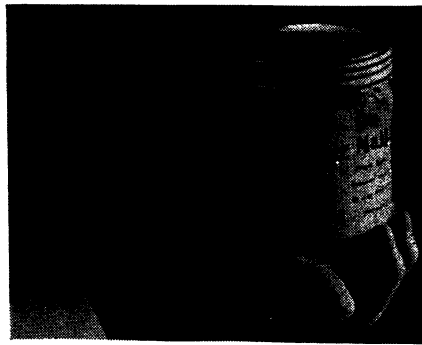


Billions of Insects—Continued

of air would hasten the egg-laying process, provided that, too, by means of an electric fan. So the moths laid their eggs through the screen, and the eggs dropped down into a trough, whence they were gathered up by the laboratory assistants.

Here then was a fine mess of nursing bottles for potential *Trichogramma* babies. How arrange their nursery to best advantage? Simplicity itself. A piece of stiff paper about 4 by 10 inches, is thinly coated with sticky shellac. Over this the moth eggs are dusted, adhering to the shellac, and giving the general effect of a coarse piece of sandpaper. Approximately 100,000 moth eggs can be stuck to one of these strips. Then the strip is bent around end to end and slipped inside a tin-bot-tomed cardboard mailing tube, about the size of a common tomato can. This is the maternity ward for the female *Trichogramma*, the nursery of the babies, and finally the traveling carriage when the new crop of insects journeys to the pest-threat-ened orchards to do battle with the codling moth.

The cylinders with the egg-laden strips within then are turned upside



A HUNDRED THOUSAND EGGS of *Trichogramma* are sent across the country by air mail in this container

down on glass shelves, and female *Trichogramma*, eager to lay their eggs, are liberated inside them. The little insects clamber over the thousands of moth eggs, stabbing and laving, stabbing and laying. Soon every one of the hundred thousand moth eggs harbors its *Trichogramma* egg.

Then the lids are screwed down on the mailing tubes, and the hecatombs of assassinated moth eggs, loaded with trouble for the orchard pests, are "ready to roll," as they say in the Artillery. If there is a war

going on at the moment, they are mailed out to the beleaguered orchardists. In a few days the eggs within the eggs have hatched, the grubs have completed their development, and the adult *Trichogramma* are ready to go to work in the open. But if all is peaceful along the orchard front, the potential flying armies are put on the reserve list by the simple expedient of piling their containers in a refrigerator. This holds them *in statu quo* until the codling moth is injudicious enough to open hostilities somewhere; then they are brought out into a warmer room and allowed to emerge, armed for battle.

Mr. Flanders has left his walnut growers' laboratory, and this fall will join the staff of the Riverside Laboratories of the University of California. But his work will be carried on by his successors; and he considers his method to be developed now to a point of commercial practicability. For this reason many of his colleagues in the ranks of economic entomology are studying it with concentrated interest. In some other places the use of *Trichogramma* has been considered (*Turn to next page*)

Crops Must Contain Minerals

Chemistry

If the human race is to continue healthy, the animals on whose meat they feed must be in best condition. And to achieve this, the food they eat must contain the proper supply of minerals and vitamins—a condition to which the farmer must see.

This was the message brought to the American Chemical Society in session at Columbus, Ohio, by C. H. MacDowell, Chicago chemist. Mr. MacDowell told of the farm as a consumer of chemical products.

"The farm is a great bio-chemical factory," said Mr. MacDowell. "The farmer must concern himself with capital, labor, instruments of production and raw materials. The soil is his primary storehouse for raw materials. However, the supplies therein are seldom balanced or complete, and never illimitable. They must be augmented and replenished. Over large areas there are deficiencies of supply not only of the more common food elements such as nitrogen, phosphorus, potassium, calcium and sulphur, but also of the rarer tit-bits such as iodine, magnesium and man-

ganese. The effect of total lack of any one of these latter is often as insidious and far-reaching as a poor supply of the former. If the crops are deficient there may result thinner and weaker livestock and poultry on the farm, milk lacking in vital minerals and vitamins, and so indirectly ill health and deficiency diseases in the city.

"Nor can the native supply of any of these elements in the soil be drawn on indefinitely, without replenishment, if economic stability and financial security are to be maintained on the farm. Inevitably with depletion of plant food supply comes decrease in both quality and quantity of yield. It doesn't rain minerals, and therefore mineral depletion must be counteracted from outside sources.

"Fertilizers undoubtedly comprise by far the largest tonnage of prepared chemicals used on the farm, but they are by no means the only ones. Plant life and animal life are subject to pests and parasites as well as disease and epidemics. These cause untold economic (*Turn to next page*)

Hoover as a Scientist

Metallurgy

Calling attention to the scientific work of President Hoover in the footnotes to his translation of Agricola's classic work, on metallurgy, "De Re Metallica," H. M. Elsey, of the Westinghouse Electric Manufacturing Co., expressed the hope that the President may eventually return to this work. He spoke before the meeting of the American Chemical Society.

Agricola's book was published in 1556. It was in 1912, while living in London, that Mr. and Mrs. Hoover collaborated on its translation. The latter was published privately.

"The footnotes are very readable and the longer ones might very well be published unchanged as chapters in a short history of the metals," said Mr. Elsey. "The evidence on a debated point is presented in lengthy quotations from the source books of early science and then the conclusions which may be drawn are given in a most logical manner. Where these conclusions are novel we must needs agree with the careful reasoning of one who approaches his problem as a metallurgist (*Turn to next page*)

Billions of Insects—*Continued*

as of possible value in fighting insect pests. This is notably so in Louisiana, where the planters are even more worried over the wickedness of the cane borer than they are over the tariff. In Illinois the defenders of the corn belt hope to enlist the aid of *Trichogramma* against their arch-foe, the European corn borer. In New England, whose classic elms are threatened by the gipsy moth, the browntail moth and the tussock moth, this same little ally on wings will probably prove of value if California methods can be worked successfully in the latitude of Boston.

Like many another of our friends in this complex world, *Trichogramma* was doing her best to help us long before we ever took the trouble to get acquainted with her. She has been on the human list of insect acquaintances only 101 years. It was in 1818 that an English naturalist first observed her, and it was not until a half-century after that, more or less, that entomologists succeeded in finding out some of the details of her life history. A good deal still remains to be learned, in spite of the fact that we are now

in position to cooperate with her in her job of destroying the eggs of other insects.

One very curious thing has been learned about her, that is probably of a good deal of help, is her peculiar way of living. *Trichogramma* is one of those peculiar females who doesn't need a mate in order to produce offspring. She just lays her eggs, and they hatch quite as efficiently as though there had been a paternal ancestor. And in some strains at least, they're all girls. Other females will produce nothing but male offspring; but surely this can't go on indefinitely. Still others have families nearer the ordinary fifty-fifty sex ratio. This is one of the things that entomologists are puzzling over at present, and the solution is not yet in sight.

One German entomologist has reported evolutionary changes in his rearing stocks, of the kind usually called mutations—sudden appearances of individuals quite unlike their parents, whose peculiarities continue to be inherited if the line is kept pure. One such mutation might prove practically valuable. This is

a wingless form, which seems to be normal in other respects. If wingless *Trichogramma* could be got on the large-scale production basis, their use would be made independent of the wind, which, of course, always threatens to carry off the tiny winged insects. They could simply be turned loose on foot, to range over twigs and leaves like doughboys cleaning up a trench system.

But whether this suggestion should prove practicable or not, the practicability of the alliance between man and his tiny ally, *Trichogramma*, has already been demonstrated, and campaigns against the hordes of six-legged enemies will undoubtedly go on, with the economic entomologist in the role of liaison officer. Not long ago Dr. L. O. Howard, for many years generalissimo of the insect fighters of America, said that "hope could be held out for man in his war with the insects if he could make domestic animals out of these parasitic forms." It seems probable that Mr. Flanders' work will be the first step in making Dr. Howard's dream come true.

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Hoover as Scientist—*Cont'd*

rather than as a historian.

"For example, Mr. Hoover argues that the so-called 'bronze-age' followed rather than preceded the 'iron age' for the reduction of iron from its ores is a very simple process, whereas in making bronze two metals, copper and tin, must be prepared and then melted and cast together to prepare the alloy. Not only is the preparation of iron simpler but it can be carried out in the solid state and the iron worked at a temperature far below the melting point of copper, hence Mr. Hoover concludes that since the simpler and easier process would probably be developed first, the use of iron would precede or at least be developed along with the use of bronze.

"As a closing comment in several of the notes, Mr. Hoover expresses the hope of writing more fully on the subject in question at some time in the future. We all know how fully occupied his time has been since then but we join in wishing that his hopes may be fulfilled, for we are sure that any such papers will be delightful reading to students of science."

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Minerals in Crops—*Continued*

losses to the farmer. They are fought and controlled by chemicals, both inorganic and organic. The mine and smelter, the coke plant and the oil well, furnish their quota in fighting the farmer's foes."

It is getting the proper mineral constituents into the food of cattle that the farmer must take as his responsibility, the speaker stated.

"Agriculture must concern itself most definitely with the proposition of producing crops not only adequate in quantity but so supplied with minerals and vitamins that the animals feeding on them will be in prime physical condition," he declared. "Only in this way can human health be guarded. Food of proper composition is the greatest factor in the continued health of man. Entire civilizations have deteriorated and passed out, largely through diet deficiencies.

"Man is basically dependent on his food supply. The soil is its primal source. If the soil is deficient in nutrients for its benign bacterial inhabitants and for ample plant health and production, the crop suffers. Properly and adequately feed

our plant crops to insure their well being, and they will in turn directly and indirectly assure us of our proper food supply.

"Chemical science and chemical products are destined to play an increasingly important and necessary role. Chemicals will continue increasingly to benefit crops, not only as direct plant foods, but by policing the crops from fungus and insect attack affecting quality as well as quantity of product. All for the good of Man."

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A California company is manufacturing paper from grape vine cuttings.

Anemia is a comparatively new and serious disease among pigs, affecting especially those raised in the confined quarters of apartment style hog houses.

Bear-proof garbage cans are an invention used in Sequoia National Park to prevent the nuisance of upset cans in public automobile camp grounds.