Harvest

volume 11 no. 2 1985

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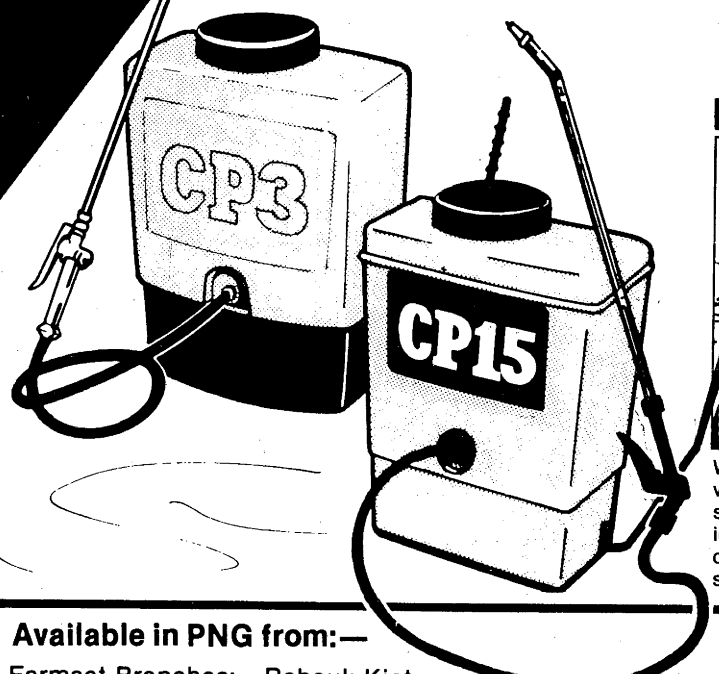

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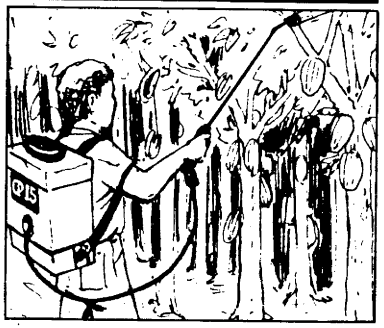

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Harvest has articles on all aspects of primary industry including agriculture, fisheries, forestry and livestock. It is read by researchers, extension workers, students and teachers all over Papua New Guinea and overseas.

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Readers' comments on articles in HARVEST or on the magazine in general are welcomed. Please address any letters to the Editor, HARVEST, Publications Section, D.P.I., P.O. Box 417, Konedobu.

THE SEPIK SALVINIA PROBLEM IS BEATEN

By S. Laup, Scientific Officer, Salvinia Control Project, Angoram, East Sepik Province

WHAT IS SALVINIA?

Salvinia molesta is a free floating water fern from South America. It reproduces only by vegetative means. New plants are formed by the division of the original one. The plant can grow rapidly and has been recorded as doubling every 2-3 days. Because salvinia can quickly cover fresh-water lakes with thick floating weed mats, it has caused problems in many tropical countries. The weed is present in several places in Papua New Guinea and has caused serious problems in the Sepik and Ramu rivers.

THE SALVINIA PROBLEM IN PAPUA NEW GUINEA

The Sepik River, which rises near Telefomin, follows a winding course through a wide floodplain for most of its 1150 km journey to the sea. This has resulted in the formation of many oxbow lagoons and shallow lakes. Salvinia is not a serious problem in the main river, as the strong current stops thick mats from forming. The main problems occur in the lakes and barats where still waters provide ideal conditions for the growth of the weed.

Salvinia is thought to have been introduced in 1971/1972. Since then, the weed has affected more than 500 km of lakes and at times covered 250 km^2 of water surface. This had a serious effect on the lives of the 40,000 people living the area. Villagers were not able to move about by boat or by canoe. The weed stopped them gathering traditional foods such as fish and sago. Children could not get to school or sick people to hospital. Access to markets was cut off and it was impossible to provide services or assistance from outside. There is an article describing the spread of sal-

Paddling a canoe through a thick mat of salvinia is not easy

-vinia in the Sepik and the problems it caused in HARVEST, Volume 5, No. 4.

Salvinia has also caused problems on a smaller scale in the Ramu river and on Waigani swamp. A very small infestation at Wau appears to have been eradicated by physical removal of plants from the water.

WHERE DID SALVINIA COME FROM?

Salvinia, as well as many other weeds, was almost certainly brought into Papua New Guinea by man. It was probably introduced as an aquarium plant by someone who did not know the problems it could cause. It

was seen in aquarium shops in Lae (1973) and in Port Moresby (1975). There is good evidence that salvinia was introduced to the Sepik in 1971/1972 by someone who lived near the river and had the plant growing in a fish tank.

By 1977, salvinia had become an obvious problem, and the government asked the United Nations Development Programme (UNDP) to help in finding a solution. A project coordinator was recruited by the UN Food and Agriculture Organization (FAO) and a joint PNG/UNDP/FAO control project began in 1981.

CONTROL METHODS

Three methods of control were tried:

1. Mechanical/Physical control

This mainly involved clearing of barats to help wind and currents flush salvinia from lakes into the main Sepik. Booms (floating fences) were built across barats and lakes to direct the flow of salvinia or to keep it in place to allow space for fishing, etc. This control measure was found to be quite useful but required a lot of labour and could only be used on certain lakes.

2. Chemical control

Spraying the weed with paraquat was found to be very effective as a short term measure, but was very expensive, costing K40 per hectare. Salvinia plants growing around the edges of lakes were sheltered by other vegetation and were not killed by the spray. Regrowth from these plants quickly covered the lakes once more. It was estimated that spraying would have to be carried out 3 times a year, and that this would cost about 1 million kina a year.

3. Biological control

When plants are taken from their native environment and introduced to a new one, they often do not have the natural enemies (insects and diseases) which would normally help to keep them under control. This is one of the reasons why plants such as salvinia can grow so quickly and become such a problem when they are introduced to new areas. Sometimes it is possible to introduce natural enemies to a country where a plant has become a weed, in the hope that they will bring it under control. This is called biological control. It is a long process, involving searches overseas and careful testing to ensure that the natural enemies will not damage any useful plants when they are released.

The salvinia control team knew that biological control offered the only chance for a cheap and permanent solution to the salvinia problem in the Sepik. Attempts at biological control of salvinia had already been made in several countries without much success. Then, in 1981 CSIRO in Australia successfully used a small South American weevil (beetle), *Cyrtobagous salviniae*, to control salvinia on Lake Moondarra in Queensland.

The weevil used to control salvinia - Cyrtobagous salviniae

THE INTRODUCTION OF *CYRTOBAGOUS*

In February 1982, 600 weevils were imported from Australia. They were released on Binatang lagoon, 10 km downstream from Angoram. To help them reproduce more quickly, the insects were concentrated in 2 floating cages, each enclosing 4 m^2 of salvinia.

By September 1982, when it was estimated that there should have been 4 generations of weevils, only 40 insects could be found in the cages! Clearly, the population was decreasing instead of multiplying. Samples

of salvinia tissue taken during this period showed that the plant was very low in nitrogen compared with plants from Lake Moondarra, where the weevils had been so successful.

A second release of 600 weevils was made into the cages, and each week, the salvinia in the cages was sprayed with a solution of urea fertilizer. This doubled the amount of nitrogen in the plants and the insects multiplied rapidly.

By December 1982 it was possible to take plants containing many insects from the cages and mix them with salvinia in the main lagoon. Surprisingly, although this salvinia was not fertilized, the insect population continued to multiply. What had happened?

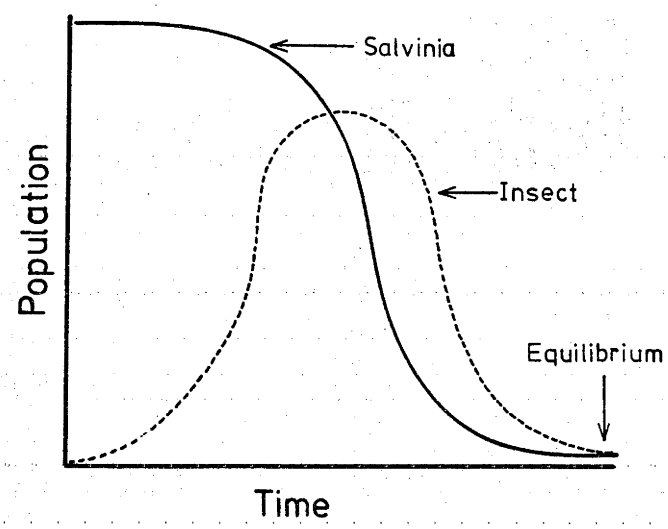
EFFECTS OF THE WEEVILS ON SALVINIA

Adult weevils feed on the buds of salvinia. Because the plant relies on vegetative reproduction, this slows both the growth of the plant and the production of new plants. *Cyrtobagous* larvae burrow inside the stem and interfere with the flow of nutrients. Leaves begin to die and eventually the whole plant rots and sinks.

As the insects damage the plant, nitrogen becomes more and more concentrated in the remaining live tissue. In addition, more nutrients are made available to the plant from the decay of salvinia already killed by the insects. With more nitrogen available, the insects lay more eggs and reproduce faster. Once the insects are established therefore, they actually improve the quality of their food supply and are able to multiply and spread rapidly.

SPREAD OF THE WEEVILS TO OTHER AREAS

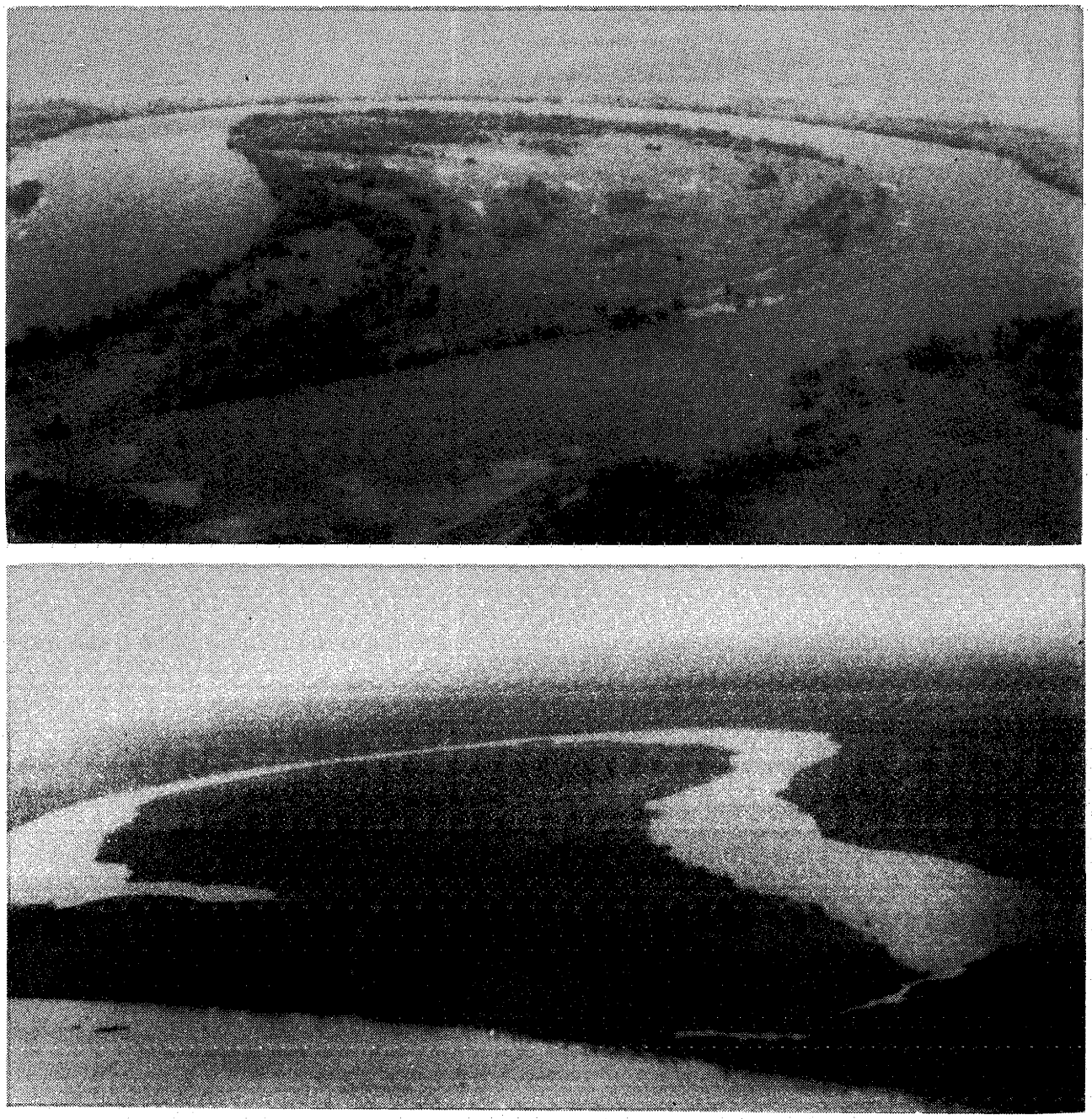
In May 1983, the control team was able to start spreading insects from Binatang lagoon to other problem areas. Weevil-infested salvinia was collected in copra sacks and carried by boat or canoe to new release sites where it was mixed with undamaged salvinia. Aircraft were used to carry sacks of weed from Angoram to Ambunti and from the Sepik to the Ramu. Over the next year, approximately 1 million weevils were distributed to new sites, where they quickly began to destroy the weed mats. By June 1985, less than 2 km^2 of salvinia remained in the Sepik and the weed was no longer a problem. Elsewhere in Papua New Guinea, the insects had also controlled salvinia in the Ramu river and on Waigani swamp.



Diagrammatic representation of the effects of Cyrtobagous *on the salvinia population*

As the graph shows, the amount of salvinia decreases as the insect population increases. However, because the weevils feed only on salvinia, they gradually use up their own food supply. When this happens, reproduction slows down and many insects starve - resulting in a population 'crash' Eventually an equilibrium (balance) point is reached where there is just enough salvinia to maintain the insect population at a very low level.

Some Sepik lakes have now been in this condition for 18 months, with only a few scattered salvinia plants growing around the edges of the lakes. This means that salvinia will never be completely eradicated, but there will be so little of it that it will no longer be a problem.



The top picture shows a lagoon in the Sepik River system which is almost completely covered with salvinia. The lagoon shown in the lower picture has been cleared of salvinia.

EFFECTS OF THE CONTROL PROGRAMME

People are able to collect sago again and report that they are catching many fish, both for their own use, and for sale in local markets. This, and other sources of revenue, such as crocodile hunting, means that school fees can be paid and that money is available in the villages. People can once more move about freely and have expressed their pleasure at the return of their traditional lifestyles after the problems which they have faced during the last 10 years.

FURTHER READING

Richards, A.H. (1979). Salvinia in the Sepik River. *Harvest* 5(4): 239-243.

SMALL-SCALE PRAWN TRAWLING IN WESTERN PROVINCE, PAPUA NEW GUINEA: A PILOT STUDY

By D.C. Cook, Senior Fisheries Extension Officer, Fisheries Division, D.P.I., Kanudi
and
C.D. Tenakanai *, Senior Fisheries Biologist, Fisheries Division, D.P.I., Daru

INTRODUCTION

Over the past few years a small scale prawn fishery has operated in the Daru area of Western Province. The fishery is based on the use of beach seine nets. The kind of prawn caught most often is the Banana prawn (*Penaeus merguiensis*), with smaller amounts of Black Tiger prawns (*Penaeus monodon*), Endeavour prawns (*Penaeus endeavouri*) and Coral prawns (*Parapenaeopsis sculptilis*). The fishery is seasonal, with the largest numbers of prawns being taken between January and May. Over the past 3 years, the total catch has been from 1.5 tonnes to 3 tonnes per year.

Although most areas along the Western Province coastline are suitable for beach seine fishing, up until now, local fishermen have tended to fish only those areas close to the market at Daru (Western District Seafood Ltd.).

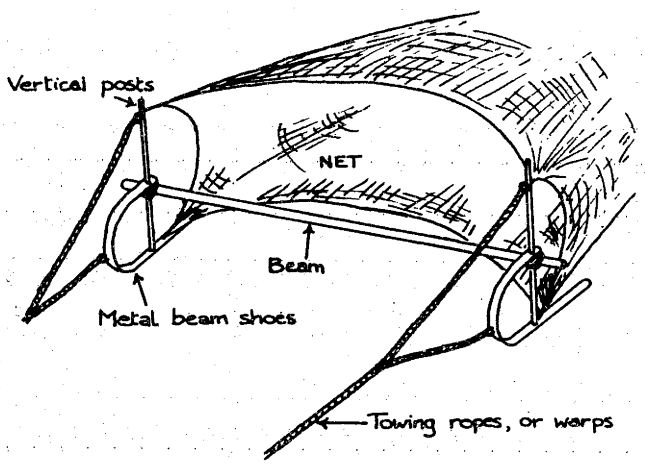
Since 1982, the Fisheries Research and Surveys Branch has carried out some trial trawling for prawns in the Daru area. In November 1984, a prawn specialist from the Fisheries Division of Queensland, visited Papua New Guinea on a 3-week assistance programme. The visit was funded by the South Pacific Commission. The main purpose of the visit was to demonstrate how to make and use the type of simple trawling gear, which is used by small-scale beam trawl fishermen in Queensland. The demonstrations and trials were carried out on the mainland opposite Daru Island.

BEAM TRAWLS

'Beam trawls' are trawls in which the net is held open by one or more beams. The beams can be lengths of wood or bamboo, or metal bars.

Beam trawls offer less resistance than other trawls which use otter boards. Therefore a larger net can be pulled using a smaller engine. However, the beam design cannot be used after a certain size when the extra strain on the beam will cause it to snap. Hence, beam trawling is usually done from small vessels. Beam trawls are also easier to handle than otter boards, and require less skill to operate.

The main parts of a beam trawl are shown in the diagram below. The metal beam shoes' prevent the vertical posts from digging into the bottom by acting as a sledge. The ring trawl shown in the diagram on page 56, has two beams, and beam shoes are not needed.

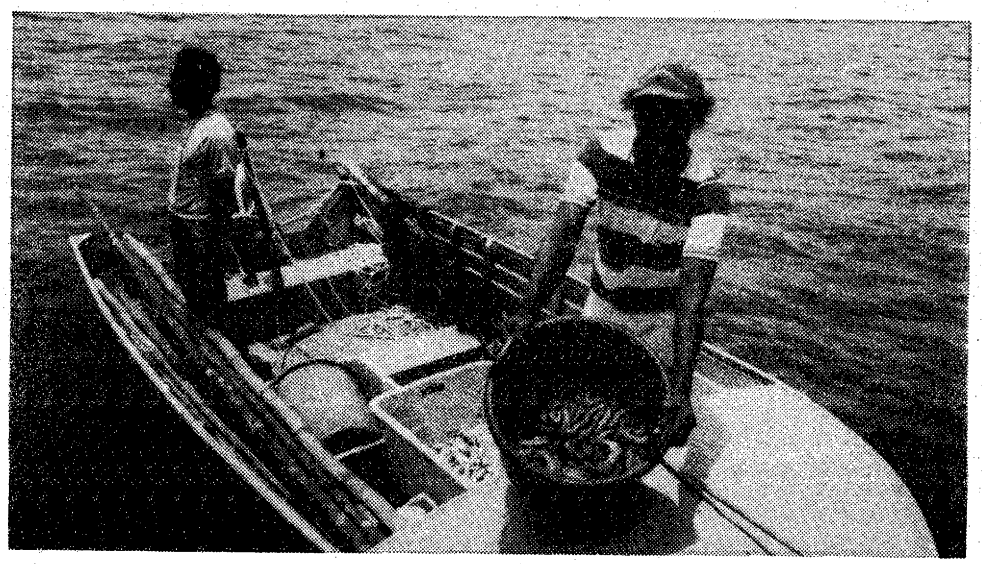


The main parts of a beam trawl

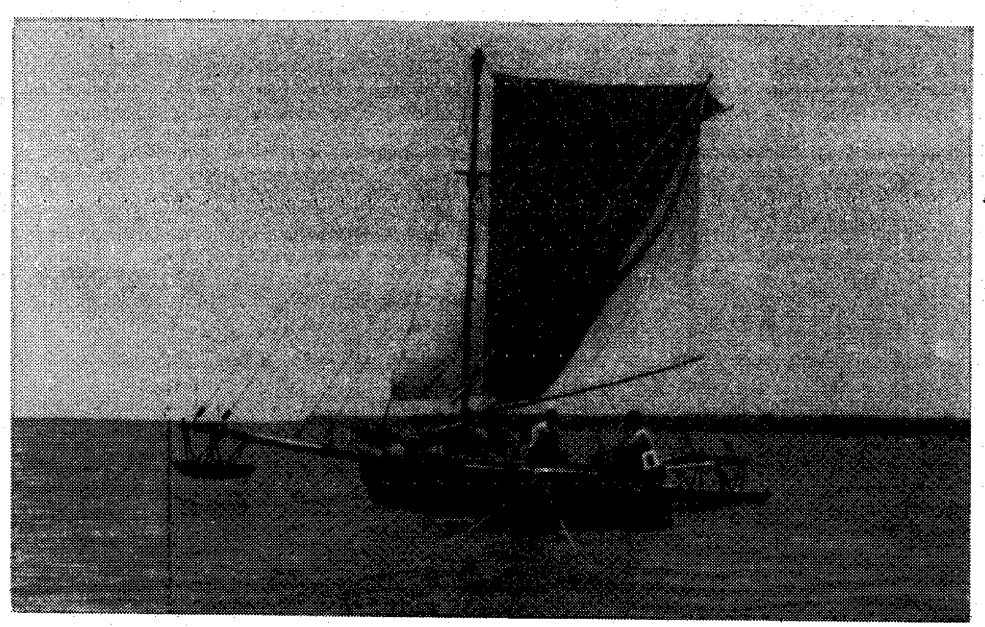
* *Present address: Fisheries Research Laboratory, P.O.Box 434, Wewak, E.S.P.*

THE THREE VESSELS USED IN THE SURVEY

The 'F.R.V. Moore - a 7.3 m plywood dory



A 4.7 m aluminium dinghy with a 35 hp outboard motor



The 'Masela' a single - masted, double outrigger sailing canoe

THE VESSELS USED IN THE SURVEY

Three types of vessels were used during the recent 3 week survey:

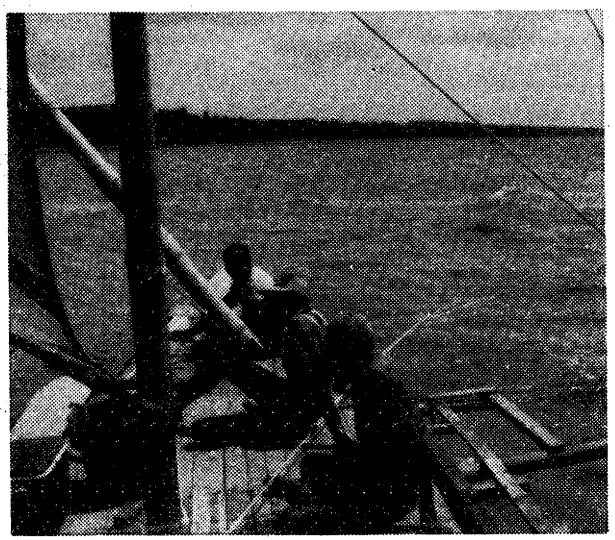
1. A 7.3 m plywood workboat, or dory, the 'F.R.V. Moore'. The 'F.R.V. Moore' is planked below the waterline and is powered by a Yanmar 3QM 30 hp inboard diesel engine. This was the largest vessel used. Its current value when new would be about K16,800. The 'F.R.V. Moore' was fitted with two small hand powered boat winches bought in Australia at $89 each (about K65). These were each fitted with 45 meters of 4 mm wire cable. The winches were bolted to a plank which was lashed across the deck of the vessel amidships. Also fitted was a simple trawl gallows. Stainless blocks (pulleys) were used to lead in the trawl warps (ropes). Beam shoes, weighing 10 kg, were made from scrap iron, and were lashed to a 5 m beam of bamboo.

2. A 4.7 m aluminium dinghy was used with a 35 hp Evinrude petrol outboard motor using a standard propeller. A towing bracket, attached to the middle seat, was used to make steering easier.

3. A local canoe, named 'Masela' and skippered by Narua of Kadawa village, was used to tow beam trawls under sail power only. The canoe was 11 m in length and was fitted with a 25 hp outboard to cut down time spent travelling between the trawls. This canoe proved to be a good fishing platform from which to work. It also had the advantage of being able to fish the shallow waters to depths of as little as 0.45 m.

The fishing trials from the canoe used only one 3.7 m trawl. However, later tests showed that in winds of 15 knots, the canoe could pull both a 3.7 m trawl and a 4.6 m trawl at the same time, at a speed of about 2 knots. The trawl warps were fastened to the base of the mast. When a course dead ahead was required the ropes were led out over the stern. To change course, the rope was unhitched from the stern and thrown out to one side. This pulled the boat around. The amount of turning effect was controlled by a lazyline' around the warps.

The dugout hulls of canoes like Masela are made from a red timbered species of tree, with small leaves. The local name is 'sida'. It was said to be fairly easy to obtain logs of this tree locally for canoe building purposes. Many of the fastenings on the canoes are lashings using bush materials or rope. The sails can be made of low-cost



The 'Masela' pulling two trawls in a 15 knot breeze

Steering the canoe using a 'lazy-line' around the trawl warps

polypropylene tarpaulins, or rice bags sewn together. Altogether, you would probably not need much more than K500 to build a large canoe, including the sails and rigging.

Depending on the quality of materials used to build the canoe, and the level of care and maintenance it receives, a canoe may last from 4-10 years. During this time it is often rebuilt once or twice as the wood used to plank it up does not last as long as the hull.

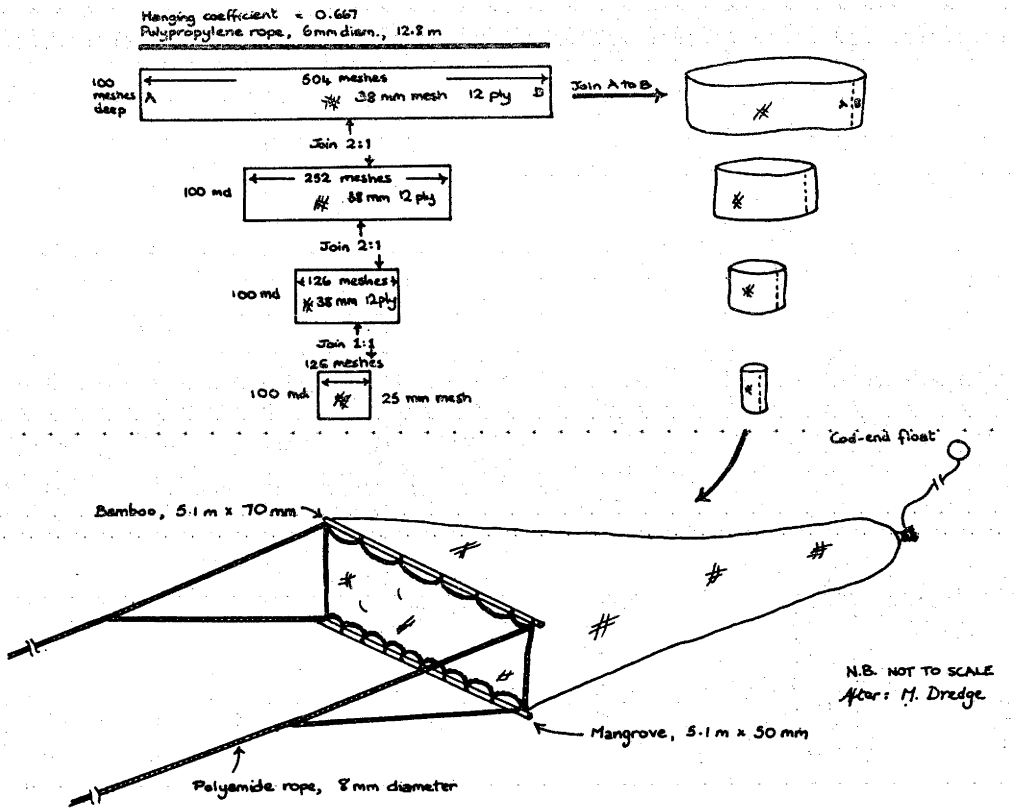
GEAR CONSTRUCTED AND USED

During much of the 3 week visit by the prawn specialist, the construction of different types of beam trawls was demonstrated to the local fisheries officers. During the remainder of the time these nets were used in fishing trials from the three vessels.

A Siebenhausen trawl and a ring trawl were made using plans supplied from the Queensland Fisheries Division. A 4-seam beam net, similar to the design used for prawn trawling in Cochin, India, was also made. Of these 3 designs, the 4-seam net is the most complex, and the ring trawl is the simplest.

In the fishing trials, we used the Siebenhausen trawl from the dory, and the ring trawl and the 4-seam trawl from the dinghy and the canoe. There was not enough time to find out whether there was any difference in effectiveness between these 3 nets. However, in the time available, all 3 appeared to fish fairly well.

The ring trawl deserves special mention because it is both simple to make and easy to operate as well as being effective. Only very basic net hanging skills are needed to make it. The design is shown in the diagram below. This design was developed by Mike Dredge, the visiting prawn specialist. It is considered to be the most suitable for construction by local fishermen at this stage. Further tests are needed to find out how effective it is under various conditions, compared to the more complicated designs.



The two beam ring trawl used in the survey

CATCH RATES

We had about 2 weeks to carry out fishing trials in the Daru area. During this time, the construction of nets and training of staff continued.

During the first week, when all 3 vessels were fishing in approximately the same area, most hauls made by the canoe were larger than most hauls made by the dinghy or the dory. The canoe's best haul of 9.5 kg in one hour was made in shallow water with the canoe occasionally bumping the bottom.

Why did the canoe seem to be the most effective trawling vessel? Possible reasons include:

a) It can operate in shallower water than the other 2 vessels;

b) The disturbance caused by the propeller on the motorised craft in shallow water could have a scattering effect on the prawns.

More trials are needed to find out whether these are the real reasons.

During the second week, catch rates were much lower than in week 1. This is thought to be because of very heavy rainfall on Monday 19 November which reduced the salinity (saltiness) of the water. For example, along the shoreline off Kadawa village, prawns had been numerous in depths of 0.45 to 0.6 m in week 1. However after the rain, the water tasted almost fresh on Wednesday 21 November, and there were very few prawns present. By Friday 23 November, fishermen reported that the prawns were numerous once again, and that the water was salty again.

The catches for which data was collected for each of the 3 vessels are shown in Table 1.

VALUE OF THE CATCH

As long as the prawns are kept in good condition, the income from the catch will depend on:

- the quantity caught
- the species
- the size
- the price paid for each grade of prawn.

In the local fish plant at Daru, catches of prawns are divided into 4 grades - large, medium, small and rejects. An example of the grading and value of a sample of 57.8 kg prawns marketed through the Daru fish plant is given in Table 2. In this sample, just over 20% of the catch were rejects'. These were mostly coral and endeavour prawns which could be sold on the local

TABLE 1. CATCHES OBTAINED DURING TRIAL BEAM TRAWLING NEAR DARU

Vessel trawled	Hours	Catch (kg prawns)	Catch per unit effort (kg/hour trawling)
Week 1			
Sailing canoe	7.67	36.43	4.75
Dinghy	2.5	7.7	3.08
'M.R.V. Moore'	1.6	5.3	3.31
Week 2 (after heavy rain)			
Sailing canoe	1.67	1.35	0.93
'M.R.V. Moore'	4.0	8.1	2.02
TOTAL	17.44	59.08	

TABLE 2. THE GRADING OF A SAMPLE OF PRAWNS AND THE INCOME FROM THESE FROM DARU FISH PLANT

Grade	Weight (kg)	% of catch by weight	Price per kg	Value (kina)	% of value of total catch
Large	5.8	10	K3.30	K19.14	19.3
Medium	19.0	34.4	K2.40	K47.76	48.2
Small	20.1	34.8	K1.60	K32.16	32.5
Rejects	12.0	20.8	Nil	Nil	0
Totals	57.8 kg	100%		K99.06	100%

Average value per kg = K99.06/57.8 = K1.71.

market in Papua New Guinea. The total value of the 57.8 kg catch was K99.06, or an average of K1.71 per kg.

OPERATING COSTS

The basic operating costs involved in trawling are fuel and ice.

Fuel. We worked out the cost of fuel used per hour trawling by the dory and the dinghy with outboard motor. The costs are given in Table 3. The canoe did not use any fuel whilst trawling.

Ice. The weight of ice bought by fishermen should be roughly the same as the weight of prawns they expect to catch, if export quality prawns are to be handled. The price of ice in Daru in November 1984 was 20t per kg (sold in 50t batches). In Table 3, the cost of ice is estimated from the weight of prawns caught per hour of trawling from the 3 vessels in week 1 of the trials. The weight of ice required is the same as the weight of prawns caught.

In Table 3, the gross income is estimated from the catch per hour in week 1 x the estimated value per kg of prawns of K1.71, as calculated in Table 2. The net income is the gross income, less the cost of fuel and ice.

From Table 3, we can see that under the conditions at the time, the fishing unit which had the highest actual income whilst trawling was the canoe. The canoe's hourly earning whilst trawling was K7.17.

For a full comparison of costs, many other factors would need to be considered. For example: the number of crew required, loan repayments, depreciation, repair and maintenance costs especially for the dinghy and dory, the need for favourable winds for the canoe and the greater speed of the dinghy.

CONCLUSION

The survey described in this article lasted only 3 weeks. Part of the time was taken up in training local fisheries officers to make the trawl gear. Therefore there was time for only a small amount of fishing from the 3 vessels. However, the high catch rates obtained in the first week of fishing by the sailing canoe indicate that the present small scale fishing operation for export-quality Banana prawns could be expanded. This would be possible if the Daru fish plant is prepared to handle greater quantities of export quality prawns. The expansion could take place using local craft, like the sailing canoe 'Masela', and low cost low technology methods such as beach seining and beam trawling. This would not involve spending large amounts of money. It is not necessary to wait for further research to be done before such an expansion is started, although a skilled technical person is needed to organise it.

TABLE 3. BASIC OPERATING COSTS AND HOURLY INCOME FOR THE THREE KINDS OF SMALL BEAM TRAWLER OPERATED DURING THE FIRST WEEK OF THE SURVEY

Vessel	Fuel used per hour trawling (litres)	Fuel cost per hour trawling (kina)	Ice cost per hour trawling (kina) (1)	Catch per hour (kg) (2)	Gross income per hour	Net income per hour trawling (3)
Sailing canoe	Nil	Nil	0.95	4.75	8.12	7.17
Dinghy (35 hp outboard)	4.44	3.55	0.62	3.08	5.26	1.09
Dory (3QM 30 hp diesel)	4.0 (estimate)	2.08	0.66	3.31	5.66	2.92

(1) The ice cost per hour trawling is estimated from the catch per hour (from Table 1) x the cost of ice in Daru (20 t per kg)

(2) Gross income per hour = Catch per hour (from Table 1) x Value per kg of prawns of K1.71 (from Table 2)

(3) Net income = Gross income - fuel and ice costs.

THE CULTIVATION OF SHIITAKE MUSHROOMS IN PAPUA NEW GUINEA

By F. Arentz, Forest Pathologist, Forest Research Station, Bulolo

INTRODUCTION

The Shiitake mushroom occurs naturally in South East Asia, Papua New Guinea and Australia. It is a favourite food in Asia and North America. It has been cultivated in Japan for many centuries and is now also cultivated in China, Taiwan, Korea, Thailand, India and Bhutan. There is a large world trade in dried Shiitake mushrooms, and demand is starting to exceed supply. So there would be a ready market for any Shiitake mushrooms grown commercially in Papua New Guinea. Mushrooms also have potential as a source of high quality protein for people in Papua New Guinea. Fresh mushrooms contain 3-4% protein and the dried product contains 30-50% protein. In addition Shiitake mushrooms are reported to have medicinal value.

This article outlines the work carried out in Papua New Guinea on mushroom cultivation. Also, the technique for Shiitake mushroom cultivation is set out.

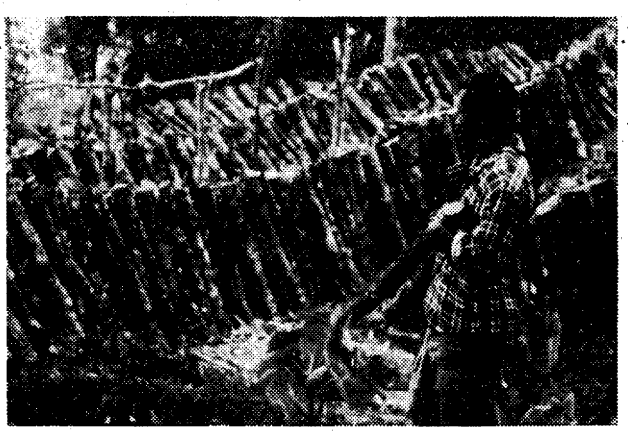
THE SHIITAKE MUSHROOM IN PAPUA NEW GUINEA

In Papua New Guinea, trials started in 1974 to see whether Shiitake mushrooms could be cultivated under our conditions. The first trial was set up at Bulolo, in the Morobe Province. The results showed that the daily temperatures were too hot to produce a high quality mushroom. Other trials were then set up in the Southern Highlands Province where conditions are more suitable for the cultivation of Shiitake mushrooms.

In 1979 NPEP funding was obtained from the National Government to build a laboratory and house at Mendi. In addition a full-time Mushroom Project Officer was recruited and, after an initial training period at Bulolo, he was placed at Mendi. A small mushroom production area was established outside Mendi, but this was later destroyed in tribal fighting. Before the production area was destroyed, dried Shiitake mushrooms harvested there were being sold in Port Moresby for K10/kilo.

Through lack of funds no further work has been done in Papua New Guinea on setting up Shiitake mushroom growing on a commercial basis.

In 1983 an FAO mushroom expert came to Papua New Guinea to examine the possibilities of growing Shiitake mushrooms commercially in Papua New Guinea. His report was very optimistic. He suggested that Shiitake mushroom cultivation was ideally suited for the more economically depressed areas of the Highlands of Papua New Guinea. On the basis of this report the Southern Highlands Department of Forests has now submitted a NPEP request for funds for 1986.



Wayong Nangi, Mushroom Project Officer, in the raising yard at Kolunda, near Mendi

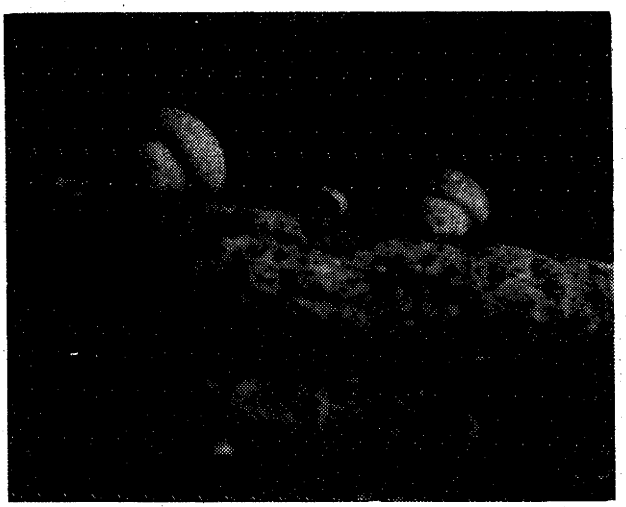
Research work being carried out now is aimed at comparing the productivity of different strains of Shiitake mushroom grown under different climatic conditions.

It is expected that the commercial production of Shiitake mushrooms in Papua New Guinea will involve both the Government and the villager. The Government will be responsible for:

- the production and distribution of inoculum;
- buying the mushrooms from the grower;
- the drying and marketing of the product.

The villager will be responsible for:

- cutting the logs on which Shiitake mushrooms are grown;
- the inoculation of the logs;
- maintenance of the logs;
- harvesting the Shiitake mushrooms.



Shiitake mushrooms just beginning to fruit on an oak log

THE SHIITAKE MUSHROOM

The Shiitake mushroom has a light brown or reddish brown cap, with a white to pale yellow margin, and a reddish brown centre. The margin of the cap sometimes has small flattened scaly marks. The gills (on the under-side of the mushroom) are white. Mushrooms range from about 40 to 120 mm in diameter. The flesh of the cap and stipe (special name for the stem of a fungus) is white, with a slightly acid taste and a faint but distinct garlic-like taste and smell. Although Shiitake mushrooms can be eaten fresh, they taste better if they have been dried.

TREES SUITABLE FOR USE AS BED LOGS

The Shiitake mushroom grows on the dead wood of oak and beech trees. These trees are members of the family Fagaceae which includes the genera *Nothofagus* (beech), *Lithocarpus* and *Castanopsis* (oak). All of these trees are common in the forests of the Highlands of Papua New Guinea. The bark of these species contains chemicals which cause the Shiitake mushrooms to grow, so that only trees of the family Fagaceae are suitable as bed logs. It is important that trees to be used for growing Shiitake mushrooms are handled carefully so as to cause as little bruising and tearing of the bark as possible. If the bark is removed from the log, the Shiitake mushrooms will not grow.

Trees of oak or beech are cut up into log lengths of 1.0 to1.5 metres. At any site all logs should be the same length. Because the logs have to be moved during the growing cycle only small logs of less than 20 cm in diameter are used. Both the trunk of the tree and branches greater than 5 cm diameter can be used. Logs which contain a lot of decayed wood, or logs which have large branch stubs are not suitable. Cut the logs with a saw or chainsaw. This will leave smoother ends on the logs, and reduces the possibility of the logs being decayed by other fungi.

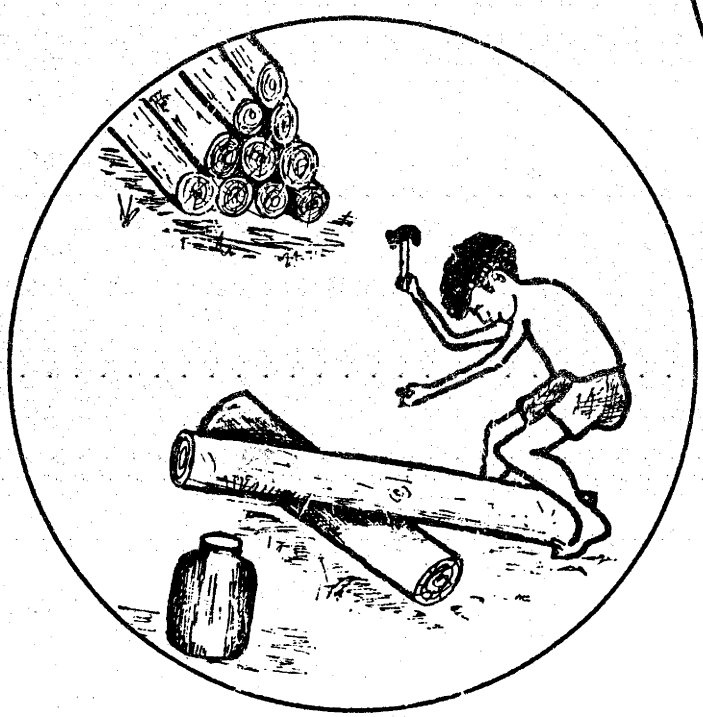
INOCULATING LOGS

The logs are assembled at the growing site and are inoculated 2 to 3 weeks after cutting. By 'inoculate' we mean that the Shiitake fungus is implanted into the logs.

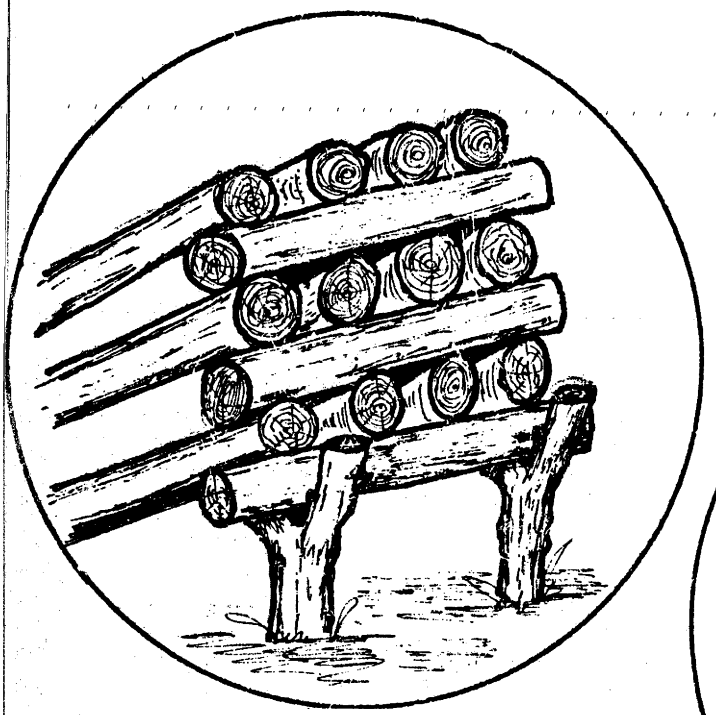
Holes 13 mm in diameter and 20 mm deep are drilled into the logs using an electric

1. *Felling of trees*

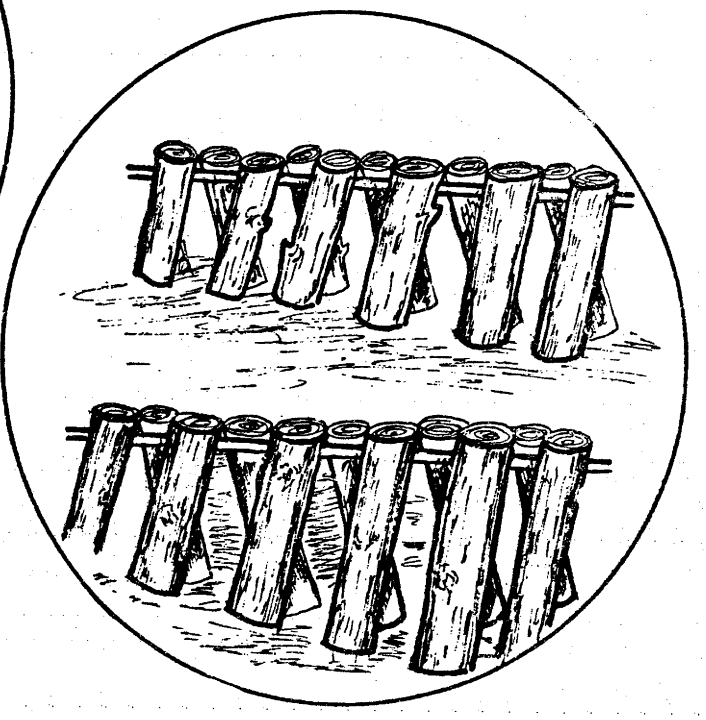
2. *Cutting of logs into lengths*



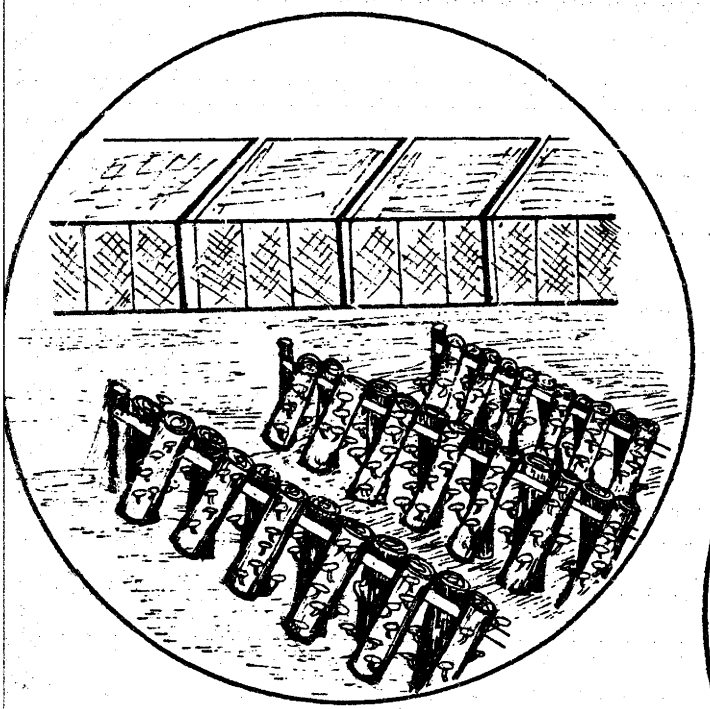
3. *Inoculating logs with pellets of wood containing the fungus*



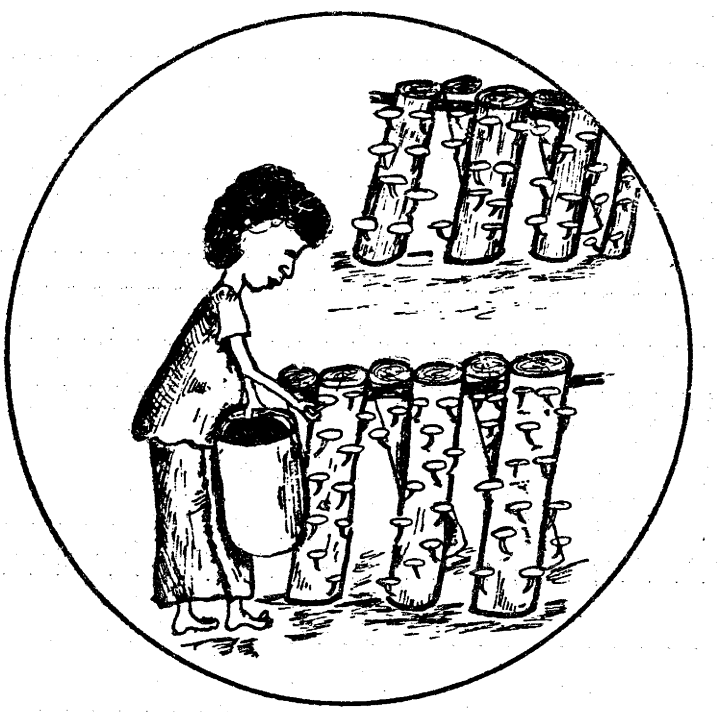
4. *Laying of 'bed logs'.*



5. *Position of logs in raising yards*



6. *Fruiting of Shiitake mushrooms*



7. *Harvesting of Shiitake mushrooms*

drill. Electricitv for the drill may come from the main supply or a portable generator. The first row of holes is drilled with the holes about 20 cm apart along the log, starting 5 cm from one end of the log. The next row of holes is made 5 to 7 cm further around the circumference, with the holes midway between the holes in the first row. If a 1 metre log is used then there will be 4 holes in the first row, and 3 in the second. This sequence is followed right around the log. It is important that no dirt or litter gets into the drilled holes.

The log is now ready for inoculating. Shiitake fungus inoculum, or spawn, is grown in glass or plastic bottles full of small rod-shaped pieces of oak wood about 13 mm diameter and 15 to 20 mm long, and a small amount of sawdust, wheat-bran, and chemicals to make the fungus grow faster. The rod-shaped pieces of inoculum are taken from the bottle and gently hammered into the drilled holes until the top of the plug is level with the bark of the log. The plug is then coated with a layer of vaseline or petroleum jelly.

Care should be taken to ensure that the logs are kept as clean as possible. If the logs are muddy there is a high risk that other fungi will grow in them. It is also important that the person inoculating the logs has clean hands and a clean hammer. Weed fungi (that is, species of fungi other than Shiitake mushrooms) are the biggest cause of the failure of Shiitake mushrooms to grow well.

LAYING

After inoculation the 'bed logs' are placed in a laying yard in an area where the Shiitake fungus will be able to grow quickly through the wood. It is important that this place should be shaded, with gentle air movement, and be well drained. Direct sunshine is unsatisfactory as the fungus stops growing when the temperature is above 30°C. The amount of shade should be 50 to 70%. The edge of the forest is more suitable than an undisturbed forest. During periods of dry weather it may be necessary to lightly water the logs.

The logs are stacked in their laying sites with single logs laid crosswise to increase ventilation, as shown in drawing number 4 on page 63. The logs remain in this position until the sapwood has been fully colonised by the Shiitake fungus. The logs should be turned around once a month to prevent uneven drying and splitting of the bark.

RAISING AND CROPPING

When the sapwood is completely colonised, the logs are suitable for cropping. This may take from 4-10 months depending on the climate, the type of wood and the strain of Shiitake mushroom used. The progress of colonisation of the sapwood can be followed from changes in the bark colour. The bark becomes darker as the Shiitake mushroom grows through the sapwood underneath. When ready, the logs are transferred to a cooler, moister, shadier site as the best temperature for mushroom formation is lower than that for vegetative growth, and the moisture content of the wood needs to be higher than required for vegetative growth. In the raising yard the logs are in an almost upright position against a single support, as shown in drawing number 5 on page 63.

Oak logs in the raising yard at Kolunda, near Mendi

Under ordinary weather conditions 2 to 5 crops of Shiitake mushrooms a year will

develop once fruiting has begun. Logs will last for 3 to 5 years. Logs should be harvested daily when fruiting takes place. The mushrooms should be picked, including the stem, when the veil (i.e. the 'skin' around the under-side of the mushrooms) has just broken and while the mushrooms are still convex (rounded).

DRYING

Shiitake mushrooms are best dried in hot air driers, starting at 30°C, and increasing the temperature by 1-2°C per hour until a temperature of 50°C is reached. Mushrooms collected in wet weather need to be dried more slowly than those collected in dry weather. Usually drying takes 12-13 hours. Finally they are heated at 60°C for 1 hour to enhance the flavour and appearance.

In Papua New Guinea the relatively high temperatures cause the Shiitake mushrooms to develop quickly and to have relatively thin caps. This means that we will only be able to produce dried mushrooms of quality lower than those produced in countries with cold climates.

FURTHER INFORMATION

Further information on Shiitake mushroom growing can be obtained from:

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P.O. Box 134,
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EARLY YIELDS FROM DWARF x TALL COCONUTS EXPERIMENT

By R.M. Brook,* Coconut Agronomist, Bubia Agricultural Research Centre, Lae

INTRODUCTION

In Papua New Guinea, hybrid coconuts have been commercially distributed by the Hybrid Coconut Project for the past 5 years. The earliest ones planted are now bearing their first nuts. The type being sold in Papua New Guinea is a cross between a dwarf type called the Malayan Red Dwarf and a tall coconut from the Solomon Islands called the Rennell Island Tall. This cross was not fully tested in Papua New Guinea before its distribution by the Project. However, it was known from experiments in other countries, such as Ivory Coast and Solomon Islands, that hybrid coconuts could produce much greater yields than the tall types usually grown.

It was decided to begin distributing hybrid coconuts in Papua New Guinea before testing was complete for the following reasons:

1. A survey of coconut plantations in 1973 showed that almost half the palms were over 50 years old. Therefore widespread replanting was necessary.

2. Other copra-producing countries, such as the Philippines, Indonesia and Malaysia decided to replant with high yielding hybrid coconuts. If Papua New Guinea also replanted with hybrids there would be an improvement in yield. Hence the copra industry here would be able to compete alongside those in other countries.

3. It would have taken at least 10 years to test the hybrids. During that time, if increased world production caused copra prices to fall, it would be far more difficult for producers without the high yielding hybrids to continue making profits.

In general, tall coconuts are slow to begin bearing, but bear the large nuts that growers prefer. Dwarf coconuts, on the other hand, are short, come into bearing quickly (the first nuts are borne just over 3 years after field planting), and produce large numbers of small nuts. Experiments showed that hybrid crosses combined the best of these characteristics. The crosses bore large numbers of large nuts, and came into bearing quickly.

Before the distribution of hybrid coconuts in Papua New Guinea, one experiment had been started to evaluate hybrids and to compare them with the best tall varieties available. The experiment was begun in 1975.

This article describes some aspects of that experiment.

EXPERIMENTAL DETAILS

Five hybrid crosses and four tall varieties are being tested in this experiment. They are listed in Table 1, together with their place of harvest, date of seednut harvest and field planting date.

There are 2 experimental sites: The Lowlands Agricultural Experiment Station at Keravat, and Bubia Agricultural Research Centre, Lae.

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* *Present address: Department of Agriculture, University of Newcastle-upon-Tyne, Newcastle-upon-Tyne, England*

TABLE 1. VARIETIES OF COCONUT PALM GROWN IN SPACING x VARIETY TRIAL AT KERAVAT AND BUBIA, WITH ORIGINS, HARVEST AND PLANTING DATES

Variety	Where obtained	Seednut harvest date	Field planting date (1975)	
			Keravat	Bubia
Malayan red dwarf x Rennell Island tall (MRD x RT)	Yandina, Solomon Islands	Nov. 1973	January	Feb.
Malayan red dwarf x Malayan tall (MRD x MLT)	Yandina	Nov. 1973	January	Feb.
Malayan red dwarf x Solomons tall (MRD x ST)	Yandina	Nov. 1973	January	Feb.
Malayan red dwarf x Gazelle tall (MYD x GT)	Ralabang Plantation, ENBP.	Jan. 1974	January	Feb.
Malayan yellow dwarf x West African tall (MYD x WAT)	IRHO, Ivory Coast	Sept. 1974	December	May
Rennell Island tall (RT)	Rennell Island, Solomon Islands	Nov. 1973	January	Feb.
Karkar Island tall (KT)	Bulu Plantation, Karkar I.	Nov. 1973	April	Feb.
Markham Valley tall (MT)	Riara Village, Markham Valley	June 1974	October	March
Gazelle Peninsula tall (GT)	Natava Plantation E.N.B.P.	Oct. 1974	June	Feb.

A full version of the experiment was planted at Keravat. Here, the palms were planted in 3 spacings:

1. 7.5 m triangle (205 palms/ha)
2. 8.5 m triangle (160 palms/ha)
3. 10 x 6 m hedge (167 palms/ha)

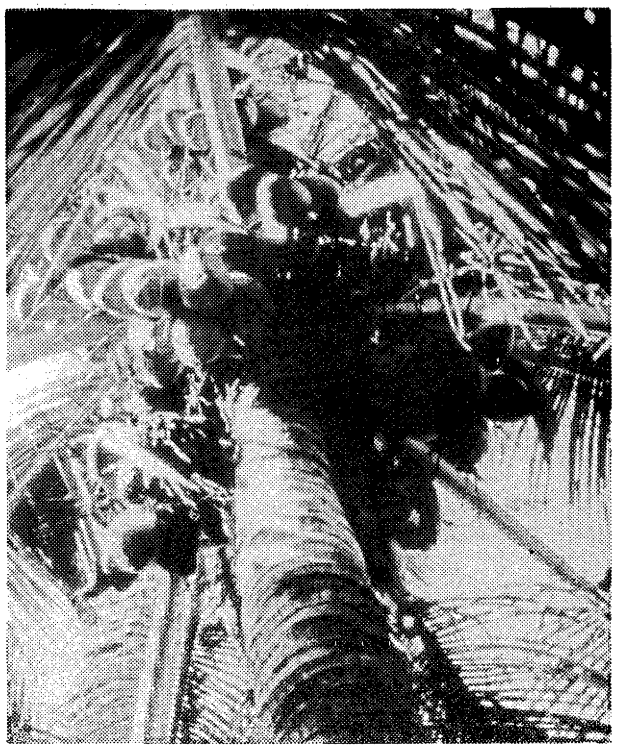
All 9 varieties were planted in each spacing. Two plots of each variety/spacing combination were planted. So there were 54 plots altogether. Each plot held 12 palms.

At Bubia, all 9 varieties were planted in plots of 12 palms, but in the 7.5 m triangle and 10 x 6 m hedge spacings only. Only 1 plot of each variety/spacing combination was planted. So there were 18 plots altogether.

The two triangular spacings were chosen as suitable for sole plantings (coconuts only). The 10 x 6 m hedge was chosen as suitable for underplanting with cocoa.

A ground cover of *Pueraria javanica* was established. All palms were ring-weeded.

At Keravat, the palms were fertilized every



The photograph on the left shows a tall coconut palm, of the type traditionally grown in Papua New Guinea. The photograph on the right shows a dwarf x tall hybrid bearing a typical heavy crop of coconuts

6 months with 0.75 kg ammonium sulphate and 0.75 kg sulphur. At Bubia, until August 1980, each palm received 0.6 kg ammonium sulphate every 6 months. After August 1980, the dose was changed to 1 kg potassium chloride per year, plus 1.2 kg magnesamon and 1.5 kg ammonium sulphate every 6 months.

RESULTS AND DISCUSSION

The results given here include:

1. Only trees that survived beetle attack
2. The yields of copra for 1982
3. The total yields up to the end of 1982

Problems

There were several problems with this experiment:

At Keravat many palms died because of attacks by the New Guinea rhinoceros beetle (*Scapanes australis*), followed by the palm weevil (*Rhyncophorus bilineatus*). These pests are not a serious problem at Bubia. Table 2 shows that there were great differences in survival of palms between variety and sites. RT was the most susceptible to attack, and GT was the most resistant to attack.

As a result of these deaths at Keravat, recording from 43 of the original 54 plots was stopped.

Palms at Bubia had a higher survival rate than at Keravat, but nut sizes were very small, possibly because of poor drainage and waterlogging of the soil.

At both Keravat and Bubia there were large numbers of rogue dwarfs in the MRD x ST and MRD x MLT plots. 'Rogue dwarfs' are hybrid seedlings that turned out to be dwarf palms. At Keravat, MRD x MLT could not be included in the results, because there were too many rogue dwarfs on the plots.

TABLE 2. SURVIVING HEALTHY PALMS AT KERAVAT AND BUBIA AFTER 6 YEARS GROWTH (Recorded in May 1981)

Variety	Keravat	Bubia
MRD x RT	47%	96%
MYD x WAT	58%	91%
MRD x ST	42%	77%
MRD x GT	59%	91%
MT	50%	92%
KT	54%	74%
RT	22%	83%
GT	67%	96%
Mean	49.9%	87.5%

It is not possible to compare the effect of spacing on the growth of the palms in this experiment because:

a) The many palm deaths at Keravat left many empty spaces on the plots.

b) At Bubia only one plot in each spacing/variety combination was planted. At least 2 plots of each are needed to make a comparison.

Therefore, the results given here only refer to the performance of the varieties. Rogue palms are not included in the calculations of yield.

Performance of the varieties

The Malayan Red Dwarf x Rennell Tall hybrid showed the most vigour from the start, and were the first to flower. At Keravat, at 24 months after field planting, 8% were flowering.

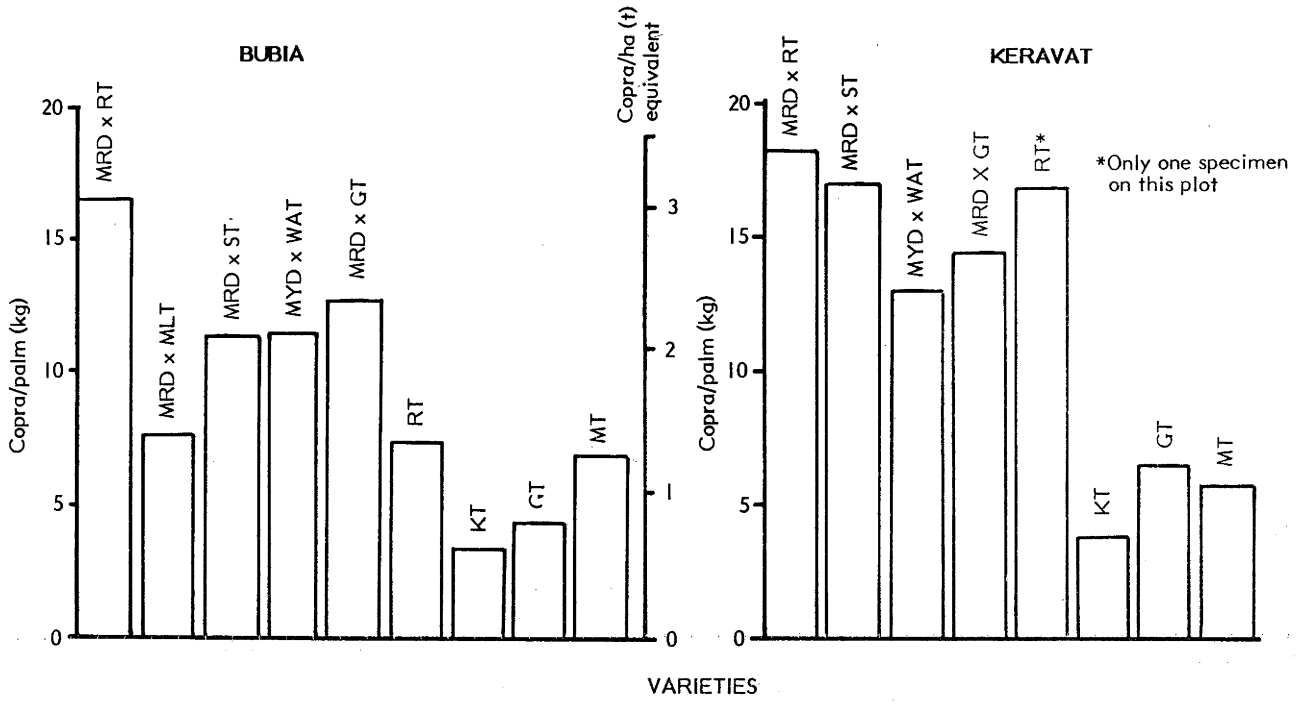
In 1982, all the hybrids gave larger yields than the tall coconuts. At both Keravat and Bubia MRD x RT had the greatest yields. MRD x ST and MRD x GT both appeared to be promising varieties, except for their small nut sizes (see Table 3). The high yield of RT at Keravat was because this was recorded from a single but heavily bearing palm.

The low yields from MYD x WAT compared with MRD x RT were surprising. In experiments elsewhere in the world, MYD x WAT has proved to be a very high yielding cross. It is the most widely grown hybrid variety in most other countries with large coconut replanting programmes.

Table 3 also shows the cumulative yields at Bubia up to the end of 1982 (i.e. yields from all the years added up). The yields are given in tonnes per hectare. MRD x RT was by far the most heavily cropping variety tested. This was because MRD x RT started to bear nuts just over 3 years after planting, and took only 5 years (from planting) to bear their first tonne of dry copra/hectare.

TABLE 3. CUMULATIVE YIELDS OF DRY COPRA AT BUBIA UP TO THE END OF 1982 AND NUT SIZES (DRY COPRA BASIS) AT BUBIA AND KERAVAT IN 1982

Variety	Cumulative yield (t/ha equivalent) at Bubia	Nut sizes in 1982			
		Bubia		Keravat	
		Copra/nut(g)	Nuts/t	Copra/nut(g)	Nuts/t
MRD x RT	11.08	160	6250	240	4170
MRD x MLT	3.74	138	7250	not represented	
MRD x ST	6.02	123	8130	185	5400
MRD x GT	6.20	128	7810	193	5180
MYD x WAT	4.41	125	8000	195	5130
RT	3.07	193	5180	249	4020
KT	1.57	155	6450	253	3950
GT	1.31	121	8260	206	4850
MT	2.94	187	5350	323	3100



Dry weight of copra per palm at Bubia and Keravat, with per hectare equivalent at Bubia, for 1982

By contrast, the best tall at Bubia, RT, took eight months longer to come into bearing and nearly seven years to bear the first tonne of copra/ha. In terms of cumulative yields, all the hybrid varieties tested out-yielded talls.

The diagram above shows that as annual yields are higher in all hybrid crosses compared with talls, this difference in cumulative yields will grow bigger as time goes on.

CONCLUSION

Although the Hybrid Coconut Project took a risk in releasing a hybrid cross which at that time had not been fully tested in Papua New Guinea, this experiment shows that the risk was justified. In terms of earliness of bearing, annual copra yield and cumulative yield, the MRD x RT hybrid was by far the best variety in this experiment up to the end of 1982 - nearly 8 years after planting.

For the grower, although this planting material may seem expensive at first, it will repay capital outlay more quickly than traditionally grown tall varieties. Also it will provide higher income per unit area of plantation.

There are a number of hybrid coconut demonstration blocks growing in all lowland provinces. Here you can see how good these coconuts are for yourself. Contact your Provincial Coconut Officer or your Area Coconut Officer via the National Crops Advisor (Coconut), D.P.I., P.O. Box 417, Konedobu.

FURTHER READING

Brook, R.M. (1982). The Hybrid Coconut Project in Papua New Guinea - its past, present and future. *Indian Coconut Journal* 12:3-8.

Thompson, P. (1981). Hybrid coconuts in Papua New Guinea. *Harvest* 7 (3): 121-125.

SOME SUGGESTIONS FOR IMPROVING MANAGEMENT ON SMALL SEMI-COMMERCIAL BROILER PROJECTS

By B.J.K. Bakau, Animal Production Officer, Poultry Research Centre, Lae

INTRODUCTION

During the past 10 years the poultry meat industry in Papua New Guinea has seen many changes. Originally, young chickens were imported from Australia. Now, the industry imports grandparent stock and rears them locally. These birds produce the country's broiler breeders which are used to produce broilers (meat chickens). See HARVEST Volume 7, No. 4 for details.

The strain of chicken used since the broiler industry was set up is called TM-70. The strain was developed by A.A. Tegel, Australia. Over the years it has been improved and it is now capable of producing 1.8 kg at 7 weeks old, compared with 1.5 - 1.6 kg at 9 weeks old, 10 years ago.

Broiler production in Papua New Guinea can be divided into two sectors: the large commercial operations, and the small semi-commercial projects run by smallholders. In smallholder projects, poor management is usually the cause of problems such as high death rates and low rates of growth, and therefore low income for the smallholder. This article examines some common problems in managing broiler projects.

SOME PROBLEMS IN MANAGEMENT

1. What to do when chickens first arrive

Too often, the grower either collects his or her chickens without preparing for them, or does not know what to do with them. This can be very serious, especially if the chickens have been on a long plane flight, or have been delayed in transit.

The first thing the grower should do when his chickens arrive is to give them some water. After chickens hatch, they can go without water for 72 hours in mild temperatures. If the chickens have been transported without water for a long time, give the water slowly, in small amounts.

Chicken feed (starter mash) should be placed on a flat surface in small amounts to start with. Later the chickens will get used to getting their feed from feed troughs, such as cut-open bamboos.

2. Brooding

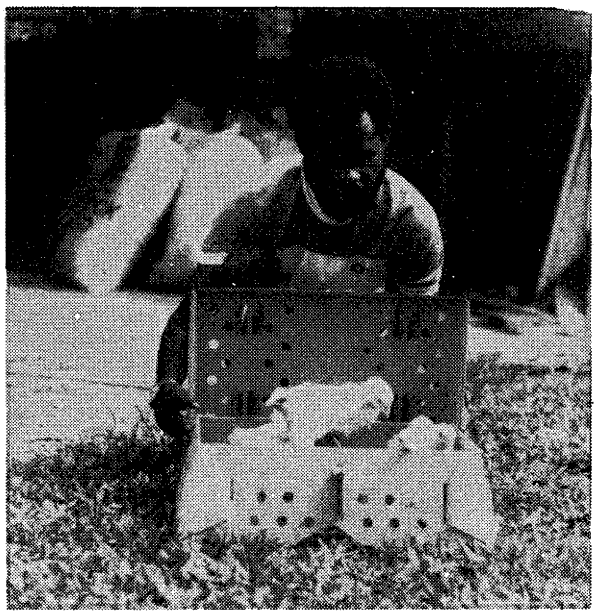
Brooding means keeping the young chickens warm. This is done by keeping them in a special enclosure, and using an artificial heat source, if necessary.

During the brooding period young chickens require special care, as they are very sensitive to any kind of stress. Normal chickens have a fairly high body temperature of about 42°C. It is important to give the young chickens extra heat until they are big enough to keep themselves warm.

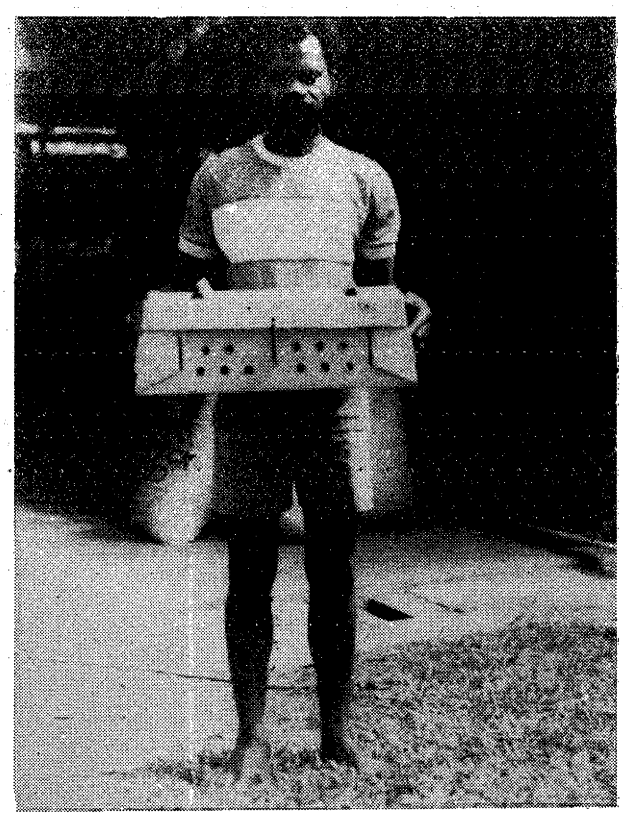
Several methods of brooding can be used. The method used depends on the number of chickens and on whether the project is in a cool or a warm area.

For lowland or coastal areas we recommend 'cold brooding', where no artificial heat source is used. A recommended method of cold brooding for 200-300 chickens is described in the article by R. Abdelsamie in HARVEST, Volume 10, No. 2.

For smallholders, in both the highlands and lowlands, we recommend a simple method of brooding using cardboard boxes. An empty tinfish (48 tins) or beer carton (24 bottles) can hold about 25 chickens. Give the young chickens food and water in an enclosure during the daytime. Put them into the boxes in the late afternoon and



Young chickens must be brooded (kept warm) for up to two weeks. A box like this is suitable. Note the airholes, so that the chickens can breathe.



The box of chickens should be taken indoors at night, especially in the cooler highlands.

close the boxes. Make a few air holes in the sides and top of the boxes so that the chickens can breathe. In highlands areas, the boxes will need to be carried into the house at night, so that on cold nights the fire will keep the chickens warm.

Another method is to use warm brooding using hurricane lamps. Two hurricane lamps are enough for about 50 chickens.

For full details about how to make warm brooders see Rural Development Series Handbook No. 4, 'Poultry', or Farming Note No. 29, 'Poultry - Australorp Chickens'.

Always check the behaviour of young chickens during brooding. If the birds crowd together, or crowd round the heat source, this indicates that it is a bit chilly in the brooder. If the chickens are scattered evenly then they are warm enough. If the chickens scatter away from the heat source, then it is too hot and the heat source should be decreased.

Wet deep litter in the brooder should be removed as soon as possible, as the smell from it will stop the chickens eating.

In the lowlands, 7 days of brooding should be enough before the chickens can be exposed to the outside environment. In the highlands, 10-14 days will be required.

3. After brooding

Straight after the brooding period, the chickens should weigh 100-120 g. From day-old to 23 days, the birds should be given broiler starter feed. After 23 days the birds should be given broiler finisher, which has a lower protein content.

The reason why two broiler feeds are used is that after the birds are about 3 weeks old, they do not need so much protein. However, for smaller projects, of less than 100 chickens, if may be economical to give broiler finisher throughout the rearing period. During the first 3 weeks it should be broken into small crumbs so that the young chickens can eat it.

4. Stocking rate

The chickens should be allowed at least 0.08

m^2 to 0.1 m^2 per bird in the chicken house (that is, 10 - 12 chickens for every square metre floor area).

5. Feeds

There are now 3 types of broiler finisher and 2 types of broiler starter made locally. They are:

Ordinary broiler starter -
20% crude protein

Ordinary broiler finisher -
18% crude protein

High density broiler starter -
22% crude protein

High density broiler finisher -
20% crude protein

High energy broiler finisher -
20% crude protein

Staff at the Poultry Research Centre have conducted trials on these feeds to find out what difference they make to the growth of broilers. It was found that high density broiler starter and high energy and high density broiler finisher gave a better result than ordinary broiler starter and finisher.

By 7 weeks, the growth of broiler chickens is complete. Any feed given after this is used in the energy requirement, or converted to body fat. If the chickens cannot be sold at one time and need to be kept longer than 7 weeks, the broiler finisher can be diluted with a high energy ingredient like corn or cassava.

Broilers should be given food and water at all times. If their needs, especially of water, are not met, this could affect their performance. Note that in the tropics chickens consume twice as much water as chickens in temperate climates. Lack of water for even a few hours will decrease growth rates. In hot weather poultry tend to spend most of their time around the water troughs and do not eat much.

Live chickens fetch very high prices when sold in local markets. The prices range from K3 in coastal areas to K5 - K10 in the highlands.

HOW CAN DIDIMEN AND DIDIMERIS HELP THE GROWER MAKE A 'PROFIT'?

There are three areas in which a didiman or didimeri could help smallholders manage their broiler projects:

1. The growers can be helped to obtain stocks of day old chicks, and feed. The didiman should also suggest how many chickens the grower should buy, keeping in mind the demand for live chickens in the area. We have seen growers make a good profit with a small project. However, when they suddenly increase the number of chickens, hoping to make even more profit, they find they cannot sell them quickly enough. So the chickens have to be kept longer than necessary, and money is wasted on feeding them.

2. It is important to keep simple farm records on stock and feed purchases. There is an article about keeping records and accounts in HARVEST Volume 10, No. 2. Records will help the grower to decide on a selling price for his birds. They also allow the didiman or didimeri to keep track of the progress of the project.

3. If the management systems recommended do not seem suitable for a particular area, or if people are using other feeds and systems didimen could advise staff at D.P.I. Labu, so that these other systems can be evaluated.

Co-ordinated extension support is essential to make sure that projects are run at a profit, and that there is always a good supply of live chickens for the local markets.

FURTHER READING

Abdelsamie, R. (1984). A chicken cold brooder suitable for the New Guinea lowlands. *Harvest* 10(2): 76-78.

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West, G.M. (1984). Farm records and accounts. *Harvest* 10(2): 54-58.

FURTHER INFORMATION

Any queries, comments or requests for further information should be addressed to:

The Officer-in-Charge
Poultry Research Centre
P. O. Box 73
LAE

(Telephone: 421022)

ENTOMOLOGY BULLETIN: NO. 37

WHITE WAX SCALE: A PEST OF CITRUS

By B.M. Thistleton, Senior Entomologist,
Kuk Agricultural Research Station, Mount Hagen

INTRODUCTION

In the highlands if a citrus tree is examined a number of small white spots of wax can often be found. The leaves, stems and fruit of these trees are usually covered with a black 'deposit'.

The white spots are insects called white wax scales, *Gascardia destructor.* These scales feed by sucking the sap from the plants through special mouthparts which are pushed into the plant stem. The black 'deposit' is a fungus called sooty mould. This lives on a sweet sticky substance called honey dew which is produced by the white wax scales.

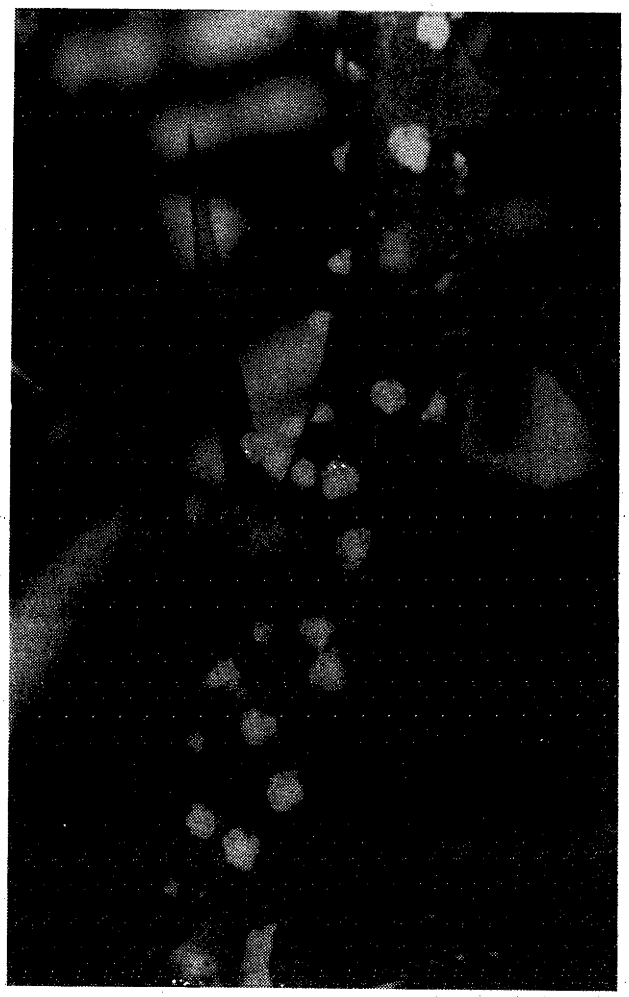
DESCRIPTION

All the white wax scales found on a citrus plant are females. The waxy covering of the adult female is irregular in shape and is up to about 9 mm across and 6 mm high. This waxy covering is for protection against enemies. The white wax scale's mouthparts are pushed into the plant and because it has a continuous supply of food it does not need to move. The adult scale therefore has no legs or wings.

The adult males of most scales are small insects with wings, completely different to the adult females. However in the case of the white wax scale, adult males are unknown.

BIOLOGY

Mature females of the white wax scale lay up to 1000 eggs and then die. The eggs remain under the scale's waxy coat until they hatch into small crawlers. The crawlers have 6 legs, like other insects. They move from the twigs to the leaves where they attach themselves to the midrib and feed on the sap through their piercing mouthparts. They produce about 13 strands of wax from their backs which gives them a star-like appearance.



A citrus branch infested with white wax scale.

The crawlers stay on the leaves for a few weeks until they have grown enough for their first moult (change of skin). They then move back to the twigs where they settle and push their mouthparts into the plant to suck the sap. They then lose their legs. They grow and change their skins several times until they are adult females, ready to lay eggs and start the cycle again. Adult males are not known and the females can lay eggs without mating.

When the scale insects feed they take into their bodies large amounts of sap from the plant. From this they take their food. However there is usually too much sugar and this is excreted in large quantities as a substance called honeydew. The honeydew covers the leaves, stems and fruit, and provides a food for a black fungus, called sooty mould, which grows on it. So plants which have very large numbers of white wax scales on them often have a large number of their leaves and fruit blackened by this fungus.

ECONOMIC IMPORTANCE

The white wax scale attacks a range of plants including citrus, avocado, guava, coffee, tea, gardenia and some bush plants. On some plants, such as citrus and gardenia, the numbers of the scales are often high. On others, such as tea and coffee, scales are rare.

The white wax scale causes damage to citrus in two ways. Firstly large numbers of scales can remove so much sap from the plant that the plant does not grow so well, and the yield of the crop is reduced.

Secondly the sooty mould, which grows on the honeydew produced by the scales, coats the leaves and so reduces the amount of sunlight that reaches them. Green plants make their food through a process called photosynthesis. This process can only occur in sunlight. By reducing the amount of sunlight reaching the leaves, the sooty mould also reduces the amount of food the leaves can make. This slows down the growth of the plant. Also the sooty mould growing on the fruit makes it look unsightly and reduces its value unless it is washed before it is sold.

CONTROL

Biological

In Papua New Guinea several predators feed on white wax scales, e.g. predatory ladybirds. However these predators do not reduce the numbers of scales enough to reduce the damage which they cause. In parts of Africa the scale insect is only present in low numbers on citrus and studies by entomologists have shown that this is because several species of parasites keep it under control. These parasites are mainly tiny wasps. They insert their eggs into the scales and their young stages live inside the scales. The parasite larvae eventually kill the scales when they themselves are fully grown and ready to change into adult parasites.

Three of these parasites have been introduced into Australia. One of these, *Paraceraptrocerus nyasicus*, gave very good control of the white wax scale in Queensland, and at the end of 1981 this species was imported into Papua New Guinea.

The parasite has given very good control of the white wax scale in the sites at which it has been released in Papua New Guinea. It is gradually spreading from these sites.

Chemical

Control by spraying with insecticides is difficult. In particular the mature scales are very hard to kill with insecticides because of the protective waxy coat.

FURTHER READING

Hassan, E. (1977). *Major Insect and Mite Pests of Australian Crops.* Ento. Press: Gatton, Queensland. 238 pp.

FURTHER INFORMATION

For further information about white wax scale, contact your nearest D.P.I. entomologist. Entomologists are based at:

PORT MORESBY
D.P.I., P. O. Box 417, KONEDOBU
Tel: 214699 x 255

KIMBE
Dami Oil Palm Research Station
P. O. Box 165, KIMBE, W.N.B.P.
Tel: 935204

LAE
Bubia Agriculture Research Centre
P. O. Box 1639 LAE
Tel: 451058

MOUNT HAGEN
Kuk Agricultural Research Station
P. O. Box 389, MOUNT HAGEN
Tel: 551377

RABAUL
Lowlands Agricultural Experiment Station
P. O. Keravat, E.N.B.P.
Tel: 926251 or 926252

Copies of this Entomology Bulletin can be obtained from: The Publications Officer, Publications Section, D.P.I., P.O. Box 417, Konedobu.

ENTOMOLOGY BULLETIN: NO. 38

BUFFALO FLY

By I. Owen, National Veterinary Laboratory, Kila Kila
and J.W. Ismay, Senior Entomologist, Entomology Section, D.P.I., Konedobu

INTRODUCTION

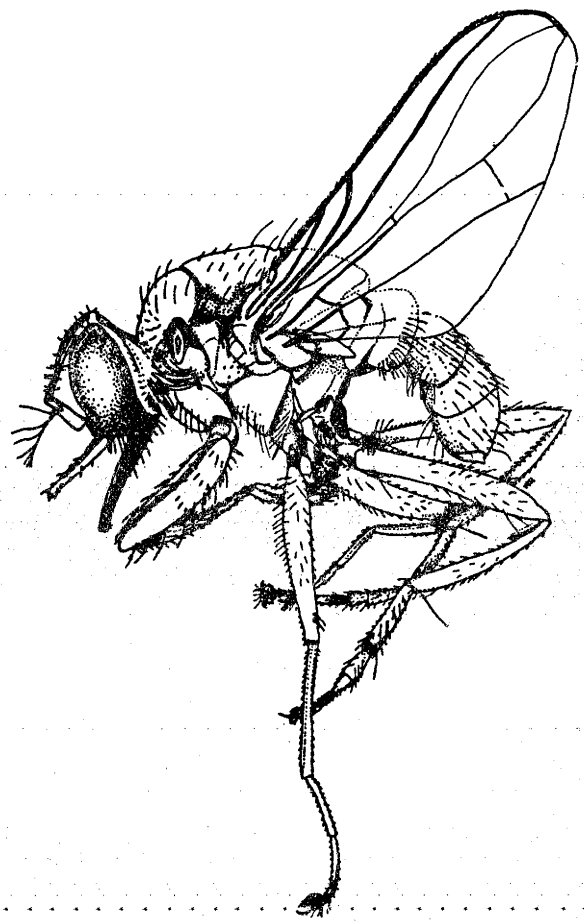
The buffalo fly, *Haematobia irritans exiqua*, is a parasite of cattle, buffalo and horses in some parts of Papua New Guinea. A parasite is an organism which lives by feeding on another live animal. The animal on which the parasite lives is called the host.

Buffalo flies are always found in close contact with their hosts. They feed on the blood of the hosts.

The buffalo fly was introduced with cattle into a few parts of Papua New Guinea, about 40 years ago. It has recently spread into other parts of the country as new roads have been opened.

DESCRIPTION

The buffalo fly is small (about 3 mm long), grey or brown, with clear wings which are usually held at an angle to the body when the fly is at rest. It has long mouthparts which it uses to pierce the skin of its host and to suck up blood.



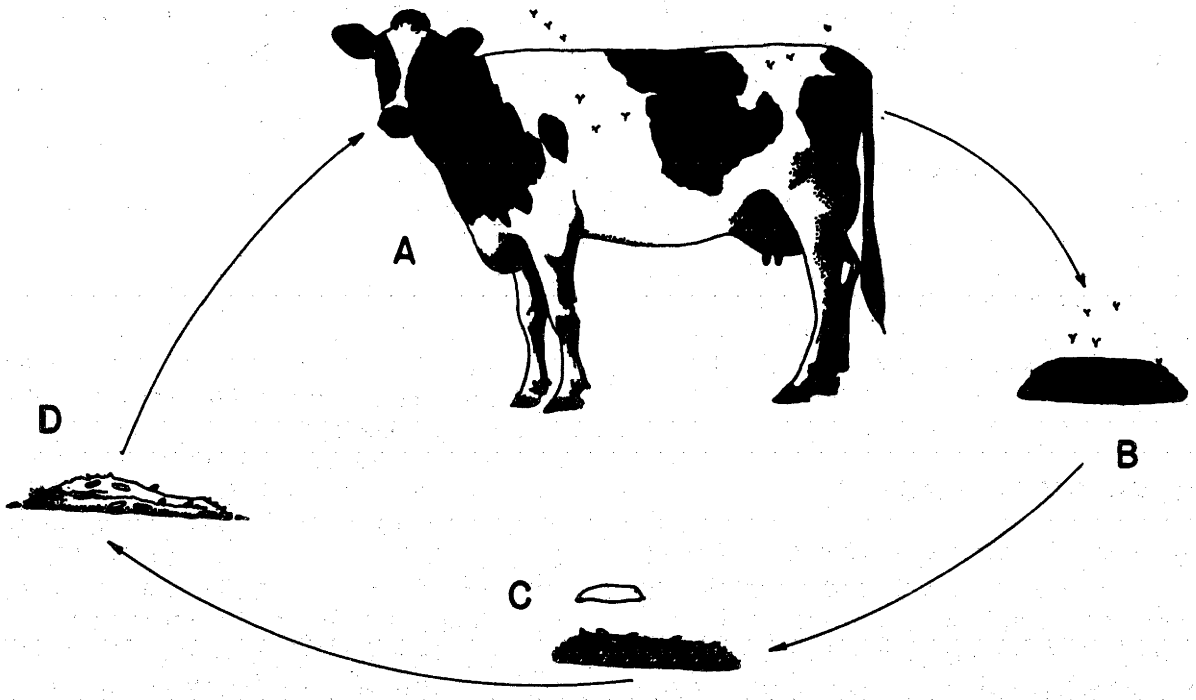
Adult buffalo fly, about 20 times actual size.

BIOLOGY

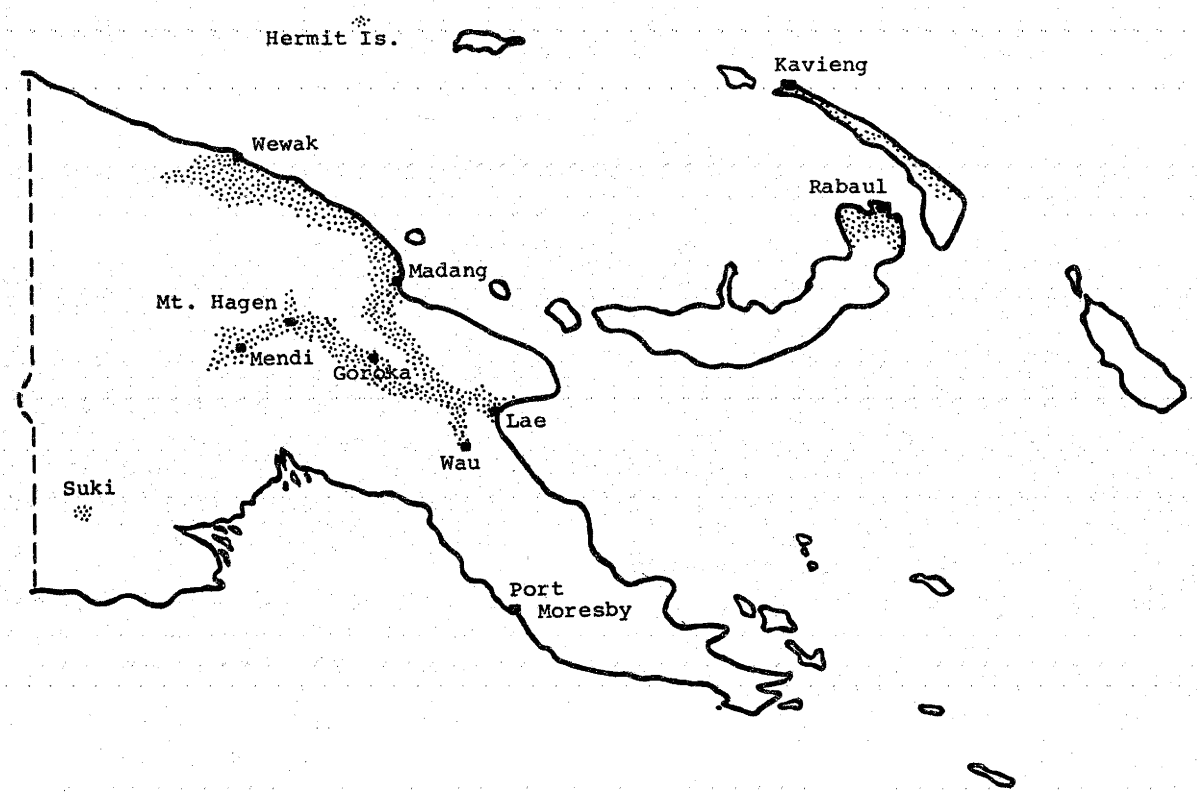
The adult female fly must feed on blood before it can lay eggs. The eggs are laid only on the fresh dung of cattle or buffalo. Larvae hatch from the eggs after about 24 hours. The larvae feed on the dung until they are mature. This takes 4 days. It may take longer in the cooler highlands.

The mature larvae leave the dung and burrow into the soil. Here they pupariate (enter the resting stage).

The puparium (resting stage) becomes an adult fly in 4 days to 3 weeks. The time depends on the weather. The adult fly lives for no more than a few weeks, but cannot live for more than 1 day away from cattle.



The life cycle of the buffalo fly. A. Adult flies on cow. B. Eggs are laid on fresh cow dung. C. Larvae (early stages) develop in the dung. D. Larvae pupariate (enter the resting stage) under or near the cow manure. When the flies emerge, they move onto the cow.



The shaded areas show the places where buffalo fly is found in Papua New Guinea.

In warm, damp conditions the life cycle from egg to adult can take only 7-11 days. In cool or dry conditions the life cycle can take much longer.

The adult buffalo flies do not often leave the host animal, except to move to another part of the body for feeding, or to lay eggs on cattle dung. If disturbed they fly up, then settle back on the animal in a few seconds. They are found in the largest numbers on the shoulders, back and sides of cattle.

ECONOMIC IMPORTANCE

The buffalo fly is important because it sucks the blood of cattle and often large numbers are found on individual animals. When very large numbers are present, they cause great irritation. The cattle spend their time trying to get rid of them by shaking their heads, flicking their tails and walking through bushes. This means that less time is spent in grazing. Over a long time this causes a slowing down in the rate of fattening.

Cattle that have buffalo fly often rub themselves against hard objects to ease the irritation. The rubbing can lead to sores which attract more buffalo flies. The sores can also lead to attack by the screw-worm fly (see Entomology Bulletin No. 12). Bulls and sick cattle are more attractive to buffalo fly than other types of cattle. Also, dark coloured individuals seem to have more flies than light ones. Brahman cattle seem to be less affected than British breeds.

The buffalo fly is usually a parasite of cattle and buffalo, but it can also be found on horses. Sometimes buffalo flies try to feed on man, sheep, pigs and dogs. There is no accurate information about losses caused by buffalo fly in the cattle industry.

CONTROL

Biological control

A method of biological control has been tried in Papua New Guinea and Australia. The method uses several kinds of dung beetles. These beetles bury dung in the soil, and make the dung unsuitable for the buffalo fly to live in. D.P.I. entomologists have introduced dung beetles into many parts of Papua New Guinea. If there are none in your area, contact the nearest D.P.I. entomologist to arrange a shipment.

Chemical control

Although dung beetles help to reduce the number of buffalo flies, better control is given by using chemicals. Several chemical sprays are used to control buffalo fly in Papua New Guinea. Anyone who wants to have cattle sprayed against buffalo fly should contact their nearest Veterinary Officer or Provincial Livestock Officer for further advice. Addresses of Area Veterinary Officers are given below.

Another method of chemical control is to use special eartags which have insecticide in them. These work well in controlling buffalo fly. However, they are rather expensive and they work for only about 4 months.

Preventing the spread of buffalo fly

If cattle are moved from one area to another, they should be sprayed. This makes sure that buffalo flies are not carried with them. One reason why buffalo fly has spread to various parts of Papua New Guinea is that cattle with buffalo fly have been carried on trucks by road without first being sprayed correctly.

REMEMBER:

1. If you wish to move livestock, you must have a permit. A stock inspector will make sure that the animals are sprayed properly against buffalo fly before a movement permit is issued.

2. A copy of the permit must go with the animals and is given to the stock inspector when they arrive.

3. Trucks that have carried livestock should be cleaned out with water, to remove all dung, before the truck returns.

If you are not sure whether buffalo fly is

present in your area, then collect the flies found on cattle. The easiest way to do this is to use an insect net in several sweeping actions over the backs of the cattle.

Put any insects caught in a small bottle, with some formalin, if you have any. Send the insects to:

The National Veterinary Laboratory
D.P.I. Kila Kila
P.O. Box 6372
BOROKO
Tel: 217931

FURTHER INFORMATION

For further information on buffalo fly and other insect pests of cattle, you should contact your nearest D.P.I. entomologist, or Area Veterinary Officer, or the National Veterinary Laboratory. Entomologists are based at:

PORT MORESBY
D.P.I., P.O.Box 417, KONEDOBU
Tel: 214699 Ext. 255

LAE
Bubia Agriculture Research Centre
P.O. Box 1639, LAE
Tel: 451058

MOUNT HAGEN
Kuk Agricultural Research Station
P.O. Box 339, MOUNT HAGEN
Tel: 551377

KIMBE
Dami Oil Palm Research Station
P.O. Box 165, KIMBE, W.N.B.P.
Tel: 935204

RABAUL
Lowlands Agricultural Experiment Station
P.O. Keravat, E.N.B.P.
Tel: 926251

Area Veterinary Officers are based at:

D.P.I. Kila Kila
P.O. Box 6372, BOROKO
Tel: 217141

D.P.I. 3 Mile
P.O. Box 73, LAE
Tel: 423844

D.P.I.
P.O. Box 766, GOROKA
Tel: 721977

Copies of this Entomology Bulletin can be obtained from: The Publications Officer, Publications Section, D.P.I., P.O. Box 417, Konedobu.

(Illustrations p. 78, p. 79 (life cycle): Michelle Kelly)

PLANT PATHOLOGY NOTE: NO. 27

COLLAR ROT OF AIBIKA

By B N Muthappa, a/Chief Plant Pathologist, Agriculture Branch, D.P.I., Konedobu

INTRODUCTION

Aibika (*Abelmoschus manihot*) is an important traditional leafy green vegetable grown in Papua New Guinea. It is particularly important in the lowlands, where it is grown in over 75% of food gardens. The young leafy shoots are used as food. Aibika has a higher nutrient content than most other green leafy vegetables.

This important crop suffers from a serious disease commonly known as collar rot. The disease is caused by the fungus *Phytophthora nicotianae* var *nicotianae* Collar rot of aibika occurs mostly in the lowlands provinces.

SYMPTOMS

The major symptoms of collar rot are yellowing of the mature leaves, wilting of the growing tips and younger leaves followed by defoliation (leaves dropping off). The stem at the collar region (where the stem and roots join) becomes black and begins to rot. This rotting of the stem progresses downwards to the root system. In advanced stages of the disease, the whole root system becomes rotted as shown in the photograph. Affected plants eventually die.

The blackened and rotted root system of an aibika plant affected by collar rot

CONTROL

1. Do not grow aibika in soil where collar rot was present in the previous season. The fungus lives in the soil and becomes active when the soil is wet due to rain or irrigation.

2. Be careful not to damage the collar region of the stem during, for example, weeding. If the plant is damaged, it is more likely to be infected by the fungus *Phytophthora nicotianae* var *nicotianae*.

3. Field trials conducted at the Laloki

Research Station during 1982 and 1983 have shown that collar rot of aibika can be effectively controlled by the fungicides Ridomil and copper paste.

Application of Ridomil 5G (granular formulation) at 5 g per plant controlled the disease. Ridomil should be applied to the soil soon after early symptoms of the disease are observed. Remove the soil around the stem to a depth of 3 cm, sprinkle on 5 g of Ridomil granules, then put back the soil to cover the fungicide. 5 g of Ridomil granules is about 1 teaspoonful. This granular formulation of Ridomil is very easy to handle.

The cost of treatment with Ridomil was 4 toea per plant, at the selling price of K8/kg for Ridomil 5G in 1983.

4. Treatment of aibika cuttings with a paste of copper fungicides before planting has been found to be effective. Bordeaux paste (copper sulphate and hydrated lime) and Cuprox (copper oxychloride) paste protect the collar region of the stem and prevent infection by the fungus. Dip lower half of cuttings of aibika in one of the fungicidal pastes. Allow to dry overnight or in shade, and then plant out in the field.

To make Bordeaux paste mix together:

1 kg copper sulphate
2 kg hydrated time
15 litres water

Dissolve the copper sulphate and hydrated lime in an equal quantity of water, then mix in the rest of the water, stirring well.

To make Cuprox paste mix together:

1 kg cuprox
5 litres water

Add the water to cuprox, stirring well.

One litre of Bordeaux paste or cuprox paste can be used to treat 100 cuttings of aibika. The cost of fungicides for 1000 cuttings worked out at K3.20 for Bordeaux paste and K14.70 for cuprox paste (1985). Cuprox paste is easier to prepare than Bordeaux paste.

FURTHER INFORMATION

Further information about collar rot of aibika may be obtained from: The Chief Plant Pathologist, Department of Primary Industry, P O Box 417, KONEDOBU.

Copies of this Plant Pathology Note and of others in the series can be obtained from: Publications Section, D.P.I., P.O. Box 417, Konedobu.

HORTICULTURE NOTE: NO. 8

CASSAVA

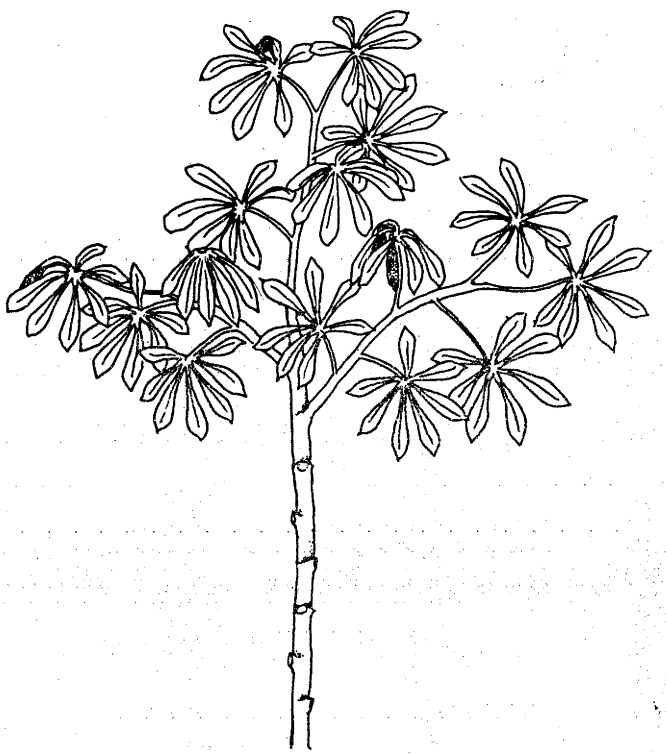
By G.A. King, Horticulturist, D.P.I., Laloki

Common name: Cassava, Manoic, Tapioca

Botanical name: *Manihot esculenta*

WHAT THE PLANT LOOKS LIKE

Cassava is a shrubby plant with upright stems up to 3 m high. The stems are sometimes branched and vary in colour from silvery-grey to reddish-brown to dark brown. The leaves have 3-7 lobes (fingers), and vary in shape, colour and size. Cassava is grown for its tubers, and occasionally for its fresh leaves.



Leaves and stem of a mature cassava plant - about one tenth natural size

WHERE IT GROWS

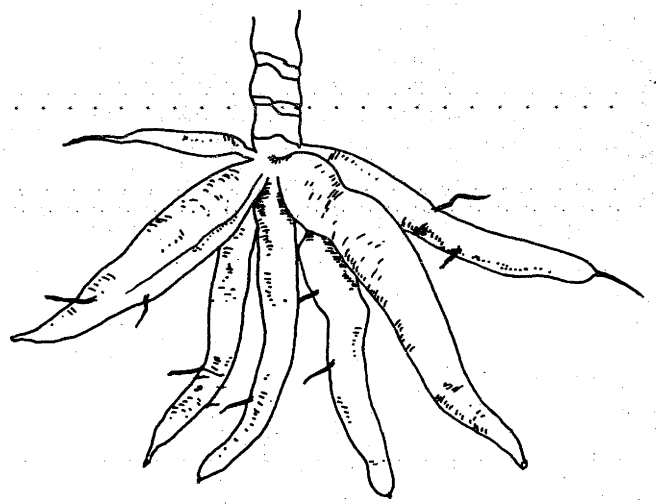
Cassava is mainly a lowland tropical crop but it grows up to 1800 m a.s.l. in Papua New Guinea. It cannot withstand frosts or long periods of cold. However once it is established, cassava can withstand long periods of drought so it is a useful crop in areas which have a long dry season (e.g. Central Province and the Markham Valley).

SOILS AND FERTILIZERS

Cassava grows best on sandy soils, but it can be grown on most soil types as long as they are not water-logged, too shallow or stony.

You can plant cassava at any time of the year, but do not plant it when the soil is very dry. In areas with a long dry season, plant cassava at the beginning of the wet season.

Cassava is usually grown on mounds or ridges but it can be grown on flat land if



Cassava tubers - about one eighth natural size

the soil is well drained. Cassava gives good yields even if the soil is not very fertile. So it is often planted as the last crop in a rotation.

Cultivating (digging) the soil improves the yield. After planting, cassava needs very little attention, except weeding.

VARIETIES

There are two groups of cassava varieties: sweet and bitter. Sweet varieties are better for eating, as they need less cooking.

HOW IT IS GROWN

Cassava is usually grown from thick stem cuttings. For best results, plant sticks 20 cm to 30 cm long, which have at least two buds. Choose sticks from plants which are at least 10 months old. Take them from the lower part of the stem.

The best spacing to use is 1 m between plants in the row, and 1 m between rows. Push planting sticks into the soil either upright or at an angle. Two-thirds of the stick should be below the soil surface.

Weed the crop until it shades the ground. If you plant cuttings in the dry season, irrigate them until they are established.

TIME TO MATURITY, HARVESTING AND STORAGE

The tubers can be dug after 10 to 12 months. They keep very well in the ground so the crop can be harvested gradually over a long period of time. However once the tubers are dug they do not keep well for more than 2 to 3 days. In some African countries and Fiji, tubers have been stored for several months in boxes or bags of moist sawdust.

A common practice in Central Province is to harvest all the tubers and cut back the stems to just above ground level. The stems then grow back and a second crop of cassava is produced.

HOW IT IS USED

The tubers of cassava contain starch, so they are an energy food. They are low in protein, but they contain some calcium, phosphorus, iron and vitamin C. The leaves of cassava are high in protein, fibre, calcium and iron. They can be used as a green vegetable.

The tubers and leaves contain small amounts of cyanide compounds and may be poisonous if eaten raw. Soaking the tubers in water for 3 to 4 days, or peeling followed by normal cooking will remove the poison.

Usually cassava is boiled before being eaten. It can also be made into a cake by grating the cassava, mixing it with coconut milk and a little sugar and baking in an oven until cooked.

Cassava can be chipped and dried in the sun to produce a meal which can be fed to poultry and pigs as a substitute for grain. (See HARVEST, Volume 7, No. 4).

PESTS AND DISEASES

Cassava has very few pests and diseases. Scale insects are occasional pests. These are carried on the stems used as planting material. A bug (*Amblypelta* sp.) can cause severe damage to the growing tips. The feeding holes are sites for infection by the fungus *Colletotrichum* sp., which causes the disease anthracnose. Anthracnose can also be carried on the planting sticks. See Horticulture Note No. 4 (Yams) for more information about this disease.

The best way to control scale insects and anthracnose is to select clean planting material.

Amblypelta can be controlled by spraying 0.1% Orthene. If anthracnose becomes a problem after planting the crop should be sprayed with Benlate.

FURTHER READING

Abdelsamie, R. (1981). Cassava as a livestock feed? *Harvest* 7(4): 172-175.

King, G.A. (1984). Horticulture Note No. 4. Yams. *Harvest* 10(3): 126-130.

Thaman, R.R. and Thomas, P.M. (1982). The cassava invasion: The cultural, nutritional and ecological impact of cassava on Pacific Island food systems. In *Proceedings of the Second Papua New Guinea Food Crops Conference*. R.M. Bourke, v. Kesavan (Eds). Department of Primary Industry, Port Moresby, pp. 330-350.

FURTHER INFORMATION

For further information and advice on vegetable growing contact the Area Horticulturist in your region. The addresses for the Area Horticulturists are as follows:

New Guinea Islands Region
Lowlands Agricultural Experiment Station
P.O. Keravat, E.N.B.P.
Tel: 926251 or 926252

Momase Region
Bubia Agricuolture Research Centre
P.O. Box 1639, LAE
Tel: 451058

Papua Region
D.P.I. Laloki
P.O. Box 417, KONEDOBU
Tel: 281068

Highlands Region
Kuk Agricultural Research Station
P.O. Box 339, MOUNT HAGEN
Tel: 551377

Copies of this Horticulture Note can be obtained from: The Publications Officer, Publications Section, D.P.I., P.O. Box 417, Konedobu.

CONTRIBUTIONS TO HARVEST

The aim of HARVEST is to help keep didimen and didimeris, teachers, research workers and other interested people informed about what is happening in primary industry all around Papua New Guinea.

If there is any work going on in your area which you think would be interesting to other HARVEST readers, we would be pleased to hear about it.

Articles can be about a single topic or project, the work of a group of people, or the primary industry of a particular area.

Articles should be presented simply and be fairly short (not more than about 3000 words, or 6-7 typed pages) with plenty of photographs or other illustrations, if possible. Black and white photographs give the best results. However, either coloured prints or slides are acceptable alternatives. Line drawings can be redrawn in ink at Publications Section if necessary.

Two copies of each article, typed with double spacing and wide margins, should be sent to the Editor, HARVEST, Publications Section, Department of Primary Industry, P.O. Box 417, Konedobu.

ENTOMOLOGY BULLETINS AND PLANT PATHOLOGY NOTES

All Entomology Bulletins and Plant Pathology Notes which have appeared in HARVEST are available as reprints. They can be obtained by writing to: The Publications Officer, Publications Section, Department of Primary Industry, P.O. Box 417, KONEDOBU. (Telephone: 214699 ext. 386)

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32. Pests of coconut palm - The New Guinea rhinoceros beetle
33. Green scale: A pest of coffee
34. Heliothis caterpillars
35. Heliothis caterpillars - a pest of sorghum
36. Pests of coconut palm - The black palm weevil
37. White wax scale: A pest of citrus
38. Buffalo fly

PLANT PATHOLOGY NOTES

1. Blister smut of maize
2. Coffee rust disease
3. Collar rot
4. Rhizobium supply service
5. Root knot nematode
6. Black pod disease of cocoa
7. South American leaf blight of rubber
8. Sweet potato little leaf
9. Taro blight
10. Fiji disease of sugar cane and its vector
11. A new treatment for bark canker on cocoa
12. The importance of quarantine against coffee rust in PNG
13. Virus diseases of taro
14. Ridomil tolerance
15. Bacterial wilt
16. Fungal diseases of tomato
17. Sweet potato leaf scab
18. Bacterial soft rot of vegetables
19. Citrus canker
20. Bark canker of cocoa
21. Vascular-streak dieback disease of cocoa
22. Seedling blight of cocoa
23. Brown eye spot disease of coffee
24. Bacterial head rot of banana
25. Rice blast
26. Nematodes - a threat to crop yield
27. Collar rot of aibika

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g) Delux seat
h) Manual adjustable rear wheels
i) Swining drawbar
j) Wet air cleaner with long stack pre cleaner
k) Dual fuel filters
l) Front end weight kit
m) Remote hydraulic control valve
n) Tropical cooling radiator
o) 12 x 4 synchro manual shuttle transmission
p) 540 rpm live power take off
q) 6.00 x 16 x 4 ply RI front tyre
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c) Diff lock
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e) Lights
f) Power steering
g) Delux seat
h) Manual adjustable rear wheels
i) Swining drawbar
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