# COB BORER *MUSSIDIA NIGRIVENELLA* RAGONOT (LEPIDOPTERA: PYRALIDAE) OF MAIZE IN IVORY COAST. II — ECOLOGICAL DATA

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**Abstract**—The larvae of *Mussidia nigrivenella* Ragonot, attack various fruits; it is the main maize cob borer in Ivory Coast. The development of attack during the cultivation, the behaviour of larvae in the field, the spatial distribution of eggs and larvae, the mortality of pre-imaginal instars and the annual fluctuations of populations are considered in this paper. This insect may represent an economical problem for seed producers in the south of the savannah area of Ivory Coast where its density exceeded 14 insects per cob, at harvest in 1984, whereas the risk of cob damaging by *Mussidia nigrivenella* appears to be very weak in the north and west of this region.

*Key Words*: Lepidoptera, Pyralidae, *Mussidia nigrivenella*, cob borer, dynamics of populations, Ivory Coast

**Résumé**—*Mussidia nigrivenella* Ragonot, dont les larves attaquent divers fruits, est le principal ravageur de l'épi de maïs en Côte d'Ivoire. Sont étudiés dans cet article l'évolution des attaques au cours d'un cycle de culture, le comportement des larves au champ, la distribution spatiale des pontes et des larves, la mortalité des stades pré-imaginaux et les fluctuations annuelles des populations. Il est souligné que ce lépidoptère, dont la densité de population a dépassé, en 1984, 14 insectes par épi à la récolte dans le sud-est de la zone des savanes, représente une menace pour les producteurs de semence de maïs dans le sud de la zone des savanes de la Côte d'Ivoire, alors que dans le nord et l'ouest le risque d'attaque de l'épi de maïs est très faible.

## INTRODUCTION

*Mussidia nigrivenella* Ragonot is a fruit pest of crops; it completed development during post-harvest storage. Its larvae have been mentioned in cocoa-pods and in maize cobs. More rarely this pest has been found in cotton capsules (Buyckx, 1962; Ghesquière, 1923; Staeubli, 1977), in the nut of the shea butter tree, *Vitellaria paradoxa* (Sorauer, 1925; Vuillet, 1912; Zacher 1922a, b), in the fruits of *Ficus* spp. (Le Pelley, 1959), *Phasoelus funatus* (Smith, 1965), and *Sphenostylis stenocarpa* (Nonveiller, 1984).

Stocks of various grains are also attacked by *M. nigrivenella*: cacao beans imported into Europe

(Evans, 1952; Potter, 1931; Varshalovich, 1975), seeds of *Canavalia* sp. and of beans (Buyckx, 1962; Le Pelley, 1959), soja beans (Moyal, 1988a) and maize grains, at the beginning of storage (Ratnadass, 1987; Tran, 1987). However, *M. nigrivenella* cannot be considered as a stock insect of maize since it generally just completes its development started in the field.

The geographic distribution of this pest is limited to Africa south of Sahara (Moyal and Tran, 1989).

The purpose of this paper is to describe the development of the population of *M. nigrivenella* in the maize field and its importance as cob borer of maize in the savannah area of Ivory Coast.
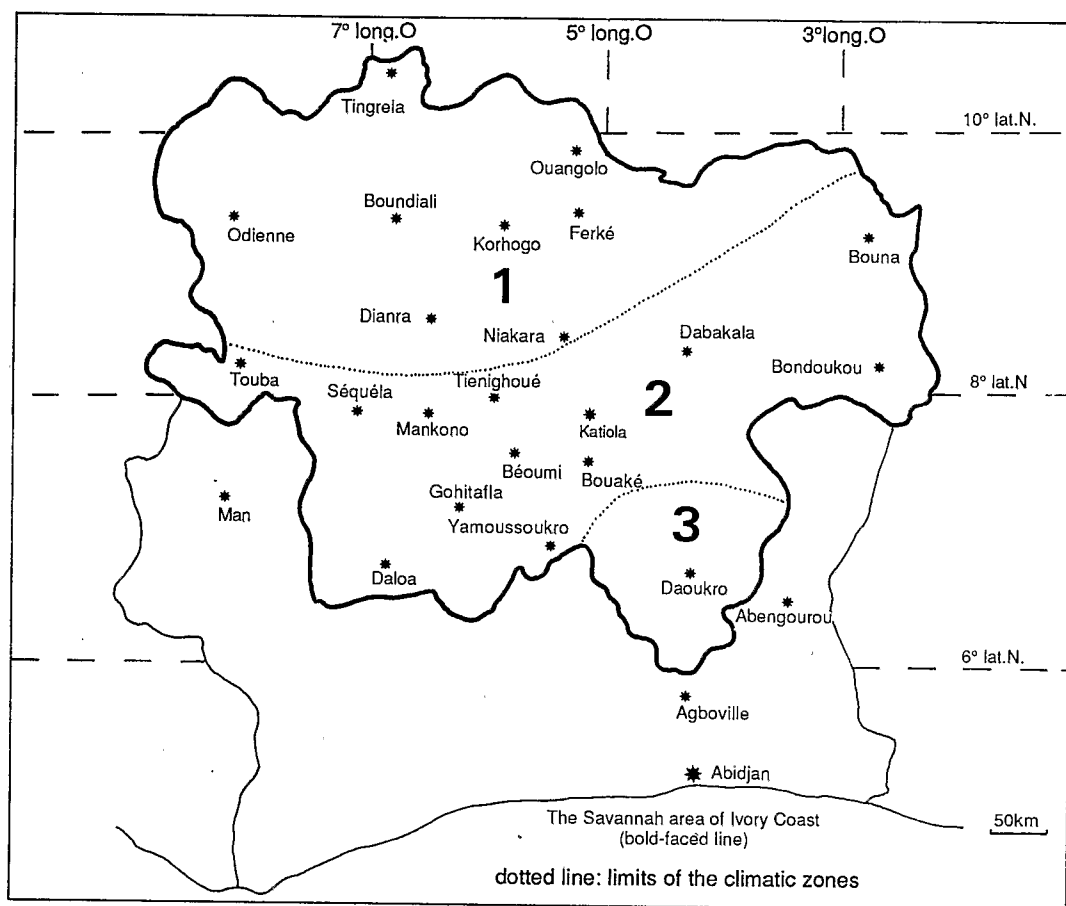
Fig. 1. Map of Ivory Coast with the limits of the savannah area (bold faced line) and of the climatic zones of this
region (dotted lines): 1. northern climatic zone (two seasons); 2. central climatic zone (transition);

## MATERIALS AND METHODS

This study has been realized in the savannah
area of Ivory Coast. This region, 188,000 km² wide,
can be divided into three climatic zones (Fig. 1):
The northern one, with a dry season from October
to May, and a rainy season with a peak in August;
the southern one with two dry seasons (the most
important from December to February, the shorter
in August–September) and two rainy seasons; a
transition zone between the two, where climate
varies with the maximum latitude reached by the
inter tropical front. If it is a high latitude, this zone
will have four seasons in a year, if not the climate
will be similar to that of the northern zone.

Pluviometry has been regularly decreasing for
the 4 years of this study (1981–1984), with a
minimum in 1983, where the drought destroyed
many food crops in the south of the savannah area.
Then in 1984, the pluviometry again reached
around the average level.

Sampling was made in various localities, either
on observation fields or on control plots in the
course of insecticide trials.

In most cases Composite Jaune de Bouaké
(CJB) was the variety used. It is the most commonly
used improved variety in peasants' fields (CIDT,
1984). The duration of its cycle from sowing to
harvest is 100–105 days. Its plants are high (more
than 3 m). Its production is on average 4000 kg/ha
during trials and its maximum yield is 6200 kg/ha
(IDESSSA, 1982). The study of the population
development during one season has also been done
with two other varieties with quicker cycle: Maïs
Témoin Station (MTS), sowing-harvest (95–100
days) and Composite Dahomey (CD),
(sowing–harvest 75–80 days).

Harvested cobs were dissected after shucks and
silks were observed in order to look for eggs.
Sampling was made at random, either in the whole
of the field (in the case of observation fields), or on
two rows of maize in the plots of insecticide trials.

It was made every 3–7 days for studying the development of populations during one growing season, whereas a single sample was taken at harvest to establish the level of populations in various localities of the savannah area. Samples were of at least 50 cobs.

Fitting of the distribution of eggs and larvae to mathematical distributions was made on Hewlett-Packard 41 CV pocket computer (Moyal, 1988a).

**RESULTS**

*Development of infestation by* M. nigrivenella *during a growing season (Figs 2 and 3)*

The number of eggs is an estimation of the actual number of eggs laid, taking into consideration the duration of hatching and the time between two samples.

The first egg-laying occurred 60 days after emergence. Progression of egg-laying is strong from 70 days after emergence for MTS and CJB, and as early as the 60th day after emergence for CD. No variety seems to have a particular attractivity: MTS, on which more eggs are found in Yamoussoukro, is less attacked in Bouaké (this study was made on large non-randomized plots).

The number of larvae and pupae obtained after dissecting cobs was far more less than the number of eggs laid (see later the study of mortality); only larvae older than the third instar were taken into account. It is very difficult to find L1 and L2 instars, hidden in the grains or cob, without any obvious damage and especially on young cobs that cannot be shelled.

The first pupae are found as early as the 75th day after emergence in Yamoussoukro and only at 90–100 DAE in Bouaké. This last figure indicates
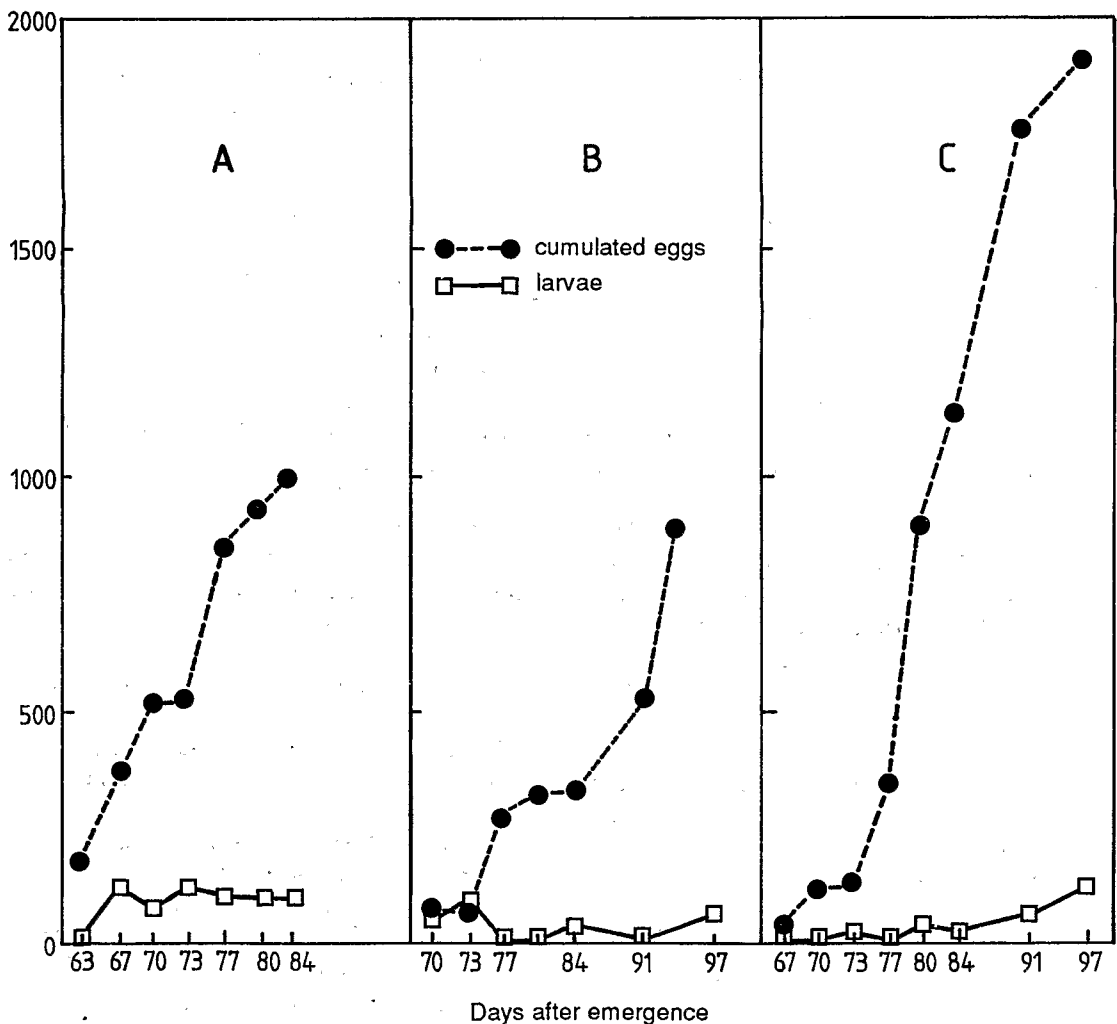


Fig. 2. Evolution of the cumulated number of eggs (solid line) and of the number of larvae (dotted line) of *Mussidia nigrivenella* in 100 cobs in Yamoussoukro (1981): (A) variety CD; (B) variety CJB; and (C) variety MTS.
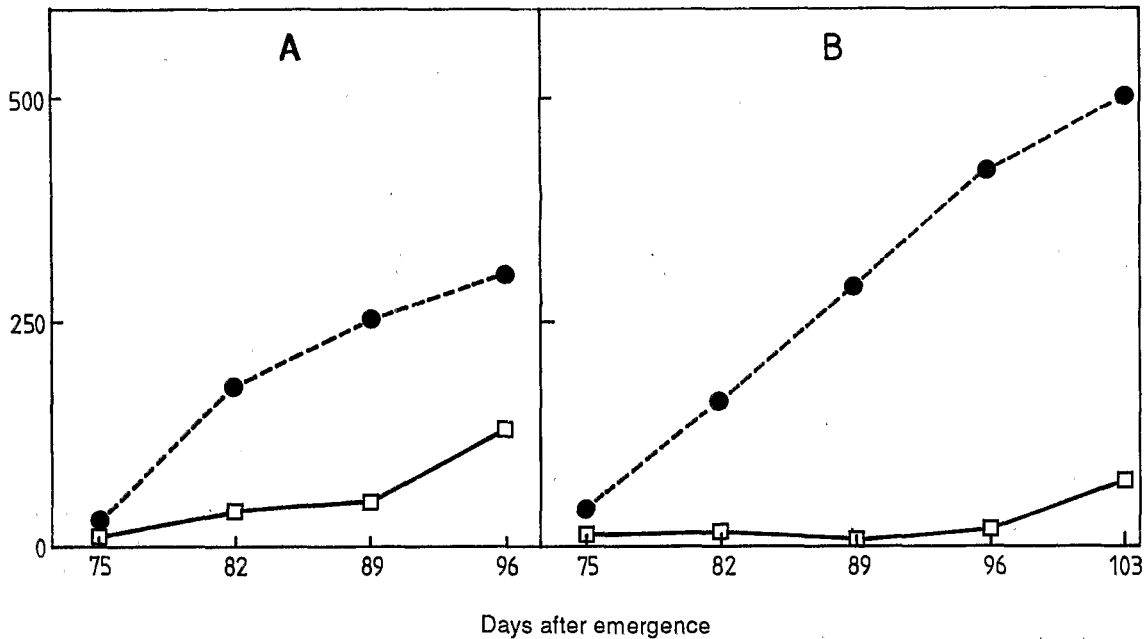
Fig. 3. Evolution of the cumulated number of eggs (solid line) and of the number of larvae (dotted line) of
*Mussidia nigrivenella* in 100 cobs in Bouaké (1981): (A) variety MTS; and (B) variety CJB.

durations of cycles of development similar to those obtained on an artificial diet (Moyal and Tran, 1991).

*Larval behaviour in the field*

Egg-laying takes place on the cob or just below (Moyal and Tran, 1989). After hatching, the larvae wander through the cob, in no particular direction. If they reach the silks, they penetrate into the cob where they will stay until the end of pupation. Only the initial first instar stage is lived outside the cob. Once the larvae are under the shucks, they stay there even when overpopulated. Cannibalism may then occur, but no dispersal as occurs in the case of *Eldana saccharina* Walker, a maize stem and cob borer.

At pupation, the larva bores through the shucks to create the adult's exit, weaves a cocoon and turns into chrysalis. No diapause phase has been observed.

Since there was heterogeneity of frequencies when the density of insects per cob is increasing, fitting to mathematical distributions was made after arranging in groups of (0 egg or insect per cob, 1 to 4, 5 to 8, etc.).

The best fit of distribution of eggs is a negative binomial distribution with a low $k$, whereas that of larvae is a Poisson distribution or a negative binomial with a relatively high $k$ (Table 1).

The mortality of eggs due to parasitism (by Trichogrammatids or Scelionids) and at rearing in the laboratory were distinguished. The mortality of the young instars L1 and L2 was deducted by difference between the number of older larvae found at dissection of cobs and the number of corresponding larvae hatched (because of the great difficulty to find young larval instars when dissecting cobs) (Table 2).

No larval nor pupal parasite was found; mortality of insects found through dissection was that not due to parasites.

*Annual fluctuations of populations (Figs 4 to 7)*

The density of population is determined for the main growing season (sowing in June) for the years 1981 to 1984).

The level of population is fairly similar for the first 3 years and higher in 1984.

The northern and western regions are less attacked, whereas the density of population increased towards the south and southeast of the savannah area; in Daoukro, at harvest in 1984, the density was more than 14 larvae of *M. nigrivenella* per cob.

Table 1. Fitting the spatial pattern for eggs and larvae of *Mussidia nigrivenella* to mathematical distributions

| Locality | Variety | Fitting for eggs | | Fitting for larvae | |
|---|---|---|---|---|---|
| | | Number of eggs/100 cobs | Mathematical distribution* | Number of larvae/100 cobs | Mathematical distribution* |
| Bouaké | MTS | 62 | BN *k* 0.53 | 138 | *P* |
| | MTS | 33 | BN *k* 0.60 | | |
| | CJB | 128 | BN *k* 0.05 | | |
| | CJB | 71 | BN *k* 0.07 | 72 | BN *k* 0.71 |
| Yamoussoukro | MTS | 575 | BN *k* 0.66 | 108 | BN *k* 1.40 |
| | MTS | 148 | BN *k* 0.19 | | |
| | CJB | 283 | BN *k* 0.23 | 60 | *P* |
| | CJB | 363 | BN *k* 0.36 | | |
| | CD | 259 | BN *k* 0.22 | 80 | *P* |
| | | 180 | BN *k* 0.10 | | |
| Beoumi | CJB | | | 480 | BN *k* 6.03 |
| Daoukro | CJB | | | 360 | *P* |
| | | | | 1430 | BN *k* 11.6 |

*BN = Negative binomial distribution with indication of the value of parameter *k*.
*P* = Poisson distribution.

Table 2. Mortality of the pre-imaginal instars of *Mussidia nigrivenella*

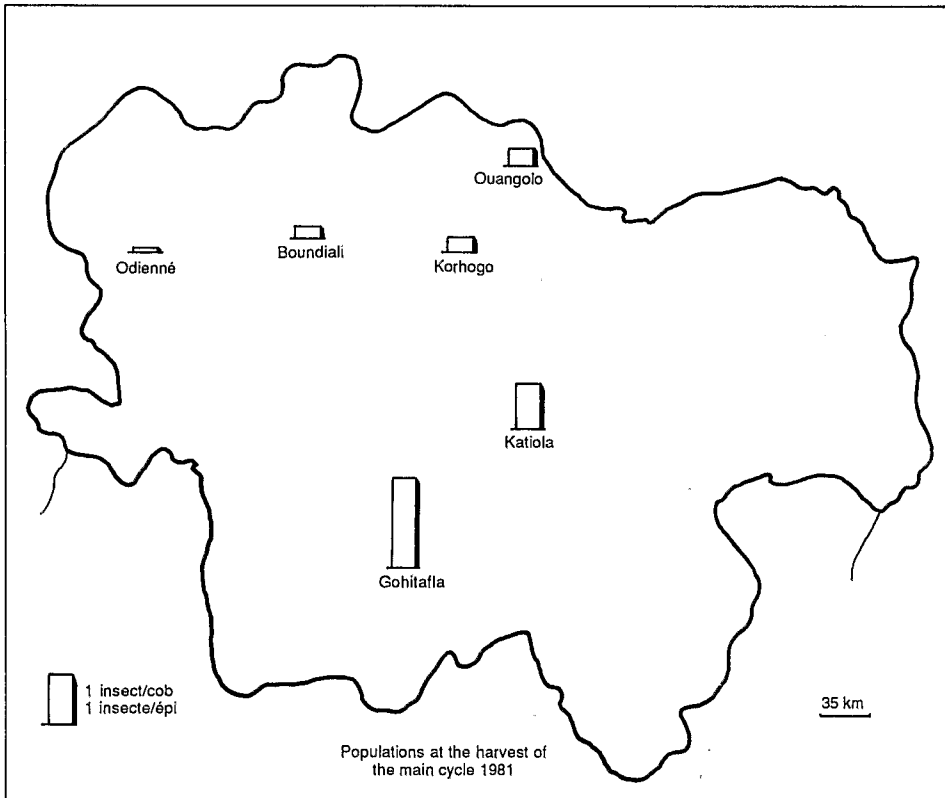| Locality | Instar | Initial | Percentage of mortality | |
|---|---|---|---|---|
| Yamoussoukro | Egg | 1066 | Parasitism | 15.7 |
| | | | Rearing mortality | 10.0 |
| | L1 + L2 | 809 | Infered mortality | 92.4 |
| | L3 to pupa | 61 | | 8.1 |
| | | | Total mortality | 94.8 |
| Bouaké | Egg | 389 | Parasitism | 1.7 |
| | | | Rearing mortality | 2.9 |
| | L1 + L2 | 371 | Infered mortality | 70.4 |
| | L3 to pupa | 110 | | 9.1 |
| | | | Total mortality | 74.3 |

Fig. 4. Population density of *Mussidia nigrivenella* at the harvest of the main cycle in 1981.
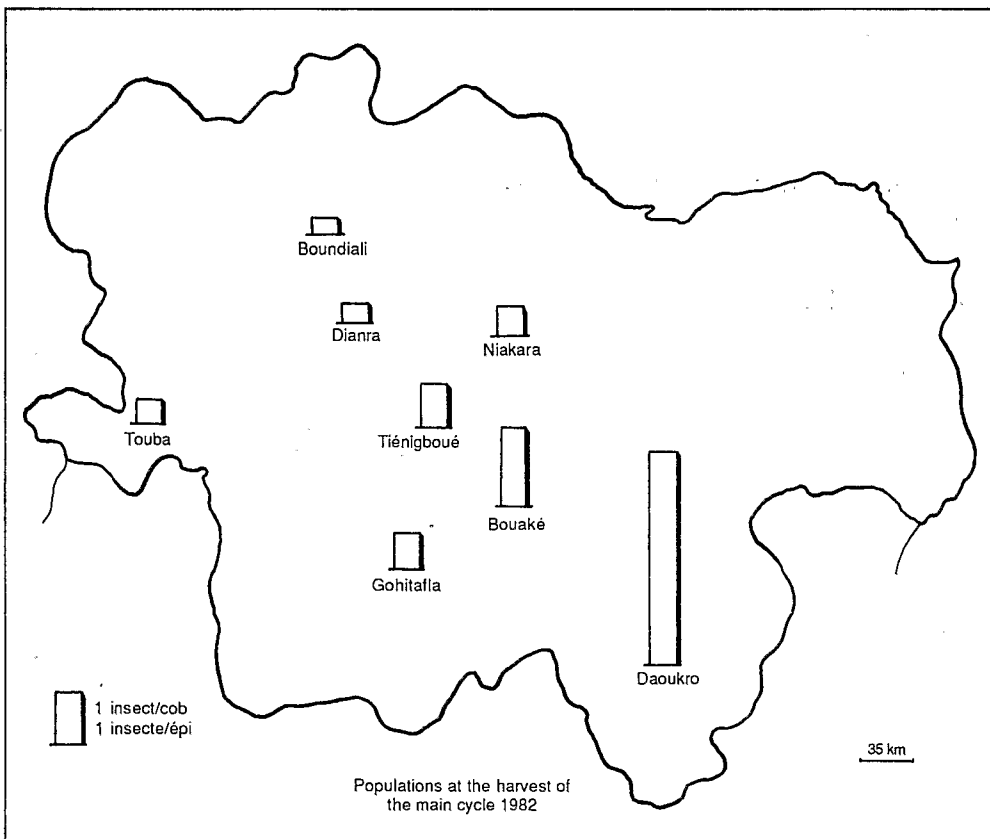


Fig. 5. Population density of *Mussidia nigrivenella* at the harvest of the main cycle in 1982.
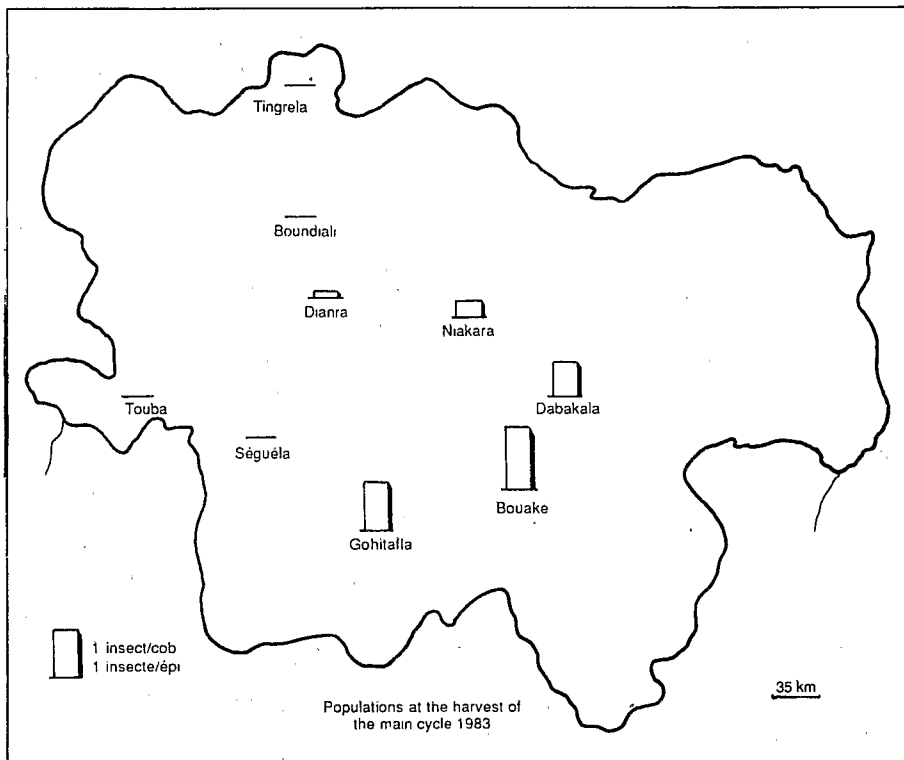
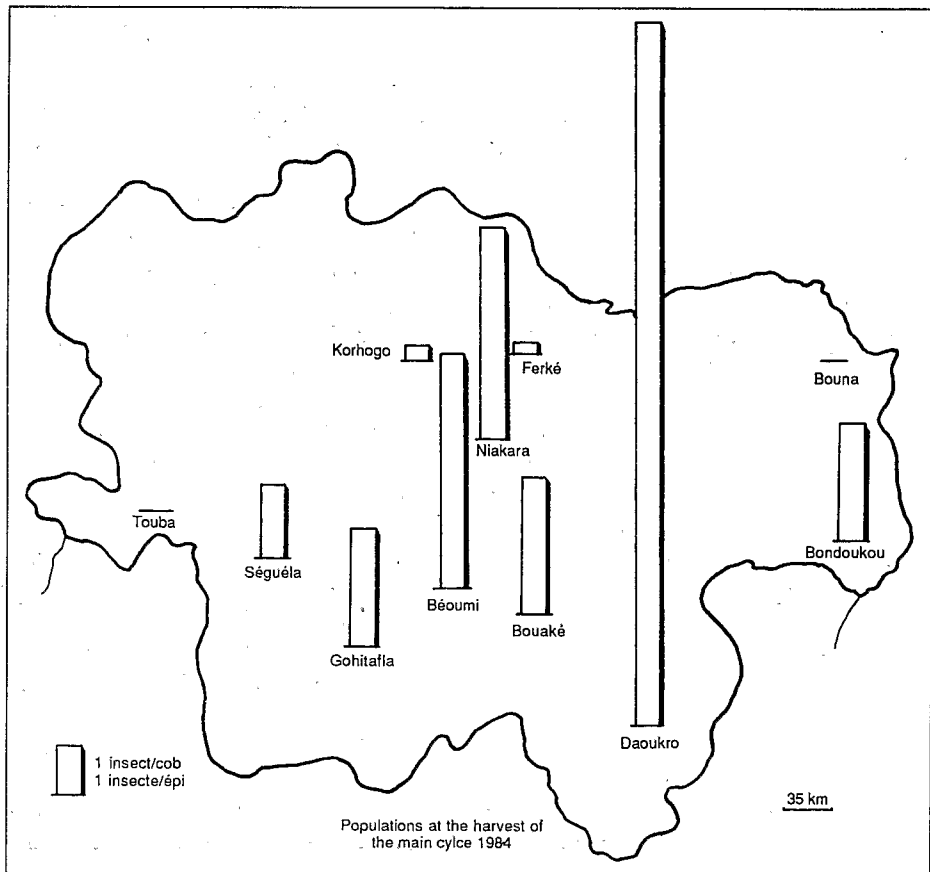Fig. 6. Population density of *Mussidia nigrivenella* at the harvest of the main cycle in 1983.



Fig. 7. Population density of *Mussidia nigrivenella* at the harvest of the main cycle in 1984.

## DISCUSSION

Results mentioned above show the importance
of *M. nigrivenella* as a pest of maize cob in the
savannah area of Ivory Coast. It is the main cob
borer (Moyal, 1988a) with fairly high population
densities in the southern part of the region.

This insect is sheltered under the shucks as early
as the second larval instar and its mortality occurs
at the early stages, egg and L1.

Only larvae that have penetrated into the cob
during the first day after hatching may live, since a
newly hatched larva cannot survive more than 1 day
without feeding.

The egg laying occurs on the shucks, but no
particular stimulus seems to attract the newly
hatched larvae towards the silks where they can
enter the cob. Their mortality is then high, from 70
to 90%, and may be explained by the fact that *M.
nigrivenella* is an African polyphagous insect, not
specialized in attacking a plant native of America.

Egg mortality varies with parasitism, density
and climatic factors. The percentage of eggs
parasitized increases with the density of eggs,
which is itself dependent on relative humidity. In
the course of this study, in a given place, egg-laying
was important when relative humidity was high and
weak when it was low (Moyal, 1988a).

The distribution of eggs is generally very
aggregative: the best fit to mathematical
distributions is a negative binomial with a low $k$,
which shows a high level of aggregation (Eliott,
1971). The rare cases when the best fit is a Poisson
distribution are those of low egg density, which
meets Eliott's opinion (1971) that Poisson
distributions fit low population densities.

The larvae distribution are best fitted either to
negative binomial distributions with a high $k$ which
then are tending to Poisson distributions
(Southwood, 1978).

This random distribution may be explained by
two factors: The dispersion of newly hatched
larvae, which, however, is certainly low, because of
the weakness of this instar, and above all,
successive egg-layings at random in the course of
time, egg-layings that are themselves aggregative
at a given time (larvae and pupae at the end of the
season originating in eggs laid during several
weeks).

The density of population is very weak in the
north and in the west and becomes stronger and
stronger towards the south and the east. This
phenomenon is frequently met in various crops
(Moyal, 1988b).

The same observation can be made every year in
spite of fluctuations that may be fairly important
from 1 year to another (particularly in 1984, where
the level of populations was high after a very dry
1983 year).

The importance of relative humidity and of
pluviometry particularly in the egg-laying may
partly explain this situation: When rains are
beginning early in the year the first generation can
be more important and then, during the second
rainy season pullulations may occur.

*M. nigrivenella* is a cob borer, the densities may
be very important, particularly in the southern part
of the savannah area of Ivory Coast. If the yield loss
due to this pest is fairly weak (Moyal, 1988a),
however, the percentage of grains attacked per cob,
and then worthless for sowing, is high, 15–20%
with five insects per cob.

Such loss levels may justify use of control
methods against *M. nigrivenella* which in the south
of the savannah area of Ivory Coast is a real
economic risk for seed producers.

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