

observed and the recovery of light successfully watched. The next night seemed to show the commencement of another minimum, but the star was low at the time of observation. The epoch would appear therefore to be some aliquot part of eight days; if the observation of April 20 is accepted, it will be about 1d. 3h. It is uncertain, as yet, whether the star has been observed at actual minimum; but the diminution of light remarked has amounted to about half a magnitude. As the star is the first certainly variable star in the constellation, it will probably be called R Canis Majoris. The place of the variable for 1875 is R.A. 7h. 13m. 49s., Decl. 16° 9' 7 S.

Mr. Sawyer gives in the same number of the *Astronomical Journal* some observations of Y Cygni, the new Algol-type variable discovered by Mr. Chandler last December. They give a general confirmation of the period, viz. 2d. 23h. 56m., deduced by Mr. Chandler from his own observations.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 AUGUST 21-27.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on August 21

Sun rises, 4h. 56m.; souths, 12h. 3m. 1' S.; sets, 19h. 10m.; decl. on meridian, 12° 9' N.; Sidereal Time at Sunset, 17h. 9m.

Moon (at First Quarter August 25, 20h.) rises, 7h. 37m.; sets, 14h. 10m.; souths, 20h. 30m.; decl. on meridian, 2° 55' N.

Planet.	Rises.		Souths.		Sets.		Decl. on meridian.
	h.	m.	h.	m.	h.	m.	
Mercury ...	3	15	10	54	18	33	17° 49' N.
Venus ...	8	39	14	10	19	41	6 18 S.
Mars ...	1	51	9	56	18	1	21 49 N.
Jupiter... ..	10	49	15	57	21	5	10 46 S.
Saturn... ..	2	18	10	13	18	8	20 16 N.

Occultations of Stars by the Moon (visible at Greenwich).

August.	Star.	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image.
			h. m.	h. m.	° ' "
22 ...	65 Virginis	6	20 34	21 26	92 307
27 ...	B.A.C. 6081	6	17 59	19 14	51 277
August.	h.				
21 ...	14	Venus in conjunction with and 9° 13' south of the Moon.			
22 ...	0	Venus at greatest distance from the Sun.			
23 ...	13	Jupiter in conjunction with and 4° 12' south of the Moon.			
25 ...	2	Mercury at least distance from the Sun.			

Variable Stars.

Star.	R.A.		Decl.		Aug.	h. m.
	h.	m.	h.	m.		
U Cephei ...	0	52.3	81	16 N.	21, 20	8 m
Algol ...	3	0.8	40	31 N.	22, 24	19 47 m
δ Libræ ...	14	54.9	8	4 S.	22, 21	0 37 m
U Coronæ ...	15	13.6	32	4 N.	24, 21	25 m
U Ophiuchi... ..	17	10.8	1	20 N.	26, 21	6 m
					22, 22	36 m
					21, 3	14 m
						and at intervals of 20 8
X Sagittarii... ..	17	40.5	27	47 S.	Aug. 24, 22	0 m
W Sagittarii ...	17	57.8	29	35 S.	24, 20	8 m
U Sagittarii... ..	18	25.2	19	12 S.	21, 0	0 M
β Lyræ... ..	18	45.9	33	14 N.	23, 21	0 m
					27, 2	0 M
δ Cephei ...	22	25.0	57	50 N.	27, 0	0 M

M signifies maximum; m minimum.

Meteor-Showers.

	R.A.	Decl.	
From Pisces ...	60	11 N.	Swift.
Near α Cygni ...	291	60 N.	Slow, brilliant trained meteors.

GEOGRAPHICAL NOTES.

THE *Bollettino della Società Geografica Italiana* for June contains a valuable contribution to the study of the ethnical relations in the Ogoway and Lower Congo basins, by the Cavaliere A. Pecile, who was associated for three years with Count Giacomo di Brazzà in his exploration of the new French protectorate in the equatorial region north of the Congo. All the multifarious tribes of this extensive region, which stretches from the coast inland to the Ubangi affluent of the Congo, are divided into two essentially distinct groups, that is to say (1) the original settled populations, either aborigines in the strict sense of the term, or such as have occupied their present homes from prehistoric times; and (2) those that have made their appearance in comparatively recent times on the Ogoway and Lower Congo continually pressing forward from the interior towards the coast. To the former group belong the Batekes, Adumas, Avumbos, Mbocos, Ondumbos, Mboshi, and many others; to the latter the Bakales, Pauens (Fans), Okandas, and Obambas of the Ogoway, and the Apfurus, Bayanzi, and others of the Congo and its northern affluents. One of the most important results of the author's researches is the light that he throws on this mysterious forward movement of the inland tribes, which is not confined to the equatorial regions, but extends almost uninterruptedly northwards to Upper Guinea and Senegambia. Here the chief aggressive populations are the Toucouleurs (mixed Berbers), Fulahs, and Mandingans, all now Mohammedans; in the Ogoway and Congo basins the Bakales, Fans, and Bayanzi, all still pagans, and mostly cannibals. These have already reached the coast at many points, pressing forward from a vast and almost impenetrable forest zone, which stretches from the seaboard eastward probably to the Niam-Niam country in the heart of the continent. But the author believes that he has discovered the very cradle of the fierce Bakale and Fan peoples about the head waters of the Ivindo (2° 30' N.), where the old settlements still exist whence the first waves of migration flowed westwards. This general westward movement is described as taking place unconsciously, or through a sort of vague instinct attracting the over-crowded inland populations towards the centres of trade on the coast. Their interests naturally impel them in the direction whence come the European commodities so much coveted by all the inland populations. The Bakales appear to have preceded the Fans by many years, their migrations being chiefly directed towards the lagoons of the Lower Ogoway, where they are now settled between the local Galoa and Inenga tribes. The Bayanzi, who have acquired the ascendancy along the right bank of the Lower Congo, seem to have come originally from the same regions as the Fans, whom they resemble in physical appearance, character, language, and usages. But while the latter are "land-lubbers," displaying absolute horror of the water, the Bayanzi have always been great fluvial navigators, so that their original home may have been the Upper Ubangi, slowly advancing down this great artery to its junction with the Congo. In general the settled aborigines are of blacker complexion and more decided Negro type; the intruders much fairer, taller, with more regular features, less woolly hair, more animated and intelligent expression. At the same time they are also more ferocious and very decided cannibals. This point, about which some doubts had been expressed, was confirmed in a startling way by the fate of three Aduma boatmen belonging to the Expedition, who happened to be left behind near a Fan village on the banks of the Ogoway, and whose skeletons were afterwards found carefully picked (*diligentemente scarnati*) by the villagers. The Fans are continually on the look-out for captives to supply their cannibal feasts, whereas the somewhat more pacific Batekes are anthropophagists rather through the necessity of procuring a flesh diet in their present territory, which is nearly destitute of large game. A chief source of their supplies are the unfortunate slaves, or the humbler members of the tribe, who are denounced by the medicine-men as the cause of any calamity, such as the sickness or death of a chief, and who are always sacrificed and eaten to propitiate the evil spirits, and at the same time to satisfy the craving for human flesh.

THE BRITISH ASSOCIATION.

THE Manchester meeting of the British Association promises to be brilliantly successful. It will probably be attended by a larger number of persons than have been present at any

former meeting; and, as we have repeatedly noted, ample preparations are being made for the hospitable reception of visitors. The meeting will be rendered especially interesting by the foreign men of science who will take part in the proceedings. To the lists, already printed, of these distinguished visitors we may now add the names of the American chemist Dr. Alfred Springer, and Dr. H. F. Weber, of Zürich. Dr. Sterry Hunt, F.R.S., of Montreal, has also expressed his intention of being present.

From an article in the *Times* of the 15th inst. we reprint the following account of the work which is expected to be done in most of the Sections:—

“Coming down to the Sections, we find the Presidential Chair of Section A (Mathematics and Physics) occupied by the Astronomer-Royal of Ireland, Sir Robert S. Ball, who is not only among the most eloquent of scientific orators, but one of the two great recognized wits of the Association, the other being a brother Irishman, Dr. Haughton. We may therefore expect something unusual in the way of presidential address from Sir Robert. The subject of the address will, we believe, be that part of the science of theoretical mechanics known as ‘The Theory of Screws.’ Its treatment will be peculiar and somewhat imaginary; it will indeed be ‘a dynamical parable,’ and contain a little more humour than is usually met with in such addresses. The general proceedings of the Section are likely to be of considerable interest. The report on the very important subject of electrolysis may possibly lead to a lengthy discussion, in which some of the more distinguished foreign visitors may be expected to take part. There may also be a discussion on the report of the Committee on Electrical Standards. Sir William Thomson will most likely exhibit his milliampere balances and read a paper on their application. Some interesting electrolytic results may be expected from Owens College, and Mr. Haldane Gee will exhibit a comparison-magnetometer. Electricity will occupy a prominent place in the Section. Mr. W. H. Preece will probably read a couple of papers. More results of Profs. Thorpe and Rücker’s new magnetic survey may be communicated. Prof. Hull will treat of the effect of continents in altering sea-level. The Ben Nevis Observatory will have another word to say on high-level meteorology, and some papers on heat will come from the Glasgow University laboratory.

“The Geological Section will be presided over by that able palæontologist, Dr. Henry Woodward, of the British Museum. Dr. Woodward, in his address, may be expected to touch on some of the more important topics that have been recently engaging the attention of geologists—the progress of the geological survey, the relations which exist between palæontology and biology, and recent special researches in various directions. There will, we believe, be a discussion by a combined meeting of this Section with the Section of Economic Science, on the question of gold and silver, in which the geologists will mainly deal with the subject of supply. Another important discussion will be on the burning topic of the arrangement of museum collections—whether palæontologists should arrange their finds to suit themselves, or whether the fact of their extinction should be ignored and these specimens be mixed up with their extant fellows.

“The Geographical Section will this year have the honour of being presided over by the chief of the Metropolitan Police, Sir Charles Warren, himself an experienced practical geographer. He will probably in his address deal with one branch of the leading geographical topic of the day—the uses of the study of geography to the practical statesman. In this, the popular Section of the Association, there will be not a few papers of popular interest. The King of the Belgians is sending over two representatives to speak on the Congo Free State, while Capt. Coquilhat, an old Congo official, will read a paper on his own account. Mr. A. Colquhoun, who is in England on short leave, has promised a paper on Burmah and another on Formosa. Mr. John Forrest, the Surveyor of Western Australia, will read a paper on that colony. Mr. Steains, a young engineer just returned from the Botocudo country in South America, will have something racy to tell of an almost unknown people. Dr. L. Wolf, of Leipzig, who has done so much important work on the southern tributaries of the Congo, will give to the Section the results of his journeys. One of the most important papers will be on the new survey of Siam, on which Mr. McCarthy, the official surveyor, has been engaged for seven years, and the beautiful maps of which he has brought home with him. Various aspects of

geographical education will be brought forward by Mr. H. T. Mackinnon, Mr. E. G. Ravenstein, and others, while the subject of Antarctic exploration may receive some attention.

“With Dr. Giffen as President of Section F (Economic Science) we may expect an address which will be worth listening to by all interested in our national progress. The subject will be ‘The Recent Rate of Material Progress in England,’ and the lessons to be adduced will doubtless come home to all in their suggestiveness, so far as holding our own with other nations is concerned. The papers which are promised for the Economic Section are likely to be of unusual interest. The bimetallic movement has a very strong hold in Manchester, and it is expected that Prof. J. S. Nicholson, of Edinburgh, will be present to advocate this cause. Very valuable light will be thrown on the subject by Mr. E. Atkinson, of Boston, who has been commissioned by the United States Government to inquire into European feeling on this important issue. M. Walrus and Mr. Dana Horton will also contribute papers on monetary matters. The status and working of limited liability companies is another subject of special interest in Lancashire; this will be dealt with by Mr. G. Auldjo Jamieson, of Edinburgh. There will also be an important discussion on a topic which is attracting attention all over the country—the depression in the value of land, and the reasons which have brought it about. Dr. Arthur Ransom will contribute an interesting statistical investigation on phthisis areas in Manchester and Salford. Another day will be devoted to a group of papers on subjects connected with foreign trade. Mr. F. Hardcastle, M.P., will read on the classification of the exports of cotton piece goods in Board of Trade returns; Mr. A. E. Bateman, of the Board of Trade, will have a paper on the statistics of our foreign trade, and what they tell us; Mr. Marshall Stevens will write on freights; and Mr. W. Westgarth and Prof. Leone Levi will deal with Australian and American protectionism.

“The economists will also give a day to education, especially in its technical aspects. With this Mr. W. Mather will deal, while Sir Philip Magnus will read a paper on schools of commerce. An interesting paper on farthing dinners in elementary schools will be contributed by Mr. Sargent, of Birmingham, who has made careful and minute observations on the working of the system. Two reports will also be presented to this Section—on the monetary standard, and on the lists by which wages are regulated in the cotton trade. The latter is an elaborate document, and will in all probability give rise to much interesting discussion.

“From Prof. Osborne Reynolds, as President of the Section of Mechanical Science, we are sure to have an address that will be of as much interest to the student of pure science as to those who deal only with its applications. As might be expected, the Manchester Ship Canal is sure to receive considerable attention in this Section, and we may expect a lively discussion on the papers by Mr. W. Shelford on ‘Improvements of Access to the Mersey Docks,’ Prof. O. Reynolds on ‘The Tides in the Mersey,’ and Mr. E. Leader Williams on ‘The Manchester Ship Canal.’ Another paper of the same class will be that by Mr. T. A. Walker on the Severn Tunnel, which is likely to be of special interest. Other papers likely to be of more than average interest will be those of Mr. Gisbert Kapp on the maximum work of dynamos, Mr. H. White on improved railway sleepers, Mr. A. S. Biggart on the Forth Bridge works, Mr. Arthur Rigg on a revolving engine, and Mr. Henry Davey on expansive working in directing pumping-engines.

“Prof. Sayce, as President of the Anthropological Section, is sure to give an address of real human interest. The science of anthropology is young, but it embraces many lines of inquiry. Prof. Sayce will very wisely confine himself to his own line—to the study of language and the evidence we may derive from it as to the history and development of mankind. He may broach some theories that will surprise orthodox anthropologists, and will have a good deal to say upon the Celts. We believe Canon Isaac Taylor is writing a paper on a subject kindred to that discussed by Mr. Sayce, and is expected to occupy the whole of Friday morning. Mr. Stuart Glennie will also contribute a paper on the same subject, and Mr. Akin Károly promises some contributions to the remote history of mankind. Mr. Flinders Petrie’s collection of Egyptian squeezes and photographs will form the subject of a paper by the Rev. H. G. Tomkins. The report of the Egyptian Photographs Committee, and that on the North American Indians, will both be of considerable interest.”

To this statement it is only necessary to add that Dr. E. Schunck will preside over Section B (Chemistry), and Prof. A. Newton over Section D (Biology).

THE JAPAN EARTHQUAKE OF JANUARY 15, 1887.¹

SOON after the occurrence of the earthquake of January 15 last, which caused considerable damage to property in and near Yokohama, the authorities of the Imperial University directed the writer to visit the places which had been affected by the shock, and to make a full report of all the circumstances. The results thus arrived at form the subject of the present paper. Before proceeding with this, however, it seems desirable to give some particulars respecting the principal shocks which have been felt in the Empire since 1879.

The earthquake of February 22, 1880, is the severest that has been experienced in the Plain of Musashi during the last ten years. The damage done to buildings was very much greater than on the recent occasion. Its origin was in the Bay of Tōkyō.

On October 25, 1881, Nemuro, in Yezo, was visited by a somewhat destructive shock. Fissures were opened in the ground, and the damage to property was not inconsiderable.

The well-known Atami Spa and its neighbourhood were convulsed on the morning of September 29, 1882, by a sudden and severe movement, which damaged embankments, destroyed an historical monument, and did sundry other mischiefs.

The earthquake of October 15, 1884, originated in the Bay of Tōkyō, and affected the Plain of Musashi. It overturned a considerable number of chimneys, cracked walls, and broke articles in museums and elsewhere. In Tōkyō, the greatest horizontal movement, in a soft ground, was 42 mm., or double the amount observed on January 15 last. However, the total damage, taking the whole affected area into account, was smaller.

The seismic waves in the disturbance of October 30, 1885, extended over the whole of Northern Japan and part of Yezo, shaking a land area of 34,738 square miles. But, though of great extent, they fortunately did little harm.

On July 23, 1886, quite a destructive earthquake visited Shinano and the neighbouring provinces, overthrowing several houses, and forming fissures in roads and hill-sides. The shock also stopped the flow of a hot spring at Nozawa. The part most severely shaken was a mountainous district some 2000 feet above the sea, including the famous active volcano of Asama, and many extinct craters. This case was an unusual one, as most of the larger earthquakes in Japan extend along the sea-shore.

Next in the list comes the severe shock of last January.

It thus appears that this Empire is visited by a more or less destructive earthquake *almost once a year*, and that the Plain of Musashi is affected in like manner *at intervals of a few years*.

The shock of last January was of most unusual violence. It originated near the coast, about 35 miles south-west of Tōkyō, and the seismic waves propagated nearly 200 miles to the west and north-east along the Pacific seaboard. On the north-west they approached but do not quite reach the shore of the Japan Sea. They shook, in all, about 32,000 square miles of land area.

In Tōkyō the disturbance began at 6h. 51m. 59s. p.m., with slight tremors. After thirty seconds from the commencement, the greatest horizontal motion (21 mm.) was recorded. The time taken to complete one to-and-fro motion of the ground was 2½ seconds. The maximum vertical motion was only 1·8 mm., being, as usual, very small compared with the horizontal movement. The principal motion continued for more than two

minutes, during which time no less than *sixty distinct shocks* occurred. The maximum velocity and maximum acceleration, which measure the overthrowing and shattering power of earthquakes, have been calculated from the above numbers, and found to be respectively 26 mm. and 66 mm. per second. These numbers, considering the range of motion, are small; or, in other words, the oscillations of the ground were comparatively gentle and slow, which serves to explain the fact that but little harm was done to property in the capital. In Yokohama, Hipp's seismograph registered a horizontal motion of 35 mm.

The origin of the shock was in a narrow band of country running from west to east in the province of Sagami, parallel to the coast, at a distance from it of about seven miles. It emanates from the western or mountainous parts of the province, passes through the southern foot of Oyama (4125 feet above the sea-level), and reaches the Bay of Yokohama in a total distance of about 30 miles. I believe the most probable cause of the shock to have been faulting or dislocation of the earth's crust along the band above named. This inference is supported by the fact that the parts of the country through which the western half of the band passes consists of rocks of different geological formations, interwoven in such a way that their junctions present lines of weakness favourable to earth-snaps. The topographical features of the district—high mountains on the north, and comparative low plateau and sea-shore on the south—also lend strength to this conclusion. Unequal distribution of loads on the earth's surface tends to facilitate bending and folding of the rocks.

It is along the above-named axis or band that the effects were most striking. They were mainly confined, however, to a small breadth on either side of it, so that places as little as two or three miles to the north or south experienced a well-marked diminution of seismic energy. This is not the first instance in the history of the severer shocks in which the destructive effects have been practically limited to a small area near the origin.

More especially on the hilly or western portion of the origin, land-slips and cracks were numerous. The cracks mostly took place in banks, hill-sides, or other situations favourable for their formation. The writer counted no fewer than seventy-two in a distance of seven miles, the largest measuring a foot wide and five hundred feet long, and all of them running parallel to the axis of origin, which is also parallel to the general contour of the country. Several wells became turbid. In some of artesian character the water permanently decreased; in others it increased. There is a ferry across the large river Banyū where it is crossed by the axial band; but the water was so agitated by the shock that for some time afterwards the boat could not be used. The water in one of the rivulets on the west became muddy. The shock was severely felt on board of vessels in Yokohama harbour, the people in many of them rushing on deck under the impression that they had been run into. The effects upon these vessels were doubtless caused partly by motion communicated through the cables, and partly by agitation of the water due to movements of the sea-bottom. The earthquake was preceded by the usual warning roar or rumbling, as of distant cannon, emanating apparently from the western part of the origin-band. In that district, too, the after-shocks on the same night were five in number, while in Tōkyō there was only one. There were four tremors near the origin during the night of the 16th.

Dwelling-houses in country towns and villages are always built of wood. Their frame-work is of timbers from four to seven inches square, crossing one another at right angles. The uprights are placed about three feet apart, and stand on rows of squared stones or boulders, the intervening spaces being filled with bamboo-laths, on which is laid the mud-plaster that forms the walls. Tiles and straw are principally used for the roof-covering. In the district near the origin these wooden houses shook with great violence. Several of them were more or less twisted, cracked, or unroofed. Sliding doors, covered with paper or of wood, which serve as shutters, partitions, and windows in Japanese houses, broke and were shot out of their grooves. The joints between the frames were in some cases badly loosened. Although there are thousands of wrecked houses, in the district of origin, on the verge of falling down, and looking as if a strong breeze would be enough to blow them over, the buildings of this class nevertheless withstood the violence of the earth movements so far as to escape actual demolition. The writer saw only two small rotten hovels which had

¹ Paper by S. Sekiya, Professor of Seismology, Imperial University, Japan. Reprinted from the Journal of the College of Science, Imperial University, Japan, vol. 1. part iii. The earthquake, the distribution and effects of which are described in this paper, is the shock which formed the subject of an article in NATURE for June 2 (p. 107), in which one of the autographic records obtained by the author with Prof. Ewing's seismographs was reproduced in *facsimile*. The diagram in question, which showed a greatest horizontal movement of 7½ millimetres, was one of those referred to near the end of this paper as having been obtained on the stiff elevated soil where the University is built, and where the amplitude of the motion was little more than one-third of the motion shown by seismographs of the same construction on the lower alluvial soil.