similar in the two plates. Moreover, the author states that the forms shown on his plates agree very closely with those obtained by Prof. Barnard in 1893; so that there being at least three photographs showing identical forms, the evidence is greatly in favour of their being true cosmical matter, as it is inconceivable that chance markings could exhibit such coincidences. To explain their absence on Dr. Roberts's plates, the author thinks that the atmosphere at Goodsell Observatory must be much clearer than is the case in England, giving as his reason the fact that the star images on his plates are much less surrounded by atmospheric glare than those of Dr. Roberts. Indeed, even with the long exposure of over eleven hours, the star discs are still easily discernible on the reproductions, showing that the observing conditions must have been extremely perfect.

METEOR PHOTOGRAPHY.—Those who may be interested in this branch of astronomy will find the illustrated description, by Mr. W. L. Elkin, of the apparatus used for this purpose at the Yale University of considerable value (*Astrophysical Journal*, vol. ix. p. 20, January).

The instrument consists of a long polar axis, driven by clockwork, and provided with means of attachment for from eight to twelve cameras round its circumference. The lenses used for this purpose are selected for their rapidity; hence we find that portrait lenses are in nearly all cases chosen. During the last November Leonid shower eight cameras were used with the instrument; six of these carried portrait lenses of from six to eight inches aperture and from twenty-seven to thirty-six inches focus, the remaining two being provided with lenses four inches in diameter.

It is, however, not indispensable to have an expensive clock-driven mounting, and for the same meteor shower a simpler apparatus was also used, having a wooden polar axis turned intermittently at intervals of ten minutes by means of a toothed wheel. By also displacing the axis slightly at each movement of the wheel, the successive star trails fell alongside each other, making a kind of time scale, which made it possible to refer any meteor trail to its position among the stars if the time of its appearance had been noted.

The article is illustrated by a photograph of the instrument in position at the observatory, and one of the successful plates showing a Leonid passing near Mars and the star-cluster Præsepe.

THE TRADE IN TORTOISESHELL.

AMONG the number of misnomers current in popular language, and more especially in that relating to natural history, few are more unfortunate than is the application of the term "tortoiseshell" to the substance which should properly be designated turtleshell, or perhaps rather turtle-skin. It is, however, far too late in the day to attempt a change; tortoiseshell it always has been, and tortoiseshell it will doubtless remain. In its manufactured state, whether in the form of inlaid buhl-work, as the handle of a fan, or as a comb, the translucent plates of tortoiseshell, with their rich mottlings of golden yellow and warm chestnut, are familiar to all. The particular species of reptile, or reptiles, from which it is derived, the part that it plays in the economy of these creatures, and the methods of the manufacture, to say nothing of the enormous volume of the trade, are, however, less matters of common knowledge.

To begin with, tortoiseshell, in the widest sense of the term, may be taken to include the horny superficial plates or shields overlying the bony case of the great majority of tortoises and turtles, although in the popular and trade sense it is restricted to those of the latter. Anatomically it corresponds to the scarf-skin or epidermis of the human integument, the underlying bony case or shell representing, to a great extent, the true skin. Turtles differ from tortoises, among other features, by the heart-shaped form of the upper half of the shell, or carapace, and the conversion of the limbs into paddles adapted for swimming. The upper part of the shell carries a median row of five large superficial horny plates, flanked on each side by a row of four or five still larger flat plates; these thirteen or fifteen large plates, affording some of the most valuable commercial tortoiseshell in the particular species whose "shell" is most in demand. On the front and hind edges of the upper bony shell and the portion connecting the latter with the plastron, or lower shell, are a series of smaller horny plates, generally twenty-four in number, which are sharply bent in the middle, and are known in the trade as "hoof." They form the least valuable portion of commercial tortoiseshell. The under surface of the shell of a turtle carries six pairs of large, more or less flat, horny plates, for which the trade term, derived from their uniform colour, is "yellow-belly." In value they sometimes exceed all but the very finest of the large upper plates, generally known simply as "shell." The term "shell" has thus a very different signification in commerce from that which it bears in natural history, where it is applied to the whole solid case of the reptile, including both the overlying horny plates and the subjacent solid bony structure.

Of the host of land and fresh-water tortoises, most of which are of comparatively small size, the horny plates (which, by the way, are altogether wanting in the so-called soft tortoises of tropical and subtropical rivers), on account of their thinness and opacity, are now of no commercial value whatever, at least in England.

Moreover, it is by no means all the species of marine turtles which yield commercial tortoiseshell. Of these marine turtles, exclusive of the great leathery turtle, which has no horny plates at all, there are three well-marked and perfectly distinct types, severally represented by the green, or edible turtle, the hawksbill, so named from the form of its beak, and the loggerhead. The latter, which is the largest of the three, taking its name from its huge ungainly head. Of the green turtle the plates are so thin and so badly coloured as to be of little or slight manufacturing importance, so that they do not apparently figure at all in the trade circulars of Messrs. Lewis and Peat. In this species the horny plates on the back, which have a dull pale brown ground-colour with streaks of black, meet together by their edges, like the tiles in a pavement, or the plaques in a mosaic. On the other hand, the much thicker and more beautifully-coloured plates on the back of the hawksbill, which afford the most valuable commercial shell, overlap one another like the slates on a roof during the greater part of their owner's life, although in very aged individuals they are joined by their edges. The largest and best plates, which are those in the middle of the sides of the back, are about a quarter of an inch thick in the centre, and measure about thirteen by eight inches; their weight being from about half-a-pound each to as much as one pound. Their translucency and beautifully mottled colours have been already mentioned. The lower plates, or "yellow-belly," on the other hand, are of a uniform golden yellow tint; while the connecting marginal plates, or "hoof," are partly plain yellow and partly mottled. In size the hawksbill is somewhat inferior to the green turtle; the length of the carapace being about thirty-two inches in the former, as against forty-two in full-grown examples of the latter. Both are found in all tropical and subtropical seas; and both resort to flat sandy shores for the purpose of depositing their eggs.

From a dead turtle the plates of tortoiseshell can be readily detached from the underlying bony framework by the application of heat. Sometimes boiling water is used, but more generally the whole shell is placed over a fire. In the West Indies one method, which may or may not be still in use, was to bury the whole shell in the ground for ten or twelve days, when the plates became readily detachable. It is stated, however, that the removal is too often effected by the cruel method of applying heat to the living animal, after which the unhappy turtle is returned to the sea to grow a fresh suit of plates. Formerly it appears to have been the custom to bore each plate of the upper shell, and to fasten together the whole series furnished by each individual turtle with wire or string; such bundles being sold together. Now, however, the samples offered at the London sales on string or wire are comparatively few, although the practice is maintained with Macassar and sometimes Ceylon shell.

In the trade circulars of Messrs. Lewis and Peat, hawksbill tortoiseshell is divided into the following geographical classes, viz.: (1) West India; (2) Zanzibar and Bombay; (3) Mauritius and Seychelles; (4) Singapore and Macassar; (5) Sydney and Fiji; and (6) Ceylon. Most of these classes are again subdivided into "shell," "yellow-belly," and "hoof"; while these latter subdivisions are again split up according to size, thickness, colour, and condition. Nos. 1 and 2 always send very large imports; next come Nos. 4 and 5, which, however, exhibit very marked seasonal oscillations; while those of Nos. 3 and 6 are much smaller.

In order to ascertain how the trade of the present day in this

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commodity compares with that of thirty years ago, reference may be made to some statistics quoted by Dr. P. L. Simmonds in 1878. From these it appears that in the year 1870 the total imports of tortoiseshell (apparently of all descriptions) into the United Kingdom were 49,332 lbs., valued at 32,503*l.* It is also stated by the same writer, that in some years prior to 1878 the amount of the imports had reached the enormous total of thirty tons, with an estimated value of 74,000*l.* In 1870 the average price per pound was between thirteen shillings and fourteen shillings and sixpence; except Indian shell, which was only worth 7*s.* 9*d.* the pound. Dr. Simmonds likewise mentions that whereas about the year 1845 selected samples had realised as much as 3*l.* 3*s.* per pound; between that time and 1870 there had been a great fall in values, although towards the latter date they showed a tendency to rise. For instance, somewhat before that year good coloured shell from Zanzibar and Singapore had fetched from 28*s.* to 29*s.* 6*d.* per pound, and fair to good qualities of West Indian from 31*s.* to 41*s.* the pound.

According to the reports issued by Messrs. Lewis and Peat for 1898, the total amount of hawksbill tortoiseshell (that is to say exclusive of loggerhead shell, which is referred to later on) offered for sale in London during that year was about 76,760 lbs., practically all of which was sold. To arrive at the average price realised at these sales, would involve long calculations without affording any very compensative advantage. Attention may accordingly be directed to certain special values. The highest prices realised during the year were at the May sale, when selected Zanzibar and Bombay shell sold at from 67*s.* 6*d.* to 112*s.* 6*d.* per pound, while two pounds weight of specially selected Sydney and Fiji were disposed of at the rate of 100*s.* per pound. Whether these are record prices, we have no information; but they are certainly ahead of any of those quoted by Dr. Simmonds in 1878, 80*s.* per pound being the maximum value mentioned by him. The next highest price during 1898 was 95*s.* per pound for selected heavy Zanzibar and Bombay shell of a reddish tint, which was disposed of in the September sale. This value is followed by prices ranging between 45*s.*, 62*s.* 6*d.*, and 75*s.* for selected Nassau and Honduras shell in the West Indian class; Jamaica and Havana shell touching, however, as much as 77*s.* the pound. Of West Indian "hoof," the best Nassau and Honduras pale-coloured descriptions realised from 18*s.* to 27*s.* at their top price; while ordinary West Indian was a few shillings cheaper. On the other hand, Zanzibar and Bombay "hoof" ranged between 6*s.* and 17*s.* 6*d.* Some of the highest prices were realised by Nassau and Honduras "yellow-belly," which fetched between 67*s.* 6*d.* and 80*s.* in September, but had fallen to between 45*s.* and 65*s.* per pound by November. "Yellow-belly" is, or was, extensively used by Spanish ladies for large hair-combs, being often much more esteemed for this purpose than the mottled upper shell. Among all the classes of hawksbill tortoiseshell, that from Ceylon seems to have the lowest value; the general quotation being between 14*s.* and 17*s.*, although as much as 34*s.* has been obtained for selected samples.

The tortoiseshell yielded by the loggerhead turtle, of which 8300 lbs. were offered and about 7300 lbs. sold by Messrs. Lewis and Peat during 1898, is a much less valuable commodity than the produce of the hawksbill. During the year in question, the usual price per pound ranged between one and three shillings, although as much as 4*s.* 9*d.* was obtained in March. The upper plates of the loggerhead are much thinner than those of the hawksbill, and of a more or less uniform dark chestnut-brown, without marked translucency.

The statistics quoted above afford a good general idea of the vast extent and value of the London tortoiseshell trade. Unfortunately, it is impossible to give the total British imports and their value, since in the Board of Trade returns tortoiseshell, together with mother-of-pearl, is lumped with other shells, and the value of the mixed imports alone given. In addition to the British trade, the imports of other European countries (although, of course, some of these may have come from Britain) are very large. France, for instance, is a very large importer of tortoiseshell, the average annual amount taken during the ten years ending with 1876 being 42,306 kilogrammes, with a value of 2,078,910 francs. China and Japan are likewise large consumers of tortoiseshell, as is also America. The annual destruction of hawksbill turtles to supply the demand for this shell must therefore be enormous; but since, like most marine creatures, these reptiles are exceedingly prolific, it by no means follows that they are in any imminent danger of extermination.

As regards its employment in the arts and manufactures, tortoiseshell being very similar in its nature to horn, is in like manner made partially plastic before working by immersion in hot water in which salt has been dissolved. The natural curvature of the plates is removed by placing them under pressure between smooth boards while in this semiplastic condition, and allowing them to cool. But, in addition to its plasticity, tortoiseshell possesses the valuable property of welding; so that when a large superficies is required, two or more plates can be readily joined together in this manner. The *modus operandi* is first of all to bevel the adjacent edges of the two plates to be united in opposite directions, and then pressing the overlapping edges together in a metal press under the action of boiling water. So intimate is the union, that when the operation is properly performed, no trace of the division is visible. Nor is this all, for by the application of moist heat tortoiseshell may be made to receive impressions of any form by being squeezed between metallic moulds. Neither are the dust and shavings made in the course of the manufacturing processes useless, for these are placed in brass moulds, where, under moist heat and pressure, they become consolidated into a homogeneous mass of any form that may be desired. Necklaces and many other small fancy articles are made in this manner.

From its high price, it is important to economise as much as possible the material used in the manufacture of tortoiseshell objects. The following ingenious example of this is described by Dr. Simmonds. "In making the frames for eye-glasses, narrow strips of tortoiseshell are used, in which slits are cut with a saw; the slits being subsequently, while the shell is warm, strained or pulled open, until they form circular or oval apertures, by the insertion of tapering triblets of the required shape. The same yielding or flexible property is made use of in the manufacture of boxes, a round flat disc of shell being gradually forced, by means of moulds, into the form of a circular box with upright sides." The only objection to this process is that the colours become so darkened as to be almost black.

In the manufacture of small combs, again, a pair of these are cut out of a single piece of shell by means of a vertical cutter, working in such a manner, that the cores left between the teeth of one comb form the teeth of the other. Similarly in buhl-work cabinets, in which tortoiseshell is inlaid with brass, both portions of the former material cut out by the fret-saw are employed. Hence in a pair of cabinets the pattern of the inlaying is reversed; the tortoiseshell forming the ground-work and the brass the inlaying in one, while in the other the opposite arrangement occurs.

Formerly the manufacture of ladies' combs, especially those made for Spain and South America, formed a very important feature in the tortoiseshell industry, some of these being a couple of feet in width, and from six inches to a foot in height. In England, at any rate, large combs are now disused. Although for veneering purposes, when the colouring of the shell is intensified by a layer of coloured varnish or metallic foil beneath it, thin tortoiseshell is employed; the thick descriptions are those most favoured at the present day in the English market.

Finally, it may be mentioned that on the continent the shell of various species of land tortoises is employed more or less extensively for buhl-work, its colour being always intensified by a substratum of bright foil; and it is said that the same material has occasionally been employed for inlaying purposes in England. Imitation tortoiseshell is made by painting horn with a paste of lime, litharge, and soda, which is allowed to dry and then rubbed off. Dark spots of lead sulphide are thus formed in the horn, giving it a mottled appearance.

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UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof. W. F. R. Weldon, F.R.S., has been appointed to the vacant Linacre Professorship of Comparative Anatomy, in succession to Prof. Ray Lankester, F.R.S.

Reading College, Reading, has been admitted to the privileges of an affiliated college.

Natural Science scholarships are announced for competition at the following colleges:—Jesus College, on April 18; Merton College, New College, and Corpus Christi College, on June 27.