Variability in Development Time and Sex Ratios of Selected Local Populations of Striped Stem Borer *Chilo suppressalis* from the Philippines

C. G. Demayo[1], Amelita T. Angeles[2], and Angelita M. Romena[3]

Abstract

Comparison of development times and sex ratios was made for selected local populations of Striped stem borer (SSB) reared on artificial diet. Significant differences in development times were observed among populations. Females had longer larval and total development time compared with the males. No significant differences were observed between the sexes in pupal development and weights. Tests of goodness of fit to a 1:1 sex ratio revealed significant excess in males in seven populations of the Striped stem borer (SSB). Significant heterogeneity among the populations in sex ratio was detected. Crosses between populations that differed in sex ratio indicated that sex ratio was a heritable trait.

When five populations were allowed to develop on nine rice varieties, it was observed that the total development time did not vary between populations but between rice varieties only. All populations showed significant excess in males across all varieties where the insects were allowed to develop.

Key Words: Life history, development, sex ratios, *Chilo suppressalis*

Introduction

The striped stem borer *Chilo suppressalis* had been considered one of the most widespread stem borer species, extending from Asia and Oceanea into the Middle East and Europe. It occurs mostly in the tropical regions, but is also adapted to temperate regions where it diapauses during the winter. The number of generations the insect undergoes in the field is largely governed by a number of crops grown in the area. In areas where only one crop is grown per year, the striped stem borers were observed to have undergone hibernation or aestivation (Khan et al, 1991).

Many studies have been conducted to determine the importance of geographical location changes and agricultural practices on the dynamics and genetics of pest populations (Loehvinsohn, 1989; Pianka, 1970; Southwood, 1967). The goal of the study reported here was to determine if striped stem borers collected from diverse geographical locations differed in life history traits.

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[1] Department of Biological Sciences, College of Science and Mathematics, MSU-Iligan Institute of Technology, Iligan City

[2] Crop Protection Division, Philippine Rice Research Institute (PhilRice), Muñoz, Nueva Ecija

[3] Entomology and Plant Biology Division, The International Rice Research Institute (IRRI), P.O. Box 933, Manila

Materials and Methods

Insect Collection. Insects were collected as moths from nine localities in the Philippines. These populations were collected from IRRI, SMC and Poblacion in Calauan in Laguna (Calauan-1 and 2), Ballesteros in Cagayan, Bagabag in Nueva Viscaya, Koronadal in South Cotabato, Lian in Batangas, and in Lamut, Ifugao. Except for Lamut in Ifugao, the localities sampled were dependent on irrigation and have asynchronous planting of different rice cultivars.

The collected moths were allowed to oviposit in TN1 rice variety and the egg masses were collected 5 days after oviposition. The leaves with the egg masses were surface-sterilized with 5% sodium hypochlorite for 5 min and rinsed three times with distilled water. The sterilized egg masses were placed in disinfected petri dishes lined with moist sterile filter paper, and allowed to hatch.

Preparation of Culture Diets. For a 1 liter diet, 17.2g of agar was dissolved in 545 ml boiling distilled water. The water-agar mixture was mixed in a blender for 1 min after which 118 g of dry-mix (BIO-SERV) was added. This was then blended again at high speed for 3 min. Three hundred sixty-six ml chilled distilled water was added and blended for 1 min before 7.4 g vitamin mix, 5 g of choline chloride, 17.6 g corn starch, and 4 ml of 10% formaldehyde were added.

Immediately after preparation, 5 ml of the diet was dispensed into each of the plastic cups that were set in plastic trays (54 cups/tray) under a laminar flow hood previously surfaced-sterilized with 5% sodium hypochlorite. The diet was allowed to cool and solidify and then pierced with the hard end of a surfaced-sterilized camel's brush to provide holes for the larvae.

The prepared diets were infested with first-instar larvae (3 larvae/cup) and stored in racks. The culture was maintained at 27.5°C to 28°C, and photoperiod was set for a 12-hour dark period in the laboratory.

Data Collection. Larval development (hatching to pupation), pupal development and weights, and hatching to emergence times (total development) of the F_1 generation were monitored daily. The data were analyzed using ANOVA with population and sex as main effects. Sex ratios of the colonies were compared by G-statistics (Sokal and Rohlf, 1981).

The moths which emerged were allowed to oviposit in TN1 rice plants and the hatched larvae were again reared in diets. In some of the populations, sex ratios were monitored up to 7th generations. Reciprocal crosses were made between selected colonies and the resulting progenies were monitored for sex ratios. The same procedure was adopted in monitoring development of the insect populations in nine rice varieties. Insects were reared in Rexoro variety for one generation before allowed to develop in different rice varieties. Relative growth rate was measured using the index used by Rausher (1984). This was done by dividing the change in larval weight (weight in 23 days - weight in 18 days) by the mean larval biomass [1/2(initial weight in 18 days + final weight in 23 days)] x 120 h. Mean development time was analyzed by ANOVA and sex ratios on different rices were analyzed using G-statistics.

Results

Larval Development. Means and standard errors, and analysis of variance for each developmental time are presented in Table 1. Populations differed significantly in larval development. Between sexes, this difference was an important factor for the differences observed between populations (Table 1). The population collected from Ifugao had the longest mean larval development time (male = 38.06 +- 0.444; female = 42.22 +- 0.486) while the shortest larval development time was manifested by IRRI-2 (male = 28.16 +- 0.08; female = 29.7 +- 0.07). Of the nine populations investigated, six groupings were found to differ significantly for one another using Tukey's test (P>0.05). The following is the order of developmental time: Ifugao> IRRI-1> Cotabato-2 and Calauan-1> Nueva Viscaya, Cagayan, Cotabato-1> Calauan-2> IRRI-2 (Table 1).

Table 1. Comparison of development times of nine selected strains of *C. suppressalis*.

	DEVELOPMENT TIME (DAYS)						
POPULATION	Larval		Pupal		Hatching to Emergence		
	male	female	male	female	male	female	
Ifugao	38.06 ± 0.44	42.22 ± 0.48	9.59 ± 0.13	9.13 ± 0.12	47.53 ± 0.42	51.34 ± 0.48	
Nueva Viscaya	33.30 ± 0.39	36.30 ± 0.23	8.79 ± 0.07	9.02 ± 0.07	41.97 ± 0.20	45.25 ± 0.26	
Cagayan	33.65 ± 0.29	35.60 ± 0.23	8.84 ± 0.11	9.29 ± 0.12	42.94 ± 0.39	45.24 ± 0.37	
Cotabato-1	35.01 ± 0.22	37.23 ± 0.23	8.87 ± 0.10	8.99 ± 0.09	39.44 ± 0.32	41.53 ± 0.37	
Cotabato-2	32.75 ± 0.15	35.17 ± 0.12	NR	NR	NR	NR	
Calauan-1	35.29 ± 0.45	36.73 ± 0.53	9.88 ± 0.12	10.09 ± 0.14	45.44 ± 0.39	46.96 ± 0.47	
Calauan-2	32.16 ± 0.04	32.34 ± 0.06	8.15 ± 0.20	7.84 ± 0.18	41.13 ± 0.09	41.25 ± 0.14	
IRRI-1	36.44 ± 0.13	37.98 ± 0.25	9.38 ± 0.07	9.06 ± 0.08	45.86 ± 0.22	47.07 ± 0.23	
IRRI-2	28.16 ± 0.08	29.70 ± 0.07	9.30 ± 0.06	9.10 ± 0.05	37.54 ± 0.18	39.22 ± 0.22	
Mean ± S.E.	33.87 ± 2.84	35.92 ± 3.51	9.10 ± 0.55	9.07 ± 0.61	42.73 ± 3.40	44.73 ± 3.92	
Source	DF	MS	F	Pr>F	DF	MS	F
Pr F	DF	MS	F	Pr>F			
Population	8	45180.67	455.22	0.0001	7	726.75	37.73
0.0001	7	45825.04	347.09	0.0001			
Sex	1	4197.94	338.37	0.0001	1	0.78	0.28
0.5936	1	30004.61	159.30	0.0001			
Sex x Population	8	829.52	8.36	0.0001	7	65.75	3.41
0.0012	7	724.89	5.49	0.0001			

NR = not recorded

Pupal Development. Means, standard errors of pupal development time in different populations were recorded and subjected to analysis of variance (Table 1). It was shown that the seven populations investigated differ in pupal development time although a comparison between the males and females within a population showed no significant variation. There was a poor sex x population interaction (Table 1) that was observed in pupal develop-

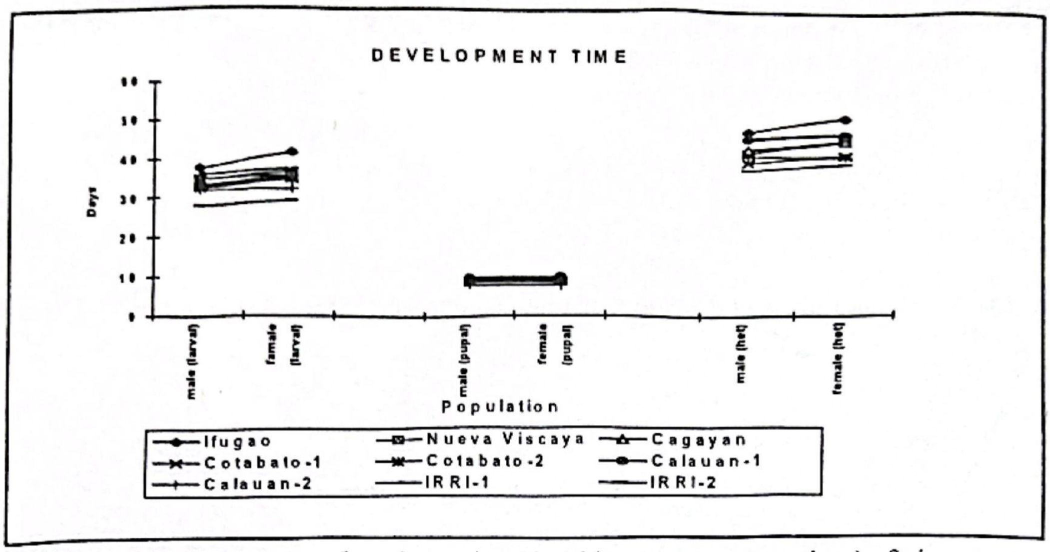

Figure 1. Development time (larval, pupal and hatching-to-emergence time) of nine strains of *C. suppressalis* reared in artificial diet.

ment indicating that sex was not a factor for the variations observed between the populations. The Calauan-2 population had the longest mean pupal development time in both sexes, while the Poblacion Calauan had the shortest (Table 1).

Pupae from the F_1 generation were dissected from the cups, sexed, and immediately weighed. The weights of the pupae from the same egg hatch dates from different localities were recorded and subjected to T-test. A significant difference between the weights of the males and females was observed within and between populations (Table 2). However, when the populations were compared, no significant differences were observed ($P < 0.05$) between them.

Table 2. Comparison of pupal weight of six selected strains of *C. suppressalis*.

POPULATION	MALE	FEMALE	T-TEST VALUE	DF	P
Bagabag, Nueva Viscaya	0.0449±0.002	0.0861±0.006	6.12	8.5	0.0022
Ballesteros, Cagayan	0.0500±0.001	0.0808±0.003	9.02	6.2	0.0001
Calauan-1, Laguna	0.0508±0.002	0.0848±0.002	11.43	28.4	0.0001
Calauan-2, Laguna	0.0572±0.002	0.0937±0.012	2.82	7.4	0.0245
IRRI-1, Laguna	0.0507±0.002	0.0818±0.002	10.50	9.4	0.0001
Cotabato-2	0.0505±0.003	0.0750±0.002	6.47	14.1	0.0001

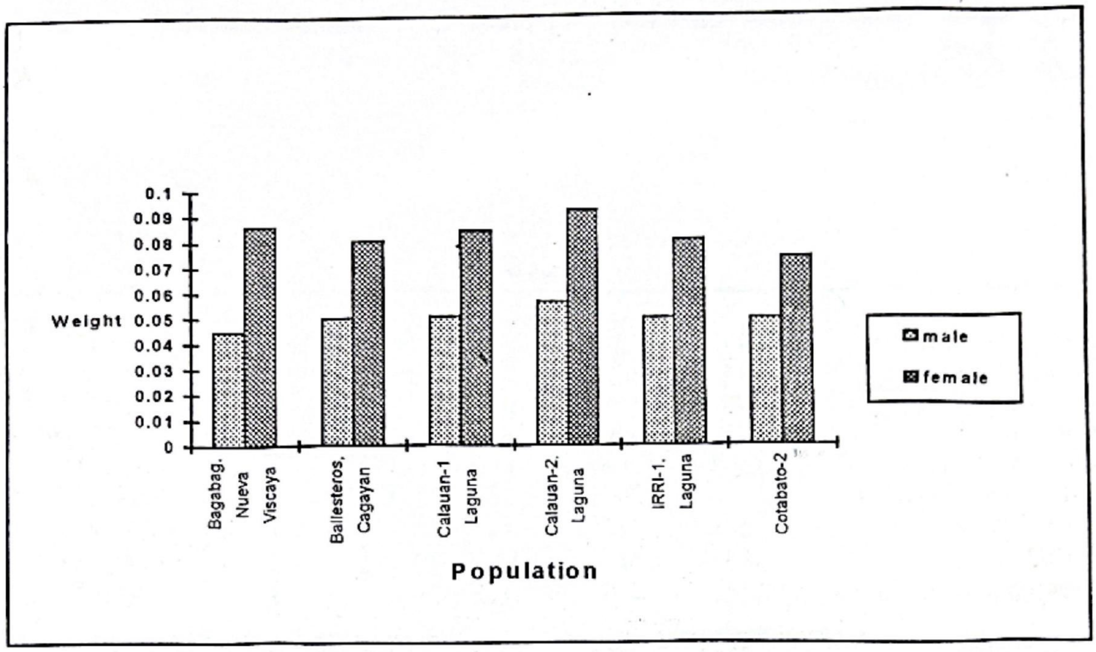

Figure 2. Pupal weights of six strains of C. suppressalis reared in artificial diet. The interaction plot indicates differences in pupal weights between the two sexes of the borer. As seen in the Figure, females are heavier than males in all of the strains studied.

Hatching to Emergence. Development of the borers from hatching to emergence from different colonies was recorded and subjected to analysis of variance (Table 1). There were significant population differences. Development of males and females differed within populations and was also shown to be a significant contributor to the variation between population observed (Table 1). Ifugao had the longest mean development time while Calauan-2 hadthe shortest developmental period (Table 1).

Sex Ratios. Test of goodness of fit on sex ratios of developing larvae using G-statistics (Sokal and Rohlf, 1981) revealed significant excess in males in 7 of 9 local populations of the striped stem borer (Table 3). Similar results were also observed among the emerging adults (Table 4). Adult sex ratio of Cotabato - 1 was not recorded. Two populations, Calauan - 1 and Lamut in Ifugao had small (nonsignificant) excess (larval and adult) sex ratios. All other populations deviated significantly from 1:1 sex ratio. The total G is consequently highly significant. The pooled G, which indicated a view of the consistent trend in favor of the males, is also highly significant. Heterogeneity among the populations was also significant, showing that there were differences among populations in sex ratio. The F_1 progenies of IRRI-2 which were collected three months later than IRRI-1 population showed the highest deviation from the sex ratio (G=241.645) although the IRRI-1 population exhibited also a relatively high (G=28.836) deviation compared to other populations. Cotabato-2 population which was collected from rice stalks in the fields in Koronadal, South Cotabato showed the lowest deviation (G = 3.67). Calauan (Poblacion) and Ifugao (Lamut) were in accordance to the 1:1 sex ratio.

Table 3. Sex ratios of first generation larval progenies of selected strains of *C. suppressalis* collected from different locations in the Philippines.

POPULATION	SEX RATIO #					
	male	female	N		DF	G[a]
Ballesteros, Cagayan	195	131	326		1	12.64**
Lamut, Ifugao	143	139	282		1	0.05 ns
Cotabato-1	961	858	1819		1	6.28*
Cotabato-2	352	303	655		1	3.67*
Calauan-1, Laguna	407	283	690		1	22.40**
Calauan-2, Laguna	106	98	204		1	0.3 ns
IRRI-1, Laguna	302	185	487		1	28.38**
IRRI-2, Laguna	832	315	1147		1	241.64**
Bagabag, Nueva Viscaya	335	240	575		1	16.16**
Total	3633	2552	6185	Total	9	331.56**
				Pooled	1	189.09**
				Heterogeneity	8	141.653**

\# The null hypothesis is a 1:1 sex ratio.
* Significant at 5% level.
** Significant at 1% level.
a G- G - statistics (Sokal and Rohlf, 1971).

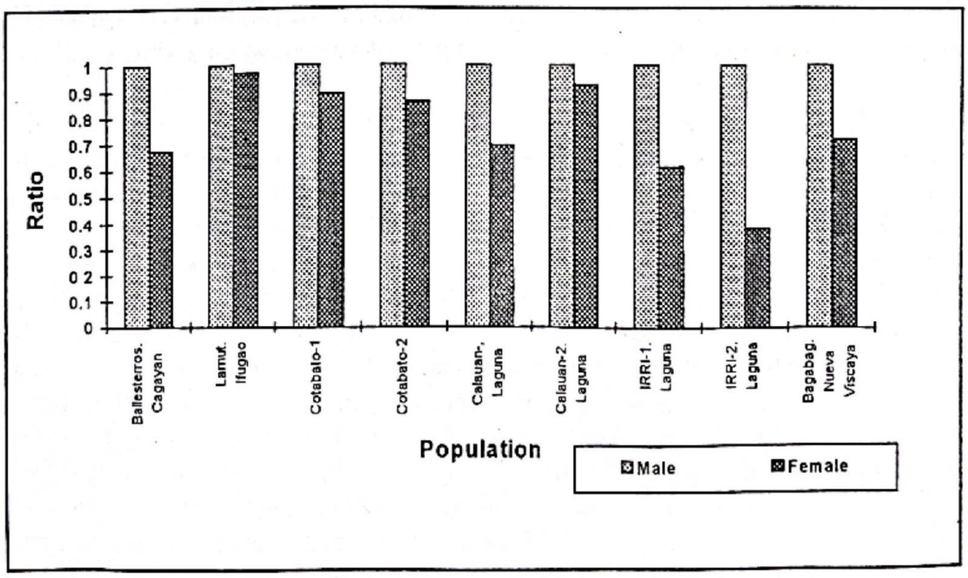

Figure 3. Sex ratios of first generation (F_1) larval progenies of nine *C. suppressalis* strains.

Table 4. Sex ratios of first generation emerging adults of selected strains of *C. suppressalis*.

POPULATION	SEX RATIO # Male	Female	N		DF	G[a]
Ballesteros, Cagayan	189	127	316		1	12.24**
Lamut, Ifugao	135	135	270		1	0 ns
Cotabato-2	300	256	556		1	3.49*
Calauan-1, Laguna	402	280	682		1	21.94**
Calauan-2, Laguna	80	74	154		1	0.22 ns
IRRI-1, Laguna	250	165	415		1	24.65**
IRRI-2, Laguna	719	309	1028		1	168.15**
Bagabag, Nueva Viscaya	320	226	546		1	16.26**
Total	2395	1572	3967	Total	9	246.97**
				Pooled	1	171.98**
				Heterogeneity	8	74.98**

The null hypothesis is a 1:1 sex ratio.
* Significant at 5% level.
** Significant at 1% level.
a G - G - statistics (Sokal and Rohlf, 1971).

The results on sex ratios monitored for several generations (Table 5) revealed that heterogeneity exists only in IRRI populations. Reciprocal crosses of selected populations showed that sex ratio seems intermediate (Table 6 and 7).

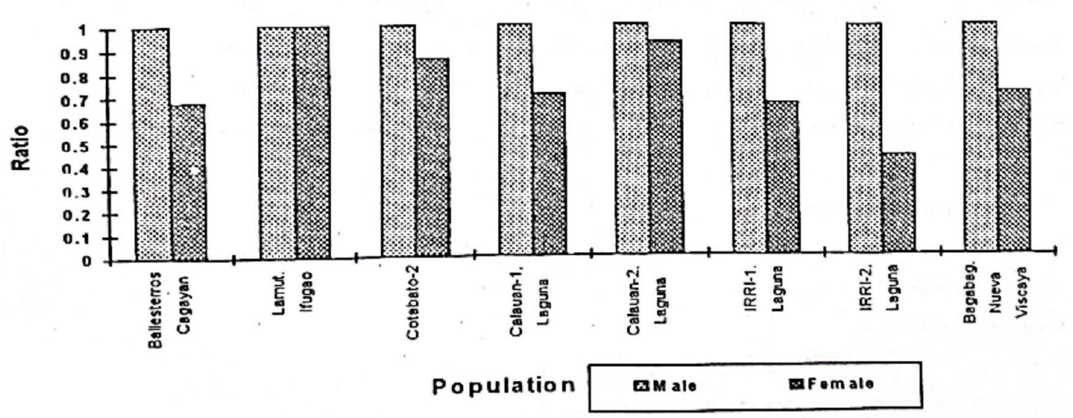

Figure 4. Sex ratios of first generation emerging adults of eight *C. suppressalis* strains.

Table 6. Comparison of sex ratios of six strains of *C. suppressalis* each generation in culture.

GENERATION	POPULATION					
	Ballesteros, Cagayan	IRRI-1, Laguna	IRRI-2, Laguna	Lamut, Ifugao	Bagabag, N. Viscaya	Koronadal, S. Cotabato
First	195:131	302:185	832:315	143:139	335:240	961:858
G	12.64*	28.39*	241.64*	0.06ns	16.67	6.28*
Second	408:241	396:200	531:279	101:95	nr	nr
G	43.47*	65.67*	82.99*	0.20ns	-	-
Third	nr	381:194	443:215	85:104	nr	nr
G	-	61.93*	80.67*	1.94ns	-	-
Fourth	1047:638	297:205	nr	509:411	537:507	181:195
G	100.29*	16.96*	-	10.45*	0.88ns	0.51ns
Fifth	nr	360:164	nr	nr	249:217	nr
G	-	75.12*	-	-	1.93ns	-
Sixth	326:243	282:190	nr	nr	157:126	nr
G	12.14*	18.05*	-	-	3.40ns	-
Seventh	nr	nr	nr	nr	7150	nr
G	-	-	-	-	2.38ns	-
	1976:1253	2018:1138	1619:755	1349:1142	139:1142	1142:1053
Total	G=168.6*	266.12*	405.3*	12.65*	24.6*	6.79*
Pooled	163.25*	248.65*	321.79*	5.01ns	17.21*	3.60ns
Heterogeneity	5.30ns	17.45*	83.51*	7.64ns	7.39*	3.19*

* significant at 1% level;

ns- not significant;

nr- not recorded;

G- G-statistics

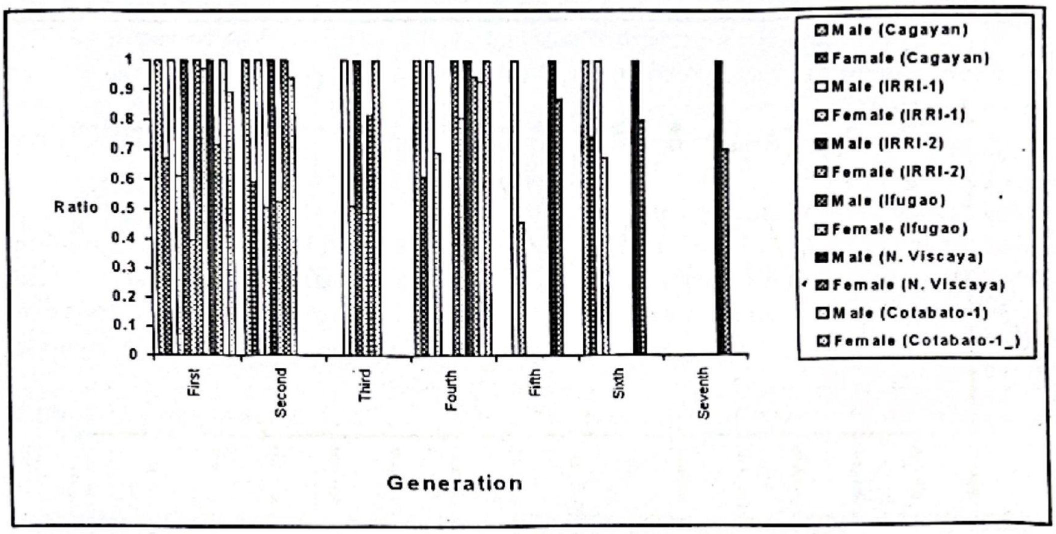

Figure 5. Sex ratios of six *C. suppressalis* strains in culture.

Table 6. Comparison of sex ratios of selected strains of *C. suppressalis* and their hybrids.

POPULATION	SEX			PROPORTION OF FEMALES	
	Male	Female	N		G
Cagayan (P)	1047	638	1685	0.378	100.29 **
IRRI-1 (P)	453	364	817	0.445	9.70 **
IRRI-2 (P)	85	104	189	0.550	1.94 ns
Ifugao (P)	443	215	658	0.326	80.67 **
Cotabato-1 (P)	181	195	376	0.518	0.51 ns
Nueva Viscaya (P)	537	507	1044	0.485	0.88 ns
Cagayan (M) x IRRI-1 (F)	201	317	518	0.612	26.18 **
Cagayan (M) x IRRI-1 (F)	358	163	521	0.312	74.79 **
Ifugao (M) x IRRI-1 (F)	474	390	864	0.451	8.19 **
Ifugao (M) x IRRI-1 (F)	157	130	287	0.453	2.54 ns
IRRI-2 (M) x IRRI-1 (F)	236	119	355	0.335	39.28 **
IRRI-2 (M) x IRRI-1 (F)	205	101	306	0.330	36.09 **
Cotabato-1 (M) x IRRI-1 (F)	293	224	517	0.433	9.24 **
Cotabato-1 (M) x IRRI-1 (F)	264	196	460	0.426	10.10 **
Nueva Viscaya (M) x Cagayan (F)	211	105	316	0.322	36.26 **
Nueva Viscaya (M) x Cagayan (F)	64	43	107	0.401	4.15 **

* - significant at 5% level
** - significant at 10% level
G - G-statistics (Sokal and Rohlf, 1971)

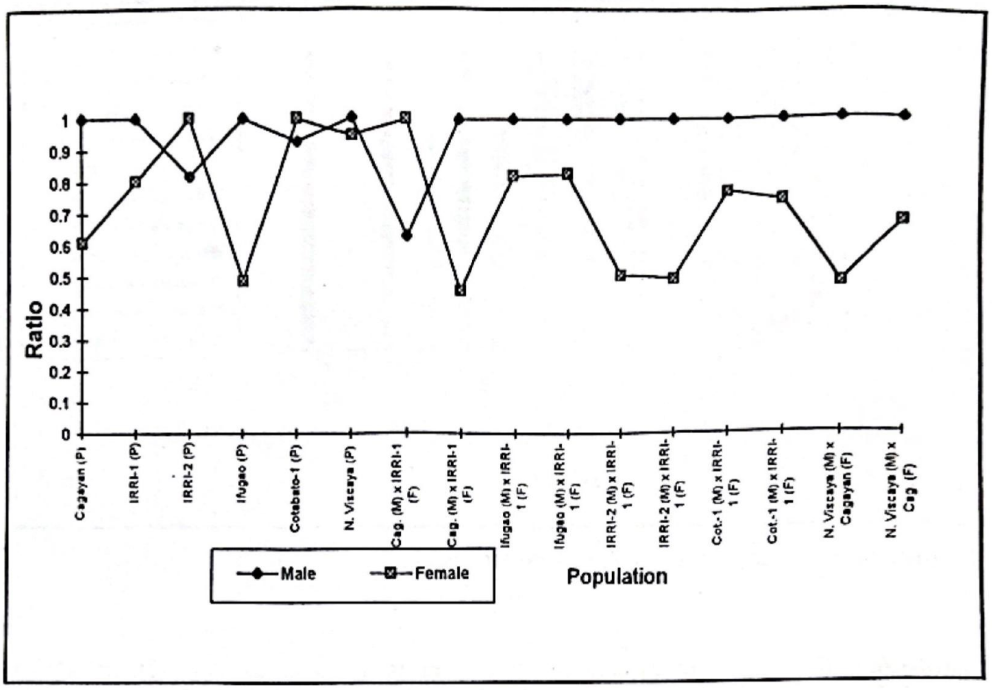

Figure 6. Sex ratios of *C. suppressalis* strains and their hybrids.

Table 7. Comparison of larval, pupal, hatching to emergence times of *C. suppressalis* strains from Cotabato-2, IRRI, and t':eir hybrids.

DEVELOPMENT (DAYS)		POPULATION							
		Cotabato-2	N	IRRI	N	Cotabato (F) x IRRI (M)	N	Cotabato (M) x IRRI (F)	N
Larva	Male	47.459±6.463	181	41.018±9.687	453	46.405±6.951	264	43.352±5.722	256
	Female	49.395±4.731	195	40.360±9.205	364	51.107±7.877	196	47.609±6.925	102
Pupa	Male	8.651±2.056	144	9.629±2.360	387	9.588±2.320	245	9.251±2.364	211
	Female	8.692±1.933	214	10.053±2.167	246	9.357±2.162	168	9.869±2.252	119
Hatching to Emergence	Male	58.396±7.859	154	49.954±8.445	372	55.335±6.149	185	51.886±5.284	202
	Female	56.219±6.832	192	52.130±8.061	247	60.316±7.964	158	57.032±6.305	155

Development on Host Rices. Means and standard errors of relative growth rates, pupal weights, development time, and sex ratios between populations reared on nine rice varieties are presented in Tables 8 - 11. Significant differences in relative growth rates were observed between populations (Table 8). The effect of rice variety was also significant but was not a factor for the differences observed between the populations. For pupal weights, no population and variety effects were observed (Table 9). For mean development time, no significant differences were observed between populations but the effect of the variety was very significant (Table 10). The sex ratios of those which have completed development on different rices show significant excess in males both within and between varieties and between populations as shown by large G-value.

Table 8. Comparison of relative growth of five strains of *C. suppressalis* reared on nine rice types.

	POPULATION					
VARIETY	Ballesteros, Cagayan	Koronadal, Cotabato	Lamut, Ifugao	IRRI, Laguna	Bagabag, Nueva Viscaya	Average all strains
O. nivara	0.178 ± 0.04	0.146 ± 0.03	0.123 ± 0.02	0.189 ± 0.04	0.228 ± 0.04	0.173 ± 0.03
O. officialis	0.151 ± 0.04	0.193 ± 0.05	0.224 ± 0.06	0.096 ± 0.02	0.487 ± 0.14	0.230 ± 0.15
O. barthii	0.075 ± 0.01	0.072 ± 0.01	0.110 ± 0.02	0.107 ± 0.02	0.235 ± 0.06	0.120 ± 0.05
IR40	0.199 ± 0.07	0.208 ± 0.05	0.116 ± 0.02	0.177 ± 0.03	0.242 ± 0.06	0.188 ± 0.04
IR56	0.050 ± 0.02	0.112 ± 0.02	0.160 ± 0.03	0.171 ± 0.03	0.248 ± 0.05	0.148 ± 0.07
IR62	0.150 ± 0.02	0.113 ± 0.02	0.169 ± 0.03	0.143 ± 0.03	0.164 ± 0.04	0.148 ± 0.02
CO18	0.118 ± 0.03	0.115 ± 0.02	0.064 ± 0.02	0.125 ± 0.03	0.274 ± 0.07	0.139 ± 0.07
W1253	0.125 ± 0.02	0.087 ± 0.03	0.083 ± 0.01	0.083 ± 0.02	0.246 ± 0.06	0.125 ± 0.07
Rexoro	0.221 ± 0.06	0.125 ± 0.03	0.172 ± 0.04	0.181 ± 0.04	0.285 ± 0.08	0.197 ± 0.06
Average for all hosts	0.141 ± 0.05	0.130 ± 0.04	0.136 ± 0.05	0.141 ± 0.04	0.268 ± 0.08	

Source	DF	MS	F	Pr>F
Population	4	5.79	8.52	0.0001
Variety	8	2.45	3.61	0.0005
Variety x Population	32	0.84	1.23	0.1902

Table 9. Comparison of weights of pupae of five strains of *C. suppressalis* reared on nine rice types.

	POPULATION					
VARIETY	Ballesteros, Cagayan	Koronadal, Cotabato	Lamut, Ifugao	IRRI, Laguna	Bagabag, Nueva Viscaya	Average. all strains
O. nivara	0.044 ± 0.01	0.046 ± 0.01	0.049 ± 0.01	0.044 ± 0.01	0.044 ± 0.01	0.046 ± 0.00
O. officialis	ns_	ns_	ns_	ns_	ns_	ns
O. barthii	0.052 ± 0.01	0.016 ± 0.02	0.050 ± 0.01	0.050 ± 0.01	0.026 ± 0.01	0.039 ± 0.02
IR40	0.049 ± 0.01	0.038 ± 0.01	0.047 ± 0.01	0.044 ± 0.01	0.043 ± 0.01	0.045 ± 0.06
IR56	0.043 ± 0.01	0.041 ± 0.00	0.050 ± 0.00	0.043 ± 0.01	0.049 ± 0.01	0.046 ± 0.004
IR62	0.045 ± 0.01	0.041 ± 0.01	0.043 ± 0.01	0.041 ± 0.01	0.046 ± 0.01	0.045 ± 0.003
CO18	0.045 ± 0.01	0.038 ± 0.01	0.045 ± 0.01	0.041 ± 0.01	0.045 ± 0.00	0.042 ± 0.004
W1253	0.042 ± 0.01	0.037 ± 0.01	0.047 ± 0.01	_	0.041 ± 0.01	0.042 ± 0.004
Rexoro	0.059 ± 0.01	0.043 ± 0.01	0.041 ± 0.01	0.042 ± 0.01	0.049 ± 0.01	0.047 ± 0.008
Average for all hosts	0.047 ± 0.01	0.037 ± 0.01	0.046 ± 0.01	0.041 ± 0.01	0.043 ± 0.01	

Source	DF	MS	F	Pr>F
Population	4.00	0.105	1.00	0.4097
Variety	7.00	0.035	0.33	0.9393
Variety x Population	27.00	0.075	0.8476	0.8476

NS - No Survivor

Table 10. Comparison of development time of five strains of *C. suppressalis* reared on nine rice types.

	POPULATION					
VARIETY	Ballesteros, Cagayan	Koronadal, Cotabato	Lamut, Ifugao	IRRI, Laguna	Bagabag, Nueva Viscaya	Average all strains
nivara	30.00+7.20	23.40+4.83	26.20+5.99	24.42+5.12	19.00+1.83	24.604+4.017
O. barthii	26.91+6.87	29.50+7.06	26.44+8.31	28.91+7.76	19.00+1.83	26.152+4.202
IR40	24.15+6.22	26.58+6.58	18.00+5.36	25.22+3.78	28.13+7.15	24.416+3.885
IR56	28.00+8.42	28.75+6.34	27.83+5.49	28.20+4.60	34.00+0.00	29.356+2.619
IR62	31.31+7.23	30.00+7.20	26.42+10.78	26.00+4.15	33.00+11.80	29.346+30.058
CO18	33.14+3.02	30.24+6.06	33.16+10.53	34.25+8.38	35.00+5.69	33.158+1.809
W1253	32.63+8.20	24.33+7.37	30.20+6.53	33.00+4.24	37.30+5.68	31.492+4.750
Rexoro	29.00+3.81	28.33+7.45	28.04+7.82	32.00+3.46	37.33+5.68	30.94+3.903
Average for all hosts	29.393+3.03	27.641+2.606	27.036+9.346	29.00+3.732	30.345+7.574	

Source	DF	MS	F	Pr>F
Population	4.00	87.453	1.63	0.1685
Variety	7.00	242.623	4.53	0.0001
Variety x Population	28	41.399	0.77	0.7876

- no data on O. officialis due to 100% mortality in all populations.

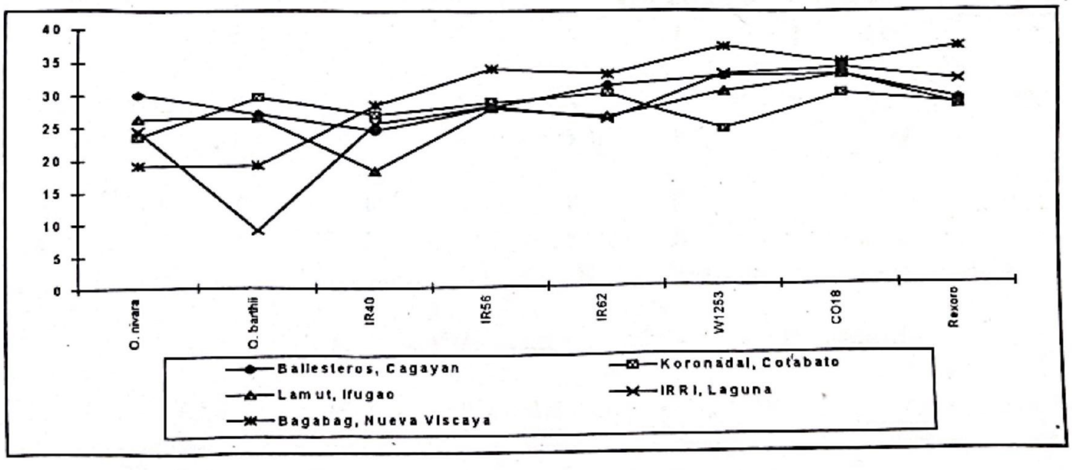

Figure 7. Development time of five strains of *C. suppressalis* reared on nine rice types. Even though the line segments of the five strains are not all parallel, the statistical analysis indicates that the lack of parallel line segments is caused by error variance and not by strain-by-rice type interaction.

Table 11. Comparison of sex ratios of five strains of *C. suppressalis* reared on nine rice types.

		POPULATION							
VARIETY	SEX	Ballesteros. Cagayan	Koronadal, Cotabato	Lamut, Ifugao	IRRI, Laguna	Bagabag, Nueva Viscaya	Total	G-Value	Host Sex Ratio
O. nivara	male	12	9	7	9	6	43	22.15**	0.81
	female	1	1	6	2	0	10		0.18
O. Officinalis	male	0	2	0	0	0	2	0	1
	female	0	0	0	0	0	0		0
O. barthii	male	7	9	10	6	6	41	12.56**	0.73
	female	8	2	2	2	2	15		0.26
IR40	male	13	10	8	8	8	46	9.27**	0.79
	female	3	2	2	2	2	12		0.20
IR56	male	13	2	12	9	9	38	12.22**	0.76
	female	5	1	4	1	1	12		0.24
IR62	male	14	9	9	10	10	51	40.65**	0.89
	female	1	1	1	0	0	6		0.10
CO18	male	9	14	5	3	3	35	25.33**	0.87
	female	1	1	2	0	0	5		0.12
W1253	male	10	5	8	2	2	31	23.65**	0.88
	female	1	1	2	0	0	4		0.11
Rexoro	male	5	7	9	4	4	26	10.05**	0.76
	female	1	1	2	2	2	8		0.23
	Total[a/]	83/21	67/10	68/21	51/9	44/11	31/82		
Population sex ratio		0.798:0.202	0.870:0.13	0.764:0.236	0.85:0.15	0.80:0.20	3.82/1		0.79:0.21
G-value		39.54**	47.25*	26.12**	32.46**	21.19**	14414**		

a/ above diagonal - male; below diagonal - female.
** significant at 1% level

Discussion

The results of this study generally show that life history differences observed between populations are location - dependent. What was interesting with this result was the variation observed between two Cotabato, two Calauan, and two IRRI populations. Cotabato-2, a population of SSB initially collected from rice stalks showed a significantly longer larval development time than that of the population collected from light trap (Cotabato - 1). This was also true with the two Calauan populations (Calauan - 1 moths were collected by test tubes from rice leaves while Calauan -2 was collected from a light trap) and the two IRRI populations (both were collected from light traps but at different times). The mean larval, pupal, and emergence time differences between these geographically close populations are indications of genetic divergence in these traits as well as of relatively restricted dispersal of the insects. However, restricted dispersal of the pest may not hold true in all cases given differences observed in two IRRI populations collected at different times but showed big differences in duration of development. This may be due to adaptation to environmental conditions such as the effect of rice varieties planted in the area, the effect of varying photoperiods, the cultivation time of the planted rice (Kikuchi, 1964; Calora and Reyes, 1971; Kishino, 1974; Koyama, 1977) or to maternal effects.

It is very difficult to assign a single meaningful sex ratio for the species *Chilo suppressalis*. Even among populations which deviated significantly from the 1:1 sex ratio the specific sex ratios varied significantly. Hybridization of colonies indicates that sex ratio is a heritable trait in SSB.

The observed variations in sex ratios between populations and within a colony over time represent striking exceptions to Fisher's theory (Fisher, 1930) that the sex ratio is in equilibrium when the totals of effort spent producing the two sexes are equal. The non-fixed ratios in most populations could be due to the fact that striped stem borers from the field seldom possess a fixed and uniform population growth rate over long time period. There are also explanations that because males are sexually capable throughout their adult lives and available females are available only briefly, the functional sex ratio becomes markedly skewed towards males.

Conclusion

It can be concluded from this study that life history of the striped stem borer is variable and significantly differs from population to population. The variations observed in development between the populations could not be attributed to synchronization of rice planting since all the insect populations investigated were collected from areas where asynchronous planting was observed. Sex ratios of hybrids are intermediate between the two parental populations, indicating that this trait is heritable.

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