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Number 1

# Distribution and abundance of some stem and cob borers in Benin

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International Institute of Tropical Agriculture

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Oyo Road, PMB 5320
Ibadan, Nigeria

Telephone: (234-022) 400300-400318
Telex: 31417 or 31159 TROPIB NG
Cable: TROPFOUND IKEJA

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# Preface

The Plant Health Research Monograph series aims to disseminate detailed research results obtained by IITA scientists in partnership with their colleagues in international and national research institutions. There are many interesting and relevant research results which deserve to be published in their entirety but are often not accepted in journals because they are too long. It is the aim of this series to allow publication of such information.

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Republic of Benin

# I. Introduction

This report describes the results and analyses of several countrywide surveys carried out in the Republic of Benin during 1990. Summaries of previous surveys (i.e. 1989) are available elsewhere. The purpose of these surveys was to: (a) estimate borer populations in maize, sorghum and millet, (b) try to establish patterns of abundance and distribution for the different borer species, and (c) begin to document the natural enemies of these borers.

A number of stem and cob boring lepidoptera attack maize in Benin. The principal species, and the ones these surveys were most concerned with, are *Sesamia calamistis*, *Eldana saccharina*, *Mussidia* sp., *Cryptophlebia* sp., *Coniesta* sp., *Busseola* sp., *Chilo* sp., and *Spodoptera* sp. It was not possible to accurately identify all larvae to species. Most of these genera have two or more species (e.g. more than 15 species of *Sesamia* have been described), and larval taxonomy is quite difficult. We recognize these difficulties and throughout the rest of this report all borers will be referred to by genus only.

# II. Methods

The surveys were undertaken in June and August 1990. In all, 117 farms were surveyed. Table 1 provides a breakdown by date, zone and crop. Farms were chosen from the major roads, using a nonsystematic selection criteria. Twenty plants were randomly selected along transects crossing the field. Because of the value of maize, and the generally small size of the fields, it was not feasible to sample more than 20 plants. Farmers were compensated in cash for the maize plants sampled but not for sorghum or millet plants.

Plants were dissected and visually searched for all life stages (eggs, larvae and pupae) of the pests. Larvae were put into vials containing artificial diet and held until emergence. Eggs and pupae were held in dry vials. All vials were brought back to the laboratory and the incidence of any parasites was recorded.

Additional information on crop growth, agronomic practices and damage estimates were also recorded. The height, basal stem diameter, and ear weight (maize only) was measured on each plant sampled. Qualitative observations on agronomic practices such as crop variety, plant spacing, relative crop growth (scale 1-5) and weed management practices were made for each field. The following damage assessments were measured on damaged plants: length of stem bored and number of internodes bored. For maize, a visual estimate was made of the percentage of ear bored.

# III. Province Summary

The four maps at the end of this report (Annexes) show the distribution of four of the common stem and cob boring lepidoptera (*Sesamia*, *Eldana*, *Mussidia* and *Cryptophlebia*). *Sesamia* has the widest distribution followed by *Eldana*. *Mussidia* and *Cryptophlebia* are restricted to the southern portion of the country, though this may reflect the preference for maize (grown more widely in the south) of these two borers.

**Atlantique Province:** Six maize fields were surveyed in this province in August 1990, exclusive of samples taken at the IITA station. The six fields were sampled when the crop was mature (80-90 DAP). Infestation rates for the combination of all borer species ranged from 35% to 75%. *Sesamia*, the most abundant species (20-60% of the plants in each field were infested),

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**Table 1. Date of sampling, location of fields and crop sampled during 1990 stem and cob borer surveys in the Republic of Benin**

| | June | | | | August | | | | June + August | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zone | Ma | So | Mi | Total | Ma | So | Mi | Total | Ma | So | Mi | Total |
| Atlantique | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 6 | 6 | 0 | 0 | 6 |
| Mono | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 8 | 8 | 0 | 0 | 8 |
| Oueme | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 7 | 7 | 0 | 0 | 7 |
| Zou | 10 | 0 | 0 | 10 | 11 | 3 | 0 | 14 | 21 | 3 | 0 | 24 |
| Borgou | 23 | 3 | 3 | 29 | 4 | 3 | 5 | 12 | 27 | 6 | 8 | 41 |
| Atakora | 2 | 0 | 3 | 5 | 7 | 13 | 6 | 26 | 9 | 13 | 9 | 31 |
| Total | 35 | 3 | 6 | 44 | 43 | 19 | 11 | 73 | 78 | 22 | 17 | 117 |

Note: Ma = maize, So = sorghum, and Mi = millet

was found in every field. The cob borer *Cryptophlebia* was also found in every field (10-30% of the plants infested), while *Mussidia* and *Eldana* were found in 50% of the fields. These latter two species were found at lower infestation levels (<35%).

**Mono Province:** In this province eight maize fields were sampled in August, crop ages ranging from 75 to 100 DAP. Infestation rates for all borer species were the lowest of the three coastal provinces, being 10-55% for all borer species. *Sesamia* and *Cryptophlebia* were equally abundant, both having been found in 7 of 8 fields, and at infestation rates of 5-35%. *Mussidia* and *Eldana* were found in half of the fields and in less than 20% of the plants in each field.

**Oueme Province:** Seven maize fields, between 75-100 DAP, were surveyed in this province during August. Infestation by all borer species was generally between 10 and 40% though in one field 85% of the plants were infested with one or more species. *Sesamia* was found in 6 of 7 fields, but fewer than 25% of the plants per field were infested. *Cryptophlebia* was found in every field and 5-55% of the plants were infested. *Eldana* and *Mussidia* were found in 5 and 2 fields respectively, and fewer than half of the plants were infested with either of these species.

**Zou Province:** In Zou province 10 maize fields were sampled in June (30-90 DAP) while 11 maize (50-90 DAP) and 3 sorghum (40-60 DAP) fields were sampled during August. In June, 7 fields contained borers and infestation rates were less than 30%. *Sesamia* was found in 3 fields, *Crytophlebia* and *Coniesta* in one field each, and no *Eldana* or *Mussidia* were found in any field. No species of borer was found in more than 25% of the plants.

The situation was somewhat different in August. Only 1 of 11 maize fields sampled was free from all borers, and in the other 10 fields infestation rates ranged from 10-75%. *Cryptophlebia*, the most common species, was found in 10 fields, *Sesamia* and *Mussidia* were found in 8 fields, and *Eldana* was found in 5 fields. Borer populations were much lower in the 3 sorghum fields

(0-15% of the plants infested). The 2 fields which were infested had only low populations of *Sesamia*, *Eldana* and *Coniesta*.

**Borgou Province:** The largest number of fields surveyed was in Borgou province. In June, 23 maize (30-60 DAP), 3 sorghum (20-50 DAP), and 3 millet (30-50 DAP) fields were sampled. During August, 4 maize (50-85 DAP), 3 sorghum (45-60 DAP), and 5 millet (40-80 DAP) fields were sampled. In the earlier survey only 4 maize fields were free of borers. In the remaining 19 fields infestation rates varied from 5-71%. *Sesamia* and *Eldana* were by far the most promenient species found in 15 and 13 fields respectively. The proportion of plants infested with *Sesamia* was 5-62% and for *Eldana* 5-20%. *Mussidia* and *Cryptophlebia* were not found in any field (including sorghum and millet). *Coniesta* was found in 2 maize fields, all 3 sorghum fields and 1 millet field. The proportion of plants infested with *Coniesta* ranged from 5% in maize to 73% in one sorghum field.

In the August survey infestation rates were much lower. Only 1 of 4 maize fields was infested with borers (*Sesamia*, 5% of the plants), and only 1 of 3 sorghum fields was infested. All 5 millet fields were infested with borers. *Coniesta* was the dominant species, found in 3 fields with 5-25% of the plants infested.

**Atakora Province:** In June, 5 fields were surveyed in this province, 2 maize (40-60 DAP) and 3 millet (40-50 DAP). Four of these fields were infested with borers (5-38%). *Sesamia* infested 1 maize field (5% of the plants). All 3 millet fields were infested with *Coniesta* (25-35% of the plants).

During the August survey 26 fields were sampled: 7 maize (45-75 DAP), 13 sorghum (50-120 DAP), and 6 millet (60-90 DAP). Four of the 7 maize fields had no borers and the other 3 had only low infestations (5-25%). The most common species, *Mussidia*, infested 15% of the plants in one field. Sorghum was more heavily attacked; all 13 fields were infested and the proportion of plants infested varied from 10-65%. The two most common borer species in sorghum were *Sesamia* (11 fields, 5-55% infestation rate) and *Coniesta* (11 fields, 5-20% infestation rate). Five of the 6 millet fields were infested with borers. The only species found in these fields was *Coniesta* (10-55% infestation rate).

## IV. Statistical Analysis

**Maize:** The correlation matrix for the eight categories of Lepidoptera (table 2) revealed no strong associations between any of the species. The strongest relationship was a slight positive association between *Eldana* sp. and *Cryptophlebia* sp. This correlation matrix includes maize data from all zones and all dates. It is interesting that there was no association between *Cryptophlebia* and *Mussidia*, the two species found in the cob. Because the cob is present only at the end of the season it seemed likely that these 2 species would have a stronger association, either positive or negative.

Overall, *Sesamia* was the most abundant species, found in 49% of all fields surveyed and 60% of the maize fields. Multiple regression analysis indicated that there was no relationship between *Sesamia* abundance and the three crop growth variables (plant height, plant diameter

and crop age). This observation was true for the entire maize data set but also when the analysis was restricted within date (June 1990 or August 1990) or zone. It appears that *Sesamia* presence or abundance is not restricted by plant height, diameter or age.

Multiple regression analysis was also used to evaluate the impact of zone, crop age, plant height and plant diameter on stem borer damage. The three damage variables measured were the length of stem tunnelled, the number of internodes bored, and the percentage of plant tunnelled. The first two were measured directly and the third was calculated from the length tunnelled and the plant height. Zone, crop age, plant height and plant diameter were used as independent variables and damage was the dependent variable in this analysis. For all three of the damage variables the fit was very poor ($r^2<0.1$). This was true even when the data set was restricted by date (June or August). These results seem to indicate that zone, crop age, plant height and diameter are not correlated with the level of damage observed. The same combination of 4 independent variables were also used in a multiple regression analysis of *Sesamia* number. Very little of the variation in the number of *Sesamia* per plant was explained by these four variables. The correlation coefficients ($r^2$) for the full data set and for June and August separately were all below 0.1, indicating that, with regard to this data set, none of these variables is important in explaining *Sesamia* abundance.

**Table 2. Correlation matrix for seven stem and cob boring lepidoptera collected on 1990 surveys in the Republic of Benin**

| Species # | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1 | 1.0 | | | | | | |
| 2 | .06 | 1.0 | | | | | |
| 3 | -.027 | -.002 | 1.0 | | | | |
| 4 | -.002 | .113 | .063 | 1.0 | | | |
| 5 | -.021 | -.017 | -.017 | -.026 | 1.0 | | |
| 6 | .001 | -.006 | -.007 | -.011 | -.004 | 1.0 | |
| 7 | -.007 | -.004 | -.004 | -.006 | -.003 | -.001 | 1.0 |

**Note:** Species are 1 = *Sesamia*, 2 = *Eldana*, 3 = *Mussidia*, 4 = *Cryptophlebia*, 5 = *Spodoptera*, 6 = *Coniesta*, and 7 = *Busseola*

Simple linear regressions were used to analyse the impact of *Sesamia* number on each of the damage variables. Because *Sesamia* was the most abundant species it accounted for most of the stem damage. When the entire maize data set was evaluated the association between the number of *Sesamia* and the level of damage was not particularly strong. The strongest association was between number of *Sesamia* and the centimeters bored ($r^2= 0.303$). The other two damage measurements, internodes bored and % plant bored, had lower $r^2$ values (0.227 and 0.266 respectively). However, using a data set restricted to the June sample date, the association between *Sesamia* number and damage improved. In the June sample the average age for maize was approximately 20 days younger than in the August sample for all zones. The regression of *Sesamia* number versus centimeters bored for the June sample is shown in figure 1. The number of *Sesamia* is a relatively good predictor of the amount of stem bored ($r^2=0.521$). However, because there were other borer species present and because not all *Sesamia* are found in the

stem, only about half of the variation is explained by this relationship. In the August sample, *Sesamia* number is a relatively poor predictor of stem tunneling ($r^2$=0.092). The reason for this is that older plants were found during the August survey and these had fewer *Sesamia*, also, because the stems were drier, most of the borers were in the cob.

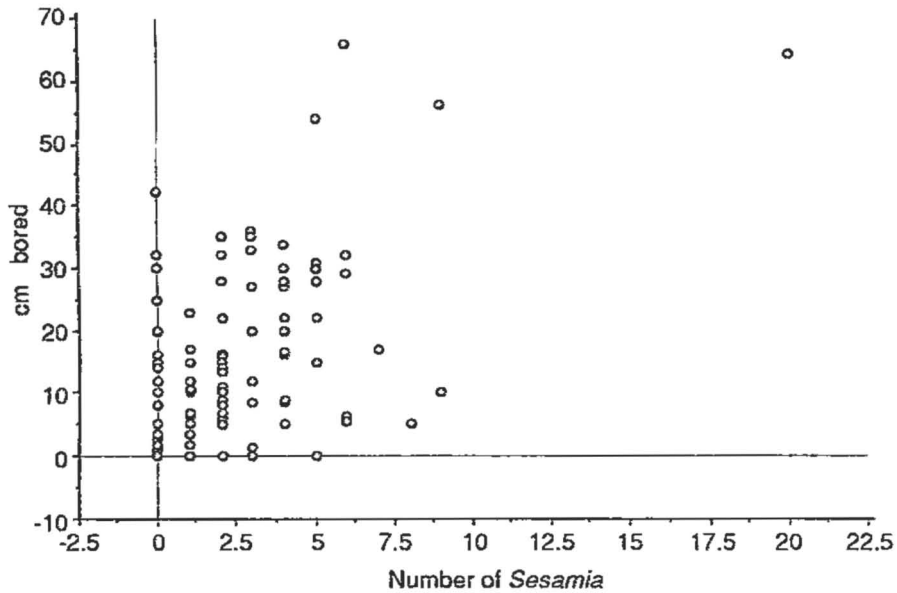



**Figure 1. The relationship (Y = 0.937 + 4.095X; $r^2$ = 0.521; n = 697) between the number of *Sesamia* larvae per plant and the amount of stem tunneling.**

Simple linear regression was used to investigate the effect of each borer species on cob weight and cob damage. For this analysis the data set was restricted to plants having cobs (i.e. older plants). Cob weights were poorly correlated with any borer species (all $r^2$<0.001). Damage to cobs expressed as the % cob bored was also poorly correlated with individual borer species. *Sesamia* had the strongest association with cob damage but the correlation was still very low ($r^2$=0.079). The relationship between stem damage and cob weight indicates how difficult damage estimates are from survey data. A restricted data set, plants with cobs and stem damage greater than zero, was used to generate figure 2. From this data stem damage only marginally affects cob weight. However, surveys can only assess this relationship at one instant in time while infestation experiments (e.g. Bosque-Perez and Mareck 1990), using repeated observations, provide a better understanding of the damage-yield relationship.

**Sorghum:** Only three stem borer species were found in the 22 sorghum fields surveyed. *Sesamia* was found in 12 fields (54.5%), *Eldana* in 1 field (4.5%), *Busseola* in 4 fields (18.2%) and *Coniesta* in 15 fields (68.2%). The number of individuals of each species found on infested plants provides information on their biologies. On sorghum plants infested with *Sesamia* an average of 1.57 (±0.185) larvae were found. Only two plants had *Eldana* larvae (one each) while 1.83 (±0.761) *Busseola* larvae were found per infested plant. Compared to these species *Coniesta* is a more aggregated species. Infested sorghum plants averaged 15.82 (±3.146) *Coniesta* larvae.

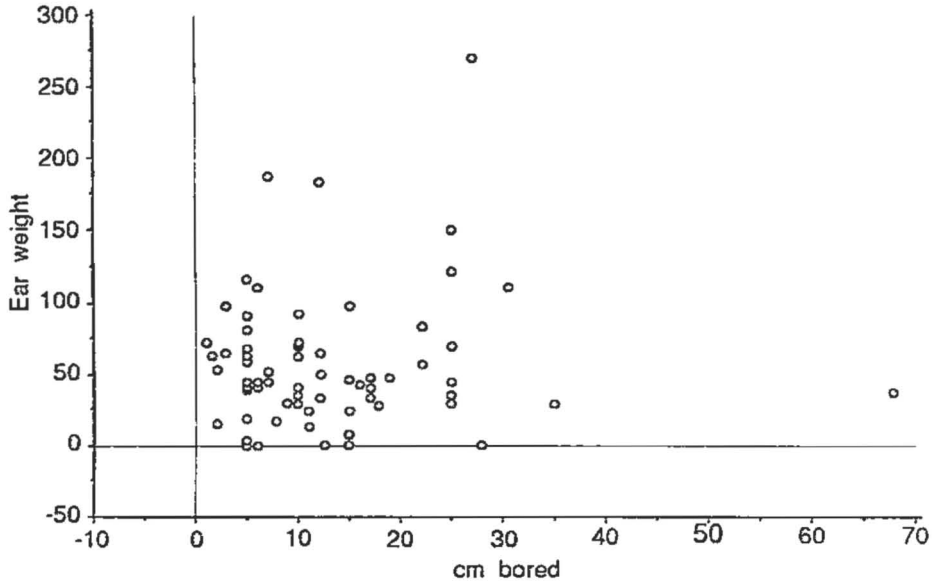



**Figure 2. The relationship ($Y = 57.354 + 0.361X$; $r^2 = 0.007$; $n = 62$) between the amount of stem tunneling and weight of maize ears.**

**Millet:** Millet fields were infested by the fewest number of stem borer species. *Eldana* was found in two fields (11.8%) and *Coniesta* was found in 12 fields (70.6%). Only a single *Eldana* was found in each of the two fields. Infested millet plants averaged 5.7 ($\pm$1.003) *Coniesta* larvae. *Sesamia* and the two cob infesting species, *Mussidia* and *Cryptophlebia*, were not found in any millet plants.

## V. Natural Enemy Data

The information on natural enemy abundance and distribution which was gathered in these surveys was not extensive. This was due in part to the loss of nearly all the samples collected in the June survey. A second problem is the uncertain identification of most of the natural enemies collected. Table 3 includes the natural enemy results from all samples collected during the 1990 surveys.

Due to the loss of samples from the June 1990 survey only the August 1990 data is included in the following analysis. Of 310 *Sesamia* larvae collected 9 (2.9%) were parasitized. Tachinids emerged from four, eulophids from four and one *Sesamia* larva was parasitized by a nematode. The parasitized *Sesamia* came from Atlantique, Mono and Zou Provinces. One hundred and fifteen *Eldana* larvae were collected. Three of these were parasitized and one destroyed by a predator resulting in a similarly low rate for natural enemies (3.5%). As with *Sesamia*, the four *Eldana* larvae attacked by natural enemies were found in the southern provinces (Atlantique and Oueme). Though *Coniesta* was the most numerous borer species collected (656 larvae compared to 310 *Sesamia* larvae) it had the lowest parasitization rate (0.6%). *Coniesta* was predominately found in millet and sorghum, and only rarely in maize. And 95% of the larvae collected were found in Atakora Province. The 4 parasites recovered from *Coniesta* larvae (1 in Zou and 3 in Atakora Provinces) were all tachinids.

**Table 3. Location, host and host plant for natural enemies recovered during 1990 Republic of Benin stem and cob borer surveys**

| Province | Collection date | Host plant | Borer (#) | Instar | Plant | Parasite location | Number |
|---|---|---|---|---|---|---|---|
| Oueme | | | | | | | |
| Ouando | 9-8-90 | Maize | *Chilo* (1) | 3 | Stem | Diptera | 6 |
| Ita-Kpiti | 9-8-90 | Maize | *Eldana* (1) | 4 | Ear | Tachinidae | 1 |
| Atlantique | | | | | | | |
| Glodjigbe | 17-8-90 | Maize | *Busseola* (1) | 5 | Stem | Tachinidae | 1 |
| Sehoue | 17-8-90 | Maize | *Sesamia* (2) | 4 | Stem | Tachinidae | 2 |
| Sehoue | 17-8-90 | Maize | *Sesamia* (1) | 4 | Ear | Tachinidae | 1 |
| Attogon | 17-8-90 | Maize | *Eldana* (2) | 2 | Stem | Diptera | 2 |
| Attogon | 17-8-90 | Maize | *Eldana* (1) | 4 | Stem | ?Predator | 1 |
| Mono | | | | | | | |
| Adjahome | 17-8-90 | Maize | *Sesamia* (1) | P | Ear | Eulophidae | 158 |
| Allogo | 8-8-90 | Maize | *Sesamia* (1) | P | Ear | Eulophidae | 144 |
| Come (Gad.) | 8-8-90 | Maize | *Sesamia* (1) | P | Ear | Eulophidae | 255 |
| Zou | | | | | | | |
| Za-Kpota | 22-8-90 | Sorghum | *Coniesta* (1) | ? | Stem | Diptera | 1 |
| Zagnanado | 22-8-90 | Maize | *Sesamia* (1) | 5 | Stem | Tachinidae | 1 |
| Zagnanado | 22-8-90 | Maize | *Sesamia* (1) | P | Stem | Eulophidae | 102 |
| Hounkpogon | 18-6-90 | Maize | ?? | | Stem | Syrphidae predator | |
| Logozohe | 28-8-90 | Sorghum | *Sesamia* (1) | 5 | Stem | Nematode | 1 |
| Atakora | | | | | | | |
| Pabegou | 12-9-90? | Millet | *Coniesta* (1) | 5 | Stem | Tachinidae | 1 |
| Dahohoun | 30-8-90 | Millet | *Coniesta* (2) | 3 | Stem | Tachinidae | 2 |
| Kpessou | 22-6-90 | Millet | ?? | | | Predator?? | |
| Borgou | | | | | | | |
| Sarawodo | 21-6-90 | Maize | *Sesamia* (1) | ? | Stem | ?????? | 2 |

It is difficult to make generalizations about the natural enemies of stem and cob borers based on the small amount of data available. However, several interesting observations can be made. No parasites of *Mussidia* or *Crytophlebia* were recovered though more than 90 of each species were collected. *Sesamia* and *Eldana* parasitoids were found only on maize and mainly in southern provinces. The low number of *Coniesta* parasitoids was also unexpected.

It would be useful to know if there is a relationship between certain natural enemies and particular host plants, especially since these stem and cob borers are found on a variety of host plants. More data will be necessary to reveal possible regional and/or seasonal patterns for natural enemy abundance.

# VI. Sampling Stem and Cob Borers

The dissection of maize plants to evaluate pest densities is very time- consuming and often requires the destruction of plants before they are ready for harvest. Thus, in order to minimize the processing of samples, the damage to plants, and number of destructive samples taken, a presence-absence sampling plan has been proposed (Schulthess et al. 1991). This sampling plan is based on the ecological relationship between % infested plants (P) and numbers of pest organisms per plant (m; P-m relationship). The 1989 survey data on maize and sorghum were used to establish the P-m relationship for the different borers feeding on these crops (figure 3). The relationship was described with the exponential model of the form:

$$P(I) = 100*1-e^{-m*\ln(a*m^{b-1})/(a*m^{b-1}-1)}$$

where 'a' and 'b' (Taylor's coefficients) are a measure of the aggregation of a species in a field (with b>1, b=1 and b<1 indicating aggregated, random, and regular distributions, respectively, and 'a' being a mere sampling factor). The Taylor's coefficients (table 4) were obtained from a linear regression of the 'between plant variance' against the 'mean per plant density' for each field. Both variables, the 'between plant variance' and the 'mean per plant density', were transformed to logarithms before analysis. A statistical comparison of the 'a' and 'b' values showed that on maize *Eldana, Mussidia and Spodoptera* (EMS) had similar spatial distributions, i.e. the same 'a's and 'b's. Hence, a common 'a' and 'b' derived from a pooled regression was used for the development of the presence-absence sampling plan.

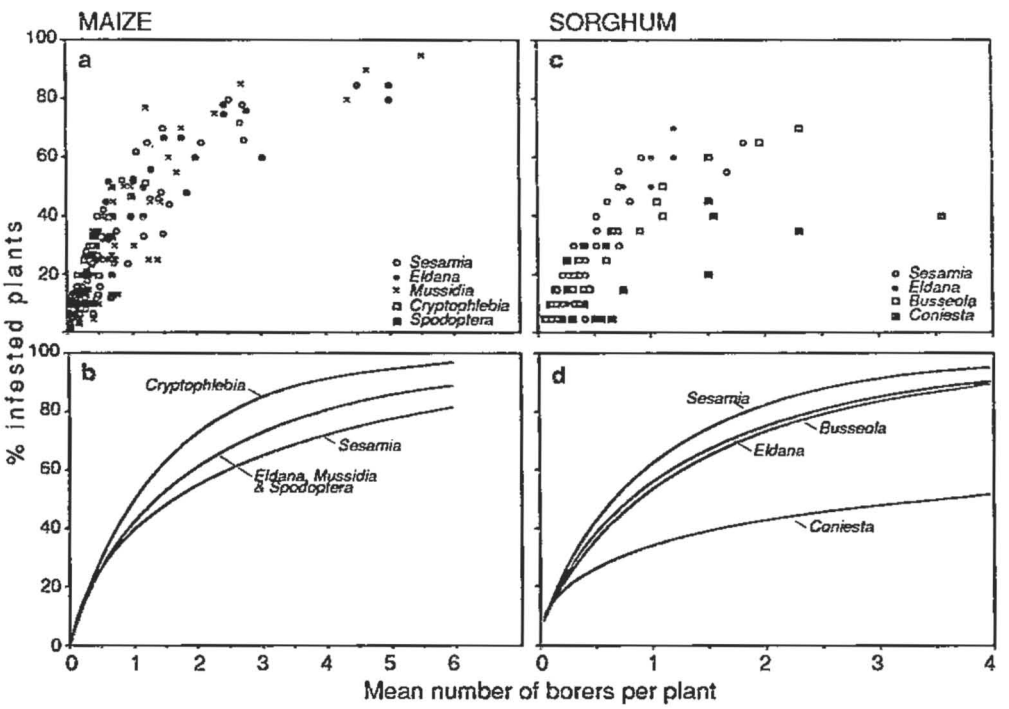



**Figure 3. The relationship between the number of borers per plant and the number of infested plants for seven stem and cob boring lepidoptera on maize and sorghum.**

**Table 4. Taylor's coefficients and $r^2$ for seven stem and cob boring lepidoptera on maize and sorghum**

| | a | b | $r^2$ |
|---|---|---|---|
| Maize | | | |
| *Sesamia* | 3.49 | 1.52 | 0.90 |
| *Cryptophlebia* | 1.90 | 1.23 | 0.87 |
| *Eldana* | 3.01 | 1.45 | 0.91 |
| *Mussidia* | 3.17 | 1.38 | 0.89 |
| *Spodoptera* | 2.94 | 1.38 | 0.89 |
| EMS | 3.05 | 1.41 | 0.92 |
| Sorghum | | | |
| *Sesamia* | 2.13 | 1.26 | 0.89 |
| *Eldana* | 2.77 | 1.36 | 0.93 |
| *Busseola* | 3.12 | 1.34 | 0.93 |
| *Coniesta* | 6.50 | 1.83 | 0.94 |

**Note:** EMS = *Eldana* + *Mussidia* + *Spodoptera*

For establishing the % infested plants, a nondestructive sample of 40 plants taken at random is recommended; the field should be divided into four quadrats, and each quadrat should be sampled by a different investigator. For evaluation of presence of stemborers, i.e. borerholes or frass, the leaf sheaths should be partly opened (on young plants) or the dry leaves stripped off the plants (on older plants). For evaluation of presence of cob borers the husks have to be opened. For establishing the species composition, a sample of 10 infested plants should be taken for dissection. Once the % infested plants and the species composition are known the respective mean per plant density can be obtained from table 5.

**Table 5. Borer density per plant using % infested plants (from presence-absence sample) and species composition (from destructive sample)**

| | Maize | | | Sorghum | | | |
|---|---|---|---|---|---|---|---|
| Borer density/ plant | *Sesamia* | *Crypto-phlebia* | *Eldana, Mussidia & Spodoptera* | *Sesami* | *Eldana* | *Busseola* | *Coniesta* |
| | % infested plants | | | % infested plants | | | |
| 0.1 | 9 | 9 | 9 | 9 | 9 | 8 | 10 |
| 0.3 | 19 | 22 | 19 | 21 | 20 | 18 | 17 |
| 0.5 | 27 | 32 | 27 | 31 | 28 | 27 | 22 |
| 0.7 | 32 | 41 | 34 | 39 | 35 | 33 | 25 |
| 0.9 | 37 | 48 | 39 | 46 | 41 | 39 | 28 |
| 1.1 | 42 | 54 | 44 | 52 | 46 | 44 | 30 |
| 1.3 | 45 | 59 | 48 | 57 | 51 | 48 | 32 |
| 1.5 | 49 | 64 | 52 | 61 | 55 | 52 | 34 |
| 1.7 | 51 | 58 | 56 | 65 | 58 | 56 | 35 |
| 1.9 | 54 | 71 | 59 | 58 | 61 | 59 | 36 |
| 2.1 | 57 | 75 | 61 | 72 | 64 | 62 | 38 |
| 2.3 | 59 | 77 | 64 | 74 | 67 | 65 | 39 |
| 2.5 | 61 | 80 | 66 | 79 | 71 | 69 | 41 |
| 2.7 | 63 | 82 | 68 | 79 | 71 | 69 | 41 |
| 2.9 | 65 | 84 | 70 | 81 | 73 | 71 | 42 |
| 3.1 | 66 | 85 | 72 | 82 | 75 | 73 | 43 |
| 3.3 | 68 | 87 | 74 | 84 | 77 | 75 | 44 |
| 3.5 | 69 | 88 | 75 | 86 | 78 | 77 | 44 |
| 3.7 | 70 | 89 | 77 | 87 | 80 | 78 | 45 |
| 3.9 | 72 | 90 | 78 | 88 | 81 | 79 | 46 |
| 4.1 | 73 | 91 | 79 | 89 | 82 | 81 | 46 |
| 4.3 | 74 | 92 | 80 | 90 | 83 | 82 | 47 |
| 4.5 | 75 | 93 | 81 | 91 | 95 | 93 | 48 |
| 4.7 | 76 | 94 | 82 | 92 | 86 | 84 | 48 |
| 4.9 | 77 | 94 | 83 | 92 | 86 | 85 | 49 |
| 5.1 | 78 | 95 | 84 | 93 | 87 | 86 | 49 |
| 5.3 | 79 | 95 | 85 | 94 | 88 | 87 | 50 |
| 5.5 | 79 | 96 | 86 | 94 | 89 | 87 | 50 |
| 5.7 | 80 | 86 | 86 | 95 | 89 | 88 | 51 |
| 5.9 | 81 | 97 | 87 | 95 | 80 | 89 | 51 |

## VII. Summary

1. Stem and cob borers are widespread, found in every province, and in both June and August.

2. *Sesamia* was the most abundant species found in half of the fields.

3. Cob borers, especially *Mussidia* and *Cryptophlebia*, appear to be important.

4. Borer infestations in maize were higher in the south than in the north.

5. In young maize plants there was a good association between *Sesamia* number and plant damage.

6. There were poor relationships between cob weight and borer species, cob damage and borer species, and cob weight and stem damage.

7. *Sesamia* and *Coniesta* were the only important borers in sorghum.

8. *Coniesta* is a highly aggregated species and the only important species in millet.

9. Very low parasitization rates for *Sesamia*, *Eldana* and *Coniesta* were observed.

10. Parasitized *Sesamia* and *Eldana* came from southern provinces, parasitized *Coniesta* came from the north.

11. No parasitized *Mussidia* or *Cryptophlebia* were collected.

12. The spatial distribution of *Eldana*, *Mussidia* and *Spodoptera* was similar and a presence-absence sampling plan was developed using pooled data.

13. To establish the % infested plants, 40 maize plants (10 in each of 4 quadrats) should be examined in the field.

14. To establish the species composition, 10 infested maize plants should be sampled and dissected.

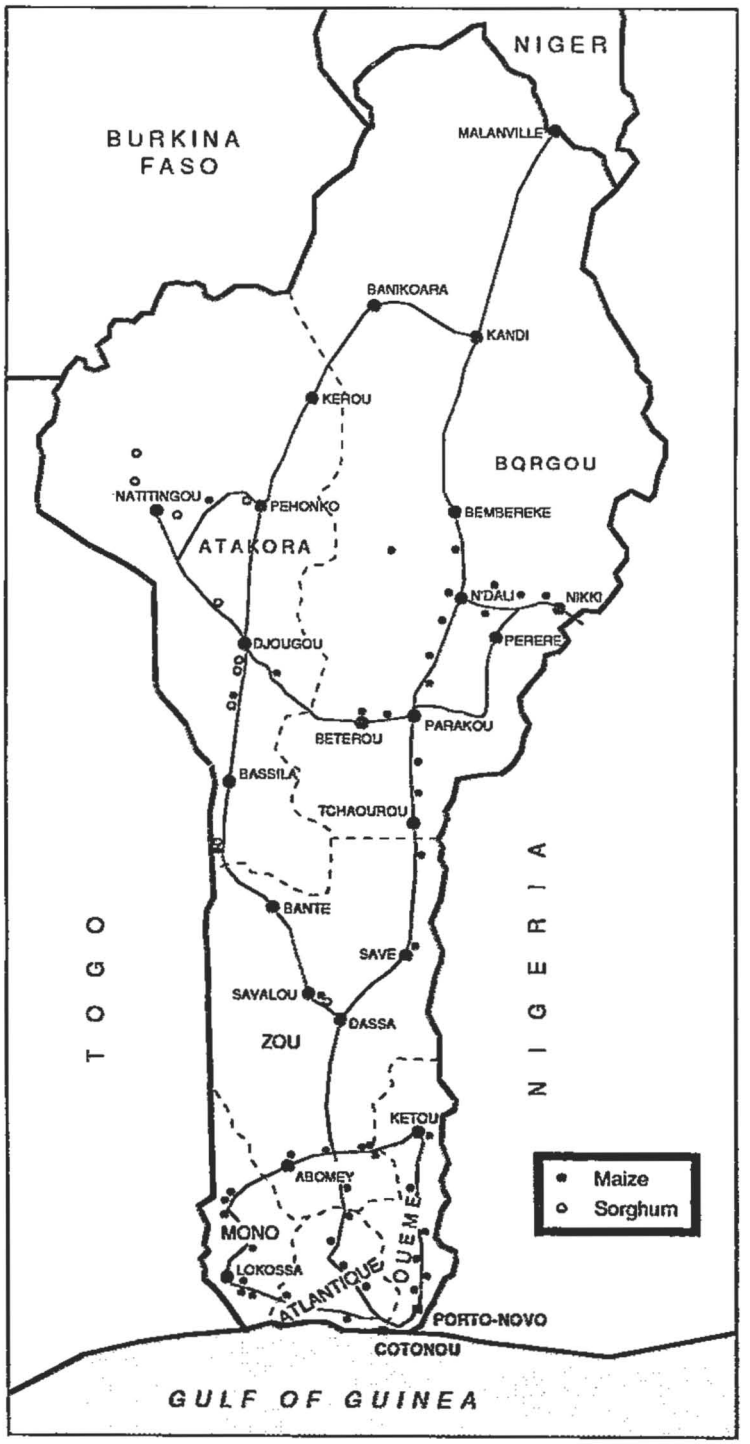
15. Table 5 can be used to determine the mean per plant density using the % infested plants and the species composition.

## References

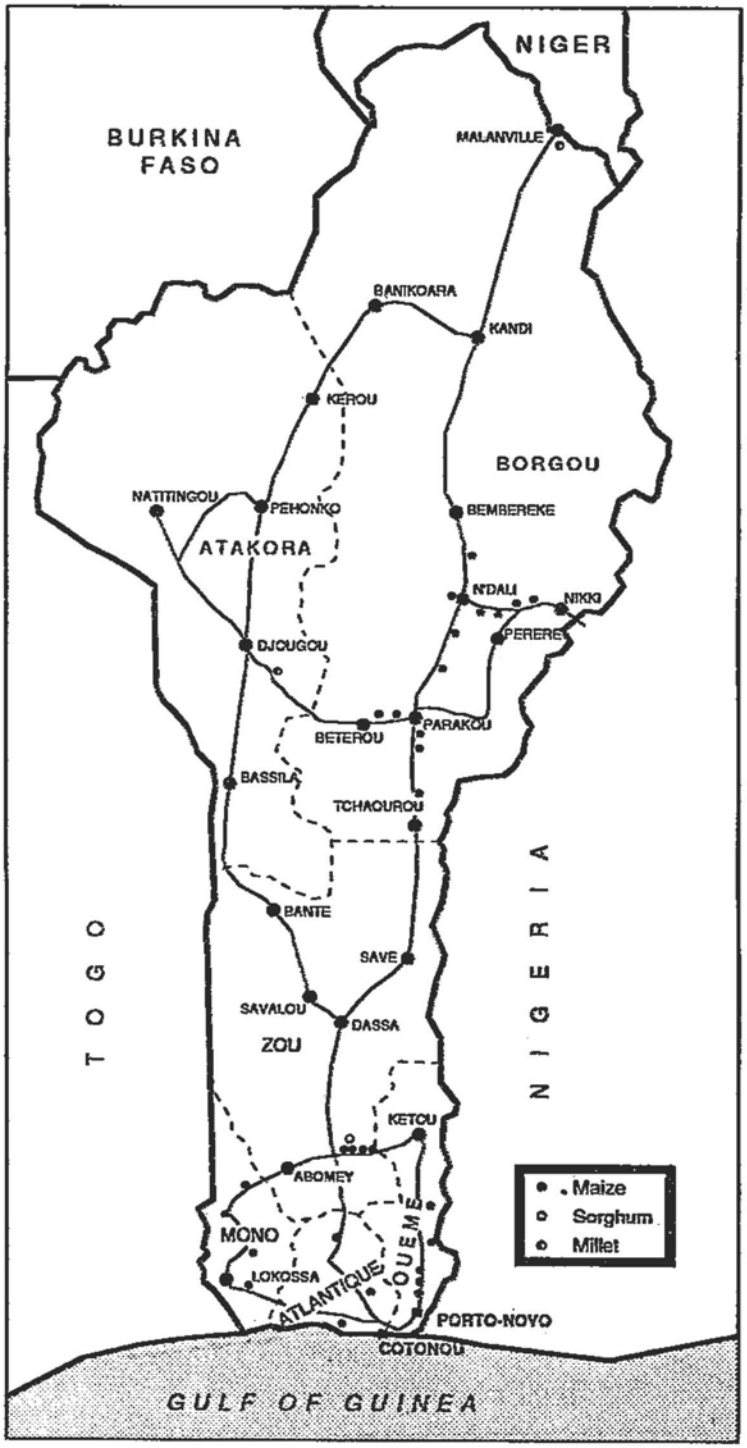
Bosque-Perez, N. A., and J. H. Mareck. 1990. Distribution and species composition of lepidopterous maize borers in southern Nigeria. *Bull. Ent. Res.* 80: 363-368.

Schulthess, F., N. A. Bosque-Perez, and S. Gounou. 1991. Sampling lepidopterous pests on maize in West Africa. *Bull. Ent. Res.* (in press).

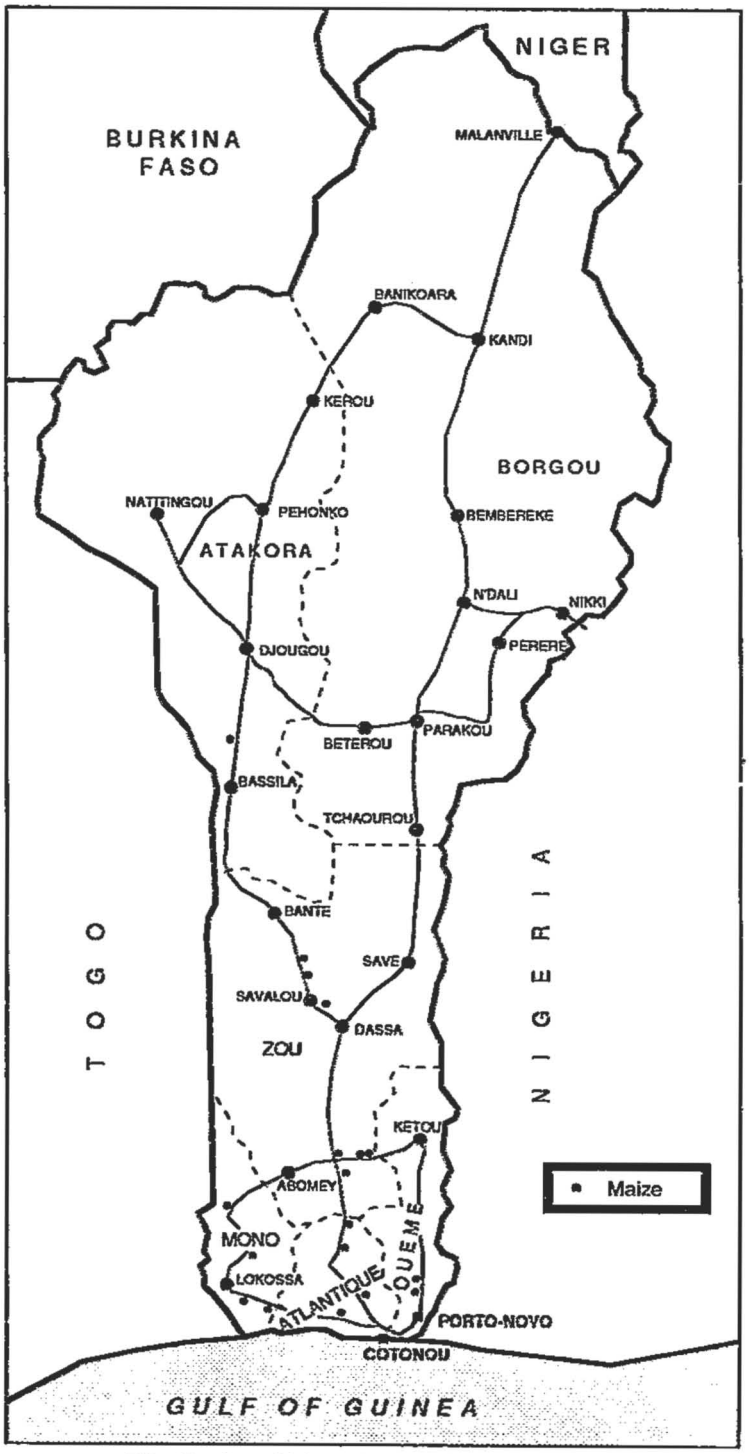
# Annexes



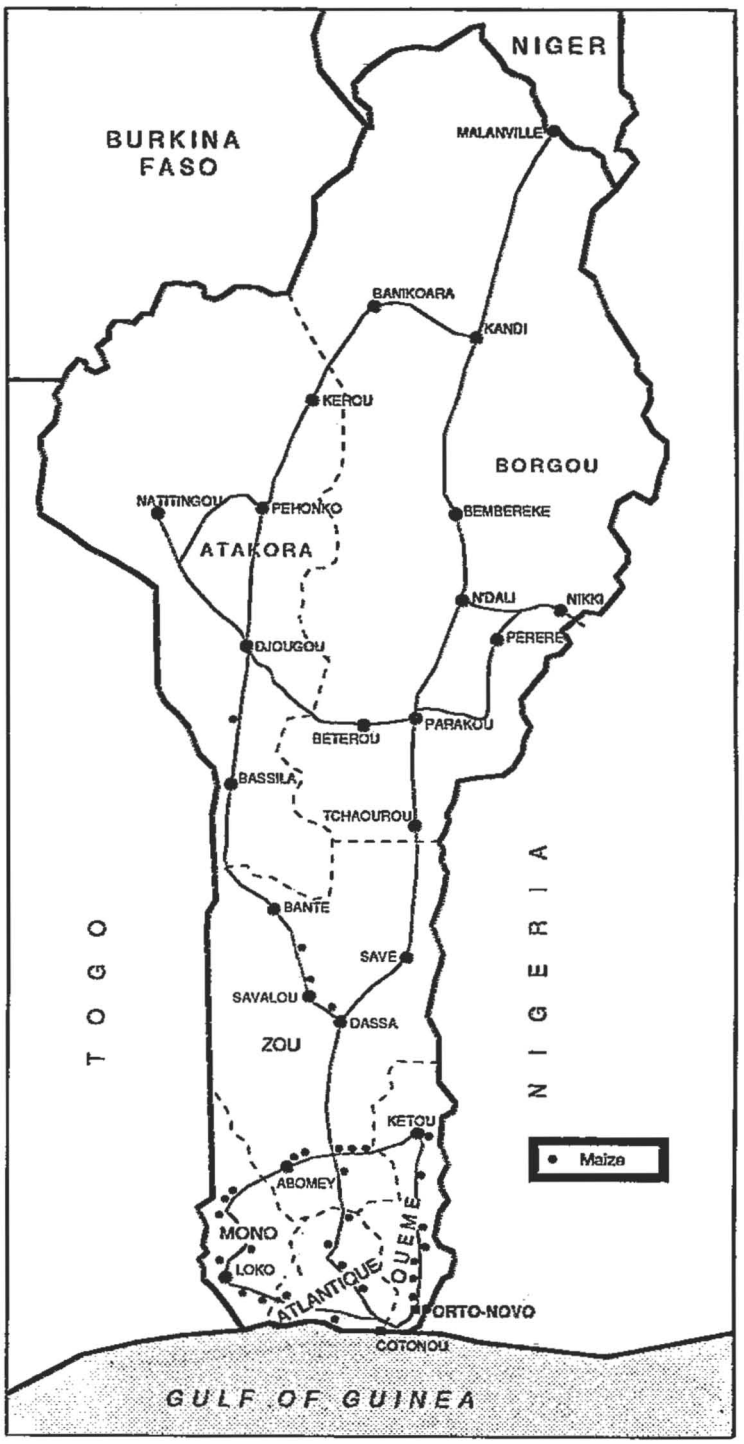

**Distribution of *Sesamia* on maize and sorghum, Benin, 1990.**




**Distribution of *Eldana* on maize, sorghum and millet Benin, 1990.**




**Distribution of *Mussidia* on maize, Benin, 1990.**




**Distribution of *Cryptophlebia* on maize, Benin, 1990.**