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Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

MARCH, 1915.

CHAPTERS IN SPECTRUM ANALYSIS.

By W. MARSHALL WATTS, D.Sc.

I.—LAW AND ORDER IN SPECTRA.

A. LINE SPECTRA.

(*Continued from page* 37.)

SERIES in line spectra, similar to that of hydrogen represented in Balmer's law, are found in many spectra, such regularities being the rule and not the exception. The most extensive of such series is that observed in sodium, and known as the Principal Series. The well-known yellow lines seen in the spectrum of a sodium flame constitute the first term of this series—the double line $\begin{Bmatrix}5896\cdot16\\5890\cdot19\end{Bmatrix}$. The second term of the series is the double line $\begin{Bmatrix}3303\cdot07\\3302\cdot47\end{Bmatrix}$; the third term is $\begin{Bmatrix}2853\cdot04\\2852\cdot84\end{Bmatrix}$; and no doubt all the other terms are double also, though the pairs may be too close to be separated. It is well known that the sodium lines are easily reversed, being then seen as dark lines, *e.g.*, the Fraunhofer lines D_1 and D_2 in the solar spectrum; and Professor Wood, by observing the *absorption* spectrum of sodium vaporised in an iron tube heated to a dull red-heat, has extended this series of lines from the seven terms previously known in the laboratory to no fewer than forty-eight terms. This extensive series is represented in the diagram (see Figure 60).

It is a question of much interest to examine whether the wonderful "law and order" exhibited by the hydrogen spectrum, and shown by the exact agreement of the observed wave-lengths with those calculated from Balmer's formula, can be traced in this still more extended series. We see that the case is now somewhat less simple than with hydrogen. In the first place, we have now to deal with a series of *double* lines, or rather with two series of single lines ending at the same convergence-frequency, since the lines of the pairs become closer and closer together as we pass from red towards blue. In the next place, we soon find that the law of the series is not so simple as that of the hydrogen series, and therefore requires a more complicated formula for its expression. The most satisfactory formula appears to be that employed by Mogendorff in 1906, and by Hicks in 1910, namely,

$$\text{O.F.} = \text{C.F.} - \frac{109675}{\left(m + \mu + \frac{c}{m-1}\right)^2}$$

Balmer's formula for hydrogen, it will be remembered, is a simpler form of this, namely,

$$\text{O.F.} = \text{C.F.} - \frac{109675}{m^2}$$

in which m is put equal to 1, 2, 3, and so on, successively, and μ and c are constants. Since we have to deal with pairs of lines, we must have two formulae, one for the less refrangible and the other for the more refrangible lines of the pairs. The best values of the constants are :—

For the less refrangible line :
$\mu = 0\cdot147408$. $c = \cdot031328$.

For the more refrangible line :
$\mu = 0\cdot148204$. $c = \cdot031380$.

The convergence - frequency, C.F., has the same value for both components, namely, 41448·67. The wave-lengths calculated from these formulae agree in the most remarkable manner with the observed values, as shown in the following table :

THE PRINCIPAL SERIES IN SODIUM.

m.	Observed. O.	Calculated.* C.	O – C.
2	{ 5896·16 { 5890·19	5896·16 } 5890·19 }	0
3	{ 3303·07 { 3302·47	3303·07 } 3302·47 }	0
4	{ 2852·93 { 2852·84	2853·04 } 2852·84 }	– ·05
5	2680·46 } Means.	2680·39 } Means.	+ ·07
6	2593·98	2593·89	+ ·09
7	2543·82	2543·86	– ·04
8	2512·15	2512·16	– ·01
9	2490·70	2490·74	– ·04
10	2475·60	2475·56	+ ·04
11	2464·53	2464·42	+ ·11
12	2456·02	2455·97	+ ·05
13	2449·46	2449·42	+ ·04
14	2444·24	2444·23	+ ·01
15	2440·06	2440·06	0
16	2436·70	2436·64	+ ·06
17	2433·85	2433·82	+ ·03
18	2431·43	2431·45	– ·02
19	2429·42	2429·44	– ·02
20	2427·72	2427·73	– ·01
21	2426·28	2426·26	+ ·02
22	2425·00	2424·99	+ ·01
23	2423·88	2423·88	0
24	2422·90	2422·90	0
25	2422·04	2422·04	0
26	2421·29	2421·29	0
27	2420·60	2420·59	+ ·01
28	2420·02	2420·00	+ ·02
29	2419·50	2419·45	+ ·05
30	2419·00	2418·96	+ ·04
31	2418·44	2418·51	– ·07
32	2418·09	2418·11	– ·02
33	2417·71	2417·74	– ·03
34	2417·38	2417·40	– ·02
35	2417·10	2417·09	+ ·01
36	2416·80	2416·81	– ·01
37	2416·56	2416·55	+ ·01
38	2416·33	2416·31	+ ·02
39	2416·11	2416·09	+ ·02
40	2415·89	2415·88	+ ·01
41	2415·70	2415·69	+ ·01
42	2415·52	2415·50	+ ·02
43	2415·37	2415·35	+ ·02
44	2415·21	2415·19	+ ·02
45	2415·06	2415·05	+ ·01
46	2414·94	2414·91	+ ·03
47	2414·78	2414·79	– ·01
48	2414·64	2414·67	– ·03
49	2414·50	2414·56	– ·06

* From the formulae

$$\text{O.F.} = 41448{\cdot}67 - \frac{109675}{\left(m + {\cdot}147408 - \dfrac{{\cdot}031328}{m-1}\right)^2}$$

for the less refrangible line, and

$$\text{O.F.} = 41448{\cdot}67 - \frac{109675}{\left(m + {\cdot}148204 - \dfrac{{\cdot}03138}{m-1}\right)^2}$$

for the more refrangible component of the pairs of lines.

NOTE.—After $m=4$ the two components of the line are not given separately, the numbers in the table being mean values.

Bevan, by following Wood's method, has found and measured similar long series of absorption lines in the vapours of lithium and the other alkali metals, potassium, rubidium, and caesium. The absorption spectrum of lithium vapour is shown in Figure 60.

The wave-lengths of the lines can be calculated with considerable accuracy from the Mogendorff-Hicks formula :

$$\text{O.F.} = 43482{\cdot}61 - \frac{109675}{\left(m - {\cdot}048596 + \dfrac{{\cdot}007564}{m-1}\right)^2}$$

as shown in the following table :

m.	Observed. O.	Calculated. C.	O – C.
2	6708·1	6708·14	– ·04
3	3232·80	3232·81	– ·01
4	2741·44	2741·40	+ ·04
5	2562·60	2562·56	+ ·04
6	2475·13	2475·27	– ·14
7	2422·55	2425·65	– ·10
8	2394·54	2394·59	– ·05
9	2373·9	2373·79	+ ·11
10	2359·4	2359·16	+ ·24
11	2348·5	2348·47	+ ·03
12	2340·5	2340·41	+ ·09
13	2334·3	2334·17	+ ·13
14	2329·0	2329·26	– ·26
15	2325·2	2325·31	– ·11
16	2321·9	2322·10	– ·20
17	2319·3	2319·44	– ·14
18	2317·1	2317·22	– ·12
19	2315·2	2315·34	– ·14
20	2313·6	2313·74	– ·14
21	2312·2	2312·37	– ·17
22	2311·1	2311·18	– ·08
23	2310·0	2310·14	– ·14
24	2309·0	2309·24	– ·24
25	2308·3	2308·43	– ·13
26	2307·5	2307·73	– ·23
27	2307·0	2307·09	– ·09
28	2306·5	2306·53	– ·03

In the diagram (see Figure 27, "KNOWLEDGE," February, 1915) drawn with oscillation-frequencies as abscissae, and the successive values of $1/m^2$ as ordinates, the Balmer series of hydrogen is represented by a straight line, drawn from the convergence-frequency of 27418·75 on the horizontal line OX. In the diagram now given (see Figure 60) the (principal) series of hydrogen, lithium, sodium, potassium, rubidium, and caesium are represented by curves drawn from the respective convergence-frequencies of these elements.

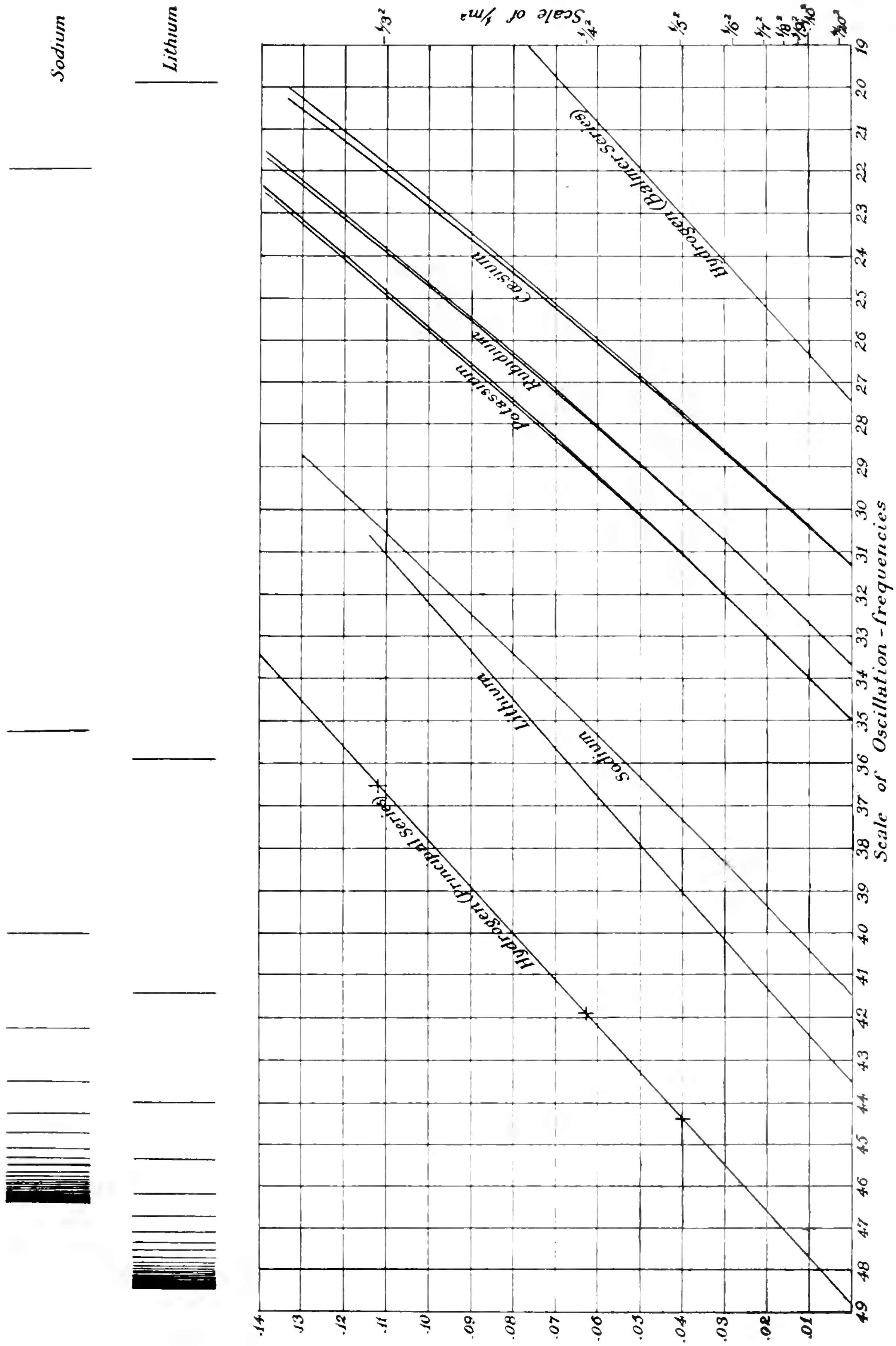

Sodium
Lithium
Scale of 1/m²
Hydrogen (Balmer Series)
Caesium
Rubidium
Potassium
Lithium
Sodium
Hydrogen (Principal Series)
Scale of Oscillation-frequencies

FIGURE 60.

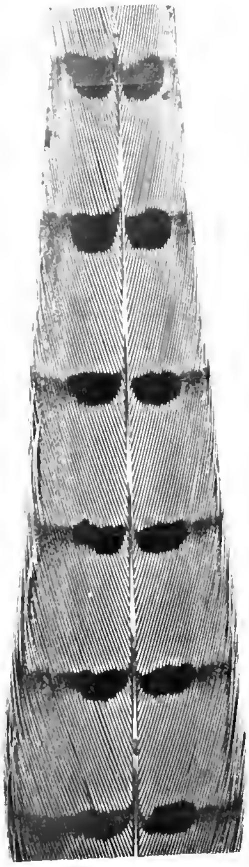


FIGURE 61.
Feather from the tail of a Cock-pheasant.

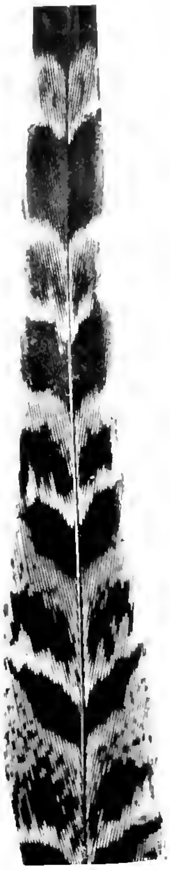


FIGURE 62.
Feather from the tail of the male Pheasant assuming female plumage.

FIGURE 63.
Feather from the tail of a Hen-pheasant.

FIGURE 64. A Cock-pheasant partially assuming the plumage of the female, now preserved in Eton College Museum. From the Millais Collection, and originally bought in Dublin in 1891.

From photographs taken by Messrs. Lascelles & Co.

It will be noticed that these curves are of very similar shape for sodium, potassium, rubidium, and caesium, but the lithium line curves slightly in the *opposite direction* to the sodium line. This difference corresponds to the difference of sign in the formula. The straight line on the left, marked hydrogen (principal series), represents a series of three lines in hydrogen observed by Professor Fowler. It is further to be noticed in this diagram that the convergence-frequencies of hydrogen, lithium, sodium, potassium, rubidium, and caesium lie in the order of the atomic weights of these elements, namely, 1, 7, 23, 39, 85·45, and 132·81 respectively.

(To be continued.)

MALE BIRDS WITH FEMALE PLUMAGE.

It is not at all an uncommon thing for hen birds, owing to old age or injury, to begin to assume the plumage of the cock, and an interesting case has been described in our columns (see "KNOWLEDGE," Volume XXXVI, January, 1913, page 7) of a hen Ostrich which, when its ovaries were removed, developed male plumage entirely. The reverse case, however, is rare. We give here a photograph of a stuffed specimen of the Common Pheasant in Eton College Museum, which came from the Millais Collection, in which the tail feathers, though of the length usually found in the male, are coloured and marked like those of the female. Figures 61 to 64 illustrate this point very well. There are also certain feathers on the sides of the bird which, instead of being brilliantly coloured like those of the cock, are sober-hued like those of the hen.

W. M. W.

THE ZOÖLOGICAL SOCIETY.

At the scientific meeting of the Zoölogical Society, held on February 9th, Sir Edmund G. Loder, Bart., F.Z.S., exhibited the tanned skin of a large Capybara (*Hydrochoerus hydrochoerus*), which he suggested might be identical with the "pigskin" of commerce, and the skull of a Walrus (*Trichechus rosmarus*) from Kamschatka, with record tusks. The weight of the skull and tusks was about forty pounds. The tusks alone weighed twenty-one and a half pounds, and measured thirty-six and a half inches in length, twenty-nine and a half inches from outside the gum, and nine and five-eighths inches in girth.

Dr. P. Chalmers Mitchell, F.R.S., F.Z.S., Secretary to the Society, exhibited preparations of the stomach and intestines of the Open-bill (*Anastomus oscitans*), and described the elaborate sifting apparatus in the stomach and the presence of only a single colic coecum.

Mr. E. Heron-Allen, F.L.S., F.Z.S., exhibited a series of skiagraphs of Foraminifera, revealing their internal structure without transparent mounting or section-cutting, or other interference with the specimens, and illustrating the application of *x*-rays to microscopical research.

Mr. Guy Aylmer, F.Z.S., exhibited some skins of mammals from Sierra Leone, including those of a Serval (*Felis capensis*) and of a Servaline Cat (*F. servalina*), and stated that a native had brought him two kittens, almost certainly from the same litter, one being spotted like the Serval, and the other obscurely speckled like the Servaline Cat. This he regarded as proof that the differences between the Servals and Servaline Cats are of no systematic importance.

Mr. E. G. Boulenger, Curator of Reptiles, read a paper on an Aglyphodont Colubrid Snake (*Xenodon merremii*), with a vertically movable maxillary bone.

FLORA SELBORNIENSIS.

MARCH, THIRD MONTH (*Continued*).

11th.—The Dandelion is *Taraxacum dens-leonis*.

The Sycamore, as we now spell it, is *Acer pseudoplatanus*.

12th.—The Furze (*Ulex europaeus*) is one of the plants that may be found in flower at all times of the year.

Dog's Mercury is *Mercurialis perennis*. Birch is *Betula alba*; the Wood Laurel, *Daphne laureola*. The Humble Bee, if it is a species of *Bombylius*, should be Humble-bee Fly. The names of the other plants mentioned under this date are: *Vinca minor*; *Alliaria officinalis*; *Senecio jacobaea*; *Cynoglossum officinalis*; *Malva sylvestris*, which still stands; *Nepeta glechoma* (Ground Ivy); *Asperula odorata*; and *Daphne mezereum*.

13th.—The Ivy-leaved Speedwell is *Veronica hederaefolia*. The Lesser Celandine is not a *Chelidonium*, but is *Ranunculus ficaria*. Wood-sorrel is *Oxalis acetosella*. The frog and toad mentioned will be the common species in each case, namely, *Rana temporaria* and *Bufo vulgaris.*

14th.—The Marsh Marigold is *Caltha palustris*. The Violets are *Viola odorata*, and the Meadow-sweet, *Spiraea ulmaria*.

15th.—*Chrysanthemum parthenium* is the name by which the Feverfew now goes. The Larch is *Larix europaea*.

17th.—The Guelder Rose is *Viburum opulus*, and the Coltsfoot, *Tussilago farfara*. Gilbert White is careful to add after his supposed record of the tuberous Moschatel that the plant was Sanicle, *Sanicula europaea*. The Pig-nut is *Carum bulbocastanum*.

19th.—The Wych-elm is *Ulmus montana*. Soapwort is *Saponaria officinalis*. The Sloe we now know as *Prunus communis*. The Butcher's Broom is *Ruscus aculeatus*, and the Wood-ant, *Formica rufa*.

21st.—*Ulmus campestris* is the name which is now used for the Common Elm.

28th.—The Hazel is *Corylus avellana*.

THE HISTORY OF THE SCOTTISH SHALE OIL INDUSTRY.

By S. C. BRADFORD, B.Sc.

MOST of the oil fuel now used for naval purposes comes from Russia, America, or Canada; but it is not generally known that a certain proportion is produced by the destructive distillation of bituminous shale in Scotland, nor that the first paraffin oil to be used on any considerable scale for lighting purposes came from the same source. With the eventual exhaustion of petroleum springs, this method will necessarily be generally adopted, and it is remarkable that in a textbook on liquid fuel, only just published, no mention is made of the subject.

As early as 1781 Lord Dundonald showed how to prepare oil from bituminous shale, but no attention was paid to his work; and it was not until 1830 that Reichenbach discovered solid paraffin. In 1839 the manufacture of the latter was attempted in France by Sellique, who six years later proposed a method for making it into candles. There was, however, no demand for the products, and solid paraffin remained little more than a laboratory curiosity, until, in 1850, James Young took out his first patent for the low-temperature distillation of coal, from which time the history of the Scottish shale oil industry may justly be said to date.

Two years previously Young had started a works for refining the petroleum from a spring in Derbyshire. This supply, however, yielded only three hundred gallons daily, and quickly gave out. Reasoning that this oil had been produced by the destructive distillation of coal at a low temperature, though ignorant of Lord Dundonald's work, he conceived the idea of producing a similar result artificially. Many experiments showed the Boghead or Torbanehill gas-coal, in West Lothian, to be the most suitable for his purpose, and the celebrated Bathgate works were soon founded. Lamp oil was the principal product, but lubricating oils and solid paraffin were also produced. Markets were created for the products, suitable lamps introduced, and "paraffin oil," as it was called, rapidly became the source of light throughout the Kingdom.

The success of the manufacture led to the erection of a number of works in Britain and on the Continent, some of the latter importing the Torbanehill coal for distillation. Factories were also started in America to treat the native coals. When petroleum began to be produced in quantity from the springs in Pennsylvania in 1859, these factories were ready to be utilised for its refinement, and led to the rapid development of the American petroleum industry, which soon became a formidable rival to the Scottish manufacture.

In 1862 the supply of Torbanehill gas-coal, which had yielded about one hundred and twenty gallons of crude oil to the ton, began to fail, and recourse was had to bituminous shale, which yielded from thirty to forty-five gallons only. Competition with American oil then began to be seriously felt, and in 1873 oils from Russia and the East commenced to be largely imported. Ammonium sulphate, a by-product of the process, had, however, begun to be used in quantity, and was supplanting Peruvian guano as a nitrogenous manure. But in 1890 its price fell rapidly in consequence of the importation of nitrate of soda.

This long series of checks necessitated constant improvements in processes, with the result that at the present time treatment of a shale yielding twenty gallons of oil to the ton is profitable, while the yield of ammonium sulphate has increased from sixteen to sixty pounds per ton.

The survival of this important home industry has undoubtedly maintained the light of the people at about half what it would otherwise have risen to, and paraffin oil is to-day considerably cheaper in England than it is in the oil-refining districts of America.

The process as now carried out comprises two main divisions. In the first, the shale is distilled in vertical retorts, into which it is delivered at the top, descending slowly, with a gradual increase of temperature as the ash is removed by mechanical means beneath. Steam is introduced below, as well as the permanent gas which is produced during the distillation, no other fuel being required. The products of the distillation are ammonia liquor and "crude oil," which collect in two layers in the receivers. In the second division the crude oil is refined by alternate distillations with fractionation into the several products, and separate treatments with oil of vitriol and caustic soda. By the distillation of the crude oil "green naphtha" is first produced, followed by "green oil" as the temperature rises These are collected separately. The former is agitated with acid and alkali, and redistilled with the production of naphtha and motor spirit. The green oil is subjected to a series of such operations by which it is separated into burning or light oils, intermediate, and heavy oils. The two latter series are cooled to remove the solid paraffin, and used for gas enrichment, liquid fuel, and lubrication.

Liquid fuel has a thermal value greater by fifty per cent. than that of coal, and has the further advantage for naval purposes of easy stowage and of smokelessness, which render its complete triumph certain.

6. March 11. Dandelion, dens leonis, blown.
Sycomore, acer majus, budding. —
12. Furze, Genista spinosa vulgaris, in bloom.
Laurel, laurocerasus, budding for bloom.
Dog's mercury, cynocrambe, blowing; the male bloom only
Birch, betula, budding.
Wood laurel, laureola, in bloom.
Humble-bee comesforth, Bombylius.
Periwinkle, vinca pervinca minor, in bloom in
Shrub-wood: this is a scarce plant.
Jack in the hedge, alliaria, springing all the winter.
Ragweed, Jacobæa, shooting.
Hounds-tongue, cynoglossum, springing.
Malva sylvestris, the common mallow, grows.
Ground-ivy, calamintha humilior folio rotundiore,
creeps about all the winter.
Wood-ruffe, asperula, appears, or rather has not
disappeared the winter thro'.
Mezereon blows.
Crocuss make a most gallant show.
13. Ivy-leaved speedwell, or small henbit, veronica
flosculis singularibus hederulæ folio, in bloom.
Common mint, mentha vulgaris, sprouts.

7.

Pilewort, chelidonium minus, blowing; less celadine.
This & other things are forced before their time by the hot sun shine.

Wood-sorrel, oxys, grown up.

Frog, rana, croaks, & spawns.

Toad, bufo, appears.

The air is full of gnats.

March 14. Marsh-marygold, populago, budds for bloom.
Blue, & white violet, viola martia purpurea, & alba, blows.

Meadow-sweet, ulmaria, sprouts.

Very white frost.

15. Feverfew, matricaria, springs.
Strawberry-tree, Arbutus, shews the rudiments of fruit.
White dead-nettle, lamium album, blows.
Ladies-bedstraw, Gallium, shoots.
Cucumber, Cucumis, shews rudiments of male bloom & fruit.
Apricot, malus armeniaca, blowing.
Peach, malus persica, blowing.
Larch, larix, budding.

8\. March 17. Apricot, malus armeniaca, blows.
Peach, & Nect: malus persica, blows.
Curran, ribes, shows rudiments of bloom.
Asp, or aspin, populus tremula, shews full blown catkins.
Gelderrose, opulus, budds.
Laburnum budds.
Lilac budds.
Rose, Rosa, leafes.
Weeping-willow, salix Babylonica, budds.
Cherry-tree, Cerasus, budds.
Colts-foot, tussilago, in bloom.
Burdock, lappa, sprouting out of the ground.
Discovered, as I suspect, the tuberous moschatel, ranunculus nemorum Moschatella dictus, in it's radical leaves. This was sanicle.
Discovered the earth-nut, or pig-nut, bulbocastanum, in it's first leaves.
19\. Cucum^rs^: Cucumis, flowers.
Wych-elm, Ulmus folio latissimo scabro, budds for bloom.
Soap-wort, saponaria, sprouts.
Larch, larix, budds for bloom.

Sloe-tree, prunus sylvestris, budds for bloom. 9.
Piony, sprouts.
Butcher's broom, ruscus, budds.
Horse-ants, [Hippomyrmeces] or great wood-ants appear.
Vernal equinox. Ice.
Single garden-hyacinths blow.
Daffodils, Narcissus sylvestris pallidus calyce luteo, blows.
21. Common elm, Ulmus vulgatissima folio lato scabro, blows.
23. Snow, & thick Ice.
24. More snow, & a freezing wind.
The bloom of the wall fruit in danger.
apple-tree, malus, budds for bloom.
25. More snow, & Ice.
26. A very deep snow!
27. A second day's snow; which lies very deep on the Ground!
28. Snow melts very fast in the sunshine.
Crown-Imperial, Corona Imperialis, buds for bloom.
Catkins of the hazel, corylus, fall.
A small grass-hopper, [locusta] appears in the cucumr. frame, hatched no doubt in the mould of the bed.

MARS.

A CRITICAL STUDY OF THE FACTS.

By J. E. MAXWELL, F.R.A.S.

There are some who have an immutable, almost sacred, conviction that the tiny speck of cosmic dust on which Fate has placed us is the only body in the universe worthy of being a theatre of life.

Even if there were no positive evidence of life in any other world, such a belief would seem to me to be unreasonable. I cannot help thinking that it owes its origin to the old religious conception of the Earth as the centre of the universe, which was the basis of the opposition to the Copernican view of the solar system.

Those who attempt to mould facts into compatibility with their unwritten creeds would be well advised to abandon either their science or their creeds, or even both, since their science, thus influenced, cannot be sound, and their creeds, in their narrow and undeveloped state, can rest but on a very slender basis.

The universal acceptation of the fact of the plurality of worlds is, to my mind, of the utmost importance. The broadening effect it would have on the minds of men is incalculable.

In the facts which have been gleaned from the planet Mars, chiefly by Professor Lowell, we would seem to have that for which we could never have dared to hope: actual positive evidence of the present existence in another world, not of mere life only, but of a high state of civilisation and mental development.

The study of Mars, then, is of the utmost philosophic importance; for herein lies our one chance of proving beyond dispute the plurality of inhabited worlds.

It is now definitely asserted that Mars is at present peopled by beings of a high mentality, in a state of civilisation greater than is at present to be found upon the Earth.

There is evidence that it is possible on Mars for all the inhabitants to combine in a work which is planet-wide in its dimensions. Such a feat is, alas! at present impossible amongst Earthians. Two seemingly friendly nations cannot agree about so trivial a matter as a Channel tunnel.

We will not waste any more words. Having, it is hoped, impressed upon the reader the importance of the subject, let us proceed to a critical examination of the facts about Mars, which indicate the existence of ultramundane intelligence.

In all probability every reader of "Knowledge" already knows what is meant by the expression "canals of Mars." The canals are very fine, hair-like markings, which intersect the whole surface of the planet. Professor Lowell estimates that they are five or six hundred in number. With one or two exceptions, each runs in the most direct manner possible from one point on the planet's surface to another. They follow the arcs of great circles owing to the curvature of the planet's surface. They thus appear straight when near the centre of the disc.

It has been said that "canals" which are seen straight when at the centre of the disc have continued to look straight, and be so drawn when near the edge of the disc. This is in many instances quite true, and can be explained.

In the first place, the limb appears so bright by contrast with the surrounding sky that generally no markings can be seen very near the edge of the disc, so that "canals" are never seen curved to any very marked degree. In the second place, canals are often such delicate objects that slight observational and areographical errors are bound to occur. In the third place—and this is most important—when a curved line is placed in proximity to a line of greater curvature, it tends to appear straight to most, if not all, observers. Hence canals close to the limb, though in reality curved, tend to appear much straighter than they could possibly be. This is a well-known optical illusion. In many cases, "canals" near the limb actually are represented as being curved.

In length the canals run to thousands of miles: their breadth is immeasurably small, and can only be ascertained by comparison with the appearance of wires of known gauge at known distances.

There can be no doubt but that there is an objective appearance of straight lines on Mars.

There are, however, some who doubt whether this appearance is given by actual linear markings on the planet's surface, or by objects which are resolvable into less regular formations unlikely to be of artificial origin.

It can, of course, be shown that irregular objects seen from a distance may appear regular. A line of dots, irregularly disposed between two points, will give, when viewed from a sufficient distance, the appearance of a straight line. Hence an object, giving the appearance of a straight line, may be composed of a chain of dots. It does not follow, however, that whenever a continuous line is seen it is necessarily composed of a row of dots. As a matter of fact, if the canals of Mars be composed of broken chains of irregular markings, it can be calculated that the interspaces must be very small, as the canals appear unbroken under high magnification. If both the single and double canals connected in so wonderful a system were, in reality, a series of dots in close apposition, it would, indeed, be a remarkable fact, and one strikingly suggestive of an artificial origin. Is it not more comprehensible and credible to regard them as continuous lines?

It has frequently been stated, and possibly believed by the uninitiated, that the canals have actually been resolved into less regular formations by means of apertures larger than those generally employed by Professor Lowell and others who record observations of canals. It is said that drawings made with larger telescopes, though revealing objects which Lowell has apparently failed to see, yet do not show any trace of the hard lines which Lowell habitually draws. In their place appear hazy, uncertain bands, or in some cases nothing at all.

It is time that these matters were fully explained in "KNOWLEDGE."

It may occur to the reader that the whole matter might be cleared up by selecting an arbitrator, who should examine Mars under the best conditions obtainable, and declare what he saw. This would seem to be a reasonable suggestion; but it is impossible, because there is a disagreement as to what are the best conditions under which to view Mars. Under certain conditions no one of any observational ability can fail to see the "canals." Under other conditions they cannot be seen at all. It is one of the purposes of this article to discuss what are the best conditions under which to view the planet.

For the benefit of those who are not accustomed to planetary observing, I may explain that it is not altogether a simple matter. An unpractised eye finds it difficult to see anything except the mere bald image of the object. It is only by long practice by an able and experienced observer that fine details can be seen at all.

A great deal also depends, as will appear, upon the quality of the observer's vision and upon climatic conditions.

It is well known that the latter affects planetary observations to a very marked extent. This is by reason of the fact that the air is not homogeneous in its refractive properties, owing to differences of temperature.

On some nights which are quite fine and clear, and would appear to a layman to be very suitable for observational purposes, "seeing" is so bad that fine details are entirely obliterated or blurred out of recognition.

Small telescopes are far less affected in this respect than are large ones. The larger the telescope, the more susceptible is it to adverse climatic conditions of this nature. This must be admitted by everyone. Telescopes of great aperture can only be used with advantage for fine detail under practically ideal conditions, which are rarely, if ever, encountered in the localities in which these great instruments are situated.

I recall a night of exceptional transparency at Mr. J. H. Worthington's Observatory on the heights of Hampshire. Jupiter, viewed with a four-inch telescope, gave a comparatively steady image; but, with an aperture of ten inches, it was less steady, but good for an English climate. Viewed with the twenty-inch reflector, it was on that night practically hopeless so far as fine detail was concerned. The brilliancy or transparency of that night is testified to by the fact that in the early hours of the morning Delavan's comet was observed low down in the eastern sky, which was already bright with the approaching dawn. It was picked up by Mr. W. H. Steavenson, and this was the first time the comet had been seen by anyone on its reäppearance after conjunction with the Sun.

It is thus apparent that it is inadvisable to use excessively great apertures under imperfect climatic conditions. Any further separation of detail which is obtained by using greater apertures is absolutely outweighed by the increase in the unsteadiness of the image.

Best results on Jupiter were on that evening obtained, not with the twenty-inch telescope, but with the ten-inch Cooke; and I am sure that this difference was not entirely due to the fact that the ten-inch is a refractor, while the twenty-inch is a reflector. It should be remembered that the climatic conditions prevailing at Mr. Worthington's observatory, which is situated at a height of seven hundred feet above sea level, are exceptionally favourable for England.

The disadvantage of using excessive apertures under imperfect conditions can be disputed by no one accustomed to the use of large instruments for work on planets. It is a matter of everyday experience, and, were this article intended for astronomers alone, I would not have thus laboured the point.

In setting up an observatory for planetary work, altitude should be one of the first considerations, for at high levels the atmosphere is least disturbed. The greater the altitude, the better the seeing. Large apertures may thus be used with advantage more frequently at high levels than at low. It is agreed by all that the observatory which enjoys the finest conditions is that of Professor Lowell, Mars Hill, Flagstaff, Arizona. Lowell makes all his observations there. This observatory is situated on the Rocky Mountains at an elevation of no less than seven thousand two hundred and fifty feet. Most of his work on Mars has been done there with a twenty-four-inch refractor, which is exceptionally free from imperfections. Even in the magnificent atmosphere at Flagstaff, Lowell finds that, save on exceptionally fine nights, best results are obtained when he is not using his full aperture. He stops his aperture down to eighteen, and sometimes even to thirteen, inches in accordance with the "seeing."

Those observers who do not draw canals use telescopes of large aperture under imperfect climatic conditions, and always, whatever the "seeing," use their full aperture. They do not see the canals; and it is doubtful whether Lowell, with all his experience and ability, could see them in like circumstances.

Another point regarding telescopes is that, in order to counteract the effects of the secondary spectrum, the greater the aperture of a telescope, the greater in proportion to that aperture must be its focal length. With telescopes of very large aperture it has been found a mechanical impossibility to make the focal length sufficiently great to counteract this defect. Lowell gets over the difficulty to a certain extent by the use of colour screens.

The idea that the reason why "canals" are not seen by users of certain large telescopes is because they are resolved into irregular component parts has now received its final death-blow. During the recent opposition of Mars a successful attempt was made at the Flagstaff Observatory to see the canals with an aperture of forty inches. With this article are published for the first time two drawings of Mars made with the forty-inch Alvan-Clarke reflector on the same evening by Professor Lowell and Mr. A. E. Slipher respectively. It is a great testimony to the steadiness of the air at Flagstaff that the canals could be seen there with an aperture of that magnitude. The canals were not seen with the greatest facility, but unmistakably appeared as thin, unbroken, straight lines.

It has been said that Lowell, though he draws exceedingly fine details in the canal system, altogether omits faint objects of a comparatively coarse nature, which appear in the dark regions of the planet on the drawings of others who see no canals. This in some cases may conceivably be true; but it cannot be argued from this that Lowell's drawings, corroborated as they are by numerous drawings of other observers, are therefore fallacious. Lowell, with his exceptionally acute vision, has devoted his life to the observation of fine planetary detail. The canals are to him the important features on Mars, and he draws them. The delicate shadings in the darker regions do not so greatly interest or occupy him.

It seemed to me that an investigation into the physiology of vision might have some light to throw on this and other astronomical problems. I found that the present state of our knowledge in this direction was rather rudimentary. There is, however, one fact which is incontrovertible: that there is a distinction between *acuteness of vision* (sometimes called acuity), which is the power enabling a man to read fine print in the distance or decipher fine planetary detail, and *sensitiveness to impression*, which is the power of appreciating faint contrasts, enabling a man to pick out faint contrasts of a comparatively coarse nature in the darker regions of the planet Mars.

These two qualities, though frequently confused, are quite distinct. The possession of one of them in a high degree is no guarantee of the possession of an abnormal share of the other. In discussing this matter with Dr. Edridge-Green, who has, I suppose, contributed more to our knowledge on the subject of the physiology of vision than any other living man, I learnt from him that acuity was dependent upon perfection of the eye, while sensitiveness to shade and colour contrasts was dependent upon the discriminating power of the mind. Colour-blindness is thus analogous to tone-deafness.

Then with regard to photography. No one will deny that in the matter of discrimination of fine detail the eye is immeasurably superior to the camera. The value of the camera is that what it records is incontrovertible, and only needs correct interpretation. It would appear practically impossible to obtain photographs of objects so delicate as the "canals." Yet this feat has been accomplished at Flagstaff, and the more prominent "canals" (including doubles) have testified to the fact of their existence by recording their image on the photographic plate, to the satisfaction of persons experienced in reading photographs. Canals can, of course, be seen only on the very finest photographs. Lowell's photographs of Mars, and Saturn also, stand absolutely unrivalled in excellence, though, since Lowell led the way in planetary photography, others have obtained good results in this direction. I refer, of course, to Professor Barnard's photographs, which, though of supreme excellence, cannot be said to excel those obtained by the Flagstaff observers.*

There are many misstatements which have been put forward on the subject of straight lines on Mars, but it is impossible to deal with all of them in a single article. The following is possibly worth mentioning as an example.

I have seen it stated that the "canals" are never seen steadily, but are merely glimpsed in flashes, generally lasting for about one quarter of a second. This is not true. Professor Lowell has assured me, during a conversation on this subject, that at Flagstaff the larger "canals" are frequently held absolutely steadily. It was, said Lowell, not easy to say for how long the more difficult features in the "canal system" were seen, but that they came out clear and sharp in moments of best seeing. As they were seen always in exactly the same place, there could be no doubt as to their objectivity. Mr. Worthington also tells me that this was also his experience when observing "canals" at Flagstaff.

* I have in my possession some photographs of Mars taken by Professor Lowell during the opposition of 1907, which he was good enough to give to me during his recent visit to England. They show indications of the canals. Unfortunately they will not bear reproduction. They are open to the inspection of any reader sufficiently interested to communicate with the Editors of "Knowledge."

In the opening passages of this article I mentioned the philosophic significance of abstractions to be drawn from a consideration of the facts about Mars. It occurs to me that some might be led to the idea that I have pursued my investigations in regard to the canals with a view to proving their objectivity and artificiality. As a matter of fact, although such considerations should have no effect one way or the other, I will confess that, if anything, they influenced me primarily to incline toward the views of Lowell's antagonists, so fearful was I of being led into a belief in conclusions influenced by their desirability. Also the objective existence of the "canals" seemed too romantic to be true. My object in mentioning the philosophic aspect was to impress upon readers the supreme interest and importance of the canal question, and also to suggest an explanation of the fact that the theory has met with such violent and, in some cases, unreasonable opposition.

There are some who, accepting Lowell's observations as accurate, endeavour to show that the "canals" might have originated in some natural manner. Space does not permit me to discuss these views in this article. Suffice it to say that the absolute directness with which these objects run, according to Lowell's drawings, their obviously economic arrangement, the progressive changes which take place along an individual canal after the melting of one of the polar caps, and a thousand other details admit of absolutely no other explanation than that they are of artificial origin.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

METEOR ORBITS.—A few years ago I referred to a paper on this subject by Mr. Charles P. Olivier. He has just published a second paper (Publications of Leander McCormick Observatory, II, 4). The results are based on two thousand eight hundred meteors observed in 1911, 1912, and 1913. His main principle is that meteors used for deducing radiants must all be observed on the same night. He gives one hundred and twenty-six parabolic orbits of meteors, which, with his previous list, brings his total up to three hundred and two. These are not all different showers. Many refer to the same shower on different nights or in different years.

He reviews the growth of our knowledge with regard to the connection of the May Aquarids with Halley's Comet. This was suspected by Falb in 1868, further discussed by Professor A. S. Herschel in 1876, and by Mr. Denning not long after. But he claims to have been the first to make the connection a moral certainty. The meteors have suffered great dispersion, both along the orbit and at right angles to it. The former is shown by the display in 1913 being nearly as great as in 1910; the latter by the fact that some of the tracks are eleven million miles from the comet's track. Observers are asked to pay special attention to these May meteors in coming years. The fact that they are observable only in the small hours considerably reduces the number of watchers. It is conjectured that the Orionids, visible in October, may also be offshoots of Halley's Comet, which makes a fairly close approach to the Earth's orbit at both its nodes. The evidence, however, is much less decisive than in the case of the Aquarids, and it is necessary to postulate much wider dispersion from the parent orbit.

Mr. Olivier considers that the Orionid radiant shows a distinct shift among the stars on successive nights, and gives the following figures:—

Date.	G.M.T.	R.A.	N. Dec.	No. of Meteors.
	d	°	°	
1911, Oct.	17·72	89·1	16·3	3
1912, ,,	18·02	88·8	15·0	5
1911, ,,	19·77	92·8	13·0	13
,, ,,	23·78	96·9	14·5	3
,, ,,	23·80	92·6	15·7	13
,, ,,	24·80	95·5	16·5	10
,, ,,	25·76	97·8	14·4	10

The R.A. seems to increase 1° daily, the declination remaining constant. This was one of the radiants that had been described as "stationary," so the discovery of its motion is of special interest.

The table of the number of meteors of various magnitudes is also interesting. Out of 2229 meteors 90 are of magnitude 0, or brighter; 167 of magnitude 1; 318 of magnitude 2; 537 of magnitude 3; 730 of magnitude 4; 323 of magnitude 5; 51 of magnitude 6; 13 fainter than 6. There is a steady increase up to magnitude 4. The falling off after this is probably due to the greater difficulty of observation, not to actual scarcity of the fainter meteors.

The August Perseïds are noted as having been very numerous in 1907 and 1910.

There is a note on the effect of the passage of a large meteor on telescopic vision. On 1911, May 17th, Mr. Latimer J. Wilson was observing Jupiter, the seeing being perfect. A large meteor passed 35′ above Jupiter. Immediately after its passage the upper atmosphere was so violently agitated that only the coarsest features of Jupiter could be seen. The oscillations lasted four or five minutes, gradually dying down.

From the long list of meteor orbits I select a few that show an unusually close approach to the Sun. The quantity *q* denotes the perihelion distance.

Date.	Radiant. R.A. °	Radiant. Dec. °	*q*
July 31	344·2	−11·6	0·010
Oct. 19	53·5	+22·4	0·019
Nov. 2	65·1	+16·5	0·069
Dec. 9	107·8	+25·9	0·032
Dec. 9	127·0	+17·1	0·018

THE PLANETESIMAL HYPOTHESIS (*Continued*).—There are four possible courses for the matter leaving our Sun under the action of the other Sun:—

(1) Some of the matter returned to the Sun.

(2) Some described elliptical orbits round it.

(3) Some may have been driven into hyperbolic or parabolic orbits. This would be lost to both systems.

(4) (*a*) Some may have been captured by the other Sun, and described elliptic orbits round it; (*b*) conversely some of the other Sun's matter may have been annexed by our system.

The further development of the theory deals only with (2) and (4) (*b*). The matter "takes the form of a spiral with two streams issuing opposite one another, . . . nearly in

FIGURE 65. Elysium. Drawing by Dr. Lowell made on 21st January, 1914. Aperture 40 inches.

FIGURE 66. Elysium. By Mr. E. C. Slipher on 21st January, 1914. Aperture 40 inches.

Figures 65 and 66 are two drawings of Mars made with the full aperture of the 40-inch reflector at Flagstaff on the same evening by Dr. Lowell and Mr. E. C. Slipher respectively. It is evident from the discrepancies that the canals were not seen with the greatest facility. With regard to the vertical double canal in the centre of the disc, Mr. Slipher, when the drawings were afterwards compared, admitted that he had drawn the double too wide. Lowell, by comparing it with "Amenthes," is nearer the truth, though he thinks he erred on the side of narrowness. Lowell probably had the best seeing on that night, as his drawing seems more accurate when compared with the mass of observations which have been made with suitable apertures.—J. E. M

FIGURE 67. Mars, 11th January, 1914, by Dr. Lowell. Aperture 24 inches. Magnification × 392.

FIGURE 68. Mars, 5th January, 1914, 12.45 a.m., by Mr. W. H. Steavenson.
Aperture 10 inches. Power × 300.

Figures 67 and 68 were made within a few days of each other—Figure 67 by Professor Lowell at Flagstaff, using full aperture of 24-inch refractor, and Figure 68 by Mr. Steavenson, using the full aperture of the 10-inch refractor at Mr. Worthington's observatory in Hants, England. It will be observed that everything appearing in Mr. Steavenson's drawing may be found also on Dr. Lowell's drawing. There can thus be no doubt but that at least the canals appearing in Figure 68 are objective.—J. E. M.

FIGURE 69.

A Rock-arch in the Triassic Sandstone at Largybeg Point.

FIGURE 70.

Caves eroded by the sea in the raised-beach platform of Holy Isle.

the plane of the orbit of the disturbing star. . . . The spiral feature relates to the streams of knots and haze, not to the individual paths of each separate constituent, which are held to be elliptical. The inner parts must revolve much quicker than the outer ones, so the spiral streams wrap up till they merge into a disc."

From the relatively small amount of matter that left our Sun the approach of the other star is supposed to have been a distant one. The close approach of two large stars would cause most of their mass to be dissipated into enormous spirals, only a small fraction being left to form the nucleus.

Returning to our own system, the expelled matter is taken to have been mainly gaseous. There is supposed to have been a recurrence of explosions separated by the Sun's natural pulsation period: this would produce definite knots in the spiral streams, these forming the nucleus of the future planets. The subsequent stages are common to many systems of cosmogony. It is shown how a direct rotation of the planets will result: " the velocity of a body in an inner elliptical orbit is on the average higher than in an outer one, but *at the points* where the inner one cuts the outer, and where alone the bodies can come together, the velocity in the outer is higher than that in the inner." This seems to be a sound solution of a long-standing difficulty, which others had tried to evade by the hypothesis of tidal inversion. According to this, the rotation was initially retrograde, but solar tides turned the planet over, reversing its tides. For a time it seemed that the retrograde motion of the outer satellites of Jupiter and Saturn supported this view. But it has now been shown that retrograde orbits are far more stable than direct ones at great distances from the primary, and this is probably a sufficient reason for the behaviour of these satellites.

The stages of the Earth's subsequent history are traced as follows:—

(1) One of the knots in the spiral formed a nucleus, which slowly grew by the aggregation of particles. Their impact would produce much heat, but chiefly in the outer layers, where it would be radiated away.

(2) Magnetic elements would be more easily captured (the authors appear to favour the iron-core theory of the Earth). Once an atmosphere was formed the particles would be ignited on entering it, and a large portion of them reduced to dust, which would slowly settle down. Sifting of the material according to its density would cause continental elevations of lighter material and ocean floors of heavier material.

(3) Radio-active elements are invoked to explain volcanic phenomena. The work of Strutt, Joly, and others is quoted in favour of the concentration of these elements in the Earth's outer layers.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

STRUCTURE OF BUD-SCALES.—The scales which protect the resting buds of trees and shrubs are usually regarded as the last leaves to be developed before the plant prepares for its winter rest, the whole leaf or only part of it showing arrested growth, and becoming modified for its function of protection. Brick (*Beih. bot. Centralbl.*, Volume XXXI) has investigated the microscopic structure of the bud-scales in a number of plants, comparing their anatomy and development with that of the ordinary leaves in each case, and has added various details to previous knowledge of bud-scale structure. He finds that bud-scales resemble leaves closely in origin and growth, but he draws a sharp distinction between the inner scales and the outermost (oldest) ones. The inner scales resemble leaves arrested in their development, agreeing with ordinary leaves in microchemical reäctions as well as structure of the epidermis and mesophyll cells and in the development of air-spaces. The outermost scales, however, have developed on divergent lines, starting at a very early stage, and fall into three distinct groups, for the scale may originate from the rudiment of either: (1) A whole leaf, (2) the basal part only of a leaf, or (3) a leaf in which stipules are already developing. The arrangement of the corky tissue in the outer scale is described in detail, its distribution being such that the bud is enveloped in a closed sheath of corky cells: these outer scales have usually very reduced vascular tissue, so that the scales receive a scanty supply of water, only sufficient to enable them to develop into a protective structure, and serve as a corky envelope around the inner portion of the bud.

CHEMICAL CHANGES IN GEOTROPISM.—It has been known for some time that, when a root or a stem is subjected to geotropic stimulation—that is, when it is placed horizontally, and is receiving the gravity stimulus to which it responds after a time by curving downwards or upwards—chemical changes take place in the cells. Eva Schley (*Bot. Gazette*, Volume LVI) has investigated these changes in some detail, and obtained interesting results, using Broad Bean seedlings. In a growing shoot the acidity of the cell-sap is greatest at the tip, decreasing downwards. When the shoot is geotropically stimulated, the concave side becomes at first more acid, but the acidity then diminishes until the greatest acidity is on the convex side. When visible curvature has been made the two sides again show equal acidity, and this condition remains until the tip has become vertical. These changes in acidity are not parallel with the relative rates of growth of the two sides; but that they are indicative of chemical processes—as yet not fully investigated—taking place in the cells as the result of geotropic stimulation is shown by the fact that the percentage of dry weight is always greater on the concave side. This is to be expected, since growth (involving loss of material) is greater on the convex side when a stem (or root) is curving under the stimulus of gravity.

CHEMISTRY.

By C. Ainsworth Mitchell, B.A. (Oxon), F.I.C.

ALCOHOL FOR INDUSTRIAL PURPOSES.—The development of many British industries has been severely checked by the want of pure alcohol, free from duty; and it is only during the last year that the Excise Commissioners have altered the regulations so as to enable manufacturers to compete on equal terms with their foreign competitors. The current issue of *The Journal of the Society of Chemical Industry* (1915, page 53) publishes these regulations as an official notice. The precautions to prevent the improper use of such duty-free alcohol include proof by the manufacturer that such spirit is essential to his industry, control of the alcohol by a revenue officer, and the addition to it of such approved substance as shall render it unsuitable and unpalatable for drinking. Regulations have also been made for the use of methyl alcohol and petrol, free of duty, for industrial purposes.

AMORPHOUS BORON AND MAGNESIUM BORIDE.—The so-called amorphous boron, as prepared from boron trioxide and magnesium, has been investigated by Mr. R. C. Ray (*Chem. Soc. Trans.*, 1914, CV, 2162), who shows that it is never free from oxygen and magnesium oxide. The results obtained indicate that it probably consists of a lower oxide of boron, possibly in combination with magnesia, in a state of solid solution in amorphous elementary boron. The magnesia may be removed by fusing the preparation with boron trioxide. The crystalline variety of boron, which is approximately pure, does not enter into direct combination with magnesium, whereas amorphous boron yields a boride corresponding to the formula Mg_3B_2, which appears to be the only boride formed by heating the two elements to red-heat under the ordinary pressure. By heating this boride at a high temperature the magnesium is expelled, and a residue containing most of the boron in a crystalline state is left.

CRUDE NITROGEN IN NATURAL GASES.—The crude nitrogen fractions separated from natural gases, such as fire-damp and the gases emitted by thermal springs, have been examined by MM. Moureu and Lepape (*Comptes Rendus*, 1914, Volume CLVIII, page 839). The analyses show that the crude nitrogen is remarkably constant in its composition, whatever its origin, and is composed of very similar proportions of nitrogen, argon, xenon, krypton, and helium. From this fact the conclusion is drawn that these constituents have a common origin, possibly, in the nebulous period. Variations in their quantities may be attributed to diffusion or other physical processes.

NICOTINE FROM WASTE TOBACCO LEAVES.—A description is given by MM. Chuard and Mellet (*Schweiz. Apoth. Zeit.*, 1914, Volume LII, page 424) of the method used in Switzerland for the manufacture of nicotine from the leaves rejected as unsuitable for the preparation of tobacco. The usual process is to extract the nicotine from these leaves immediately after the removal of the crop of choice leaves, but the experiments cited show that this is a mistake. If the stripped stems be left in the ground, and the soil treated with sodium nitrate, there will be a further growth of leaves, and consequently an increased yield of nicotine. For example in some cases the amount of the alkaloid obtained was increased by as much as seventy-seven per cent.

When the nicotine was extracted from the plants at once the average yield was 0·725 gramme per plant, whereas, when the leaves were allowed to grow again, the yield was increased to 1·284 gramme.

It was proved that the sodium nitrate was not directly responsible for the production of nicotine, but that it acted indirectly as a fertiliser, stimulating the growth of the plant. The proportion of nicotine showed considerable variations in different parts of the same plant, much more being present in the roots and shoots than in the stems.

GEOGRAPHY.

By A. SCOTT, M.A., B.Sc.

STREAM-VALLEYS AND THEIR MEANING.—The three chief processes operative in the development of the "thalweg" of a stream are vertical down-cutting, lateral cutting, and "sweep" or the down-valley migration of the meanders. The first of these is dominant when the bed of the stream is considerably higher than the local equilibrium level, so that the stream tends to cut vertically downwards through the subjacent rocks. The result is typically a narrow gorge, with steep sides, and following the course which the stream had before the initiation of the down-cutting. When the gradient is low, the second process is the one which is most active. The stream tends to swing from side to side in its valley, so that a differential wear on the channel ensues. As is well known, the maximum deposition occurs on the inside of the meanders, and a complementary corrosion on the outside. This seems to be mainly due to the current tending to move in a tangential direction at the bends, this tendency increasing with large volume and low gradient. The ultimate form, therefore, is a scalloped outline, with large circular meanders symmetrically arranged. The comparative rarity of this form is due to the operation of the third process, which, in general, is most important, and leaves the greatest ultimate impress on the shape of the valley. In addition to the tangential flow at a bend, there is a strong tendency, due to the down-stream component of gravity, for the stream to take the shortest course, *i.e.*, that round the inside of the bend. The actual course of the strongest current is the resultant of these two, and this explains not only the asymmetric erosion of the meanders, but also the tendency of the latter to migrate down-stream. Circumstances which favour this migration are, low gradient with but little down-cutting, and a large volume of water carrying coarse material. In a river with intrenched meanders the solid rocks resist all three processes, but in a broad valley with rock sides the latter oppose lateral cutting, while the soft alluvial material of the valley-flat offers little resistance to sweep.

The rate of uplift is often an influential factor in determining which of these processes has had the greatest effect. If the uplift be rapid, down-cutting becomes predominant, and the stream entrenches itself in its original course. If the rate of uplift be equal to, or less than, the original rate of down-cutting, lateral cutting and down-valley sweep come strongly into play, with the formation of broad, regular curves, the outsides of which are usually steep and undercut, and the insides smooth and shelving.

J. L. Rich (*Journal of Geology*, July–August, 1914) has classified valleys into three types—Open Valleys, Intrenched Meander Valleys, and Ingrown Meander Valleys—and has considered the formation of each type in terms of these processes. The Open Valley may either be straight or meandering, with wide, open curves and steep sides. The Intrenched Meander Valley, which is apparently the same as the Incised Meander type of other authors, is "one whose stream, having inherited a meandering course from previous erosion cycles, has sunk itself into the rock with little modification of its original course." The windings of the stream follow those of the valley, and river-flats are conspicuously absent. The Ingrown Meander Valley is one which has either developed a meandering course or has expanded an inherited one. This type is characterised by steep, undercut sides on the outside of the curves, and gentle deposition slopes on the inside.

The first of these types is formed when a comparatively straight stream undergoes a rapid uplift. The stream entrenches itself by down-cutting, which continues till grade is reached, when lateral cutting comes into play. This, however, is soon superseded by a down-stream migration of the bends, and the final form is either a broad, open valley, with flat bottom and long, flat curves, or a steep-walled, narrow V-shaped valley. The Intrenched Meander Valley results from the rapid uplift of a meandering stream, which continues to hold its original course, and to entrench itself deeper into the subjacent rocks as long as down-cutting is the principal factor. This type is rarely found, because, when the uplift ceases or becomes slow, Ingrown Meander Valleys develop owing to the operation of the other processes. This third type generally results from the gradual uplift of both straight and meandering streams. The meanders tend to increase through lateral cutting, with the consequent corrosion on the concave sides and deposition on the convex, while sweep leads to asymmetry of the bends, and finally to their down-stream migration. This is particularly the case when uplift ceases and a flood-plain forms.

Obviously the whole three types may be present in a single drainage system, which, for example, undergoes a rapid uplift. The main stream would form an Open Valley where originally straight, and a valley of the second type where originally meandering, while the tributaries of the upper parts would develop Ingrown Meander Valleys, as their rate of uplift would be relatively slow.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

RAISED BEACH FEATURES IN ARRAN.—The two figures give illustrations of sea-wear during the period of the ten-foot raised beach which fringes the island of Arran. In Figure 69, on page 80, a rock-arch is shown, which has been eroded in the soft Triassic sandstones and grits at Largybeg Point. The view was taken from the sea. The arch occurs just above high-water mark at the extreme seaward edge of the raised beach. It was initiated by the erosion of a soft band, the weathering of which had caused the deep nick in the sky-line seen towards the right side of the photograph. The collapse of the block of sandstone which formerly filled the arch took place along well-marked joint-planes, seen on the right side of the arch.

Figure **70, on page 80,** shows caves formerly eroded by the sea on the ten-foot raised beach platform of the Holy Isle, opposite Lamlash. These are well above high-water mark, and make a recess in the cliff which rises at the back of the raised beach.

In both photographs the sandstones show a remarkable hollow weathering, frequently with raised ribs, forming a reticulated pattern. This is supposed to be due to variations in the quantity or composition of the abundant calcareous cement of the Triassic sandstone. The weathering picks out with great delicacy those parts which are more susceptible to solution and decay.

WATER SUPPLY IN MILITARY AREAS.—The Geological Survey has just issued an interesting pamphlet entitled "Notes on Sources of Temporary Water Supply in the South of England and Neighbouring Parts of the Continent." This was written primarily to aid the Royal Army Medical Corps of the First London Division Territorial Force in finding drinking water at short notice by temporary works. It is pointed out that all running streams are highly dangerous as drinking water in a seat of war or populated area, and wells, although not subject to the same sweeping condemnation, are liable to suspicion, especially when shallow. All water obtained from superficial deposits is liable to contamination in these areas, and requires careful testing before use. In choosing a site for a well, a warning is given to avoid the neighbourhood of obvious sources of pollution, such as farmyards, cemeteries, sewage works, etc., and to make a trial farther up a valley than any of these dangerous sites.

On chalk areas running water is usually sparse, and the water is trapped within the fissures of the rock. This supply may be discharged by springs at the outcrop of a relatively impermeable stratum, or may be reached by wells sunk below the plane of saturation. The chalk supplies hard but usually pure water.

These considerations apply to a large part of the war area in Central and Northern France and Belgium, where the strata are generally similar in age and composition to those of the London and Hampshire basins, but the tract of ground east of Valenciennes presents quite different problems. It consists of highly inclined or vertical strata of Devonian and Silurian ages, forming the hills of the Ardennes. In this area recourse will doubtless be had to springs, many of which are to be trusted. No water, however, from whatever source, should be used without testing.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

THE WEATHER OF MARCH.—The general meteorological features of the month of March are very irregular, but its main character is that of boisterousness and cold. Sometimes a strong north-east wind is prevalent, which, when it lasts many days, induces a rapid evaporation from the soil, respecting which there are numerous old proverbs, such as :—

"A peck of March dust is worth a king's ransom."
"A dry and cold March never begs its bread."

March was a very cold month in the years 1845, 1865, 1883, and 1892 ; and it was a very mild month in the years 1841, 1859, 1882, 1893, 1896, 1903, and 1912.

The average mean temperature at Greenwich for March is 41°·9 ; in 1859 it was as high as 46°·8, while in 1845 it was as low as 35°·6. The average maximum temperature is 49°·8 ; the highest mean was 56°·9 in 1893 and the lowest 42°·7 in 1845. The average minimum temperature is 35°·1 ; the highest mean was 40°·5 in 1859, and the lowest 29°·3 in 1883. The absolute highest temperature recorded was 71°·5 in 1848 on the 31st, and the absolute lowest 13°·1 in 1845 on the 14th, and also in 1890 on the 4th. The average number of days on which the temperature falls to or below the freezing-point is ten. In 1845 there were four days on which the temperature was continuously below the freezing-point.

The average rainfall for the month of March is 1·52 inches ; the greatest amount was 4·05 inches in 1851, and the least 0·17 inch in 1852. The heaviest fall in one day was 1·21 inches in 1832, on the 14th. The average number of "rain days" (*i.e.*, on which 0·01 inch fell) is 13·2, the greatest number of days was twenty-two in 1848 and 1896, and the least three in 1852. Snow falls on the average on three days. Hail or "graupel" (*i.e.*, soft hail) usually falls on one or two days. The average amount of bright sunshine at the Kew Observatory, Richmond, is one hundred and six hours.

The average barometric pressure in London for March is 29·955 inches, the highest mean was 30·374 inches in 1854, and the lowest mean was 29·531 inches in 1909.

"March many weathers."
"March comes in like a lion and goes out like a lamb."

WEATHER FORECASTS BY CINEMATOGRAPH.—In an interesting article on "Forecast Distribution," by Mr. G. W. Smith, in the *Monthly Weather Review*, it is stated that the display of weather forecasts on moving-picture (cinematograph) screens is the latest method employed in the United States for giving the information to the public, and was successfully begun in March, 1912. This means of forecast display is now used in eight cities. Mr. Smith also says that the Weather Bureau has ever been alert to take advantage of every opportunity tending to the betterment of the forecast distribution, and is to-day making the forecasts available to more than five and a half million persons (mostly by telephone), exclusive of those supplied through the daily newspapers, daily weather maps, display of flags, and on moving-picture screens.

MICROSCOPY.

By J. E. BARNARD, F.R.M.S.

MICRO-ORGANISMS AND THE WAR.—In all wars of any magnitude, other than the one now in progress, the loss of life from disease has been considerably greater than that resulting from wounds. In the present war the bacterial foes are being so efficiently dealt with that the state of affairs is likely to be reversed, thanks to the efficiency of the Army Medical Service and the great efforts that are being made to lessen both medical and surgical infection.

There are many causes operating to produce this result. Of course, general hygiene has been very carefully attended to, so that the sanitary conditions in camps and other places where men are gathered together for training are very much better than have ever been obtained before. At the same time, the method of vaccination, particularly against typhoid and tetanus, has been exceedingly efficient. In the case of typhoid, which has been the most prevalent of all epidemic diseases in previous campaigns, the result has been nothing less than extraordinary, and the method of anti-typhoid inoculation has proved a marvellous success. No method in preventive medicine can be infallible, but this one has approached as nearly to that state of affairs as can be hoped for. It is very much to be regretted that some people in this country—well-intentioned, it may be, but sadly lacking in scientific insight—have tried to persuade men against being inoculated for typhoid. The results are not only likely to be injurious to those who refuse to submit to what is, after all, but a trivial infliction, but constitute, at the same time, a serious danger to their fellow-men. The Army Council has been well advised, no doubt, in not taking any drastic steps to put an end to the anti-vaccination propaganda. At the same time, there is not the slightest doubt that in cases where the anti-vaccinationists have been successful in fomenting a feeling of resistance, fortunately not very many, the results have been unfortunate enough for the victims involved. Preventive medicine has now become the most important branch of medical research, and the results which have been obtained more than justify any methods that have been decided upon at the present juncture. The danger from epidemic diseases may, and probably will, become more pronounced as the summer approaches; but there is this to be said: the longer it is deferred, the more efficient become the means to combat the danger when it arrives. One important factor—the water supply—has been dealt with very thoroughly, and it is not too much to say that at the present time arrangements are in force which, if only carried out thoroughly, as they should be, leave little room for any danger occurring either to the men under training, or to those actually on service at the front. As to the danger of wound infection, that is a very real one. Those fighting in France are under the influence of a soil that is highly manured, and which is as a result highly productive. Its very productivity shows that it is a good bacterial culture medium, and the result is that a wound, when it occurs, is at once exposed to a chance of bacterial infection against which it is extremely difficult to provide, although the men are supplied with first-aid appliances of the best description. As a result, it is a point for discussion whether an aseptic or antiseptic method of dealing with wounds is, under such conditions, the more efficient. There is much reason to expect that the methods of Lister and antiseptic methods in general will have to be reïntroduced, and that these may prove, after all, to be the soundest and most practical when dealing with infected wounds.

Bacteriological investigations are now in full working order at the front, and field laboratories are provided, well equipped in every respect for efficiently carrying out their diagnostic work. There are a large number of organisms that have to be provided against, and some few of these are illustrated here. Microscopists have not of necessity a collection of bacterial preparations at their disposal, and it is for this reason that the photo-micrographs accompanying this article have been reproduced. They by no means represent all the organisms that will be met with, but they are at least a fairly representative series.

DESCRIPTION OF FIGURE 71.

a—Staphylococcus pyogenes aureus. × 1500. A spherical organism, about 0·75μ in diameter, which stains easily with all aniline dyes. It is the commonest of all organisms met with in suppurative conditions, such as abscesses and boils, and is present normally on the skin, in the mouth, and even in the air.

b—Streptococcus pyogenes. × 1500. Occurs in chains, each individual organism being from 0·75 to 1μ in diameter. It stains well with all aniline dyes. Fission takes place in one direction only; hence the chain formation. The chains vary in length, and may be modified by cultivation. It occurs in inflamed conditions, in gangrene, and in acute abscesses, and is also the cause of erysipelas. There are several varieties of the organisms, but they are very closely allied.

c—Streptococci in pus. × 1000.

d—Streptococci in milk. × 750.

e—Bacillus tuberculosis in giant cell. × 750. A slender rod with rounded ends, which has a beaded appearance when suitably stained. It does not stain well with aqueous solutions of dyes. Its growth in artificial cultivation is very slow, several weeks being required at 37° C. Man is attacked at all age-periods with tuberculosis, its manifestations differing somewhat at varying stages of development. It is not an immediate accompaniment of the early stages of war, but is only too likely to occur at a later stage in those who have become enfeebled by exposure or unavoidable privation.

f—Tube cultivation of *Bacillus tuberculosis.* Natural size. Three months' growth.

g—Phagocytosis. × 750. The leucocytes in the blood stream ingest any bacteria present, and so rid the body of the infection.

h—Micrococcus Meningitidis. × 1000. Occurs as single cocci or as diplococci within the leucocytes. It stains well with ordinary dyes, and grows freely at 37° C. on suitable culture media. It is the specific cause of epidemic cerebro-spinal meningitis, commonly known as "spotted fever."

DESCRIPTION OF FIGURE 72.

i—Bacillus tuberculosis in sputum. × 1500.

j—Diplococcus pneumoniae. Pure cultivation. × 1500. It retains its vitality on ordinary culture media for but a short period. It stains readily with ordinary aniline dyes and by Gram's method.

k—Bacillus tetani. × 1500. A straight rod with rounded ends, which forms spores freely. The spores are frequently present in the dejecta of cattle and horses, and in the earth, so that wound-infection from this source is an ever-present danger.

l—Bacillus typhosus. Pure cultivation. × 1500.

m—Spirillum cholerae Asiatica. Pure cultivation. × 1500. Curved rods, 1 to 2μ in length, sometimes forming a half-circle. Often referred to as the "comma bacillus."

n—Bacillus typhosus, showing flagellae. × 1000.

o—Diplococcus pneumoniae. Film preparation of blood. × 1000.

p—Bacillus diphtheriae. × 1000.

PHOTOGRAPHY.

By EDGAR SENIOR.

MAKING NEGATIVES FROM BLACK AND WHITE ORIGINALS.—It is sometimes required to copy pen-and-ink drawings, printed matter, and so on, and to obtain negatives that will yield proofs in pure black and white, in which case the deposit on the plate, which corresponds to the high lights, must have great opacity, while the shadows or lines must be represented by clear glass. To those who are accustomed to the manipulations connected with the wet collodion process the production of the requisite type of negative would not present much difficulty, since the intensification required in order to gain the necessary opacity is both quickly and easily accomplished. In the case of gelatine dry plates, although there are a number of ways of intensifying the image taken upon them, the time occupied in the manipulations is much longer, as more thorough washing is required between each operation; but even then the shadows, as a rule, are not represented by the clearness of collodion. There is a deposit which it is difficult to get rid of which increases as the opacity grows, especially if a full exposure has been given; and if the exposure has been short it is difficult to intensify with any degree of satisfaction. Thus, chiefly owing to the greater sensitiveness of the gelatine plate, a slight action takes place, and a small deposit is formed over those portions of the film which should be perfectly transparent. One of two things, therefore, remains to be done: either to make the best we can of the conditions as they stand, or to use such means as will modify the results it is desired to obtain. Adopting the latter course, the first thing that should be done is to employ a process plate and give a full exposure, but without in any degree over-exposing, and use a strong source of light whenever possible for the illumination of the original. For development the ordinary pyro-soda developer with an extra quantity of bromide has been found to answer well in practice. The development of the image, however, must be very carefully watched, and at the first appearance of any cloudiness the negative must at once be placed (without washing) into a dish containing a solution of citrate of soda, of a strength of about fifteen grains to the ounce of water;

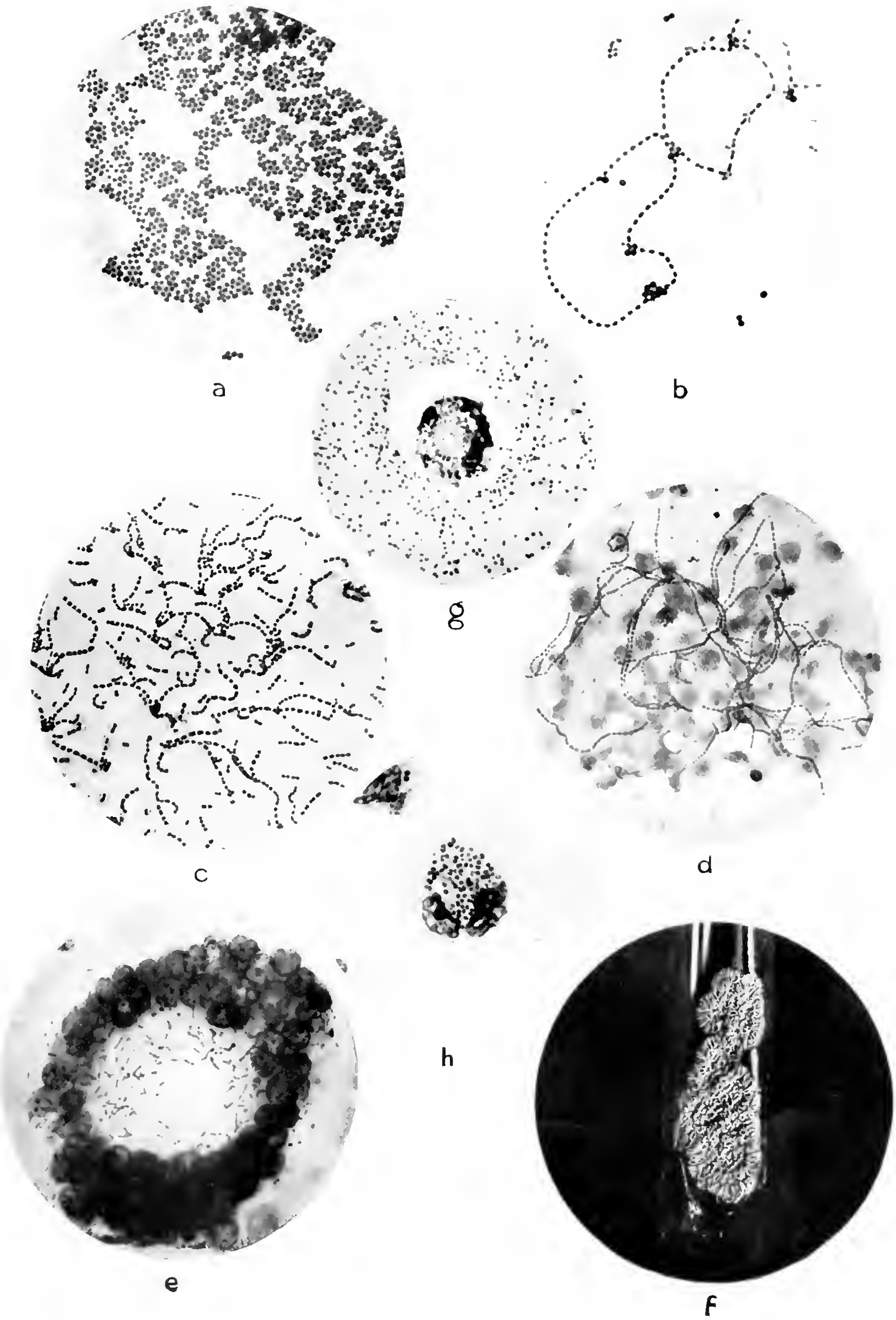


FIGURE 71.
Bacteria which have to be combated during the war. For descriptions see page 84.

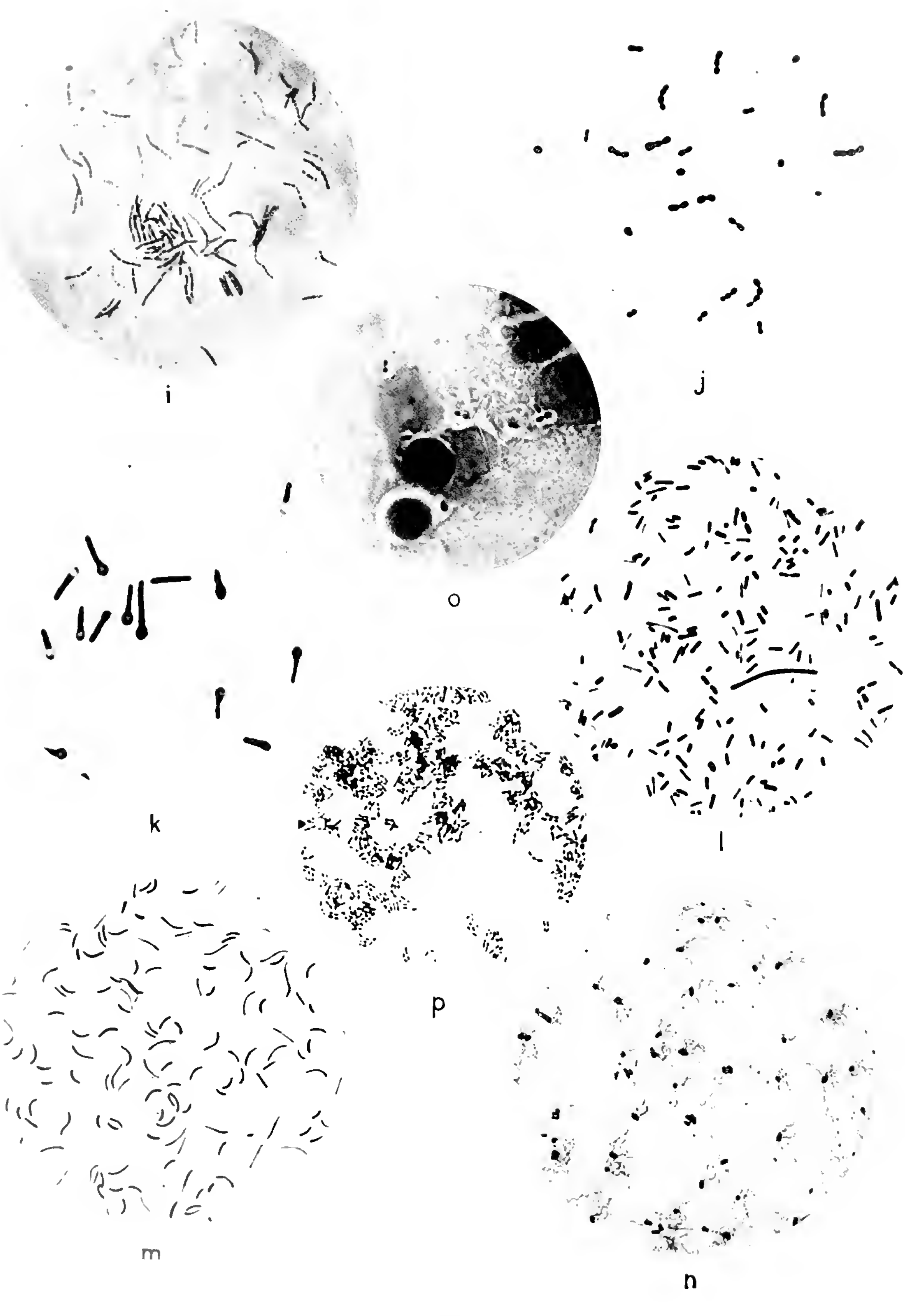


FIGURE 72.
Bacteria which have to be combated during the war. For descriptions see page 84.

or, if the plate be known to be over-exposed, a little of this solution added to the developer previous to the commencement of development will in most cases work wonders. The plate should always be allowed to remain in the citrate of soda solution for about half a minute, when it is taken out and replaced without washing in the developer again, and development allowed to proceed until the requisite density is obtained. If, after fixing, the lines or shadows of the negative appear to be at all clogged, the image, after very thorough washing, should be treated with Farmer's reducer, prepared as follows :—

A.

Potassium ferricyanide	24 grains
Water	1 ounce

B.

Sodium thiosulphate ("hypo") ...	96 grains
Water	1 ounce

The solutions A and B must be mixed together at the moment required for use, as they do not keep when once added together. If treatment with this reducer diminishes the density of the high lights, then intensification must be resorted to. For this purpose Monchoven's intensifier will be found very suitable, as it gives great density, and is, at the same time, non-staining; and, moreover, intensification can be repeated if necessary. The following is the formulae for the solutions :—

No. 1.

Mercuric chloride	$\frac{1}{2}$ ounce
Potassium bromide	$\frac{1}{2}$,,
Water	20 ounces

No. 2.

Silver nitrate	$\frac{1}{2}$ ounce
Water (distilled)	10 ounces

No. 3

Potassium cyanide (pure)... ...	$\frac{1}{2}$ ounce
Water (distilled)	10 ounces

No. 3 is added gradually to No. 2, when a dense precipitate at once forms; as more of No. 3 is added the precipitate first formed begins to dissolve up, and when only a small quantity remains the solution is ready for use. There must not be any excess of potassium cyanide. This solution is kept in a stoppered bottle, labelled "Silver Cyanide Solution." The negative to be intensified is placed in No. 1 until thoroughly bleached; it is then very thoroughly washed, and then placed in the silver cyanide solution to blacken. The necessity of thorough washing after every operation, and especially after treatment with either "hypo" or mercury, cannot be too strongly impressed, nothing less than from a quarter to half an hour under a constant stream of water being sufficient. In fact, if it is a subject of importance that we are at work upon, an hour is sometimes occupied in washing; and in this way we never fail to obtain clean and brilliant negatives suitable for any purpose that may be required of them: certainly in any class of negative work where these agents are employed, the secret of success lies in the thoroughness with which the washing is performed, and when these conditions are fulfilled a negative intensified with mercury is both bright and clean, and of considerable permanence. But the fact remains that for this particular class of work the results are not equal to those obtained upon wet collodion.

PHYSICS.

By J. H. Vincent, M.A., D.Sc., A.R.C.Sc.

SELENIUM CELLS.—The term "selenium cells" may be suitably confined to photo-electric cells in which one of the electrodes consists of a layer of selenium. Cells of this type were investigated by Minchin. A strip of aluminium is coated with selenium, raised to a temperature of 200° C., and, after being kept at this temperature for some hours, is slowly cooled. The prepared strip is now dipped into the cell, which contains acetone, the other electrode being a platinum wire. If the two electrodes are now connected to an electrometer, this instrument indicates a difference of potential between the electrodes when the selenium surface is illuminated. The selenium becomes positively charged with respect to the acetone. The difference of potential varies as the square root of the intensity of illumination. Photo-electric cells of this character are extraordinarily sensitive: by their means Minchin was able to detect the effect of the light from planets and stars.

SELENIUM BRIDGES.—An apparatus in which the change in the electric resistance of selenium when illuminated is studied may conveniently be termed a "selenium bridge" to distinguish it from photo-electric cells with a selenium electrode. Selenium is a very poor conductor of electricity, but becomes more conductive when heated for some time at 200° C., and then slowly cooled. In this condition its electric resistance decreases under the influence of light. The effect of light is practically instantaneous, but the recovery on its withdrawal is gradual. In order to render the fall of the resistance of selenium on illumination easily demonstrable, it should be arranged that the initial resistance of the bridge is so low as to allow of its easy measurement. This is readily managed by coating a cylinder of mica with selenium, and winding a pair of copper wires on it in a double spiral, so that the wires are insulated from each other by the selenium. The resistance between the wires should now be measured, and, if all is right, this should be several megohms. The whole is now heated and annealed, when the resistance in the dark will be found to have fallen to a value easily measured. On exposing such a bridge to bright sunlight, its resistance may fall as much as fifty per cent. Bridges made on this plan, and conveniently mounted for experimentation, can be procured from instrument-makers, who catalogue them as "selenium cells."

SELENIUM CRYSTALS.—Most experimenters who have worked at the curious photo-electric properties of selenium have used the material in the state into which it is brought by slow annealing. The mass is then probably a congeries of interlacing crystals. Recently single crystals of selenium have been studied by Brown and Sieg (*Physical Review*, August, 1914; *Philosophical Magazine*, October, 1914). By employing a needle-shaped crystal, it was first shown that, when silver electrodes pressing on the crystal were used, the resistance of the whole lay chiefly in the crystal, and not at the contacts. Next, it was proved that, when the resistance decreases on illumination, the decrease is due to a change of resistance in the crystal itself, and is not limited to the contacts. So long as any light fell on any part of the crystal there was a marked fall of resistance, even though the illuminated portion of the crystal was not in the direct line of flow of the current. This transmission of the effect of light to a distance was well shown in a remarkable experiment. A long, thin crystal was held between electrodes at one end, and a narrow beam of light was allowed to play on the crystal at various points in its length, while the resistance across the end between the electrodes was measured. It was found that the fall in resistance was as great when the light struck the crystal at the end remote from the electrodes as when it fell close to them. We thus have the amazing result that the action of the light may be transmitted laterally to a greater distance than ten millimetres. The authors are inclined to the view that, when light acts on a crystal, it operates some mechanism which controls by secondary action the conductivity of the whole crystal.

SALTS COLOURED BY KATHODE RAYS.—An interesting paper on this subject was read before the Physics Section of the British Association at the Australian meeting by Professor E. Goldstein, who discovered the effect, and has done most of the work on the subject. The paper is reported in *Nature* of December 31st, 1914. If kathode rays fall on certain salts, such as common salt, potassium chloride, or potassium bromide, vivid colours are immediately produced. Common salt becomes yellow-brown; potassium chloride turns a beautiful violet; potassium bromide becomes a deep blue colour; sodium fluoride takes on a fine rosy tint. The colours so acquired are permanent, if the specimens are kept in the dark at ordinary laboratory temperature; but in the daylight, and also under heat, the colours gradually disappear until the original white condition is again reached. Solid solutions, produced by fusing a small quantity of a colourable salt with a great mass of a salt which itself remains colourless in the kathode rays, acquire brilliant colours when subjected to the rays, the colour assumed depending on the solvent as well as on the solvend. Very small admixtures are sufficient to produce intense colours.

The first theory proposed to account for these effects was that of Wiedemann and Schmidt, who regarded the phenomenon as consisting in chemical reduction. Thus, in the case of potassium chloride, the chlorine would be set free, while the remaining potassium is dissolved in the unaltered salt, which it colours. In support of this theory Giesel coloured rock-salt by heating it in the vapour of sodium or potassium. But the Giesel salts, although they look like those coloured by the kathode rays, have quite different properties in other respects. They do not fade on exposure to light; they give alkaline solutions, while the kathode ray-coloured salts give neutral solutions; the Giesel salts do not give marked photo-electric effects, as do the Goldstein salts. Finally, they are not phosphorescent, while the Goldstein salts are. Goldstein has made salts acquire all the properties of the Giesel salts by the prolonged action of kathode rays, the temperature of the salts being allowed to rise during the bombardment. To these salts, and to those produced by Giesel, the theory of Wiedemann and Schmidt probably applies, while the explanation of the Goldstein effects is that separation of the constituents of the molecule occurs, but that neither constituent is removed completely. On this view the components remain at quite small distances apart, and are thus ready to re-combine.

RADIO-ACTIVITY.

By Alexander Fleck, B.Sc.

DEFLECTION OF RECOIL PARTICLES.—It was mentioned recently in these notes that, when an α-particle carrying a positive charge was liberated, the residual part of the atom also acquired positive electricity. Just as a gun starts travelling with a certain relatively small velocity in the direction opposite to that of the discharged bullet, so when an α-particle is sent off with a large initial velocity the large part of the atom remaining recoils with a velocity which, although small, is appreciable, and, as stated above, with a positive charge. In the February number of *The Philosophical Magazine*, Walmsley and Makower describe the behaviour of this recoil particle from radium-A when it is subjected to a strong magnetic field. In such a field β-rays are completely deflected, and no trace of them is found beyond the borders of the field, while the γ-rays are not known to be influenced at all; α-rays are deflected slightly, and travel along the circumference of a circle of large radius. It is found that the recoil particles also travel along the circumference of a circle, of which the radius is double that of the circle belonging to the expelled α-particles deflected by the same field.

GYROSCOPIC ATOMIC MODEL.—In the same journal Dr. A. C. Crehore contributes a paper giving his views on atomic structure. One great point of difference between his model and the more generally accepted Rutherford model is that, whereas the latter supposes that the positive charge is concentrated on a very small nucleus in the centre of the atom, this gyroscopic model suggests for the distribution of the positive electricity a sphere of which the diameter is of the order of 10^{-12} centimetres, and within which the electrons vibrate, their "enormous frequency of orbit revolution" confining them to one plane. It is not possible to discuss fully this theory here, but one point may be raised. Dr. Crehore deduces from his hypothesis that "beta-particles may come from any electron in the atom. . . . In the central nucleus theory they cannot come from the outside rings, and must be restricted to the inner electrons or the nucleus itself."

It has been proved, however (*Journal of the Chemical Society*, 1914, Volume CV, page 247), that the β-particles are entirely different from the majority of the electrons which are present in the atom, and the number of which can, in many cases, be altered by chemical means. In this respect at least, therefore, the gyroscopic model is not so satisfactory as the theory which supposes the atom to consist of a nucleus surrounded by a ring, or by rings, of electrons.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A., LL.D.

GIGANTIC CUTTLEFISH. — C. Ishikawa and Y. Wakiya describe the partly digested remains of a gigantic Squid from the stomach of a Sperm Whale. The mantle alone seems to have been about four feet in length. It is probably *Moroteuthis robusta*, which has been captured only twice before—by Dall and by D'Arcy Thompson.

MYRMECOPHILOUS ORGANS IN A CATERPILLAR.—In the caterpillar of *Lycaena orion* there are two kinds of structures adapted for the attraction of ants. They have been carefully described by Ehrhardt. When the caterpillar is touched by an ant it protrudes two papillae with glandular hairs on its eleventh segment, and a scent is exhaled which the ants like. If the ants touch with their antennae a glandular area on the tenth segment, a minute drop of secretion is exuded from a pair of slits, and this is eagerly licked off. The secretory structures are transformed glandular hairs, and they can be brought into activity by titillation or otherwise. Ehrhardt induced by electrical stimulation ten secretions in a minute and a half. The caterpillars always have ants about them, and these are doubtless of protective value.

THE EXTRAORDINARY CASE OF FLATA.—In 1896 Professor J. W. Gregory described and figured a Homopterous insect, known as "Flata," or "Phromnia," many specimens of which had formed on the upper part of a stem an extraordinary cluster, like a flowering spike. The species occurs in two forms, green and reddish, and Professor Gregory's figure showed the green individuals on the upper part of the stem, and the red ones beneath them, the appearance being curiously like a red-flowered spike, with green unopened buds above. In 1902 Mr. S. L. Hinde pointed out that, although he had often seen Flata and its larva in British East Africa, he had never seen the grouping described by Gregory. He noted, however, that the red and green insects in a mixed group were very like the flowers and buds of a leguminous plant. Professor Poulton suggested that the first specimens of a group to emerge may be red, and those that issue later, green, and that Professor Gregory may have seen undisturbed groups, and Mr. Hinde groups which had broken up and reässembled. Each of the descriptions has been subsequently confirmed from tropical Africa.

Dr. A. D. Imms, Reader in Entomology in the University of Manchester, relates the history of the observation, and adds his own very interesting experience. While touring in the Himalayan foot-hills, he came across examples of an Indian species, *Phromnia marginella*. The clusters of larvae looked like groups of small white blossoms. They were covered with long white waxy filaments, probably distasteful to birds. The adults were found in two colours—pea-green and pinkish buff—but they occurred intermixed. Out of seven colonies observed, all were disposed along the middle or base of branches among the foliage, and not at the apices of twigs, but they were like opening buds. The white filaments of the larvae are closely allied to Chinese white wax. In addition to wax, the larvae of *Phromnia marginella* excrete a sweet liquid, which hardens on the leaves. According to Cotes, the natives (in Garawal) eat this stuff, and call the insects "Dhaberi," which means sheep, the reference being to their habit of clustering together, and jumping away when disturbed. Dr. Imms gives a striking photograph of the larvae covered with the white waxy filament.

HABITATS OF NEMATODE WORMS.—In a memoir on freshwater Nematodes in North America Mr. N. A. Cobb calls attention to the astounding variety in the habitats of these threadworms. They occur in arid deserts, at great depths, in hot springs, amidst polar ice, in the soil, in fresh water, and in the sea. "As parasites of fishes, they traverse the seas; as parasites of birds they float across continents and over high mountain ranges." They or their ova are carried by wind and running water, by birds and insects, or by almost anything that moves. One species is almost restricted to the vermiform appendix of man; another has its adult form only in grains of wheat; a third has never been found, except in the felt mats on which mugs of beer are set. "The sour sap issuing from the wounds of a tree, often many feet above the ground, not infrequently contains Nematodes that are specific to the wounds of that particular kind of tree."

Attention is also directed to some other points of much interest. Thus eggs and larvae can survive prolonged drought, and Mr. Cobb states that the revival of mummified Nematodes may take place after as long a period as a quarter of a century. Many are parasitic and harmful; many that devour rotting material may help to clean things up; and a few are known to be actively advantageous, by feeding on their injurious relatives and on baneful micro-organisms.

Mr. Cobb refers also to their prolific multiplication—a single female sometimes producing thousands of eggs and to the huge numbers that may be found close together. "A thimbleful of mud from the bottom of the ocean may contain hundreds of specimens. The number of Nematodes in the top six inches of an acre of ordinary arable soil amounts to thousands of millions. Statistical calculations relative to the number of Nematodes in a single acre of soil near San Antonio, Texas, U.S.A., disclosed that if they could start in a procession for Washington, D.C., two thousand miles away, each close on the tail of the one in front, the head of the procession would reach Washington before the rear had left San Antonio." We have not verified this.

SOLAR DISTURBANCES DURING JANUARY, 1915.

By FRANK C. DENNETT.

JANUARY proved to be a very unsatisfactory month for the solar observer owing to the prevalence of cloud. No observations were made by any of the observers on eight days (1st, 10th, 14th, 19th, 25th, 27th, 28th, and 30th). On the 26th only faculae were seen, but the disc never appeared free from disturbance. The longitude of the central meridian at noon on January 1st was 91° 4′.

No. 48 of the December list remained on the disc until January 2nd, and therefore reäppears on the present chart.

No. 1.—This was first seen as a group of at least a dozen spotlets and pores within the north-eastern limb on January 2nd, and followed by a faculic ridge. By the 6th there was a great leader with one larger and some small umbrae twenty-nine thousand miles in greatest diameter, and a trailer with two umbrae fifteen thousand miles in diameter. On the 8th the leader was enlarged by penumbral extensions to thirty-two thousand miles. Both spots had undergone considerable change by the 9th, and the large spot was last seen close to the north-western limb on the 12th. The disturbance was eighty-six thousand miles in length.

No. 2.—Two pores were seen nearing the north-western limb on the 4th, one remaining visible until the next day.

No. 3.—A little group of three pores; the larger leading was seen on the 12th and 13th. It was not observed on the 15th, probably owing to the constant passage of thin cloud making observation difficult. On the 16th the area was very faculic, and contained several pores, closing up to the south-western limb.

No. 4.—A solitary spot, about 1° in diameter, was observed from the 12th until the 23rd. On the 18th there were two minute pores away to the south-west.

No. 5.—On the 16th, when first seen, there was a group of four pores; but when last seen, on the next day, only the trailer remained.

No. 6.—A small spot was observed from the 16th until the 21st, containing two umbrae and once accompanied by a pore.

No. 7.—A spot with two conspicuous umbrae, some twelve thousand miles across, was seen from the 16th until the 24th.

No. 8.—A pair of pores in a faculic ridge near the north-western limb was seen only on the 29th.

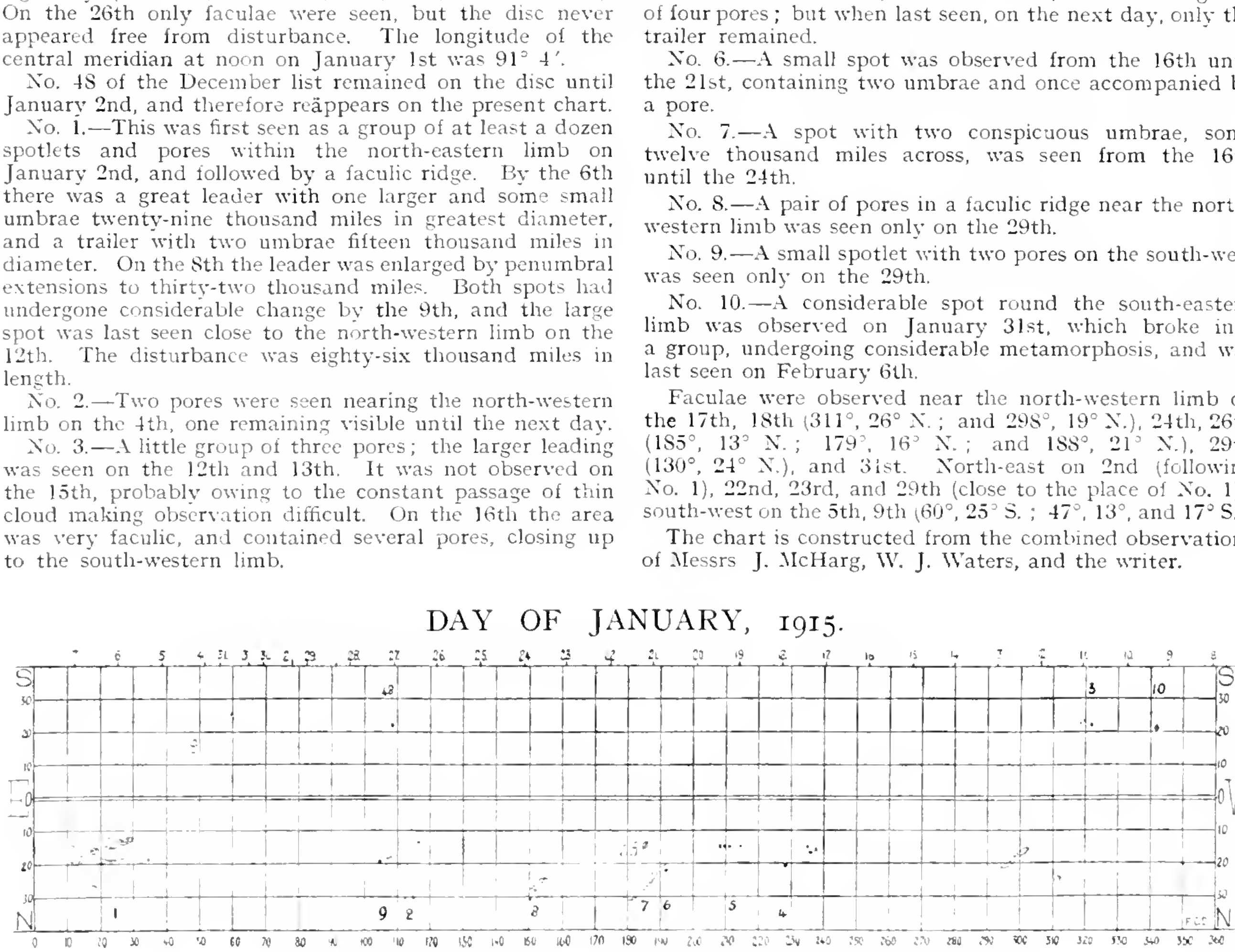
No. 9.—A small spotlet with two pores on the south-west was seen only on the 29th.

No. 10.—A considerable spot round the south-eastern limb was observed on January 31st, which broke into a group, undergoing considerable metamorphosis, and was last seen on February 6th.

Faculae were observed near the north-western limb on the 17th, 18th (311°, 26° N.; and 298°, 19° N.), 24th, 26th (185°, 13° N.; 179°, 16° N.; and 188°, 21° N.), 29th (130°, 24° N.), and 31st. North-east on 2nd (following No. 1), 22nd, 23rd, and 29th (close to the place of No. 1); south-west on the 5th, 9th (60°, 25° S.; 47°, 13°, and 17° S.).

The chart is constructed from the combined observations of Messrs J. McHarg, W. J. Waters, and the writer.

DAY OF JANUARY, 1915.



THE FACE OF THE SKY FOR APRIL.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 14.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°
Apr. 1	0 39·3	N. 4·2	13 38·2	S. 15·1	23 11·1	S. 7·8	22 8·3	S. 11·9	23 0·4	S. 7·4	5 44·6	N. 22·6	7 58·7	N. 20·3
,, 6	0 57·5	6·1	18 50·2	S. 26·5	23 38·6	5·0	22 31·0	10·1	23 4·6	7·0	5 46·0	22·6	7 58·6	20·3
,, 11	1 15·8	8·0	23 8·4	S. 3·5	0 8·1	S. 1·8	22 53·5	8·1	23 8·7	6·6	5 47·6	22·6	7 58·6	20·3
,, 16	1 34·2	9·8	2 54·6	N. 21·9	0 39·6	N. 1·9	23 15·8	6·0	23 12·8	6·1	5 49·3	22·6	7 58·7	20·3
,, 21	1 52·8	11·6	7 10·5	N. 25·3	1 13·4	5·9	23 38·0	3·9	23 16·7	5·7	5 51·1	22·6	7 58·8	20·3
,, 26	2 11·5	N. 13·3	11 28·3	N. 0·8	1 50·0	N. 10·2	0 0·1	S. 1·6	23 20·5	S. 5·4	5 53·1	N. 22·7	7 59·0	N. 20·3

TABLE 15.

Date.	Greenwich Noon. Sun. P	Sun. B	Sun. L	Greenwich Midnight. Moon. P		Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
	°	°	°	°		°	°	°	°	h. m.	h. m.
Apr. 1	− 26·3	−6·5	345·5	+19·4	Apr. 3	−24·8	+1·2	32·9	24·6	11 6 *e*	11 19 *e*
,, 6	26·4	6·2	279·5	− 6·6	,, 10	25·0	1·3	57·0	355·3	10 26 *e*	2 12 *e*
,, 11	26·4	5·9	213·5	−21·9	,, 17	25·1	1·4	81·1	326·0	9 47 *e*	3 0 *e*
,, 16	26·1	5·5	147·5	−14·0	,, 24	−25·2	+1·5	105·3	296·8	9 7 *e*	3 48 *e*
,, 21	25·7	5·1	81·5	+ 8·6							
,, 26	− 25·1	−4·6	15·4	+22·2							

P is the position angle of the North end of the body's axis measured eastward from the North point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the ease of Jupiter System I refers to the rapidly rotating equatorial zone, System II to the temperate zones which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1 T_2 multiples of $9^h\ 50^m{\cdot}6$, $9^h\ 55^m{\cdot}8$ respectively.

For the future the data for the Moon and Planets in the Second Table will be given for Greenwich Midnight, *i.e.*, the Midnight at the end of the given day.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving Northwards at a slackening pace. Its semi-diameter diminishes from 16′ 2″ to 15′ 54″. Sunrise changes from $5^h\ 42^m$ to $4^h\ 36^m$; sunset from $6^h\ 28^m$ to $7^h\ 18^m$.

MERCURY is a morning star till May 1, when it is in superior conjunction with the Sun. Semi-diameter diminishes from 3″ to 2½″. Illumination increases from ⅔ to Full.

VENUS is a morning star. Illumination increases from $\frac{7}{10}$ to $\frac{8}{10}$. Semi-diameter diminishes from 8″ to 7″.

THE MOON.—Last quarter $6^d\ 8^h\ 12^m$ *e*. New $14^d\ 11^h\ 36^m$ *m*. First quarter $22^d\ 3^h\ 39^m$ *e*. Full $29^d\ 2^h\ 19^m$ *e*. Perigee $1^d\ 12^h$ *e*. Apogee $17^d\ 4^h$ *e*. Perigee $30^d\ 7^h$ *m*, semi-diameter 16′ 34″, 14′ 44″, 16′ 44″ respectively. Maximum librations 3^d 7° N., 8^d 6° W., 17^d 7° S., 24^d 8° E., 30^d 6° N. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 16).

MARS is still badly placed, having been in conjunction with the Sun on Dec. 24th.

JUPITER was in conjunction with the Sun on Feb. 24th, and is therefore difficult to observe this month. 9′ North of Venus on 15th, 4^h *e*. Equatorial diameter 35″, Polar 33″.

TABLE 16. Occultations of Stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reäppearance. Time.	Reäppearance. Angle from N. to E.
1915.			h. m.	°	h. m.	°
Apl. 1	WZC 849	7·0	—	—	4 35 *m*	285
,, 16	WZC 189	6·9	8 17 *e*	7	—	—
,, 20	WZC 474	6·6	11 11 *e*	101	—	—
,, 21	37 Geminorum	5·8	0 40 *m*	120	—	—
,, 22	WZC 582	6·6	10 46 *e*	123	—	—
,, 23	WZC 584	6·7	0 4 *m*	117	—	—
,, 23	BD+15°·2027	6·5	8 14 *e*	152	9 18 *e*	272
,, 25	*d* Leonis	5·1	8 16 *e*	164	9 14 *e*	270

From New Moon to Full disappearances occur at the Dark Limb, from Full to New reäppearances.

Configurations of satellites at 4^h 30^m a.m.

JUPITER'S SATELLITES.

Day.	West.		East.		Day.	West.		East.	
Apl. 1	3	○	214		Apl. 16	231	○	4	
,, 2	21	○	4	3●	,, 17	2	○	134	
,, 3	2	○	413		,, 18	1	○	234	
,, 4	14	○	23		,, 19		⊙	1 $\frac{3}{4}$	
,, 5	42	○	13		,, 20	21	○	$\frac{3}{4}$	
,, 6	4231	○			,, 21	34	○	$\frac{2}{1}$	
,, 7	43	⊙	2		,, 22	43	○	2	1●
,, 8	43	○	12		,, 23	$4\frac{3}{2}$ 1	○		
,, 9	4213	○			,, 24	42	○	13	
,, 10	42	○	13		,, 25	41	○	23	
,, 11	41	○	23		,, 26	42	○	13	
,, 12	2	○	413		,, 27	421	○	3	
,, 13	213	○	4		,, 28	3	○	21	4●
,, 14	3	○	124		,, 29	31	○	42	
,, 15	3	○	24	1●	,, 30	32	⊙	4	

The following satellite phenomena are visible at Greenwich, all in the morning hours:—7^d 5^h 9^m I. Sh. E.; 10^d 4^h 44^m 46^s II. Ec. D.; 14^d 4^h 44^m I. Sh. I.; 15^d 5^h 1^m I. Oc. R.; 19^d 4^h 21^m II. Sh. E.; 20^d 4^h 32^m IV. Tr. I.; 22^d 3^h 48^m 52^s I. Ec. D.; 23^d 4^h 22^m I. Tr. E.; 26^d 4^h 3^m II. Sh. I.; 27^d 3^h 59^m III. Sh. I.; 28^d 3^h 44^m 17^s IV. Ec. D., 4^h 7^m II. Oc. R.; 30^d 4^h 3^m I. Tr. I.

The Northward motion of Jupiter will make this year's opposition (which occurs on September 17th) more favourable for European observers than those of the last four years, in which it has been very low down.

SATURN is between Taurus and Gemini. Is now approaching conjunction with the Sun. Was in quadrature March 17th. Polar semi-diameter 8″. Major axis of ring 40″, minor 18″. Angle P−5°·9.

Eastern elongations of Tethys (every 4th given) 2^d $0^h\cdot8$ *e*, 10^d $2^h\cdot1$ *m*, 17^d $3^h\cdot4$ *e*; of Dione (every 3rd given) 2^d $1^h\cdot6$ *m*, 10^d $6^h\cdot8$ *m*, 18^d Noon; of Rhea (every 2nd given) 3^d $2^h\cdot0$ *e*, 12^d $3^h\cdot0$ *e*.

For Titan and Japetus E., W. stand for East and West elongations, I. for Inferior (North) conjunction, S. for Superior (South) conjunction. Titan 1^d $5^h\cdot7$ *m* W., 5^d $5^h\cdot2$ *m* S., 9^d $7^h\cdot7$ *m* E., 13^d $7^h\cdot7$ *m* I., 17^d $5^h\cdot1$ *m* W.; Japetus 10^d 2^h *m* E.

URANUS is a morning star but badly placed. Was in conjunction with Sun on February 1st.

NEPTUNE is stationary on 8th, diameter 2″.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant.			Remarks.
	R.A.	Dec.		
	°		°	
Mar. – May	263	+	62	Rather swift.
Apl. 12-24 ...	210	–	10	Slow, fireballs.
,, 16-25 ...	301	+	23	Swift, streaks.
,, 18-23 ..	189	–	31	Slow, long.
,, 19 May 9	201	+	8	Slow.
,, 20 22 .	271	+	33	Important shower, Lyrids.
,, 20-25 ...	218	–	31	Slow, long paths.
,, 30 ...	291	+	59	Rather slow.
Apl.—May .	193	+	58	Slow, yellow.
Apl.—May ..	296		0	Swift, streaks.

DOUBLE STARS AND CLUSTERS.—The tables of these, given three years ago, are again available, and readers are referred to the corresponding month of three years ago.

VARIABLE STARS.—Stars reaching their maxima in or near April, 1915, are included. The lists in recent months may also be consulted. (See Table 17.)

COMETS.—A new comet (1915a) was discovered by Mr. J. C. Mellish, about Feb. 10th, in R.A. 17^h, N.Dec. 3°. Daily motion + 1^m, South 6′. Its place in April cannot yet be predicted. Medcalf's Periodic Comet has been detected by Miss Leavitt. It passed perihelion about 1914, June 5th (period 7 years 8 months), and is now extremely faint.

TABLE 17. LONG-PERIOD VARIABLE STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m. s.	° ′		d.	
R Lyncis . .	6 54 18	+55 27	6·5 to 14·0	379	1915—Apr. 9
V Cancri	8 16 53	+17 34	7·1 to 12·8	272	,, May 4
S Hydrae	8 49 8	+ 3 24	7·5 to 12·5	256	,, May 9
R Virginis	12 34 12	+ 7 27	6·2 to 11·1	145	,, May 5
V Ursae Min. ..	13 37 10	+ 7 45	7·5 to 8·7	71	,, May 18
R Can Venat.	13 45 18	+39 58	7·4 to 12·2	328	,, Mar. 24
R Bootis	14 33 27	+27 6	5·9 to 12·2	223	,, Apr. 21

Night Minima of Algol 1^d, 5^d $5^h\cdot0$ *m*, 8^d $1^m\cdot8$ *m*, 10^d $10^h\cdot6$ *e*, 13^d $7^h\cdot4$ *e*, 28^d $3^h\cdot5$ *m*. Period 2^d 20^h $48^m\cdot9$.

Principal Minima of β Lyrae 9^d 1^h *e*, 22^d 11^h *m*. Period 12^d 21^h $47^m\cdot5$.

REVIEWS.

AËRONAUTICS

The Aëroplane.—By C. GRAHAME-WHITE and HARRY HARPER. 280 pages. 16 plates and other illustrations. 7-in. × 5-in.

(T. C. & E. C. Jack. Price 3/6.)

This book is a good popular account of present-day aërial machines. We say present-day because these inventions progress so rapidly that the date of publication is of importance, though no year appears on the title page. The work comprises a general history of the development of the flying machine from earliest times, and, after detailing the early experiments of Lilienthal, Maxim, and the brothers Wright, describes all the more recent machines. There is a short chapter, or rather portion of a chapter, dealing with balloons and airships, and there are incidental brief explanations of such accessories as the petrol engine. Some sixteen fine plates from photographs illustrate the principal events, but it seems a pity that these have not been inserted opposite the matter to which they refer. Numerous other rather crude line drawings help to elucidate the subject. The book is clearly written in unpretentious style, and does not attempt to go at all deeply into technicalities. A good index would have added to its value.

B. B. P.

ASTRONOMY.

Stellar Movements and the Structure of the Universe.—By A. S. Eddington. 262 pages. 4 plates. 22 diagrams. $8\frac{3}{4}$-in. × $5\frac{3}{4}$-in.

(Macmillan & Co. Price 6/- net.)

The book is on a selected yet comprehensive branch of astronomy, the subject of stellar distribution being more than two hundred years old. The two hundred and sixty-two pages are divided into twelve chapters, each of intense interest: they are written in a scientific yet popular form, except Chapters VII and X, which are mathematical. In addition to these twelve chapters there are four plates of nebulae, twenty-two diagrams, and an efficient index.

We would like to make one or two comments. We have an inherent impression that when a book is called a monograph we may expect to find the book substantially complete upon the subject, both in its historical and present-day aspects: the dissociation of one from the other prevents the author from affording a more complete account to the reader. The author has to assume that the reader knows the history and the work of the pioneers in the subject, and one is apt to get a superficial view of the state of the particular branch of knowledge treated of. Our view may be too comprehensive of what a monograph may be. True, the author, in this instance, clearly states in his preface: "No attempt has been made to treat the subject historically. I have preferred to describe the results of investigations founded on the most recent data rather than early pioneer researches. . . . But it was outside my purpose to describe the steps by which knowledge has advanced; it is the present situation that is here surveyed." If one will only read the book—and it is a book in which every line should be read carefully—with this qualification in view, he need not allow his mind to wonder on omitted historical data; it is essentially a survey and a thoughtful assimilation of researches in this particular and absorbing branch of astronomy during the last twenty-five years.

Most of the chapters are crammed with selected statements of facts derived from the numerous recent workers in this subject, among whom the author has been one of the most earnest and prolific investigators. Numerical references and a bibliography are given at the end of each chapter. It must not for one moment be understood that this book is a mere collection of facts from others' work; the author both advances and explains many theories throughout to account for the numerous phenomena which stellar astronomy presents. We notice that the data in Chapter I are not quite up to date, and the omission of Professor H. C. Plummer's radial-velocities investigations is conspicuous. We hope that, should another edition be required, this and other omissions will be rectified; and we especially desire that one or even two chapters be added, for historical interest, treating of the spade-work prior to 1890. The book is well printed, but on surfaced paper. We notice two misprints of Lalande on page 19.

F. A. B.

CHEMISTRY.

Chemical Engineering.—By J. W. Hinchley, A.R.S.M., Wh.Sc. 103 pages. 70 illustrations. $7\frac{1}{2}$-in. × 5-in.

(J. & A. Churchill. Price 2/6 net.)

The title of this book appears too comprehensive, since it deals exclusively with the manipulation and transport of solid materials, and does not claim to cover the ground where the engineer requires the assistance of the chemist. Within its limits, however, it gives much useful information as to the different types of machinery used in chemical works, and shows which are the most suitable for special kinds of work. Mechanical details are clearly described and illustrated, and the principles underlying the action of the machines are explained at sufficient length. But it is a pity to issue a valuable little book of reference without an index.

C. A. M.

Elements of Qualitative Chemical Analysis.—By J. Stieglitz. 2 volumes. 312 and 153 pages. $8\frac{1}{2}$-in. × $5\frac{1}{2}$-in.

(G. Bell & Sons. Price 6/- net each volume.)

The first volume deals with the general chemical and physical principles underlying chemical analysis, and more particularly with the laws of equilibrium and the modern theories of solution; while the second volume is intended as a practical companion to the first, with which it should be used simultaneously. The method of teaching is that employed by the author in the University of Chicago, and seems to be well adapted to develop the critical faculty in students. Nothing is to be taken as proved, but every theoretical statement is to be practically tested, and systematic questions are put to make clear the meaning of every operation. There is no doubt but that anyone who conscientiously works through these volumes will have a thorough grasp of the principles of analysis, or that he will have received a good preparation for quantitative work. The second volume is interleaved with blank pages upon which the student may note anything that strikes him at the time of the experiment.

C. A. M.

GEOLOGY.

Proceedings of the Geologists' Association. Volume XXVI. Part 1.—Edited by Horace Woollaston Monckton. 104 pages. 11 plates. 7 figures. 9-in. × 6-in.)

(Edward Stanford. Price 2/6 net.)

This part is an interesting one, and contains a paper by Mr. Reginald Smith, in which some "Prehistoric Problems in Geology" are considered, with a view to concentrating the attention of the archaeologist and the geologist on points which need to be cleared up, and which at present obscure our notions of prehistoric man.

Among the questions dealt with is the current view that Britain was not finally separated from the Continent before the period of La Madeleine, the last great division of the palaeolithic Cave period. An implement exhibited in illustration of the paper, found *in situ* in the raised beach at Brighton, was of the St. Acheul type, which shows that the beach was not older than the St Acheul period. An illustration, reproduced by permission (see Figure 75), shows an implement which Sir J. Prestwich found, in 1869, at Downton, in the highest terrace overlooking the lower Avon. Other matters discussed include the freshwater gravels of Bournemouth, palaeolithic gravels at Ipswich, and in Ireland and in Scotland. The remainder of the publication consists of a brief report of the Session 1913–1914, and detailed accounts of eight geological excursions. Some excellent photo-micrographs of rocks which we are privileged to reproduce (see Figures 73 and 74), obtained in Cornwall, are introduced as illustrations in the account of the visit to the St. Austell district. All the excursions are described in the thorough and valuable manner for which the Geologists' Association is justly famed.

W. M. W.

The Deposits of the Useful Minerals and Rocks.—By F. Beyschlag, J. H. L. Vogt, and P. Krusch. Volume I. Translated by S. J. Truscott. 514 pages. 291 illustrations. 9-in. × 6-in.

(Macmillan & Co. Price 18/-.)

This book is the first volume of a treatise on ore deposits, which promises to be the most comprehensive one yet pub-

From photographs by *H.M. Geological Survey*

FIGURE 73.

A photomicrograph of Luxulyanite, Luxulyan. × 30. Ordinary Light.

FIGURE 74.

A photomicrograph of Anorthoclase-bearing Granite, Gready Quarry, Luxulyan. × 14. × Nicols.

FIGURE 75.

Flint Implement found by Sir J. Prestwich at Downton, Wilts, 1869. (Natural History Museum.)

(From its *Proceedings*, by the courtesy of the Geologists' Association.)

FIGURE 76. Dwarf Chamaeleon (*Chamaeleon pumilus*).

FIGURE 77. Cat Snake (*Tarbophis fallax*).

(From "Reptiles and Batrachians," by E. G. Boulenger. By the courtesy of Messrs. J. M. Dent & Sons.)

lished. The literature of the subject is voluminous and widely scattered; much of it is purely descriptive, and written from an empirical standpoint. The authors of this volume have not only "digested" the literature, but have endeavoured to give an account of the general principles underlying the genesis and occurrence of ore deposits. With this end in view, the description of separate occurrences has been inserted only as illustrative of these principles. Therein the book differs from most previous ones on the same subject, which have been more in the nature of descriptive handbooks.

The introductory part is concerned mainly with the morphology and mineral content of the various types, and includes an abundance of interesting and useful data regarding the association and relative amounts of the various elements in different ore fields. It is perhaps a little unfortunate that Clarke's "Data of Geochemistry" appeared too late for the wealth of information contained therein to be utilised. The second part of the volume deals with the difficult subject of classification, and the evolution of this from the morphological systems of von Cotta and other early writers to the present-day genetic ones, is traced. The one finally adopted by the authors, while it does not differ radically from that of Beck, is in advance of the latter in the subdivisions of the main groups.

There are four main divisions: magmatic segregations, contact-deposits, cavity-fillings and metasomatic deposits, and ore-beds. These are subdivided on the basis of the mineral content. It is only natural that the last of these groups should be the least satisfactory, as it includes many deposits the genesis of which is still very doubtful. The remainder of the book is occupied by a systematic examination of the first two groups, and of the tin, apatite, and mercury lodes in the third.

It can unhesitatingly be said that the authors have succeeded in their difficult task, and it is impossible to praise too highly the skill with which they have correlated the great accumulation of evidence. Furthermore, they have been eminently successful in their presentation of the genetic principles, and have shown that this branch of geology has a considerable claim to rank as a rational science.

On the whole, the translator has done his part well, particularly in the rendering of the numerous technical terms into English. In places, however, the diction is unduly obscure, owing to a great deficiency in punctuation marks. Some terms, such as "eutecticum" and "sodium-granite," scarcely conform to English usage, while the use of the name "labradorite" to designate a rock and a mineral indiscriminately is somewhat confusing. The value of the book is enhanced by a large number of excellent illustrations indicative of the geological structure of the various deposits; but the general "get-up," though otherwise good, is marred by a number of misprints. Thus, there is one in the table on page 149, another in the formula of durdenite on page 219, while both "aragonite" and "arragonite" appear in the one paragraph. It is somewhat strange to see "aluminium" characterised as a mineral, while on page 83 "atomic weight" is used instead of "specific gravity." These, however, are only minor defects in a most useful and readable book, which can be thoroughly recommended to all interested in the subject.

A. S.

NATURAL HISTORY.

Reptiles and Batrachians.—By E. G. BOULENGER, F.Z.S. 278 pages. 202 illustrations. 9½-in. × 6½-in.

(J. M. Dent & Sons. Price 16/- net.)

Mr. Boulenger has produced a very attractive and at the same time useful book: attractive because it is simply written and has a wealth of really beautiful illustrations, and useful because many of the reptiles and amphibians described are commonly kept in captivity, or could easily be so with little, if any, discomfort to themselves. Moreover, Mr. Boulenger has introduced a classification which shows the systematic position of the animals without encroaching unduly upon the space available for the consideration of life-histories and habits.

Any lover of nature will enjoy reading the book, even if "cold-blooded" creatures do not specially appeal to him. In dealing with the Tudtara of New Zealand, which has become almost extinct on the larger islands, though it is protected on the smaller ones in the Bay of Plenty, Mr. Boulenger shows how rapid its extermination has been by pointing out that while twenty-five years ago a specimen could be purchased from almost any dealer for from twenty to thirty shillings, the price is now about fifteen pounds. The book contains some interesting notes on the Giant Tortoises; the South Albemarle Tortoise, attains the length of five and a half feet and weighs nearly five hundredweight. The eggs are about the size of a tennis ball, and the young grow rapidly—in fact, when four years old they are nearly two feet in length. An adult tortoise may not increase in size for a hundred years or more, and its length of life may be judged from the fact that specimens have been kept in captivity for more than two hundred years. These notes will give some idea of how the animals are treated, and the book deals also with Crocodiles, Lizards, and Snakes, besides the Batrachians: tailless, like the frogs and toads; tailed, like the salamanders; and limbless like *Ichthyophis* and *Typhlonectes*.

By the courtesy of the publisher, we are enabled to reproduce two of the illustrations, namely, that of the Chamaeleon and that of the Cat Snake (see Figures 76 to 77).

W. M. W.

PHYSICS.

The Dynamics of Surfaces.—by PROFESSOR DR. MED. LEONOR MICHAELIS. Translated by W. H. Perkins, M.Sc. 118 pages. 8 illustrations. 8½-in. × 5½-in.

(E. & F. N. Spon. Price 4/- net.)

This book is intended as an introduction to the study of biological surface phenomena, and is primarily written to enable biologists to deal with the problems of surface reäctions more fundamentally than they have done hitherto. We think that it will form an excellent guide to any serious student of adsorption and allied surface effects. The references to the literature of the subject are numerous, and will greatly smooth the path of any explorer into this important region of chemical physics. Such readers will be found among biologists, but also among those who approach the subject as chemists and physicists; while the scientific dyer will here find much that is of interest. We find the book very free from misprints; a curious one, however, occurs on page 104, where, in a reference to a paper by Reinold and Rücker, the first-named author is called "Reynolds."

J. H. V.

Smithsonian Physical Tables.—By FREDERICK E. FOWLE. Sixth Revised Edition. 355 pages. 9-in. × 6-in.

(Wesley & Son. Price 8/6.)

These tables form one of a series of four volumes of tables issued by the Smithsonian Institution, the others being the Meteorological, Geographical, and Mathematical Tables. In magnitude the Physical Tables are intermediate between Kaye and Laby's Physical and Chemical Constants and Landolt-Bőrnstein-Meyerhoffer's Physikalisch-chemische Tabellen. An introduction of thirty-five pages deals with units of measurement and conversion formulae: this is followed by tables of formulae for conversion factors and of numerical conversion factors. Tables of mathematical functions now follow, including useful lists of differentials, integrals, and series. The body of the book of Physical Tables begins at page 68 with Strength of Materials, and consists of accurate data on many subjects of importance and interest to physicists, all well arranged and clearly printed. The volume adds another debt which science owes to the Smithsonian Institution.

J. H. V.

TRAVEL.

On the Trail of the Opium Poppy.—By SIR ALEXANDER HOSIE, M.A., LL.D. 2 volumes. 300 and 308 pages. 26 illustrations. 1 map. 15 illustrations. 1 map. 9¼-in. × 6¼-in.

(George Philip & Son. Price 25/- net, two volumes.)

Ten years or more ago the Government let it be known that India was prepared to forgo her opium revenue, and that it was the Chinese craving for the drug, and not England's desire to force it upon China, which was responsible for the continuance of the traffic in Indian opium. A movement was set on foot in China against the cultivation of the poppy and the consumption of opium, and in 1906 a very drastic Imperial decree was made. The terms of this will be found in Appendix I of the book before us. The British Government, by request, undertook annually to diminish the export of opium from India if the Chinese Government carried out its arrangements for diminishing the production and consumption of opium in China.

In 1910 and 1911 it fell to the lot of Sir Alexander Hosie to investigate the extent of poppy cultivation in those provinces which had previously been the chief centres of opium production. The results of his mission are given in Appendix II, but his two volumes themselves contain the story of his travels in a little known and in part unexplored country. It may be said at once that the account is full of interesting details, from the trials of the traveller who has to weigh out silver as currency, and always gets worsted in the exchange, to the account of the flags set out in the fields to charm away injurious insects. Sir Alexander Hosie, in a previous book—"Three Years in Western China"—described the coccus which excretes white wax on the branches of an ash (*Fraxinus chinensis*). He now records that the insect is propagated on a large leaflet privet (*Ligustrum lucidum*). In Yunnan, he found that there were plantations of privet entirely devoted to the purpose, and at the end of April the mother scales, containing the minute cocci, are ready for transport to the other provinces, where the ash is cultivated.

The volumes are well illustrated and well worth reading.

W. M. W.

NOTICES.

TROPICAL AGRICULTURE.—The Proceedings of the Third International Congress of Tropical Agriculture, which have just been published (London: John Bale, Sons & Danielsson; 10/- net), form a substantial volume of over four hundred pages. The volume is edited by the Honorary Secretaries of the Congress, which, it will be remembered, was held last June at the Imperial Institute.

THE SYDNEY TREASURES.—The family collection of Earl Sydney, Lord Chamberlain to Queen Victoria, will be sold by auction by Messrs. Knight, Frank & Rutley, early in the season, owing to the death of the Honourable Robert Marsham-Townshend. The dispersal of these works of art and the library will be the most important sale since the declaration of war, and will arouse interest both in England and America.

LONDON COUNTY COUNCIL LECTURES.—Among the free public lectures which will be given at the Horniman Museum during March, at 3.30 on Saturday afternoons, are the following: March 13th, "Serbian History and Folklore," by Mr. A. R. Wright; March 20th, "The Folklore of Flanders," by Mr. Edward Lovett; and March 27th, "Bruges, Past and Present," by Miss Abram.

THE GEOLOGY OF HAVERFORDWEST.—The Board of Agriculture and Fisheries desire to give notice of the publication of a Geological Memoir of the country around Haverfordwest; price 3/6. This volume, which forms Part XI of the Memoir on the South Wales Coalfield, and is explanatory of the New Series One-inch Map, Sheet 228, describes the eastern part of the Pembrokeshire Anthracite District.

UNIVERSITY OF LONDON APPOINTMENTS BOARD.—We have received a copy of a pamphlet from the University of London dealing with the work of the Appointments Board. The primary aim of the Board is to benefit the graduates by assisting them to secure employment, but it would be equally true to say that its object is to assist the employer who has in it—ready to hand—a selecting medium for the higher classes of employment.

INSECT PESTS AT THE FRONT.—Under the title of "The Minor Horrors of War," Messrs. Smith, Elder & Co. are publishing a number of articles which have appeared since the beginning of the war in the *British Medical Journal*, by Dr. A. E. Shipley, the Master of Christ's College, Cambridge. These articles, which are fully illustrated, deal with various insect and other pests which cause disgust, discomfort, and often disease amongst our troops now fighting in all quarters of the globe.

THE ROYAL INSTITUTION.—At a recent meeting of the members a letter was read, from the Honourable Sir Charles A. Parsons, saying that it gave him much pleasure to enclose a cheque for five thousand pounds in favour of the Royal Institution, which might be of some help at the present time. There is no doubt that many societies are feeling the pinch of war, and Sir Charles Parsons's example is one which, if followed, might save much anxiety on the part of officials who are loth to see good work stopped.

LIVINGSTONE COLLEGE.—We have received from the new Principal of Livingstone College, Dr. Loftus E. Wigram, a copy of the College Year Book, which shows that this institution is still carrying on its valuable work. Besides matters of special interest to students, we may mention that the Year Book contains a number of reviews of scientific books dealing with medical and hygienic literature. One letter included is from an old student who went to a station where his predecessors had all died quickly, owing, he found, to the mosquitoes. The student set to work, and found some acres of stagnant water. This he drained and turned into a good garden ground, with the result that the mosquitoes disappeared, and the health of the district at once improved.

A FOLDING TRENCH HYPERSCOPE.—We are very much pleased to call attention to the "Metron" folding trench hyperscope, manufactured by Mr. C. Baker, of 244, High Holborn, of which already a large number is being employed by the British Expeditionary Force. This apparatus has been designed to enable an observer occupying a trench or under cover to watch the movements of the enemy without in any way exposing himself. Two handles are provided, one on each side of the instrument, through which stakes can be driven into the front of the trench, thus holding the hyperscope and leaving the observer's hands free to manipulate his binoculars. An important feature of this hyperscope is that it folds, and is consequently very compact for carrying. It is made in two models: (*a*) of well-seasoned three-ply wood, waterproof Government-grey painted (price £1 5s.); and (*b*) of metal similarly painted, but of lighter weight (price £1 10s.). The mirrors being set in metal cases are well protected; should, however, a mirror be broken, a spare one can easily be fitted by the user. These hyperscopes can be made in varying lengths, but the twenty-four-inch model is recommended for ordinary trench work: this folds to 25-in. × 7½-in. × ¾-in. The size of the mirrors is 6-in. × 3¼-in., and, being of selected patent plate, allows prism or other binoculars to be used with the instrument.

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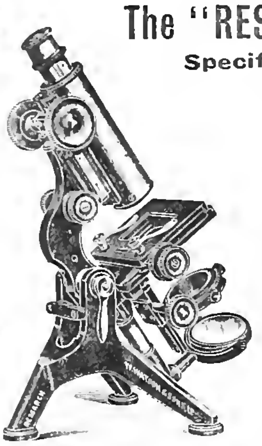

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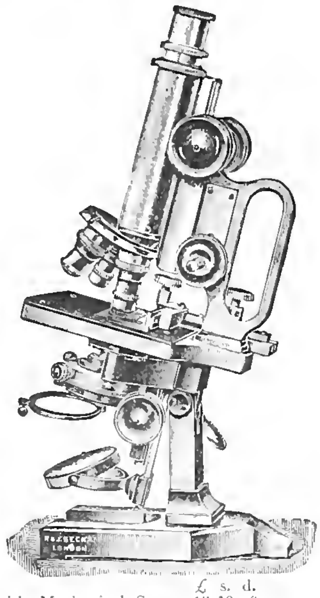

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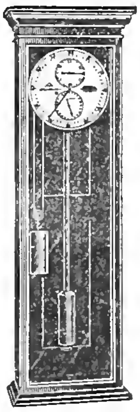

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