QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES

DIVISION OF PLANT INDUSTRY BULLETIN No. 831

FURTHER STUDIES ON THE IMMATURE STAGES OF THE COMMON SPECIES OF ARMYWORMS, CUTWORMS AND BUDWORMS FOUND IN QUEENSLAND

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SUMMARY

A key to the larvae of four genera of noctuid moths; *Agrotis, Heliothis, Pseudaletia* and *Spodoptera* (Brown and Cantrell, 1978) is expanded to include *Mythimna* and *Persectania*. A key to the pupae of these genera is given, including a key for the separation of some species of the genera *Agrotis, Mythimna, Persectania* and *Spodtoptera*.

I. INTRODUCTION

Since the study of Brown and Cantrell (1978) was completed, material of the immature stages of the sugarcane armyworm, *Mythimna loreyimima* (Rungs) and the southern armyworm, *Persectania ewingii* (Westwood) have become available, and the opportunity is taken to provide a means of identification of larvae of these species by modifying their key.

In addition, a study of the available pupae of the genera treated by Brown and Cantrell (1978) and the two additional species treated in this paper was made, allowing the presentation of a key to separate them.

Kirkpatrick (1961) has already provided a means of separating the pupae of the common species of *Heliothis* in Australia. An examination of the criteria used by him confirmed that they are satisfactory.

Pupae of the African species of *Spodoptera* were treated by Brown and Dewhurst (1975) including some species which also occur in Australia. Additional information and a note on a difference noticed in Australian specimens of *S. exigua* Hübner is presented.

As in the paper by Brown and Cantrell (1978), the key to larvae applies only to ultimate and penultimate instars, and nomenclature of setae follows Hinton (1946). The nomenclature of species of *Persectania, Agrotis* and *Pseudaletia* mentioned in the text follows that of Common (1954, 1958, 1965).

The structure of a typical pupa is shown in figure 1.

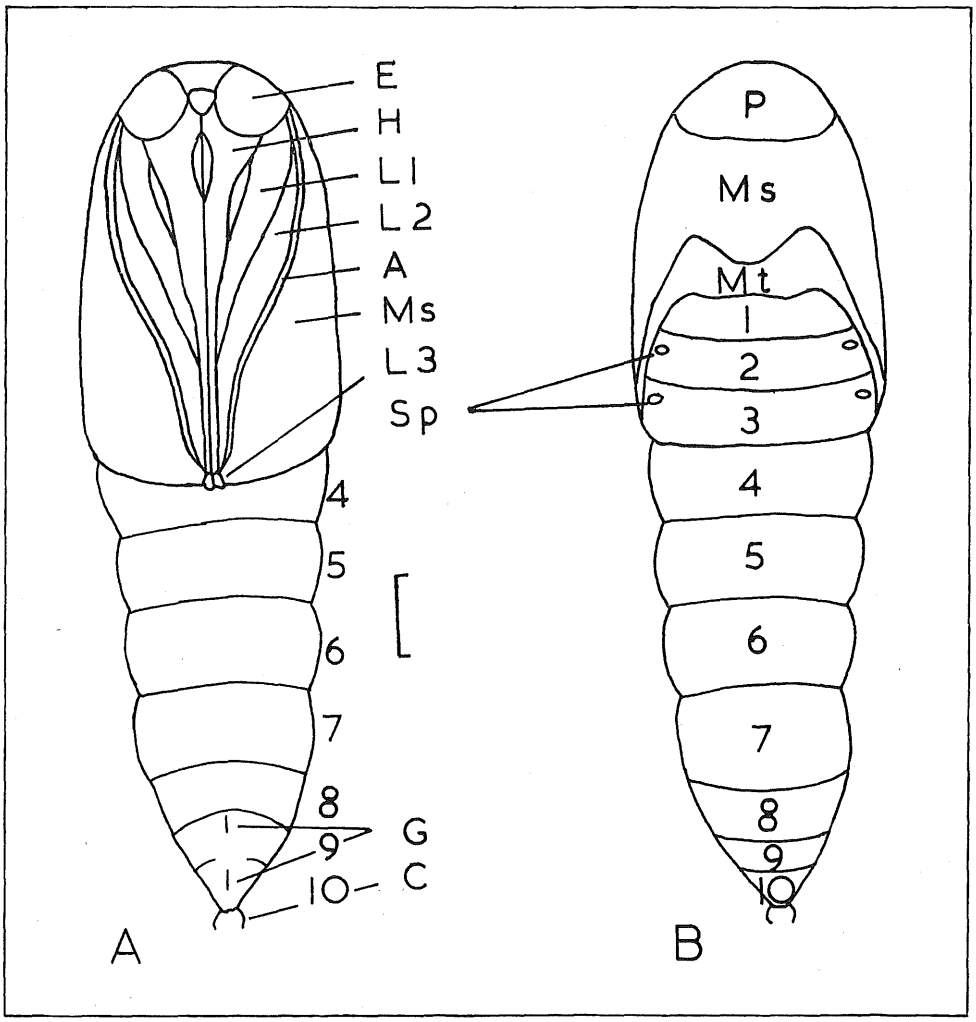

Figure 1. Diagramatic view of a noctuid pupa. A, Ventral; B, Dorsal. (A, antenna; C, cremastral spines; E, eye; G, genital 'scars'; H, haustellum; L, leg; Ms, mesothoracic wing; Mt, metathoracic wing; P, pronotum; Sp, spiracle; 1-10, abdominal segments). Scale = 2.00 mm.

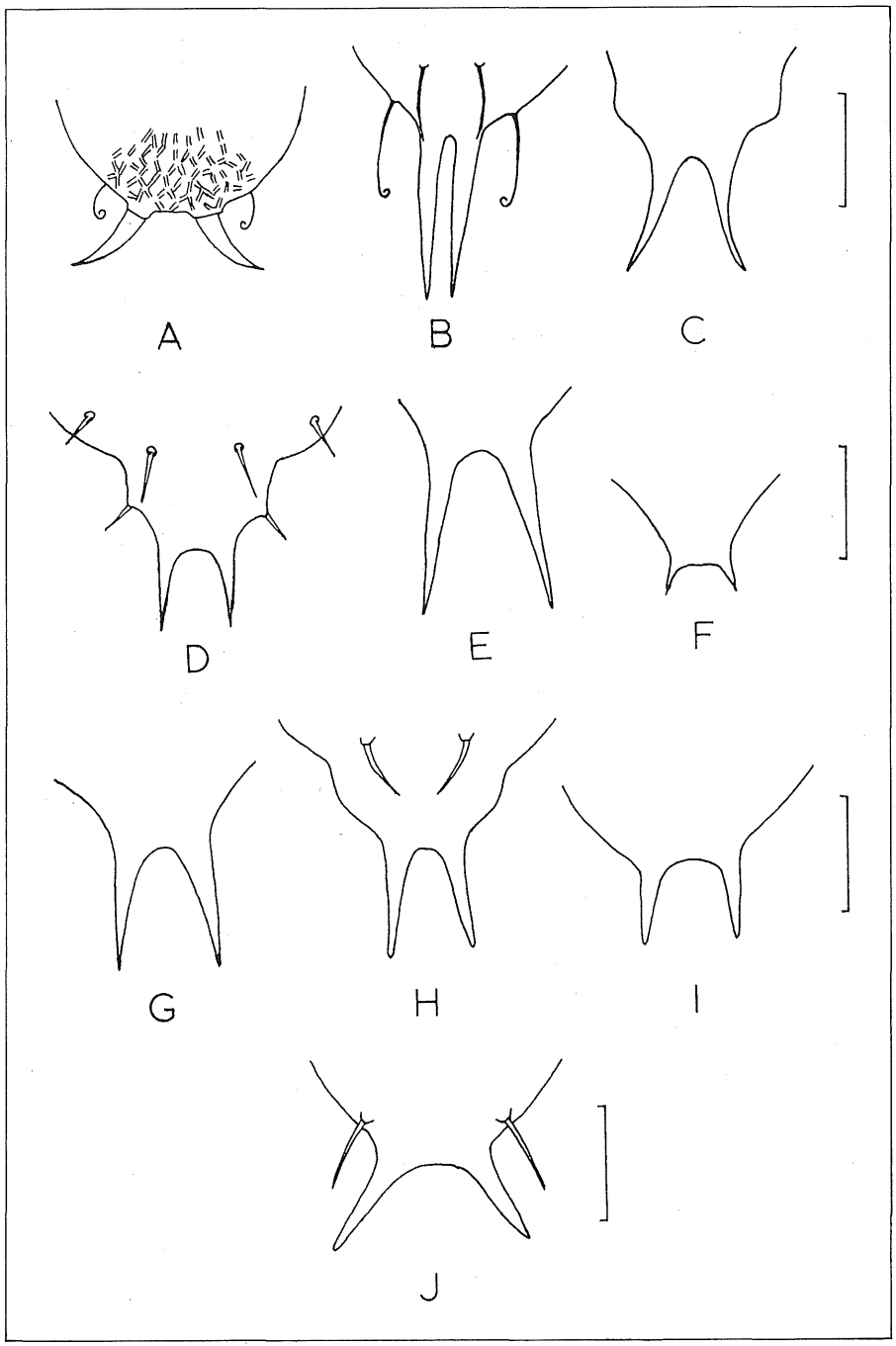

Figure 2. Pupal cremastral spines, dorsal. A, M. loreyimima; *B,* P. convecta; *C,* A. ypsilon; *D,* A. munda; *E,* S. mauritia; *F,* S. exigua; *G,* S. litura; *H,* A. infusa; *I,* S. exempta; *J,* P. ewingii. *Scale = 0.5 mm.*

II. KEY TO LARVAE

Persectania ewingii can be incorporated into the key of Brown and Cantrell (1978) with the following amended couplets:

2. Pinnacula of setae of the first seven abdominal segments not distinct.....3
Pinnacula of setae of the first seven abdominal segments distinct.....2a

2a. All abdominal spiracles situated in the dark lateral stripe....*Persectania ewingii* (Westw.)
Spiracles above the second, third and fourth abdominal prolegs situated in the light stripe below the dark lateral stripe.....*Pseudaletia* spp.

Mythimna loreyimima can be incorporated into the key of Brown and Cantrell (1978) with the following amended couplets:

3. Meso- and metathorax and the first eight abdominal segments each with a pair of conspicuous dark, semicircular dorsolateral spots, remainder of pattern indistinct....5
Larvae not as above.....4

4. Larvae in high-density populations velvety black with yellowish longitudinal lines. Low density populations light brown to greenish. (But note that colouration is extremely variable.) Cuticle around bases of setae D1 and D2 on abdominal segments without any pigmentation. Cutting edge of mandibles dentate.....4a

Colour of larvae independent of population density, always dark with lighter longitudinal lines. Cuticle surrounding setae D1 and D2 on abdominal segments weakly sclerotized dorsally, sometimes also anteriorly and posteriorly, but never entirely surrounding the base of the setae to form a pinnaculum. Cutting edge of mandibles smooth and sharp, with a median notch.....*Mythimna loreyimima* (Rungs)

4a. Spiracles entirely dark; mandibles with poorly developed teeth.....
Spodoptera exempta (Walk.)

Spiracles pale, surrounded by a black rim; mandibles with well developed teeth.....
Spodoptera exigua (Hübn.)

III. KEY TO PUPAE

1. Spiracles situated on mounds raised well above the pupal cuticle when viewed in profile, cremastral spines close together at base.....*Heliothis* spp.

Spiracles situated in a depression in the cuticle or slightly raised above it, in which case the cremastral spines well separated at base.....2

2. Cuticle with a pattern of raised ridges around bases of cremastral spines which are widely separated (figure 2A).....*Mythimna loreyimima* (Rungs)

Cuticle smooth or slightly roughened around bases of cremastral spines.....3

3. Abdominal segments 4–7 each with a single dorsal row of deep pits in the cuticle.....
Persectania ewingii (Westw.)

Abdominal segments 5–7 each with a single dorsal row of deep pits in the cuticle.....
Pseudaletia spp.

Abdominal segments 4–7 with multiple rows of deep pits dorsally, or sculpturing limited to several rows of shallow punctures.....4

4. Abdominal segments 8–10 with a number of dorsal and lateral symmetrically-arranged setae (figures 2D, 3B).....*Agrotis munda* (Walk.)

Abdominal segments 8–10 without such setae.....5

5. Abdominal segments 4–7 with multiple rows of deep pits in the cuticle dorsally.....
Agrotis ypsilon (Hufn.)

Abdominal sculpturing limited to shallow punctures.....6

6. Abdominal segments 2 and 3 each with several rows of punctures as deep as those on posterior segments. Cremastral spines as in figure 2E.....
Spodoptera mauritia (Boisd.)

Abdominal segments 2 and 3 without punctures, or if some are present, smaller and shallower than those on posterior segments.....7

7. Cremastral spines widely separated at base, short and strongly diverging (figure 2F).....
Spodoptera exigua (Hübn.)

Cremastral spines longer, sub-parallel or slightly diverging (figures 2G–I).....8

8. Spiracles raised above the surface of cuticle, rim simple....*Spodoptera exempta* (Walk.)
   Spiracles not so raised or posterior rim of spiracle ornate.....9
9. Most specimens with a pair of prominent dorsal setae anterior to the cremastral spines (figure 2H). Rim of spiracle simple.....*Agrotis infusa* (Boisd.)
   No such setae present. Posterior rim of spiracle, viewed from behind, with strong strengthening ridges.....*Spodoptera litura* (F.)

IV. NOTES ON PUPAE

Agrotis spp. (figures 2C, D, H; 3) are generally characterized by rugose cuticle around the tip of the abdomen and often by the presence of supplementary setae. In contrast to the situation with larvae where *A. ypsilon* and *A. infusa* are difficult to separate, the pupae are easily distinguished, both on the shape of the cremastral spines and by the dorsal abdominal sculpturing, consisting of deep pits in *A. ypsilon* but limited to punctures in *A. infusa.* Also the spiracles in *A. ypsilon* are slightly raised above the surface of the cuticle, whereas they are flush in *A. infusa. A. munda* may be separated on the basis of the prominent setae on abdominal segments 8–10. The spiracles in this species are elevated in a similar manner to those of *A. ypsilon.* The abdominal sculpturing in all species is limited to segments 4–7, similar dorsally and ventrally in *A. infusa* and *A. munda* but limited to sparse punctures ventrally in *A. ypsilon,* in contrast to the dorsal pits.

Heliothis spp. are readily identified by the combination of obviously elevated spiracles and the close spacing of the cremastral spines. The abdominal sculpturing consists of shallow punctures and is limited to segments 5–7. The cuticle is smooth around the bases of the cremastral spines.

Mythimna loreyimima (figures 2A; 4B) exhibits a characteristic sculpturing of the cuticle around the bases of the cremastral spines; this is in the form of an irregular raised pattern of sharp ridges. The shape of the cremastral spines is also distinctive. Abdominal sculpturing is present on segments 4–7 in the form of a dorsal row of deep pits, some close together so that the dark rims are touching, others separated. Anterior to these pits are scattered shallow punctures. Laterally the pits merge into punctures which continue on the ventral surface. The openings of the spiracles are very narrow and slit-like.

Persectania ewingii (figures 2J; 4A) also shows abdominal sculpturing in the form of deep pits dorsally on segments 4–7, becoming shallow punctures laterally; however, there is no ventral sculpturing. The area surrounding the spiracles is clearly marked off from the rest of the cuticle by a distinct rim. The cuticle around the bases of the cremastral spines is smooth and there are additional strong setae anterior to the spines and on the lateral margins of segment 10. Segment 8 has an obvious thorn on each lateral margin.

Pseudaletia spp. (figures 2B; 4C). Like the larvae, the pupae of *P. convecta* and *P. separata* cannot be separated. They can be recognized by the single dorsal row of deep pits on segments 5–7 of the abdomen and the basal approximation of the cremastral spines. Unlike *M. loreyimima* and *P. ewingii* in which each pit has its own distinct darkened rim, the pits are situated in a darkened area of the cuticle so that the individual rims are not visible. Laterally there are a few scattered shallow punctures which continue in a reduced form ventrally at least on segment 7. Two pairs of setae surround the cremastral spines, one pair anterodorsally, the other on the lateral margins of segment 10.

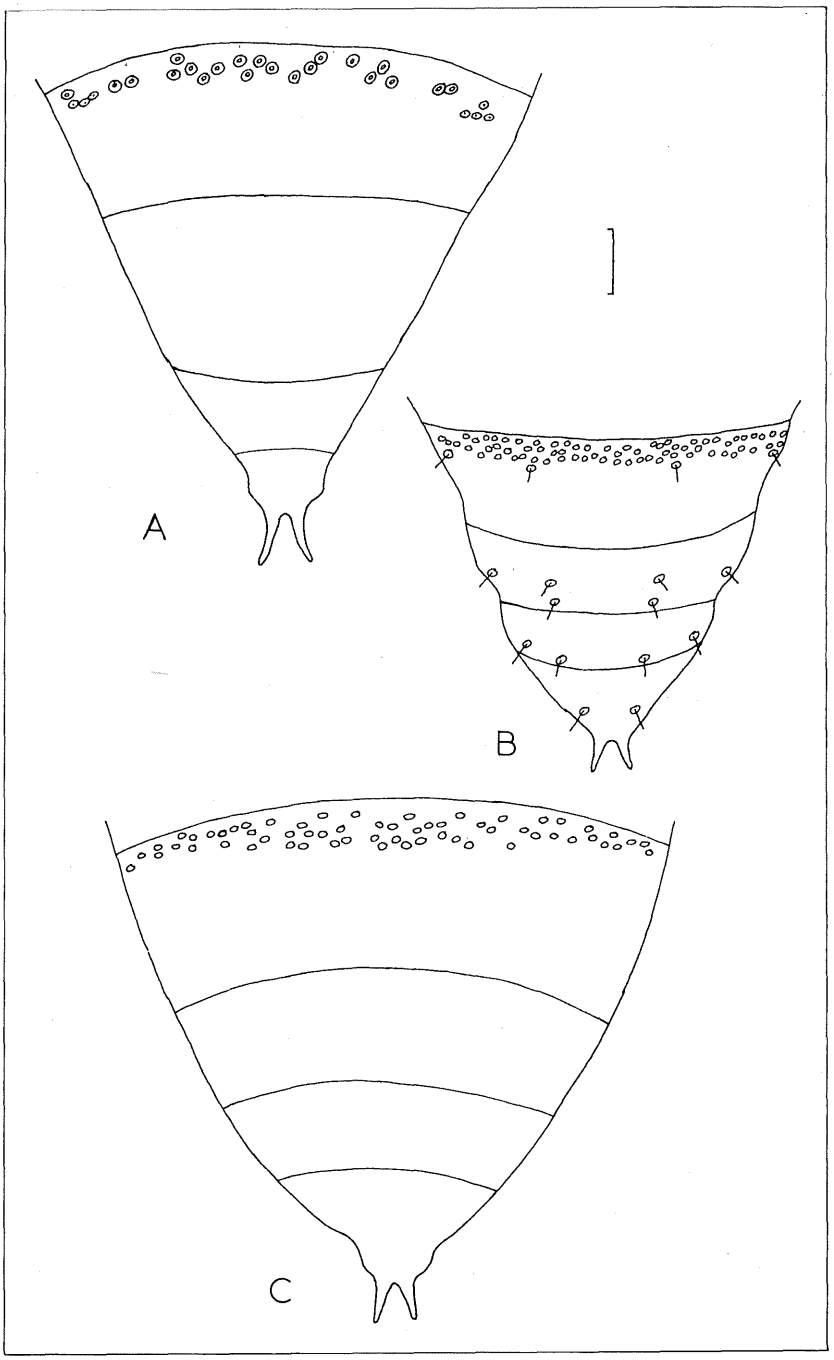

Figure 3. Pupal abdominal segments 7-10, dorsal, Agrotis *spp. A,* A. ypsilon; *B,* A. munda; *C,* A. infusa. *Scale = 0.65 mm.*

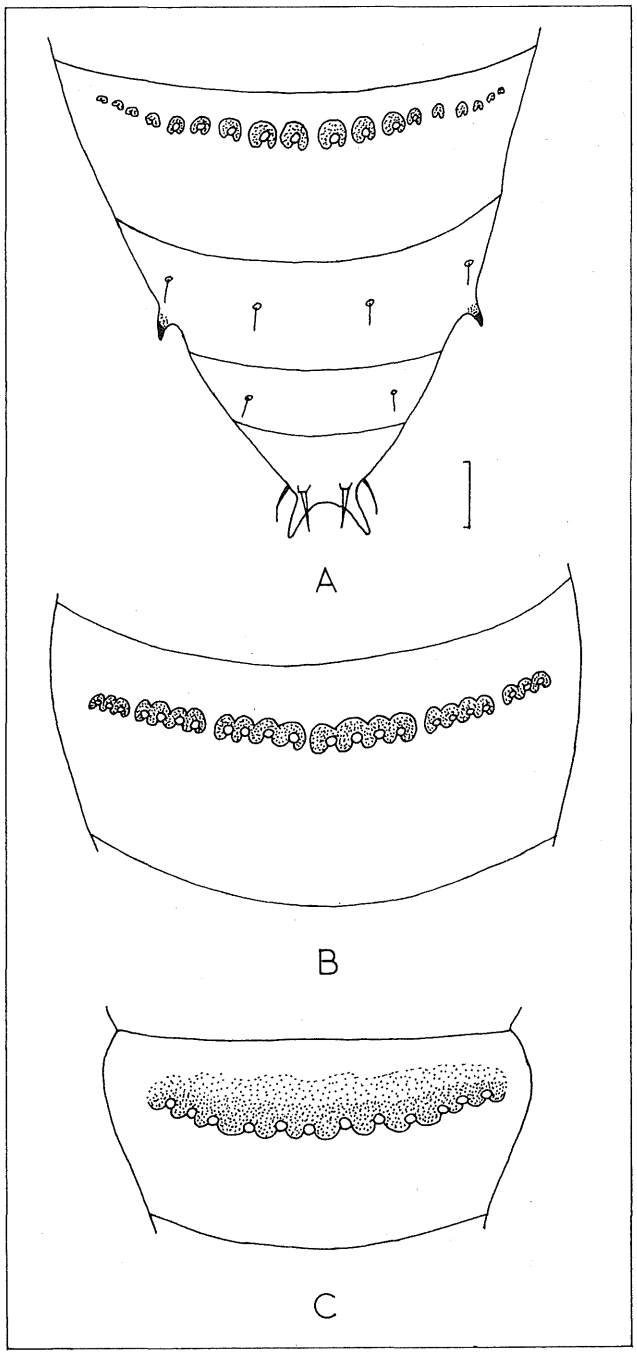

Figure 4. Pupal abdominal segments, dorsal. A, segments 7-10, P. ewingii; *B, segment 7,* M. loreyimima; *C, segment 7,* P. convecta. *Scale = 0.65 mm.*

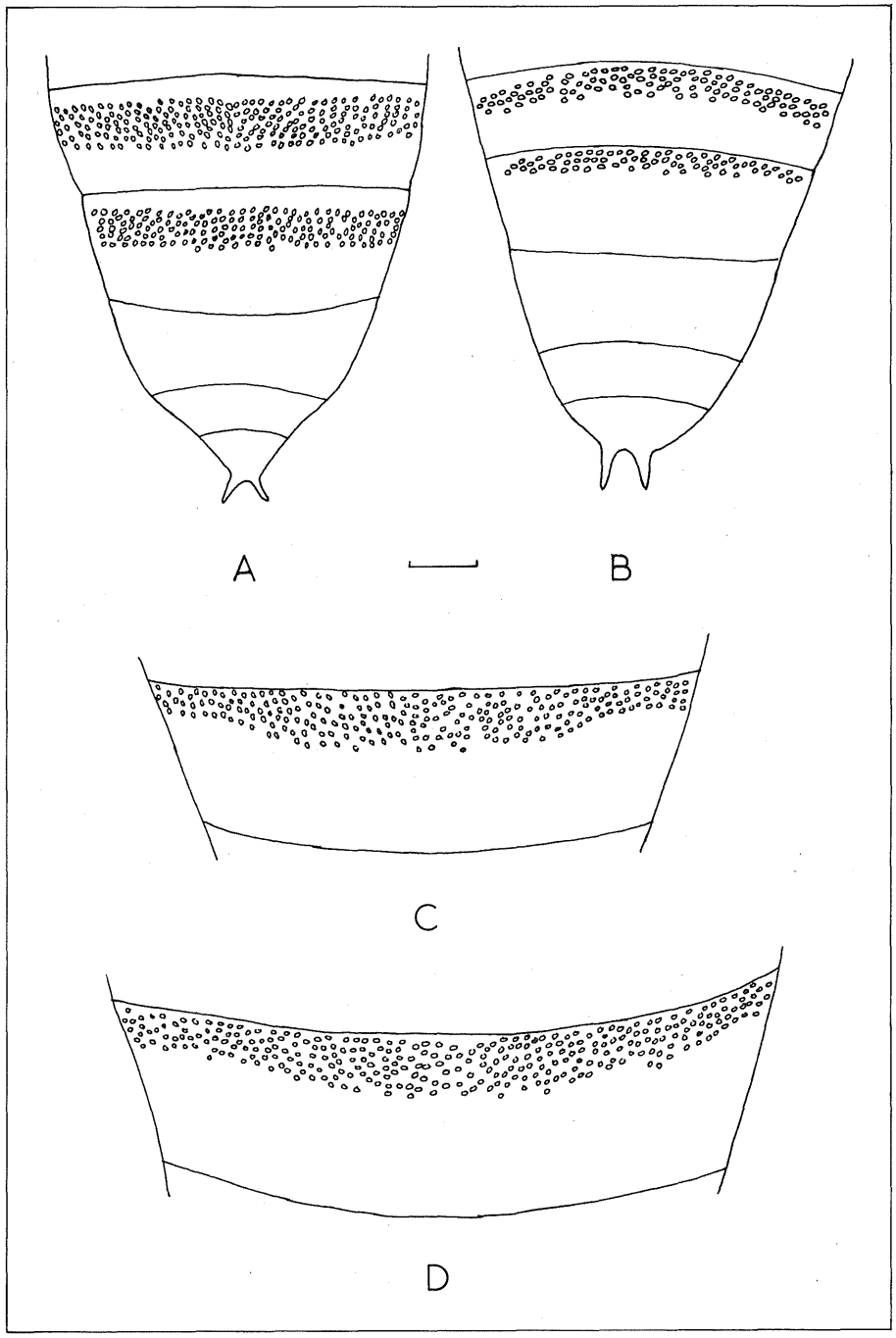

Figure 5. Pupal abdominal segments, dorsal, Spodoptera *spp. A, segments 7-10,* S. exigua; *B, segments 7-10,* S. exempta; *C, segment 7,* S. mauritia; *D, segment 7,* S. litura. *Scale = 0.65 mm.*

Spodoptera spp. (figures 2E–G, I; 5) are characterized by abdominal sculpturing in the form of shallow punctures but generally denser than in other genera and extending anteriorly to segment 3, or in *S. mauritia* to segment 2. The cuticle is smooth around the bases of the cremastral spines which vary specifically (figures 2E–G, I). In all species other than *S. mauritia,* the punctures on abdominal segment 3 are weaker and sparser than those on segments 4–7. *S. litura* is readily distinguished by the ridged posterior spiracular rim. *S. exigua* and *S. exempta* can be separated by combinations of characters of the spiracles and cremastral spines.

Brown and Dewhurst (1975) studied the pupae of African species of *Spodoptera,* including the species *exempta, exigua* and *mauritia* which also occur in Australia. Characters cited for *exempta* and *mauritia* agree generally with specimens of these species examined in the present study. However, they state that *exigua* normally has a cremaster with two pairs of spines with 'a small subterminal pair dorsally in addition to the normal terminal pair'. None of the pupae examined in the present study showed such a secondary pair of spines.

V. ACKNOWLEDGEMENTS

Thanks are due to Dr I. F. B. Common, C.S.I.R.O., Canberra and Mr R. H. Broadley, D.P.I., Toowoomba who provided some of the material used in this study.

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(Received for Publication 9 April 1979)

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