Population Biology of the Endangered Fluminense Swallowtail Butterfly Parides ascanius (Papilionidae: Papilioninae: Troidini)

Authors: Herkenhoff, Elisa Vieira, Monteiro, Ricardo Ferreira, EsperanÇO, Alexandre Pimenta, and Freitas, André Victor Lucci

Source: The Journal of the Lepidopterists' Society, 67(1) : 29-34

Published By: The Lepidopterists' Society

URL: https://doi.org/10.18473/lepi.v67i1.a3

Journal of the Lepidopterists' Society
67(1), 2013, 29–34

POPULATION BIOLOGY OF THE ENDANGERED FLUMINENSE SWALLOWTAIL BUTTERFLY *PARIDES ASCANIUS* (PAPILIONIDAE: PAPILIONINAE: TROIDINI)

ELISA VIEIRA HERKENHOFF, RICARDO FERREIRA MONTEIRO, ALEXANDRE PIMENTA ESPERANÇO

Laboratório de Ecologia de Insetos, Departamento de Ecologia, Instituto de Biologia, Universidade Federal do Rio de Janeiro (UFRJ). CP 68020; CEP 21941-590, Ilha do Fundão, Rio de Janeiro, RJ, Brazil; e-mails: elisabio@gmail.com, monteiro@biologia.ufrj.br, pimentas@yahoo.com

AND

ANDRÉ VICTOR LUCCI FREITAS

Departamento de Biologia Animal and Museu de Zoologia, Instituto de Biologia, Universidade Estadual de Campinas, CP 6109, Campinas, SP, 13083-970, Brazil; email: baku@unicamp.br (corresponding author)

ABSTRACT. A population of *Parides ascanius* butterflies was studied for 12 months in Rio de Janeiro, SE Brazil. The population size was approximately 10–20 individuals with a maximum of 50 individuals. Sex ratio was biased, with males dominating in most months. The residence time was 12.7 ± 10.1 days for males, with a maximum of 28 days. Males travel distances of up to 400 m, but most individuals were recaptured within 150 to 250 m of their original capture site. Our results show that *P. ascanius* has a relatively long adult life span and maintains high population numbers, suggesting that habitat loss rather than population attributes explains its rarity and endangered status.

Additional key words: Papilionidae, *Parides,* Population biology, Troidini, mark–release-recapture

The genus *Parides* Hübner, 1819 (Papilionidae: Troidini) is exclusively Neotropical, with 34 species occurring from Mexico to Argentina (Tyler et al. 1994; Rachelli 2006). The larvae feed exclusively on *Aristolochia* (*Aristolochia*ceae), a group of plants known for containing toxic secondary compounds (Tyler et al. 1994). *Parides* adults are unpalatable and are involved in mimicry rings with several other species of butterflies and moths (Brown et al. 1981; Tyler et al. 1994; Rachelli 2006). Most *Parides* are associated with forests and other moist habitats (Tyler et al. 1994; Rachelli 2006), and it has been shown that several species are sensitive to anthropic disturbance, making them potentially useful organisms for environmental monitoring in the Neotropics (Tyler et al. 1994).

The fluminense swallowtail butterfly, *Parides ascanius* (Cramer, 1775) (Figure 1A), is a threatened butterfly endemic to the coastal lowland swamps of Rio de Janeiro (Otero & Brown 1986). The species is monophagous, using only *Aristolochia macroura* Gomes (*Aristolochia*ceae) (Fig. 1B) as its larval host (Otero & Brown 1986). D´Almeida (1966) suggested that *Parides ascanius* was potentially endangered, and in 1973 this species became the first Brazilian butterfly officially recognized as being threatened with extinction (Otero & Brown 1986). The current situation for *P. ascanius* is delicate; most known populations live outside the boundaries of protected reserves. The species, under constant pressure from habitat loss due to increased urbanization of all coastal plains in Rio de Janeiro, is considered to be endangered in Brazil (Otero et al. 2000; Uehara-Prado & Fonseca 2007; Brown & Freitas 2008). In addition, the Biological Reserve of Poço das Antas, a major conservation area that harbors large colonies of this butterfly (Otero & Brown 1986), has suffered severe impacts in the 1970's and 1980's due to drainage projects involved with straightening the "São João" river basin, as well as construction of the Juturnaiba dam to supply water to coastal cities. These actions have produced deep environmental changes in the region, with large areas being flooded by the lake and other areas becoming dry, resulting in frequent vegetation fires.

Because of its importance as a conservation icon, *P. ascanius* has been heavily studied over the past several decades, with research having been done on the butterfly's behavior, natural history, early stages, chromosomes, chemical ecology and conservation (D'Almeida 1922, 1966; Brown et al. 1981; Otero 1984; Otero & Brown 1986; Tyler et al. 1994; Brown et al. 1995; Emmel et al. 1995; Tavares et al. 2006; Uehara-Prado & Fonseca 2007; Silva-Brandão et al. 2008). However, there have been no studies on the population ecology of *P. ascanius*; the few published accounts on this topic have resulted from studies carried out more than 20 years ago (Brown et al. 1995; Tyler et al. 1994).

Given the fragile situation of *P. ascanius*, the goal of the present study is to present detailed population data for this species, gathered in a protected area, in order to provide information that could aid in future management of this endangered butterfly species.

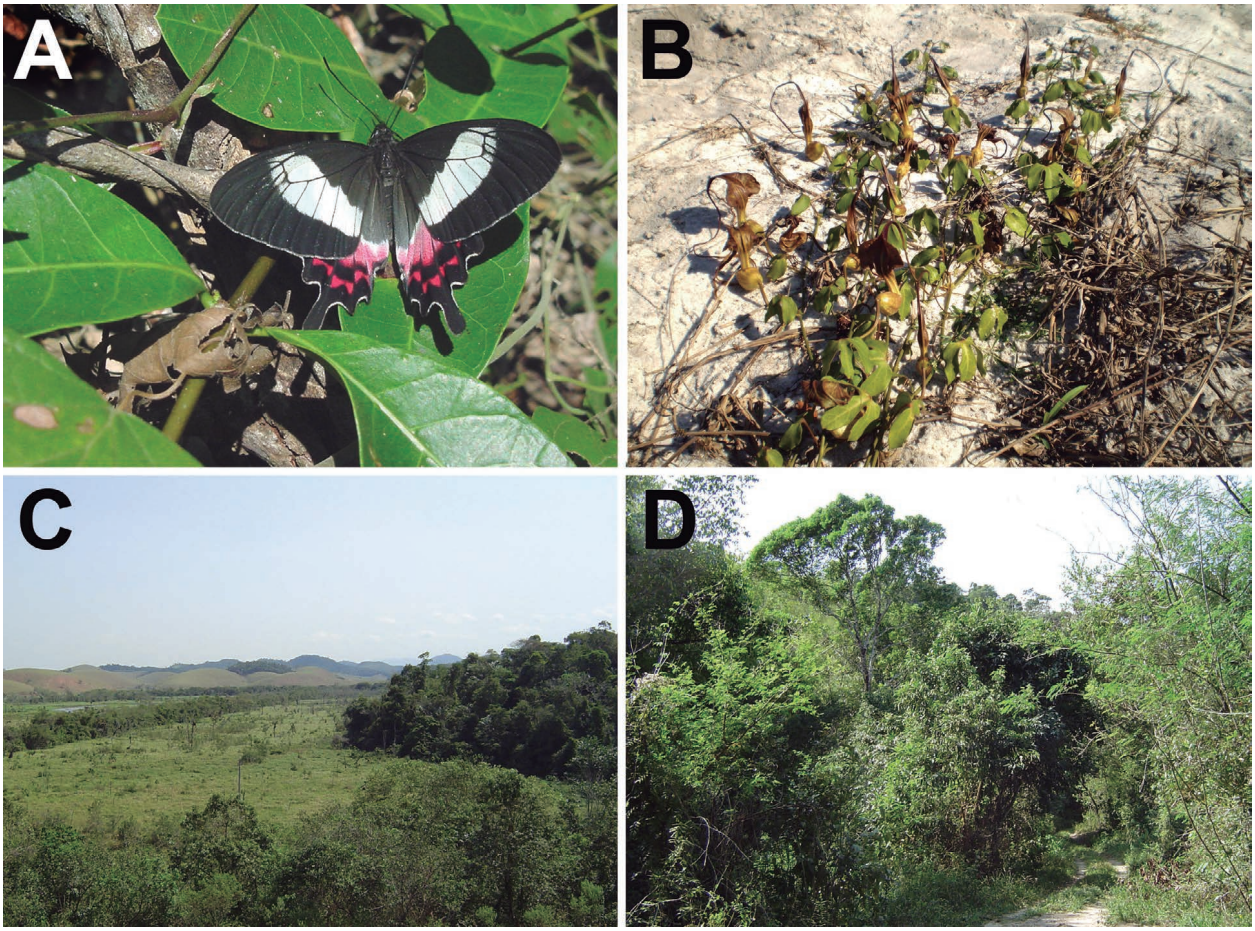

FIG. 1. **A.** A female of *Parides ascanius*; **B.** The host plant, *Aristolochia macroura*, growing in sand; **C.** General view of *P. ascanius* habitat in Poço das Antas Biological Reserve, Silva Jardim, RJ; **D.** Close-up of *P. ascanius* habitat.

STUDY SITES AND METHODS

A mark-release-recapture (MRR) study was carried out in the Poço das Antas Biological Reserve (22º30'–22º33'S, 42º15'–42º19'W; ca. 100 m a.s.l.), in the city of Silva Jardim, Rio de Janeiro State, Southeastern Brazil (Fig. 1C, D). The reserve comprises 5,500 ha of lowland swamps and sand forests. Annual rainfall reaches 2000 mm and the average annual temperature is 24°C (DNMET) (a climagram for the study area is presented in Fig. 2). Butterflies were marked and recaptured in a trail (800 m long, divided into 5 m sectors, Fig. 1D) along the São João river during 12 months, from October 10, 2004 to September 7, 2005, for a total of 18 days (approximately 5 hours/day). Butterflies were net-captured, individually numbered on the underside of both forewings with a black permanent felt-tipped pen, and released. Characteristics of each individual (age, wing damage, point of capture, sex and food sources) were recorded for later analysis (as in Ramos & Freitas; 1999 and Beirão et al. 2012). Wing wear, based on three categories (new, intermediate and old) was used as an additional age measure for individual butterflies (as in Ramos & Freitas 1999). Age structure was calculated for both sexes together, through the monthly means of daily proportions of each category. Wing damage was also measured in three categories: intact, low damage (one to three wing cuts) and high damage (more than 3 wing cuts). Monthly wing damage was calculated for both sexes together, through the monthly means of daily proportions of each category.

The MRR data were analyzed using the Lincoln-Petersen-Bailey method for estimating population parameters (Francini 2010a, b). Only males were analyzed because of the low number of females. To estimate the number of individuals present per day, recaptured individuals were considered to be present on all previous days since the first capture (= marked animals at risk, following Freitas & Ramos 2001). Time of permanence in population (= minimum permanence, an indirect measure of longevity) was calculated as days elapsed between marking and last recapture (following

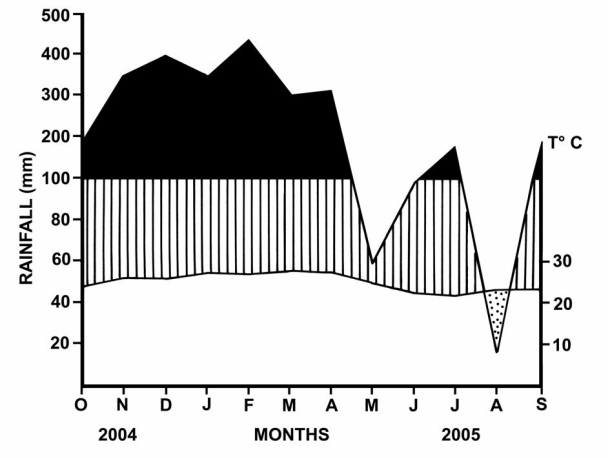

FIG. 2. Climatic diagram of the study site (see methods) during the study period (format following Walter 1985). Dotted = dry periods, hatched = humid periods, black = superhumid periods.

Brussard et al. 1974). The sex ratio was calculated through the monthly means of daily proportions in number of individuals captured per day.

RESULTS

Population dynamics: The number of individuals captured per day varied from zero to 38 for males (mean = 15.9; SD = 12.7; n = 17 days), and from 1 to 16 for females (mean = 4.4; SD = 4.0; n = 18 days). The population size (based on number of individuals present per day) was not stable throughout the year, with a marked peak in number of individuals during the spring (Fig. 3). The population analyses showed that population size varied between 16 and 240 males (Table 1). Considering the maximum values (number estimated plus one standard error), the population could reach values of approximately 200 males, with up to 500 males on some days (Table 1). However, due to the low number of recaptures, these should be considered as rough estimates.

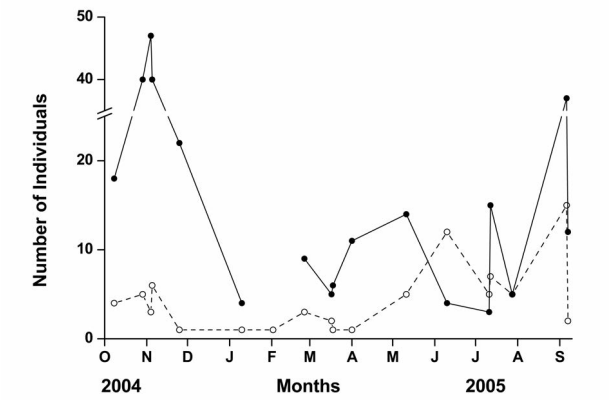

FIG. 3. Number of *Parides ascanius* individuals present per day in the study site within Poço das Antas Biological Reserve (Silva Jardim, RJ) from October 2004 to September 2005. Solid circles = males, open circles = females.

TABLE 1. Population data of *Parides ascanius* in the Poço das Antas Biological reserve. F = marked females, M = marked males, M+R = marked plus recaptured males, NIPD = number of males present per day, N = estimated number of males, SE = standard error, LP = Lincoln-Petersen-Bailey (males only).

Date	F	M	M + R	NIPD	LP N ± SE
8.X.2004	4	18	18	18	---
29.X.2004	5	38	38	40	156 ± 84
4.XI.2004	3	27	36	47	111 ± 51
5.XI.2004	6	18	33	40	126 ± 80
25.XI.2004	1	10	22	22	110 ± 136
10.I.2005	1	4	4	4	40 ± 52
2.II.2005	1	0	---	---	---
25.II.2005	3	9	9	9	54 ± 68
17.III.2005	2	5	5	5	30 ± 37
18.III.2005	1	5	5	6	30 ± 30
1.IV.2005	1	9	11	11	165 ± 220
11.V.2005	5	14	14	14	70 ± 86
10.VI.2005	12	4	4	4	16 ± 19
11.VII.2005	5	3	3	3	16 ± 14
12.VII.2005	6	13	15	15	90 ± 113
28.VII.2005	4	5	5	5	190 ± 259
6.IX.2005	16	37	37	37	240 ± 250
7.IX.2005	1	11	12	12	---

Residence Time: The residence time (based on recaptured individuals) varied from one to 28 days for males (mean = 12.7 days; SD = 10.08; n = 36). For the two females recaptured, residence times were of one and 17 days respectively. Table 2 shows male permanence in the population. Male life expectance (following Cook et al., 1967) was calculated as 12.3 days.

Sex Ratio: The sex ratio of individuals captured and marked was male biased, with 230 males and 77 females marked ($X^2 = 76.2$; df = 1; $P < 0.0001$), or nearly 3 males : 1 female, with males being dominant in all but one month (Fig. 4). Both sexes had low recapture rates; 36 males (15.6%) and only 2 females (2.3%) were recaptured at least once, and the maximum number of recaptures for a single individual was two.

Age structure: During the 12 months of this study, age structure was quite stable. The increase of "new"

TABLE 2. Permanence of marked *Parides ascanius* males in the Poço das Antas Biological reserve. Days elapsed between marking and last recapture represent the minimum permanence (MP) for each individual.

MP	Males	P (%)
1-6	12	33.3
7-12	8	22.2
13-18	2	5.6
19-24	6	16.7
25-30	8	22.2
Total	36	100.0

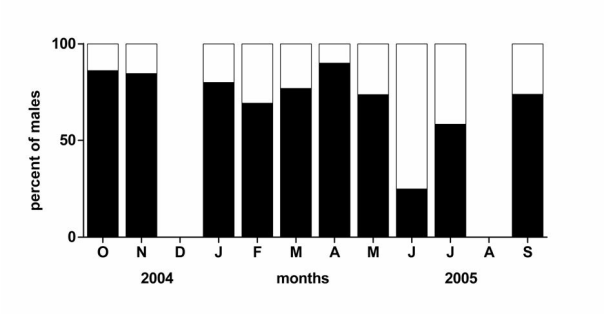

FIG. 4. Sex ratio of *P. ascanius* from October 2004 to September 2005. Data presented as percent of males (in black) by month (based on means of each day's captures).

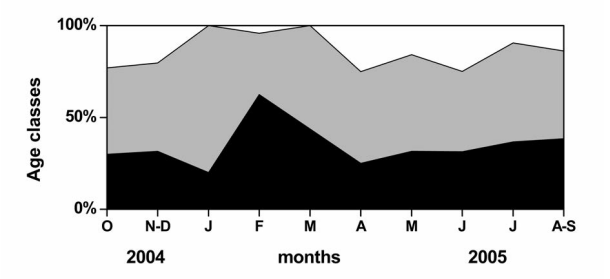

FIG. 5. Age structure for *P. ascanius* (both sexes) from October 2004 to September 2005 within the study site (black = new individuals, gray = intermediate, white = old).

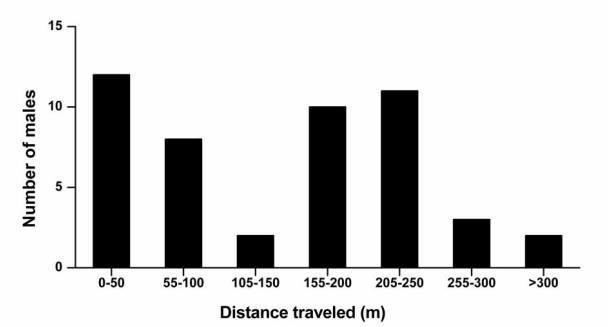

FIG. 6. Maximum distances traveled by males of *P. ascanius*, using data from all recaptured individuals.

individuals in February-March, 2005 is an artifact, since the population size during this period was small (Fig. 5).

Vagility: On average, maximum vagility of males (mean = 142.9 m, SD = 95.50, n = 48) was higher than that of females (mean = 65.0 m, SD = 86.31, n = 4), but no comparisons could be done due to the low amount of data for females. The maximum travel distance recorded for a male was 400 m, roughly twice the maximum distance recorded for a female (190 m). More than half of all males (54%) traveled 150 m or more during the study (Fig. 6).

Wing damage: The proportion of different damage classes was stable throughout the 12 months of study, with most individuals presenting no substantial wing damage and only a few individuals showing high levels of wing damage (Fig. 7).

Adult natural history and behavior: Within the study area, *Parides ascanius* is a relatively common species found along forest edges and in open areas, especially near patches of its larval host plant, *Aristolochia macroura.* Other five species of Troidini are sympatric with *P. ascanius* in the study area: *Battus crassus crassus* (Cramer) , *Battus polystictus galenus* (Fruhstorfer), *Battus polydamas polydamas* (Linnaeus), *Parides zacynthus zacynthus* (Fabricius) and *Parides anchises nephalion* (Godart). All but *B. polystictus polystictus* are known to use *A. macroura* as a larval host plant (Brown et al. 1981, 1995, Tyler et al. 1994). Adults of *P. ascanius* became active at approximately 0800 h, but this varied within a season according to weather. They characteristically flew low (0.5 to 2.0 m above the ground) and were seldom observed flying higher than three meters.

DISCUSSION

The population parameters of *P. ascanius*, including residence time, a male-biased sex ratio, and pronounced fluctuation in numbers throughout the year, are similar to those reported for other *Parides* species (Brown et al. 1981; Tyler et al. 1994; Freitas & Ramos 2001). However, population size was larger than that reported for most species of *Parides* (Cook et al. 1971; Freitas & Ramos 2001; Tyler et al. 1994: 60), being comparable to those of *P. burchellanus* (Westwood) in Central Brazil (Beirão et al. 2012) and *Parides neophilus* (Geyer) and *Parides proneus* (Hübner) in a semi-deciduous forest in southeastern Brazil (Brown et al. 1981; Tyler et al. 1994: 60). Even taking into account that sampling intervals in the present study were not the ideal, the results of population size can be considered trustworthy. The spring population peak of *P. ascanius* (September–November), for example, concurs with previous reports (D'Almeida 1966; Tyler et al. 1994: 67).

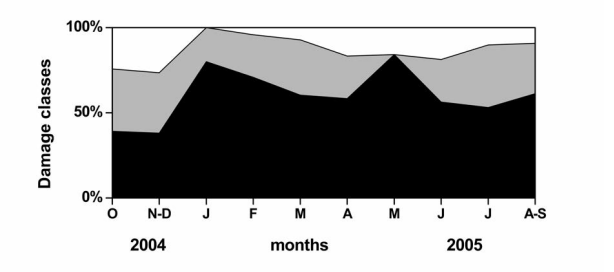

FIG. 7. Percentage of wing damage in *P. ascanius* (both sexes) (black = intact, gray = low damage, white = high damage).

Average and maximum residence times for *P. ascanius* males are equivalent to those reported for most *Parides* species; in Southeastern Brazil, Brown et al. (1981, 1995) reported maximum life spans of 33 to 56 days depending on the species, and Freitas & Ramos (2001) reported a maximum of 30 days and an average of roughly 14 days for males of *Parides anchises nephalion* in coastal Brazil. Life expectancy for males of *P. ascanius* (12.3 days) was high compared to that reported for *P. neophilus* (5.6 days, Cook et al. 1971) and *P. anchises nephalion* (5.7 days, Freitas & Ramos 2001), but was lower than the value obtained for males of *P. burchellanus* (18 days; Beirão et al. 2012).

The sex ratio of *P. ascanius* was male-biased, with a proportion near 3:1, somewhat above the 2:1 ratio reported for most natural populations of *Parides*, including a previous study on *P. ascanius* (Tyler et al. 1994; Brown et al. 1995; Freitas & Ramos 2001; Beirão et al. 2012). Male biased sex ratios are usually observed in butterflies in the field even if laboratory broods are 1:1, and are usually related to behavioral differences between sexes (Brussard & Ehrlich 1970; Freitas 1996; Ramos & Freitas 1999 and references therein). However, sex ratios measured for reared broods of *P. ascanius* will be required before we can confirm that the male-biased sex ratio results from differential capture rates between sexes, as has been proposed for other butterfly species.

Based on our results, especially with regard to the surprisingly large size of our study population, we suggest that the threatened status of *P. ascanius* cannot be explained by its biological traits, such as population size, vagility and life expectance, all which are very similar to those described for several unthreatened species of *Parides* (see above), but are instead a result of severe habitat loss. This theory, first anticipated by D'Almeida (1966: 65), has been strengthened by over two decades of research on *P. ascanius*; numerous studies have documented the destruction of coastal swamps where this species occurs, and the subsequent replacement by residential areas (Otero & Brown 1986; Otero & Marigo 1990; Tyler et al. 1994; Uehara-Prado & Fonseca 2007; Brown & Freitas 2008).

The future of *P. ascanius* will depend on a combination of factors, including: the discovery and preservation of additional populations; establishment of additional protected habitats; and management of captive butterflies for reinforcement and reestablishment of viable populations in potentially suitable areas (Otero et al. 2000; Uehara-Prado & Fonseca 2007; Brown & Freitas 2008; Freitas & Marini-Filho 2011). Future molecular studies should focus on investigating how genetically isolated the remaining populations of *P. ascanius* are, and should establish the constraints that limit its distribution to the coastal lowlands of Rio de Janeiro and southern Espírito Santo (but see Uehara-Prado & Fonseca 2007). *Parides ascanius* stands as a conservation symbol for Rio de Janeiro. The actions outlined above, combined with educational programs and an increase in habitat connectivity in the region where *P. ascanius* occurs, will potentially prevent loss of the few remaining populations of this spectacular butterfly.

ACKNOWLEDGEMENTS

We thank Jim Miller for critical reading of the manuscript. This study was funded by National Research Council of Brazil (CNPq). Thanks to CNPq for scholarship of EVH (Graduate Program in Ecology, UFRJ) and RFM (research productivity program, number 304348/2010-4) and "Instituto Chico Mendes de Conservação da biodiversidade (ICMBio)" for license to work in Poço das Antas Biological Reserve. AVLF was supported by the "Fundação de Amparo à Pesquisa do Estado de São Paulo" (FAPESP, 04/05269-9), and the Brazilian CNPq (302585/2011-7). This publication is part of the RedLep "Rede Nacional de Pesquisa e Conservação de Lepidópteros" SISBIOTA-Brasil/CNPq (563332/2010-7), and of the BIOTA-FAPESP Program (2011/50225-3).

LITERATURE CITED

BEIRÃO, M. V., F. C. CAMPOS-NETO, I.A. PIMENTA & A. V. L. FREITAS. 2012. Population biology and natural history of *Parides burchellanus* (Papilionidae: Papilioninae: Troidini), an endangered Brazilian butterfly. Ann. Entomol. Soc. Amer. 105:36–43

BROWN, K.S. JR. & A. V. L. FREITAS. 2008. *Parides ascanius* (Cramer, 1775). *In* Livro vermelho da fauna brasileira ameaçada de extinção (A.B.M. Machado, G.M.M. Drummond & A.P. Paglia, ed.). MMA, Brasília, DF, Fundação Biodiversitas, Belo Horizonte, MG, p.433.

BROWN, K. S. JR., A. J. DAMMAN & P. P. FEENY. 1981. Troidine swallowtails (Lepidoptera: Papilionidae) in Southeastern Brazil: Natural history and foodplant relationships. J. Res. Lepid. 19:199–226.

BROWN, K. S. JR., C. F. KLITZKE, C. BERLINGERI & P. E. R. DOS SANTOS. 1995. Neotropical swallowtails: Chemistry of food plant relationships, population ecology, and biosystematics, pp. 405-445. *In* J. M. Scriber, Y. Tsubaki, and R. C. Lederhouse [eds.], Swallowtail butterflies: Their ecology and evolutionary biology. Gainesville, Scientific Publishers, FL.

BRUSSARD, P. & P. R. EHRLICH. 1970. The population structure of *Erebia epipsodea* (Lepidoptera: Satyrinae). Ecology 51:119–129

BRUSSARD, P. F., P. R. EHRLICH & M. C. SINGER. 1974. Adult movements and population structure in *Euphydryas editha*. Evolution 28:408–415.

COOK, L. M., L. P. BROWER & H. J. CROZE. 1967. The accuracy of a population estimation from multiple recapture data. J. Animal Ecol. 36:57–60.

COOK, L. M., K. FRANK & L. P. BROWER. 1971. Experiments on the demography of tropical butterflies. I. Survival rate and density in two species of *Parides*. Biotropica 3:17–20.

D'ALMEIDA, R. F. 1966. Catálogo dos Papilionidae americanos. Sociedade Brasileira de Entomologia, São Paulo, Brazil.

D'Almeida, R. F. 1922. Mélanges lépidoptérologiques. Etudes sur les lépidoptères du Brésil. Berlin, R. Friedländer & Sohn. viii + 226 pp.

DNMET. 1992. Normais climatológicas (1961–1990). Departamento Nacional de Meteorologia, Ministério da Agricultura. Brasília, Brasil.

EMMEL, T. C.. P. J. ALIAZAR, K. S. BROWN JR. & E. SUOMALAINEN. 1995. Chromosome evolution in the Papilionidae, pp. 283–298. *In* J. M. Scriber, Y. Tsubaki, and R. C. Lederhouse [eds.], Swallowtail butterflies: Their ecology and evolutionary biology. Gainesville, Scientific Publishers, FL.

FRANCINI, R. B. 2010A. Métodos para estudar ecologia de populações de borboletas. 201pp. http://www.archive.org/details/MtodosParaEstudarEcologiaDePopulaesDeBorboletas (accessed June 2011).

FRANCINI, R. B. 2010B. CMLR_2010. Programa para estimativas populacionais (available free by the e–mail rb.francini@yahoo.com).

FREITAS, A. V. L. 1996. Population biology of *Heterosais edessa* (Nymphalidae) and its associated Atlantic Forest Ithomiinae community J. Lepid. Soc. 50:273–289.

FREITAS, A. V. L. & R. R. RAMOS. 2001. Population biology of *Parides anchises nephalion* (Papilionidae) in a coastal site in Southeast Brazil. Braz. J. Biol. 61: 623–630.

FREITAS, A. V. L. & O. J. MARINI-FILHO. 2011. Plano de Ação Nacional para Conservação dos Lepidópteros Ameaçados de Extinção. Instituto Chico Mendes de Conservação da Biodiversidade, Brasília, DF.

OTERO, L. S. 1984. *Parides ascanius* (Cramer, 1775), borboleta ameaçada de extinção. In: Lacerda, L. D., D. S. D. Araujo, R. Cerqueira, & B. Turcq (Orgs.). Restingas: Origem, Estrutura e Processos. Niterói, CEUFF. p. 369–371.

OTERO, L. S. & K. S. BROWN JR. 1986. Biology and ecology of *Parides ascanius* (Cramer, 1775) (Lep., Papilionidae), a primitive butterfly threatened with extinction. Atala 10/12: 2–16.

OTERO, L. S. & L. C. MARIGO. 1990. Butterflies—beauty and behavior of Brazilian species. Marigo comunicação visual, 127 pp., Rio de Janeiro, RJ, Brazil.

OTERO, L. S., K. S. BROWN JR, O. H. H. MIELKE, R. F. MONTEIRO, J. COSTA, M. V. MACEDO, J. BECKER, N. D. SALGADO, S. SANTOS & G.E MOYA. Invertebrados terrestres. *In* H. G. Bergallo, C. F. D. Rocha, M. A. S. Alves. and M.V. Sluys .(Eds.) A fauna ameaçada de extinção do Estado do Rio de Janeiro.1 ed.Rio de Janeiro : Editora da Universidade do Estado do Rio de Janeiro, 2000, p. 53–62.

RACHELI, T. 2006. The genus *Parides*: an unended quest. p. 116. Goecke & Evers, Keltern, Germany.

RAMOS, R. R. & A. V. L. FREITAS. 1999. Population biology, wing color variation and ecological plasticity in *Heliconius erato phyllis* (Nymphalidae). J. Lepid. Soc. 53:11–21.

SILVA-BRANDÃO, K. L., A. M. L. AZEREDO-ESPIN & A. V. L. FREITAS. 2008. New evidence on the systematic and phylogenetic position of *Parides burchellanus* (Lepidoptera: Papilionidae). Mol. Ecol. Res. 8:502–511.

TAVARES, M. T., A. B. NAVARO–TAVARES & G. DE S. S. ALMEIDA. 2006. The species of Chalcididae (Hymenoptera) parasitoids of *Parides ascanius* (Cramer), an endangered Papilionidae (Lepidoptera) from restingas of Southeastern Brazil. Zootaxa 1197:55–63.

TYLER, H., K. S. BROWN JR. & K. WILSON. 1994. Swallowtail Butterflies of the Americas: A Study in Biological Dynamics, Ecological Diversity, Biosystematics, and Conservation. Scientific Publishers, Gainesville, Florida.

UEHARA-PRADO, M. & R. L. FONSECA. 2007. Urbanization and mismatch with protected areas place the conservation of a threatened species at risk. Biotropica 39: 264–268.

Received for publication 3 June 2012; revised and accepted 20 August 2012.