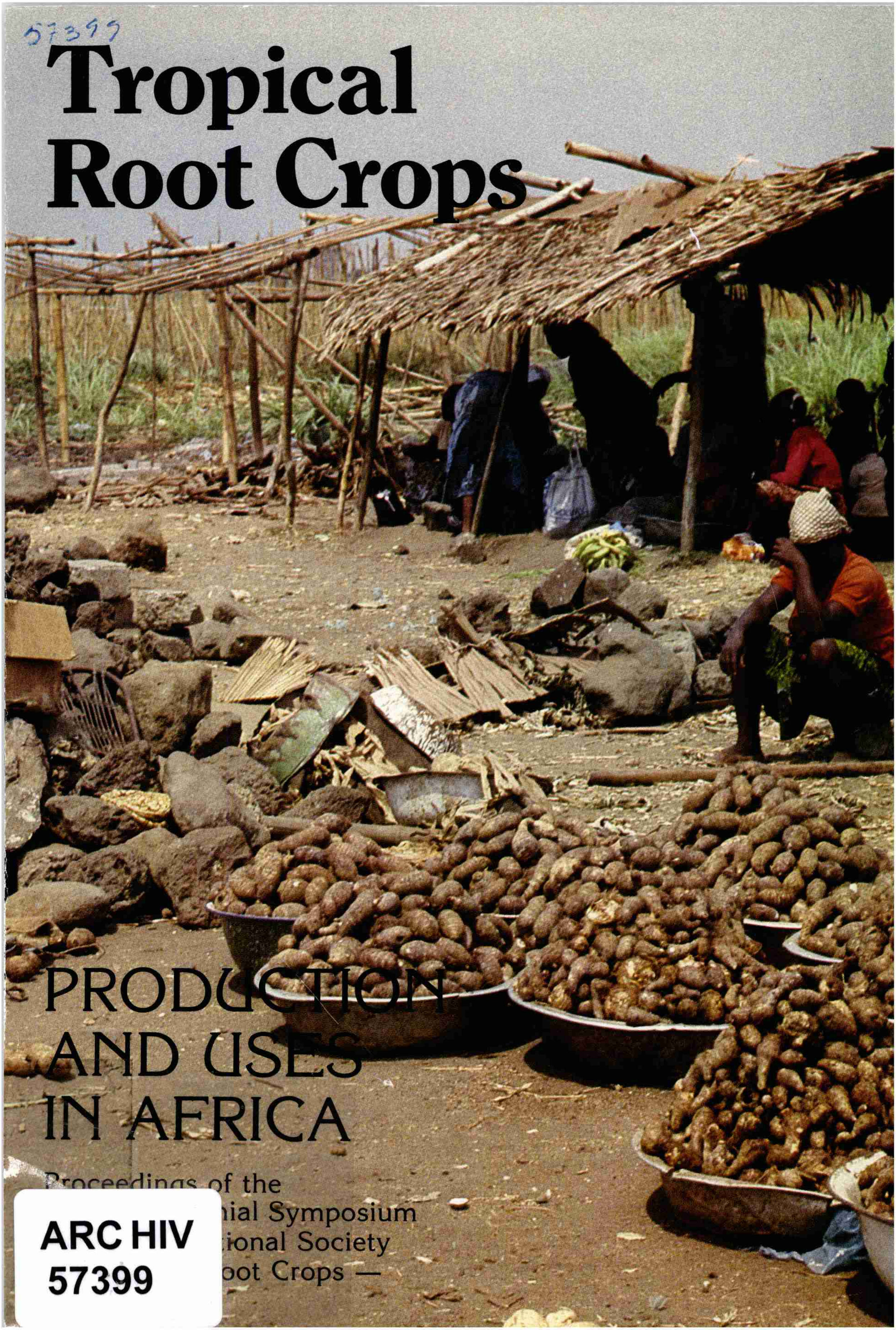
Tropical Root Crops



PRODUCTION AND USES IN AFRICA

Proceedings of the
...nial Symposium
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The International Society for Tropical Root Crops — Africa Branch was created in 1978 to stimulate research, production, and utilization of root and tuber crops in Africa and the adjacent islands. The activities include encouragement of training and extension, organization of workshops and symposia, exchange of genetic materials, and facilitation of contacts between personnel working with root and tuber crops. The Society's headquarters are at the International Institute of Tropical Agriculture in Ibadan, Nigeria, but its executive council comprises eminent root and tuber researchers from national programs throughout the continent.

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TROPICAL ROOT CROPS: PRODUCTION AND USES IN AFRICA

Abstract

A mixture of original research, updates on procedures, literature reviews, and survey reports, this document resulted from the second symposium of the International Society for Tropical Root Crops — Africa Branch, with 77 participants from 16 countries. The focus was cassava, yams, cocoyams, and sweet potatoes, from the perspectives of breeders, agronomists, soil specialists, plant pathologists, entomologists, nutritionists, food technologists, etc. Learning from past successes and failures, many of the researchers directed their efforts toward problems obstructing progress in reaching improved production and use of root crops and attempted to view, realistically, the context in which their results would be applied.

Résumé

Résultats de recherches récentes, mises à jour sur les méthodes de recherche, revues de publications et rapports de sondages sont contenus dans ce document issu du Deuxième symposium de la Société internationale pour les plantes-racines tropicales — Direction Afrique, qui a réuni 77 participants de 16 pays. Des communications sur le manioc, le taro, le yam et la patate douce ont été présentées par des phytosélectionneurs, des agronomes, des pédologues, des phytopathologistes, des entomologistes et des spécialistes de la nutrition et des aliments, entre autres. Tirant leçon de leurs succès et de leurs échecs, beaucoup de ces chercheurs ont dirigé leurs efforts vers la solution des problèmes qui entravent l'augmentation de la production et de la consommation des plantes-racines et ont tenté de considérer d'un œil réaliste le contexte qui sera celui de l'application de leurs recherches.

Resumen

Una mezcla de investigaciones originales, actualizaciones de procedimientos, reseñas de literatura e informes de encuestas, este documento es el resultado del segundo simposio de la Sociedad Internacional de Raíces Tropicales, Filial Africana, que contó con 77 participantes de 16 países. El simposio se centró en la yuca, el ñame, el cocoñame y las batatas, desde la perspectiva de los fitomejoradores, los agrónomos, los especialistas en suelos, los patólogos vegetales, los entomólogos, los nutricionistas, los tecnólogos alimenticios, etc. A partir de los éxitos y fracasos anteriores, muchos de los investigadores encaminaron sus esfuerzos hacia los problemas que obstaculizan el avance para lograr una producción y un uso mejorados de las raíces y trataron de obtener una visión realista del contexto en que los resultados pueden ser aplicados.

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TROPICAL ROOT CROPS:
PRODUCTION AND USES IN AFRICA

EDITORS: E.R. TERRY, E.V. DOKU, O.B. ARENE, AND N.M. MAHUNGU

PROCEEDINGS OF THE SECOND TRIENNIAL SYMPOSIUM OF THE INTERNATIONAL SOCIETY FOR TROPICAL ROOT CROPS — AFRICA BRANCH HELD IN DOUALA, CAMEROON, 14 – 19 AUGUST 1983

CONTENTS

Yams

Comparative Bioecology of Two Coccinellids, Predators of the Cassava Mealybug, in the Congo

G. Fabres[1] and A. Kiyindou[2]

Within the biocenosis of the cassava mealybug (*Phenacoccus manihoti*), two coccinellid species, i.e., *Exochomus flaviventris* and *Hyperaspis senegalensis hottentotta*, stand out because of their large numbers and their constant presence in the ecosystem. The biological parameters of these two predators were studied in the laboratory. The biological cycle, development time of different stages, sex ratio, as well as fertility and longevity of the females were determined. Using the data, we calculated the intrinsic rate of multiplication of each species and compared the control potential of these two local aids to pest control. In the field, population dynamics were studied along with those of the mealybug. The range of variation in population numbers in each species and the time of emergence in the field were recorded. This information allows one to define the role played by the species in regulating mealybug populations. It also should serve to direct the choice of exotic species to be introduced to supplement these insects' predatory activity.

The entomofauna associated with the cassava mealybug (*Phenacoccus manihoti*) abounds, particularly polyphagous predators during each dry season. Among these various biological control agents, the coccinellids, *Exochomus flaviventris* and *Hyperaspis senegalensis hottentotta*, drew our attention because of the consistency with which they were found in cassava fields, the sizable increase in their populations during gradation of the mealybug, and their potential impact on mealybug numbers. A comparative morphological study has already been published. The present paper deals with the bioecological parameters of these two species.

Material and Methods

Exochomus flaviventris and *H. s. hottentotta* strains were obtained from the Kombe district, 17 km from Brazzaville. The larvae were raised individually in plastic containers with screen lids for ventilation. The bottom of the containers was covered with filter paper, which was moistened regularly. The adults were reared in pairs in identical containers. Food consisted of excessive amounts of *P. manihoti* eggs in ovisacs.

The experiment was conducted simultaneously in both species at a mean temperature 26°C (range 21°–31°C) and relative humidity 70% (range 61–89%). These values correspond with conditions recorded at Kombe. The photoperiod was 12 h.

We studied duration of embryonic development, duration of development of different preimago stages, duration of female sexual maturity, sex ratio, female longevity and fertility. On the basis of these findings, we drew up life tables and calculated the intrinsic rate of multiplication for each species.

Fluctuations in the numbers of both species were recorded along with the development of gradation in *P. manihoti* during a field study conducted in 1979, which was a remarkably typical year. We followed the biological cycle of the predators in nature, compared the gradation profiles of their populations, and, adopting the same approach as in the laboratory, studied the potential of each of these organisms for controlling the phytophagous insect.

Results

A study of the development cycle in the laboratory revealed that the incubation time was virtually the same in both coccinellids (Table 1). The most marked differences in development time were recorded during the larval stages (es-

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Table 1. Pre-imago coccinellid development (in days).

Stage	*H. senegalensis hottentotta* (27)		*E. flaviventris* (25)	
	Mean	Range	Mean	Range
Egg larva	6.5	5–9	6.2	6–7
L1	3.0	2–6	4.1	4–5
L2	1.9	1–4	4.6	4–6
L3	2.0	1–3	5.7	5–7
L4	8.8	7–11	11.9	10–15
Nymph	10.6	9–12	8.3	7–11
All	33.07	31–37	40.8	36–51

Table 2. Longevity and fertility of laboratory-reared *H. s. hottentotta* and *E. flaviventris*.

	H. s. hottentotta		*E. flaviventris*	
	Mean	Range	Mean	Range
Longevity of adults (days)	172.3	129–186	112.2	80–159
Preoviposition (days)	8	3–16	15	9–21
Overall fertility (eggs/female)	289.3	9–1081	125.4	7–337
Mean daily fertility (eggs/female/day)	2.3	0–9	1.9	0.1–5.8

pecially stages L_2 and L_3). On an overall basis, pre-imago development was shorter in *H. s. hottentotta* than in *E. flaviventris* (33.07 and 40.8 days, respectively).

Egg-laying began an average 8 days after emergence of the female in *H. s. hottentotta* and after 15 days in *E. flaviventris* (Table 2). In *H. s. hottentotta*, females represented 43.5% of the total population, whereas in *E. flaviventris*, the females were 58.9%. These figures are similar to those recorded in the field, i.e., 43.6% females for *H. s. hottentotta* and 55.2% for *E. flaviventris*. These findings will be used later to calculate the reproductive capacity of each species.

Exochomus flaviventris females had a shorter lifespan than *H. s. hottentotta* females (112.2 days vs 172.3 days) and laid fewer eggs (Table 2). Life and fertility tables for both species (Fig. 1 and 2) supplement the findings by showing that, in *H. s. hottentotta*, fertility decreases very rapidly with the age of the females (Fig. 1), a trend not noted in *E. flaviventris* (Fig. 2).

On the basis of findings during rearing operations involving the larval stages and pairs, we calculated multiplication rates, taking into account development time, sex ratio, longevity, and fertility and quantified the reproductive potential of a coccinellid population. When one knows whether a female is likely to be alive at age x (lx) and how many eggs she will likely lay between age x-1 and age x (mx), then the intrinsic rate of multiplication can be calculated from the formula, rc ($\log_e$ Ro/Tc) where Ro = lxmx, the net multiplication rate; Tc = age of the female when half of her eggs have been laid; and rc = reproductive capacity.

Langhlin's parameter may be considered here a good mathematical approach that is both more complex and less clearcut in its biological significance because it is used for comparative purposes. It can be extrapolated in the field where only two or three coccinellid generations develop during the dry season.

The reproductive capacity of each species was determined. Theoretically, under the conditions of the study, *E. flaviventris* increased its population by a factor of 66.6 in a generation lasting 77 days, whereas *H.S. hottentotta*, multiplied 123.7 times in 64 days. Thus, *H. s. hottentotta*, which was able to increase its numbers quicker and more effectively than *E. flaviventris* under iden-

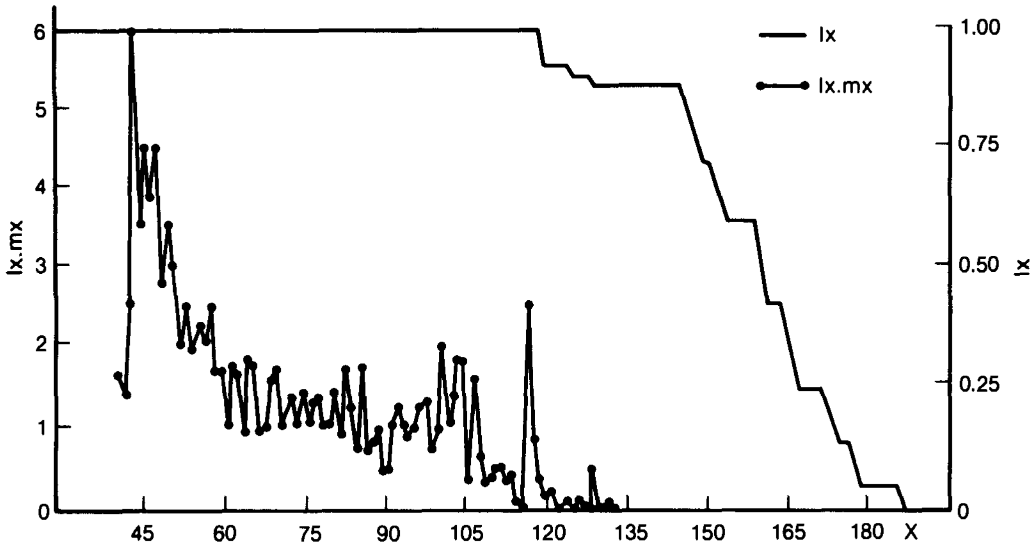

Fig. 1. *Fertility of female* H.s. hottentotta *as a function of age.*

tical conditions of development, should be found in greater numbers on *P. manihoti* colonies in cassava fields.

We conducted a field study to test this hypothesis. Chronological variations in prey numbers were studied along with fluctuations in the population densities of *E. flaviventris* and *H. s. hottentotta* in a cassava field. We counted all the developing stages of the mealybugs found on 30 stem apices picked at random, all the developing stages of both coccinellids on the colonies examined, and adults from both coccinellid species collected in limed traps. With the findings obtained, we traced the gradation profile of the bug and its two predators (Fig. 3).

The gradation profiles of the two coccinellids

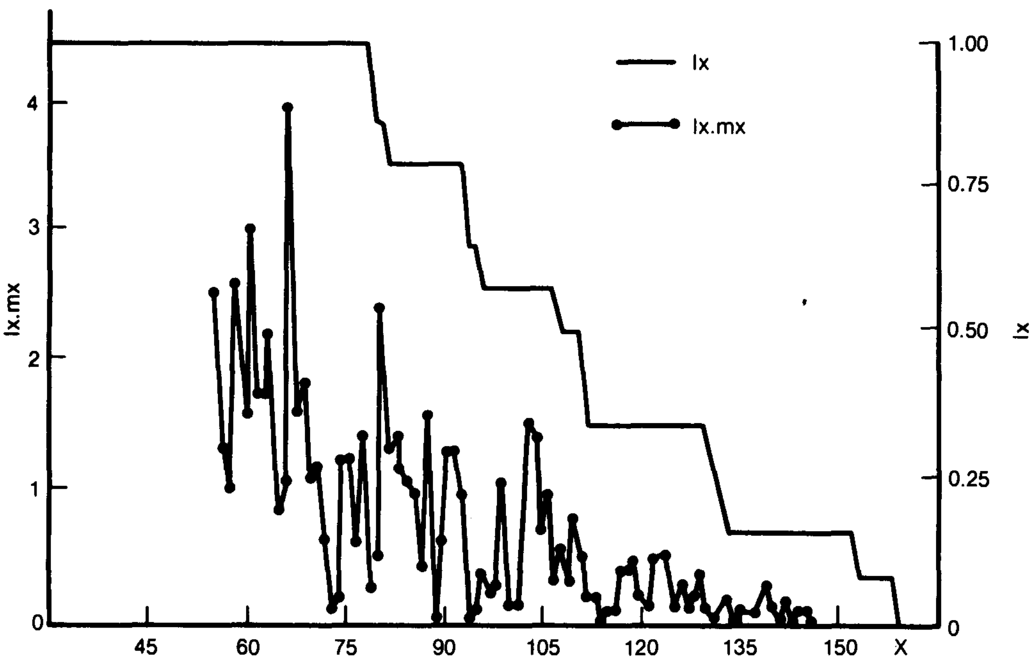

Fig. 2. *Fertility of female* E. flaviventris *as a function of age.*

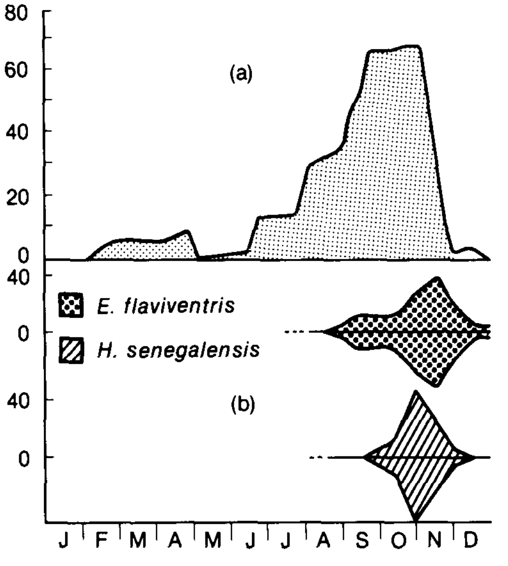

Fig. 3. *Gradation profile of (a) the cassava mealybug and (b) two of its predators.*

are a perfect illustration of laboratory breeding results: *H. s. hottentotta* increased far more rapidly and effectively than *E. flaviventris* (48 *H. s. hottentotta* individuals in the last week of October as opposed to 39 *E. flaviventris* specimens in the 3rd week of November). *Exochomus flaviventris*, however, was found more consistently in the fields. It appeared in August and remained in relatively large numbers until the end of December, whereas populations of *H. s. hottentotta* did not develop until October and November. The former can maintain its population on relatively small numbers of the phytophage and intervene early, even though its predation potential is not so great as that of *H. s. hottentotta*. The latter, unfortunately, only grows in number when the mealybug population is high and does not intervene in the early stages of gradation.

Discussion

When both coccinellid species were studied in the laboratory under identical conditions, we found that their populations differed in reproductive capacities, with *H. s. hottentotta* being a much better performer and, theoretically, equipped to control *P. manihoti* populations.

Conditions — both ecological and behavioural — in the field are far removed from the relatively simple experimental conditions created in the laboratory, and results may vary widely. In nature, *H. s. hottentotta* is abundant at the time of pullulation of the prey but emerges late and disappears early. There are several possible explanations for this phenomenon: abiotic factors, especially temperature, may not have the same effect on the two coccinellid species during the transition from the cool season (June–July) to the hot season (starting in August). *Exochomus flaviventris* females lay their eggs directly in contact with the mealybug ovisacs whereas *H. s. hottentotta* females often lay their eggs on branches that do not harbour any mealybugs. As a result, mortality among the larvae may be high while searching for prey. The presence of the pest may differ in its stimulatory effect on the species.

Autecology and ethology studies are needed if we are to determine the role these coccinellids could play as pest-control agents.

Conclusions

The plan to introduce New World predators to control the mealybug involves establishing exotic coccinellids in a new environment. Our study gives clearcut indications of characteristics that would complement local coccinellids without becoming their competitors. In our opinion, the exotic predators should be able to maintain their numbers on low-density populations of the prey, like *E. flaviventris*, but, like *H. s. hottentotta*, be able to increase their numbers rapidly and to intervene as soon as the mealybug begins to pullulate. We believe that researchers should begin systematically to screen exotic coccinellids to find organisms that are best able to meet the criteria we have just outlined.