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INCEPTION REPORT

PROJECT: U.N.S.F./S.P.C. PROJECT FOR RESEARCH ON THE CONTROL OF THE COCONUT PALM RHINOCEROS BEETLE

Date Operations authorized to commence: 13th November, 1964

Period covered by report: 13th November, 1964 -
28th February, 1965

I. SUMMARY

The Project headquarters is established on the Nafanua Agricultural Research Station located about two miles from the centre of Apia, Western Samoa.

The physical plant consists of a laboratory and insectary combined under one roof, and a 20 x 40 foot building used at present for a work shop.

The professional staff at Project headquarters appointed to date are:

1. Project Manager,
Dr. C.P. Hoyt.
2. Insect Ecologist (Project Area),
Dr. A.D. Hinckley.
3. Insect Pathologist (Project Area),
Mr. K.J. Marschall.
4. Entomologist (Project Area),
Mr. A. Catley.

Other staff at Project headquarters employed to date are:

1. Secretary to Project Manager,
Mrs. A. Catley.
2. Laboratory Technician,
Mr. Eti Tia'i.
3. Field Assistant/Driver,
Mr. Tuiopaito Sapele.

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4. Field Assistant - Foreman,
Mr. Sua Fiso.

5. Laboratory Assistant,
Mr. Ioane Ioane.

Junior Technical Officers in training under the Project who have been nominated by their governments are:

1. Mr. Sefo Logologo,
(Nominated by Tokelau Administration, N.Z.).
2. Mr. Sipaia Fatuesi,
(Nominated by Government of American Samoa, U.S.A.).

Other nominations are expected shortly.

Research contracts and consultant services have been negotiated with the following metropolitan institutions:

1. Institut für Biologische Schadlingsbekämpfung,
Darmstadt, Germany. - For the study of diseases of
Oryctes spp. and related coleoptera.
2. Commonwealth Scientific and Industrial Research Organization,
Division of Mathematical Statistics, Canberra, A.C.T.,
Australia, for advice in design and analyses of experiments.

II. DETAILS OF WORK

1. General

Because the professional staff for Project Area operations arrived at Project headquarters considerably before the official commencement date of the Project, progress has been made in obtaining background knowledge of the general biology and ecology of Oryctes rhinoceros under Samoan conditions.

Mr. G.A. McIntyre of the C.S.I.R.O., Division of Mathematical Statistics, visited the Project in Samoa from the 11th to 18th of January, 1965. During his visit, trips were made to areas selected in advance as being possible sites for field experiments on Oryctes. After seeing the sites, and having discussions with Dr. Hinckley, Mr. Catley and Dr. Hoyt, Mr. McIntyre prepared advisory notes on the "set up" of the experiments discussed.

2. Studies of the ecology of Oryctes.

By 11th December 1964, the meteorological recording station was completed and operational at Nafanua. During the period from 13th November, 1964 to 28th February, 1965 covered by this report, Dr. Hinckley finished the analysis of his damage survey data and then concentrated on the improvement of the beetle traps to be used in later experiments. In the latter, he was aided by Mr. Catley. Dr. Hinckley prepared a comprehensive report on his findings since he arrived in Samoa in March 1964. A summary of this report is appended (Annex I).

Dr. Hinckley and Mr. Catley visited Tonga between the 24th of January 1965, and the 8th of February for the purpose of seeing at first hand the Oryctes infestation and control methods used there. Advice was given to the Tongan Department of Agriculture on possible ways to improve control of the beetle in certain situations.

On his return to Samoa work was started to establish the experiments designed by Mr. McIntyre.

3. Entomology.

Mr. Catley's initial survey to determine the status of previously introduced parasites and predators which has been coupled with the collection of material for laboratory and field experiments, brought to light the fact that one of the predatory beetles introduced in 1955 had become established. This find is of considerable interest, both from the point that the original introduction was of only 6 adult beetles and 38 larvae, but also that this elaterid, Alaus speciosus, is fairly common within the area of its establishment.

Mr. Catley visited Tonga in company with Dr. Hinckley from 24th January to 9th February. Following his return to Samoa he has been working on experiments with possible chemical attractants.

A considerable amount of correspondence has been carried on with overseas scientists and suppliers to obtain advice and supplies for work with insecticides, attractants and chemosterilants. Throughout the period following his arrival in Samoa in September 1964, Mr. Catley has been working on techniques of rearing larvae under insectary conditions. This is very difficult in Samoa, although not in other areas, due to the prevalence of infection of the larvae by the pathogenic fungus, Metarrhizium anisopliae.

4. Insect Pathology

Mr. Karl J. Marschall arrived at Project headquarters in March, 1964. Since the official starting date of the Project, 13th November, 1964, he has continued his studies of the anatomy of adult Oryctes and the biology of the fungus, Metarrhizium. In February 1965, Mr. Marschall brought his initial findings together in a summary report which is appended (Annex II).

III. GOVERNMENT PARTICIPATION

Through the agency of the South Pacific Commission, the governments of Australia, France, New Zealand, United Kingdom, United States of America and Western Samoa have undertaken to contribute financially and materially to the Project.

The host country, Western Samoa, has shown considerable interest in the Project. In addition to providing their counterpart contribution of buildings and working sites etc. as set forth in the Plan of Operation, they have made available the services of staff and transport before the signing of the Plan of Operation, and have been very helpful in overcoming the various minor difficulties which arise from time to time.

The South Pacific Commission has of course played a big role in the Project's advancement, and continues to do so.

IV. ANALYSIS OF PROBLEMS ENCOUNTERED

1. Logistical

Although many items of required equipment were ordered in advance of the date of commencement by the executing agency, few have as yet been received at Project headquarters. However, by the exercise of considerable ingenuity by the Project staff, many of the difficulties due to lack of basic lab. equipment have been overcome at least temporarily, by adapting household wares etc. to the various needs.

2. Technical

As has been stated under the "details of work", the most serious problem encountered has been the fungus, Metarrhizium.

V. EVALUATION OF PROJECT

It is not possible at this early date to give an evaluation of the Project.

Original text: English.

Charles P. Hoyt
Project Manager

14th January, 1965

1964

ANNUAL REPORT

ALDEN D. HINCKLEY
Ecologist (Project Area)

SUMMARY

During the period from 1st March to 31st December, measurements were made of beetle damage, populations, and behavior. As equipment became available, records of rainfall, temperature, and humidity were started.

The assessment of beetle damage was based on counts of cut fronds and full-sized nuts on palms at 50 stations throughout Western Samoa. 78% of the palms had been attacked during the past 2 years; 34% of all fronds had feeding marks. Reduction in nut crop (estimated by comparing damaged and undamaged palms in each area) was 19.5%. Damage and reduction were 3 times greater along the jungle margin than elsewhere. Villages were also important foci of infestation. By applying the reduction measurements for each district, to records of copra production, it was estimated that 4,028 tons worth £227,985 were lost to the beetle in 1963.

Using the average number of cut fronds per palm as an indication of beetle density, a preliminary estimate of 9 adult beetles per 100 palms was obtained. Collections from crowns and samples taken with traps appeared to corroborate this relative sparsity of the beetle population.

Catch rates (trap nights per beetle) ranged from 44.3 for trays painted red and filled with water to 0.75 for an "Insectocutor" light. Artificial stump traps averaged 17.7 trap nights per beetle in the open, and 35.5 near or under trees. The beetles in trap samples were measured, weighed and dissected, data being obtained on their age, sex, egg capacity, and gut contents. For most of these there were no conspicuous differences between trap samples, but males predominated 2 to 1 in the artificial stump catch.

Ground collections of eggs, larvae and adults provided information on clutch size, mortality factors, and larval food. As many as 45 eggs were laid by a female during one visit to a breeding site. Parasitization by Scolia wasps and infection by Metarrhizium fungi killed grubs in compost heaps. The larvae had a very wide food range. Their presence in cocoa stumps and kapok logs may explain much of the damage in palm areas adjacent to cocoa.

Laboratory studies of flight and feeding were also made during the year. In tethered flights, the average speed was about 7 m.p.h. and the duration 70 minutes. Penetration rates of beetles feeding in crowns, petioles, and sugarcane were 3.7, 4.0 and 4.7 c.m./day. Stays averaged 7 days in petioles.

During 1965 further damage surveys will be made in Samoa, Tonga and Fiji. Collections of beetles in crowns and of all stages in breeding sites will be continued, with measurements of beetle/palm ratios, breeding site productivity, mortality of immature stages, and dispersal of adults. Studies on stridulation, mating, and oviposition are also planned.

Original text: English.

19th February, 1965

ANNUAL REPORTMARCH 1964 - FEBRUARY 1965K.J. MARSCHALL
Insect Pathologist (Project Area)

The work on the pathology of the Rhinoceros beetle (Oryctes rhinoceros (L.)) during the period from March 1964 to February 1965, comprised field surveys for infectious diseases on the islands of Western Samoa, breeding experiments, cultivation and transmission of a fungal disease, and anatomical studies.

As soon as transport facilities were available from the beginning of April, an intensive field study was started, to investigate the conditions under which the beetle populations were living in the field, and whether any diseases or abnormalities among those populations could be found. The searches took place in the villages, on plantations, and in areas of wild forest adjacent to plantations, and included large breeding sites; e.g. compost heaps, saw-dust heaps and large piles of coconut logs, as well as isolated breeding places like single stumps or logs and rotten Pandanus in otherwise clean plantations or on the fringes of the indigenous forest. The surveys were conducted on the islands of Upolu, Savai'i, and Manono.

The investigations showed that most of the populations of larvae in the field were healthy and of completely normal appearance. But in some places grubs and pupae were found to be infected by the green muscardine fungus Metarrhizium anisopliae (Metchnikoff) Sorokin.

In places of infestation the percentage of the infected grubs varied greatly, but was usually above 50 per cent. There were not infrequently places with a mortality of 100 per cent due to Metarrhizium. The disease prevailed in wet and swampy areas, but single individuals infected by Metarrhizium were also found in wet stumps and even high up in standing palm trees, the tops of which were rotten. Due to the exceptionally wet weather, an increase of Metarrhizium incidence was observed towards the end of 1964. A great percentage of Metarrhizium infected specimens was obtained from Sogi (Apia), Faleata, Toamua, Anoama'a and Lotofaga on Upolu, and from Vaia'ata on Savai'i.

It is beyond doubt that Oryctes larvae are heavily attacked by Metarrhizium not only in the laboratory, but in the field as well.

Specimens were found in the field which were either moribund with fungal hyphae in their tissues, as could be seen under the microscope, or already dead and covered with the green conidia of the fungus on the outside of their integument. Many grubs too, showed marks of earlier attacks, small brown spots and specks on the cuticula. At microscopical investigation, these spots proved to represent the site of entrance of the fungus, and consisted of melanized deposits just under the body wall, with clusters of phagocytic blood cells around the invading fungal hyphae. These spots should not be confused with very similar melanized formations, which appear after an injury of the integument, and look very much the same, but fail to show remnants of fungal hyphae.

Over 20 per cent of the larvae collected from the field, died in the laboratory from Metarrhizium in less than 10 days after they were brought in. The following Table No. 1 shows the distribution of the mortality due to Metarrhizium over the time of rearing in the laboratory, giving only the confirmed cases of death from Metarrhizium of those grubs which were kept in single confinement.

TABLE 1

Instar	Dead animals after entering the Lab.					
	0 - 5 days	6 - 10 days	11 - 15 days	16 - 30 days	31 - 60 days	Over 60 days
1st instar larvae	5	3	5	4	13	
2nd instar larvae					1	
3rd instar larvae	1	5	7	14	9	1
Pupae		1		2	1	

The grubs reared in big cages were not counted, although they almost all died from Metarrhizium. Sick and moribund grubs were not put in single confinement because of lack of containers, or not even brought into the laboratory at all. If they had been included, the percentage mortality within 10 days after entering the laboratory would be markedly higher than 20 per cent. Experiments demonstrated that the incubation period from the moment of infection until the animal displays severe signs of sickness, or dies, lies between 13 and 16 days. Therefore it can be concluded that field-collected larvae had already contracted the disease in their natural habitat.

No other diseases apart from Metarrhizium anisopliae could be detected in the field. Some pathological phenomena in grubs, under laboratory investigations turned out to be septicaemia as a consequence of injuries inflicted by either predators, other larvae, or other environmental conditions.

Breeding experiments were quite unsuccessful, and not conclusive at all, due to lack of space, containers and heavy losses through Metarrhizium.

After we moved into our new laboratory, much work was devoted to the construction of the most urgently required laboratory equipment, and to the development of staining techniques for field work for the discovery of diseases at an early stage.

In the field of morphology and anatomy, a close study of the genital organs of both sexes of beetles was carried out. In the female genitalia, two so far unknown organs, first described and previously investigated by Dr. C.P. Hoyt (Hoyt, personal communication, 1963), were discovered to represent mycetomes which most probably serve as organs for retaining and transmitting microbes essential for the nutrition of the offspring. In the male genitalia, similar structures were found. The work on these organs will be resumed as soon as the required histological equipment arrives.

The prevention of the damaging effects of Metarrhizium in the laboratory, which makes breeding of grubs almost impossible, is a difficult problem. Several ways of approach to a feasible solution have been undertaken, and are still under trial, but no results have been obtained so far. Experiments include sterilization of feeding media by heating, antibiotics, fumigation, and irradiation by Ultra Violet Light, and sterilization of spores on the integument of larvae. It is also planned to collect and/or manufacture spore-free feeding media.

Experiments were carried out to cultivate Metarrhizium fungus on artificial media, with the intention of finding ways to transmit this disease, and eventually to grow spores for dissemination in the field on a large scale, as well as to find out how to combat its detrimental effect in the laboratory. Spores were harvested from conidia growing on the outside of dead grubs, and hyphae were ex-planted from tissues of moribund larvae. Experiments to grow the fungus on Pepton-Agar were successful, and the spore raised on artificial medium were still virulent and infectious on grubs of Oryctes. These investigations await further trials. At present work on the conditions and the time of germination of the spores both on artificial medium and on the grubs themselves, as well as on the incubation period, is in progress.

