THURSDAY, JUNE 29, 1882

THE FUNERAL TENT OF AN EGYPTIAN QUEEN

The Funeral Tent of an Egyptian Queen. By Villiers Stuart, of Dromana, M.P. (London: John Murray, 1882.)

THE startling discoveries of the royal mummies in the pit of the Deir-el-Bahari has already been the subject of great interest, and cast an unexpected light on the history of embalming and the vicissitudes of the dead as well as the living, revealing the unexpected transport of the monarchs from their costly chambers and sarcophagi of the Biban-el-Molouk to the Deir-el-Bahari in the fifth year of a monarch named Herhor, of the 21st dynasty, one of that line of ambitious pontiffs who, at a time of national decay, mounted the Egyptian throne. That the tomb of the Deir-el-Bahari was the resting-place of Herhor himself and his family appears from the discovery of their mummies at the same site along with 6000 sepulchral objects, some of which are already filtering to Europe, and others discovered at least ten years ago, already enrich the collections of the Louvre. The numerous duplicates of the smaller and portable objects can neither be all retained in the country, nor is it desirable they should be in the interests of science, for the interest would be languid which allowed them all to remain on the banks of the Nile. The reason why these archæological treasures were deposited in the Deir-el-Bahari is quite uncertain, and as the hieratic inscriptions on the shrouds only speak of their removal and condition, the cause is likely for the present to remain undiscovered. The Deir-el-Bahari was built by Thothmes I., II., Hatasu, the ambitious queen, and her warlike brother Thothmes III., as it was a spot especially favoured by the 18th dynasty. Probably the 21st dynasty was descended by the female line from the 18th, for families do not readily become extinct in that direction, and there are living descendants of the Plantagenets at the present day. The resumption of the titular names of the 18th dynasty by the 21st also points to a connection between the two families, although it is difficult to conceive the precise point from which it started. As however the first monarch of the 21st had been a prince of Kush or Æthiopia, and these princes or viceroys were continued in a lineal descent during the 18th and 19th dynasties, it may perhaps be the case that Pinotem I. and II. were descended by that family from the monarchs of the 18th dynasty.

It is not necessary to dwell on the mummies, but some of the facts mentioned by Mr. Villiers Stuart in his work are remarkable, such for example as the wailing of the Arab women along the Nile on their removal by the steamers to the Museum of Boulaq, for although professional mourners the lamentations of these women were spontaneous and gratuitous. On the arrival of the mummies at Cairo, that of Thothmes III. was unrolled, and that illustrious soldier, a little man, a martial pigmy of the most fragile mould, far more fragile than the flowers with which he was surrounded, vanished like a dream after, as it is said, a rapid photograph had been taken of his features, so that only a carte de visite of his remains has been left for posterity. Rameses II. was a hero of the grenadier type, for his height is at least six feet, but he has not been unrolled, the loss of Thothmes III. having discouraged the Boulaq authorities, so that for the present the vexed question of his features, whether the heroic aquiline nose or the ordinary flat Egyptian, remains in abeyance. The other mummies which have been partly denuded are the priest Nebseni, of the 18th dynasty, whose features are good Egyptian, and Pinotem II., whose capacious mouth and thick lips announce a Nigritic origin or intermixture of blood; others, as Isiemkheb and Makara, have been left in their bandages for a future period to unravel. The queen Notemut, the grandmother of Makara, and a remote progenitor of Isiemkheb, had however hair streaked with silvery gray, and was an old woman still retaining the coquetry of a careful plaiting of her locks. Some of the family were of mixed origin, and when was the Egyptian race otherwise, except when foreign conquests introduced other blood into the country. The greater portion, however, of Mr. Stuart's work is occupied with the description of the leather canopy of the queen Isiemkheb. This ancient pall was composed of numerous pieces of leather tanned by the bark of the *sont* or acacia, and sewn together by red cord, and is supposed to have covered the mortuary cabin of the sacred boat or horse, to which it formed a kind of baldacchino. It is exceedingly brittle, and the colours are still well preserved, the centre 9 feet long by 6 feet wide, and divided into two equal sections, one of which is covered by pink and yellow rosettes on a blue ground, the other displaying six flying vultures flying with extended wings and holding feather sceptres in their claws; they are separated from one another by horizontal lines of hieroglyphs, the name and titles of Masaharuta, high priest of Amen Ra, the deity of Thebes, and a row of pink rosettes on a yellow ground. On either side is a flap divided from the central section by four bands of colours—blue, red, yellow, and green—and further divided by a border of spearhead pattern. Below this comes a row of panels containing a row of emblematical devices, predominant amongst which is the scarabæus, flying with extended wings, thrusting forward the solar disk—emblems of the sun-god—but having with this emblem the representation of a gazelle, supposed to be the favourite of the queen, twice repeated, a singular representation of two united ducks, and ornaments like the Greek antefixal and the cartouche or royal name of Pinotem II. seven times repeated. Below this is a border of pink and blue chequers at the bottom, with a broad kilt of pink or perhaps originally scarlet. This magnificent work of leather measures 22 feet 6 inches in length, and 19 feet 6 inches wide, containing a space of 201 square feet of leather. It is the most remarkable object next to the historical mummies of the whole collection, and exhibits the greatest technical skill in preparation, and artistic excellence in execution and design. Its age is somewhere about the time of Solomon, but the length of the reigns of the monarchs of the 21st dynasty lies entombed in the vaults of the Serapeum, which contained the 24th, 25th, and 26th Apis mummies, and which Mariette found practically inaccessible from the collapse of the vault. The period, however, was that of foreign alliances, as shown by the flight of Adad, the Idumæan

prince, to Egypt, and his marriage with the sister of the queen. Besides the devices the canopy was ornamented with a hieroglyphical inscription, the purport of which appears to be that the queen in the future state was in the arms of Khonsu, one of the deities of Thebes, son of Mut and Amen, "redolent with perfumes sweet as those of Punt," the present Somali or Guardafui, and "crowned with flowers." Those found in the coffins of this period, and which still preserved their original colours, have been determined to be blue larkspur, yellow mimosas, or acacias, and the white lotus, besides which, according to Mr. Stuart, a moss was discovered in the coffins resembling a kind found only in Greece. The coloured plate of the canopy which accompanies this part of the work gives an idea of the brilliancy of this remarkable piece of leather embroidery as it appeared nearly three thousand years ago. Specimens of this leather canopy, which have been brought to England, show that the colours with which it was painted or dyed still retained their original lustre. From some unknown circumstance they have, like the flowers, never paled by the effects of time.

In his commentary on the text, which it is unnecessary to follow here in detail, Mr. Stuart has given an account of the scarabæus, known as the *Copris Isidis* of Savigny, and detailed a fact not generally known or described in the account of that insect. Instead of propelling the clay ball or pellet or the dung cased in with clay as the other kinds of this family are said to do with their hind legs, the male *Copris Isidis* carries the ball on its head and neck, for which the peculiar formations of the horns and projections of the thorax are specially adapted. One has been found wending its way over the ground with its spherical load, another has been knocked down bearing it as the beetle hummed his drony flight through the air.

Besides the description of the leather pall, Mr. Stuart gives some account of the recently discovered pyramid of Pepi at Sakkarah and that of Haremsaf. The interior of these pyramids, unlike any of the others, was covered with incised inscriptions coloured green, a peculiarity seen also on some sepulchral tablets. The inscriptions of these pyramids are mythological phrases, consisting of formulas like those of the Ritual comparing the passage of the soul of the deceased kings after death through the heavens to the movement of the constellation Orion and the course of Sothis or the Dog Star. Amongst the other new facts mentioned in these inscriptions is that of the tree of life, which is placed in the island of the blest amongst the pools of the fields of the Aahlu or Egyptian Elysium. A new light is shed on the earlier mythology by these texts, which chiefly turn on the Nut or goddess of the Ether, from whom Osiris and the monarch in the character of that god is descended. These remarkable texts have been translated by Brugsch-Bey, and Lauth. It is much to be regretted that these inscriptions are so entirely religious, and that these earliest of hieroglyphic monuments offer no contribution to the history of that remote period, Meidoum, is surrounded by tombs, in one of which the author found the name of Senofru of the 3rd dynasty. The attempts to solve the antiquity of this sepulchre from other sources has failed like all the earliest works of Egypt; for the passage is uninstructive, some scribes of a later age have scrawled or scratched a memorandum of a visit, but the walls are otherwise silent, and the chamber has not been found in which the royal tenant was deposited. The mastabas of the age do not abound in relics, and the antiquity of some of the terra cotta vases has been impugned, the criteria of the different kinds of pottery being obscure. At Dashour the author found a very early tomb of a person named Afoua, but although the style of art announced a high antiquity, the inscriptions curt, and in the oldest form, offered no novel points of interest, they were like those of the slab of the 3rd dynasty at Oxford, supposed to have been brought by Greaves from Egypt.

Mr. Stuart has published the tomb of Rameses, the governor of Thebes, in the reign of Amenophis IV., and the so-called Khuenaten, and enters into a discussion of the difference between Amenophis IV. and the heretic monarch. The general idea is that Amenophis IV. adopted the worship of the sun's disk soon after his accession, and altered his name from Amenophis, or "the peace of Amen," to that of Khuenaten, or the "splendour of the disk," in honour of the orb of heaven, whose worship he had substituted for that of the Theban god. The fact that the features of Amenophis and Khuenaten essentially differ, the one depicted as a rotund youth, the other that of a haggard septuagenarian, had long attracted attention, and been explained on the hypothesis that the portraits of Egyptian royalty were conventional, and therefore not to be depended on, and that the introduction of the new worship had unshackled the technical details of the Egyptian artists. But who was the mysterious Khuenaten? was he an emasculated virility of the harem, or a withered senility of the Nigritic race who had ascended the throne of Egypt? Was he possibly the old queen Tii, who, ambitious of power, had assumed manly costume and, attended by a mock or daughter queen and attendant princesses, endeavoured to set up a new capital and a foreign cultus at a small but rival capital. All is mystery, the facts pointed out by Mr. Stuart of the different features which could not change with the same facility as the name, the different functionaries of the two courts, the strange and servile homage paid by the courtiers of the old heretic and perhaps impostor, the copious bribery of the novel monarchy only add to the unsolved problem, and are not the least interesting part of the work. The identity of the two monarchs as two single gentlemen rolled into one will be long contested, as even the tomb at Thebes gives the same name and titles to the erased and mutilated heretical forms of Khuenaten. Amongst his miscellaneous plates are one of the mummy of Thothmes III. in its bandages, a box of the queen Makara, and some mummies of the find at Deir-el-Bahari.

These are also known from the photographs of M. Emile Brugsch, attached to the report of Maspero. Some discussions and examples of the Indo-Germanic nature of the Egyptian language are given; but this branch of philology is a knotty point, for the Egyptian language is not of a decidedly Indo-Germanic construction, although many of the words undoubtedly have Indo-Germanic analogies.

The main interest of the work, however, centres in the monuments of the Deir-el-Bahari, especially the leather canopy of Isiemkheb. There are, however, in Egypt such an enormous mass of unpublished monuments and

inscriptions that even the Deir-el-Bahari find is not to compare with the inscriptions on the temples of Denderah and Edfu, and those of the caves of Siut.

HYDROGRAPHICAL SURVEYING

Hydrographical Surveying; a Description of the Means and Methods employed in constructing Marine Charts. By Capt. W. J. L. Wharton, R.N. (London: Murray, 1882.)

CAPT. WHARTON, who has had considerable experience in nautical surveying, having been in command of surveying vessels for nearly ten years, has devoted his time, during the short interval he has been unemployed, to writing a work on this part of the naval profession which he modestly describes, in his preface, as an endeavour to collect together information, which has existed for years in a traditionary form amongst surveyors, for the benefit of young officers who may wish to devote themselves to surveying work in the future.

A book of this sort was certainly much needed as since the time of Sir Edward Belcher, only one treatise has been written by a naval surveyor—Capt. R. Mayne, R.N., C.B.—and we think Capt. Wharton deserves the thanks of the profession for his exertions, and we hope to see his work adopted as the text-book for instruction at the Royal Naval College.

Before however reviewing Capt. Wharton's treatise we propose to state briefly what we consider to be the requirements of a nautical survey.

The perfection of marine surveying appears to us to be the representation in a graphic form, readily understood, of the coasts and harbours of the world with their various off-lying dangers; marking distinctly the various features of high and low water lines, showing the dangers to be avoided and the channels available for navigation, placing prominently on the chart those objects on the land which serve best to ascertain the position of a ship, and subordinating all other features to these objects, so that the channels to be used, and the marks by which those channels can be recognised, are easily distinguished; as well as representing the set of the tides and currents and the errors of the compass. To execute such a survey it is evident considerable care must be bestowed in ascertaining accurately the positions of the land marks, as on these depend the whole of the work, but this accuracy need not be carried to such a degree of minuteness that it cannot be shown on the chart; for, after all, the principal object of a *chart* is to show the soundings; and enough care has been bestowed on the land-marks if their positions are ascertained with sufficient precision for soundings. Of course circumstances occasionally arise when, from other causes, it may be advisable to modify this arrangement, but not for the purpose of navigation.

Capt. Wharton appears to have kept these objects steadily in view in writing his work. The work commences with a description of the instruments used in nautical surveying, which, although previously given by Heather and by Simms, cannot be considered out of place, and then gives a description of marine surveying in general, afterwards entering into particulars. We regret that in the description of the sextant the important errors of centering and graduation have been overlooked.

We much commend the following remark at p. 54, too often ignored by surveyors:—"The accuracy necessary in many details of a chart depends very much upon its scale. Over-accuracy is loss of time. Any time spent in obtaining what cannot be plotted on the chart is, as a rule, loss of time."

Of course the scale on which a survey should be executed should be settled after due consideration. It is evident that an inaccessible coast, off which there is deep water, does not require the same accuracy of delineation as a coast studded with bays and harbours, or off which numerous dangers exist; or those portions of the globe little frequented by shipping the same care as the coasts of the United Kingdom. These points must to a great extent be left to the officers in charge of a survey, but the scale once settled no time should be wasted over details which cannot be shown on that scale.

Capt. Wharton's remarks on soundings are excellent. There is no doubt that this, the most important work of the marine surveyor, is very monotonous. To sit in a boat day after day, from early morn to dewy eve, marking in a book soundings and angles, with the salt from the spray drying up one's skin, and the sun blistering one's nose requires more than ordinary zeal, patience, and perseverance; and only long practice enables the surveyor to really take an interest in this work. Young surveyors should, however, remember, that every other detail is subordinate to this, and that until they can really sound, thoroughly, over a given patch of ground without loss of time they cannot be considered masters of the profession.

Capt. Wharton's remarks on obtaining latitudes and running meridian distances are excellent. We think indeed that, in the latitude, the same results might be obtained with less figures, but it is by no means easy to draw a hard and fast line.

In the remarks on tides, no mention is made of the importance of referring the result obtained to a fixed mark on the shore, nor any observation as to the diurnal inequality, and consequently the necessity of, on all occasions, when practicable, registering both day and night tides. In the Eastern Archipelago the diurnal inequality is in some places 4 to 5 feet, and in Australia the mean tide level also differs at different times. These facts appear to have escaped Capt. Wharton's notice, but probably will be inserted in another edition.

In the remarks on searching for Vigias, and ascertaining the position of a ship at sea, Capt. Wharton seems to think accurate observations cannot be obtained, as he asserts the position of a ship to be doubtful to three miles.

On this point we must differ from him, as long experience has proved, to our own satisfaction, that provided the weather is fairly clear the position of the ship can be obtained to half a mile. Nor in asserting this do we rest on single evidence, as Capt. Moriarty, R.N., C.B., in the *Great Eastern*, had no difficulty in picking up the end of the Atlantic cable when it had been slipped from the ship.

The fact is the great error in sea observations is due to the refraction of the horizon, but it must be borne in mind that, excepting in shallow water, this is but slight, and that it can always be corrected by observing on opposite sides of the horizon.

By taking advantage also of the bright planets passing the meridian in the day time good observations can be obtained for latitude and longitude *at the same time* (a great point), whilst the sun is above the horizon, as well as at sunrise and sunset, when by Sumner's method three or more stars can be combined to give the position. We admit that constant practice is required to take these observations accurately, but they *can* be obtained, and as it is very useful to be able to make certain of a ship's position, as often as possible, all officers should practise themselves in observing both Venus and Jupiter with the sun above the horizon.

Whilst however not agreeing with Capt. Wharton on some few points, we think his work will be found most useful, not only for young officers taking up surveying but also as a book of reference for older surveyors, and personally feel much obliged to him for combining in one volume so many useful remarks and tables which have hitherto been only in MSS. or pamphlets.

THE HORSE IN MOTION

The Horse in Motion as shown by Instantaneous Photography; with a Study on Animal Mechanics, founded on Anatomy and the Revelations of the Camera, in which is demonstrated the Theory of Quadrupedal Locomotion. By J. D. B. Stillman, M.A., M.D. Executed and Published under the Auspices of Leland Stanford. (London: Trübner and Co., 1882.)

THE above is the somewhat long title of a large and important work issuing from the well-known Cambridge (U.S.) University Press. Long as is the title, the name of the principal contributor to the volume is left unrecorded there, though indeed even a cursory glance over its contents shows how much indebted is the whole question of the mode of motion in the horse to the elaborate series of investigations of Mr. J. Muybridge.

Leaving aside the anatomical and teleogistic arguments of Dr. Stillman, as contained in some hundred pages of letterpress, we cull from a postscript to the same the following interesting information, which we give as we find it in the book. Some time in 1872, Mr. L. Stanford, of Palo Alto Farm, in California, had his attention called to the very controverted question as to the action of a trotting horse, and conceiving the idea that the photographic camera might be made available to illustrate the action, he, according to the authority before us, consulted with Mr. Muybridge and induced him to undertake some experiments in instantaneous photography. Some ten years ago, a photograph taken in the space of the one-twelfth of a second was considered quite a success, and it would seem that the experiments made then by Mr. Muybridge were inconclusive. In 1877 Mr. Muybridge, however, renewed his experiments. A few pictures were taken of "Occident," a noted trotter belonging to Mr. Stanford, while he was in motion, and one of these, representing the horse with all his feet clear of the ground was enlarged, retouched, and distributed. This result was so extraordinary and so successful, that it was determined to try others on a more extended scale. It was assumed that if one picture could be taken instantaneously, an indefinite number might also be taken, and so the various positions assumed by the horse in a single complete stride could be illustrated.

Mr. Muybridge was authorised to procure the needed apparatus, and a building suitable to the purpose was erected on Mr. Stanford's farm. By 1878 preparations were complete, and every resource of the photographic art had been provided. Twelve cameras were placed in the building at intervals of twenty-one inches, with double shutters to each, and these shutters were so arranged that the whole series of exposures were made in the time occupied by a single complete stride of a horse. The very ingenious mechanism invented by Mr. Muybridge it would be impossible to describe without the assistance of illustrations, but it may be stated that he was thereby enabled to double the number of his cameras, and the whole of the large series of twenty-four figures each, which are used to illustrate this volume, were taken by him. They were very accurately taken, and the heliotypes are perfect transcripts of the original photographs.

Thanks to the zeal and energy of Mr. Muybridge, and the liberality of Mr. Stanford, we are now enabled to see for ourselves the various attitudes assumed by a horse in running, trotting, leaping, and the result is most strange. It would seem as if most civilised nations had failed to recognise the true action of this noble quadruped, as if all had settled down into being content with a conventional idea of how a horse in motion ought to be represented. Now our artists will have no excuse; they can directly interrogate nature, as represented to them in these silhouettes, no doubt at first they may follow her with fear, for some of the positions look strange, not to say grotesque, but soon both artist and the public will have learnt to recognise the truth: and once this is so, the old style will be in its turn regarded as grotesque, and as representing but an early stage in the development of art.

Mr. Muybridge's photographs will be of immense importance to all art students, and they should be attentively studied by all admirers of the horse. A few other photographs are given in this volume of the various stages of motion in the cow, dog, deer, and boar.

OUR BOOK SHELF

Unexplored Báluchistán: a Survey of a Route through Mekrán, Bashkurd, Persia, Turkistan, and Turkey. By Ernest A. Floyer. (London: Griffith and Farran, 1882.)

AN entertaining book of travel, but by no means an exploration of "Unexplored Báluchistán," as is indeed sufficiently evident from the sub-title. Nevertheless, Mr. Floyer has investigated and partly solved some interesting geographical questions in the little-known province of Bashkurd (Bashakard), on the Perso-Mekrán frontier, which he visited on two separate occasions during the years 1876-7. This region, which had been merely skirted by Goldsmid, Lovett, Ewen Smith, St. John, and others connected with the Perso-Balúch Boundary Commission of 1872, and with the development of telegraphy in Persia and Mekrán in 1873-4, was ascertained to comprise six separate territories or districts — Gavr and Parment in the east, Jagda in the west, Marz and Pizgh north and south respectively, and Daroserd with the capital, Angurhán, in the centre. The town, which appears to be a place of great natural strength, was found to lie in 26° 40′ N. lat., 57° 55′ E. long., or about thirty miles from the position assigned to it on Major St. John's map. The Aphen-i-Band range, between Daroserd and Pizgh, was crossed near its western extremity, and ascertained to run east and west under 26° 30′ N., at a mean elevation of 3600

feet, the culminating point of the whole province being apparently the Gu-Koh peak (6,400 feet) in the Parment district.

A survey of the Ab-washur water-parting, between Bashkurd and Hormuz Strait, considerably reduced the supposed eastward extension of the Minâb basin, and showed conclusively that it was in no way connected with the Bampur River, which many geographers have hitherto made to discharge through the Minâb into the Persian Gulf. Mr. Floyer now argues with much force that the true outlet of the Bampúr is the Sadích (Sadaich), which reaches the coast in 58° 40′ E., in the Gulf of Omán, and which seems to flow from the Shahri country, through the Shimsani Pass, in the Band-i-Marz range. He found that where he crossed the Haliri in 28° N., 57° 40′ E., it was already a considerable stream, 90 feet broad, and 4½ feet deep. The furthest head-waters of this important river, of which next to nothing was previously known, are in the Jemal Bariz range, whence it flows in a south-easterly direction to the Rudbar and Shahri districts. Here it would be almost necessarily joined by the Bampúr River, coming from the north-east, and the united stream, whose further course has hitherto remained an unsolved problem, would appear to flow thence through the Shimsani Pass southwards to the Sadích. Hence the Sadích would seem to be the lower course of the Haliri-Bampúr, thus draining nearly the whole of the region in south-east Persia, between 57°–61° E., and 25° 30′–29° N. But this interesting point cannot, of course, be finally determined without a more thorough exploration of the Rudbar and Shahri districts between Bampúr and the Ab-washur water-parting.

The work, whose chief fault is its misguiding title, is written in a pleasant, vivacious style, and contains much useful information touching the ethnical, social, and linguistic relations of the Balúchi tribes on the Perso-Mekrán frontier. A. H. KEANE

A Synopsis of Elementary Results in Pure and Applied Mathematics: containing Propositions, Formulæ, and Methods of Analysis, with Abridged Demonstrations. By G. S. Carr, B.A. Vol. i., Section ix. (London: C. F. Hodgson and Son, 1882.)

IN our notices of the previous sections we have sufficiently indicated the scope of this work. The present section is devoted to the integral calculus, and takes up its numbered articles at 1900, and closes at 2997: the pagination being pp. 313–440 of part ii. of vol. i. The same honest work, for which we have already commended the author, is conspicuous here, and the utility of having such a handy manual on the calculus is evident. It would be impossible to furnish here the results of a thorough examination of the text; the preparation for such a task would take up a very long time; but we would recommend a testing of the several parts to which a reader may have occasion frequently to refer, so that the book might be consulted with full confidence. We are glad to find that the likelihood of the occurrence of such errors as we mentioned in our notice of the first part, is reduced to a minimum by the very careful method of revision now adopted by Mr. Carr. We have much pleasure in commending this new section to the notice of our mathematical readers.

A Collection of Examples and Problems on Conics and some of the Higher Plane Curves. By Ralph A. Roberts, M.A. (Dublin: Hodges, Figgis, and Co., 1882.)

THESE Examples will serve as an excellent compendium of results to a student who is working through Dr. Salmon's Treatises on Conic Sections and on the Higher Plane Curves. In fact it was whilst the author was reading the above-named works that he conceived these useful illustrative exercises. Mr. Roberts shows himself to be an apt mathematician, and to have a very extensive acquaintance with the classes of curves considered. These are mostly curves of the second, third, and fourth orders. The Problems have been, in general, suggested by Dr. Salmon's treatises and by Dr. Casey's Memoir on Bicircular Quartics: Mr. Roberts also acknowledges his indebtedness to Darboux's Sur une classe remarquable de courbes et de surfaces algébriques. Occasional explanatory matter is thrown in here and there, and concise proofs are given in several cases. As the text-books contain a limited number of examples, this work will be a useful supplement to them. We like almost everything about the book except the paper, and that appears to us to be of a very inferior character.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Recent Unseasonable Weather

IN view of the recent unusually cold weather in England and Scotland, which has been so well described and proximately explained in last week's NATURE, the following paragraph, extracted from the *Standard* of June 15, appears to me highly suggestive, especially as regards one of the probable causes for the "unwonted high pressures" on the northern side of the depression which is accused of being the immediate source of these unseasonable conditions:—

"News from Iceland states that the Spitzbergen floe-ice surrounds the north and east coast, entirely preventing navigation. A Norwegian steamer endeavouring to reach Bernfiord, on the south-east coast, last week, was caught in the ice and had to put back. Owing to the presence of these immense ice-fields vegetation has made no progress, causing a great loss of horses and sheep through starvation. Epidemics of measles and small-pox have been introduced into the island from Europe, and are making extensive ravages among the population; the former is especially prevalent in Rejkjavik."

Now it has been ascertained with some considerable degree of certainty by Messrs. Blanford and Eliot, the Government meteorologists in India, that a heavy winter snowfall over the North-west Himalaya exercises a marked and prolonged influence in lowering the temperature and elevating the atmospheric pressure and thereby directly affecting the winds and weather, over the whole of Northern India, and parts of Central India; and indirectly to a much greater distance. Turning to Europe, we find the distance from Rejkjavik, on the west coast of Iceland to London is about 1140 miles, or about the same as from Lahore to Calcutta (1080 miles), while from Cape Horn on the east coast of Iceland to Edinburgh the distance is only 750 miles, or about the same as from Calcutta to Agra. To any one familiar with Indian weather charts or the meteorology of that country, it would appear absurd not to attempt to correlate the meteorological conditions at places so comparatively near as the above-mentioned towns; and in fact experience has shown that the meteorology of the Punjâb is not only intimately connected with that of Lower Bengal, but also with that of Southern India. If therefore it has been found that an abnormally heavy snowfall in the North-West Himalaya, such as that which characterised the winters of 1876-77 and 1877-78, exercised a marked effect on the meteorology of Northern India, which was felt at places situated 1000 miles or more from the seat of action, may it not be reasonably inferred that the presence of a large mass of ice or snow in the Icelandic area would be likely to give rise to similar atmospheric conditions over these islands? It seems therefore not at all improbable, that the abnormal weather during the past few weeks may be directly due in some considerable measure to the coincident appearance of large masses of ice off the eastern coasts of Iceland, like those which, from the account in the *Standard*, appear to be at present prevailing to an unusual extent.

In the case of India an abnormally heavy fall of snow in the

Himalayan zone is found to be associated, not only with the subsequent conditions already named, but also with an *initially*, and therefore according to experience *subsequently* weak south-west monsoon, which in its turn invariably causes local, if not general drought and famine. These heavy snowfalls are found to have a tendency to recur at the minimum sun-spot epochs, and are proximately due to some condition of the upper anti-monsoon current, at present not exactly known, by which a larger amount of vapour is deposited in the winter, on the Himalaya as snow, and on the North Indian plains as the "winter rains."

It does not appear that we can so readily account for the occurrence of the present ice-floes off Ireland or for the large masses which have been encountered this spring in the Western Atlantic. They must however to some extent be due to the unusually warm winter which seems to have prevailed pretty uniformly over the North Atlantic and North-West Europe, and which has detached a larger proportion than usual of the Arctic ice-fields. And though it is improbable that we shall find any such regular periodicity in the amount of these ice-floes in the Atlantic as in that of the Indian winter snows and rains, it is worthy of notice to observe that they have a decided tendency to occur to an unwonted extent about the times of maximum sun-spot—like the present. Thus Prof. Fritz, of Zurich,[1] gives the following as the list of years in which floating ice was found most abundantly in the lower latitudes of the North Atlantic:—

Years of greatest frequency of floating ice.	Epochs of maximum sun-spot.
1789	1788·1
	1804·2
1816–18	1816·4
1828–29 }	
1831 }	1829 9
	1837·2
	1848·1
1862–64	1860·1
1868 }	
1869 }	1870·6

It is also interesting to notice that in 1862 Heis's "Wochenschrift" mentions that the floating ice-masses in the Atlantic caused "a noticeable cooling of the weather in *June* over Europe." And it is further significant to find in a detailed list of the ice met with every month in the Atlantic by ships belonging to the North German lines from 1860 to 1869, that 1868 and 1869 (the year in which similar weather to the present is mentioned as having been observed by the writer of the paragraph in NATURE) were the years in which the greatest quantity of ice was encountered. Though I agree with Dr. Hann in attributing more importance to the *tropical* than to the *polar* area, in influencing the *general* weather of these latitudes, I think it very probable on theoretical grounds that we are relatively more influenced by the *latter* area in *summer* and by the *former* in *winter*, and that just as it has been inferred that the regular recurrence of periods of diminished temperature in Europe, is due to the regular movements of the ice in the polar area so we may reasonably conclude that abnormal movements of the ice, especially in the Spitzbergen area, are likely to produce periods of abnormal coolness such as that which at present prevails. In any case the moral to be drawn, if we really do intend to solve the weather problem, is by all means to have a meteorological station in Iceland, and endeavour to study the weather as we are fortunately able to do in India, on a *large scale*, instead of merely confining our attention to the minute range of conditions we are able to observe within the limited area of these islands.

E. DOUGLAS ARCHIBALD

The Analysis of the Tuning Fork

IN NATURE last week there is a short description of Mr. W. F. Stanley's well-devised experiments, by which the tuning-fork "is shown not to depend upon a vibrating ventroid."

Few persons would readily obtain the experimental steel rod, or would care to attempt the feat of sawing through the bend of the fork down into the stem, and some musical readers may like to know that (missing, of course, the pretty effects) there is a less arduous way of arriving at the conclusion to which Mr. Stanley has directed attention. By very simple experiments I have been accustomed to show that Chladni's analysis, as generally accepted, is not in all particulars borne out by the evidence of facts. If a vibrating tuning fork is held in its upright position by means of a knife-blade passed through the prongs, pressing upon the inner bend so that the stem is in contact with the table, without its being held by the fingers, there will be a communication of vibrations fully as strong as when held in the usual manner, with variation of intensities according to differences in the degrees of pressure. In this experiment the fork at its bend is subjected to pressure both above and below. The argument, therefore, is that the existence of a segment in transversal vibration, occupying the bend of the fork as figured in Chladni's analysis, is incompatible with the evidence. As in all musical instruments, the communicating of transversal vibrations from one solid to another is invariably through the nodes, and as segments are always destroyed by firm pressure, it seems clear that the analysis should be amended. If a vibrating fork is drawn across a stretched string with pressure, the prong passing from the bend towards the point or end, the integrity of the vibrations of the fork is not impaired, and there is but a slight transference of vibration to the string; but it is otherwise with respect to a stretched wire, as when the prong comes into contact with the wire, its vibrations cease; the wire will not be subordinated to the coercive activity of the prong as the string is; yet if the fork is placed with the prongs astride the wire, so that the bend, at the seat of the alleged segment, rides upon the wire, the wire readily conveys the vibrations, and acts as a sound-post. It may be shown that the stem of the fork acts likewise as a sound-post, since we may substitute a free stem; if a vibrating fork is held by the stem, and if through the prongs another fork has the shoulder of its stem pressed upon the bend, then, when the point of this second stem is brought into contact with a solid, the vibrations of the fork are transmitted through it from the bend, with nearly the strength of tone as would be produced by the original fixed stem. The stem itself may be dispensed with as a part of the system, for if the fork is held so that the external part of the bend, where it joins the stem, is pressed against the edge of a table or other solid, its vibrations are not interfered with; neither is the strength of tone diminished, except as in each of these instances, varying in the usual way according to the degree of pressure.

HERMANN SMITH

June 19

"Combing" of Waves

ALL who have watched waves breaking on the sea-shore must have noticed the furrowed or "combed" appearance of the back of a wave as it curls over. If the water is not much disturbed by wind, it is seen, on attentive watching, that this "combing" appears suddenly, and begins at the advancing edge of the crest, and spreads backwards. With small waves a foot or so in height and of long extended front, such as are seen in shallow water, it may be observed that the crest, which in this case rolls down the front of the wave, is at first smooth and even, while the back of the wave is also smooth and unfurrowed, but the edge of the crest suddenly becomes crenated, and almost simultaneously the combing appears on the back of the wave, travelling rapidly backwards from the crenated edge. Moreover a considerable length of the wave appears to be similarly affected almost at the same instant. With larger waves, whose crest falls rather than rolls upon the concave front, I have observed that the edge is at first smooth and even, but that it suddenly becomes uneven, and often fringed with a row or rows of drops, and that at the same instant the combing appears. In both cases, if there is much wind, the regularity of the phenomenon is disturbed, and observation is in other ways rendered difficult. The action is so exactly parallel to something which takes place in the splash of drops, and which I have described in detail in a paper recently read before the Royal Society (see *Proc. Roy. Soc.*, No. 218), that I think your readers may be interested in a brief statement, with special reference to this more familiar case of waves, of the explanation there put forward. The explanation amounts to this:—It is well known that a long cylinder of liquid is unstable, and will, if left to itself, at once tend to split into a row of equal, equidistant drops; the splitting being effected by a constriction of the cylinder in certain places, and a bulging out in others. Again, if a mass of liquid is bounded by an edge whose surface is approximately a portion of a long cylinder, there is good reason for supposing that this cylindrical edge will be subject to similar laws of stability, and that it will tend to cleave in the same way, the surface being forced in in certain places, and out in others. Now a wave's crest presents such a cylindrical edge.

[1] In his work, "Ueber die Beziehungen der Sonnen flecken-periode zu den Meteorologischen und Magnetischen Erscheinungen," p. 175.

It will, therefore, of itself, cleave in the way described, and the flow of water will thereby be hindered at the constrictions, and aided at the places of bulging out. Thus lines of easiest flow will be set up, which in their turn will determine the furrows on the back of the wave. The fringe of drops is due to the splitting in a similar manner of the cylindrical jets shot out from the places of bulging, where the flow is aided. Indeed, much of the seething at the edge of a wave is, I think, attributable to the breaking up of such jets in this manner. In the case of the minute phenomenon of a drop-splash, I have been able, in some degree, to bring this explanation to the test of measurements, which, so far as they go, quite confirm it. The regularly-toothed edge of a spot of candle-wax that has fallen on a cold object, affords in a permanent form a familiar illustration of the same action.

A. M. WORTHINGTON

Clifton College, Bristol, June 20

THE SEAL ISLANDS OF ALASKA[1]

TEN years have only just elapsed since the Government of the United States of America obtained by treaty the territory of Alaska, including the seal islands situated off its coast in the Bering Sea, and at that time although the sealskin trade occupied thousands of hands, and had done so for at least a century previous, yet next to nothing was known of the animal producing the skins, and there was not, even in the museum of the Smithsonian Institution, a perfect skin and skeleton thereof. This state of things has happily now vanished, and through the joint action of Prof. Spencer Baird and the Secretary of the Treasury of the United States, Mr. Henry W. Elliott, was enabled to visit the Pribylov Islands in 1872, and we cannot but admire the zeal and energy which enabled him to reside in these dreary and desolate places all through the seasons of 1872 to 1874 inclusive. While a brief digest of Mr. Elliot's notes were published in 1874, it is only now that he has been enabled to publish a complete monograph on the subject, an emended copy of which, reprinted from the Report on the Fishery Industries of the Tenth Census at Washington in this year, is now before us. It forms a quarto volume of some 176 pages, and is illustrated by two maps and twenty-nine plates of subjects from the author's pencil. The writer's opportunities for observation, it will be noticed, were especially good. The previous observations of Stellar and others left much to be desired. The geographical distribution of the Arctic fur seal (Callorhinus) is very peculiar. In the Arctic waters of the Atlantic they have not been found, in the corresponding waters of the Pacific they are virtually confined to four islands in Bering's Sea, namely St. Paul and St. George of the tiny Pribylov group, and Bering and Copper Islands of the Commander group. On the former two they swarm. On the latter two, though the larger in area, the seals do not occur in such quantities. It seems impossible to avoid the reflection here as to the waste of fur seal life in the Antarctic regions, and along the coasts of South America, from which, as a centre, the Arctic forms, probably, originally came. Not a century ago the fur seals rested on the Falkland Islands in millions for hundreds that are to be found there now, and it seems hopeless to expect that a British parliament could, with all its many labours, trouble itself to frame regulations, such as the Russians and Americans have done, with the object of repeopling, even in time, these splendid breeding-grounds which, on the Falklands, lie in the very track of commerce, and which, unlike the Alaskan Islands, have beautiful and safe harbours.

The Pribylov Islands were discovered by the hardy navigator whose name they bear, in 1786, and one of the islands is called after his sloop, the *St. George*. He took possession in the name of Russia. Almost striking against the island in a fog, the sweet music to his ears of numerous seal rookeries was wafted towards him. For a little time he kept his secret; but he was soon watched, and his treasure had to be shared with others. These islands lie in the heart of Bering Sea; they are just far enough south to be beyond the reach of permanent ice-floes, upon which the Polar bears could have reached them. Fog banks shut out the sun nine days out of ten during summer, and the breeding season. By the middle of October strong, cold winds from the Siberian Steppes sweep across them. By the end of January great fields of sludgy, broken ice bear down on them; and from December to May, or June, they lie ice-bound. It is owing to this constant, cold, moist, shady, gray weather, that these islands are frequented by such millions of the fur seals. Let the sun but shine out, and the temperature rise to 60° F., or 64° F. in the shade, and both seals and natives are at once incommoded by the glare and heat. During the winter of 1872-73 Mr. Elliott, while watching with all the impatience which a man in full health and tired of confinement can possess, to seize every opportunity upon quiet intervals between the storms of sleet, in order to make a short trip for exercise, only got out *three* times, and then only by the exertion of great physical energy. On one occasion the temperature sank to $-4°$, and the wind velocity, as recorded by one of the Signal Service anemometers, was at the rate of 88 miles per hour. This storm lasted for six days. The average summer temperature is between 46° and 50° F. in ordinary seasons. The cloud effects are, as might be anticipated, something wonderful, but the aurora is scarcely to be seen. The islands are of volcanic formation; their vegetation seems interesting, and algæ (seaweeds) seem to abound. This is the weakest part of the author's report, and it would be well worthy of the Smithsonian Institute to have the whole flora of these islands carefully investigated. Only a few very hardy vegetables are raised on St. Paul's. As yet, rats seem not to have landed on the islands, though mice have become troublesome, and the cats brought to keep the mice in order, have by inordinate indulgence in meat (seal) eating, become wonderfully altered; they are described as "stubby balls," having become thickened, short, losing the greater portion of their tails (in the second and third generations), and their voices are altered into a prolonged, fearful cry, that surpasses anything ever heard in these countries. So bad is this caterwauling, that it even at times arouses the wrath of the sluggish Aleutians. Foxes and lemmings abound on St. George; the latter are not found at St. Paul's. Birds abound, and though fishes are scarce, invertebrate life in the waters of the group seems abundant. The "natives" of the island were about 400 in number in 1880, of whom some eighteen were whites (Russian), and the rest Aleutians. The births never equalled the deaths, but they are constantly being recruited by the Alaskan Commercial Company. Now-a-days the people are comfortably housed and well clothed. Seal meat is their staple food; and by the regulation of the Treasury they can kill, every autumn, an average of twenty-three to thirty young seals for each man, woman, and child in the settlement. As each pup averages ten pounds of good meat, this would show an average of about 600 pounds of flesh meat for each. To this diet they add butter, sweet crackers, and sugar. They are passionately fond of butter. No epicure could appreciate good butter more than these people, and the sweetest of all sweet teeth are to be found in the jaws of an Aleut. The Company allows them fairly liberal supplies of these, also rice and tobacco. As an illustration of the working ability of the natives on the seal grounds, the following shows the actual time occupied by them in finishing up the three seasons' work which Mr. Elliott personally supervised on St. Paul's Island.

In 1872,	50 days'	work of	71 men	secured 75,000 skins.
In 1873,	40 ,,	,,	71 ,,	75,000 ,,
In 1874,	36 ,,	,,	84 ,,	90,000 ,,

[1] "A Monograph of the Seal Islands of Alaska," by Henry W. Elliott. Reprinted, with Additions, from the Report on the Fishery Industries of the Tenth Census (U.S. Commission of Fish and Fisheries). Washington, February, 1882.

This shows the increased ability and consequent celerity of action among the natives.

Here it may be mentioned that by an Act of Congress the exclusive right of taking a certain number of fur seals every year for a period of twenty years on these islands was granted to the Alaskan Commercial Company of San Francisco, subject to certain reservations and conditions. The Company seem to have done far more than they were actually by law required, and the benefit to the people has been no less great than to the Company; and where it was simply impossible under the old state of things to collect the lawful quota of 100,000 seals' skins annually in less than from three to four working months, it is now done by the same amount of hands in less than thirty days, and so the whole of the skins are preserved at their prime, and it is rare that any of them are unfit to be sent to London, whereas in comparatively recent years, often as many as three-fourths were rejected; comment on such an altered state of things is needless. Here it may be interesting to note that almost all the raw seal hides are sent to London, from whence, when dressed, they are distributed all over the civilised world where furs are worn. Our reader will surely know that the seal-skins as worn by the seals and as offered for sale by the furrier are very different-looking objects. Instead of the sleak, glossy coats familiar to us, the sealskin when on its own owner's back is a very unattractive thing, the fur not being visible, but hidden away under a coat of stiff over-hair, which is of a dark gray brown or grizzled colour. Not only is this hair removed, but the whole fur is dyed.

The seal life on the Pribylov group consists not only of the fur seal (*Callorhinus ursinus*), but also of the sea lion *Eumetopias Stelleri*, the hair seal (*Phoca vitulina*). and the walrus (*Odobænus obesus*). Of these it is only the first that is of any commercial value; but in this work we have some very interesting sketches of the life and manners of the others, and some very characteristic portraits. As our space will not allow us to refer in detail to these, we may here mention the fine figure of an old male walrus, being a life study, forming Plate 21, and the figures of the sea lions on Plate 16. The life studies of the common hair seal on Plate 4 are also very excellent; this animal, so common in the Atlantic, would appear to be rare in the North Pacific. Although the skin of the sea-lion has little or no commercial value, yet to the natives it is most valuable; it supplies them not only with its hide and flesh, but they also utilise its fat, sinews, and intestines; its very lip bristles are in great demand in China for pickers to the opium pipes, and for several ceremonies peculiar to the joss houses. The walruses are of little value unless for their hides; these are used for covering the frames of boats, and when the latter are thoroughly and constantly attended to they form the best species of lighter that can be used on the islands, standing more thumping and pounding than any sort of a wooden boat or even than a corrugated iron lighter.

It is, however, the history of the fur seal that will chiefly interest the readers of this volume. It repairs to these islands to breed and to shed its hair and fur, in numbers that seem almost fabulous. It seems to be an animal of wonderful instinct; indeed, our author thinks that few, if any, creatures in the animal kingdom exhibit a higher order of instinct. A male, when in his prime, about 6 or 7 years of age, will measure 6½ to 7¼ feet in length from the tip of his nose to the end of his little tail, and will weigh from 400 to 600 pounds. Its muzzle and jaws are about the same size and form as those of a full blooded Newfoundland dog, only the lips are pressed against one another as in man; on either side of the muzzle are an expressive pair of large bluish hazel eyes. In one of the plates there is a very excellent portrait by the author, of an old male. When the fur seal moves on land, it may be almost said to step with its fore feet, but it brings up the rear of its body in a quite different style, for after every second step ahead with the anterior limbs, it will arch its spine, and in arching it drags and lifts up and brings forward the hind feet to a fit position under its body, giving it, in this manner, fresh leverage for another movement forward by the fore feet, in which movement the spine is again straightened out. If it be frightened, its abandons this method. "It launches into a lope, and actually gallops so fast, that the best powers of a man in running are taxed to head it." This rapid progress it can only keep up for some thirty or forty yards at most, then it sinks to the earth, gasping and breathless. The adult males are always the first to arrive on the seal-ground, which has been deserted by all of them since the close of the preceding year. These arrivals begin about May 1. Not the oldest, but the most ambitious, land first. Up to June 1 more seals arrive, but about this period the seal weather begins—foggy and moist; and as the gray banks roll up and shroud the islands, the bull seals swarm out of the depths by thousands, and take up advantageous positions. The labour of locating and maintaining a position on the rookery is a terribly serious business for the late-coming males, as it is throughout all the time to those males that occupy the water-line of the breeding-grounds. A constantly sustained fight between the new comers and the occupants goes on morning, noon, and night without cessation, frequently resulting in death to one, and even to both the combatants. This fighting is done with the mouth. The sharp, canine teeth, tear out great masses of the skin and blubber. One old veteran, specially watched, took up his position on the water-line early in May. He had to fight from forty to fifty desperate battles; and when the fighting season was over he was there, covered with scars, and frightfully gashed, raw, festering, and bloody, with one eye gouged out, but lording it still bravely over his harem of some fifteen or twenty females. These seals are profound sleepers, so much so that one, cautiously keeping to the leeward, and stepping softly, would find it easy to approach near enough to pull the whiskers of any old male; but on the first touch the trifler must be prepared to jump back with electrical celerity, if he has any regard for the sharp teeth and tremendous shaking which would await him. On young seals the trick may be played with impunity, but to the great terror and confusion of the little sleepers. While the females and young have but one note, a hollow prolonged bla-a-ting call, addressed to their young: the bulls have the power of uttering four distinct calls or notes. They seem to suffer misery from a comparatively low degree of heat. From the time of the males landing, until the close of the season—about three months—they never leave the stations they have secured for a single moment, and of necessity they abstain during all this time from food of any kind, or water. It is no wonder, therefore, that after such a fast they return to the sea mere bony shadows of what they were.

About the middle of June the females arrive, and, bad as the fighting among the males has been up to this to secure good stations on the land, it is now ever so much worse for the possession of the cows. These latter are much smaller and more lithesome than the males, seldom over 4 to 4½ feet in length. Their heads and eyes are exceedingly beautiful; their expression is gentle, intelligent, and attractive. The females land on the "rookeries" for the purpose of gestation, and the young are born very soon after the arrival of the females. The females are received by the males on the water-line stations with attention; they are alternately coaxed and asked up on the rocks, as far as these beach-masters can do so, by chuckling, whistling and roaring, and once up they are immediately under the most jealous supervision; but owing to the covetous and ambitious nature of the bulls which occupy those stations to the rear of the water-line ones and some

way back, the little cows have a hard time of it at the first and when they are few, for no sooner is one pretty creature fairly established in the station of male number one, who has got her there, than he perhaps sees another of her style in the water from whence she has come, and he devotes himself to coaxing the later arrival by the same winning methods so successful before; whereupon bull number two, one station in the rear, observing bull number one to be off guard, reaches out with his long, strong neck, picks up the passive cow by the scruff of her neck, just as a cat does a kitten, and deposits her upon his ground; and this will happen again and again until the little cow will finally find herself several stations back. Her last lord not being exposed to the same temptations as lie on the water level, gives her such care that not only could she not leave if she wished, but no other bull gets a chance of seizing her. When the females have all landed and the harems are full, it would seem that those nearest the water may contain on an average from fifteen to twenty females, those in the rear from five to twelve. The courage of the fur seal is of the highest order. As regards man, it is invariably of a defensive character. Though always on the defensive, he never retreats, but he will not attack; the cows, however, are easily frightened and are timorous. Shortly after the females are landed, the young are born; they are for the first three months of a jet black colour, are about fourteen inches long, and weigh about four pounds. It would seem that they are nursed only every second day, the mothers going off to the fish grounds to get a supply of food, but they may also return to suckle their young at night. When returning in the daytime, each mother at once recognises her own young, though there may be thousands upon thousands all together blaating at once. Before entering into such a crowd, the mother stops and calls out, just as a sheep does for a lamp, and out of all the din she then recognises her offspring's voice, and makes direct for it; but it would seem that the young ones do not often know their own mothers.

Early in August the young seals, now about six weeks old, are taught to swim. If dropped into deep water about this period down goes their bullet-like head, and they are drowned; at first they try their skill in the shallow pools, for a week or two they only flounder about, thrashing the water as little dogs will do. When for the first time they are well launched out they soon turn to the shore, and if by some receding wave they should be left high and dry, they will crawl away for a little distance and, quite exhausted, will coil themselves up to take a short recuperative nap, and then to the swimming lesson again. Once boldly swimming they seem to fairly revel in it. The parents do not in the slightest degree supervise or direct the young in swimming. The young shed their black coat about the middle of October; the second or sea-going jacket, does not at first vary in colour between the sexes, nor does a pronounced difference take place until after the third year. The females bear their first young when they are three years old, and the period of gestation lacks only a few days of a year.

The great herds of "bachelor" seals, numbering perhaps one-third to one-half of the whole aggregate of the 5,000,000 seals known to the Pribylov group, are never allowed under the pain of death to put their flippers on or near the rookeries. These are the seals of most importance to commerce, for with the exception of a few thousand young ones and an odd old male, these are the only ones slaughtered for their hides. They locate them in immense tracts, mostly away from the rookeries, but sometimes the road to these will pass along or through a rookery, where, as long as the bachelors keep to the main road, they are never molested; but if they pry about, it is all over with them, for they are literally torn to pieces. These bachelors are wonderfully gentle, but they are possibly the most restless animals in creation, they never seem quiet, not even in their sleep, they do not fast, as they constantly leave the land for the sea, though this at irregular periods depending a good deal on the weather; on land they sport and roll about as if in perfect enjoyment, curling and uncurling themselves, in fact they seem to be surcharged with a quite joyous life, but when in play they never grovel or bite or seem to show even an angry feeling. It is we have seen very different with them when they are a little older and begin to take upon themselves the cares of a harem. These seals pass a deal of their time in the water, where their gambols are truly wonderful, and the time they can remain under water is, Mr. Elliott writes, "past belief." They are readily, when on land, classified as to age. They shed their fur and hair during August. Passing over a detailed and well illustrated account of the various rookeries, carefully calculated as containing some 3,193,042 breeding seals and their young in 1873, and of non-breeding seals over 1,500,000, and the speculations as to the vast amount of fish consumed by this immense army, we have to notice briefly the chapter on the taking of the seals. Except for food, none but the "bachelors" are slaughtered when their furs are in good trim: the natives get between a herd and the sea, and then gently drive it up to a slaughtering station. In cool and moist weather the seals can be safely moved along at the rate of half a mile an hour; on firm grassy ground three or four men can secure and guide as many as a thousand seals at the same time. They are permitted frequently to halt, rest, and cool, as over heating injures their fur, and so on they go to death, and to supply with their hides the markets of the world. They never show fight, and are as docile as a flock of sheep; the bull seals on the contrary will fight rather than endure the panting torture of travel, so that if any of them get mixed up with a herd of bachelors they are easily let drop out; their fur is of no value. On arriving at the slaughter places the herd is allowed to cool, and then the killing begins; the labour of skinning is severe and trying even to experts; the hide has to be taken off at once. The skins are taken from the field to the salt-house, where they stay for two or three weeks, being pickled; after this they are taken and rolled into bundles of two skins in each package, with the hairy sides out and lightly corded. In this state they go by steamer to San Francisco, where they are counted for the tax, and from thence they are shipped to London.

In a series of illustrative and supplemental notes to this volume, there are a number of very interesting details as to the Russian Seal Islands; as to the Fauna and Flora of the Priblyov Group; a digest of the data in regard to the fur seal rookeries of the South Atlantic and Pacific, and the number of skins taken therefrom. There is a translation of Veniaminov's account of the Russian seal industry at the Priblyovs, 1842; a meteorological abstract for the months from September, 1872, to April, 1873, which was an unusually severe winter; and a history of the organisation and regulations of the Alaskan Commercial Company, under whose excellent management the seal-skin trade is now carried on. In concluding a necessarily somewhat brief notice of this excellent monograph, we would congratulate Mr. Commissioner Spencer Baird on being the means of obtaining for men of science and of commerce so much valuable information, and we can scarcely give too much praise to Mr. Henry M. Elliott for his most artistic and praiseworthy history of the most interesting of all Pinnipeds.

A DYNAMOMETER FOR ALTERNATING CURRENTS OF MODERATE STRENGTH

THE object of this instrument, which I had the pleasure of bringing before the Physical Society at their Oxford meeting, is chiefly medical. But it occurred to

me that a few details, mainly constructive, might prove of interest. It was suggested by Mr. Preece, in consequence of a statement made by me in a paper on "Measurement in the Medical Application of Electricity," read before the Society of Telegraph Engineers. This statement was to the effect that some difficulty still existed in the trustworthy estimation of induction currents of medium strength, such as are habitually used for physiological and therapeutical purposes. The French International Commission had only imperfectly remedied the deficiency by recommending the universal adoption of a particular pattern of induction coil made by a single German firm, and arbitrarily graduated to a "sledge" apparatus. Mr. Preece thought that a dynamometer, which may be regarded as a galvanometer of which the moving magnet is replaced by a suspended coil introduced into the circuit, would answer the purpose; since the deflection of the coil is in one uniform direction, although the currents traversing the circuit are alternate. This very practical hint seemed to offer a prospect of obtaining accuracy in a department of science in which it is much needed. But on examining existing dynamometers I found only Weber's original instrument, which, in spite of its immense value, is fitted only for a well-appointed laboratory, and another, made by Messrs. Siemens for the measurement of very intense electric light currents, which erred on the opposite side of deficient delicacy. The dynamometer of Messrs. Siemens, shown at the French International Exhibition, by means of which the alternating currents of telephones were demonstrated, was probably in the same category, though neither I, nor the president of the Physical Society could obtain any exact details of its internal arrangements.

An electrodynamic balance, described in the *Annalen der Physik* in 1881 by Helmholtz, comes somewhat closer to the requirements of the case, but this, like that of Weber, is a delicate apparatus, difficult of transportation. It might, however, prove excellent as a means of calibrating a less perfect and absolute, but more handy instrument, such as that I was in search of.

Another form of dynamometer had been incidentally named to me by Mr. Ayrton, of his invention, in which the moving coil is replaced by a piece of soft iron which becomes magnetic during the passage of the current. Of this also further details were wanting.

I therefore attempted to make one for myself by the usual method of suspending a coil of wire from two silk fibres within a fixed coil, bringing its two ends to mercury contacts at the lower part, and joining all up in one circuit. Two defects at once appeared. 1. The coil of copper wire was far too heavy to move with the small currents at my disposal; and when it did swing, it continued to oscillate slowly for an unlimited time, giving no satisfactory reading. 2. The mercury contacts caused so much friction as absolutely to stop all motion whatever.

It was therefore obvious that (1) a light coil, and (2) a sensitive bifilar suspension were needed. Both of these must have a fairly high electrical conductivity. The second of these desiderata may be dismissed first. I found at the gold lace shops bobbins of silver-gilt wire, in which the gold is drawn over the silver in manufacture; not merely plated on. These two combined have a diameter of $\frac{1}{800}$ of an inch; which is exactly that of the finest platinum wire commercially made. But whereas the resistance of 1 metre of the latter is 62·2 ohms, that of the former is only 9·8 ohms. An induction shock from Dubois-Reymond's apparatus passed through a metre of this wire has such strength, that I do not wish to try it again, nor should I venture to administer it to an invalid.

It occurred to me that (1) the light coil might be obtained by using fine aluminium wire covered with silk. Messrs. Johnson and Matthey, with their usual courtesy, drew this for me specially, to a diameter of 1-100th of an inch, or even less,[1] and Mr. Rickards, of Derby, completed the operation.

By winding this on a mandril, tying the ring thus obtained with silk threads, and immersing in photographic amber varnish, which I find much less dense, and as good an insulator as Shellac, I obtain a coil composed entirely of metal and silk, which is at once rigid, light, and conductive. One of these, of 1·25 inches internal diamater, not of very fine wire, contains forty-two turns of wire in five layers, its length thus being over four yards. It weighs 6·25 grammes, less than 100 grains, its resistance is about half an ohm.

On suspending this light coil from two threads of the silver-gold wire named above, I found its deflections considerable, and easily measured, even with moderate currents. It could easily be made "dead-beat." The bifilar couple was varied by giving the suspending points a sliding motion to and from each other. By also fashioning the suspensions in the form of light vertical springs, the two threads were kept at an approximately equal tension.

Aluminium appears to offer great advantages for employment in such functions as these. It is said in Watt's "Dictionary," that "the electric conducting power of aluminium is eight times as great as that of iron, and about equal to that of silver," where probably the comparison is intended to be made with equal weights, and not volumes. But even if it were lower, it would be abundantly sufficient for the purpose named, as the currents are of high tension, and as the resistance need not be materially less than that of the suspending wires given above. Its specific heat is very great, so that moderate changes of temperature affect it but little. This property might render it valuable for the fabrication of resistance coils.

It was stated at the meeting that this metal had been tried by Messrs. Siemens, but given up in consequence of the failure of connection in the ends of the aluminium wire. This difficulty I have not found, probably in consequence of the high tension, and also from the fact that the contacts are between gold and aluminium, both stable substances. In any case the difficulty could be overcome by making a gripping contact with a light clamp, such as is already used in watchwork. Nor can Messrs. Siemens' unsuccessful attempt for other purposes be, I think, considered as a distinct anticipation of this. The mechanical advantage of such a light coil in diminishing moment of inertia, and in reducing the force of the bifilar couple, can hardly be denied on theoretical grounds, and is, indeed, borne out by experiment. W. H. STONE

MATHEMATICS AT THE JOHNS HOPKINS UNIVERSITY

FROM time to time we receive copies of the *University Circular*. From two now before us, we make a few extracts, which will serve to show what this young but promising University has done (or attempted to do) in the session 1881-82. The students have been thirty-two in number; of these, twenty followed advanced and University courses, and twelve pursued collegiate courses.

Supreme over the department presides Prof. Sylvester, F.R.S., who, besides editing the *American Journal of Mathematics* and reading papers at the Mathematical Seminary (similar in its character to our own London Mathematical Society), has delivered two courses of lectures—one on the Theory of Numbers (and in especial on an extension of Tchebycheff's theory concerning Prime Numbers), the other on a new theory of universal multiple algebra.

This session on the invitation of the Trustees, Prof. Cayley was called in as *amicus curiæ*, and arrived at

[1] The finest wire has not yet been measured in the microscope; it passes through the smallest hole of the B.W.G., No. 80.

Baltimore in December last. At the January meeting of the Seminary, he read a paper "On Two Cases of the Quadric Transformation between two Planes," and has subsequently read other papers, and been a contributor to the *Journal*. But the result of his visit has been the delivery of "a systematic and highly original course of lectures upon Algebraical Geometry, in connection with the Abelian and Theta Functions."

These lectures, we hope, will be given, in book form, to a more extended audience. Besides the ordinary class lectures, given by the able staff of assistant professors, some of whom are well known to mathematicians here, short courses of lectures have been delivered by Mr. C. S. Peirce (who has recently annotated and published in the *American Journal* his father's fine work on "Linear Associative Algebra"), on the Logic of Relatives, by Dr. Story; on the Clebsch-Gordan invariantive theory; and by Dr. Craig, on the Construction and Direction of a Riemann's surface (how these two last courses recall to our minds a departed master.)

Leibnitz somewhere says "Les mathématiques sont l'honneur de l'esprit humain;" if this be so, then the University has done well in assigning so great a part of its time and resources to the study of the higher branches of this department of knowledge. But indeed Johns Hopkins is a true university, for it is catholic in its sympathies, and enfolds in its wide embrace all branches of culture and learning.

In No. 13 is an abstract of a lecture before the students by Dr. James Bryce, M.P., on our English universities.

R. T.

KŒNIG'S EXPERIMENTS IN ACOUSTICS

I.

IN the volume mentioned below[1] Dr. Kœnig has collected the valuable series of researches in experimental acoustics that have been published by him chiefly in the *Annalen* of Poggendorff and of Wiedemann during the past twenty years. Many of these researches are well known in England, having attained to "classic" importance, and their main results are to be found embodied in all the best text-books of acoustics. Other researches of more recent date are yet known only to the few, but will doubtless win their way to general knowledge before long. The most novel points in the book are the late researches of its author with the ingenious instrument known as the wave-siren. This invention Dr. Kœnig has applied to support his views upon the origin of the beats of imperfect consonances, and also to investigate the influence of differences of phase upon the quality of tones. The general nature of the wave-siren has already been explained in the pages of NATURE, but in the sequel we will attempt to describe fully its most recent forms, as applied in the last investigation. In addition to these deeply interesting matters of recent research, there is a mine of wealth contained in the volume. The first chapter deals with the application of the graphic method in acoustics; an equally interesting chapter on manometric flames and their applications occur a little further on. Dr. Kœnig's researches on the standard tuning-fork or "*diapason normal*" are too well known to need comment. The reader will find the whole series of papers collected in Chapter XIII. He will also find notices of an adjustible tuning-fork capable of giving a variety of tones, of a curious tuning-fork clock, of new stethoscopes, of instruments for producing continuous beats audible to a large company of persons, together with researches on the phase of vibration of two associated telephones, on the fixed notes charcteristic of the different vowel sounds, and on several other matters of great importance. He must not, indeed, expect to find deep mathematical insight nor folios of analytical equations. But he will find a perspicuous and fascinating record of experiments planned with rare ingenuity, carried out with honesty, patience, and consummate skill, by the man whose exceptional abilities as experimentalist and constructor have done more than those of any other physicist to make the science of experimental acoustics what it is to day.

In the present article we shall refer in some detail to Dr. Kœnig's researches on the influence of phase upon the quality of sound.

It has long been an accepted doctrine of acoustics that every continuous sound possesses three recognizable characteristics, viz., *pitch*, *intensity* and *quality*, and that these three characteristics depend respectively upon the frequency, the amplitude, and the degree of complexity of the sonorous vibrations. The third of these characteristics, the *quality* of a sound, has also been denominated "*timbre*" or "*clang-tint*" by those who affect Gallic or Teutonic proclivities in scientific nomenclature. Everyone now knows that, by whatever name this third characteristic is called, it constitutes the almost indefinable yet perfectly recognizable difference which exists between a note as played on one musical instrument and the same note as played upon another. The notes may be the same in pitch and in intensity, but there is a residual difference in quality that the dullest ear cannot mistake.

It was by one of the finest pieces of scientific research by Germany's greatest living physicist, that the true cause of this mysterious "quality" was established. Helmholtz's great work on *The Sensations of Tone* takes for its basis the fact that with every fundamental "tone" or perfectly simple sound there co-exists a whole series of "partial tones," which together with the fundamental make up the mass of sound that we usually call a "note." All our musical instruments yield us complex sounds in which every fundamental is accompanied by a variety of upper partial tones (sometimes called by mistranslation "overtones"; and also, by a far more serious mistake, "harmonics), the number of such upper partials and their relative intensity being a consequence of the conditions of vibration in the instrument. Hence instruments having different kinds of vibrating parts—strings in one, reeds in another, columns of air in another—will emit tones that vary in number and intensity of accompanying partial tones; and the ear taking the mass of complex vibration as a whole will pronounce that there is a difference *in quality*. Helmholtz's theory, in short, asserts that the quality of a tone depends on the following points: firstly, whether there were any upper partials present; secondly, what those upper partials were; thirdly, what their relative intensity toward one another and toward the fundamental note might be. Thus, for example, the thin quality of the notes of wide, stopped organ-pipes, which contrasts both with the full rich quality of the pianoforte notes, and with the harsh, strident, irrepressible notes of the harmonium, becomes intelligible when it is rendered plain that in the first case there is an almost complete absence of upper partials, that in the second the partials, though numerous, are loud only for such partial tones as are concordant with the fundamental, while in the third discordant partials, loud and shrill mingle with the fundamental.

But there is a negative proviso in Helmholtz's theory of a very important kind, namely, that differences in quality of tone depend "*in no respect on the differences in phase under which these partial tones enter into composition.*"[1]

This negative law, which Helmholtz has sought to confirm by various experimental proofs, is a consequence of the hypothesis that the ear unconsciously analyzes complex sounds into their simple elements—the partial tones—each simple (partial) tone actuating a separate part of the nerve-structures of the ear. Before Helm-

[1] "Quelques Expériences d'Acoustique." Par Rudolf Kœnig. (Paris: R. Kœnig, 27, Quai d'Anjou, 1882.)

[1] *Helmholtz*. Sensations of Tone (Ellis's Translation) p. 186.

holtz's time, the theory had been propounded that quality depended on the *form* of the vibrations of the wave of sound; but since differences of phase greatly affect the form of the vibration, Helmholtz was forced either to abandon the new hypothesis that the ear thus decomposes complex tones into simple ones, or else to establish by experiment that no difference of phase affected the perception of quality by the ear.

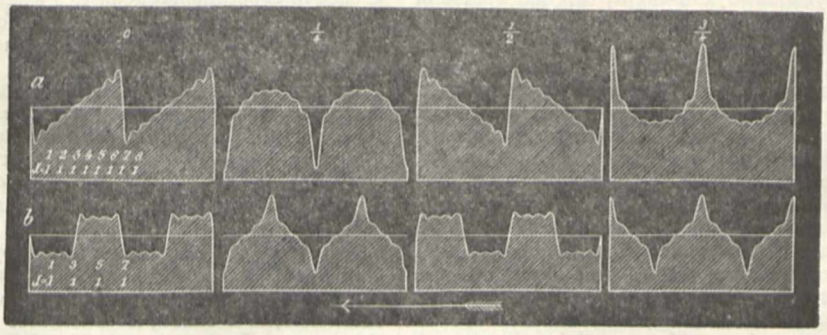

FIG. 1.—Resultant curves formed by compounding together the wave-forms of a harmonic series of simple tones of equal intensity but differing in phase.

The difference of form introduced into a complex vibration by a difference of phase between its components is already known; but Kœnig has brought forward some very striking examples. Fig. 1*a*, for example, gives the curves which result from compounding together the wave-forms of a note and its first eight upper partials, each of the nine tones being of equal intensity. Of the four curves ranged in line the first corresponds to the resultant when the components start at similar phases, each component beginning from zero with descending ordi-

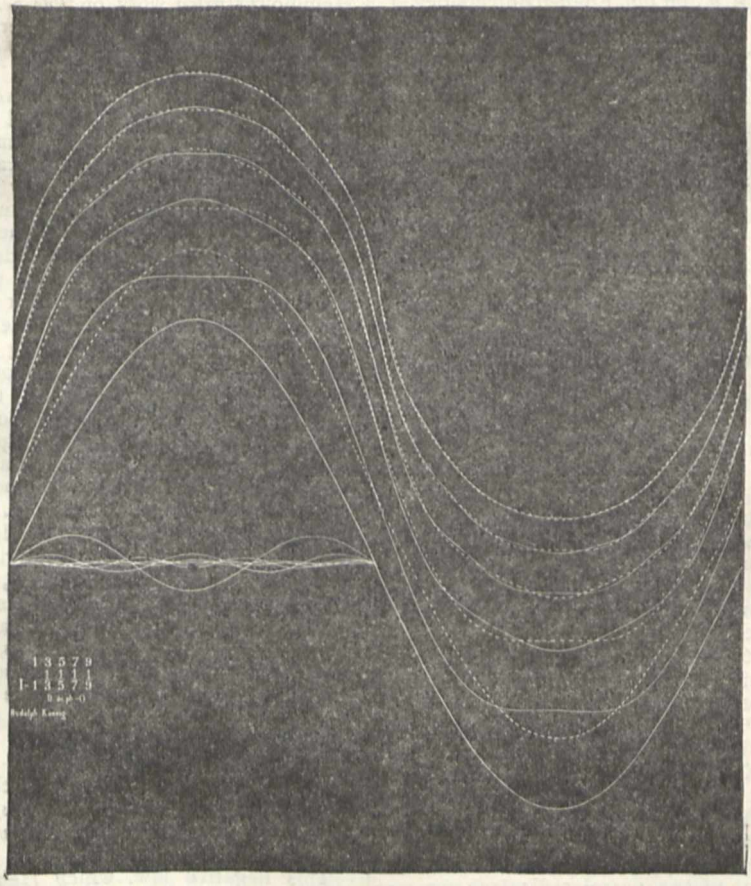

FIG. 2.—Resultant wave-form for odd members of series of upper partial tones when there is no difference of phase.

nates. In the second of the row, each of the separate component waves begins with a negative ordinate of maximum amplitude, or differing in phase by one quarter from the first case. In the third the difference is half a wave-length, and in the fourth case three-quarters of a wave-length. It will be noticed how very different these curves are to the eye, though compounded of the same elements. It will also be observed that the curves for

difference of phase = ½ is a reversed copy of that for which the difference of phase = 0; while the curves for phase-difference ¼ and ¾ are reversed copies of one another. Now, according to Helmholtz's theory, all these forms of vibration should yield identical sounds in the ear. Kœnig finds, on the contrary, the startling result that the sounds are perceptibly different in quality. His proof is extremely simple. The curve, calculated graphically with great care, is set off upon the circumference of a cylindrical band of thin metal, the edge being then cut away leaving the shaded portion, the curve being repeated half a dozen times, and meeting itself after passing round the circumference. For convenience the four curves to be compared are set out upon separate rims of metal, all of which are mounted upon one axis to which a rapid motion of rotation can be imparted. Against the indented edges of these rims wind can be blown through an appropriate slit; the whole combination forming a variety of the Wave-Siren described a few months ago in the columns of NATURE (p. 358, vol. xxiv.). It will be

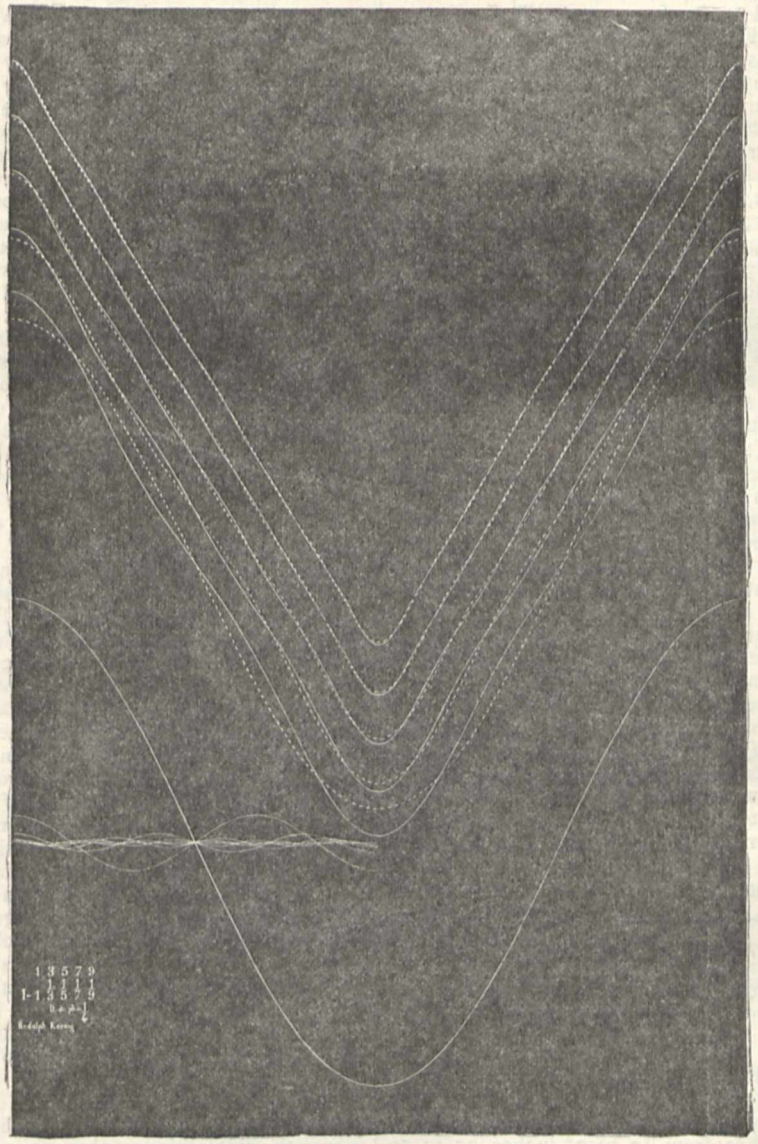

FIG. 3.—Resultant wave-form for odd members of series of upper partial tones when the difference of phase is a ¼.

obvious that as these indented curves pass in front of the slit the maximum condensation will result when the slit is least covered, or when the point of greatest depression of the curve crosses the front of the slit. The negative ordinates of the curves correspond therefore to condensations, the positive ordinates to rarefactions. Now, according to Kœnig's experiment, the sound is louder and more forcible, with a difference of phase of ¼, than in any other case, that with ¾ difference being the most gentle and soft in tone; whilst the curves of phase 0 and ½ yield intermediate qualities of tone. Kœnig also finds that by combining simply a note and its octave, the loudest resultant sound occurs when the phase of combination is ¼, a difference of phase of ¾ again yielding the feeblest resultant. In Fig. 1, *b*, four curves are shown corresponding to the combination of the odd members, 1, 3, 5, 7, 9, of the harmonic series, taken as before as of equal intensity. In this case the form of the waves is identical for the phases 0 and ½ and also for the phases ¼ and ¾. The latter yield a loud and strident tone as com-

pared with the former, though according to Helmholtz's theory their tones should be alike. It may be objected to these illustrations that in all natural sources of tone one never finds a whole series of partial tones every member of which is equally loud as the fundamental tone. It is more nearly true for most musical instruments that the higher up one goes in the series of partial tones the feebler are they in comparison with the fundamental tone.

Accordingly, Kœnig has combined, as in Fig. 2, a series of partial tones corresponding to the respective frequencies 1, 3, 5, 7, 9, making the amplitude of each partial tone inversely proportional to its frequency. The separate curves are shown in Fig. 2, both grouped about a horizontal line, and also as successively superposed upon the fundamental. The uppermost of the set of curves exhibits the final resultant; which, in this case, where the difference of phase is taken as *nil*, and all the components rise from zero together, is seen to consist of bold, well-rounded sinuosities. In Fig. 3, curves identical in wave-length and amplitude, but differing in phase by $\frac{1}{4}$, are compounded together; but the final resultant shows a wave-form that is practically a zig-zag. Now if these bold sinuosities and zig-zags be cut out in thin metal and curled up into circumferences so as to adapt them to use as wave-sirens in the manner before-mentioned, it is again found that the zig-zags corresponding to differences of phase $\frac{1}{4}$ and $\frac{3}{4}$ yield always harsher and louder tones than the rounded sinuosities that correspond to 0 and $\frac{1}{2}$.

These observations are very remarkable, and have important bearings that must be left for discussion in the next article on Kœnig's work.

For the present we will conclude by observing that more than once it has been pointed out that a certain perception of difference of phase did exist. Sir W. Thomson has suggested that there is evidence of this in the phenomenon of slow beats which by a curious acoustic illusion almost always suggest the idea of something revolving. The writer of this notice had also previously pointed out that in certain cases where a compound sound was led separately to the two ears a difference of phase between the components could be detected.

It may not be generally known that Dr. Kœnig has quite recently republished under the title of "*Quelques Expériences d'Acoustique*" the most important of his recent researches, including those on the Wave-Siren and on the Beats of Imperfect Consonances. The figures herewith presented, and those which will accompany the continuation of this notice, are taken by Dr. Kœnig's courteous permission from this his very valuable contribution to experimental acoustics. S. P. T.

THE RAINFALL OF THE GLOBE

PROF. LOOMIS has recently contributed a paper on this subject to the *American Journal of Science* of no small interest and value. The paper gives the mean annual rainfall at 713 places in all parts of the globe, and the results are graphically represented on a map of the world as closely as can be done by five tints of one colour. These tints represent respectively annual amounts of rain under 10 inches, from 10 to 25 inches, 25 to 50 inches, 50 to 75 inches, and above 75 inches. It is stated that the map is merely a provisional one, it being Prof. Loomis's expressed intention to publish a list of additional observations with a revised edition of the map; and in the meantime he invites the assistance and criticism of meteorologists in furtherance of the work.

The map shows unquestionably the broad features of the geographical distribution of the rainfall of the globe, so that any changes that will be made in a future issue, however interesting and important these may be locally, will only be rectifications of the iso-hyetal lines in some of their subordinate details.

Leaving out of consideration all exceptionally heavy rainfalls confined to limited spots, such as those of Cherapunji, in Assam, which amounts to 492 inches annually, and the Stye, in Cumberland, which is about 190 inches, the heaviest rainfall is met with in the rain-belt, which surrounds nearly the whole globe lying between the north-east and south-east trade-winds. Absolutely the largest rainfalls over large regions are to be found where the trade-winds, after having traversed a great breadth of ocean, are forced against and over a breadth of land, of some elevation and extent which lie across their path. Of these the best examples are the highlands of Java, Sumatra, and Assam, in the Old World, and parts of the north of South America, and of the steep slopes of Mexico facing the Gulf of Mexico in the New World, over which the trades or monsoons discharge their moisture so copiously as to raise the rainfall over large tracts up to, and in cases considerably above 200 inches annually. The influence of height is well illustrated by the rainfall of Mauritius; thus, while at the observatory it is 46 inches, it amounts at Cluny to 149 inches on a mean of the same 19 years. Similarly in St. Helena, while near the sea-level it is only 5 inches, at a height of 1764 feet it is 48 inches. In Ascension, no part of which rises to any considerable height, the annual rainfall is only 3 inches, and the whole island is little else than a burned-up desert.

The rainfall is particularly large in mountainous regions in both hemispheres above lat 40°, situated on the eastern shores of the great oceans, and consequently in the full sweep of the strong westerly winds of these high latitudes. Thus large portions of Scotland north of the Clyde, one or two small patches in England, a few spots in Ireland, large tracts between California and Alaska, the south of Chile, and the west coast of the south island of New Zealand have an annual rainfall exceeding 80 inches. Nay, even at Bergen, lat. 60° 23' N., bathed in the warm, moist, westerly winds of the Atlantic, the rainfall is 73 inches annually, which is the largest rainfall yet observed anywhere at so high a latitude. Those headlands, even though of comparatively small height, which ran out into the sea, meeting the moist oceanic winds, have rainfalls very considerably above the average—owing doubtless largely to the greater friction of land than water on the winds, thus partially arresting their progress, and inducing a more copious precipitation.

As causes of deficient rainfall, Prof. Loomis enumerates five, viz.: (1) a uniform direction of the winds during the year, such as prevails within the regions of the trades, illustrated by the rainfall of Ascension, Sahara, and South California; (2) the prevailing wind having crossed a mountain range, thence descends on the leeside, illustrated by desert of Gobi, Chili, and large tracts in Spain; (3) ranges of mountains so high as to obstruct the free movement of the surface-winds towards the interior, as parts of Central Asia and California; (4) remoteness from the ocean measured in the direction from which the wind proceeds, illustrated by the gradual diminution of the rainfall on advancing eastward into Europe; and (5) high latitudes, since beyond lat. 60°, at a little distance from the ocean, it seldom exceeds 10 inches, and there are apparently large tracts in North America and Asia, where the rainfall is less than 10 inches. As regards this last statement, observation scarcely bears it out, since in Europeo-Asiatic continent, only two stations in latitude the above 60°, viz. Kola in Russian Finland, on the Arctic Sea, and Yakutsk, show rainfalls less than 10 inches, and these are doubtful owing to the short periods over which the observations extend.

The truth is there are other causes powerfully influencing the distribution of the rainfall than these, which an examination of the rainfall of the individual months, notably January and July, best discloses. These causes have their explanation in the systems of low and high pressures, which appear and disappear with season. Of these the most

prominent are the low pressures which occupy the centres of continents in the summer months, and the northern portions of the Atlantic and Pacific Oceans in the winter months; and on the other hand, the high pressures which fill the centres of the continents in the winter months, and the high pressures in the oceans immediately to the west sides of the great continents, about lat. 36°, as shown by the Admiralty's physical charts of the Atlantic, Pacific, and Indian Oceans.

To take, as an example, the great summer barometric depression of Central Asia with the winds, flowing in upon it on all sides vortically, carrying with them the moisture of the ocean from which they come. Thus East Siberia is then swept by south-east and east winds, which distribute to westward as far as Irkutsk, in July, a monthly rainfall of 3 inches and upwards. Now since the annual rainfall of this region is all but wholly determined by the rains of the summer months, the extension of these rains inland wholly determines the position of the annual iso-hyetal lines. Again, to westward of long. 100° in Siberia, the rains have their origin in the Atlantic and Arctic seas, and since west and north-west winds prevail from Archangel to Central Asia, they bring with them comparatively so large a share of moisture from the ocean, as to raise the annual rainfall over the greater part of these northern regions to about 20 inches, or even more. On the other hand, on the east side of the Ural Mountains, which drain these winds of much of their moisture, the summer rainfall is much less. From north of the Caspian and Aral Seas, southward to the Persian Gulf, and eastward to the Indus, the summer winds are north-west, and since they thus advance over regions rapidly rising in temperature, little if any moisture is deposited in their train, thus rendering this extensive region one of the largest arid tracts of the globe.

These, with other considerations, indicate that the courses of several of the iso-hyetal lines, where observations are sparse, should be regulated to a greater extent than has been done in the map before us, by the positions of river-basins and mountain ranges in their relations to those seasonal winds, which really determine the annual amounts of the rainfall.

One of the most important points to which attention is drawn by Prof. Loomis, is that more rain falls on the eastern than on the western sides of continents. This remark holds good everywhere, until we reach the higher latitudes of both hemispheres, where the predominating winds become westerly. Thus the rainfall at San Francisco is only from a half to a third of the amount which falls on the coast of Pennsylvania in the same latitude; and about the same proportions, or even proportions still more striking, are seen on comparing Morocco with the Chinese coast, and the west with the east coasts of South Africa, Australia, and South America. The explanation is to be found in the portions of the areas of low and high pressures, with their accompanying winds, during the season whose rainfall determines the annual amounts. On the east side of the continents the prevailing summer winds are south-west, south, or south-east, which having traversed a large extent of ocean, and constantly advancing into higher and colder latitudes, spread a copious rainfall over the regions they traverse. But on the other hand, since the west side of continents in the same latitude lies between the region of abnormally high pressure in the ocean immediately to westward, and the low pressure of the interior, north-west winds in the northern, and south-west winds in the southern hemisphere prevail there; and as they advance into lower latitudes or over regions of a constantly increasing temperature, they deposit little or no rain in their course. Hence, owing to the failure, more or less complete, of the summer rains, it follows that the annual rainfall of these portions of the continents is small.

In preparing the second issue of the map, attention should be directed, in addition to the regions already indicated, to the rectification of the lines of equal rainfall over Iceland, the south-east of Norway, the Gulf of Guinea, the temperate regions of South America, and Northern, Central, and Western Australia, and we feel assured meteorologists will heartily co-operate with Prof. Loomis, and give him all possible assistance in completing the important work he has so successfully begun.

NOTES

THE name of Prince Leopold (Duke of Albany) has been added to the General Committee of the Darwin Memorial Fund, subscriptions to which, we may remind our readers, are still being received at the Royal Society, Burlington House, by the Hon. Secretaries, Prof. T. G. Bonney and Mr. P. Edward Dove.

THE communication from Greenwich which appeared in our last number, p. 175, showed that in the double magnetic storms of April, the Greenwich times of commencement of disturbance were, for Greenwich, April 16, 11h. 32m., and April 19, 15h. 35m.; and for Toronto, Canada, April 16, 11h. 34m., and April 19, 15h. 34m. The communication in question was followed by one from M. Dechevrens, reporting the magnetic disturbance as commencing suddenly also at Zi-ka-wei, China, at 7h. 36m. on the morning of April 17, and as being as suddenly renewed at 11h. 40m. on the morning of April 20; equivalent to April 16—11h. 30m., and April 19, 15h. 34m. Greenwich time. The outbursts thus occurred at the same absolute time at Toronto, Greenwich, and Zi-ka-wei.

THE Prince and Princess of Wales opened the handsome new Technical School at Bradford on Friday. The Prince, in the various speeches he gave showed that he has a real appreciation of the necessity for scientific training in this country, if we are to keep on a level with the other great nations in our industry and commerce.

THE Commission appointed by M. Ferry to report on the construction of the rotating dome for the large refractor of the Paris Observatory, has held numerous meetings at the Conservatoire des Arts et Métiers, Col. Laussedat, director of the establishment, being in the chair. Only two projects have been reserved for final choice. M. Eiffel proposes to use a saline solution in a horizontal circular channel placed on the wall to diminish the weight of the rotary roof.

WE are glad to learn that owing to the exertions of Admiral Mouchez, magnetical observations will soon be resumed at the Paris Observatory, in subterranean chambers which have been excavated in the newly annexed grounds. These observations will be self-registering by photography, in conformity with the instruments established by M. Mascart at the Collège de France. Direct observations will also be conducted with the old instruments which were used by Arago, which were famous for his prognostications of Auroræ, at a period when, the electric telegraph not having been invented, many days must elapse before the arrival in Paris of news from the northern parts of Europe.

IN the course of a few weeks all the International circumpolar observatory parties will have arrived at their different destinations, or be on their way thereto, and on August 1 the observations will commence simultaneously on the common plan framed by the different conferences held in Hamburg in 1879, in Bern in 1880, and in St. Petersburg in 1881. By the present arrangement Russia has three stations, the United States and Germany two each, whilst England, Austria, Sweden, Norway, Denmark, France, Holland, Italy, and Finland maintain one each, of which three—the French, the Italian, and one German—will be established in the Antarctic regions. The total number

of stations will thus be sixteen, with a complement of some 150 men. The work will be carried on continuously for thirteen months, and the expeditions will leave their quarters on September 1, 1883. On their return an International Conference will assemble—it is suggested in London—in order to examine the material collected, which will, it is hoped, give important results, particularly as regards meteorology.

"LA LAMPE SOLEIL," or the sun lamp as it is called, from the likeness of its rays to solar light, was successfully tried on Saturday last in the vaults of the Royal Exchange. This lamp is the invention of MM. Clerc and Bureau of Brussels, and is so simple in its action as to require no regulating mechanism. It consists of a square block of marble or dry limestone, having two holes pierced into it from above. The holes slant together until they nearly meet just within the base of the block. Into these holes are inserted the two carbon rods forming the poles of the arc, and the current traversing the partition of calcareous stone between their points heats it to incandescence, and thus a soft white light is emitted from the bottom of the block. This light is remarkably steady, and is very suitable for picture galgalleries. It was used to light the picture gallery in the recent Paris Electrical Exhibition, and is now employed in the *foyer* of the Grand Opera House, Paris. The limestone is calcined by the current, and the carbons feed themselves by gravity as they are consumed. The ugly shape of the lamp is certainly against its use, unless it be sufficiently well screened from view, but its simplicity is decidedly in its favour.

THE new Report (1880) of the Smithsonian Institution contains among other valuable material, a Bibliography of Sir W. Herschel's writings, a list of his published portraits, and a long and very careful synopsis of his scientific writings. This last occupies nearly 100 pages, and its value to the student is evident. Appended there is a subject-index to the scientific writings of Herschel. The same volume contains the first results of the attempt of the Institute to issue a yearly report of the work done at observatories all the world over; the report covers upwards of 100 pages.

OF the Smithsonian Report, upwards of 200 pages are occupied with a Record of Recent Scientific Progress, in which Prof. Baird writes the Introduction, Prof. Holden, Astronomy, Dr. G. W. Hawes, Geology and Mineralogy, Prof. G. F. Barker, Physics and Chemistry, Prof. Barlow, Botany, Prof. Theodore Gill, Zoology, and Mr. O. T. Mason, Anthropology. Mr. Mason also contributes a separate Bibliography of Anthropology, in which (p. 412) we find the following curious entry—"Vikin's (A.) ship."

ON the recommendation of the Agricultural Chamber in Stockholm the Swedish Government has accepted the invitation to participate in the International Fishery Exhibition to be held in London next year, and granted a sum of about 3000*l.* towards the expenses of representation. The Norwegian Government has also accepted the invitation, and a small sum has been voted by the Storthing.

AT a recent meeting of the Smoke Abatement Committee, held at 44, Berners Street, Mr. Ernest Hart in the chair, jurors' reports were handed in from Col. Festing, C.B., Prof. Chandler Roberts, F.R.S., Mr. Atchison, Mr. D. Kinnear Clark, Mr. Harris, and others, on behalf of the various juries, discussing the results obtained and tabulating the figures shown by the various tests. Great satisfaction was expressed at the excellent results which these reports show to have been achieved by some of the leading exhibits in the economy of fuel and abatement of smoke in open grates, as well as the satisfactory action of open grates and kitcheners intended for burning anthracite or smokeless coal. The hon. secretary (Mr. W. R. E. Coles) announced that the Manchester Exhibition of Smoke-Abating Apparatus, carried out partly under the auspices of this Society, had proved highly successful, and had attracted great interest among the practical men in the Lancashire district, and would, it was believed, be fruitful in good results. The arrangements were discussed for converting this committee into a permanent institution for smoke abatement, under the provisions of the law. It was announced that the Duke of Westminster would preside at a meeting to be held at Grosvenor House on Friday, July 14, for the purpose of distributing the awards, when it was expected that all the reports and tabulations would be ready in the form of a volume for public information.

THE President of the Italian Antarctic Expedition has received, at Genoa, a letter from Lieut. Bove, announcing the arrival of the expedition at Punta Arenas, on April 24 from Staten Island. Staten Island has been thoroughly examined as to its fauna, flora, topography, hydrography, and commercial utility.

THE *Hope*, commanded by Sir Allen Young, left the Thames last week to search for and succour the *Eira*, under Mr. Leigh Smith, missing in the Arctic regions for about a year. The *Hope* is 450 tons register, is fortified for ice work, well equipped, and with provisions for two years, and a year's supply for the *Eira*. Sir Allen, while he will doubtless use his discretion, has been instructed to avoid entering the ice, if possible. It has certainly been a peculiar Arctic season, so far as ice condition are concerned, and Sir Allen may find when he gets on the ground that all his calculations and arrangements are at fault.

MR. C. HOLCOTT BROOKS, Secretary of the Californian Academy of Sciences, sends us the following note on a meteor in Wyoming, which he states is "well authenticated in all respects." "May 11, at 4 p.m., in Weber Cañon, Wyoming Territory, while the sun was shining brightly, a sudden and steady glow in the sky attracted attention to an immense meteor, whose brilliant colours were beautiful beyond description. Its track across the heavens was marked by a large red belt, which after its brightness had died out, left a column of clearly defined white smoke in its place. It fell in a south-easterly direction, and was observed by a scientist who recently arrived in this city, and who attended the meeting of the California Academy of Sciences last evening."

NEW seismic apparatus for indication of earthquake-motions on Etna have been devised by the brothers Brassart, at the instance of Prof. Tacchini. From an illustrated account in the *Rivista Scientifica Industriale*, we gather that the indicator for undulatory shocks is in form as follows: a funnel grooved interiorly (and looking like a small inverted umbrella) is fixed at one end of a pivoted horizontal bar having a counterpoise; it has an aperture at the bottom, which allows of its oscillating a little way with the bar on a vertical column, on which is placed a vertical style with weight at top (this latter act being facilitated by a sliding brass tube). This weight, by its fall (contrary to the direction whence the shock comes), into one of the eight lettered grooves of the funnel (N, E, &c.), indicates the direction, and, depressing the bar, closes a circuit, making an electro-magnet, the result being that the pendulum of a small clock on the base-board is liberated. Thus if the clock had been set at 12, and it indicated 5 when looked at, this would show that the liberating shock had occurred five hours before. An electric bell may be introduced; also the liberation of the pendulum may be effected without electricity. In an arrangement for vertical shocks, a spiral of fine wire, with platina-tipped weight, is suspended vertically over a cup of mercury;

the circuit being closed when the weight dips in the mercury, with effects as above.

THE Société Nationale d'Acclimatation de France, at its Annual General Meeting, lately held in Paris, awarded a medal of the first class to Mr. J. E. Harting, F.L.S., for his monograph on "Ostriches," and his recently-published work on "Extinct British Animals."

WE are glad to learn that the Geographical Society have finally resolved to make further use of the services of Mr. Joseph Thomson in the work of African exploration. The region to be explored by Mr. Thomson is that around Mount Kilimanjaro, about which our knowledge is so meagre. Mr. Thomson will set out in the beginning of next year.

WE have received a copy of an interesting address by Prof. F. W. Hutton of Canterbury College, New Zealand, on "Biology in an Arts Curriculum." The author takes as his subject the principle of selection, and after briefly explaining its importance in biology, proceeds to argue that it is of not less importance in psychology and sociology. The analogues, or rather parallels, which he draws are thoughtful and interesting, as the following examples will show :—"Either from transmission, or from early association, every man has a number of opinions common to the nation and to the class in life to which he belongs, which may be called his inherited opinions; but as his reasoning powers develop, these opinions are subject to variation. The variations may be owing to original ideas arising in his mind we know not how, like the variations of structure in animals; or they may be due to education, that is, to coming into contact with other minds, either personally or through books; and it must be noticed that, unlike structural variations, these mental variations may be produced at any time in a man's life, and may or may not remain constant. Physical transmission is not necessary; mental transmission from mind to mind diffuses a variation rapidly through all the individuals, and consequently it is not necessary for the action of selection that the originator of an improved mental variation should have any bodily offspring. When mental variations compete with one another, selection constantly acts on them through the agency either of utility or of sympathy." Similarly in Sociology Prof. Hutton shows that the principle of selection is all-important, and therefore that the political constitution which best admits of variation within due limits, or is most flexible, is most likely to survive in a struggle with other political constitutions. Hence, he maintains, the growing tendency of Monarchies to supplant Despotisms, and of Republics to supplant Monarchies; also of the progress of parliamentary forms of government—parliamentary discussion being but the principle of selection applied to political ideas. The parallels thus drawn between the principle of selection in biology and its operation in psychology and sociology, are well presented; but they are clearly in no way closely analogous to the survival of the fittest among organisms. There is just such a resemblance as there is in the case to which Prof. Hutton alludes of the analogy between the biological and the social organism, and which, as he truly observes, is incomplete and apt to be misleading. "Indeed, it would not be difficult to find in this analogy as many discrepancies as likenesses. What, for instance, in the organisation of an animal answers to the professors of theology, medicine, or law? What to prisons and reformatories?" &c. So, we think, in the principle of selection, although there is a general resemblance in its operation in biology and in psychology or sociology, the resemblance is nevertheless only general, and may not be pressed too far. Thus, the single fact noticed by the author that variations of ideas may propagate themselves without the aid of heredity, is alone sufficient to constitute an immense difference between the two classes of cases—the biological and the sociological—and it is further evident that in biology there is nothing corresponding to individual judgment, which is the most important agent in selecting variations of ideas.

IN the current number of the *Journal of Forestry* is an excellent article on Epping Forest, in which the natural beauties of this well-known resort are faithfully portrayed. It is to be hoped that in the discussion that has raged and is still raging as to the management of Epping Forest under its new superintendent, the aim of Parliament for its preservation "in its natural aspect as a forest" will not be lost sight of. In the words of the writer of a paragraph on the subject in the same number of the *Journal of Forestry*, we repeat that "it is a forest that the public want, and not a gigantic park or tea garden."

IT is well known that of late a good deal of attention has been devoted in America to the manufacture of sugar from the Sorghum. In connection with this subject a letter has recently been published in the *New York Daily Tribune* from Prof. Silliman, in which he gives a detailed account of the value of the most important varieties. There seems to be a great future in America for the Sorghum as a sugar producer.

THE discussion of diurnal ranges of temperature having shown to Dr. Woeikof (*Izvestia* of the Moscow Society of Naturalists for 1881) how much they depend upon the topographical conditions of different stations, he discusses in the last number of the *Journal* of the Russian Chemical and Physical Society the influence of the same conditions on the average temperatures of winter and on the deviation from average temperatures, especially during anti-cyclones. Comparing the observations at different Swiss stations, he finds that the annual range of temperatures does not always diminish with the height of the station; it is less on isolated mountains, but it is greater in high valleys when they are wide. Discussing further the differences of temperature in valleys and on isolated mountains, he shows how the temperature of the air in the former is often much colder than on the mountains, as well in Switzerland as on the Caucasus, and in Eastern Siberia; and he concludes that the map of isotherms, recently published by Dr. Wild in his great work "On the Temperatures in the Russian Empire," does not give a true idea of the distribution of winter-temperatures, especially in Siberia; most of the stations of this country being situated in valleys, where the temperature is lowered during the winter by typographical conditions, the isotherms for January occupy altogether a too southern position on this map. Thus, for instance, the January isotherm of $-31°$ which passes through the Voznesensky gold-mine, is lower by $7°{\cdot}2$ than the true temperature for this place, and by $10°{\cdot}1$ if the necessary reduction to the sea-level be taken into account.

ON the 14th inst., at 2 p.m., a severe earthquake was felt at the town of Luleå in Sweden (65° 40′ N., 22° 7′ E.). The shocks, which were several, were felt within a radius of thirty-six miles, doors being thrown open, flower-pots turned over, &c., through the tremor of the earth.

M. BRAZZA has delivered in the large hall of the Sorbonne a lecture on his discoveries in the Ogowe, and his efforts to establish a regular communication between the Ogowe and Congo through a land district. These efforts have proved successful.

THE frequent observations of the mirage in the south and central part of Sweden is very remarkable. From time to time we are told that whole landscapes, cities, and castles, with moving objects, have been observed reflected on the sky for hours, and we again learn that a similar display of the forces of Nature was seen one afternoon last month over the lake of Orsa, in a remote part of Dalcarlia, lat. 61°, which is stated to have reflected a number of large and small steamers, as if plying on the lake, and from whose funnels even the smoke could be

observed to rise. Later on the scene changed to a landscape, the vessels now taking the form of islands in the lake, covered with more or less vegetation, and at last the mirage dissolved itself in a haze. The phenomenon, which lasted from 4 to 7 o'clock p.m., is said to have furnished a most magnificent spectacle.

THE additions to the Zoological Society's Gardens during the past week include a Yellow Baboon (*Cynocephalus babouin* ♀) from West Africa, presented by Mr. A. Collison; a Slender Loris (*Loris gracilis* ♂) from Ceylon, presented by Mrs. A. H. Jamrach; a Vulpine Phalanger (*Phalangista vulpina*) from Australia, presented by Mr. E. Meek; a Burmese Tortoise (*Testudo elongata*) from the Western Dooars of Bhotan, presented by Mr. B. H. Carew; a —— Tree Snake (*Ahætulla liocercus*) from Pernambuco, presented by Mr. C. A. Craven; a Common Adder (*Vipera berus*), British, presented by Mr. F. W. Elliott; a Rude Fox (*Canis rudis*), a Common Rhea (*Rhea americana*) from South America, deposited; a Yellow Baboon (*Cynocephalus babouin*) from West Africa, received on approval; a Burrhel Wild Sheep (*Ovis burrhel*), born in the Gardens, eight Summer Ducks (*Aix sponsa*), six Swinhoe's Pheasants (*Euplocamus swinhoii*), bred in the Gardens. The following insects having emerged during the past week:—Silk Moths: *Actias selene, Samia cecropia, Attacus mylitta;* Moths: *Hypochera io, Deilephila euphorbiæ, Deilephila vespertilis, Trochilium apiformis, Sciapteron tabaniformis, Sesia musciformis, Callimorpha dominula;* Butterflies: *Apatura iris, Vanessa xanthomelas, Vanessa urticæ, Aporia crabægi.*

OUR ASTRONOMICAL COLUMN

MASKELYNE'S VALUE OF THE SOLAR PARALLAX.—Mr. Dunkin has consulted the first edition of Vince's "System of Astronomy," published in 1797, and finds therein Maskelyne's article on a new method of determining the solar parallax, the same as in the second edition which appeared in 1814.

Mr. W. J. Davies, writing from Tyglyn, Cilian Aeron, Cardigan, asks, with reference to this value of the parallax, Is it not probable that this was first published in the *Philosophical Transactions?* Prof. Ball, in his "Elements of Astronomy" (Longmans, 1880), page 361, gives the value 8″·723, and the authority for it, viz., *Phil. Trans.*, vol. lxi. p. 574, year 1771. On this point we may remark that Prof. Ball, according to the statement in his preface, has mainly relied for his numerical data upon Houzeau's "Répertoire des Constantes Astronomiques"—a work which, though excellently designed, would, according to our experience of it, benefit by a careful revision. There are a number of errors in the first edition, which are likely to be copied into more popular works, unless attention be drawn to them. In the present case, where reference is made for Maskelyne's parallax to the *Phil. Trans.*, 1771, p. 574, we find at that page a paper by Dr. Hornsby, entitled "The Quantity of the Sun's Parallax as deduced from the Observation of the Transit of Venus, on June 3, 1769, by Thomas Hornsby, M.A., Savilian Professor of Astronomy in the University of Oxford, and F.R.S.," in which the parallax from a number of combinations is found to be 8″·78. Maskelyne's name is not mentioned in the paper, which appears to relate exclusively to Hornsby's own deductions.

Mr. Dunkin having traced the publication of Maskelyne's note to 1797, the only earlier work of Vince in which it would be likely to be found, is the first edition of his text-book, the "Elements of Astronomy," 1790. Mr. Davies remarks that Olinthus Gregory, in his "Treatise on Astronomy," published in 1803, refers to Maskelyne's method, and considered it the best that had been given; he explains it almost in the same words as in Vince, adding that the assumed value 8″·83 was taken "agreeably to the result of observations on the transit in 1761."

THE COMET OF MAY 17.—M. Trépied, in an account of his observations made in Egypt during the total solar eclipse of May 17, which was communicated to the Academy of Sciences on the 19th inst., has the following interesting note:—"Vers le milieu de la totalité, j'aperçus à droite du Soleil, par un angle zénith de environ 90°, un trait légèrement courbé vers le bas, d'un effet singulier, et en discordance évidente avec le reste de la couronne. Je n'ai pas eu un seul instant l'idée que ce pouvait être une comète; je n'en ai reconnu la nature qu' une heure après l'eclipse, en comparant mon croquis à l'une des photographies obtenues par le Dr. Schuster. Cette photographie montrait nettement le noyau à une distance du bord du Soleil un peu supérieure au diamètre de cet astre; l'angle zénith et la direction de la queue s'accordaient bien avec ce que j'avais dessiné, mais j'avais arrêté le trait à une distance beaucoup trop faible du bord. Je n'ai pas cru cependant qu'il me fût permis de rien changer à mon dessin." The sketch referred to is copied in the *Comptes rendus* of the above sitting of the Academy. M. Trepied further remarks: "L'eclat de la comète m'a paru du même ordre que celui des parties extérieures de la couronne." The position of the observing station, as provisionally determined by M. Trépied, is in longitude 1h. 57m. 40s. east of Paris, and latitude 26° 33′ 21″, where the middle of totality occurred at 8h. 31m. 53s. a.m. local mean time. M. Trépied says in the week following the eclipse he searched for the comet many times before sunrise and after sunset, but without detecting it.

The comet has doubtless been sought for elsewhere, though unfortunately without success. The object notified as having become visible some ten days since in the Cape Colony, near the sun in the evenings, would be the comet 1882 *a* (Wells), March 17).

DAYLIGHT OBSERVATION OF COMET 1882 *a*.—Prof. Julius Schmidt writes to the *Astronomische Nachrichten* that on June 10 after 3 p.m., in an exceptionally clear sky at Athens, he observed the comet, though with difficulty, in the 6-feet refractor of that observatory. By ten observations (the instrumental corrections from previous determination) the approximate position was found to be—

h. m.	h. m. s.	° ′
June 10, at 3 59·7 M.T. Athens,	R.A. 5 0 40,	Decl. +23 19·4.

This place differs from that inferred from the last orbit given in this column (on observations to May 21) by −5′·5 in R.A. and +3′.2 in declination. The comet's distance from the nearest limb of the sun was about 2°·8.

PHYSICAL NOTES

PROFESSORS BELLATI AND NACCARI, of the University of Padua, have recently sent to the Academy of Sciences at Turin, a memoir on the heat developed in solid and liquid dielectrics by successive electrostatic polarisations. They find that when a dielectric, placed between two metal armatures, is subjected to successive polarisations by means of a Ruhmkorff's coil, the dielectric is warmed. This result had already been obtained by Siemens and Righi in the case of glass; the authors of the memoir have experimented also on liquid dielectrics. They have employed two methods: in one of these the heating was indicated by the dilatation of the liquid dielectric (or, in the case of a solid dielectric, of another liquid) observed in a capillary tube. In the other method, the liquid dielectric was contained in a glass vessel, in which were two concentric metallic cylinders serving as the armatures of a condenser. The outer one of these two cylinders was open above and below; the other was closed, and communicated with a horizontal capillary tube containing benzine. This cylinder, therefore, acted as the bulb of an air-thermometer, the heating of the dielectric being indicated by the displacement of the benzine in the capillary tube. This phenomenon must not be confounded with the electric expansion discovered by Fontana more than a century ago, and more recently studied by Govi, Duter, and Quincke. The true electric expansion is instantaneous, and ceases when the polarisation ceases; but the expansion due to the heat developed in the dielectric by repeated charges and discharges is progressive, and increases by prolonging the action of the induction coil. Professors Bellati and Naccari found no electrolytic decomposition in the dielectric, nor was the heating due to the passage of a feeble current through the dielectric.

THE utilisation of the earth's internal heat is a subject which is attracting the attention of scientific men in Japan just now. At a recent meeting of the Seismological Society, Mr. Milne introduced the subject for the consideration of the members. He first drew attention to the fact that philosophers have told us the whole available energy upon the surface of the earth had in some

way or other its action and its existence traceable to the sun. That there was an unlimited supply of energy in the interior of the earth was a circumstance which had, he said, been overlooked. In speaking of this energy, Mr. Milne first referred to that portion of it which crops out upon the surface in countries like Japan, Iceland, and New Zealand, in the form of hot springs, solfataras, volcanoes, &c. He stated that there was an unlimited supply of water in hot springs within a radius of one hundred miles around Tokio, and that the heat of these springs could be converted into an electric current, and the energy transmitted to the town. The second part of the paper referred to the possibility of obtaining access to the heat which did not crop out in the surface.

THE whole behaviour of homogeneous colours is explained (according to Herr Albert, *Wied. Ann.*, No. 5), on the Young-Helmholtz theory, by this assumption: To a lessening of the intensity of vari-coloured light correspond various lessening of the strength of sensation, such that for rays of less wave-length, to whatever part of the spectrum they belong, it decreases more slowly than for rays of greater wave-length.

GEOGRAPHY IN RUSSIA

THE just issued "Annual Report of the Russian Geographical Society for 1881" shows that during last year the Society has again accomplished a good deal of useful scientific work. A subject to which much attention was given was the establishment of polar meteorological stations. The station at Novaya Zemlya has already been in operation, as is known, for two years, and a new one, which will be established at the mouth of the Lena, is provided with the best instruments, and is intrusted to persons who will be able to make of it a first-class meteorological observatory. During the summer the expedition will reach the shores of the Arctic Ocean, and begin the meteorological observations. The Dutch station will be erected at Port Dickson, at the mouth of the Yenisei.

Among the scientific expeditions undertaken by the Society, that of M. Polakoff, to Sakhalin, promises to give very interesting results. The rich ornithological collections made in the Alexandrovsk Valley, on the western coast, proved that the birds of Western Sakhalin have a remarkable likeness with those of Siberia and Northern Russia. The same is true with regard to the former inhabitants of Sakhalin, whose stone implements and remains of earthenware, discovered in great masses, are much like, or even identical to, those of European Russia; the presence of obsidian implements, however, originally from Kamschatka, or from the islands of the Pacific, hints that the inhabitants were in intercourse with these countries. M. Polakkoff has also discovered dwellings of the same period, which were holes, like those of the Kamtchadales, the numerous stone pieces which were used to be attached to the nets, show that the nets of the prehistoric man were very large, and that fishing was carried on to a great extent at that period.

The result of M. Polakoff's explorations of the eastern shores of the island, as well as in its middle parts, are not yet known. M. Adrianoff's journey in very little known parts of the Tormsk and Sayan Mountains, during which the explorer crossed Lake Teletzekoye and the Shapshal Mountains, have given rich materials for the geology, zoology, and botany of these countries. The travels of A. E. Regel to the Pamir, M. Hedroitz's explorations of the alluvial deposits of the Amu-daria, M. Lessar's travel to Saraks, and M. Moushketoff's researches on Caucasus, have already been mentioned in NATURE.

A very interesting journey, mentioned in the "Report," was made by A. W. Eliseeff, who tried to follow the same route to Palestine which was followed by the Jews during their exode from Egypt. M. Eliseeff discovered during the journey numerous traces of man of the Palæolithic and of the Neolithic periods in Arabia Petrea, as well as in Egypt and in Palestine. The prehistoric man of the Sinai peninsula belonged to two different types: one, with light bones, of the Semitic type, and the other, with massive bones, of the Berber type; dolichocephalic skulls are predominant. Both had the custom of burning corpses, and did not neglect anthropophagy; however, their chief food consisted of wild animals, fishes, and molluscs. The disposition of these remains confirms the hypothesis of Owen, that the Sinai peninsular and lower Egypt were under water, excepting the higher terraces, after man inhabited the banks of the Nile. As to the present inhabitants, the Arabs of the peninsula afford two different types: a western one, more akin to the Fellah and Egyptian type, and the eastern one, which is of a purer Arabian origin. The nomad Bedouins belong to different sub-types, and there are in the Bedouin desert, traces of a fair-haired people, as well as representatives of Berberian and Ethiopian blood. Some very interesting material for a knowledge of prehistoric man was also discovered by M. W. Malakhoff, during his journey on the western slopes of the Middle Ural. The remains of this epoch are very numerous, especially on the shores of lakes, and they are the more interesting, as we find here the first vestiges of an epoch when the Neolithic man began to discover the properties of metals, and to manufacture metallic implements from the rich ores he found on the Ural. The skeletons of men of this period discovered, together with mixed implements of stone, bone, and copper, are most interesting, especially with regard to the skulls, which represent a very low stage of human development. The remains of a later epoch (implements and rock hieroglyphics) are also very numerous. M. Malakhoff concluded his researches by ethnographical observations on the present Permyaks, whom he considers as very nearly akin to the primary prehistoric inhabitants of this region. G. N. Potanin's exploration of the Votyaks, of their migrations, mythology, and customs, and an excursion of S. K. Kouznetzoff to the Tcherenisses of the Vyatka government promises to yield interesting results.

Among the new publications of the Society we notice the following:—The Anthropology of Mordvinians, by W. N. Mairoff, is printing, and will appear in the eleventh volume of the Ethnographical Memoirs of the Society; the anthropological researches of K. S. Mereshkovsky in the Crimea, preliminary reports of which have appeared in the *Izvestia*, will soon be ready to print; G. N. Potanin's work, "Sketches of North-Western Mongolia," being a report, in two volumes, of his first journey in Mongolia, is an important acquisition for the geography of Asia; the first volume contains abundance of valuable geographical information, and the second contains the ethnographical results, with twenty-six tables of drawings. Volumes iii. and iv. of this work, the third already being under press, will contain the results of the second journey of M. Potanin in Mongolia; the work of N. M. Prshevalsky, "Travels in the Deserts of Central Asia" will consist of six volumes, with more than 120 drawings and maps, four volumes being devoted to the zoology, botany, and geology of these countries; the first volume is already finished by the author, as well as several parts of the following volumes:—An interesting map of Jungaria, drawn up by the Swedish Lieutenant Renat in the eighteenth century, after several months' imprisonment by Kalmuks, was published last year by A. S. Maksheef. Finally, the "Report" mentions also a series of pamphlets, in French, published for the Geographical Exhibition at Venice, which contains very good reviews of scientific work done in Russia in hydrography, zoo-geography, botanical geography, geology, and statistics during the last five years.

The ninth volume of the Memoirs of the Society for the Physico-Geographical Section contains an excellent work by A. W. Kaulbars on the delta of the Amu-daria—unhappily without the atlas of maps and drawings, which the Society was unable to publish. The tenth volume will contain the materials collected by the expedition of Karelin in 1830, which are not yet published.

PRELIMINARY NOTICE OF THE RESULTS ACCOMPLISHED IN THE MANUFACTURE AND THEORY OF GRATINGS FOR OPTICAL PURPOSES[1]

IT is not many years since physicists considered that a spectroscope constructed of a large number of prisms was the best and only instrument for viewing the spectrum, where great power was required. These instruments were large and expensive, so that few physicists could possess them. Prof. Young was the first to discover that some of the gratings of Mr. Rutherfurd showed more than any prism spectroscope which had then been constructed. But all the gratings which had been made up to that time were quite small, say 1 inch square, whereas the power of a grating in resolving the line of the spectrum increases with the size. Mr. Rutherfurd then attempted to make as large gratings as his machine would allow,

[1] By Prof. H. A. Rowland. (Extract from Johns Hopkins University Circular, No. 16.) Communicated by the Author.

and produced some which were nearly 2 inches square, though he was rarely successful above 1¾ inches, having about 30,000 lines. These gratings were on speculum metal, and showed more of the spectrum than had ever before been seen, and have, in the hands of Young, Rutherfurd, Lockyer, and others, done much good work for science. Many mechanics in this country, and in France and Germany, have sought to equal Mr. Rutherfurd's gratings, but without success.

Under these circumstances, I have taken up the subject with the resources at command in the physical laboratory of the Johns Hopkins University.

One of the problems to be solved in making a machine is to make a perfect screw, and this, mechanics of all countries have sought to do for over a hundred years and have failed. On thinking over the matter, I devised a plan whose details I shall soon publish, by which I hope to make a practically perfect screw, and so important did the problem seem, that I immediately set Mr. Schneider, the instrument maker of the university, at work at one. The operation seemed so successful, that I immediately designed the remainder of the machine, and have now had the pleasure since Christmas of trying it. The screw is practically perfect, not by accident, but because of the new process for making it, and I have not yet been able to detect an error so great as 1-100,000th part of an inch at any part. Neither has it any appreciable periodic error. By means of this machine I have been able to make gratings with 43,000 lines to the inch, and have made a ruled surface with 160,000 lines on it, having about 29,000 lines to the inch. The capacity of the machine is to rule a surface 6¼ × 4¼ inches, with any required number of lines to the inch, the number only being limited by the wear of the diamond. The machine can be set to almost any number of lines to the inch, but I have not hitherto attempted more than 43,000 lines to the inch. It ruled so perfectly at this figure that I see no reason to doubt that at least two or three times that number might be ruled in one inch, though it would be useless for making gratings.

All gratings hitherto made have been ruled on flat surfaces. Such gratings require a pair of telescopes for viewing the spectrum; these telescopes interfere with many experiments, absorbing the extremities of the spectrum strongly; besides, two telescopes of sufficient size to use with 6-inch gratings would be very expensive and clumsy affairs. In thinking over what would happen were the grating ruled on a surface not flat, I thought of a new method of attacking the problem, and soon found that if the lines were ruled on a spherical surface, the spectrum would be brought to a focus without any telescope. This discovery of concave gratings is important for many physical investigations, such as the photographing of the spectrum both in the ultra-violet and the ultra-red, the determination of the heating effect of the different rays, and the determination of the relative wave-lengths of the lines of the spectrum. Furthermore, it reduces the spectroscope to its simplest proportions, so that spectroscopes of the highest power may be made at a cost which can place them in the hands of all observers. With one of my new concave gratings I have been able to detect double lines in the spectrum which were never before seen.

The laws of the concave grating are very beautiful, on account of their simplicity, especially in the case where it will be used most. Draw the radius of curvature of the mirror to the centre of the mirror, and from its central point with a radius equal to half the radius of curvature draw a circle; this circle thus passes through the centre of curvature of the mirror, and touches the mirror at its centre. Now if the source of light is anywhere in this circle, the image of this source and the different orders of the spectra are all brought to focus on this circle. The word focus is hardly applicable to the case, however, for if the source of light is a point, the light is not brought to a single point on the circle, but is drawn out into a straight line with its length parallel to the axis of the circle. As the object is to see lines in the spectrum only, this fact is of little consequence, provided the slit, which is the source of light, is parallel to the axis of the circle. Indeed, it adds to the beauty of the spectra, as the horizontal lines due to dust in the slit are never present, as the dust has a different focal length from the lines of the spectrum. This action of the concave grating, however, somewhat impairs the light, especially of the higher orders, but the introduction of a cylindrical lens greatly obviates this inconvenience.

The beautiful simplicity of the fact that the line of foci of the different orders of the spectra are on the circle described above, leads immediately to a mechanical contrivance by which we can move from one spectrum to the next, and yet have the apparatus always in focus; for we have only to attach the slit, the eye-piece, and the grating to three arms of equal length, which are pivoted together at their other ends, and the conditions are satisfied. However we move the three arms, the spectra are always in focus. The most interesting case of this contrivance is when the bars carrying the eye-piece and grating are attached end to end, thus forming a diameter of the circle with the eye-piece at the centre of curvature of the mirror, and the rod carrying the slit alone movable. In this case the spectrum as viewed by the eye-piece is normal, and when a micrometer is used, the value of a division of its head in wave-lengths does not depend on the position of the slit, but is simply proportional to the order of the spectrum, so that it need be determined once only. Furthermore, if the eye-piece is replaced by a photographic camera, the photographic spectrum is a normal one. The mechanical means of keeping the focus is especially important when investigating the ultra-violet and ultra-red portions of the solar spectrum.

Another important property of the concave grating is that all the superimposed spectra are in exactly the same focus. When viewing such superimposed spectra it is a most beautiful sight to see the lines appear coloured on a nearly white ground. By micrometric measurement of such superimposed spectra we have a most beautiful method of determining the relative wave-lengths of the different portions of the spectrum, which far exceeds in accuracy any other method yet devised. In working in the ultra-violet or ultra-red portions of the spectrum we can also focus on the superimposed spectrum, and so get the focus for the portion experimented on.

The fact that the light has to pass through no glass in the concave grating makes it important in the examination of the extremities of the spectrum where the glass might absorb very much. There is one important research in which the concave grating in its present form does not seem to be of much use, and that is in the examination of the solar protuberances; an instrument can only be used for this purpose in which the dust in the slit and the lines of the spectrum are in focus at once. It might be possible to introduce a cylindrical lens in such a way as to obviate this difficulty. But for other work on the sun the concave grating will be found very useful. But its principal use will be to get the relative wave-lengths of the lines of the spectrum, and so to map the spectrum; to divide lines of the spectrum which are very near together, and so to see as much as possible of the spectrum; to photograph the spectrum so that it shall be normal; to investigate the portions of the spectrum beyond the range of vision; and lastly to put in the hands of any physicist at a moderate cost such a powerful instrument as could only hitherto be purchased by wealthy individuals or institutions.

To give further information of what can be done in the way of gratings I will state the following particulars:—

The dividing engine can rule a space 6¼ inches long, and 4¼ inches wide. The lines, which can be 4¼ inches long, do not depart from a straight line so much as 1-100,000th of an inch, and the carriage moves forward in an equally straight line. The screw is practically perfect, and has been tested to 1-100,000th of an inch, without showing error. Neither does it have any appreciable periodic error, and the periodic error due to the mounting and graduated head can be entirely eliminated by a suitable attachment. For showing the production of ghosts by a periodic error, such an error can be introduced to any reasonable amount. Every grating made by the machine is a good one, dividing the 1474 line with ease, but some are better than others. Rutherfurd's machine only made one in every four good, and only one in a long time which might be called first-class. One division of the head of the screw makes 14,438 lines to the inch. Any fraction of this number in which the numerator is not greater than say 20 or 30 can be ruled. Some exact numbers to the millimetre, such as 400, 800, 1200, &c., can also be ruled. For the finest definition either 14,438 or 28,876 lines to the inch are recommended, the first for ordinary use, and the second for examining the extremities of the spectrum. Extremely brilliant gratings have been made with 43,314 lines to the inch, and there is little difficulty in ruling more if desired. The following show some results obtained:—

Flat grating, 1 inch square, 43,000 lines to the inch. Divides the 1474 line in the first spectrum.

Flat grating, 2 × 3 inches, 14,438 lines to the inch, total 43,314. Divides 1474 in the first spectrum, the E line (Ang-

ström 5269·4) in the second, and is good in the fourth and even fifth spectrum.

Flat grating, 2 × 3 inches, 1200 lines to one millimetre. Shows very many more lines in the B and A groups than were ever before seen.

Flat grating, 2 × 3¼ inches, 14,438 lines to the inch. This has most wonderful brilliancy in one of the first spectra, so that I have seen the Z line, wave-length 8420 (see Abney's map of the ultra-red region), and determined its wave-length roughly, and have seen much further below the A line than the B line is above the A line. The same may be said of the violet end of the spectrum. But such gratings are only obtained by accident.

Concave grating, 2 × 3 inches, 7 feet radius of curvature, 4818 lines to the inch. The coincidences of the spectra can be observed to the tenth or twelfth spectrum.

Concave grating, 2 × 3 inches, 14,438 lines to the inch, radius of curvature 8 feet. Divides the 1474 line in the first spectrum, the E line in the second, and is good in the third or fourth.

Concave grating, 3 × 5½ inches, 17 feet radius of curvature, 28,876 lines to the inch, and thus nearly 160,000 lines in all. This shows more in the first spectrum than was ever seen before. Divides 1474 and E very widely, and shows the stronger component of Ångström 5275 double. Second spectrum not tried.

Concave grating, 4 × 5¾ inches, 3610 lines to the inch, radius of curvature 5 feet 4 inches. This grating was made for Prof. Langley's experiments on the ultra-red portion of the spectrum, and was thus made very bright in the first spectrum. The definition seems to be very fine, notwithstanding the short focus, and divides the 1474 line with ease. But it is difficult to rule so concave a grating, as the diamond marks differently on the different parts of the plate.

These give illustrations of the results accomplished, but of course many other experiments have been made. I have not yet been able to decide whether the definition of the concave grating fully comes up to that of a flat grating, but it evidently does so very nearly.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The following awards have been made at St. John's College for proficiency in natural science:—Foundation Scholarships to Bateson, Goodman; Exhibitions to Edmunds, Love, T. Roberts (already scholars), and to Acton, Andrews, Clementson. T. Roberts also received a Wright's Prize, with augmentation of scholarship to 100*l.* for the year. In the Open Exhibition Examination at Easter, H. Stroud (Owens College) was awarded a a Foundation Scholarship of 100, and Fuller (Perse School, Cambridge), 50*l.* for three years.

In the long list of lectures on Natural Science for the ensuing academical year, lately published, we note as new courses or features of special interest, Mr. Shaw's lectures on some Applications of the Higher Mathematics to Physics (Michelmas Term); Dr. Roberts's lectures on Physiography (Michaelmas Term); Prof. Hughes's Course of Dynamical Geology (Lent Term); Dr. Vines's complete course of advanced Botanical Study, extending through the year; Prof. Newton's lectures on the Evidence of Evolution in the Animal Kingdom, in the Michaelmas Term, and on the Geographical Distribution of Animals, in the Easter Term; and Prof. Balfour's announcement of his lectures and practical work, as Professor of Animal Morphology.

The annual report of the Botanic Gardens Syndicate details work done in improving the Gardens, and amongst valuable additions to the collection, the Tonga plant, recently introduced from the Fiji Islands. A special collection of medical plants has been formed, which already contains the most important hardy plants, and some of considerable rarity. About 8000 labels have been written during the year.

With regard to the recent Mathematical Tripos (in which Messrs. Welsh of Jesus College, and Turner of Trinity College, were respectively Senior and Second Wranglers), although the twenty-nine Wranglers may enter for a further advanced examination in January next, they are by no means compelled to do so. The examination, so far as it has already proceeded, includes very many of the subjects of the old Mathematical Tripos, and we anticipate that unless the colleges decline to elect to Fellowships Wranglers who do not proceed to the higher examination, many will rest content with the test already undergone. The recent talk about the "abolition of the Senior Wrangler" has not a very valid basis.

THE eighth annual meeting of the Yorkshire College was held at Leeds on Saturday, Sir Edward Baines in the chair. Prof. Marshall, the principal, made a satisfactory report, and a resolution of the council was confirmed to proceed with the completion of the new college buildings. On the proposition of the Mayor of Leeds (Alderman Tatham) it was resolved that, in memory of the late Lord F. Cavendish, M.P., the late president of the college, who for twelve years had been one of its foremost promoters, a fund be established for the endowment ot a Cavendish Professorship of Physics or for such other purpose as the council should deem best.

SCIENTIFIC SERIALS

Notes from the Leyden Museum, vol. iv. No. 2, April, 1882, contain: On American Diptera, by F. M. van der Wulf.—On new species of Lycidæ, Lampyridæ, and Telephoridæ, and on a new Sumatran species of Callimerus, by Rev. H. S. Gorham.—On new species of Pedilidæ and Anthicidæ, and on a new African species of Hister, by S. de Marseul.—On the Holothurians in the Leyden Museum, by Dr. H. Ludwig.—On some British Indian reptiles and amphibia, by Dr. A. Hubrecht.—On the Pselaphidæ and Scydmænidæ of the Sunda Islands by Dr. L. W. Schaufuss.—Description of a new species of Apogonia, by Dr. D. Sharp.—On a new species of Pantolamprus from Liberia, by Dr. E. Candèze.

Bulletin de la Soc. Imp. des Naturalistes de Moscou, tome lvi. No. 3, 1882, contains; V. Kiprijanoff, on fish remains in the Siwerischen Osteoliths (2 plates).—Dr. Max Schmidt, on *Bolborhynchus monachus*.—Prof. K. Lindeman, on *Coleophora tritici*, a new injurious Russian insect.—Dr. J. v. Bedriaga.—On the Amphibia and Reptiles of Greenland.—F. v. Thumen, contributions to the fungal-flora of Siberia.—N. Vischniakoff, on the *Ammonites distractus* of Quensted.—Prof. Bredichen, report on the tails of comets 1881 *b* and *c*.—Dr. E. Kern, on a new milk ferment from the Caucasus (2 plates).—Th. A. Sludski, on two inequalities taking place in the movement of the solar system (in Russian).—A. Becker, journey to Southern Daguestan.—M. Menzbier, comparative review of the ornithological fauna of Moscow and Toula.—A. Regel, Correspondence.

Zeitschrift für wissenschaftliche Zoologie, vol. xxxvi., part 4, 1882, contains J. Brock, on the anatomy and systematic position of the Cephalopoda (with plates 34 to 37).—O. Katz, contribution to a knowledge of the tegumentary system of the pouch and its several accompanying organs in the marsupials (with plates 38-40).—R. Rössler, contribution to the anatomy of the Phalangidæ (with plates 41 and 42).

Archives des Sciences Physiques et Naturelles, May 15.—Study on the chemical composition of albuminoid substances (continued), by A. Danilewsky.—Mean diurnal heights of Lake Leman, at Secheron, from 1874 to 1881, by P. Plantamour.—The rheolyser, by E. Hartmann.—Darwin considered as regards the causes of his success and the importance of his works, by Alph. de Candolle.

Sitzungsberichte und Abhandlungen der naturwissenschaftlichen Gesellschaft Isis in Dresden, July to December, 1881.—On some lime-spar crystals, by A. Pungold.—Flora of Dresden and its environs, by C. F. Schulze.—On the oldest traces of fossil plants in Saxony, by H. B. Geinitz.—On the progress of Geological researches in North America, by the same.—On the occurrence of Cenomanian petrefactions at Dohne, by J. v. Deichmüller. On the occurrence of the Riesengebirge races of *Pinus Montana*, Müll., in the Saxon-Bohemian Oberlausitz, by O. Drude.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 15.—"On an Arrangement of the Electric Arc for the Study of the Radiation of Vapours, together with the Preliminary Results." By Professors Liveing and Dewar.

By the arrangement described, the authors are able to make observations as the temperature rises and as it falls, and so to trace the influence of temperature in many cases in which the extent of that influence was before doubtful. The temperature

attainable is doubtless far below that of the arc, but still it is quite sufficient to maintain iron and aluminium in the state of vapour, and show the reversal of the lines of these elements with singular sharpness. The temperature of the interior is sufficiently high to transform the diamond into coke, even in a current of hydrogen, and the result may be taken as proving that the temperature is above that of the oxyhydrogen flame.

The apparatus is thus constructed:—A rod of carbon, 15 millims. in diameter, perforated down its axis with a cylindrical hole 4 millims. in diameter, is passed through a hole in a lime block, and is connected with the positive electrode of a Siemens' dynamo electric machine; another carbon rod, unperforated, is passed into the lime block through a second hole at right angles to the first, so that its end meets the middle of the other rod inside the block of lime. The second rod is connected with the negative electrode of the dynamo-machine, and after contact is made between the two rods, is raised a little, so that the arc discharge continues between the two carbon rods within the block of lime. In this way, the outside of the perforated rod or tube becomes intensely heated, the heat is retained by the jacket of lime, and the interior of the tube gradually rises in temperature, and attains in the central part a very high point. By stopping the arc it can be made to pass through the same stages of temperature in the inverse order. Observations are made by looking down the perforation. When the light issuing from the tube is projected by a lens on to the slit of a spectroscope, the heated walls of the tube give at top and bottom a continuous spectrum, against which various metallic lines are seen reversed, while in the central part, when the tube is open at the farther end, the spectrum is discontinuous, and the metallic lines seen reversed against the walls at top and bottom, appear as bright lines.

By passing a small rod of carbon into the perforation from the further end, a luminous background can be obtained all across the field, and then, as the walls of the tube are hotter than the metallic vapours between them and the eye, the metallic lines are only seen reversed. A very slight alteration in the position of the carbon rod makes the lines disappear, or reappear, or show reversal, and as the core is adjusted by eye-observation before photographs are taken, all the conditions of the experiments are thoroughly known and are under easy control. The authors have taken photographs of the violet and lower part of the ultra-violet spectrum given by the tube at successive intervals while the temperature was rising, and noted the following results. When commercial carbons were used the first lines to be seen as the temperature rose were the potassium lines, wave-length 4044·6, next the two aluminium lines between H and K became conspicuous, then the manganese triplet about wave-length 4034, and the calcium line, wave-length 4226, then the calcium lines near M and an iron line, probably M, between them, and then gradually a multitude of lines which seem to be all the conspicuous iron lines between O and *h*. At this stage, when the small rod is used to give a background, the bright continuous spectrum is crossed by a multitude of sharp dark lines, vividly recalling the general appearance of the solar spectrum. In the higher region the continuous spectrum extends beyond the solar spectrum, and the magnesium line, wave-length 2852, is a diffuse dark band, while all the strong iron lines about T, and the aluminium pair near S, are seen as dark lines. The behaviour of the calcium lines H and K is peculiar. These lines are often absent altogether, when the line wave-length 4226 and the two near M are well seen, and when the two aluminium lines between them and many of the iron lines are sharply reversed. Even the introduction of a small quantity of metallic calcium or calcium chloride into the tube did not bring them out reversed. They were only seen as bright lines, not very strong, when the small rod was removed.

In some of the photographs H is visible as a bright line without K. The authors have formerly observed that K shows reversal in the electric arc spectrum taken in a lime crucible on the addition of aluminium, when H remains bright, and such a condition as that shown by the hollow carbon tube when H is present without K, might legitimately have been predicted. The lithium lines at 4603 and 4131 are often bright when many other lines in the neighbourhood are reversed, and must therefore be regarded as relatively difficult of reversal. As a rule, the lines less refrangible than 4226 are balanced as to their emissive and absorptive power and therefore disappear, while the more refrangible are reversed. The cyanogen group at 3883 remain bright when the iron lines on either side are reversed; they often, however, disappear on the continuous spectrum. Many lines about P and Q of the solar spectrum are reversed. The cyanogen band above K is generally to be found in the photographs of the spectrum when only air is in the tube. It is then very faint, and is the only cyanogen group visible. If ammonia is passed into the tube the fine set above K, the N group, and, although less plainly marked, the set at 4218 appear. In one plate the thin lines at 4380 and the group of seven at 4600 appear along with the blue hydrocarbon set. It is well known that ammonia reacts on carbon at a white heat, producing cyanide of ammonium and hydrogen, so that the genesis of the cyanogen spectrum under the present conditions is a crucial test of the validity of the author's former observations on this subject.

Both the indium lines 4101 and 4509 are persistently reversed, together with several lead lines. Tin gives lines partly reversed in highly refrangible portions of the spectrum, and silver gives a fine fluted-looking spectrum in the blue. Chloride of calcium gives a striking set of six or seven bands about M, which may be seen both bright and reversed.

When the small rod is removed, it is easy at any moment to sweep out the vapours in the tube by blowing through it; it is equally easy to pass in reducing or other gases. Ammonia introduced seems to facilitate the appearance of reversed lines. On passing this gas through a tube containing magnesia, the set of lines just below *b*, which the authors have always found to be associated with the presence of magnesium and hydrogen, and is most probably due to some compound, instantly appear. When the authors can command several electric arcs to heat a considerable length of carbon tube, and are enabled to examine the radiation of a powerful arc passing through the vapour in the tube, valuable results may be anticipated.

Linnean Society, June 15.—Sir J. Lubbock, Bart., M.P., F.R.S., in the chair.—The following gentlemen were elected Fellows of the Society:—The Rev. R. Collie, Chas. A. Ferrier, J. D. Gibson-Carmichael, Sir J. R. Gibson-Maitland, Bart., W. D. Gooch, M. Murphy, Rev. H. A. Soames, H. C. Stephens, H. G. W. Stephens, and James Turner.—Mr. W. T. Thiselton Dyer exhibited specimens of *Equisetum giganteum* from Brazil, which is said to have aërial stems attaining 30 feet.—Mr. C. B. Clarke drew attention to a bundle of Hampshire *Orchis*, in support of his view regarding the *O. incarnata*, L.—Mr. H. N. Ridley showed a *Carex glauca* with two pediceled spikes and lower male spike, each arising from a complex utricle; and he also showed a specimen of *Lolium perenne* exemplifying transition from plumes to carpellary leaves.—Mr. G. J. Fookes exhibited and explained peculiarities of malformation in specimens of wallflower and *Clematis lanuginosa*, var. *alba*.—Sir John Kirk gave information concerning specimens of fruit leaves and the rubber of *Landolphia florida* obtained from the island of Pemba, North Zanzibar; and he showed native bells and rubber beaters from East Central Africa, pointing out the beaters were the only application of the rubber made use of by the negroes.—Sir J. D. Hooker read a paper on "*Dyera*," a new genus of rubber-producing plants belonging to the natural order Apocyneæ, from the Malayan Archipelago. The nearest affinity is with *Alstonia*, from which it differs in the sessile stigmas and singular pistils. Its flower is very minute, scarcely 1–8th of an inch long, and ovules of 1–200th of an inch diameter, yet these are succeeded by fruits of immense size.—The next communication was on the caoutchouc-yielding Apocynaceæ of Malaya and Tropical Africa, by W. T. Thiselton Dyer (for which see science notes).—Prof. E. Ray Lankester afterwards read notes on some habits of Scorpions. Of *Androctonus funestris*, Ehr., he referred to their manner of burrowing in the sand, making horizontal tunnels occasionally 8 inches long. The process of exuviation was described, the scorpion then pushing its large chelæ into the sand and scraping rapidly backwards with the three anterior pairs of walking legs. *Androctonus* in walking raises its body well from the ground, and carries the tail and sting arched over the back, thus differing from *Euscorpius*, which keeps the body low, and drags the tail behind, with only the very tip bent. *Androctonus* feeds at dusk, seizing its prey with the left chela, and, swinging the tail overhead, pierces its victim, and, afterwards grasping the body by the short cheliceræ, sucks the nutrient substances. The comb ordinarily is not sensitive, though it may be more so during the breeding season. Specimens of *Euscorpius* fought with each other, then using the chelæ, and not the sting.—Mr. G. Brook read a paper on a new genus of Collembola (*Sinella*), allied to

Degeeria, Nic. The former differs from the latter in possessing four, and not sixteen eyes, in the absence of the long abdominal hairs, and in the different construction of the claws and mucrones. —Mr. McLachlan made a communication on a Marine caddis-fly from New Zealand. Material for examination of this curious discovery having been received by the author from Prof. Hutton of Canterbury, New Zealand, who found larvæ, &c., in rock pools between high and low water-mark in Lyttleton Harbour. The small pupa case is surrounded with and strengthened by portions of a coralline. Mr. McLachlan finds that the caddis-fly in question has been referred to as a new genus, *Philanisus*, by Walker, and apparently the same form described by Brauer under the name of *Anomalostoma*, but neither of these entomologists seem to have known anything regarding the development or habits of the insect.—Prof. P. M. Duncan, in a paper on the genus *Pleurochinus*, L. Agass., now shows that the linking it with the fossil forms from Gand, as described by D'Archiac and Haime, is erroneous. The minute anatomy of its test corresponds closely with that of *Temnopleurus*, with which he places it as a sub-genus; it being distinct from *Temnochinus*, and the Nummulitic so-called Temnopleuridæ of D'Archiac and Haime.—Mr. F. M. Campbell gave his observations on a probable case of parthenogenesis in the house spider (*Tegeneria*). He submits that the fertility of one of the spiders he kept in confinement for 11 months, during which time she twice moulted and afterwards laid eggs, which were duly hatched, can only be explained by one of the two alternatives—(1) either impregnation must have occurred prior to the casting of the two exuviæ, and therefore in an immature stage; or (2) parthenogenesis takes place in the Aracnidea, of which no case (virgin reproduction) has hitherto been recorded in the true spiders. —A paper was read, on the indication of the sense of smell in Actiniæ, by Messrs. W. H. Pollock and G. J. Romanes. From their experiments, it appears probable that a kind of diffused olfactory sense is possessed by these lowly organised creatures. —Thereafter the following papers were read:—On the fungi of Queensland, Australia, by Messrs. M. J. Berkley and C. E. Broome; on a new Infusorian allied to *Pleuronema*, by F. W. Phillips; on *Teredo utriculus*, Gm., and other ship-worms, by S. Hanley; on a collection of ferns from the Solomon Islands, by J. G. Baker; and the fifteenth contribution to the Mollusca of the *Challenger* expedition, by the Rev. R. Boog Watson.—With a few remarks from the President, concluding the session, the meeting adjourned till November 2.

Meteorological Society, June 21.—Mr. J. K. Laughton, F.R.A.S., president, in the chair.—The following papers were read:—A new metal screen for thermometers, by the Rev. F. W. Stow, M.A., F.M.S. This screen differs from the ordinary Stevenson in the following respects:—(1) It is somewhat larger. (2) It has a single set of double zinc louvres. (3) It is partially closed at the bottom to cut off radiation from the ground. The advantages claimed for the use of zinc louvres are:—(1) The conductivity of metal causes the heat derived from the sun's rays to be distributed over every part of the louvres. (2) The louvres being much thinner than those of wood, the circulation of air through the screen is not only much greater absolutely, but much greater also in proportion to the bulk of the louvres. (3) The zinc louvres, therefore, are much more sensitive to changes of temperature than wooden ones. Comparative readings of thermometers in this screen, along with those in an ordinary Stevenson screen, were made during the summer of 1881. From these, the author is of opinion that the Stevenson becomes unduly heated when the sun shines, but this may be as much due to its small size as to the material of which the louvres are made. The thermometers in it are only three to five inches from the louvres at the back of the screen, against seven to eight inches in the zinc screen. The roof, too, is single, and the box is open at the bottom. The author also says that there is no need to condemn all wooden screens, but there does seem to be some reason to think that screens with metal louvres might be better.—On the effect of different kinds of thermometer cribs, and of different exposures in estimating the diurnal range of temperature at the Royal Observatory, Cape of Good Hope, by David Gill, LL.D., F.R.A.S. Meteorological observations were commenced at the Cape Observatory in 1841, when the thermometers were placed in a well-ventilated crib, before a south window, through which they could be read. The buildings were, unfortunately, burnt in 1852. A small wooden house with double roof, and affording a free passage of air, was then erected on the site of the old meteorological observatory. The instruments were placed in the middle of this building, and observations were recommenced on the same plan as before, and continued until the end of August, 1858. On September 1 the thermometers were transferred to a crib erected in front of the south-west window of the transit-circle room. This crib is well ventilated, except on the side next the transit-room window, but the great mass of solid masonry in the immediate neighbourhood of the thermometers appears seriously to affect the range of temperature. For many years a Glaisher stand has been in use, and at the end of 1880 the author caused a Stevenson screen to be erected in its immediate neighbourhood. In this paper the author gives results of observations made in the window, Stevenson and Glaisher screens, during the year 1881, from which it is evident that the exposure of the thermometers in the window crib gives a distinctly smaller, and on the Glaisher stand a larger, daily range of temperature than in the Stevenson screen.—Some account of a cyclone in the Mozambique Channel, January 14–19, 1880, by C. S. Hudson.—Rainfall of Frere Town, Mombassa, East Coast of Africa, 1875-1881, by R. H. Twigg, M.Inst.C.E., F.M.S.

Anthropological Institute, June 13.—General Pitt-Rivers, F.R.S., president, in the chair.—Mr. Mann S. Valentine, of Richmond, Virginia, exhibited a series of figures carved in steatite and mica schist, forming part of a large collection found by him in Virginia and North Carolina. The whole collection consists of some 2000 specimens, consisting of various animals and household utensils, cups, &c.; the human beings are all clothed, and are represented riding on animals and sitting on chairs, and indicating a remarkably advanced state of civilisation; and in some instances, obvious traces of contact with Europeans. Mr. A. H. Keane describ d the district in which the objects had been found, and the tribes that were known to have inhabited that country.—The following papers were read: Nepotism in Travancore, by the Rev. S. Mateer; the Laws of Madagascar, by Dr. W. G. Parker; and Cummer Co., Wexford, by G. H. Kinahan, Esq.

BERLIN

Physical Society, June 9.—Prof. Roeber in the chair.—Prof. Neesen described experiments on the relation between specific heat and temperature; and first, in the case of distilled water. In these, he used the method of cooling, and the ice-calorimeter; the manipulation of which he indicated. Each time, after filling the calorimeter, and before the heated substance was introduced, the mercury-column, whose displacement, due to the melting ice, was to be observed, showed spontaneous movements, first back and then forwards; which source of error could be partly avoided by using glass for the external envelope of the calorimeter, instead of the zinc-vessel. It further appeared, that the first two measurements always gave too small values, and were useless, probably because the ice, which was to be melted by the cooling body, was not at 0° C. at the beginning of the experiment, but at a lower temperature, and therefore a part of the communicated heat was used in heating to 0° C. The carefully purified distilled water, whose specific heat was to be ascertained, was in a platinum or glass capsule; in the former the soldering occasioned great difficulties, so that most experiments were made with glass. The measurements already made (they will be extended next winter) range in temperature from 2° to 30° C. (by a normal air-thermometer). If the directly observed changes of volume be taken as ordinates, and the temperatures as abscissæ, a curve is obtained, differing little from a straight line. A close examination of the numerical values shows that the mean specific heat of distilled water from 2° C. slowly increases to a maximum between 20° and 21°, beyond which, to 30°, it slowly decreases; but the divergences from the mean value are always very slight. According to the mercury-thermometer, the maximum of the specific heat is about 12° C., instead of 20°. Prof. Neesen does not regard the numerical values as absolute, but merely, for the present, indicative (*orientirende*); and he hopes to verify them by further measurements. —Dr. Hertz reported on experiments which he had made on the vapour-tension of mercury, by a different method from that lately described by Dr. Hagen. The vapour-tension was measured at high temperatures, and values were obtained which likewise were smaller than Regnault's, but greater than those found by Dr. Hagen. From his values, Dr. Hertz calculated a formula, according to which he produced a curve of the vapour-tension of mercury with varying temperature; its zero point being at absolute zero (−273° C.). For low temperatures 0° C., 10°, and 20°,

the values he deduces from his formula, are under those obtained experimentally by Dr. Hagen for the same temperatures.

BERLIN

Physiological Society, June 2.—President, Prof. du Bois-Reymond.—Prof. Kronecker reported upon the experiments which Dr. Melzer made to determine the action of the vagus and superior laryngeal nerves upon respiration. The idea that the action of the vagus in respiration has already been definitely determined, proved to be unwarranted by the facts of the case. It is known that stimulation of the nerve can both suspend inspiration and expiration; but the conditions of the opposed effects are still to be investigated. Now the experiments of Dr. Melzer have shown that these conditions are very manifold and complicated. In a succession of cases, it is the strength of the electric current that determines a particular effect; slight stimulation of the vagus, producing a cessation of respiration in inspiration, great stimulation producing the cessation in the position of expiration, whereas stimulation of medium intensities produced cessation in an intermediate position. Further, the condition in which the respiratory apparatus was at the moment of stimulation of the vagus, determined the results of the stimulation; the effect of an equal degree of stimulation during inspiration being exactly the reverse of what it would have been if applied during expiration. Simultaneous stimulation of the vagus and the superior laryngeal had likewise very diverse effects. If one nerve was more strongly stimulated than the other, the effects of the more strongly stimulated nerve overcame those of the other. If the stimulation in both was equally strong, the results were cessation, either in the position of deep expiration (this taking place when the vagus assisted the action of the superior laryngeal), or in an intermediate position when the two nerves acted antagonistically. Dr. Melzer has also had opportunities of observing individual differences in the action of the vagus, and supposes that the sex of the animal experimented upon may have some influence. Since Hunter's time there have been very few attempts to count the pillars in the electric organs of the Torpedoes, and his view as to their number was universally received as accurate. By the numerous careful countings of Prof. Fritsch, on the contrary, it was discovered that the number of the pillars only differed slightly in large and small specimens of the same species, being often even greater in small specimens than in large ones; embryos of Torpedoes were examined by him, and these already exhibited the same number of pillars as are to be met with in adult specimens of the same species. On the whole the number of pillars in several species of Torpedoes, which are to be regarded as "good species," is pretty nearly the same. It varies between 400 and 600; very large differences in the number of the pillars are to be regarded as "species-characters," and are to be taken into consideration in diagnosis. And from this point of view Hunter's results admitted of an explanation. For Herr Fritsch had an opportunity of seeing two preserved specimens of the American *Torpedo occidentalis* in Vienna. These were, in spite of their shrinking in the spirit, one metre long, and they turned out, when a calculation was made of the number in their electrical organ, to have more than 1000 pillars; it is hence probable that Hunter's giant electric rays were specimens of *Torpedo occidentalis* that were washed upon the English coasts by the Gulf-stream, and that Hunter's enumerations do not in the least contradict the doctrine of preformation.

PARIS

Academy of Sciences, June 19.—M. Jamin in the chair.—The following papers were read:—On the reaction-current of the electric arc, by MM. Jamin and Maneuvrier. With a Gramme machine and an arc between unequal carbons, or between some metal and carbon, there is a differential current, by which a galvanometer is affected—largely when copper, zinc, or mercury is used; little (and about equally) with lead, iron, and carbon: these latter show the greatest resistance. The current is explained, not by a difference of resistance, but by an inequality in the inverse reactions of the arc in the two directions. With a mercury arc, the differential current wholly changes the working of the machine, one system of currents being greatly weakened, while the other grows in strength.—On the reciprocal displacements of halogen substances, and on the secondary compounds which rule them, by M. Berthelot.—Separation of gallium, by M. Lecoq de Boisbaudran. He describes the separation from zirconium, manganese, and zinc.—M. du Moncel presented his work, "On the Microphone, Radiophone, and Phonograph."—Total eclipse of the sun observed at Souhag (Upper Egypt), May 17 (civil time), 1882, by M. Thollon.—Same subject: Observations of M. Trépied. He concludes as follows: The position of the green line of the corona corresponds exactly with that of 1474 (Kirchhoff). The relative intensities of dark lines do not seem to be preserved in the spectrum of bright lines. There seems to be a relation between the frequency of the spots and the structure of the corona. There was undoubtedly an increase of intensity of absorption lines in the group B, on the moon's contour; but the author cannot confidently infer a lunar atmosphere.—Same subject, by M. Pinseux.—The President, on a proposal by M. Dumas, asked the Astronomical and Navigation Sections to prepare a programme of observation for the solar eclipse in 1883.—A letter from M. Ferry announced the opening of the Volta competition for a second period of five years.—On a linear equation, by M. Darboux. The displacements through small dilatation or condensations produced in any indefinite homogeneous and isotropic medium, are calculable like a Newtonian attraction, by M. Boussinesq.—On the determination of carbonic acid in the air at Cape Horn, by MM. Müntz and Aubin. They describe apparatus for their method, furnished to Dr. Hyades, who has been familiarised with its use.—On the products of distillation of colophany, by M. Renard.—On microzymas as cause of the decomposition of oxygenated water, by the tissues of animals and plants, by M. Béchemp. He shows that the microzymas of different organs and tissues show unequal energy in action on oxygenated water. Numerical results are given in a table. The microzymas of the lung have the greatest activity; it is as great at first as that of bioxide of manganese, but soon diminishes. Microzymas of the blood and the liver rank next.—On various properties of hydrocyanic acid, by M. Brame. The bodies of animals poisoned with the acid remained in good preservation after a year, though sometimes exposed to 38° C. Preserved in closed vessels, they lose the smell of the acid, and acquire that of formiate of ammonia, which is found in the serous liquid. To embalm with the acid, a little of some substance which absorbs water while hardening (chloride of zinc) should be introduced after the acid.—Chemical composition of different layers of a lava current of Etna, by M. Ricciardi. There is more sesquioxide of iron in the parts in contact with aqueous vapour and atmospheric air.—Lithological determination of the meteorite of Estherville, Emmet County, Iowa (May 10, 1879), by M. Meunier.—On the branchia and circulatory apparatus of *Ciona intestinalis*, by M. Roule.—Comparison of alkaline chlorides as regards toxical power or minimum fatal dose, by M. Richet. These experiments, with chlorides of lithium, sodium, potassium, rubidium, and cæsium, were on guinea-pigs, and by injection under the skin. There seems to be no relation between atomic weight and toxical power.—M. Neujean, in a note, proposed manufacture of manures from the basic scoriæ (containing 10 to 15 per cent. of phosphoric acid) from Bessemer retorts, Martin furnaces, and others.

CONTENTS