STUDIES ON THE BIOLOGY OF TWO CONGENERIC SPECIES OF CALLOSOBRUCHUS

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Species of the genus *Callosobruchus* are very damaging pests of stored legumes. Although the two best known species are *Callosobruchus maculatus* (F.) and *Callosobruchus chinensis* (L.), other species such as *Callosobruchus rhodesianus* (Pic.) and *Callosobruchus subinnotatus* (Pic.) are restricted to South Africa and West Africa, respectively (**Prevett**, 1966) ; (**Giga** and **Smith**, 1987). These restricted *Callosobruchus* species are known to cause considerable damage in localised areas. *C. maculatus* and *C. subinnotatus* are widely distributed in the sub-sahelian and humid W. Africa where *C. maculatus* is found attacking cowpea and other pulses including bamberra groundnuts, while *C. subinnotatus* attacks bambarra groundnuts alone (**Booker**, 1967 ; **Prevett**, 1966).

Labeyrie (1981) observed that information is available on the possibilities of attack by bruchids for only a dozen out of the 89 man-consumed legume species. The possibilities of bruchids finding and establishing on new host legume species can only be demonstrated experimentally (**Jonhson**, 1990). Hitherto, the preference of legume seeds for oviposition and development by *C. maculatus*, *C. chinensis*, *Callosobruchus anali* (F.) and *C. rhodesianus* have been explored (**Arora** and **Singh**, 1971 ; **Howe** and **Currie**, 1964 ; **Giga** and **Smith**, 1987). The present work investigated the preference of seeds of legume types by *C. maculatus* and *C. subinnotatus* for oviposition and development. Also the interactions between the two bruchids were studied.

MATERIALS AND METHODS

The four legume types investigated for suitability as hosts of the bruchids are bambarra groundnut (*Voandzeia subterranea* L. Thouars), Cowpea (*Vigna unguiculata* L. Walp.), Soyabean (*Glycine max.* L. Merr.) and African yambean (*Sphenotylis stenocarpa* (hochst. ex. A. Rich) Harms.

The bruchids came from cultures maintained separately in cooled incubators at 30°C and 70 % r.h. *C. maculatus* was reared on Ife brown cowpea variety while *C. subinnotatus* was reared on TVSU 9 bambarra nuts variety.

Oviposition studies :

Oviposition studies were carried out at choice and non-choice conditions. The choice condition involved adding 3 pairs of newly-emerged and mated adults to a Petri dish containing 20 seeds of each of the legume types. This was replicated seven times for each of the bruchids. The number of eggs on the seeds were counted after 24 h.

Egg deposition at the non-choice condition was observed at 30°C, 70 % r.h. in cooled incubators with 12 h illumination. Thirty plastic tubes of dimensions 2,5x 7,5 cm were set up with 3 g quantity of seeds for each legume type. These tubes were divided into two batches. A female and two males (0 - 24 h old) of *C. maculatus* were placed in each of the 15 tubes of the first batch while *C. subinnotatus* in the same sex ratio as for *C. maculatus* were added into each of the remaining 15 tubes. These tubes were covered with muslin held firmly over the top of the tubes with rubber bands. The seeds were checked for eggs every 24 h and were replaced with fresh seeds since it is known that egg laden seeds inhibit oviposition in bruchids (**Messina** and **Renwick**, 1985). Observation was continued until the female bruchids died.

Developmental studies :

The seeds that had been previously infested were used for this study and were sterilized by heating them in an oven at 60°C for 4 h. These seeds were conditioned at 30°C, 70 % r.h. for 2 weeks before being placed in 250 ml jars where they were exposed to 20 pairs of the bruchids for 24 h. Seeds of each legume type were treated separately. Seeds that had 5 eggs were selected and used for the study. These seeds were placed 5 in each tube and 20 tubes were set up for each legume type and for each of the bruchids. The tops of specimen tubes were covered with muslin secured with rubber bands. The tubes were arranged in desiccators and placed in incubators maintained at 30°C, 70 % r.h. Observations for adult emergence started 2 weeks after setting up the experiment. The emerged adults had their sexes determined and weights obtained. The emergent dates and total number of F_1 adults were also noted. The observation of adult emergence was terminated 2 weeks after the first adult emerged. The data arising from the developement and oviposition experiments were analysed using double Analysis of variance and Duncan's multiple range test.

Effect of interaction between C. maculatus and C. subinnotatus on their populations :

De-infested bambarra groundnuts were conditioned at 30°C, 70% r.h. for 2 weeks. 100 g quantities were later weighed into twenty-one 500 ml jars. Newly-emerged adult bruchids (0-24 h old) were added into the jars as described below :

thirty pairs of *C. maculatus* were added into each of seven jars : thirty pairs of *C. subinnotatus* were added to another 7 jars while the remaining jars were added 30 pairs of *C. maculatus* and 30 pairs of *C. subinnotatus*. These jars were kept in incubators maintained at 30°C, 70 % r.h. and the number of the adults were checked every 30 days until the populations crashed.

Cross effectiveness of *C. maculatus* oviposition marker for *C. subinnotatus* and vice-versa :

To determine if the oviposition markers of *C. maculatus* and *C. subinnotatus* are effective for each other, seeds of bambarra groundnuts of the variety TVSU 9 were put in two 500 ml jars and the seeds in one jar were exposed to the females of *C. maculatus* while those of the other jar were exposed to females of *C. subinnotatus* for 16 h. The seeds were later segregated by egg loads and those bearing 3 eggs per seed were distributed in twenty's into 6 Petri dishes for each of the bruchids. Twenty seeds without eggs were added to each of the Petri dishes and 6 newly emerged and mated females (0 - 24 h old) of *C. maculatus* were added to each of the plates containing the seeds bearing the eggs of *C. subinnotatus* while 6 females of *C. subinnotatus* were added to each of the dishes containing seeds that bore eggs of the *C. maculatus*. The adults were allowed to remain for 24 h in the dishes and the eggs added to seeds were noted and data arising from the study was analysed using Wilcoxon's signed ranks test.

RESULTS AND DISCUSSION

Oviposition experiment :

When the females of *C. maculatus* were offered and restricted to seeds of particular lagume types, the mean total number eggs laid per female ranged between 58,8 eggs on cowpea and 70,8 on soyabean (figure 1). Also at a similar condition *C. subinnotatus* laid between 72,0 eggs on the yambean and 94 eggs on bambarra seeds (figure 1). The number of eggs laid on these seeds at the non-choice condition were not significantly different. However, when the seeds of the various legumes were mixed and these offered to the bruchids, the females of the two bruchids preferred bambarra and cowpea seeds for oviposition. At the choice condition more eggs were deposited on the plump bambarra seeds than on the other seeds ($P < 0,05$) while the least number of eggs were deposited on the small soyabean seeds. It would appear that at choice condition, seed type, colour and size affect the choice of the seeds as substrates for oviposition (**Nwanze** and **Horber**, 1976 ; **Gokhale** and **Srivastava**, 1975), but at the non-choice condition several other factors could be responsible for oviposition (**El Sawaf**, 1956 ; **Giga** and **Smith**, 1987). *C. subinnotatus* was found to be more fecund than *C. maculatus*. Giga and Smith (1987) also found *C. maculatus* to be more fecund than *C. rohedsianus*.

Adult emergence and development from egg to adult : the two species differed significantly in the number that completed development on different legumes ($P < 0,05$, table 1). *C. maculatus* developed fastest and more F_1 adults emerged on cowpea than on the other legumes ($P < 0,05$), while *C. subinnotatus* developed fastest on bambarra than on the other legumes. The lowest number of *C. maculatus* completed development on soyabean while the least number of *C. subinnotatus* completed development on the yambean. **Giga** and **Smith** (1987) found that *C. maculatus* did better on cowpea than on soyabean. It would appear that the bruchids prefers their natural hosts to the other legumes for

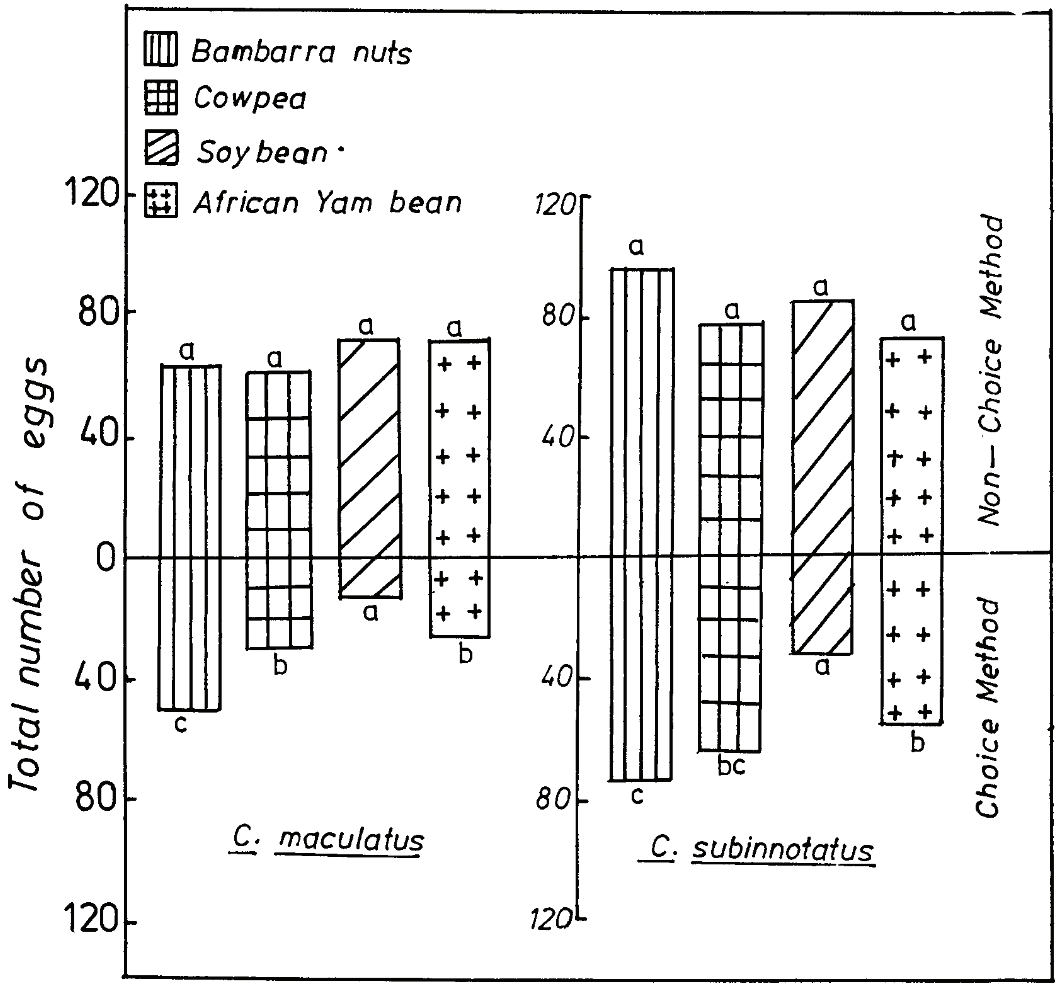

Fig. 1. Egg de-position on seed of four legume types by C. maculatus and C. subinnotatus. Bars having different letters are significantly different $p < 0.05$) Analysis was done with DMRT.

Table 1 : Data for number of F_1 adults per seed and development periods of the bruchids on the seeds of the legume types

LEGUMES		BAMBARRA	COWPEA	YAMBEAN	SOYBEAN
F_1 adults	*C. maculatus*	$2,9 \pm 0,3^{c}$	$4,3 \pm 0,5^{d}$	$1,7 \pm 0,2^{ab}$	$0,8 \pm 0,2^{a}$
Per seed		C		a	ab
Mean ± S.E	*C. subinnotatus*	$4,0 \pm 0,2$	$2,6^{b}$ - 0,3	$0,8 \pm 0,2$	$1,7 \pm 0,3$
Developmental					
	C. maculatus	$29,3 \pm 1,9^{a}$	$26,4 \pm 0,4^{a}$	$39,4 \pm 1,7^{b}$	$51,2 \pm 2,1^{c}$
period (days)	*C. subinnotatus*	$28,2 \pm 0,2^{a}$	$26,9 \pm 0,5^{a}$	$49,6 \pm 1,2^{b}$	$47,6 \pm 0,9^{b}$

Values having different superscripts are significantly different ($P < 0,05$)

Analysis done with DMRT. S.E of treatment mean = 0,464.

Table 2 : Mean weights (mg) of adult bruchids emerging from the seeds of the legume types

LEGUME TYPE		BAMBARRA GROUNDNUT	COWPEA	AFRICAN YAMBEAN	SOYBEAN
Wt. of females (Mean ± S.E)	*C. maculatus*	$4,6 \pm 0,1^{b}$	$4,1 \pm 0,07^{ab}$	$4,3 \pm 04^{ab}$	$3,7 \pm 0,05^{a}$
	C. Subinnotatus	$12,6 \pm 0,1^{bc}$	$13,4 \pm 0,2^{c}$	$11,1 \pm 0,3^{b}$	$7,9 \pm 0,4^{a}$
Wt. of males (Mean ± S.E)	*C. maculatus*	$4,2 \pm 0,12^{b}$	$3,5 \pm 0,2^{ab}$	$3,7 \pm 0,11^{b}$	$2,8 \pm 0,64^{a}$
	C. subinnotatus	$10,5 \pm 0,3^{bc}$	$11,7 \pm 0,4^{c}$	$9,3 \pm 0,2^{b}$	$6,7 \pm 0,3^{a}$

Horizontal values followed by different superscripts are significantly different ($P < 0,05$)

Analysis was done using DMRT.

Table 3 : Cross effectiveness of *C. subinnotatus* oviposition marker for *C. maculatus* and vice versa

SEED TREATMENT	TOTAL No. OF EGGS ADDED TO		P*
	CONTROL	TREATED	
Treated seeds bear 3 eggs of *C. subinnotatus* each + 6 *C. maculatus*	214	80	< 0,001
Treated seeds bear 3 eggs of *C. maculatus each* + 6 *C. subinnatatus*	404	220	< 0,01

* Wilcoxon's signed rank test

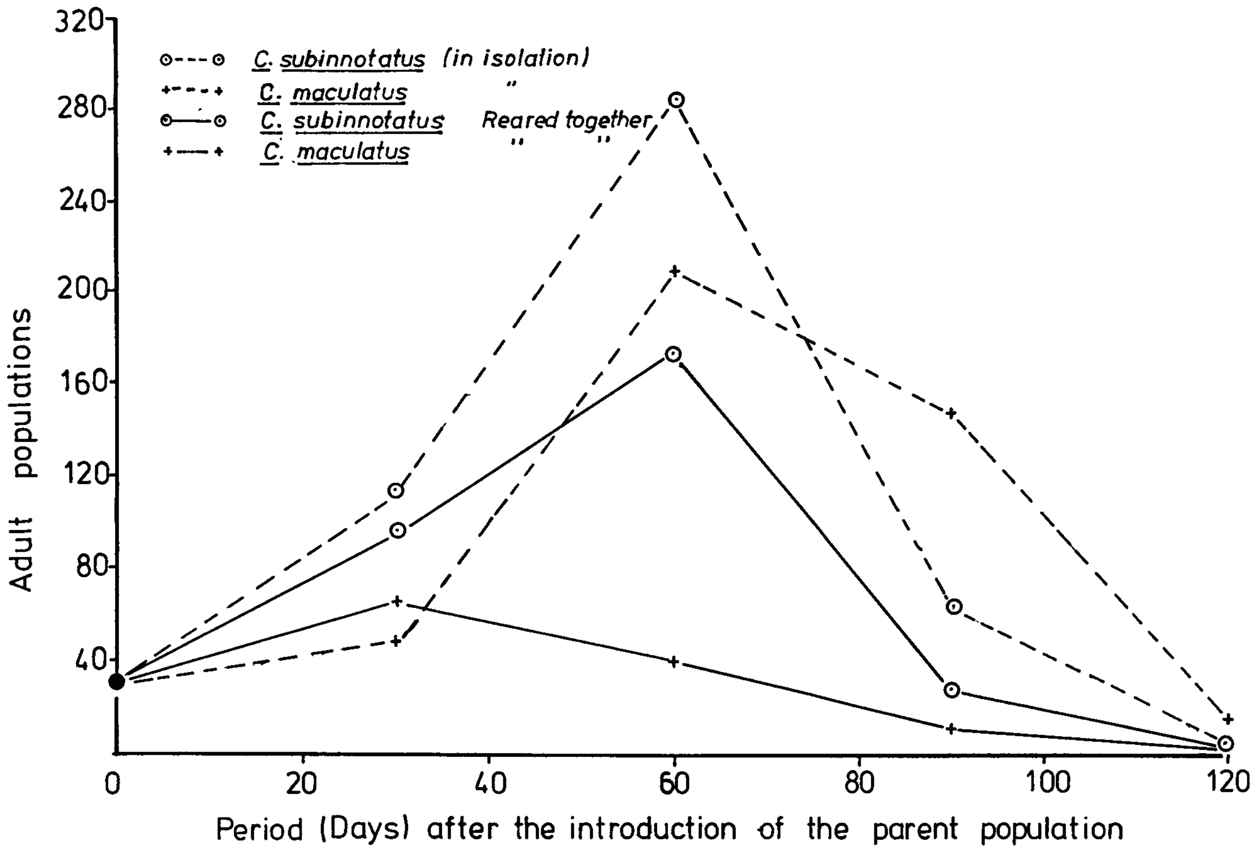

Fig. 2. Growth curves of adult populations of C. maculatus and C. subinnotatus reared in isolation and together.

development. *C. subinnotatus* did fairly well on soyabean and could become a pest of the legume if the preferred seeds are not available.

Generally, the adults of *C. subinnotatus* were heavier than those of *C. maculatus* (P < 0,05, table 2). The adults that emerged from bambarra and cowpea seeds were significantly heavier than those that emerged from soyabean (P < 0,05). **Giga** and **Smith** (1987) observed small sized individuals of *C. maculatus* and *C. rhodesianus* reared on soyabean.

Interaction between *C. maculatus* and *C. subinnotatus* : the population growth curves of the bruchids are in figure 2.

When *C. maculatus* and *C. subinnotatus* were reared together on bambarra, *C. subinnotatus* did better than *C. maculatus* but both populations thinned down after 90 days. It is probable that *C. subinnotatus* was able to do better because it is more fercund than *C. maculatus*. Also the growtih curves of *C. maculatus* and *C. subinnotatus* reared separately were similar to those of the two bruchids reared together but there were more progenies at the second generation when the bruchids were reared singly. When *C. maculatus* occur together with *Bruchidius atrolineatus* (Pic.) it was found that *B. atrolineatus* disappeared completely after 3 months (**Alzouma**, 1989). In this case, however, it is known that *B. atrolineatus* is not well adapted to the storage environment. In the case of *C. maculatus* and *C. subinnotatus* it is probable that both bruchids avoid laying eggs on seeds bearing each others eggs. Also the ovicidal action (**Sakai** *et al.*, 1986) of the larvae of the bruchids could have caused the disappearance of the populations after the third generation.

Cross effectiveness of the oviposition marker of *C. maculatus* for *C. subinnotatus* and vice-versa :

The oviposition markers of the two bruchids were significantly effective for each other (P 0,05, table 3). This has been observed for *C. maculatus* and *C. chinensis* (**Sakai** *et al.*, 1986) but *C. maculatus* marker has been found to affect *C. rhodesianus* but not vice-versa (**Giga** and **Smith**, 1985). Since these two bruchids occur together on bambarra nuts, the maker tends to ensure that they distribute their eggs evenly on the seeds and avoid seeds bearing eggs of their congeneric species.

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ETUDE DE LA BIOLOGIE DE DEUX ESPECES CONGENERES DE *CALLOSOBRUCHUS*

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RESUME

Nous avons entrepris en laboratoire l'étude de certains aspects de la biologie de *Callosobruchus maculatus* (F.) et de *Callosobruchus subinnotatus* (Pic.). Au Nigéria, ces deux coléoptères attaquent les stocks d'arachides bambarra et d'autres légumineuses. Leur ponte et leur développement s'est avéré plus rapide sur les arachides bambarra et sur le pois sauvage que sur toute autre espèce végétale.

Des études portant sur la compétition entre les deux coléoptères ont montré que le type de semence affectait leur niveau d'interaction et leur taux de survie. La compétition favorise aussi l'insecte qui s'installe le premier sur une semence particulière. Nous avons aussi étudié la distribution des oeufs sur les semences et il semblerait que les insectes puissent distinguer les oeufs de leur propre espèce de ceux des autres espèces.