gullet, this whale does not require to open its mouth very wide; as the gullet is only from $1\frac{3}{4}$ inches to 2 inches in diameter, it indicates that the food consists of small morsels. The sharp, enamelled tooth at the summit of the tusk is probably used for tearing and rending soft-bodied animals such as cuttle-fishes, and possibly for tearing aside seaweeds when in search of food.

The tusks are 14 inches in length, $2\frac{1}{2}$ inches wide at the jaw, $1\frac{3}{8}$ inches at the summit beneath the conical real tooth, and from $\frac{3}{8}$ inch to $\frac{1}{2}$ inch thick. On the back the blubber was 3 inches thick, and $1\frac{1}{2}$ inches on the belly. The oil was of fine quality, and had great penetrating power, almost like paraffin. Owing to the advanced state of decomposition of the viscera, the contents of the stomach were not examined.

From the foregoing it is evident either that previous drawings and data in regard to Layard's whale are more or less inaccurate, or that the present specimen indicates a new species. The drawings show that the upper lip or tip of the beak covers the lower lip, while the photographs indicate that the upper jaw slightly projects beyond the lower, the reverse being apparently the case in Sclater's and Moseley's illustrations. The lips were not horny, but rather like hardish flesh. The skull is very asymmetrical, the bulk of the frontal bones inclining from the right to the left side.

The creature had apparently been injured at some previous time, as the tongue-bones and two vertebræ showed signs of having been fractured and repaired. One of the most remarkable features of this whale is the small size of the flippers as compared with that of the body. The backward position of the dorsal fin is also noticeable. With the exception of those of the skull, the bones are remarkably light and porous. Those of the beak are, however, brittle, dense, and hard.

F. W. FITZSIMONS.

Port Elizabeth Museum, May 30.

The Radio-activity of Lead and other Metals.

IN the course of some experiments that have been recently carried out in the physical laboratory at Toronto on the natural conductivity of air confined in vessels made of different metals, a wide variation was observed in the results obtained with different samples of lead. The lowest conductivity observed with air enclosed by this metal corresponded to an average production of 23 ions per c.c. per second, and the highest to a production of 160 ions per c.c. per second. The lowest value hitherto recorded for lead appears to be that quoted by Eve in his paper in the *Phil. Mag.* of September, 1906, in which he gives 96 ions per c.c. per second as the number he obtained with this metal. The sample of lead which exhibited the low activity just referred to was a sheet which had been used as a lining in a case in the laboratory for nearly thirty years.

With zinc and aluminium receivers it was found that on the average 15 ions per c.c. were generated per second in the air which they enclosed.

From measurements made with the gamma rays from radium on the ionisation produced in air confined in a lead cylinder (1) when unlined, and (2) when lined with thin sheet aluminium, due allowance being made for absorption, it was found that the ionisation in a lead cylinder due to the gamma rays was one-half that obtained with the excited secondary radiation. On the other hand, with an aluminium cylinder, the ionisation due to the secondary radiation was found to be approximately one-half that produced by the gamma rays. Assuming these results to hold for the penetrating radiation from the earth, it follows that on the average 9 ions per c.c. per second are generated in free air by this radiation. It also follows that the difference between the natural ionisation in air observed with the aluminium cylinder, viz. 15 ions per c.c. per second, and that found with the least active lead, viz. 23 ions per c.c. per second, can be wholly explained by differences in the secondary radiation excited in the two metals. This result, combined with the observed differences in the conductivity of air enclosed in vessels made of different samples of lead, goes to show that the high activity usually observed with lead is due to the presence of active impurities in it, and not to the existence of any intrinsic activity possessed by the metal. In this connection it is interesting to note that Elster and Geitel (*Phys. Zeit.*, November, 1906, and May, 1907) have recently been able to extract from commercial lead oxide and a sample of lead an active substance which they suggest may possibly turn out to be radium F.

In the experiments described above, the measurements were made with a sensitive quadrant electrometer on air confined in cylindrical vessels 60 cm. high and 24 cm. in diameter.

J. C. MCLENNAN.

University of Toronto, June 25.

Inheritance and Sex in Abraxas grossulariata.

IN February, 1906, in conjunction with the Rev. G. H. Raynor, I gave a paper to the Zoological Society on the inheritance of a variety of the moth *Abraxas grossulariata* and its relation to sex (Proc. Zool. Soc., 1906, vol. i., p. 129). We found that when the var. *lacticolor* (*flavofasciata*) was crossed with the type it behaved as a Mendelian recessive, disappearing entirely in generation F_1. When two heterozygotes were mated together, var. *lacticolor* reappeared, but only in the female sex, roughly half the females and all the males being typical. When a heterozygous male was mated with *lacticolor* female, the variety appeared in both sexes in the offspring, viz. in about half the males and half the females. When, however, a *lacticolor* male so produced was paired with a heterozygous female, we found that all the males were typical and all the females *lacticolor*. This result was given in our paper with some hesitation, since it was founded on a rather small number of specimens (29 ♂, 11 ♀), but this year it is amply confirmed. I have reared 116 males and 74 females from six families of this mating, and every male is typical, every female *lacticolor*. Mr. Raynor has also reared equally large numbers with the same result. From a family of the converse cross, on the other hand (*lacticolor* ♀ × heterozygous ♂), I have reared 24 type ♂, 22 *lacticolor* ♂, 17 type ♀, 18 *lacticolor* ♀, a fair approach to the expected equality in each sex.

I think it may be concluded definitely that in this case

(1) The type is completely dominant.
(2) DR♀ × DR♂ gives DD♂ + DR♂, DR♀ + RR♀.
(3) R♀ × DR♂ gives DR♂ + R♂, DR♀ + R♀.
(4) DR♀ × R♂ gives DR♂, R♀.
(5) R♀ × R♂ gives R♂, R♀.

(In [2] above the absence of DD females has not been proved.)

This confirmation of our previous results seems to me to lend some support to the provisional hypothesis of sex-determination outlined in the paper referred to.

L. DONCASTER.

University of Birmingham, July 2.

THE DOUBLE-DRIFT THEORY OF STAR MOTIONS.

THE problem of determining the motion of the sun amongst the stars has undergone a great change in consequence of Prof. J. C. Kapteyn's investigations which have recently become known. These researches indicated that the stars surrounding us do not form a simple system, but a dual one. From a discussion of the motions of the stars of Bradley's catalogue, Prof. Kapteyn demonstrated the existence of two great streams of stars passing through one another, and found the directions of motion of these streams relative to the sun and to one another. The Bradley stars, numbering about 2600, are mainly stars visible to the naked eye; they cover nearly three-quarters of the celestial sphere, and throughout the whole of this area Prof. Kapteyn found the same two streams prevailing, and it seemed probable that all the stars he examined belonged to one or other of the two streams.

The investigations with which this article more particularly deals are based on the proper motions deduced by Prof. Dyson and Mr. Thackeray from their re-reduction of Groombridge's Catalogue. The number of stars included is 4200, all confined to a region within 52° of the North Pole. About 1100 Carrington proper motions were also examined; these were all within 9° of the Pole. These two catalogues contain a large proportion of stars much fainter than those of Bradley, and enable the inquiry to be extended as far as magnitude 9·5. The same two streams are found to prevail among these faint stars, and it seems a fair conclusion that all the stars down to at least magnitude 9·5—more than half-a-million in number—are within the scope of the theory. It should, however, be remembered that only *samples* have been taken, in limited regions of the sky, for these fainter stars, so that there is a possibility of unexpected deviations from theory in the at present unexplored regions.

To indicate how it is possible to distinguish whether the stars in a given region of the sky belong to a single system or to a double system, or to something still more complex, it will be well to take an actual instance. In Fig. 1 the curve P has been drawn to

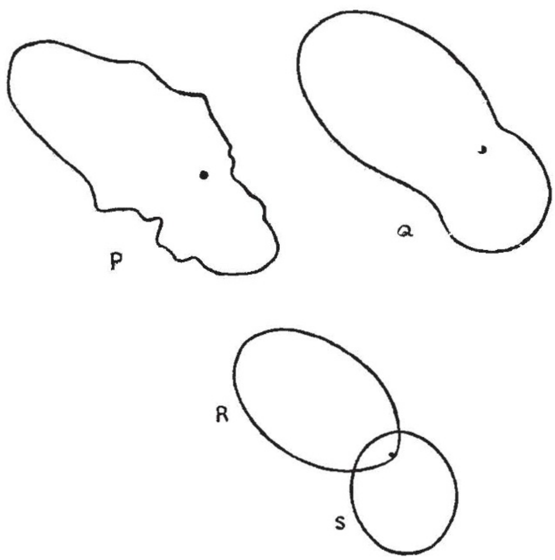

FIG. 1.—Showing the analysis of the observed motions into two simple drifts.

summarise the proper motions of the stars in a region of the sky comprising parts of the constellations Draco, Boötes and Hercules. The radius drawn from the dot to the curve in any direction represents (by its length) the number of stars moving in that direction, or rather within 5° on either side of that direction. Now the distribution of proper motions indicated by this figure cannot possibly be due to a system of stars forming a single "drift," that is, a system in which the motions of the stars *inter se* are haphazard, though the system as a whole may be in motion relative to the sun (or, as it is more usually expressed, the sun may be in motion relative to the system). The type of curve resulting from such a drift can be calculated mathematically; R and S are such curves. It is not difficult to see that, having regard to the position of the origin, no curve of this symmetrical type could be chosen which would at all approximately coincide with the observed curve P. The hypothesis of one drift, therefore, does not give even an approximation to the observed distribution of proper motions. But by combining the two drifts R and S, we obtain the curve Q, which agrees very closely with the observed curve. The differences between P and Q are, in fact, insignificant, and of a purely accidental character.

For each of seven regions into which the Groombridge stars were divided, as well as for the Carrington stars, the observed distribution of proper motions allowed itself to be dissected in this way, and exhibited as the result of two simple drifts intermingled. The agreement between the observed distribution and the theoretical distribution was not always quite so perfect as in the case illustrated. For instance, in one region the observed curve showed twenty-four stars moving where they ought not to have been; presumably they formed a local system; but such an irregularity is small compared with the two main drifts, which in that region each included more than 400 stars. Most of the regions, however, did not show even such a small irregularity as this.

The shape of the simple drift curve depends on the velocity of the drift (relative to the sun) as compared with the mean velocity of the stars of the drift relative to one another. Naturally, for high drift-velocities the curve becomes more elongated, for the tendency then is for all the stars to move nearly in the direction of the drift, the individual motions being relatively

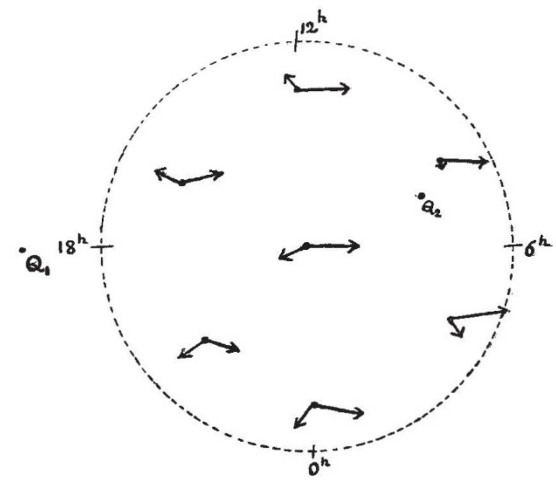

FIG. 2.—The region within 52° of the North Pole. The arrows show the magnitudes and directions of the drift velocities.

small; for low drift-velocity the curve is rounder, approaching the form of a circle about the origin for the limiting case of zero drift-velocity. The curves R and S correspond to drift velocities 1·20 and 0·45 respectively (the unit is 0·886 of the mean peculiar speed of the stars). The analysis, therefore, not only shows the directions in which the two systems of stars are moving, but also their velocities.

Fig. 2 is a diagram of the part of the sky covered by the Groombridge catalogue. At seven points (the centres of seven regions into which the area was divided) are drawn pairs of arrows representing the velocities of the two drifts in magnitude and direction, determined for each region independently, as explained above; but in each case the shorter arrow of the pair has been drawn on twice the scale of the longer one, so that the difference in velocity of the two drifts is even greater than appears from the figure. This attempt to represent a considerable portion of the sphere on a plane surface is necessarily imperfect, but it is sufficient to show that each set of arrows is directed approximately from a point, viz., the longer arrows from the point Q_1 (R.A. 18h., Decl. + 18°) on the left of the figure, and the shorter arrows from the point Q_2 (R.A. $7\frac{1}{2}$h., Decl. $+58°$). It will be convenient to refer to the two systems as Drift I. and Drift II.; Drift I. accordingly is a group of stars in rapid motion from the point Q_1, and Drift II. a group in comparatively slow motion from the point Q_2, its velocity being, in fact, not quite one-third that of Drift I. Fig. 2 also shows that the speed of Drift I. appears smaller in the regions nearest Q_1, and of Drift II. in the regions nearest Q_2. This is because that part of the drift motion which is in the line of sight has no effect on the proper motions, and cannot be detected by examining them. The component of the drift motion *across* the line of sight decreases as the apex of the drift is approached, and vanishes at the apex itself.

Another result from the mathematical analysis is that the stars are nearly equally divided between the two drifts, Drift II. having, perhaps, a slightly greater proportion. It is rather remarkable that although some parts of the sky are more than twice as rich in stars as others, the approximately equal division between the two drifts is maintained in every region.

It is natural to inquire whether there may not be some other distinction between stars of the two drifts besides their motions. The fact that the sun moves comparatively slowly relative to Drift II. rather suggests that the sun belongs to this drift. In that case it might be expected that the Drift II. stars would be nearer on the average than those of Drift I., the latter forming a sort of background. The magnitudes of the proper motions (which have up to this point not been considered) afford data for testing this point. Due allowance having been made for the fact that the true Drift II. motion has already been found to be very much less than that of Drift I., the apparent motions indicate the same mean distance for the two drifts. In fact, a mathematical calculation showed less than 5 per cent. difference between the mean distances of the two drifts (though it is improbable that the data can be trusted quite so far as this). Remembering that the two drifts divide the stars in nearly the same proportion in all the regions, it would seem that they are as completely mixed as it is possible to imagine.

One point of great interest is the distribution of the stars of different spectral types among the drifts. It has been customary to regard Secchi's two types as forming to a certain extent two systems, for Type II. stars are very evenly distributed throughout the sky, whereas those of Type I. tend to congregate in the plane of the Milky Way. It is, however, quite certain that the division into two spectral types and the division into two drifts do not correspond. If we examine Type I. stars alone, both drifts are evident; and so also if Type II. stars are examined alone. Nevertheless there is a systematic difference between the distribution of the proper motions of the Type I. and Type II. stars, which manifests itself in every region examined (including the Bradley stars). It may perhaps be interpreted as being due to a higher percentage of Type II. stars in Drift II. than in Drift I., but it now appears more probable that the difference consists in Type II. stars having larger "peculiar" motions (the haphazard individual motions) than Type I. stars. In addition to some satisfactory direct evidence, this latter explanation is supported by the fact that nearly all the "runaway" stars are of Type II., and it also agrees with the difference in distribution of Type I. and Type II. stars; the former mainly congregate in one plane, whilst the latter, perhaps originally in the same plane, would have become more uniformly distributed in consequence of their greater individual velocities.

There is no indication of any relation between magnitude and drift, except possibly in the case of the very bright stars (brighter than magnitude 4·0). These latter seem to belong principally to Drift I., but they are so few in number (in the area examined) that the result may very well be accidental.

Having determined the motions of the two drifts of stars relative to the sun, and knowing also that the stars are nearly equally divided between them, it is easy to determine the motion of the sun relative to the combined drifts—in fact, to determine the *solar apex*. In this way the solar apex is found to be at R.A. 17h. 45m., Decl. $+31°$; it is naturally fairly close to Q_1, since the velocity of Drift I. predominates. From the same stars, by Airy's method, Dyson and Thackeray found the solar apex to be at R.A. 18h. 20m., Decl. $+37°$. The somewhat greater R.A. of their determination (and of most other determinations) is probably the result of using the magnitudes of the proper motions. This position, deduced by means of the two-drift theory from the directions of the proper motions only, has the advantage of being free from all assumptions as to the distances of the stars, but the probable accidental error is large. The two-drift theory further directs attention to the true nature of the "solar motion" so determined; it is in no sense an *absolute* motion, and there is now no justification for confounding it with the motion relative to the æther, as has sometimes been done.

In conclusion, whilst Prof. Kapteyn's theory accounts in a simple manner for the very anomalous and unsymmetrical way in which the directions of motion of the stars are distributed, it is still awaiting the verdict of the spectroscopic determinations of line-of-sight velocities. The material exists in plenty for applying this test; it simply awaits examination by those who have access to it. The investigation of the motions of still fainter stars, and of regions of the sky which have not yet been explored, offers a large field for further research.

A. S. EDDINGTON.

SEVENTH INTERNATIONAL ZOOLOGICAL CONGRESS.

THE arrangements for the seventh International Zoological Congress, which will be held at Boston, August 19–23, under the presidency of Mr. Alexander Agassiz, are now well advanced. The congress will open formally on the afternoon of August 19 in the Harvard Medical School, and arrangements will then be made for the meetings of the sections. The subdivision proposed is rather elaborate, for there are to be sections on general zoology, systematic zoology, experimental zoology, marine zoology, evolution, heredity, and so on. There will be three general meetings; the International Committee on Zoological Nomenclature, under Prof. R. Blanchard, will continue its arduous labours; and numerous addresses, communications, and exhibits have already been arranged for. It need hardly be said that the arrangements for hospitality are generous. On each day of the strict congress week there will be luncheon at the invitation of the Boston local committee, and the evenings will be occupied with receptions and dinners.

On the afternoon of August 22 there will be an excursion to Wellesley College; August 24 will be devoted to a visit to the museums of Harvard University; August 25 is Woods Hole Day; August 26 Columbia University Day; August 27 the American Museum Day. On August 28 the members of the