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AN ARTIFICIAL DIET FOR CONTINUOUS REARING OF THE COFFEE BERRY BORER, *HYPOTHENEMUS HAMPEI* (FERRARI) (COLEOPTERA: SCOLYTIDAE)

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Abstract—The composition and preparation of an artificial diet for the coffee berry borer, *Hypothenemus hampei* is described. Ten generations were obtained without any significant change in fecundity. Development at 25°C on this diet was similar to previously reported work using coffee berries. One female reared on this diet lived for 380 days. This diet will permit investigations into the genetics of insecticide resistance, potential biopesticides and other research, requiring a convenient laboratory rearing system.

Key Words: Artificial diet, *Hypothenemus hampei*, rearing, coffee berry borer

Résumé—Le mode de préparation et la composition d'un milieu d'élevage artificiel pour le scolyte du café *Hypothenemus hampei* est décrit. Jusqu'à présent, dix générations ont été obtenues sans changement significatif de la fécondité. Le cycle de développement à 25°C est similaire à celui reporté par ailleurs dans la littérature, sur des élevages sur cerises de café. Une durée de vie maximale de 380 jours a été observée sur une femelle élevée sur ce milieu. Ce milieu artificiel permet de conduire des recherches dans le domaine de la génétique de la résistance aux insecticides, dans la prospection de biopesticides potentiels, ou dans tout autre domaine nécessistant un élevage permanent au laboratoire.

Mots Clés: *Hypothenemus hampei*, élevage, milieu artificiel

INTRODUCTION

Hypothenemus hampei is a major pest of coffee, feeding exclusively on berries; it does not damage the vegetative parts of the plant. Native to Central Africa, it has spread to most coffee producing countries in the world. Significant coffee-growing areas where it has not yet been detected include Costa Rica, Hawaii and Papua New Guinea. Its biology and ecology in different parts of the world have been extensively studied (Waterhouse and Norris, 1989), but little attention has been paid to the dietetics and nutrition of either larvae or adults. Villacorta (1985) has described an artificial diet for rearing successive generations of the coffee berry borer, but the formulation includes specialized natural ingredients difficult to obtain in many regions of the world. The lack of a suitable laboratory rearing method was a major constraint to our research into the genetics of endosulfan resistance (Brun et al., unpubl. data) and the development of methods for the integrated pest management of *H. hampei*. We developed this diet to provide the large quantities of *H. hampei* of consistent quality and physiological status necessary for this work. This paper describes an artificial diet comprised of readily obtainable ingredients, on which several strains of *H. hampei* have been reared for over 10 generations. No detailed information was collected on the intrinsic rate of increase of the insect on this diet, since our aim was simply to develop a diet to enable other research.

MATERIALS AND METHODS

Diet composition

Dietary ingredients are listed in Table 1.

Table 1. Ingredients in the artificial diet for the coffee berry borer

Ingredients	Quantity
Group I	
Water	1000 ml
Agar	32 g
Group II	
Wheat germ	40 g
Casein	10 g
Sucrose	20 g
Coffee bean powder	150 g
Group III	
Water	25 ml
Methyl-p-hydroxy benzoate	1.75 g
Sodium propionate	1.2 g
Ascorbic acid	0.3 g
Group IV	
Water	10 ml
Penicillin	350 mg
Streptomycin	350 mg
Ascorbic acid	2.5 g
Vanderzants Vitamins	1 g

Diet preparation

Dried green coffee beans and wheat germ were ground to fine powder using a hammer mill ("GONDARD, 2 hp, France"). Group II ingredients were combined and partially mixed before molten agar (Group I, agar and water mixed and heated to boiling) was added and stirred well to achieve complete mixing. The solution (25 ml) of mould inhibitors (Group III) was then mixed in. When the mixture had cooled to 60 °C, vitamins and antibiotics (Group IV) dissolved in 10 ml of water were added. After a final mixing the completed diet was poured into shallow trays, to form a layer ca. 7 mm deep. Sheets of solid diet were dried at 40°C, on elevated wire grids until they attained a leathery texture. Plugs of diet (15 mg) were cut with a cork borer and placed into small plastic vials closed with a plastic stopper in which a small hole was pierced for ventilation.

H. hampei *rearing*

Adult *H. hampei* were obtained from infested berries collected from the East Coast of New Caledonia. Adults were obtained by cutting open berries kept for some weeks in the laboratory to allow pupae and larvae to become adults. Adult females were transferred individually into small plastic vials with a fine paint brush.

Feeding generally occurred within a few hours after females were put onto the media. In most cases, egg-laying started within the first 2 weeks but sometimes females laid eggs within the first few days. Relative humidity was an important factor in rearing coffee berry borer, excess humidity often led to fungus development, and dry conditions to higher mortality. Good sanitation reduced the fungal contamination to a minimum. Rearing was done in the dark. Females were transferred to fresh diet every 2 months to begin a new cycle of egg-laying. No attempt was made to manipulate eggs individually, because of their extreme fragility.

In order to give preliminary information on rates of reproduction and development on this diet, 16 mated females were fed individually on the diet in small containers kept at 25°C and 85% r.h., and observed at intervals. Observations on egg laying, larval development, pupae and adult emergence were made by external examination through the transparent plastic vials at 20, 28, 41 and 57 days. At 70 days the experiment was terminated by cutting open the medium to count all individuals present in the diet.

RESULTS AND DISCUSSION

The first eggs laid were observed after 12 days. Eggs hatched after 3–5 days, while larvae pupated after about 3 weeks. Pre-pupae had a duration of 2–3 days, with from 3–5 days in the pupal stage. This amounted to a life cycle of 4–5 weeks. This rate of growth compares closely with that recorded in the literature (Corbet, 1933; Bergamin, 1943; Munoz, 1989). Just over half of the total offspring were obtained 41 days after the beginning of the experiment (Table 2). After 70 days, only half of the offspring had reached adulthood, due in part to the protracted period of oviposition.

Table 2. Progeny of 16 mated females reared on artificial diet, showing the proportion in various life stages (%), at intervals after females were placed on the diet

	Days after females are placed on artificial diet				
Stages	20	28	41	57	70
Eggs	90	46	30	12	2
Larvae	10	54	63	41	12
Pupae			5	28	34
Adults female			2	16	47
Adults male				3	5
Total offspring	30	83	135	218	251

On average females produced 16 offspring, which is less than the fecundity recorded by previous workers, summarized in Munoz (1989). However, the number of offspring recorded here was probably limited by the size of rearing containers, lacking possibility of movement by females to new locations for oviposition, and the duration of our observations (70 days). The majority of the diet available was consumed during this period.

Various records of longevity have been reported (Waterhouse and Norris, 1989), but the previous maximum reported was 282 days for females (Bergamin, 1943). Longevity of females on our artificial diet generally conformed to these observations. However, one female reared on this diet lived for 380 days, extending this previous report significantly. Ten generations have already been obtained on this diet.

The results indicate that the diet described above will successfully support all stages of the berry borer and that it is now possible to maintain laboratory colonies on a diet with readily obtainable ingredients. The continuous rearing of this major pest is an essential step for many aspects of research into the development of an integrated pest management programme for the coffee berry borer, such as rearing of parasitoids or for the evaluation of microbial pesticides such as *Bacillus thuringiensis* and *Beauveria bassiana.* This diet has been used successfully for genetic studies on the inheritance of endosulfan resistance (Brun et al., unpubl. data).

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