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Role of age and weather on residence time of males of *Anartia amathea roeselia* butterfly in a subtropical area in Southeastern Brazil

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Abstract
Residence-rate and residence time of butterflies are dependent of their survival which is dependent of its age. Survival declines only when they will senesce but can be affected by environmental conditions which can be weather, predation, and/or resource availability. The present study has the objective of estimate the role of (1) age and (2) abiotic environmental variables on residence time of males of the common butterfly, *Anartia a. roeselia*, during winter-spring of 2005 in a subtropical region in the coast of São Paulo, Brazil. The population was tracked during 159 days, from June to November 2005, using the method of multiple marking with recaptures to estimate residence rate and residence time and minimum population numbers at each sampling date. Residence was checked in each sampling cohort against sex, age at first capture, and size of butterflies. Multiple regression linear models were used to test ln transformed residence curves. The weed plant *B. alba* (Asteraceae) was the main nectar source for *A. a. roeselia* during the study. Recruiting of new males was continuous together with the arrival of individuals not yet detected. The home-range of males appear to be bigger than of that sampled area because at least 30 individuals remained more than five samplings without detection. Maximum residence time of males reached to 63 days with a residence rate = 0.93 indicating a residence time of = 14.7 days. Number of missings on each date were significant proportional with total number of old individuals in the sample. Residence time of *Anartia a. roeselia* males was affected negatively by two abiotic (weather parameters): minimum atmospheric pressure and difference between maximum and minimum atmospheric pressure. The average time to catch a butterfly had low but significant correlation with wind intensity. Residence rate and residence time are higher in males collected in age classes Intermediate and new.

Keywords: *Anartia amathea roeselia*, multiple marking technique, residence time, edge ecology

1. Introduction

About 36 years ago, Ehrlich [1] published a revision discussing the main aspects of the structure and dynamics of butterfly populations. Since that time, temporal dynamics and population ecology of common temperate butterfly species were very well studied, resulting in several papers that are now classics of population ecology. As a good example, we can take the series of papers on *Euphydryas* spp. Several species in this genus were studied in the last 40 years as models in the study of population biology of temperate butterflies [2]. The studies made with *Euphydryas editha* showed the importance of abiotic (weather) and biotic conditions (habitat loss, plant decline, parasitoids, and human impact) upon their populations [3, 4] and the importance of long-term studies to establish patterns of cause and effect.

Except the work of Peixoto & Benson [5], other studies on ecology of Neotropical butterflies had little or no attempting to correlate population dynamics with the environmental, weather or climatic conditions [6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20]. By the other hand, in temperate areas, several authors drew attention to the role of temperature and weather conditions on the activity of butterflies [21, 22, 23, 24, 25, 26].

In a world that is becoming warmer, the knowledge of influence of weather conditions on subtropical and tropical species of butterflies is important [27]. In this context, the question that arises is whether abiotic conditions have the same importance in tropical regions as observed in temperate regions.

Multiple marking with recapture method (MMR) was used in studies for estimating of allele frequency [28] or ecological parameters in butterfly populations [8]. Considering only the adult stage, butterflies are short-lived organisms and have short residence times or longevities

(Days or months) in the population contrasting with vertebrates, which generally live years or decades [29, 30]. This difference creates a problem because three main assumptions which underlie all MMR methods for estimating of ecological parameters are not accomplished. These assumptions are: (1) the probability of capturing any member of the population is the same; (2) the marked animals become completely mixed in the population after being marked, and (3) the samplings must be at discrete time intervals and the actual time involved in taking the samples must be small in relation to the total time [31, 32].

Other point is that in vertebrates, the incorporation of age of an animal at first capture improves size estimates in open populations [33].

Ages of adult butterflies can be estimated with good accuracy if the researcher knows well the physical changes presented in their bodies along their life. The degree of scale loss was used as a reasonable predictor of the age of an adult *Heliconius ethila* butterfly [8]. In other studies, wing wear or tattering together with scale loss was used but it can’t be correlated with age of the studied species [34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44].

Another source of trouble is when the studied population has overlapping generations. In this situation, at any point in time, the population has a mix of individuals with different ages.

In spite of all these questions, the estimation of residence time of butterflies was accomplished using individuals of all age classes in several studies.

Residence time (RT) and the residence-rate (RR) of butterflies are dependent of their survival [45] which could be dependent of its age. Although survival declines with age it can be affected by environmental conditions as weather, predation, and/or resource availability. Other complication which arises when studying butterflies is when the sampled area is smaller than the actual butterfly home-range. In this situation its movement became an important factor that diminishes encounter probability and increases the missing of a marked individual which is more vagrant, therefore masking the results.

Observations by the author during warmer months (December to March) from 2003 to 2005 in the Baixada Santista region, coastal São Paulo State (SE Brazil), indicated that the butterfly *Anartia amathea roeselia* (Nymphalidae) was resident and common in the region of river Quilombo, near 40 km NE of Santos. Dozens of butterflies of this species were frequently observed on open secondary vegetation on the edges of the road that follows the river. In this area *A. a. roeselia* is multivoltine, occurring all year round with a population peak in autumn [46]. Although butterflies of this genus are common in neotropics only five works were produced [47, 48, 49, 50], only two with *A. amathea roeselia* [51, 52].

The present study had the objective to estimate the role of (1) age and (2) abiotic environmental variables on residence time of the butterfly *Anartia a. roeselia* males along winter-spring of 2005 in a subtropical region in the coast of São Paulo state, Brazil.

2. Material and Methods

2.1 Study area

A population of the butterfly *Anartia amathea roeselia* (Eschscholtz, 1821) (Nymphalidae: Nymphalinae: Nymphalini) was studied in a site located in the edges of a dirty road at right bank of river Quilombo, Santos, São Paulo, Brazil (23°51'26.14"S and 46°20'58.63"W to 23°51'22.88"S and 46°20'35.71"W (Fig. 1). Samplings were made in the edges of six delimited and contiguous areas of 75 m each totalizing 450 m (Fig. 1D). The status of vegetation of the edges was recorded on each month, from March (before the beginning of study) to November 2005 showing their successional stage (partially cleaned, totally cleaned or in succession).

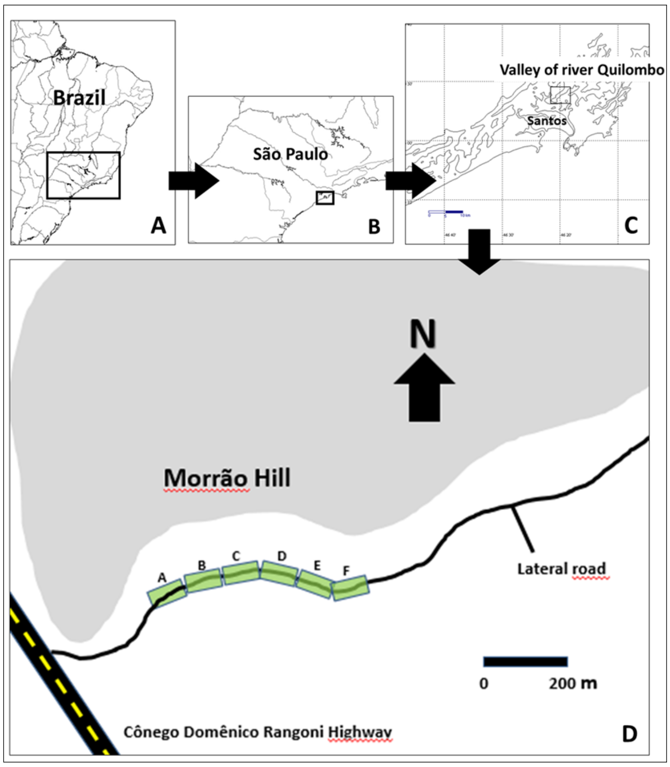

Fig 1: Study area in Brazil (A); in littoral of São Paulo (B); in Baixada Santista (C); in the dirty road along river Quilombo; (D) study area, with six delimited sampling areas. See Francini [46] for more details on study area

2.2 Climate and weather data

Wordclim data [53, 54] was used to construct the climate diagram of study area with resolution of 30 arc seconds (1 pixel ≈ 1 km^2) for the period from 1960 to 1990 (Fig. 2A). In the study area, mean year temperature is 22.0°C and mean rainfall is 2516.0 mm, December being the rainiest month (280.4 ± 45.9 mm) and July the driest (65.5 ± 20.0 mm). This includes the area in a climate type Af in Köppen´s classification [55]. Weather data for the period of study was obtained in the site Weather Underground [56] derived from data of Santos Airport (SBST; Brazilian Air Force). During 2005, the mean year temperature was 23.2°C and mean rainfall was 298.0 mm, January being extremely rainiest with 1040 mm and May, August and October with less than 70 mm of rain (Fig. 2B). In preliminary multiple regression analysis the follow weather variables were used: TEMMAX: maximum mean daily temperature (°C); TEMMIN: minimum mean daily temperature (°C); DIFTEM: difference between TEMMAX and TEMMIN (°C); DEWMAX: maximum mean daily dew-point (°C); DEWMIN: minimum mean daily dew-point (°C); DIFDEW: difference between DEWMAX and DEWMIN (°C); RHYMAX: maximum mean relative humidity (%); RHYMIN: minimum mean relative humidity (%); DIFRHY: difference between UREMAX and UREMIN (%); PREMAX: maximum mean atmospheric pressure (hPa); PREMIN: minimum mean atmospheric pressure (hPa);

DIFPRE: difference between PREMAX and PREMIN; WINMAX: maximum mean wind velocity (km/h); TRAINF: total daily rainfall (mm); DRAINF: Number of rainy days. But, after adequate testing, only two: minimum mean atmospheric pressure in hPa (PREMIN) and difference between maximum and minimum mean atmospheric pressure in hPa (DIFPRE) were used.

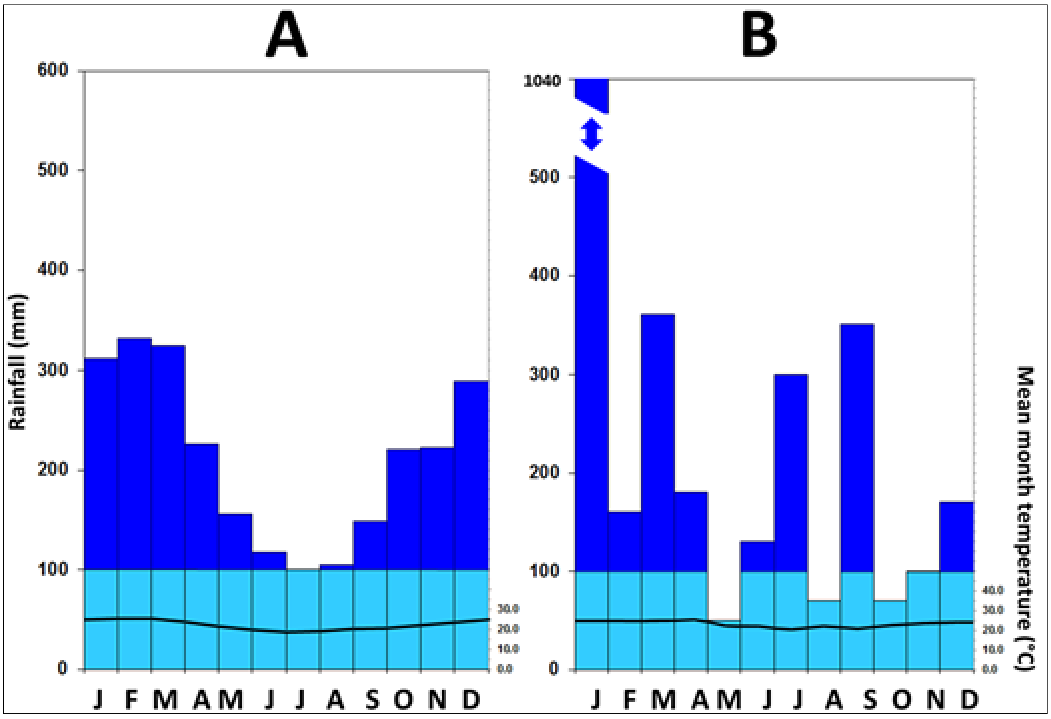

Fig 2: (A) Climate diagram of the study area (data 1960-1990) according Worldclim [53] using pattern proposed by Walter & Lieth [57]. The mean year temperature was 22.0°C and mean rainfall was 2516.0 mm with December being the rainiest month (280.4 ± 45.9 mm) and July the driest (65.5 ± 20.0 mm). (B) Idem for 2005

2.3 Field sampling
The population was studied in an interval of 159 days, from June 9 to November 14, 2005, during 56 samplings days. Butterflies were collected with entomological net with 2 mm mesh. When several butterflies were netted together at same time, they were immobilized by clamping their wings with clothespins. Each individual was marked with a silk paper tag glued with colorless finger nail polish at the base of the left hind wing [20, 46]. Each tag received an alphanumeric code with three digits, printed in a laser printer. Collected specimens were sexed, measured (forewing length in mm; FWL) and their age was estimated by visual inspecting of body and wings [8], with all these operations made at shade. Three age classes were considered: NEW (1), Intermediate (2), and OLD (3). After marking, a digital single lens-reflex (DSLR) camera with a 70-300mm macro lens was used to "recapture" several individuals in following samplings.

2.4 Data tabulation
Data was tabulated using Excel constructing a separated raw table for each sex. In these tables, the status of each butterfly was placed in lines and dates in columns of all 139 consecutive days including ones when no sampling was made. In each cell, the code 1 was used to indicate the first and subsequent recaptures. Absence of the individual before and after capture-recapture period received the code 0. These recapture matrixes were used to construct the residence time matrixes (in days) substituting 0 by 1 between the first capture and last recapture cells. Number of active butterflies (NAB) present at each day was obtained summing columns of each sampling. Minimum number present (MNP) was the sum of all days from the first to the last recapture. Matrixes of butterfly ages were also constructed substituting the 1 by age estimate (1, 2 or 3). All butterflies marked at one sampling date were considered as a cohort. Although females were collected they will be considered in a future analysis in other paper.

The analysis of male population size and residence rate considered only the period from June 9 to July 31 because there was a risk that butterflies marked after July 31 would be collected only after November 14 with residence estimates being underestimated. This interval was choosing after the end of fieldwork when was possible to have an idea about the permanence of butterflies in the population. September 23 was the last sampling with recaptures from June-July period. Therefore, data collection was divided in six sections: (A) June-July capture-recapture data used for main analysis; (B) August-September, 23 data, using only recaptures; (C - D) empty, with no data; (E - F) August-September, 23 data, not used for main analysis.

2.5 Data analysis
All statistical analysis were made using R software v. 3.2.2 win [58] and RStudio v. 0.99.489 [59]. The residence-rate was estimated plotting the natural logarithm of the number of remaining individuals in the population against time, following [60, 34, 45]. Comparison of residence curves were made using multiple regression and package ggplot2 [61, 62]. Estimates of butterfly numbers were made only for June to August using Jolly-Seber approach [63, 64, 65]. This was accomplished using an algorithm produced using Visual Basic for Applications with Excel software, available by the author

on https://archive.org/details/CMLR2017JSPB. Monthly mean of estimates was used to obtain confidence intervals. Relative influence of the weather variables upon residence time was analyzed by multiple regression using five intervals of 10 days. Models were created considering averages of each weather parameter except rainfall, which was summed. I discarded collinear variables and ones that were not significant reaching in a parsimonious final model with only two weather variables. Comparisons between frequencies were made using contingency test with G statistic [66].

3. Results and Discussion

3.1 Sources of nectar for adult foraging

In the studied population the main sources of nectar were *Bidens alba* (Asteraceae) and a *Asclepias curassavica* (Apocynaceae), respectively. Inflorescences of *Wedelia paludosa* (Asteraceae) were common only on the end of the samplings, from September to November (Fig. 3).

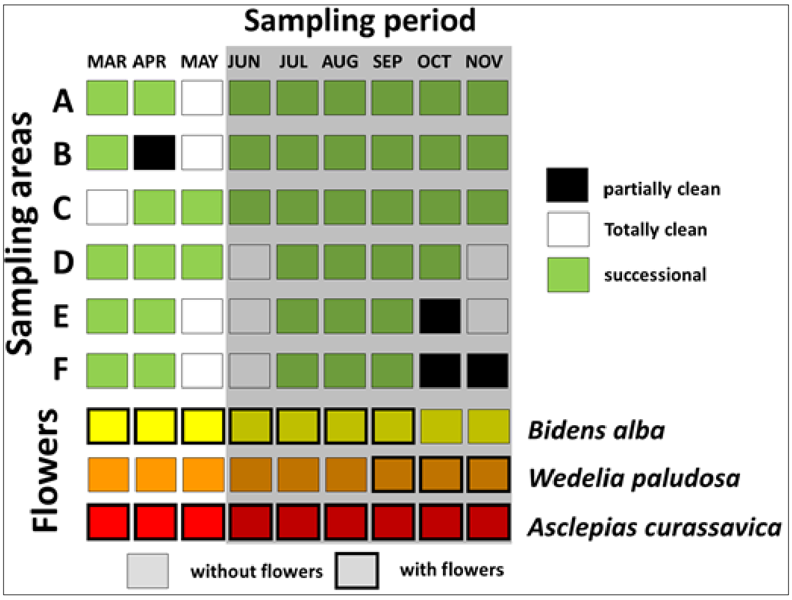

Fig 3: Status of each sampling area from March to November 2005 showing its successional stage and floral resources present after and during sampling period

The number of flowers of *B. alba* and *A. curassavica* in sampling areas A, B and C remained high during sampling period. The number of inflorescences in the flowers of *B. alba* ranged from 1 to 23 (mean = 9.9 flowers/m^2; sd = 2.91 flowers/m^2; n = 30).

Edges dynamics is important to maintain the adequate ecological condition to ruderal plants and animals. In this study, edge alterations were derived from the anthropogenic cleanings that promoted continuous, but not foreseeable impacts, that changed the vegetation succession stage. When an area with plenty of flowers of *Bidens alba* was cut all butterflies migrate to neighbor's ones where this or other floral resource were abundant. However, if larval foodplants were present the larvae could be killed.

By the other side, areas in the beginning of the vegetation successional stage with moist soil were more searched by females. Silberglied *et al*. [48] suggested that anthropogenic activities benefit *Anartia* and *Junonia* species because their larval foodplants are the same and grow along the draining or irrigation channels and that big populations can be found in roads or cultivated fields in Latin America.

3.2 Weather dynamics and butterfly foraging during study

During June-July, there were four periods of worst weather: June 20 and 21, June 28 and 29, July 5 to 9, and July 20 (Fig. 4 A-E). All of them were preceded by a drop in atmospheric pressure and humidity with the arrival of a cold front coming from the South Pole. Average maximum temperature (Fig. 4 A), was higher (26.8°C) in June than in July (24.2°C) (t = 2.9128, df = 51.545, p = 0.005).

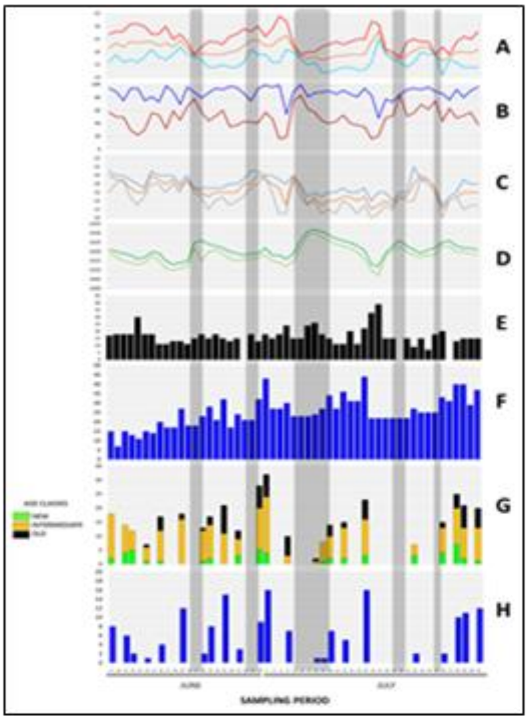

Fig 4: Weather conditions and males of *A. a. roeselia* butterflies in the study area during samplings. Gray shading indicates worst weather rainy days. (A) Maximum and minimum temperature (°C). (B) Maximum and minimum relative humidity. (C) Maximum and minimum dew point temperature (°C). (D) Maximum and minimum atmospheric pressure (hPa). (E) Maximum wind velocity (km/h). (F) Minimum number present. (G) Active butterflies and age structure at each sampling. (H) Missing individuals at each sampling

The number of active butterflies foraging on flowers of *B. alba* had a peak in the morning, between 1100h and 1200h on June, and between 1000h and 1100h on July (Fig. 5). On the other hand, this activity extended to the 1600h on June but finishing to 1400h on July.

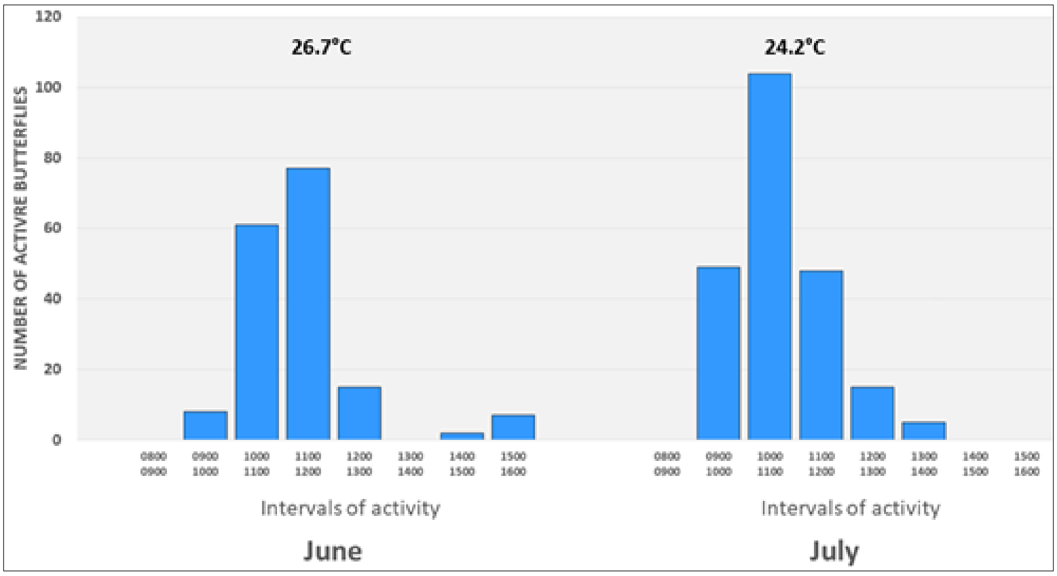

Fig 5: Number of active male butterflies in classes of one hour on each sampling during the study. The values above bars are mean monthly temperature.

3.3 Captures and recaptures

A total of 309 males was collected, marked and released from June 9 to November 14. However, as stated in methods, I considered only the 178 males collected and marked from June 9 to July 31. Last recapture of males from this period was made on September 23. The results that follow are based on this sampling period. The recaptures enclosed 92 males (51.68%) (Table 1). Maximum number of recaptures was 11 times in male G4.

Table 1: Number of recaptures of males of *Anartia amathea roeselia* butterflies during the study.

Number of recaptures	Number	%
0	86	48.31
1	42	23.60
2	25	14.04
3	7	3.93
4	6	3.37
5	4	2.25
6	3	1.69
7	2	1.12
8	1	0.56
9	0	0.00
10	1	0.56
11	1	0.56
Total	178	100.00

Negative or neutral effects of marking and capture on recapture frequencies of butterflies in MMR process were discussed by Singer & Wedlake [67] and Morton [68, 69]. All sampling process was very consistent as showed by cumulative numbers of new captures with recaptures being relatively high for males, indicating that the process of marking and recapture did not changed so much the butterfly behavior. When released, several freshly marked individuals returned to their behavior before collecting. Also the use of DSLR to proceed "recaptures" with the identification of the alpha-numeric code aided to reduce butterfly net-shyness as proposed by Mallet *et al.* [70].

With increase of sampling effort, the accumulated total of non-marked males in the population increased linearly ($R = 0.9812$; $F_{1,157} = 4082$; $p < 0,0001$) showing a continuous recruiting together with the arrival of individuals not yet detected. The number of samplings that each individual was not seen or recaptured ranged from one to 17 (Table 2).

Table 2: Number of samplings that individuals of males of *Anartia amathea roeselia* butterflies were not seen but recaptured before.

Samplings with no detection	Number of males
1	17
2	14
3	5
4	16
5	13
6	5
7	2
8	2
9	2
10	1
11	1
12	0
13	1
14	0
15	1
16	1
17	1

The number of males that were recaptured at least two times was 65 (36.51%) although several were not recaptured or seen during several samplings. Thirty individuals remained more than five samplings (more than 10 days) without to be recaptured but other lasted only few samplings but repeating this pattern several times.

Number of missing butterflies, that is, individuals seen for the last time in one sampling date, had a peak on July 15 when 11 butterflies were missed (Fig. 4 H).

Correlation between age at first capture and number of days of residence was low (R = -0.30; t = -4.1897; df = 181; p < 0.001). Multiple regression analysis of male cohort missings against present and future weather conditions are not significant. On the other hand, percentage of recaptures of class NEW individuals was 87.23% (n = 47), 47.75% (n = 111) for class Intermediate, and only 15.00% (n = 20) for OLD. The consequence is that the number of missings on each sampling date (Fig. 4 H) were significant proportional to total number of old individuals in the sample (prop.test X^2 = 31.781; df = 2; p<0.0001).

To solve this puzzle, the term "concept of temporally bounded populations" was coined by Pfeifer *et al.* [71] for a "population that has a set of individuals living in the same delimited area within a specified period of time". In their study, they emphasized the importance of the estimation of total population size.

3.4 Male numbers

Male numbers estimated by Jolly-Seber method varied from 19 to 88 in June (n = 11) and from 46 to 107 in July (n = 11). Monthly averages showed significant differences between them, with June values (mean = 41.0 butterflies) being smaller than July values (mean = 75.5 butterflies) (Welch two sample t-test t = -3.8476, df = 19.637, p = 0.001; Fig. 6).

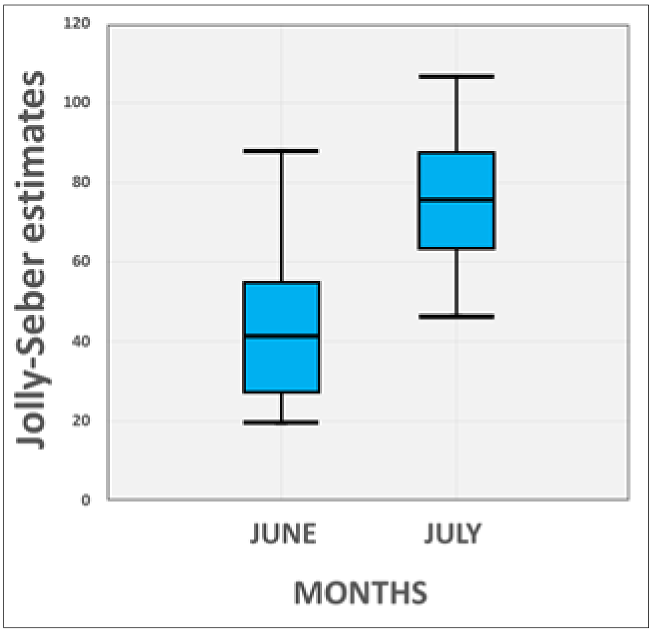

Fig 6: Mean, confidence interval (box) and interval of variation (whiskers) of Jolly-Seber estimates of the number males of *A. a. roeselia* butterflies in the study area from June and July 2005

The problem of the use of absolute methods on population size estimation was discussed by different authors with emphasis on the high value of errors of the estimates [72, 73]. However, count based estimates of population size or relative abundance are appealing because they permit population monitoring without mark-release-recapture studies [74, 75].

The minimum population number of males at samplings (Fig. 4 F) ranged from 1 on June 15 to 37 on July 1 when numbers reached a peak. The number of active males on each sampling date (Fig. 4 G) was positively correlated with the minimum number present (R = 0.7025; F = 21.4345; p = 0.0003; Fig. 7).

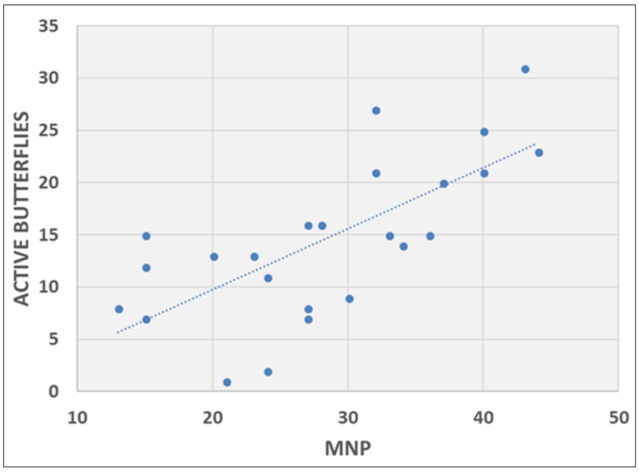

Fig 7: Number of active males of *A. a. roeselia* butterflies in the study area during samplings in function of minimum number present (R = 0.7025; F = 21.4345; p = 0.0003)

The average time to catch a butterfly (TCB) in each sampling was highly variable ranging from 1.6 to 20.0 minutes. Correlation between TCB with the wind intensity was low but significant (R = 0.47; F = 18.793; p = 0.0005) showing the role of wind in the flight of these butterflies. Brown [76] observed that direction of insect flight was influenced by wind. Dover *et al.* [77] showed that the total number of butterflies observed during 14 samplings had tendency to decrease in function of the increase of wind speed. However, Metner *et al.* [78] showed that wind direction but not wind speed was determinant of the number of monarch butterflies seen on their samplings. Polcyn *et al.* [79] demonstrated experimentally the effects of wind on the heat loss by *Vanessa cardui* butterflies. Tsuji *et al.* [80] observed that *Colias* butterflies do not initiate flight at higher wind velocities (> 1.0 m/s) and also that wind has an important hole on the heat loss in this species. Wikstroem *et al.* [81] observed no effect of wind speed, up to five on the Beaufort scale, on the number of species or individuals during their 15 days' survey. However, they stated that the butterfly assemblages were clearly affected by wind speed with each species responding differently to wind.

In the present study, the results do not evidence the observed by Fosdick [73] in Ecuador. Herein, the population of *A. a. roeselia* had overlapping generations with continuous recruiting during the two months. Fosdick study showed a suddenly recruiting of males after heavy rains which was not the pattern observed in the present study. However, although Fosdick's work was done in an area much closer to the equator, Sheppard & Bishop [82] indicated that his data was not correctly analyzed and this pattern could not be correctly interpreted.

3.5 Age structure

During samplings of males, age class Intermediate predominated, except on July 4 when there were more individuals of the age class OLD (Fig. 4 G). Recruiting of males was continuous during 82.6% of samplings, with a peak on July 28. The near total predominance of age class Intermediate for males seems to be linked to the residence expectance of near 15 days because new recruits change quickly their age class status (mean = 2.1 days; sd = 1.01 days; n = 15).

3.6 Residence time

Maximum residence time of males reached to 63 days (#51). And only 27 individuals (14.7%) were resident for more than 20 days. Residence curve of males fitted exponential model and when transformed (log e) were highly significant ($R = 0.9807$; $F = 1531.7835$; $p < 0.0001$; Fig. 8) with RR = 0.9343 and RT = 14.7 days.

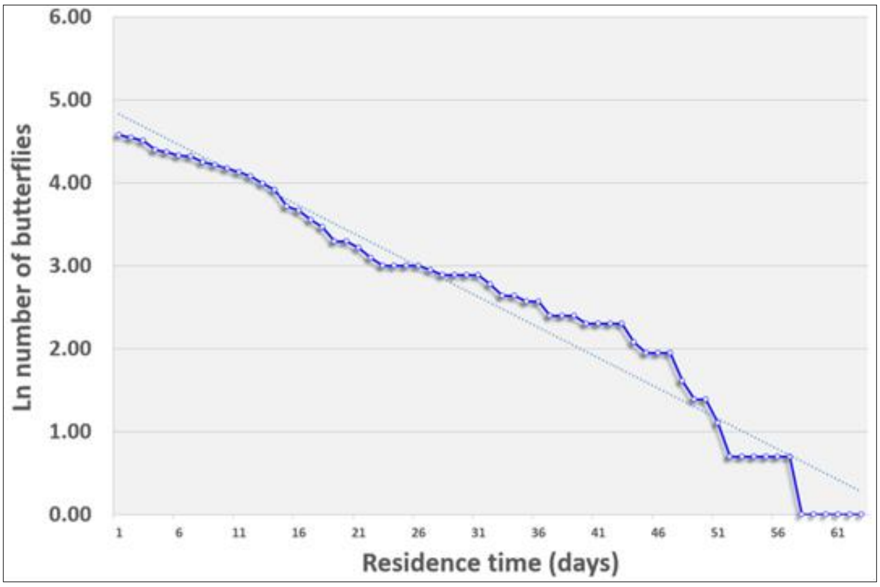

Fig 8: Residence curve of males of *A. a. roeselia* in the study area ($y = -0.0734x + 4.9008$; $R = 0.9807$; $F = 1531.7835$; $p < 0.0001$)

Separated estimates for age classes showed that both RR and RT are higher in males collected in age class Intermediate and, as expected, the values RR and RT of age class OLD were minimum for males (Table 2).

Table 2: Residence rate (RR) and residence time (RT) for males *Anartia amathea roeselia* butterflies of three age classes during the study.

	New	Intermediate	Old
R^2	0.9692	0.9401	0.6555
b	-0.0716	-0.0643	-0.1542
F	1351	957.9	24.74
df	1,43	1,61	1,13
p	< 0.0001	< 0.0001	< 0.001
RR	0.9309	0.9377	0.8571
RT	13.9665	15.5521	6.4851

Maximum residence times known for males of Neotropical butterfly species range from 6 to 162 days (Table 3).

Table 3: Maximum residence time (days) detected in populations of Neotropical butterflies. Names according to Lamas [83]. MRT: maximum residence time (days). RBF: author, non-published data.

Species	MRT	Site/Reference
Placidina euryanassa	45	Morro do Japui, São Vicente, SP, Brazil [13]
Heterossais edessa	65	Morro do Japui, São Vicente, SP, Brazil [14]
Mechanitis lysimnia	67	Morro do Japui, São Vicente, SP, Brazil [14]
Dircenna dero	23	Morro do Japui, São Vicente, SP, Brazil [14]
Parides anchises nephalion		Morro do Voturuá, São Vicente, SP, Brazil [18]
Aeria olena	24	Santa Genebra, Campinas, SP, Brazil [84]
Aeria olena	120	Horto Florestal, Sumaré, SP, Brazil [84]
Aeria olena	> 24	Costa e Silva, Campinas, SP, Brazil [84]
Tithorea harmonia pseudethra	34	Mata da Pedra, Mogi Guaçu, SP, Brazil [84]
Heliconius ethila	162	Arima Valley, Trinidad [8]
Heliconius erato	> 71	Rincon de Osa, Puntarenas, Costa Rica [85]
Parides ascanius	28	Poço das Antas, Silva Jardim, RJ, Brazil [86]
Methona themisto	62	Uberlândia, MG, Brazil [87]
Euptoieta hegesia	14	Unicamp, Campinas, SP, Brazil [88]
Archonia brassolis tereas	30	Vale do Rio Quilombo, Santos, SP, Brazil [RBF]
Actinote zikani	6	Paranapiacaba, Santo André, SP, Brazil [20]
Actinote mamita mitama	10	Unicamp, Campinas, SP, Brazil [RBF]
Actinote pellenea pellenea	13	Morro do Japui, São Vicente, SP, Brazil [89]
Actinote brylla	16	Morro do Japui, São Vicente, SP, Brazil [89]
Heliconius sara apseudes	85	Vale do Rio Quilombo, Santos, SP, Brazil [RBF]

However, in Afrotropical region, mark-recapture data of more than 30,000 marked individuals with less than 10% recaptures of 47 species of fruit-feeding butterflies in a tropical forest in Uganda showed residence times ranging from 67 to 200 days [90, 91]. Analyzing metadata of 340 species of butterflies, Beck & Fiedler [92] showed that adult feeding habit has strong links with life spans. In one geographic area, there was a hierarchy in lifespan with pollen-feeders living longer than fruit feeders which, in turn, live longer than nectar feeders. Solitary or aggregated foraging may affect survival or fecundity in insects [93, 94, 95, 96].

Transformed (natural logarithm) of residence time data in the five intervals of 10 days was affected negatively by both minimum atmospheric pressure and the difference between maximum and minimum atmospheric pressure (Adjusted R-squared:0.975; $F_{2,2} = 79.00$; $p < 0.01$).

Present study showed a high number of males being resident only one day (Fig. 4 H). This pattern would indicate that they are experimenting high death rates or have high dispersal rate. However, when we look to data we can accept that the no subsequent recapture of a marked male butterfly is derived from its vagrant behavior. Male seems to be more vagrant than female meaning that its home range is bigger than that sampled area. Therefore, a male may die during this “no detection” period of time. The residence time of each sampled cohort was dependent of the age of that cohort when marked at first time and the weather did not have significant hole. However, the analysis of five cohorts in intervals of ten days showed that the role of atmospheric pressure was significant. Although we expect that some weather conditions as temperature, rainfall, cloud cover or wind affect negatively the residence of butterfly species there are a cascade of interactions between them that may be difficult or obscure the true condition. Rainfall is dependent to dew point, which is the temperature at which the water vapor in air at constant barometric pressure condenses into liquid water at the same rate at which it evaporates. At temperatures below the dew point, water vapor became liquid and rains. When a cold front arrives at sea level, the best rain predictor is the rapid fall of barometric pressure. Bigger the fall, more quickly the rains arrive. Therefore, in this study made at near sea level, both minimum atmospheric pressure and the difference between maximum and minimum atmospheric pressure were good metrics to predict worst weather condition to these butterflies.

3.7 Size of butterflies

The FWL of males ranged from 22 mm to 28 mm (Shapiro-Wilk normality test $W = 0.8037$; $p < 0.0001$; median = 27 mm; n = 178). The correlation of size of males (FWL) and residency time was not significant.

The size of adult of each species of butterflies is genetically determined but is also dependent of the environmental conditions and availability of food plants in the larval stage. Each species has one mean size for each sex but the actual size of a butterfly or moth reflects the constraints their received in larval stage as in the moth *Manduca sexta* [97]. In males of *A. a. roeselia* there was no correlation between FWL and residence time. Therefore, size appears to be low power in determining the residence of male butterflies.

4. Conclusions

1. The asterace *B. alba* was the main nectar source for *A. a. roeselia* during the study.
2. Recruiting of new males was continuous together with the arrival of individuals not yet detected.
3. The home-range of males appear to be bigger than of that sampled area because at least 30 individuals remained more than five samplings without detection.
4. Maximum residence time of males reached to 63 days with a residence rate = 0.93 indicating a residence time of = 14.7 days.
5. Number of missings on each date were significant proportional with total number of old individuals in the sample.
6. Residence time of *Anartia a. roeselia* males was affected negatively by two abiotic (weather parameters): minimum atmospheric pressure and difference between maximum and minimum atmospheric pressure.
7. The average time to catch a butterfly had low but significant correlation with wind intensity.
8. As expected, both residence rate and residence time are higher in males collected in age classes Intermediate and new.

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