

THE CATERPILLAR PEST OF INDIGO IN BEHAR.

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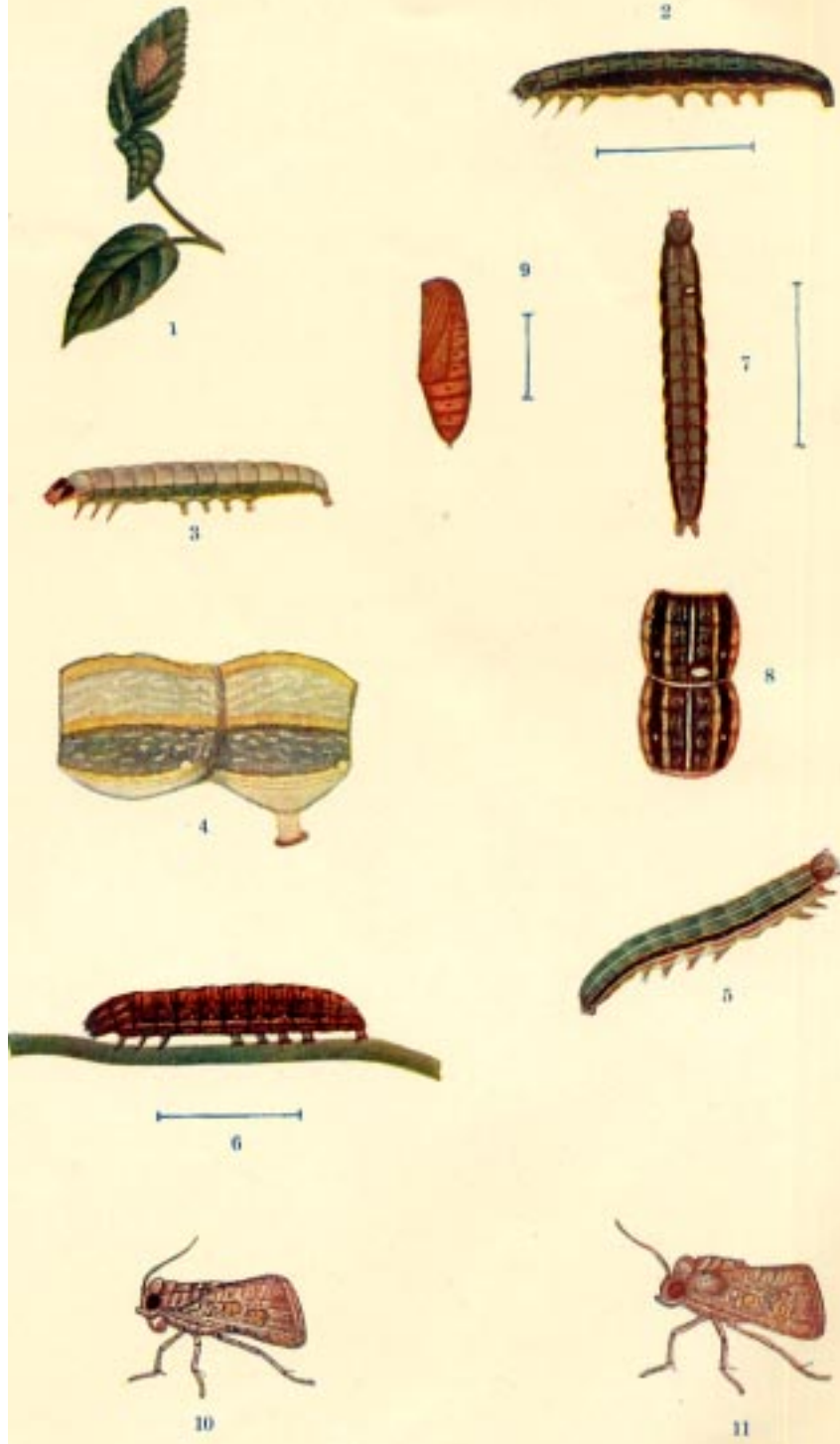
IN some years the newly germinated indigo in Behar is swept off by a "caterpillar" pest, familiar to all indigo planters. This pest must not be confused with the caterpillar that later in the season swarms upon the cut plant and is found in abundance upon indigo steeping in the vats. These caterpillars are of distinct species. The former, which is the subject of this article, has not been reared from indigo during the rains, nor is it one of the many common caterpillars found upon indigo that is being cut. Its scientific name is *Caradrina exigua*. Apart from its significance to the indigo planter, this caterpillar is a sporadic pest principally of the irrigated vegetable crops of the hot weather; it is one of many of the leaf-eating caterpillars, which though common in the plains is not likely to be easily recognised. It is here discussed principally from the point of view of the indigo planter, and the suggested remedy, if generally adopted, would prevent any further losses from this pest.

LIFE HISTORY.

Eggs.—The eggs are of the typical noctuid form, spherical, with radiating lines; each is pearly white, similar to a poppy seed in shape and size. Before hatching, they deepen slightly in colour, the darker colour of the developing larva showing through the semi-transparent shell. Eggs are laid in clusters, the first eggs on the leaf, side by side, not touching and irregularly arranged; later eggs on the first. Between and over the eggs are short whitish hairs, which in quantity are buff coloured. If the egg cluster is small and consists only of 10 to 50 eggs on the leaf, it is usually not covered but only has hairs between each egg. (Pl. XXIII, fig. 1).

The number of eggs varies; there are abundant small clusters of some 10 to 40 eggs; whilst larger clusters have forty to over one hundred, and the largest some two hundred and more. Eggs are laid on the leaf, the

PLATE XXIII



INDIGO CATERPILLAR.

situation depending upon the plant. On maize and large leafed *binda* (*Ramtorai*), the eggs are laid on the lower side of the leaf in large clusters. On young indigo the cluster is small, and is laid on the uppermost surface of a leaf. On lucerne, the eggs are laid on the uppermost surface of a leaf near the top of the shoot, the clusters varying much in size.

The eggs hatch naturally on the second day, *i.e.*, if laid on the night of the first, they will hatch during the day or night of the third. Being laid on the growing leaf, they are kept moist by the plant ; if laid in cages, or if the leaf is plucked and dried, the eggs still hatch normally. The temperature prevailing when all the eggs under observation have hatched has been high, the typical high temperatures of April in the plains, running up to and over 106° in the shade : even this temperature, with a very dry hot west wind, has not affected eggs on the plant or kept dry in the shade. The eggs, therefore, are not sensitive to a temperature of 106° in the shade with an air humidity of less than 30. The hot dry conditions prevailing with a west wind in Behar do not affect them, nor does the cooler moist east wind that also blows at this time.

Caterpillar.—The caterpillars on hatching leave the egg cluster and gather on the surface of the leaves. On young indigo, they web up the small leaves, joining them together with silk. If the indigo leaf is large enough, they simply web up a single leaf, joining the opposite edges with silk. On lucerne they either web together the leaflets or web up the whole top of the shoot. Within this shelter, the larvæ live gregariously, eating the epidermis of the leaf and gradually skeletonizing it. For two to three days they live thus in shelter, and then commence to separate. The larva is no longer gregarious, and moves about and feeds steadily on the leaf. With changed habits, it hides under shelter, on the surface of the soil, at the base of the plant, between the leaves when not feeding, and comes out to feed. As a rule they feed during the morning about 9 to 11 A.M. and then retire to shelter. From 4 P.M. again they are very active, moving from plant to plant in search of food. They are in this stage very voracious, steadily devouring the leaves ; a large amount of plant tissue is eaten and the leaves are rapidly stripped. They quickly increase to their maximum size and retain their active habits till full-grown.

The young larva is green, the head black. As growth proceeds, the colour alters, the white lateral band first appearing, the dorsal lateral surface then darkening as a regular band just above the lateral white line. (Pl. XXIII, Fig. 2). A little red pigment develops on the lateral line in indigo-feeding caterpillars, and the dark band above may not appear. (Pl. XXIII, Fig. 5). Superficially the indigo-feeding and lucerne-feeding cater-

pillars are much unlike, the broad dark band of the latter giving it a very distinct appearance. The figures do not express this very well, the figure (5) giving best the banded appearance of the lucerne-feeding caterpillar. Caterpillars, reared first on indigo and then on lucerne, become dark in most cases. The following is a description of a typical half-grown caterpillar on indigo :— a smooth noctuid form caterpillar, cylindrical, the head and prothorax small ; there are five pairs of prolegs ; the colouring is that of the *Agrotinæ*, uniform ground colour with stipples, a broad lateral band ; the dorsal area is green, with fine white and darker stipples ; the lateral band is, in full grown specimens, white with more or less red ; the ventral area is green ; the spiracles are oval, set on the lateral line, black rimmed, white inside and with a white area round. The colouring varies, the red on the lateral line being absent from young specimens. There are short dark hairs on each segment, and particularly on the head and tail. The full grown caterpillar is of very diverse colouring and no adequate description can be drawn up. Figures 2-7 in Plate XXIII represent typical caterpillars. Apart from the colouring, the caterpillar is the typical smooth larva of the *Agrotinæ*, with short hairs, with five pairs of sucker-feet, and without humps or protuberances.

When wholly full-grown and full-fed, the caterpillar seeks shelter, usually on the surface of the soil at the base of the plant, or under a stone, or among leaves or other material on the ground. Where necessary a small amount of webbing is produced as a covering and a very rough cocoon is formed with bits of leaf or other material.

Pupa.—After the usual rest, the pupa is formed. The chrysalis is of the usual noctuid form, with a double spine at the tip of the abdomen. (Fig. 9, Pl. XXIII). The interesting point about this stage is the duration, which varies very largely according to (1) temperature, and (2) atmospheric humidity. When the temperature goes down in November, the full grown caterpillars turn to pupæ, after hiding away in a sheltered place. Any that have already turned to pupæ remain as pupæ so long as the temperature is low. This is the ordinary ‘hibernation,’ the method adopted by the insect of protecting itself against cold. As the air warms in February, the conditions become favourable for moths to hatch, but the air is now drier and, if a west wind blows, may be very dry. Then, though the temperature may be high, moths will not hatch until the air is moist, and this is the normal method the pupa has of behaving ; with the first moist warm wind they in dry conditions hatch out. Actually, hot dry air either prevents the moth hatching or delays it ; pupæ kept in quite dry air often fail to hatch at all or are delayed, but with the first moist air they hatch out quickly. The period of pupation may then be very long (three months) in winter, very short (five

days) in normal moist warm weather, or any period between the two when the air is hot and dry. The importance of this influence of cold or drought upon the length of the pupal stage is discussed in a later paragraph of this article.

Moth.—The imago is a small moth, whose appearance is best realised from Figures 10 and 11, Plate XXIII. It hides in shelter by day, coming out at dusk to fly in the fields. I have never caught it at light and believe it to be a light-shunning species.

The length of the life-history varies, the most rapid being as follows :—

Egg, two days	} eighteen days or less than three weeks.
Larva, nine „	
Pupa, five „	
Moth, two „	

This was in the insectary with abundant food. In the field, it appears to be somewhat longer, the larva living even as long as a fortnight with plentiful food. The period between the time the egg is laid until the moth again lays eggs is from 17 to 30 days normally. Whether the broods will succeed each other so rapidly throughout the year depends upon circumstances. In the absence of food the moth lives for some time until she can lay eggs. It is probable that from November to March the insect normally hibernates as a pupa, except in exceptionally moist warm areas of India (*e.g.* parts of Lower Bengal).

DAMAGE.

This insect occurred in great numbers in Surat in April and May, 1904, the larvæ being found in a plot of land, irrigated from a well, on which maize, bhinda (*Hibiscus esculentus*) and bhimada (*Amaranthus sp.*) were grown together. The caterpillars eat all these crops freely.

In the following year, immense numbers were found destroying the lucerne crop of the Pusa experimental farm ; the first sign of the pest was the great numbers of caterpillars found eating the crop ; active measures had to be taken at once, as it was already too late to check all destruction. Twenty seers of caterpillars were actually destroyed, a seer containing 12,000 caterpillars. It was estimated that this was rather more than half the actual number which may be put at 400,000. Allowing each moth a production on the average of 200 eggs, this requires only 2,000 female moths, or 4,000 moths in all as parents ; the previous generation (in March) would, therefore, require only sixteen female moths as parents, or 32 in all, to survive the winter. Assuming then that 32 moths emerged from hibernation, found

mates and laid eggs in March, the April outbreak is accounted for. I do not suggest that only this number actually survived the winter, but this is the minimum necessary.

After this, the third brood of caterpillars was not definitely found. An enormous percentage of caterpillars were parasitised in the large second brood, but what this percentage was could not be definitely ascertained; of the caterpillars counted over half had *Tachinid* eggs outside. In addition many were destroyed by Ichneumons whose eggs are laid inside; and digger wasps (*Ammophila*) were busy carrying off the caterpillars. *Carabid* beetles ate others as did the predaceous bug *Canthecona furcellata*; finally mynas feasted on the hordes of caterpillars. The field was a scene of insect carnage. How many survived cannot be even estimated. After this attack stray broods were found during the rains on various plants including *Amaranthus* and various weeds, besides lucerne.

None of these broods were large and definite, but the insect was scattered, a normal member of the fauna, behaving as do other such moths with irregular broods until November and then hibernating during the cold weather; unless the insect had been very abundant it would not probably be found on crops, as wild foodplants (leguminous weeds) occur abundantly in the rains.

In 1906, precisely the same phenomenon occurred at the Pusa Farm; in this case the first brood was found and partially destroyed, so that the second brood was largely checked. The eggs of the early brood of caterpillars were first found on the 15th March; the large second brood of eggs was destroyed on April 18th and 19th. The sequence was apparently much the same; the early moths emerged, laid eggs and produced the first brood (March 15th). They transformed, laid eggs and the immense second brood was found. On April 18th and 19th a large quantity of eggs was collected on the lucerne. They were estimated by weight and count at 2,414 clusters. Two days later, a small fresh batch was laid, and it was found that in spite of the great number removed, the field was infested with eggs and caterpillars to a considerable extent. The field was accordingly cut right over and the caterpillars starved. Starvation produced but little effect, the larger ones pupating, the smaller ones waiting for a week until water was applied and the plant started growing again. There were small irregular broods during May and June, but the parasites gradually increased and the percentage of parasitised caterpillars eventually became a very high one, rising to 50 and in some batches to nearly 90 per cent.

In three successive years we have the same phenomenon observed—the occurrence of the pest in April in large numbers—and there is other evidence

that it occurs frequently. The curious behaviour of the insect merits a word of explanation. We must remember that in each attack the maize and the lucerne has been the only available crop, and that only in a small area. The lucerne in Pusa is about three acres, is irrigated and offers a fine growth of moist green plant at a time when no other crop of the kind is available. Accordingly all the moths gather there, and give a quick and healthy first brood which gives us an enormous second brood. In the rains, this brood would be scattered over the country side and not be noticed. The phenomenon is, therefore, perfectly natural, illustrating how our artificial methods of growing crops upset natural conditions.

The occurrence of this pest on lucerne is not the important fact but leads up to the occurrence of the pest on indigo. It is now known that the "caterpillar" which attacks young indigo is this insect. I have had but one season to study this pest on indigo, but my previous experience of it has enabled the life history to be carefully worked out, and little observation was required to note the peculiar points of its attack on indigo. Indigo is sown in March and April and comes up quickly. At the same time the moths emerge from hibernation and lay eggs on the young indigo. They lay small clusters, fairly well scattered. The caterpillars hatch, web up the leaves and give rise to the cobweb appearance noticed by planters. In a day or two they move out and feed more widely. A single egg cluster means much damage in one spot; a half-grown caterpillar requires some twenty "two-leaf" indigo plants a day; it will entirely destroy a larger plant daily. A single cluster of 40 eggs causes havoc in the area round about, say for perhaps ten yards radius; ten such clusters may result in the destruction of a large area. This is actually what occurred at Hursingpur in 1906. Caterpillar was not plentiful as it was on the lucerne at Pusa (*i.e.*, some 100,000 per acre) but was well scattered; yet this was sufficient to destroy a large acreage of young indigo. A moving half-grown caterpillar bites the epidermis of the upper surface of each of the two first leaves and then moves on. That plant, under certain circumstances, dies. The destruction is thus very widespread, if there is a fair number of such moving caterpillars in a field. Supposing the caterpillars destroy the field, what can they do? They do what they did in 1906 when the lucerne was cut, wander out of the field seeking for food. If they then enter a field not attacked they will play havoc with it. This is, I believe, what occurs in a normal caterpillar year in indigo districts.

There are some other points, which must be specially noticed. Why are some fields attacked and not others? The better form of the question is why do the moths lay eggs in some fields? It is difficult to say

what guides a moth in her choice between two fields ; perhaps she comes to one first, perhaps the plant is finer or better growing. No one can answer this question, but if we realise that the choice rests with the moth and that it is not a question probably of a "seeted" or "unseeded" field, we can see that the point is immaterial. What has the east or west wind to do with it? To planters the east or west wind is always an important factor. The east wind is a moist moderately warm wind blowing up from Bengal ; the West wind is a dry parching wind, where the temperature rises up to and over 106° in the shade and the percentage humidity in the air is from 10 to 30. In the east wind, moths hatch out ; the two big egg-laying nights on lucerne at Pusa coincided with an east wind ; in the insectary, a moist atmosphere or a moist east wind brings the moths out ; in a dry atmosphere, at the same temperature, the moths either fail to hatch or hatch late. The prevalence of east wind is favourable to moths hatching, the west wind unfavourable. Therefore, if there are on the 1st April numbers of caterpillars pupating, and an east wind blows on the 3rd to 7th, the moths come out and lay eggs about the 6th ; caterpillars then appear on the 10th. If the west wind blows till the 10th, and then an east wind, moths hatch out on the 11th and the eggs are laid ; the planter sees cobweb on the 14th and says the east wind brought caterpillar. There is another effect of west wind which I would commend to the notice of planters. In a dry west wind, a plant bitten by caterpillar withers far more quickly than in an east wind ; a planter has caterpillar, but his field looks green and he does not see it because the moist east wind preserves his plant. Next day a west wind blows, with the result that on the following day all the plant nibbled by caterpillar is dead. That planter may say the west wind killed his plant and not caterpillar or he may think back to the east wind, which he says brought it. I have had a variety of opinions expressed to me, but all can be reconciled with these two facts—(1) an east wind assists moths to hatch and to lay eggs ; (2) a west wind kills plants bitten by caterpillar.

It may be remembered that a west wind does not injure *caterpillar* provided there is green food obtainable. Similarly a west wind does not affect the eggs. Caterpillar can be readily reared in the driest hottest wind if it has moist food. When, however, a young field is struggling against caterpillar in an east wind, and a west wind blows and dries up the plant, the caterpillar will die also. A re-sowing then may be successful. A curious fact told to me by planters of experience is that if a plant recovers, it is not again attacked ; but if a field dies and is re-sown, it is likely to be re-attacked. My knowledge of the intimacies of the life of the caterpillar and what is more important, the moth, is not deep enough to solve this problem without

a certain amount of theory, but there is probably some difference in the composition of the leaves of the later plants. For the indigo planter, the salient facts are that if the emergence of the moth in any quantity coincides with the germination of his indigo, he is likely to get the eggs laid on the plant and so get a "caterpillar year." If an east wind brings out the moths at the right moment, the crop will suffer. Should the west wind be blowing and the moth delay till the indigo is well up, or should there be few or no moths, then the young crop is likely to escape. If it were possible to sow indigo earlier and get the plant established before the moth could hatch, the crop would probably withstand caterpillar and suffer less. This point is curiously illustrated by the following quotation from a letter from Mr. Murray. "It may help your investigation to know that 30 years or so ago, this concern used to have a caterpillar plague almost every year. We noticed, however, that the 'jatchings,' that is, the sowings where the drills were tested, (the testing generally beginning about the middle of February,) were hardly ever affected by the caterpillar. We then decided to sow earlier in the concern, to begin sowing about the 23rd to 25th February instead of 7th March, and we found that these early sowings almost invariably escaped or only had the plague to a small degree. We did not find this early sowing to be an actual specific; but most undoubtedly the early sown plant was to a very great extent immune. Of course the caterpillars do harm, even if the plant recovers from their attack. Its growth is checked for at least three weeks, and no one can assert that this is a benefit."

I believe planters generally will corroborate the statement that caterpillar is really destructive in quite young indigo only, and that it does far less harm when once the indigo is well established. At the present time of sowing, the young plant is at the critical time when moth emerges and lays eggs, and it is just the coincidence that brings about the severity of the attacks.

REMEDIES.

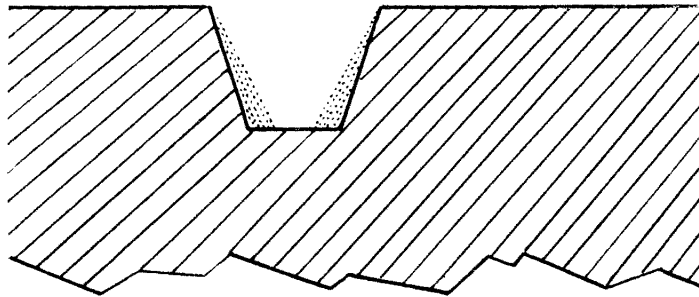
So far as our present knowledge goes, this pest is important (1) as the caterpillar that attacks young indigo; (2) as an occasional pest of irrigated crops in April and May.

Indigo planters regard "caterpillar" on their young crop with very varying degrees of importance. Many appear to regard it as a serious pest, others believe it is less destructive than the west wind. I attribute the destruction of young indigo to "caterpillar" and so long as the Sumatran indigo plant (as opposed to Java-Natal) is sown as at present, the

caterpillar will be a more or less serious pest, occurring irregularly. The fact that it only comes at irregular intervals must be remembered, and there is no means of knowing that it will come till it actually is found on the plant. There are three lines of treatment :—

(a). To sow Java-Natal indigo in place of Sumatrana. Planters who substitute Java-Natal will not suffer from caterpillar, both from the different time of sowing and the apparent immunity of this plant to the insect. Java sown at the same time as Sumatrana was not attacked in 1906. How far this preventive is available is not a matter that can be discussed here, but it is a point in favour of the substitution of Java-Natal for Sumatrana indigo.

(b). A significant fact is that in 1905, though there was a considerable acreage of Sumatrana indigo in the Pusa farm, no caterpillar was found upon it, but only on the lucerne. In 1906 though caterpillar was abundant at many estates, it was in Pusa abundant again in lucerne and was not destructive on fields of indigo at Dhuli close by, and only slightly so at Birowli. In both years the lucerne was attacked in preference to indigo. It would then appear that we have a fairly simple preventive, namely to grow a small area of lucerne under irrigation, as a trap crop for the pest. How far this is possible I cannot say, but it would seem to be a method worth the careful attention of indigo planters. In the Pusa experimental farm, three acres of lucerne have been sown each year in October, which are periodically irrigated and cut to supply fodder for the cattle. The crop is a very valuable one for this purpose. On an indigo estate, an acre of lucerne at each outwork and at the factory would probably be sufficient. I would surround the plot of lucerne with a trench six to eight inches deep, with sloping sides of loose soil as in the accompanying diagram. On the



experience of two seasons at Pusa, there will be first a small, then a large brood of caterpillar on the lucerne. The indigo will not be attacked at all. The lucerne can be cut in rotation as is done at Pusa, and the fodder

will be valuable. I would not destroy the caterpillars. Picking off the egg clusters is advisable, which can be readily done by a very few boys ; all will not be found, but the second brood of caterpillars will probably be destroyed by parasites and other enemies, whose increase will be beneficial to the checking of other pests on the later crops. That is, I would pick off egg clusters if possible ; I would let the rest of the caterpillars eat the lucerne, isolating them in it by means of the trench, and using them to breed the abundant parasite, &c., which will be of such value later on in the season. Any other measures to destroy the caterpillar on lucerne must either unfit the crop for use as fodder or entail more expense than the crop is worth. At the same time the data given below as to the means adopted for checking the pest on lucerne will enable any planter to decide for himself if he will destroy caterpillar.

The value of the lucerne is primarily to draw the caterpillar off the indigo, secondarily to provide fodder. It is not necessary that the lucerne should be sown in October and irrigated till March. If at least four-fifths of the field always has a good growth of lucerne from March 10th to April 20th, the desired object will be effected. Sowing lucerne in October with no subsequent irrigation will produce a crop, which cannot, however, be periodically cut. Where irrigation is available, say in March and April, its cost will be more than met by the fodder which can be cut in rotation, always leaving four-fifths of the field in green lucerne to act as a trap to moth.

(c) It is unlikely that the sowing of lucerne as a trap crop will be adopted generally, and it is probable that there will be outbreaks of caterpillar on young indigo on estates that have taken no precautions. It seems worth while to discuss what can be done in such cases. Rolling the plants or running a hanger over the field is useless ; the caterpillar will escape in the crevices not reached by the roller or hanger. Spraying the young plants is feasible and should be a most simple operation. A cart on which is placed a barrel and pump attached to a long iron tube arranged across the back of the cart just above the ground, with nozzles fixed at intervals on the tube will, acting like the ordinary road watering cart, spray a very large area. The width of the iron tube with nozzles should be as wide as possible. The cart simply goes up and down the field as rapidly as possible, a coolie in the cart working the pump. The initial expense of such an outfit would not exceed Rs. 100 at the most, and the cost of spraying material would be under Re. 1 per acre. The cost of labour cannot be estimated till the daily acreage done is known. Such a machine used in Australia in spraying wheat covers 15 acres an hour and has a width of 50 ft.; the sections of piping that project on each side of the cart are removable and are put on only

when the cart is in the field. With such an arrangement 100 acres daily should be covered, more if the matter is urgent ; and by taking the worst fields in order, any ordinary outbreak should be checked. I do not advocate such an arrangement, but describe it because it is feasible and may appeal to indigo planters. If such spraying was the only remedy I would advocate it.*

The pest must also be considered as an occasional pest to other crops. In 1905, when the lucerne was being destroyed by it, coolies were employed to run large bags over the fields, sweeping up the caterpillar. Illustrations of these bags are given in "Indian Insect Pests" (pages 72-73). The bags were used between 9 and 11 A.M. and between 4 and 6 P.M. In four days' work, twenty seers, estimated to contain 250,000 caterpillars, were destroyed, and the bulk of the damage averted. Bags cost about Rs. 3 each, and for five acres of lucerne, six coolies were employed for four days. In 1906 the attack was expected ; eggs were accordingly collected, the two days' work yielding an estimated number of 2,414 clusters. The number of eggs per cluster averages about 100. The work was finished in two days. It was then found that, more eggs having been laid two days later and some number of caterpillars having hatched from eggs missed or already hatched before egg collecting was commenced, the best plan was to cut over the field and starve the caterpillars. This was accordingly done and no further trouble experienced, a fresh growth of lucerne coming on. In small areas of irrigated crops as at Surat, no remedy can be put into the hands of the cultivator at present. It is feasible for him to remove the eggs and caterpillars, but he does not know the eggs and prefers not to destroy the caterpillars. In Surat, the field was very thickly sown with a mixture of crops and there were many weeds. The cultivator then removed the weeds and much of the crops, leaving the best plants which had escaped. His loss was thus small, enough plants being left to give him a full crop.

IDENTIFICATION.

At present, it is impossible to be certain of the identity of the insect except from the winged (imago) stage. The fact that the eggs are white, ribbed, laid in clusters with a covering of hair, does not do more than point to the eggs as those of a noctuid moth. The larva is of the typical form found in the Trifine divisions of the noctuidæ. Its colouring distinguishes it from some caterpillars, and it is clearly distinct from most common

* Details of the machine will be supplied on application.

caterpillars ; but it alone cannot be specifically identified. The pupa is similar to many others. The combination of all these facts, together with the habits of the pupa, is not sufficient even to distinguish the insect as a *Caradrina*. A caterpillar similar to those figured here, hatching from similar eggs, on one of the food-plants named, may very likely be *Caradrina exigua*, if found in March, April, May, under circumstances as described above. The indigo planter is probably safe in identifying his "caterpillar" with this insect (not the caterpillar of indigo in the rains). Final and conclusive identification can be obtained only from the moth and then only with extreme care. Those who have some technical knowledge of moths may see the characters of the genus defined by Hampson "Moths, Fauna of India, Vol. II." For others, the figures on plate XXIII are the only useful means of identification, short of the simplest which is to send the caterpillar, chrysalis or moth for identification, the first two being sent alive.

DISTRIBUTION.

The pest has been reared in Pusa, Surat and Kaira, from lucerne indigo, *Amaranthus Spp.*, *Celsia coromandeliana*, Senji (*Melilotus parviflora*), maize, bhindi (*Hibiscus esculentus*), and some weeds. The Central Provinces entomological assistant (Ratiram Khamparia) reared it from cotton, maize and safflower. Mr. Hayman reared it on gram (*Cicer arietinum*) in the Cawnpore farm. It is recorded in Indian Museum Notes, Vol. II, p. 10, as reared from linseed from Patna. (See under *Laphygma*). It has been sent from Narainganj and Bogra, Eastern Bengal, as a pest of jute, and it attacked jute slightly in 1906 at Pusa.

Hampson gives its distribution generally as Europe, South Africa, North and South America, Honolulu and throughout the Oriental region, while the Indian Museum has specimens from Karachi, Dehra Dun and (Dudgeon collection) Sikkim.

In Indian Museum Notes will be found the late Mr. de Niceville's notes on "Indigo Caterpillar," under the heading *Agrotis segetis*, Sch. (Vol. V, p. 145). Though Mr. de Niceville knew that a *Caradrina* has been reared from the indigo caterpillar formerly sent in, he reared *Euxoa* (*Agrotis*) *segetis* from a caterpillar sent in to him and so put all his notes under that heading. The information there given by indigo planters does actually refer to *Caradrina exigua*.

ENEMIES.

Like other pests, *Caradrina exigua* has enemies, which normally keep it in check. These include (1) Parasites ; (2) predators ; (3) birds.

Among the parasites, the most important appears to be a fly, similar in general appearance to the house flies, but belonging to a distinct family (Tachinidæ). This fly may be seen in the lucerne fields; if observed it will be seen to be flying and settling near caterpillars; suddenly it flies up, alights on the caterpillar and deposits an egg on it. The egg is semifluid but hardens at once to a hard white object, a small white spot (see Pl. XXIII, Fig. 8). This egg is usually laid on the upper part of the body, on the second segment behind the head. Possibly this position is chosen as it is not possible for the caterpillar to bite off the egg, but occasionally the egg is laid on the last segment. The caterpillar appears to have a vague knowledge of its foe and is very irritable, twisting quickly when the fly settles. The fly has to be very agile to lay its egg. Caterpillars with these white spots are doomed; they feed and grow, but within them the maggot hatched from the egg is feeding and, when presently they turn to chrysalides, from each chrysalis there comes, not the moth, but the fly.

Other parasites in the form of ichneumons have been reared; these are wasp-like flies, not so common as the Tachinid fly but which equally destroy the caterpillars.

Predators are insects which feed upon caterpillars. Among the more important is a wasp (*Ammophila* Sp.) which stings the caterpillars, thereby paralysing it; it then flies off with it, lays it in a burrow, and deposits on it an egg. The egg hatches, the grub feeds on the paralysed caterpillar and becomes in due course a wasp. There are also small beetles (*Carabidae*) which feed upon the small caterpillars. A bug (*Canthecona furcellata*) is also found, which sucks out the caterpillars and thus kills them.

Mynas are fond of caterpillars and gather in the lucerne fields for a meal. They should not be frightened off as they do much good.

EXPLANATION OF PLATE.

- Fig. 1. Egg cluster on indigo.
 ,, 2. Caterpillar, a week old, fed on lucerne.
 ,, 3. ,, fed on indigo. x 1½.
 ,, 4. ,, two segments to show colour. Magnified.
 ,, 5. ,, full-grown, fed on indigo.
 ,, 6. ,, full-grown, fed on lucerne.
 ,, 7. ,, full-grown, fed on lucerne, with egg of Tachinid fly.
 ,, 8. ,, thoracic segments, to show egg of Tachinid fly.
 ,, 9. Pupa.
 ,, 10. Moth, male.
 ,, 11. Moth, female.