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S Sambathkumar
Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

C Durairaj
Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

S Mohankumar
Department of Plant Biotechnology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

N Ganapathy
Department of Cotton, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Correspondence
S Sambathkumar
Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Studies on sex ratio of castor shoot and capsule borer, *Conogethes punctiferalis* Guenee (Lepidopteara: Crambidae) in Castor

S Sambathkumar, C Durairaj, S Mohankumar and N Ganapathy

Abstract
The castor shoot and capsule borer, *Conogethes punctiferalis* (Guenee) is an important and one of the most devastating pests of castor. The sex ratio of *C. punctiferalis* adults was compared for two years (2011 and 2012) on castor. The sex ratio (♂: ♀) was female- biased during both years and it was 1.0:1.92 and 1.0:1.41 respectively. The chi-square test for heterogeneity in sex ratio, showed non-significant departure from 1.0: 1.0 ratio in both years. The paired ‘t’ test also revealed the non-significant difference in the sex factor between two years

Keywords: Castor, pest, castor shoot and capsule borer, *Conogethes punctiferalis*, sex ratio

1. Introduction
Castor is indigenous to the South Eastern Mediterranean Basin, Eastern Africa, and India, but is widespread throughout tropical regions and is widely grown as oil seed crop. The seeds with hulls removed contain 35 to 55% oil. The castor shoot and capsule borer, *Conogethes punctiferalis* (Guenee) is an important and one of the most devastating pests of castor. Apart from castor it causes major constraints in the production of other crops like cardamom and some tropical fruit trees. Castor is mostly grown as rainfed crop and not much emphasis is given for the plant protection activities and farmers relied upon only insecticides for managing the insect pests under irrigated cultivation. Development of effective management strategies for controlling *C. punctiferalis* will require knowledge of its biological relationships with its host plants. Among these, an important component will be an understanding of host suitability [7]. Sex ratio of insects especially in lepidopterans plays a major role in mating and oviposition. Generally, equal number of male female population in the environment leads to exploitation of the complete potential of insect species for reproduction. Hence, the present study on identifying the existing sex ratio of *C. punctiferalis* was conducted at Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore during July to December for two successive years (2011 and 2012) from the field collected populations of castor plants.

2. Material and Methods
Larvae of *C. punctiferalis* infested castor shoots and capsules were collected randomly from castor and were brought to the laboratory and randomly 20 larvae along with capsules and shoots were separated. These were kept in plastic troughs (40 cm dia.), with a layer of filter paper at the bottom to absorb excess moisture from the host. The trough was covered with muslin cloth and secured tightly using rubber band. The culture was maintained at a temperature of 27.9 ± 2.2^{O} C and relative humidity (RH) of 76.6 ± 9.1 per cent. The troughs were regularly examined for pupation and the pupae from the trough were transferred to adult rearing plastic baskets (22.5 cm dia. and 25 cm height). Ten replications were maintained and each replication comprised of 20 randomly selected pupae from the field collected and laboratory cultured population. After the adult emergence males were identified by the presence of tapering abdomen with black colour at tip and female moths had tubular abdomen with a prominent hole at tip. The sex ratio (♂: ♀) and sex factor relationship were calculated using the formulae,
Sex Ratio = Number of female moths / Number of male moths
Sex Factor = Number of female moths / Total number of moths

The sex ratio and sex factor of *C. punctiferalis* during two successive years were subjected to statistical analysis and the significance was tested by chi-square test of heterogeneity ($\chi2$) and paired ‘t’ test.

3. Results and Discussion

The results showed that, during 2011, the maximum emergence of female moths (63.5%) of *C. punctiferalis* was recorded than the male moths (36.5%). Same trend of maximum female emergence of 57.0 per cent was observed in 2012 also. The sex ratio of *C. punctiferalis* was 1.0 : 1.92 and 1.0 : 1.41 during 2011 and 2012 respectively and were biased towards female moths. This was in conformity with the findings of Mazanec (1984) reported that sex ratio of jarrah leafminer, *Perrhida glyphopa* was biased towards females (0.74 : 1.00). Sex ratio of *Maruca vitrata* was found to be 1.0 : 0.50 to 1.0 : 0.84 of females and males on pigeonpea and cowpea [13]. Similarly female dominant field population of adult moths was recorded in *Leptidea sinapis* Linnaeus (2.17:1.0 to 12.2:1.0), *Aricia allous* (4.0:1.0) and *A. agestis* (2.87:1.0) [16]. The female- biased sex ratio (♂ : ♀) was also reported in *M. vitrata* populations collected from legume hosts such as lablab (1.0 : 1.95) pigeonpea (1.0 : 1.41), green gram (1.0 : 1.54) and black gram (1.0 : 1.51) [15].

In some cases, certain biotic and abiotic stresses may induce the abnormal sexual distortion in insects. Nutrition of host plants is one such factor that also played an important role in sex ratio of many lepidopteron insects. In spruce bud worm, increase in number of male moth production was reported when the population fed on poor nutrient sources and they were more sensitive to nutritional stress [12]. Distortion of sex ratio may sometimes be beneficial because when there are more males the likelihood of fertilizing females increases.

In order to supplement the results of sex ratio, sex factor also showed non-significant deviation from 0.5 in all hosts evaluated through chi square test (Table 1). In 2011, the sex factor was 0.64 and it was 0.58 in 2012. Results of chi square test showed that the sex ratio (♂ : ♀) and sex factor of *C. punctiferalis* did not differ significantly from 1.0: 1.0 and 0.5: 0.5 respectively on castor during both years studied (Table 1). Similarly paired ‘t’ test also showed non-significant differences among the hosts and both years with respect to sex ratio. Similarly, higher emergence of 62.2 per cent of female moth emergence of *Spodoptera exigua* on pigweed was also recorded [7]. Jiggins *et al.* (2002) and Idris and Hassan (2012) reported the non-significant sex ratio in *Acraea encedon* and *Danaus chrysippus* respectively.

The pooled data of two years also showed that the sex ratio of *C. punctiferalis* was female biased (1.0 : 1.67). Similarly, mean sex factor was 0.61 (Table 1). Similarly, the mean male and female moth emergence was 39.8 and 60.2 per cent respectively. The chi square test for heterogeneity on sex factor showed non-significant departure from 0.5 ratio. Similarly, paired ‘t’ test also showed non-significant difference in the sex factor between two years. Similar conclusions were also given by Sambathkumar and Durairaj (2012) from the field collected populations of *M. vitrata* from different pulses.

However, imbalanced sex ratio or early emergence of one sex may lead to same-sex sexual interactions (SSSI), led to no offspring production [2]. In the case of Arthropods, the same-sex courtship and copulation were reported in 117 species [3, 14]. This behaviour was also reported earlier in males of *Corcyra cephalonica* [8], *Jalmenus evagoras* [5], *Acraea andromacha* [1], *Antheraea mylitta* [4] and *Heliconius charitonia* [6]. Also, the higher proportion of female sex in an insect population would lead to availability of more numbers of unmated female insects which would be an energy loss to the population.

Table 1: Sex ratio of *C. punctiferalis* in castor

Parameter		2011	2012	Mean
Male moths		73	86	79.5
Female moths		127	114	120.5
Total		200	200	-
Adult emergence (%)	Male	36.5	43.0	39.8
	Female	63.5	57.0	60.2
Sex ratio#				
♂ : ♀		1.0 : 1.92	1.0 : 1.41	1.0 : 1.67
SD#		0.86	0.46	-
$\chi2$ value		0.0881^{NS}	0.9322^{NS}	-
‘t’ value		1.6078^{NS}		-
Sex factor				
♂ / ♀		0.64	0.58	0.61
SD#		0.088	0.086	-
$\chi2$ value		0.9999^{NS}	0.9999^{NS}	-
‘t’ value		1.4746^{NS}		-

#Mean and SD of 10 replications and each replication with 20 pupae; NS – Not significant, *Significant at 5% level; **Significant at 1% level

Table $\chi2$ value @ (0.05, 9) = 8.343

‘t’ table value @ (0.05, 9) = 2.262

4. Conclusion

It could be concluded that the continuation of the present study along with identification of key environmental factors on the sex ratio may prove helpful in the exploitation of weather bound calendar based cultivation of castor and also to the other major host plants in commercial scale.

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