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Distribution and species composition of lepidopterous maize borers in southern Nigeria*

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Maize is an important source of food and feed in many parts of Africa. It is the primary staple and a major source of calories for half the population of sub-Saharan Africa. Past research—such as the study reported here—has shown lepidopterous stem borers to be important insect pests on the crop, causing major yield losses, especially on late-planted or 'second-season' maize. Based on the data gathered, a control strategy is being developed that will integrate host plant resistance with biological control agents and improved agronomic practices.

Introduction

Stem borers are among the economically most important pests of maize in Africa. Four borers cause significant yield loss: the maize stalk borer, *Busseola fusca* Fuller (Lepidoptera: Noctuidae); the pink stalk borer, *Sesamia calamistis* Hampson (Lepidoptera: Noctuidae); the African sugar cane borer, *Eldana saccharina* Walker (Lepidoptera: Pyralidae); and the spotted stalk borer, *Chilo partellus* Swinhoe (Lepidoptera: Pyralidae) (Bowden 1954; Harris 1962; Appert 1970; Brenière 1971; Girling 1978). Feeding by borer larvae on maize plants usually results in crop losses, as a consequence of death of the growing point (deadhearts), early leaf senescence, reduced translocation, lodging, and direct damage to the ears (Appert 1970; Brenière 1971). Estimated yield losses caused by maize borers in Nigeria range from 10 to 100 % (Usua 1968*a*).

A large proportion of maize in West Africa is grown in the forest zone. The rainy season in this zone lasts 6 – 9 months (March to November); in some regions the rains are bimodal, interrupted by a short, unreliable 'August break'. The August break divides the rainy season into 'first' and 'second' seasons. Maize planted at the beginning of the rains is called first season maize, and maize planted after the August break is referred to as second season maize. Maize stem borers are far more abundant in the second than in the first season, and the second crop is sometimes a complete loss (Adeyemi et al. 1966; Girling 1980). Consequently, many farmers in the bimodal rainfall zone of West Africa do not plant second season maize (Tams and Bowden 1953; IITA 1976).

The objectives of this study were to monitor natural infestations of maize borers during the second planting season, and to determine the distribution and relative importance of the different borer species in several locations in southern Nigeria. This information is a prerequisite for the development of an integrated pest management program for these insects.

Materials and Methods

Experiments were conducted during the second planting season at four locations in southeastern Nigeria in 1985, and at two locations in southwestern Nigeria in 1986. In 1985, trials were planted the first week of August at the following locations: the

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high rainfall station of the International Institute of Tropical Agriculture (IITA) at Onne near Port Harcourt, Rivers state; the National Cereals Research Institute Station at Amakama near Umuahia, Imo state; a farmers' field in Sapele, Bendel state; and the Diocesan and Development Services Research Farm at Idah, Benue state (Fig. 1). These locations were chosen to represent a wide area within southeastern Nigeria, including forest zone locations and a forest-savanna transitional zone location (Idah). Two maize hybrids, 8341-6 and 8338-1, were planted in fifty 5-m rows each at all four locations. The former hybrid matures earlier than the latter. In 1986, trials were planted the second week of August in a farmers' field at Alabata and at the IITA main station, Ibadan, both in Oyo state. Twenty-five 5-m rows of the early-maturing, open-pollinated variety TZESR-W were planted at each location. An early-maturing variety was chosen for the 1986 trial because these two locations have a shorter growing season than the 1985 sites. All plantings had a spacing of 75 cm between rows and 25 cm between plants. Two seeds per hill were planted, and the stand was thinned to one plant per hill 2 weeks after emergence. Fertilizer was applied: 300 kg ha^{-1} of NPK (15-15-15) at planting, and 170 kg ha^{-1} of calcium ammonium nitrate 4 weeks after planting. Twenty-five plants per variety per location were randomly sampled every 2 weeks. Plants were brought into the laboratory, dissected, and the number of borer larvae and pupae per plant determined. The borer species were identified by the senior author, following the keys by Tams and Bowden (1952), Brenière (1976), and Staeubli (1977). The number of damaged plants was recorded and when ears were present, the number of damaged ears and the number of larvae per ear were also recorded. In 1986, the number of *Mussidia nigrivenella* Ragonot (Lepidoptera: Pyralidae) eggs was also counted. The extent of borer damage on each sampling date in 1986 was assessed by examining the dissected plants for presence of borer damage (as done in 1985) and by additionally counting in the entire field the plants that showed external signs of damage.

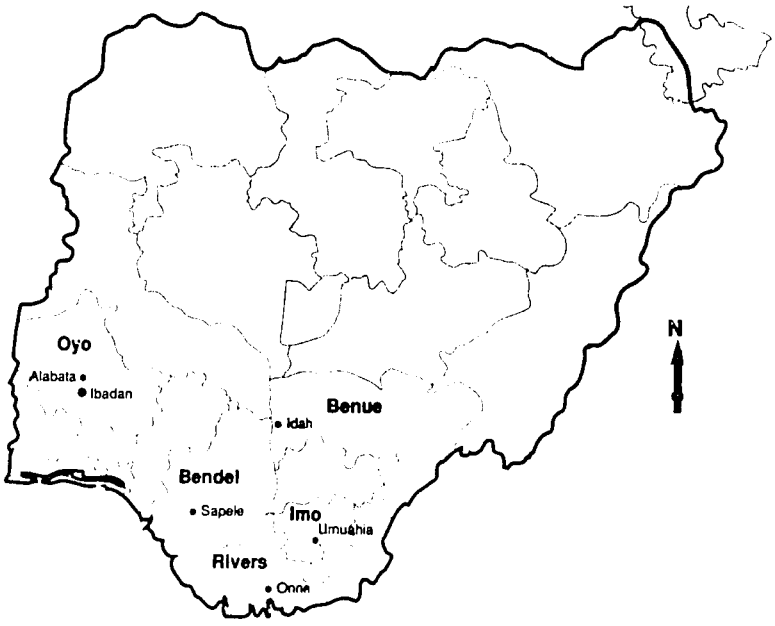

Figure 1. Locations in Nigeria where trials were carried out.

Results

1985 Trials

There were marked differences in the incidence and severity of stem borer attack among locations in 1985 (Figs. 2 and 3). The peak of oviposition by *S. calamistis* occurred slightly earlier in Umuahia than in Onne. Four weeks after planting, the percentage of plants with borer damage (Fig. 2) and the number of larvae per 25 plants were higher at Umuahia. Infestations at Sapele and Idah started later, and 4 weeks after planting the percentage of plants with borer damage here was lower than at the other two locations. Infestation increased sharply at Onne, with over 80% of the plants showing borer damage 6 weeks after planting, compared to 50% at Umuahia, 22% at Sapele, and 11% at Idah (Fig. 2). *S. calamistis* was the dominant species in all locations up to 8 weeks after planting. *E. saccharina* was first found at Onne at this time, and by the end of the season it was the most abundant species at all locations except Umuahia, where *S. calamistis* comprised over 50% of the larvae found (Fig. 3).

By harvest time, almost 100% of the plants sampled at all locations had some borer damage (Fig. 2). Numbers of larvae were higher at Sapele and Onne (up to five larvae per plant) than at Idah or Umuahia (up to two larvae per plant). The mean number of larvae per plant was greatest on hybrid 8341-6 (Fig. 3). The distribution of *E. saccharina* larvae within the plants was similar at all locations, with the majority of larvae found in the stems (Table 1). At Sapele and Umuahia, the majority of *S. calamistis* occurred in the stem; at Idah, however, most of the larvae were found in the ears. *B. fusca* was found only at Idah, where it constituted 2% of the population 11 weeks after planting. *Cryptophlebia* sp. (Lepidoptera: Olethreutidae) was found at Onne, Idah, and Umuahia, while *Coniesta* (=*Acigona*) *ignefusalis* (Hampson) (Lepidoptera: Pyralidae) was found at all locations. These two species constituted a relatively minor proportion of the borer population (Fig. 3).

At Sapele and Onne, all the ears showed damage. The mean number of larvae per ear was highest at Sapele (up to four larvae per ear) and lowest at Idah and Umuahia (up to one per ear); *E. saccharina* was the predominant borer in the ears at all locations except Umuahia (Table 2). *M. nigrivenella*, a preharvest pest of maize, which infests the ears and continues developing in storage (Moyal 1988), was found at all locations. It was especially abundant in Sapele, but at this location it was present only in hybrid 8341-6 (Fig. 3).

1986 Trials

The percentage of plants with borer damage was higher at Alabata than at IITA, Ibadan, at 3 and 5 weeks after planting but from 7 weeks after planting onward the percentage of maize plants with borer damage was lower at Alabata (Fig. 4). By harvest time, borer damage was observed on 80% of the plants sampled at Alabata, and on 92% at Ibadan (Fig. 4). The infestation with *S. calamistis* began earlier and

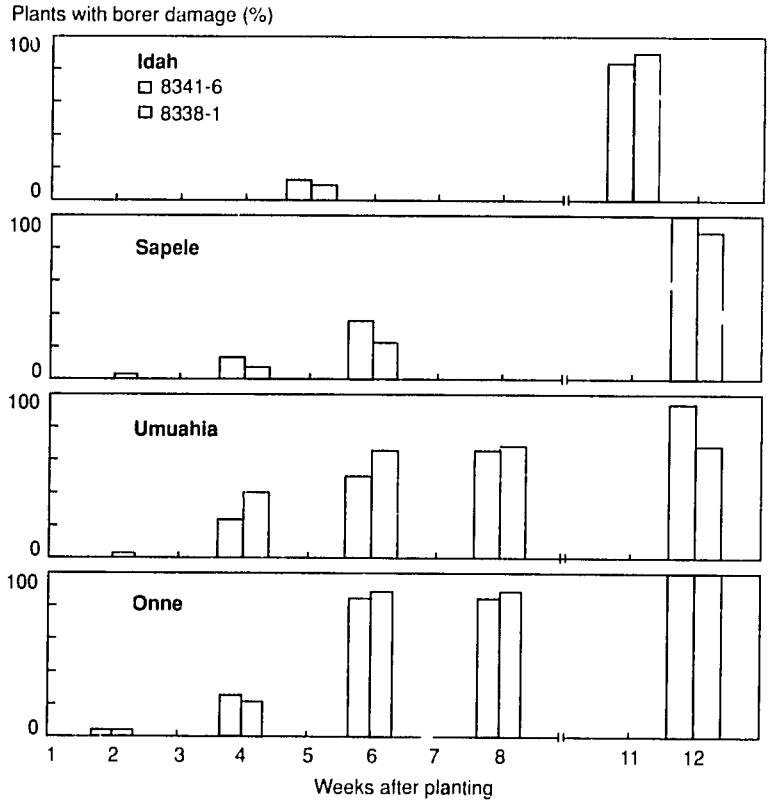

Figure 2. Percentage of plants of two maize hybrids with borer damage at four locations in southeastern Nigeria, 1985.

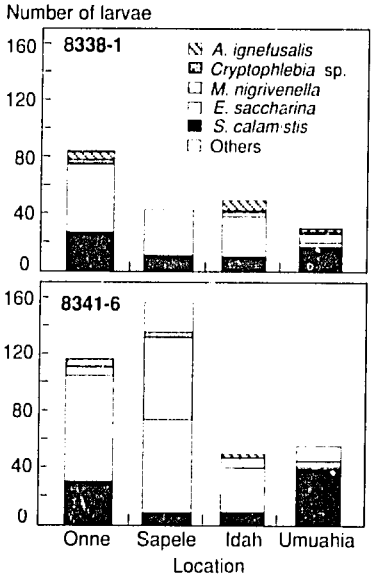

Figure 3. Species and number of lepidopterous larvae per 25 plants in two maize hybrids sampled 12 weeks after planting, southeastern Nigeria, 1985.

was higher at Alabata than at IITA, Ibadan, but later in the season the incidence of this insect was similar at both locations (Fig. 5). From 9 weeks after planting onward, the mean number of borer larvae per plant was higher at IITA, Ibadan than at Alabata.

E. saccharina was first detected in both locations 9 weeks after planting, but the incidence of this pest was always higher at IITA, Ibadan. As in 1985, the majority of *E. saccharina* larvae were found in the stems (Table 3). Up to six *E. saccharina* larvae per plant were found 11 weeks after planting at IITA, Ibadan, the highest number found at any location in 1985 or 1986. *E. saccharina* was the predominant ear borer at Alabata from 11 weeks after planting onward, while *M. nigrivenella* was most abundant at IITA, Ibadan (Table 4). At IITA, Ibadan, 44% of the ears were found to be infested with *M. nigrivenella* eggs or larvae 15 weeks after planting; 84% of the eggs were found attached to the silks.

Discussion

Kaufmann (IITA 1981) described *S. calamistis* as 'a moist-area oriented species' dominant in southeastern Nigeria, in contrast to *E. saccharina* referred to as 'a dry area oriented species' dominant in the western part of the country, and observed that this was a "definite pattern in the distribution of stem borers of maize". Our findings did not confirm this alleged distribution pattern. Kauffman's report was based on samplings in only one location in eastern Nigeria (Umuahia or Umudike). A more detailed sampling regime, which included several locations in southeastern Nigeria, demonstrated the importance of *E. saccharina*; this species was the dominant maize borer at the time of harvest at all sites we sampled in 1985 except Umuahia (Table 2). The reasons for the virtual absence of *E. saccharina* from Umuahia (IITA

Table 1. Distribution of *Sesamia calamistis* and *Eldana saccharina* larvae in the plant and percentage of ears with larvae in two maize hybrids in southeastern Nigeria, 1985.

Location[1] and hybrid	Percentage of larvae in stem		Percentage of larvae in ears		Percentage of ears with larvae	
	S. calam.	*E. sacch.*	*S. calam.*	*E. sacch.*	*S. calam.*	*E. sacch.*
Sapele						
8338-1	80	77	20	23	10	20
8341-6	40	50	60	50	16	52
Onne						
8338-1	40	64	60	36	60	90
8341-6	72	84	28	16	67	89
Idah						
8338-1	14	76	86	24	22	30
8341-6	43	57	57	43	19	41
Umuahia						
8338-1	61	80	39	20	22	2
8431-6	69	100	31	0	44	0

1. Sampling 12 weeks after planting, except at Idah (11 weeks).

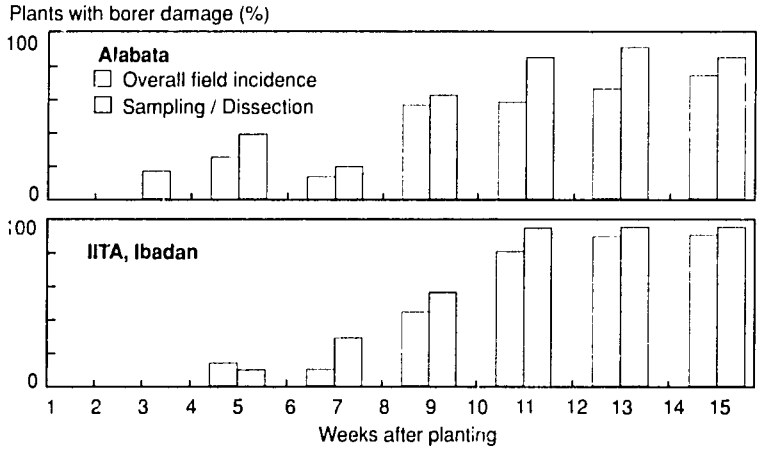

Figure 4. Percentage of maize plants with borer damage at two locations in southwestern Nigeria, 1986.

Table 2. Mean number of larvae per ear and borer species composition in two maize hybrids in southeastern Nigeria, 1985.

Location and hybrid[1]	Mean no. larvae/ear	Species composition (%)				
		E. sacch.	*S. calam.*	*M. nigrivenella*	*Cryptophlebia* sp.	Others[2]
Sapele						
8338-1	0.5	70	30	0	0	0
8341-6	3.9	27	8	64	0	1
Onne						
8338-1	3.1	48	39	0	7	6
8341-6	2.8	40	28	16	16	0
Idah						
8338-1	0.9	46	25	21	8	0
8341-6	1.2	55	24	18	0	3
Umuahia						
8338-1	0.8	4	44	37	15	0
8341-6	1.0	0	53	3	10	34[3]

1. Sampling 12 weeks after planting, except at Idah (11 weeks).
2. Includes *Acigona ignefusalis* and *Busseola fusca*.
3. Some larvae dead at time of examination, identification not certain.

Table 3. Distribution of *E. saccharina* and *S. calamistis* larvae in maize plants, and percentage of ears with larvae in two locations in southwestern Nigeria, 1986.

Location[1] and hybrid	Percentage of larvae in stem		Percentage of larvae in ears		Percentage of ears with larvae	
	S. calam.	*E. sacch.*	*S. calam.*	*E. sacch.*	*S.calam.*	*E. sacch.*
9 WAP[1]						
IITA, Ibadan	66	94	33	6	8	12
Alabata	50	50	50	50	10	10
11 WAP						
IITA, Ibadan	14	79	86	21	20	52
Alabata	50	77	50	23	8	16
13 WAP						
IITA, Ibadan	80	74	20	26	8	24
Alabata	50	38	50	62	4	32
15 WAP						
IITA, Ibadan	0	97	100	3	4	4
Alabata	100	70	0	30	0	16

1. WAP = Weeks after planting.

1985) are not clear (Table 2). Absence of alternate hosts and/or microclimatic differences might be responsible; this aspect deserves further investigation.

At IITA, Whitney (1970) found larvae of *B. fusca* to comprise 45% of the larval population in the stems of maize plants at the end of the first planting season, while *E. saccharina* comprised 14% and *Sesamia* spp. 8%. Usua (1968b) carried out samplings in November-December 1964 and found *B. fusca* to be the predominant pest of maize in the rainforest of southwestern Nigeria. At Ibadan, he found *B. fusca* to be the most abundant borer of maize from September to November 1964 and in September of 1965 (Usua 1968*b*). This is in marked contrast with our findings since we observed *S. calamistis* and *E. saccharina* to be the predominant maize borers at both Ibadan (in September) and Alabata (in November). In our samplings, *E. saccharina* was especially abundant at IITA, Ibadan with up to six larvae per plant at the end of the growing season. The use of minimum tillage and growing three crops of maize per year might help explain the high incidence of this insect at IITA, Ibadan. *E. saccharina* is known to survive well in maize stubble (Adeyemi 1969). The abundance of E. *saccharina* at IITA had previously been reported (IITA 1980). We did not find *B. fusca* at IITA, Ibadan, while at

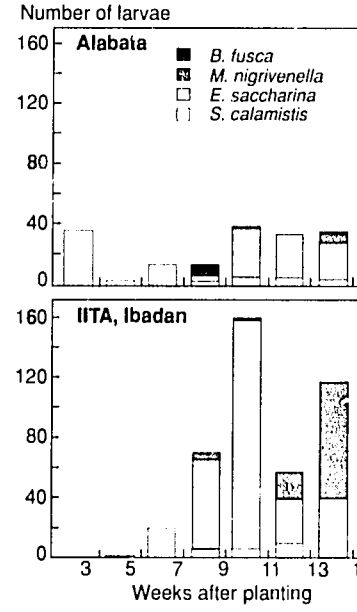

Figure 5. Species and number of lepidopterous larvae per 25 maize plants at two locations in southwestern Nigeria, 1986.

Table 4. Mean number of borers per ear and species composition in maize planted in two locations in southwestern Nigeria, 1986.

Sampling date and location	Mean no. larvae/ear	Species composition (%)		
		E. saccharina	*S. calamistis*	*M. nigrivenella*
9 WAP[1]				
IITA, Ibadan	0.5	25	17	58
Alabata[2]	0.3	28.6	28.6	28.6
11 WAP				
IITA, Ibadan[3]	1.6	78	15	5
Alabata	0.4	56	33	11
13 WAP				
IITA, Ibadan	1.0	32	8	60
Alabata	0.8	85	15	0
15 WAP				
IITA, Ibadan	3.0	1	1	98
Alabata	0.5	62	0	38

1. WAP = Weeks after planting.
2. *Busseola fusca* constituted 14% of larvae found.
3. *Cryptophlebia* sp. constituted 2% of larvae found.

Alabata this insect was found only at 9 and 11 weeks after planting and even then it constituted only 29 and 3% of the borer population, respectively. Harris (1962) reported *S. calamistis* to be abundant at Ibadan and indicated *E. saccharina* might occasionally be the most common stem borer of maize at the end of the growing season. In Ghana, Leyenaar and Hunter (1977) reported *Sesamia* spp. and *E. saccharina* as the most damaging pests of maize in the forest zone, and *B. fusca* as the most abundant borer in the savanna zone. Similar distribution of borers has been reported by Cochereau (1985) in Côte d' Ivoire.

The two methods used to assess the percentage of maize plants with borer damage in 1986 were compared. In general, plant dissection permitted the detection of stem borer damage in a larger number of samples than counting the number of plants with external signs of damage (Fig. 4). At Ibadan, the difference in the number of damaged plants detected by each method was more marked early in the season (Fig. 4). This is probably because stem borers like *S. calamistis* (the predominant species early in the season in our studies) might be damaging plants without leaving external signs of damage. Later in the season, the percentage of plants with borer damage detected is very similar using either method. This is probably because at that time *E. saccharina* is the most abundant stem borer and its presence is easy to detect by the frass hanging from the adult exit holes in the stem. The results obtained with either method would be affected by, among other factors, the time of assessment during the growing season and the predominant stem borer at the time. Sampling entire plants has the disadvantage of being a destructive and more labor intensive method.

In 1985, *M. nigrivenella* was most abundant at Sapele, particularly on hybrid 8341-6. The female moths of this pest lay eggs on the silks of the maize ear (Moyal 1988). The large number of *M. nigrivenella* on hybrid 8341-6 might have been due to preference for this hybrid or to a sharp and short-duration oviposition peak of this insect, coinciding with the silking period of the hybrid. This hybrid is earlier than 8338-1. The infestation of *M. nigrivenella* at Ibadan in 1986 (44% of the ears) was similar to a 40% infestation observed at Sapele the previous year. Whitney (1970) found this insect to comprise 51% of the insect population in maize ears at the end of the first planting season at IITA, Ibadan. The large difference in the number of *M. nigrivenella* eggs we found at Ibadan 9 weeks after planting (1.8/ear) and the number of larvae found 11 weeks after planting (0.1/ear) suggests heavy mortality or migration. Similar observations have been made by Moyal (1988). Eggs and young larvae on the silks are exposed to predators and rainfall. *M. nigrivenella* was found at all locations, and it was observed to cause extensive damage to the ears of maize. Little is known about the bionomics of *M. nigrivenella* in Nigeria; this aspect deserves further attention. Recently, Moyal (1988) has completed a thorough study of this pest in Côte d' Ivoire.

The studies reported here confirmed the importance of stem borers in southern Nigeria and prompted further investigations on the impact of some of these insects on the yield of maize. The results of these latter investigations are reported elsewhere (Bosque Pérez and Mareck, in press). There is a need to develop control practices for the major maize stem borers in West Africa. IITA has been involved in developing sources of resistance to *S. calamistis* and *E. saccharina* (Bosque-Pérez et al. 1989); we believe resistance could be combined with other control practices to reduce the economic losses experienced by maize farmers.

References

Adeyemi, S. A. O. 1969. The survival of stem borer population in maize stubble. Bulletin of the Entomological Society of Nigeria 2: 16-22

Adeyemi, S. A. O., J. Donelly, and J. A. Odetoyinbo. 1966. Studies on chemical control of stem borers of maize. Nigerian Agricultural Journal 3: 61-66.

Appert, J. 1970. Insects harmful to maize in Africa and Madagascar. Madagascar Institute of Agronomic Research, Madagascar. 71 pp.

Bosque-Pérez, N.A., and J.H. Mareck. In press. Effect of the stem borer *Eldana saccharina* (Lepidoptera: Pyralidae) on the yield of maize. Bulletin of Entomological Research 81:—

Bosque-Pérez, N. A., J.H. Mareck, Z. T. Dabrowski, L. Everett, S. K. Kim, and Y. Efron. 1989. Screening and breeding maize for resistance to *Sesamia calamistis* and *Eldana saccharina*. Pages 163-169 *in* Toward insect resistance maize for the third world: Proceedings of the International Symposium on Methodologies for Developing Host Plant Resistace to Maize Insects. CIMMYT. Mexico, D. F. 327 pp.

Bowden, J. 1954. The stem-borer problem in tropical cereal crops. Pages 104-107 in Report, 6th Commonwealth Entomological Conference. Commonwealth Institute of Entomology, London.

Brenière, J. 1971. Les problèmes des lépidoptères foreurs des graminées en Afrique de l'Ouest. Annales de Zoologie Ecologie Animale 3: 287-296.

Brenière, J. 1976. Reconnaisance des principaux lépidoptères du riz de l'Afrique de l'Ouest. Agronomie Tropicale 31: 213-231.

Cochereau, P. 1985. Ecologie des populations, en Côte d'Ivoire, du foreur africain de la canne à sucre et du maïs *Eldana saccharina* Walker. Institut des Savanes-ORSTOM, Côte d'Ivoire. 99 pp.

Girling, D.J. 1978. The distribution and biology of *Eldana saccharina* Walker (Lepidoptera: Pyralidae) and its relationship to other stem borers in Uganda. Bulletin of Entomogical Research 68: 471-488.

Girling, D. J. 1980. *Eldana saccharina* as a crop pest in Ghana. Tropical Pest Management 26: 152-156.

Harris K. M. 1962. Lepidopterous stem borers of cereals in Nigeria. Bulletin of Entomological Research 53: 139-171.

IITA (International Institute of Tropical Agriculture). 1976. Cereal Improvement Program. In-house report for 1975. IITA, Ibadan, Nigeria. 116 pp.

IITA (International Institute of Tropical Agriculture). 1980. Annual report for 1979. IITA, Ibadan, Nigeria. 152 pp.

IITA (International Institute of Tropical Agriculture). 1981. Research highlights for 1980. IITA, Ibadan, Nigeria. 64 pp.

IITA (International Institute of Tropical Agriculture). 1985. Annual report for 1984. IITA, Ibadan, Nigeria. 238 pp.

Leyenaar, P., and R. B. Hunter. 1977. Effect of stem borer damage on maize yield in the coastal savanna zone of Ghana. Ghana Journal of Agricultural Science 10: 67-70.

Moyal, P. 1988. Les foreurs du maïs en zone des savanes de Côte d'Ivoire. Collection Etudes et Theses, ORSTOM, Institut Français de Recherche Scientifique pour le Développement en Coopération, Paris. 367 pp.

Staeubli, A. 1977. Contribution à l'étude de *Cryptophlebia leucotreta* (Meyrick) particulièrement au Bénin. Coton et Fibres Tropicales 32: 325-349.

Tams, W. H. T., and J. Bowden. 1952. A revision of the African species of *Sesamia* Guenée and related genera (Agrotidae: Lepidoptera). Bulletin of Entomological Research 43: 645-678.

Usua, E. J. 1968a. Effect of varying populations of *Busseola fusca* larvae on the growth and yield of maize. Journal of Economic Entomology 61: 375-376.

Usua E. J. 1968b. The biology and ecology of *Busseola fusca* and *Sesamia* species in south-western Nigeria. I. Distribution and population studies. Journal of Economic Entomology 61: 830-833.

Whitney, W. K. 1970. Observations on maize insects at the International Institute of Tropical Agriculture (IITA), Ibadan. Bulletin of the Entomological Society of Nigeria 2: 146-155.