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COB BORER *MUSSIDIA NIGRIVENELLA* (LEPIDOPTERA; PYRALIDAE) OF MAIZE IN IVORY COAST. I — MORPHOLOGICAL AND BIOLOGICAL DATA

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Abstract—*Mussidia nigrivenella* Ragonot is the main cob borer of maize in Ivory Coast. An accurate description of male and female genitalia is given. Rearing in the laboratory has permitted determination of the number and duration of the pre-imaginal instars, fecundity of adults and fertility of eggs as also the sex-ratio. An artificial diet has been elaborated which provides conditions of similar development to those observed in the field: The insect has 5 to 6 larval instars and the total duration of development from the egg-laying to the adult emergence is 46 days for the male and 49 days for the female.

Key Words: Lepidoptera, Pyralidae, *Mussidia nigrivenella*, cob borer, genitalia, artificial diet

Résumé—*Mussidia nigrivenella* Ragonot est le principal ravageur de l'épi de maïs en Côte d'Ivoire. Une description détaillée des genitalia mâles et femelles est réalisée. L'élevage en laboratoire a permis de déterminer le nombre et la durée des stades pré-imaginaux, la fécondité des adultes et la fertilité des oeufs ainsi que le sex-ratio. Un milieu d'élevage artificiel des larves a été mis au point: il a permis d'obtenir des conditions de développement voisines de celles observées au champ: l'insecte passe par 5 à 6 stades larvaires et la durée totale du développement depuis le dépôt de l'oeuf jusqu'à l'émergence de l'adulte est de 46 jours pour le mâle et de 49 jours pour la femelle.

INTRODUCTION

Various species of borers attack maize cobs in Ivory Coast (Moyal, 1988): Some of them are stem and cob borers like *Busseola fusca* (Fuller), *Sesamia calamistis* Hampson, *Sesamia botanephaga* Tams & Bowden (Noctuidae) and *Eldana saccharina* Walker (Pyralidae); others are specifically cob borers: *Cryptophlebia leucotreta* (Meyrick) (Tortricidae) and *Mussidia nigrivenella* Ragonot (Pyralidae). Furthermore, *Heliothis* (or *Helicoverpa*) *armigera* Hübner (Noctuidae) may be found in maize cobs when generally very localized pullulations of this species occur; this insect, mainly a cotton pest in Ivory Coast, is rarely found on maize crops where it is above all phyllophagous.

M. nigrivenella is the most important of these cob borers in Ivory Coast (Moyal, 1988). This species has been first described by Ragonot (1888). Unfortunately, the original publication is no more available neither in the French nor in the British Museum of Natural History. Nevertheless one can find it in an apparently complete form in the Romanoff's work (1893).

Janse (1941) gave a further description without the genitalia that only Corbet and Tams (1943) figure in a little detailed side view, only permitting the distinction with the genitalia of Lepidoptera of stored products.

The purpose of this paper is to give an accurate description of the genitalia of *M. nigrivenella* and some results about the biology of this insect reared on artificial diets in the laboratory.

MATERIALS AND METHODS

The insects were gathered from cobs of maize in the savannah area of Ivory Coast (from latitude 6°5' to 10°3' N and from longitude 3° to 8° W) for several years.

The genitalia were observed after dissection, after exposure in cold Potassium hydroxide bath. The insects were reared at an average temperature of 22°C (± 2°C) and between 60 and 80% r.h.

Adults were put in truncated cone-like plastic containers of 22 cm high and of a base dia of 9 cm and a vertex dia of 12 cm. A wet-honeyed cotton was put in the container to feed adults as well as waxed paper to help egg laying.

Larvae were reared on artificial diet, individually or in groups of 20 to 30 caterpillars.

RESULTS

Description of genitalia

Male genitalia. Fig. 1. Valve convex, long and rather thin, with costa valvula and sacculus well-sclerotized and easily distinguishable and with long bristles. Valvula next to costa at its apical end onto the fourth of its length and then diverging but staying fairly parallel.

Sacculus as long as valvula and narrowing regularly towards its distal end. Vinculum broad, U-shaped, with thin arms well sclerotized.

Anellus (surrounding the penis in its middle part), slightly sclerotized, U-shaped with thick arms from which are starting, at two thirds their height, two lateral arms as long as those of the anellus and parallel to them.

Gnathos (Fig. 1C) with a median sub-cylindrical trunk strongly laterally and slightly centrally sclerotized. From the point-shaped, fore-end of this median trunk are two U-shaped arms on both sides, firstly flattened and twisted and then becoming rounded and more regular towards the hind-end. Apical end of the median trunk slightly concave. Ventrally with respect to the gnathos is a reversed Y-shaped lower fultura with its axis parallel to that of the gnathos (covering up the gnathos in a ventral view and for this reason not figured on the general drawing of genitalia). Uncus with rounded apex, fringed with little bristles. Sinuous penis (Fig. 1D) with ductus ejaculatorius close to the caecum penis. Aedoeagus without cornutus and with bevel-edged end.

Female genitalia. Fig. 2. Bursa copulatrix with a narrowing at two thirds its length. Before the narrowing, bursa rather swelling, slightly longer than wide, with a large signum having its central part well sclerotized and some diffuse spines round. Apical end less wide than the former part.

Ductus bursae as long as the part of the bursa with signum. Apophyses slender, the posterior twice longer than the anterior and with the anterior end curved towards the venter. Anal papillas sub-triangular, joined at the posterior end and strongly sclerotized on the dorsal and latero-anterior margin.

Biological data

Two artificial diets were tested for the rearing of larvae: The "Poitout" diet (Poitout and Bues, 1970) and an experimental diet where the corn semolina was more important (Table 1).

Number and duration of the pre-imaginal instars (Table 2 and Fig. 3). The peak of egg hatching is at 6–7 days: 7.5% of the young larvae appear on the 5th day, 52% on the 6th day, 37% on the 7th, 3% on the 8th and 0.5% on the 9th.

On the "Poitout" diet, duration of the larval life is much longer and the variability of the duration of each instar is much more important than on the experimental diet. Besides, the apparition of a 6th larval instar is more frequent on "Poitout" diet: 58% (vs 0% on the experimental diet) of larvae that will produce female adults and 38% (vs 12% on the experimental diet) of those that will produce males have six larval instars. The pre-nymphal instar on average lasts 1 day. The pupation, that takes place under shelter of a cocoon, lasts 8 –10 days.

The duration of development of the future males (46 days from the egg-laying until the adult emergence on the experimental diet) is slightly

Table 1. Composition of the artificial diets (in g) used for the rearing of *Mussidia nigrivenella*

	"Poitout" diet	Experimental diet
Distilled water	120	120
Agar	3.0	3.0
Corn semolina	22.4	33.0
Benzoic acid	0.25	0.25
Nipagin	0.20	0.20
Aureomycin chlohydrate	0.04	0.04
Brewer's yeast	2	3
Wheat germ	6	–
Ascorbic acid	2	–

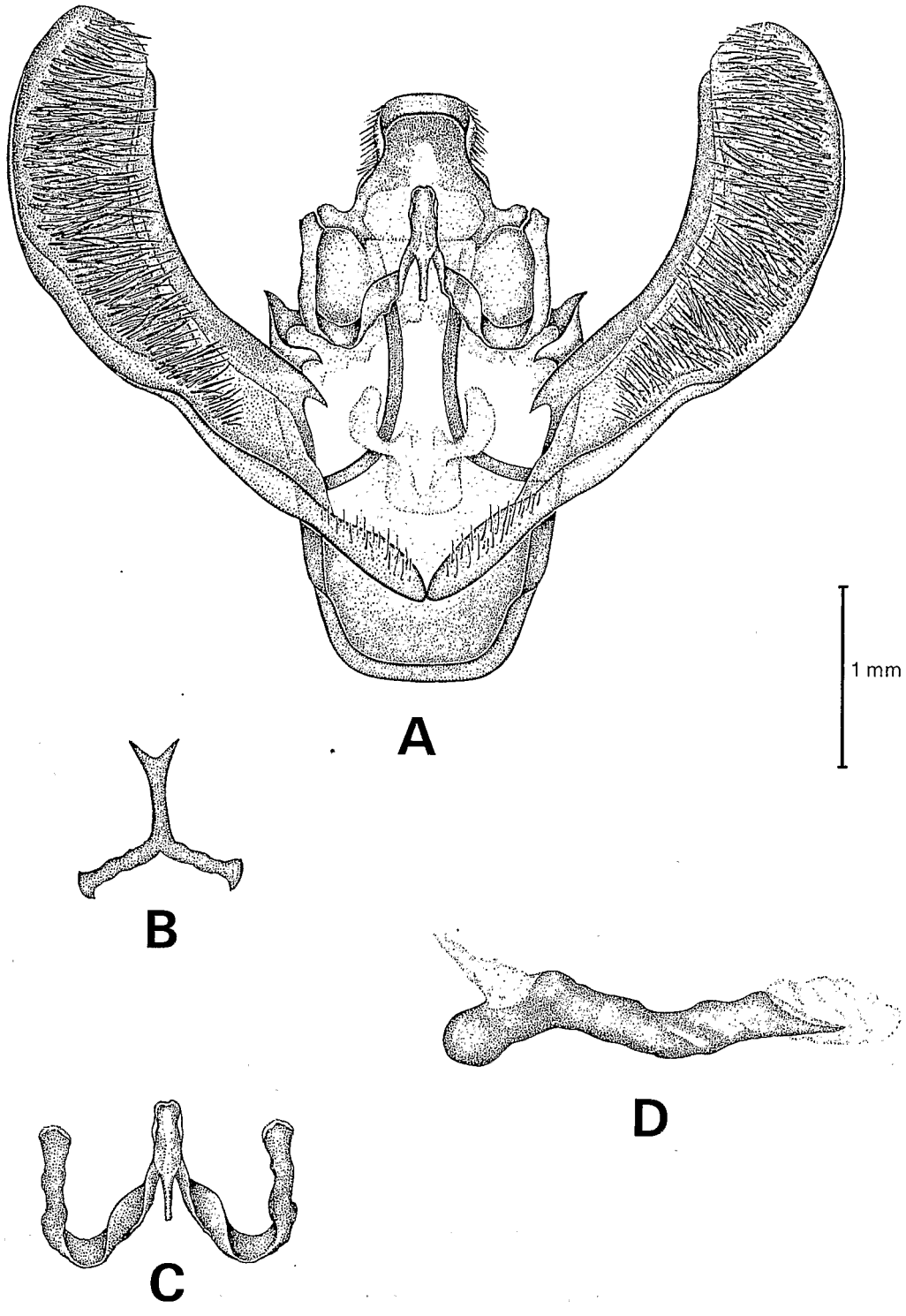

Fig. 1. Male genitalia of *Mussidia nigrivenella*. A. general ventral view (penis and lower fultura removed); B, Lower fultura; C, Gnathos; D, Penis.

faster than of the females (49 days). The adult lives 3–4 days.

Fecundity and fertility. The dissection of a newly emerged female reveals more than 650 eggs in the ovaries. During the rearing the fecundity was much less than this potential: thus, the females of the fourth generation laid on an average 69 eggs and those of the fifth generation only 18 eggs.

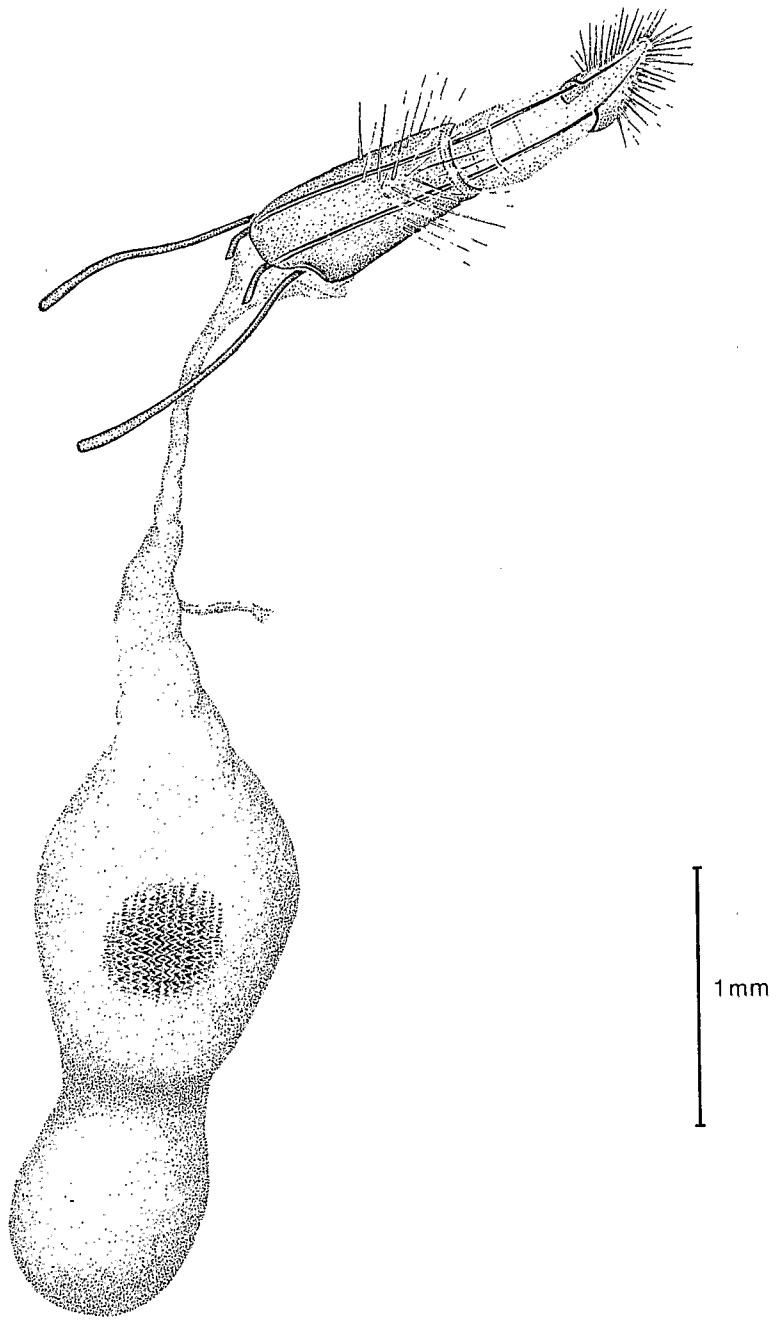

Fig. 2. Female genitalia of *M. nigrivenella.*

The fertility of eggs was, on average 25%. An explication is probably the number of adults by container, with an equilibrated sex-ratio. The number of eggs laid and the percentage of fertile eggs grows, when the number of adults by container increases to 40 and then decreases.

In both cases data can be fitted to a parabola with a maximum at about 40 adults. These regressions, although significant, explain only 30–40% of the observed variation.

The sex-ratio. The ratio of the number of males to the number of females is about 1:1.041 in the 4th generation, 0.907 in the 5th. There is no correlation between the sex-ratio and the fecundity and fertility (varying from 0.2 to 2.7).

Table 2. Duration (in days) of pre-imaginal instars of *Mussidia nigrivenella* for both artificial diets

	"Poitout" diet		Experimental diet	
Instar	Mean	Extrema	Mean	Extrema
Egg	6.4	5–9	6.4	5–9
L1	9.8	5–22	6.6	5–12
L2	5.4	2–16	3.0	1–9
L3	8.5	1–27	4.5	1–12
L4	7.0	1–12	3.9	1–7
L5 + L6	33.4	13–58	13.6	9–26
Male chrysalis	10.0	9–11	8.5	7–11
Female chrysalis	9.9	9–12	8.8	7–11
Total chrysalis	9.95		8.85	

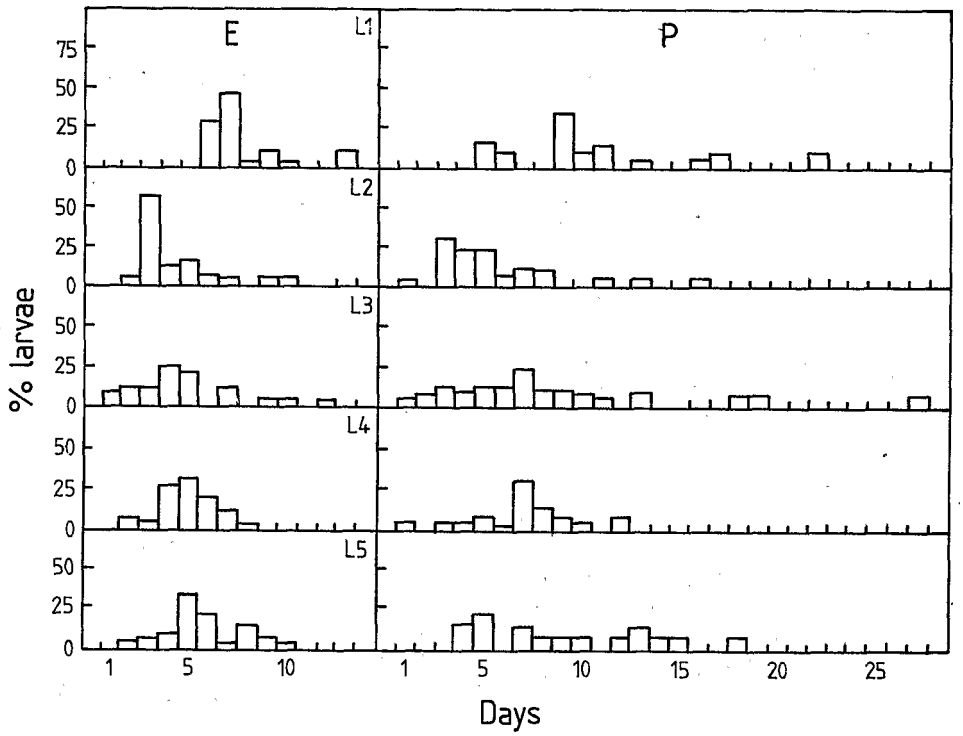

Fig. 3. Frequency of larval instars durations on the "Poitout" diet (P) and the experimental diet (E).

DISCUSSION

Following the study of the pre-imaginal instars (Moyal and Tran, 1989), the description of genitalia of *M. nigrivenella* permits the determination of all the instars of this insect. The figures presented here maybe will help to avoid wrong determinations in the future, particularly prejudicial to field entomologists such as Pollet et al. (1978), of *Catopyla disorphnea* Bradley on maize cob, whereas it was *Mussidia nigrivenella* (*C. disorphnea*, described by Bradley in 1968, is a species only attacking Meliaceae). Rearing in the laboratory revealed important differences of development between caterpillars feeding on two artificial diets of a yet very similar composition. The experimental diet, with more corn semolina, was more representative of the natural development conditions (Moyal and Tran, 1991), whereas the "Poitout" diet gave very different results.

The larval mortality is important on both diets. When 20 to 30 larvae were gathered, mortality was 55% on an average for several generations on the experimental diet and 65% on the "Poitout" diet.

Mortality occurs regularly during the cycle, increasing at the end of the larval life on the experimental diet. This may be explained for the most part by cannibalism or injuries. On the contrary, the mortality on the "Poitout" diet occurs at 81% in the first week, which seems to indicate that the larvae of the first instar refuse to feed.

Many authors studied the relation between the insect density and the fecundity (Peters and Barbosa, 1977). The graph obtained with *M. nigrivenella* is of the "Allee" type (Watt, 1960), with a density optimum and a decreasing fecundity and fertility on either side of this optimum. This relation is however, more complex when the effect of the relative humidity changes the graph parameters (Utida, 1941).

Moreover, the relative humidity is certainly the main reason for the weak fecundity obtained during the rearing; it could not be controlled in the rearing room where it sometimes fell to 60%. Studies in the field (Moyal, 1988) showed that egg-laying by *M. nigrivenella* was increasing with the relative humidity. Guennelon (1972) made a similar observation for *Ostrinia nubilalis* Hübner, the european corn-borer, egg-laying stopped when r.h. fell under 70%. For mass rearing of *M. nigrivenella,* for biological control or varietal resistance, it is necessary to specify optimum relative humidity. Mass rearing will certainly be necessary in the future, because *M. nigrivenella* induces important crop losses in some regions (Moyal and Tran, 1991), but may be difficult due to cannibalism.

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