EVALUATION OF *EPHESTIA KUEHNIELLA* AND *CORCYRA CEPHALONICA* AS HOSTS FOR MASS REARING *TRICHOGRAMMA* SPECIES nr. *MWANZAI* AND *TRICHOGRAMMATOIDEA* SPECIES nr. *LUTEA*

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ABSTRACT

Production of vegetables free of chemical pesticides requires, among other things, use of biocontrol agents that can be effectively and efficiently produced in large quantities. Two factitious hosts were evaluated for their suitability in mass rearing of two native Trichogrammatids. Egg cards bearing host eggs were separately offered to female parasitoids in glass vials and allowed to parasitise for 24 hours. New egg cards were offered daily till death of the female parasitoid. The number of eggs parasitised, emerged adult progeny and female progeny differed significantly between the two parasitoids, with *Trichogramma* sp. nr. *mwanzai* appearing to be superior to *Trichogrammatoidea* sp. nr. *lutea*. There were no differences in the mass production efficiency and quality of progeny between the *Ephestia kuehniella* and *Corcyra cephalonica*. The two hosts can be effectively used for mass production of either of the parasitoids.

Key words: Biocontrol, egg-parasitoids, *Helicoverpa armigera*, tomato pests.

1.0 INTRODUCTION

The development of an efficient mass rearing system requires appropriate choice of a suitable factitious host for parasitoid multiplication (Hassan, 1994). Often, insects other than the target hosts are used to reduce the cost or increase the efficiency of mass production of parasitoids. However, even for a polyphagous parasitoid, the suitability of these factitious hosts may vary greatly. Characteristics such as host egg volume, chorion thickness, nutritional content, age and egg distribution can affect parasitism rates as well as the number, quality and sex ratio of parasitoids reared from these host eggs (Baorong *et al.,* 1992; Corrigan and Laing, 1994; Greenberg *et al.,* 1998); Hoffmann *et al.,* 2000). The suitability of a host may also depend in part on the origin of the parasitoid, because selection within populations reared on different hosts may lead to genetic adaptation over time (Hoffmann *et al.,* 2000).

The influence of host insects on parasitism and progeny production by different *Trichogramma* species in the laboratory under choice and no choice situations and field tests have been studied (Abera, 2001), but hardly any studies on native species of trichogrammatids in Kenya. The objective of this study was to determine the suitability of two factitious hosts commonly used in mass rearing of parasitoids as part of the criterion in the selection of the most suitable host species for mass production of two native aarhenotokous trichogrammatids, *Trichogrammatoidea* sp. nr. *lutea* and *Trichogramma* sp. nr. *mwanzai* (Pinto and Stouthamer, 1994) for biocontrol of *Helicoverpa armigera* Hübner on tomato in Kenya, where farmers rely on chemical pesticide for its control. The need for evolving cheaper and cost-saving materials and techniques as part of promoting the large-scale utilisation of trichogrammatid egg parasitoids in Africa has been emphasised. The two lepidopteran hosts which are amenable to ease mass rearing on cereal grains in Kenya include *Ephestia kuehniella* Zeller and *Corcyra cephalonica* Stainton.

2.0 MATERIALS AND METHODS

Studies were carried out at International Centre for Insect Physiology and Ecology (ICIPE) Animal rearing and Quarantine Unit (ARQU), Nairobi Kenya. *Ephestia kuehniella* and *C. cephalonica,* used as hosts were reared at ARQU. Two native trichogrammatid species *Trichogramma* sp. nr. *mwanzai* and *Trichogrammatoidea* sp. nr. *lutea* were recovered from medium altitude areas in Kenya. The parasitoids were reared for several generations (Abera, 2001). *Trichogramma* sp. nr. *mwanzai* and *Trichogrammatoidea* sp. nr. *lutea* were reared on *E. kuehniella* and *Corcyra cephalonica* and their development compared. The experiments were carried out under controlled conditions, 25±2°C, RH 60±10% and 12:12 LD. Five, one-day-old mated females of each parasitoid species were placed in 3½-inch glass vial and each set of the females was offered approximately 150 eggs on an egg card from each of the two factitious hosts. Parasitism was allowed for 24 hours, after which the card containing parasitised eggs was confined in a clean sterilised glass vial to await

emergence. Parasitoids were offered a new egg card daily until their natural death. After parasitoid emergence, 10 males and 10 females from each parasitoid host combination were individually placed in 3½-inch glass vials and offered honey solution as food on paper stripes. Data on progeny longevity was collected until the death of all individuals.

2.1 Data Analysis

Insect counts were transformed into $\log_{10}(x + 10)$ before analysis. The parasitism, sex ratio and adult emergence data were subjected to repeated measures of analysis of variance (ANOVA) for a complete randomised design using the General Linear Model procedure (SAS Institute; 2000). Student-Newman-Keuls (SNK) procedure was used to separate the means, as a post ANOVA procedure. Comparison of the two parasitoids for the different parameters (parasitism, emergence and female progeny) was done using the Studentized test (Proc T test) (SAS institute, 2000).

3.0 RESULTS

3.1 Number of Host Eggs Parasitised

The number of host eggs successfully parasitised during the initial three days of adult parasitoid life, was found to differ significantly between the two hosts *E. kuehniella* and *C. cephalonica* for *Trichogramma* sp. nr. *mwanzai* ($F = 18.43$ $df = 1,17$ $P = 0.0005$) while for *Trichogrammatoidea* sp. nr. *lutea,* no significant difference ($F = 0.12$ $df = 1,17$ $P = 0.74$) was observed. The total number of eggs parasitised on the two hosts for *Trichogramma* sp. nr. *mwanzai* were 36.34 ± 2.24 and 25.76 ± 1.44 respectively. The respective numbers for *Trichogrammatoidea* sp. nr. *lutea* were 25.16 ± 1.72 and 24.46 ± 2.48 (Table 1). When the two parasitoids reared on *E. kuehniella* were compared in their rate of parasitism, *Trichogramma* sp. nr. *mwanzai* was found to parasitise more compared to *T.* sp. nr. *lutea* ($t = 3.98$ $df = 18$ $P = 0.0009$). However, when *C. cephalonica* was used as the rearing host, no significant difference ($t = 0.45$ $df = 18$ $P = 0.66$) on parasitism rate was observed between the two parasitoids. Considering the overall numbers of eggs parasitised over the full adult span of 13 days, no significant difference was observed for the two hosts for both the trichogrammatid species tested (see Table 1). The two parasitoids did not differ in their overall rates of parasitism when either *E. kuehniella* ($t = 0.13$ $df = 8$ $P = 0.9$) or *C. cephalonica* ($t = 1$ $df = 8$ $P = 0.35$) was used as host respectively.

Table 1: Mean (± se) number of host eggs successfully parasitised during the initial and overall adult lifespan of two trichogrammatids on two factitious hosts corcyra cephalonica and Ephestia kuehniella

Total number of host eggs parasitised						
Period (days)	Trichogrammatid Species	Factitious Host		Statistical Parameters		
		Ephestia kuehniella	*Corcyra cephalonica*	F	df	P
Initial (1-3 days)	*Trichogramma* sp. nr *mwanzai*	36.34±2.24a	25.76±1.44b	18.43	1,17	0.0005
	Trichogrammatoidea sp. nr. lutea	25.16±1072a	24.46±2.48a	0.12	1,17	0.7400
Overall(1-13 days)	*Trichogramma* sp. nr. *mwanzai*	41.38±3.48a	35.44±2.16a	2.40	1,17	0.1400
	Trichogrammatoidea sp. nr. *lutea*	39.78±5.26a	35.44±2.16a	0.36	1,17	0.560

*Means followed by the same lower case letter in the same row are not significatly different (Student-Newman-Kuels muliple comparison test, $p<0.05$)

3.2 Number of Adult Progeny Emerged from Parasitised Eggs

The numbers of adult progeny in the initial three days of adult parasitoid life, were also found to differ significantly between the two hosts *E. kuehniella* and *C. cephalonica* for *Trichogramma* sp. nr. *mwanzai* ($F = 22.05$ $df = 1,17$ $P = 0.0002$) while for *Trichogrammatoidea* sp. nr. *lutea* no significant difference was observed ($F = 3.69$ $df = 1,17$ $P = 0.071$) (Table 2). The two parasitoids differed ($t = 3.99$ $df = 18$ $P = 0.009$) on number of adult progeny produced from successfully parasitised eggs of *E. kuehniella*. *Trichogramma* sp. nr. *mwanzai* recorded more adult progeny compared to *Trichogrammatoidea* sp. nr. *lutea*. Significant differences ($t = 2.24$ $df = 18$ $P = 0.038$) were also observed between the two parasitoids when *C. cephalonica* was used as the rearing host *Trichogramma*. sp. nr. *mwanzai* recorded a significantly higher number of adult progeny compared to *Trichogrammatoidea* sp. nr. *lutea*. For the total numbers of adult progeny that emerged over the full adult span of 13 days, no significant difference between the two hosts was observed for both the trichoframmatid species tested (Table 2). The two parasitoids also did not differ in the number of adult progency produced when either *E. kuehniella* ($t = 0.2$ $df = 8$ $P = 0.844$) or *C. cephalonica* ($t = 0.63$ $df = 8$ $P = 0.55$) was used.

Table 2: Mean (± se) number of adult progeny (± se) produced from host eggs parasitised during the initial and overall adult lifespan of two trichogrammatids on two factitious hosts Corcrya cephalonica and Ephestia kueniella

Total number of host eggs parasitised						
Period (days)	*Trichogrammatid Species*	*Factitious Host*		*Statistical Parameters*		
		Ephestia kuehniella	*Corcyra cephalonica*	F	df	P
Initial (1-3 Days)	*Trichgramma* sp. nr. *mwanzai*	30.04 ± 2.12a	19.34 ± 1.22b	2.05	1,17	0.0002
	Trichogramoidea sp. nr. *lutea*	19.38 ± 1.64a	14.94 ± 1.4a	3.69	1,17	0.0710
Overall (1-13 days)	*Trichogramma* sp. nr. *mwanzai*	33.40 ± 2.95a	27.92 ± 1.3a	2.92	1,17	0.1100
	Trichogrammatoidea sp. n. *lutea*	29.32 ± 4.09a	32.22 ± 4.34a	0.30	1,17	0.5900

Means followed by the same lower case letter in the same row not significanl different (Student-Newman-Kuels multiple comparison test, $p<0.05$)

3.3 Proportion of Females in the Progeny (Sex Ratio)

There was a significant difference ($F = 18.95$ df = 1,17 $P = 0.0004$) in the number of female progeny produced during the initial three days of adult parasitoid life between the two hosts *E. kuehniella* and *C. cephalonica* for *Trichogramma* sp. nr. *mwanzai.* For *Trichogrammatoidea* sp. nr. *lutea* no significant difference ($F = 0.02$ df = 1,17 $P = 0.90$) was observed. The total numbers of female progeny on the two hosts for *Trichogramma* sp. nr. *mwanzai* were 23.24 ± 1.59 and 15.52 ± 1.02 respectively. The respective numbers for *Trichogrammatoidea* sp. nr. *lutea* were 11.54 ± 1.30 and 11.76 ± 1.25 (Table 3). When the two parasitoids were compared, *Trichogramma* sp. nr. *mwanzai* recorded more female progeny compared to *Trichogrammatoidea* sp. nr. *lutea* when either *E. kuehniella* ($t = 5.70$ df = 18 $P = 0.0001$) and *C. cephalonica* ($t = 2.32$ df = 18 $P = 0.032$) were used as the rearing hosts. For the overall numbers of female progeny over the full adult span of 13 days, there was no significant difference between the two hosts for both the trichogrammatid species tested. The two parasitoids did not differ in overall number of female progeny produced when either *E. kuehniella* ($t = 1.24$ df = 8 $P = 0.25$) or *C. cephalonica* ($t = 0.64$ df = 8 $P = 0.54$) was used as host.

Table 3: Mean (± se) number of female progeny adult produced host eggs parasitised during the initial and overall adult lifespan of two trichogrammatids on two factitious host Corcyra cephalonica and Ephestia kuehniella

Total number of host eggs parasitised						
Period(days)	*Trichogrammatid Species*	*Factitius Host*				
		Ephestia kuehniella	*Corcyra cephalonica*	F	df	P
Initial (1-3 days)	*Trichogramma* sp. nr. *mwanzai*	23.24±1.59a	15.52±1.02b	18.95	1,17	0.0004
	Trichogrammatoidea sp. nr. *lutea*	11.54±1.30a	11.76±1.25a	0.02	1,17	0.9000
Overall (1-13 days)	*Trichogrammatoidea* sp. nr *mwanzai*	24.50±1.66a	21.76±1.37a	2.01	1,17	0.1700
	Trichogrammatoidea sp. nr. *lutea*	16.56±2.17a	21.76±1.37a	0.60	1,17	0.4500

Means followed by the same lower case letter in the same raw are not sifnificantly different (Student-Newman-Kuels multiple comparison test, $p<0.05$)

3.4 Progeny Adult Longevity

The adult parasitoids of the progeny reared from eggs of *C. cephalonica* showed a significantly higher longevity in relation to those reared on *E. kuehniella* for *Trichogramma* sp. nr. *mwanzai* . For *Trichogrammatoidea* sp. nr. *lutea* however, no significant effect of host on longevity was observed (Table 4).

Table 4: Mean (± se) longevity (days) of two trichogrammatids trichogramma sp. nr. mwanzai and trichogrammatoidea sp. nr. lutea reared on two factitious hosts. Temperature 25± 2°C, RH 60± 10% and 12:12 photophase

Longevity (days)					
Trichommatid Species	*Factitious Host*		*Statistical Parameters*		
	E. kuehniella	*C. cephalonica*	F	df	P
Trichogramma sp. nr. *mwanzai*	3.00±0.38b	4.95±0.39a	13.36	1,38	0.0008
Trichogrammatoidea sp. nr. *lutea*	3.25±0.32a	4.55±0.63a	2.37	1,38	0.1320

Means followed by the same leeter on the same raw are not sifnificanly different (sudent-Newman-Keuls test, $p < 0.05$) where N=20

4.0 DISCUSSION

This study focussed on comparing two factitious hosts, *E. kuehniella* and *C. cephalonica* for their relative efficiency in mass production of two trichogrammatid candidates. Since commercial production systems may choose either to utilise the most productive age (initial 3 days) or the overall adult lifespan (total of 13 days), parameters were considered for both durations. The three quantitative parameters considered were, the number of host eggs successfully parasitised, the number of adult progeny produced and the number of female adult progeny as the most critical criterion. The qualitative (fitness) parameter is the longevity of the progeny adults. The study also compares the performance of the two native trichogrammatids on the two hosts respectively.

Comparing the mean number of successfully parasitised eggs during the initial adult span (3 days) of the two trichogrammatids, the hosts did not differ significantly for *T.* sp. nr. *lutea* while for *Trichogramma* sp. nr. *mwanzai, E. kuehniella* recorded significantly more parasitised eggs than *C. cephalonica*. This trend indicates that the choice between the two hosts is linked to the trichogrammatid species proposed to be multiplied. Earlier studies by Bigler *et al.* (1987) on *T. maidis* comparing *E. kuehniella* and *S. cerealella* did not show any difference between the two hosts in terms of parasitism. However, Singh *et al.* (1998) found *C. cephalonica* to record higher percent parasitism than *S. cerealella* in case of both *T. braisliensis* and *T. exiguum.* The effect of the rearing host has also been observed in *T. dendrolimi* Matsumura where significantly higher parasitism was recorded on the Chinese oak silk moth, *Antheraea pernyi* Guerin-Meneville compared to *C. cephalonica* (*Liu et al.,* 1998). It is apparent that attributes related to behaviour in an animal such as rate of parasitism are expected to be variable because many factors influence behaviour and the comparative suitability of hosts also tends to vary with candidate *Trichogramma* species (Vet *et al.,* 1990). The overall host eggs parasitised in the total adult lifespan of the parasitoids did not show any significant difference between the hosts compared. This trend is similar to the results of Bigler *et al.* (1987), who found the two test hosts to be comparable, when tested on another trichogrammatid, *T. maidis*. It could be concluded therefore that for this attribute, if production is limited to the initial 3 days of adult life, *E. kuehniella* appears to be more suitable for rearing *Trichogramma* sp. nr. *mwanzai* while both hosts appear equally suitable for mass rearing *Trichogrammatoidea* sp. nr. *lutea*. However if the production system covers the entire adult span of the parasitoids, both hosts; *E. kuehniella* and *C. cephalonica* appear to be equally suited for mass rearing.

The number of adult progeny produced for initial period (1-3 days) of access to host eggs was found to follow a similar trend as that for the number of parasitised eggs, with *E. kuehniella* being superior to *C. cephalonica* for *Trichogramma* sp. nr. *mwanzai,* while both were similar for *Trichogrammatoidea* sp. nr. *lutea*. The progeny produced within the overall duration (1-13 days) of exposure to host eggs

also followed a trend similar to that of number of eggs parasitised. This indicates that the successful emergence of the progeny after successful parasitism was not affected by any differential developmental success of the two parasitoid species in both the hosts compared. Considering this attribute, the two hosts were suitable for rearing.

The number of female progeny produced during initial (1-3 days) exposure to host eggs differed significantly between the two hosts for *Trichogramma* sp. nr. *mwanzai,* while for *Trichogrammatoidea* sp. nr. *lutea*, no significant difference was observed. The number of female progeny produced in the overall duration of exposure (1-13 days) of host eggs did not differ significantly for the two hosts. This result suggests that the two trichogrammatid species differ in their oviposition behaviour and for *Trichogramma* sp. nr. *mwanzai*, *E. kuehniella* seemed superior to *C. cephalonica* if the initial 3 days of adult parasitoid life were to be utilised. However, both hosts appear to be equally efficient for production of female progenies if the entire adult span (1-13 days) of the potential generation is utilised. This is in conformity with the findings of Corrigan and Laing (1994) and Bigler *et al.* (1987), who observed no difference in progeny emergence and sex ratio of progeny between two test hosts *E. kuehniella* and *S. cerealella*. However, Singh *et al.*, (1998) found one of the test hosts *C. cephalonica* to be superior to a different host (*S. cerealella*). This suggests that the suitability and therefore efficiency of the laboratory hosts may differ with the candidate trichogrammatid species. Among factors which may influence the progeny production is the extent of correlation between host selection and host suitability (Mackauer, 1983).

The quality parameter being the longevity of the progeny adults, was however found to show that *E. kuehniella* was inferior to *C. cephalonica* incase of *Trichogramma* sp. nr. *mwanzai,* whereas both were at per for *Trichogrammatoidea* sp. nr. *lutea*. The longevity of *T. galloi* and *T. pretiosum* varied depending on strain and host on which they were reared. For *T. pretiosum*, parasitoids reared on *C. cephalonica* showed higher longevity in relation to those reared on *E. kuehniella* and *S. cerealella*. For *T. galloi*, there was only the effect of strain on longevity, which was not observed concerning the factitious host. This attribute (longevity) by itself does not reflect the potential performance of the adults and a follow-up study by combining the longevity with fecundity and host finding efficiency, including dispersal rate should be undertaken.

The two parasitoids differed significantly during initial (1-3 days) exposure to host eggs in number of successfully parasitised eggs, adult progeny that emerged and female progeny. *Trichogramma*. sp. nr. *mwanzai* appeared to be superior in the three quantitative parameters compared to *Trichogrammatoidea* sp. nr. *lutea*. This result suggests that *Trichogramma* sp. nr. *mwanzai* is superior to *Trichogrammatoidea* sp. nr. *lutea* since it performed better in both hosts.

In general, the results from this study suggest that the mass production efficiency and quality of the progeny does not differ between the two hosts, *E. kuehniella* and *C. cephalonica* for *Trichogrammatoidea* sp. nr. *lutea* and *Trichogramma* sp. nr. *mwanzai* if the entire lifespan of the adult parasitoids is utilised. However, the former appeared inferior for progeny longevities. Further studies on other related fitness parameters of the progeny would be useful in evaluating the overall suitability of the two hosts for this parasitoid. It is evident from this study that production when limited to the first 3 days would be more economical (considering handling time, diet for the parasitoids for their entire lifespan) than if it is extended for the entire lifespan of the parasitoid. It was also found out that both hosts, *E. kuehniella* and *C. cephalonica* appear to be equally suited for a 'slow' turnover system (covering the entire adult span of the parasitoids). It is evident also that the choice of host should be done in relation to the target parasitoid species to be mass-produced.

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