

STUDIES ON THE ECOLOGY OF THE DIAMOND-
BACK MOTH. *PLUTELLA XYLOSTELLA* (L.) (LEPI-
DOPTERA: PLUTELLIDAE). 1. DISTRIBUTION AND
DESCRIPTION OF THE DIFFERENT STAGES

Pedro J. Salinas

Instituto de Investigaciones Agropecuarias, Universidad de Los Andes
Apartado 220, Mérida

RESUMEN

En el presente trabajo se indica la importancia de *Plutella xylostella* (L.) como una plaga de cultivos de crucíferas. Se presenta la distribución mundial incluyendo países donde no se ha citado ningún récord. Se citan las localidades y fechas donde ocurrieron los primeros reportes de la presencia de esta especie en América y Venezuela. Se presentan descripciones detalladas de los diferentes estadios. El presente trabajo fue realizado en el Imperial College, Ascot, Berks, Inglaterra.

SUMMARY

The importance of the diamond-back moth as a pest of cruciferous crops is given. The species world distribution is given and special mention is made to the countries where no records have been published. The dates and places when first recorded in North

and South America, and in Venezuela, are given. Description of the different stages are given.

INTRODUCTION

Plutella xylostella (L.) (Lepidoptera: Plutellidae) is one of the most important pests of cruciferous crops in many regions and its control has been tried by different means specially synthetic insecticides. With the frequent use of DDT this pest became resistant to that chemical as early as 1953, as reported by ANKERSMIT (1953). It required about 30 to 40 generations to develop resistance, and is probably the first crop pest to be recorded as resistant to DDT. In spite of the amount of work published there are proportionally few papers on the detailed biology and ecology of the insect. Therefore it was felt that there was a need for some work to be done on certain aspects which might contribute to a better understanding of the relations between individuals (specifically the larvae) and also between this species and other species which may interact with it, i. e. parasites and predators.

DISTRIBUTION

The diamond-back moth is a species with a wide distribution throughout, the world (Fig. 1) and with a great adaptability to different climatic conditions which has made it to be a recognised major pest in temperate and tropical regions. The records of the species give their distribution from the Arctic Zone in the North to about 50° Latitude South; and almost everywhere around the world between those limits. Records of *P. xylostella* were not available at the time of writing from the following countries: Belice (British Honduras), Guatemala, Honduras, Panamá, Ecuador, in America; Spanish Sahara, Mauritania, Niger, Portuguese Guinea, Sierra Leone, Liberia, Ivory Coast, Upper Volta, Togo, Dahomey, Nigeria, Central Africa Republic, Muni River, Gabon, Republic of Congo, Southwest Africa Republic, Bechwaland, Mozambique, Somali Republic, South Arabia Emirates, South Arabia (S. Yemen), in Africa; and Borneo and Mongolia in Asia. Although records

were not found from those countries it is most probably that the insect is in many of them but not paper has yet been published.

In North America has been recorded since 1855 in Illinois, causing severe damage (FITCH, 1855). In South America it has been recorded for the first time from Argentina by BRETHERS in 1923, who gives a brief description of the insect and its damage. The Distribution Map of Pest N^o 32 (revised) (Commonwealth Institute of Entomology, London, 1967) cites specimens in the British Museum (Natural History) from Pará, Paraná (Brasil) in 1892, and 1896, which therefore might be the first record for South America.

In Venezuela it has been recorded since 1939 by BALLOU (1945) who found all the stages abundant on cabbage in Caracas and surroundings, during the third week of March, 1939. Later the pest has been recorded from almost any place where cruciferous crops are grown, mainly in the northern and in the Andean regions of the country, usually causing severe damage.

DESCRIPTION OF THE DIFFERENT STAGES

The different stages of *P. xylostella* have been described and/or illustrated accurately by many authors. A summary is given below:

EGG

ABRAHAM & PADMANABAN (1968) describe the egg as minute yellowish-white (0.5 mm). BARTELL (1966) describes it as pale yellow at oviposition, darkening as the embryo develops until shortly before eclosion when the dark head capsule and body of the larvae can be seen looped beneath the now transparent chorion. The surface of the chorion is finely sculptured with a pattern of small circular bosses but it is very thin and plastic and the egg rather delicate. The shape is flattened oval, some 0.51 mm (range 0.49-0.52 mm) in length and 0.27 mm (range 0.26-0.28 mm) in width.

HARCOURT (1956) describes it as oval, flattened, pale green to lemon-yellow, the surface embossed with a pattern of small,

circular, raised areas, the larval outline visible before hatching. 0.44 mm length, 0.26 mm width in average. HARDY (1938) describes it as oval, light yellow with a sculptured surface, the colour disappears and embryo becomes visible before hatching. Length 0.8 mm approximately. ROBERTSON (1939) describes it as oval, light yellow, the chorion embossed with a pattern of small, circular, raised areas; approximately 0.49 mm length, 0.26 mm width. SHAW (1959) describes it as oval, pale greenish yellow and about 1/64 in. (= 0.40 mm). ULLYETT (1947) describes it as small, oval, yellow.

The material studied in the present work is illustrated in Fig. 2.

LARVA

ABRAHAM & PADMANABAN (1968) describe the newly hatched larva as pale-white with pale-brown head; the full grown larva about 10 mm long, light green, moderately stout, attenuated at each extremity, smooth, with short, scattered, bristly hairs. HARCOURT (1956) describes it as subcylindrical and relatively hairless, with five pairs of prolegs; the body of the first instar entirely lacking in pigmentation except for patches, the head is dark brown; later instars similar to first but more pigmented spots on body, head capsule is lighter mottled with dark brown pigment; at the end of the final instar the body is greenish. HARDY (1938) describes the newly hatched larva as about 2 mm in length, 8-9 mm when full grown, bright green, but with variations such as red and yellow forms.

ROBERTSON (1939) gives the most detailed descriptions and illustration of the larval stages, especially of the chaetotaxy: *First instar*: Head width, 0.163 mm, very dark brown; body almost entirely lacking pigmentation; *Second instar*: Head width, 0.264 mm; only distinguishable from first instar by microscopic examination; head very dark, body shows little trace of pigmentation; *Third instar*: Head width, 0.378 mm, head colour very variable, body may appear pale green; *Fourth instar*: Head width, 0.628 mm, light incolour, body more or less colourless but later light green, and later on is more intense, red pigments and dark pigments may develop. SHAW (1959) describes the young larva as grey with very

noticeable small black head, the mature larva being light green, spindle shaped and about $\frac{1}{2}$ in. (= 12.7 mm) long, head lighter than when young. ULLYETT (1947) describes the newly hatched larva as small, green, about 2 mm long.

The material studied in the present work is illustrated in Fig. 3.

PREPUPA

HARCOURT (1956) affirms that there is no ecdysis between the last larval instar and this stage, the two differing only slightly in general appearance; the prepupa is more contracted in form, specially in the region of the head and thorax, and is pale green. HARDY (1938) mentions the prepupa as being the responsible for spinning the cocoon but does not describe it. ROBERTSON (1939) again gives the most detailed description of the prepupae, he also affirms that there is no ecdysis marking the beginning of the prepupal stage; he describes it as having the head and three thoracic segments drawn up closely, the thorax increases in circumference, the abdomen decreases; from bright green changes to pinkish fawn; a cuticular covering is formed beneath the larval skin, which becomes loosened and can be removed without injury to the prepupa; all the chaetotaxy is described in detail (as in the larval stages); he suggests that the most noticeable features of the thorax are the wings have become everted and lie external to the body; he also gives detailed illustrations. ULLYETT (1947) affirms that the fully grown larva spins a cocoon in which it prepupates, but does not describe the prepupa.

PUPA

ABRAHAM & PADMANABAN (1968) describe the pupa as about 6 mm long, inside a loosesilken cocoon. HARCOURT (1956) describes it as obovate, cephalic end rounded, body widest in thoracic region, and tapering toward the caudal segment, mouth parts clearly defined, mesothoracic wings long, average 7 mm long, pale green and becomes light fawn with brownish markings, enclosed in neat, open-network, silken cocoon open at both ends, last larval skin remains at anal end within cocoon. HARDY (1938) describes it as about 7 mm, light green or white later brown or black, loosely en-

closed in fine net cocoon spun by the prepupa. ROBERTSON (1939) gives the most detailed description of all; he describes it as light green, pinkish fawn or almost colourless, but almost black before emergence of the adult; obtected type, cephalic end rounded, body widest in thoracic region and tapers toward the caudal segment; he gives illustrations and shows the differentiation in the sexes. SHAW (1959) describes it as enclosed within a fine net cocoon, light green but dark brown later. ULLYETT (1947) describes it as green first, brown later, inside a delicate cocoon formed by a fine network of white, silken threads.

The material studied in the present work is illustrated in Fig. 5.

ADULT

ABRAHAM & PADMANABAN (1968) describe the adult as having 14 mm of wing expanse, narrow wings with pale marks on them, when at rest appear together as diamond-shaped median dorsal patches. HARCOURT (1956) describes it as small, slender, greyish-brown, wing expanse slightly more than $\frac{1}{2}$ in. (\approx 12.7 mm) at rest forewings slightly upturned at the posterior end, creamy-yellow dorsal band with irregular black border and three undulations, hind wings dark grey, females lighter in colour, markings less distinct. HARDY (1938) describes it as small, slender, greyish-brown, wing expanse about 10 mm, at rest wings slightly turned-up at rear end, creamy-yellow band with irregular black border and three undulations; he also quotes MEYRICK (1927) description as follows: "Length 11-16 mm, head ochreous-white, tuft of palpi long, forewings narrow, fuscous, more or less ochreous tinged, often with darker strigulae, towards costa paler and sometimes whitish-sprinkled, a paler or whitish-ochreous dorsal streak from the base of the tornus, upper edge whitish and thrice sinuate upwards, edged with darker suffusion, hind wings grey". ROBERTSON (1939) does not describe it but quotes the description of HUDSON (1918) as follows (here summarized): "... wing expansion over $\frac{1}{2}$ in. (\approx 12.7 mm). Antennae ringed with black near the middle and apex, forewings rather narrow, with apex acute in the male, and the termen oblique; brown often purplish-tinged, paler in the female; the male has a broad cream-coloured dorsal streak from base to near tornus, often

edged with black towards disc; in the female this stripe much less distinct, often marged in the general ground colour; there is a series of indistinct black dots below the costa and another series on the dorsum. The hind wings are grey”.

The material studied in the present work is illustrated in Fig. 6.

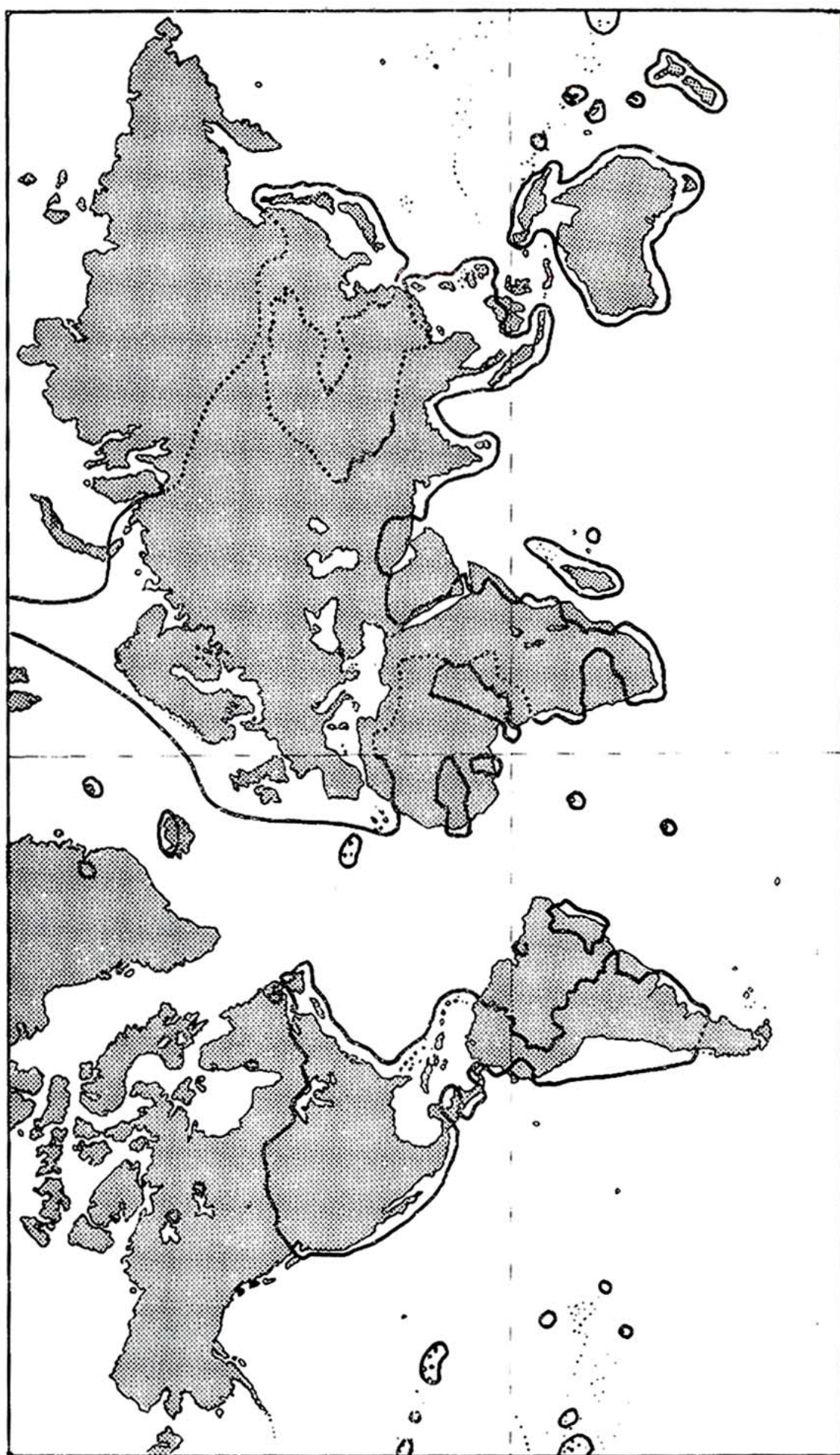


Figura 1

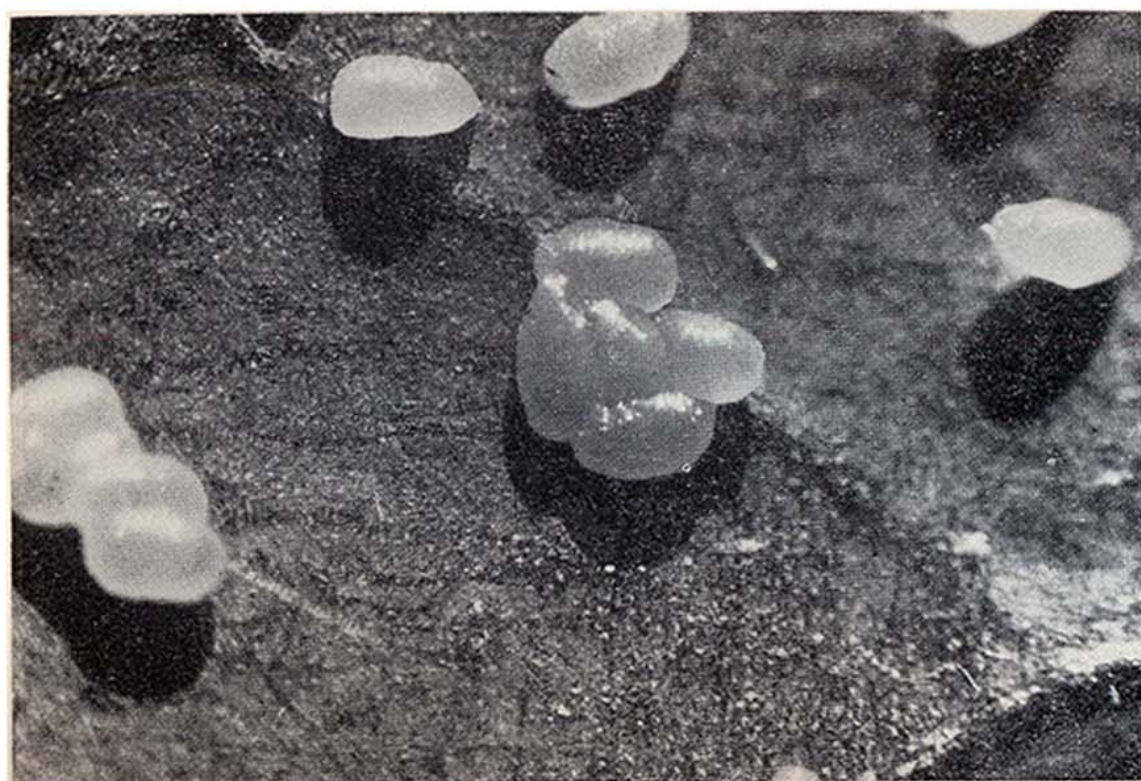


Fig. 2. Eggs of *P. xylostella*, recently hatched

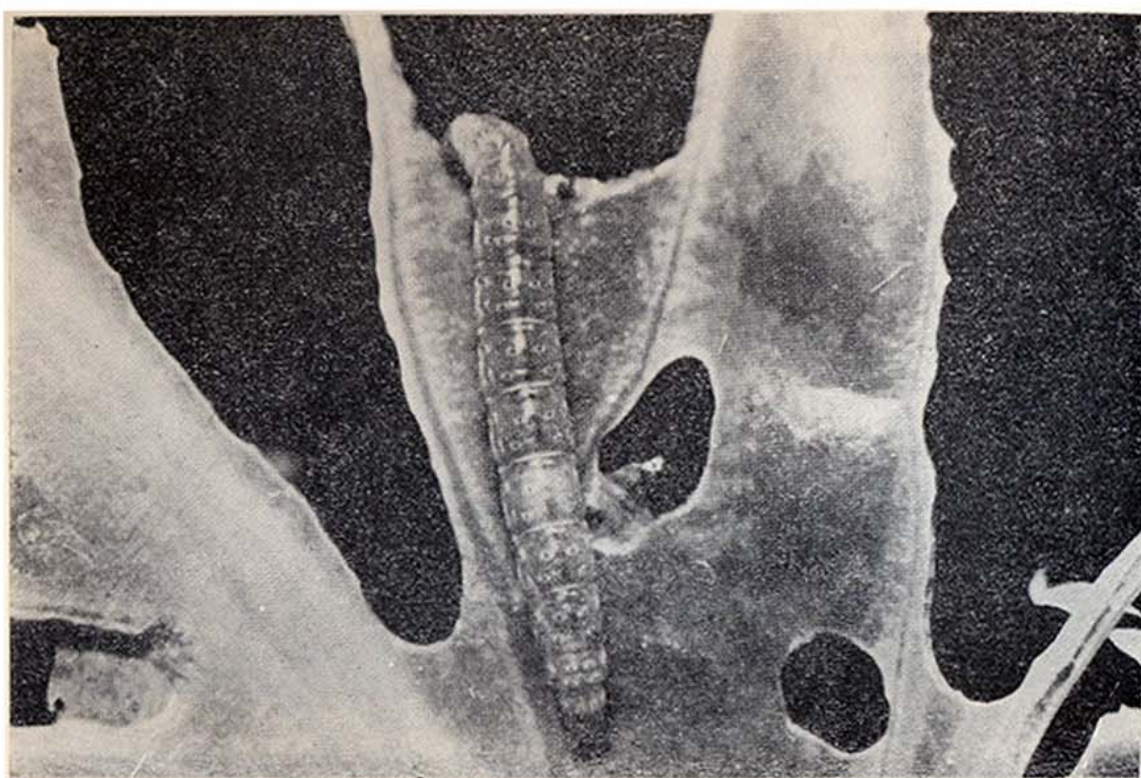


Fig. 3. Larva (4th instar) of *P. xylostella*

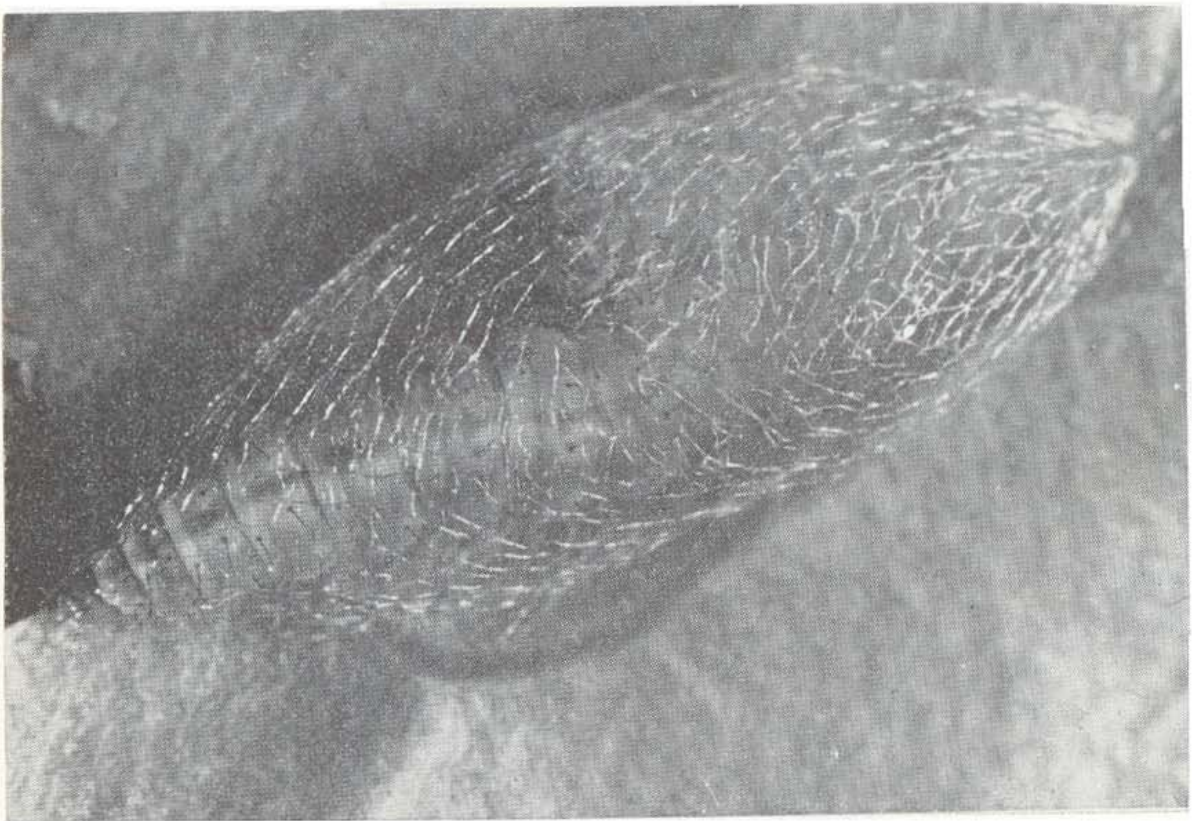


Fig. 4. Pre-pupa of *P. xylostella* weaving the cocoon

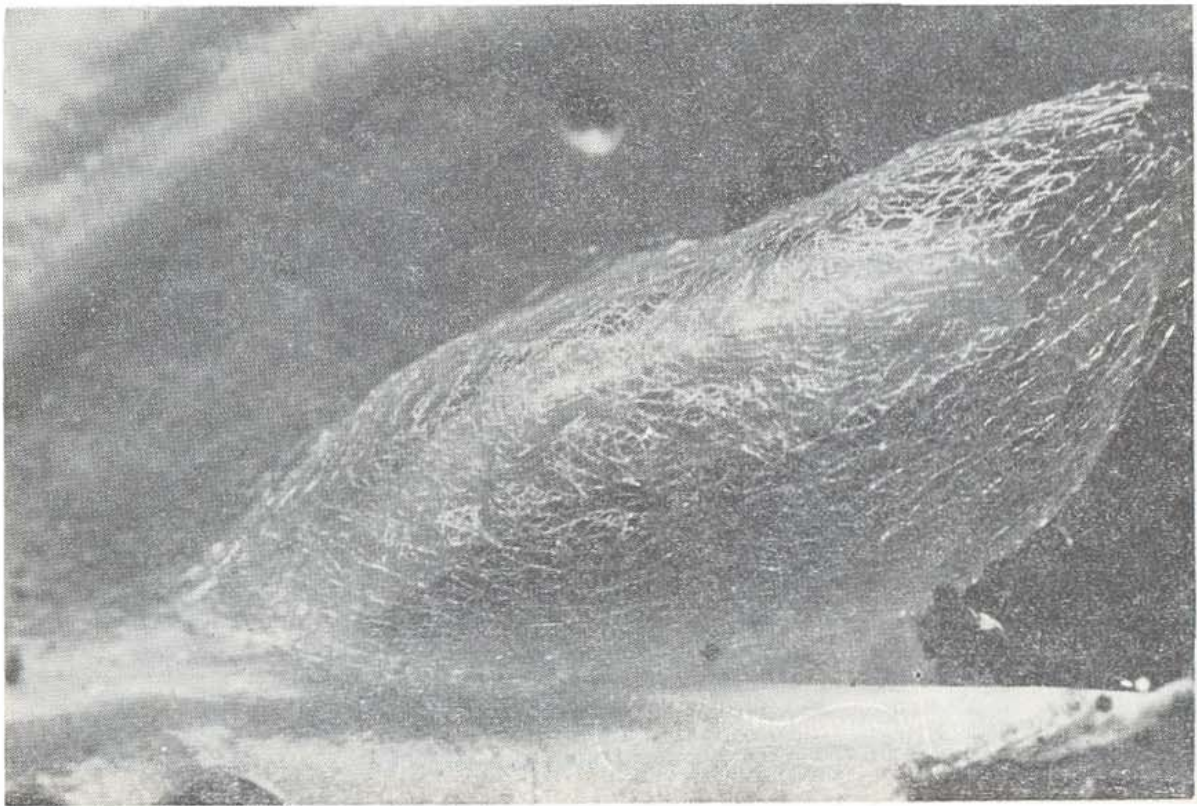


Fig. 5. Pupa of *P. xylostella* in cocoon



Fig. 6. Adults of *P. xylostella* in copula. Male on the left

REFERENCES

- ABRAHAM, E. V. & PADMANABAN, M. D.
1968 — Bionomics and control of the diamond-back moth, *Plutella maculipennis* Curtis. Indian J. Agric. Sci. 38:513-519.
- ANKERSMIT, G. W.
1953 — DDT-resistance in *Plutella maculipennis* (Curt.) (Lep.) in Java. Bull. ent. Rest. 44:121-125.
- BALLOU, C. H.
1945 - - Notas sobre los insectos dañinos observados en Venezuela, 1938-1943. 3^o Conf. Interamer. Agric., Caracas, N^o 34. 151 p.
- BARTELL, R. J.
1966 - - Studies on the water loss from the eggs of Lepidoptera. Ph. D. Thesis. London University. 173 p.
- FITCH, A.
1855 -- First report on the Noxious, beneficial and other insects of the state of New York. New York State Agric. Soc., Albany.

- HARCOURT, D.G.
1956 — Biology of the diamondback moth *Plutella maculipennis* (Curt.) (Lepidoptera: Plutellidae), in eastern Ontario. I. Distribution, economic history, synonymy, and general description. 37th Rept. Quebec Soc. Prot. Plants, 1955: 155-160.
- HARDY, J.E.
1938 — *Plutella maculipennis* Curt., its natural and biological control in England. Bull. ent. Res. 29: 343-372.
- MEYRICK, E.
1927 — A revised handbook of British Lepidoptera. London.
- POSADA, L.; I. Z. DE POLANIA; I. S. ARÉVALO; A. SALDARRIAGA; F. GARCÍA-ROA & R. CÁRDENAS
1970 — Lista de insectos dañinos y otras plagas en Colombia. Ministerio de Agricultura. Instituto Colombiano Agropecuario. Programa Entomología. Publicación Miscelánea N° 17. 202 p.
- ROBERTSON, P.L.
1939 — Diamondback moth investigations in New Zealand. N. Zealand J. Sci. Techn. A 20:330-340.
- SHAW, M.W.
1959 — The diamondback moth *Plutella maculipennis* (Curtis). A historical review with special reference to its occurrence in Scotland in 1958. Trans. R. High. Agric. Soc. 4:56-80.
- ULLYETT, G.C.
1947 — Mortality factors in populations of *Plutella maculipennis* Curtis (Tineidae: Lep.) and their relations to the problem of control. Union S. Afr. Dept. Agric. Forest., Ent. Mem. 2:77-202.

Recibido: 10 marzo 1975.

Aceptado: 20 octubre 1975.