deeply interesting results obtained by them. Moreover, it is suggestive of many possibilities of future discovery.

S. Lawrence Bigelow.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Experimental Zoology, Vol. III., No. 2 (July, 1906), contains the following articles: 'Observations and Experiments Concerning the Elementary Phenomena of Embryonic Development in *Chætopterus,*' by Frank R. Lillie. This is a study of the origin and behavior of formative stuffs in the early development of an annelid by direct observation, and by various experiments, *e. g.,* analysis by centrifugal force, by staining intra vitam, and by suppressing the process of cleavage without prejudice to other embryonic processes. The standpoint is that a complete account of embryonic development would trace everything back to the chromosome complex of the species. 'Regeneration of Grafted Pieces of Planarians,' by Lilian V. Morgan. A complete head may regenerate from a posterior cut surface of planarians if a very short piece is grafted in a reverse direction on a larger piece. 'Experiments on the Behavior of Tubicolous Annelids,' by Charles W. Hargitt. 'Inheritance of Dichromatism in *Lina* and *Gastroidea,*' by Isabel McCracken, Stanford University. In this paper the author records the results of an attempt to determine the behavior in heredity of the alternate characters in dichromatic species. Two dichromatic beetles, *Lina lapponica* and *Gastroidea dissimilis,* were bred under controlled conditions through a series of generations, four in the former, seven in the latter. The investigator finds an accumulative dominance of one color over the other from generation to generation, or a prepotency of the dominating color that apparently eventually eliminates the recessive color from the dominant line. The recessive color behaves like a typical Mendelian recessive.

DISCUSSION AND CORRESPONDENCE.

WHEN DID FRANKLIN INVENT THE LIGHTNING-ROD?

The bi-centenary of Benjamin Franklin's birth has served to recall attention to the varied achievements of this remarkable man, but it would hardly be expected that new facts could be learned regarding the invention of the lightning-rod, upon which his popular fame as a natural philosopher chiefly rests.

Franklin's classic experiment with the electrical kite, by which he demonstrated the identity of lightning and artificial electricity, was performed at Philadelphia during the summer of 1752. The date June, which is frequently quoted, seems to have been authorized by Priestley in his *History of Electricity.* On the contrary, his French contemporary, De Romas, who claimed the idea of the electrical kite, maintained that Franklin did not fly his kite in June, nor until after he had heard of the success of the French experimenters, Dalibard and Delor, who, in May, 1752, collected the electricity during a thunderstorm by metal rods, according to a method which he himself had suggested. Authorities differ as to whether Franklin knew of this when he obtained the same results with his kite, Park Benjamin, on page 589 of his 'Intellectual Rise in Electricity,' asserting that Franklin desired to confirm the French experiments. If this be true the kite experiment could hardly have been executed at Philadelphia so soon as the following month, that is in June, but, at all events, no mention of it occurs anywhere until a letter describing it, written there in October to Peter Collinson at London, was read before the Royal Society on December 21, 1752. This communication, which appeared in the *Gentleman's Magazine* for December, 1752, and in the *Philosophical Transactions* for the same year, was reprinted with Franklin's 'Experiments and Observations in Electricity,' of which the second part of the first edition was published at London in 1753. While it seems to have passed unnoticed that the letter describing the electrical kite in the *Philosophical Transactions* is dated October 1 and the same letter in the collected papers bears the date October 19, a date subsequently adopted by his biographers, it was reserved for a German bibliographer, Professor Hellmann, to point out, in publishing a facsimile of this

letter from the *Philosophical Transactions,* in No. 11 of *Neudrucke von Schriften und Karten über Meteorologie und Erdmagnetismus* (Berlin, 1898), that an important omission had been made in the slightly different version printed in the collected papers. The present writer finds that this error has been perpetuated by such careful biographers of Franklin as Sparks, Bigelow and Smyth, who, having reprinted the letter from the collected papers, also omit this concluding paragraph:

I was pleased to hear of the success of my experiments in France, and that they there begin to erect points upon their buildings. We had before placed them upon our academy and state-house spires.

Professor Hellmann supposes that Franklin, by the last statement, wished to claim priority in the use of pointed rods as lightning conductors.

Already in his 'Opinions and Conjectures Concerning the Properties and Effects of the Electrical Matters, arising from Experiments and Observations made at Philadelphia, 1749,' contained in a letter to Peter Collinson, dated July 29, 1750, Franklin had proposed to test the electricity of thunder-clouds and had suggested the possibility of the lightning-rod. In order to continue his experiments, Franklin, in September, 1752, erected on his house an insulated iron rod, connected at its lower end with a pair of bells which, by ringing, would show that the rod was electrified. On April 17, 1753, he charged one Leyden jar from this rod and another jar with positive electricity from a frictional machine, concluding from this and subsequent experiments

That the clouds of a thunder-gust are most commonly in a negative state of electricity, but sometimes in a positive state.

Further on in the same letter in which the preceding experiments were described, written at Philadelphia in September, 1753, Franklin says:

Metalline rods, therefore, of sufficient thickness, and extending from the highest part of an edifice to the ground, being of the best material and complete conductors, will, I think, secure the building from damage, either by restoring the equilibrium so fast as to prevent a stroke, or by conducting it in the substance of the rod so far as the rod goes so that there shall be no explosion but what is above its point, between that and the clouds.

This is generally believed to be the first definite announcement of the lightning-rod, although Poggendorff, in his 'Geschichte der Physik,' page 867, casts doubt on Franklin's sole claim to its invention by saying that J. H. Winkler, of Leipzig, in his 'Programma de avertendi fulminis artificio,' Lipsia, 1753, recommended the use of lightning conductors and gave directions for their erection, in consequence of which, probably, they were first introduced into Germany in 1754.

I shall show, however, by what follows that Franklin had prepared detailed instructions for the installation of lightning-rods nearly a year before he wrote the letter that has just been quoted. In *Poor Richard's (Improved) Almanac* for 1753, edited by Richard Saunders (Benjamin Franklin's pseudonym) and published in Philadelphia by B. Franklin and D. Hall, the material for which must have been ready not later than October, 1752, occurs the following remarkable article which seems to have entirely escaped the attention of Franklin's biographers and of scientific students generally.

How to secure Houses, &c. from Lightning. It has pleased God in His Goodness to Mankind, at length to discover to them the Means of securing their Habitations and other Buildings from Mischief by Thunder and Lightning. The Method is this: Provide a small Iron Rod (it may be made of the Rod-iron used by the Nailers) but of such a Length, that one End being three or four Feet in the moist Ground the other may be six or eight Feet above the highest Part of the Building. To the upper End of the Rod fasten about a Foot of Brass Wire, the size of a common Knitting-needle, sharpened to a fine Point; the Rod may be secured to the House by a few small Staples. If the House or Barn be long, there may be a Rod and Point at each End, and a middling Wire along the Ridge from one to the other. A House thus furnished will not be damaged by Lightning, it being attracted by the Points and passing thro the Metal into the Ground without hurting any Thing. Vessels also,

having a sharp pointed Rod fix'd on the Top of their Masts, with a Wire from the Foot of the Rod reaching down, round one of the Shrouds, to the Water, will not be hurt by Lightning.

From the foregoing it is evident that Franklin drew up definite instructions for erecting lightning-rods before the close of the year 1752 and from the contemporaneous letter, describing the electrical kite, it would appear that at this time some edifices in Philadelphia were thus equipped, but whether for their protection or for experiment is uncertain.

A. Lawrence Rotch.
Blue Hill Meteorological Observatory,
August 13, 1906.

DRIED COTTON CULTURES ONCE MORE.

It would appear from a recent communication in Science that the original dictum of Messrs. Harding and Prucha that the nodule-forming bacteria will not survive when dried upon cotton is now to be modified to apply only to those cultures dried (?) in a Petri dish enclosed in a paper bag and stored in a drawer or under conditions considered to be similar to this. Although an attempt is made to show that such a method closely resembles that used in the original preparation of cotton cultures, the actual difference in drying time will be so evident to any one who cares to try the experiment that it need not be discussed here. Indeed, it would hardly seem necessary to demonstrate the fact that of two pieces of cotton containing the same amount of moisture, one enclosed in a Petri dish, and the other exposed to the action of an abundance of warm air, the one in the air will dry much sooner than the protected piece. One would as readily expect clothes to dry as rapidly enclosed in a box, wrapped in paper and put away in a drawer as when hung upon a line. In fact it was this very question of rapidity of drying which caused the various 'germ-proof' methods of preparing the cotton to be abandoned. It was found that even in a specially constructed box of large size (approximately 8 x 2 x 2 feet) through which air was forced over a warm coil, that the length of time required for drying was entirely too long, and for practical purposes, considering the way in which the cultures were to be used, it was better policy to turn out a culture which might be more or less contaminated than to destroy the nodule-forming bacteria in an attempt to produce a pure culture. Experiments showed that all attempts, with the facilities available, to produce absolutely pure cultures upon cotton involved an unwarranted sacrifice of efficiency.

It has been supposed that the result obtained by the users of the dried cotton cultures would of itself be a sufficient refutation of the statement that dried cotton cultures were valueless. This seems to be the case since an attempt is now made to explain the reports received by users of the cultures upon 'psychological' grounds.

If the bacteria will not live upon cotton it is of course necessary to account in some way for the thousands of satisfactory reports received from this country and elsewhere, and the psychological explanation would seem to be as good as any. It should be remembered, however, that many of the favorable reports were furnished by those fully as competent to judge of the results obtained as a member of an experiment-station staff—that a considerable number of these experiments were checked by uninoculated plots and that photographs showing the difference between these treated and untreated plots are available in all cases where it was possible to obtain them. Furthermore, the reports covered tests with sterilized soil and sand as well as field experiments.

Since the publication of a few of the favorable reports first received, there have been many others which emphasize even more strongly the benefit derived from cultures when used under the conditions for which they are designed. During the past season, while the statement that the cotton cultures were valueless was very widely published, producing, one would suppose, anything but a favorable psychological effect, most satisfactory reports continued to be received.

Although it is manifestly impossible in this statement to refer directly to any of these reports, it may not be out of place to cite