entomologists, Rondani and Ghilioni who, during the fifties and sixties of the past century first suggested the use of parasitic insects for similar purposes (p. 50).

It is worthy of note that Erasmus Darwin, the grandfather of the illustrious Charles Darwin, pointed out clearly the possibilities of biologic control in his "Phytologia, or the Philosophy of Agriculture and Gardening," published in London in 1800.

In the course of his very careful studies on the life history and habits of plant lice, "Most curious and important animals which may in process of time destroy the vegetable world," he did not fail to take careful account of the natural enemies. Concerning the larva of the Syrphid fly he says:

> The most ingenious manner of destroying the aphis would be effected by the propagation of its greatest enemy, the larva of the aphidophorous fly of which I have given a print and which is said by Reaumur, Tom. III, Mem. 9, to deposit its eggs where the aphis abounds and that, as soon as the larvae are produced, they devour hundreds around them with no other movements but by turning to the right or left, arresting the aphis and sucking the juices. If these eggs could be collected and carefully preserved during the winter, or protected from injury in hot-houses, it is probable that this plague of the aphis might be counteracted by the natural means of devouring one insect by another; as the serpent of Moses devoured those of the magicians (p. 356).

Again, referring to the white butterflies which deposit their eggs on cabbage plants:

> Cabbage caterpillars would increase in destructive numbers, but are half of them annually destroyed by a small ichneumon-fly which deposits its own eggs in their backs. . . . This ichneumon fly should therefore be encouraged if his winter habitation could be discovered.

It is not to be expected that so keen an observer would overlook the desirability of utilizing the larger natural enemies of insects.

> All these noxious animals might be destroyed or diminished by encouraging the breed of small hedgebirds, and perhaps of larks, and rooks by not taking their nests. I have observed that house sparrows destroy the maychafier. . . . The various species of linnets carry small caterpillars to their gaping young.

Whatever may be our estimate of the poetic ability, or the evolutionary theories of Erasmus Darwin, he may well be proclaimed the forerunner of modern economic entomologists. He discusses methods of trapping cutworms under rubbish, tree pests by trap bands and tar-paper, collecting and burning leaves to destroy the eggs of other species. He recommends the heating of grain to destroy its insect pests without injuring its germinating quality, and using hot water or steam against others. He found that the essential oils are all deleterious to certain insects, and learned by experience that while oil of turpentine would kill aphids it also killed the branches of a nectarine tree on which he used it. Arsenic, tobacco dust and tobacco fumes he used with varying degrees of success. Especially interesting were his experiments with sulphur which he used both in fumigation and in dusting, which might be accomplished with "a powder-puff, such as hair dressers use."

Particularly interesting is the fact brought to my attention some years ago by Professor C. R. Crosby that this early worker recommended the supposedly very modern lime-sulphur mixture as an insecticide.

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A MATHEMATICAL PROOF

IN SCIENCE for January 16, 1931, it is stated that "Tropfke in the third edition (1930) of Volume 1 of his history does not furnish proof of Professor Miller's claims" relating to Babylonian mathematics. This raises the interesting question what conditions a mathematical proof must satisfy. Such a proof seems to imply not only that the arguments are correct but also that those for whom it is intended can follow these arguments completely. For instance, I have given what seems to me to be a proof of Sylow's theorem to many classes and yet I feel utterly unable to prove this theorem to one who knows nothing about the theory of groups, and this includes the great majority of the people whom I know. Similarly, proofs relating to the history of mathematics seem to imply that those for whom they are really proofs can look up the sources and verify the statements. In this sense no one can prove to me anything relating to the ancient mathematics of the Babylonians or of the Egyptians since I am unable to read their writings and can not verify that the translations thereof are correct.

One of my most noted teachers, Professor Sophus Lie, used to tell his students that he accepted many mathematical results which he had not completely proved himself but which he believed others had fully proved. He said that he felt that he had to do this in order to make rapid progress. Similarly, I would like to think that I knew some things about the ancient mathematics of the Babylonians and the Egyptians even if I am unable to go to the sources, and references to these sources seem to me to be of value only to those who can read the original writings. In particular, I am not able to determine whether the references which Tropfke gives to the division of the circle into 360 equal parts by the later Babylonians prove

the point in question since I can not read the original, but I have confidence, perhaps undue confidence, in the truthfulness of such noted scholars notwithstanding the fact that others in whom I have less confidence have made opposite statements.

Not only does the inability to read the original frequently constitute a serious difficulty in the way of using the sources as regards historical statements in mathematics but in some cases these sources are not known to exist. For instance, the original of Euclid's "Elements" is not known to be extant and yet these "Elements" are commonly regarded as very important in the history of our subject. It seems therefore that some of the most noted mathematical historians have reached conclusions which could not have been based on a study of the original documents. It is, of course, not implied here that it is undesirable to go to the sources with respect to questions relating to the history of mathematics whenever this is possible. On the other hand, it is implied that valuable conclusions have sometimes been drawn by those who have not been in position to do this. At any rate, it is well to bear in mind that a mathematical proof depends upon the knowledge relating to the subject on the part of those for whom it is intended and hence is relative, not absolute.

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MORE ABOUT TWISTED GRAIN IN TREES

SCIENCE for February 13, 1931, contains an article by C. K. Wentworth noting the predominance of right-handed twist in spirally grained trees. Similar observations have been recorded by others. A Forest Service official on the Pike National Forest, Colorado, reports that out of 396 alpine fir trees, 85 per cent. had right-handed twist and 14 per cent. left-handed twist, leaving only 1 per cent. with straight grain. Similarly, 26 pines showed 14 individuals with right-handed twist and 4 with left-handed twist. The author also was struck with the predominance of right-handed twist when trying to find trees with left-handed twist suitable to photograph. On the other hand, in an examination of 463 Douglas fir timbers at a mill in Tacoma, Washington, he was surprised to find 94 with left-handed twist and only 8 with right-handed twist (very slight twists not being considered). The other timbers were straight grained.

No satisfactory explanation of the cause of spiral grain has yet been made. There even remains the question as to whether it is due to heredity or environment. H. G. Champion, of the Forest Service of India, reports that seed from straight-grained trees give fewer spirally grained seedlings than seed from twisted trees. The resulting grain, however, was examined only in the young stems of seedlings, and it is not certain whether the same condition would be maintained as the trees grow older.

On the other hand, Paul van Oye reports from France that trees with tap roots have no torsion, those with lateral roots have slight torsion, and those with running roots have it to a marked degree. This corresponds to the general observation that in the higher altitudes where the soil is scant and tap roots can not develop, spiral grain is much more common than in the deeper soil at lower elevations.

The frequent deduction, as made by Wentworth, that twisted grain may be due to prevailing winds acting on asymmetrical crowns is not tenable since there is no evidence within the tree trunk that actual twisting of the trunk took place after the wood was formed. Such twisting would show distinct mechanical injury to the fibers which is not found to be the case. Furthermore, the twist would be greatest near the center and least at the periphery of the trunk, assuming that it developed gradually over a period of years. Usually the reverse is the case.

Any satisfactory explanation of the cause of spiral grain must also explain why trees should be straight grained, since whatever factors are operative in keeping the fibers of most trees parallel with the axis of the trunk are modified in producing spiral grain. To say straight grain is the normal condition is not adequate, since in some hardwood species, especially in the tropics, the normal condition is for the fibers to be inclined right-handed for a number of years, then left-handed for about the same period, and then back to right-handed, and so on.

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PUBLICATION OF INDUSTRIAL RESEARCH

THE growth of industrial research in America and the intermingling of purely utilitarian scientific work with the so-called "pure" scientific research that may be found in many industrial laboratories raise a question of vital interest in the reporting of science to the public.

Often the achievement of a new industrial process is made known to the public through the medium of a publicity statement issued by an individual or a corporation. Often these publicity statements do not have the wealth of detail that characterizes the publication of a scientific paper. The circumstances surrounding a technical development are often highly complicated. A patent may be pending. Or for other reasons the heads of the organization paying for the research do not wish to reveal the scientific and technical details of the process or the invention.