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Population Structure of *Mesoclemmys vanderhaegei* (Bour, 1973) (Testudines:Chelidae) in the Cerrado of Chapada dos Guimarães, Mato Grosso, Brazil

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Abstract: Studies on population structure of freshwater turtles belonging to the family Chelidae are scarce in Brazil. Herein we describe the structure of a population of the chelid *Mesoclemmys vanderhaegei* in a Cerrado area in the municipality of Chapada dos Guimarães, Mato Grosso, Brazil. A total of 80 individuals were captured in five collecting sites, from January to March 2007: 42 adult females, 27 adult males, and 11 juveniles with undetermined sex. Among 80 individuals, 24% were recaptured, at least once. This is the first attempt to estimate the size of a population of *Mesoclemmys vanderhaegei*. Our results suggest that additional sampling efforts are needed for more accurate estimates of population structure. Nevertheless, they surely provide minimum values of the number of individuals of *M. vanderhaegei* living in the locality sampled.
Keywords: *Chelidae, Neotropics, sex ratio, population size, freshwater turtles.*

BRITO, E.S., STRUSSMANN, C. & PENHA, J.M.F. **Estrutura de população de *Mesoclemmys vanderhaegei* (Bour, 1973) (Testudines: Chelidae) no Cerrado de Chapada dos Guimarães, Mato Grosso, Brasil.** Biota Neotrop., 9(4): http://www.biotaneotropica.org.br/v9n4/pt/abstract?short-communication+bn00209042009.

Resumo: Estudos sobre estrutura de populações de quelônios da família Chelidae são escassos no Brasil. Nós descrevemos a estrutura de uma população de *Mesoclemmys vanderhaegei* de uma área de Cerrado, no município de Chapada dos Guimarães, Mato Grosso, Brasil. Os indivíduos foram capturados entre os meses de janeiro e março de 2007, em cinco sítios de coleta. Foram capturados 80 indivíduos: 42 fêmeas, 27 machos e 11 indivíduos com sexo não determinado (jovens). Dos 80 indivíduos capturados, 24% foram recapturados pelo menos uma vez. Esta é a primeira tentativa de estimar o tamanho de uma população de *Mesoclemmys vanderhaegei*. Embora nossas estimativas sugiram a necessidade de maior esforço de captura, nossos dados permitem apontar números mínimos de indivíduos para a localidade amostrada.
Palavras-chave: *Chelidae, Neotrópicos, razão sexual, tamanho de população, quelônios aquáticos.*

Introduction

Information on structure and size of chelonian populations are essential to adequately evaluate their responses to impacts imposed by antropic activities and habitat changes and, ultimately, to evaluate their conservation status (Smith et al. 2006). However, data on population dynamics of such organisms with long life cycles are usually difficult to obtain (Gibbons 1987, Pough et al. 1998). According to Congdon et al. (1994), even long term studies on chelonians offer limited information regarding their life history traits.

Natural history data are lacking for the most majority of Brazilian species of freshwater turtles (Souza 2004), including those in the family Chelidae, which also occurs in Australia. It comprises more than 50 species, of which 17 were recorded in Brazil (Bonin et al. 2006). Among them is *Mesoclemmys vanderhaegei*, also recorded for Paraguay and Argentina. According to the literature, the species is restricted to the upper and medium Paraguay River Basin (Iverson 1992, McCord et al. 2001, Bour & Zaher 2005, Bonin et al. 2006), although additional records refer to its presence in rivers belonging to the Amazon Basin (Villaça 1999, Brandão et al. 2002). The species is considered as "near threatened" by the International Union for Conservation of Nature (IUCN 2008).

We here describe the structure and population size of *M. vanderhaegei*, after field studies in Cerrado (a huge savannah-like formation in central Brazil) habitats at Chapada dos Guimarães (Mato Grosso, Midwestern Brazil).

Material and Methods

Specimens of *M. vanderhaegei* were captured from January to March 2007, in five distinct sites (Table 1). These are mainly small, oligotrophic streams, two of them artificially dammed. Bottom substrate was rocky, sandy, or muddy, and riparian vegetation consists of grasses, shrubs, and small trees. The two dammed streams (Quineira and Monjolinho), and two marginal lagoons existing along the stream at Aldeia Velha also presented abundant aquatic vegetation, both submergent and floating.

A 1km section was sampled along each stream, where seven funnel traps (1 m long × 0.45 m external diameter × 0.20 m entrance diameter; plastic mesh 5.0 × 1.0 mm) baited with bovine meat were set near and parallel to the margins. Distance between each consecutive trap varied from 20 to 100 m. At Aldeia Velha, a single trap was installed on each of the two marginal lagoons, in addition to the seven traps installed along the main course of the stream. At each collecting site, traps were maintained in operation for six consecutive days, being revised three times a day (06:00-07:00 AM; 02:00-03:00 PM, and 08:00-09:00 PM). Trapped individuals were marked according to Cagle (1939), measured (maximum carapace length – CL, in mm), and sexed, after which they were released at the capture site. Sex was determined by external examination of secondary sexual characteristics: chelid males usually possess a longer and thicker tail than females. Individuals in which sex could not be determined (N = 11), all of them with CL measuring less than 100 mm, were treated as juveniles and grouped together in a single category (hereby treated as "SND").

Specimens positively sexed were used to test if sex ratio differed from 1:1 by means of the chi-square test. Due to the small number of degrees of freedom (only 1), Yates Correction for Continuity was employed to run this analysis (Zar 1999). We used MARK™ software to estimate population size (N) at each sampling site. We divided the six sampling days in two capture sessions of three days each, and ran the analyses considering the population as a closed one. We ran together all the estimates, considering each population as a group (a total of five groups analyzed). MARK is a flexible software which allows testing hypothesis about spacial and temporal variation influencing probabilities of capture (p) and of recapture (c) of individuals. Estimates were done by using the method of maximum likelihood. Because of the reduced number of capture sessions (only two) we could test only two models: a more general one (in which p and c do not differ between sites) and a most restrictive (p and c dependent on sites). In order to estimate N we constraint $p = c$ for the second capture session (Cooch & White 2007). Selection of the models was based in the corrected Akaike Information Criterion (AIC_c) (Burnham & Anderson 2002). AIC_c is a statistics that combines a relative measure of adjustment (or deviance) of the models (dev), and the number of estimated parameters (K), where AIC_c = dev+2K (Burnham & Anderson 2002, Cooch & White 2007). The lower the AIC_c, the better the model, which therefore represents the best compromise between absence of precision in the estimates

Table 1. Localities of capture of *Mesoclemmys vanderhaegei* in Chapada dos Guimarães (Mato Grosso, Brazil), with geographical coordinates and kind of aquatic habitat searched, and data matrix employed in the modeling process: total number of turtles captured, number of turtles captured in each of two capture sessions, and numbers of turtles recaptured on each locality. Abbreviations: D – artificially dammed stream; S – stream; L – lagoon.

Tabela 1. Localidades de captura de *Mesoclemmys vanderhaegei* em Chapada dos Guimarães (Mato Grosso, Brasil), com as coordenadas geográficas e tipos de habitats aquáticos amostrados em cada localidade, e matriz de dados empregada para modelagem: número total de indivíduos capturados, número total de indivíduos capturados em cada uma das duas sessões de captura e número total de indivíduos recapturados em cada localidade. Abreviações: D – córrego represado artificialmente; S – córrego; L – lagoa.

Sites	Coordinates	Habitat	Total number of captures	Number of new captures on each of two capture sessions		Recaptures (recapture rate)
				Captured only on 1st session	Captured only on 2nd session	
Monjolinho	15° 24' 51.9" S 55° 48' 11.5" W	D	18	3	13	2 (11.1%)
Aldeia Velha	15° 26' 07.8" S 55° 45' 45.4" W	S, L	17	15	1	1 (5.8%)
Quineira	15° 27' 46.7" S 55° 44' 45.8"W	D	24	14	1	9 (37.5%)
Independência	15° 25' 07.9" S 55° 20' 23.0" W	S	8	3	5	0
Congonhas	15° 23' 00.7" S 55° 50' 23.0" W	S	13	6	0	7 (53.8%)

(models incorporating many parameters) and better adjustment (lower deviance) (Cooch & White 2007).

Results

A total of 80 individuals of *M. vanderhaegei* were captured, of which 42 (52.50%) were females, 27 (33.75%) were males, and 11 (13.75%) were SND (Figure 1). In females, mean length of the carapace (CML) was 168 ± 16 mm (variation from 106-193 mm), and mean mass was 453.29 ± 123.43 g (variation from de 120-650 g). In males, CML was 139 ± 18 mm (variation from 103-180 mm), and mean mass was 260.00 ± 107.59 g (variation from 110-600 g). In SND, CML was 81 ± 11 mm (variation from 67-97 mm), and their mean mass was 60.5 ± 22.59 g (variation from 30-100 g). Total length of the carapace in females was significantly higher than in males ($p < 0.001$; $F_{1.67} = 40.251$) (Figure 2).

Sex ratio differed from 1:1. Although it was female-biased (1.55♀:1.00♂), the difference was not statistically significant ($X^2_c = 3.275$; df = 1; $0.05 < p < 0.10$).

From the 80 *M. vanderhaegei* captured during the field study, 19 (24%) were recaptured at least once. Recapture rates in distinct sites varied from zero to near 54% (Table 1). In spite of having estimated the higher number of parameters (K = 15), the most restrictive model (*p* and *c* site dependent) returned the lower AIC_c (-158.131) and better explained our data (Table 2). The model allowed to estimate a population of 33.15 individuals in the Monjolinho stream (sd= 16; 95% CI = 20.77 to 100.64); 23.61 individuals in Aldeia Velha (sd = 12.93; 95% CI = 17.56 to 94.3); 24, in Quineira (sd= 0.0); 29691.05 in Independência (sd = 1485346.5; 95% CI = 131.37 to 7141613.5), and 13 individuals in the Congonhas stream (sd = 0.0). The more general model had no support (AIC_c = -113.218; ΔAIC_c = 44.91) but has produced more realistic estimates. Based on this model, the estimates for population sizes were: 26.72 individuals in the Monjolinho stream (sd = 4.85; 95% CI = 21.15 to 42.13); 25.21 individuals in Aldeia Velha (sd = 4.66; 95% CI = 19.91 to 40.13); 35.8 individuals in Quineira (sd = 5.96; 95% CI = 28.63 to 54.07); 11.6 in Independência (sd = 2.85; 95% CI = 8.91 to 22.13), and 19.16 individuals in the Congonhas stream (sd= 3.88; 95% CI = 14.98 to 32.14).

Discussion

Sex ratio diverging from expected values of 1:1 is usual among chelonian natural populations (Gibbons 1990), which may be caused by pressures exerted by distinct ecological processes. These may include

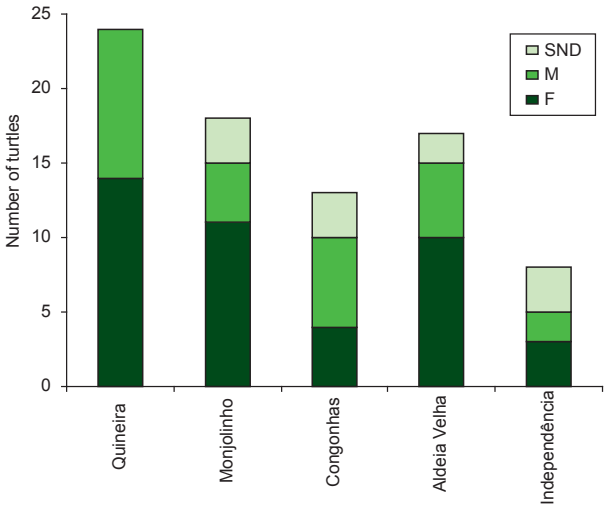

Figure 1. Number of individuals of the freshwater turtle *Mesoclemmys vanderhaegei* captured on each of the five sampling sites studied at Chapada dos Guimarães (Mato Grosso State, Brazil) between January and March 2007. SND – individuals with sex not determined in the field (N = 11); M – males (N = 27); F – females (N = 42).

Figura 1. Número de indivíduos de *Mesoclemmys vanderhaegei* capturados em cada um dos cinco sítios estudados em Chapada dos Guimarães (Mato Grosso, Brasil) entre janeiro e março de 2007. SND – indivíduos com sexo não determinado no campo (N = 11); M – machos (N = 27); F – fêmeas (N = 42).

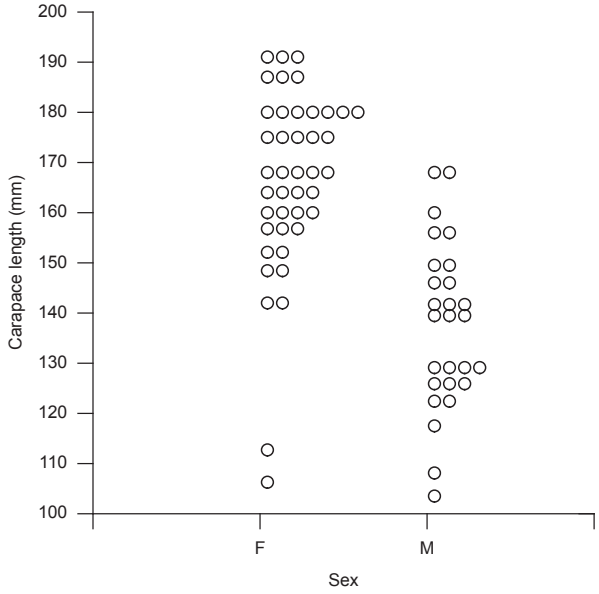

Figure 2. Maximum carapace length in relation to sex in 69 individuals of *Mesoclemmys vanderhaegei* captured at Chapada dos Guimarães (Mato Grosso State, Brazil): F - females (N = 42) e M - males (N = 27).

Figura 2. Comprimento total da carapaça, em relação ao sexo, em 69 indivíduos de *Mesoclemmys vanderhaegei* capturados em Chapada dos Guimarães (Mato Grosso, Brasil). F = fêmeas (N = 42) e M= machos (N = 27).

Table 2. Models testing the effect of site and capture session in the estimating of population size of *Mesoclemmys vanderhaegei*. Models are ranked according to AIC_c. In the model "*p*(s) = *c*(s)N(s)", capture probability (*p*) and recapture probability (*c*) are site (*s*) dependent; in "*p*(.) = *c*(.)N(s)", *p* and *c* are constant. Both models assume *p* = *c*.

Tabela 2. Modelos empregados para testar o efeito do sítio e da sessão de captura na estimativa do tamanho populacional de *Mesoclemmys vanderhaegei*. Os modelos foram ordenados de acordo com o valor de AIC_c. No modelo "*p*(s) = *c*(s)N(s)", a probabilidade de captura (*p*) e a probabilidade de recaptura (*c*) são dependentes do sitio de amostragem (*s*); em "*p*(.) = *c*(.)N(s)", *p* e *c* são constantes. Ambos os modelos assumem que *p* = *c*."

Model	AIC_c	ΔAIC_c	AIC_c Weight	K	Deviance
p(s) = c(s)N(s)	-158.131	0.00	1.00	15	13.5
p(.) = c(.)N(s)	-113.218	44.91	0.00	6	79.196

differential mortality rates among sexes, differential activity, movements, and habitat use, as well as sex determination by temperature and trapping bias (Gibbons 1990, Gibbons & Lovich 1990, Smith & Iverson 2002, Georges et al. 2006). Traps used in the present study cannot be responsible for the sex ratio slightly biased for females, as they allowed the capture of individuals from distinct size classes and were baited with bovine meat, an item consumed in higher frequencies by males than by females of *M. vanderhaegei* (E.S. Brito, unpublished).

Bait efficiency, higher in lentic habitats than in faster moving waters, may be responsible for the relatively high recapture rate obtained during the study, particularly in the sites with floating and submerging aquatic vegetation, lagoons and dammed streams.

In spite of generating some unrealistic estimates of numbers of the chelid *Mesoclemmys vanderhaegei*, the better of the two models tested here included the parametrization of the spatial variation in capture rates. Hypothesis to explain this variation (which could not be tested due to our experimental design and/or small sample) include variation in habitat structure or quality, and differential habitat use by individuals from distinct size classes or sexes. Nevertheless, unrealistic estimates of N for some sites (namely, Independência and Congonhas streams) were clearly a product of the data matrix structure. Estimates of N in any mark-recapture model depend on data about the number of unique individuals encountered, and on probabilities of encounters (Lukacs 2009). The latter is estimated based on the proportion of marked individuals in the population, which in turn is calculated considering the number of recaptures and the number of new captures, since the second capture session and so on. Because there was not a single recapture in Independência stream, and no new capture on the second capture session in Congonhas stream, data were insufficient to obtain precise estimates of N for these two streams.

This is the first attempt to estimate population size for *M. vanderhaegei* in Brazilian cerrados. Low numbers of captures and recaptures in the second session suggest that capture effort was insufficient (number of traps/site lower than required). Even so, they provided estimates of the minimum number of individuals on each sampling site. To obtain more realistic data on population size and tendencies in subsequent field research, it will be important to broaden spatial and temporal scales, in order to obtain improved estimates for other essential demographic parameters, such as age-specific survival and reproduction. To improve techniques for evaluating and analyzing population sizes in freshwater chelonians is an essential step to conserve them, a major concern in habitats under high environmental pressure, such as olygothrophic Cerrado small streams (Wantzen 2003, Wantzen et al. 2006).

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