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Some Biological Parameters and Morphological Descriptions Study on the Milkweed Bug, *Spilostethus Pandurus Scop.*, (Hemiptera: Lygaeidae)

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Abstract

The milkweed bug, *Spilostethus pandurus,* is an agricultural pest in Egypt and some other tropical and subtropical areas. The objective of the present work is to clarify some biological parameters and morphological descriptions to emphasize the future researches from the ecological view point to the physiological study, biochemical study and control programs, integrated pest management program, study. Adult emergence of *S. pandurus* in summer season was higher than that in winter season. The increased longevity of *S. pandurus* was associated with prolonged rate of sexual maturation and low mean daily fecundity and that the life span increased during the cold months of the year and decreased during the hot summer and the males lived longer than females. The morphological descriptions of the adult and immature stages of *S. pandurus* were agreed with the taxonomic illustrations.

Key words: Milkweed bug; Biology; development; morphology.

Introduction

The milkweed bug *Spilostethus pandurus,* occurs throughout Egypt all the year round (Priesner and Alfieri, 1953). The Hemipteran bugs have long been established in Egypt as one of the serious pests infesting the seeds of great number of plants (Schaefer and Panizzi, 2000; Meguid et al., 2013). The milkweed bug *S. pandurus* is widely distributed in tropical and subtropical areas where at times it causes serious damage (Kugelberg, 1973a).Their economic importance has been steadily increased in recent years, and the annual losses due to their ravages against vegetables and other crops are sometimes great and immeasurable. It infests numerous crops including sunflower seeds, water melon seeds, squash seeds, cantaloupe seeds, pea nuts, cotton, sorghum, sesame, lobia, tomato and egg plant, sugar-cane and okra, pecans, whole kidney seeds, wheat and cabbage (Thangavelu, 1979). In Giza, Egypt, El-Shazly (1996) measured six overlapping generations in a year. The objective was to study and to clarify the importance of the biological study and the morphological descriptions of *S. pandurus* which is becoming extensively used for future ecological physiological, biochemical and Integrated Pest Management programs (IPM) studies.

MATERIAL AND METHODS

A. Biological Study

The laboratory colony of *S. pandurus* was initiated from nymphal instars and adults were collected from sunflower plants *Helianthus annuus* (Asterales, Asteraceae) from Balteem district, Kafr El-Shiekh, Egypt. The stock culture of *S. pandurus* was maintained in 5 quart polyethylene cylindrical containers (20 cm in diameter and 22 cm in height), the used rearing technique was according to El-Sherif (1991). The adult containers were examined once daily for the egg deposition. The cellucotton rolls containing masses of eggs were transferred to the nymphal rearing plastic containers (11 cm in diameter and 12 cm in height) and supplied with sunflower seeds and water. All the containers were tightly covered. New cellucotton rolls were introduced.

The percentage of adult Emergence

Ten groups of 50 newly molted fifth instars nymphs were put separately into 10 plastic containers. Each container was supplied with sunflower seeds, water and covered to prevent nymphs from escaping.

The preoviposition period

Ten pairs of newly emerged adults, each of one male and one female. They were put separately into ten 250 cc beakers and supplied with sunflower seeds, water and cellucotton rolls for the egg deposition. The preoviposition period were recorded daily.

The fecundity and fertility

Ten pairs of newly emerged virgin adults, one male and one female were kept separately into ten 250 cc beakers each of them was supplied with dried sunflower seeds, water and rolls of cellucotton. The adults were observed daily for oviposition. The number of eggs laid per female was counted and the percentage of hatching was calculated. Female *S. pandurus* laid nearly 11-15 egg batches in its whole life.

The longevity of adults

The longevity of solitary, unisexual gregarious and bisexual adults of *S. pandurus* was studied under laboratory conditions during summer and winter season. Five groups of the milkweed bugs were used. The 1st group consisted of 30 males alone and the 2nd group consisted of 30 females alone (solitary), the two groups were put individually each in 250 ml beaker provided with water and sunflower seeds. The 3rd group consisted of 30 males individually and the 4th group consisted of 30 females individually (unisexual gregarious). The 5th group consisted of 15 males and 15 females together (bisexual adults). The last 3 groups were put separately in 3 cylindrical jars (16 cm in diameter and 22 cm in height) and supplied with sunflower seeds and water (unisexual groups and bisexual groups). The newly emerged adults from individually separated last instars nymphs were used and the mortalities were recorded daily.

The incubation period of egg stage

Ten groups of 100 newly laid eggs were put into ten 50 cc beaker onto a piece of cotton and the beaker was covered. The time of hatching was recorded.

The duration of Nymph instars:

Thirty newly hatched nymphs were put separately into a jar (16 cm in diameter and 22 cm in height), supplied with sunflower seeds, water and covered. The nymphs were examined daily, the number of molted nymphs from each instar was counted and the time of molting was recorded. The numbers of emerged adults were counted and the time of emergence was also recorded. To study the whole nymphal stage, the time from egg hatching to adult emergence, another 5 groups of 50 newly hatched first instars nymphs were put separately into 5 plastic jars, (16 cm in diameter and 22 cm in height), supplied with sunflower seeds, water and covered. These nymphs were examined daily for adult emergence. The duration of the whole nymphal stages were observed in both summer and winter seasons.

All the experiments were conducted under regulated laboratory conditions in summer season, from June to September, at 30 $\pm$ 2°C, 60 $\pm$5% RH. and 14:10 LD; as well as, in winter season, from November to February, at 22 $\pm$ 2°C, 60 $\pm$5% RH. and 14:10 LD. The experiment was repeated 3 times for each group under laboratory conditions.

B. Morphological Study

The external morphological descriptions were carried out using drawings the different body parts of the milkweed bugs by a camera Lucida attached to Hund Wetzlar SM 33 stereomicroscope. Also photos were taken by Olympus E-420 camera attached to Olympus SZX-9 stereo microscope. The principle measurements are in millimeters along the midline and the widest part of the milkweed bug body. The morphological terms and the wing venation terminologies are based on Gad'alla (1996).

RESULTS

A. Biological Study

The males and females individuals nearly emerge at the same time. Abnormal emergence of adults was observed; some adults wings remained folded, un-expanded to cover the abdomen and the body slightly shrunken. Sometimes, in others emerged with their head, or the head and a part of the body remained inside the exuvia. These bugs were unable to free themselves and failed to complete the emergence. Adults resulting from abnormal emergence usually died. The mean percentage of adult emergence and of egg hatching in summer season was higher significantly ($P \leq 0.0001$) than that in the winter season by 1.36% and 1.9% folds, respectively. The mean number of eggs laid by a female was exceeded significantly ($P \leq 0.0001$) by 1.5 fold in summer season. Whereas, the preoviposition period in summer season was decreased significantly (P≤0.0001) by 2.3 fold in summer season than that in winter season (Table 1). The mean longevity of both males and females in unisexual, gregarious and bisexual populations was significantly (P≤0.001) longer in winter than in summer. The females lived longer than the males from all the population studied (Table 2). The incubation period of *S. pandurus* eggs at summer season was shorter than that in winter season by 2.154 fold (Table 3). The mean duration of the different nymphal instars were significantly (P≤0.0001) longer in winter season than summer season (Table 4). The duration of the fifth nymphal instars were the maximum (8.21±0.083 and 11.22±0.79 days) and the duration of the third nymphal instars were found to be the minimum (3.7±0.078 and 6.12±0.085) days at summer and winter, respectively.

Table (1): Biological parameters of *S. pandurus* at two different seasons under laboratory conditions.

Season	Mean±S.E.			
	Percentage of Adult Emergence	**preoviposition period in days**	**Number of eggs per female**	**Percentage of hatching**
Summer (June-September**)**	88±3% (72-98%)*	3.9±0.146 (3-5)*	96.4±1.94 (75-120)*	91.5±1.14% (80.41-99.03%)*
Winter (November-February)	64.8±2.79% (50-78%)*	8.96±0.147 (8-10)*	63.9±3.84 (26-103)*	47.7±1.15% (39.39-57.78%)*

*Numbers between brackets indicates the minimum and maximum value of the above mean at P≤0.0001.

Table (2): Mean longevity of solitary, gregarious groups and both sexes populations of adult *S. pandurus* at two different seasons under laboratory conditions.

Season	**Mean longevity in days ± S.E.**					
	Solitary bugs		Gregarious bugs		Both sexes together	
	Males	Females	Males	Females	Males	Females
Summer (June-September)	20.01 ±0.15 (18-22)*	22.87 ± 0.17 (20-25)*	17.65 ± 0.11 (16-19)*	20 ± 0.08 (19-21)*	12.44± 0.19 (9-15)*	17.15± 0.54 (7-23)*
Winter (November-February**)**	21.82 ± 0.14 (20-24)*	30.94 ± 0.27 (27-35)*	28.82 ± 0.25 (25-32)*	26.01 ± 0.3 (21-30)*	27.3± 0.17 (25-30)*	28.27± 0.33 (23-33)*

*Numbers between brackets indicates the minimum and maximum value of the above mean at $P \leq 0.001$.

Table (3): Incubation period of *S. pandurus* eggs at two different seasons under laboratory conditions.

Season	**Incubation period of eggs in days**		
	Min.	Max.	Mean ± S.E.
Summer (June-September**)**	3	5	3.9±0.146
Winter (November-February)	7	10	8.4±0.201

Table (4): Duration of different nymphal instars & whole nymphal stages of *S. pandurus* at two different seasons under laboratory conditions.

Season	**Mean Duration in days ± S.E.**					**Duration of whole nymphal stages in days**
	1st instar	2nd instar	3rd instar	4th instar	5th instar	Mean±S.E.
Summer (June-September)	4.6±0.15 (3-7)*	3.81±0.08 (3-5)*	3.7±0.078 (3-5)*	4.97±0.086 (4-6)*	8.21±0.083 (7-9)*	25.13±0.83 (21-30)*
Winter (November-February)	9.1±0.081 (8-10)*	7.17±0.14 (5-9)*	6.12±0.085 (5-7)*	7.17±0.083 (6-8)*	11.22±0.79 (10-12)*	38.47±0.99 (33-44)*

*Numbers between brackets indicates the minimum and maximum value of the above mean at P≤0.0001.

B. Morphological Study

a) Description of adult stage

The body of the milkweed bug is divided into three regions, head, thorax and abdomen. Newly emerged adult *S. pandurus* has a soft body, pale yellow in color with few grey spots, which changes gradually to black. Its wings and body are normal in shape. Its legs are soft and orange in color after a time, they change to black color. The legs are well developed and the insect is able to walk immediately after emergence. In a short time, the cuticle of the adult hardens and assumes its normal color and becomes red black. The adult milkweed bug is a 10-13 mm long insect. The female pygidium is triangular in outline and cleft, whereas, that of the male is rounded and shining (Plate II). Males are smaller in size as compared to the females, Table (5).

Head capsule and its appendages

The head capsule is of opithognathous type, with red Y-shaped marking. Vertex with a slightly convex basal area, frons is the median transverse part, shiny with very fine punctuations; clypeus elevated apicomedially; juga are triangular in shape; only clypeus is separated from these all parts by a definite suture (Plate I and III). Compound eyes are black in color and strongly protruded, two ocelli lying so close to them. Antennae are four segmented, clavate and black in color. Its length nearly 1.5 times as long as head that combined with the prothorax. The 1st segment is the thickest and shortest one, about 0.2-0.3 as long as any of the following segment, the 2nd segment is the longest one, the 3rd segment is slightly shorter than the 2nd segment and the 4th segment is fusiform. The mouth parts are piercing sucking with elongate proboscis, used to tear or pierce the tissues and also to inject its saliva, which contains digestive enzymes inside this tissue and help to suck the food material.

Thorax an its appendages

The Pronotum, (dorsal view), is trapezoidal in shape with very diagnostic black stripes laterally. Its posterior border partly overlaps the second thoracic segment. The mesonotum consists of a median marginal phragma with a subrectangular prescutum, a narrow scutum and a triangular scutellum that is bordered by a narrow postscutellum. Prescutum kidney shaped with one middle suture and two lateral convergent sutures. The metanotum is comparatively narrow and composed of median triangular prescutum, lateral narrow triangular scutum and external flange like scutellum. The anterior and posterior notal processes of mesonotum and metanotum are situated on scutum and scutellum, respectively. The thoracic segments are differentiated, (ventral view), into lateral pleural and middle sternum. The pleura are well developed and subdivided by the pleural suture into a smaller presutural epimeron and a larger postsutural episternum. The sternum consists of a middle basisternum ending with sternellum. The metathoracic segment has two scent glands that are represented by an external ostiolar peritreme and surrounded by an evaporative area (Plate III). The fore wings, (Plate IV), are of hemelytra type that is divided into two regions, the coriaceous red basal area, and this red part is about 0.75 of the total wingspan and apical membranous area. The coriaceous area is again divided into more or less triangular corium and a narrow clavus. The distal membrane is dark fumigated, with three white spots, one at the inner margin where the clavus ends, another near the outer margin and the third a little distal to the second towards the centre. Its veins are: costa, subcosta, radius, median, cubitus and vannal. The hind wings, (Plate IV), are membranous and characterized by having an oblong discal cell and vannal fold. Its veins are: costa, subcosta, hamus, radius, median, cubitus and vannal. Axillary sclerites are four in number. The first and second ones are broad and nearly equal in size while the third and fourth sclerites show different shapes. The legs, (Plate IV), are covered with hairs, spines; tibia much hairy than femur. The three pairs of walking legs, (Plate V), are more or less alike, with a slight difference in the size and shape. Coxae are nearly truncate cone shaped; trochanter is not segmented; middle and hind femora are simple; tibiae are cylindrical and apically toothed with strong setae, tibiae of fore and middle legs are nearly as long as femora while that of hind legs are longer than femora; tarsi are 3 segmented, the 2^{nd} segment is the shortest and the 3^{rd} ends with 2 sclerotized sickle shaped claws and 2 distinct pulvilli.

Abdomen

The abdomen, (Plate I and II), consists of 10 segments. The first abdominal segment is free in both sexes. The spiracle openings from the 2^{nd} to 6^{th} segment are black and prominent. All segments are with black marks dorsally. In the male the 7^{th} segment is strongly sclerotized, hairy and developed into lobe. It can be produced forward and backward to a small extent as occasion arises specially at time of copulation. The 8th segment is also much chitinous but smaller than the 7th segment and remains telescoped in the socket of the later. The 9th segment is capsular in form and hairy. It encloses the genital armature and the small 10th segment with anal opening. In the female the 7th segment remains telescoped under segment 6 and its turn covers segments 8 and 9 which when drawn out becomes conspicuous by the presence of a pair of genital valves in each. The 10th segment bears the anal slit.

b) Description of the immature stages

The egg is 1.05±0.034 mm long and 0.6±0.02 mm width. It is oval in shape, the anterior and posterior pole slightly rounded, only the anterior pole surrounded by a crown of micropylar process which are minute and can't be seen by naked eye. It is pearl-colored when laid and orange red just before hatching; the chorion is thin, transparent and smooth. The first nymphal instar is 1.64±0.042 mm in length and 0.696±0.015 mm in width. Newly emerged nymphs are bright red ; thorax is pale brown turns to dull red and then is to reddish brown; eyes, antennae, mouth parts and legs are black; last antennal segment larger, thicker, darker and clubbed ; the three pairs of walking legs are nearly a like except in size. The second nymphal instar is 2.48±0.084 mm in length and 0.956±0.026 mm in width, a slight constriction between the thorax and the abdomen giving the nymphs a sway backed appearance; thorax short and broad; legs similar to that of the 1st nymphal instars. The third nymphal instar is 3.65±0.1 mm in length and 1.63±0.084 mm in width. The only mesonotum with wing pads measuring 0.6 mm; legs are similar to those of the first and second nymphal instar except in size. The openings of the dorsal stink glands are visible. The forth nymphal instar is 6.1±0.14 mm in length and 2.55±0.069 mm in width. The eyes are black; tip of the clypeus is observed dorsally; prothoracic shield decorated with two dark stripes, meso and meta-thorax are subequal and posterior to the anal segment, posterior end of the tibia and tarsi are dark; wing pads are about 0.94 mm with margin and posterior ends black; dorsal sting gland openings very prominent. The fifth nymphal instar is 9.45±0.28 mm in length and 4.47±0.14 mm in width. The wing pad is 2.8 mm in length and dark shining brown; mesothorathic wing pads overlap and hides those of the metathorax; the segments 2 to 7 with distinct black marks in the connexivum; the dorsal abdominal spiracular openings is enlarged; the genital segment is black; with a mark difference in the genital sterna of the males and females; in the males thickening of the sternal areas quite dissimilar with a large hollow knob like structure in the 9th sternum is observed, (Plate VI).

Table (5): Body measurements of adult males and females of *S. pandurus*

Measurements	Mean ± S.E. (n= 50)	
	Male	**Female**
Total body length (mm.)	11.91± 0.096	12.558± 0.205
Antennal length (mm.)	4.762± 0.092	5.042± 0.119
Rostrum length (mm.)	4.11±0.029	4.14±0.02
Head length (mm.)	1.037±0.014	1.128±0.007
Head width (mm.)	0.877±0.011	0.968±0.01
Prothoracic length (mm.)	2.072±0.021	2.173±0.015
Prothoracic width (mm.)	3.69± 0.046	3.872± 0.042
Abdomen length (mm.)	5.88±0.049	6.04±0.014
Abdominal width (mm.)	4.144± 0.085	4.4± 0.065
Fore wing length (mm.)	9.69±0.27	10.15±0.11
Fore wing max width(mm.)	3.2±0.06	3.4±0.09
Hind wing length (mm.)	7.82±0.13	8.09±0.04
Hind wing max. width(mm.)	3.55±0.18	3.37±0.4
Hind femur length (mm.)	3.4±0.06	3.45±0.12
Hind femur max. width(mm.)	0.48±0.03	0.47±0.01
Fore leg total length (mm.)	7.74±0.064	7.77±0.059
Middle leg total length (mm.)	9.01±0.092	9.01±0.12
Hind leg total length (mm.)	11.03±0.15	11.08±0.38

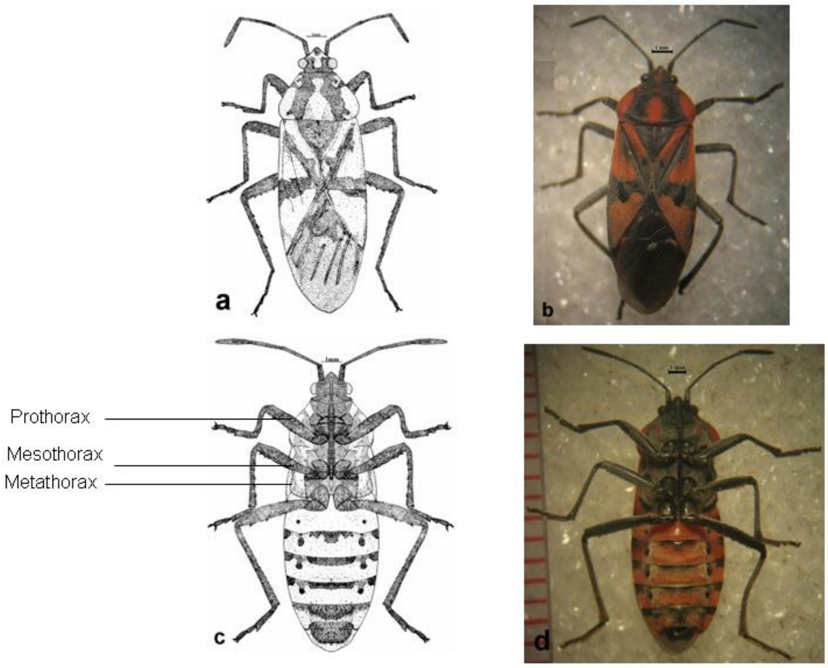

Plate I: Line drawing: (a) Dorsal view of adult male and (c) Ventral view of adult male. Bar= 1mm.
Digital photos: (b) Dorsal view of adult male and (d) Ventral view of adult male. Bar= 1mm.

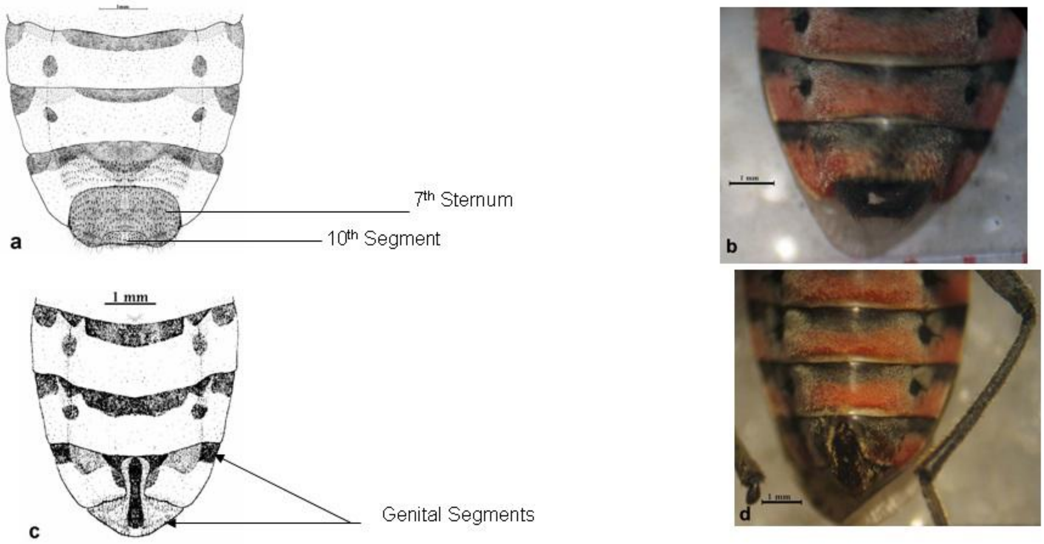

Plate II: Line drawing: (a) Ventral view of male abdominal end and (c) Ventral view of female abdominal end. Bar= 1mm.
Digital photos: (b) Ventral view of male abdominal end and (d) Ventral view of female abdominal end. Bar= 1mm.

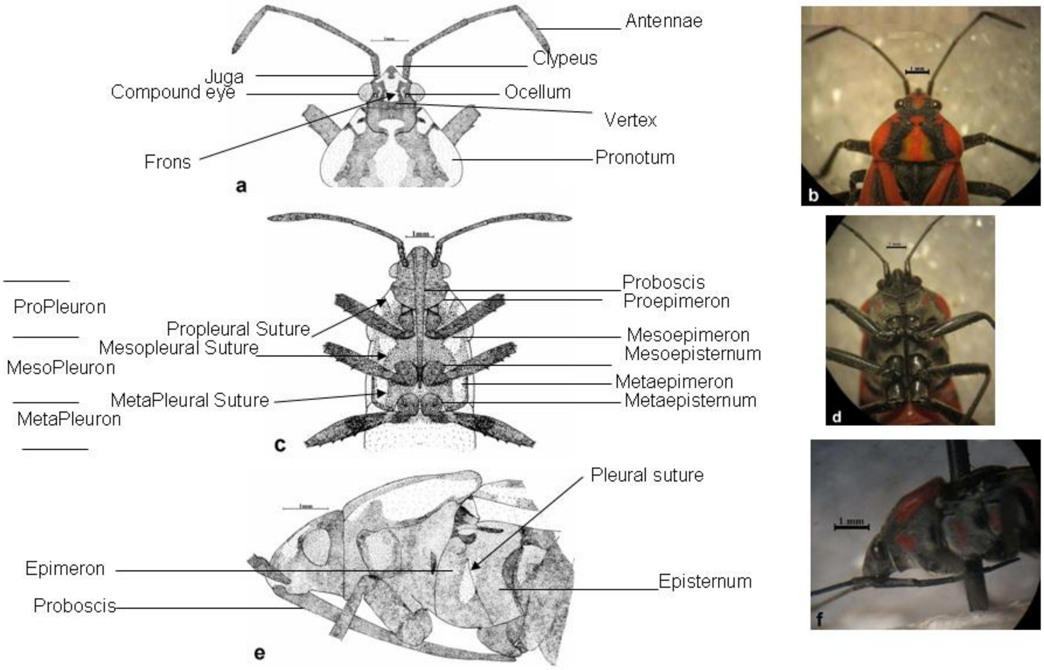

Plate III: Line drawing: (a) Dorsal view of head and pronotum, (c) Ventral view of head and pronotum and (e) Lateral view of head and pronotum. Bar= 1mm.
Digital photos: (b) Dorsal view of head and pronotum, (d) Ventral view of head and pronotum and (f) Lateral view of head and pronotum. Bar= 1mm.

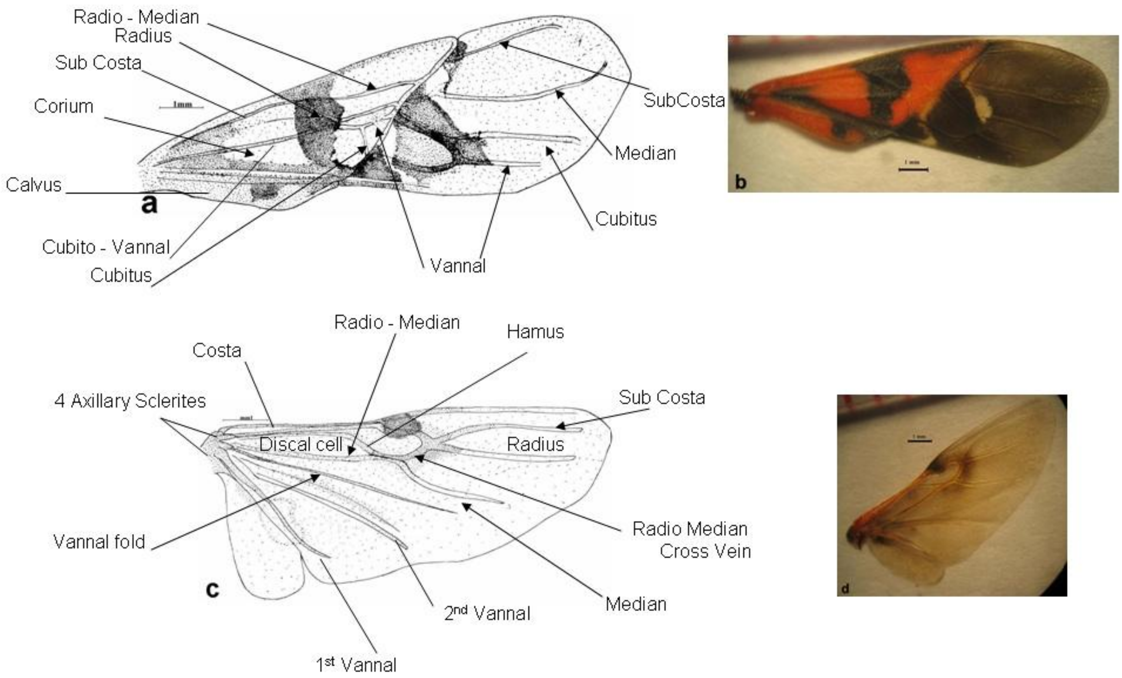

Plate IV: Line drawing: (a) Fore wing, (c) Hind wing. Bar= 1mm.
Digital photos: (b) Fore wing, (d) Hind wing. Bar= 1mm.

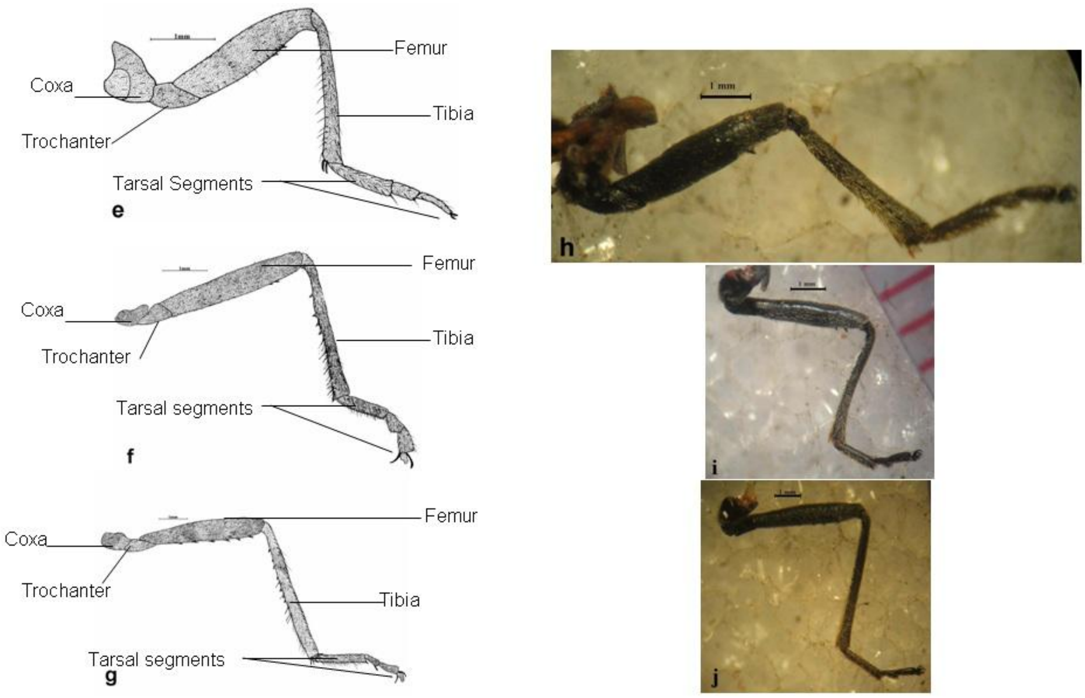

Plate V: Line drawing: (e) Fore leg, (f) Middle leg and (g) Hind leg. Bar= 1mm.
Digital photos:(h) Fore leg, (i) Middle leg and (j) Hind leg. Bar= 1mm.

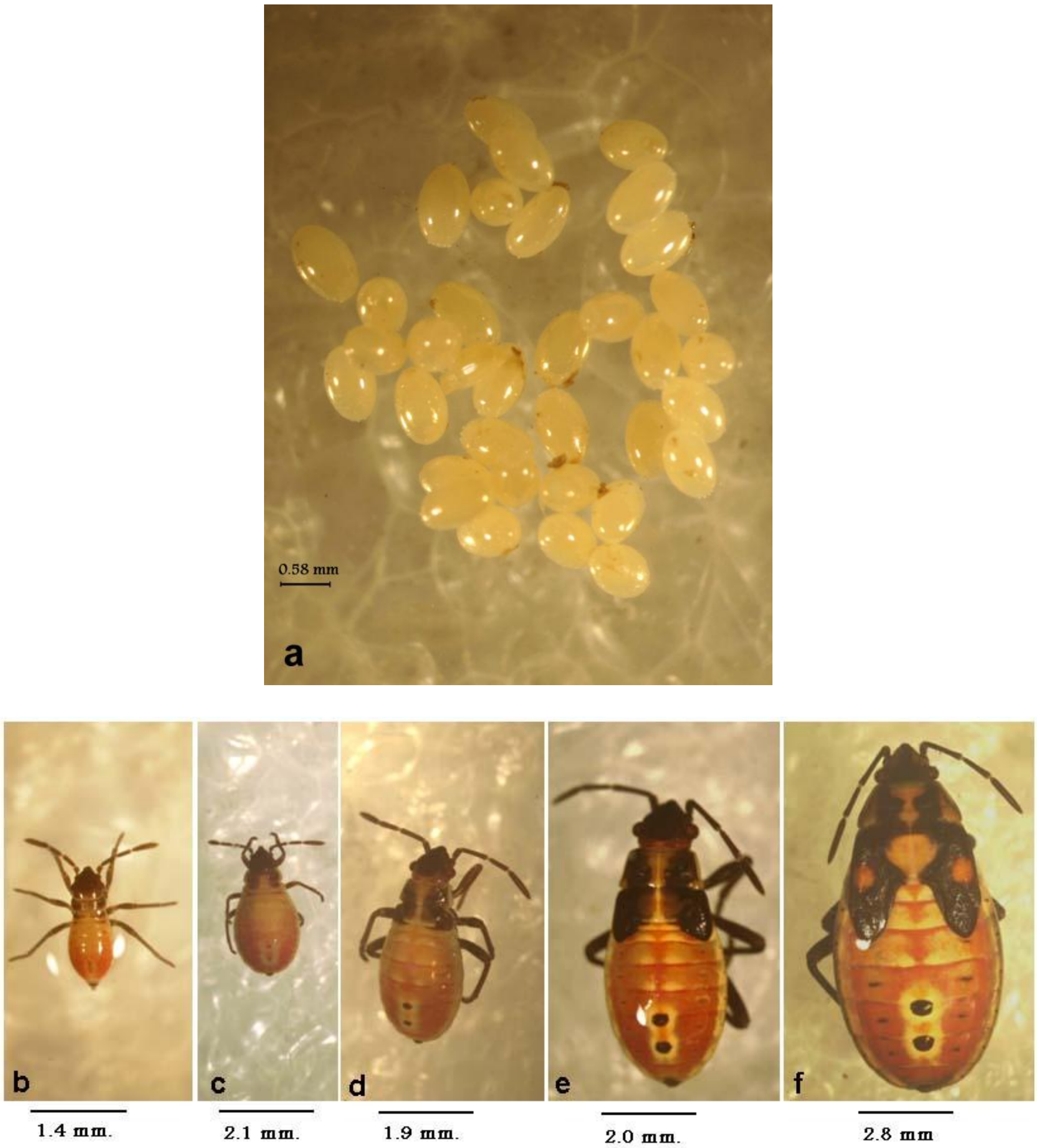

Plate VI: Digital photos: (a) Egg mass, (b) 1st instar nymph, (c) 2nd instar nymph, (d) 3rd instar nymph, (e) 4th instar nymph and (f) 5th instar nymph.

DISCUSSION

The results of rearing under laboratory conditions clearly showed that the difference in the development of the insect in the summer season and the winter season was drastically different. Adult emergence of *S. pandurus* in summer season was higher than that in winter season. Chopra and Yadav (1974) found five generations of *S. macilentus* in North India and this bug reached its peak abundance in the crop fields in mid-August. Thangavelu (1979) reported that in south India under warmer conditions there are six to seven overlapping generations of *S. pandurus*. The results of preoviposition period not matched with the result obtained by Hunter and Leigh (1965), they reported that females of *Euschistus conspersus* (Hemiptera : Pentatomidae) had preoviposition period averaging 17.4 days when reared at laboratory conditions (temperature was 80±2º F and relative humidity was 45±5%). kugelberg (1973 c) stated that the adults of *S. pandurus* started to mate after about 7 days and the first egg batch may be laid as soon after 4 more days, at temperature 25±1º C, relative humidity 60±10% and long day conditions (18 L-6 D). Kugelberg (1973 b) reported that *Lygaeus equestris* (L.) (Hemiptera : Lygaeidae) bugs brought to the laboratory in September or October begin to mate after about 15-40 days, while insects brought to the laboratory in March begin to mate after about 5 days. This was also the case in insects brought from the hibernation site in March to 25º C and long day conditions but without any food supply. Kugelberg (1973 c) stated that the female of *S. pandurus* reared at 25±1º C and 60±10% relative humidity may lay at least 10 egg batches in the piece of cotton provided. Each batch usually contains 50-60 eggs and that this was also found for the same bug under fluctuating temperatures by Bhattacherjee (1959). Ewete and Osisanya (1985) found that the mean number of eggs laid by a female of *Oxycarenus gossypinus* (Heteroptera: Lygaeidae) reared on okra seeds per day was 15.05 eggs at 25-33º C.On the other hand, our result is not agreed with that of Hunter and Leigh (1965), who reported that the average life span of *Euschistus conspersus* adults (Pentatomidae) was longer for males (161.8 days) than for females (108.5 days) under laboratory conditions (80±2º F and 45±5% R.H.). The result obtained by Ewete and Osisanya (1985) found that in laboratory studies on *Oxycarenus gossypinus* (Distant) (Lygaeidae) at 25-33º C, the life span of mated males was longer than the life span of mated females in case of bisexual population fed on different seeds. El-Shazly (1996) stated that increased longevity of *S. pandurus* was associated with prolonged rate of sexual maturation and low mean daily fecundity and that the life span increased during the cold months of the year and decreased during the hot summer and the males lived longer than females. Hunter and Leigh (1965) found the average incubation period of *Euschistus conspersus* (pentatomidae) egg was 6.2 days (range 5.5- 7.5 days) under laboratory conditions (at 80±2º F and 45±5% R.H.). Kugelberg (1973 c) found that the egg stage of *S. Pandurus* ranged from 7-10 days with the average of 9 days under laboratory conditions (25±1º C and 60±10% R.H.). The same author, however, noticed that the egg stage was longer in his study than that of Bhattacherjee (1959) who reared the same bug on different food and fluctuating temperature. Kugelberg (1973 b) reported that the egg stage of the related bug; *Lygaeus equestris* (*L.*) lasted 8-10 days at 25º C which he noticed to be very comparable to the 8-12 days egg stage reported by Puchkova (1954). However, raising temperature to 37º C reduced the egg stage to 3-5 days only for this insect (Kugelberg, 1973 b). Hunter and Leigh (1965) reported that the mean duration of the five nymphal instars of *Euschistus conspersus* (Pentatomidae) were 3.1, 5.6, 4.3, 4.9 and 7.7 days, respectively at 26.5±1º C (80±2º F) and 45±5% R.H. They also reported that the mean duration of the 5th nymphal instar was the longest one (7.7 days). Kugelberg (1973 c) reported that the five nymphal instars of *S. Pandurus* were 6.1, 4.6, 4.8, 5.7 and 10.4 days, respectively under laboratory conditions of 25±1º C and 60±10% R.H. Also, also he reported that the duration of the 5th nymphal instar was the longest one (10.4 days). The same author in (1973 a) reported that the mean duration of the 5th nymphal instar of the related species *Lygaeus equestris* (*L.*) reared on different food was the longest one. Vennila et al. (2010) studied the biology of the mealy bug *P. solenopsis* under controlled laboratory conditions (23.3-30.2 º C and 40.5-92.5% RH).They found that the development from immature stages to adult stage was greater for males (18.7±0.9 days) compared to females (13.2±1.8 days). They also reported that the reproductive period lasted 30.2 days.

The morphological descriptions of the adult and immature stages of *S. pandurus* agree with the taxonomic illustrations of an earlier author, (Bhattacherjee, 1959), who described immature and adult stages of *Lygaeus pandurus* Scopoli (Hetroptera: Lygaeidae). Also Gad'alla (1996), reported that the original name of *S. pandurus* was *Cimex pandurus* (Scopoli, 1763) and in 1964 it was named *S. pandurus* Scopoli (Slater, 1964)._ From the above results and discussion we can clearly conclude that the hot weather of the summer favored the development of adult *S. pandurus* than the cold winter days. The present study clearly shows that the insect *S. pandurus*, is an excellent experimental insect, because of its simple breeding conditions. Also it survives all the year round.

It is hoped that the basic biological and morphological study will clear the way for further ecological, physiological and biochemical investigation on this bug species. Also this study could help in Integrated Pest Management programs, IPM, to control this very economically important bug which was registered as one of the agricultural pest in tropical and subtropical areas.

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