who is willing to pay the dues. The statement has recently been made that this has resulted in a membership which is largely non-professional. Such a statement is wholly misleading. While the fact that a man is a member of the society is no guarantee that he is a trained chemist, there are very few members who are not engaged in chemical work and I think I am safe in saying that ninety per cent. of the members have had a good chemical training.

The American Chemical Society is about to establish a *Journal of Industrial and Engineering Chemistry*. This journal, too, is to be sent to all members of the society. The objection has been raised that it should be sent only to those members who are especially interested in it. Such a course does not seem wise for two reasons. First, in accordance with the ideal of the society, which is to care adequately for the needs of all classes of chemists, we wish to continue to furnish all of our members with original papers as well as with abstracts in all fields of chemistry. Second, if we were to adopt the other plan, we could afford to give as a rebate to any one who does not care for the journal only the amount which would be saved by printing a smaller number of copies. This amount is so small as to be scarcely an object. We seem to be justified, therefore, in adopting for the *Industrial Journal* the same plan which has met with so much success in the case of *Chemical Abstracts*.

We already have some members in nearly every civilized country in the world—in England, Germany, South Africa, Australia, New Zealand, China, Japan, Chili, Brazil, Argentina and many others.

The broad policies which have been adopted by our society can succeed only on the basis of a very large membership. We need the loyal support of every American chemist.

W. A. Noyes

THE THEORY OF THE PARASITIC CONTROL OF INSECT PESTS

All who have recently discussed the question of the possibility of controlling insect pests by the use of parasitic or predaceous insects or by fungous or bacterial diseases, have failed to consider the subject from a very important point of view.

The conditions determining the life or death of insects are much more complicated than is usually appreciated, and the individual factors in the problem are far from independent. The correct estimation of this interdependence of the causes of death in insects is of vital importance in this connection. The efficiency of each factor is so influenced by the efficiency of the others that the elimination of one cause of death or the addition of an entirely new natural enemy will usually have but a slight effect upon the rate of survival or none at all.

The reproductive powers of most organic beings are very great. Were not all creatures liable to die prematurely, that is, before they reproduced themselves, reproduction would of necessity have been limited to two offspring from each pair. Whenever reproduction is at a more rapid rate it is a *prima facie* evidence that the chance of premature destruction requires it and the greater the reproductive power the higher this normal death rate. Were conditions otherwise, rapid extinction or enormous increase would result. The fact that species maintain themselves for ages with the ratio between the birth rate and that of premature death not varying an appreciated fraction of a per cent. is very evident.

This balance between birth- and death-rates is much greater than the numerical stability. For instance, in the case of a species increasing a hundred fold in a generation, an average disturbance of only a hundredth part of a per cent. in this ratio —*i. e.*, if on the average one more individual in ten thousand should come to maturity—this would result in nearly tripling the numbers of individuals within a hundred generations, and one tenth of one per cent. augmentation—*i. e.*, if one more in a thousand should survive—would be an increase in numbers amounting in the same period to nearly fourteen thousand fold.

DISTURBING, CONTRIBUTING AND EFFECTIVE FACTORS

The various causes of death may be classed into two groups; first, those that destroy all insects in a certain condition or position, irrespective of the numbers present (for instance, frost, which might kill the same proportion whether there was but one to the acre or a hundred thousand); and second, those that are more and more efficient as the numbers increase. This is true in general of predaceous and parasitic insects and of diseases. Causes of death of the first class will aid in maintaining the balance in an insect to the extent they are uniform in their action, the regularly recurring winter, for instance; but are usually erratic and disturbing rather than balancing. Those of the second category, however, all tend towards balance and their efficiency is attested by the approximate balance maintained in nature. Probably in all cases numerous parasites and predators and other factors of this same class contribute to form the controlling environment of an injurious species, and each factor has a different potentiality. Those of the second category can be further subdivided into two classes, the contributory and the effective. In the former class, the efficiency increases with the increase of the host, but not in a sufficient ratio to ever overtake it. Thus with the host at one hundred per acre it may destroy one third, at two hundred four ninths, at four hundred thirteen twenty-sevenths, etc., never reaching fifty per cent. Any series that does not ultimately pass the percentage of normal death rate is incapable of itself diminishing the numbers of its host. Its only effect is in slowing down the rate of increase until some effective factor becomes operative or until a disturbing factor like frost produces a general destruction.

The effective class of factors is that in which the ratio finally reaches one hundred per cent. Thus with the host at one hundred per acre it may destroy say one half, at two hundred three quarters, at four hundred, seven eighths, etc.; finally reaching a fraction so large that only those survive that are necessary to maintain the species.

Every factor of this class has its particular point of balance. One may overtake the host at two hundred per acre and another only at two million per acre, but both be finally efficient. To a member of this class of checking factors, Mr. Elwood Cooper, the former Horticultural Commissioner of California, would apply the term "the true parasite," and those alone he would consider worthy of importation.

To determine at any time the status of an insect we should have to know the percentage of efficiency of each factor under the existing numerical prominence of the host and in order to prognosticate the future we should need to know the ratio of increased or decreased efficiency of each under the changed numbers of the host.

None of these factors can ever be determined with any great degree of accuracy because they are each involved in as complicated a system of interrelations and in many cases the efficiency of a check against any one insect is profoundly influenced by the ups and downs of numerous other insects that serve as alternate hosts.

The complication of the subject indeed is so great that accuracy even of observation will be impossible, but the failure to reckon with all the factors of the problem will make conclusions of little significance.

The interrelation of factors may be of the most complicated nature; for instance, a parasite which of itself might be wholly inefficient due to its slow rate of reproduction as compared with that of its host, might be rendered very efficient by the cooperation of a contributing factor which could only delay the rate of increase.

It will be thus readily seen that the efficiency of all these factors working together is neither the sum nor the average of the potential efficiency of each, though much nearer the latter than the former. Many writers have assumed that by adding a new parasite, its efficiency was simply added to that of others previously existing. This supposition is certainly far from the theoretical conception of the interrelations of species as presented above, and has not been borne out in actual experience.

RELATION OF LIFE CYCLE OF HOST

Thus far the insect whose control is sought is conceived of as existing in but one condition. The growth and transformation of insects add still further complications to the subject. The checks are not simultaneous in their action, but at each stage in the progress of its development the insect lives in a different environment. The parasites, for instance, that affect the egg will find the next generation of eggs perhaps more profoundly influenced by the checks that have operated during the remainder of the life of the insect than anything they have accomplished, and so perhaps with the checks operating at any stage. A serious attack of one parasite during early larval life might result in protecting the insect from still more efficient destroyers in the late larval stage and really cause more to come to maturity.

SUGGESTIONS FOR LABORATORY STUDY

We can eliminate most causes of death under artificial breeding conditions and often produce one hundred per cent. of survival. When this can be done we are in a position to begin the experiment of testing first one at a time each cause of death, then to study their interrelations or the simultaneous or alternating effects of two of these factors, in the case of parasites studying as thoroughly in detail also their environment. Until considerable work of this kind is done the basis for our theories will not have been well enough established to deserve a place as science.

ECONOMIC RELATIONS

The power of an insect to do damage is due as a rule to the number present during their chief feeding period, and may be quite independent of the numbers that finally come to maturity, and is absolutely independent of the ratio between birth and death rates. A temporary disturbance of this rate produces increase or decrease and may place an insect suddenly in the destructive class or remove it, but while an insect maintains itself in injurious numbers the ratio is as low as though the insect were rare.

In the case of most of our injurious insects the natural increase is more than a hundred fold, so that less than one per cent. is in these cases the established average rate of survival. This is true even of such recently introduced pests as the gypsy and brown tail moths, and the boll weevil, everywhere, except when the conditions are temporarily disturbed by efforts at control and along the border of the infested area where the insects are invading new territory.[1]

[1] This invasion of new territory probably involves but a narrow strip. In the case of the

This being the case it will be evident that the effective portion of the work of any introduced parasite lies within the fraction of one per cent. that would otherwise survive. It therefore follows that should an insect be introduced that would destroy fifty per cent. of the pest, more than forty-nine per cent. of this fifty per cent. is simply the destruction of individuals that would have died from other causes. The real question to be settled therefore becomes whether the new insect replaces a more or a less efficient cause of death. The apparent per cent. of efficiency is really no criterion whatever of the value of the introduction. That which we are desiring to secure is the reduction of the numbers especially during the period of injury, and therefore the only significant datum is the determination of the relative abundance maintained by the injurious species. The numbers of any particular parasite is not even a safe index of its rôle in the maintenance of this status, unless one were able to accurately weigh its efficiency as contrasted with that which it replaced.

All entomologists appreciate that natural enemies are largely if not the only controlling factors that maintain the present status of insect abundance, but do not so uniformly appreciate that the change of status though related is nevertheless essentially a different problem.

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AN ASTRONOMICAL EXPEDITION TO ARGENTINA

The Department of Meridian Astrometry of the Carnegie Institution, in charge of Professor Lewis Boss of the Dudley Observatory at Albany, N. Y., where the work of the department is carried on, is dispatching an expedition to the Argentine Republic to establish a branch observatory there. This observatory will be established at San Luis about 500 miles west from Buenos Aires. This town of about 10,000 inhabitants is located near the eastern edge of the Andean plateau at an elevation of about 2,500 feet. It is reported to have a fine climate with remarkably clear skies.

The new observing station consists of the necessary observing structures, and temporary barracks for office rooms and quarters for the staff. The principal instrument will be the Olcott Meridian Circle of the Dudley Observatory. This instrument will be set up in its new location for the purpose of making reciprocal observations upon stars already observed at Albany, together with observations upon all stars from south declination to the south pole that are brighter than the seventh magnitude, or which are included in Lacaille's extensive survey of the southern stars made at the Cape of Good Hope in 1750. It is thought that this new scheme of making reciprocal observations on the same stars, with the same instrument, alternately used in the two hemispheres will present peculiar advantages in point of accuracy in the systematic sense. To reach this accuracy has long been the problem of fundamental work in astronomy. It is estimated that the work of observation in Argentina will last three or four years.

The object of these observations is to gather material for facilitating the construction of a general catalogue of about 25,000 stars, in which will be contained accurately computed positions and motions of all the stars included in it.

The department has already completed for publication a general catalogue of 6,188 stars, including all the most accurately ob-

boll weevil the extreme annual migration is about the width of two counties. The total extension of this insect into new territory only requires an average survival of about two per cent. in the outer two tiers of counties.