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Biology of *Pyrilla perpusilla* Walker (Homoptera:Lophopidae), A Pest of Sugarcane in the Wet Zone of Sri Lanka

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Abstract: Biology, life history, preliminary behaviour of mating and egg laying and laboratory rearing of *Pyrilla perpusilla* Walker (Homoptera:Lophopidae) were studied in University of Kelaniya in the wet zone of Sri Lanka from 1993 July to 1994 July. The bug is one of the serious insect pests of sugarcane in Sri Lanka. Female *P. perpusilla* has a pre oviposition period of 8.8±1.077 days and the average fecundity was 133±10.2 eggs. Eggs are laid in clusters on both the lower (abaxial surface) and upper surfaces (adaxial surface) of sugarcane leaves preferably on lower surface and are covered with white waxy filaments. The eggs are white, oval and have a mean length of 1.04±0.148 mm. Incubation period was 6.9±0.87 days in the field conditions and 6.8±0.81 days in cage conditions. There were five nymphal instars and nymphal phase was 40-60 days. Longevity of the adult female was significantly greater than that of males. Analysis of aggregated sampling data for males and females showed that the sex ratio was 1: 1.

Key words: *Pyrilla perpusilla*, sugarcane planthopper, biology, sugarcane, Sri Lanka

Introduction

Sugarcane is commercially cultivated on a large scale in the dry zone in Sri Lanka especially in the Ampara (6° 23' N latitude and 81° 00' longitudes) and Moneragala (7° 16' N latitude and 81° 40' longitudes) districts. The plantations are found in the areas of Higurana, Pelwatta, Sevanagala and Udawalawe. Although there are no large scale cultivations of sugarcane in the wet zone of Sri Lanka, at present it is grown in home gardens in the wet zone for indigenous medicinal purposes (personnel observation by both authors).

Sugarcane is subjected to attack by number of insect pests, resulting in loss in yield, poor juice quality and low sugar recovery. The most serious insect pest of sugarcane recorded in sugarcane growing areas in Sri Lanka during the recent past was the Sugarcane Planthopper *Pyrilla perpusilla* Walker (Homoptera: Lophopidae) (Kumarasinghe, 1988). It can be seen at low levels of population in wet zone (personnel observation by both authors) and, is also a widely distributed in the Oriental region. It is one of the most destructive pests of sugarcane (Gupta and Ahamad, 1983).

Both nymphs and adults of this pest suck sap from the leaves of sugarcane but most of the damage is caused by the nymphal stage. The feeding punctures turn pale yellow and the coalescence of such spots imparts a yellowish colour to the leaves (Butani, 1964). Furthermore, due to continuous feeding of sap by thousands of planthoppers, the leaves become wilted and growth of the plant is arrested. In addition to the direct physical injuries, *P. perpusilla* is also responsible for reduced

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photosynthesis due to the growth of powdery mildew on its honeydew secretions (Asre *et al*., 1983). Rahman (1942) and Rahman and Singh (1943) have assessed that the heavy *P. perpusilla* infestations reduce the sucrose content by 3-4% and purity by 3-26%. However, they found that the glucose ratio of the plant increases three fold after *P. perpusilla* infestations.

A large number of plants including various types of grass species are recorded as alternate hosts of *P. perpusilla* and some of these are used by this pest for both feeding and reproduction. *Zea mays*, *Sorghum* sp. (Gupta and Avasthy, 1954) *Pennisetum americanum*, *Hordeum vulgare* (Brar, 1981), *Mormordica charantia*, *Abelmoschus esculentus*, *Luffa aegyptica*, *Citrulus vulgaris*, *Cucurbita pepo* (Rahman and Nath, 1940), *Oryza sativa* (Power, 1981), *Avena fatua* (Sinha *et al*., 1974), *Pisum sativum* and *Bambusa arundinacea* (Flether and Ghosh, 1919) serve as alternative host plants for *P. perpusilla*.

The increasing impact of *P. perpusilla* has elicited concern among entomologists who require pest management options. The biology and behaviour of *P. perpusilla* were described by some entomologists in various parts of the India (Gupta and Ahamad, 1983; Rahman, 1942; Fletcher, 1914; Quadri and Aziz, 1950; Patel *et al*., 1993). However, according to Kumarasinghe and Wratten (1996), many of these studies are incomplete and have limited applicability. Furthermore, there is little information available on the biology of this pest in the dry zone of Sri Lanka (Kumarasinghe and Ranasinghe, 1985), and there is no information available in the wet zone of Sri Lanka at all. Therefore, the main objectives of the present study were to elucidate the biological, behavioural and morphological aspects of *P. perpusilla* in the wet zone of Sri Lanka. Results presented here may be helpful for future planning of large scale cultivation of Sugarcane in the same environmental conditions in the tropics especially for pest management purposes.

Materials and Methods

Experimental Plot

Studies were carried out on a sugarcane plot of 25x25 m located within the premises of the University of Kelaniya, in Gampaha district (7°22' N latitude and 79° 83' longitudes) in the wet zone of Sri Lanka during the period of July 1993 to July 1994. The cuttings of the sugarcane variety Co 775 obtained from the Sugarcane Research Institute were planted within experimental plot following standard agricultural practices. The number of plants in the experimental plot was approximately 1100. Plants were fertilized with NPK fertilizer once in 3 months and watering was carried out when necessary. No insecticides, herbicides or fungicides were used.

Experimental Insects

Four to five months after planting, naturally occurring *P. perpusilla* began to attack the plants. Field and laboratory experiments were started after *P. perpusilla* became available in the experimental plot. Some biological aspects were studied in rearing cages outside the experimental plot since both nymphs and adults were very active jumpers.

Experimental Protocol

Rearing Studies

P. perpusilla was reared in controlled conditions in the cages at University of Kelaniya, Sri Lanka, to determine its biological aspects such as oviposition, fecundity, longevity and also for development experiments. Adults of *P. perpusilla* were collected from the experimental plot and reared outdoors

in cages made with wooden frames (150x150x60 cm) and covered on all sides with organdy cloth. There was an opening of 90x60 cm covered with organdy cloth on one side of each cage for introduced sugarcane plants and the insects. Cage was placed on a wooden platform covered with polythene to protect it from termite attack.

Sugarcane plant approximately 60 cm in height and grown in soil polythene container (25 cm diameter and 35 cm high) were separately placed inside each cage. Unparasitized egg clusters collected from the sugarcane plot together with parts of the sugarcane leaves on which they were found were stapled on to leaves of a potted plant without disturbing the eggs (the criterion used to recognize a parasitized egg was dark colour as opposed to the white colour of the unparasitized one). Egg clusters were examined daily until the eggs hatched.

Life Stages Studies

Upon hatching the first instar nymphs from each egg cluster were transferred to potted plant placed inside another cage. These nymphs were left undisturbed to feed, moult and eventually metamorphose into adults. Adults were carefully observed and sexed using morphological features.

Pre- oviposition, oviposition and post oviposition periods were studied under laboratory conditions. Adult males and females were collected from the rearing cages within 24 h of last moult. Batches of the three males and a female were placed separately in twenty rearing jars (10 cm internal diameter x 21 cm high). A 10-12 cm long piece of sugarcane leaf was placed inside each jar; the leaf portions provided nourishment for *P. perpusilla* as well as surfaces on which to rest and oviposit. A 2.5 cm thick layer of plaster of pairs was laid at bottom of each jar in order to provide sufficient moisture for sugarcane leaf from wilting. The mouth of each jar was covered with a muslin cloth allowing aeration to the adults. Fresh leaves were supplied daily while removing the old leaves. Insects in the rearing jars were monitored daily until all the insects died. Pre oviposition, oviposition and post oviposition periods were recorded.

Twenty pairs of newly emerged adults collected from the rearing cages were placed inside a new rearing cage containing a potted sugarcane plant. They were allowed to mate and oviposit. The number of egg clusters produced each day by the 20 females was recorded. In another separate experiment, newly emerged adult males (n = 20) and females (n = 20) were collected from the rearing cages and placed separately in rearing jars described earlier with 10-12 cm long piece of sugarcane leaf. Fresh leaves were supplied daily while removing the old leaves. Insects in the rearing jars were monitored daily until all the insects died in order to determine the longevity of adults.

Incubation period and viability of eggs were studied both in the laboratory and field. Newly laid egg clusters were randomly selected in rearing cages (n = 20) and field (n = 20). They were observed daily until hatching. To determine percentage viability of eggs, unparasitized egg clusters along with parts of the sugarcane leaves on which they were found were collected from the experimental plot (n=20) and rearing cages (n=20). The number of eggs in each cluster was recorded after carefully removing the white waxy filament covering with a camel hair brush. Number of unhatched eggs in each cluster was recorded after the incubation period. The incubation period and viability of eggs in inside the cage and under field conditions were compared using t-test.

For the developmental experiment, ten sets of newly hatched first instar nymphs were reared individually on pieces of sugarcane leaves placed in rearing jars described earlier; approximately 10-12 cm long piece of sugarcane leaves were placed obliquely inside the jars with one end resting on the bottom and the other touching the sides of the jar with the adaxial surface facing upwards. This disposition of the leaves enabled nymphs to rest and feed on the abaxial surface as they usually do in

the field. The pieces of leaves were replaced daily with fresh ones. Nymphs were examined daily and the number of instars was determined by observing moults. Exuviae were removed as they appeared and the duration of each instar also recorded.

Morphological Studies

Twenty egg clusters were collected from the experimental plot and brought into the laboratory with the parts of leaves on which they were attached. Length and breadth of each egg cluster was measured using dividers and a millimeter scale. The waxy filaments covering was gently removed using camel hair brush. The eggs were then individually transferred to a glass slide and length and breadth of each egg was measured under a light microscope fitted with a micrometer eyepiece. A total of 200 randomly selected eggs were measured. The length and breadth of first and second instars were measured using a light microscope fitted with a micrometer eye piece; the later instars and adults were measured using a pair of dividers and a millimeter scale. Morphological features of the eggs, nymphs and adults were examined under a stereomicroscope (x25).

Field Studies

Sex ratio, mating and oviposition behaviour of the *P. perpusilla* were studied under field condition. To determine the sex ratio, adult *P. perpusilla* present on every plant under experimental plot were sexed and counted once a week. This was possible on account of low population density. As it was possible to distinguish adult males from females using morphological differences in the abdominal tips; approximately 50% of adults present in the field on each sampling occasion were sexed *in situ*. Sex ratio of adults was determined using χ^2 test.

Preliminary observations of mating and egg laying behaviour were carried out in the field. Focal animal sampling (Martin and Bateson, 1986) was chosen (observing one individual until the end of the desired behavior) and duration of time for the behaviour was recorded (n = 20). The total numbers of egg clusters found on the adaxial and abaxial surfaces of the leaves of every plant in the experimental plot was counted once a week. At the same time, total numbers of egg clusters found on the luxuriant plants and scraggy plants were also recorded. Data were analysed using paired sample t-test for oviposition site selection.

Measurements of Physical Environmental Factors

Daily maximum and minimum temperatures within the experimental plot and rearing cages were measured using a six's maximum and minimum thermometers. Relative humidity was measured using a thermohydrograph. Daily rainfall was recorded using a standard rain gauge.

Results and Discussion

Biology, life history, preliminary behaviour of mating and egg laying and laboratory rearing of *Pyrilla perpusilla* Walker (Homoptera:Lophopidae) were studied at the University of Kelaniya in the wet zone of Sri Lanka from 1993 July to 1994 July and this is the first record of the presence of *P. perpusilla* in the wet zone of Sri Lanka. There was no evidence that any life stages of *P. perpusilla* were present on the stem of sugarcane rather than leaves. Therefore, it can be confirmed that, no insects were on the planting materials which were brought from the Sugarcane Research Institute to the University of Kelaniya. Any *P. perpusilla* found in the experimental plot was the result of the build up of naturally available population of this insect in the wet zone of Sri Lanka.

P. perpusilla was established throughout the study period since there were no use of insecticides, herbicides or fungicides. Subsequently, *P. perpusilla* found in the experimental plot were identified by comparing their morphological characters with voucher specimens from the Sugarcane Research Institute from the Sri Lanka.

Adult *P. perpusilla*, found in Kelaniya are a straw coloured, medium sized bugs with a prominent cylindrical rostrum. Sexes differ in size; the female has an average length of 1.7±0.2 mm, the male is slightly smaller with an average length of 1.5±0.3 mm. The female also has characteristic circular pads at the tip of the abdomen. Adults were relatively inactive during the early morning, evening and night, typically remaining lower surface of the leaves. During the day (10.00 am to 3.00 pm) adults became more active and were found on both the upper surface and lower surfaces of the leaves and jumping from plant to plant.

Newly emerged adult females were ready to mate two days after emergence from the fifth nymphal instar. Males and females began to copulate about two days after their last moult and mating occurred usually during the day. Males and females mated multiple times, usually with different partners, with each mating episode lasting 1-2 h. Females typically mated multiple times during a 1 week period before starting to oviposit. Mating continued throughout the oviposition period.

Females carry an egg cluster for about 60-90 min at the tip of their abdomen before depositing it on a leaf. Females oviposit mainly during the day. However, in some cases it was observed that females oviposit even at night. Females have a pre-oviposition period which range from 7-11 days, with a mean of 8.8±1.0 days. Maximum, minimum and mean values for the oviposition periods are 22, 10 and 15±1.4 days, respectively while the same values for post oviposition phases are 8, 2 and 5±2.0 days, respectively (Table 1).

Eggs are laid in clusters (length ranged from 12 to 18 mm with mean of 13.3±1.9) mainly on the undersides of leaves near the mid rib both during the day and night which are covered with white fibrils of wax. The eggs are oval in shape, small (0.8 to 1.3 mm length with a mean of 1.04±0.148 mm) and white in colour in the early stages turning pale yellow prior to hatching. Although eggs are laid on both the lower (abaxial) and upper (adaxial) surfaces of leaves, the lower surface (abaxial) is preferred (paired t test: $p<0.001$); furthermore luxuriant plants were preferred to scraggy plants (paired t test: $p<0.001$): this is probably because they are better protected from direct sunlight and parasitism when laid on the lower surface of the leaf. The brilliant white waxy covering makes the egg cluster conspicuous to predators but the advantage of having a white waxy covering is probably due to the fact that it reflects harmful solar radiation away from the eggs which have a thin and delicate chorion.

Table 1: Duration of various life parameters of *P. perpusilla*

	Duration (in days)		
Life history parameter	Minimum	Maximum	Average (± SE)
Pre oviposition period	07	11	8.80±1.00
Oviposition period	10	22	15.00±1.40
Post oviposition period	02	08	5.00±2.00
Male longevity	21	31	25.00±3.10
Female longevity	31	37	33.10±1.80
Incubation period (in field)	06	09	6.90±0.87
Incubation period (in Lab)	06	08	6.80±0.81
First instar nymphs	08	12	9.50±1.60
Second instar nymphs	07	12	10.91±1.06
Third instar nymphs	06	10	8.26±1.03
Fourth instar nymphs	09	14	12.26±0.80
Fifth instar nymphs	10	13	11.20±0.95

A female during her lifespan produces 2-5 egg clusters with an average of 3.3±1.1. The number of eggs in a cluster obtained from rearing cage ranged from 17-56 with mean of 33.0±10.3 while eggs in a cluster obtained from the experimental plot ranged from 18-57 with mean of 32.0±10.8. The difference in means between eggs in a cluster laid in rearing cages and in the experimental plot is not statistically significant (t-test; $p > 0.05$). The total number of eggs laid by a female during her lifetime ranged from 47–200 with a mean of 133±10.2.

Kumarasinghe and Ranasinghe (1985) have stated that the mean number of eggs in an egg cluster of *P. perpusilla* in Kantale (in dry zone), Sri Lanka was 35. The mean number of eggs in a cluster at Kelaniya (in field) was found to be 33.05±10.39. Despite the differences in climatic conditions between Kelaniya and Kantale the mean number of eggs in a cluster in both places is approximately the same; this indicated that the number of eggs in a cluster is an inherent trait unaffected by climatic differences which exist between Kantale (dry zone) and Kelaniya (wet zone).

Under laboratory conditions, the incubation period ranged from 6-8 days with a mean of 6.8 ±0.81 days and under field conditions it ranged from 6-9 days with a mean of 6.9±0.87 days (Table 1). The difference between incubation period under laboratory and field conditions is not significantly difference (t-test; $p>0.001$). Egg viability recorded from egg clusters collected from the rearing cages was found to be 89.79% while that of egg clusters collected from experimental plot was 87.22%. There was no significant difference between viability of eggs laid in rearing cages and in the experimental plot (t-test; $p>0.001$).

Longevity of the adult females was significantly greater (t-test $p<0.01$) than that of the males; females lived for 31-37 days with a mean of 33.15±1.81 days whereas the longevity range of the males was 21-31 days with a mean of 25±3.13 days (Table 1). The viability of eggs appears to be affected by the ambient relative humidity especially when it shows drastic fluctuations (Mogal *et al.*, 1983). They reported that the viability of eggs was 49% at 7.03% RH and it gradually increased with increasing relative humidity reaching a maximum of 92% at 82.26% RH. Meteorological data recorded during this study showed that the relative humidity at Kelaniya had a narrow range of fluctuation between 70 and 87% with a mean of 81±3.2% and that the viability of eggs remained high throughout the study period. Since the mean viability of eggs recorded in the study (89.74%) is very close to the maximum percentage viability (92%) recorded by Mogal *et al.* (1983). It is likely that the range of relative humidity prevailing at Kelaniya is optimal for the hatching of *P. perpusilla* eggs.

Pyrilla perpusilla has five nymphal instars. The first instar nymphs are white in colour and its two compound eyes are dark red. It has two anal filaments. The mean duration of the first instar nymphs was 9.5±1.6 days. The body of second instar nymphs and their anal filaments is pale brown in colour. The mean duration of the second nymphal period was 10.91±1.06 days. The third instar nymphs are similar to that of the second instar nymphs. The mean duration of the third instar was 8.26±1.03 days. Duration of the fourth instar was 12.26±0.80 days while fifth instar nymphal period was 11.20±0.95 days (Table 1). Nymphs at this stage are dark brown in colour and much more active than previous instars.

Records of adults males and females counted in the field showed that there is no appreciable departure from the male: female ratio of 1:1 (χ^2 test $p>0.05$). Absolute counting of males and females was carried out for this sex ratio study. Sampling of an animal population is necessary only when the population is large, since counting of individuals is time consuming and costly. However, when a population is small and individuals could be conveniently counted, a census of the population may be carried out; this gives a true value of the absolute population size within limits of human error and wherever possible is preferable to sampling. It was observed that a low population level of

P. perpusilla remained through out the study period in the study area. Principle factors responsible for a low level of abundance of *P. perpusilla* in the wet zone of Sri Lanka have been described by Ganehiarachchi and Fernando (2000).

There was no overlap of adults of different generations of *P. perpusilla* during the present study since the maximum lifespan of adult females was much shorter than the developmental period from egg to adult and there were no other sugarcane fields in the neighborhood, the study plot was sufficiently isolated and immigration was unlikely.

During the period of this study the daily minimum temperature fluctuated between 20.3 to 26.7°C and the daily maximum temperature between 30 to 32.4°C. The difference between maximum and minimum ranged from 4 to 10.2°C. Daily value of temperature and relative humidity inside rearing cages used in this study were only marginally higher than those in the experimental plot. However, various biological characteristics such as fecundity of females, mean oviposition period of females and percentage viability of eggs were not significantly different inside cages and field conditions. Therefore these cages can be recommended for use in growth and fecundity studies of *P. perpusilla*.

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