the other, in which the jars were left undisturbed in the laboratory. The eggs were examined under low magnification occasionally during the following months, and up until November 5 no sign of larval development had appeared. Owing to the stress of other work further examination was not made until the middle of December, at which time large numbers of eggs in both the still and aerated jars contained fully formed larvae and some in each series were hatching.

It is apparent, therefore, that the eggs of *E. pecuarum* will hatch after spending the summer in a quiescent stage undergoing an incubation period of several months in either still or moving water. This finding offers an explanation for the fact that, in addition to the numbers of adults which emerge every spring from certain rivers, enormous numbers are produced during spring floods from the many "cutoffs," "bays" and lakes which are to be found in the lowlands of Mississippi and Arkansas and in which the water is quiet, except when adjacent rivers overflow. Since all *Simulium* larvae, so far as is known, require running water for their development, it appears that the long period which *E. pecuarum* spends in the egg stage is an adaptation for passing the several months during which a large part of its breeding places are likely to be unsuited for larval life. It seems probable that adult gnats are not produced from larvae coming from eggs which hatch in these quiet waters except in the event that a spring overflow occurs and keeps the waters in motion for a period sufficient to permit larval maturity. When such an overflow occurs, myriads of larvae may develop more or less simultaneously and give rise to swarms of adults, which under weather conditions favorable for their survival and migration cause large losses of farm animals.

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BIOLOGICAL CONTROL OF AN INSECT PEST BY A TOAD

IT is generally appreciated that many of the most destructive insect pests of any crop, in any country, are of foreign origin, inasmuch as in their migrations some at least of their natural enemies are left behind. Biological control of such introduced insect pests is therefore much more to be expected than the control of native insect pests by foreign natural enemies. The practical control of the native white grubs, the most serious and generally destructive insect pest of agricultural crops in Puerto Rico, by means of an introduced toad is therefore somewhat more notable and is perhaps the first authentic record of a foreign predator successfully reducing the numbers of an insect pest which is native to the country in which it was destructive. The foregoing statements and the history of the white grubs which follows are from no less an authority than Dr. George N. Wolcott, entomologist of the Insular Experiment Station of Puerto Rico.

The white grubs of Puerto Rico are larvae of large beetles of several species of the genus *Phyllophaga* (*Lachnosterna*); these species are found nowhere else in the West Indies or continent. In the mainland United States related species are known as May beetles or June bugs.

The rapid expansion of the sugar industry, following the change in governmental status of Puerto Rico in 1898, provided a continually more abundant food supply for these white grubs and also tended to eliminate many of their natural enemies such as owls and other large insectivorous birds. In some of the richest and otherwise most productive regions of the island, all the cane fields were more or less affected and cane harvesting often became a race to see if the stalks could be gathered before the grubs had completely destroyed all the roots.

Attempting to control the pest, an expensive method of hand collecting the grubs and beetles was first used. On one property during six years approximately 12,000,000 beetles were collected and an equal number of grubs. Other methods of artificial control were tried, such as dynamiting the fields, maintaining a herd of pigs to follow the plow and eat the grubs and by applying various chemicals. Also attempts were made to introduce insect parasites of other species of grubs from other countries, but all resulted in failure.

The first importation of the Surinam toad, *Bufo marinus* L., from Barbados, was made in 1920 by the Puerto Rico Experiment Station of the U. S. Department of Agriculture to combat these white grubs. In the winter of 1923–24 R. Menéndez Ramos, director of the Insular Experiment Station, brought in 40 additional individuals from Jamaica.

Bufo marinus is comparatively large, averaging 6 inches in length and is more than double the size of the ordinary American toad. It is venomous, but thousands have been collected by children for distribution without the venom being noticed. However, a dog seizing one in the mouth may receive a fatal dose of poison.

The first introductions were released on the station grounds at Mayaguez. A few years later they were being collected at the station and distributed to all parts of the island. Hundreds and thousands were carried from the station to the cane fields of the southern coast, where May beetles were most abundant and the toad could be of greatest value in reducing

the numbers of white grubs. From Puerto Rico these toads have now been sent to Louisiana and Hawaii, and from Hawaii they have been sent to the Philippines and Australia. Incidentally some of these toads were taken from Puerto Rico to Mauritius by one of their entomologists, but the authorities there would not allow them to enter.

An important contribution has been made by Mrs. Raquel Dexter, of the University of Puerto Rico, in determining the contents of the alimentary tract of this toad. It was found that over a quarter of the food of the toad in cane fields consists of May beetles and another eighth consists of large leaf-eating weevils or "vaquitas," the grubs of which are second only to the common white grubs in their destructive effect on roots of sugar cane. Only one fortieth of the food consisted of the changa or Puerto Rican mole cricket, a serious pest of tobacco and vegetables.

The status of the white grub in Puerto Rico has been changed from a major to a minor pest of sugar cane by the toad. In 1933 a foreign entomologist, studying the insect parasites of white grubs, had difficulty in obtaining a sufficient supply of them on which to rear large numbers of parasites in the laboratory. After a completely successful method of killing white grubs by chemical means (emulsion of carbon bisulfid) was found, the only opportunities for its use in Puerto Rico have been limited to small areas in pineapple plantations at elevations where the toad is even yet not present in sufficient abundance. So many reputed failures, or worse, in the past, have resulted from the introduction of predatory animals and birds, such as the English sparrow and the starling into the United States, and the mongoose from India into other parts of the tropics, that this decidedly beneficial introduction of a batrachian is worthy of record.

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SCIENTIFIC BOOKS

CHRONICA BOTANICA

Chronica Botanica. Edited by FR. VERDOORN. Editorial and Publishing Office, P. O. Box 8, Leiden, Netherlands. April, 1935. 447 pp. Price, 15 Netherl. guilders.

FEW persons, even those professionally engaged in the science, realize the extent and complexity of present-day botany. There is a distinct need for a periodic survey of this vast field, and it is such a survey that is attempted in "Chronica Botanica." The first volume of this periodical (for it is intended that it shall appear annually) has recently made its appearance, and one can not examine it carefully without marveling at its accuracy and the reasonably complete manner in which it has succeeded in covering its chosen field. It is, to be sure, a compilation dependent in large measure upon the cooperation of collaborators everywhere, yet an immense amount of detailed work must have been required in the editorial office.

After a brief introduction by E. D. Merrill, stressing the need of international cooperation among botanists, and an illustration calling attention to the fact that it is just two hundred years since the original edition of Linnaeus' "Systema Naturae" was published at Leiden, there is an almanac for 1935 and the first three months of 1936, in which are designated the dates of important meetings and various anniversaries occurring during that period. Fifteen pages are then devoted to the Sixth International Botanical Congress to be held at Amsterdam in September, with a brief history of former botanical congresses, and thirty-five pages to forthcoming national and international gatherings.

Then follows the really important section, a "review of all branches of plant science during 1934." This takes up each country of the world in alphabetic sequence, and under each the names of the places where botanical work is carried on, with a résumé of the operations, during the year, of each institution from which a report was available. More than half of the book is devoted to this impressive review of botanical accomplishment and is freely illustrated with pictures of gardens, laboratories and buildings; there are also portraits of many botanists, especially of those who died during 1934. Another section is taken up with correspondence; one lists new periodicals; and a very useful one of thirty-four pages supplies new and changed addresses.

There are two indexes, one of plants and one of persons; although the latter seems quite complete, its omission of detail appears to be the greatest defect of the volume. Even the lighter phases of the science are not ignored, three pages being occupied by a series of humorous cartoons depicting the history of botany in the Netherlands from the first century to the present time. The editor is to be congratulated upon the production of a reference work indispensable to the botanist who wishes to keep abreast of the times, and it is to be hoped that the undertaking will receive from all quarters the support that it so richly merits.

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