

ing for November 2, 9, and 16, will be read with interest, as it forms a valuable contribution to our knowledge of this subject. Mr. Webb has evolved a graphical method of solution for non-cylindrical shafts, in which a graph of  $\sqrt{I/w}$  is drawn for the shaft,  $w$  being the weight per unit length, and  $I$  the moment of inertia of the section in bending. The whirling speed can then be estimated roughly from a set of typical curves included in the paper, or can be calculated by employing graphically Mr. Webb's two formulæ. For the purpose of checking the new method, a number of new solutions has been found by rigorous mathematics. These cases include a cylindrical shaft, a solid shaft consisting of one or more conical pieces, a hollow shaft with all its weight in the rim, and consisting of one or more conical pieces, and a solid shaft the meridian curve of which consists of one or more parabolic arcs, all of them, produced if necessary, touching the axis. For all cases the agreement is remarkably close, and shows that the new graphical method is valid if (maximum value of  $Iw$ )/(minimum value of  $Iw$ ) is less than 40,000, which limit probably includes all shafts likely to be required in practice. Mr. Webb's method is based on a hitherto unpublished approximate method of attacking the general problem devised by Mr. W. H. Barling some years ago. Mr. Barling's hypothesis is that there is no transference of energy between consecutive elements of the shaft, and it gives correct results for cylindrical shafts.

MESSRS. J. M. DENT AND SONS, LTD., will shortly publish "A Complete System of Nursing," by Miss A. M. Ashdown. It is claimed for the work that it will contain all the practical information which a nurse may require during her training and in actual practice.

MESSRS. DULAU AND CO., LTD., 37 Soho Square, W.1, have just issued a valuable and interesting catalogue (No. 69, November) of more than 1600 works on Botany (Phanerogams and Cryptogams), Zoology (Vertebrates and Invertebrates), Herbals, Gardening, and Agriculture. Many of the books offered for sale are rare, and a considerable proportion, being of foreign origin, are difficult to obtain in a new condition at present. The catalogue should be of service to many of our readers.

In the article on "Ferro-Concrete Ships" which appeared in last week's NATURE, it should have been stated that we were indebted to *Engineering* for the blocks with which the article was illustrated.

### OUR ASTRONOMICAL COLUMN.

ORBITS OF COMETS.—The orbits of three comets are discussed by S. Ogura in *Annales de l'Observatoire Astronomique de Tokyo*, tome v., part 3. (1) Comet 1827 II. was discovered by Pons on June 20, 1827, and observed by him for a month; Pons used a ring micrometer, and his observations show rather large residuals. The definitive orbit is as follows:—

$$\begin{aligned} T &= 1827 \text{ June } 7^{\text{h}} 19^{\text{m}} 24^{\text{s}} 22 \text{ G.M.T.} \\ \omega &= 19^{\circ} 18' 56'' 12'' \\ \Omega &= 317^{\circ} 39' 39'' 67'' \\ i &= 136^{\circ} 26' 11'' 00'' \\ \log q &= 9.9067087 \\ \log e &= 9.9774915 \\ \text{Period} &= 63.83 \text{ years} \end{aligned}$$

The period is considered to lie between fifty-nine and sixty-nine years. The orbit of the comet of 1500 shows a distant resemblance, but identity is improbable.

(2) The comet of 1132 was observed in Japan on October 5, 7, and 9; its motion was extremely rapid,

100° being described in four days. The following orbit is deduced:—

$$\begin{aligned} T &= 1132 \text{ August } 30^{\text{h}} 20 \text{ G.M.T.} \\ \omega &= 114^{\circ} 3' \\ \Omega &= 201^{\circ} 1' \\ i &= 106^{\circ} 4' \\ \log q &= 9.8666 \end{aligned}$$

These elements indicate a near approach to the earth, the distance being 0.045 on October 7. This comet was also observed in China and Europe, but the positions are less precisely defined than in the Japanese record.

(3) The comet of 1240 was observed with considerable precision in Japan; it passed close to Jupiter, and the head was stated to be "as big as Venus." The following orbit is deduced from the Japanese and Chinese observations:—

$$\begin{aligned} T &= 1240 \text{ January } 21^{\text{h}} 06 \text{ G.M.T.} \\ \omega &= 331^{\circ} 3' \\ \Omega &= 124^{\circ} 5' \\ i &= 75^{\circ} 4' \\ \log q &= 9.8246 \end{aligned}$$

The minimum distance from the earth was 0.36 on February 2. The orbit somewhat resembles that of comet 1863 IV.

THE IRON ARC AS A SOURCE OF STANDARD WAVELENGTHS.—Previous investigations have shown that the wave-lengths of many of the lines in the spectrum of the iron arc, which is in such frequent use as a source of standard wave-lengths, are subject to variations depending upon proximity to the electrodes. The possible elimination of this "pole-effect" has been the subject of an important investigation by Messrs. St. John and Babcock (*Astrophysical Journal*, vol. xlvii., p. 138). It has been shown that the effect disappears in the case of the Pfund arc *in vacuo*, and becomes negligible in a narrow central zone of the same type of arc in air when the negative pole is of carbon. The former, however, is not a convenient everyday source, and the latter is lacking in intensity. The practical outcome of the extensive experiments is to show that a Pfund arc, with both poles of iron, may be relied upon to give the "fundamental" wave-lengths of even the most sensitive lines, if the length of the arc be not less than 8 mm. and the current not more than 5 amperes; under these conditions a horizontal zone near the centre at least  $1\frac{1}{2}$  mm. wide may be used with safety. This arc also has the advantage of giving sharply defined lines, and uniformity in the relative intensities. The investigation has shown that the pole effect has not been entirely eliminated in the case of the adopted international standards, and that certain supposed anomalous displacements of iron lines in the sun become normal when the fundamental wave-lengths of such lines are used for comparison.

CAPE OBSERVATORY REPORT.—The report of his Majesty's Astronomer at the Cape of Good Hope for 1916 has been received. Besides work of a more or less routine character, we note that a new programme of observations of close circumpolar stars with the reversible transit-circle has been undertaken, with special reference to the determination of the constant of aberration. Mr. J. Voûte has completed his series of observations for stellar parallaxes by means of right ascension measures, and has also made observations of double stars. The programme of observations for radial velocities of stars with the Victoria telescope and four-prism spectrograph was completed before the end of the year, and experiments with a shorter camera are in progress with a view to the extension of the observations to fainter stars. Photographs of the sun, intended to supplement the Greenwich series, were

obtained on 333 days; when possible, duplicates were taken at short intervals for the detection of spots of brief duration. In addition to the usual system of telegraphic time-signals, arrangements have been completed for the daily transmission of a wireless signal for the use of shipping in South African waters.

### THE CLASSIFICATION OF THE BRITTLE-STARS.<sup>1</sup>

THE Ophiuroidea have long presented a problem to the systematist, and its solution was not advanced when the palæontologist joined the neontologist in council. The reason is twofold: the modern representatives of this Echinoderm class differ little in great points, but greatly in little points; the Palæozoic representatives, which do differ much, and should throw light on the origins of orders, are so preserved as to be difficult of interpretation. Twenty-five years ago Mr. Jeffrey Bell divided the recent forms according as they could only move the arms horizontally or could also coil them vertically, the latter being regarded as more primitive. Dr. J. W. Gregory extended this system by adding an order for those yet more primitive forms in which the arm-bones still consisted of the original paired elements. It was early pointed out that these divisions represented successive grades rather than divergent orders; but doubt has since been cast even on their correspondence with reality by the observations of Schöndorf, Sollas, Mortensen, and Spencer on the older fossils and on the crucial genus *Ophioteris*. Now a voice from the East complains: "I found the classifications very unsatisfactory. Indeed, their imperfections became a haunt to me." From a study of recent genera, Mr. Matsumoto infers that in respect to both mouth-frame and arm-bones the forms which can only move their arms horizontally are more primitive than those which can coil them vertically. He therefore rejects any system based mainly on the joint-faces, and puts forward a classification of his own.

The difficulty presented by the Palæozoic forms is evaded by separating them as a sub-class: *Egophiuroidea*. Since this admits no genera with ventral arm-plates it cannot quite correspond with the *Palophiuræ* (Haeckel), but its difference from the *Protophiuroidea* (Sollas) is not obvious. Neither is it clear whether the author would regard the *Egophiuroidea* as a non-persistent group parallel to both *Asteroidea* and *Ophiuroidea*, or whether he would bring it into the ancestry of modern brittle-stars.

All normal Ophiuroidea with the ventral surface of the arms covered by plates are constituted a sub-class *Myophiuroidea*. Its Palæozoic representatives have no distinct plates in the skin of the central disc, the mouth-frames are slender, dorsal arm-plates are absent or incipient, ventral arm-plates are small and depressed below the projecting edges of the side plates. Among recent forms it is the *Ophiomyxinæ* that come nearest to this condition, but it is also approached by those *Ophiacanthidæ* in which the arms are only flexible horizontally. From the *Ophiomyxidæ* Mr. Matsumoto derives all the *Trichasteridæ* and *Gorgonocephalidæ*, and separates the three families as an order *Phrynophiurida*.

From the early *Ophiacanthidæ* are supposed to spring all the other Ophiuroidea, diverging along three lines. The first of these passes, through those *Ophiacanthidæ* which can coil the arms vertically, to the *Hemieuryalidæ*; and these two families compose the order *Læmophiurida*. The two other lines never attain vertical

<sup>1</sup> "A Monograph of Japanese Ophiuroidea, arranged according to a New Classification." By Hikoshichiro Matsumoto. Journ. Coll. Science, Tokyo, vol. xxxviii., Article 2. Pp. 408+vii plates. (University, Tokyo, March 31, 1917.)

coiling. From one another they are distinguished in the articulation of the radial shield and genital plate: in the one case this is by a single ball-and-socket joint, in the other case by two condyles and sockets. The former line passes, through the *Amphilepididæ*, to the *Amphiuridæ* and *Ophiotrichidæ*, and, since these two families have stout mouth-frames and teeth, the whole order is called *Gnathophiurida*. Along the other line arises a host of forms, divergent in structure and complex in relationship, which are grouped under five families: *Ophiodermatidæ*, *Ophiochitonidæ*, *Ophiocomidæ*, *Ophiolepididæ*, and *Ophioleucidæ*.

Mr. Matsumoto's classification, being essentially phylogenetic, will have to be checked by the palæontologist before it can be considered established. The morphological bases, however, seem well selected and are well illustrated.

F. A. B.

### ATMOSPHERIC POLLUTION.

THE second report (1915-16) of the Committee on Atmospheric Pollution has just been issued in the form of a supplement to the *Lancet*, the delay in its appearance being due to lack of funds. This difficulty has now been met by the receipt from the Department of Scientific and Industrial Research of a Government grant, which provides the necessary equipment for collecting and analysing the smoke deposits at different centres. The work, moreover, has been given official approval and status by placing it under the control of the Meteorological Office, the committee being constituted as an advisory committee of that department.

Owing to the depletion of the staffs formerly collaborating in these investigations, certain stations have found it impossible to continue observations, so that the list for the year is curtailed. The general methods of analysis and tabulation of results are, with slight modifications, those previously described in the former report (*NATURE*, May 4, 1916, vol. xcvii., p. 203).

It is interesting to note from the point of view of fuel economy that the deposit for the year in the County of London alone, which consisted of matter derived from waste fuel in the form of smoke, amounted to 54,200 tons. The report adds that not only is it necessary to scrutinise carefully every source of waste, but it is equally necessary to conserve the health and physical energy of the people. From this point of view it refers to the fact that the average weight of air consumed per day by the adult human being is 30 lb., as compared with 7.2 lb. of solid food and water.

In the section devoted to a discussion of results a comparison is drawn between the total solids deposited in the six summer and the six winter months of 1915-16 with the corresponding periods of 1914-15. Without reproducing details of the results it may suffice to say that in the larger number of centres there has been an increase in the amount, a few centres in the Manchester and Glasgow area showing a decrease in the winter months, while Birmingham Central, Bolton, Malvern, Sheffield, and York show a diminution in the summer months. Of the actual quantities, the mean monthly deposit in tons per square kilometre is tabulated for the different centres. It appears from this that Oldham has the distinction of showing the largest deposit of total solids, carbonaceous matter other than tar, and insoluble ash, while Glasgow occupies the highest place in ammonia, sulphates, and tar. Malvern shows the minimum deposits in nearly every item. If there were the same fierce rivalry between towns as existed in medieval Italy, we might hope that industrial centres might vie with Malvern in improving their atmosphere.

There seems very little prospect of any such peaceful