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Studies on the combined effects of constant temperature and relative humidity on progeny production and sex-ratio of *Cheiloneurus pyrillae* Mani, an egg parasitoid of *Pyrilla perpusilla* Walker

With Table 1–3

Introduction

The sugarcane leaf hopper (*Pyrilla perpusilla* Walker) is one of the most serious pest of sugarcane crop in almost all the parts of Indian sub-continent. It often occurs in epidemic proportion and accounts for heavy losses to cane growers and sugar industry as well. Fortunately this pest is known to be attacked by a large complex of natural enemies including the egg parasitoid, *Cheiloneurus pyrillae* Mani (Encyrtidae: Hymenoptera) in India. Few workers like Muliyil and Lakshamanan (1942) and Narayanan and Kundan Lal (1953), although, had realised the importance of this egg parasitoid in the population fluctuation of *Pyrilla* in sugarcane fields, nothing is known so far about the effect of any physical factor on the various life processes of this parasitoid. In order to explore the possibility of its use as bio-control agent, attempts were made, for the first time, in the present study to gather information about the effects of two important physical factors like temperature and relative humidity on the progeny production and sex-ratio of *C. pyrillae* and the results so obtained are presented in this paper.

Material and methods

Parasitised eggs of *P. perpusilla* were collected from the sugarcane fields and parasitoid adults emerged from such eggs in the laboratory were used for experimental purposes. Five pairs of freshly emerged adults of *C. pyrillae* were isolated from its stock culture and released in a glass rearing tube (10 × 3.75 cm). Three such tubes were prepared and kept for study at each of 27 combinations of constant temperature and relative humidity. Altogether, there were nine test temperatures viz; 15, 17.5, 20, 22.5, 25, 27.5, 30, 30.5 and 35 ± 1.5°C and for each of these temperatures there were three regimes of relative humidity viz; 50, 70 and 90 percent. Adult parasitoids in each rearing tube were provided with sufficient number of freshly laid eggs of *Pyrilla* for parasitisation and were fed on sucrose solution (10%). Open ends of these rearing tubes were closed with fine muslin cloth pieces. The host eggs for parasitisation and diet for feeding of parasitoid adults were renewed daily till all the parasitoid adults died in a rearing tube. The host eggs after subjecting them to overnight parasitisation were withdrawn from respective rearing tubes and were examined daily to record the

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number of healthy as well as parasitised host eggs, on the basis of symptoms that appeared externally in them. The fertility of female parasitoid was measured in terms of the average number of host eggs that displayed the symptom of parasitisation due to a single female. Total number of parasitoid adults emerging from the parasitised host eggs and the number of males and females in a total emergence were counted to work out the percentage of adult emergence as well as the relative proportion of two sexes at different test combinations of temperature and relative humidity. Data, in percentages, on adult emergence and proportion of females were subjected to angular transformation and those on fertility were transformed to $\sqrt{N+1}$ before analysing them statistically.

For maintaining constant temperatures, B.O.D. incubators were used whereas desired levels of relative humidity were obtained in desiccators by using different concentrations of potassium hydroxide solution following the method of SOLOMAN (1951).

Results

A. Fertility of female

From the data given in Table 1, it is obvious that *C. pyrillae* reacted sharply to different levels of temperature but its responses to varying levels of relative humidity

Table 1
Fertility (Mean number of parasitised host eggs/female) of *Cheiloneurus pyrillae* MANI at various combinations of constant temperature and relative humidity.

Temperature (± 1.5 °C)	Relative humidity (%)			Mean
	50	70	90	
15.0	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
17.5	3.30 (2.07)	3.73 (2.18)	3.73 (2.17)	3.59 (2.14)
20.0	24.20 (5.02)	24.67 (5.07)	24.45 (5.04)	24.44 (5.04)
22.5	25.77 (5.17)	25.53 (5.14)	25.57 (5.15)	25.62 (5.16)
25.0	17.40 (4.29)	16.93 (4.23)	17.73 (4.32)	17.36 (4.27)
27.5	10.80 (3.43)	10.43 (3.38)	10.47 (3.39)	10.57 (3.40)
30.0	4.00 (2.24)	4.00 (2.23)	4.36 (2.32)	4.12 (2.26)
32.5	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
Mean	10.68 (3.02)	10.66 (3.02)	10.79 (3.05)	

	Temperature (A)	Relative humidity (B)	Interaction (A) × (B)
C. D. (P = 0.01)	(0.52)	*	*

* Not significant

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ranging from 50 to 90 percent remained almost alike. Its fertility rate was the maximum (25.62 eggs/female) at 22.5 ± 1.5°C. Any deviation in temperature from the optimum i.e. 22.5 ± 1.5°C, led to reduction in the fertility of this parasitoid and as such the lower and upper limits of the temperature at which the parasitoid female ceased to lay eggs were 15 and 32.5 ± 1.5°C, respectively. The second and third favourable temperatures, from the parasitoid's fertility point of view, were around 20 and 25°C, respectively.

B. Emergence of parasitoid adults

Effect of rearing temperature on the emergence of parasitoid was quite conspicuous but variation in the relative humidity, over a wide range of 50 to 90 percent, did not cause any significant difference (Table 2). The rate of parasitoid emergence, on an

Table 2
Mean percentage of adult emergence of *Cheiloneurus pyrillae* MANI at various combinations of temperature and relative humidity.

Temperature (± 1.5 °C)	Relative humidity (%)			Mean
	50	70	90	
17.5	84.2 (66.64)	83.1 (65.82)	83.3 (65.58)	83.5 (66.01)
20.0	94.8 (76.93)	95.1 (77.23)	94.7 (76.72)	94.9 (76.96)
22.5	93.1 (74.86)	94.6 (76.67)	94.0 (75.88)	93.9 (75.80)
25.0	91.0 (72.55)	90.3 (71.99)	90.1 (71.79)	90.5 (72.11)
27.5	77.9 (61.98)	74.8 (59.87)	78.4 (62.31)	77.0 (61.39)
30.0	60.0 (50.79)	60.7 (51.16)	60.2 (50.87)	60.3 (50.94)
Mean	83.5 (67.29)	83.1 (67.12)	83.4 (67.19)	

	Temperature (A)	Relative humidity (B)	Interaction (A) × (B)
C. D. (P = 0.01)	(1.95)	*	*

* Not significant.

average, was the highest (94.9%) at 20 ± 1.5 °C followed by 93.9 percent at 22.5 ± 1.5°C. With the further rise in rearing temperature above 22.5°C there was a corresponding decline in the rate of adult emergence and its minimum value i.e. 60.3 percent was obtained at 30 ± 1.5°C.

C. Sex-ratio

The ratio between males and females of *C. pyrillae* that emerged from the parasitised host eggs was found to vary remarkably with the changes in rearing temperature but it remained almost unaffected by variations in the relative humidity from 50 to 90 percent (Table 3). In general, there was a decline in the relative proportion of females as

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Table 3
Mean percentage of females of *Cheiloneurus pyrillae* MANI produced at various combinations of temperature and relative humidity.

Temperature (± 1.5 °C)	Relative humidity (%) 50	70	90	Mean
17.5	79.5 (63.14)	79.6 (63.17)	79.6 (63.16)	79.6 (63.16)
20.0	79.4 (63.02)	78.6 (62.49)	79.5 (63.15)	79.2 (62.88)
22.5	78.6 (62.46)	78.7 (62.50)	79.7 (63.25)	79.0 (62.74)
25.0	69.7 (56.69)	69.7 (56.56)	70.6 (57.22)	70.0 (56.83)
27.5	66.2 (57.81)	67.8 (55.47)	66.6 (54.74)	66.8 (56.00)
30.0	60.0 (50.97)	56.4 (46.66)	55.5 (48.18)	57.4 (49.27)
Mean	72.3 (59.01)	71.8 (58.14)	71.9 (58.28)	

	Temperature (A)	Relative humidity (B)	Interaction (A) × (B)
C. D. (P = 0.01)	(2.07)	*	*

* Not significant.

the rearing temperature increased from 17.5 to 30 ± 1.5°C. There was, however, no significant difference in the relative proportion of females, which varied from 89.0 to 79.9 percent at temperatures falling between 17.5 and 22.5 ± 1.5°C. The percentage of females, on an average, was found to be the minimum (57.4%) when the rearing temperature was kept at 30 ± 1.5°C.

Discussion

Findings of the present study revealed many interesting and useful information, hitherto unknown, about the reproductive biology of *C. pyrillae* in relation to temperature and relative humidity.

Temperature was found to influence the fertility of *C. pyrillae* whereas the relative humidity did not produce any remarkable impact. Lower and upper extremes of temperature beyond which the parasitoid female ceased to lay eggs were 17.5 and 30 ± 1.5°C, respectively whereas the optimum temperature for getting maximum fertility was found to lie around 22.5°C. Complete loss of fertility at or above 32.5 ± 1.5°C may be attributed to failure of mating and non-production of fertile eggs due to restlessness and extreme mobility in both sexes caused by high temperature as it was observed in the present study. Reduced rate of fertility with the decrease in temperature below the optimum level is probably due to reduced metabolic activity and complete suppression of oviposition at or below 15°C is obviously due to the complete loss of activities in either sexes. From these observations, it thus, becomes clear that *C. pyrillae* is able to breed over a very narrow range of temperature i.e. from 17.5 to

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30°C but its breeding activities remain unaffected by variation in relative humidity between 50 and 90 percent. Furthermore, a temperature around 22.5°C seems to be optimum for the maximum egg laying of this parasitoid in the laboratory and hence it could be expected to breed in the field only when such physical conditions exist therein.

Differential effect of temperature on the rate of adult emergence may be attributed to the differential rate of mortality among developing parasitoids at different rearing temperature. Such effects were observed in the case of certain other egg parasitoids like *Trichogramma evanescens minutum* RILEY and *Trichogramma fasciatum* PERKINS by PRADHAN and PESWANI (1954) and RAM and SHARMA (1977), respectively.

The sex-ratio of *C. pyrillae,* like that of its fertility and adult emergence was also greatly influenced by temperature and not by relative humidity. As the sex-ratio is known to be an important population growth parameter, effect of various factors including the temperature on it has been the subject of studies in insects of economic importance. Possible role of temperature in influencing the sex-ratio of an egg parasitoid, *T. evanescens* was first explained by LUND (1938). According to this author, the maximum number of parasitoid females emerged at 25°C and any deviation from it, lowered the relative number of females due to differential stimulation or inhibition of copulation or oviposition rate. In similar way, the role of temperature in influencing the sex-ratio of *C. pyrillae* may also be explained.

From the experimental results discussed above, it becomes clear that the egg parasitoid, *C. pyrillae* is very specific in its temperature requirement while it is able to breed and develop over a wide range of relative humidity. These findings may be utilised in raising the mass culture of this parasitoid in the laboratory and in making a guess about its fate under a particular set of temperature and humidity conditions prevailing in sugarcane fields.

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Summary

The natural population of the sugarcane leaf hopper (*Pyrilla perpusilla* WALKER), one of the major pest insects on sugarcane in India is regulated by a large complex of natural enemies, the egg parasitoid *Cheiloneurus pyrillae* MANI being one of them. Effects of controlled temperature and relative humidity on progeny production and sex-ratio of this egg parasitoid are discussed for the first time. This parasitoid is able to breed and develop over a wide range of relative humidity but it is very specific in its temperature requirements. Its breeding activities may increase or decrease depending upon the temperature. Lower and upper extremes of temperature within which this parasitoid could continue to breed were around 15 and 30°C, respectively. From the fertility point of view, a temperature between 20 and 25°C seems to be suitable for it but a temperature at 22.5 ± 1.5°C is preferred. Rearing of this parasitoid at 20 or 22.5 ± 1.5°C proved to be most advantageous for getting the maximum rate of parasitoid emergence. The relative proportion of females increases with the corresponding decrease in temperature from 30 to 17.5 ± 1.5°C, and at all the temperatures, the females outnumbered the males. Taking all the points into consideration, for better multiplication and development of *C. pyrillae,* a temperature around 22.5°C needs to be maintained, whereas the arrangements for maintaining the relative humidity may not be needed.

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Zusammenfassung

Die natürliche Population der Zuckerrohr-Singzikade (*Pyrilla perpusilla* WALKER), eines der hauptsächlichen Insekten auf Zuckerrohr in Indien, wird durch einen großen Komplex natürlicher Feinde geregelt, zu denen auch der Eierparasitoid *Cheiloneurus pyrillae* MANI gehört. Zum ersten Mal werden hier die Auswirkungen von Temperatursteuerung und relativer Luftfeuchtigkeit auf Nachwuchsproduktion und Geschlechterverhältnis dieses Eiparasitoiden erörtert. Dieser Parasitoid kann sich in einem breiten Bereich relativer Luftfeuchtigkeit fortpflanzen und vermehren, ist aber an sehr bestimmte Temperaturbedingungen gebunden. Seine Fortpflanzungsaktivität erhöht oder vermindert sich entsprechend der Temperatur. Die untere und obere Temperaturgrenze, innerhalb deren sich der Parasitoid vermehren kann, liegt etwa bei 15 °C bzw. 30 °C. Hinsichtlich der Fruchtbarkeit scheint eine Temperatur zwischen 20 °C und 25 °C förderlich zu sein, aber eine Temperatur von 22,5 °C ± 1,5 °C wird bevorzugt. Die Aufzucht des Parasitoiden bei 20 °C oder 22,5 °C ± 1,5 °C erwies sich am günstigsten zur Erzielung einer maximalen Vermehrung. Der relative Anteil der Weibchen erhöht sich bei entsprechendem Absinken der Temperatur von 30 °C auf 17,5 °C ± 1,5 °C, und bei allen Temperaturen überwiegt die Zahl der Weibchen die der Männchen. Zieht man alle Faktoren in Betracht, so sollte zur besseren Vermehrung und Entwicklung von *C. pyrillae* eine Temperatur um 22,5 °C eingehalten werden, während Vorkehrungen hinsichtlich der relativen Luftfeuchtigkeit nicht erforderlich sind.

Резюме

Объем естественной популяции тростниковой перчей цикацы (*Pyrilla perpusilla* WALKER), одного из самых распространенных насекомых на тростнике в Индии, регулируется большим комплексом естественных врагов, к которым относится и паразитоид *Cheiloneurus pyrillae* MANI. Впервые обсуждается влияние регулирования температуры и относительной влажности на производство потомства и соотношение полов этого паразитоида яиц. Этот паразитоид яиц может размножаться в широком диапазоне относительной влажности, требует, однако, определенных условий температуры. Активность его размножения повышается или снижается в соответствии с температурой. Верхняя и нижняя температурные границы в пределах, которых паразитоид может размножаться, равны примерно 15° или 30°C. Температура от 20°C до 25°C, кажется, благоприятствует плодовитости, но предпочтительная температура 22,5°C ± 1,5°C. Разведение паразитоидов при 20°C или 22,5°C ± 1,5°C оказалось оптимальным для достижения максимальной степени размножения. Относительная доля самок повышается при соответствующем снижении температур от 30°C до 17,5°C ± 1,5°C. При всех температурах количество самок превышает количество самцов. С учетом всех факторов для улучшения размножения и развития *C. pyrillae* рекомендуется соблюдать температуру ок. 22,5°C, а меры регулирования относительной влажности воздуха не требуются.

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