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PEST CONTROL BY THE BILOGICAL METHOD

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The term biological control refers to the direct or indirect manipulation by man of living natural enemies of pest organisms in deliberate attempts to reduce populations of the latter (pest), to such levels, that economic damage is eliminated or significantly reduced. There is no universal agreement on the above definition as some workers have defined biological control as the action of parasites, predators or pathogens regardless of whether or not man deliberately introduces, manipulates or modifies the biological control agents. Recent workers have extended the term to include the use of antibiotics, the use of resistant strains of plants, the use of sterilised males of the pest species and the use of non-pest species that drive out pest species by competition. In spite of the many deviations and extensions it is generally agreed that the term biological control means the reduction of populations of living organisms brought about by other living organisms.

Approaches to Biological Control

There are three main approaches to biological control work—

(1) To initiate permanent biological control by the selection and introduction of suitable biological control agents not already present in the pest infested area. Permanent biological control can be self-perpetuating and if successfully accomplished is certainly the cheapest of all pest control methods.

(2) To effect temporary biological control by the release of very large numbers of biological control agents. This in the main is used to supplement already existing permanent control. Temporary biological control methods are resorted to very often in order to overcome a sudden flux in pest populations, especially in short term crops such as vegetables.

(3) Intensification of the activity of biological control agents by suitably modifying the environment; wherever possible, so that it would be favourable towards the multiplication of the control agents. The establishment of "reservoirs" where food and alternate hosts would be available is an example.

The Popularity of Biological Control

The last 15 years or so has seen a remarkable interest in the biological method of pest control. The gain in popularity of this method of pest control is due largely to a realisation of the inherent weaknesses in the chemical method of pest control. Some of these weaknesses are, destruction of beneficial insects, accumulation of toxic residues, and development of pest resistance. The recent recognition of the gradual development of a resistance to insecticides by pest organisms lends a very serious turn to the entire outlook. Insecticides which were found effective a few years ago might now, or in the near future, be found ineffective, or have their effectiveness reduced. This will automatically promote or necessitate the use of more and more toxic chemicals. Thus the hazards to human beings, livestock and vegetation are being gradually increased.

Biological Control of Coconut Pests

The problems of pests and diseases (relating to both investigation and treatment) are made more acute in coconut palms due to the inherent tallness of the palm. The hazards and difficulties of spraying or dusting operations are obvious. The task of getting the spray fluid or dust to reach the pest organism too becomes an intricate operation. The biological method of pest control if successfully applied thus offers an easy way out.

Biological control has been successfully applied on a number of coconut pests, the more prominent of which are, the Coconut moth in Fiji—*Levuana iridescens* Beth-Baker, the Coconut-scale—*Aspidiotus destructor*. Sign. and the Coconut caterpillar—*Nephantis serinopa*. Meyr.

The Coconut Moth in Fiji

Levuana iridescens was known as a very serious defoliator of coconuts and the resulting economic loss had been very heavy. After much investigation a parasitic tachinid fly—*Ptychomia remota* Ald., from Malaya was introduced in 1924 and by 1927 the parasite had reduced the pest population to such a level that it ceased to be a problem. *Ptychomia remota* was found in Malaya as a parasite on a species related to the levuana moth.

The Coconut Scale

The coconut scale — *Aspidiotus destructor* Sign., too could be a serious pest, if uncontrolled and could result in considerable reduction in coconut production. In the Portuguese islands of Principe, production in 1955 had been reduced to 30% of the normal figure due largely to coconut scale infestations. The coccinellid predatory beetle — *Cryptognatha nodiceps* Mshl., was introduced from Trinidad and by 1958 the pest was completely under control and production was back to normal. The coconut scale had also been a serious problem in the Fiji Islands in 1928 and was controlled successfully by the introduction of *Cryptognatha* from Trinidad. In Ceylon the coconut scale is satisfactorily controlled by the indigenous predatory coccinellid beetle — *Chilocorus nigritus* Muls.

The Coconut Caterpillar

The Coconut caterpillar—*Nephantis serinopa* Meyr., has been a serious pest in India, Burma and Ceylon. There are a number of natural enemies of this pest both in India and Ceylon and the combined action of all these biological control agents brings about a certain amount of control. Included among them are several species of predatory spiders and both larval and pupal parasites. Several birds too, chief among which are the

"Mynah" and the Crow, have been observed in a predatory role, and it is a fairly common sight to see these birds foraging among infested leaflets for prey.

In the biological control of the coconut caterpillar the results achieved so far have not been particularly spectacular. In the bethylid wasp — *Perisierola nephantidis* Mues., and the tachinid fly—*Spoggosia* (*Stomatomyia*) *bezziana* Bar., we have very good larval parasites, but unfortunately their efficiency is reduced by the fact that both are liable to be hyperparasitised. In the eulophid wasp *Trichospilus pupivora* Fer., we have once again an excellent pupal parasite. It is however susceptible to changes in temperature and humidity.

In view of the fact that permanent biological control of the coconut caterpillar has not been very firmly established, it has become necessary to engage in temporary biological control methods, to assist the permanent control in combating sporadic outbreaks of the pest. In temporary control methods, biological control agents are produced in laboratories and mass releases of these agents are then made on infested lands.

It is reported that *Microbracon brevicornis* Wesm., *Elasmus nephantidis* Rohw., and *Tetrastichus israeli* M & K., have been successfully used in different parts of India, but attempts to colonize them in Ceylon have so far failed.

The Black Beetle

The black beetle or rhinoceros beetle, *Oryctes rhinoceros*. L. is the most ubiquitous of coconut pests. Much work has been done on its biological control with very little or no success. Some ground beetles have been observed as predators on *Oryctes* but their influence as a controlling factor has been found negligible. A fungus *Metarrhizium anisopliae* has been tried out by a number of research workers, Friedericks (1913), Bryce (1915) Hopkins (1927), Corbet (1932), Smith (1936) and many others after them, but the results obtained so far have not been very encouraging. Among the Bacteria, *Bacillus popillae.* and another of the *Bacillus anthracis* group have been tried out but without much success. A virus *Rhabdionvirus oryctes* is also being tried out.

A number of parasitic insects belonging to the Scoliidae have been tried out as biological control agents. Of these *Scolia ruficornis*. F. a parasite of *Oryctes boas* and *Oryctes monoceros* in Zanzibar was introduced into Western Samoa by Simmonds in 1945 and it was reported that the parasite was keeping the pest under check in a small coastal belt in Western Samoa. Another Scoliid, *Scolia procer*. Ill, observed as a parasite on *Oryctes* in Malaya has also been introduced in the South Pacific islands. In spite of intensive work on the biological control of *Oryctes* there is no definite indication yet that parasites and predators are responsible for the apparent control of *Oryctes* in South-East Asia.

The Red Weevil

The red weevil, *Rhyncophorus ferrugineus*, F. is a very serious and widely distributed pest on coconut palms. Investigations into the possibilities of biological control of the red weevil, have so far not revealed any biological control agents of significance.

Other Pests

The other pests of coconut are all considered as minor pests and it is very seldom that they appear in outbreak proportions in Ceylon. They are either kept under check by their naturally occurring enemies or the physical and environmental conditions under which they live have not been favourable for their rapid multiplication. The nettle grub *Parasa lepida*. Cram., is known to have quite a number of naturally occurring hymenopterous parasites. The 'bagworm', *Manatha* (*Psyche*) *albipes* too is known to have a few indigenous parasites.

Weeds

Weeds too could be very troublesome pests on coconut lands. Of the many troublesome weed pests *Eupatorium odoratum* occupies a very prominent place. A related species *Eupatorium* (*adenophorum*) *grandulosum*. has been successfully controlled by the biological method, both in India and Australia.

A gall-fly *Procecidochares utilis* has been very successfully used in the control of this weed. A fungus *Cercospora eupatorii* has also been used against Eupatorium in Australia. It would be interesting to study the possibilities of using biological control agents against *E.odoratum* in Ceylon.

Biological Control Work at C.R.I.

Biological control work at the Coconut Research Institute started with work on the control of the coconut caterpillar.—*Nephantis serinopa*. Meyr. This work was earlier done by the Department of Agriculture at Peradeniya. With the formation of the Crop Protection Division and the appointment of a Crop Protection Officer in April, 1956, the Coconut Research Institute took on the task of coconut caterpillar control. The Department of Agriculture was engaged in breeding only the eulophid pupal parasite, *Trichospilus pupivora* Fer. After the Coconut Research Institute took over, nucleus material of the larval parasites, *Microbracon brevicornis* Wesm., and *Perisierola nephantidis* Mues., were got down from India, and mass multiplication and release of these parasites too were done at Lunuwila, in addition to the breeding and release of *Trichospilus pupivora*.

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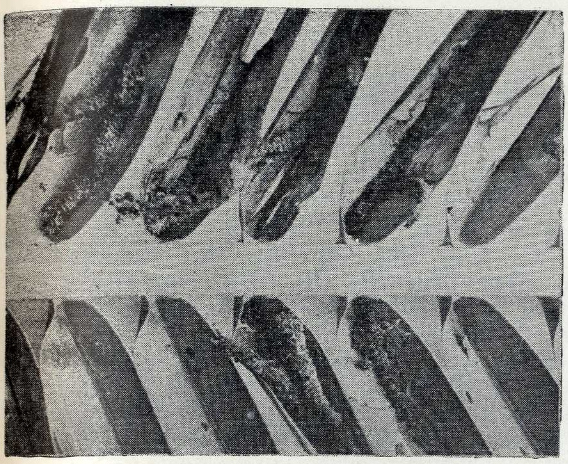
1. A section of a coconut caterpillar infested leaf showing larval galleries.
2. Pupa of *Nephantis serinopa* (Coconut Caterpillar). (Magnification x 2.5 approx.)
3. Moth of *Nephantis serinopa* (Coconut Caterpillar) (Magn. x 3 approx.)
4. A *Corcyra cephalonica* larva paralysed by the parasite *Perisierola nephantidis* prior to egg laying. (Magnification x 5 approx.)
5. Tiny grubs of *Perisierola nephantidis* on the under-side of a *Corcyra* larva with the adult parasite close-by. (Magnification x 5.5 approx.)
6. Grubs (young) of *Perisierola* shown feeding on a *Corcyra* larva with the adult parasite guarding them. (Magnification x 5.5 approx.)
7. Fully grown grubs of *Perisierola* collected for cocoon formation. (Magnification x 1.5 approx.)
8. Cocoons of *Perisierola* (Magnification x 1.5 approx.)
9. Cocoons of *Perisierola* on an infested leaflet.



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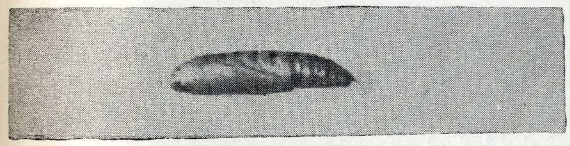

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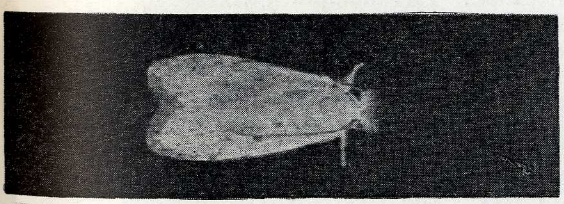

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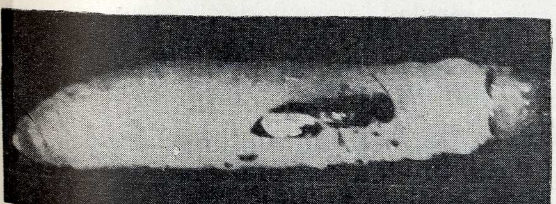

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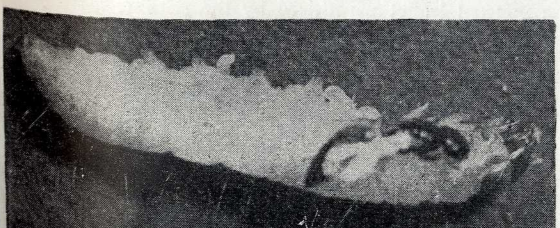

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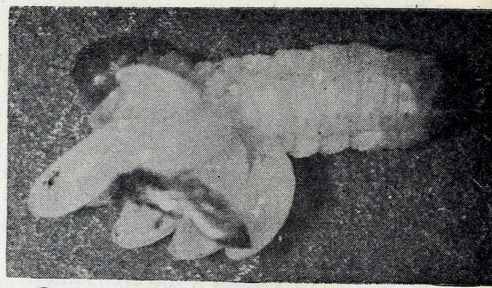

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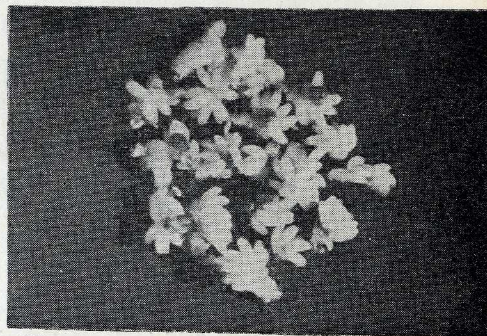

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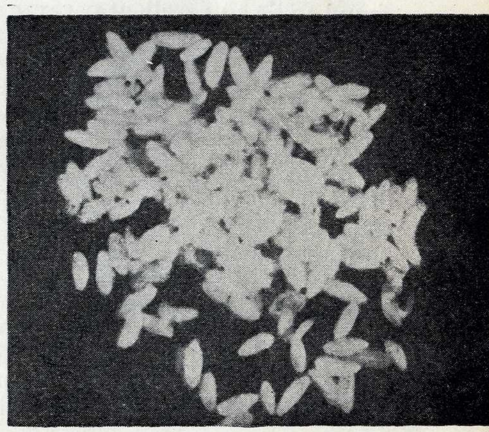

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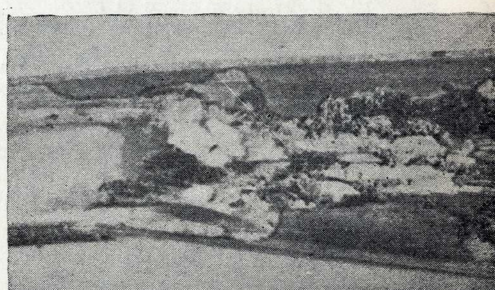

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In December 1959, Dr. V. P. Rao, Entomologist of the Commonwealth Institute of Biological Control Indian Station visited the Institute and brought with him a colony of the pupal parasite *Tetrastichus israeli* M & K. With this nucleus material it was possible to build up populations, and mass releases of *Tetrastichus* were done in caterpillar infested estates in the Eastern and North-Western Provinces. The position however is that this parasite has so far failed to get established.

In November 1960 Mr. Edwin Dharmaraju joined the Coconut Research Institute on an assignment under the Colombo Plan. Under his supervision a Parasite Breeding Station was opened at Batticaloa, where mass multiplication and releases of parasites were done. The Eastern and Northern Provinces were supplied with parasites from the Station at Batticaloa while the other provinces were supplied with parasites from the Station at Lunuwila.

When the Parasite Breeding Station at Batticaloa was opened in February 1961 the Coconut Caterpillar was causing serious damage to plantations in the Eastern Province. Almost the entire coastal belt from Vakarai to Pottuvil was heavily infested with the caterpillar. This condition prevailed till amost the end of 1963. However by the end of 1966 only about 4 estates in the Eastern Province were infested with Coconut Caterpillar. Of these, the infestations on three estates were relatively mild.

Mass multiplication and release of the larval parasite *Microbracon brevicornis* Wesm., *Perisierola nephantidis* Mues., and *Spoggosia* (*Stomatomyia*) *bezziana* Bar; and the pupal parasites *Trichospilus pupivora* Fer; and *Tetrastichus israeli* M & K., were done at Batticaloa. The tachinid *Spoggosia* was found to be an excellent parasite in the Eastern Province and if not for its hyperparasites might have kept the pest under check by itself. It was found that the eulophid pupal parasite — an equally excellent parasite in the Western and North Western Provinces — was also heavily hyperparasitising the puparia of *Spoggosio* in the Eastern Province. On account of this the release of *Trichospilus* in the Eastern Province was discontinued. Furthermore it was found that the field populations of *Trichospilus* in the Eastern Province diminished considerably during the heavy drought periods, when the pest caterpillar was found to be most active. With noontime temperatures exceeding 90°F and relative humidities falling below 40% most field populations of *Trichospilus* were lost. From field collections of parasitised *Nephantis* pupae it was observed that parasites either did not emerge or the few that emerged were very weak and died soon after emergence. In accordance with these findings the breeding of *Trichospilus* is being done now at Lunuwila and releases of this parasite in the North-Western, Western and the Southern Provinces are being intensified.

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10. Fully grown grubs of *Perisierola* feeding on a Corcyra larva with adult parasite guarding them. (Magnification x 10 approx.)

11. A Coconut Caterpillar larva, on an infested leaflet parasitised by the parasite *Perisierola nephantidis*. (Magnification x 3 approx.)

12. Pupae of the coconut caterpillar parasitised by *Trichospilus* showing parasites emerging from the pupae. (Magnification x 1.5 approx.)

INSET *Trichospilus pupivora* adult (Magnification x 15 approx.)

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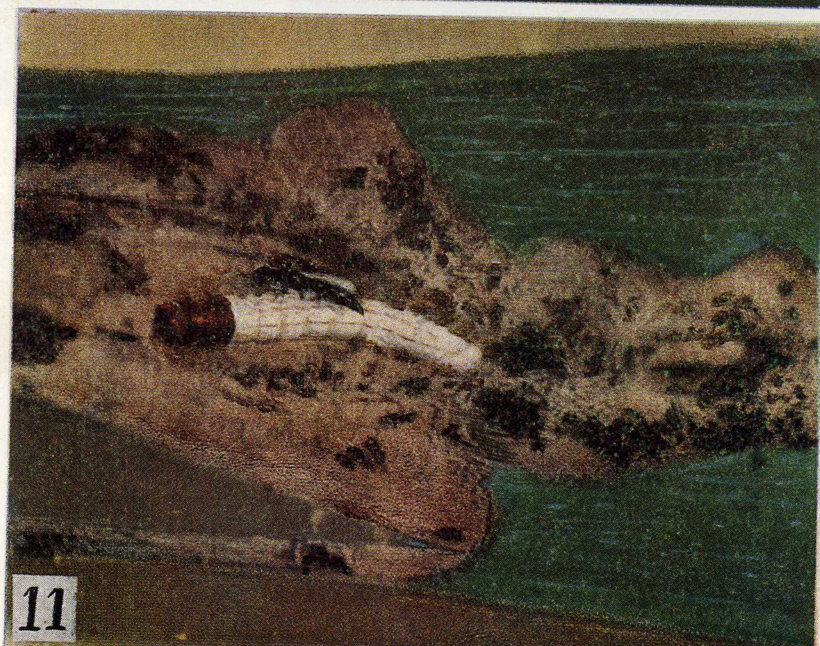

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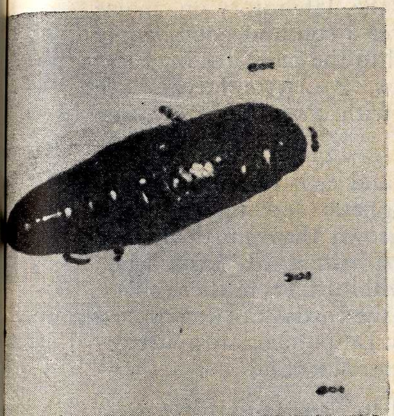

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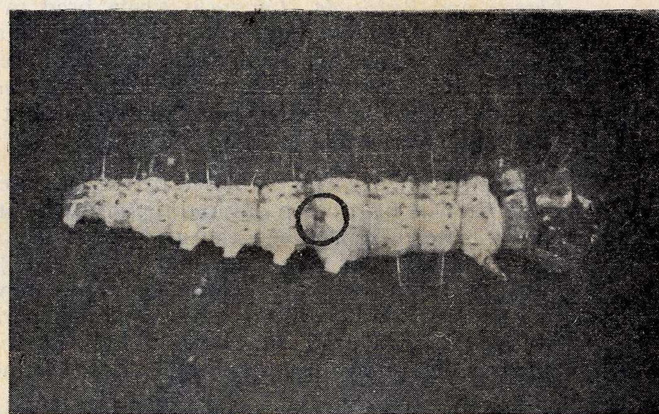

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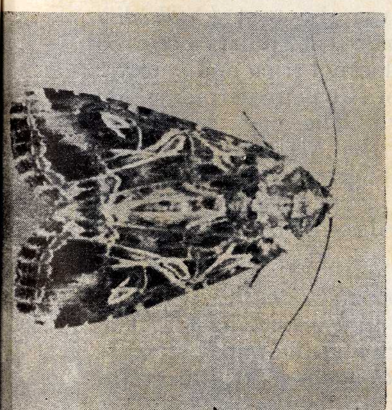

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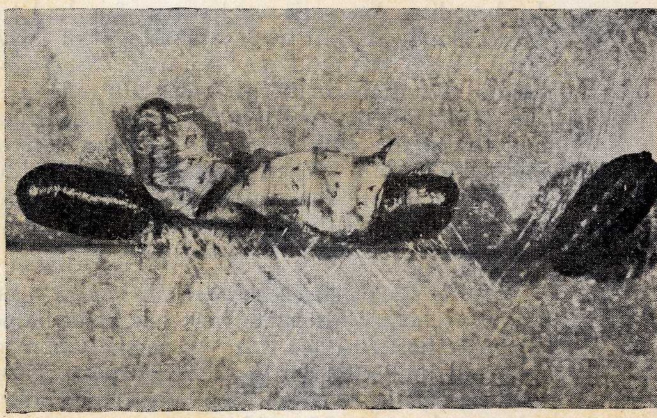

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13. The pupal parasite *Trichospilus pupivora* emerging from a parasitised pupa of *Prodenia litura* (Magnification x 2.5 approx.)

14. Moth of *Prodenia litura* (Magnification x 2 approx.)

15. A *Nephantis* caterpillar parasitised by *Spoggosia bezziana* showing empty egg shell (encircled) and a dark spot indicating point of entry of parasite grub into the caterpillar. (Magnification x 5 approx.)

16. Remains of *Nephantis* caterpillar parasitised by *Spoggosia bezziana* with 2 puparia formed from grubs that have been feeding on the caterpillar. (Magnification x 4 approx.)

Laboratory Breeding Work

In laboraory breeding of parasites, an alternate host which can be easily reared under laboratory conditions, is generally used for mass multiplication of parasites. *Corcyra cephalonica* Staint; has been found to be a very satisfactory alternate host for the breeding of the larval parasites *Microbracon* and *Perisierola*. *Corcyra* is easily bred in the laboratory on maize in the form of broken grain. This method ensures a constant good supply of *Corcyra*. The larval stage of *Corcyra* is offered to the parasites in 3″x1″ glass tubes for parasitisation. With *Microbracon*, 2 *Corcyra* larvae are used per fertilised female in a glass tube but with *Perisierola* only one *Corcyra* larva is used per fertilised female.

The host (*Corcyra*) is paralysed by the parasite and eggs deposited on it. The parasite eggs hatch out and the grubs (young) start feeding on the host larva (caterpillar). When the grubs are fully grown they are collected on to rectangular pieces of paper (2½″ x 2″—"parasite cards"), on whch the grubs spin their silken cocoons and pupate within. From these silken cocoons the adult parasites emerge. These "parasite cards" are despatched to caterpillar infested estates in 3″x1″ glass tubes. Despatches are generally made a day or two prior to the due date of emergence of adults.

A drawback in the breeding of the tachinid fly *Spoggosia* (*Stomatomyia*) *bezziana* Bar; is that so far we have not been able to find a satisfactory alternate host for laboratory breeding of the parasite. *Spoggosia* has been found to oviposit on a number of species with varying degrees of success, but a satisfactory host for mass multiplication of the parasite has not been found. In breeding *Spoggosia* we have so far, had to use the pest (*Nephantis*) caterpillar itself, but when a shortage of *Nephantis* caterpillars occurred other caterpillars too have been used. *Spoggosia* doesnot sting and paralyse the host but deposits its eggs — usually only one or two per caterpillar — on the body of the actively feeding caterpillar. The eggs hatch out and the young grub bores through the skin of the *Nephantis* caterpillar and feeds within. When the parasite grub is fully grown it usually comes out and pupates. The puparia are collected and despatched to *Nephantis* infested estates, or the adults emerging are allowed to mate and the mated females are released in the infested estates.

For breeding of pupal parasites (*Trichospilus pupivora* and *Tetrastichus israeli*) a very satisfactory alternate host has been found in *Prodenia litura* L. The alternate host *Prodenia* is reared in the laboratory and the pupal stage is collected and used for breeding purposes. Once again 3″ x 1″ tubes are used for setting of cages. The pupae are offered to the parasites in these tubes at the rate of 5 to 10 parasites per pupa.

Parasites produced in the laboratories are generally sent to estates by post but in the case of *Spoggosia* (*Stomatomyia*) releases, wherever possible, are made personally by an officer of the Institute.

The Ideal in Biological Control

The complete eradication of an insect pest-species is an almost impossible task. The biological method of pest control is used not so much with an idea of completely eradicating a pest species, but with the aim of reducing pest populations to such a level that economic damage is either eliminated or reduced to negligible proportions.

The ideal in biological control would be the selection and introduction of biological control agents with a very strong preference for the pest, but when the pest population is reduced to almost non-existent levels, the introduced agent should be able to survive on an alternate host. Such a biological control agent will be self-perpetuating, and is almost certain to be a success. A few of the other important factors are, that there should be no possible hyperparasites in the field, that it should not be harmful to other beneficial organisms and considerations of climate.

Thus the aim should be to search for more and more new parasites. The import and trying out of exotic parasites, free of their natural enemies should be given a prominent place in this scheme of work.

Integration of Biological and Chemical Control

Both biological and chemical control methods have their own disadvantages. Some of the disadvantages of chemical control have been discussed earlier. In addition, the high cost of chemical spraying is a factor of some significance.

In biological control the results are not immediately felt. It generally takes time for the build-up of field populations of biological control agents. Thus control is effected only gradually and is directly proportional to the rate of build-up of biological control agents in the field. Furthermore if an efficient biological control agent has not been found the method could only be partly effective.

In any planned pest control programme a consideration of all the factors which could influence reduction in pest populations is necessary. The introduction or initiation of anything new should not have strong deleterious effects on the other controlling factors.

Integrated chemical and biological control wherever possible is highly desirable, but great care must be exercised, in the choice of chemicals, method of application, time of application, frequency of application etc., in such work. This is to ensure that the other controlling factors such as biological control agents are not adversely affected. It might also be necessary to make a study of the insect populations in the field in general before any chemical applications such as spraying are made.

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