MedCrave
Step into the World of Research
MOJ Ecology & Environmental Sciences

Research Article

Open Access
CrossMark

Population parameters and dynamic life table of stick-insect *Cladomorphus phyllinus* Gray, 1835 (Phasmatidae, Cladomorphinae)

Abstract

The Phasmatodea Order is represented by terrestrial insects, phytophagous and wide distribution. About 200 species have been described in Brazil as *Cladomorphus phyllinus*. The aim of this study was to describe the biology as well as measure population parameters. The specimens were kept in cages with temperature and natural photoperiod. We used 22 animals that were fed with leaves of guava, *Psidium guajava* Linnaeus. For the construction of the dynamic life table, the following parameters were used: specific survival by age group; survivorship or survival compared to live-born animals; specific fertility by age group; specific mortality by age group and life expectancy. Initially, the cohort of animals was monitored weekly, for a total period of 55 weeks. However, to facilitate data tabulation, they were grouped into age groups. The cohort was then divided into 11 periods of 35 days each; thus totaling 385 days. The survival curve, constructed with the survivorship data, indicate to a curve of type II, where the mortality rate is relatively constant throughout life. The animals began to lay eggs at the 23rd week. The period with the highest fecundity was t5 with 93 eggs per female. With the life table, the population projection was performed in future time intervals. In the time t = 291, the λ value stabilizes at 2.0747 and the population reaches stable age distribution. The data indicate high biotic potential for the species, in contrast to the density of data in the field, when the group is usually found in low densities, probably indicating low effectiveness of camouflage combined with the fragility of the animals against environmental adversities.

Keywords: biodiversity, survival curve, phasmids, cohort table

Volume 8 Issue 4 - 2023

Afonso Pelli, Paloma Cristina Pimenta, Pedro Machado Pelli

Programa de Pós-Graduação em Ciência e Tecnologia Ambiental, Disciplina de Ecologia & Evolução, Instituto de Ciências Biológicas e Naturais. Universidade Federal do Triângulo Mineiro, Brazil

Correspondence: Afonso Pelli, Programa de Pós-Graduação em Ciência e Tecnologia Ambiental, Disciplina de Ecologia & Evolução, Instituto de Ciências Biológicas e Naturais. Universidade Federal do Triângulo Mineiro, Av. Frei Paulino, 30, Uberaba/MG CEP 38025-180, Brazil, Email afonsopelli@gmail.com

Received: July 05, 2023 | **Published:** August 21, 2023

Introduction

The Phasmatodea Order is represented by terrestrial insects, that are nocturnal, phytophagous and distribution covering temperate and tropical ecosystems.[1] More than 3.000 species have been cataloged, and the greater diversity of the group is concentrated in the tropics.[2] These insects are found on trees and resemble twigs, branches, leaves, and lichens.[3] The Insects that belong to this order are popularly known as stick-insects.[2,4]

About 200 species have been described in Brazil, and for decades, *Carausius morosus* Sinéty, 1901 was a much used as research animal. Recently other species have also been created in the laboratory for different purposes.[3,4] *Cladomorphus phyllinus* Gray, 1835 shares with the others the habit of living on plants and feed exclusively on leaves and buds.[5,6]

Cladomorphus phyllinus is polyphagous and widely distributed throughout northeast of Argentina, southern Amazon, eastern Brazil including Mata Atlântica and nearby regions.[5,7,8]

For construction of the cohort life table or dynamic life table is necessary the number of individuals in every age group, the probability of survival and fertility rate. The life table expresses the interaction between individuals and their environment by providing change information on population size, essential for understanding the population dynamics.[9–11]

The objective of the present study was to describe aspects of the biology and life history of the species *Cladomorphus phyllinus*,[5] as well as to measure population parameters.

Materials and methods

The study was conducted in laboratory of Ecology "Nico Nieser", in the Federal University of Triângulo Mineiro. 22 animals of the species *Cladomorphus phyllinus* were used. They were kept in a cage with dimensions of 80x75x45 cm, with wooden frames and nylon screen. Testimony exemplaries were deposited in PELL Collection in Uberaba/Minas Gerais (Figure 1).

Figure 1 Testimony exemplaries (female on the right, male on the left) deposited in PELL Collection in Uberaba/MG.

The individuals were fed in guava leaves *Psidium guajava* Linnaeus, counted every seven days, and the number of eggs was measured (Figure 2).

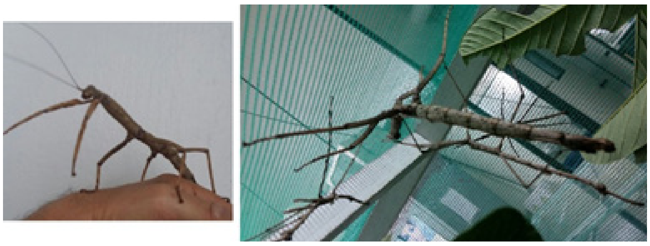

Figure 2 Specimens of *Cladomorphus phyllinus* Gray, 1835, bred at the Nico Nieser Animal Facility at the Federal University of Triângulo Mineiro, in Uberaba/Minas Gerais. A female on the right and, on the left, two males and a female.

The following parameters were recorded: survival Sx, defined as the proportion of subjects at age x surviving to age x + 1 (than Sx = nx + 1/nx); lx or survivorship, which is probability of survival over time intervals or survival of newborn to age x, calculated as lx = nx/n_0. By definition all born alive, then lx_0 = 1. The proportion of infants at age 1 is the probability of surviving from age 0 to age 1; than lx_1 = S_0.

By definition, bx is fecundity, or the number of offspring produced per female per breeding season or age. The mortality rate (mx) is the proportion of individuals dying of age x to age x + 1, on average, or mx = [nx – (nx + 1)]/nx.

The life expectancy of the individual of age x (ex) is calculated based on the formula ex = Tx/nx, with life expectancy for living organisms at the beginning of x time interval. For the calculation of ex is required tx calculation, which is the sum of the average survival per interval or the number of surviving individuals per time interval. This parameter has no biological significance and is only used for the calculation of tx.

The logistical and geometric growth models have analogy in the form of growing populations in the exponential growth phase. Thus, the loge λ = r or λ = er. For λ means the population growth rate between time intervals in geometric growth; but it needs to be considered same number of episodes of birth and death.

Results

The life table expresses the survival and fertility of *Cladomorphus phyllinus* under laboratory conditions for 11 periods of 35 days, totaling 385 days. Age was represented by number of days in the interval x to the interval x + 1, since the reproduction of this species is continuous (Table 1).

Table 1 Dynamic life table for *Cladomorphus phyllinus*, created under laboratory conditions

tx	nx	Sx	lx	mx	ex	bx
tx0	22	0,818	1,000	0,182	5,14	
tx1	18	0,944	0,818	0,056	5,17	
tx2	17	0,941	0,773	0,059	4,44	
tx3	16	0,875	0,727	0,125	3,69	
tx4	14	0,857	0,636	0,143	3,14	5,250
tx5	12	0,833	0,545	0,167	2,58	93,143
tx6	10	0,600	0,455	0,400	2,00	73,833
tx7	6	0,833	0,273	0,167	2,00	65,667
tx8	5	0,600	0,227	0,400	1,30	51,667
tx9	3	0,333	0,136	0,667	0,83	61,000
tx10	1	0,000	0,045	1,000	0,50	12,000

tx, time; nx, number of living individuals; lx, survivorship; mx, mortality; Sx, survival rate; ex, life expectancy; bx, fertility

Of the 22 animals alive at tx_0, 18 were alive at 35 days (Tx1). So S_0 and L1 are both equal to 0.81. Of these 22 individuals, 14 reach reproductive age, representing approximately 64% of the population (Table 1).

The mortality rate (mx) has remained relatively constant, with higher rates in periods tx_6 to tx_{10}. In the 23rd week, the animals began laying eggs. In tx_4, the observed rate was 5.25 eggs per female, followed by 93.14 in Tx_5, during which there was the greatest fecundity, 93.143 eggs/female. Life expectancy (ex) ranged from 5.14 in tx_0 to 0.50 at tx_{10}.

The survival curve for *Cladomorphus phyllinus* is shown in Figure 3. The survival curve is constructed with survivorship data, and can take three different forms.[10] The survival curve observed in this cohort of *Cladomorphus phyllinus* approaches Type II, with a relatively constant mortality throughout life. This pattern is common for some populations of insects and birds.[12–14] In most species of plants, amphibians, reptiles, and small invertebrates, in which young animals are vulnerable to predation and other risk factors, mortality is higher in the early stages of life, featuring the type III of survival curve.[13]

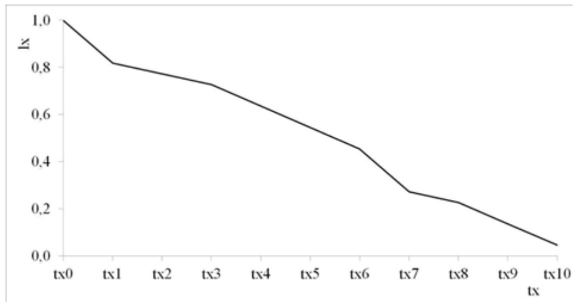

Figure 3 Survival curve for *Cladomorphus phyllinus* Gray, 1835, bred at the Nico Nieser Animal Facility, at the Federal University of Triângulo Mineiro, in Uberaba/Minas Gerais, created under laboratory conditions.

Discussion

As pointed out by Pelli et al.,[10] stable age distribution, corresponds to the period in which the population grows, or decreases, at the same rate. In this condition, the percentage proportion of individuals per age group is maintained. This phenomenon occurs when environmental conditions remain constant for several time intervals. Under these conditions the value of λ stabilizes, and the value of the intrinsic rate of instantaneous growth (r) can be estimated.

With the population projection data, computed from the dynamic life table, and considering the geometric growth model, at time t = 291, the λ value stabilizes at 2.074741.

The range in which the population reached a stable age distribution, that is the proportion of the number of animals in each age group, remain constant over the time intervals, with the population increasing or decreasing.

This will only be possible if environmental conditions remain constant for several time intervals and, therefore, specific mortality and birth rates by age group, also remain constant.[10]

In the present study, the females laid an average of 362.56 eggs. This value is slightly lower than that observed by Alvarenga et al.,[7] when the observed value was 392.3/female. Another difference that draws attention is the longevity of the animals. Alvarenga et al.[7] report that females can live up to eight months of age, whereas in the present study, females lived up to 385 days, a value much higher than that observed by Alvarenga et al.[7]

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

To *Triatoma sordida*,[10] the population has reached a stable age distribution at t = 229, with a value of λ = 2.00546, slightly lower than λ value found by us, indicating high potential growth rate for *Cladomorphus phyllinus*.

The intrinsic rate of increase of a population may be indicated by r_m. This exponential growth rate is calculated for populations with stable distribution. This would be the exponential rate of increase when the population presents stable age distribution. Naturally stable age distribution is only achieved when the environmental conditions remain constant, thus the population attributes remain constant by age group.

As environmental conditions do not remain constant over time, this stable age distribution is rarely achieved. Therefore, we can work with an approximate value of intrinsic rate of increase, called r_a. For this cohort, the calculated r value was 0.72838.

At time t = 291, when the population reached stable age distribution, the percentage distribution of individuals within the population would be 58.421% of individuals in the time interval tx_0, 23,033% at the interval of time tx_1; 10,480% by tx_2; 4.753% by tx_3; 2.005% by tx_4; 0.828% by tx_5; 0.332% by tx_6; 0.096% by tx_7; 0.039% by tx_8; 0.011% to 0.002% and tx_9 in the time interval tx_{10}, showing that most of the population could be constituted by young insects.

In the laboratory, the species *Cladomorphus phyllinus* presents a high biotic potential, however, in fauna surveys, this group normally presents low densities.[15–19] In systematic collections, this group presents low densities, probably indicating low effectiveness of camouflage combined with the fragility of the animals in the face of environmental adversities.[15–19]

Conclusion

In the present study, *Cladomorphus phyllinus* showed a high biotic potential, as the λ value stabilized at 2.0747. This value is superior to that of several other species already reported in the literature. It is interesting to note that despite this attribute, the species can be considered rare in nature. Few reports exist of the occurrence of the species. The studied species is very showy, and draws attention for its unique traits, yet it is not reported often.

The authors consider that not only the biotic potential can eventually determine the success of the species, but also other variables such as: pollution, destruction of natural habitats and, in a way, an eventual strategy. No predator will specialize in rare prey. Another hypothesis raised is that the primary line of defense of the species is not effective. These animals camouflage themselves and, therefore, are called leaf and stick insects. However, if the strategy were efficient, it would be able to obtain resources and, at the same time, not be used as a resource.

In conclusion, the authors point out the high biotic potential of the species, associated with its eventual fragility under natural conditions, which reflect in low population densities.

Acknowledgments

To Prof. Dr. Ângelo Barbosa Monteiro Machado (*in memoriam*), at the Department of Zoology at the Federal University of Minas Gerais, a great enthusiast of Brazilian entomology. Prof. Ângelo Machado kindly provided the stick insect matrices.

Funding

Institute of Biological and Natural Sciences of the Federal University of Triângulo Mineiro.

Conflicts of interest

Authors declare that there is no conflict of interest for the publication of this article.

References

1. López–Mora U, Llorente–Bousquets J. Lista de especies y clave ilustrada de los géneros de phasmatodea (Insecta) de México. Rev *Mex Biodiv*. 2018;1:46–78.
2. Bank S, Cumming Rt, Li Y, et al. A tree of leaves: phylogeny and historical biogeography of the leaf insects (*phasmatodea: phylliidae*). *Commun Biol*. 2021;932:1–12.
3. Burack J, Gorb SN, Büscher TH. Attachment performance of stick insects (*phasmatodea*) on plant leaves with different surface characteristics. *Insects*. 2022;13:1–20.
4. Shelomi M, Cytochrome P450 genes expressed in phasmatodea midguts. *Insects*. 2022;10:863–873.
5. Kumagai AF, Fonseca NG. Uma nova espécie de *Cladomorphus* Gray, 1835 (Phasmatidae, Cladomorphinae) de minas gerais, Brasil. *Rev Bras Entomol*. 2009;53:41–44.
6. Zhang C, Guo X. Organization of the mitochondrial genome of *Ramulus Irregulatiter Dentatus* (Phasmatidae: Phasmatidae). *Front Genet*. 2022;13:1–12.
7. Alvarenga CD, Souza HR, Giustolin TA, et al. Biologia de *cladomorphus phyllinus* gray (phasmatodea: phasmatidae) em folhas de goiabeira (*psidium guajava*). *Entomobrasilis*. 2018;11(2):65–69.
8. Forero D, Campos La, Castro–Huertas V, et al. Evolutionary mechanisms for camouflage in *Cladomorphus Phyllinus* (Phasmatodea): a reflection on the role of evidence for hypotheses proposition. *Anais Da Academia Brasileira De Ciências*. 2020;92:1–5.
9. Rodríguez–Espinosa FL, Martínez–Rivero MLA, Gómez–Leyva JF. Parámetros biológicos y tabla de vida de dos poblaciones de *Chloridea Virescens* (Fabricius) (Lepidoptera: Noctuidae) asociadas al tabaco Negro. *Revista De Protección Vegetal*. 2018;2:1–10.
10. Pelli A, Silva MA, Sarmento FR, et al. 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*. 2007;40:25–28.
11. Relyea R, Ricklefs R. A economia da natureza. Editora Guanabara Koogan S.A. 8th edn. Rio De Janeiro. 2021. ISBN: 8527716771.
12. Silva CCA, Laumann RA, Moraes MCB, et al. Comparative biology of two congeneric stinkbugs, *Chinavia Impicticornis* and *C. Ubica* (Hemiptera: Pentatomidae). *Pesquisa Agropecuária Brasileira*. 2015;50:355–362.
13. Igua–Mjonathan S, Sanchez A Daniel E, John Wilson Martinez–O. Parámetros poblacionales y descripcion de los instares ninfales de *Protortonia Ecuadorensis* (Hemiptera: Monophlebidae). *Bol Cient Mus Hist Nat Univ Caldas*. 2020;1:121–134.
14. Ramírez VH, López–Mata L, Cruz–Rodriguez JA, et al. Nicho de regeneración de *Abies Religiosa* (Kunth) Schltdl. & Cham. En El Monte Tláloc, Parque Nacional Iztaccíhuatl–Popocatépetl, México. *Bot Sci*. 2022;2:331–344.
15. Contador T, Rendoll J, Mackenzie R, et al. Comunidades de invertebrados terrestres do arquipélago diego ramírez (56°31's), o local

de estudo ecológico de longo prazo mais ao sul da América: Diversidade E Afinidades Com As Ilhas Subantárticas Do Oceano Antártico. Instituto Annales Patagonia (Chile). 2020;48:83–98.

16. Herbas LJZ, Cartagena IL, Naoki K, et al. Variación en la composición de visitantes florales de cacao (*Theobroma Cacao*) Entre cinco sistemas de producción en sara ana, alto beni, Bolivia. *Ecología En Bolívia*. 2020;3:145–159.
17. Rafael JA, Limeira–De–Oliveira F, Hutchings RW, et al. Insect (Hexapoda) diversity in the oceanic archipelago of fernando de Noronha, Brazil: updated taxonomic checklist and new records. *Rev Bras Entomol*. 2020;64:1–26.
18. Palomino–Gómez L, Gallego–Ropero MC. Entomofauna asociada al cultivo de granadilla de quijos *Passiflora Popenovii* (Passifloraceae). *Bol Cient Mus Hist Nat Univ Caldas*. 2021;2:181–196.
19. Escobar–Escobar N, Castro–J M, Baquero–G Y, et al. Identification of functional groups of insects associated with family agricultural production systems in the province of Sumapaz, Colombia. *Bol Cient Mus Hist Nat Univ Caldas*. 2022;1:41–54.