POPULATION DYNAMICS OF *Cosmoclopius nigroannulatus* Stal (HEMIPTERA, REDUVIIDAE) IN TOBACCO CULTURE

JAHNKE, S. M., REDAELLI, L. R. and DIEFENBACH, L. M. G.

Departamento de Fitossanidade, Faculdade de Agronomia UFRGS, Av. Bento Gonçalves, 7712, CEP 91540-000, Porto Alegre, RS, Brazil

Correspondence to: Luiza Rodrigues Redaelli, Departamento de Fitossanidade, Faculdade de Agronomia, UFRGS, Av. Bento Gonçalves, 7712, CEP 91540-000, Porto Alegre, RS, Brazil, e-mail: luredael@ufrgs.br

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(With 2 figures)

ABSTRACT

The role of predators influencing populations of insects considered as pests is extremely important for agroecosystems. The population ecology of *Cosmoclopius nigroannulatus,* a predatory reduvid associated with the tobacco culture was investigated aiming to study the population dynamics of adults, along the culture cycle. In an experimental plot of approximately 300 m^2, in Porto Alegre (30°0'S; 51°13'W), RS, Brazil, 270 tobacco plants were grown; each plant identified by alphanumeric coordinates. Using the mark-release-recapture method, daily samplings were done from August to December 1999, and three times a week from this date until April 2000. The adults were captured by hand, marked, sexed and released on the same plant they were captured. The individual number and plant coordinate were registered. Population estimates were analyzed by the Fisher-Ford method. In 107 sampling occasions, 604 individuals were marked, 273 males and 331 females. Three generations of *C. nigroannulatus* were registered during the culture cycle. The colonizing generation was represented by 14 males and 15 females (a sex ratio of 0.48), the first by 109 males and 137 females (0.44) and the second by 150 males and 179 females (0.46). The estimated daily survival rate varied between generations decreasing from 98% in the colonizing generation to 87% in the second. The observed longevity or permanence time in the experimental area varied significantly among generations, being at about 40 days in the colonizing generation, 13 days in the first and 5 days in the second. It was observed that as the population increases, the survival and/or permanence time in the area decreases, suggesting a relation between this and a decline in the available resources probably with an associated increase in intra-specific competition.

Key words: *Cosmoclopius nigroannulatus,* reduvids, predators, tobacco, natural enemies.

RESUMO

Dinâmica populacional de *Cosmoclopius nigroannulatus* Stal (Hemiptera, Reduviidae) em cultura de fumo

A ação de predadores sobre populações de insetos considerados pragas é de suma importância em agroecossistemas. A ecologia populacional de *Cosmoclopius nigroannulatus*, um reduvídeo predador associado à cultura do fumo, foi investigada para estudar a dinâmica populacional dos adultos ao longo do ciclo da cultura. Numa área experimental (300 m^2), em Porto Alegre (30°01'S; 51°13'W), RS, Brasil, foram plantadas 270 mudas de fumo, identificadas por coordenadas alfanuméricas. As amostragens foram diárias de agosto a dezembro de 1999 e, a partir de então, três vezes por semana até abril de 2000. Os adultos foram capturados manualmente, marcados, sexados e devolvidos à mesma planta. Foram registrados o número, a coordenada e a localização na planta. Para análise das estimativas populacionais foi utilizado o método Fisher-Ford. Nas 107 ocasiões de amostragem, foram marcados 604 indivíduos, sendo 273 machos e 331 fêmeas. Foram registradas três gerações de *C. nigroannulatus* durante o ciclo da cultura. A geração colonizante foi composta por 14 machos e 15 fêmeas; na primeira geração foram registrados 109 machos e 137 fêmeas e na segunda, 150 machos e 179 fêmeas. A razão sexual na geração colonizante foi de 0,48, na primeira geração, de 0,44 e na segunda, 0,46. A sobrevivência diária estimada variou entre gerações, decrescendo de 98% na geração colonizante para 87% na segunda. A longevidade observada ou tempo de permanência na área variou significativamente entre gerações, ficando em torno de 40 dias na geração colonizante, 13 dias na primeira geração e 5 dias na segunda. Observou-se que, com o aumento da população, ocorre a diminuição da sobrevivência e/ou tempo de permanência na área, sugerindo que este fato possa estar ligado a uma diminuição dos recursos disponíveis e, conseqüentemente, ao aumento da competição intra-específica.

Palavras-chave: *Cosmoclopius nigroannulatus,* reduvídeos, predadores, fumo, inimigos naturais.

INTRODUCTION

The presence of natural enemies in a community may influence considerably the interactions between prey populations, interfering in the organization of this community. Hassell & Waage (1984), Price *et al.* (1986) and Van Driesche & Bellows (1996), among others, discuss this kind of influence in which predators act as mediators of interactions between populations, acting dependently of density. For Price *et al.* (1986) population density is influenced by the predation pressure the individuals are exposed to and by mechanisms of defense developed in this interactive process. Most of the studies with predatory insects populations have been carried out aiming at the biological control of pests.

The role of natural enemies in the regulation of populations of herbivorous insects has been the target of several studies. Fowler (1987) studied the impact of natural enemies on pests populations in rice crops in Sri Lanka, using exclusion methods of predators and parasites under field conditions. Zhang *et al.* (1994) studied the interaction between the predatory bug *Orius similis* Zheng (Hem., Anthocoridae) and *Pectinophora gossypiela* Saunders (Lep., Gelechiidae), a pest of cotton crop, under field conditions, in Hubei province, China. Rosenheim (1998) discuss the population regulation of herbivorous insects by different predators, besides pathogens and parasitoids. Sait *et al.* (2000), investigating a multi-species system with predator-prey interactions, propose that the succession by which an area is colonized determines the dynamics of the populations involved.

Although reduvids have an important role as predators (De Bach & Rose, 1991; Pedigo, 1996; Van Driesche & Bellows, 1996), very few studies were developed involving these organisms, both in Brazil and abroad. Bueno & Berti Filho (1984) and Freitas (1994), studied biological aspects of *Montina confusa* Stal (Reduviidae) and claimed that this species presents a long life-cycle, an advantageous characteristic in a program of biological control, considering it may consume a great amount of prey during its vital cycle. Specially in Brazil, most of the studies with predators deal with life-cycle in laboratory conditions. Although population dynamics studies are essential for the comprehension of predator-prey relationships in agroecosystems, they are still rare.

Cosmoclopius nigroannulatus Stal (Hem., Reduviidae) is an important predatory species related to the tobacco culture. In Southern Brazil, Silva *et al.* (1968) mention *C. nigroannulatus* as a predator of *Corecoris dentiventris* Berg (Hem., Coreidae), commonly known as the tobacco-gray-bug.

Caldas (1998) identified *C. nigroannulatus* as the most abundant predator of nymphs of *C. dentiventris* in an experimental tobacco culture, in Porto Alegre, RS. Canto-Silva (1999) registered an average mortality of more than 90% for nymphs of *C. dentiventris* in a work carried out in the same experimental area. In a pilot study *C. nigroannulatus* was observed predating other phytophagous insects as *Myzus persicae* (Sulzer), *Macrosiphum euphorbiae* (Thomas) (Hem., Aphididae) *Epitrix* sp., and *Diabrotica speciosa*, Germar (Col., Chrysomelidae).

Fallavena (1993) comments that *C. nigroannulatus* is easily reared in laboratory conditions, and may be indicated as a potential agent for the biological control of pests, not only in tobacco, but also in other crops, considering that this species is a generalist. In spite of this, no population studies were carried out with this species.

Therefore, the present work aims to investigate aspects of population dynamics as colonization, population size, number of generations and the sex ratio of adults of *C. nigroannulatus* in an experimental tobacco crop, using the mark-release-recapture method.

MATERIAL AND METHODS

The tobacco crop (*Nicotiana tabacum* L.; Virginia variety K326) was established in the experimental area of the Departamento de Fitossanidade, UFRGS, in Porto Alegre (30º01'S and 50º13'W), RS, in the beginning of August 1999. The seedlings were planted in 10 rows with 27 plants each, in a total of 270 plants. Spacing between plants was 0.8 m and 1 m between rows, following the usual recommendation for tobacco culture. No phytosanitary measures were applied. The samplings were done in the morning, approximately at the same time; daily from August 3rd 1999 to December 15th 1999, during the colonization period, and three times a week from December 17th 1999 to April 5th 2000.

At each sampling occasion all plants were inspected and any *C. nigroannulatus* adult found was captured by hand, marked and release back on the same plant. Marks were made with permanent ink marker and consisted of a system of code points based on a suggestion by Brussard (Southwood, 1978); an independent sequence of marks was used for each sex.

The populational estimates were analyzed by the Fisher-Ford method (Fisher & Ford, 1947; Begon, 1979) after testing its assumptions. In the Fisher-Ford's method, the term "capture" refers to all captured individuals in a given occasion, marked or not. The term "recapture" refers to the individuals already marked.

Longevity was estimated as the difference, in days, between the last and the first capture of each individual. This way, the obtained values represent the minimum longevity.

The recapture frequency was calculated as the total number of recaptured individuals/total number of marked individuals X 100. The sex ratio was calculated as rs = n. of ♂/(n. ♂ + ♀). The significance tests used were the Qui-square and U of Mann-Whitney. Microsoft Excel 7.0 and Bioestat 2.0 were used for calculations.

RESULTS AND DISCUSSION

In 107 sampling occasions (those when at least one individual was captured) from August 1999 to April 2000, a total of 604 adults, 331 females and 273 males, were marked.

The colonization of the tobacco experimental plot began on September 19th 1999, with the arrival of a female, the first male arriving on September 21st 1999. Colonization was gradual and extended from September 19th to December 3rd 1999 (Figs. 1a and b). The colonizing generation was composed of 29 individuals, 15 females and 14 males.

The first *C. nigroannulatus* was captured after the beginning of the experimental plot colonization by *C. dentiventris*. Neverthless nymphs of *C. dentiventris* were not present yet. In this period, adults of *C. nigroannulatus* were observed eating aphids (*M. persicae* and *M. euphorbiae*) and beetles (*Epitrix* sp. and *D. speciosa*, Col.: Chrysomelidae). Possibly, the presence of other phytophagous insects acted as an attractive stimulus to this predator. Rosenheim (1998) highlights the importance of this aspect in the colonization of cultivated areas by natural enemies.

Besides the colonizing generation, two other generations of *C. nigroannulatus* were registered in the area during the crop cycle (Figs. 1a and b). Adults of the first generation were recruited from December 20th up to the end of January 2000. During this period we registered 137 females and 109 males. Recruitment of adults of the second generation occurred from the first week of February to the end of the culture cycle, around April 5th 2000, when a total of 150 males and 179 females was registered. Overlapping of generations occurred in February and March when individuals of both the first and second generation were captured. Capture pattern in the area was similar for males and females along the sampling period. Abrupt oscillations in the record of consecutive samples can be a consequence of random variations, intrinsic to the sampling process, in the proportion of adult *C. nigroannulatus* individuals marked or not, and/or of weather conditions.

The sex ratio obtained for the whole sampling period was of 0.45 (0.91♂ : 1♀). This result differs from the one obtained by Fallavena (1993) who registered a sex ratio of 0.54 for the same species in laboratory conditions. Other works, also in laboratory, dealing with different reduvid species have obtained diverse values for the sex ratio, as Bueno & Berti Filho (1984) for *M. confusa*, 0.50, and Amaral Filho & Fagundes (1996) for *Zelus longipes* L. 0.44. Differences between estimates obtained both in field and laboratory are expected, even for the same species, because a series of different biotic and abiotic factors can interfere in the development of insects and, consequently, in the result obtained. There was no significant difference relative to the expected estimate (0.50) in each generation. In the colonizing generation the sex ratio was 0.48 ($\chi^2 = 0.03$; gl = 1; $p > 0.05$), in the first generation 0.44 ($\chi^2 = 3.43$; gl = 1; $p > 0.05$), and in the second 0.46 ($\chi^2 = 1.18$; gl = 1; $p > 0.05$).

Percentage of recapture was high, considering the whole sampling period. More than half of the captured individuals was recaptured at least once. Frequency of recapture was at about 63% for males and 54% for females, the difference being not significant ($\chi^2 = 0.25$; gl = 1; $p > 0.05$).

Recruitment of new individuals determines a decrease in the proportion of marked individuals, which reflects itself in a lower number of recaptures, indicating, respectively, the onset of recruitment of the first and second generation of adults. This decline intensifies in the end of the crop cycle, between March and April, possibly associated to the mortality of individuals or abandonment of the area by them, as a consequence of decreasing resources. In a simultaneous work carried out in the same area, it was observed that in this period (March and April), there were no nymphs of *C. dentiventris* (Cristiane Ramos de Jesus, UFRGS, personal communication), the potential prey of *C. nigroannulatus*. Also, at this time, the plants had mostly dry leaves, which would constitute an inadequate resource to maintain and/or attract other phytophagous insects that might act as alternative prey. This way, recruited individuals would be induced to leave the area searching for food. Thus, it seems that the population increase of *C. nigroannulatus* might be influenced by its own density.

Population sizes observed in the field and the Fisher-Ford estimates, are presented in Figs. 2a and b. Although the fluctuation pattern of estimated densities approaches that obtained in field observations, its values were overestimated for the periods corresponding to the first and second generations. This overestimate could be detected due to the exhaustive sampling carried out, which allowed the evaluation of the method efficacy for this kind of estimate. Populational peaks observed precede in some days the peaks estimated through the Fisher-Ford method, which is characteristic of this procedure. This is because to estimate the population density it evaluates differences in numbers of marked and not-marked individuals. In the period corresponding to the colonizing generation, such values were very close to densities observed. So, a pronounced decrease in the number of recaptures, both for males and females, from mid-January onwards, as already mentioned, could be responsible for the overestimate of populational densities. Another factor that can be related to overestimated results is an assumption of the method itself – a constant survival rate within a generation. This rate could have been fluctuating daily by influence of biotic and abiotic factors.

Table 1 presents daily survival estimates for males and females using the Fisher-Ford method and average longevity observed from capture and recapture data. Estimates of survival and longevity, in this case, may be connected not only to the death of the individual but to its emigration or time of permanence in the area. The fact that the method does not allow the distinction between death and emigration is discussed by Begon (1979) and presented as a limitation.

In relation to longevity, there is no significant difference between sexes in the colonizing generation ($U = 69$; gl = 1; $p = 0.1225$) nor in the second generation ($Z = -1.6739$; gl = 1; $p = 0.0942$). A significant difference between males and females was registered for the first generation ($Z = -2.2346$; gl = 1; $p = 0.0253$). The lower longevity of females could have been caused, at this time, by a greater investment in oviposition. Allocation of resources for reproduction can decrease the individual's survival or growing rate, characterizing what is called the "reproductive cost" (Begon & Mortimer, 1986; Begon *et al.*, 1990). The supposed higher reproductive investment in this period could have been triggered by plentiful food resources for the offspring, represented by the presence of many nymphs of *C. dentiventris* (Cristiane Ramos de Jesus, UFRGS, personal communication), as well as of other phytophagous insects.

TABLE 1
Estimated daily survival by the Fisher-Ford method and observed longevity of adults of *Cosmoclopius nigroannulatus* in the three generations registered in a tobacco experimental plot, based upon the numbers of captured individuals (n). Porto Alegre, RS.

Generations	Females			Males		
	n	Estimated daily survival (%)	Observed longevity (average ± SE)	n	Estimated daily survival (%)	Observed longevity (average ± SE)
Colonizing	15	98	39 ± 5.100	14	98	42.35 ± 5.518
1st	137	96	11.35 ± 1.045	109	92	14.31 ± 1.147
2nd	179	88	4.13 ± 0.518	150	87	5.12 ± 0.550

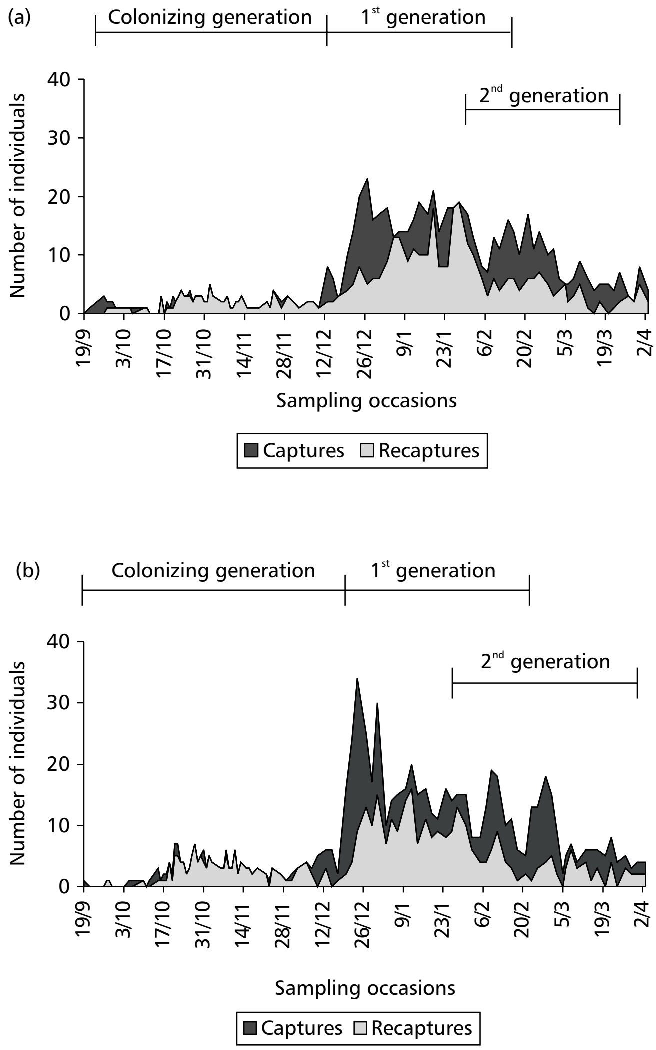

Fig. 1 — Number of adults of *Cosmoclopius nigroannulatus* captured and recaptured and time of occurrence of generations in a tobacco experimental plot. Males (a); females (b). Porto Alegre, RS.

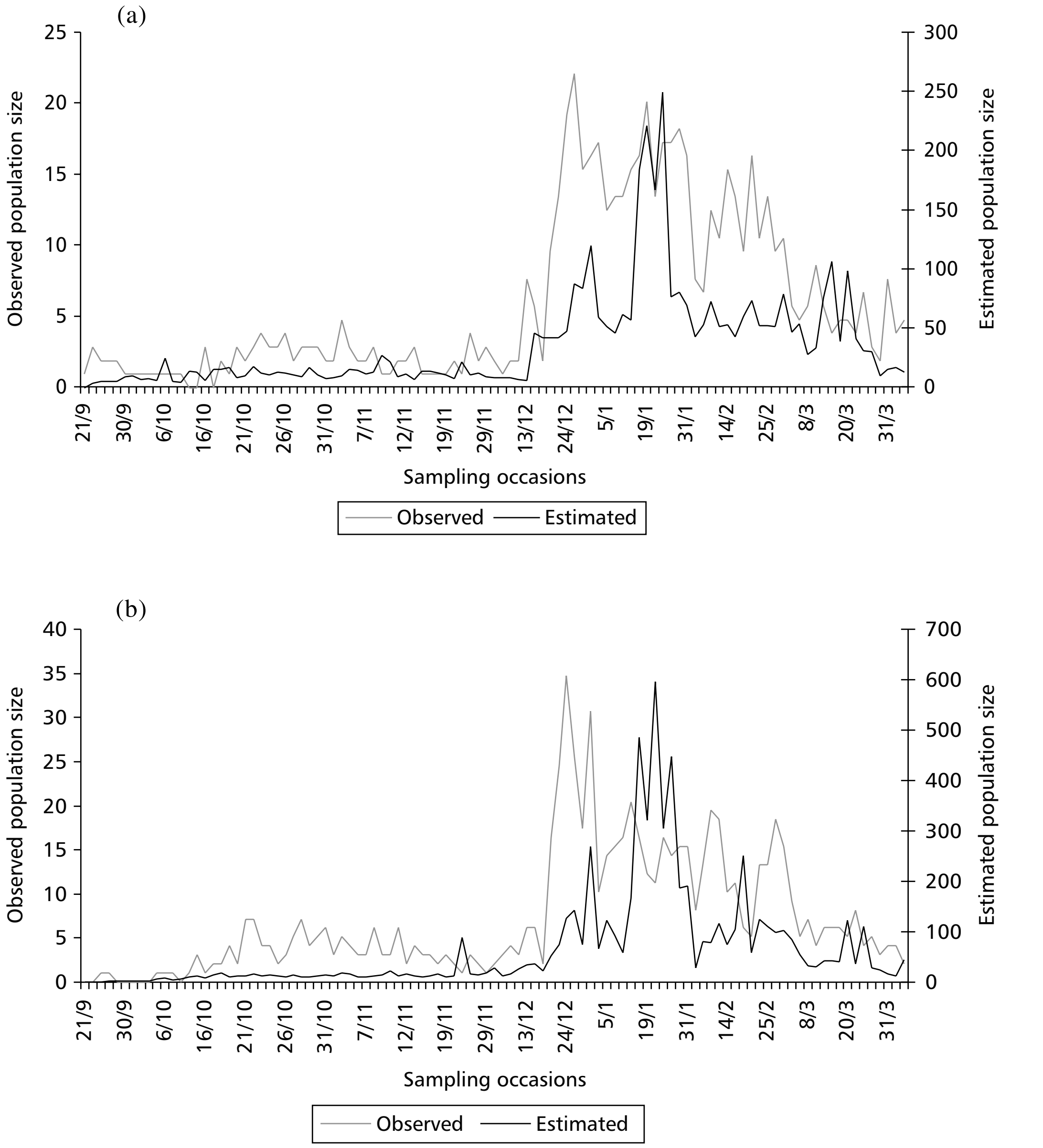

Fig. 2 — Populational size of *Cosmoclopius nigroannulatus* adults observed in field and the estimated by the Fisher-Ford methods, males (a) and females (b), in a tobacco experimental plot. Porto Alegre, RS.

Both the daily survival and the longevity observed showed a decline for successive generations. This can be explained considering that for the calculation of these estimates, the method considers the time elapsed between the capture and the last recapture of each individual. Thus, these estimates would be reflecting an increase in the mortality and/or abandonment of the area by individuals during the first and second generations.

Regulation of predators populations can occur due to competition for resources, among other factors. According to Solomon (1980), the effect of competition on the individual is stronger the larger the number of competitors. In this sense, the increase in density of a predator (and consequent increase in the direct interference among individuals) would increment the emmigration rate (Begon & Mortimer, 1986).

Fallavena (1993), working with the same species in laboratory conditions, registered an average longevity of 137.2 days for males and 165.7 days for females. Moreover, the hypothesis that the results of the present work are highly influenced by the emmigration is reinforced by the capture of individuals that were marked in the last year.

Based upon the results obtained and particularly in the high sampling intensity achieved, it is possible to infer that *C. nigroannulatus* is efficient in colonizing the crop area. The fact that the individuals of the colonizing generation remained in the area for a longer period than the other generations is important, because it perhaps guarantees an efficient colonization of the area, an essential aspect in a program of biological control. Besides the efficient colonization of the area, this specie's populations showed a good capacity for remaining long periods in the crop, reinforcing the previous idea of usefulness for biological control programs.

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