

Observation of scavenging events on shells of *Megalobulimus* (Gastropoda, Pulmonata) by Lear's macaws

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There is a surprising lack of information in the literature on the basic biology of Neotropical land snails (Simone 2006, Salvador & Simone 2014); descriptions of ecology, behavior, physiology and relationships to the rest of the fauna are extremely scarce. As such, any new piece of information about this long neglected group of animals should be promptly shared.

In this regard, we report the curious occurrence of Lear's macaws, *Anodorhynchus leari* Bonaparte, 1856 (Psittacidae), feeding on empty shells of *Megalobulimus* snails (Strophocheilidae). Two events were observed: the first occurred in Euclides da Cunha, on August 9, 2012, reported by Lima *et al.* (2014); the second event took place in Canudos, on May 10, 2014, and is reported here for the first time. In the second event, the shells were immediately collected afterwards and the material donated to the Museu de Zoologia da Universidade de São Paulo (MZUSP; São Paulo, Brazil), being registered under the catalog number MZUSP 132219. Both cities, Euclides da Cunha and Canudos, are located in the northeastern portion of Bahia state, Brazil.

In the **first event**, a Lear's macaw was observed perching on a licuri palm tree (*Syagrus coronata* (Mart.) Becc.; Arecaceae), manipulating a *Megalobulimus* shell with its feet and constantly handling it with its beak (*see* Figure 1); after the

bird noticed the observers' presence, it dropped the shell and flew away (Lima *et al.*, 2014).

In the **second event**, a group of five macaws were found under the branches of an unidentified tree and one of them was manipulating a *Megalobulimus* shell (same species as first event; shell length circa 10 cm) with its beak and feet. At first sight, this macaw seemed to be playing with the shell; however, on a closer inspection it became clear the bird was breaking small pieces off the shell, from an already-large hole it had made. This behavior lasted five minutes until the shell was dropped.

The peculiar hole the bird left on the shell was made on the body whorl immediately before the peristome (*see* Figure 2). Notably, the thick peristome *per se* was not damaged (Figure 2). The shell from the first event, however, was more thoroughly broken and hollowed out, having its body whorl and columella completely removed (Figure 1). This breakage pattern is also caused by other birds and possibly mammals (Simone & Salvador, 2016). Lima *et al.* (2014) also reported finding shells with this same breakage pattern in the following months.

The shells (Figure 2) compare extremely well to *Megalobulimus intercedens* (Martens, 1876), a species originally described from Bahia. Bequaert (1948), however, considered this

species indistinguishable from *M. terrestris* (Spix, 1827), which display a large amount of conchological variation. Herein, we follow the classification of Bequaert (1948). *Megalobulimus terrestris* is widely distributed, ranging from Ceará state in NE Brazil to Santa Catarina state in the southern part of the country (Simone, 2006).

The endemic genus *Megalobulimus* Miller, 1878 includes the largest land snails of South America (Jaramillo Roldán *et al.*, 2014), and are thus often colloquially referred to as “Megasnails”. Moreover, their shells are usually heavily calcified and very sturdy, often with increasingly thickened peristomes as the animals grow older (Bequaert, 1948; Fontenelle & Miranda, 2012; Miranda *et al.*, 2014). Populations of *Megalobulimus* spp. are mostly nocturnal, little-studied in the wild (Beltramino *et al.*, 2015) and usually occur at low densities (Eston *et al.*, 2006; Miranda & Fontenelle, 2015), but might, as other land snails, display higher densities in regions with calcareous substrates (R.B.S., personal observation). Calcium is one of the most important factors for a land snail’s survival (Fournier & Chétail, 1984; Barker, 2001) and there is a possibility of calcium-poor environments resulting in shorter lifespans for *M. paranaguensis* (Miranda *et al.*, 2014). The rocks in the localities where the present material comes from are mainly calcareous (CPRM, 2006).

As mentioned above, Lima *et al.* (2014) were the first to point out the consumption of *Megalobulimus*’ shells by Lear’s macaws in their review of food items consumed by these birds. They suggested that macaws need this supplementary source of calcium, since their regular food items do not have significant levels of this element.

Calcium is an important element for birds, as it takes part in numerous biochemical reactions and is the main component of bones and eggshell (de

Matos, 2008). Increases in calcium levels are related to the reproductive stage of female birds (Hochleithner, 1994; Harr, 2002) and empty snail shells have been reported as a calcium supplement prior to egg-laying (*e.g.*, Graveland, 1996; Allen, 2004). Furthermore, decline in snail abundance is linked to deformed eggshell and lower viability of eggs and chicks in great tits, *Parus major* Linnaeus, 1758 (Paridae) (*e.g.*, Graveland, *et al.* 1994; Graveland & van der Wal, 1996).

As the scavenging events reported here took place on May and August, they are not necessarily related to reproduction, which for Lear’s macaws take place from September/October, when they start to search for suitable nesting spots, to April (Sick *et al.*, 1987; Amaral *et al.*, 2005).

In any event, shells of terrestrial snails represent a concentrated source of calcium that is readily available to land vertebrates. As such, they could potentially be an important source of dietary calcium for macaws. Observations such as the present one are thus essential for identifying future avenues of study. Further studies should investigate whether shell consumption is simply a calcium supplement (proposed by Lima *et al.*, 2014, and applicable for both males and females) or is exclusive to the reproductive phase (mainly related to eggshell production and thus, a female-exclusive behavior).

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REFERENCES

- Allen, J.A. 2004.** Avian and mammalian predators of terrestrial gastropods. *In*: Barker G.M. (Ed.) Natural Enemies of Terrestrial Molluscs. CABI, Wallingford. pp. 1-36.
- Amaral, A.C.A., I.M. Hernandez, B.F. Xavier, S.D. Bella. 2005.** Dinâmica de ninho de arara-azul-de-lear (*Anodorhynchus leari* Bonaparte, 1856) em Jeremoabo, Bahia. *Ornithologia* 1:59-64.
- Barker, G.M. 2001.** The Biology of Terrestrial Molluscs. CABI, Wallingford.
- Beltramino, A.A., R.E. Vogler, G.D.E. Gutiérrez, A. Rumi. 2015.** Impact of climate change on the distribution of a giant land snail of South America: predicting future trends for setting conservation priorities on native malacofauna. *Climatic Change* 131:621-633.
- Bequaert, J.C. 1948.** Monograph of the family Strophocheilidae, a Neotropical family of terrestrial mollusks. *Bulletin of Museum of Comparative Zoology of Harvard* 100:1-210.
- CPRM. 2006.** Mapa Geodiversidade do Brasil. CPRM/Serviço Geológico do Brasil, SGM, MME, Brasília.
- Eston, M.R., G.V. Menezes, A.Z. Antunes, A.S.R. Santos, A.M.R. Santos. 2006.** Espécie invasora em unidade de conservação: *Achatina fulica* (Bowdich, 1822) no Parque Estadual Carlos Botelho Sete Barras, SP, Brasil. *Revista do Instituto Florestal* 18:173-179.
- Fontenelle, J.H. & M.S. Miranda. 2012.** The use of outer lip in age estimation of *Megalobulimus paranaguensis* (Gastropoda, Pulmonata). *Strombus* 19:15-22.
- Fournier, J. & M. Chétail. 1984.** Calcium dynamics in land gastropods. *American Zoologist* 24:857-870.
- Graveland, J. 1996.** Avian eggshell formation in calcium-rich and calcium-poor habitats: importance of snail shells and anthropogenic calcium sources. *Canadian Journal of Zoology* 74:1035-1044.
- Graveland, J. & R. van der Wal. 1996.** Decline in snail abundance due to soil acidification causes eggshell defects in forest passerines. *Oecologia* 105:351-360.
- Graveland, J., R. van der Wal., J.H. van Balen, A.J. van Noordwijk. 1994.** Poor reproduction in forest passerines from decline of snail abundance on acidified soils. *Nature* 368:446-448.
- Harr, K.E. 2002.** Clinical chemistry of companion avian species: a review. *Veterinary Clinical Pathology* 31(3):140-151.
- Hochleithner, M. 1994.** Biochemistries. *In*: Ritchie B.W., Harrison G.J., Harrison L.R. (Eds.) Avian medicine: principles and application. Wingers, Lake Worth. pp. 176-198.
- Jaramillo, Roldán E., J. López Martínez J., R. Ramírez, L.E. Velásquez Trujillo. 2014.** Análisis morfológico del sistema reproductor e identificación molecular a través de los marcadores mitocondriales COI y 16S rRNA de *Megalobulimus oblongus* (Mollusca, Strophocheilidae) de Colombia. *Revista Peruana de Biología* 21:79-88.
- Lima, D.M., S. Tenório, K.O. Gomes. 2014.** Dieta por *Anodorhynchus leari* Bonaparte, 1856 (Aves: Psittacidae) em palmeira de licuri na caatinga baiana. *Atualidades Ornitológicas* 178:50-54.
- de Matos, R. 2008.** Calcium metabolism in birds. *Veterinary Clinics of North America: Exotic Animal Practice* 11(1):59-82.
- Miranda, M.S., J.H. Fontenelle, I.L. Pecora. 2014.** Population structure of a native and an alien species of snail in an urban area of the Atlantic Rainforest. *Journal of Natural History* 49:19-35.
- Salvador, R.B. & L.R.L. Simone. 2014.** New species of *Cyclodontina* from Bahia, Brazil (Gastropoda, Pulmonata, Odontostomidae). *Iheringia* 104(4):484-487.
- Sick, H., L.P. Gonzaga, D.M. Teixeira. 1987.** A arara-azul-de-lear, *Anodorhynchus leari* Bonaparte, 1856. *Revista Brasileira de Zoologia* 3(7):441-463.
- Simone, L.R.L. 2006.** Land and Freshwater Mollusks of Brazil. EGB/FAPESP, São Paulo.
- Simone, L.R.L. & R.B. Salvador. 2016.** Taxonomical study on a sample of land snails from Nanuque (Minas Gerais, Brazil), with descriptions of three new species. *Stuttgarter Beiträge zur Naturkunde A, Neue Serie* 9:9-30.



Figure 1. Left: a Lear's macaw, perched on a licuri palm tree, manipulating a *Megalobulimus* shell. Right: researcher holding the same shell, showing the resulting breakage pattern. Images extracted and modified from Lima *et al.* (2014).



Figure 2. Shells of *Megalobulimus terrestris* from Canudos (Bahia state, Brazil) after being scavenged by a Lear's macaw (top row) and intact (bottom row).