

MADRAS
AGRICULTURAL DEPARTMENT

YEAR BOOK
1927

MADRAS
PRINTED BY THE SUPERINTENDENT, GOVERNMENT PRESS

1928

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YEAR BOOK, 1927

SPRAYING EXPERIMENTS IN COFFEE
WITH VARIOUS TYPES OF PUMPS.

It has now been proved beyond doubt that spraying is effective as a means of reducing the amount of leaf diseases and increasing the crop. Attention is, therefore, called to methods of application.

With the 2-3 gallon container sprayers of the pressure type mostly in use, a considerable amount of time is wasted in unscrewing the cap, filling the sprayer with mixture, screwing on the cap tightly and then pumping up to the required pressure. Not only so but as the mixture escapes through the nozzle, the pressure falls and while the first portion of the sprayerful is in the form of a fine mist; the last portion comes not as a mist, but in the form of a rain with considerable loss by drip, etc.

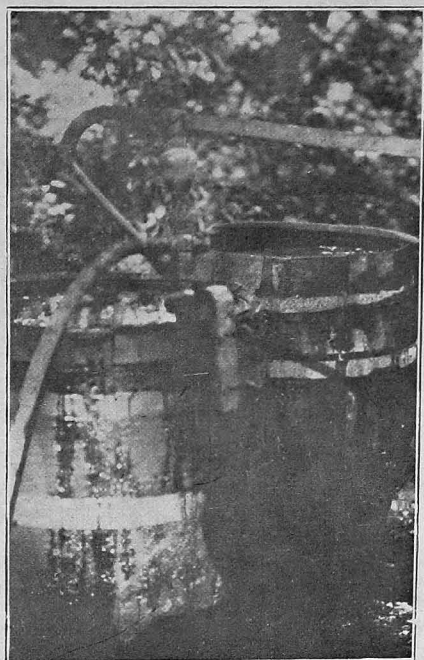
It requires no great effort to see that by the use of pumps, a constant pressure can be maintained and the greater part of the time lost in filling the container sprayers eliminated. Three types of pumps were obtained—small, medium and large size. The former was represented by the Four Oaks Southern Cross, a small pump weighing 12 lb. and for use is attached to the side of a barrel. Being of light weight, it is easily carried through the coffee. The medium sized pump was

represented by Drake and Fletcher's No. 18 and the large size by Drake and Fletcher's Drake Spraying Pump Headland.

From small experiments carried out with the Southern cross pump last year, it was thought that this pump might carry two hoses instead of one. Consequently the ones ordered this year were fitted for carrying two 25 feet lengths. In practice, however, it was found that two hoses were too much for the size of the pump and the work too hard on the coolies. The pumps were, therefore, used with 50 feet of hose on one side and a single nozzle. The illustrations Nos. 1 and 2 will give an idea of the pump and the type of spray obtained with a Four Oaks No. 71 nozzle fitted with a smaller hole than is generally used.

A team of four coolies was used with each pump, two men pumping, one man spraying and a fourth coolie for stirring the mixture and looking after the hose. With a good pressure maintained the spray is an excellent one, but if the men at the pump are poor, the spray is not so good. The number of trees sprayed per hour working in the above fashion averaged about 100, so that in a 6-hour working day between 500 to 600 trees should be done. This, however, cannot be kept up for long without thorough cleaning and overhauling of the pump. Great care has to be taken with the resin soda solution. If overboiled, the resin soda turns white when put into water and forms large flakes instead of making a proper solution. These flakes tend to clog up the nozzles and the mesh at the end of the suction hose pipe.

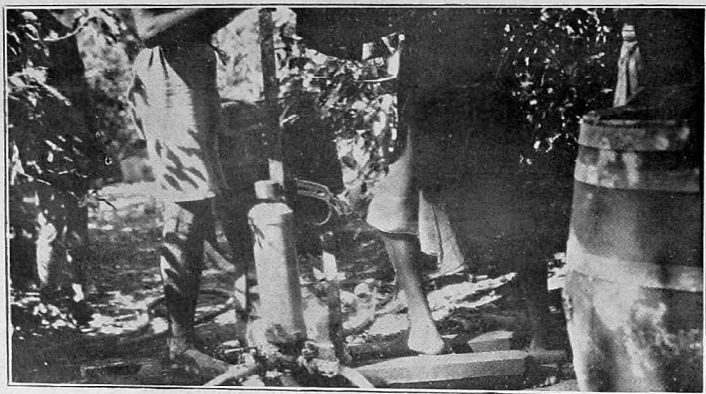
On the second day's spraying a bad resin soda solution was added to the spraying mixture. The



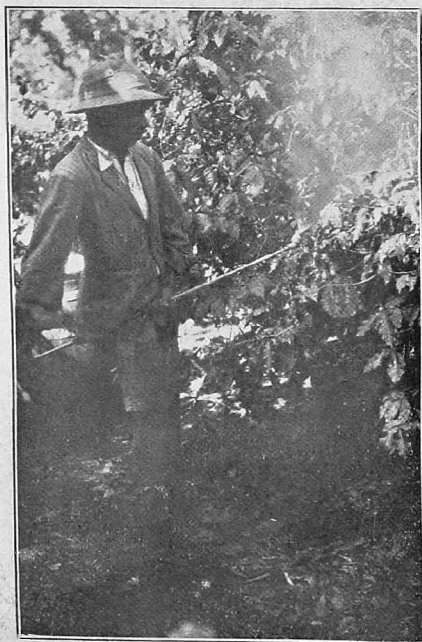
No. 1.



No. 2.



No. 3.



No. 4.

end of the suction hose got clogged up and had to be constantly cleaned. Some of the resin soda got on to the piston, increased the friction and made it extremely difficult to work the pump. The nozzle got choked up and the coolies instead of trying to find out the cause of the extra energy needed to work the pump, put their full weight into it. The result was that something had to go and the piston bent. While these pumps, therefore, are quite effective in skilled hands, they are not built to stand up to the usage given them under estate condition nor can they get the care and attention which is necessary to keep them at their maximum efficiency.

The medium-sized Drake and Fletcher's No. 18 pump showed no special characteristics which would make it pre-eminently useful for coffee spraying work. It is, in fact, a clumsy article and requires a fair amount of space in which to work it. The Drake Spraying Pump has a greater capacity and is easier to work.

The Drake Spraying Pump Headland was mounted on a platform of 2×6 feet lengths of $2" \times 4"$ planks joined together with a 4" space between them. The overall width of the platform was thus 1 foot and the overall width of platform and pump was about 18".

Two 100 feet lengths of hose were used each filled with a 3 feet brass rod and "Mistifier" spray nozzles using the No. 1 centre-piece with smallest hole. The spray was an exceptionally good one. An idea of the pump and the spray will be obtained from photos Nos. 3 and 4.

With the pump in good working order, two coolies can keep it going for a considerable time,

three coolies seemed to be ample for the power required. As a matter of fact, when most of the coolies struck work one day, two women kept the pump going with seeming ease.

The team required for working the pump was as follows:—Three men on the pump, one woman or boy for stirring the mixture and keeping the suction nozzle clean, etc., one man on each nozzle for spraying and one boy or woman on each hose for pulling it after the man who was actually doing the spraying—a total of 8 coolies.

Working the pump in a path the spraying coolies go one on either side of the path and spray a row of trees at right angles to the path to the full length of the hose. With 6' × 6' coffee this will mean about 15–16 trees and with 5' × 5' coffee about 18–19 trees from the pathway. Going down between two unsprayed rows, he takes a full row out and coming back, he sprays the row on the other side. Thus if he sprays the left hand row going out, he sprays the right hand row coming back. The hose is pulled out by the woman or boy after the spraying coolies to its full length and then comes back to the pump and pulls in the slack as the spraying coolie returns to the spot from which he started. He then misses two rows of coffee—one sprayed and one unsprayed and goes down between the next two, the second and third rows, i.e., between the next two unsprayed rows and repeats the process. Thus if

B.....A
D.....C
F.....E
H.....G



AB, CD, EF, GH are lines of coffee with the pump at ×, the spraying coolie would go down between the rows AB and CD taking the row AB out

and the row DC back, then he would go down between rows EF and GH taking EF out and HG back. By taking a whole row out and a whole row back, every alternate space is missed and so only half the distance has to be walked, that would have to be done, were he only to spray a half row on either side of the space and walk back without spraying. In this case he would have to go down every space between rows instead of every second space.

With both hoses going, the pump can spray 4 gallons of mixture in 3 minutes. The average number of trees done per gallon was three. The coffee on which the work was done was 5' x 5' and the trees were very thick and full of leaf. Theoretically the pump should therefore do 12 trees in 3 minutes, equal to 240 trees per hour. In actual practice with necessary stoppages for moving the pump, etc., it was found that about 200 trees per hour was done, i.e., in a 6-hour day about 1,200 trees or about an acre of 6' x 6' coffee. Eight coolies with small container sprayers will do about 100 trees per day each, total 800 trees. With this sprayer the work is done 50 per cent quicker.

On the particular estate where the spraying was done, coolies with container sprayer last year on similar coffee were only doing 73 trees per sprayer per day, i.e., eight coolies were doing 584 trees per day. In this case therefore the eight coolies were doing double the work they did last year with greater ease while the work was very efficiently done.

Where coffee is thick, as it was in the block where the experiments were carried out, it is almost impossible to take the D.S.P. through it.

With 100 feet of hose pipe parallel paths in 5' x 5' coffee should be cut about every 36-37 rows. With 150 feet of hose, paths could be cut every 55-56 rows. In 6' x 6' coffee with 100 feet hose length, parallel paths would be required every 30-31 rows and with 150 feet lengths every 46-47 rows. Quite sufficient room is given if the sides of two rows are cut back on to the main stem. Photo. No. 5 shows a path so made.

With increased length of hose, there is increased difficulty in keeping it clear of entanglements in working and increased cost in depreciation. The hose supplied according to rubber spraying experience, will probably last about three years if properly looked after.

During the spraying experiments the double pawl in the ratchet attachment was removed and it was found that there was little difficulty in getting the coolies to take the full stroke as shown by the quadrant. If the pump be provided with an arrangement which will show the full length of stroke to be taken, and at the same time allow the upright operating lever and cross bar to be easily removed, the pump can be much more easily taken into coffee for spraying purposes. It takes some time with the present attachment to loosen the quadrant bracket bolts, unscrew the bolt which keeps the end of the lever in position and remove the operating lever and adjusting it again when taken into its proper position in the coffee for spraying. This could be simplified in such a way that only the bolt which keeps the end of the lever in position, would have to be unscrewed, and the lever lifted off.



No. 5.

Cost of spraying.—The cost of spraying 3 acres of 5' × 5' coffee, 1,750 trees per acre, is as follows :—

Labour—	RS.	A.	P.
60 men at 6 annas	22	8	0
30 women at 4 annas	7	8	0
	<u>30</u>	<u>0</u>	<u>0</u>

The sixty men shown above included ten maistries, who were mostly on supervision work at the various pumps and on various works. As the coolies themselves become more efficient, a considerable saving in labour could be shown. As regards transport of water, this was lighter than usual as a semi-rotary pump No. 2 size with 300 feet of hose, was used to pump water from the ravine up to the place where the mixture was being made. With about a 40 feet lift, this pump, which is a rather small size, pumped water at the rate of 3–4 gallons per minute. One coolie could easily fill a 30-gallon cask in 10 minutes. It would take the same coolie from 10–15 minutes to fetch one kerosene oil tin of water, i.e., 4 gallons the same distance.

The total amount of mixture used was 1,728 gallons—576 gallons per acre. At the request of the Manager, the mixture was raised from 4 × 4 × 50 solution to 5 × 5 × 50 solution with 4 lb. resin and 2 lb. soda as adhesive.

Total amount of chemicals used was :—

	RS.	A.	P.	RS.	A.	P.
Copper sulphate 175 lb. at... 0 5 6 per lb.	60	0	0			
Lime 175 „ ... 0 1 0 „	11	0	0			
Resin 140 „ ... 0 6 0 „	52	8	0			
Soda 70 „ ... 0 3 0 „	13	0	0			
				<u>136</u>	<u>8</u>	<u>0</u>
Chemicals ...						
Labour ...				<u>30</u>	<u>0</u>	<u>0</u>
Total cost for 3 acres ...	166	8	0			
Cost per acre ...	<u>55</u>	<u>8</u>	<u>0</u>			

A $4 \times 4 \times 50$ solution is, however, quite effective and by using this weaker solution, the cost would be reduced by Rs. 4-8-0 per acre to Rs. 51 per acre.

The amount of mixture used per acre is high—576 gallons. The coffee is close planted and very thick and considerable care was taken to see that the trees were efficiently done. Ordinarily 400–450 gallons per acre are sufficient for $6' \times 6'$ coffee. Taking the average required as 450 gallons with a $4 \times 4 \times 4 \times 2 \times 50$ solution, with the costs of materials shown above, the cost per acre will work out as follows :—

	RS.	A.	P.		RS.	A.	P.
36 lb. copper sulphate at	0	5	6	...	12	6	0
36 „ lime at	0	1	0	...	2	4	0
36 „ resin at	0	6	0	...	13	8	0
18 „ soda at	0	3	0	...	3	6	0
					<hr/>	<hr/>	<hr/>
Total cost of chemicals					31	8	0

Taking the cost of labour about Rs. 7-8-0 to Rs. 10 the total cost works out about Rs. 40 per acre. This figure is not to be compared with the costs shown by Shevaroy and Mysore planters, who reckon Rs. 15 to Rs. 25 per acre sufficient. The actual costs will undoubtedly vary according to the size of the trees and the amount of foliage on them, the distance from water and the type of coolie. A small block of 30 acres on the estate where the experiments were carried out, was sprayed last year with a $10 \times 10 \times 4 \times 2 \times 50$ solution with container sprayers. The cost per acre worked out at the colossal figure of Rs. 93 per acre.

The sprayed area however carried through a 14 cwt. crop as against 12-cwt. on the unsprayed surrounding coffee. Outturns from the sprayed

area were 91 as against 97 on the unsprayed. This year the crop on the area sprayed last year is reckoned between 7-8 cwt. per acre, while the unsprayed is not more than 5. The spraying therefore has been responsible for an increase in crop of roughly 4 cwt. per acre which at Rs. 70 per cwt. amounts to Rs. 280—a very handsome return on an expenditure of Rs. 93. In October last year this block stood out against the unsprayed surrounding area, ripened up its crop better and carried more leaf right through the dry weather.

These figures again go to show the damage caused by leaf disease from immediately after the monsoon until after crop has been picked. If spraying cannot be done to protect and keep leaf already produced by the tree then, a dose of easily available nitrogen immediately after the monsoon is of the greatest value. Such an application helps growth and replaces leaf which is attacked by leaf disease and lost by new leaf. Such new leaf is of very definite value in ripening up crop.

Thanks are due to the Managing Director of the Koorghully Estate for placing coffee and labour at my disposal for carrying out these experiments and for his generous hospitality while doing so.

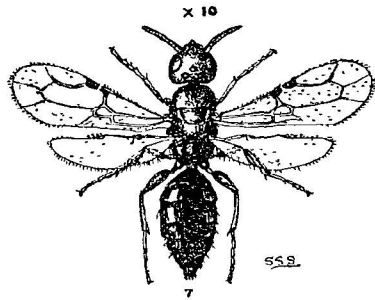
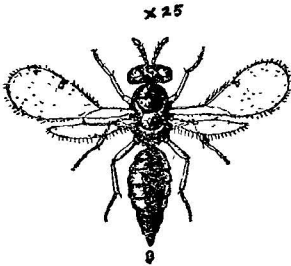
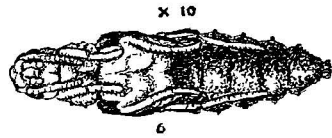
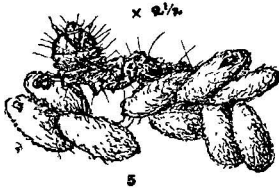
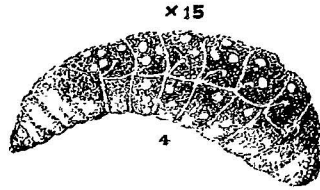
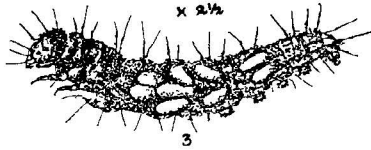
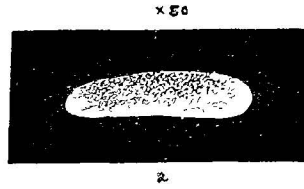
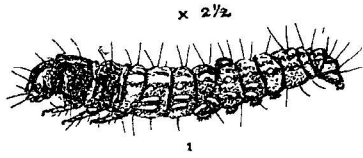
D. G. MUNRO.

EXPLANATION OF PLATE.

BETHYLID PARASITE OF NEPHANTIS.

Parasierola sp.

- Figure 1. Paralyse^d Nephantis caterpillar with eggs laid on the sides. ($\times 2\frac{1}{2}$).
- „ 2. Egg of Bethylid—enlarged. ($\times 50$).
- „ 3. Bethylid grubs feeding on Nephantis caterpillar. ($\times 2\frac{1}{2}$).
- „ 4. Bethylid grub—enlarged. ($\times 15$).
- „ 5. Cocoons of the Bethylid by the side of the shrivelled body of the host. ($\times 2\frac{1}{2}$).
- „ 6. Pupa of the Bethylid—ventral view. ($\times 10$).
- „ 7. Bethylid wasp—enlarged. ($\times 10$).
- „ 8. Secondary parasite on the Bethylid—female enlarged. ($\times 25$).



Life-history of Parasierola sp.

NOTES ON THE LIFE-HISTORY AND HABITS
OF *PARASIEROLA* SP.—THE BETHYLID
PARASITE OF *NEPHANTIS SERINOPA*.

BY

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AND

M. C. CHERIAN, B.A., B.SC., D.I.C.

Introductory.—A small, black, ant-like wasp of the Fam. Bethylidae (Parasitic Hymenoptera), identified by the Imperial Bureau of Entomology, London, as a species of *Parasierola*, has of late assumed much importance in South India as an important element of the parasite complex, bringing about the natural control of the “*Black-headed Caterpillar*” of coconut—*Nephantis serinopa*. In several places in the Central and East Coast Districts of the Madras Presidency, wherefrom an attack of *Nephantis serinopa* had been reported, it had been observed that the pest usually disappeared of its own accord within a fairly short time, and on investigation this fact was invariably noted to be due to the increase in numbers of 3 or 4 different parasite enemies of the pest attacking it in its different stages. Whereas *Parasierola* was noted to attack the fullgrown caterpillars, another—the Braconid—*Apanteles* sp.—parasitised the young caterpillars, while a third—*Elasmus nephantidis* (Madras Year Book, 1926, pp. 39—50) oviposited on pupating caterpillars inside cocoons, and a fourth—*Stomatoceras sulcatiscutellum*—attacked the pupal stage. Owing to a combined onslaught of these different parasites affecting its several stages, the pest would appear to be effectively brought under control in nature in these

areas. It was as a result of these observations that two of these parasites—*Parasierola* and *Apanteles*—were introduced into Mangalore in 1924–25 with fairly successful results.

A detailed study of the life-history of this Bethyloid parasite—*Parasierola*—was undertaken at the Insectary at the Agricultural Research Institute, Coimbatore, in connection with the efforts at the introduction of the parasite into the West Coast and the object of this paper is to make a record of the observations made.

Distribution.—This parasite has been noted from the following districts of this Presidency :—

<i>Ganjām District</i>	... Chicacole Road.
<i>Vizagapatam District</i>	... Vizianagram, Anakapalle.
<i>Gōdāvāri District</i>	... Samalkota.
<i>Kistna District</i> ...	.. Gannavaram.
<i>Guntūr District</i> ...	... Tenali.
<i>Madras</i> ... ..	... Tondiarpet.
<i>Chingleput District</i>	... Chingleput, Madurantakam, Tiruvalur, etc.
<i>South Arcot District</i>	... Palur, Chidambaram, Tirukkoyilur, Tiruvannamalai, etc.
<i>Tanjore District</i>	... Nidamangalam.
<i>North Arcot District</i>	... Katpadi, Gudiyāttam, Ocheri, Wallajah, Kagankarai
<i>Chittoor District</i>	... Tondavada, Chandragiri.
<i>Salem District</i> ...	... Salem, Ayodhyapatnam, etc.

<i>Coimbatore District</i>	...	Coimbatore, Tudiya- lur, Podanur, etc.
<i>Malabar District</i>	...	Calicut, Cannanore, Purathur, Gothu- ruthi, etc.
<i>Cochin State</i>	... ...	Ernakulam.

The adult parasite.—The female wasp is 4 to 5 mm. long with a somewhat elongate but depressed body. The general colour of the body is shiny black, with the antennae and legs light yellowish brown. The general appearance of the wasp is somewhat ant-like. The male is more or less similar to the female but smaller, being 3 to 4 mm. long. While in the female the abdomen tapers to a point, it ends rather bluntly in the male. The wasps are comparatively strong fliers and in one case there was positive proof that they had flown to a distance of one mile from the spot of liberation.

Lifeshistory and habits.—The wasps (Figure 7) are active creatures usually found running about among the tunnels of the coconut caterpillar in search of their prey. When introduced into large jars at the Insectary along with live caterpillars living in their tunnels on leaflets, the wasps were often noticed to mob and kill fullgrown caterpillars and feed on their body juices. Mating was observed to take place freely within a day or two of emergence. In nature the fertilized female would appear to enter the tunnels and go about in search of caterpillars for oviposition. Fullgrown larvae that are about to pupate inside their cocoons seem generally to be preferred. The parasite bites its way into the cocoon, stings the caterpillar and

lays 8 to 13 eggs on its body. In a few cases as many as 15 eggs have been noted. The wasps may also attack fullgrown caterpillars in an active condition among the tunnels, gripping them with their jaws and paralysing them simultaneously with the aid of their sting. While generally only large caterpillars are attacked, in a few cases small sized ones were also found parasitised, but in these cases only one egg or two were noticed to be deposited.

The adult wasps were found to feed under confinement in cages but sparingly on sugar or jaggery water; they appeared to prefer the body juices of fresh caterpillars. In certain instances, fresh cocoons of Braconid parasites found on infested coconut leaves were noticed to have been bitten into at Salem and other places and it is possible that the adult Bethylids were responsible for such injury.

At the Insectary, individual females were separated out soon after pairing in tubes and kept under observation for taking egg-laying and longevity records. The wasp was provided with a fresh caterpillar every day and when eggs were found laid, the larva was removed and replaced by another. Eggs appeared to be laid within 2 or 3 days after emergence and mating and a female was noted to lay on the average 8 to 10 or 12 eggs a day. As observed under the conditions of a cage the average length of life of an adult was noted to be about 2 weeks, but in three cases, as shown in the table appended, three individuals lived for 33, 43 and 44 days and had laid 89, 125 and 142 eggs respectively within that time. It is not improbable that, under natural and perhaps more

favourable conditions individuals may live longer and lay a greater number of eggs.

TABLE I.—Longevity and egg-laying records of three Bethyloid females.

Date.	A	B	C
3 Oct. 1925	Collected.	Collected.	.
7 "	12 eggs	..	...
8 "	.....	15 eggs.	Emerged.
10 "	.....	12 do.	...
11 "	.....	6 do.	11 eggs
12 "	10 eggs.	..	.
13 "	6 do	..	8 eggs
14 "	...	10 eggs.	...
15 "	7 eggs.	6 do	10 eggs
16 "	3 do.	..	...
17 "	..	...	10 eggs.
18 "	10 eggs.	4 eggs.	...
19 "	..	9 do.	8 eggs.
20 "	7 eggs.	8 do.	4 do.
21 "	4 do	...	5 do.
22 "	.....	5 eggs.	...
23 "	..	...	6 eggs.
24 "	13 eggs.	8 eggs	...
26 "	...	7 do.	2 eggs
27 "	...	9 do	...
28 "	14 eggs	...	10 eggs.
29 "	..	6 eggs	..
31 "	10 eggs.	..	8 eggs.
1 Nov. 1925	..	10 eggs.	...
3 "	..	4 do.	...
4 "	10 eggs.	..	..
5 "	..	6 eggs.	...
6 "	..	...	7 eggs
7 "	7 eggs.	8 eggs.	...
10 "	7 do	..	Found dead.
12 "	..	8 eggs.	.
13 "	5 eggs	...	..
15 "	Found dead.	1 egg.	.
16 "	.....	Found dead.	..

Egg stage.—The egg (Figs. 1 and 2) is about $\frac{3}{4}$ mm. long, more or less translucent, elongate, cylindrical, somewhat curved, very slightly bulged at the extremities. The egg appears to be firmly glued on to the body of the caterpillar since it cannot be detached easily. The eggs are usually laid horizontally or obliquely along the sides of the host, but may also be laid on the dorsal or ventral surface. The duration of the egg stage is quite short, being a little over a day but it may vary from 24 hours to 48 hours. In one case (observed by Mr. Cherian) an egg noted to have been laid at 4 p.m. on 29th October 1925 had not hatched even at 9 p.m. on the 30th October, but was found to have turned into grubs by the morning of 31st October. The actual duration could thus not be noted, but should have been more than 29 and less than 39 hours.

Larval stage.—(Figs. 3 and 4). It is rather difficult to say when exactly the egg passes into the grub stage, since the larva does not change its position after hatching, but begins to suck the host at the place of deposition. In the early stages, the setting in of the peristaltic movements of the alimentary canal, detectable only under a lens, is almost the sole indication of the egg having hatched. The grub is at the time of hatching about $\frac{3}{4}$ mm. long and almost translucent; within a few hours, however, it gets more rotund and turns light yellow brown in colour. By the second day, the grub assumes a light pink colouration mottled with grey and by the third day the colour deepens to pinkish brown in which the mottling becomes more conspicuous. The fullgrown grub is 4 to $4\frac{1}{2}$ mm. long, rather thick-set, with the body tapering

to a point anteriorly but enlarging rather rapidly behind into the bulged and almost rotund posterior half. When fullfed the grubs detach themselves from the shrunken carcase of the host and begin to spin oval cocoons of silk within the tunnels of the pest, usually in the neighbourhood of the dead caterpillar. The cocoons are generally of a buff-brown colour, though in certain cases the colour is a spotless white. The texture of the cocoon is rather loose and flimsy, and as generally the grubs congregate together while spinning, the cocoons spun by them occur in massed groups, knit together by an external meshwork of loose silken strands. Each individual cocoon may vary from 4 to 6 m.m. in length and $1\frac{1}{2}$ to 2 m.m. in breadth.

After finishing spinning, the grub casts off its meconium at one pole of the cocoon and enters a quiescent state, wherein it is of translucent white colour. In about a day or two it casts the larval moult and assumes the pupa stage.

Pupal stage—(Figs. 5 and 6).—The freshly formed pupa is a beautiful translucent grey. The enclosing membrane being thin, the pupa shows clearly in relief the rudiments of the limbs and body of the adult. The duration of the pupal period is rather short being about 4 days on the average. The eyes of the pupa assume a reddish colour at the end of the first day and on the second turn dark red. On the third day the pupa turns brown and on the fourth the whole body becomes fully black. On the fifth day the pupal moult is cast, but the wasp rests within the cocoon allowing time for the cuticle and the wings to harden. The adults tear open the sides of the cocoons and emerge by the sixth or the seventh day.

TABLE II.—Detailed lifehistory observations of the wasp.

Stages.	Date.	Observations.
Egg stage ...	8-10-25	11 a.m. female provided with a caterpillar.
	9-10-25	9 a.m. 8 eggs found laid (exact time not known).
Larval stage .	10-10-25	9 a.m. found hatched.
	11-10-25	9 a.m. found growing.
	12-10-25	9 a.m. fullfed, preparing to spin cocoons.
	13-10-25	9 a.m. had spun cocoons.
	14-10-25	9 a.m. still grubs inside cocoons.
Pupal stage ..	15-10-25	9 a.m. found pupated, eyes reddish.
	17-10-25	9 a.m. eyes dark red
	18-10-25	9 a.m. body brown.
	19-10-25	9 a.m. fully black.
Imago stage ...	20-10-25	9 a.m. pupal skin cast, wasps found resting quiet, to allow cuticle to harden.
	21-10-25	9 a.m. still within cocoons (10 a.m.).
	22-10-25	(5) wasps had emerged and found active. (All females: ♀ ♀).

TABLE III.—Further records of detailed lifehistory.

Particulars	A	B.	C.	D.
Eggs found laid ...	26-10-27	27-10-27	28-10-27	28-10-27
Eggs found hatched .	27-10-27	28-10-27	29-10-27	29-10-27
Duration of egg period.	1	1	1	1
Grubs pale yellow ...	28-10-27	29-10-27	30-10-27	30-10-27
Grubs pink mottled with white dots	29-10-27	30-10-27	31-10-27	31-10-27
Grubs fullfed and about to make cocoons.	30-10-27 (weak and so not cocooning).	31-10-27	1-11-27	1-11-27
Pupated (eyes, and ocelli red brown, other portions of body white).	2-11-27	3-11-27	3-11-27	3-11-27
Larval period .	6	6	5	5
Eyes and ocelli dark brown, other portions white	4-11-27	5-11-27	6-11-27	6-11-27
Eyes ocelli, mouth parts, legs and antennae dark brown, other portions black.	5-11-27	7-11-27	7-11-27	8-11-27
Adults emerged ...	7-11-27	8-11-27	9-11-27	10-11-27
Pupal period ...	5	5	6	7

TABLE IV.—Table of Lifehistory Records.

Serial number.	Egg found laid.	Larva found hatched.	Duration of egg period.	Date of cocooning.	Duration of active larval life.	Found pupated.	Duration of larval period.	Adults emerged.	Duration of pupal period.	Total life cycle.	Remarks regarding sex.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	23rd Oct.	24th Oct.	1	27th Oct.	3	1924.	..	5th Nov.	..	13	..
2	28th "	29th "	1	1st Nov.	3	..	..	11th "	..	14	..
1925											
3	9th "	10th "	1	12th Oct.	2	14th Oct.	4	22nd Oct.	8	13	..
4	12th "	13th "	1	16th "	3	..	..	23rd "	..	11	..
5	12th "	13th "	1	17th "	4	..	..	24th "	..	12	..
6	13th "	14th "	1	17th "	3	..	..	25th "	..	12	..
7	14th "	15th "	1	18th "	3	..	..	25th "	..	11	♂ & ♀
8	14th "	15th "	1	18th "	3	..	..	26th "	..	12	all ♀s
9	15th "	16th "	1	19th "	3	..	..	27th "	..	12	♂s
10	17th "	18th "	1	21st "	3	Bethylid pupae attacked by Pedeuloides mite	..	..	..	..	..
11	18th "	19th "	1	22nd "	3	..	..	29th Oct.	..	11	..
12	19th "	20th "	1	23rd "	3	..	..	31st "	..	12	..
13	20th "	21st "	1	24th "	3	..	..	2nd Nov.	..	13	..
14	21st "	22nd "	1	Nephantis and	..	Bethylid larvae attacked by Tyroglyphus mite	..	..	..	..	..
15	22nd "	23rd "	1	26th Oct	3	..	..	4th Nov.	..	13	♂ & ♀
16	23rd "	24th "	1	..	..	..	..	4th "	..	12	all ♀s
17	26th "	27th "	1	30th Oct.	3	..	..	9th "	..	14	♂s
18	27th "	28th "	1	1st Nov	4	..	..	11th "	..	15	..
19	28th "	29th "	1	2nd "	4	..	..	11th "	..	14	♂ & ♀
20	29th "	31st "	2	3rd "	3	..	..	14th "	..	16	♂ & ♀
21	30th "	31st "	1	Bethylid grubs sickly.	..	..	..	..	..	..	..
22	31st "	1st Nov.	1	4th Nov.	3	..	..	14th Nov.	..	15	..
23	1st Nov.	2nd "	1	6th "	4	..	..	16th "	..	15	♂ & ♀
24	2nd "	3rd "	1	6th "	3	..	..	17th "	..	15	all ♀s
1926											
25	6th Feb.	7th Feb.	1	..	..	..	..	20th Feb.	..	14	..
26	7th "	8th "	1	13th Feb.	5	..	..	22nd "	..	15	..
27	9th "	..	..	..	..	..	..	24th "	..	15	..
28	11th "	..	..	..	..	..	..	26th "	..	15	..
29	12th "	..	..	..	..	..	..	26th "	..	14	..
30	20th "	..	..	..	..	..	..	5th Mar.	..	13	..
31	24th "	..	..	..	..	..	..	8th "	..	12	..
32	27th "	..	..	..	..	..	..	11th "	..	12	..
33	6th Mar.	7th Mar	1	10th Mar.	3	..	..	17th "	..	11	..
34	10th "	..	..	15th "	..	..	..	22nd "	..	12	..
35	11th "	12th Mar.	1	16th "	4	..	..	22nd "	..	11	..
36	13th "	14th "	1	16th "	2	..	..	24th "	..	11	..
37	14th "	15th "	1	18th "	3	..	..	26th "	..	12	..
38	15th "	16th "	1	18th "	2	..	..	25th "	..	10	..
39	17th "	18th "	1	20th "	2	22nd Mar.	4	29th "	7	12	..
40	18th "	19th "	1	..	..	22nd "	3	29th "	7	11	..
41	19th "	20th "	1	22nd Mar.	2	..	..	30th "	..	11	..
42	20th "	21st "	1	..	..	..	..	31st "	..	11	..
43	21st "	..	..	..	..	..	..	31st "	..	10	..
44	24th "	..	..	..	..	..	..	9th Apr.	..	16	..

Duration of life cycle.—From the tables given above it is apparent that the egg stage lasts only about a day, the grub stage, including the prepupal period within the cocoon, about 4 to 6 days and the pupal about 4 days. The adult however usually rests for about 2 days within the cocoon after undergoing the pupal moult, so that the duration of the pupal stage appears to be longer than it really is. The total length of the life cycle has been found to vary from 11 to 16 days.

From these figures it is clear that the multiplication of this parasite is fairly rapid and that it is at an advantage as compared with the host so far as quickness of reproduction is concerned.

Natural enemies.—Though fairly efficient as a check on *Nephantis* its usefulness has been greatly circumscribed on account of its being subject to secondary parasitism. This is specially the case on the West Coast—particularly in Malabar and Cochin—where its numbers are cut down so much by the activities of hyper-parasites towards the end of the season that it ceases to be of any use unless its numbers are continually reinforced by breeding under controlled conditions in cages at the Laboratory.

Hyper-parasite No. 1.—Probably a Proctotrupid. At Coimbatore and throughout the West Coast the chief hyper-parasite is a small black wasp, about 1 to 1½ m.m. long which seeks fresh cocoons not only of *Parasierola* but also of various species of *Apanteles* and inserts its eggs on the grubs and pupæ. Usually two or three individuals of the wasp emerge from each cocoon. Hyperparasitised cocoons can be detected by the presence of two to

three small, clear-cut round holes on the sides of the silken cocoons.

2. *Hyper-parasite No. 2*.—Probably a species of *Eurytoma*. Found abundantly on the West Coast; about 3 m.m. long. Attacks fresh cocoons both of the Bethyloid and Apanteles. Only one wasp emerges from a single cocoon.

3. *Hyper-parasite No. 3* (Figs.).—A metallic blue Chalcidid—*Pleurotropis sp.*—(about $1\frac{1}{2}$ to 2 m.m. long) collected in small numbers on the Bethyloid cocoons in North Arcot District and later on also in Cochin.

4. *Mites*.—*Pediculoides ventricosus* has been met with as enemy of the pupa in cocoons, both in nature and in cages; while a Tyroglyphid mite has been noted on pupae inside cages.

5. In cages especially in wet weather, the cocoons were found affected by a *fungus*.

Field observations.—In conjunction with Apanteles it has in many cases proved an efficient check on the Nephantis pest in the East Coast districts of Madras. Introduced into Mangalore and South Kanara, where it was not previously present, it proved its efficiency by bringing about a control of the pest in conjunction with Apanteles. In Cochin and Malabar, however, the hyper-parasites have apparently been acting as a handicap against its usefulness, but in Coimbatore District, where since 1924 a heavy infestation of Nephantis occurred at Podanur, Tudiyalur and Coimbatore, the Bethyloid and the Braconid have, in spite of the presence in abundance of the hyper-parasites, apparently been able to bring the pest under control, though they took a much longer time to do so than in the East Coast districts of Madras.

Owing to the facility with which it could be reared in cages under laboratory conditions, large numbers of this parasite as well as of two others, *Elasmus nephantidis* and the Eulophid pupal parasite, were bred out in the laboratories at Calicut and Mangalore and used for liberation in places in Malabar and South Kanara where these parasites were lacking. By this means a fair amount of control has been achieved in certain parts of Malabar and South Kanara, but in some of the areas, especially in South Malabar, owing to the heaviness of the infestation and the inadequacy of the staff needed, satisfactory results have not yet been forthcoming.

This parasite as well as others appear, moreover, to be susceptible to the influences of the weather to a large extent. An excess of humidity, as is noticeable during the torrential rains of the south-west monsoon as also excessive dryness, as is met with during the months of March, April and May is inimical to their multiplication. At these times parasite activity is at a very low ebb and consequently the pest increases enormously. If, however, during the summer months a few good showers are received, the parasites are not very adversely affected.

CRABS IN PADDY FIELDS

BY

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1. *Nature of crab-damage.*—Crabs cause serious damage to paddy crops in several ways. They nibble sprouting seedlings in the nurseries and so result in a dearth of seedlings for transplanting. They also cut across newly planted seedlings in fields. The latter form of trouble often becomes acute, rendering it necessary to fill up gaps caused by the destruction of plants. This entails delay, additional worry, and unnecessary reserve of seedlings. They also make holes through the bunds of the fields, and, in one night, a field may be completely drained through these holes. In times of shortage of water, such fields often cannot be refilled for several days, and damage may thus be done to the crop, indirectly, at any stage in the growth period. Where the pest is serious the services of one man may be necessary to go round the bunds filling up the holes, and the expense of this is not inconsiderable.

2. *Methods of control*—(a) *Careful drainage.*—It has been noticed that crabs find themselves “at home”, and do the greatest damage, only in fields which remain under water. Other fields which are quite well-drained are comparatively free from the harmful attentions of the crab. But then, paddy fields that are not perfectly level cannot be drained off the last drop of standing water; and thorough drainage every day will, besides promoting quick growth of weeds, expose the fields to the grave risk of sudden shortages in channel supply. Furthermore, careful regulation of water in the field is impossible on rainy days.

(b) *Catching crabs.*—Crabs can be got rid of either by employing professional coolies to hand-catch them, or by setting up crab-traps in the field. The former method is costly and subject to the availability of labour; while the latter is inexpensive, simple, and self-acting. A brief description of how to set up a crab-trap is given below. A wide-mouthed ordinary mud-pot (chatty) is buried in a corner of the paddy field so that the mouth of the pot is just flush with the level of the soil in the field. The pot is baited with two handfuls of well-fried rice-bran moistened and made into large lumps for convenience in handling. In frying, no oil is necessary, and the frying should be stopped when the bran becomes most fragrant. If the whole field is under water, the pot also will naturally get filled with water. This, however, will not wash out the bran in the pot as wet-bran quickly settles to the bottom of the pot. The smell of the rice-bran attracts the crabs, which drop into the pot and are held captive there, the sloping convex neck of the pot effectively preventing all means of escape. The same bait, may be allowed to remain in the pots for two days without detriment to the efficiency of the trap. Various other baits such as wheat-flour, powdered ground-nut cake, and fish-meal, were tried, but rice-bran was found to give the best results. Usually five or six crab-traps are found enough for an acre plot, and these may be restricted with advantage to the vicinity of field-bunds, which harbour numerous crab-holes. The earthen pots can be had for an anna each, and rice-bran is sold at the rate of 48 Madras measures for six annas. Both the initial expense and the cost of renewing the bait are trifling. The crabs in the pots should be

removed daily and destroyed. The dead crabs if rotted by burying in pits, form good manure. Fresh baits may be placed either daily or on alternate days.

3. *Results of trials with crab-traps.*—At the Paddy Breeding Station, Aduturai, an intensive and systematic campaign against crabs is carried on with the aid of crab-traps, and the problem of eradicating the crustacean pest has received attention in several aspects. The salient points disclosed so far are presented below :—

(i) *When water is first let into fields.*—The first operation for preparing a paddy-field is the letting in of water, at the commencement of the season. The water first let in runs into, and fills up, all cracks and crevices in the field, displacing the crabs from their holes. The crabs then rise to the surface, and the gravid females liberate their young when the whole field gets well under water. It was therefore found that hand-catching crabs just when water was first let into fields resulted in the capture of gravid females together with their unliberated young. This fact held out great promise of an effective method of extermination. The catching of gravid females with their unliberated young is of particular importance when it is remembered, that as many as 300 to 400 young ones are carried in the abdominal flap of a single gravid female.

It occurred to the writer that the crab-traps found so useful in Burma might well replace the manual labour involved in hand-catching, at the time of the first wetting of fields. To ascertain how far this idea was practicable nine crab-pots were sunk in a field, just before water was first let

in. In an adjacent field of about the same extent, no crab-traps were laid, but coolies were engaged to hand-catch crabs. The catches from the two fields were kept separate, counted, and recorded. This procedure was repeated with pairs of adjacent fields in the entire Kuruvai-area at the station. Table No. 1 gives a brief statement of catches in the comparative trials with the two methods, to wit, 'hand-catching', and 'trapping'. The cost of labour engaged for hand-catching is also recorded therein.

TABLE I.—Statement of catches at the time of first letting in of water. (Kuruvai fields.)

Date of catch.	Block and field number.	A.—Plots (crab traps).					B.—Plots (hand-caught).					Cost of labour.
		Males.	Females.	G. Females		Total.	Males	Females.	G. Females.		Total.	
				Y.T.	Y.L.				Y.T.	Y.L.		
1927.												RS. A. P.
3rd July ..	C-1	46	8	12	32	98	35	2	23	16	76	0 3 0
30th June	C-2	44	11	17	22	94	34		18	26	78	0 3 0
Do.	C-3	33	22	...	20	84	16	3	26	11	56	0 3 0
29th June .	C-4	45	13	11	22	91	24	9	6	19	58	0 3 0
Do.	C-5	31	22	12	17	82	33	4	17	26	80	0 3 0
26th June...	C-6	35	8	15	20	78	25	13	25	1	64	0 3 0
27th June ...	C-7	49	23	13	27	112	8a-2	2	2	...	6	0 1 0
28th June .	C-7b	44	8	3	32	87	7c-32	17	10	...	59	0 3 0
3rd July ...	F-7	28	12	5	2	47	57	14	54	5	130	0 2 0
8th July ...	F-6	45	35	9	40	129	47	8	28	18	101	0 3 0
9th July ...	F-5	23	7	11	5	46	35	..	28	9	72	0 4 0
Do. ...	F-4	11	4	5	7	27	27	..	21	7	55	0 4 0
Total ..	...	434	173	122	246	975	367	72	258	138	835	2 3 0
Sex ratio of population.		1 : 1.2					1 : 1.2					
Among females.	gravid	Per cent of crabs with young ones—33 Per cent of crabs which have liberated their young ones—67.					Per cent of crabs with young ones—65. Per cent of crabs which have liberated their young ones—35.					

NOTE.— { Y.T.—Gravid females with young intact.
Y.L. Do. do. do. liberated.

It would appear from a scrutiny of Table No. I, that among gravid females trapped in crab-pots only 33 per cent of them were found with their young ones unliberated and still intact, while the rest had already set free their young. In the hand-catching trials the percentage of gravid females with their young still unliberated, is higher than in the other method. This is only natural, as the gravid females require time and submersion under water (two conditions which are easily fulfilled in the crab-pots) before they can liberate their young ones. There is the additional fact that in hand-catching a gravid female on being noticed is at once lifted up by the crab-catching girl and put into her receptacle without being allowed any more time and contact with water, whereas a gravid female crab trapped by a pot lies captive under water in the pot and is removed only after several hours. The aggregate catch is higher in the "pot" method, and there is the further advantage of inexpensiveness. It will be seen that, in all, 835 crabs were caught by hand-catching at a cost of Rs. 2-3-0 while 975 crabs were trapped by pots, for baiting which $1\frac{1}{2}$ annas worth of rice-bran had been used.

(ii) *Catches in planted fields.*—The campaign was continued in planted fields also. Five crab-traps were installed in each planted field as soon as transplanting was over. Of these five traps, one was placed near the inlet to the field, one near the outlet, one in the centre, and two at the sides close to the bunds. As transplanting in different fields proceeded apace, the crab-traps also were duly installed in each field. The rice-bran bait was renewed on alternate days, and daily catches

were recorded. It was observed that the catches in the pots increased on rainy days, due probably to crabs getting flooded out of their holes and being forced to move about in the fields. Tables II, III, and IV give details of catches in "Kuruvai" planted fields recorded during the months of July, August, and September, 1927.

TABLE II.—Statement of catches in planted fields (Kuruvai) during the month of July 1927.

Date of catch	Number of crabs trapped.				Total.
	Males.	Non-gravid females	Gravid females.	Young ones	
11th July 1927 ..	2	1	3	148	154
12th ..	4	6	3	22	35
13th ..	5	2	1		8
14th ..	18	3	9	270	300
15th ..	45	7	29	591	666
16th ..	11	2	16	505	534
17th ..	11	12	3	239	265
18th ..	6	..	8	84	93
19th ..	26	1	23	182	232
20th ..	21	..	22	471	514
21st ..	40	1	19	238	298
22nd ..	73	13	43	166	295
23rd ..	47	18	44	383	492
24th ..	59	24	43	468	594
25th ..	35	18	22	250	325
26th ..	56	7	20	613	696
27th ..	53	9	25	417	504
28th ..	42	16	15	445	518
29th ..	55	7	16	266	344
30th ..	57	15	30	291	393
31st ..	68	28	24	477	597
Total ..	734	184	418	6,526	7,862

Note—The total number of crab-traps operating in the fields increased as more and more plots were gradually planted up. This number therefore varied from 20 on 11th July 1927 to 118 on 31st July 1927 progressively with the advance of planting.

TABLE III.—Statement of catches during the month of August 1927. Kuruvai fields.

Total number of pots—129.

Date	Males.	Non-gravid females.	Gravid females.	Young.	Total
1927.					
1st Aug.	33	17	9	263	322
2nd "	69	9	38	202	318
3rd "	61	10	30	435	536
4th "	47	9	40	557	653
5th "	41	17	15	673	746
6th "	33	6	26	1,086	1,151
7th "	52	15	28	1,276	1,371
8th "	56	11	58	2,135	2,260
9th "	25	4	27	1,260	1,316
10th "	29	3	27	927	986
11th "	38	7	51	1,815	1,911
12th "	25	14	15	889	943
13th "	24	7	20	1,407	1,458
14th "	23	3	45	1,390	1,461
15th "	46	7	61	1,120	1,234
16th "	33	5	34	733	805
17th "	29	7	26	647	709
18th "	19	7	30	991	1,047
19th "	20	5	24	801	850
20th "	29	..	18	836	883
21st "	32	2	23	1,209	1,266
22nd "	20	3	20	872	915
23rd "	18	7	14	1,309	1,348
24th "	16	1	23	912	952
25th "	23	2	20	1,170	1,215
26th "	11	6	21	746	784
27th "	16	8	13	515	552
28th "	15	4	7	525	551
29th "	27	1	31	1,078	1,137
30th "	31	3	22	682	738
31st "	31	13	38	858	940
Total ..	972	213	854	29,319	31,358

Average catch 7.8 crabs per pot per day.
 Sex ratio of Males Females
 (972) : (1,067) :: 1 : 1.09.

TABLE IV.—Statement of catches in planted Kuruvai fields during September 1927.

Total number of pots—129.

Date	Males.	Non-gravid females.	Gravid females.	Young.	Total.
1927.					
1st Sep. ..	37	16	31	902	986
2nd "	34	18	30	808	890
3rd "	29	8	22	518	577
4th "	15	3	28	773	819
5th "	21	9	17	565	612
6th "	9	1	12	465	487
7th "	14	1	26	492	533
8th "	25	1	40	899	965
9th "	10	1	20	371	402
10th "	15	3	18	549	585
11th "	13	4	14	379	410
12th "	14	6	9	408	537
13th "	6	1	4	262	273
14th "	10	1	16	492	519
15th "	4	4	1	344	353
16th "	10	2	5	278	295
17th "	1	..	1	256	258
18th "	4	..	4	290	298
19th "	9	7	2	216	234
20th "	8	1	5	315	329
21st "	4	1	5	185	195
22nd "	15	9	18	353	395
23rd "	5	3	2	138	148
24th "	6	3	9	156	174
25th "	6	7	4	92	109
26th "	3	1	..	105	109
27th "	11	8	7	52	78
28th "	9	12	2	80	103
29th "	14	11	..	61	86
30th "	7	2	5	64	78
Total ...	368	144	357	10,868	11,737

Average catch per pot per day .. . 3 crabs.

(iii) *Catches in channel-courses.*—The damage done by crabs to the planted crop can be easily reduced at small cost by the crab-traps. But the water-channel is all the time bringing in a continual supply of fresh crabs. It is therefore imperative that crab-traps should be installed in the beds of channels and water-courses. At the Paddy Breeding Station, Aduturai, there are five subsidiary channels (A, B, C, D and E respectively)

irrigating the fields. Three pots in each of the two channels A and B, and six pots in each of the three channels C, D, and E were installed at distances of about 70 to 80 yards from each other. Tables V and VI represent the recorded catches from these channel-traps.

TABLE No. V—Statement of catches in the channel pots for the month of August 1927.

Date.	Channel A (3 pots).	Channel B (3 pots).	Channel C (6 pots).	Channel D (6 pots).	Channel E (6 pots).	Total.
1927.						
1st Aug. ... ..	..	..	30	36	15	81
2nd " ... ..	..	..	38	16	11	65
3rd " ... ..	..	..	12	13	6	31
4th "	16	24	16	13	5	74
5th "	11	31	12	22	12	88
6th "	12	20	18	11	10	71
7th "	7	8	10	23	16	64
8th "	6	20	17	5	5	53
9th "	12	10	7	12	12	53
10th "	8	14	14	9	7	52
11th "	2	4	9	10	5	30
12th "	5	5	8	15	9	42
13th "	10	9	9	9	8	45
14th "	14	10	11	14	13	62
15th "	9	8	15	15	8	55
16th "	18	18	29	15	10	90
17th "	6	6	14	11	5	42
18th "	15	14	13	22	9	73
19th "	5	3	6	7	7	28
20th "	7	11	11	24	4	57
21st "	4	1	5	6	3	19
22nd "	13	14	13	18	10	68
23rd "	5	2	8	9	3	27
24th "	6	10	12	23	8	59
25th "	19	8	16	12	10	65
26th "	4	8	17	17	12	58
27th "	4	14	4	11	5	38
28th "	12	12	16	33	12	85
29th "	6	6	12	12	8	44
30th "	7	16	8	14	9	54
31st "	9	9	12	13	13	56
Total ...	252	315	422	470	270	1,729

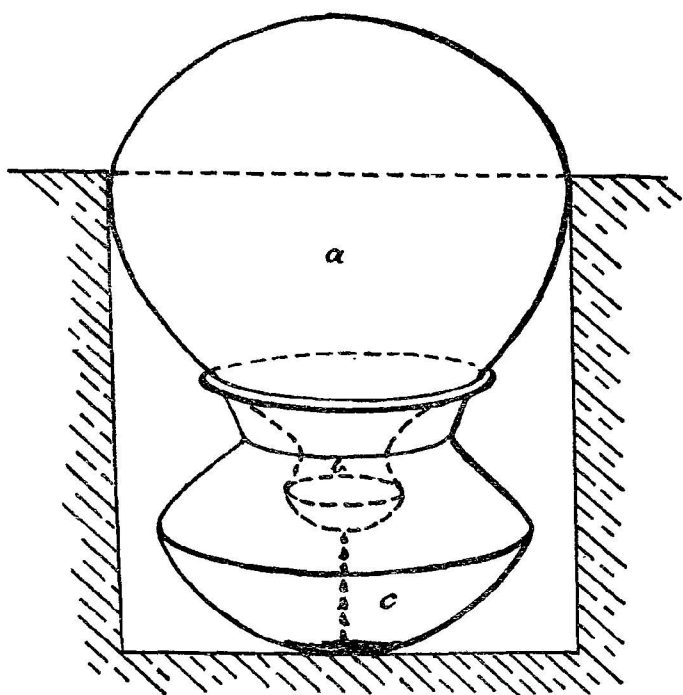
Average catch per pot per day 2.3 crabs.

TABLE VI.—Statement of catches in the channel pots
for the month of September 1927.

Date.	Channel A (3 pots).	Channel B (3 pots).	Channel C (6 pots)	Channel D (6 pots)	Channel E (6 pots).	Total.
1927.						
1st Sep.	2	8	19	38	11	78
2nd "	15	21	17	24	7	84
3rd "	6	6	13	15	10	50
4th "	6	9	7	10	8	40
5th "	4	1	6	6	6	23
6th "	1	1	4	6	3	15
7th "	13	8	12	25	4	62
8th "	3	8	5	14	5	35
9th "	9	21	13	23	12	78
10th "	5	2	5	8	12	32
11th "	9	12	19	30	10	80
12th "	4	1	8	15	5	33
13th "	4	18	19	29	18	88
14th "	6	3	8	11	10	38
15th "	10	10	18	16	12	66
16th "	3	11	12	11	9	46
17th "	8	29	10	22	9	78
18th "	11	9	18	8	9	55
19th "	13	17	36	26	14	106
20th "	8	20	17	14	6	65
21st "	13	14	24	18	8	77
22nd "	8	19	27	15	6	75
23rd "	13	12	19	18	10	72
24th "	5	5	8	8	7	33
25th "	7	9	12	7	6	41
26th "	3	12	4	6	4	29
27th "	9	5	20	22	5	61
28th "	6	9	8	6	6	35
29th "	6	8	15	25	11	65
30th "	5	7	14	11	8	45
Total	215	315	417	487	251	1,685

Average catch per day per pot 23 crabs.

4. *Turning dead crabs to good account.*—The daily haul from the crab-traps was emptied into a large pit after the crabs had all been killed by drowning or otherwise. A fresh layer of earth was strewn over the buried crabs every day and rammed, so as not to expose the dead crabs to birds of prey. The buried crabs rot well in nine to ten weeks. A sample of the crab manure prepared in this manner was sent to the Government



Agricultural Chemist, Coimbatore, for analysis and the figures obtained are given below :—

Moisture ...	...	...	10'46	per cent.
Loss on ignition	...	...	4'26	"
Insolubles	...	...	73'21	"
Solubles ...	...	...	12'07	"

Total ... 100'00

Phosphoric acid ...	...	...	0'31	per cent.
Potash ...	...	...	0'45	"
Nitrogen ...	...	...	0'20	"

A manurial experiment has also been laid down to compare the effect of equal bulks of crab-manure and village cattle manure respectively, on crop-yield of paddy. Trials with cyanogas "A" dust are being conducted against crabs, but this method seems unnecessarily expensive. It may be recorded that rats have, on several occasions, been found dead in the crab-trap pots.

A NOTE ON COCONUT SHELL OIL.

Coconut shell oil was prepared at the Kasaragod Experiment Station on several occasions in a rudimentary manner as detailed below :—

2. *Preparation.*—The process adopted was very simple and the apparatus used were equally so which consisted of (a) an earthen pot with a narrow mouth, (b) a coconut shell lid provided with a small round hole at the bottom and just to cover the mouth of (a), and (c) one copper vessel to receive the distilled oil. (Please see the diagram below.)

Fresh coconut shells were broken into small pieces and filled in the pot (a) whose mouth was

then covered with (b) and fitted up carefully so that the pieces inside pot (a) might not drop down when inverted but at the same time to allow the oil formed inside to trickle down through. It must be remembered that a fair sized pot holds shell pieces of 30 nuts. The copper vessel (c) was first placed in a small pit and the pot (a) was kept inverted over it as shown in the diagram. The pit was just spacious enough to bury the copper vessel (c) and about two-third portion of the mud pot (a). The pit was then filled up carefully with moistened earth and the uncovered one-third portion of the mudpot was covered with a thin layer of fine and moistened earth. Next process was to keep some fire over it burning for about 3 hours. The shells got completely charred and the oil formed out of the same was found collected in the copper vessel. The husks of 100 coconuts (pericarp) were enough for one complete process.

When the whole apparatus had got sufficiently cooled down the oil was taken out and found to weigh $\frac{1}{2}$ lb. (the product of 30 nuts).

3. *Cost*.—Calculating the cost of shells and husks used, the cost of 1 lb. of oil comes to nearly 8 annas.

4. A sample of the oil was examined by the Government Agricultural Chemist, Coimbatore. His remarks are sub-joined :

“The sample as received is a black thick liquid with an acrid penetrating smell. It is acid in reaction to litmus. When submitted to qualitative examination and fractional distillation it is found to contain Pyroligneous acid, aneline oils, creasote, etc. The oil when lightly painted on wood dries up quickly with a black slightly glossy

surface. It is not washed away by soap and is not easily affected by acid or alkali."

5. The oil serves as an excellent paint for wooden and iron materials. It is an antiseptic and is used in Malabar as a medicine for all wounds. All sorts of cuts are cured if the oil is immediately applied to them.

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THE SOMA PLANT, SARCOSTEMMA.

The following note appeared in "Nature" of 25th September 1926 :—

"A note by Professor G. Jouveau Dubreuil in the Indian Antiquary for September deals with the identity of the sacred Soma plant. Dr. Vincent Smith pointed out that while the plant used in the sacrifices of the Parsis of Yezd and Kirman, as well as of the Deccan and Bombay, is identified with one or other of the species of *Asclepias*, the real Soma plant may have been different. Mr. Havell has suggested that it is *Eleusine*, the common millet still found in the Himalayas. An inquiry has been made as to the plant used by the Somayagis who practise the Soma sacrifice among the Nambudris, a very high caste of Brahmans in the district of Malabar, who having been sheltered from invasion and change have thus preserved the Vedic tradition. A reply was received from the great temple of Taliparamba where are the best

examples of *agnidriyas*—the temples of the Vedic fire—that the Somavalli plant was a rare plant found in the mountains and was obtained from a Raja who lived at Kollangode ten miles south of Palghat. After some difficulty a specimen of the plant was obtained. It proved to be a climbing plant having a stem which was green, bare, round and woody, and containing a milky liquor. It is absolutely without foliage and has been identified as belonging to the genus *Asclepias*.”

A Botanical Assistant was sent in March 1927 to Kollangode to collect this plant. It can only be a *Sarcostemma* and not an *Asclepias*. The very young and tender parts of the plant have minute, opposite, bract-like leaves which soon dry and fall off.

The plant is used by the Somayagis among the Nambudris for the Soma sacrifice. It is a very expensive Yagam (sacrifice) often five to six thousand rupees are spent over it and it extends over eight to ten days. During this period the man who performs the sacrifice sits as well as sleeps on the skin of a black buck which has been caught alive and killed by suffocation.

The juice of the Soma plant is an important thing required in this Yagam. The Soma plant is not to be found in Malabar except in the Tenmalai Hills which belong to the Raja of Kollangode and it has to be obtained from him. The Soma juice and ghee are poured into the fire with a wooden spoon made of *Acacia catechu*. The juice is not only used in the sacrifice but it is also drunk by the sacrificer.

A METHOD OF SELECTING RING-DISEASE FREE POTATO SEEDS FOR PLANTING

BY

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In the Madras Presidency the cultivation of potato has for a long time been confined to the Nilgiris. Of late, attempts have been made to extend its cultivation to Yercaud and Hosūr in the Salem district. On the Nilgiris the "ring" disease of potato is common especially in the swampy areas and causes much loss to the cultivator. The disease spreads through the use of diseased potatoes and by growing the crop in places where the soil has been previously infected by the organism causing the disease. To control the disease two kinds of methods are to be adopted. (1) Only seed potatoes which are free from disease should be used and (2) fields which had borne a diseased crop should not be planted to potato for some years.

2. On the Nilgiris, the Badagas plant whole tubers and do not use cut pieces as seed. When whole tubers are planted, one may safely take it for granted that the seed is healthy if it was from a crop which had been absolutely free from disease. But in a tract like the Nilgiris where the disease is almost universally present—though the degree of infestation may not be the same in all places—and where the cultivator does not carefully note the presence of the disease, the selection of healthy tubers is rather difficult. It is only in advanced stages of the disease that the symptoms of infection are noticed on the surface of the tubers by the presence of the "weeping eyes." On the other

hand, if the infection were only slight the symptoms would not appear quite visible on the surface. Hence there is a danger of using slightly diseased tubers as seed which will obviously produce a diseased crop.

3. If the tubers are cut before planting a more rigorous selection is possible. Potatoes showing even the slightest brown discolouration of the tissues inside can be rejected and healthy tubers selected. On the Nilgiris the ryots never cut their seed potatoes.

4. Experience in the West is of help to us in this connection. *Nature* (No. 2888) says that "Potato growers frequently hesitate to cut their seed potatoes on account of the uncertainty as to the yield per plant and to the growth and healthy development of the cut sets. This second point has been investigated by J. H. Priestly and C. C. Johnson (Journal of the Ministry of Agriculture, Volume XXXI, No. 11) who indicate the precautions needed to eliminate this uncertainty. The healing of the cut surface of a tuber is brought about by the deposition of suberin deposit which forms a barrier to the entry of moulds and bacteria capable of attacking and rotting the tuber. If the potato is cut in moist air this suberin layer is continuous over the whole surface ; but if the air be dry the suberin is patchy and organisms are able to penetrate through the cracks between the patches thus damaging the tuber."

5. In the light of the above it was decided to carry out experiments with cut potatoes under local conditions. To begin with, trials were conducted in the Mycologist's pot culture house

at Coimbatore. The following tables give the results :—

TABLE I.

Treatment.	Number of potatoes planted.	Date of planting.	Date of first germination.	Date of maximum germination	Total germination.	Fate of potatoes not germinated.
		1925.	1925.	1925		
Whole tubers ..	7	11th Sep.	19th Oct.	28th Oct	6	Rotten.
Cut potatoes preserved for 24 hours.	12	Do.	28th Sep.	26th Oct.	12	...
Cut and preserved for 48 hours.	12	Do.	Do.	29th Oct.	11	Good and sound. Not rotten.
Cut and exposed to sun for 24 hours.	12	Do.	30th Oct.	...	1	Rotten.
Cut and exposed for 48 hours.	12	Do.	No germination.	...	N'l.	Do

The cut potatoes were preserved by keeping them in a warm and dark corner away from the influence of wind or sun for a period of twenty-four or forty-eight hours as the case may be. A thin layer of straw was spread over them and sprinkled with water to keep them moist.

TABLE II.

Treatment.	Number of potatoes planted.	Date of planting.	Date of first germination	Date of maximum germination.	Number that germinated.	Fate of potatoes not germinated
		1925.	1925.	1925.		
Whole tubers planted at once.	20	14th Nov.	26th Nov.	30th Nov.	8	Rotten
Cut tubers planted at once (cut into 2).	20	Do.	23rd Nov.	Do.	15	Do.
Cut tubers planted at once (cut into 4).	20	Do.	Do.	Do.	12	Do.
Whole tubers preserved for 24 hours and planted.	20	15th Nov	28th Nov.	Do.	10	Sound on 30th Nov. 1925
Cut into 2 and preserved for 24 hours.	40	Do.	23rd Nov.	Do.	32	Do.
Cut into 4 and preserved for 24 hours.	40	Do.	Do	Do.	32	All except one rotten
Tubers exposed for 24 hours	20	16th Nov.	28th Nov	Do.	4	Rotten.
Cut into 2 and exposed for 24 hours.	40	Do.	...	...	...	Do.
Cut into 4 and exposed for 24 hours	40	Do.	...	...	...	Do.

6. Encouraged by the above results field trials were made at the Potato Experiment Station at Nanjanad. Apart from the question of yield it was intended to note also the prevalence of the ring-disease in the various plots. In all cases healthy potatoes were used for the experiment. One hundred and ninety-five tubers or cut seeds were used respectively. The results are below :—

Treatment	Date of planting.	Date of first germination.	Date of maximum germination.	Total number of plants.	Number of wilted plants.	Percentage of wilt.	Yield in lb.			
							Medium.	Chats.	Rejected.	Total.
Whole tubers preserved for 24 hours.	19th Sep. 1926.	23rd Oct. 1926.	20th Nov 1926.	189	3	1.6	10	6	2	18
Whole tubers exposed for 24 hours.	Do	Do.	Do	172	2	1.2	7	3	3	13
Cut tubers preserved for 24 hours	Do.	Do.	Do.	189	1	.5	7	4	2	13
Cut tubers exposed for 24 hours.	Do.	Do.	Do.	192	6	3.1	4	4	3	11

7. Days were cloudy and weather was wet when this experiment was conducted and the condition of the weather was responsible for the similarity of the yields from protected and exposed sets as Priestly and Johnson are reported to have obtained under similar conditions in England with the "Great Scot" variety.

8. Hence the same experiments were again repeated in April 1927 at the Potato Experiment Station. On this occasion the weather was quite clear. The following results were obtained :—

Treatment.	Number planted	Date of planting.	Date of first germination.	Date of maximum germination.	Total number.	Yield.	Weight of diseased tubers
		1927.	1927.	1927.		LB.	LB.
Whole tubers preserved for 24 hours.	200	23rd Apr.	23rd May.	10th July	177	32	1
Cut potatoes preserved for 24 hours.	200	Do.	Do.	26th June	187	28	$\frac{1}{2}$
Cut potatoes exposed for 24 hours.	200	Do.	30th May.	10th July.	19	1 $\frac{1}{2}$	$\frac{1}{2}$

NOTE.—Towards the close of the experiments a portion of the plot where the cut protected sets had been planted was damaged by porcupines and hence the slight difference in yield between the preserved cut potatoes and whole tubers.

9. The foregoing results prove conclusively that the use of cut seed potatoes gives the same yield if not more than the whole tubers provided the cut potatoes are preserved in a warm moist place away from the sun and wind for a period of 24 hours. As Priestly and Johnson have pointed out the cut seeds which are exposed to the sun and wind for a period of 24 hours are liable to be attacked by fungi and bacteria when planted in the soil and consequently rot. The use of cut sets preserved before planting does not increase the chances of infection of ring disease any more than the use of whole tubers. In both the experiments conducted at Nanjanad where the ring disease is prevalent, it was found that though the infection was little it was more in the crop raised from whole tubers than in the one from preserved cut seeds.

10. Since it has been found that the use of preserved cut seeds can be safely recommended

for adoption, a more rigorous selection of disease-free seeds is possible. It is easy to reject the seeds which show even the slightest trace of discoloration of the tissues inside and to use only healthy seeds. Thus one source of infection can be eliminated altogether. Moreover, much saving of seeds is effected and thus the cost of production is reduced.

11. The writer is wholly indebted to the Government Mycologist for suggestions and facilities freely given in starting and conducting the trials which form the subject matter of this paper.

12. Thanks are also due and are tendered to the Curator, Government Botanic Gardens, Ootacamund, and successive managers in charge of the Nanjanad farm without whose help and co-operation this work would not have been possible.

MANURIAL EXPERIMENTS WITH POTATOES.

The following experiments were carried out at the Potato Experiment Station, Nanjanad, in the Nilgiris. The land on this station is very poor and is typical of that to be found on these hills on which the Badaga cultivates potatoes and other crops. The success of the crop is dependant to a large extent upon seasonable rains and bulky manure is absolutely necessary. In the experiments discussed in Table I the lime was applied in the hot weather and the other manures applied at the time the land was ploughed.

TABLE I.

Manure.	Yield per acre in maunds.						Increase over no manure plot.
	1923.	1924.	1925.	1926.	1927.	Average.	Average.
1. No manure	89	57	66	62	54	66	
2. Fish-guano, 10 cwt per acre	267	201	67	184	169	178	112
3. Lime, 4 cwt. per acre ...	236	198	99½	178	204½	183	117
Fish-guano, 10 cwt. per acre.							
4. Cattle manure 5 tons per acre.	537	281	235	277	316½	329	263
Fish-guano, 10 cwt per acre							
5. Nitrate of soda, 1 cwt per acre.	291½	174	...	...	..	233	167
Fish-guano, 10 cwt. per acre.							
6. Nitrate of soda, 2 cwt. per acre	...		111	171½	143½	142	76
Fish-guano, 10 cwt. per acre.							

The results indicate very clearly that organic nitrogenous manure is required, more especially bulky manure. It is not a question of nitrogen alone as artificial nitrogenous fertilizers will not take the place of organics even when the dose is increased.

In all cases the method of cultivation was the same but in 1927 a deeper cultivation was given with a steel eagle plough which increased the cost.

The economics of these results are set out in the table below. The following are the basal costs :—

	RS.	A.	P.	
Fish-guano	6	8	0	per cwt.
Lime	1	4	0	„
Cattle manure	3	0	0	per ton.
Nitrate of soda	14	8	0	per cwt.

Potatoes valued at Re. 1 per maund.

It is to be noted that nitrate of soda is now much cheaper but this will still not make the use of this fertilizer a paying proposition as it does not produce the desired yield and an increase in the dose appears to depress the yield.

TABLE II.

Manure.	Average yield per acre in maunds	Cost of manure per acre.		Average cost of cultivation per acre.		Value of crop per acre		Profit per acre.	
		RS.	A	RS.	A	RS.	A.	RS.	A.
1. No manure	66	Nil.		60	0	66	0	6	0
2. Fish-guano, 10 cwt per acre.	178	65	0	60	0	178	0	53	0
3. Lime, 4 cwt per acre	183	70	0	60	0	183	0	53	0
Fish-guano, 10 cwt. per acre.									
4. Cattle manure, 5 tons per acre.	329	80	0	60	0	329	0	189	0
Fish-guano, 10 cwt per acre.									
5. Nitrate of soda, 1 cwt per acre.	233	79	8	60	0	233	0	92	8
Fish-guano, 10 cwt. per acre.									
6. Nitrate of soda, 2 cwt per acre	142	94	0	60	0	142	0	Loss	
Fish-guano, 10 cwt. per acre.								12	0

The importance of bulky organic manure having been recognized and the difficulty in getting fish-guano and its rising price being recognized another series of experiments was conducted to test various quantities of the former and to see if it could be supplemented with an artificial

nitrogenous fertiliser like nitrate of soda. The results are tabulated below :—

TABLE III.

Manures	Yield per acre in maunds.					Average	Increase over no manure plot.
	1923.	1924	1925	1926	1927		Average.
1 No manure	103	56	33	55½	40	58	...
2 Cattle manure, 5 tons per acre.	...	137	96	107	180½	130	72
3. Cattle manure, 10 tons per acre.	333	179	138	150	233	207	149
4. Lime, 4 cwt. per acre. Cattle manure, 5 tons per acre.	} 243	137	86½	97½	172	146½	88½
5. Nitrate of soda, 1 cwt. per acre. Cattle manure, 5 tons per acre	} 208	...	...	...	...	208	150
6. Nitrate of soda, 2 cwt per acre. Cattle manure, 5 tons per acre.	} ..	51	84	96½	201½	108	50
7. Nitrate of soda, 2 cwt. per acre	97	..	...	...	...	97	39

This again emphasizes the point that heavy applications of bulky organic manure are necessary, the best result being obtained with an application of 10 tons of cattle manure per acre. This is slightly improved by previously liming the land. Artificials cannot apparently take the place of organics or be used to supplement them.

The economics of this experiment are shown in Table IV, the same basis of calculation being employed as before.

TABLE IV.

Manures.	Average yield per acre in maunds.	Cost of manure per acre.	Cost of cultivation per acre.	Value of crop per acre.	Profit per acre.
		RS. A.	RS. A.	RS. A.	RS. A.
1. No manure	58	Nil.	60 0	58 0	2 0 Loss.
2. Cattle manure, 5 tons per acre.	130	15 0	60 0	130 0	55 0
3. Cattle manure, 10 tons per acre.	207	30 0	60 0	207 0	117 0
4. Lime, 4 cwt. per acre.	146½	20 0	60 0	146 8	66 8
Cattle manure, 5 tons per acre.					
5. Nitrate of soda, 1 cwt. per acre.	208	29 8	60 0	208 0	118 8
Cattle manure, 5 tons per acre.					
6. Nitrate of soda, 2 cwt. per acre.	108	44 0	60 0	108 0	4 0
Cattle manure, 5 tons per acre.					
7. Nitrate of soda, 2 cwt per acre.	97	29 0	60 0	97 0	8 0

The difficulty of getting sufficient cattle manure is a great problem on the Nilgiris and the quantity available is a limiting factor both of the area which can be put under this crop profitably and the yield obtained. In order to overcome this shortage experiments have been laid down to try and supplement it by collecting weeds like *Lobelia*, *Bracken*, *Eupatorium*, which are common in the scrub jungle and using these as bedding for the cattle or putting them directly in the manure

pits. About 30 tons of manure made in this way were prepared in 1927 and it analysed as follows :—

					Calculated to original moisture.
Moisture (original)	...	...	...	...	52'16
Organic matter	...	...	...	...	16'57
Insoluble matter	...	...	...	...	19'05
Soluble matter	...	...	...	...	12 22
					100'00
Phosphoric acid	...	...	...	...	0'19
Potash ...	...	...	...	...	0'54
Nitrogen	...	...	...	...	0'51

In 1928, with five and a half pairs of cattle it was found possible in this way to prepare 16 tons of cattle manure for the first crop and 42 tons for the second crop. This applied at the rate of 5 tons per acre supplemented with 15 cwt. of fish guano substitute together with deep cultivation with a steel eagle plough gave us a crop of 1,692 maunds from 5 acres of main crop, and 1,127 maunds from 4.66 acres. This works out at 6 tons per acre which is fairly satisfactory and is the best yield we have ever obtained on this station.

SIZE OF SEED EXPERIMENT.

An experiment was conducted to ascertain the best size of seed potato to use. The Badagas use the small unsaleable potatoes known as chats for seed to a great extent. The usual practice on the Experiment Station is to use medium-sized potatoes for seed, to sell the big potatoes for eating purpose and to feed chats to pigs. In Europe it is very often the custom to use big potatoes for seed but to cut these up. There is apt to be a danger here when this is done from insect attack.

The following results were obtained over a four years trial. The variety used was Great Scot :—

TABLE V.

Size of seed.	Yield per acre in maunds.				Average.	Average quantity planted.	Total.
	1924.	1925	1926.	1927.			
Cut potatoes	206	271	374	541	389	69	5 6
Chats	254	231	288	456	344	28	12·3
Medium	372	314	387	580½	448	70	6·4
Big	491	433	436	683	561	111	5·0

As was expected the bigger the seed planted the bigger the yield obtained. It is, however, hardly economical to use large table potatoes for seed and the use of medium-sized potatoes for seed is in all probability quite correct. There is, however, a justification for the Badaga and from his point of view chats are probably the most economical kind of seed to use, since they go further and are unsaleable for eating purposes.