of land each of area 1,100 or 1,50 of an acre, the plots being selected on a purely random basis. Of course every effort should be made to compare the results of the experiments with such other information as may be available from trade statistics, settlement investigations and the like.

ON SOME PARASITES FOUND IN ASSOCIATION WITH THE STEM WEEVIL PEST OF COTTON IN SOUTH INDIA (*Pempheres affinis*, F.) & THEIR ROLE IN ITS BIOLOGICAL CONTROL*

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It is now over two decades since the cotton stem weevil *Pempheres affinis*, F. began to attract some attention as a fairly important pest of cotton in South India, and the first paper (1) on the general features and life history of this insect was published by the senior author. Since then, this pest, which was in the early years confined chiefly to the cambodia variety of cotton, has been directing its attentions to other cottons and distributing itself fairly widely in the cotton areas of South India. As a consequence, special attention has had to be paid to this insect along with other important pests of cotton viz., the boll worms, and even the help of legislation had to be resorted to for the control of these important pests. Side by side, intensive studies on the different aspects of the problems connected with this insect have also been carried out by the Government Entomologist and by a special staff appointed for this work by the Indian Central Cotton Committee. The peculiar habits of this weevil as an internal feeder in its destructive stages have made it rather difficult to tackle it by means of the ordinary mechanical or insecticidal methods of control, and it is found that the only possible means of keeping the pest under some control must mainly consist of prophylactic cultural means and plant sanitation, the breeding of resistant strains of cotton, or by trials in biological methods by the use of parasites or predators. Speaking of biological methods and the agencies in that direction, with which this paper is mainly concerned, it is needless to add that it is in the first place essential to find out whether any such natural enemies really exist and get some definite ideas regarding their potentiality before any control measures in that direction are attempted. With a view to find out if the pest is subject to the attacks of such natural enemies the authors have been carrying on some work, and the experience of the past two or three years has so far shown that this insect, unlike some of our common insect pests, is not commonly subject to

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parasites or predators, and till now studies in this direction have revealed the existence of only a few parasitic wasps in comparatively very small numbers associated with the developing stages of this weevil pest. These being the first definitely identified and reared records of insect enemies of this stem weevil, the authors have thought it desirable to present this fact in this short paper with the available systematic and biological notes gathered so far regarding these parasites and their role as natural enemies.

The Parasites. The parasitic insects so far found associated with the stem weevil number five in all, and appear to belong to two different families of wasps; of these five, two are braconids and the other three which are smaller in size belong to the well-known group of chalcid wasps. Of the two braconids the larger form appears to be a species of the genus *Spathius;* since only a few specimens have been secured, it is proposed to record the exact specific identification after sufficient material of the parasite is secured; Species of *Spathius* are usually found attacking the larvae of powder post beetles (Bostrychidae) found damaging stems of trees, wooden posts, bamboo framework etc.; one species of *Spathius, Spathius piperis*, W has been noted however from the Dutch East Indies as a larval parasite of a weevil *Lophobaris piperis* and Beeson and Chatterjee have recently noted (4) two or three species of *Spathius* attacking weevils of the genera *Camptorrhinus, Osphilia* and *Mecistocerus* attacking forest trees. The smaller braconid of which only a single specimen has been so far reared out is a species of *Microbracon* closely allied to *M. gelechidiphages* described by the senior author (5) as parasitic on the cotton boll worm.

Of the three chalcid wasps noted so far in association with the stem borer weevil, one is a *Eulophid* and appears to belong to the genus *Olinx*, F—a genus not recorded before from India. One of the other two appears to be a *Pteromalid* belonging most probably to one or other of the two genera *Pachyneuron*, W or *Hypsicamara*, F. The smallest of the three which has only been noted very recently appears to belong to the family Encyrtidae. It is proposed to describe these parasites as soon as possible in a separate systematic paper elsewhere.

The biggest braconid was found in very small numbers and was mainly obtained from dead plants kept for emergence of adult weevils from the early sown cotton crop during the end of December. Some of the adult wasps were found to possess only vestigial wings. Examinations in March showed stray cases of the pupae of this wasp enclosed in thin tough dirty white cocoons. The pupae were found in the tunnel, one for each host grub. The incidence is found rather negligible as far as noted, since not more than a dozen have been obtained so far.

In the case of the chalcids, though adult parasites of the Eulophid were obtained even from stems collected at the end of the season which

were kept for observation during August, September etc., they were prominent only during March and in fact, at the fag end of the season, when the dominant stage was found to be the grub of the parasite. Stray adults also were found *in situ*. In April all the stages were being obtained viz., grubs, pupae and adults, the former two obtained to a smaller degree. In stray cases just emerging adults were noticed from the stems. There were also cases where the adults were found dead *in situ*. It appears that only the grub stage of the pest is attacked and that only one parasite attacks a single host grub and these grubs are generally found parasitised in the earlier stage. The grub of the Eulophid is very minute and is generally found associated with the host larva and can be detected only after careful observation; such a grub taken pupated in a day or two. In the case of the Pteromalid the grubs are generally stout, grayish in colour, and tapering at the ends with the central region bulged up, and these are found singly in the tunnel of the host with absolutely no trace of the latter; and in all such cases the parasitic grub is found to be a fully fed one which, when separated and kept in a tube, pupates almost in a day or two. Before pupation the grub throws out faecal pellets around it in a circular fashion and after undergoing shrinkage pupates. The pupa is white in colour at the outset but changes to a brownish dark tinge after three or four days, and the adult emerges at the end of a week or seven days. In the case of the pupa the head and thorax are dark and the abdomen alone is white. These two forms appear to be ectoparasites and so can easily be detected in the tunnel made by the grub. The braconid also appears to be ectoparasitic. It is interesting to note that the Eulophid wasp has also been noted as a parasite of the cotton stem borer buprestid beetle *Sphenoptera gossypii* in the Ceded districts.

As is the case with many other insect parasites these forms appear on the pest more at the end of the crop season than at any other time; anyhow the effectiveness of these parasites depends upon the degree of incidence which may vary in different cases.

Biological Control of the weevil and suggestions in that direction. In investigating the possibilities of utilising these parasites in the control of the cotton stem weevil one very important point to remember is, that, unlike numerous other crop pests, especially caterpillar pests of sorts which feed exposed on the plants and which offer easy access to numerous enemies, this pest in its destructive stages is a borer, spending all its earlier life stages inside the stem of a plant which has a fairly hard bark. It is therefore clear that it is not all parasites which can attack such an insect, but only those which are specially adapted to reach the grub inside the stem that have chances of exercising any control over the developing pest; and even in such cases the success of the parasite depends a good deal on the particular stage of the host which is vulnerable, and the favourable stage of the plant when the

parasite can get easy access through the stem. The economic entomologist, who is anxious to adopt biological methods of control against this pest by using parasites, has therefore to carry out preliminary investigations more or less on the following lines to get some idea of the potentialities of such natural agencies.

A. Carry on breeding of parasites from borer infested cotton in the different areas to find out (a) the different kinds of parasites; (b) the comparative incidence and habits of parasites in relation to the pest and its stages for one or more crop seasons; (c) the inter-relations and bionomics of the parasites themselves to find out if there occur any hyperparasitism, superparasitism or any such complexities which might interfere with the proper effectiveness of any of the parasites. It is not unlikely that a condition which may be called a parasitic complex might exist in the case of many pests as has been pointed by previous workers and by the senior author in his paper (9).

B. Study the parasites of other fairly common boring beetles or caterpillars, especially those of such weevils as the agathi weevil (*Alcides bubo*) the stem weevil attacking Gogu, Hibiscus and often cotton shoot (*Alcides affaber*) other species of weevils attacking lablab and other leguminous stems, the amaranthus weevil (*Lixus brachyrhinus*) and other beetles like the ground stem boring beetle (*Sphenoptera perotetti*), other borer beetles like Bostrychidae (powder post beetles), Ipidae (timber boring and ambrosia beetles), the longicorns like the coffee borer *Xylotrechus*, the mango borer *Batocera*) the fig borer (*Olenecamptus*) etc., and of boring caterpillars like the agathi stem borer (*Cossid*), the citrus shoot borer (*Arbela*).

The discovery of the alternate host plants which offer actual breeding facilities to this pest will also help not only in locating its haunts when there is no cotton in the field, but also to find out what parasites are found breeding on the insect in these alternate host plants. Ballard (2) makes the rather amazing statement that it has been found breeding in or feeding on many different plants and that it has been bred from the different plants not to speak of others on which the adult has been noted. Experiences of the writers and other later workers have however shown that though the weevil has been now and then collected from a few other Malvaceous plants besides cotton it has not so far been found actually breeding on any other plants except on Bendai (*Hibiscus esculentus*) to a small extent, on stray *corchorus* plants (3) and on Gogu (*Hibiscus cannabinus*). It has to be remembered that noting the adult of an insect on a plant and actually finding the same breeding on it (showing the grub and its other stages on it) are two different phenomena and one cannot conclude without sufficient evidence that the insect is breeding on it by merely noting the adult casually perching or mating on a plant. The study of the alternate hosts is to find out if there are any parasites common to any

of the above borer beetles and in any of the other host plants on this pest and if so whether any such parasites could be bred out in sufficient numbers artificially from two or more other hosts.

Information on items such as numerical, seasonal and reproductive aspects will also afford valuable clues as to the most promising methods of carrying on biological control. If predatory natural enemies are found available, the same lines of investigation as in the case of parasites may be pursued. It is needless to add that most of these lines of preliminary work will be found necessary in dealing with the control of any crop pest by the use of natural enemies, especially of insect parasites or predators and that the scientific values of such studies both to the systematist and the economic entomologist will be very great. A perusal of the very interesting paper by Pierce (6) on the valuable studies on the cotton boll weevil of Mexico and its parasites made during the past several years in the U. S. A. would give one an insight into the intricacies of the weevil pest problem and offer valuable suggestions for future lines of work against such pests. It may also be added that biological methods of pest control may not be quite successful in all cases, may be partially helpful in some, and not exclusively effective in most cases as may be seen by the perusal of a recent paper (7) by Sweetman on this subject where he gives a helpful list of all these categories.

In conclusion we can only quote the telling remarks of Dr. Thompson when he says (8) "Generally speaking, no one species of parasite or predator is likely to bring the host under control over the whole of the infested area. To produce this result, the introduction of additional species will usually be necessary, while in many cases, their efforts must be aided by the methods of agricultural, chemical or mechanical control". We would also commend to enthusiasts on Biological control Thompson's excellent papers on the subject before they attempt any serious work; for, in his own words "the idea of biological control has now become fashionable and is tending to degenerate into a kind of superstition or fad" (8). It has therefore to be reiterated that the study of the natural control of insects by biological methods and their proper utilisation demands a thorough study of the bionomics of the whole group of parasitic insects in relation to a single point which may be called the parasite complex of a pest.

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OMUM OR BISHOP'S WEED (*CARUM COPTICUM*)

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Introduction. There is probably not a single household, rich or poor in South India, that does not keep a stock of omum water ready against any stomach ailment. As an infallible remedy against indigestion, its efficacy is known to all, and it is one of the few articles of medicinal use, that are sold by even the street hawkers.

The omum plant and its products have a glorious and ancient history behind them. In those early days of civilisation, when Egypt led the world, that country happened to be the sole source of supply to other nations. Later Afghanistan, Persia and other Mohammadan countries of Asia traded in this commodity and owed not a little to this plant, for their flourish and prosperity. It was in the 15th and 16th centuries that omum water came to be known in Europe for its therauputic properties, and references eulogising the excellence of the omum water received from Alexandria and Crete, can be found in the writings of Ponnet, who was physician at the court of King Louis XIV of France. This monarch whose name will go down in history for some famous gastronomic feats must have had,—perhaps at the instance of his physician—recourse to this carminative more than once in his life, to afford relief, when inordinate greed at the dining table made him feel for his indiscretion.

In India itself, omum water has been known and used from the earliest times. Bengal was the chief Province of cultivation and source of supply, but Ujjain—famous as the capital of the great Vikramadithya—has been known to produce the best quality of omum water from the middle ages.

Area and Soil. The total area under this crop in this country is about 100000 acres, of which Bengal occupies more than a third. Madras has about 5000 acres. Curiously there is an opinion that this crop does not thrive on fertile soils, and it is therefore often cultivated chiefly on the poorer types of soils. As a garden crop it is