



## SHORT COMMUNICATION

### Predation of *Curatella americana* seeds by *Aratinga aurea* parrots

Ademir Kleber Morbeck Oliveira<sup>1\*</sup>, Ana Carolina Nunes<sup>2</sup> and Gisele Canal Farias<sup>2</sup>

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**ABSTRACT:** (Predation of *Curatella americana* seeds by *Aratinga aurea* parrots). *Curatella americana* is a common tree species widely distributed throughout the Pantanal, a swampy region in Mid-Western Brazil. Each tree produces a large number of fruits that are appreciated by many species of birds and mammals including *Aratinga aurea* parrots. However, there is limited information about the influence of seed ingestion by parrots on the germination process of this tree species. Thus, the objective of this research was to evaluate the germination of non-predated *Curatella americana* seeds (collected from the fruits) compared with predated seeds (that had passed through the digestive tract of parrots), collected in the 'Pantanal do Negro' area. The collected material was brought to the laboratory and the seeds were subjected to seven treatments: (1) intact seeds (Control); (2) seeds without arils (aqueous pulp); (3) digestive system – seeds that passed through an animal's digestive system; (4) hydrochloric acid at 0.01 N (pH 2); (5) hydrochloric acid at 0.001 N (pH 3); (6) hydrochloric acid at 0.0001 N (pH 4) and (7) seeds with arils placed in hydrochloric acid (pH 3). Each group was evaluated daily for a period of 55 days. The compared variables were: the germination percentage, the germination speed index and the mean germination time. The highest germination rate (70%), germination speed (1.5) and germination time (23.5 days) were obtained for seeds without aril. The results obtained by the Control seeds were similar to those found for the seeds that had passed through the digestive system of birds or were exposed to acid, indicating that this seed type has specific mechanisms for germination.

**Key words:** Frugivory, seed dispersal, Pantanal, lixeira, maritaca.

**RESUMO:** (Predação de sementes de *Curatella americana* por periquitos *Aratinga aurea*). A espécie arbórea *Curatella americana* apresenta-se amplamente distribuída na região do Pantanal, Centro-Oeste do Brasil. Com grande quantidade de frutos por árvore, as sementes são consumidas por muitas espécies de mamíferos e aves, entre elas o periquito *Aratinga aurea*. Levando-se em consideração as poucas informações sobre a influência da ingestão de sementes por psitacídeos, no processo de germinação, o objetivo desta pesquisa foi avaliar a germinação de sementes de *Curatella americana* coletadas de frutos não predados com sementes que passaram pelo trato digestório de periquitos, com coletas realizadas no Pantanal do Negro. O material coletado foi transportado para laboratório e as sementes submetidas a sete tratamentos: 1 - Controle - sementes intactas; 2 - Sementes sem arilo (polpa aquosa); 3 - Sementes que passaram pelo sistema digestório; 4 - Ácido clorídrico a 0,01 N (pH 2); 5 - Ácido clorídrico a 0,001 N (pH 3); 6 - Ácido clorídrico a 0,0001 N (pH 4); e, 7 - Sementes com arilo, submetidas a imersão em ácido clorídrico (pH 3). O experimento foi avaliado diariamente durante 55 dias, sendo calculados a percentagem de germinação, índice de velocidade de germinação e tempo médio de germinação. A maior taxa de germinação (70%), índice de velocidade de germinação (1,5) e tempo médio de germinação (23,5 dias) foram obtidos para sementes sem arilo. Os resultados obtidos pelas sementes controle são similares aos encontrados para as sementes que passaram pelo sistema digestório das aves ou foram expostas ao ácido, indicando que este tipo de semente possui mecanismos específicos para germinação.

**Palavras-chave:** Frugivoria, dispersão de sementes, Pantanal, lixeira, maritaca.

## INTRODUCTION

In the process of seed dispersal through ingestion of fruits and seeds (a process known as 'endozoochory'), acids and digestive enzymes often accelerate the germination process by breaking the rigidity of the seed-coating (Levely and Galetti 2002). When it does not damage the seed, this chemical scarification produces an exchange of gas with the environment, eliminates germination inhibitors, and facilitates water penetration and the reactivation of metabolic processes. These processes may determine the efficiency of germination (Traveset and Verdú 2002).

However, certain species may act as predators by killing the seed embryo. Parrots are considered to be see

predators, because they typically cause damage when foraging for seeds, and have a negative impact on the reproductive success of plant species due to large losses of fruits in different neo-tropical trees (Renton 2001, Silva 2005, among others). The action of seed dispersal by parrots has also been observed, as reported in the study of Sazima (2008) where the parrot *Brotopogon tirica* (Gmelin, 1788) dispersed seeds of the species *Syagrus romanzoffiana* (Cham.), known popularly as "jerivá", carrying the fruit to consume it in other trees.

Most parrot species are generalists when it comes to food. Their diet includes seeds and fruits of various types, obtained in the trees or on the ground (Sick 2001,

1. Prof. Dr. do Programa de Pós-Graduação em Meio Ambiente e Desenvolvimento Regional, Universidade Anhanguera, Uniderp2. Campo Grande, MS, Brasil.

2. Discente do Curso de Ciências Biológicas, Universidade Anhanguera, Uniderp. Campo Grande, MS, Brasil.

\*Autor para contato. Email: [akmorbeck@hotmail.com](mailto:akmorbeck@hotmail.com)

Paranhos *et al.* 2007, Silva 2007). There are also records of parrots consuming buds, flowers and leaves, especially when the availability of fruits is low (Sick 2001, Ragusa-Netto and Fecchio 2006).

One parrot species that consumes a great variety of fruits and seeds, is the parakeet known as *Aratinga aurea* (Gmelin, 1788). It is small ( $\pm 24$  cm total length), popularly known as 'Parakeet King', or 'Maritaca' (Sigrist 2009), and is common in parts of the Pantanal and in rocky scrublands. Silva (2007) points out that this species of parrot usually feeds most voraciously on diasporas of the *Myracrodruon urundeuva* Allemão (Anacardiaceae), and *Albizia hasslerii* (Chodat) Burkart (Mimosaceae).

*Curatella americana* L. (Dilleniaceae) is one of the plant species that produces seeds eaten by this bird. This tree, commonly known as 'Lixeira', is an Amazonian species which has a wide neo-tropical dispersal and is found in the Pantanal. It is particularly abundant in areas of shrubland that has undergone change, and produces seeds with nutritious arils that are much sought after and consumed by birds (Lorenzi 2008).

Taking into account the lack of extant studies concerning the processes of predation and/or the induction of germination perpetrated by birds in areas of the Pantanal biosphere (fundamental to our understanding of the dynamics of these ecosystems), this study aimed to evaluate the effect of the passage of *Curatella americana* seeds through the digestive tract of *Aratinga aurea* on the germination process, in comparison to other treatments.

## MATERIAL AND METHODS

The study area was located at the Research Institute of the Pantanal (19°29'12.2" to 19°30'49.8" S and 55°35'28.5" to 55°42'37.9" W): an area of 2,618 hectares, located in the 'Pantanal do Negro', Mato Grosso do Sul, Brazil. The material was collected in November 2010. The birds were identified by a field guide (Sigrist 2009) while they were feeding on trees of the *Curatella americana* species. Their feces were collected from landing sites nearby, and mature fruits of *C. americana* were collected from different trees on the site. The collected material was then transported to the Laboratory of Inter-disciplinary Research into Biodiversity and Environmental Systems, Anhanguera-Uniderp University, Campo Grande, MS.

The treatments were as follows: 1 - control, untreated

seeds; 2 - seeds whose arils had been manually removed; 3 - seeds that had passed through the birds' digestive tract; 4 - seeds without aril, treated with hydrochloric acid at 0.01 N (pH 2); 5 - seeds without aril, treated with hydrochloric acid at 0.001 N (pH 3); 6 - seeds without aril, treated with hydrochloric acid at 0.001 N (pH 4); and 7 - seeds with aril, placed in hydrochloric acid (pH 3). The seeds were immersed in acid for ten minutes and then rinsed with water for a further three minutes, to simulate a possible passage through the digestive tract (Treatments 4, 5, 6 and 7). The seeds were then placed in a Petri dish which was lined with two sheets of filter-paper, moistened with Ranol fungicide (0.1%). This was subsequently maintained in a B.O.D. type germination chamber, at 26 °C, under 12-hour a day illumination using artificial light. Four replicates of 50 seeds per treatment were adopted for each group.

The seeds were randomly selected to compose the groups and the observation period was 55 days. The seeds were observed daily and they were considered germinated when there was a radicle protrusion of 2.0 mm.

The variables assessed were: germination rate (G), the germination speed index (GSI) and mean germination time (MGT - days) (Ferreira and Borghetti 2004). The germination percentage data were then converted into an arc-sine  $(x/100)^{0.5}$ , and the original data (unprocessed) were presented in a table. The data were subjected to analysis of variance (ANOVA) and analysed via Bioestat 4.0 statistical software (Ayres *et al.* 2004) at a level of 5% probability, and, when significant, Tukey's mean test was carried out at a level of 5% ( $p < 0.05$ ).

## RESULTS AND DISCUSSION

Seeds initiated their process of germination between the 14<sup>th</sup> and 15<sup>th</sup> days of the experiment, except for seeds with arils (Control) which began to germinate on the 24<sup>th</sup> day. Germination was distributed over a long period of time, with seeds germinating each day, which produced high AGT values (Table 1). Brancalion and Marcos Filho (2008) suggest that the distribution of germination over a longer period of time might be beneficial because it increases the chances of seedlings in finding a favorable environment for installation.

According to Lorenzi (2008), the germination of seed species occurs between 10 and 20 days after sowing in seed-beds exposed to full sun; a similar result was obtained

**Table 1.** Germination (%), germination speed index (GSI) and mean germination time (MGT) in seeds of *Curatella americana* after seven treatments, placed in B.O.D.

| Treatments             | Germination | GSI     | AGT (days) |
|------------------------|-------------|---------|------------|
| Control                | 27 c        | 0.40 cd | 35.2 cd    |
| Aril Group             | 70 a        | 1.5 a   | 23.5 a     |
| Digestive System Group | 27 c        | 0.48 bc | 29.8 b     |
| pH 2 Group             | 21 c        | 0.31 d  | 35 cd      |
| pH 3 Group             | 40 b        | 0.60 b  | 33 bc      |
| pH 4 Group             | 26 c        | 0.36 cd | 37.9 d     |
| Acid Aril Group        | 31 bc       | 0.33 cd | 34 bcd     |

Averages followed by the same letter in the column do not differ statistically from one another using Tukey's test ( $p > 0.05$ ).

ned for all treatments, with the exception of the Control.

The highest germination rate, strongest germination speed index and shortest mean germination time period (indicating greater vigor) occurred in seeds of the Aril Group (Table 1). The group of seeds that passed through the digestive tract had a lower rate and germination strength, probably as a result of excessive damage to the seeds caused by animal digestive acids (chemical scarification). The results obtained for the other acid treatments, used at different concentrations, also resulted in lower germination and loss of vigor (Tab. 1), thus indicating that breaking the rigidity of the seed coat by acids has a negative effect on the germination process. The process of collecting seeds from wild animals, by examining feces, enables evaluators to see if the seeds are damaged and/or have lost their viability during the ingestion and digestion processes; seed germination must be evaluated to determine whether an animal is a “good or bad” disperser (Galetti *et al.* 2006).

Passage through the digestive tract may or may not increase the germination rate, because different plant species respond in different ways (Levely and Galetti 2002). Furthermore, the dispersal characteristics of animals may also interfere with germination rates, because the manner and strategy involved in feeding on fruits varies with different species (Galetti *et al.* 2006, Jordano *et al.* 2006). Traveset and Verdú (2002) also showed that birds tend to have highly positive effects on seed germination (i.e. higher germination percentages, compared with uningested seeds).

Traveset *et al.* (2008) measured changes in seed mass, water content, permeability, seed coat thickness, texture, and resistance in *Phillyrea angustifolia* L. and *Myrtus communis* L., after ingestion by *Turdus merula* Linnaeus, 1758 and found a number of differences between the plant species: *P. angustifolia* seeds lost mass, mainly due to water loss, and had thinner coats after passage through the gut, but *M. communis* seeds did not. Seeds of both species had increased permeability, while *M. communis* seeds in particular became less resistant to breakage. The passage of seeds through the guts of birds sped up germination in both species, especially in *M. communis*. Increased permeability in seeds of both species following ingestion resulted in a higher germination rate. Moreover, seeds with thick coats (and in the case of *P. angustifolia*, harder coats) germinated at a slower rate and produced seedlings that also grew more slowly, indicating a cost associated with coat thickness and/or hardness for seedling emergence. There is great heterogeneity in germination responses among and within plant species and a large variety of factors, both intrinsic and extrinsic to the plants, which influence such responses.

For example, Lo (1995), studying seeds consumed by a species of Psittacidae, *Guaruba guarouba* (Gmelin, 1788), demonstrated that the presence of aril surrounding the seeds of *Maytenus obtusifolia* Mart. or pericarp, in seeds of *Gomidezia feniziana* O.Berg., delayed the germination process, while the germination rate of seeds

consumed by birds was higher.

The same author states that after conducting germination tests with seeds found in bird feces, the germination rate was higher for seeds of some species that had passed through the digestive tract of the animal when compared with the control, as was the case for *Erythroxylum ovalifolium* Peyr. This demonstrates that passage through the digestive system can facilitate the germination process in certain plant species.

Moreover, Figueroa and Castro (2002) examined seeds collected from four woody species of the temperate rainforest of Chiloé (Chile): *Gaultheria mucronata* (L. f.) Hook. & Arn., *Luma apiculata* (DC.) Burret, *Myrteola nummularia* (Poir.) O. Berg and *Myrceugenia planipes* (Hook. & Arn.) O. Berg. The seeds were: ingested seeds (seeds collected from the feces of birds), extracted seeds (seeds obtained directly from the fruits) and intact fruits (fruits collected directly from the plants). The researchers concluded that birds did not affect the seed viability for any of the four species studied. These results are different to those found in this present study, which show that the rate and the strength of germination decrease when seeds pass through the digestive tract.

According to Sick (2001), Silva (2005; 2007) and Paranhos *et al.* (2007), the Psittacidae family can act as seed predators; the process of seed predation is inter-specific and plays an important role in regulating and structuring plant communities. However, Barros and Marcondes-Machado (2000), Paranhos *et al.* (2007) and Sazima (2008) state that the group can also be considered as dispersers, contributing to the recruitment of native species.

Silva (2007) also suggests that through seed predation many parrots can have an important influence on plant diversity in certain areas, and increase the chance of other tree species becoming established by reducing competition for space.

In this study, *Aratinga aurea* cannot be considered a predator of seeds in the plants under observation, because germination rates were similar for control seeds, seeds passing through the digestive system and those subjected to acid treatments. The highest rates of germination found in this study were GSI and AGT, in the treatment of seeds without arils, and this finding is supported by results from a study by Ferreira *et al.* (2005), studying seeds of *Passiflora alata* Curtis, which demonstrated that the removal of the seed aril led to a higher rate of germination.

The results may also indicate that the species *Curatella americana* might have a specific mechanism for dispersing its seeds at higher rates or with greater seed production, thus offsetting the low germination rates observed in this study.

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## REFERENCES

- AYRES, M., AYRES JR, M., AYRES, D. L. & SANTOS, A. S. 2004. *BioEstat 4.0: Aplicações estatísticas nas áreas das ciências biológicas e médicas*. Manaus: Sociedade Civil Mamirauá. 364 p.
- BARROS, Y. M. & MARCONDES-MACHADO, L. O. 2000. Comportamento alimentar do periquito-da-caatinga *Aratinga cactorum* em Curaça, Bahia. *Ararajuba*, 8(1): 55-59.
- BRANCALION, P. H. S. & MARCOS FILHO, J. 2008. Distribuição da germinação no tempo: causas e importância para a sobrevivência das plantas em ambientes naturais. *Informativo Abrates*, 18(1, 2, 3): 11-17.
- FERREIRA, A. G. & BORGHETTI, F. 2004. *Germinação: do básico ao aplicado*. Porto Alegre: Artmed. 323 p.
- FERREIRA, G., OLIVEIRA, A., RODRIGUES, J. D., DIAS, G. B., DETONI, A. M., TESSER, S. M. & ANTUNES, A. M. 2005. Efeito de arilo na germinação de sementes de *Passiflora alata* Curtis em diferentes substratos e submetidas a tratamentos com giberelina. *Revista Brasileira de Fruticultura*, 27(2): 277-280.
- FIGUEROA, J. A. & CASTRO, S. A. 2002. Effects of bird ingestion on seed germination of four woody species of the temperate rainforest of Chiloé island, Chile. *Plant Ecology*, 160(1): 17-23.
- GALETTI, M., PIZO, M. A. & MORELLATO, P. C. 2006. Fenologia, frugivoria e dispersão de sementes. In: CULLEN, J. L., VALLADARES-PADUA, C. & RUDRAN, R. (Eds.). *Métodos de estudos em biologia da conservação e manejo da vida silvestre*. Curitiba: Universidade Federal do Paraná. p. 395-422.
- JORDANO, P., GALETTI, M., PIZO, M. A. & SILVA, W. R. 2006. Ligando frugivoria e dispersão de sementes à biologia da conservação. In: DUARTE, C. F., BERGALLO, H. G., SANTOS, M. A. and VA, A. E. (Eds.). *Biologia da conservação: essências*. São Paulo: Editora Rima. p. 411-436.
- LEVELY, D. J. & GALETTI, M. (Eds.). 2002. *Seed dispersal and frugivory: ecology, evolution and conservation*. Wallingford: CABI Publishing. 544 p.
- LO, V. K. 1995. Extensão da distribuição de *Guaruba guarouba* para o norte do Estado de Mato Grosso, Amazônia Meridional (Psittaciformes: Psittacidae). *Ararajuba*, 3: 93-94.
- LORENZI, H. 2008. *Árvores brasileiras: manual de identificação e cultivo de plantas arbóreas nativas do Brasil*. V.1. Nova Odessa: Instituto Plantarum de Estudos da Flora. 384 p.
- PARANHOS, S. J., ARAUJO, C. B. & MARCONDES-MACHADO, L. O. 2007. Comportamento alimentar do Periquito-de-encontro-amarelo (*Brotogeris chiriri*) no interior do Estado de São Paulo, Brasil. *Rev. Bras. Orn.*, 15(1): 95-101.
- RAGUSA-NETTO, J. & FECCHIO, A. 2006. Plant food resources and the diet of a parrot community in a gallery forest of the southern Pantanal (Brazil). *Braz. J. Biol.*, 66(4): 1021-1032.
- RENTON, K. 2001. Lilac-crowned parrot diet and food resource availability: resource tracking by a parrot seed predator. *Condor*, 103(1): 62-69.
- SAZIMA, I. 2008. The parakeet *Brotogeris tirica* feeds on and disperses the fruits of the palm *Syagrus romanzoffiana* in Southeastern Brazil. *Biotropica*, 8(1): 231-234.
- SICK, H. 2001. *Ornitologia brasileira*. Rio de Janeiro: Editora Nova Fronteira. 922 p.
- SIGRIST, T. 2009. *Guia de campo: avifauna brasileira*. São Paulo: Avis Brasilis. 492 p.
- SILVA, P. A. 2005. Predação de sementes pelo maracanã nobre (*Diopsittaca nobilis*, Psittacidae) em uma planta exótica (*Melia azedarach*, Meliaceae) no oeste do Estado de São Paulo, Brasil. *Rev. Bras. Orn.*, 13(2): 183-185.
- SILVA, P. A. 2007. Predação de sementes por periquitos *Brotogeris chiriri* (Psittacidae) em *Chorisia speciosa* (Bombacaceae). *Rev. Bras. Orn.*, 15(1): 127-129.
- TRAVERSE, A. & VERDÚ, M. 2002. A meta-analysis of the effect of gut treatment on seed germination. In: LEVELY, D. J. & GALETTI, M. (Eds.). *Seed dispersal and frugivory: ecology, evolution and conservation*. Wallingford: CABI Publishing. p. 339-350.
- TRAVERSE, A., RODRIGUEZ-PÉREZ, J. & PIAS, B. 2008. Seed trait changes in dispersers' guts and consequences for germination and seedling growth. *Ecology*, 89(1): 95-106.