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Population Ecology

Estimation of the Effect of the Predator *Scytodes globula* (Araneae: Scytodidae) on *Loxosceles laeta* (Araneae: Sicariidae) Populations

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Abstract

It has been reported that *Scytodes* spiders are predators of spiders of the genus *Loxosceles*, but the question of the effect of *Scytodes globula* Nicolet on *Loxosceles laeta* (Nicolet) populations is still unanswered. The goal of this study is to analyze the population effect of *S. globula* on the population dynamics of *L. laeta* by means of simulation with projection matrices, considering the seasonal fluctuation of fecundity, random meetings between the predator and the prey, and limited growth of the *L. laeta* population. We found that the most important parameters to predict the characteristics of the population at equilibrium are the fertility and the survival function of the spider of advanced developmental stage. Also, the predator *S. globula* significantly decreases population size, population fluctuations, and the proportion of reproductive individuals of *L. laeta*. The most probable effect of *S. globula* on *L. laeta* populations is a decrease of 20% of the population size. This is insufficient to consider this species as an agent of biological control of *L. laeta*. However, the action of *S. globula* is not negligible because decreasing the *L. laeta* population by about 20% could mean a decrease of about 15% in the incidence of loxoscelism. This action is probably less effective than other epidemiological measures such as house cleaning and insecticides or arachnicides and probably similar to the direct action of humans eliminating one or two spiders per year in their houses, but it helps.

Key words: spider, ecology, population dynamics

Spiders are predatory arthropods that can be found in almost all habitats, with population densities that can become very high (Turnbull 1960, 1973; Nyffeler 2000). Spiders prey mainly on insects and other spiders, so they are very important in natural ecosystems and agroecosystems in controlling populations of herbivores. For example, spiders of the genus *Lycosa* are the cause of 21.1% of the mortality of herbivorous insects such as Orthoptera, Hemíptera, and Homoptera in some agro-ecosystems (Van Hook 1971) and up to 77.8% of the herbivorous biomass in some forested environments (Moulder and Reichle 1972). As generalist predators, they produce a top-down effect in a trophic cascade. Spiders have a direct effect through predation, but also indirect effects (not mediated by consumption) on the population of herbivorous insects, including dispersion and habitat changes that can account for 38% of mortality produced by spiders (Nakasuji et al. 1973). Also, risk perception by the insect population decreases the activity of herbivory (Schmitz et al. 1997, Snyder and Wise 1999). Another important effect produced by spiders is overkilling, which is killing more prey than are consumed; this excess may be between 20 to 61% of prey in some

species such as *Dyctina volicripes* Keyserling, *Argiope trifasciata* Forskal, and *Achearanea tepidadiorum* Koch (Riechert 1999). Spiders have been used successfully as biological control agents in some plantations of apples and rice crops (Maloney et al. 2003); conservation favoring the natural increase of spider populations has been proposed (Marín and Perfecto 2013).

Spiders also find favorable microenvironments in urban ecosystems, where they find appropriate shelters, thermally favorable and stable environments, and a multitude of prey consisting of microarthropods associated with the human environment, which may favor their development. Thus, in natural environments, agro-ecosystems, and urban environments, spiders are playing a significant role in controlling populations of arthropods and probably in suppression of unwanted pests (Sandidge 2004).

Few studies have focused on the control of urban pest populations using spiders as control agents (Guarisco 1991, Sandidge 2004, Fischer et al. 2006, Fischer and Krechemer 2007). Spiders feed on heterospecific as well as conspecific spiders (cannibalism; Wise 1993, Huets and Brunt 2001). Thus, if two or more spider

species overlap in space and time, interspecific competition, aggression, and predation may be inevitable (Sandidge 2004).

Guarisco (1991) reported predation of two common house spiders, *A. tepidariorum* and *Steatoda triangulosa* Walckenaer 1802, and provided evidence that their presence may help to decrease populations of two medically important species, *Amblyomma americanum* L. and *Loxosceles reclusa* Gertsch and Mulaik. Sandidge (2004) showed that three cosmopolitan spiders, *A. tepidariorum*, *S. triangulosa*, and *Pholcus phalangioides* Doleschall 1859 have only limited possibilities for biological control of *L. reclusa*, reporting only negative but nonsignificant correlation between populations of the first two species and the population of *L. reclusa*. Fischer and Krechemer (2007) showed that the predation on *Loxosceles intermedia* Mello Leitao by *P. phalangioides* exists, but that it prefers insects instead of spiders; araneophagy is a complementary item in their diet, thus probably the presence of *P. phalangioides* in human dwellings is not enough to control the populations of *L. intermedia*.

There is little information about the predators of *Loxosceles laeta* (Nicolet), one of the main spiders that causes necrotic arachnidism in South America. Predators of other *Loxosceles* species include some reptilian species such as *Tropidurus peruvianus* (Delgado 1966) and the gecko *Hemidactylus mabouia* (Ramires and Fraguas 2004), some monkeys of the genus *Lagothrix* (Foelix 2011), frogs such as *Scinax rubra*, and bats such as *Eptesicus brasiliensis* (Fisher et al. 2006). Recently it has been reported that the spiders of the genus *Scytodes* ("spitting spiders") are predators of *L. laeta* and can affect populations of this species in natural and experimental conditions (Fernandez et al. 2002, Canals et al. 2015a).

The spitting spider present in Chile, *S. globula* Nicolet (Platnick 2004), has been little studied (Canals et al. 2008, Taucare-Ríos 2013). It is a synanthropic spider that may be found in dark and wet places. It is an active hunter that usually does not build webs. This spider has a venom gland that produces toxin only in the anterior section of the gland, while the posterior section produces a gum-like substance (Kovoor and Zylberger 1972, Foelix 2011). It hunts it prey by spitting the latter substance; the prey is glued to the substrate before *S. globula* injects its venom (Monterosso 1928; Dabelow 1958; Burgis 1980, 1990; Gilbert and Rayor 1985). *Loxosceles laeta* and *S. globula* are nocturnal spiders, although *L. laeta* has part of its activity during daylight hours like *L. reclusa* (Cramer 2015).

Studies on energetics, thermal preferences, and water loss have shown that these species prefer similar thermal micro environments and that their heat, cold, and desiccation tolerances are similar (Alfaro et al. 2013; Canals et al. 2013, 2015b,c). The geographic distribution of the species is different, but their distribution overlaps between 30°S and 40°S in central Chile (Canals et al. 2016).

It has been reported that *Scytodes* spiders are predators of spiders of the genus *Loxosceles* (Ades and Ramires 2002, Canals et al. 2015a) and also are predators of other spiders such as Salticidae and spiders of the genus *Drassodes* (Jackson et al. 1998, Ades and Ramires 2002, Fernandez et al. 2002, Canals and Solís 2013). It has been reported that *L. laeta* has high reproductive potential in the absence of *S. globula* (Canals and Solís 2014), but *S. globula* has a high probability of killing *L. laeta* in individual meetings and it is able to double the mortality of spiderlings in cohort experiments (Canals et al. 2015a). However, these studies suppose the permanent presence of *S. globula* in breeding boxes, an unnatural scenario distant from that usually found in domiciliary environments. This leaves unanswered the question of what is the effect of *S. globula* upon *L. laeta* populations in a more natural scenario. Our goal is to study the population effect of *S. globula* on the population dynamics

of *L. laeta* by means of simulation with projection matrices, considering the seasonal fluctuation of fecundity, random meeting between the predator and the prey, and limited growth of the *L. laeta* population.

Materials and Methods

Model
The model for the population dynamics of *L. laeta* was a Leslie matrix with instantaneous and delayed density dependence, representing the effect produced by the current population and the population at the emergence of the spiderlings from the egg sac, respectively. Simulations in the presence and in absence of the predator (*S. globula*) were performed. In the absence of *S. globula*, a logistic population increase was used with a carrying capacity (K) estimated by the maximum average of spiders captured in houses of Santiago, Chile. Four age intervals of three months each were considered in the Leslie matrix; the last age interval includes spiders whose stage is greater than the VI molt, including the spiders of high reproductive value and the adults (Canals and Solís 2014).

The model was: $N_{t+1} = L \cdot Q_t^{-1} \cdot N_t$, where N is the age vector, L the projection matrix, and Q the density-dependence diagonal matrix (Canals et al. 1991). On the diagonal, the Q matrix contains elements $q_{it} = 1 + aN_{t-i-1} + bN_t$, where a and b correspond to the delayed and instantaneous parameters, respectively. These parameters meet the assumption $K = (\lambda_1 - 1)/(a + b)$, where λ_1 is the main eigenvalue of L (Pielou 1969, 1977).

The matrix expression of the model is:

$$\begin{bmatrix} n_1 \\ n_2 \\ n_3 \\ n_4 \end{bmatrix}_{t+1} = \begin{bmatrix} 0 & 0 & 0 & \dfrac{F(a_1(t)) \cdot \theta(t)}{c} \\ p_1(a_2(t)) & 0 & 0 & 0 \\ 0 & p_2(a_3(t)) & 0 & 0 \\ 0 & 0 & p_2(a_4(t)) & \phi(t) \end{bmatrix} \cdot Q_t^{-1} \cdot \begin{bmatrix} n_1 \\ n_2 \\ n_3 \\ n_4 \end{bmatrix},$$

where n_i is the number of individuals in age stage "i"; F is the fecundity, which is concentrated in the last age stage; c is a constant that accounts for the individuals in the last age stage not all being females and in this stage not all individuals are adults; p_1, p_2, and p_3 are the survival probabilities; $\theta(t)$ is a periodic function that varies between 0 and 1 that represents the seasonal fluctuations in fecundity: $\theta(t) = \frac{1 + sen(\pi t/2)}{2}$, $t = 1, 2, 3 \ldots$; and $a_i(t)$ are functions which introduce stochastic fluctuations of the parameters. The function $\varphi(t)$ meets the assumption: $n_4\phi(t) = \sum_1^E a_5(t)\alpha_i n_{4(t-i)}$, and corresponds to the individuals surviving the fourth age stage, because this spider can live about four years (E = 16) (Galiano and Hall 1973, Schenone and Letonja 1975). The α coefficients were selected considering $\alpha_1 = 1$ and $\alpha_{16} = 0$, decreasing linearly. The random number $a_5(t)$ determines stochastic fluctuations and the maximal effect that *S. globula* can produce on the survival of adults.

Parameters
The average of the maximum number of individuals of a significant size of *L. laeta* found in the five most infested houses in Chile was 162.8 ± 56.0 spiders per house (Schenone et al. 1970). Considering that adults may represent between 10 and 20% of the spider population in this species (Canals and Solís 2014), a carrying capacity $K = 1000$ was considered for the entire spider population in the simulations. For the fecundity of *L. laeta* a value $F = 87.5 \pm 44.2$ (mean $\pm$ standard deviation) was used, varying randomly in its confidence interval $IC_{0.95} = [52.1; 122.9]$ (Canals et al. 2015a). The male/female ratio has been estimated from 1:2 (66.7% females)

Table 1. Parameters for *L. laeta* used in the three scenarios simulated: 1) Without *S. globula*, 2) With stochastic meeting and with uncertain outcome with *S. globula* (*), and 3) With permanent meeting with *S. globula*

Parameters	1)Without *S. globula*		2) With *S. globula**		3) With *S. globula*	
	li	ls	li	ls	li	ls
F	52	123	52	123	52	123
p_1	0.284	0.405	0.196	0.405	0.196	0.277
p_2	0.322	0.460	0.145	0.460	0.145	0.204
p_3	0.268	0.461	0.014	0.461	0.014	0.212

F and p_i are fecundities and survival proportions, respectively, and li and ls are the inferior and superior confidence limits, respectively.

(Canals and Solís 2014) to 1:8 (88.8% females) (Schenone et al. 1970), but n_4 includes individuals older than 9 months, which are individuals with at least six molts, some of them immature individuals (Canals and Solís 2014). Because of this, a reasonable proportion of 50% of reproductive females was considered ($c = 2$).

For the estimations of the survival probabilities at each age stage (p_i), we used the relationships: $\text{Ln}(1000N/N_0) = 6.78 - (0.0106 \pm 0.00099)t$, (mean $\pm$ 1.96 standard errors), where Ln is the natural logarithm, $l_x = N/N_0$ is the proportion of survivors at time t (days) for *L. laeta* in the absence of *S. globula* and $\text{Ln}(1000N/N_0) = 7.21 - (0.0202 \pm 0.00128)t$ for *L. laeta* in the presence of *S. globula* based on Canals et al. (2015a). Then l_i for each age class "i", the mortality proportion $q_i = \frac{l_i - l_{i+1}}{l_i}$ and in consequence $p_i = 1-q_i$ with its respective confidence limits were obtained (Table 1).

Sensitivity Analysis

The elasticity of the outcome variables was (Ω): $\frac{x \partial \Omega}{\Omega \partial x} = \frac{\partial \Omega / \Omega}{\partial x / x}$ with respect to each parameter (x) of the matrix L. The outcome variables were the average maximum size of the population (N_{max}), the population fluctuation at equilibrium ($\Delta N = N_{max} - N_{min}$), and the median of the proportion of individuals in the fourth age class at equilibrium (π_4). All these variables were estimated based on the last 10 iterations which correspond to the equilibrium situation. The effect of a variation of 5% ($\delta x/x = 0.05$) in F, $p1$, $p2$, $p3$, and $\varphi(t)$ on N_{max}, ΔN, and π_4 were studied

Simulations

Three scenarios of population dynamics of *L. laeta* were performed, with 50 iterations (12.5 years) repeated 30 times each: 1) without *S. globula*, 2) with stochastic meeting with *S. globula* and uncertain outcome, and 3) with permanent meeting with *S. globula*. The values of the parameters of the first and the third scenario were estimated directly from the relationships of Canals et al. (2015a). For the third scenario, we used a probability of aggressive meeting between the species, PA = 0.594, and a victory probability of *S. globula*, PV = 0.684, in consequence the probability of aggressive meeting and victory of *S. globula* is $P = 0.594 \times 0.684 = 0.406$ (Canals et al. 2015a). This means that in the permanent presence of *S. globula* (such as in Canals et al. 2015a) the maximum effect on the adults is 40% mortality. For this reason, a constant factor of 0.6 (1–0.4) was considered in the coefficients α_i in the survival parameter of the adults ($\varphi(t)$).

In the second scenario, the possibility of not meeting with *S. globula* was considered. In this case, the probability to select the parameters (p_1, p_2, and p_3) that characterize the development of *L.*

laeta in the absence of *S. globula* was 0.6 and the probability to select the parameters in the presence of *S. globula* was 0.4. This was achieved by extending the limits of the confidence intervals and allowing the parameters to take values in this interval respecting these probabilities, by means of random numbers. There was also a variable effect (between 0.6 and 1) on maximal effect on the survival of the adults ($\varphi(t)$) by means of the random number $a_5(t)$

Analysis

The variation of the outcome variables N_{max}, ΔN, and π_4 was analyzed after obtaining 30 values for each scenario. These were compared by means of one-way ANOVA with *a posteriori* multiple comparisons using the Tukey test. The normality and homoscedasticity assumptions were tested with Levene and Bartlett tests, respectively, and in the cases of N_{max} and ΔN logarithmic transformations were performed to fulfill the assumptions.

Results

Model

The model allowed adequate simulation of logistic growth of the population of *L. laeta*. Without seasonal fluctuations or delayed density dependence, the maximum population size reached the carrying capacity K = 1000 individuals, with an eigenvalue $\lambda = 1.0$ and $\pi_4 = 10.23\%$. Maintaining all parameters constant, the periodic fluctuation of fertility induced seasonal population cycles where the population fluctuated between 496 and 3,938 individuals. The delayed density dependence (DDR) induced new cycles and decreased the amplitude of the cycles, between 303 and 2,738 individuals (Fig. 1). Cycles of λ and π_4 were also observed; the latter varied between 7.1 and 94.9% with seasonal fluctuations of fertility and between 5.0 and 88.1% when DDR was added. Greater DDR produced greater cyclic behavior in the population dynamics (supplementary information).

Sensitivity Analysis

The most important parameters to determine N_{max}, ΔN, and π_4 were fertility (F) and the survival of spiders in the fourth age class $\varphi(t)$ (Table 2). For N_{max} and ΔN the effect of F, p_3, and $\varphi(t)$ was positive, i.e., the higher their value, the larger the population size and with larger population fluctuations. In contrast, p_1 and p_2 produced the contrary effect, but of low magnitude. The fertility F had a negative effect on π_4, suggesting that higher fertility produced a lower proportion of advanced developmental stages.

Simulations

There were clear differences in the three outcome variables in the three different scenarios ($F_{2,87} = 64.5$, $P \ll 0.001$ for π_4, $F_{2,87} = 63.5$, $P \ll 0.001$ for ΔN, and $F_{2,87} = 126.0$, $P \ll 0,001$ for N_{max}; Fig. 3). The three outcome variables N_{max}, ΔN, and π_4 decreased progressively from the first scenario without *S. globula* to the third scenario where *S. globula* showed its maximal effect (Figs. 2 and 3).

Discussion

The inclusion of resource limitation including density dependence and the carrying capacity in the projection matrix increased the realism of the model. This method has been described for a long time (Pielou 1969, 1977) and used successfully to predict population dynamics, including species of medical interest (Canals et al. 1991). In this model the density dependence parameter (DD) included two
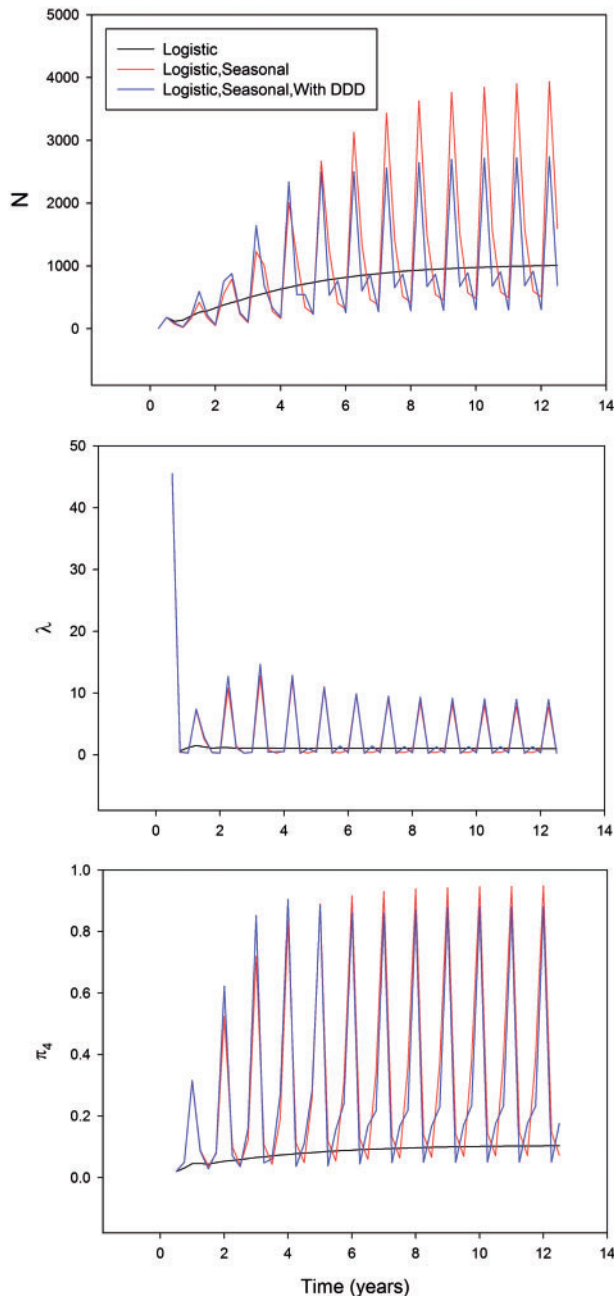
Fig. 1. Simulation of A) logistic growth (black), B) seasonal logistic growth (red), and C) seasonal logistic growth with delayed density dependence of *L. laeta* (blue). In this example, for all simulations $F = 90$, $p_1 = 0.239$, $p_2 = 0.404$, $p_3 = 0.158$, $DD = a = 0.0044$ (selected for $K = 1000$). For B) the random variation and the periodic fluctuations $\theta(t) = \frac{1 + sen(\pi t/2)}{2}$ was included, and in C) $DD = (a + b)$, where $a = pDD$ (instantaneous density dependence) and $b = (1-p)DD$ (delayed density dependence).

Table 2. Elasticities (or relative sensitivities) of the outcome variables: average maximum population size (N_{max}), population fluctuation (ΔN), and mean proportion of individuals in the fourth age class (π_4) with respect to the fertility (F), survival at each age interval (p_1, p_2, and p_3), and the survival of individuals of the fourth age class ($\varphi(t)$)

	N_{max}	ΔN	π_4
F	+0.463	+0.583	−0.544
$p1$	−0.055	−0.079	−0.196
$p2$	−0.002	−0.003	−0.0003
$p3$	+0.003	+0.002	+0.004
$\varphi(t)$	+0.477	+0.333	+0.256

The signs + and − represent direct and inverse effects, respectively.

very important in *L. laeta* because about 100 spiderlings emerge per egg sac and they stay in a small area before dispersion (Canals et al. 2015a, Galiano 1967). In this period there is high mortality with a type III survival curve, characterized by high mortality of juveniles (Canals and Solís 2014); cannibalism and scavenging behavior have been reported (Vetter 2008, Canals et al. 2015a).

The reproductive period of *L. laeta* occurs during spring and summer (Canals et al. 2015a), which is well simulated by the periodic fluctuation of fertility. The delayed density dependence induces fluctuations in the logistic growth, which agrees with that described previously (Pielou 1969). Secondary cycles of minor importance are induced when delayed density dependence is included.

The sensitivity analysis showed that the most important parameters to predict the characteristics of the population at equilibrium are fertility and the survival function of the spiders of advanced developmental stage. This was an expected result because in this species the reproductive value increases progressively from 9 months to a maximum at one year old (Canals and Solís 2014). Thus, this explains why the elasticities of p_3 and $\varphi(t)$ were positive, indicating a direct relationship with population size (N_{max}), fluctuations (ΔN), and π_4. Small variation in the early developmental stages had little effect on the final population because the mortality is high in these stages. As expected, fertility had a positive effect on N_{max} and ΔN but a negative effect on π_4, because an increase in fertility induced increments in the number of individuals in the early development stages, decreasing the relative importance of spiders of large size and adults. This also explains the high value of p1 in the π_4 elasticity.

The predator *S. globula* decreased significantly N_{max}, ΔN, and π_4, which agrees with the sensitivity analysis because predation affects negatively the survival function of adults and their reproductive capacity. Without *S. globula* the proportion of individuals older than the VI molt was nearly 18.5%, which agrees with previous estimations (Canals and Solís 2014). However, this proportion had large seasonal fluctuations, reaching very low values in the reproductive period because of the great emergence of spiderlings. Schenone et al (1970) reported 79.6% adults and 20.4% immature individuals. However, this may be explained by the difficulty in finding small individuals during sampling.

The population size of *L. laeta* may decrease to 80% in the second scenario and to 53% in the third scenario. However, the last scenario is highly unnatural and represents a superior limit of the effect of *S. globula* on *L. laeta* because it assumes that the predator is always present, as in the experiments reported by Canals et al. (2015a). In this experiment the spiderlings were always with *S. globula* without dispersion capacity. Although both species may be found in reduced places of about 1 m² (Canals and
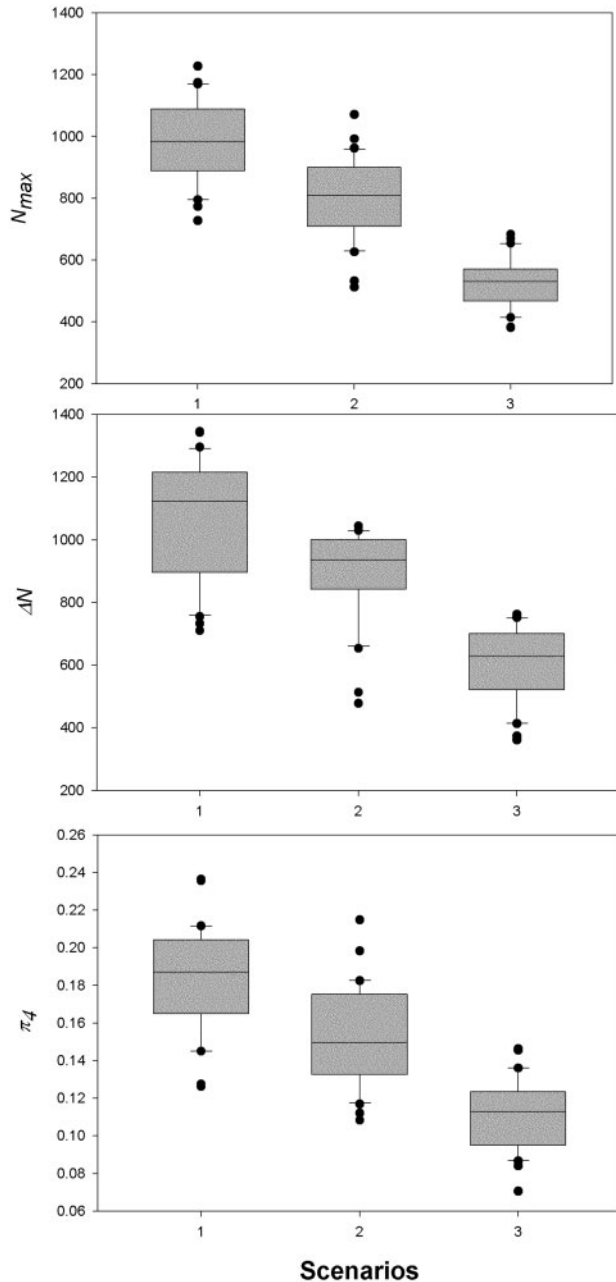
components. The instantaneous density dependence (a = pDD) considers the effect of the interference among individuals by means of intraspecific competence for space or prey. This may occur by a decrease in the number of prey as a result of predation or by interference (Sandidge 2003, Cramer 2008, Vetter 2011). A direct effect by cannibalism also may occur (Fischer et al. 2006, Souza-Silva and Ferreira 2014). Delayed density dependence (b = (1−p)DD) accounts for the effect on the current population of direct and indirect effects that occur during the early developmental periods. This is

Fig. 2. Effect of *S. globula* on population outcome variables of *L. laeta*. Comparisons of average maximum population size (N_{max}), population fluctuation ($\Delta N = N_{max} - N_{min}$), and mean proportion of individuals in the fourth age class (π_4) at equilibrium for the three scenarios: 1) without *S. globula*, 2) with *S. globula* but stochastic meeting between the species, and 3) with permanent presence of *S. globula*.

Fig. 3. Population growth of *L. laeta* 1) without *S. globula* (black), 2) with *S. globula* but stochastic meeting between the species (blue), and 3) with permanent presence of *S. globula* (red).

Solís 2013), adults and spiderlings have high dispersion capacity. The more probable effect of *S. globula* on the *L. laeta* population was represented by the second scenario. In this scenario the population size of *L. laeta* decreased by 20%, which affected adult and subadult spiders in the same proportion. Schenone et al. (1970) reported an average of 4 spiders per house in urban areas and 12 spiders per house in rural areas. Thus, the action of *S. globula* could mean a decrease of one spider in urban areas and two in rural areas. This may be less than or at most equal to the action of a human in a house.
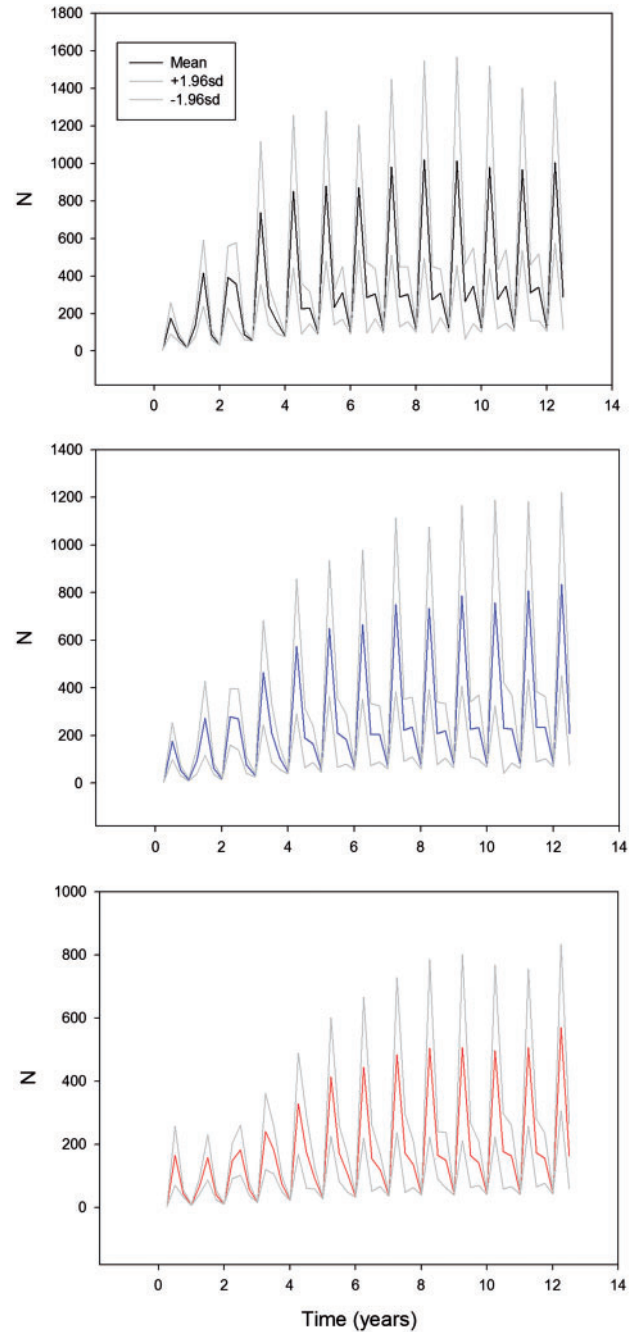
Our model considered encounters between the two species, the probability of aggression, and the probability that this aggression results in death of a *L. laeta*, but not the circumstances in which the encounters occur. *L. laeta* are sit-and-wait predators spending more of their time inactive, like *L. reclusa* and other *Loxosceles* species (Cramer 2015). Because of this the predator *S. globula*, which actively searches for prey, might have a chance to end up as a prey in a web of *L. laeta*. This possibility was not considered in our model, but in laboratory experiments of encounters of the two species there were no differences in the overall probability of predation when *L. laeta* was the resident or when it was the intruder, even though the

resident usually built an irregular web that was not an obstacle to predation by *S. globula* (Canals et al 2015a). Other unknown behavioral aspects may affect the probability of predation, but we expect that these were accounted for by the random numbers considered in the model.

The predator *S. globula* preys on spiders and on insects in unknown proportions. The only study of dietary preference in *Scytodes* was conducted with *S. longipes* Lucas, showing that this species had an acceptance rate of 67.5% for spiders but also of 39% for insects (Nentwig 1985). The opportunist behavior of generalist spiders limits the ability of these spiders to serve as biological control agents. To reduce the population of *L. laeta* effectively, the predator population must be near the population density of the potential prey species to have a negative impact (Sandidge 2004). Also, the potential control agent must have the ability to feed on the potential prey without injury or with a relatively low risk of injury; however, in our case *L. laeta* occasionally preys on *S. globula* and in aggressive meetings *S. globula* may lose one or more legs (Canals et al. 2015a, Ades and Ramires 2002).

These results suggest that although *S. globula* is a predator of *L. laeta* and there is a documented effect on the mortality rate of spiderlings with consequences for population dynamics, this is insufficient to consider this species as an agent of biological control of *L. laeta*. This agrees with the results of Sandidge (2004) with other spider species preying on *L. reclusa* and with the results of Fischer and Krechemer (2007) for the predation of *L. intermedia* by *P. phalangioides*. However, from an epidemiologic point of view the action of *S. globula* is not negligible, because decreasing the *L. laeta* population by about 20% reduces the probability of meetings with humans and in consequence the incidence of loxoscelism. Rios et al. (2007) reported 287 cases in 2005, 21 of the cutaneous-visceral form. If we consider a coexistence of 33% between *S. globula* and *L. laeta* (Fernández et al. 2002), without *S. globula* the cases of loxoscelism would be 191, with 14 of the cutaneous-visceral form. The introduction of *S. globula* in houses where it is not present could decrease these numbers to 153 and 11 per year, respectively. Considering the total of cases in houses with and without *S. globula* this would mean a decrease of about 15% in the incidence of loxoscelism. This action is probably less effective than other epidemiological measures such as house cleaning and insecticides or arachnicides and probably similar to the direct action of humans in houses eliminating one or two spiders per year, but it helps.

Acknowledgments

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