ECOLOGY, BEHAVIOR AND BIONOMICS

Seasonal Population Dynamics in *Lucilia eximia* (Wiedemann) (Diptera: Calliphoridae)

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Dinâmica Populacional Sazonal em *Lucilia eximia* (Wiedemann) (Diptera: Calliphoridae)

RESUMO - Neste estudo variações sazonais da fecundidade, tamanhos de asa e tíbia foram investigadas em populações naturais de *Lucilia eximia* (Wiedemann), na tentativa de determinar as alterações bionômicas da espécie, associadas à sazonalidade. Exemplares de *L. eximia* foram coletados mensalmente em Botucatu, SP, durante dois anos e as fêmeas adultas dissecadas para estimar a fecundidade. O tamanho do corpo foi estimado por medições de asa e tíbia. A fecundidade e o tamanho do corpo foram analisados sazonalmente. Uma trajetória temporal relativamente constante foi encontrada para fecundidade e tamanhos de asa e tíbia durante os 24 meses de estudo. Fortes correlações positivas entre tamanhos de asa e tíbia, fecundidade e tamanho de asa e fecundidade e tamanho de tíbia foram observadas. A manutenção dos valores estáveis em *L. eximia* indica que a espécie sofreu pouca influência sazonal durante o período analisado. Esse resultado confirma o perfil demográfico e bionômico estável da espécie a despeito das variações climáticas sazonais observadas na área de estudo.

PALAVRAS-CHAVE: Mosca-varejeira, sazonalidade, fecundidade, tamanho corpóreo

ABSTRACT - In this study the seasonal variation of fecundity, wing and tibia sizes were investigated in natural populations of *Lucilia eximia* (Wiedemann) as an attempt to determine the variations in life history of the species associated to seasonality. Specimens of *L. eximia* were monthly collected in Botucatu, São Paulo, Brazil, during two years and the adult females dissected to estimate fecundity. Body size was estimated by measuring wing and tibia. Fecundity and body size were seasonally analysed. A relatively constant temporal trajectory was found for fecundity, wing and tibia size over twenty-four months. Strong positive correlations between wing and tibia size, fecundity and wing and fecundity and tibia were observed. The maintenance of stable values in *L. eximia* indicates that it has suffered little seasonal influence over the period analysed. This result confirms the demographics and life history stable profile of the species in spite of seasonal climatic changes observed in the study area.

KEY WORDS: Blowfly, fecundity, body size

Lucilia Robineau-Desvoidy species are named greenbottles because of their brilliant metallic green coloration, which appears to vary with age (Smith 1986). However, the species of the genus *Lucilia* are also considered as blowfly, since they exhibit the same synanthropic and feeding behavior observed in other Calliphoridae species (Stevens & Wall 1996). Adults, especially males, are frequently found on flowers where they feed on the nectar (Smith 1986). Most species of *Lucilia* are saprophagous, breed in carrion and dung, usually being the first to appear in carrion in sunlight (Archer & Elgar 2003). In Brazil the most common *Lucilia* species is *Lucilia eximia* Wiedemman (Moura *et al.* 1997). *L. eximia* is a nearctic and neotropical species frequently found in rural and urban areas that breeds primarily in carcasses but also in rotten fruit and urban garbage (Madeira *et al.* 1989).

L. eximia has medical and veterinary importance because it causes secondary myiasis in humans and primary myiasis in animals (Madeira *et al.* 1989). Further, this species can be used in forensic medicine as a biological indicator in estimating the post-mortem interval (Moura *et al.* 1997). *L. eximia* has been reared in a wide variety of corpses, including pigs (Souza & Linhares 1997) and human bodies (Freire 1914).

Around 30 years ago, three species of Calliphoridae blowflies introduced into the Americas: *Chrysomya megacephala* Fabricius, *C. putoria* Wiedemann, and *C. albiceps* Wiedemann colonized several countries of South America including Brazil (Guimarães *et al.* 1978). This invasion resulted in a decline of *L. eximia* and another native American species, *Cochliomyia macellaria* Fabricius (Guimarães *et al.* 1978, Madeira *et al.* 1989). Although the

consequence of intraspecific competition for food among immature stages of *Chrysomya* spp. and *C. macellaria* species has received renewed attention from both theoretical and experimental standpoints (Godoy *et al.* 1996, 2001), very little is known about *L. eximia* (Silva *et al.* 2003), mainly with respect to its population dynamics.

Dynamic behavior is important in the assessment of relevant demographic aspects of biological invasions (Hengeveld 1989). However, dynamic behavior usually depends on factors associated to demography, such as growth rate and carrying capacity (Hengeveld 1989). The values of demographic parameters associated with population growth may exhibit high variation between different species and populations (Gotelli 1995). The causes of variation are usually diverse and depend on the environment and/or the biological attributes of each organism (Brewer 1994).

Fecundity, survival, developmental rate, weight and body size are generally density-dependent characters influenced by environmental factors in insect populations (James & Partridge 1998). Thus, it is possible that the population density of blowflies is strongly associated with seasonality, since competitive ability has been considered temporally different among species and populations (Reis *et al.* 1999).

In the present study the seasonal variation in fecundity, wing and tibia sizes in natural populations of *L. eximia* have been analysed as an attempt to contribute to the understanding of its population dynamics.

Material and Methods

Specimens of *L. eximia* were monthly collected from December 2000 to November 2002 in the vicinity of the *campus* of the São Paulo State University located at Botucatu, São Paulo State, Brazil. Adult flies were maintained under laboratory conditions in cages (30 cm x 30 cm x 30 cm) covered with nylon at 25 ± 1°C, being fed water and sugar *ad libitum*. Adult females were fed fresh liver to permit complete development of the gonotrophic cycle (Linhares 1988). Females were dissected and the number of eggs was recorded. Body size was estimated by measuring right wing and second tibia length of the flies. Seasonal fecundity, wing and tibia sizes were compared by one-way ANOVA. Pearson's coefficient was used to analyse the correlation between life-history parameters. Mean monthly temperatures and humidities for the Botucatu area were obtained from the Meteorological Station of São Paulo State University at Botucatu. São Paulo State.

Results and Discussion

L. eximia exhibited a relatively stable temporal trajectory for fecundity, tibia and wing length over twenty-four months (Figs.1-3). There was no significant correlation between temperature and fecundity or wing length or tibia length ($P > 0.05$), but there was highly significant correlation between wing length and fecundity ($r = 0.73$, $P < 0.05$), tibia length and fecundity ($r = 0.63$, $P < 0.05$) and, tibia and wing lengths ($r = 0.72$, $P < 0.05$). No significant correlation between humidity and fecundity or body size has been found ($P > 0.05$).

The weak oscillations found for fecundity, wing and tibia length indicate that these three characters are relatively constant over the year, suggesting weak impact of seasonal effects. Reigada & Godoy (2005) have also observed this result in a similar study with *C. megacephala*; however, positive correlations between fecundity and body size and body size and temperature have been observed in natural populations of the species. The difference in terms of correlation between the life history characters of *L. eximia* and *C. megacephala* might be explained by the abundance patterns inherent in each species, since *L. eximia* has been found throughout the year in spite of temperature changes (Moura *et al.* 1997, Reigada & Godoy 2005).

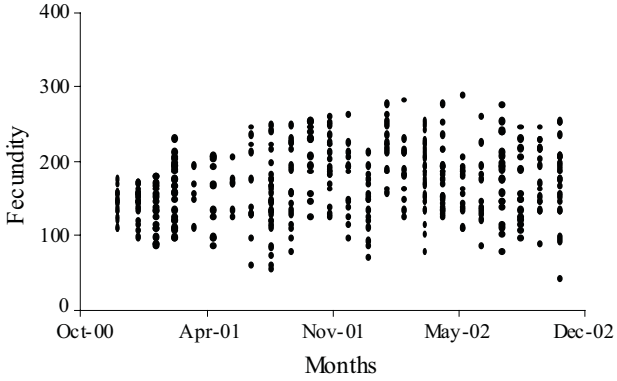

Fig. 1. Seasonal variation of fecundity (number of eggs) in *L. eximia*.

Of all biological parameters directly associated with growth rate in blowflies, fecundity plays an important role in population dynamics since it determines the population growth potential (Godoy *et al.* 1996, 2001). The dynamic behavior of blowflies has been analysed by mathematical models with results revealing that the stability of population equilibrium depends essentially on survival and fecundity (Godoy *et al.* 1996, 2001; Silva *et al.* 2003). Using bifurcation theory to perform a parametric sensitivity analysis, Godoy *et al.* (1996) observed that the variation of fecundity and survival produces qualitative changes in population dynamics of *C. macellaria*, *C. megacephala* and *C. putoria*. These species exhibit changes from stable equilibrium to a two-point limit

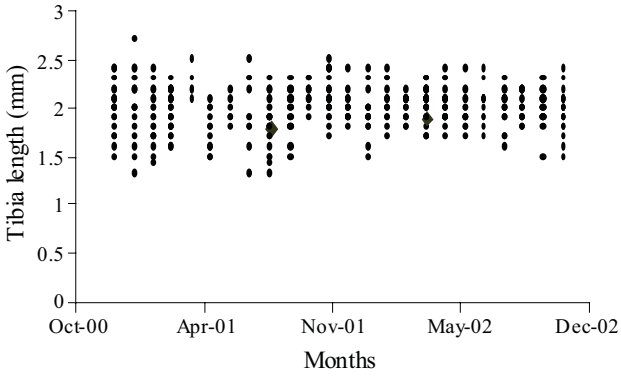

Fig. 2. Seasonal variation of tibia length (mm) in *L. eximia.*

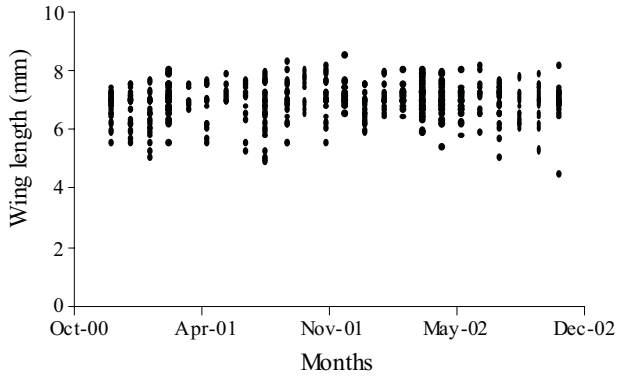

Fig. 3. Seasonal variation of wing length (mm) in *L. eximia*.

cycle (Godoy *et al.* 1996). However, the increase of fecundity values in *C. megacephala* promotes successive changes in dynamic behavior, starting with two-point limit cycle, going through four-point limit cycle and then reaching chaos (Godoy *et al.* 1996). The values used in these simulations are apparently real in natural populations (Ullyett 1950), nevertheless, nothing is known about the seasonal variations in fecundity of natural blowfly populations.

The temporal oscillations in blowflies have frequently been studied to investigate the association between seasonality and abundance of adults (Linhares 1981). The results of these studies (Linhares 1981, Mendes & Linhares 1993) have revealed that *Chrysomya* spp. have been colonizing new areas in the Americas with evident success. As a consequence, the structure of the Brazilian blowfly fauna has undergone change.

Of all the environmental factors, temperature has been considered the most important, since it can influence the population dynamics of insects, directly as seen, for example, in the population growth of *M. domestica* L., particularly in Equatorial and tropical zones, where high densities are observed (Levine & Levine 1991). Although some studies have been designed to investigate population behaviour in response to temperature, they have focused specifically on geographical variation, genetic divergence and natural selection, differing from the present investigation, which focuses on the census of life history characters.

The effects of temperature on the development and survival of insects have been extensively investigated (Thind & Dunn 2002). The rates of physiological processes are strongly influenced by body temperature and this thermal sensitivity may affect profoundly the behavior, ecology and evolution of ectotherms (David *et al.* 1983). The responses to temperature seem to vary with species and other taxonomic groups. Outbreaks of many defoliator species are apparently synchronised over wide geographical areas. Explanations of synchronicity include, among other factors, the theory of climatic release (Greenbank 1956).

The annual activity and spatial distribution of Calliphoridae have been investigated in a Mediterranean area, as in a holm-oak ecosystem in western Spain. Over two years, in pasture and woodlands habitats, *Lucilia sericata* Meigen was always the dominant species over the summer, followed by *C. albiceps* (Martinez-Sánchez *et al.* 2000). In Brazil, *L. eximia* is a blowfly species apparently capable of maintaining a more stable population size than other calliphorids, in spite of seasonal changes (Moura *et al.* 1997). Linhares (1981) investigated the annual variation in the incidence of the Calliphorid species in the region of Campinas, State of São Paulo, and showed that *L. eximia* was relatively abundant throughout the year long, exhibiting a much more stable population size than *Chrysomya* species or *C. macellaria*.

We have been pursuing the population ecology line with *L. eximia* and other blowflies, focusing mainly on population dynamics (Silva *et al.* 2003) and intra and interspecific interactions (Rosa *et al.* 2004) and we believe that the information that we have gathered will help to elucidate the mechanisms and processes taking place in this case of biological invasion by *Chrysomya* species.

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References

Archer, M.S. & M.A. Elgar. 2003. Effects of decomposition on carcass attendance in a guild of carrion-breeding flies. Med. Vet. Entomol. 17: 263-271.

Brewer, R. 1994. The science of ecology. Saunders College Publishing, 2nd ed., Ft Woth, 773p.

David, J.R., R. Allemand, J. Van Herrewege & Y. Cohet. 1983. Ecophysiology: Abiotic factors, p.105-170. In M. Ashburner, H.L. Carson, J.N. Thompson (eds.), The genetics and biology of *Drosophila*, Academic Press, London, 284p.

Freire, O. 1914. Algumas notas para o estudo da fauna cadavérica na Bahia. Gaz. Med. Bahia 46: 110-125.

Godoy, W.A.C., C.J. Von Zuben, S.F. Reis & F.J. Von Zuben. 1996. Dynamics of experimental populations of native and introduced blowflies (Diptera: Calliphoridae): Mathematical modelling and the transition from asymptotic equilibrium to bounded oscillations. Mem. Inst. Oswaldo Cruz 97: 641-648.

Godoy, W.A. C., F.J. Von Zuben, C.J. Von Zuben & S.F. Reis. 2001. Spatio-temporal dynamics and transition from asymptotic equilibrium to bounded oscillations in *Chrysomya albiceps* (Diptera, Calliphoridae). Mem. Inst. Oswaldo Cruz 96: 627-634.

Gotelli, N.J. 1995. A primer of ecology, Sinauer Associates Inc, Sunderland, 206p.

Greenbank, D.O. 1956. The role of climate and dispersal in the initiation of outbreaks of the spruce budworm in New Brunswick I. The role of climate. Can. J. Zool. 34: 453-476.

Guimarães, J.H., A.P. Prado & A.X. Linhares. 1978. Three newly introduced blowfly species in Southern Brazil (Diptera: Calliphoridae). Rev. Bras. Entomol. 22: 53-60.

Hengeveld, R. 1989. Dynamics of biological invasions, Chapman and Hall, London, 160p.

James, A.C. & L. Partridge. 1998. Geographic variation in competitive ability in *Drosophila melanogaster*. Amer. Nat. 151: 530-537.

Levine, O.S. & M.M. Levine. 1991. Houseflies (*Musca domestica*) as mechanical vectors of Shigellosis. Inf. Imm. 31: 445-452.

Linhares, A.X. 1981. Synanthropy of Calliphoridae and Sarcophagidae (Diptera) in the city of Campinas, São Paulo, Brazil. Rev. Bras. Entomol. 25: 189-215.

Linhares, A.X. 1988. The gonotrophic cycle of *Chrysomya megacephala* (Diptera: Calliphoridae) in the laboratory. Rev. Bras. Entomol. 32: 383-392.

Madeira, N.G., G.A R. Silveira & C. Pavan. 1989. The occurrence of primary myiasis in cats caused by *Phaenicia eximia* (Diptera: Calliphoridae). Mem. Inst. Oswaldo Cruz 84: 341.

Martinez-Sánchez, A., S. Rojo & M.A. Marcos-García. 2000. Annual and spatial activity of dung flies and carrion in a Mediterranean holm-oak pasture ecosystem. Med. Vet. Entomol. 14: 56-63.

Mendes, J. & A.X. Linhares. 1993. Atratividade por iscas e estágios de desenvolvimento ovariano em várias espécies sinantrópicas de Calliphoridae (Diptera). Rev. Bras. Entomol. 37: 157- 166.

Moura, M.O., C.J.B. Carvalho & E.L.A. Monteiro-Filho. 1997. A preliminary analysis of insects of medico-legal importance in Curitiba, State of Paraná. Mem. Inst. Oswaldo Cruz 92: 269-274.

Reigada, C. & W.A.C. Godoy. 2005. Sazonal fecundity and body size in *Chrysomya megacephala* (Fabricius) (Diptera: Calliphoridae). Neotrop. Entomol. 34: 163-168.

Reis, S.F., C.J. Von Zuben & W.A.C. Godoy. 1999. Larval aggregation and competition for food in experimental populations of *Chrysomya putoria* (Wied.) and *Cochliomyia macellaria* (F.) (Dipt. Calliphoridae). J. Appl. Entomol. 123: 485-489.

Rosa, G.S., L.R. Carvalho & W.A.C. Godoy. 2004. Survival rate, body size and food abundance in pure and mixed blowfly cultures. Afr. Entomol. 12: 97-105.

Silva, I.C.R., P.F.A. Mancera & W.A.C. Godoy. 2003. Population dynamics of *Lucilia eximia* (Dipt. Calliphoridae). J. Appl. Entomol. 127: 2-6.

Smith, K.G.V. 1986. A manual of forensic entomology. University Printing House, Oxford, 205p.

Souza, A.M. & A.X. Linhares. 1997. Diptera and Coleoptera of potential forensic importance in southeastern Brazil: Relative abundance and seasonality. Med. Vet. Entomol. 11: 8-12.

Stevens, J. & R. Wall. 1996. Species, sub-species and hybrid populations of the blowflies *Luculia cuprina* and *Licilia sericata* (Diptera: Calliphoridae). Proc. Royal Soc. Lond. B 263: 1335-1341.

Thind, B.B. & J.A. Dunn. 2002. A laboratory evaluation of a regulated airflow through wheat at four combinations of temperature and humidity on the productivity of three species of stored product mites. Exp. Appl. Acarol. 27: 89-102.

Ullyett, G.C. 1950. Competition for food and allied phenomena in sheep-blowfly populations. Phil. Trans. Roy. Soc. Lond. 234B: 79-174.