A Biological Study of the Lawn Armyworm, Spodoptera mauritia (Boisduval), in Hawaii (Lepidoptera: Phalaenidae)[1]

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The lawn armyworm, *Spodoptera mauritia* (Boisduval), was first correctly recorded from Hawaii in 1953 (Pemberton, 1955) and within a year (Tanada, 1955) became one of the most serious pests of lawns, particularly those planted with Bermuda grass, *Cynodon dactylon* (L.) Persoon (fig. 1). Although the name *S. mauritia* appears early in Hawaiian literature, it was being used erroneously at that time for the nutgrass armyworm, *Laphygma exempta* (Walker) (see Swezey, 1938). Recently Fletcher (1956) has placed Hawaiian specimens in the subspecies, *Spodoptera mauritia acronyctoides* Guenée, rather than in the nominate subspecies, *S. mauritia mauritia* (Boisduval). He reported the distribution of the former subspecies as the Oriental, Indo-Australian, and Pacific regions.

The present importance of *S. mauritia* and the limited knowledge of its biology in Hawaii have prompted this study. In addition to the laboratory studies, which were conducted both at the Hawaii Agricultural Experiment Station and the Experiment Station of the Hawaiian Sugar Planters' Association, field observations of both authors are included herein.

DESCRIPTION OF STAGES

The descriptions and measurements of the various stages were based on live or freshly killed specimens. Length measurements were made of individuals soon after they had molted. Widths of the larval heads were measured under the binocular stereoscopic microscope. Such head measurements were obtained from molted head capsules except in the case of the last larval instar

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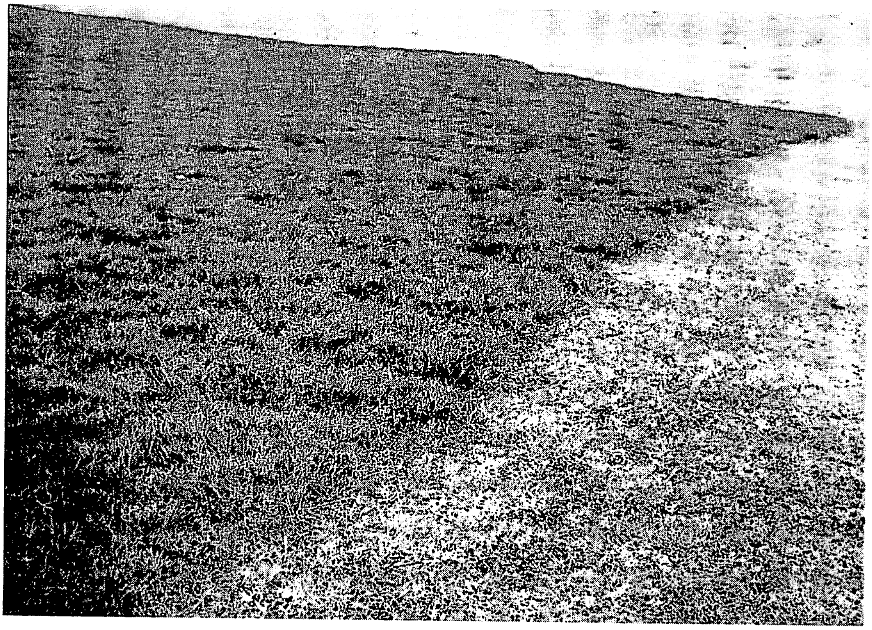

FIG. 1. Portion of a Bermuda grass lawn in the Aina Haina area of Honolulu damaged by the lawn armyworm during January 1956. The sharply defined "front" separates the denuded area at right from the undamaged portion at left.

when they were based on head capsules still attached to the larvae because head capsules discarded before pupation were split open and could not be measured accurately.

Eggs: The eggs are laid together in masses which vary greatly in size, shape, and number of eggs. The egg masses are frequently rather elongate-oval in outline, and are about 10 mm. to 20 mm. long and 5 mm. to 10 mm. wide (fig. 2, A). They consist of from one to five or more irregular layers of eggs. The upper layers usually contain progressively fewer eggs so that the entire egg mass has a somewhat convex appearance. Long, light-brown, hair-like setae from the terminal end of the female's abdomen may cover the egg mass so thickly that individual eggs are not visible. Some masses, presumably those of older females which have depleted their supply of setae, are less heavily covered. The eggs when laid are light tan in color and have a slightly pearly luster. They generally darken to a gray or dark tan before hatching, but in some masses they acquire a pronounced greenish or pinkish cast. Individual eggs are circular in outline and somewhat flattened at the lower pole where they come in contact with the substratum. Their exterior is sculptured with fine longitudinal striations which extend from the micropylar pole to about the equator. Their lower surface is smooth. They measure about 0.5 mm. in diameter and about 0.4 mm. through the polar axis.

Mature larvae: Larvae in the seventh and eighth instars are considered mature (see section on life history), and a thorough description of such larvae is given below as an aid to the identification of caterpillars of this species. The immature instars are considered in less detail.

The mature *S. mauritia* larva is a typical smooth-skinned armyworm (figs. 2, C; 5, A), and attains a length of about 35 mm. to 40 mm. when fully grown. Newly molted seventh-instar larvae averaged 22.88 mm. in length, and head capsules of this stage averaged 2.78 mm. in width. Eighth-instar individuals, when they occurred, averaged 36.55 mm. in length when young, and their head capsules averaged 3.5 mm. in width (table 1).

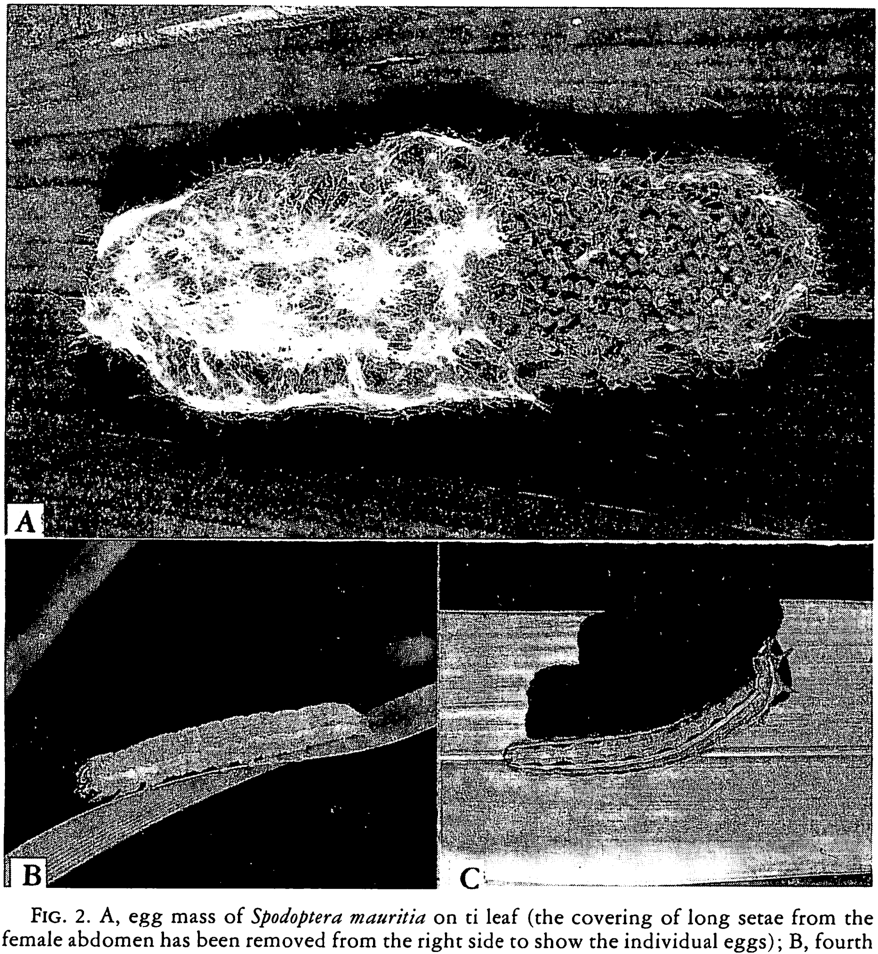

FIG. 2. A, egg mass of *Spodoptera mauritia* on ti leaf (the covering of long setae from the female abdomen has been removed from the right side to show the individual eggs); B, fourth instar larva of *S. maurita* on a grass blade; C, seventh-instar *S. mauritia* larva feeding on sugar cane leaf.

The basic body pattern of the mature larva is quite constant, although there may be considerable variation among individuals in the relative amounts of dark- and light-pigmented areas. The head capsule is predominantly brown and is darkest in a band just laterad of the adfrontal and coronal sutures. The frons is testaceous, and a distinctly pale mark, shaped like an inverted Y, occupies the adfrontal areas on either side and extends along the coronal suture. The regions of the ocelli and genae are irregularly testaceous. The pronotal shield is brownish, with three narrow, pale yellow or white, longitudinal stripes.

On each side of the body a distinct pale subdorsal band, which is about 0.75 mm. wide and continuous with the pale lateral stripe of the pronotal shield, extends the entire length and onto the anal shield. These bands vary in color from almost pure pale yellow to light reddish-brown. A darker, much less distinct, more irregular, and frequently interrupted medio-dorsal band extends posteriorly from the medio-dorsal stripe of the pronotal shield. The darker dorsal area between these bands is predominantly grayish, varying in shade in different individuals. A pair of prominent, elongate, jet-black marks occurs on all body segments except the prothorax and the tenth abdominal, one on each side just mesad of the mesal border of the subdorsal band. These marks vary somewhat in size from specimen to specimen but never coalesce to form a continuous band. Where strongly developed, the marks are shaped approximately like acute triangles and attain their maximum width in the anterior half of the segment which they occupy. On each side, the lateral region of the body ventrad of the subdorsal band and dorsad of the lower edges of the spiracles is occupied by a pair of darkish longitudinal bands, each about 0.75 mm. wide, which are separated by a very fine, often interrupted, pale line. The lower or spiracular band is usually the darker and is generally purplish-brown in color. The upper or supraspiracular band is grayish with a yellow or greenish tinge. In fully fed larvae the upper band tends to darken and lose its greenish cast so that the two bands are more nearly concolorous. Some specimens possess a small black mark on each abdominal segment immediately above the spiracle and just below the fine pale line which separates the spiracular and supraspiracular bands.

A pale yellowish to light reddish-brown subspiracular band, similar to the subdorsal band, is usually discernible on each side. In some specimens the ventral margin of this band may be poorly delineated from the pale venter. The spiracles are black.

Under magnification, the derm of the unsclerotized portions of the body, except the jet-black marks, is seen to consist of a fine reticulate pattern of tiny light and dark marks. In the light bands the light component is pale yellow and the dark component is mostly a light reddish-brown. In the darker bands the dark component is mostly black and the light component white. In preserved specimens the yellow and reddish colors are lost so that the medio-dorsal band is less evident, and the subspiracular band is often indistinguishable from the pale venter.

The mandibles (fig. 3, C) have five distinct teeth, and their oral faces are without a basal or sub-basal tooth. The frons is slightly longer than broad, and the coronal arm of the epicranial suture is longer than the frontal arms. The adfrontal sutures are confluent well before the occiput, and the length of the coronal suture from the occiput to this juncture is about equal to the length of the frons (fig. 3, B). The anterior prolegs each possess 16 to 19 crotchets arranged in a homoideous uniordinal mesoseries.

The setal pattern of the mature caterpillar is illustrated in figures 3 and 4. Setigerous tubercles, with the exception of IV, V, and VI of the prothorax, and VI of the meso- and metathorax, are not noticeably sclerotized. Seta IIIa of the abdominal segments is represented by a papilla and a very small, fine seta. The eighth abdominal spiracle was found to be from 1.3 to 1.5 times as long dorsoventrally as the seventh.

There are two other species of grass-inhabiting armyworms in Hawaii with which *S. mauritia* caterpillars possibly may be confused. These are the cosmopolitan armyworm, *Pseudaletia unipuncta* (Haworth), and the nutgrass armyworm, *Laphygma exempta* (Walker). Mature *P. unipuncta* caterpillars (fig. 6, A) are less vividly marked than those of *S. mauritia*. The pale subdorsal bands are absent or barely discernible, and the conspicuous black dorsal marks which occur in *S. mauritia* larvae are not present. In *P. unipuncta* a narrow, interrupted, blackish band with a fine white line along its ventral margin lies between the supraspiracular and the subdorsal bands. The mandibles of *P. unipuncta* possess but two obscure teeth, whereas those of *S. mauritia* and *L. exempta* have five distinct teeth. Seta A^1 of the face is mesad of A^2 in *P. unipuncta*, but in *S. mauritia* and *L. exempta* it is laterad of A^2.

The larvae of *L. exempta* vary widely in coloration, much more so than do those of *S. mauritia*. However, the darker forms, which sometimes resemble *S. mauritia* in the possession of a pair of dorsal black marks on each segment, differ in that the spiracular band is much darker and conspicuously narrower than the supraspiracular band (fig. 6, B). Also, the dark forms of *L. exempta* have a conspicuous white spot behind and slightly above the spiracle on abdominal segments I to VIII. Such spots are absent or barely discernible in mature *S. mauritia* larvae, but are more pronounced in fifth- and some sixth-instar individuals. The ratio of the dorsoventral length of the spiracles of the seventh and eighth abdominal segments furnishes a convenient character for the separation of mature larvae of these two species. In 20 specimens of *S. mauritia* which were measured, the eighth abdominal spiracle was 1.3 to 1.5 times as long as the seventh, whereas in 15 specimens of *L. exempta*, the eighth ranged from 1.8 to 2 times as long as the seventh abdominal spiracle.

The structures of the spinneret and labial palpi are used extensively by Crumb (1956) in his classification of the larvae of the Phalaenidae. Although

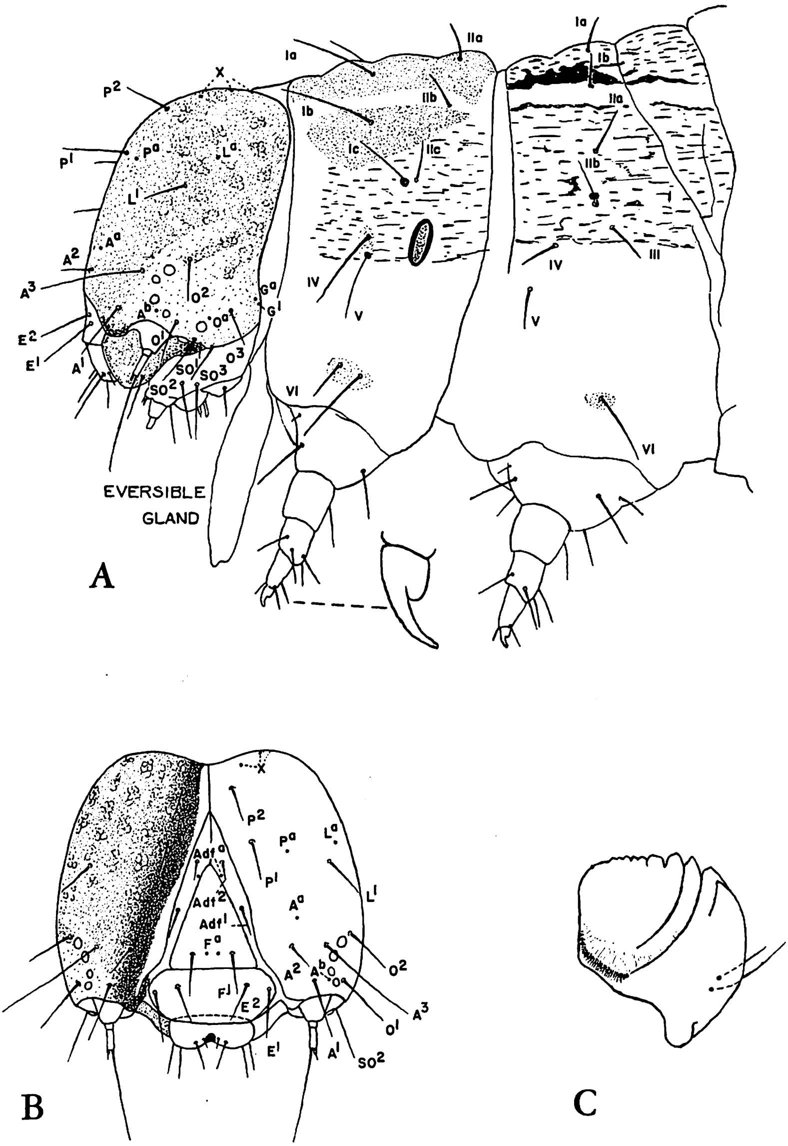

FIG. 3. Mature larva of *S. mauritia*. A, lateral aspect of head, prothorax, and mesothorax; B, frontal aspect of head; C, inner face of left mandible.

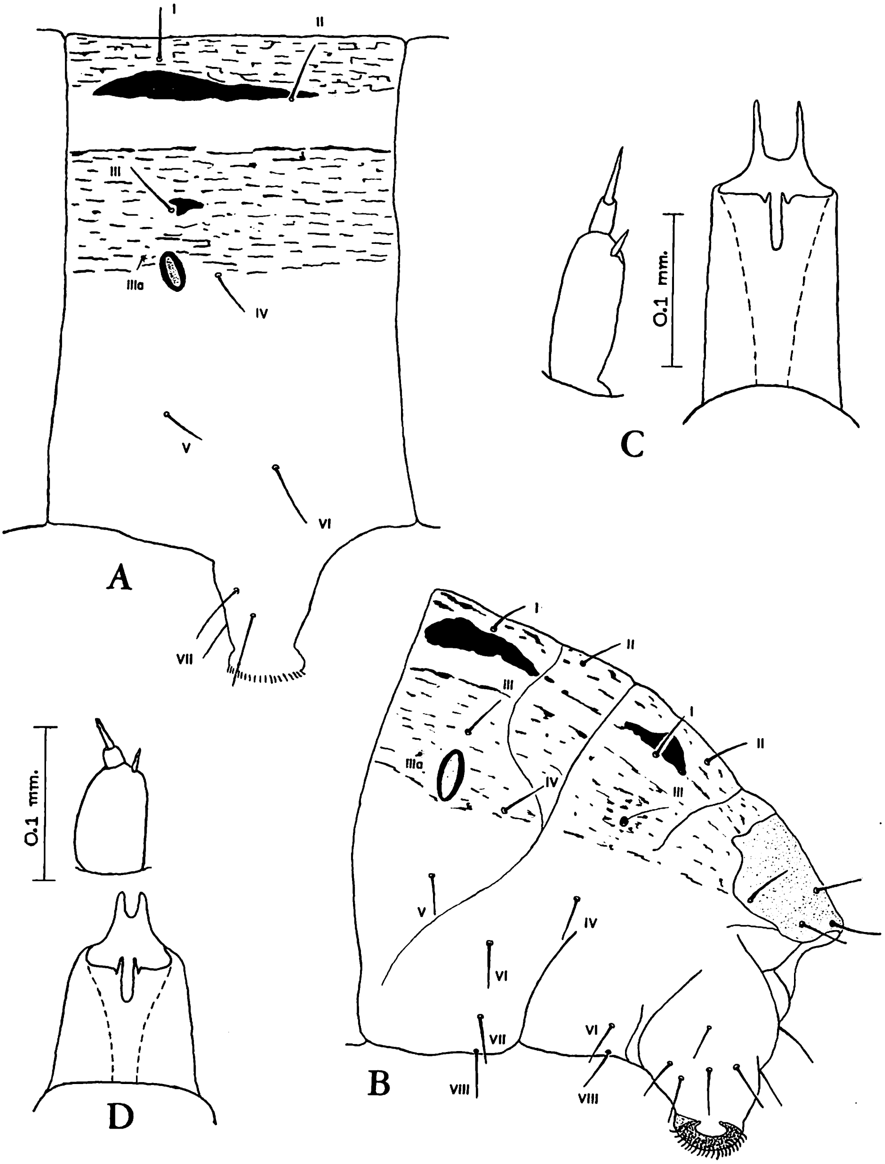

FIG. 4. A, lateral aspect of fourth abdominal segment of mature *S. mauritia* larva; B, lateral aspect of abdominal segments VIII to X; C, spinneret and labial palpus of mature *S. mauritia* larva; D, spinneret and labial palpus of mature *Laphygma exempta* larva.

neither *S. mauritia* nor *L. exempta* is included in Crumb's treatment (which is limited to North American forms), these characters have been figured here (fig. 4, C, D) for comparative purposes. In Crumb's key both of these species run to his "Group 7" of the subfamily Amphipyrinae. *L. exempta* will not run to the genus *Laphygma*, as the third segment of the labial palpus is less than one-half as long as the basal segment.

Immature larvae: The first-instar larvae upon hatching averaged 1.24 mm. in length and the width of their head capsules averaged 0.30 mm. (table 1). Their head capsules, prothoracic and anal shields, and legs are black, and the body setae arise on conspicuous dark pinacula. Soon after feeding, the larvae attain a general greenish body color, and a few white longitudinal lines become discernible. A medio-dorsal line, and a subdorsal line on each side are the most distinct of these. There is also a somewhat less distinct supraspiracular line on each side which is closer to the subdorsal line than this is to the medio-dorsal.

Second-instar larvae, shortly after ecdysis, averaged 3.06 mm. in length, and their head capsules averaged 0.47 mm. in width (table 1). The head capsule, shields, and legs of this instar are largely a pale testaceous color. The dark pinacula at the bases of the body setae are relatively smaller than in the first instar. The medio-dorsal, subdorsal, and supraspiracular white lines of the first stage are apparent, and, in addition, there is usually a relatively wide, white, subspiracular band on each side.

Newly molted third-instar larvae averaged 4.16 mm. in length, and their head capsules averaged 0.69 mm. in width (table 1). Third-instar larvae resemble those of the second instar except that the white subspiracular band is usually more pronounced.

Young fourth-instar larvae averaged 6.41 mm. in length, and their head capsules averaged 0.95 mm. in width (table 1). During the fourth instar the larvae are still predominantly greenish in color (fig. 2, B). The head is usually pale testaceous, but in some more strongly pigmented individuals it may be somewhat darker laterally with a pale frons. The pronotal shield is also slightly darker in some specimens. Three pale longitudinal lines, continuous with the medio-dorsal and the subdorsal lines of the body, are discernible on the pronotal shield in this and subsequent instars. The subdorsal and, particularly, the mediodorsal lines are relatively wider than in previous instars, and the subspiracular band is well developed. Above this is a green spiracular band which is usually slightly darker than the green areas of the dorsum. This is bounded dorsally by a narrow, pale, supraspiracular line. In some specimens, the spiracular band may be entirely light purplish in color; in others, the purplish area is reduced to streaks in various portions of the posterior end of the stripe and sometimes to some of the anterior segments. A short blackish streak is frequently present on the mesothorax along the mesal margins of each of the subdorsal lines. The black pinacula surrounding the body setae are relatively small and extend very little beyond the margins of the papillae.

Newly molted fifth-instar larvae averaged 8.30 mm. in length, and their head capsules averaged 1.43 mm. in width (table 1). Upon reaching the fifth instar, the larvae acquire the fundamental pattern of stripes and markings characteristic of the mature armyworm. Although some larvae are predominantly green, others have the brown or purplish-brown color of the later larval instars. A pair of narrow black marks is usually present on each segment behind the prothorax along the mesal border of the subdorsal bands. The prothoracic and anal shields are dark brown to blackish. The three pale stripes of the prothoracic shield are well defined. In darker individuals, the area mesad of the subdorsal band is noticeably darker than the area ventrad and is often brown or purplish-brown. The supraspiracular band is noticeably

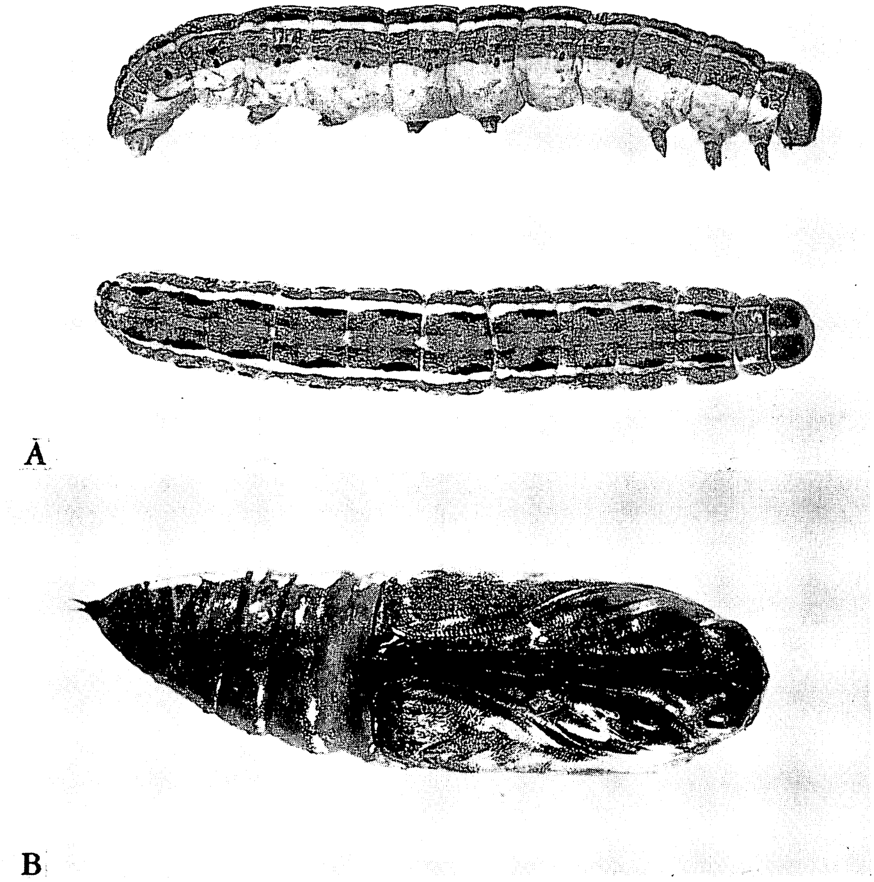

FIG. 5. A, lateral and dorsal aspects of mature *S. mauritia* larva; B, ventral aspect of *S. mauritia* pupa.

lighter and more greenish than is the spiracular band, and an interrupted fine white line separating these bands is usually discernible. Many specimens possess small white spots in the spiracular band, one of which is located on each segment posterior to and slightly dorsad of the spiracle. These spots are also evident in some sixth-instar larvae but are absent or hardly noticeable in seventh- and eighth-instar larvae. Body setae of this and subsequent instars lack dark pinacula. The coloration of the head is similar to that of the mature caterpillar.

Young sixth-instar larvae averaged 16.75 mm. in length, and head capsules of this stage averaged 2.05 mm. in width (table 1). In the sixth instar the dorsal black markings are more strongly developed than in the preceding stage, and the general color is grayish- or purplish-brown. The spiracular band is darker than the supraspiracular in this and in young seventh-instar larvae; but in most older mature larvae the greenish color of the supraspiracular band fades, and the bands often appear nearly concolorous.

Pupae: The pupa (fig. 5, B) is of the same general form as other species of armyworms and cutworms. It is reddish-brown in color when fully hardened, hairless, and rather smooth. Its average length was found to be about 16 mm., ranging from 14 to 18 mm. in the twenty specimens measured. Its maximum width is about 4.5 mm.

Adults: Both sexes of the adult moth have been redescribed recently by Fletcher (1956). There is a consistent and well-marked sexual dichromism in this species. The male (fig. 7, B), which is the more vividly marked sex, has a conspicuous white diagonal mark in the anterior median area of the upper surface of the forewing, between the whitish or buff-colored orbicular spot and the roughly reniform dark spot. In the female (fig. 7, A) this region is dull grayish-brown and is not appreciably different from adjacent areas. Pale markings, which are found in the distal portion of the forewings of the male, are more strongly developed than those in the forewings of the female. These include an area of white, suffused with brown, near the apex of the wing; a fine, white, subterminal fascia; and an incomplete white fascia which extends from near the distal end of the diagonal white mark to the posterior margin. In general, the brownish areas of the forewings are darker in the male than in the female. The hind wings of both sexes are pale except for a darker area along the costal margin anterior to vein Rs, and along the outer margin. The undersurface of the forewing is mostly dull grayish. In some specimens, particularly males, the proximal area of the undersurface may be considerably paler, and some also show a streak of dull reddish along the costal margin. The wing expanse varied from 34 mm. to 40 mm. in females and from 30 mm. to 37 mm. in males.

The dorsum of the thorax is thickly clothed with elongate grayish to reddish-brown scales. The legs, particularly the coxae, femora, and tibiae of the fore pair, are clothed with brushes of similarly colored, slender, elongate, hair-like scales. These brushes are much more strongly developed in the male sex. The vestiture of the abdomen is usually slightly lighter in color than that of the thorax.

In Hawaii, *S. mauritia* adults most closely resemble those of *Laphygma exempta. L. exempta* adults average slightly smaller (wing span 28 mm. to 35 mm.) than those of *S. mauritia* and may be distinguished by minor differences in the pattern of the forewings. In *L. exempta* the amount of variation among individuals of the same sex is much greater than which has been en-

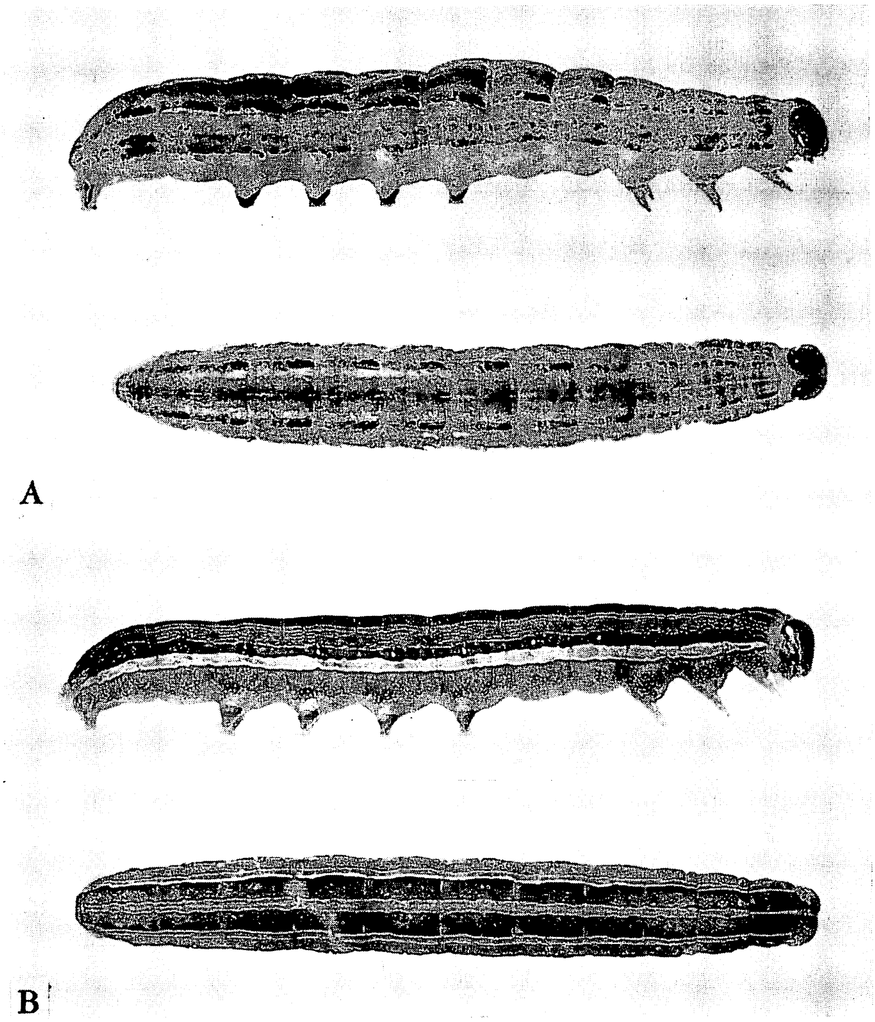

FIG. 6. A, lateral and dorsal aspects of mature *Pseudaletia unipuncta* larva; B, lateral and dorsal aspects of mature *Laphygma exempta* larva.

TABLE 1. Measurements of head-capsule width and larval length in the larval instars of *S. mauritia* (Boisduval)

INSTAR	WIDTH OF HEAD CAPSULES			LENGTH OF LARVAE*		
	No. measured	Mean (mm.)	Standard Deviation (mm.)	No. measured	Mean (mm.)	Standard Deviation (mm.)
I.......	40	0.30	0.010	20	1.24	0.159
II......	40	0.47	0.024	20	3.06	0.352
III.....	40	0.69	0.038	20	4.16	0.433
IV......	40	0.95	0.067	20	6.41	0.884
V.......	40	1.43	0.170	20	8.30	0.933
VI......	40	2.05	0.224	20	16.75	2.900
VII.....	29	2.78	0.279	18	22.88	1.914
VIII....	19	3.5	0.16	20	36.55	3.649

* Larvae measured shortly after ecdysis.

TABLE 2. Duration of the various immature stages for individuals of *S. mauritia* (Boisduval)

DURATION (Days)	EGG*	1ST INS.	2ND INS.	3RD INS.	4TH INS.	5TH INS.	6TH INS.	7TH INS.	8TH INS.	PUPA
1............			1	11						
2............			35	31	13	17	13	1		
3............	23	20	21	12	42	38	30	11		
4............	4	33			1		14	12	1	
5............		3						3	6	
6............								14	6	
7............								11	7	
8............								1		2
9............										6
10............									1	8
11............										8
12............										9
13............										2
14............										1
15............										
16............										1
Total Number Indiv........	27	56	57	54	56	55	57	53	21	37
Mean Duration (Days)..	3.2	3.7	2.4	2.0	2.8	2.7	3.0	5.0	6.1	10.9

* Number of egg masses rather than individual eggs.

countered so far in *S. mauritia*. The general coloration of the forewing of *L. exempta* males is usually somewhat lighter than that of *S. mauritia* males. In the forewing of the former species there is a more extensive pale apical area which extends diagonally some distance basad of the pale subterminal fascia. Also, most *L. exempta* males possess a fairly definite pale mark near the base of the forewing, which in *S. mauritia* is represented by a brownish area only slightly lighter than its surroundings. The anteromedian reniform spot is dark and well defined in all *S. mauritia* males but is frequently obscure in

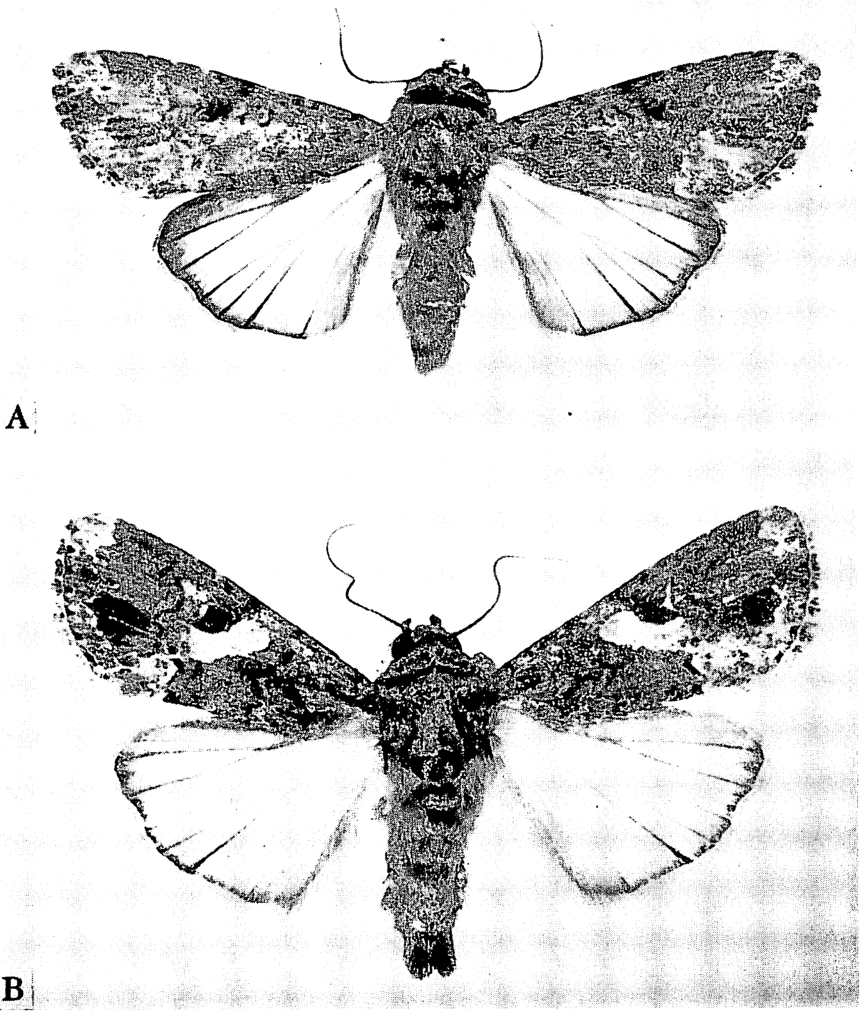

FIG. 7. A, adult female *S. mauritia*, dorsal aspect; B, adult male *S. mauritia*, dorsal aspect.

those of *L. exempta*. In *L. exempta* males the light orbicular spot usually is a trifle larger and more elongate, and the area between it and the reniform spot is usually not entirely pale, as it is in *S. mauritia*. *S. mauritia* males have a patch of dark brown just basad of the pale subterminal fascia and slightly behind the median longitudinal axis of the wing. In *L. exempta* this area is paler and usually contains two or three well-defined, slender, dark, elongate, pyramid-shaped marks. Such marks are usually absent, or never more than faintly suggested in *S. mauritia* males. The brushes of scales on the forelegs are much less noticeably developed in *L. exempta* males.

Females of the two species are less easily separated on the basis of wing pattern than are the males. The dark reniform spot on the forewing of *S. mauritia* females is well defined but in *L. exempta* females this spot is much less definite, frequently being indistinguishable. Two fine, irregular, dark, anterior-to-posterior fasciae are usually fairly well developed in *L. exempta* females—one about one-third, and the other about two-thirds the distance from base to apex. In *S. mauritia* females these fasciae, particularly the basal one, are less definite and more interrupted. As in the male sex, the orbicular mark is slightly larger and more elongate in *L. exempta* females than in those of *S. mauritia*.

LIFE HISTORY AND HABITS

The armyworms immediately after hatching were reared individually in sterilized, half-pint, cardboard containers that were covered with a half of a sterilized petri dish. These caterpillars were fed mainly tender young shoots of napier grass, *Pennisetum purpureum* Schumach. The adults were kept in one-gallon, wide-mouth glass jars and fed sugar water placed in a syracuse watch glass containing absorbent cotton. Crumpled paper toweling was placed in the jars to serve as oviposition sites. The temperature in the laboratory ranged mainly between 72°F (22°C) and 85°F (29°C) with occasional extremes of 68°F (20°C) and 86°F (32°C). The relative humidity was ordinarily 56 to 85 per cent with extremes of 50 to 92 per cent.

Mating and oviposition: Inasmuch as the adults may mate within a day after emerging from the pupal case, the newly emerged females were kept together with adult males during the first night after emergence and then separated individually into half-pint containers. The preoviposition period of nine females under observation that produced fertile eggs averaged 3.7 days with extremes of 1 and 7 days. Two additional females with preoviposition periods of 9 and 11 days, respectively, laid only sterile eggs. This indicates that mating may normally stimulate oviposition. One female laid eggs within 24 hours, but this record should be confirmed by further observations. In South India, Anantanarayanan and Ramakrishna Ayyar (1937) recorded the preoviposition period as 3 to 6 days.

In the laboratory, the gravid females usually began to oviposit shortly after dusk. Most of the eggs were deposited before midnight, but some were also laid during the early morning hours before daybreak. Once oviposition had started, the females would continue to lay eggs even in the presence of a bright light. During oviposition the moth would remain fairly rigid except for a slight quivering of the antennae. The tip of the abdomen moved continuously and stopped only for an instant to eject an egg. Then, moving over the still moist egg the moth spread over it the long, hair-like setae which readily became detached from the tip of the abdomen. The eggs usually were laid close to each other but not necessarily in a systematic pattern, as the female sometimes skipped places for several eggs in a row and returned later to fill the gaps. Upon completion of egg-laying, the female remained standing above the egg mass for about half a minute wiping off more setae from her abdomen onto the eggs.

The rate of egg-laying in the case of one female was 25 eggs during the first four minutes, and after 30 minutes the egg mass contained 273 eggs. The number of egg masses laid by five females averaged 8.6 masses per female. Oviposition began on the first day after emergence and continued to the eighth day. The maximum number of masses deposited by one female during a single night was three. These females had been kept with males only during the first night after emergence and thereafter were caged individually.

In nature, females were observed to deposit their eggs mainly on the foliage of shrubs and small trees, and on leaves of the lower limbs of taller trees. They rarely laid their eggs on the blades of the lawn grasses which are attacked by the larvae, and the few masses that were observed on grass blades were usually small with relatively few eggs. Cherian and Anantanarayanan (1937) reported that egg masses deposited on the leaves of rice plants in India were small (15 to 20 eggs per mass) as compared to those laid in the laboratory. Normal-sized egg masses were sometimes found on the leaves of stools of sugar cane in Honolulu, but such cane was not fed upon by the caterpillars.

Surface texture of foliage had little or no effect on its attractiveness for oviposition. Just as many egg masses were laid on leaves with smooth surfaces as on those with rough or hairy surfaces. Leaf size, except for very tiny or narrow leaves (less than ¼ inch in width), also was not an important factor in the choice of oviposition sites. Among the more common garden plants, mango, palms, Chinese banyan, breadfruit, loquat, and pandanus were frequently favored as oviposition sites by *S. mauritia* females.

The wooden and concrete walls and eaves of houses and other buildings were often utilized as oviposition sites. *S. mauritia* is strongly phototropic, and often large concentrations of egg masses were found on buildings and foliage near an outdoor light, or in the vicinity of a window from which light emerged most of the night. The concentration of egg masses in the vicinity of such lights is probably an important factor affecting the density and distribution of larval populations in residential areas. There was an indication that more eggs were laid on walls on the leeward sides of buildings than on those on the windward sides. Eggs were sometimes laid on laundry left out overnight.

Individual egg masses of *S. mauritia* were found to contain as many as 1372 eggs, and the mean number of eggs in 16 masses was 709. Anantanarayanan and Ramakrishna Ayyar (1937) reported that, in India, egg masses usually contained from 50 to 500 eggs, and the maximum number of eggs laid by one female in the laboratory was 2750. A range of 200 to 300 eggs per mass was reported by Otanes (1925); 200 to 400 by Commun (1932); 100 to 200 by Smith (1933); and 200 to 300 by Otanes and Karganilla (1940).

The eggs required an average of 3.2 days to hatch under laboratory conditions (table 2). Hutson (1920) observed that the egg stage ranged between 7 to 10 days; Commun (1932) and Smith (1933) observed that it averaged 7 days; Cherian and Anantanarayanan (1937) as 3 to 5 days; and Anantanarayanan and Ramakrishna Ayyar (1937) as 4 to 5 days; Otanes and Karganilla (1940) reported it as 2 to 4 days.

Larval stages: The duration of the first larval stadium averaged 3.7 days in the laboratory (table 2). Hutson (1920) recorded this stadium as 10 days, and Smith (1933) as 2 days. The second stadium lasted an average of 2.4 days, as compared to 4 days reported by Smith (1933). The third stadium averaged 2.0 days, the fourth 2.8 days, and the fifth 2.7 days (table 2). Smith (1933) reported 3, 1, and 3 days respectively for these stadia. The sixth stadium averaged 3.0 days, the seventh 5.0 days, and the eighth, when it occurred, averaged 6.1 days (table 2).

According to the published records, the larvae of *S. mauritia* apparently do not have a constant number of larval instars. Otanes (1925) found that the larvae molted six times (and therefore must have passed through six instars). Smith (1933) reported five larval stages. In South India, Anantanarayanan and Ramakrishna Ayyar (1937) observed that the larvae underwent five molts in the majority of cases but occasionally had six or seven molts.

In our laboratory studies, some larvae pupated after the seventh instar, but in others an additional molt occurred. Although observations were rather limited, the occurrence of the additional instar seemed to be correlated with the duration of the seventh stadium (note the bimodal nature of the duration of the seventh stadium in the figures of table 2). When the larvae required 5 to 8 days to complete the seventh instar, they tended to pupate directly; but when they were in this instar only 2 to 4 days they molted into the additional eighth instar. Thus, the occurrence of an eighth molt did not necessarily increase the total larval period to any great extent. Anantanarayanan and Ramakrishna Ayyar (1937) also reported that additional molts did not appreciably prolong the larval period of *S. mauritia*. In Hawaii the additional eighth molt in *S. mauritia* larvae occurred independently of the sex of the larvae, and the cause of its occurrence was not determined.

The entire larval period averaged 27.7 days under laboratory conditions in Hawaii. A period of about a month was given for the larval stages by Hutson (1920); 18 days by Jarvis (1922); from 14 to 23 days by Otanes (1925) and Otanes and Karganilla (1940); from 3 to 5 weeks by Rao (1926), Dammerman (1929), and Cherian and Anantanarayanan (1937); and from 21 to 32 days by Anantanarayanan and Ramakrishna Ayyar (1937).

Only the first- to fifth-instar larvae were seen feeding during the day. The older larvae are largely nocturnal and ordinarily spend the daylight hours hidden in the loose soil or humus below the grass; exposing themselves during the day only when migrating to new feeding areas. Such migrations result when heavy populations of caterpillars denude the lawn of all suitable grass. On several occasions caterpillars have been observed crossing gardens and sidewalks apparently in search of food.

Severe damage to lawns by *S. mauritia* larvae is frequently characterized by a sharply defined "front" between the undamaged and denuded areas of grass (fig. 1). Such fronts tend to move forward a foot or so each night when large populations of mature or nearly mature caterpillars are present in the grass. The damaged area commonly spreads outward from shrubs, trees, sides of buildings, etc., that have been utilized as oviposition sites by the female moths.

No cannibalism was observed among the larvae in the field or in the laboratory even under conditions of crowding and food shortage. Smith (1933), however, reported that crowding caused cannibalism.

Pupal stage: Pupation occurs within a loosely formed cocoon of dirt, plant material, and larval webbing. The pupa is usually found in the soil or in organic debris at the base of grass turf. The duration of the pupal stage averaged 10.9 days in the laboratory (table 2). Ballard (1921) reported the length of the pupal stage as 10 days, and Anantanarayanan and Ramakrishna Ayyar (1937) reported it as 5 to 10 days.

Adult longevity: Fifteen newly emerged female moths which were kept individually in half-pint containers and fed sugar water lived an average of 10.6 days, with extremes of 9 and 14 days. The longevity of the three males studied averaged 10.3 days under the same conditions.

HOST RANGE AND HOST PREFERENCE

Inasmuch as the recorded host range of *Spodoptera mauritia* is rather extensive, there is a possibility that the two subspecies of *S. mauritia* which were distinguished by Fletcher (1956) may have somewhat different host preferences. It is also possible that some authors have confused *S. mauritia* larvae with other caterpillars of similar appearance, such as those of *Prodenia litura* (Fabricius). *S. mauritia* has been reported from various countries as a pest of a number of grasses including rice (Ballard, 1921; Anantanarayanan and Ramakrishna Ayyar, 1937; Commun, 1932; etc.), sugar cane (Jarvis, 1922; Dammerman, 1929), young maize (Dammerman, 1929; Otanes and Karganilla, 1940), barley (Fletcher, 1920), millet (Maxwell-Lefroy, 1909; Fletcher, 1920), wheat (Fletcher, 1920), Bermuda grass (Maxwell-Lefroy, 1909), *Pennisetum typhoideum* Rich. (cumbu) (Rao, 1956), *Eleusine coracana* Gaert. (ragi) (Rao, 1956), *Paspalum dilatatum* Poir. (Smith, 1933), *Paspalum scrobiculatum* L. (Fletcher, 1920), *Panicum setigerum* (P. Beauv.) and *Agropyron repens* (L.) P. Beauv. (Anonymous, 1941), and unspecified grasses (Maxwell-Lefroy, 1909; Dammerman, 1929; Lever, 1946). Besides grasses, *S. mauritia* is known to feed on the sedge *Fimbristylis tenera* Roemer and Schultes (Rao, 1926) and has been reported damaging coconut foliage in Ceylon (Jepson, 1924), cowpea in India (Fletcher, 1920), tobacco in Mauritius (Corbett, 1926; Edward, 1927; Commun, 1932), and crucifers and *Vigna catiang* Endl. in Tonkin (Commun, 1932).

As damage by *S. mauritia* in Hawaii has so far been limited to lawns composed almost entirely of Bermuda grass, an attempt was made to obtain some information concerning its host range and possible host preference. Tests of two types were conducted: (1) starvation tests to determine the ability of larvae to survive on various grasses, sedges, and a few other plants; and (2) host preference tests to determine if larvae would exercise a choice between acceptable food plants.

Starvation Tests: In one series of tests, about 100 recently hatched first-instar larvae were confined in large battery jars containing the food plant to be tested. Testing was confined to the most tender growth of the host plant; and fresh host material was provided every two or three days. In every test, control larvae were fed Bermuda grass. After about 10 days the live larvae in each jar were counted. Tests of each host were repeated at least three times.

In the second series of tests, about 25 larvae in their fifth to early seventh instar, which had been reared on Bermuda grass, were placed in jars with the various test plants. Counts were made after all the surviving larvae had pupated. The control larvae were fed Bermuda grass until pupation. The hosts tested were mostly common lawn grasses and lawn weeds found in and around Honolulu, but a few crop plants were also included. These tests were also replicated three times.

Of the hosts tested the following proved acceptable to both first-instar and later-instar larvae: sugar cane seedlings (two weeks old), *Eleusine indica* (L.) Gaertner (wiregrass), *Stenotephrum secundatum* (Walt.) Ktze. (buffalo grass), *Zoisia matrella* (L.) Merr. (Manila grass), *Paspalum dilatatum* Poir. (Dallis grass), *Chaetochloa verticillata* (L.) Scribner (bristly foxtail), *Digitaria henryi* Rendle (crabgrass), *Cyperus gracilis* R. Br. (McCoy grass), *Cyperus rotundus* L. (nutgrass), and *Cyperus kyllingia* Endl. (kyllinga). Survival on these hosts ranged from 72 to 100 per cent in the various tests, with no material difference between Bermuda grass and the test hosts.

Survival of first-instar larvae on leaves of young corn plants (about one foot high) was 26, 68, and 82 per cent in three tests, while survival in the controls was 66, 82, and 100 per cent respectively. Older larvae developed without difficulty on young corn, and survival was nearly 100 per cent. In five tests with the following two hosts, *Zoisia tenuifolia* Willd. (velvet grass) and leaves of sugar cane grown from cuttings, survival of first-instar larvae was low (0 to 5 per cent with cane leaves, and 0 to 22 per cent on velvet grass). When older larvae were tested on these two hosts survival approached 100 per cent in all trials, although the time required for the larvae to complete development was several days to a week or more longer than in the controls.

In three trials with young fronds of the Macarthur palm, *Actinophloeus macarthuri* (Wendl.) Becc., all the first-instar larvae succumbed after 3 or 4 days, although some attempted to feed at the tips of leaflets. Later-instar larvae were able to feed on the palm leaflets, and as many as 60 per cent in one test were able to complete development to pupae. However, these required 7 to 10 days longer than the controls. In tests with the foliage of *Lycopersicon esculentum* Mill. (tomato), *Nicotiana tabacum* L. (tobacco), *Cordyline terminalis* (L.) Kunth. (ti), and *Zingiber* sp. (ginger), none of either the first-instar or later-instar larvae survived.

Although only a small number of food plants were tested, the above results indicate that in Hawaii the host range of *S. mauritia* is limited largely to grasses and sedges. Apparently almost any grass can serve as a host, but in the case of tough or hard foliage, as with sugar cane grown from cuttings (the usual method of field propagation) and velvet grass, there may be a very high mortality of first-instar larvae when they are restricted to such hosts. Velvet grass was the only one of the common lawn grasses tested which showed some resistance to attack by *S. mauritia.* Corn seems to be less suitable as a host for the young larvae than most of the smaller grasses. It also appears that the development of later-instar larvae is somewhat prolonged when these are forced to feed on the tougher hosts. Anantanarayanan and Ramakrishna Ayyar (1937) reported that *S. mauritia* preferred the tender leaves of paddy rice 4 to 10 days old and ignored leaves which were over a month old.

Host preference: On the island of Oahu, damage by *S. mauritia* has been confined very largely to Bermuda grass lawns. Lawn weeds such as wire grass and nut-grass which often occur within armyworm-damaged lawns usually show little evidence of feeding. Such observations have led to the speculation that *S. mauritia* larvae are selective when presented with a choice of acceptable grasses. To test this hypothesis, first-instar larvae were confined in battery jars containing two bunches of fresh grass leaves approximately equal in quantity: one of Bermuda grass and one of the other test grass. Fresh bunches of both grasses were added daily, and after 5 or 6 days the food material was carefully removed, the number of larvae on each host counted, and evidence of feeding noted. Because of the limited time available, only two grasses were tested against Bermuda grass in this manner. These were buffalo grass, a tough, thick-leaved grass commonly grown for lawns and which has not yet been seriously attacked by *S. mauritia*, and wire grass, a common and persistent lawn weed. Tests with each of these grasses were repeated three times.

In the tests with buffalo grass, the larvae showed a definite preference for Bermuda grass. In the three trials, only 2.6, 5.0, and 10.0 per cent, respectively, of the larvae were on buffalo grass at the conclusion of the tests and there was very little evidence of feeding on the buffalo grass leaves. In the tests with wire grass, there were 56.9, 51.6, and 29.5 per cent, respectively, of the larvae on the grass at the conclusion of the tests. Here, only the last test indicated a preference for Bermuda grass over wire grass by the armyworm. However, in the first two tests, both the wire grass and the Bermuda grass were taken from lush, unmowed, well-watered plots, and consequently the leaves were all very tender. In the last test the wire grass was taken from a lawn where it was a prostrate and tough-leaved form. These results indicate that probably the tenderness of the leaves rather than the species of grass may be the more important factor determining the choice of grass fed upon by *S. mauritia* larvae. Smith (1933) also reported that *S. mauritia* was partial to certain grasses, but he was able to raise the larvae successfully in the laboratory on a number of grasses that were ignored by larvae in the field.

NATURAL ENEMIES

Microorganisms: A polyhedrosis virus attacking *S. mauritia* was first reported in Hawaii by Bianchi (1956). That the so-called bacterial disease reported by Anantanarayanan and Ramakrishna Ayyar (1937) may have been caused by a polyhedrosis virus is suggested by the similarity in symptomatology. According to Tanada and Beardsley (1957), the polyhedrosis virus found by Bianchi may have entered Hawaii together with its host. In the field, the virus has been observed both in young (second- to fourth-instar) larvae and older larvae. In several outbreaks of *S. mauritia* on lawns in Hawaii, a large percentage of the larvae were killed by virus epizootics. Accordingly, this virus may have some promise in the microbial control of the armyworm.

Spores of a microsporidian were found in eggs of *S. mauritia* collected in the field at Waialae-Kahala, Honolulu. These eggs were apparently killed by the protozoan, which was tentatively identified as *Nosema* sp. The microsporidian is highly infectious and can be readily transmitted by feeding contaminated foliage to the larvae. Some infected larvae survived to maturity, and the adults were found to contain microsporidian spores. The effect of this microsporidian in the natural control of *S. mauritia* in the field has not been evaluated.

Many dead eggs of *S. mauritia* were observed covered with a dark-green fungus. The fungus appeared more commonly in the wet areas of the valleys than in the drier areas near the coast. Although in a few preliminary attempts, it was not possible to transmit the fungus to healthy eggs and larvae, further tests should be conducted to prove conclusively whether it is a true pathogen or merely a saprophyte developing on eggs killed by other causes.

An entomogenous fungus attacking the larvae was reported by Smith (1933). In Ceylon, Hutson (1920) reported a fungus and a bacterial disease on *S. mauritia.*

Predators: Inasmuch as observations of predators attacking *S. mauritia* in Hawaii were made incidentally while collecting material for other purposes, the predator list discussed here is undoubtedly incomplete.

The egg stage of *S. mauritia* is subject to attack by several predators, but, except in the special circumstances cited below, these appeared to be of minor importance in the reduction of armyworm populations. Two species of ants were found attacking and destroying healthy eggs on foliage. *Monomorium floricola* Jordan was associated with *S. mauritia* eggs at several places in the Aina Haina-Wailupe Circle section of Honolulu. These minute ants were observed to enter egg masses through apparently ant-made holes in the top or at the sides of the overlying mat of setae, where they appeared to have crushed the contained eggs and removed their contents. At one location, these ants at times completely destroyed many egg masses on a *Pandanus* tree that was regularly and heavily utilized for oviposition by *S. mauritia* females. The number of egg masses consumed by ants on this tree was once estimated to be about one-third of the total viable egg masses present. In a few instances the big-headed ant, *Pheidole megacephala* (Fabricius), was observed attacking *S. mauritia* eggs on mango foliage in a manner similar to that of *Monomorium.*

Coccinellids occasionally were found feeding on *S. mauritia* eggs; but it appeared that such predation was largely incidental, for in such cases they were associated with infestations of scales, mealybugs, or aphids upon which these beetles normally feed. Of the three species of coccinellids involved, both adults and larvae of *Orcus chalybeus* (Boisduval) were seen feeding on eggs, while only the adults of *Cryptolaemus montrouzieri* Mulsant and *Scymnus roepkei* Fluiter were so observed.

In the course of this study, the only predators of *S. mauritia* larvae observed in Hawaii were the giant toad, *Bufo marinus* (L.), and the Indian mynah bird, *Acridotheres tristis* (L.). However, it seems probable that some insects (such as wasps, lacewing larvae, and ants) and other invertebrate predators may also attack caterpillars in the grass. In Ceylon, predatory bugs (Hemiptera) and a beetle, *Cicindela sexpunctata* Fabricius, are reported to feed on the caterpillars (Hutson, 1920). In South Africa, Dick (1943) observed that the Argentine ant destroyed the prepupae and pupae of *S. mauritia.*

Mynah birds have frequently been observed converging on lawns where the caterpillars of *S. mauritia* are abundant, and Swezey (1909) considered the mynah bird a valuable enemy of armyworms and cutworms in Hawaii. In Ceylon (Henry, 1917) and in India (Ballard, 1921) mynah birds have also been reported feeding on *S. mauritia* larvae. Other birds such as ducks, storks, cranes, herons, egrets, chickens, and crows have occasionally been reported to be effective in the control of this armyworm in various countries (Henry, 1917; Hutson, 1920; Ballard, 1921; Otanes, 1925; Y. R. Rao, 1926; Commun, 1932; Ramakrishna Ayyar,1 933; Anantanarayanan and Ramakrishna Ayyar, 1937).

Our observations on the giant toad indicate that it may be an important factor limiting *S. mauritia* populations, since the nocturnal feeding habits of the toad coincide with those of the mature armyworm. Out of a total of 26 toad feces found on two lawns in the Kailua section of Oahu following an armyworm outbreak in the spring of 1956, 25 were found to contain head capsules of *S. mauritia* larvae. On a lawn badly infested with armyworms in the Aina Haina area of Honolulu, one large fecal mass was found to contain 138 armyworm head capsules, which probably represents the total number of armyworms consumed by that particular toad during one or two nights. It is worth noting, though not necessarily indicative of a direct correlation, that nearly all the serious armyworm damage in the Aina Haina-Wailupe Circle area has occurred in the drier areas where toads are scarce or absent. In Fiji, *Bufo marinus* has also been reported feeding on *S. mauritia* larvae (Lever, 1939).

Parasites: The insect parasites which have been reared from *S. mauritia* have all been known previously in Hawaii as enemies of other species of Lepidoptera, particularly of various species of armyworm and cutworms. For detailed information relating to armyworm parasites in Hawaii, the reader is referred to papers on the subject by Pemberton (1948) and Bianchi (1944).

Two species of egg parasites which attack *S. mauritia* occur rather commonly on the island of Oahu. The scelionid, *Telenomus nawai* Ashmead, has been bred from *S. mauritia* egg masses collected in the Aina Haina and Waialae-Kahala areas of Honolulu (Beardsley, 1955). A survey of egg parasitization made over a period of about a year showed that at some stations (*i.e.* upper Aina Haina) anywhere from 60 to 95 per cent of the egg masses in a sample contained eggs parasitized by *T. nawai.* At stations in another locality about one-half mile distant (*i.e.* Wailupe Circle) only an occasional sample contained one or two parasitized egg masses. The ecological factors responsible for this difference in parasitization at the two localities have not been determined.

Usually only a portion of the eggs in a given mass was parasitized by *T. nawai*, and the remaining unparasitized eggs (numbering a few to nearly all in a given mass) gave rise to caterpillars. Occasional egg masses were found which were 100 per cent parasitized, but the majority of those which yielded parasites were from 20 to 80 per cent destroyed. The heavy covering of setae as well as the several layers of eggs in an egg mass seem to hinder the parasite so that it is less effective than on the thinner, less heavily covered egg masses of *Laphygma exempta.* It was also observed both in the field and in the laboratory that adults of *T. nawai*, although fully formed, frequently failed to emerge from parasitized eggs.

The second species of egg parasite found parasitizing *S. mauritia* eggs in Hawaii was the trichogrammatid, *Trichogramma minutum* Riley. Usually, this wasp was less plentiful in egg samples than was *T. nawai*, and, like the latter, it rarely parasitized all the eggs in a given mass. It was not uncommon for an egg mass collected in the field to yield adults of both *T. nawai* and *T. minutum*, as well as some caterpillars.

Three species of braconid wasps so far have been reared from *S. mauritia* larvae in Hawaii. Caterpillars parasitized by these wasps are killed before they are more than about half grown, and consequently such caterpillars do not attain the older, more destructive stages.

The braconid egg-larval parasite, *Chelonus texanus* (Cresson), was first reported attacking *S. mauritia* in Hawaii by Van Zwaluwenburg (1955). This species has frequently been seen ovipositing in *S. mauritia* eggs in the field, and adults have been bred from field-collected larvae. This wasp was introduced into Hawaii from Texas in 1942 to combat *Laphygma exempta* (see Bianchi, 1942). In *S. mauritia*, the parasite grub emerges when the host larva is in the fifth or sixth instar, and feeds externally for a day or so until the host remains are reduced to a head capsule and a bit of skin. Pupation takes place in a cocoon in ground litter. The life cycle from oviposition to emergence of the adult wasp required about 30 days when reared on *S. mauritia* in the laboratory.

Several egg masses on which *C. texanus* females were seen ovipositing in the field were collected and held in the laboratory. From 14 to 60 per cent of the caterpillars which issued from these egg masses and which survived until the fifth instar eventually were killed by the parasite. However, when young caterpillars (in second, third, and fourth instars) were collected at two stations in the Aina Haina-Wailupe Circle area during a period of 6 months, never more than 2 or 3 per cent of them were parasitized. It appears that *C. texanus* may be of minor importance in the natural control of *S. mauritia*.

Apanteles marginiventris (Cresson) was also first observed by Van Zwaluwenberg (1955) on *S. mauritia*. It was likewise introduced from Texas for the control of *L. exempta*, and appears to be one of the most important natural enemies of *S. mauritia* in Hawaii. It was the parasite most frequently reared from early-instar *S. mauritia* larvae collected in the field.

Females of *A. marginiventris* lay their eggs in first-instar armyworm larvae, and on sunny mornings they may frequently be seen searching for suitable hosts among grass blades in armyworm-infested lawns. The fully fed parasite grub emerges from the host caterpillar when the latter is in the fourth instar, and forms a white cocoon, usually on a grass blade. Where lawns are mowed frequently and the cuttings removed, a fairly large proportion of the cocoons may thereby be destroyed. The life cycle of this parasite from oviposition to adult emergence required 12 to 18 days when reared on *S. mauritia* larvae in the laboratory. Individual collections of second- to fourth-instar armyworms made at two stations in the Aina Haina-Wailupe Circle area of Honolulu during 1956 and 1957 were from less than 10 to more than 80 per cent parasitized by *A. marginiventris*, with an overall average of 31.6 per cent at one station, and 32.8 per cent at the other. A hyperparasite, *Eupteromalus* sp., was once reared from field-collected cocoons of *A. marginiventris*.

Like the two preceding species, *Meteorus laphygmae* Viereck was purposely introduced from Texas in 1942. It has been reared from *S. mauritia* larvae on several occasions but appears to be less important than *A. marginiventris*. Females of *M. laphygmae* oviposit in young *S. mauritia* larvae (probably only those in the first and second instars), and when mature the parasite grub leaves the host, which is then usually in the fourth or fifth instar. The brownish *M. laphygmae* cocoons, each attached to a grass blade by a long silken thread, may sometimes be found in lawns infested by *S. mauritia*.

Three species of tachinid flies have been found parasitizing *S. mauritia* larvae in Hawaii. *Chaetogaedia monticola* (Bigot) and *Achaetoneura archippivora* (Williston) were reported previously (Beardsley, 1955), and *Eucelatoria armigera* (Coquillett) is now recorded for the first time. When parasitized by one of these flies, the host caterpillar is killed in the pupal or last larval stage, generally after it has completed feeding. Therefore, such caterpillars, even though parasitized, may contribute materially to lawn damage before they succumb. When plentiful, these flies probably constitute an important factor limiting the size of armyworm populations. However, no attempt was made to evaluate the relative importance of the flies as natural control factors.

A number of parasites have been recorded from *S. mauritia* in other parts of the world. In Ceylon, Hutson (1920) reported two species of small parasitic wasps, and two species of braconid parasites, one a *Macrocentrus* species, were reported from Fiji (Lever, 1946). Swezey (1940) reared the ichneumonid, *Echthromorpha conopleura* Krieger, from the pupae in Guam, and on one occasion he found 22 per cent of the pupae parasitized. In New Guinea, a braconid, *Microdus* sp., was reared from *S. mauritia* larvae and apparently exercised noticeable control (Anonymous, 1941). In South India, *Charops dominans* (Walker) (an ichneumonid); *Apanteles ruficus* Haliday, and *Chelonus* sp. (braconids); and *Euplectrus uplexiae* Rohwer (an eulophid) were reared from *S. mauritia* by Anantanarayanan and Ramakrishna Ayyar (1937). Ballard (1921) reported *Chelonus carbonator* Marshall and a *Chelonus* sp. as parasites in India. The tachinid parasites, *Cyphocera varia* Fabricius, *Sturmia bimaculata* Hartig, *Tachina fallax* (Meigen), *Pseudogonia cinerascens* Rondani, and *Actia aegyptia* Villeneuve have been recorded from *S. mauritia* in South India (Ballard, 1921; Rao, 1926; Anantanarayanan and Ramakrishna Ayyar, 1937). Tachinids have also been reported as parasites of *S. mauritia* in South Africa (Dick, 1943), in the Philippines (Goco, 1921; Otanes, 1925) and various parts of

South East Asia (Thompson, 1947). In using Thompson's list of parasites it should be remembered that Hawaiian records included therein are not valid as the host upon which they were based was actually *Laphygma exempta*, misidentified as *S. mauritia*.

SUMMARY

A biological study of the lawn armyworm, *Spodoptera mauritia* (Boisduval), was conducted under laboratory conditions in Hawaii. Field observations of some aspects of its biology are also included in the study. The stages in the life history of the armyworm are described in detail, and the results of life history studies are presented.

The entire life cycle from egg to adult required approximately 42 days. Each female moth laid an average of 8.6 egg masses in the laboratory. In nature, most of the eggs were deposited on the foliage of shrubs and trees, and on eaves and walls of buildings. Very few eggs were laid on the leaves of the grasses which serve as food for the larvae. Completion of the larval stages required about 28 days, and the pupal stage about 11 days. Most of the larvae studied passed through seven larval instars, but some went through an additional, or eighth, larval instar. This extra instar occurred in larvae of both sexes.

In Hawaii, most of the damage caused by this armyworm has been in lawns planted with Bermuda grass, *Cynodon dactylon* (L.) Persoon. Starvation and host preference tests indicated that the host range of the larva is limited largely to grasses and sedges. The larvae selected tender over tough foliage and, when forced to feed only on tough foliage they took longer to complete their development.

The natural enemies of *S. mauritia* that were observed in the field in Hawaii are discussed. Among these, a polyhedrosis virus, *Bufo marinus* (L.) (the giant toad), *Telenomus nawai* Ashmead (a scelionid egg parasite), *Apanteles marginiventris* (Cresson) (a braconid parasite of the young larvae), and three species of tachinid flies appeared to be the most important biological control agents.

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