CONTROL BY ANTS OF PEST SITUATIONS IN TROPICAL TREE CROPS; A STRATEGY FOR RESEARCH AND DEVELOPMENT*

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ABSTRACT

More successes than failures have been reported in the literature of attempts at manipulation of ants for pest control in tropical tree crops. Hence, the concept of this kind of control is of more than academic interest, and it is from this standpoint that an approach is suggested to the evaluation and development of ant-induced control in such a crop.

A series of stages comprising definition of the pest problem, selection of a candidate ant species, development of techniques for manipulation of the ant, and estimation of the economic viability of a feasible control scheme are put forward.

The most difficult part of such a programme is the development of methods for establishing and maintaining large populations of the useful ant in the crop. The reasons for this vary from case to case, and some examples are discussed.

INTRODUCTION

IT is now well established that many species of ant which form large colonies have a profound effect on the species composition of the insect fauna within their foraging areas (Wheeler 1910). In Europe, Banks (1962) working on beans and Gosswald (1951), Wellenstein (1957) and others working on pine forests have recorded these effects, but most of the better documented cases relate to the effect of ants on the distribution of pests within tropical crops. *Table* 1 shows some examples from tree crops in the tropics. Attempts have been made to manipulate the ants concerned in some of these examples so as to spread the controlling effect of the ant at will over large areas. An indication of the outcome of those attempts is shown in the table, and it can be seen that there have been at least five successful cases. The concept of using ants as control agents in tree crops then, is much more than just a theoretical possibility. The present paper suggests a generalised approach to the evaluation and development of ant induced solutions to pest control problems, and considers some of the principles involved.

RESEARCH PROGRAMME

Figure 1 shows the main stages making up such a programme of evaluation and development, and the points at which the use of ants may be contra-indicated. The first step in any attempt at pest control is to define the pest problem, and in the tropics, particularly with tree crops, a complex of damaging organisms is usually involved. Obviously before starting to search for a solution to a particular problem, it is advantageous to know as much as possible about the biology of the pests involved and their interactions with the crop and with each other.

Stage 2 is to find out which possibly useful ant species are available. At first sight this appears to be an immense task because of the great diversity of tropical ant faunas. Wilson (1959), for example, collected 172 species of ant in two square kilometres of Papua New Guinea lowland rainforest. In any particular instance, however, a process of elimination quickly reduces the number of species suitable for further consideration to the order of five to ten.

First to be eliminated are all species not already present in the country in which the pest problem occurs. The risks incurred by

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Table 1.—Accounts of ants controlling insect pests of tropical tree crops

Ant	Pest	Success	Crop	Place	Author
Anoplolepis longipes	Pseudodoniella laensis	n.a.	cacao	PNG	Szent-Ivany 1961
Dolichoderus bituberculatus	Helopeltis sp.	yes	cacao	Java	Meer Mohr 1927
Oecophylla longinoda	Pseudotheraptus wayi	no	coconuts	Zanzibar	Van der Plank, 1960 Way, 1953
Oecophylla longinoda	Distantiella theobroma	n.a.	cacao	Ghana	Collingwood, 1971 Leston, 1970
Oecophylla smaragdina	Amblypelta cocophaga	yes	coconuts	Solomon Islands	Brown, 1959 Greenslade, 1971 O'Connor, 1950 Phillips, 1956 Stapley, 1971b
Oecophylla smaragdina	Amblypelta theobromae	n.a.	cacao	PNG	Szent-Ivany 1961
	Cephonodes hylas	no	tea	Assam	Corbett, 1937
Oecophylla smaragdina	Pantorhytes plutus	n.a.	cacao	PNG	Szent-Ivany 1961
Oecophylla smaragdina	Pseudodoniella laensis	n.a.	cacao	PNG	Szent-Ivany 1961
Oecophylla smaragdina	Tesseratoma papillosa	yes	citrus	Sthern China	Groff & Howard 1925
Wasmannia auropuncta	cocoa mirids	yes	cacao	Cameroun	Bruneau de Mire 1969
unidentified ant	unidentified species	yes	dates	Yemen	Botta 1841

Manipulation of ant to extend control: yes = successful
no = unsuccessful
n.a. = not attempted.

the introduction of an ant species into new geographical areas are too great for such a step to be taken with our present lack of knowledge of ant ecology. One only has to consider the problems which followed the accidental introduction of the fire ant into the southern states of the United States of America (Wilson 1958) to appreciate what can happen when the factors regulating the population of an introduced ant are not known.

Next to be eliminated are all those species not already present in the crop in the geographic region under consideration. This assumes that all those ants capable of inhabiting the crop environment are already doing so. This assumption may be false in the case of a crop recently introduced into an area or a crop which has been extensively sprayed with insecticide in the recent past. Ideally in such cases, time should be allowed for the ant fauna to stabilize itself before proceeding.

All ant species which forage exclusively in microhabitats, such as rotting logs, which are not inhabited by the crop pests can also be eliminated, as too can all species not foraging in high densities. The latter could not give the crop a sufficiently intensive protective cover.

In the case of cacao in Ghana, this process of elimination leaves some eight or nine species of ant only which are worthy of further investigation (Leston 1970, Room 1971). For cacao in Papua New Guinea the number is as low as two or three.

The short-list of possibly useful ants is next passed on to stage 3 in *Figure* 1. In stage 3 it is decided if any of the species has a potentially useful controlling effect on the pest complex. This can most easily be done

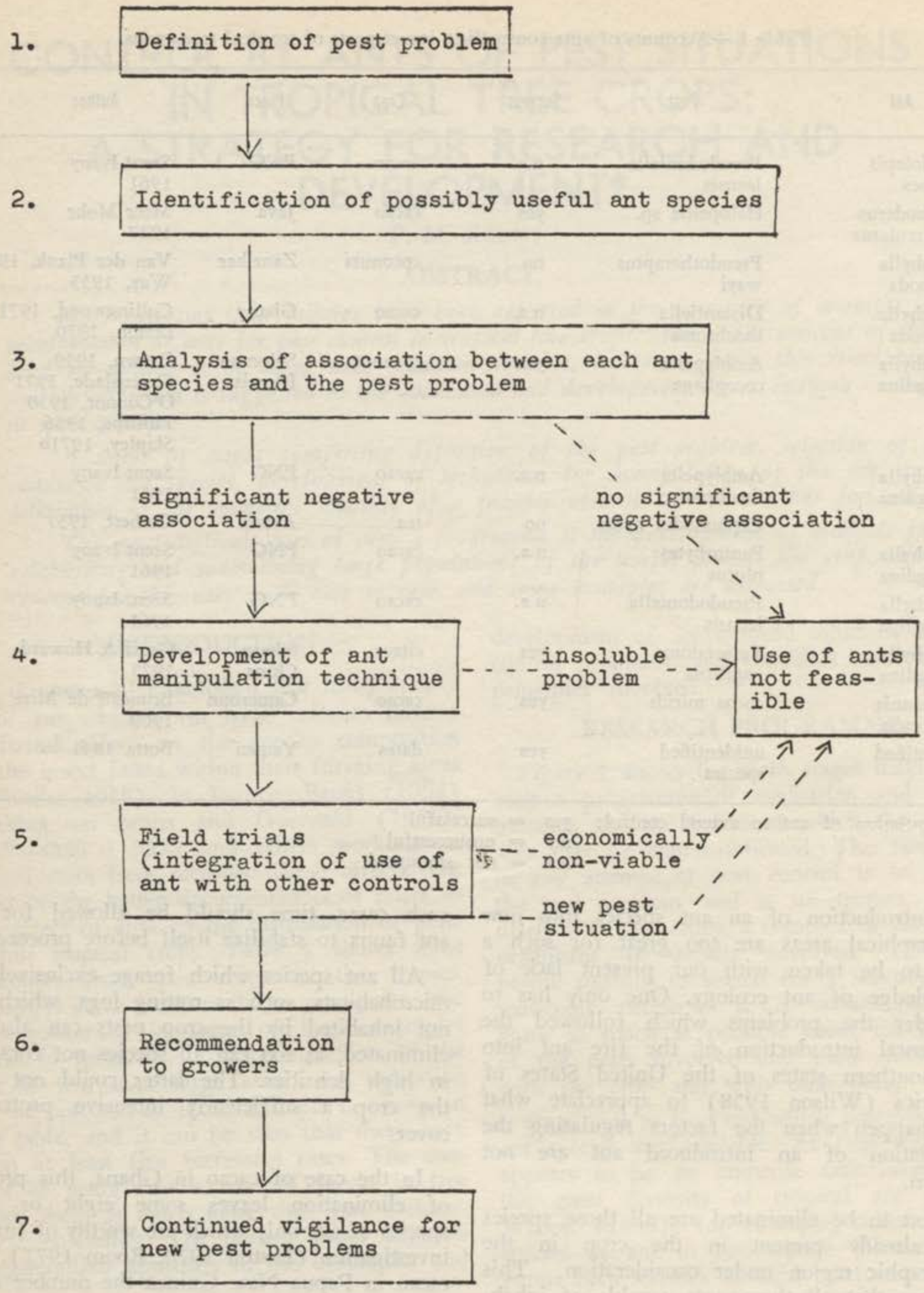

Fig. 1. Selection and development of an ant as a pest control agent

using some form of stratified random sampling technique designed to show how the pest and ant species are distributed with respect to each other in the crop. Care should be taken to separate distributional correlations reflecting true interspecific interactions, from correlations reflecting the action of other variables on the various species. In some tree crops, such factors as the species of tree used to give 'top shade' and the level of shade provided are important variables in addition to the factors which operate in all crops, such as the spacing of the crop plants, physiological condition of the crop and climatic effects.

If none of the short-listed ant species appears to affect the distribution of the pest complex in a beneficial way, then obviously some alternative to ant induced control must be sought. It may be found for example that an ant is negatively associated with part of the pest complex, and positively associated with the rest. Many predatory ants also tend plant feeding Homoptera and as a result are implicated in pest situations, sometimes even involving secondary transmission of plant virus or fungus diseases (Strickland 1951, Evans 1971). On the other hand, if one of the ants does appear promising, then a study should be made of how it can be spread and maintained throughout large areas of the crop. This is carried out in stage 4.

There is a great deal of evidence to show that in a reasonably uniform habitat, such as in a monocrop, the single most important factor affecting the distribution of an ant is the distribution of the other ants with which it competes for some limiting resource (Brian 1952, Leston 1971, Way 1958, Yasuno 1963). Thus, no rational attempt at changing the distribution of one ant in a crop can be made, without at the same time changing in a complementary way the distribution of its more important competitors.

Room (1971) examines the nature of competition in ant communities. Briefly: the most important competitors of an ant which forms large colonies are other ants which form large colonies. In such cases, it is usually observed that the ants do not compete for nesting resources, but rather for foraging area. Nesting resources are not usually limiting because most large colony ants build their nests with such super-abundant materials as soil, triturated vegetable fibres or living leaves. Food on the other hand, does appear to be a limiting resource, and most large colony ants seem to have adopted unspecialised feeding habits and the defence of large foraging territories to ensure its supply. These foraging territories are maintained almost entirely free from individuals from other large colonies, either of the same, or other species of ant.

Reference back to the correlation study carried out in stage 3 should make it abundantly clear with which other ants the potentially useful species has a mutually exclusive relationship.

DEVELOPMENT

The task in stage 4 now becomes one of introducing and maintaining large populations of the beneficial ant, while at the same time displacing and holding back the competitors of the beneficial species. This can be attempted in two steps.

First, the number of individuals of the original dominant ant inhabitants of the area must be greatly reduced. If species using single discrete nests are present, these nests and their inhabitants can be completely destroyed. If species having a large number of dispersed nests are present, then the whole area could be sprayed with a suitable nonpersistent insecticide, or poisonous baits could be used.

Next, before the original inhabitants or insurgent ants have time to build up large populations, the beneficial ant should be introduced. This should be done in such a way that the introduced species is present, and remains, in sufficiently large numbers to defeat any remaining or invading competitors.

To do this successfully, all the individuals introduced into a sub unit of the area must be from the same colony, otherwise inter-colony fighting will seriously reduce the number of introduced individuals which survive (Pontin 1969). In order to maintain the numerical superiority of the introduced species, its rate of worker production must be kept as high as possible. Obviously dealate queens must be introduced with the workers, and it must be ensured that the supply of food is adequate. If it was necessary to spray the crop to displace the original ant inhabitants, some food may have to be artificially provided for a while. In most cases, it would probably be necessary to introduce the Homoptera tended by the beneficial ant if the ant's food requirements are to be fully satisfied. This may present difficulties in that the timing of Homoptera introduction may have to be geared to the vegetative state of the crop. (e.g. flushing or fruiting) to ensure success.

Once a useful ant has been successfully introduced into an area, it might prove sufficiently resilient to maintain itself without outside help. Alternatively, the routine destruction of nests of antagonistic species and the provision of food during lean periods may be required. Provision of food in any instance would have to be carefully investigated because the foraging pattern of the ant might be disrupted to the detriment of its pest controlling effect.

If and when it is felt that an ant can be manipulated in a reliable and usable way, then the technique must be tested on a field trial basis to establish whether its use is economically viable or not. In particular, any deleterious effects arising from mutualistic relationships between the ant and Homoptera, such as disease transmission, should be assessed. At this stage it would also be advisable to consider the possibility of integrating ant induced control with other methods of control so that too much reliance is not placed on any one method.

EXTENSION

Finally, if the field trials of the complete control scheme are successful, the techniques can be recommended for general use with the crop, with the proviso that growers should remain alert for the development of new pest situations at all times.

PROBLEMS

In practice, most of the difficulties in a programme run along the lines just suggested would be expected to occur in stage 4: the development of ant manipulation techniques. The following are some brief examples of such problems.

The eradication of ants which compete with beneficial species can be difficult. *Pheidole megacephala* (Fabr.) has been particularly troublesome in attempts to spread *Oecophylla smaragdina* F. (Stapley 1971a) and *Anoplolepis longipes* (Jerd.) (Lancaster—personal communication). This is because its diverse nesting sites in the ground and in trees and its habit of constructing roofs over main foraging trails make it relatively inaccessible to insecticides. However Stapley (1971b) has recently overcome this problem using a combination of insecticides and cultural practices unfavourable to *Pheidole*.

The foraging density of an introduced ant can only be maintained if an egg-laying queen is included in each transplanted colony. *Oecophylla longinoda* (Latr.) and *O. smaragdina* would be much more useful in a number of tree crops throughout the old world tropics if only some means could be devised of ensuring the collection of the queen with each colony to be moved.

Obtaining populous colonies of some ants in an easily transportable form can be a problem. At present, the most promising approach seems to be the use of attractive artificial nests which can be sealed at a time of minimum foraging activity and then carried to the introduction site. In Cameroon, *Wassmania auropuncta* Roger has been transported in hand woven raffia trap nests (Bruneau de Mire 1969) and in Papua New Guinea *Anoplolepis longipes* was transported in bamboo nodes sealed with banana leaves (personal observation).

The maintenance of large continuous areas covered by a number of abutting foraging territories of the same species of ant may prove difficult in some cases. The reasons for this are complex, and have been dealt with in some detail by Room (1971). Briefly, it appears that one of the main reasons could be that the ants remove their particular prey spectrum so efficiently from within their foraging territories that they rely on immigration of prey from areas not foraged by them to maintain their supply of protein. The provision of proteinaceous food in such a way that the pattern and intensity of foraging are not unduly disturbed may help overcome this problem.

Finally, though an ant may be able to maintain a high rate of worker production in the environment of a crop badly damaged by pests, when the crop recovers conditions of food supply or nest site may become unsuitable. For example, a ground nesting species may have worker production reduced by a drop in nest temperature caused by an increase in the shade cast by a good crop canopy.

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