POPULATION BIOLOGY OF *Parides anchises nephalion* (PAPILIONIDAE) IN A COASTAL SITE IN SOUTHEAST BRAZIL

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(With 3 figures)

ABSTRACT

A population of *Parides anchises nephalion* was studied during seven months in SE Brazil. The population size was about 10-20 individuals (with theoretic maximum near 60 individuals), with small variations in some months. Sex ratio was male biased, with males dominating in all months. The age structure was not stable, with an increase in new individuals before the population peak in December. The residence time was 14.1 ± 8.2 days for males and 9.0 ± 3.6 to females, with the maximum registered of 30 days. Males can travel distances of up to 400 m, but most individuals were always recaptured in the same site. The mean forewing length was greater in females. The population features agree with those found in other species of *Parides* in other neotropical sites.

Key words: Papilionidae, Parides, population biology, Troidini, mark-realease-recapture.

RESUMO

Biologia populacional de *Parides anchises nephalion* (Papilionidae) em uma área litorânea no Sudeste do Brasil

Uma população de *Parides anchises nephalion* foi estudada ao longo de sete meses no Sudeste do Brasil. O tamanho populacional variou em torno de 10-20 indivíduos (com um máximo teórico próximo a 60 indivíduos), com pequenas variações em alguns meses. A razão sexual foi desviada para excesso de machos, com estes sendo dominantes em todos os meses. A estrutura etária não foi estável, com um aumento dos indivíduos novos antes do pico populacional em dezembro. O tempo de residência foi de 14,1 ± 8,2 dias para machos e 9,0 ± 3,6 dias para fêmeas, com um máximo registrado de 30 dias. Os machos podem se deslocar por distâncias superiores a 400 m, entretanto, a maioria dos indivíduos foi recapturada sempre no mesmo local. O comprimento médio das asas anteriores foi maior nas fêmeas. As características da população estão de acordo com aquelas descritas para outras espécies de *Parides* em outros sítios Neotropicais.

Palavras-chave: Papilionidae, *Parides*, biologia populacional, Troidini, marcação-recaptura.

INTRODUCTION

Population studies of butterflies (using mark-release-capture method) have been considered an important step in understanding their ecology and behavior, usually revealing many features with few months of work (Ehrlich, 1984; Tyler *et al*., 1994). In the tropics, most studies have been done with forest species (Schappert & Shore, 1998), especially Heliconiini (see references in Ramos & Freitas 1999). However, many studies of tropical butterflies were carried out with species of

Ithomiinae (Drummond-III, 1976; Haber, 1978; Young & Moffet, 1979; Vasconcellos-Neto, 1980; Trigo, 1988; Freitas, 1993, 1996; Pinto & Motta, 1998) and Papilionidae (Cook *et al*., 1971; Brown-Jr. *et al.*, 1981, 1994; Morais & Brown-Jr., 1992; Tyler *et al.*, 1994).

Species of Papilionidae are considered easy to study; they are strongly attracted to flower patches or wet sand, are of large size, and are easy to mark without causing trauma.

However, good long-term population studies on Papilionidae are very few, both in North American and especially neotropical species (Tyler *et al.*, 1994), making any additional study on this group an important source of information future work. The present paper describes the population features of *Parides anchises nephalion* (Godart, 1819), a papilionid butterfly common in several kinds of forests in SE Brazil (Tyler *et al.*, 1994), being especially common in habitats with a low-to-medium level of disturbance along rivers, in clearings, and along forest edges (Brown-Jr. *et al.*, 1981; Brown-Jr., 1992; Morais & Brown-Jr., 1992; Tyler *et al.*; 1994).

STUDY SITES AND METHODS

A mark-release-recapture (MRR) study was carried out in Morro do Voturuá (46°22'W, 23° 57'S), in the city of São Vicente. The site was originally covered with lowland subtropical rainforest (Ururahy *et al*., 1987). The annual rainfall reaches 2500 mm and the average annual temperature is 21 °C (Setzer, 1949; Prodesan, 1969; Nimer, 1972), with the mean in the coldest month of 18.2° C and in the warmest month of 25.3° C (Santos, 1965) (Fig. 1 – methods following Santos 1965, and Walter, 1985). Most of the area is covered by secondary forest on low hills (100-200 m elevation), and the study was conducted on a trail about 700 m long passing through anthropic areas and entering the forest (details of the area are in Ramos & Freitas, 1999). Mark-release-recapture studies were made during 7 months, from 5 August 1996 to 17 February 1997, totaling 28 field days (about 4 hours/day). Butterflies were captured with an insect net, individually numbered on the underside of both forewings (in the white central macula) with a black permanent felt-tipped pen, and released.

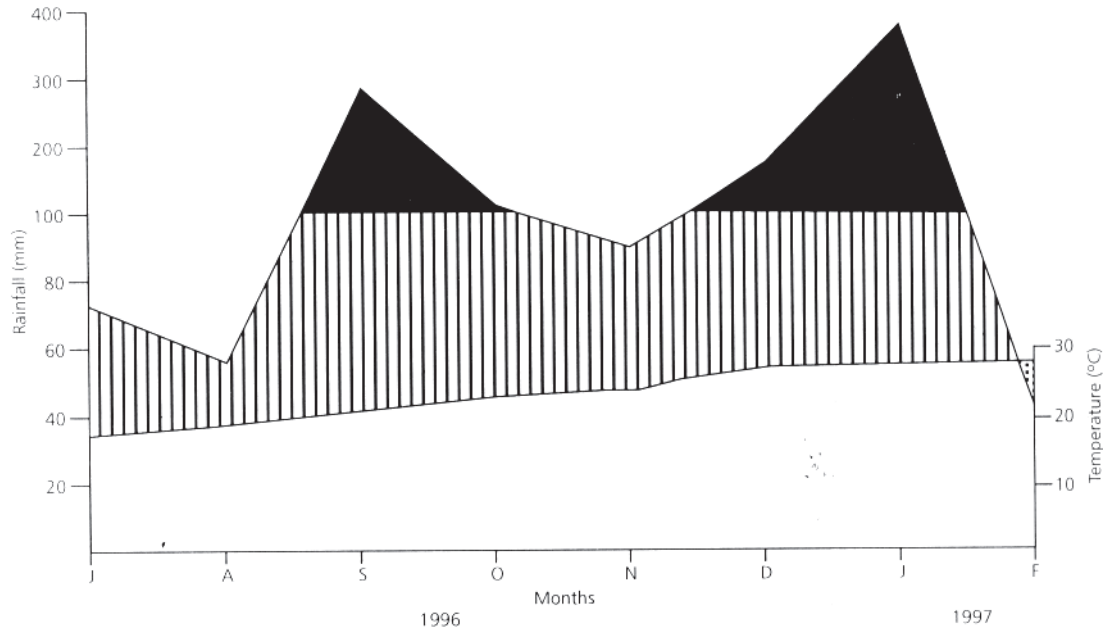

Fig. 1 — Climatic diagram of the São Vicente region during the study period (format following Santos, 1965, and Walter, 1985). Hatched = humid periods; black = superhumid periods; and dotted = dry periods.

Age (based on wing wear), forewing length (in mm), point of capture, sex, and food sources were recorded (Freitas 1993, 1996; Ramos & Freitas, 1999). The age of individual butterflies was estimated in six categories based on wing wear (Ehrlich & Davidson, 1960; Brussard & Ehrlich, 1970; Ehrlich & Gilbert, 1973). Age structure was calculated as the daily proportion of each category, and grouped into monthly means.

The MRR data were analyzed by Lincoln-Petersen-Bailey, Jolly-Seber and Manly-Parr methods (Southwood, 1971) for estimating population parameters (software developed by R. B. Francini, UNISANTOS). Only males were analyzed because of the low number of females. Daily results were tabulated as "number of individuals captured per day" (NICD, including marked + recaptured), and "number of individuals present per day" (NIPD). To estimate the NIPD, recaptured individuals were considered to be present in the population on all previous days since the day of first capture (= marked animals at risk).

RESULTS

Population dynamics: The NICD varied from one to 11 for males (mean = 3.75; SD = 2.34; n = 28 days), and 0 to 7 for females (mean = 1.21; SD = 1.75; n = 28 days). The NIPD of males also varied from one to 11 (mean = 4.32; SD = 2.84; n = 28 days) (Table 1, Fig. 2). The population was stable from August to November, with a small increase in number of individuals in December, 1996, with the number of individuals decreasing in January and February, 1997 (Fig. 2). The results of population analysis are shown in Table 1. In general, the three methods showed that population size varies from 10 to 20 males. Considering the maximum values (number estimated plus one standard error), population size could reach values around 40 males, with up to 60 males on some days (Table 1). However, due to the low number of recaptures, these estimations should be considered with caution.

Sex ratio: The sex ratio of individuals captured and marked was male biased (77 males and 31 females marked; $\chi^2 = 19{,}6$; $P < 0.001$), and near 2.5 males : 1 female. Males dominated in all months, and all the captured individuals were males on October, 1996 and February, 1997 (Fig. 3, Table 2). Males were recaptured from one to four times, but females only once; 18 males (23.4%) and three females (9.7%) were recaptured at least once.

Age structure: The six initial age categories were grouped into 3: young, including freshly emerged and new; intermediate (the same); and old, including old, very old, and a few tattered (Freitas 1993, 1996; Ramos & Freitas, 1999). Age structure during the six months was not stable, with an increase in the number of young individuals in September, followed by an increase in the proportion of old individuals in November and December (Fig. 3).

Residence time: The residence time (based on recaptured individuals) varied from one to 30 days for males (mean = 14.1 days; SD = 8.22; n = 18) and from five to 12 days for females (mean = 9 days; SD = 3.61; n = 3), but statistical differences could not be calculated due to the low number of females. Table 3 shows permanence in the population for males.

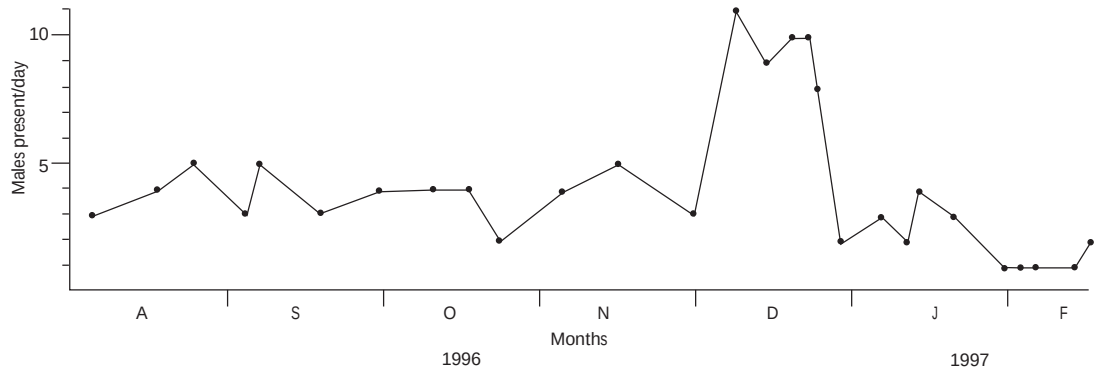

Fig. 2 — Population size (based on the NIPD) of *Parides anchises nephalion* (males) in Morro do Voturuá, August, 1996 to February, 1997.

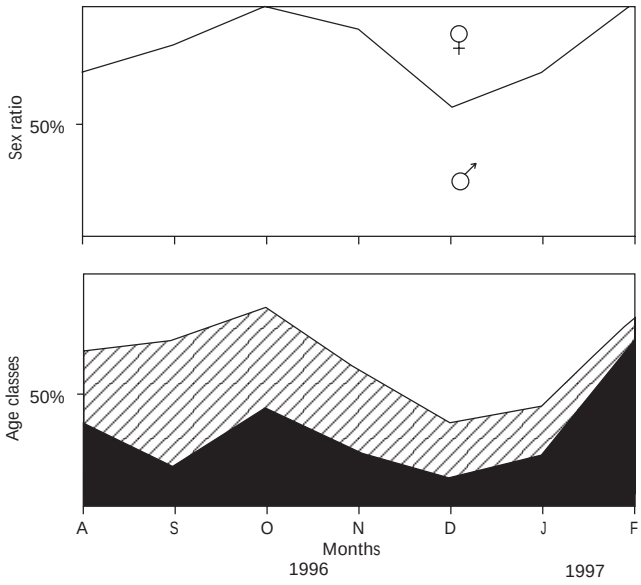

Fig. 3 — Populational parameters of *Parides anchises nephalion* marked in Morro do Voturuá, August, 1996 to February, 1997. Above, sex ratio (based on monthly recruitment), as percent of males in each month's captures; below, age structure (for males only). Black = young individuals; hatched = intermediate; and white = worn individuals; as % of each day's captures).

Life expectance of males (following Cook *et al.*, 1967) was calculated as 5.64 days.

Vagility: Only males were analyzed due to the low number of recaptures of females. The maximum distance traveled by an individual was 400 m in a straight line. In general, most individuals were recaptured at the same site (13 of the 18 recaptured individuals), and 5 individuals were recaptured at a different point (mean = 200 m, SD = 141.4, n = 5).

Wing size: The forewing length ranged from 32 to 51 mm in males and from 39 to 51 mm in females. The average forewing length of females (mean = 42.2 mm, SD = 3.71, n = 75) was greater than that of males (mean = 46.8 cm, SD = 2.99, n = 31; t = 6.12, df = 104, $p < 0.001$). The variation in mean forewing length of males showed no clear pattern along the study period (Table 2).

Adult natural history and behavior: In the study area *Parides anchises nephalion* is a common species found in secondary areas, and the adults are commonly found flying in forest, feeding on flowers on forest edges or near the host-plants. Besides *P. anchises*, *P. agavus* was the only additional species in the genus present in the study area, but two additional species, *P. tros* and *P. zacinthus* are present in nearby sites (ont the mountain slopes, and coastal sand forests respectively). Adults began activity around 0800 h, but this could vary within a season according to the weather. They presented low flight (from 0.5 to 2m high), but could be observed flying more than five meters high on several occasions. Adults were almost always observed feeding on flowers, with the species most used in this site being *Impatiens walleriana* Hook.f. (Balsaminaceae) (100 records), an introduced plant species that produces flowers year-round. Additional species observed being used as nectar sources by *P. anchises nephalion* were a species of Rubiaceae growing in the forest (10 records), the Verbenaceae *Stachytarpheta polyura* (L.) (5 records) and *Lantana camara* L. (3 records). Only *Aristolochia triangularis* was observed as larval host plant in the study site. The behavior observed in ovipositing females and larvae was the same as reported in the literature (see Brown-Jr. *et al.*, 1981).

DISCUSSION

Even if there are some good populational studies with species of *Parides* (Cook *et al.*, 1971; Brown-Jr. *et al.*, 1981, 1994; Brown-Jr., 1992; Tyler *et al.*, 1994), there is little information about *Parides anchises*, especially in the coastal region.

The population size of *P. anchises nephalion* in the present study peaked at tens of individuals. Considering that the adult sex ratio is 1:1 in most species (Tyler *et al.,* 1994; Brown-Jr. *et al.;* 1994), the adult population size could be obtained by doubling the estimated number of males, giving a maximum possible of about 120 individuals, but usually 30 to 80 individuals. These values were near that obtained to several species of *Parides* throughout the neotropics, (Cook *et al.*, 1971; Brown-Jr. *et al.*, 1981, 1994; Tyler *et al.*, 1994), with *P. anchises* reported as ocurring among the lowest population levels. Despite the low density of the adults, the observed pattern is very different from those reported to populations of *Heliconius* (Nymphalidae), that shows stable populations numbers throughout the year (Turner, 1971; Ehrlich & Gilbert, 1973; Araujo, 1980; Rogner & Freitas, 1999); and similar to those observed in populations of Ithomiinae, but with smaller population numbers (Vasconcellos-Neto, 1980; Freitas, 1993, 1996; Pinto & Motta, 1997).

During the study period, the population growth occurred in the hottest and wettest month, and decrease in a unusual dry month (February 1997), but, unfortunately, seasonal patterns could not be discussed due to the short study period.

TABLE 1
Populational data for *Parides anchises nephalion* in the Morro do Voturuá. M + R = marked plus recaptured; NIPD = number of individuals present per day; N = number estimated; SE = standard error; LP = Lincoln-Petersen-Bailey; JS = Joly-Seber, MP = Manly-Parr.

Date	M + R	NIPD	LP N ± SE	JS N ± SE	MP N ± SE
5 Aug	3	3	12 ± 14	–	–
17 Aug	3	4	15 ± 18	–	–
24 Aug	4	5	12 ± 13	–	–
4 Sep	2	3	12 ± 15	4 ± 8	–
7 Sep	5	5	10 ± 8	3 ± 0	–
19 Sep	3	3	6 ± 4	2 ± 2	3 ± 0
30 Sep	5	5	8 ± 5	4 ± 0	5 ± 0
11 Oct	4	4	20 ± 24	–	–
18 Oct	4	4	12 ± 13	–	–
24 Oct	2	2	10 ± 12	–	–
5 Nov	4	4	24 ± 30	–	–
16 Nov	5	5	20 ± 24	–	–
1 Dec	3	3	18 ± 18	–	–
9 Dec	11	11	25 ± 19	10 ± 0	11 ± 0
15 Dec	6	9	16 ± 12	17 ± 23	24 ± 18
20 Dec	7	10	11 ± 5	16 ± 16	14 ± 4
23 Dec	7	10	14 ± 8	15 ± 15	17 ± 8
25 Dec	7	8	17 ± 15	8 ± 8	14 ± 9
30 Dec	4	5	12 ± 13	8 ± 12	–
7 Jan	2	3	4 ± 3	–	–
12 Jan	1	2	5 ± 6	2 ± 2	–
14 Jan	4	4	8 ± 6	2 ± 0	–
21 Jan	3	3	3 ± 0	2 ± 0	–
31 Jan	1	1	2 ± 1	–	–
3 Feb	1	1	2 ± 1	–	–
6 Feb	1	1	2 ± 1	–	–
14 Feb	1	1	3 ± 3	–	–
17 Feb	2	2	–	–	–

TABLE 2
Sex ratio and mean male forewing length (in mm) (both based on monthly recruitment) of *Parides anchises nephalion* in this study. Asterisks indicates that the sex ratio was significantly different from 1:1 (chi-square tests, $p < 0.05$). m = males; f = females, MFL = male forewing length, N = sample size.

Month/year	Sex ratio		Male forewing length	
	m:f	(%)	Mean ± SD	N
Aug/1996	10:4	71:29	43.0 ± 3.74	10
Sep/1996*	10:2	83:17	41.8 ± 4.52	10
Oct/1996	8:0	100:0	41.6 ± 3.16	8
Nov/1996	9:1	90:10	43.8 ± 2.68	9
Dec/1996	28:21	57:43	41.8 ± 4.06	27
Jan/1997	7:3	70:30	42.1 ± 4.26	7
Feb/1997	5:0	100:0	41.2 ± 1.26	4
Total	77:31	71:29	42.2 ± 3.71	75

TABLE 3
Permanence of marked males of *P. anchises nephalion* in the Morro do Voturuá. Days elapsed between marking and last recapture represent the minimum permanence (MP) for each individual.

MP	Males	P (%)
1-6	3	16.7
7-12	5	27.8
13-18	5	27.8
19-24	3	16.7
25-30	2	11.0
Total	18	100.0

The average time of residence and the life expectance agrees with those found in other species of *Parides* (Cook *et al.*, 1971; Brown-Jr. *et al.*, 1981, 1994; Tyler *et al.*, 1994). Cook *et al*. (1971) found an life expectance of 5.7 days for *P. neophilus*, very near that obtained in the present study (5.6 days).

In general, the maximum permanence reported for most species of *Parides* was around 6 to 8 weeks in the field, except for *P. anchises*, *P. ascanius* and *P. neophilus*, all with maximum permanence values of around 2-4 weeks (Tyler *et al*., 1994, Brown-Jr. *et al.*, 1994, this study). The average time of residence of *Parides* can be considered low if compared with those of other tropical mimetic butterflies such as Heliconiini (Turner, 1971; Benson, 1972; Ehrlich & Gilbert, 1973; Araujo, 1980; Quintero, 1988; Ramos & Freitas, 1999), and Ithomiinae (Vasconcellos-Neto, 1980; Freitas, 1993, 1996; Table 5 in Ramos & Freitas, 1999).

Brown-Jr. *et al.* (1981) cited the low lifespan of adults combined with weekly samples (resulting in low recapture rates) as the main reason for not using estimates in a study with Troidini in the Campinas region. Fuiture studies with populations of Troidini should consider this, and the population should be studied at intervals shorter than one week.

The male biased sex ratio was also recorded for some natural populations of *Parides* (about 2 males: 1 female according to Brown-Jr. *et al.*, 1994), but reared lots typically results in a sex ratio of 1:1 (Tyler *et al*., 1994, Brown-Jr. *et al*., 1994).

Thus, like in most butterflies, male biased sex ratio could be a result of differences in the

behavior of males and females, resulting in a higher catchability of males (Brussard & Ehrlich 1970; Ehrlich & Gilbert, 1973; Ehrlich, 1984; Ehrlich, *et al*., 1984; Freitas, 1993, 1996; Tyler *et al.*, 1994; Ramos & Freitas, 1999).

Even if species of *Parides* were good flyers and traveled distances of up to 55 km (Brown-Jr. *et al*., 1981, 1994), these values could vary according to the studied area. In *P. anchises* the maximum distances recorded varied from 140 to 1,500 m (Brown-Jr. *et al*., 1994), and in this particular the results obtained in the present work are in accord with those of previous studies.

Unfortunately, the average distances were not presented in these previously cited works, and the averages are probably a more representative parameter of the population than maximum values.

The use of flower resources by *P. anchises nephalion* in Morro do Voturuá is similar to that recorded in Monjolinho (a small forest fragment near Campinas, SP) (Brown-Jr. *et al*., 1981), where the most used species was also *Impatiens*, an introduced plant species.

In general, all features described to *P. anchises nephalion* in the present paper agree with those recorded for other species of *Parides* in the Neotropics. However, this information is important in understanding the ecology of *P. anchises*, which is one of the most widespread species of *Parides*, ranging from North Argentina to Panamá (see maps in Tyle *et al.*, 1994), and occurring in several habitats and forest types. Some very widespread species could present differences in population features throughout their range (Ramos & Freitas, 1999), and understanding of this ecological plasticity could helps in understanding the ecology of tropical insects.

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