

Role of Wild Habitat in the Invasion of Cereal Crops by Stemborers in Africa with Special Reference to *Chilo partellus* and *Busseola fusca*

Donor: Gatsby Charitable Foundation, UK

Collaborators: Rothamsted Experimental Station, UK; Kenya Agricultural Research Institute (KARI)

Background

ICIPE and the Rothamsted Experimental Station (RES) in the United Kingdom are collaborating on this 4-year project initiated in March 1994. In view of the crucial importance of the cereal stemborers in reducing yields of maize and sorghum in Africa, ICIPE and RES scientists are undertaking in-depth studies on the dynamic relationship between the population of stemborers and their natural enemies on wild hosts and cultivated crops.

The general objective of the project is to study the multiple interactions among cultivated crops, wild hosts plants, various stemborer species, and natural enemies affecting the dynamics of pest populations, and to use this information in development of a sustainable integrated pest management approach. Some wild hosts act as trap plants, whereas others are reservoirs for pests; the latter are responsible for higher infestations on cultivated plants. By learning as to what accounts for the differences in pest dynamics between natural wild systems and agroecosystems, one can learn much about the underlying ecological processes that create the observed patterns of distribution and abundance of stemborers in nature, and about those allelochemicals that protect the wild plants from herbivory. The plant breeders and entomologists can use such information in developing resistant/tolerant crop varieties. The project aims to identify wild grasses of economic importance to farmers, which could serve as 'trap crops' for stemborers, as well as reservoirs and shelter for borer natural enemies.

The project is carried out in three different ecologies in Kenya: the coast, the lake shore, and the high altitude regions in the west of the country. The RES is collaborating with the ICIPE in the fields of insect genetics, plant chemistry, and insect movement. ICIPE scientists are collaborating closely with agronomists and entomologists from the Kenya Agricultural Research Institute (KARI) conducting field trials and identification of wild hosts. This project and the Wageningen Agricultural University (WAO) Project at ICIPE are collaborating in the field of identification of natural enemies and conducting field trials on stemborer colonisation processes. Recommendations for stemborer management and other techniques arising from this project will be distributed widely through KARI.

In 1995 we will assess if preserving wild grass biodiversity would be an effective means of habitat manipulation for stemborer control by using them as 'trap plants' and through enhancing the impact of natural enemies.

1. SELECT AREAS OF WILD HABITAT FAVOURABLE AND UNFAVOURABLE TO STEMBORERS, AND STUDY DISTRIBUTION PATTERN OF STEMBORERS

RELATIVE TO DISTRIBUTION OF WILD HOSTS

Participating scientists: Z. R. Khan*, K. A. Nyarko
(*Project Coordinator)

Assisted by: P. Chiliswa, G. Asino, N. Mwelesa

Work in progress

Based on destructive sampling, field sites were selected in three different ecologies—hot and humid (Kenya coast, up to 1080 m elevation), warm and semi-arid (lakeshore area, about 4300 m altitude), and high altitude, wet and cool area (Trans Nzoia district, more than 6500 m altitude). From each ecological zone, eight different locations, based on pest abundance, cropping pattern, and abundance of different grass species, were selected. Extensive surveys were undertaken four times during the year. Several wild host plants of various stemborer species (*Chilo partellus*, *Busseola fusca*, *Sesamia inferens* and *Eldana saccharina*) were recorded (Table 1). Seasonal changes in larval density on cultivated and wild host plants were also recorded. Studies on population dynamics of stemborers on cultivated versus wild host plants are underway.

Future activities

Chilo partellus and *Busseola fusca* pheromones will be used in collaboration with KARI to study the relative abundance of these insects and to confirm the relevance of the sites selected by destructive sampling. Destructive sampling will be continued at six-week intervals to study population dynamics of stemborers on wild and cultivated host plants.

2. STEMBORER ABUNDANCE AND DISTRIBUTION ON CULTIVATED AND WILD HOST PLANTS, AND THEIR MOVEMENT BETWEEN TWO HABITATS

Participating scientists: Z. R. Khan, W. A. Overholt

Assisted by: P. Chiliswa, G. Asino, N. Mwelesa,
J. Randriamananoro[?] (ARPPIS PhD student)

Collaborators: W. Powell, I. Woiwod, L. Smart (Rothamsted Experimental Station),
J. Wandera, M. Mulla (KARI, Kitale)

Work in progress

During the short rainy season of 1994, a 6 x 6 field trial was established at Mbita Point Field Station incorporating cultivated and selected wild host species to study colonisation processes of stemborers on various plants. They included a susceptible maize (INB-A), a susceptible sorghum (IS 18363), *Hyparrhenia rufa*, *Panicum maximum*, *Pennisetum purpureum* and *Sorghum versicolor*. Each plant species was replicated six times in plots of 6 x 6 m. The study revealed interesting aspects of multiple interactions among cultivated plants, wild hosts, various stemborer species, and their natural enemies. Oviposition by *C. partellus* was maximum on cultivated sorghum, followed by wild sorghum (*S. versicolor*) and maize (Figure 1). *Hyparrhenia rufa*, *P. maximum* and *P. purpureum* were the least preferred hosts for oviposition. On maize, oviposition was maximum on 5-week-old plants, whereas on

sorghum and wild sorghum, oviposition increased with the age of plants, because of new tillers. Sorghum and wild sorghum were the most suitable hosts for stemborer development, whereas *Hyparrhenia rufa*, *P. maximum* and *P. purpureum* were least suitable. *Hyparrhenia rufa* was, however, a more preferred host as compared to maize or sorghum.

Studies on the behavioural and biological responses of *Busseola fusca* adults and larvae to various cultivated and wild hosts have been conducted. In both choice and no-choice tests, *S. versicolor* and *S. arundinaceum* elicited the highest rates of oviposition. In choice oviposition tests, *H. rufa* was preferred over both susceptible and resistant maize. In no-choice tests, however, *H. rufa* and *Echinochloa pyramidalis* were least effective in eliciting oviposition. The rates of larval survival, growth and development were highest on *S. versicolor* and *S. arundinaceum*. Food consumption and utilisation by third-instar *B. fusca* larvae was significantly higher on *S. versicolor* and *S. arundinaceum* as compared to *P. purpureum*, *E. pyramidalis* and *H. rufa*.

Future activities

Quantitative assessment of the influence of naturally occurring wild host plants, and agroecological factors on the dynamics of stemborers will be assessed. To further expand our knowledge on stemborer colonisation processes in different ecologies, a 6 x 6 experiment incorporating new wild hosts will be planted at KARI stations at Mtwapa and Kitale during 1995. Behavioural and physiological responses of *Chilo partellus* to selected wild hosts will be studied to assess the suitability of the grasses as hosts. Studies on the movement of stemborers between cultivated and wild host plants will be initiated in collaboration with RES at Kenya coast.

3. IDENTIFY PARASITES, PREDATORS AND PATHOGENIC MICROORGANISMS ASSOCIATED WITH STEMBORERS IN CULTIVATED AND WILD HABITATS

Participating scientists: Z. R. Khan, W. A. Overholt

Assisted by: P. Chiliswa, G. Asino

Work in progress

In collaboration with the Wageningen Agricultural University (WAU) Project at ICIPE, various parasitoids have been identified from stemborer larvae collected from wild and cultivated plants. Major among these were *Cotesia flavipes*, *Cotesia sesamiae*, *Dentichasmias busseolae*, *Euvipio rufa*, and *Pediobius fud* and wild hosts have , introduced in Kenya two years ago by WAU Project, seems to be well established on both cultivated cereals and wild grasses. Levels of stemborer parasitisation on cultivated and wild hosts is being studied.

Future activities

Collection and identification of the natural enemies from cultivated and wild hosts will continue in 1995.

4. IDENTIFY AND EVALUATE BEHAVIOUR-MODIFYING PLANT CHEMICALS FROM CULTIVATED AND WILD HOSTS AND NON-HOST PLANTS FROM STEMBORERS AND THEIR NATURAL ENEMIES

Participating scientists: W. Lwande, S. Waladde,
Z. R. Khan

Assisted by: E. Nyandat, H. M. Kahoro, L. M. Moreka,
G. Asino

Collaborators: L. Wadhams, J. Pickett (Rothamsted Experimental Station)

Work in progress

To test plant allelochemicals for eliciting oviposition by *B. fusca* gravid females, a 'surrogate stem' was designed and evaluated. The surrogate stem was made of wax paper (18.5 cm long, 17.5 cm wide) tightly rolled on a wooden rod (20 cm long, 1 cm diameter). The surrogate stem closely simulated the maize stem with intact leaf sheaths. *Busseola fusca* readily inserted their ovipositors into the gaps between the surrogate stem and leaf sheaths and laid eggs in linear rows as they did in maize plant stems. The surrogate stem provided physical stimuli necessary for eliciting *B. fusca* egg laying and has greatly facilitated bioassay of plant allelochemicals to the insect's ovipositional response.

Contact chemical stimuli, extracted from maize plants, do not seem to play a key role in influencing choice of oviposition sites by *C. partellus*. Therefore, efforts are underway to identify volatile allelochemicals from various cultivated and wild host plants. Volatile allelochemicals are being collected using the dynamic headspace collection method in the laboratory. Volatiles trapped on Porapak Q or C-18, will be analysed by GC-MS and bioassayed using combined gas chromatography-electroantennography (GC-EAG) at Rothamsted Experimental Station.

Future activities

Electrophysiologically-active compounds in the volatile samples will be located using GC-EAG. Separation of the samples will be done by AI 93 gas chromatograph and FID. Electrophysiologically active compounds in the samples will be identified by coupled GC-MS. The activity of the compounds will be confirmed by behavioural and electrophysiological bioassays.

5. EXAMINE GENETIC DIVERSITY AMONG PEST POPULATIONS FROM CULTIVATED AND WILD HOSTS

Participating scientist: Z. R. Khan

Assisted by: P. Chiliswa

Collaborators: H. Loxdale, C. Brooks (Rothamsted Experimental Station)

Work in progress

The aim of this study is to look for genetic differentiation between stemborer populations collected from cultivated and wild hosts. ICIPE and RES are closely collaborating on this activity. The cheapest, quickest and best understood technique currently available is enzyme electrophoresis and so far this method was used to do all the investigations. Deep frozen larvae, pupae and moths collected from cultivated and several wild hosts were transported to RES. The only stemborer species examined so far is *C. partellus*. Initially out of the 17 soluble enzymes and three

running buffers screened, ten enzymes stained and resolved well enough to warrant further investigation. These are EST, GOT, G6PDH, HBDH, HK, IDH, MDH, MPI, PGI and PGM.

Future activities

The preliminary results on insect genetics are encouraging. Similar studies with *B. fusca* will be initiated in 1995. More samples of *C. partellus* and *B. fusca* will be collected from different host plants and from different ecological regions. When allozyme electrophoresis work is near completion, Randomly Amplified Polymorphic DNA (RAPD) profiles from samples taken from selected hosts will be compared.

Training activities

The following ARPPIS students participated in the research project:

- Jean J. Randriamananoro, PhD student from Madagascar
- Sumaya E. R. M. Kheir, PhD student from Sudan.