## INSECT GRAFTING.

BY WILLIAM H. HALE, PH.D.

Mr. Henry E. Crampton, Jr., an instructor at Columbia University, has for a year or more been conducting experiments in grafting together different insects so as to make composite forms. Very little publicity was given to the matter, however, till Prof. John B. Smith, the well-known entomologist of New Jersey, called attention to it a few days ago, and indicated that it was likely to produce valuable as well as curious results.

His experiments have been almost all performed on the Bombycid moths, particularly Philosamia cynthia, Samia cecronia, Callosamia promethea and Teles prometheus. These all have large chrysalids, and hence can be more readily manipulated, for the grafting is done in this stage of development.

Fig. 1.—TANDEM UNION, SAME SPECIES.

The process consists of cutting two chrysalids, putting the cut edges together, and fastening them by brushing the line of union with melted paraffine, which at once hardens and holds the pieces firmly together. When the moth is sufficiently developed to leave the chrysalis, the operator assists by picking off the shell in bits. This is generally necessary because of the abnormal condition of the insect under this treatment. About ten per cent of the insects operated on have lived to reach the imago stage, the proportion being larger when the two individuals selected were of the same species, and much smaller, about six per cent, when they were of different species; the first being called homoplastic, the second heteroplastic union. An attempt will be made this season to breed from some of the moths produced by grafting.

Mr. Crampton was the first to apply grafting to

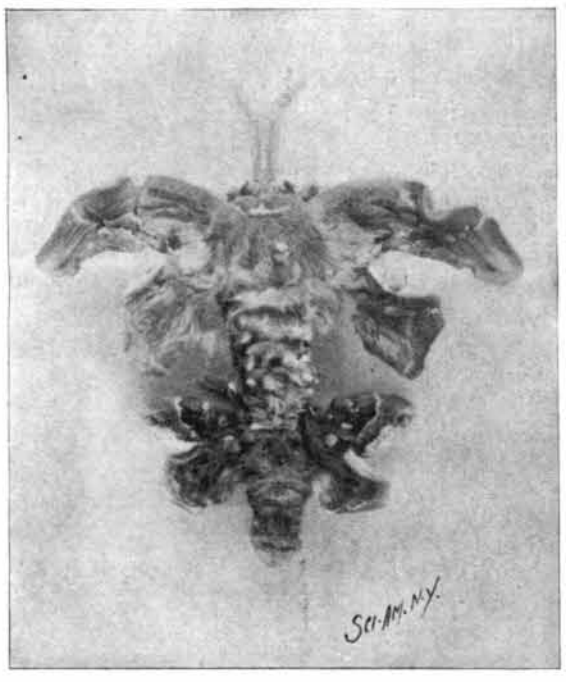

Fig. 2.—TANDEM UNION OF MOTHS OF DIFFERENT SPECIES.

insects. Prof. Born, in Germany, had already grafted toads and frogs in the tadpole state; other experimenters had grafted hydræ and also earth worms.

The primary object of the experiments on insects was to ascertain the effect of grafting on the color of

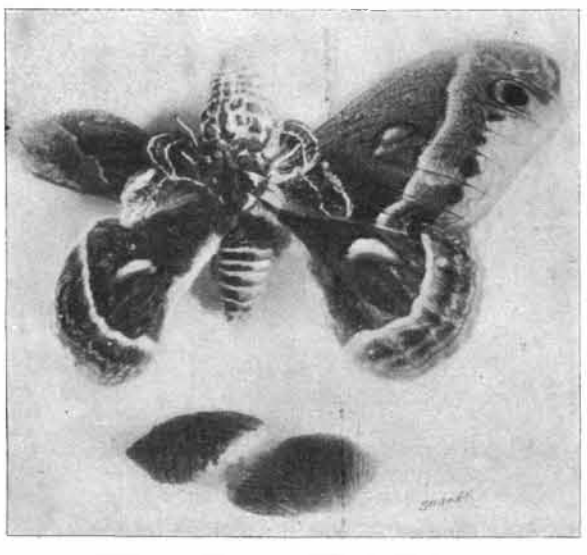

Fig. 3.—TWIN UNION OF MOTHS HEAD TO HEAD.

insects. In many species of insects the male and female present marked difference in coloration. An instance is the Collosamia promethea, a specimen of which I saw in Mr. Crampton's laboratory, part of a male and part of a female moth being united together. The results as to coloration, however, are not yet considered satisfactory.

Inasmuch as color is due to the chemical constituents of the food as affected by the digestive or other chemical change produced in the body of the insect, the study is of much scientific interest. It may also have a very practical application if we can artificially impart a protective coloring to useful insects.

It is found that the proportion of successful operations is better when more than half of each pupa is used. The process of grafting involves some loss of hæmatolymph; and this loss can only be made up by increasing the amount of pupa retained.

It proved that all attempts to join lateral halves of two different pupæ in normal proportions—half of each—were unsuccessful.

The tandem unions succeeded a little better where only normal proportions were used. Fig. 1 shows such a union of two individuals of the same species. Where the species were different, however, only one successful attempt was made out of thirty-two. In this case the anterior portion is Cynthia, the posterior Promethea.

Tandem unions taking more than half of each pupa succeeded much better. About twelve per cent survived. These unions gave monstrosities with elongated bodies and two sets of wings, as shown in Fig. 2, where again the anterior portion is Cynthia and the posterior Promethea.

The twin unions were by far the most successful, as but little of the pupa was cut off. Fourteen out of sixty-nine survived. These were made in great variety: head to head; tail to tail; back to back; and in some cases fusion of wings was produced by exposing the roots of pupal wing cases and uniting the wounds. Figs. 3, 4, 5 and 6 show various unions. I also noticed at the laboratory one specimen in which the antennæ were united at the base.

It sometimes happens when pupæ of different species are united that one will mature before the other. Mr. Crampton now has such a specimen which was united "tandem." The tail part has matured and come out alive; the head still lives in the chrysalis state, but will probably come out alive before this is printed.

Mr. Crampton explained to me that the work of insect grafting was taken up by him rather as an amusement and recreation from more arduous labors. He has just discovered by further experiments on fused moths an example of a reciprocal color effect, believing that the color of one kind of moth will appear in a portion of another kind. No doubt other important discoveries will be made as further experiments are continued. What has been accomplished is quite novel and interesting.

### The 1897 Fire Loss.

The fire loss of the United States and Canada for the year 1897, as compiled by The New York Journal of Commerce, shows a total of $110,319,650. The following comparative table shows the losses by months for the years 1895, 1896 and 1897:

| | 1895. | 1896. | 1897. |
|---|---|---|---|
| January | $11,895,600 | $11,040,000 | $12,049,700 |
| February | 12,360,200 | 9,780,100 | 8,676,750 |
| March | 14,239,300 | 14,889,600 | 10,562,950 |
| April | 11,018,150 | 12,010,600 | 10,883,000 |
| May | 7,761,350 | 10,618,000 | 10,193,600 |
| June | 9,223,000 | 5,721,250 | 5,684,450 |
| July | 9,085,000 | 9,033,250 | 6,626,350 |
| August | 9,929,000 | 8,895,250 | 6,454,000 |
| September | 10,766,300 | 8,200,650 | 9,892,000 |
| October | 13,411,500 | 8,993,000 | 11,387,500 |
| November | 10,131,500 | 5,211,800 | 7,189,800 |
| December | 10,018,800 | 11,962,000 | 11,328,650 |
| Totals | $129,839,700 | $115,655,500 | $110,319,650 |

### English Spoken and Written.

At the recent Postal Congress attention was called to the fact that two-thirds of all the letters which pass through the post offices of the world are written by and sent to people who speak English. There are substantially 500,000,000 persons speaking colloquially one or another of the ten or twelve chief modern languages, and of these about 25 per cent, or 125,000,000 persons, speak English. About 90,000,000 speak Russian, 75,000,000 German, 55,000,000 French, 45,000,000 Spanish, 35,000,000 Italian, and 12,000,000 Portuguese, and the balance Hungarian, Dutch, Polish, Flemish, Bohemian, Gaelic, Roumanian, Swedish, Finnish, Danish and Norwegian. Thus, while only one-quarter of those who employ the facilities of the postal departments of civilized governments speak as their native tongue English, two-thirds of those who correspond do so in the English language. This situation arises from the fact that so large a share of the commercial business of the world is done in English, even among those who do not speak English as their native language. There are, for instance, more than 20,000 post offices in India, the business of which in letters and papers aggregates more than 300,000,000 parcels a year, and the business of these offices is done chiefly in English, though of India's total population, which is nearly 300,000,000, fewer than 300,000 persons either speak or understand English.

Though 90,000,000 speak or understand Russian, the business of the Russian post department is relatively small, the number of letters sent throughout the Czar's empire amounting to less than one-tenth the number mailed in Great Britain alone, though the population of Great Britain is considerably less than one-half of the population of Russia in Europe. The

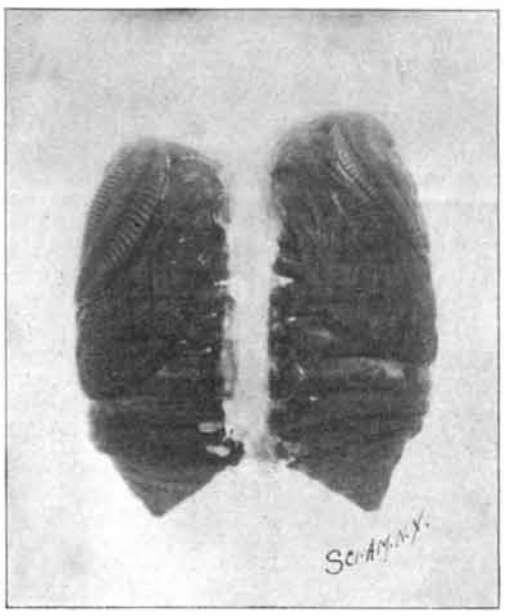

Fig. 4.—TWIN CHRYSALIS, UNITED.

Southern and Central American countries in which either Spanish or Portuguese is spoken do comparatively little post office business, the total number of letters mailed and collected in a year in all the countries of South and Central America and the West

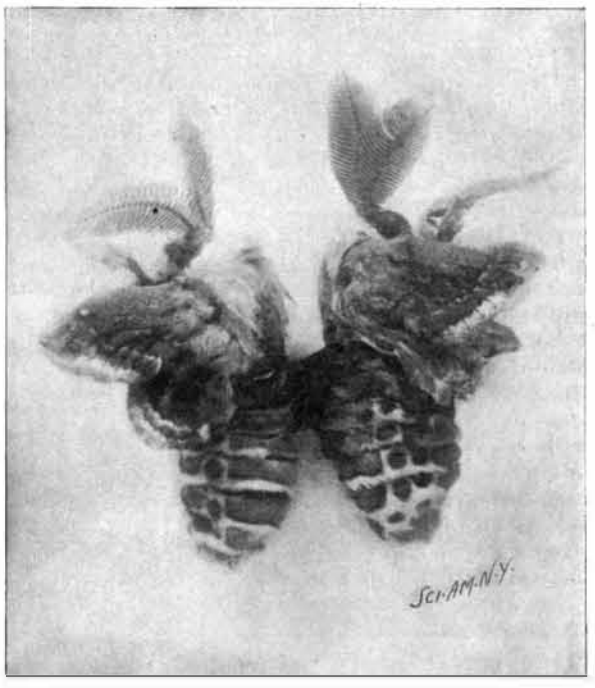

Fig. 5.—TWIN CHRYSALIS OF Fig. 4 IN PROCESS OF DEVELOPMENT.

Indies being less than in Australia. Chile and Argentina are, in fact, the only two South American countries in which any important postal business is done, and most of the letters received from or sent to foreign countries are not in Spanish, but in English, French, German or Italian.

NEW YORK'S zoological garden will be the largest in

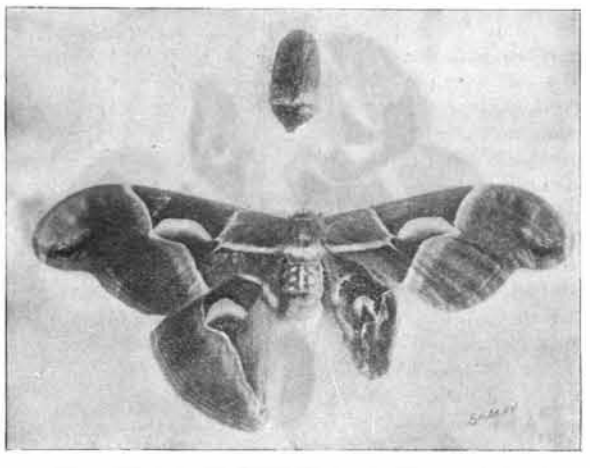

Fig. 6.—HOMOPLASTIC UNION, SHOWING UNEVEN SIZE OF WINGS.

the world, comprising within its boundaries no less than 261 acres. The next largest is at Washington, which has 168 acres. The Berlin garden has 60, the Paris garden 50, and the London garden 31 acres.