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# Phenology in the diet of *Chaunus arenarum* (Anura: Bufonidae) in a soybean field of Córdoba province, Argentina

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**Abstract**: We examined the diet of *Chaunus arenarum* during the entire soybean growth season at a locality in Córdoba province, Argentina. A total of 62 toads (14 in December, 10 in January, 14 in February, 14 in March, and 10 in April) were analyzed to assess gastrointestinal contents. A total of 1963 prey items were found, 1439 of which were considered harmful to soybean plants. In December the most frequently consumed prey item was *Acromyrmex* sp. (Hymenoptera, Formicidae), whereas in January, February, March and April the most abundant prey item was *Armadillium vulgare* (Crustacea, Isopoda). Significant correlations were detected between the percentage of harmful arthropods consumed and the height of the soybean plants for each month throughout the period. We suggest that *C. arenarum* should be considered a potential bio-control agent of soybean pests.

**Key words**: Argentina, biological control, *Chaunus arenarum*, soybean crop.

**Resumen**: **Fenología en la dieta de *Chaunus arenarum* (Anura: Bufonidae) en un cultivo de soja en la provincia de Córdoba, Argentina.** – El propósito de este trabajo fue analizar la dieta de *Chaunus arenarum* durante el desarrollo de un cultivo de soja en la provincia de Córdoba, Argentina. Se examinaron los contenidos gastroinstestinales de 62 individuos adultos de *C. arenarum* (14 en diciembre, 10 en enero, 14 en febrero, 14 en marzo y 10 en abril). Un total de 1963 ítems fueron encontrados, de los cuales 1439 son considerados perjudiciales para la planta de soja. En diciembre la presa consumida con mayor frecuencia fue *Acromyrmex* sp. (Hymenoptera, Formicidae), mientras que en enero, febrero, marzo y abril fue *Armadillium vulgare* (Crustacea, Isopoda). La correlación entre el porcentaje de artrópodos perjudiciales consumidos y la altura de la planta de soja a través de todo el periodo de estudio fue significativa. Los resultados obtenidos permiten afirmar que *C. arenarum* podría ser considerado como un importante agente en el control biológico de especies perjudiciales en los cultivos de soja.

**Palabras clave:** Argentina, *Chaunus arenarum*, control biológico, cultivo de soja.

## INTRODUCTION

The role of generalist predators in biological control has received increased attention in the last years (LANDIS *et al.*, 2000; LEE *et al.*, 2001; SYMONDSON *et al.*, 2002; RUTLEDGE & O'NEIL, 2005). Anuran amphibians are considered generalist predators in

many ecosystems (TOFT, 1980, 1981; LAJMANOVICH, 1995, 1996; PELTZER & LAJMANOVICH, 1999, 2002; DURÉ & KEHR, 2001, 2004). Moreover, HYATT & HUMPHREY (1995), LAJMANOVICH *et al.* (2003) and ATTADEMO *et al.* (2005) suggested that anurans are important natural predators of many agricultural herbivores, such as sucking bugs (*Nezara viridula*) and chewing lepidopterans (*Anticarsia gemmatalis*).

Transgenic soybean *Glycine max* (L.) Merr, is one of the most important monocultures in Argentina, with an annual production of 30 million metric tons. A large diversity of insects affects this oleaginous plant from germination until maturity, causing diverse types and levels of damage (HIGLEY & BOETHEIL, 1994; HARTMANN *et al.*, 1999). Insecticides are heavily used in the control of harmful species, despite their negative side effects (HIN *et al.*, 2001).

The toad *Chaunus arenarum* is commonly encountered in agro-ecosystems (ATTADEMO *et al.*, 2005; PELTZER *et al.*, 2006). This species is a member of the family Bufonidae and is distributed over a wide geographical area, including Brazil, Argentina, Uruguay, and Bolivia (GALLARDO, 1987). This species has been systematically redefined as *Chaunus*, comprising all neotropical species named "*Bufo*", except for *Rhinella* (FROST *et al.*, 2006). In the present study we examine the diet of *C. arenarum* during a soybean growth season, from December to April. The results of this study are of ecological importance and may also contribute to the use of biological control of natural predators in soybean fields.

## MATERIALS AND METHODS

The study was conducted in a soybean field of Córdoba province, Argentina (31° 14' 46" S, 63° 33' 8" W) from December 2002 to April 2003. Mean annual rainfall in the region is 800 mm and mean annual temperature is 18 °C.

We collected 62 adults of *C. arenarum* (n = 14 in December, n = 10 in January, n = 14 in February, n = 14 in March, and n = 10 in April) using pitfall traps (CORN, 1994; ATTADEMO *et al.*, 2005). Diet was analyzed by removing the entire gastrointestinal tracts using a binocular microscope. Prey items were grouped in categories and identified to the lowest possible taxonomic level. The number of prey items present in each digestive tract was recorded. For each category the frequency of occurrence (number of digestive tracts containing that particular prey category divided by the total number of tracts analysed) was calculated using the formula of LESCURE (1971). The anuran and arthropod specimens were deposited in the herpetological and entomological collections of the School of Biochemistry and Biological Sciences of Santa Fe, Argentina (ESS-FBCB-UNL).

## RESULTS

A total of 1963 prey items were found in the diet of *C. arenarum* (Table 1), 1439 of which were arthropods harmful to soybean plants (*Anomala* sp., *Agriotes* sp., *Conoderus* sp., *Lagria villosa, Phanaeus splendidulus, Diloboderus abderus, Cyclocephala* sp., *Pantomorus* sp., *Astylus atromaculatus, Diabotrica speciosa, Spilosoma virginica, Spodoptera* sp., *Peridroma saucia, Anticarsia gemmatalis, Rachiplusia nu, Schistocerca* sp., *Gryllus argentinus, Anurogryllus muticus, Elaeochlora viridicata, Delphacodes aff. kuscheli, Edessa meditabunda, Dichelops furcatus, Nezara viridula, Acromyrmex* sp., and *Armadillium vulgare*). Harmful arthropods represented 73% of the total prey items consumed.

**TABLE 1.** Prey consumed by *C. arenarum* during a soybean growth season in Córdoba province, Argentina. n = total number of organisms found in the digestive tracts, % = percentage of each category in the total number of prey, f = absolute frequency in the digestive tracts, x = without numerical data, (n.i) = not identified, (–) absent, (*) herbivorous species.

**TABLA 1.** Presas consumidas por *C. arenarum* durante el desarrollo del cultivo de soja en la provincia de Córdoba, Argentina. n = número total de organismos encontrados en sistema digestivo, % = porcentaje de cada categoría sobre el total de presas, f = frecuencia absoluta en el sistema digestivo, x = sin datos numéricos, (n.i) = no identificado, (–) ausente, (*) especies herbívoras.

| | December | | | January | | | February | | | March | | | April | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | f | n | % | f | n | % | f | n | % | f | n | % | f |
| Coleoptera | | | | | | | | | | | | | | | |
| Larva (n.i1) | 1 | 0.21 | 1 | 1 | 0.21 | 1 | – | – | – | – | – | – | – | – | – |
| Larva (n.i2) | – | – | – | 1 | 0.21 | 1 | – | – | – | 1 | 0.19 | 1 | – | – | – |
| Adult (n.i1) | – | – | – | 1 | 0.21 | 1 | 3 | 0.73 | 3 | – | – | – | – | – | – |
| Adult (n.i2) | 6 | 1.28 | 4 | – | – | – | – | – | – | – | – | – | – | – | – |
| Coleoptera Carabidae | | | | | | | | | | | | | | | |
| Adult (n.i1) | 6 | 1.28 | 4 | 17 | 3.54 | 6 | 1 | 0.24 | 1 | 3 | 0.5 | 1 | – | – | |
| Adult (n.i2) | 3 | 0.64 | 3 | 2 | 0.42 | 2 | 4 | 0.98 | 3 | 3 | 0.58 | 2 | 8 | 8.79 | 4 |
| Adult (n.i3) | – | – | – | 2 | 0.42 | 1 | – | – | – | – | – | – | – | – | – |
| Coleoptera Elateridae | | | | | | | | | | | | | | | |
| *Agriotes* sp.* | 5 | 1.07 | 3 | 9 | 1.87 | 3 | – | – | – | 4 | 0.78 | 3 | – | – | – |
| *Conoderus* sp.* | – | – | – | 2 | 0.42 | 1 | – | – | – | 3 | 0.58 | 1 | – | – | – |
| Coleoptera Lagriidae | | | | | | | | | | | | | | | |
| *Lagria villosa* * | 11 | 2.35 | 6 | 95 | 19.79 | 5 | 64 | 15.61 | 10 | 29 | 5.64 | 10 | 5 | 5.49 | 3 |
| Coleoptera Scaraboeidae | | | | | | | | | | | | | | | |
| *Diloboderus abderus* * | – | – | – | 26 | 5.42 | 4 | 14 | 3.41 | 5 | 7 | 1.36 | 1 | – | – | – |
| *Phanaeus splendidulus* * | – | – | – | – | – | – | 2 | 0.49 | 2 | 3 | 0.58 | 1 | – | – | – |
| *Anomala* sp.* | 4 | 0.85 | 1 | 20 | 4.17 | 3 | 9 | 2.19 | 2 | – | – | – | – | – | – |
| *Cyclocephala* sp.* | 5 | 1.07 | 2 | 4 | 0.83 | 1 | – | – | – | – | – | – | – | – | – |
| Larva (n.i) | – | – | – | 1 | 0.21 | 1 | – | – | – | – | – | – | 1 | 1.09 | 1 |
| Coleoptera Tenebrionidae | | | | | | | | | | | | | | | |
| *Scotobius* sp. | – | – | – | – | – | – | – | – | – | 2 | 0.39 | 1 | – | – | – |
| Coleoptera Curculionidae | | | | | | | | | | | | | | | |
| *Pantomorus* sp.* | 6 | 1.28 | 4 | – | – | – | 4 | 0.98 | 1 | – | – | – | – | – | – |
| Coleoptera Chrysomelidae | | | | | | | | | | | | | | | |
| *Diabrotica speciosa* * | – | – | – | 5 | 1.04 | 2 | – | – | – | 3 | 0.58 | 3 | – | – | – |
| Adult (n.i) | – | – | – | 1 | 0.21 | 1 | – | – | – | 1 | 0.19 | 1 | – | – | – |
| Coleoptera Melyridae | | | | | | | | | | | | | | | |
| *Astylus atromaculatus* * | – | – | – | – | – | – | – | – | – | – | – | – | 32 | 35.16 | 1 |
| Coleoptera Cicindelidae | | | | | | | | | | | | | | | |
| Adult (n.i) | – | – | – | – | – | – | 1 | 0.24 | 1 | – | – | – | – | – | – |
| Lepidoptera Arctiidae | | | | | | | | | | | | | | | |
| *Spilosoma virginica* * | – | – | – | – | – | – | – | – | – | 32 | 6.22 | 6 | – | – | – |
| Lepidoptera Noctuidae | | | | | | | | | | | | | | | |
| *Spodoptera* sp.* | – | – | – | – | – | – | 3 | 0.73 | 1 | 34 | 6.61 | 6 | – | – | – |
| *Peridroma saucia* * | – | – | – | – | – | – | 2 | 0.49 | 2 | 15 | 2.92 | 4 | – | – | – |
| *Anticarsia gemmatalis* * | – | – | – | 3 | 0.62 | 2 | 7 | 1.71 | 3 | 77 | 14.98 | 7 | 2 | 2.20 | 1 |
| *Rachiplusia nu* * | – | – | – | 2 | 0.42 | 1 | – | – | – | | | – | – | – | – |
| Ortoptera Acridiidae | | | | | | | | | | | | | | | |
| *Schistocerca* sp.* | 5 | 1.07 | 3 | 1 | 0.21 | 1 | – | – | – | 6 | 1.17 | 3 | – | – | – |

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**TABLE 1** (cont.)

| | December | | | January | | | February | | | March | | | April | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | f | n | % | f | n | % | f | n | % | f | n | % | f |
| Ortoptera Gryllidae | | | | | | | | | | | | | | | |
| *Gryllus argentinus* * | – | – | – | – | – | – | – | – | – | 2 | 0.39 | 1 | – | – | – |
| *Anurogryllus muticus* * | – | – | – | – | – | – | – | – | – | – | – | – | 1 | 1.09 | 1 |
| Ortoptera Gryllotalpidae | | | | | | | | | | | | | | | |
| *Scapteriscus borellii* * | 2 | 0.42 | 2 | – | – | – | 1 | 0.24 | 1 | – | – | – | – | – | – |
| Ortoptera Ramaleidae | | | | | | | | | | | | | | | |
| *Elaeochlora viridicata* * | – | – | – | – | – | – | 1 | 0.24 | 1 | – | – | – | – | – | – |
| Homoptera Delphacidae | | | | | | | | | | | | | | | |
| *Delphacodes kuscheli* * | – | – | – | 2 | 0.42 | 1 | – | – | – | – | – | – | – | – | – |
| Nymph (n.i) | – | – | – | – | – | – | – | – | – | – | – | – | | | |
| Heteroptera Pentatomidae | | | | | | | | | | | | | | | |
| *Edessa meditabunda* * | – | – | – | 5 | 1.04 | 3 | 4 | 0.98 | 2 | 2 | 0.39 | 1 | – | – | – |
| *Nezara viridula* * | 2 | 0.42 | 2 | 1 | 0.21 | 1 | 1 | 0.24 | 1 | 12 | 2.33 | 1 | 2 | 2.20 | 2 |
| *Dichelops furcatus* * | 2 | 0.42 | 2 | 1 | 0.21 | 1 | 1 | 0.24 | 1 | – | – | 1 | – | – | – |
| Nymph (n.i) | – | – | – | – | – | – | – | – | – | 1 | 0.19 | 1 | – | – | – |
| Heteroptera Reduviidae | | | | | | | | | | | | | | | |
| Adult (n.i) | – | – | – | – | – | – | 1 | 0.24 | 1 | – | – | – | – | – | – |
| *Atrachelus cinereus* * | – | – | – | 1 | 0.21 | 1 | – | – | – | – | – | – | – | – | – |
| Hymenoptera Formicidae | | | | | | | | | | | | | | | |
| *Solenopsis* sp. | 17 | 3.63 | 3 | 8 | 1.66 | 1 | – | – | – | 11 | 2.14 | 1 | – | – | – |
| *Acromyrmex* sp.* | 146 | 31.19 | 12 | 37 | 7.71 | 9 | 2 | 0.49 | 1 | 13 | 2.53 | 1 | – | – | – |
| *Pheidole* sp. | 122 | 26.06 | 13 | 49 | 10.21 | 10 | 19 | 4.63 | 6 | 19 | 3.70 | 2 | – | – | – |
| *Ectatomma* sp. | 12 | 2.56 | 3 | 4 | 0.83 | 1 | – | – | – | 5 | 0.97 | 1 | – | – | – |
| *Camponotus* sp. | – | – | – | 3 | 0.62 | 1 | – | – | – | – | – | – | – | – | – |
| Adult (ni) | 84 | 17.95 | 14 | 46 | 9.58 | 12 | – | – | – | 12 | 2.33 | 1 | 2 | 2.20 | 1 |
| Isoptera * | | | | | | | | | | – | – | – | – | – | – |
| Adult (n.i.) | – | – | – | – | – | – | 4 | 0.98 | 1 | – | – | – | – | – | – |
| Dermaptera Forficulidae | | | | | | | | | | | | | | | |
| *Doru lineare* | – | – | – | – | – | – | – | – | – | 13 | 2.53 | 2 | – | – | – |
| Blattaria Blattidae | | | | | | | | | | | | | | | |
| *Blatta germanica* | 4 | 0.85 | 3 | 2 | 0.42 | 2 | 1 | 0.24 | 1 | 2 | 0.39 | 1 | – | – | – |
| Nymph (n.i.) | 1 | 0.21 | 1 | – | – | – | – | – | – | – | – | – | – | – | – |
| Crustacea Isopoda | | | | | | | | | | | | | | | |
| *Armadillium vulgare* * | 16 | 3.42 | 5 | 127 | 26.45 | 9 | 261 | 63.66 | 6 | 196 | 38.13 | 8 | 32 | 35.16 | 6 |
| Arachnida Aranidae | | | | | | | | | | | | | | | |
| Adult (n.i.) | 1 | 0.21 | 1 | – | – | – | – | – | – | – | – | – | – | – | – |
| Arachnida Lycosidae | | | | | | | | | | | | | | | |
| *Lycosa* sp. | 5 | 1.07 | 3 | 1 | 0.21 | 1 | – | – | – | 1 | 0.19 | 1 | 4 | 4.39 | 3 |
| Chilopoda Scolopendridae | | | | | | | | | | | | | | | |
| Adult (n.i.) | – | – | – | – | – | – | – | – | – | 2 | 0.39 | 1 | – | – | – |
| Diplopoda | | | | | | | | | | | | | | | |
| Adult (n.i.) | 2 | 0.42 | 2 | – | – | – | – | – | – | – | – | – | – | – | – |
| Mollusca Gastropoda | | | | | | | | | | | | | | | |
| (n.i.) * | – | – | – | – | – | – | – | – | – | – | – | – | 2 | 2.20 | 1 |
| Other animals | x | x | 9 | x | x | 12 | x | x | 7 | x | x | 12 | x | x | 6 |
| Total number of prey | 468 | | | 480 | | | 410 | | | 514 | | | 91 | | |
| Gastrointestinal tracts analyzed | 14 | | | 14 | | | 10 | | | 14 | | | 10 | | |

In December the most frequently consumed prey item was *Acromyrmex* sp. (Hymenoptera, Formicidae) followed by *Pheidole* sp. (Hymenoptera, Formicidae). In January, February, March and April the most frequently consumed prey item was *Armadillium vulgare* (Crustacea, Isopoda). The second most abundant prey in January and February was *Lagria villosa* (Coleoptera, Lagriidae), while in March *Anticarsia gemmatalis* (Lepidoptera, Noctuidae) and *Astylus atromaculatus* (Coleoptera, Melyridae) in April were the most frequently found prey items in the diet of *C. arenarum* (Table 1).

A significant correlation between the percentages of harmful arthropods consumed by *C. arenarum* and the height of the soybean plants in each month of the study period was found ($r = 0.976$, $P < 0.05$) (Fig. 1).

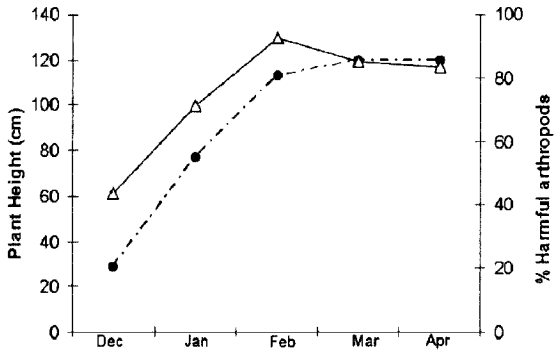


FIGURE 1. Relationship between percentage of harmful arthropods consumed by *C. arenarum* (—Δ—) and soybean plant height (–.–•–.–).

FIGURA 1. Relación entre el porcentaje de artrópodos perjudiciales consumidos por *C. arenarum* (—Δ—) y la altura de la planta de soja (–.–•–.–).

## DISCUSSION

The analysis of the diet composition of anurans living in crops is important in order to understand the anurans' role in the control of harmful arthropods (PREMO & ATMOWIDJOJO, 1987; HIRAI & MATSUI, 1999; ATTADEMO *et al.*, 2005).

Our data suggest that *C. arenarum* can be considered a generalist predator that consumes a wide variety of arthropod prey usually found in soybean fields. Most arthropods found were herbivores harmful to soybean plants (BREWER & ARGUELLO, 1980; HIGLEY & BOETHEL, 1994; BAIGORRI & GIORDA, 1998; MORRONE & COSCARÓN, 1998; SAINI, 2001). No-tilling farming has provided suitable habitats (e.g. humid areas) to noxious organisms (e.g. *Armadillium vulgare* and *Acromyrmex* sp.) (ARAGÓN, 2002). This can explain the high percentage of herbivores present in the toad's diet.

A significant relationship between the percentage of harmful arthropods consumed and the growth of soybean plants was observed. This suggests that the abundance of harmful species in fields increases with growing complexity and height of soybean plants. Indeed, the increment of herbivores in soybean plants is correlated with the natural histories of each species throughout the cultivation period (BAIGORRI & GIORDA, 1998).

Native biological control agents provide potential advantages over classical biological control (BELLOWS, 2001). Accordingly, DENOTH *et al.* (2002) recommended the use of native fauna to control pest species, because they may have little impact on non-target native species that have long coexisted with the control agent. In addition, field entomologists and farmers have recognized that conservation of natural enemies is important to achieve an effective biological control in many agricultural systems (WILBY & THOMAS, 2002). The literature on natural enemies of soybean, such as invertebrate predators and parasitoid species, and on fungi infestation is abundant (PITRE, 1983; SAINI,

2001). Few authors have proposed that amphibians may be potential natural enemies of species harmful to soybean plants (WOOD, 1976; HYATT & HUMPHREY, 1995). Recently, LAJMANOVICH *et al.* (2003) and ATTADEMO *et al.* (2005) suggested that anurans may contribute to the control of harmful species. The toad *Chaunus arenarum* is commonly encountered in agro-ecosystems species and further studies are necessary to test this hypothesis. We suggest that *C. arenarum* should be considered an important biological control agent in natural suppression of harmful species, as it was demonstrated in previous studies (ATTADEMO *et al.*, 2005, 2007).

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