was added from time to time to preserve the requisite amount of moisture within the cage, resulted in small cavities being formed outside the nest. From time to time a mite would find its way into one of these cavities and would remain there for a longer or shorter time. Such mites were constantly watched over by a detail of from two to six workers from the colony and while the workers never fed or in any other manner cared for the mites, so far as could be determined, they were nevertheless unremitting in their self-imposed guardianship both day and night.

That the mites were in no way dependent upon the ants for food or for care was determined by placing several hundred of the former in a plain glass bottle with a small supply of worker and larva "cadavers" and other refuse matter taken from the cemeterial chamber of a large artificial formicary. Water was added from time to time to keep the mass sufficiently moist and the bottle isolated by water to prevent any living ants from obtaining access to it. On this dead and decaying matter the mites lived and thrived for over sixty days, when other duties caused us to neglect the daily application of moisture and the death of the mites resulted.

We therefore feel safe in venturing the opinion that these two mites are scavengers, pure and simple, in the colonies of the Argentine ant and as such they are tolerated by the latter, although their presence is not necessary to the welfare of the community and no effort is made by the ants to secure or retain their services.

Careful search in the colonies of other species of *Formicina* has thus far failed to reveal the presence of either of these two species of *Uropoda.*

Baton Rouge, La., June 22, 1908.

THE FUNDAMENTAL PRINCIPLES OF SPRAYING

By H. T. Fernald, *Amherst, Mass.*

The use of arsenical poisons in the control of insect pests has now continued for nearly half a century. During that period, starting with but a few pounds a year, the demand has increased until many tons of these materials are now annually consumed and their use is one of the fundamental principles of economic entomology. Yet, a careful examination of our actual knowledge of arsenicals in their relation to insect and plant life gives surprising results, showing how little is really known and how much is merely empirical, and in-

dicates that a broad field for chemical, entomological and physiological research is waiting for explorers.

Everyone who sprays is aware how variable are the results he obtains at different times; how one treatment may be very successful while another, under apparently similar conditions, may prove much less satisfactory. Some writers advise spraying on warm, cloudy days; others on bright days to obtain the best results. The addition of one or two pounds of lime to each pound of Paris Green to prevent burning the foliage is generally urged; yet, even then, injury sometimes follows, and the only explanation generally offered seems to be that the materials were not sufficiently well mixed.

It is generally claimed that injury to foliage is due to the presence of free (uncombined) arsenic in the spray, but it is interesting to note that even this has not been conclusively proven. And when the nature of the action of the poison on the insect is questioned, the answer seems to have been drawn entirely from human toxicology rather than from a study of the poisoned insects themselves, while differences in the ease with which different pests are killed by poisons have been explained as due to varying powers of elimination of the poisons from their bodies,—only a guess, though one which may prove to be correct.

Even the chemical aspect of the insecticides has its uncertainties. Dictionaries of solubility state that copper arsenite is insoluble in water, whereas everyone who has used this substance as a spray knows that it is necessary to add lime to prevent burning the foliage. It would seem then, either that such statements as to solubility are very loose in their nature, or that the burning is due to some of the impurities always present in commercial articles. Which is the truth? What are the impurities and what parts may they play when used as sprays? These and many other questions must be settled by the chemist and entomologist working together.

Weather conditions have already been mentioned. How far do these affect or modify results when other factors remain fixed? Is it sunlight, temperature, humidity or all these and perhaps other conditions in addition which are involved? The meteorologist must also contribute his share toward the solution of spraying problems.

At the present time there are too few data of experiments made under conditions known with exactness; with materials of fixed and known composition; and with careful studies of the results, to enable us to draw safe conclusions on this subject. Many factors are involved and these must each be studied separately in their changes while the others remain fixed, thus involving long series of experi-

ments, before we shall have a knowledge of the fundamental principles which will enable us to attain the best results. Such an investigation has already been begun at the Massachusetts Experiment Station with the anticipation that five or ten year's work may give results which will help place spraying on a firm and scientific basis.

DESCRIPTION OF NEW DEVICES FOR REARING INSECTS

By A. F. Burgess, *Washington, D. C.*

One of the serious problems which it was necessary to solve in order to successfully rear the parasitic and predaceous insects which were being shipped from Europe to prey on the gypsy and brown-tail moths was to secure apparatus by means of which these insects, as well as their hosts, could be successfully reared in large numbers. All of the old style equipment in general use by entomologists for rearing work was tested, but in many cases it was found that radical improvements were necessary in order to accomplish the results desired. It was of primary importance to place the insects under as nearly as possible natural conditions and at the same time to keep them in confinement where they could be studied and observed and not allowed to escape from captivity. The purpose of this paper is to call the attention of working entomologists and others who may be interested in rearing insects to several devices which are now in use at the Gypsy Moth Parasite Laboratory, Melrose Highlands, Mass., and which have been found to meet some of the serious defects of the equipment that is in general use in insectaries and insect-breeding laboratories.

The most important of these is a tray for rearing insects which was devised by Mr. W. F. Fiske of the Bureau of Entomology, Washington, D. C., who is in charge of the Parasite Laboratory. It is illustrated in Pl. 3, Figs. 1 and 2. The standard size used at the laboratory is 14 in. square and 3 in. high. The bottom is covered with cheese-cloth which is attached by paste to the sides of the tray. With the exception of a 2-in. rim around the upper edge, the top is open; while directly beneath this rim a band of sticky Tanglefoot is placed in order to prevent the escape of the insects. This band is applied before the cheese-cloth bottom is attached and it is a simple matter to replace the bottom with a new piece of cheese-cloth when desired. The tray is built of one half inch white wood stock and the joints are securely nailed and glued in order to make it tight. A modification