the strictly socializing work of our actual high schools more definite, more effective and more nearly universal." The sixty-seven pages of bibliography at the close of the book deserve the highest praise. The titles are carefully selected, well arranged, and in part annotated. The editor has rendered a great service to students of secondary education, especially those offering courses in the subject.

Clayton C. Kohl

PLANT AUTOGRAPHS[1]

The importance of investigations on physiology of plants lies in the fact that it is only by the study of the simpler phenomena of irritability in the vegetal organisms that it is possible to elucidate the more complex physiological reactions in the animal. The difficulty of investigation lies in the apparent immobility of the plant. It is often impossible by visual inspection to distinguish even between specimens, one of which is alive and the other killed. Means have, therefore, to be discovered by which the plant itself is made to reveal its internal condition, and changes of that condition, by characteristic signals recorded by it. These responsive reactions may manifest themselves in change of form or in change of electric conditions. In his investigations the author has employed both methods of mechanical and electric response.

In recording mechanical response great error is introduced from friction of the writer against the recording surface. This has been overcome in the author's Resonant Recorder, where the record consists of a series of intermittent dots due to the vibration of the writing point. In this manner it is possible to record time-intervals as short as a thousandth part of a second. Moreover in order to eliminate completely all personal equation, the apparatus has been made perfectly automatic. Thus the plant attached to the recording apparatus is automatically excited by a stimulus absolutely constant. In answer to this it makes its own responsive record, goes through its period of recovery and embarks on the same cycle over again without assistance at any point from the observer.

Mimosa exhibits a remarkable periodic variation of excitability; the response being practically abolished in the early hours of the morning, the sensibility is gradually increased to a maximum by noon. The latent period of the leaf is one six hundredth part of a second. Crucial tests of the excitatory character of transmitted impulse are afforded by physiological blocks produced by the local application of cold, of poison and electrotonic block. These prove that the transmission of excitation in *Mimosa* is a process fundamentally similar to that occurring in the animal. The effects of drugs on plants are remarkably similar to the effects on animal tissues. The characteristics of the rhythmic tissues in animals and plants are precisely similar. There is hardly a single phenomenon of irritability observed in the animal, which is not also to be found in the plant.

[1] Abstract of a paper read before Section G of the American Association for the Advancement of Science at the Philadelphia meeting, by Professor J. C. Bose.

SPECIAL ARTICLES

INHERITANCE IN THE HONEY BEE

More or less time has been devoted by the writer, during the past four years, to a study of inheritance in the honey bee, as a project under the Adams Fund. Innumerable obstacles to the progress of this investigation have presented themselves, but sufficient data have accumulated to justify the announcement of a few interesting points.

The matings have been made, for the most part, at an isolated mating station on the Gulf Coast prairie, about forty miles northwest of Houston, Texas. The location of the station is almost ideal for this purpose, for there are no trees or shrubs affording shelter for bees and no bees occur except those purposely taken to the mating station.

The matings thus far have been confined to crosses between the Italian and Carniolan races. As is well known, the pure bees of the former race are distinctly yellow, while those of the latter are more or less gray, but always, when pure, devoid of yellow color. For the

primary crosses stocks were selected which had been under observation for several generations without having shown any indication of impurity.

Pure Italian queens mated to Carniolan drones produce workers and queens which are indistinguishable, so far as color is concerned, from the parent Italian stock: that is, in the F_1 generation of this, the "primary," cross, the yellow color is completely dominant. In the reciprocal cross, in which Carniolan queens are mated to Italian drones, the yellow color is also dominant, but not as completely so as in the primary cross: the F_1 queens and workers show nearly, but not quite, as much yellow color as the parent Italian stock. The significance of this in practical bee-breeding is at once apparent. For years professional queen-breeders have assumed that if an Italian queen throws workers which show the typical Italian coloring it is prima facie evidence that she has been purely mated. From the above results it is evident that such is not necessarily the case, for such a queen might have mated to either an Italian or Carniolan drone (or even, presumably, to a black drone), and in either case her workers would have the typical Italian color. The purity of an Italian queen's mating therefore can not be determined by an examination of her workers. Further reference to this is made below. The production of yellow workers by a pure Carniolan queen, on the other hand, immediately stamps her as having been impurely mated.

There is also excellent evidence as to the inheritance of characteristics other than color. For example, the marked proclivity of the Carniolans to use wax instead of propolis for sealing crevices, fastening frames together, attaching hive-covers to frames, etc., comes dominantly to the surface in the F_1 generation of the primary cross. In the F_1 generation of the reciprocal cross this trait is also much more in evidence than in the pure Italian race, though not as completely dominant as in the case of the primary cross.

It seems to be a well-established law of heredity that an individual always produces gametes of the same kind as those of which it is itself composed. With this law the queen-bee appears to comply without exception. As the drone is produced parthenogenetically he is essentially a gamete and behaves as such in inheritance, at least so far as the color factor is concerned. Pure Italian queens mated to Carniolan drones produce only Italian drones; and Carniolan queens mated to Italian drones produce only Carniolan drones. This is strictly in accordance with the theory of Dzierson. However, the daughters of Italian queens which have mated to Carniolan drones produce both Italian and Carniolan drones, produce them in equal numbers, and do not produce any other kind. The F_1 queens of the reciprocal cross likewise produce drones of these two kinds and in equal numbers. This is in accordance with the theoretical expectation under Mendelian law. If the constitution of a pure Italian queen be represented by II and of a pure Carniolan queen by CC, the former will produce gametes I and I, and the latter, gametes C and C, these being Italian and Carniolan drones, respectively. A hybrid queen, however, has the constitution IC and produces gametes I and C in equal numbers, these of course materializing as Italian and Carniolan drones. The practical application of this is that the only test of an Italian queen's mating is found in the color of the drones produced by her daughters.

Another interesting consideration is that the production of an F_1 drone seems to be an impossibility and this, in turn, makes the production of a strict F_2 generation look like another impossibility. Beekeepers will at once argue that drones intermediate in color occur in nature, and such is the case. However, drones from purely mated queens are known to vary widely in color and this may possibly explain the occurrence of intermediate coloring. We are still in ignorance regarding the causes of this variation, and it is hoped that further data from the mating-station will throw more light on this as well as on other phases of this interesting problem.

WILMON NEWELL

COLLEGE STATION, TEXAS,
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