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SOME ASPECTS OF THE ECOLOGY OF ELAEIDOBIUS KAMERUNICUS FAUST, THE POLLINATING WEEVIL OF OIL PALM, WITH EMPHASIS ON DEVELOPING SAMPLING TECHNIQUES

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by

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December, 1984

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Some aspects of the ecology of the pollinating weevil of oil palm, *Elaeidobius kamerunicus* Faust - an exotic insect to Malaysia imported from Cameroon, West Africa, three years ago - were studied in 1983 and 1984. In particular, sampling techniques for estimating the weevil population were developed and the effect of rat predation on the immature weevils was studied. In the course of these studies, certain aspects of the weevil's behaviour and activity were investigated.

Field studies concerning the ecology of the weevil requires a satisfactory method for estimating the weevil population. Three sampling methods were compared: petri dish traps set on receptive female inflorescences, sticky traps incorporating anthesising male flowers as bait, and sampling the weevil-covered spikelets of the anthesising male inflorescence. The last method was found to be superior - it was more reliable and the data could be converted to an absolute estimate. To be reliable, the method must consider the time of sampling, stage of anthesis of the male inflorescence, and position of spikelet on the male inflorescence. Taking samples after

5 pm, separating the anthesising male inflorescences into three stages, and stratified sampling from six sections of the male inflorescence were found to be optimal for a reliable estimation.

The two trapping methods - spikelet trap and petri dish trap - could not be used in a practical manner for estimating the weevil population in the field; at least not until the extraneous variations are effectively controlled. This will require better understanding of the mechanisms involved in the attraction of the weevils to the male and female inflorescences. There were indications that certain palms were genetically more attractive to the weevils.

Now that the weevil has been successfully established throughout Peninsular Malaysia and Sabah, and has proved to be an efficient pollinator of oil palm, the immediate concern is to maintain its numbers in the estates. Rats were found to be an important predator of the weevils, feeding on them when the weevils were still in the immature stages (eggs, larvae and pupae) in the post-anthesised male inflorescence (PAMI). In a series of studies, the extent of immature weevil mortality due to rats in the oil palm plantation of Universiti Pertanian Malaysia, Serdang, Selangor, was determined. Weevil mortality was indirectly measured by rat damage to the PAMI. The immature weevil mortality due to rats was found to be 83 percent and was comparable between 8-year and 11-year plantings. Even at this high mortality rate, a good fruit set of 71 - 84 percent was achieved and corresponding weevil populations of between 54,000 - 95,000/ha sustained.

Abstrak tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi sebahagian dari syarat-syarat untuk mendapatkan ijazah Master Sains

ASPEK-ASPEK EKOLOGI ELAEIDOBIUS KAMERUNICUS FAUST, KUMBANG PENDEBUNGAAN KELAPA SAWIT DENGAN PENEKANAN TERHADAP TEKNIK-TEKNIK PENGAMBILAN SAMPEL

oleh

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Beberapa aspek ekologi kumbang pendebungaan kelapa sawit, *Elaeidobius kamerunicus* Faust - serangga yang telah dibawa masuk ke Malaysia dari Cameroon, Afrika Barat pada tahun 1981 - telah dikaji pada tahun 1983 and 1984 di ladang kelapa sawit Universiti Pertanian Malaysia, Serdang, Selangor. Kajian telah ditumpukan bagi membentuk teknik-teknik pengambilan sampel bagi membuat anggaran populasi kumbang, dan mengkaji kesan pemangsaan oleh tikus terhadap kumbang-kumbang muda. Dalam pada itu, beberapa aspek perlakuan dan aktiviti kumbang-kumbang telah juga dikaji.

Kajian di ladang mengenai ekologi kumbang memerlukan cara membuat anggaran populasi yang baik. Tiga cara pengambilan sampel telah dibandingkan: perangkap piring petri yang diletakkan pada bunga-bunga betina yang "receptive", perangkap-perangkap berpelekat yang menggunakan bunga-bunga jantan yang sedang dalam "anthesis" sebagai bahan penarek, dan mengira kumbang-kumbang pada "spikelet" bunga-bunga jantan yang sedang "anthesis". Cara yang terakhir sekali didapati terbaik, dan maklumat yang diperolehi boleh dijadikan

anggaran mutlak. Untuk mengukuhkan kepercayaan, cara ini mesti mengambil kira masa sampel diambil, peringkat "anthesis" bunga jantan dan juga bahagian "spikelet" bunga jantan. Waktu yang sesuai untuk mengambil sampel ialah selepas jam 5:00 petang. Pengambilan sampel cara berstratum (6 bahagian bunga) meliputi 3 peringkat "anthesis" adalah disyorkan.

Perangkap spikelet dan perangkap piring petri tidak boleh digunakan untuk membuat anggaran populasi kumbang di ladang selagi perbedaan-perbedaan yang di dapati belum boleh dikawal dengan berkesan. Ini memerlukan fahaman yang lebih baik mengenai mekanisma-mekanisma yang terlibat dari segi penarikan kumbang-kumbang kepada bunga-bunga jantan dan betina. Ada tanda-tanda yang menunjukan bahawa baka-baka kelapa sawit yang berlainan mempunyai daya tarikan yang berbeda terhadap kumbang-kumbang.

Memandangkan bahawa kumbang-kumbang ini telah berkembang dengan jayanya sebagai perdebunga kelapa sawit yang cekap diseluruh Semenanjong Malaysia dan Sabah, masaalah kini ialah dalam menentukan bahawa populasinya di ladang-ladang adalah terpelihara. Tikus-tikus merupakan pemangsa utama yang mungkin boleh mempengarohi bilangan kumbang-kumbang. Tikus memakan telur, larva dan kepompong kumbang selepas "anthesis" bunga jantan tamat. Di dalam satu siri kajian, kadar kematian kumbang-kumbang muda yang disebabkan oleh serangan tikus ditentukan. Kematian kumbang telah diukur secara tidak langsong dengan kerosakan tikus pada bunga-bunga jantan selepas anthesis. Kadar kematian kumbang-kumbang muda akibat serangan tikus ialah 83% bagi tanaman yang berumor 8 tahun dan 11 tahun. Walau pun kadar kematian kumbang adalah tinggi, peratus kejadian buah juga tinggi (71 - 84%). Populasi kumbang adalah dianggarkan antara 54,000 hingga 95,000 sehektar.

CHAPTER 1

INTRODUCTION

Elaeidobius kamerunicus Faust (Curculionidae: Coleoptera), the pollinating weevil of oil palm, is an exotic insect to Malaysia (Syed *et al*., 1982). It was first imported from Cameroon, West Africa, as a beneficial insect to improve the pollination efficiency of oil palm, the chief plantation crop in Malaysia. Since its first release in February 1981 some three years ago, it has become well established throughout West Malaysia and Sabah (Mohd Basri *et al*., 1984).

The impact of the weevil on the Malaysian palm oil industry and the Malaysian economy has been tremendous. It is especially so since oil palm is the highest export value crop in Malaysia, accounting for 9.4 percent of the total external trade and 59 percent of the entire world production in 1982 (Malaysian Economic Report 1982/83). Not since the replacement of dura variety with the higher-yielding tenera in the 1960s has production increased as much as with the introduction of the weevils. The Primary Industries Minister, Datuk Paul Leong, announced in the February 1984 Weevil Symposium organised by the Palm Oil Research Institute of Malaysia (PORIM) and Malaysian Oil Palm Growers' Council (MOPGC) that the weevil netted an extra $364 million of palm oil (12.5% increase) and saved a further $52.9 million from discontinuing hand-assisted pollination in 1982 alone. Today, the weevil has become one of the world's major success stories in the use of beneficial biological agents.

Nonetheless, little has been studied on the biology and ecology of the weevil except for the pioneering work by R. A. Syed (Syed, 1979; 1982). Since it affects a crop of tremendous importance to the economy of the nation - whether as a resource to be utilised efficently, or in the remote possibility, as a potential pest - it is beneficial to study the ecology and biology of the weevil in its new environment.

OBJECTIVES

This study was undertaken to investigate some aspects of the ecology of *E. kamerunicus* with the following objectives:

(a) To develop reliable sampling techniques for estimating the weevil population in the oil palm estate.

(b) To study the extent of rat predation on the weevils at the pre-adult stages.

(c) To study certain aspects of the weevil's behaviour and activi[illegible]lation to the host plant, the oil palm.

THE STUDY AREA

Field studies were conducted at the oil palm plantation of Universiti Pertanian Malaysia in Serdang, Selangor.

The plantation consisted of 63 hectares of 8-year and 11-year palms (Plate I) planted in 1976 and 1973 respectively, with each planting covering an approximately equal area. The oil palms were <u>Elaeis guineensis</u> Jacq. of tenera (dura x pisifera) variety, triangle-planted 30 feet apart. The actual study area was 10 hectares consisting of five one-hectare plots of each planting. Each plot - which served as a replicate - had 150 palms.

The study area was well-drained and was situated on undulating terrain of clayey, lateritic soil of the Gajah Mati, Terap and, to a lesser extent, Munchong series. The soil contained petroplintite nodules often within 0 - 50 cm of the surface.

The climate is classified under the semi-humid with monsoon climate according to the Koppen classification (Mokhtaruddin & Othman, 1980). In 1983, the mean daily maximum and minimum temperatures were 32.9 C and 22.5 C respectively, and the total annual rainfall was 1767 mm. The rainfall regime is characterised by two maxima and two minima a year - the driest months in 1983 were December and June, and the wettest, May and September. Over the period of study in 1983 and 1984, there was considerable variation in average monthly rainfall and sunshine hours: December 1983 was unusually dry while February and April 1984 were uncharacteristically wet; also, March and April 1984 experienced considerably longer daily sunshine hours (Appendices A and B).

PLATE I

Oil Palm in Study Area : 8-year Palm (left) and 11-year Palm (right)

Chisel shown is about 2 m. long

CHAPTER 2

REVIEW OF LITERATURE

GENERAL

Insect Pollination of Oil Palm

Dr. R.A. Syed, an entomologist formerly with the Commonwealth Institute of Biological Control, was responsible for introducing the pollinating weevil, E. kamerunicus, into Malaysia. In Cameroon, Syed (1979) found that about a dozen species of insects visited both the anthesising male and receptive female inflorescences of the oil palm, Elaeis guineensis Jacq., thereby effecting pollination. The main pollinators were several species of weevils of the genus Elaeidobius.

In West Malaysia, before the weevil was introduced ,Thrips hawaiiensis (Morgan) was the main pollinating agent and a micromoth, Pyroderces sp., also contributed towards pollination (Syed, 1979; Tay, 1981). Although thrips was the major pollinator, both Syed (1981) and Tay (1981) indicated that it was not efficient. Thrips activity was minimal under cloudy and rainy conditions. Thrips population fluctuated greatly with location and dropped in the wet season (Tay, 1981). Hand pollination of young palms was therefore necessary in West Malaysia. In Sabah, where no thrips and few other insects were found on the oil palm, assisted pollination was conducted for both young and old palms.

That the oil palm is chiefly insect- and not wind-pollinated was first demonstrated by Syed (1979). Before that, the oil palm was believed to be mainly wind-pollinated (Jagoe, 1934; Hardon and Turner, 1967; Hartley, 1967; Turner and Gilbanks, 1974). Syed observed in Cameroon that where insect pollinators were abundant, natural pollination was adequate while in Sabah, where few insects visited the flowers, it was poor. The differences in climate were not significant enough to explain the big difference in fruit set efficiency. Syed's finding was confirmed by two experiments, one in West Malaysia (Tay, 1981) and the other in Le Me in West Africa (Desmier, 1982) which showed that in the presence of insecticides when the female inflorescence was receptive, only half the percentage of fertile fruits per bunch formed as compared with the untreated female inflorescences.

The Potential of *Elaeidobius* spp. as Pollinators in Malaysia

In Cameroon, Syed (1982) initially studied the life history and host specificity of three species of *Elaeidobius* as potential candidates for introduction into Malaysia. The species were: *E. kamerunicus*, *E. plagiatus*, and *E. subvittatus*. The aim of his investigations was "to determine whether *Elaeidobius* spp. could be introduced to pollinate oil palm ensuring that they would not damage oil palm or other desirable plants".

All three species were found to be specific to oil palm. Of 43 plant species tested in the laboratory using Wapshere's (1974) method of evaluating biological weed control, the weevils did not oviposit on the flowers of any plant except oil palm. They bred on spent male inflorescences and visited female inflorescences only during receptivity. They did not injure the female flowers or the fruit. Syed (1982) thus concluded that they were safe for introduction into other countries. Of the three species, he found E. kamerunicus to be the most suitable. It was the most numerous in both dry and wet seasons, carried more pollen grains than the other species, and had a fairly good searching ability.

Elaeidobius kamerunicus was first imported into Malaysia in July 1980 by Unilever, a multinational company with oil palm plantations in Cameroon and Malaysia. Under quarantine conditions, Kang and Zam (1982), of the Malaysian Department of Agriculture, carried out host specificity tests on the weevils. Their results also showed that the weevil was specific to oil palm. The weevil was first released in Mamor and Pamol Estates near Kluang, Johore, in February 1981, and in Pamol Estate, Sabah, a month later (Syed, 1982). By April 1982, the weevil had been introduced or had spread to virtually all the oil palm estates in Malaysia (Mohd Basri et al., 1983).

Biology and Ecology of E. kamerunicus

The development from egg to adult is between 7 to 14 days in the field (Syed, 1982; Zam, 1982; Suhaimi, 1983); and the average adult longevity, 15 to 17 days (Syed, 1982; Suhaimi, 1983).

The adults are attracted to both the male and female flowers of oil palm supposedly by the strong aniseed smell of the flowers. This is a commonly held belief (e.g. Syed, 1982; Teo, 1984) which is unsupported by experimental evidence. The weevils do not stay long on the female flowers for the adults feed only on anther filaments or anther tubes of opened male flowers of oil palm (Syed, 1982). Although specific to the oil palm, Elaeis guineensis, in laboratory experiments, the adult weevils could survive - but not oviposit - for a week on E. oleifera, Veitchia sp. and Eugenia aqueous flowers, and two weeks on Cocoa nucifera flowers (Zam, 1982). Against these four plant species, only the flowers of E. guineensis greatly attracted the weevils (Zam, 1982).

Subramaniam (1982) observed in two estates in Selangor that the weevils were inactive between 7.30 am to 8.30 am and were most active between 12.30 pm to 2.30 pm. In West Africa, they were found to be inactive between 6.30 am to 9.00 am (Desmier, 1982). The weevils were also found to be less active on cloudy days and after downpours (Subramaniam, 1982). The population was lower during the wet season (Syed, 1982).

The anthesising male inflorescences are attractive to the weevils for five days and the females, for two days (Subramaniam, 1982; Syed, 1982). Adult weevils are not found on the male inflorescences before anthesis or after anthesis is completely over. Neither do they visit the female inflorescences before or after stigmatic receptivity (Syed, 1982). The weevils are most abundant on the male flowers on the third day of anthesis when all the florets have opened (Subramaniam, 1982; Syed, 1982); on the female inflorescences, the first day of stigmatic receptivity is the time of greatest weevil visitation.

The thrips appeared to have been partially displaced by the weevil due to habitat and breeding-site competition. In the initial establishment of the weevil, wherever it colonised a new area, the population of thrips decreased as that of the weevil increased (Syed et al., 1982). From a pre-weevil mean population of 162 per spikelet, the thrip density stabilised at about four per spikelet six months after introducing the weevil (Syed, 1982). Laboratory tests by Zam (1982) which showed that the presence of adult weevils on the spikelets did not adversely affect the number of thrips, therefore, were not valid in the field.

Population Dynamics

The weevil density was found to range from 75 to 105 adults per anthesising male spikelet in Cameroon (Syed, 1982). It varied little among 19-, 9- and 3-year old palms. In Selangor, Malaysia, the weevil density was 105 to 145 adults per spikelet a year after the weevil was introduced (Subramaniam, 1982). Syed (1982) further observed that the reproductive rate was inversely proportional to the population density and that the population varied little between dura and tenera oil palm varieties, but pisifera variety appeared to be more attractive.

The weevils rapidly established in Malaysia. Following their first release at Mamor and Pamol Estates near Kluang, Syed *et al.* (1982) monitored the population build-up and dispersal of the adult insects. They found that within six months, the weevils were well established over a radius of more than five kilometres from the release site.

Highlands Research Unit was the first to estimate the weevil population on a per unit area basis (Subramaniam, 1982). They classified the stages of anthesis into four: 25 percent, 50 percent, 100 percent first day, and 100 percent second day of anthesis. The mean density per male inflorescence - averaging over 3-, 11-, and 22-year palms - were found to be 1,900, 4,100, 9,000 and 3,800 respectively for the four stages of anthesis. The weevils were most abundant during the third stage of anthesis. The mean population per hectare was 56,000 for 3-year palms, 70,000 for 11-year palms and 95,000 for 22-year palms.

Impact of the Weevil on the Oil Palm Industry

Syed (1982) reported a 20 percent gain in oil per hectare in two estates in Peninsular Malaysia and 53 percent in one East Malaysian estate in 1982 over the previous year. The kernel yield increased by 35 to 47 percent. The gains in oil and kernel were attributed to improved pollination by the weevils as shown by the increase in fruit set (the percentage of flowers which develop into normal fruits) from 50 percent to 74 percent. Nation-wide, the crude palm oil (CPO) production increased by 12.5 percent in 1982 alone.