NONASEPTIC WHEAT GERM DIET FOR *MEGALOPYGE OPERCULARIS* (LEPIDOPTERA: MEGALOPYGIDAE)

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ABSTRACT

A nonaseptic, wheat germ, agar-based diet has been developed for rearing the puss caterpillar, *Megalopyge opercularis* Abbot and Smith.

Megalopyge opercularis Abbot and Smith is commonly known as the puss caterpillar. Its distribution extends from Maryland to Mexico (McGovern et al. 1961). The caterpillars are capable of inflicting painful stings, causing dermatitis and sometimes systemic reactions sufficiently severe to require hospitalization.

Very little is known about the biology of this important species. Even such basic information as the number of larval instars, time of pupation within the cocoon, etc., is uncertain or unknown. This lack of information is the result of the difficulty in rearing this species. Attempts to rear them on foliage have not been successful (Bishopp 1923, McGovern et al. 1961). Micks (1956) reported some success when using yaupon leaves. While yaupon has the advantage over elm, silver maple, etc. of not wilting or drying quickly, in our experience we find it is still unsatisfactory, and the caterpillar is, therefore, still developing under stress. The sedentary habits of the caterpillar do not permit the successful rearing on foliage, even when yaupon leaves are used. The leaves dry quickly, but often the larvae stay on without attempting to move to fresh leaves, thereby entering into a state of depression eventually ending in death. Such behavior is not anticipated to affect their rearing as much when an artificial diet is used. This is that prompted the author to search for an artificial diet.

A widely used artificial diet in rearing insects is the wheat germ diet, and investigators, working with different species, have developed various modifications of this medium.

MATERIAL AND METHODS

ADULT EMERGENCE TUB—This container is a 3 gal ice cream tub (Fig. 1), screened by ninon held in place with segments of tape. The tub is lined with slightly overlapping strips of paper towel, about 13 cm wide, held in place by tape at the top. Cocoons are incubated in this tub, and the adult on emergence will settle on the strips of paper towel or on the ninon.

The newly emerged adult is carried on its paper or ninon support to the mating and oviposition tub. This tub is the same in all details as the emergence chamber. The strip of paper towel supporting the adult is taped to the inside of the new chamber. If the adult was attached to the ninon top of the emergence chamber, the ninon carrying the adult is placed on top of the mating chamber

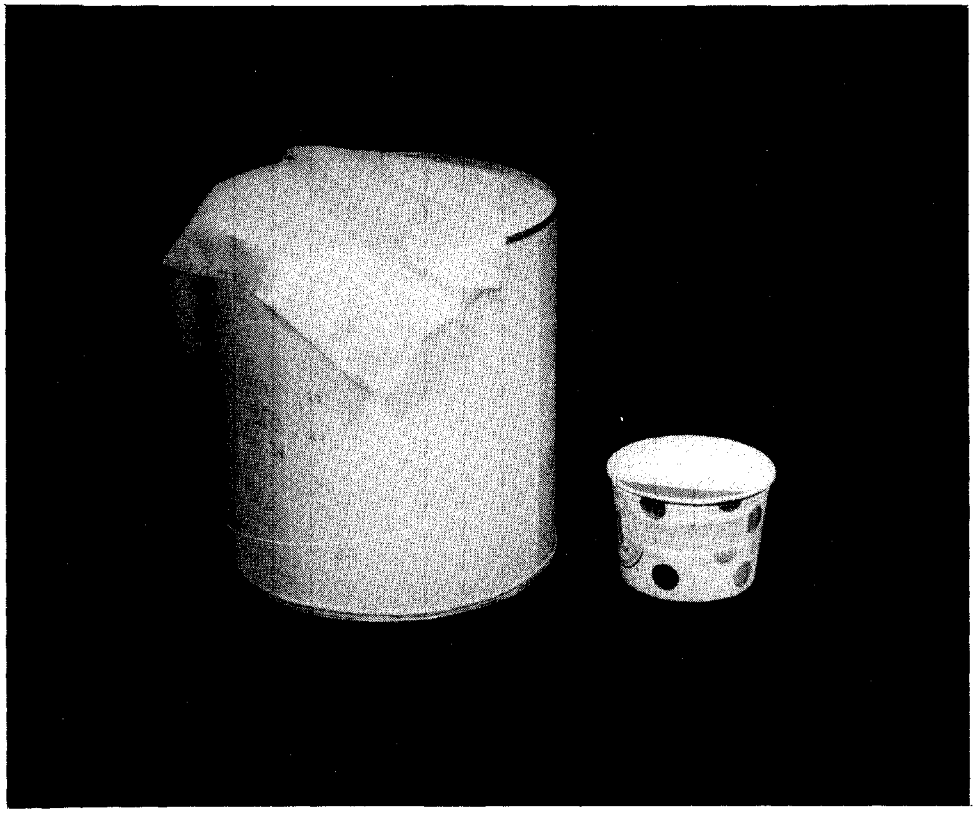

Fig. 1. Adult emergence, mating, and oviposition tub (left), and rearing carton (right).

and used as a screen. In each tub 1 female and 1 or 2 males are confined. The adult almost always stays motionless during the day, even when its support is moved, and requires no food or water. After mating, the eggs are laid the following night on the ninon and the paper strips.

INCUBATION CHAMBER—The egg patches can be left in place in the mating and oviposition tub for 6 days (to near hatching), and are then transferred directly to the rearing carton. However, if the climate is too hot and dry, the segment of paper towel (or ninon) carrying the egg patch is cut and taped inside an empty jar or beaker. The latter is placed in a screened (with ninon) battery jar and a wet paper towel is placed on top of the screen during the hot part of the day. The eggs are held here for 6 days; then the segment is taped on the inside of a rearing carton containing the diet.

REARING CARTONS—The most suitable container for the present diet is an ice cream carton (Fig. 1), No. 2186-SE, 16 oz., squat container, untreated, with a tablid (American Can Company, Dixie Products, Easton, Pennsylvania). This allows free gaseous exchange and absorbs excess moisture, therefore allowing no condensation.

Access of light is provided by cutting a rectangular window 7 × 2 cm in the side of the carton. This is screened by ninon on the outside, fixed in place by tape on the inside to prevent the tiny larvae from getting trapped in the seams.

When mature, the larvae spin their cocoons on the wall or inside the lid. On the renewal of food, the segment of the carton containing the cocoon is cut carefully and transferred into the "emergence tub".

TRANSFERRING LARVAE—In transferring the larvae to a fresh diet, a larva if moving, is gently brushed onto the new diet with a fine camel-hair brush. Otherwise, to avoid handling injuries, the old food is cut around the larva and both are laid on the fresh food. Usually the larva leaves the old food, which is picked out. During this process, with older larvae, the fecal pellets are also brushed out.

TABLE 1. COMPOSITION OF THE WHEAT GERM DIET FOR REARING *Megalopyge opercularis*.

Component	Amount
Mixture I	
Wheat germ premix (special wheat germ diet for insects—Vanderzant-Adkisson)*	14 g
Sorbic acid*	0.05 g
Methyl paraben*	0.1 g
Formaldehyde	0.05 ml
4 M KOH	0.4 ml
Raw linseed oil	0.2 ml
Cholesterol*	0.03 g
Distilled water	25 ml
Mixture II	
Agar (granulated)	1.5 g
Distilled water	35 ml
Vitamin premix (Vanderzant modification vitamin mixture for insect diet)*	1.5 g
Aureomycin*	0.015 g
Kanamycin sulfate (powder)	0.01 g

*Obtainable from Nutritional Biochemical Corporation.

DIET COMPONENTS—The components of the artificial medium with the amounts used are listed in Table 1. Most of them are secured from Nutritional Biochemical Corporation except the linseed oil (from Curtin Scientific Company), the agar (Difco Bacto-Agar), and Kanamycin, potency 780 Mcg/Mg (from Bristol Laboratories). The potency of Aureomycin (Chlorotetracycline Hcl) is 912 Mcg/Mg.

The wheat germ premix contains wheat germ, casein, sugar, Wesson salt mixture, and alphacel. In this project a "new modified" premix is used which contains in addition, linseed oil 0.2% and cholesterol 0.05%. The ratios of linseed oil and cholesterol contained in this premix are a small fraction of the usual amounts required by insects, especially *Megalopyge opercularis*. Therefore, additional amounts of these 2 components are added to make the present formula. A minimum amount of water should be used. The proper amount can be determined by observing the specified carton 1 or 2 days after pouring the final diet. No moisture or stain should show on the outside of the carton around the area where the food is located. In a uniform, homogenous wheat germ premix and pure agar the amount of water needed should be fixed. Not more than 30 ml is required for Mixture I. A total of about 60 ml should be sufficient if the mixing process goes steadily, without unnecessary delay.

The inhibitors and antibiotics used gave excellent results. There was no indication of yeast, mold, or bacterial colonies in the diet, despite the fact that no autoclaving, sterilization, or even detergents were used throughout the project. Utensils and glassware were washed freely with tap water and left to dry on paper toweling.

In this diet, a full use is made of the available premixes, with no additional undefined meal or leaf extract being included in the formula.

MIXING OF DIET COMPONENTS—Mixture I is prepared by adding its components in the order listed in Table 1 to the required amount of distilled water in a beaker. Continuous mixing with an electric or powerful magnetic stirrer is necessary.

Mixture II is prepared by gradually adding the agar to the distilled water in a smaller beaker, with continuous stirring. The mixture then is heated on a hot plate until it starts boiling at the surface. Throughout heating, the solution must be stirred slowly, especially at the bottom, to avoid burning. As soon as the mixture is brought to a boil, it is removed from the heater and allowed to cool gradually to a temperature around 52°C, with continuous stirring. The exact temperature depends on the temperature of the surroundings. The lower the cooling point, the better the diet will be.

Mixture II is then poured into Mixture I, mixed vigorously for a few seconds, then the vitamins, aureomycin, and Kanamycin are added promptly, followed by vigorous stirring for some seconds. The final diet is promptly poured into the rearing carton. There should be no delay, as the diet tends to gel quickly. The final product is sufficient for one 16 oz carton. The carton is left uncapped for 1 hr after which it is ready for receiving the larvae.

RESULTS AND DISCUSSION

Colonies of this species can easily be started by collecting cocoons which are common on various kinds of trees. However, for testing the present diet, it was possible to collect a male and a female resting next to each other on an elm tree. These were confined in the laboratory in a mating and oviposition tub. In the laboratory the windows were kept open all the time, and conditions were somewhat similar to the external environment. Eggs were laid, then hatched on 13 October 1972. Throughout development, they were offered only the present diet. Development in cold weather was very slow. Cocoon formation took place between 27 January 1973 and 11 March 1973. The larval stage lasted 3.5-5 months. Many of the reared adults laid fertile eggs. Also, 2 small trees were inoculated with some of these second generation eggs and resulted in healthy larvae, cocoons, and adults.

REARING OTHER INSECTS—This formula was tested on the saddleback caterpillars, *Sibine stimulea* (Clemens). Young larvae collected in the field developed quickly, forming cocoons. The diet was also utilized by older saltmarsh caterpillars, *Estigmene acrea* (Drury), that were collected from the field.

ACKNOWLEDGMENT

Acknowledgment is due to Bristol Laboratories, Syracuse, New York for supplying the Kanamycin needed for this project. This research received support from the Academic Grant Fund of Loyola University.

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PSEUDOSCORPIONS PHORETIC ON FIREFLIES—(*Note*). While conducting field experiments on flashing behavior of fireflies involving the identification of all individuals seen flashing in a grassy grove (U. of Fla. Campus), 3 *Photuris* "sp. *D*" (new, unnamed sp., Lampyridae) were found with pseudoscorpions clinging to their legs by 1 pedipalp. All the pseudoscorpions were female *Paratemnus elongatus* (Banks) (Atemnidae). This is the first record of pseudoscorpion phoresy on fireflies and also the first record of phoresy by a species of *Paratemnus.*

Specifics: female, 30 cm above ground on grass, a single pseudoscorpion attached to hind tibia, 9 June 1974; female, 35 cm above ground on grass, 3 pseudoscorpions attached to hind tibiae, 12 June 1974; male, on ground, 2 pseudoscorpions on each hind tibia, 1 on mesofemur, 12 June 1974. Twenty or more perched, flashing fireflies of 3 *Photuris* species were examined on each of 13 evenings between 25 May and 19 June; approximately one-fifth of the individuals were *Photuris* D. There was no evidence of mechanical damage to the fireflies; and during the 3 or 4 days that 2 fireflies were observed in the laboratory, their guests continued to hold on by the pedipalp and the fireflies continued in apparent good health.

The restricted period of observed phoresy reported here suggests that *Paratemnus elongatus,* like some other species, may have a "certain time during the summer" when this behavior is displayed (P. Weygoldt, *The biology of pseudoscorpions,* 1969, p. 116).

It appears doubtful that the fireflies with more than 1 rider could have flown. When phoresy involves species that differ in size by as little as these two, the hosts probably suffer appreciable loss of energy and mobility, and in cases of multiple riders, perhaps total genetic death (fail to reproduce). If the significance of the phenomenon to the pseudoscorpions is dispersal, then selection should strongly favor the development in pseudoscorpions of signals or other behavior that would prevent multiple attachment; if the firefly with 5 riders couldn't fly, then the pseudoscorpions were phoretic failures. It has been suggested (Muchmore, 1971, Proc. Roch. Acad. Sci., 12:95) that transportation is only an incidental part of this phenomenon, the real basis of which is predation. More observations are required.—J. E. Lloyd, University of Florida, Gainesville, 32611, and W. B. Muchmore, University of Rochester, Rochester, New York, 14627.