UFSM

CIÊNCIA e NATURA

ISSN 2179-460X
OPEN ACCESS

Ci. e Nat., Santa Maria, v. 48, e64990, 2026 • https://doi.org/10.5902/2179460X64990
Submitted: 03/29/2021 • Approved: 11/24/2025 • Published: 07/23/2026

Biology-Ecology

Dynamic life table of *Nauphoeta cinerea* (Olivier 1789), Blaberidae, Blattaria

Tabela de vida dinâmica para *Nauphoeta cinerea* (Olivier 1789), Blaberidae, Blattaria

Anna Clara Balbina Silva[I], Afonso Pelli[I]

[I] Universidade Federal do Triângulo Mineiro, Uberaba, MG, Brazil

ABSTRACT

Life tables are used to describe and understand population dynamics studies. The cockroach *Nauphoeta cinerea* is among the most used species as an alternative model to replace mammalian trials, as they have high reproductive capacity, short life cycle, and low maintenance. This study aimed at developing a dynamic life table for *Nauphoeta cinerea*, to better understand the biology of this insect. The experiment was conducted with an initial population of 27 individuals, with a specific age group, counted and fed weekly. Reproductive characteristics have been evaluated, and life table was used to estimate the mean generation time (T), net reproductive rate (Ro), intrinsic rate of increase (Rm) and finite rate of increase (λ). The data obtained from the life table indicate that *Nauphoeta cinerea* has higher initial survival rates, high biotic potential, and good growing capacity under favorable breeding conditions.

Keywords: *Blattodea*; Population dynamics; Fertility; Population parameters

RESUMO

Tabelas de vida são usadas para descrever e compreender estudos de dinâmica populacional. A barata *Nauphoeta cinerea* está entre as espécies mais utilizadas como modelo alternativo para substituir os experimentos em mamíferos, por apresentar alta capacidade reprodutiva, ciclo de vida curto e baixa manutenção. Este estudo teve como objetivo desenvolver uma tábua de vida dinâmica para *Nauphoeta cinerea*, para melhor compreender a biologia deste inseto. O experimento foi realizado com uma população inicial de 27 indivíduos, com faixa etária específica, contados e alimentados semanalmente. As características reprodutivas foram avaliadas, e a tabela de vida foi usada para estimar o tempo médio de geração (T), a taxa reprodutiva líquida (Ro), a taxa intrínseca de aumento (Rm) e a taxa finita de aumento (λ). Os dados obtidos na tábua de vida indicam que *Nauphoeta cinerea* tem maiores taxas de sobrevivência inicial, alto potencial biótico e boa capacidade de crescimento em condições favoráveis de reprodução.

Palavras-chave: *Blattodea*; Dinâmica populacional; Fertilidade; Parâmetros populacionais

1 INTRODUCTION

Population dynamics analyze the variations in the number of individuals and also the influence of the environment over them. Life tables are used to describe and comprehend those variations (Relyea, Ricklefs, 2021). There are two types of life tables, the dynamic one, that monitors the entire life cycle of a cohort and the static one, that uses characteristics to estimate the population age at a particular time, like horns or growth rings (Girão Filho et al., 2018).

In the case of a dynamic life table, it is possible to estimate lots of population parameters, including mortality and survival rates specified by age group, intrinsic rate of increase, and the mean generation time, enabling the projecting of the population in future time intervals (Marques et al., 2015). The environment influences the performance of the individuals, changing the population parameters (Medeiros et al., 2017).

Dynamic life tables are used in pest studies because they elucidate the behavior of populations. Furthermore, they allow for an understanding of population parameters (Alvarado et al., 1987; Godoy, Cividanes 2002), in addition to being used for quantifying development, fecundity, and survival. These studies can be used to control pests (Becklin et al., 2025; Chen et al., 2025; Gutierrez et al., 2025).

The ability of organisms to stay in the environment in the course of time is different for each population. The dynamic life table is an efficient tool for understanding the biotic potential of a population (Medeiros et al., 2017).

Cockroaches are insects of the Order Blattaria, Burmeister, 1829. They have succeeded to adapt to diverse environments, including urban areas. Those insects have peculiar characteristics, like an omnivorous habit, necrophagy, high reproductive capacity, adaptability to various environments, and can easily hide in small gaps (Silva, Pelli, 2019; Silva, Pelli, 2020; Silva, Pelli, 2021; Silva, Pelli, 2022).

Adults and nymphs can carry dozens of viruses, bacteria and fungi, besides other microorganisms, eventually pathogenic for humans. They can be considered plagues, as they play an important role as mechanical vectors, in addition to causing damage to store products (Kakumanu et al., 2018).

The cockroach *Nauphoeta cinerea* (Olivier) is grey, the adult insect measures 25-29 mm long, its wings are stained and do not cover all its abdomen. They are originally from East Africa and are currently distributed in the tropical regions worldwide (Santos et al., 2019; Silva et al., 2019).

This work aimed to construct a dynamic life table for *Nauphoeta cinerea.*

2 MATERIAL AND METHODS

The animals have been raised in a vivarium, with controlled photoperiod, 12 hours light/ dark, at room temperature, in Uberaba/MG, at the Nico Nieser Ecology & Evolution Laboratory of the Department of Pathology, Genetics and Evolution of Universidade Federal do Triângulo Mineiro. The license has been granted by ICMBio, nº 63276-1.

Twenty-seven newborn individuals have been selected and purchased from available matrices. The animals have been raised and kept in 30 x 20 x 15 cm plastic boxes. Solid Vaseline was used on the box edges in order to avoid escaping or possible contamination. The boxes had wood shaving bedding, cardboard cylinders for accommodation of the individuals and enrichment of the environment (and a 7 cm diameter Petri dish with paper towel and water). The food was put on the wood shavings. The insects were fed with fish feed pellets containing 33% of Guabi® protein and papaya ad libitum, once a week. Once a month the complete cleaning of the boxes was done (they were arranged in shelves). Counting of the individuals was done weekly, materials like seedlings or dead bodies were disposed. Eventual oothecas were placed apart. After hatching, the nymphs were counted and separated.

The collected data were analyzed using Microsoft Excel software, version 2021. The dynamic life table describes the mortality in periods of time, called mx. The survival probability, here named Sx, is calculated by the survival percentage, equals the number of alive individuals at the ages x and x+1. The probability of a newborn remaining alive at age x between various time intervals is represented by the survival rate, called lx. The dynamic life table shows that it is possible to estimate the life expectancy (ex) of an individual at age x.

In the current study, it has been considered that the sex ratio of the population follows the pattern 1♂: 1♀.

The female average fecundity, expressed in progenies produced by age group, is usually called bx. This parameter was obtained by the total number of collected first instar nymphs, divided by the total of cohort females.

The net reproductive rate, (R0), represents the number of females produced from a female, it is calculated by summing up the p products of survival and fecundity columns specified by age (∑lx bx). The average duration of one generation, named T, must be understood as the average time interval between the birth of a female and of her offspring; it is the result of the summation of the products obtained by the multiplication of columns x, lx, and bx and then divided by R0. The approximate value of rm can be designated by ra, which is an approximation of the intrinsic rate of increase. From the calculated result of ra, it is possible to estimate lambda (λ), calculated as r = loge λ (Pelli et al., 2007).

3 RESULTS AND DISCUSSION

The life table shows *Nauphoeta cinerea* survival and fecundity under experimental conditions for 432 days. Age is represented by the number of days of the interval x to x+1. Time was tabulated in intervals of approximately 33.23 days.

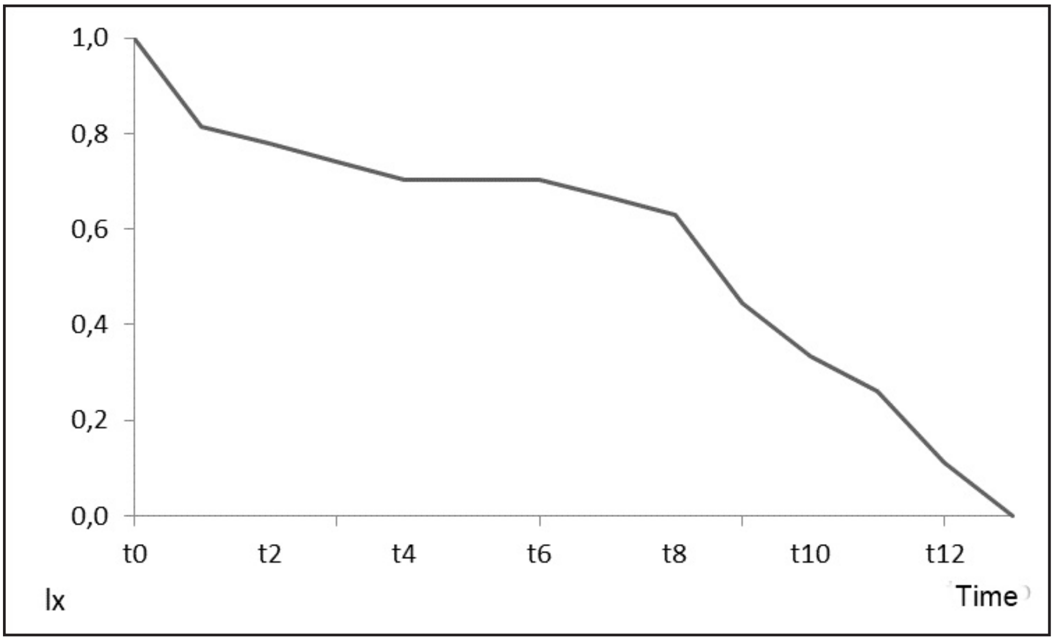
According to what is shown in the table, from 27 alive animals in t_0, 22 were alive at 68 days (t_1). And since then, S_0 and l_1, equal 0.815. As seen before in other surveys, the mortality rates are usually higher in the early stages of life and remain constant at low levels, until the death of the last individual (Pelli, Pimenta, Pelli, 2023; Peixoto et al., 2016). The observed survival curve resembles the type II-curve, whose mortality rate is relatively constant throughout life. In this study, it was observed a peak in mortality rates in t_0 and, from t_8. Also, more than 74% of the population reach reproductive age (Figure 1).

Table 1 – Life table for *Nauphoeta cinerea* used in laboratory conditions (tx - time interval, nx - number of living individuals, lx – survival, mx - mortality rate, Sx – survivorship rate, ex - life expectancy and bx – fertility)

tx	nx	lx	mx	Sx	ex	bx
t0	27	1.000	0.185	0.815	7.389	
t1	22	0.815	0.045	0.955	7.955	
t2	21	0.778	0.048	0.952	7.310	
t3	20	0.741	0.050	0.950	6.650	147
t4	19	0.704	0.000	1.000	5.974	284
t5	19	0.704	0.000	1.000	4.974	185
t6	19	0.704	0.053	0.947	3.974	186
t7	18	0.667	0.056	0.944	3.167	98
t8	17	0.630	0.294	0.706	2.324	93
t9	12	0.444	0.250	0.750	2.083	164
t10	9	0.333	0.222	0.778	1.611	64
t11	7	0.259	0.571	0.429	0.929	
t12	3	0.111	1.000	0.000	0.500	

Source: Organized by the authors (2020)

Figure 1 – Survival curve for *Nauphoeta cinerea*, created under laboratory conditions



Source: Organized by the authors (2020)

According to Santos et al. (2019), *Nauphoeta cinerea* reproductive age begins at 150 days old. In this present study, the individuals started to reach adulthood at 90 days and began oviparity after 20 days. The rate observed in t_3 was 147 nymphs; in t_4, 284 nymphs; 185 in t_5; 186 first instar nymphs in t_6; 98 in t_7; 93 in t_8; 164 in t_9; 64 in t_{10} and 0 in T_{11} and T_{12}; producing, on average, a total of 610.5 nymphs/ female, considering the sexual rate of 1: 1. The value obtained for average duration of one generation was 5.5 time intervals, or 183.8 days between generations. The net reproductive rate showed value R_0 equals to 787.93 females produced by female. Analyzing the model of geometrical growth and projecting the population by means of a dynamic life table, it can be observed that λ value stabilizes in 3,64926, in time interval t = 180. When λ value remains stable, indicating that the population has reached the stable age distribution, which is only possible when mortality and birth rates specified by age group remain constant. Otherwise speaking, for this to happen, the environmental conditions must be constant at several time intervals.

The intrinsic rate of increase of a population is represented by R_m, in other words, the exponential rate or geometric growth rate, when the population reaches the stable age group distribution. However, the environmental conditions are constantly changing, in time and space, hence the population hardly reaches the stable age group. The approximate value of R_m, calculated by r_a, equals to $\log_e R_0/T$; the result was 0.0158. From the ra results, it is possible to estimate the lambda value (λ), calculated as $r = \log_e \lambda$, resulting in 2.7618.

The time required for the population to double in size may be named t_2. It can be calculated as $\log_{e\lambda}$, which is $0.69/\log_e \lambda$; corresponding to 0.679 years or 247. 9 days.

4 CONCLUSIONS

The dynamic life table contributes to the construction of *Nauphoeta cinerea* life history. The information gathered allows us to analyze the population development and parameters, which are features of the studied population, probably similar to other populations of the same species. This information can be used for population (or species) management and control, functioning as a strategy for helping to use the species for a variety of purposes, including being a resource for feeding animals, experimental laboratory studies and teaching practices. In addition to its high reproductive capacity, they have a relatively short life cycle and low maintenance requirements.

ACKNOWLEDGEMENTS

The authors are grateful to FAPEMIG (Fundação de Amparo à Pesquisa do Estado de Minas Gerais) for the partial support of the project by granting a master's scholarship (process 23085.003285 / 2019-61) in the Graduate Program in Environmental Science and Technology, University Federal do Triângulo Mineiro.

REFERENCES

Becklin, S., Jin, Y., Rebarber, R., & Tenhumberg, B. (2025). Spatial dynamics of a pest population with stage-structure and control. *Journal of Mathematical Biology, 90*, e48. doi: 10.1007/s00285-025-02208-x

Chen, Z., Luo, Y., Wang, L., Sun, D., Wang, Y., Zhou, J., Luo, B., Liu, H., Yan, R. & Wang, L. (2025). Advancements in Life Tables Applied to Integrated Pest Management with an Emphasis on Two-Sex Life Tables. *Insects, 16*(3), e261. doi: 10.3390/insects16030261

Girão Filho J. E., Pádua L. E. M., Portela G. L. F., Sousa F. M., Silva J. D. C. (2019) Thermal requirements, life expectancy and fertility tables of *Aphis craccivora* (Hemiptera: Aphididae) in *Vigna unguiculata* (Fabales: Fabaceae) under laboratory conditions. *Arq Inst Biol*, *86,* e0142018. doi: 10.1590/1808-1657000142018

Godoy, K. B., Cividanes, F. G. (2002). Tabelas de esperança de vida e fertilidade para *Lipaphis erysimi* (Kalt.) (Hemiptera: Aphididae) em condições de laboratório e campo. *Neotropical Entomology, 31*(1), 41-48. doi: 10.1590/S1519-566X2002000100006

Gutierrez, A. P., Ponti, L., Neteler, M. et al. (2025). Geospatial physiologically based demographic modeling and analysis of thirteen invasive species in Africa: why the biology matters. *Environ Sci Eur 37*, e67. doi: 10.1186/s12302-025-01084-y

Kakumanu, M.; Maritz, J.; Carlton, J.; Schal, C. (2018). Overlapping Community Compositions of Gut and Fecal Microbiomes in Lab-Reared and Field-Collected German Cockroaches. *Applied and Environmental Microbiology, 84*(17), e01037-18. doi: 10.1128/AEM.01037-18

Medeiros, M. O.; Alves, S. M.; Souza, E. A.; Kimura, M. T.; Frohlich, W. F. (2017). Tabela de vida de fertilidade para *Scaptocoris carvalhoi* Becker, 1967 (Hemiptera: Cydnidae) em *Urochloa decumbens* (Poaceae). *Biodiversidade, 16*(3), 2-15. http://periodicoscientificos.ufmt.br/ojs/index.php/biodiversidade/article/view/6009

Peixoto, P. G., Oliveira, R. V., Miranda, V. S., Paulino, T. P., De Andrade, R. M., Pelli, A. (2016). Avaliação Proteica e Parâmetros Populacionais de *Cynaeus angustus* (LeConte) (Coleoptera: Tenebrionidae). *EntomoBrasilis, 9*(2),108-113. doi: 10.12741/ebrasilis.v9i2.561

Pelli A., Pimenta P. C., Pelli P. M. (2023). Population parameters and dynamic life table of stick-insect *Cladomorphus phyllinus* Gray, 1835 (Phasmatidae, Cladomorphinae). *MOJ Eco Environ Sci.; 8*(4), 143-146. doi: 10.15406/mojes.2023.08.00284

Pelli, A., Silva, M. A. Da, Sarmento, F. R., Martins, E., Mata, S. A. Da, Domingues, M. A., & Ramirez, L. E. (2007). Parâmetros populacionais para *Triatoma sordida* Stal, 1859, o vetor mais frequente da doença de Chagas no Triângulo Mineiro (Heteroptera, Triatominae). *Revista Da Sociedade Brasileira De Medicina Tropical,* 40(1), 25–28. doi: 10.1590/S0037-86822007000100005

Relyea, R. & Ricklefs, R. E. (2021). A economia da natureza. Rio de Janeiro, RJ/Brazil: Guanabara Koogan.

Santos, D. S., Rosa, M. E., Zanatta, A. P., Oliveira, R. S., Almeida, C. G. M., Leal, A. P., Sanz, M., Fernandes, K. A., Souza, V. Q., Assis, D. R., Pinto, E., Belo, C. A. D. (2019). Neurotoxic effects of sublethal concentrations of cyanobacterial extract containing anatoxin-a(s) on *Nauphoeta cinerea* cockroaches. *Ecotoxicology and Environmental Safety*, 30(171), 138-145. doi: 10.1016/j.ecoenv.2018.12.068

Silva, A. J.; Menegon, L.; Prentice, C. (2019). Como os diferentes estágios do desenvolvimento interferem na composição proximal da barata cinerea (*Nauphoeta cinerea*). *Brazilian Journal of Development, 5*(12), 32510-32516. doi: 10.34117/bjdv5n12-315

Silva A. C. B., Pelli A. (2019). Current state of knowledge of cockroaches, Order Blattaria Burmeister, 1829. *UNINGÁ Rev*., 34(2), 28-38. https://revista.uninga.br/uningareviews/article/view/2950

Silva, A. C. B.; Pelli, A. (2020). Ciclo Circadiano para *Nauphoeta cinerea* (Olivier, 1789) (*Blattodea, Blaberidae*) em condições climatizadas de laboratório. *Brazilian Journal of Development, 6*(9): 65437-65444. doi: 10.34117/bjdv6n9-103

Silva, A. C. B.; Pelli, A. (2021). Avaliação da repelência de *Allium sativum*, L. (alho) visando o controle de *Nauphoeta cinerea* (Olivier, 1789). *Acta Ambiental Catarinense,* 19(1): 1-7, doi: 10.24021/raac.v19i1.6225

Silva, A. C. B., Pelli, A. (2022). Atividade repelente de extratos de louro em *Nauphoeta cinerea* (Olivier, 1789). *Acta Biologica Brasiliensia,* 5(1): 5–14. doi: 10.18554/acbiobras.v5i1.7203

Authorship contributions

1 – Anna Clara Balbina Silva

PhD in Tropical Medicine and Infectious Diseases from the Federal University of Triângulo Mineiro (UFTM).
Orcid link: https://orcid.org/0000-0002-7891-7308 • email: annaclara1996@live.com
Contribution: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing.

2 – Afonso Pelli

PhD in Aquaculture from São Paulo State University (UNESP).
Orcid link: https://orcid.org/0000-0001-8279-2221 • email: afonsopelli@gmail.com
Contribution: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing.

How to quote this article

Silva, A. C. B., Pelli, A. (2026). Dynamic life table of *Nauphoeta cinerea* (Olivier 1789), Blaberidae, Blattaria. *Ciência e Natura,* Santa Maria, v. 48, e64990. DOI: 10.5902/2179460X64990. Available in: https://doi.org/10.5902/2179460X64990.