

E-ISSN: 2320-7078

P-ISSN: 2349-6800

JEZS 2019; 7(1): 1206-1210

© 2019 JEZS

Received: 14-11-2018

Accepted: 17-12-2018

Nirmali Borah

Department of Entomology,
Biswanath College of
Agriculture, Biswanath Chariali,
Sonitpur, Assam, India

LK Hazarika

Retired Professor and Head,
Department of Entomology,
Assam Agricultural University,
Jorhat, Assam, India

Biology and morphometrics of *Periplaneta americana*

Nirmali Borah and LK Hazarika

Abstract

Biology and morphometrics of *Periplaneta americana* (L.) (Blattodea: Blattellidae) were studied in the Physiology Laboratory, Department of Entomology, Assam Agricultural University, Jorhat. Six instars were observed in the present study. The pre- oviposition period, incubation period, nymphal period, adult longevity and total life cycle period were recorded to be 8.4 ± 1.40 , 40.66 ± 4.43 , 326.83 ± 76.30 , 272.76 ± 57.40 and 367.50 ± 74.95 days, respectively. In morphometrics study, the body parameters like body length, antennal length, head width, pronotum length and width were measured, and it was observed that the adult exhibited sexual dimorphism, the male being comparatively longer and larger than the female.

Keywords: Cockroach, growth and development, ootheca, instar

Introduction

Cockroaches are the oldest and dominating omnivorous as well as detritivorous insects [2, 3, 5, 7, 10, 19] because of their association with rich diversity of gut bacterial and ciliate symbionts [3, 4, 6, 15]. Currently, 4,600 species and over 460 genera are described worldwide; a number of species are the most important public health pests, such as the American cockroach, *Periplaneta americana* (L.) (Blattodea: Blattellidae), which generally contaminate human food with bacteria (including the species of *Salmonella* and *Shigella*) that cause food poisoning. *P. americana* is the largest amongst the common peridomestic cockroaches measuring on an average 4 cm in length. *P. americana* is second only to the German cockroach, *Blattella germanica* (L.) (Blattodea: Blattellidae) in abundance and was introduced to the United States and to the old world including India from Africa as early as 1625 [2]. Though it is the most important household and public health pest in India, its biology has not been studied so far specially in the subtropical part of India, probably because it requires one year to complete one life cycle. Cornwell [5], Rau [18], Schal *et al.* [20] and Wright [22], attempted to describe biology of this pest elsewhere without detailing of instars and their morphometric analysis. It is high time to fill those voids in order to understand why this semi-domesticated species is so successful in the tropical and sub tropical region of the country and becoming one of the major household pests. Therefore, the present study was taken up in order to access various biological parameters like ootheca character, fecundity, egg, nymphal period and adult longevity along with the morphometrics of all the instars.

Materials and Methods

The experiment was conducted during 2013-2017 in the Physiology Laboratory of Department of Entomology, Assam Agricultural University, Jorhat.

Mass rearing of *P. americana*

A colony of the American cockroach, *P. americana* (Dictyoptera: Blattidae), was maintained in the laboratory. The colonies were maintained in wooden cages (90 × 60 × 60 cm) containing glass bell jars (Borosil; 32 cm long and 22 cm diameter). The bell jars were covered with muslin cloth to prevent cockroaches from getting out and other animals from getting in, and provided with wooden plates (13.5 cm × 10.5 cm) as dividers, which served as shelter and gave the cockroaches a place to hide and breed. The top of the bell jar was coated with a layer of Vaseline to prevent the cockroaches from crawling to the top of bell jars. Breeding boxes were kept clean with attention to sweep or scoop the bottom of the enclosure from their waste and frass as required usually at 2-3 days interval.

Correspondence

Nirmali Borah

Department of Entomology,
Biswanath College of
Agriculture, Biswanath Chariali,
Sonitpur, Assam, India

The cockroaches were supplied with crushed dog biscuits (Pedigree), and moist sponges as water source were provided separately in petri plates (9 cm diameter) inside the bell jars. The food was placed in the corners directly on the container floor. Nymphs were separated and were reared inside plastic containers (8 cm length and 8.5 cm diameter) by providing food and water as above. The mixture of breeding diet provided a high proteinous food at all times. Care was taken to keep the diet dry to prevent growth of mould, bacteria, mites and beetles.

Biological attributes and morphometry

The newly laid oothecae were collected from the colony and kept separately one by one. Each ootheca was checked daily and the date when it hatched and the number of first instars were recorded. Each cohort of nymphs was placed in an individual plastic container provisioned with dog biscuits, water vial, and piece of cardboard. Each cohort of nymphs was reared together, and the dates when they moulted into the next instars were recorded. Last instars were removed from breeding colonies and placed in glass jars provisioned with dog biscuit, water, and a piece of folded cardboard. As soon as the nymphs moulted into adults, they were sexed and male and females were kept together inside plastic containers at a ratio of 1:3 for mating provisioned with food, water and shelter. The containers were also covered with muslin cloth. Females were inspected regularly, and the day on which ootheca appeared was recorded. On deposition, each ootheca was placed singularly into an individual plastic container again provisioned with food, water and shelter as described earlier and examined daily to record the number of first instars hatched as well as to note down nonviable eggs or dead pre emerged nymphs. Thus the nymphs were allowed to grow from one instar to another. In the mean time, thirty nymphs of each instar were preserved in 70 per cent alcohol for measuring, while adults were subjected to this study by freezing them in the refrigerator for three to five minutes. The body length (front of the head to the tip of the abdomen in nymph and from front of the head to the tip of the wings in adults), antennae length, head width (between the outside edges of the eyes), pronotal length (along the dorsal midline) and width (at its widest point) and ootheca per female, eggs per ootheca, incubation period, number of nymphs per successive ootheca, nymphal period, life cycle period, and adult longevity were recorded. The dispersion of the mean values of all biological parameters and body measurements was worked out by calculating SEM (Panse and Sukhatme) [16].

Results and Discussion

Biology of *P. americana*

P. americana is a long-lived household insect pest associated with human races for millions of years. Female deposits the ootheca after carrying it for a few hours to a few days. Table 1 showed ootheca characters and life cycle variables of this insect. Dark brown coloured (bean shaped) ootheca length, width and weight were 10.53±1.48 mm, 5.23±0.45 mm and 125.73±16.35 mg, respectively. This finding corroborates with that of Cornwell [5], Perrott and Miller [17] who also reported ootheca length to be 8-10 mm.

Fecundity of cockroaches is counted by multiplying ootheca numbers per female with eggs per ootheca, and thus the mean number of oothecae per female and the eggs per ootheca were 13.86±1.56 and 14.93±1.89, respectively (Table 1). These

findings are similar to those of Barbara [1], Cornwell [5], Hahn and Arseno [8] and Kolisch [14] who reported that a female American cockroach produced 10, 16, 14 and 6 to 16 ootheca per year, respectively. Variable results with respect to eggs per ootheca were found by earlier workers, for example, Whitworth and Ahmad [21] reported presence of 12-40 eggs per ootheca, while Barbara [1] and Jacobs [11] found 16 and 14-16 eggs per ootheca, respectively.

Table 1: Ootheca characters (Mean ± SEM size in mm; weight in mg) and life cycle variables (Mean ± SEM period in days) of *P. americana*, Jorhat, Assam (2013-2017)

Parameters	Measurement
Ootheca	
Length	10.53±1.48
Width	5.23±0.45
Weight	125.73±16.35
Fecundity	
Ootheca numbers per female	13.86±1.56
Eggs per ootheca (numbers)	14.93±1.89
Hatching percentage	90.63±5.57
Pre oviposition period	8.40±1.40
Incubation period	40.66±4.43
I Instar	40.70±4.41
II Instar	44.96±2.66
III Instar	56.20±1.16
IV Instar	58.60±1.28
V Instar	61.11±3.44
VI Instar	65.26±1.47
Nymphal period	326.83±76.30
Life cycle period	367.50±74.95
Adult longevity	272.76±57.40

Sample size = 30

In the present study the number of eggs hatched per ootheca was 12.76±2.20 with a hatching percentage of 90.63±5.57. The results are in contradictory with that of Barbara [1] who recorded 16 eggs per ootheca. The pre oviposition period, incubation period, nymphal period, adult longevity and life cycle period from egg to nymph recorded during the present investigation were 8.4±1.40, 40.66±4.43, 326.83±76.30, 272.76±57.40 and 367.50±74.95 days, respectively with six nymphal instars (Table 1 and Plate 1 [a to f]). The duration of each nymphal instar recorded during the present investigation was 40.70±4.41, 44.96±2.66, 56.20±1.16, 58.60±1.28, 61.11±3.44 and 65.26±1.47 days, respectively. The present findings are in conformity with that of Hahn and Ascerno [8], Kolisch [14], Rau [18], who also observed an incubation period of about 45, 42 and 38-49 days, respectively. The study regarding numbers of nymphal instars is in accordance with that of Barbara [1] who recorded 6-14 instars of *P. americana*. However, the results are in contradictory with Kolisch [14], Perrott and Miller [17] and Rau [18] who observed 13 moults (14 instars), 7-8 moults (8-9 instars) and 25 moults (26 instars), respectively. The total nymphal period and adult longevity recorded in the present study is in contradictory with that of Hahn and Ascerno [8] who found the total nymphal duration of 215 to 400 days with an adult female life span of 440 days. Similarly, Perrott and Miller [17] also reported adult life span of approximately one year. This kind of variability regarding fecundity and life cycle variables may perhaps be related to environmental and geographical conditions.

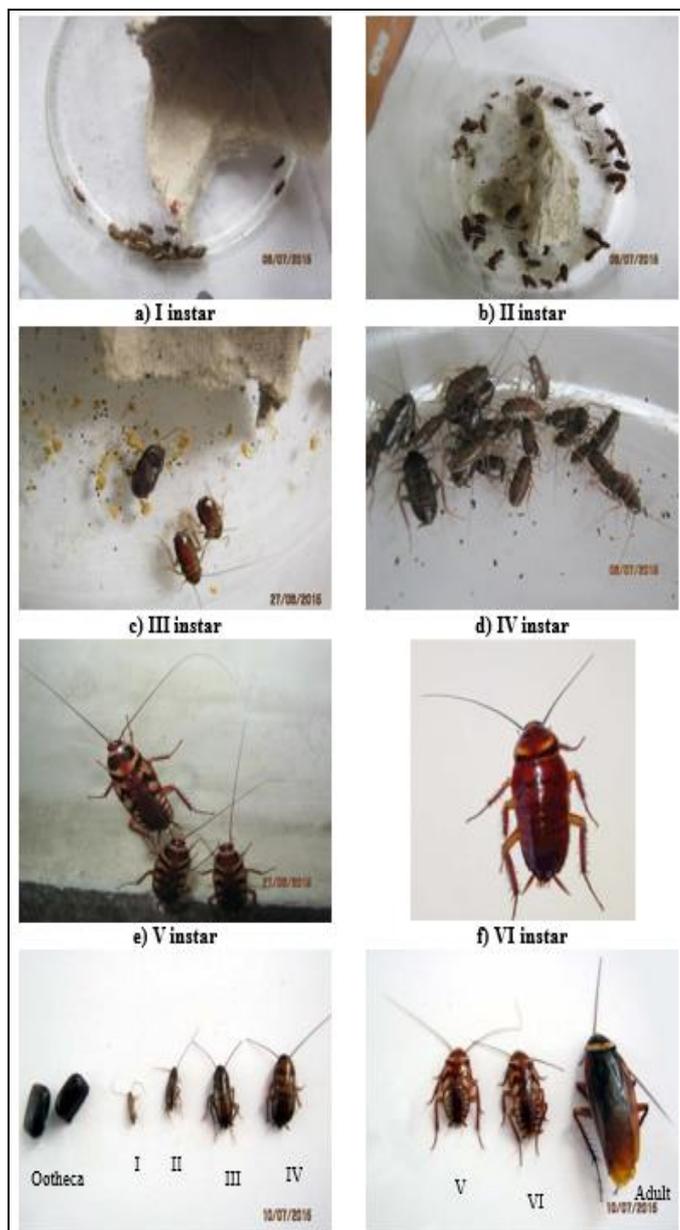


Plate 1: (a to f). Photographs showing ootheca, six instars and adult of *P. americana*

Morphometrics of *P. americana*

The morphometrics of the nymphs and adult *P. americana* are summarized in Table 2 and depicted in Fig. 1 to 5. It was observed that the body length increases significantly in each successive instar from first (3.26 ± 0.60 mm) to sixth (39.33 ± 2.04 mm) and attained its peak in adult stage. The adult male *P. americana* was longer than the adult female with a body length of 43.30 ± 6.38 mm whereas, the female body length recorded was 39.43 ± 2.03 mm. The male *P. americana* has a pair of styli in addition to a pair of cerci (Plate 2). Whereas, the females possess only a pair of cerci at the tip of the abdomen (Plate 3). The results regarding adult body length are in accordance with that of Hahn and Ascerno [8], Koehler *et al.* [13] and Perrott and Miller [17] who observed that the body length of both male and female *P. americana* was about 38.10 to 50.80, 31 to 51 and 38 mm, respectively. Contradictorily, Jacobs [11] reported that the adults of American cockroach were 12.70 to 25.40 mm long.

The antennae length recorded from first instar to sixth instar were 5.01 ± 0.13 , 14.41 ± 0.61 , 15.17 ± 0.30 , 23.62 ± 0.98 , 25.01 ± 0.13 and 45.02 ± 0.25 mm, respectively. The adult male and female antennal length recorded were 50.08 ± 1.61 and 43.03 ± 3.85 mm. The head width recorded from first instar to sixth instar were 1.04 ± 0.04 , 1.51 ± 0.08 , 2.59 ± 0.32 , 3.00 ± 0.28 , 4.00 ± 0.09 and 4.02 ± 0.08 mm, respectively. The head width of adult male and female were 5.00 ± 0.10 and 4.11 ± 0.18 mm. The pronotum size (length \times width) recorded from first instar to sixth instar were $(1.06 \pm 0.06) \times (1.07 \pm 0.70)$ mm, $(1.15 \pm 0.08) \times (1.17 \pm 0.09)$ mm, $(3.05 \pm 0.22) \times (3.71 \pm 0.37)$ mm, $(4.86 \pm 0.16) \times (6.94 \pm 0.19)$ mm, $(6.92 \pm 0.11) \times (8.87 \pm 0.15)$ mm, $(7.96 \pm 0.06) \times (9.03 \pm 0.10)$ mm, respectively. The pronotum size (length \times width) of adult male and female were $(9.45 \pm 0.57) \times (10.96 \pm 0.71)$ and $(9.14 \pm 0.46) \times (10.80 \pm 0.71)$ mm, respectively. It was observed that the antennal length, head width and pronotum size (length \times width) increased from first instar to sixth instar and peaked at the adult stage. During development of an insect, a series of allometric changes occurs at both biochemical and morphological level (Hazarika and Gupta) [9]. Similar to these findings, Kim and Rust [12] in their study on invasive Turkestan cockroach, *Blatta lateralis* observed that in all cases except the pronotal length between the fourth and fifth instars, each instar was significantly larger than the preceding instar.

Table 2: Morphometrics (Mean \pm SEM in mm) of *P. americana*

Instars	Body length	Antennae length	Head width	Pronotum length	Pronotum width
I	3.26 ± 0.60	5.01 ± 0.13	1.04 ± 0.04	1.06 ± 0.06	1.07 ± 0.70
II	6.20 ± 0.58	14.41 ± 0.61	1.51 ± 0.08	1.15 ± 0.08	1.17 ± 0.09
III	15.66 ± 0.65	15.17 ± 0.30	2.59 ± 0.32	3.05 ± 0.22	3.71 ± 0.37
IV	25.43 ± 0.54	23.62 ± 0.98	3.00 ± 0.28	4.86 ± 0.16	6.94 ± 0.19
V	31.50 ± 0.80	25.01 ± 0.13	4.00 ± 0.09	6.92 ± 0.11	8.87 ± 0.15
VI	39.33 ± 2.04	45.02 ± 0.25	4.02 ± 0.08	7.96 ± 0.06	9.03 ± 0.10
Adult (male)	43.30 ± 6.38	50.08 ± 1.61	5.00 ± 0.10	9.45 ± 0.57	10.96 ± 0.71
Adult (female)	39.43 ± 2.03	43.03 ± 3.85	4.11 ± 0.18	9.14 ± 0.46	10.80 ± 0.71

Sample size = 30

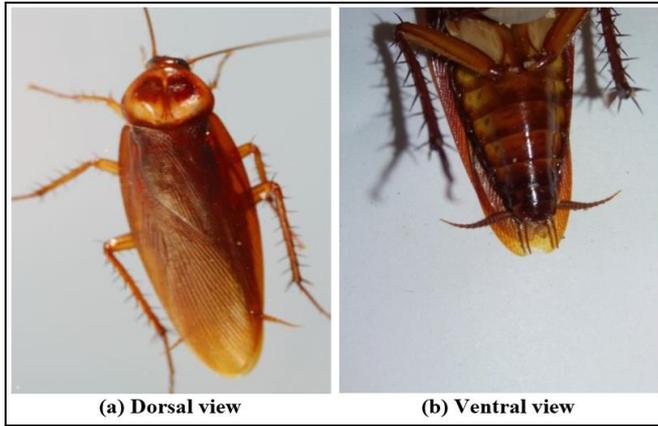


Plate 2: Photographs showing dorsal view (a) and ventral view of the abdomen (b) of an adult male *P. americana*

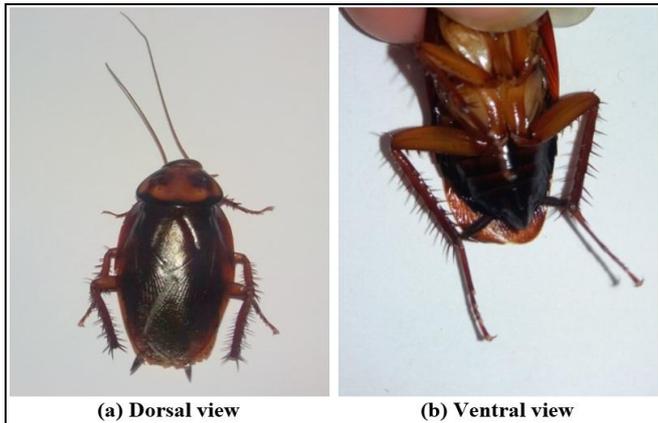


Plate 3: Photographs showing dorsal view (a) and ventral view of the abdomen (b) of an adult female *P. americana*

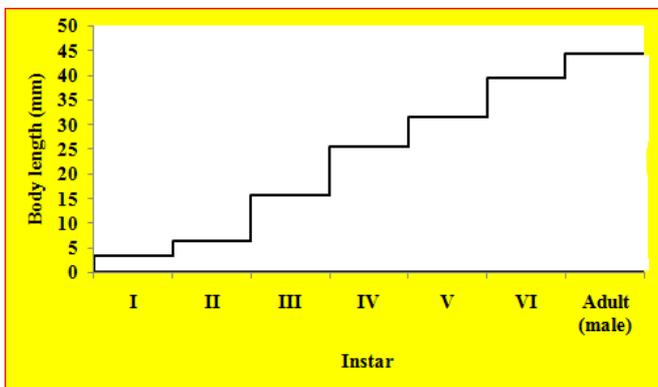


Fig 1: Body length (mm) of *P. americana* from first instar to adult

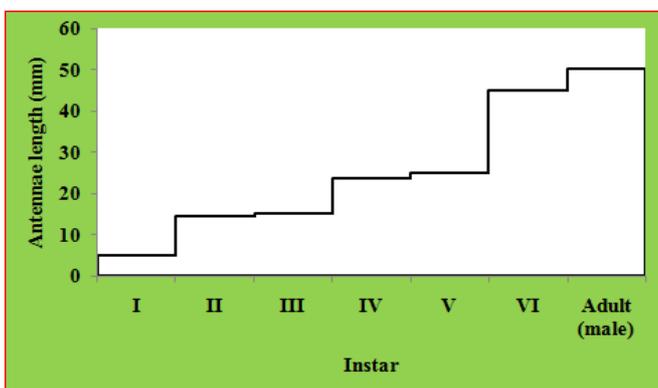


Fig 2: Antennae length (mm) of *P. americana* from first instar to adult

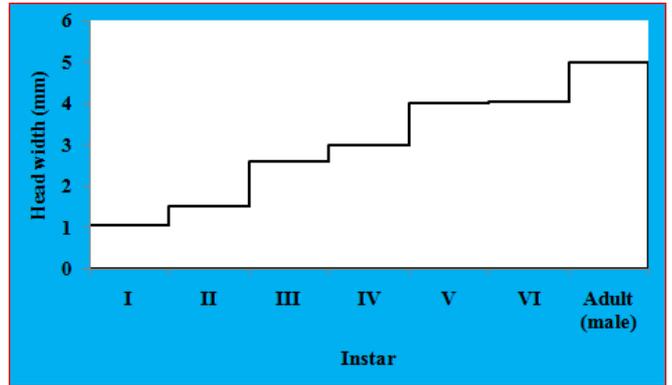


Fig 3: Head width (mm) of *P. americana* from first instar to adult

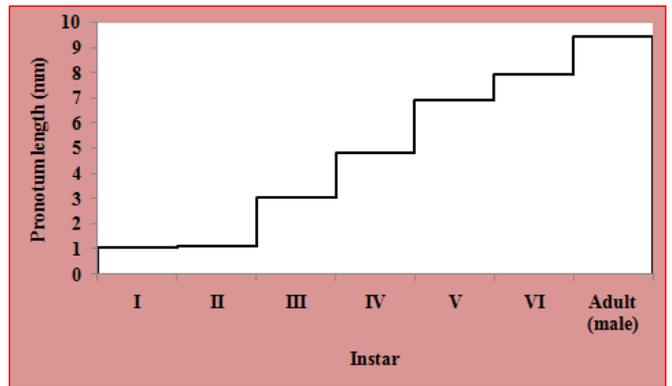


Fig 4: Pronotum length (mm) of *P. americana* from first instar to adult

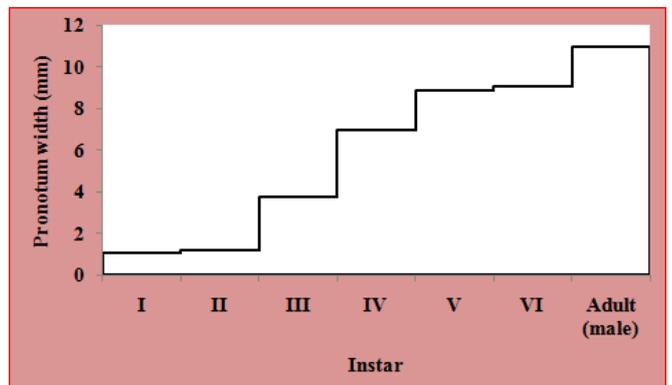


Fig 5: Pronotum width (mm) of *P. americana* from first instar to adult

Conclusion

From the present investigation it can be concluded that *Periplaneta americana* is a serious household pest where the adult can live up to about one year with a production of 11-17 ootheca per female and the male are comparatively larger than the female.

References

1. Barbara KA. American Cockroach, *Periplaneta americana* (L.) (Insecta: Blattodea: Blattidae). University of Florida. IFAS Extension, 2014, 1-4.
2. Bell WJ, Adiyodi KG. (eds.). The American Cockroach. Chapman and Hall, London. 1982, 529.
3. Bell WJ, Roth LM, Nalepa CA. Cockroaches: Ecology, Behavior, and Natural History. JHU Press, Baltimore, 2007.
4. Bracke JW, Cruden DL, Markovetz AJ. Intestinal microbial flora of the American cockroach, *Periplaneta*

- americana* L. App. Environ. Microb. 1979; 38:945–955.
5. Cornwell PB. The cockroach. Hutchinson and Co., Ltd., London, 1968, 391.
 6. Cruden DL, Markovetz AJ. Microbial ecology of the cockroach gut. Annu. Rev. Microbiol. 1987; 41:617-643.
 7. Guthrie DM, Tindall AR. The Biology of the Cockroach. Edward Arnold Ltd., London, 1968, 408.
 8. Hahn J, Ascerno M. Cockroaches. University of Minnesota Extension Service. 2005, 1-7.
 9. Hazarika LK, Gupta AP. Variation in haemocyte population during various developmental stages of *Blattella germanica* (L.) (Dictyoptera, Blattellidae). Zool. Sci. 1987; 4:307-313.
 10. Huber I, Masler EP, Rao BR. Cockroaches as models for neurobiology: applications in biomedical research. CRC Press, Boca Raton, 1990, 1-2.
 11. Jacobs SB. American cockroach *Periplaneta americana* (L.). Entomological notes. 2013.
 12. Kim, T. and Rust, M.K. Life history and Biology of the Invasive Turkestan cockroach (Dictyoptera: Blattidae). J Econ. Entomol. 2013; 106(6):2428-2431.
 13. Koehler PG, Bayer BE, Branscome D. Cockroaches and their management. Entomology and Nematology Department, UF/IFAS Extension, 2011.
 14. Kolisch J. Cockroach Biology. Cockroach control Manual. 1995; 3:8-13.
 15. Mullins DE, Cochran DG. Nutritional ecology of cockroaches. In Nutritional Ecology of Insects, Mites, Spiders, and Related Invertebrates. F.J. Slansky and J.G. Rodriguez, editors. John Wiley & Sons, New York. 1987; 885-902.
 16. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. ICAR, New Delhi, 1985.
 17. Perrot RC, Miller DM. American cockroach. Virginia Cooperative Extension. 2010, 1-4.
 18. Rau P. The life history of American cockroach, *Periplaneta americana* Linn. (Orthoptera: Blattidae). Entomol. News. 1940; 51(7):186-189.
 19. Rust MK, Owens JM, Riersen DA. Understanding and Controlling the German cockroach. Oxford University Press, New York, 1995, 430.
 20. Schal C, Gautier JY, Bell WJ. Behavioural ecology of cockroaches. Biol. Rev. 1984; 59:209-254.
 21. Whitworth RJ, Ahmad A. *Cockroaches*. Kansas State University Agricultural Station and Cooperative Extension, 2007.
 22. Wright CG. Life history of the brown cockroach. J Georg. Entomol. Soc. 1973; 8:274-277.