Letters to the Editor.

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Positive Ray Analysis of Copper.

THE chief difficulty in analysing an element with a high melting-point by means of positive rays lies in the construction of a suitable furnace for evaporating the metal. I have recently succeeded in obtaining rays of copper by using a molybdenum furnace, heated with a coil of molybdenum wire embedded in alundum cement. Three isotopes were observed separated by two units in atomic weight. The relative intensities were about 1·4 : 1 : 1, the lightest being the strongest. Rays of rubidium were also obtained, probably from the cement, and showed two isotopes, as found by Aston with his method of analysis. The relative intensities gave a mean atomic weight of 85·51, in good agreement with the chemical atomic weight 85·45. To obtain agreement with the chemical atomic weight of copper 63·57, it is necessary to suppose the isotopes to be 62, 64, and 66, since this gives a mean atomic weight of 63·76, which is as close as would be expected. A direct comparison with rubidium is desirable, but further experiments will be necessary before the comparison can be regarded as conclusive, since the rubidium rays probably start at the surface of the cement and may fall through a different potential from the copper rays. A few comparisons suggested the even atomic weights, so that we may provisionally take the isotopes of copper as of atomic weights 62, 64, and 66. This seems to mark the first exception to the rule observed by Dr. Aston to hold for chlorine, potassium, bromine, rubidium, and antimony, that elements with odd atomic numbers have isotopes with odd atomic weights, and may be connected with the fact that copper occupies a place in the series of elements where the atomic weights begin to increase rapidly with atomic number.

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June 9.

Expansion of the Wings of Lepidoptera after Emergence from the Chrysalis.

No one who has watched a butterfly or moth emerging from the chrysalis can fail to have been impressed by the rapid expansion of the wings. This expansion is not real growth, but merely the opening out of the contents of a carefully packed parcel, and the general character of the changes which occur in the process is well known.

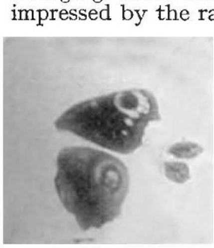

FIG. 1.—Pupal and extended wings of V. Jo (distance between lines = 1 inch). The pupal wings were removed from the chrysalis just before emergence.

The true growth of the wings takes place and is completed in membranous sacs just within the walls of the chrysalis, and the form of the wings can be distinguished from the outside. The position of the wings during their development is such that the upper surface of the fore wing is next to the wall of the chrysalis, and within a day or two from the time of hatching the colours and markings can in many cases be recognised.

Each wing consists of two separate membranes, united with the nervures, on which the scales are mounted, the stems of the scales entering sockets in the membranes placed in fairly symmetrical rows, though the irregular shape of the spaces between the nervures prevents the symmetry being exact.

The point to which the present note is intended to direct attention is the numerical relation between the size of the pupal and expanded wings, and the reason for the constancy of this relation. In all the lepidopterous wings which I have examined the pupal wing has very nearly one-third of the dimensions of the wing of the perfect insect (Fig. 1).

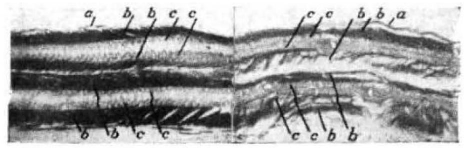

FIG. 2.—Section of pupal wings parallel to the nervures. × 60. FIG. 3.—Section of pupal wings at right angles to the nervures. × 60.
Sections in Figs. 2 and 3 were cut from the chrysalis, and show both the fore and hind wings.

If the fully developed wing is removed from the chrysalis and sectioned, the reason for the one-to-three ratio is immediately evident so far as regards extension parallel to the nervures, but the "accordion" folding whereby the scale-bearing membranes expand in a direction at right angles to the nervures is rather more complex.

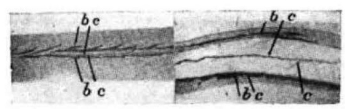

FIG. 4.—Section of extended wings parallel to the nervures. × 60. FIG. 5.—Section of extended wings at right angles to the nervures. × 60.
These sections are from the posterior part of the fore wing not far from the margin.

The section parallel to the nervures is shown in Fig. 2 and diagrammatically in Fig. 6. Here the wing membrane is seen folded so that the distance from fold to fold is the same as the depth of the fold, and therefore the extended is three times that of the folded dimension. To realise the character of folding in the other principal direction, imagine a series of camera bellows fully extended A_1A_2, etc., to be placed side by side, Fig. 9, so that the sides C_1C_2, C_2C_3, etc., will remain in contact when the bellows are contracted. Then remove the lower sides B_1B_2, etc., and join the free edges of C_1C_2, C_2C_3, etc. It is clear that the surface thus formed is developable, and that if, to start with, the bellows are compressed to one-third of their extended length the developed surface will in all directions have three times the dimension which it has when folded.

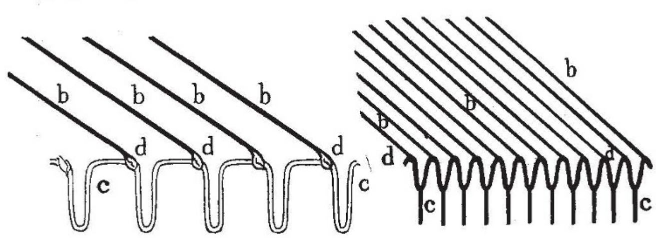

FIG. 6.—Diagrammatic section of pupal wing parallel to the nervures. FIG. 7.—Diagrammatic section of pupal wing at right angles to the nervures.
The letters refer to those in Figs. 2 to 7.—(*a*) Wall of chrysalis; (*b*) scales; (*c*) wing membrane; (*d*) sockets in membrane.

The section of the membrane cut in this direction presents a much more complex appearance (see Figs. 3 and 7) than that parallel to nervures.

The compression to one-third of the extended dimension in the transverse direction appears to be