Kenia and Kilimandscharo, has been a subject of so much controversy among geographers, that the results of this expedition have been looked for with great interest. It is with regret that we learn from a communication of Dr. Hildebrandt's, dated Suez, November 2, that he has been compelled to return, leaving the summit of Kenia still untrodden by the foot of a European. He left Mombassa on January 10 with forty attendants, and after two months of exhaustive travel amidst hostile tribes, reached Kitui, in Ukamba. Here, in full sight of Kenia, he was compelled to pause and retrace his footsteps, his followers utterly refusing to venture among the marauding tribes intervening between him and his journey's goal, and he himself being only saved by the swift application of an antidote from death by poison given by the natives. On reaching Zanzibar the physicians declared his health impaired to such an extent that restoration could only be hoped for in a more temperate clime. Dr. Hildebrandt has suffered unusually from the two invariable concomitants of the African explorer—sickness and the hostility of the aborigines, his two expeditions from Zanzibar in the spring and autumn of 1875 being both shortened and hampered by these causes.

HERR SCHÜTT, a civil engineer, has been despatched by the German African Society to St. Paul de Loanda to undertake an expedition through the region lately traversed so successfully by the hunter, Dr. Pogge.

ONE of the effects of the war in the east appears to be the discovery in out-of-the-way towns in Russia, of gems of unsurpassed size and beauty, which doubtless have been jealously hoarded by their possessors, and only brought to light in times, like the present, of national necessity. Some of these gems have naturally found their way to this country; perhaps the most remarkable are—an aquamarine, far superior to anything before seen in England, weighing over six ounces and a half, without the slightest blemish, and of a deep sea-green tint; also a topaz rivalling that purchased for the Grand Mogul at Goa for 11,260*l*. These two remarkable gems were received from Moscow by Mr. Bryce M. Wright, Mineralogist, of Great Russell Street, the possessor of the unique suite of diamonds called the "Bryce Wright Diamonds," valued at 21,000*l*.

WE are requested to state that in the abstract of Mr. Perkin's paper read at the meeting of the Chemical Society on November 1 the word "cumenyl" was, by a slip, written "cinnenyl" throughout the report.

THE additions to the Zoological Society's Gardens during the past week include a Common Squirrel (*Sciurus vulgaris*), European, presented by Mr. T. Massey, F.Z.S.; a Greater Sulphur-Crested Cockatoo (*Cacatua galerita*), from Australia, presented by Mr. F. Lablache; a Radiated Tortoise (*Testudo radiata*) from Madagascar, presented by Mr. H. Harrison; two Red-backed Squirrel Monkeys (*Saimaris œrstedi*), two Black-handed Spider Monkeys (*Ateles melanochir*), a Derbian Opossum (*Didelphys derbianus*) from Central America, a Bonnet Monkey (*Macacus radiatus*) from India, a Rufous-vented Guan (*Penelope cristata*) from Costa Rica, deposited; a Bay Antelope (*Cephalophus dorsalis*) from West Africa, received in exchange.

THE LIBERTY OF SCIENCE IN THE MODERN STATE[1]

WHEN the honourable request was addressed to me by our committee to deliver a lecture to the meeting upon this occasion, I asked myself whether I should not treat of a special department of the latest development of science, in accordance with that point of view to which I drew attention originally, and of which you were reminded by Prof. Klebs only the other day. But I decided this time to give expression to a more general want, principally because it seems to me that the time has come when a certain explanation must take place between science as we represent it and work in it, and general life as a whole, and because in the special history of the continental nations of Europe the moment is rapidly approaching when the mental fate of nations by decisions in the highest quarters may be determined perhaps for a long time to come.

It is not for the first time, gentlemen, that upon the occasion of a meeting of this Association I have been able, as a warning, to point out almost dramatic events happening in our neighbouring state. On a former occasion I could draw attention to occurrences which had just taken place beyond the Rhine, and which, however far they may apparently be removed from our task, yet concern the same contested domain after all, that namely upon which a decision must be made with regard to determining what position modern science is to occupy in the modern state. Let us be sincere—here we may perhaps be doubly so,—it is the question of ultramontanism and of orthodoxy, which moves us continually. I may say that I look forward with real fear to the events which will happen among our neighbours in the course of the next years. We here, at this moment, may look round with a certain pride and we may observe the course of things with a certain calmness. But to-day, when we are celebrating the fiftieth anniversary of this Association, it is certainly becoming to remember how great a change has taken place in Germany, and specially at Munich, since the days when Oken assembled German naturalists and physicians for the first time.

I would only refer shortly to two facts; they are well-known enough, but then they are also important enough to be mentioned again. The one is that when, in the year 1822, the handful of men who constituted the first meeting of the German Association of Naturalists met at Leipzig they thought it still so dangerous to hold a meeting of that description that it was really held in perfect secrecy. The names of the Austrian members could indeed be published only thirty-nine years later, viz., in 1861. The second fact which strikes us when we remember Oken is, that he, the valued and renowned teacher, the ornament of the Munich high school, died in exile in the same canton of Switzerland in which Ulrich von Hutten ended his life full of troubles and contests. Gentlemen, the bitter exile which oppressed the last years of Oken's life, which caused his death far away from those scenes where he had sacrificed the best powers of his life, this exile will remain the signature of the time which we have gone through. And as long as there is a German Association of Naturalists, we shall thankfully remember that this man bore all the signs of a martyr until the time of his death, we shall point him out as one of those who with their blood conquered and obtained for us the liberty of science.

Nowadays, gentlemen, it is easy to speak of the liberty of science in Germany; now we are perfectly secure even here, where, only a few decades back, the fear was great that a new change of things might perhaps produce the extreme reverse, and we can in all calmness discuss the highest and most difficult problems of life and the hereafter. The addresses which were delivered at the first and second general meetings certainly prove sufficiently that Munich is now a place which can bear to hear the representatives of science in the most perfect liberty. I was not able to listen to all these addresses, but I have since read those of Professors Haeckel and Nägeli, and I must say we cannot ask more than to be allowed to continue to discuss with such liberty.

If it were only a question of rejoicing over this possession I should indeed not have claimed your attention for that object. But, gentlemen, we have arrived at a point when it becomes necessary to investigate whether we may hope to retain securely for the future the possession which we actually enjoy. The fact that we are enabled to discuss, as we do to-day, is not a sufficient

[1] Address delivered at the Munich meeting of the German Association, by Prof. Rudolf Virchow, of Berlin.

security that it will always remain so for one who, like myself, has had many years' experience of public life. Therefore I think that our efforts should not only tend to claim the attention of all for the moment, but I believe we ought also to ask ourselves what we are to do to maintain the present state of things. I will tell you at once, gentlemen, what I would represent to you as the chief result of my observations, what I would like to prove here principally. I would like to show that for the present we have nothing more to ask, but that on the contrary we have arrived at the point when we must make it our special task to render it possible, *through our moderation, through a certain resignation with regard to personal opinions and predilections* that the favourable disposition of the nation towards us, which we now enjoy, does not change to the contrary!

In my opinion we are really in danger of doing harm to the future, by making use too amply of the liberty which the present state of things offers us, and I would warn you not to continue in the arbitrariness of personal speculation, which now claims prominence in many domains of natural science. The explanations which my predecessors have given you, those of Prof. Nägeli in particular, will yield a series of the most important points of view, with regard to the course and limits of natural knowledge, to all who read them, and it cannot be my task to repeat them. But I must point out in reference to them, and I would like to adduce a few practical instances from the experience of natural science, how great a difference there is between what we give out as real science in the strictest sense of the word, and for which alone we may in my opinion claim the totality of all those liberties which we may designate as liberty of science, or, if we express ourselves still more exactly, as *liberty of scientific teaching*,—and that larger domain, which belongs more to speculative expansion, which sets problems, and finds the tasks to which modern investigation is to be applied, and which anticipatively formulates a series of doctrines, which are still to be proved, and the truth of which must yet be found, but which in the mean time may be taught with a certain amount of probability, in order to fill certain gaps in knowledge. We must not forget that there is a limit between the speculative domain of natural science and that which is actually proved and perfectly determined. The demand is addressed to us that this limit shall be not only occasionally pointed out, but fixed with the greatest exactness, so that each single worker shall at all times be perfectly conscious of where the limit is drawn, and how far he may be requested to admit that what is taught is actual truth. That, gentlemen, is the problem which we have to work out *in ourselves*.

The practical questions which are connected with this, lie very near. It is evident that for whatever we consider to be secured scientific truth, we must demand the complete admission, into the scientific treasure of the nation. *This the nation must admit as part of itself*—it must consume and digest it, and continue to work at it. Just in this lies the double promotion which natural science offers to the nation:—On the one hand the material progress, that enormous progress which has been made in modern times. Everything which the steam engine, telegraphy, photography, chemical discoveries, the research into colours, &c., have produced, all this is essentially based on this—that we, the men of science, complete the doctrines entirely, and when they are perfectly complete and secure, so that we know with certainty that they are natural scientific truths, that we then give them to the nation at large; then others can work with them as well, and can create new things, of which formerly nobody had any idea, of which nobody dreamt, which come into the world as perfect novelties, and which reform the condition of society and of states. This is the material significance of our labours. The mental importance, on the other hand, is similar. If I present the nation with a certain scientific truth which is completely proved, to which not the least doubt attaches, if I demand that everybody shall convince himself of the correctness of this truth, that he shall assimilate it, that it shall become part of his thought, then I suppose as a matter of course, that his conception of things generally must be affected by it. Each essentially new truth of this kind must necessarily influence the whole method of conception of man, the *method of thinking*.

If, for instance, to refer to a case in point which lies near, we consider the progress which has been made during recent years with regard to the knowledge of the human eye, beginning at the time when the single component parts of the eye were first anatomically separated, when these single and anatomically separated parts were first examined microscopically and their different arrangement shown, down to the time when we gradually learned to know the vital qualities and the physiological functions of the different parts, until at last, by the discovery of the retina-purple (*Sehpurpur*) and of its photographic properties, a progress was made of which but a year ago we hardly had an idea, then it is evident that with each progressive step of this kind a certain part of optics, particularly the doctrine of vision, is determined and changed. By this we learn in a perfectly certain manner how the action of light takes place in the interior of the human body itself, and that it is quite an outside organ of the human body, not the brain, but the eye which experiences this action. We learn by it that this photographic process is not indeed a mental operation, but a chemical phenomenon, which occurs by the help of certain vital processes, and that in reality we do not see the external things, but their images in our eye. We are thus enabled to gain a new analytical fact for the knowledge of our relations to the world outside of us, and to separate more distinctly the purely mental part of vision from the purely material part. Thus a certain part of optics, and through it one of psychology, is entirely reformed. Chemistry now steps in to investigate questions which up to the present were entirely out of its range, particularly the highly important questions, What is retina-purple? What substance is this? How is it formed, how decomposed, and how again formed? The solution of these questions will not fail to open an entirely new field for investigation; let us hope that also on the field of technical photography we shall soon make some progress, that we shall learn how to produce many-coloured photographs. Thus a mixture of steps of progress is formed, which belong partly to the material and partly to the mental domain. And I therefore say, that with each true step of progress in natural knowledge a series of changes must necessarily take place in the internal relations of the human race as well as in the external ones, and nobody can prevent new knowledge from influencing him in a certain sense. Each new part of real knowledge works on in man, it produces new conceptions, new trains of thought, and nobody can avoid, after all, placing even the highest problems of the mind into a certain relation with natural phenomena.

But there is still another side of practical consideration which lies far nearer to us. Everywhere in the entire German Fatherland we are now occupied in remodelling educational affairs, in enlarging and developing them, and in determining their precise forms. The new Prussian educational law is on the threshhold of coming events. In all German states larger school-houses are being erected, new institutions are founded, the universities are enlarged, high schools and middle schools are established. At last the question arises, What is to be the principal tenor of what is taught? Where shall the school lead to? In what directions shall it work? If natural science demands, if we have been exerting ourselves for years to obtain an influence in our schools, if we demand that natural knowledge shall be admitted into education in a much larger measure, so that this fertile material be offered early to the youthful minds, in order to form the basis of a new conception, then we must indeed own that it is high time that we understood one another with regard to what we can and will demand. If Prof. Haeckel says that it is a question for pedagogues whether the theory of descent is now to form the basis of instruction, whether the plastidule soul is to be adopted as the basis of all considerations regarding mental phenomena, and whether the phylogeny of man is to be followed up into the lowest classes of the organic empire, and even beyond it up to spontaneous generation, then this is, in my opinion, a mere shifting of tasks. If the theory of descent is as certain as Prof. Haeckel thinks it is, then we must demand its admission into the school, and this demand is a necessary one. How could we imagine that a doctrine of such importance, which influences the conscience of everybody in so revolutionary a manner, which creates directly a sort of new religion, should not be entirely incorporated into the educational plan! How would it be possible to ignore such a revelation—as I may indeed call it—in our schools, and to kill it by silence as it were, or to leave the transmission of the greatest and most important steps of progress, which our conceptions have made in the whole century, to the option of the pedagogue? Indeed, gentlemen, that would be a resignation of the most severe kind, and in reality it would never be exercised. Every schoolmaster who might receive this doctrine in his mind would teach it as well, even unconsciously. How could he do otherwise? He would have to simulate altogether, he would have to rob himself at times of his own knowledge in the most artificial

manner, in order not to show that he knew and recognised the theory of descent, and that he knew exactly how man has originated and whence he comes. If indeed he did not know where man goes to, yet he would at least believe that he knew for certain how in the course of æons the progressive series shaped itself. Therefore I say that if we really did not demand the admission of the theory of descent into the educational plan, this would yet be accomplished of its own accord.

We certainly should not forget, gentlemen, that what here we express, perhaps still with a certain timid reserve, is propagated by those outside with a confidence increased a thousand-fold. For instance, I have once pronounced the phrase—in opposition to the doctrine then reigning of the development of organic life from inorganic matter—that each cell had its origin in another cell, indeed at that time with special reference to pathology, and principally with regard to man himself. I may remark here that in both relations I still to-day consider this phrase a perfectly correct one. But when I had pronounced this doctrine and had formulated the origin of the cell from the cell, others were not wanting who extended this phrase not only in the organic world far beyond the limits for which I had intended it, but who put it down as generally valid even beyond the limits of organic life. I have received the most wonderful communications both from America and Europe, in which the whole of astronomy and geology were based upon the cellular theory, because it was thought impossible that something which was decisive for the life of organic nature upon this earth should not be equally applied to the heavenly bodies, which were said to be round bodies after all, and which had shaped themselves into globes and represented so many cells flying about in universal space and playing a part there similar to that of the cells in our body.

I cannot say that the authors of these communications were all decided fools and simpletons; on the contrary, from some of their explanations I gained the idea that many an otherwise educated man, who had studied much and finally attacked the problems of astronomy, could not understand that the utility of heavenly phenomena should be based upon something else than the utility of human organisation, so that he, in order to gain a monistic conception eventually arrived at the supposition that the heaven must also be an organism, that indeed the whole world must be an organism of useful arrangement, and that no other principle but that of the cells could apply to it. I cite this only in order to show what shape things take outside, how "theories" are enlarged, and how our own doctrines may return to us in a form fearful to ourselves. Now only imagine how the theory of descent may be shaped to-day in the head of a socialist!

Indeed, gentlemen, this may seem ridiculous to many, but it is very serious, and I only hope that the theory of descent may not bring all those horrors in our country which similar theories have actually brought to our neighbours. Anyhow this theory, if carried through to its consequences, has an extremely dangerous side and that the socialists have a certain notion of it already, you will doubtless have remarked. We must make this quite clear to ourselves.

Nevertheless the matter might be as dangerous as possible, the confederates might be as bad as they could be, and yet I say, from the moment when we are convinced that the theory of descent is a doctrine perfectly proved, so certain that we could swear by it, that we could say, thus it is,—from that moment we must not hesitate to introduce it into general life, transmit it not only to every educated person, but teach it to every child, make it the basis of our whole conception of the universe, of society, and of the state, and found our educational system upon it. This I consider a necessity.

In saying this I am not at all afraid of the reproach, which to my astonishment has made a great noise in my Prussian Fatherland, while I was absent in Russia, I mean the reproach of *half-knowledge*. Strange to say, it was one of our so-called liberal journals which asked the question whether the great faults of our time, and socialism in particular, were not based upon the diffusion of half-knowledge. With reference to this I would like to state here, in the midst of the Naturalists' meeting, that *all* human knowledge is only piece-work. All of us who call ourselves naturalists, only possess pieces of natural science; none of us is able to come here and represent each science with the same right, or participate in the discussions of any scientific section. On the contrary, it is just because they have developed themselves in a certain one-sided direction, that we esteem the special scientific men so highly. On the other fields we are all in half-knowledge as it were. Oh! that we could only succeed in diffusing this half-knowledge more and more, if we could succeed in causing at least the majority of educated persons to progress far enough to be able to survey the principal directions which the single departments of natural science are taking, and to follow their development without meeting difficulties too great to be overcome, so that they would at least be aware of the general progress of science, if, indeed, they were not acquainted, at every moment, with the totality of all single and special proofs. We do not get much further ourselves. I, for instance, have honestly tried during my time of life to obtain chemical knowledge; I have even worked in a laboratory, but I feel thoroughly incompetent to sit down at some chemical meeting without preparation, and to discuss modern chemistry in all directions. Nevertheless I am able to penetrate, after a time, so far into any chemical novelty that it does not strike me as incomprehensible. But I must always first acquire this understanding, I have not got it to start with; and when I want it again I must acquire it again. That which honours me is the *knowledge of my ignorance*. The most important part is that I know perfectly well what I do *not* know of chemistry. If I did not know that then of course I should always be wavering to and fro. But as I imagine that I am tolerably well aware what I do not know, I say to myself every time I am obliged to enter a domain which is still closed to me: "Now I must begin again to learn, now I must study afresh, now I must do as anybody does who enters the domain of science." The great error, which is equally shared by many educated people, consists in not remembering that with the enormous extent of natural science and with the inexhaustible quantity of detailed material, it is impossible for any single person alive to command the totality of all these details. That we get far enough to know the *foundations* of natural science and the gaps which exist in our own knowledge, so that every time we find a gap of this kind we say to ourselves,—"Now you enter a domain which is unknown to you,"—that is what we must arrive at. If everybody was only sufficiently aware of this, many a one would beat his breast and own that it is a dangerous thing to draw general conclusions with regard to the history of all things when one is not even entirely master of the material from which these conclusions are to be drawn.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—This term has witnessed the election of two new Natural Science fellows. Mr. A. M. Marshall, Senior in the Tripos of 1874, has been elected at his own College, St. John's. His able papers on Embryology have been an important addition to the researches which are making the British school again famous in this subject, and he is the first Doctor of Science in Comparative Anatomy in the University of London. Two of the newly-elected fellows of St. John's are taking to Medicine, viz., Dr. Marshall and Mr. McAlister, the last Senior Wrangler. At Trinity the open fellowship has been adjudged for the first time to a non-member of the College, Mr. J. N. Langley, B.A., of St. John's, whose services as Demonstrator of Physiology to Dr. Foster are most highly appreciated, while his originality and perseverance in research will, before long, be much more widely known than at present. I understand that the aid of Prof. Huxley was called in, giving the highest guarantee to the examination in Biology, and that several candidates showed themselves in every way worthy of a fellowship, especially in the original memoirs which were sent in before the examination.

The new buildings for anatomy and physiology are advancing to completion and are partially occupied, Mr. Balfour's two practical courses of Comparative Anatomy being accommodated in them. Dr. Foster will transfer much of his work here after Christmas. The new buildings will be almost too small as soon as completed, for Dr. Foster has fifty men and several ladies working in his elementary classes this term, a very large number when it is considered that this is voluntary and not prescribed work. It is but a just tribute to Dr. Foster's rare value as a teacher who makes his students think, who sacrifices his time most indefatigably for their interests, and who cultivates the powers of investigation developing in his pupils with all the care of a parent. Instead of engrossing authority to himself, he sets his senior pupils to lecture on the subjects they make a special study; thus during the present winter the advanced class will receive lectures from Dr. Gaskell, Mr. Langley, and Mr. Lea. Mr. Vines has returned from working in Germany

with Sachs, and is lecturing to a large class on Vegetable Physiology. Next year he will start the first practical course of botany, and, being unable to induce his college to provide apparatus for a laboratory, intends to furnish it at his own expense. Among other lectures in natural science Prof. Dewar's on Physical Chemistry are taking high rank. It is to be noted that Mr. Apjohn, the late lamented Prælector of Chemistry at Caius College, was to have received a fellowship this term by special vote of the whole of the fellows. The prælectorship is to be continued mostly in its old form, but it is worthy of note that the prosecution of original research is put prominently among the duties of the office, as well as the instruction of students from the University generally. There are nearly a score of candidates, including such well-known names as Mr. W. Noel Hartley, Dr. J. T. Bottomley, and Dr. Dittmar.

Prof. Clerk Maxwell greatly interested the Philosophical Society at its last meeting by an account of Henry Cavendish's unpublished writings and experiments on electricity. He was not generally known to have done much electrical work, and his papers were long in the hands of Sir W. Snow Harris, who is declared by Prof. Maxwell, after careful examination, to have made no use of Cavendish's work without full and adequate acknowledgment. These writings are left in a form quite fitted for publication, and will greatly advance the reputation of the great philosopher. His exactness, his candour, his grasp of the subject, his notable achievements with the small variety of instruments available in his time, were fully shown by the examples cited to the Society. Yet these were less than his remarkable insight into electrical laws, his correct conception of potential, his ideas of investigating the total charges of bodies, and the resistance of electrolytes. Prof. Maxwell thought that nobody had ever possessed so large and various a collection of condensers of known capacity as Cavendish, but his family taciturnity prevented his merits from being fully known. He trained himself to be his own galvanometer, and the general value of his results is remarkable when compared with those obtained by modern instruments.

In regard to university reform, it appears that in some colleges at least there is a danger of the non-resident fellows, who form the largest proportion of the governing body under the act, endeavouring to maintain at a very high number the fellowships to which no duties are attached; of course every such fellowship diminishes the funds available for definite association with the progress of research and education. Some men hold very strongly to the "start in life" theory of fellowships; viz., that they ought to receive three hundred a year for a number of years in order that they may gain three thousand a year in a profession the more speedily.

GLASGOW.—Mr. Gladstone has been elected Lord Rector of Glasgow University in succession to the Earl of Beaconsfield.

BERLIN.—The well-known botanist, Prof. Sachs, of Würzburg, has received a very flattering call to Berlin. Neither pains nor money seem to be spared by the Prussian Government in attracting to the capital the foremost talent of Germany; and certainly in this choice of a successor to Alexander Braun no change of policy is shown.

GÖTTINGEN.—The sum of 50,000 marks has recently been appropriated for the erection of a phyto-physiological institute in the Botanical Gardens.

GIESSEN.—In consequence of the late discussions excited by Prof. Mommsen's articles on the Ph.D. examinations in Germany, the University of Giessen has issued an announcement stating that for the future no faculty can bestow the title of Doctor, except on the basis of a thesis and oral examination.

DORPAT.—The winter attendance at the university is 853, of whom but seven are non-Russian.

BRUNSWICK.—On October 16 interesting ceremonies took place at the opening of the magnificent new buildings of the Carolo-Wilhelminum Polytechnic, in which representatives of the Government, and delegates from all the great German polytechnics, took part. The new edifices are of great extent, and richly equipped with all possible adjuncts for modern technical education, so that this well-known institution will be able to maintain its well-earned reputation. The Carolo-Wilhelminum is the oldest polytechnic in Germany, having been founded in 1745, and the list of its students embraces many distinguished names, such as Gauss, the mathematician, Christopher Codrington, the English commander at the naval victory of Navarino, &c.

SOCIETIES AND ACADEMIES

LONDON

Chemical Society, November 15.—Dr. Gladstone in the chair.—The following communications were made:—First report to the Chemical Society on some points in chemical dynamics, by Dr. Wright and Mr. Luff. An elaborate series of experiments was made to find out the temperatures at which the actions of carbonic oxide, hydrogen, and free amorphous carbon on oxide of iron or oxide of copper are first perceptible. The authors find that this temperature varies with the physical condition of the oxide used, that hydrogen acts, on a given oxide, at a lower temperature than carbon and carbonic oxide, at a lower temperature than hydrogen, and that a given reducing agent begins to act on copper oxide at a lower temperature than on iron oxide.—On the chemistry of cocoa butter, Part I.; two new fatty acids, by C. T. Kingzett. The first acid is a low acid of the series, $C_nH_{2n}O_2$, having the formula $C_{12}H_{24}O_2$, *i.e.*, lauric acid, but it melts at 57°·5. The second acid is a high acid having the formula $C_{64}H_{128}O_2$, crystallising in microscopic needles or granules, melts at 72°·2, and at a high temperature distils apparently unchanged. The author proposes for it the name of theobromic acid. It is pointed out that the usual statement in books, "that cocoa butter yields almost exclusively stearic acid" is entirely incorrect.—The third paper was on the influence exerted by time and mass on certain reactions in which insoluble salts are produced, by Mr. M. P. Muir. The author has taken solutions containing known quantities of calcium chloride and potassium or sodium carbonate mixed, allowed to stand for a certain number of minutes, and then estimated the quantity of calcium carbonate formed. He has arrived at the following conclusions:—That the greater portion of the chemical change takes place during the first five minutes; the reaction then decreases in rapidity. The relative masses of the salts exert an important influence. Thus if the mass of alkaline carbonate be four times that required, the action is completed in five minutes, but if an equivalent quantity only be present the action is not finished in forty-six hours. Potassium carbonate yields more calcium carbonate in a given time than sodium carbonate. An increase of temperature increases, whilst dilution, especially with solutions of potassium or sodium chloride, diminishes the rapidity of the action. Some experiments are given on the action of solutions of calcium sulphate and sodium chloride.

Entomological Society, November 7.—Prof. Westwood, president, in the chair.—Mr. McLachlan exhibited ten of the thirteen species of Lepidoptera collected by Capt. Feilden and Mr. Hart in Grinnell Land, between 78° and 83° N. lat, during the recent Arctic Expedition, and made some remarks upon the general insects of the Arctic Regions.—The Rev. A. Eaton also made some observations upon the same subject.—Mr. Meldola exhibited a five-winged specimen of *Gonepteryx rhamni*, taken in Norfolk by Mr. John Woodgate; likewise a gynandromorphic specimen of *Pieris brassicæ*, caught in Oxfordshire by Mr. J. B. Watson. The right half of the latter insect was female and the left half male.—Mr. H. Goss exhibited a gynandromorphic specimen of *G. rhamni*, captured in Sussex; in this insect also the right side was female and the left side male.—Mr. J. W. Douglas exhibited a specimen of *Polyphylla fullo*, Linn., which had flown on to a steamer at Antwerp, and been thus brought to this country. Mr. Douglas also exhibited a specimen of the rare *Tettigometra impressopunctata* and one of *Typhlocyba debilis*, both taken on Sanderstead Downs; and likewise, for comparison, an example of *T. tenerrima*.—Mr. W. C. Boyd exhibited a larva of *Pieris rapæ* attacked by *Microyaster*.—The president read notes on exotic Coleoptera, and exhibited specimens of *Calometopus Nyassæ*, *Amblyodus Nicaraguæ* and drawings of other species.—Prof. Westwood also remarked upon an Indian *Mantis* (*Gongylus gongylodes*) which had been recently described by Dr. Anderson in the *Proceedings* of the Asiatic Society of Bengal for August, 1877, as being a simulator of a flower to a remarkable degree of perfection.—Mr. Wood-Mason also made remarks upon the same subject and upon stridulating organs in crustaceans with reference to a letter on this subject by Mr. Saville Kent in this journal (vol. xvii. p. 11). Mr. Wood-Mason likewise announced the discovery of a stridulating apparatus in a *Phasma*.—Sir Sydney Saunders read a note on the specific identity of the Hampstead *Atypus*. Mr. F. Enoch exhibited and made remarks upon a male and female of this spider.—The following papers were read:—Descriptions of new species of the coleop-

terous genus, *Callirhipis* (*Rhipidoceridæ*), in the British Museum, by C. O. Waterhouse.—Descriptions of a new genus and two new species of *Sphingidæ*, with remarks on the family generally, by A. G. Butler.—Descriptions of *Halticinæ*, by J. S. Baly.—Descriptions of new species of *Cleridæ*, with notes on the genera and corrections of synonymy, by the Rev. H. S. Gorham.

Royal Astronomical Society, November 9.—Dr. Huggins, F.R.S., in the chair.—A very large number of papers were presented.—Lord Lindsay was called upon to read Mr. Gill's report upon the expedition to Ascension to obtain the parallax of Mars, from which it appeared that in spite of meteorological difficulties and many causes of anxiety most satisfactory results had been obtained, and Mr. Gill had gone up a mountain to recruit his health.—Several important mathematical papers were then read; one by the Astronomer-Royal on the solar parallax, as deduced from telescopic observations of the transit of Venus, 1874.—Next a paper by Prof. Adams on the motion of the moon's node, and a paper by Mr. Neison on three small inequalities in the mean motion of the earth, and a small inequality in the mean motion of Mars. These were followed by three observational papers on the recent opposition of Mars; one by the Astronomer-Royal, read by Mr. Christie, giving the summary of what was seen at Greenwich both with the telescope and spectroscope; the next by Mr. N. E. Green, giving an account of his expedition to Madeira and what he saw of Mars with a fine 13 inch reflector. This paper was accompanied by a series of beautiful drawings of the planet by the author. The third paper, on Mars, was by Mr. John Brett, being a discussion of a series of telescopic observations made in Cornwall, the purport of which was to show that the generally received hypothesis of the physical condition of Mars was altogether fallacious, neither the snows nor the seas having any foundation in fact. This paper was also illustrated by a series of drawings.—Then followed a paper by Lord Lindsay, on a new form of spectroscope, and the meeting adjourned.

Anthropological Institute, November 13.—Dr. John Evans, F.R.S., president, in the chair.—The Rev. T. A. Bennett and F. V. Dickins were elected members.—An interesting series of casts of skulls made of papier-maché were exhibited, and a special vote of thanks was ordered to be sent to Prof. Bogdanow, of Moscow, by whom they were presented to the Institute.—Major-Gen. A. Lane Fox, F.R.S., exhibited some flint flakes from Egypt, and a note from Capt. R. F. Burton was read on the same.—The director then read a paper by Mr. H. H. Howorth, F.S.A., on the spread of the Slaves: Part I., the Croats.—This was followed by a paper on the Castilieri d'Istria, by Capt. R. F. Burton, H.M.'s Consul at Trieste.—Mr. Hyde Clarke, the President, Major-Gen. A. Lane Fox, and Mr. Moggridge took part in the discussions.

Institution of Civil Engineers, November 13.—Mr. George Robert Stephenson, president, in the chair.—The paper read was a review of the progress of steam shipping during the last quarter of a century, by Mr. Alfred Holt, M. Inst. C.E., of Liverpool.

PARIS

Academy of Sciences, November 12.—M. Peligot in the chair.—M. Faye presented the volume of the *Connaissance des Temps* for 1879.—On some applications of elliptic functions (continued), by M. Hermite.—*Résumé* of a history of matter (fourth article) by M. Chevreul. This relates to the views of Lavoisier, Stahl, Scheele, Cavendish, and Priestley.—Observations on the principle of maximum work and on the spontaneous decomposition of hydrated bioxide of barium, by M. Berthelot.—On the limits of etherification, by M. Berthelot. In experimenting on etherification sixteen years ago he put aside a number of mixtures to be kept a considerable time, in order to ascertain the limit of the reactions produced at ordinary temperatures. The mixtures consisted of acetic acid and alcohol (equal equivalents), acetic acid and glycerine, tartaric acid and alcohol, valeric acid and alcohol. He has now examined these. The general laws of etherification are confirmed, and especially the identity of the limits of combinations between acids and alcohols, from ordinary temperatures up to 260°.—On the order of appearance of the first vessels in the shoots of some Leguminosæ (second part), by M. Trécul.—The Academy elected a commission to present a list of candidates for the vacancy among the Foreign Associates, caused by the death of M. von Baer.—On the numeration of globules of milk for the analysis of woman's milk, by M. Bouchut. A drop of milk is mixed with 100 drops of slightly saline water (distilled). A drop of the mixture is placed under the microscope, whose eye-piece is divided into squares; the number of globules in each square is counted, and the average taken; from this may be deduced the number in one cubic millimetre. The globules were thus counted in milk of 158 nurses, before, during, and after suckling. The average of globules is about 1,026,000 per cubic millimetre of milk, or a hundred and two milliards six hundred millions per litre; but between 800,000 and one million per cubic millimetre, the milk is considered of good quality. In one table are given the density and the quantity of butter corresponding to given numbers of globules of cow's milk.—New formulæ for the study of the motion of a plane figure, by M. Haton de la Goupillière.—On the migration of the puceron of the cornel tree and its reproduction, by M. Lichtenstein. This puceron comes from the roots of gramineæ, and returns to them. Its mode of reproduction is that termed by the author *anthogenesis*.—Observations on the subject of a recent communication from M. Fabre, by M. Millardet. The secretary announced a new biennial prize, founded by M. Maujean.—Discovery of a small planet at the Observatory of Paris, by M. Paul Henry.—Discovery of a small planet at the Observatory of Pola, by M. Palisa.—Observations of planets 125 and 176 made at the Paris Observatory (equatorial of the garden), by MM. Paul and Prosper Henry.—New stellar systems, by M. Flammarion.—On the equation with partial derivatives of the third order expressing that the problem of geodesic lines, considered as a problem of mechanics, supposes an algebraic integral of the third degree, by M. Lévy.—On the evolution of red corpuscles in the blood of oviparous vertebrates, by M. Hayem. The red corpuscles proceed from a peculiar colourless element, which from the first phases of development is distinct from the white corpuscles; the name of *hæmatoblast* is given it. The white corpuscles are foreign to the formation of the red, both in oviparous vertebrates and in the higher animals; but whereas in the latter the red corpuscles of new formation are coloured, whatever their minuteness, in the oviparous, the embryonic corpuscles are at first quite without hæmoglobin.—On the spots and crevices of pears, by M. Prillieux. These are due to the growth of a small parasitic champignon.—On the semi-diurnal variations of the barometer, by M. De Parville. He thinks it improbable that aqueous vapour has a preponderating influence in these variations.—On the quantities of heat liberated in mixtures of sulphuric acid and water, by M. Maumené. Sulphuric acid recently heated does not liberate, with water, the same quantity of heat as the same acid kept several months. This phenomenon, denoted as a tempering of liquids, seems to him a source of error in researches on thermo-chemistry not hitherto considered.

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