



## STOMACH CONTENT ANALYSIS OF *Crypturellus noctivagus noctivagus* (TINAMIFORMES, TINAMIDAE) IN SOUTHERN BRAZIL

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**Abstract:** Studies reporting specific aspects of forest tinamous' feeding ecology are still scarce in the scientific literature, and most of the available information report only casual observations. The *Crypturellus noctivagus noctivagus* (Tinamiformes, Tinamidae) is a forest bird endemic to Brazil, which occurs from southern Bahia to Rio Grande do Sul. In this study, we analyzed food items found in the stomach content of one *C. n. noctivagus* individual in the state of Rio Grande do Sul, Brazil. We found seeds of *Nectandra megapotamica* (Laurales, Lauraceae) and *Myrcianthes gigantea* (Myrtales, Myrtaceae), totalizing 2.259 g. We also found insect fragments of the orders Coleoptera and Lepidoptera, one individual of the family Curculionidae (Coleoptera), and one larval specimen of *Dirphia muscosa* (Lepidoptera), totalizing 0.637 g of stomach content, and rock fragments weight 1.741 g. This study provides records of the *C. n. noctivagus* species feeding habits, contributing to the knowledge about the trophic ecology of Tinamiformes in South Brazil.

**Keywords:** Pampa Biome; Seasonal deciduous forest; Tinamiformes; Yellow-legged Tinamou.

The Yellow-legged Tinamou *Crypturellus noctivagus* (Wied, 1820) is a forest bird endemic to Brazil, included in the Order Tinamiformes (BirdLife International 2016). In regard to conservation status, the species is considered as Vulnerable at the national level (ICMBio 2016). Two subspecies are recognized: *Crypturellus noctivagus zabele* (Spix, 1825), found in the North portion of the states of Bahia, Piauí and possibly Pernambuco, and *Crypturellus noctivagus noctivagus* (Wied, 1820) which occurs from South Bahia, following southwards by the coastal region, through Atlantic Forest remnants (Magalhães 1994, BirdLife International 2016, Tomotani & Silveira 2016), to the Pampa Biome in the Rio Grande do Sul state, where only one relictual population is known (Corrêa *et al.* 2010). In the Rio Grande do Sul state, *C. n.*

*noctivagus* is classified as Critically Endangered at the regional level (FZB 2014).

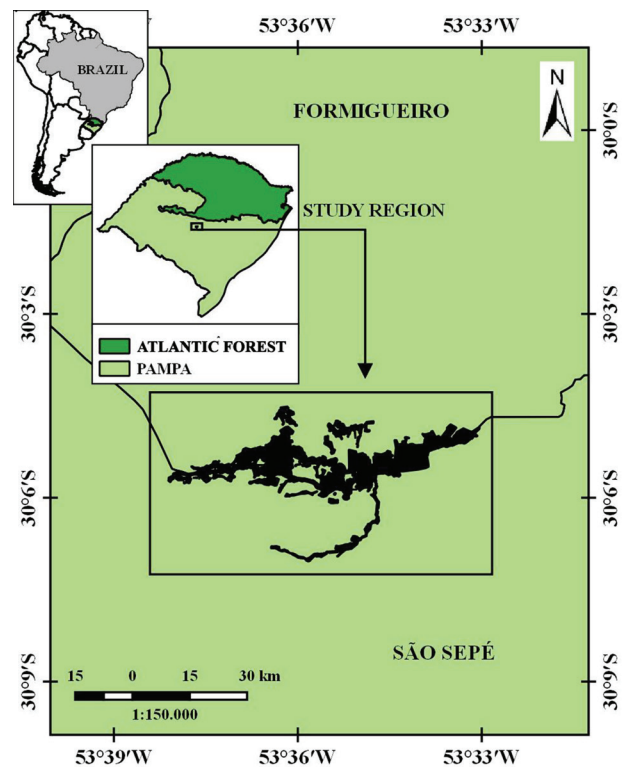
The Yellow-legged Tinamou has terrestrial habits, using the ground to displace and to attend its trophic demands (Magalhães 1994, BirdLife International 2016), foraging on fallen fruits, bugs and ants (Berlepsch & Ihering 1885, Sick 1997). Some field studies report specific food items in the diet of wild tinamous, such as *Nothura maculosa* (Silva & Sander 1981), *Nothura pentlandii* (Mosa 1993) and *Nothoprocta perdicaria* (González-Acuña *et al.* 2006). Regarding forest tinamous (*e.g.*, species of the genus *Crypturellus*), information about specific food habits are still scarce in the literature. In general, these birds are known to feed on fruits, seeds, arthropods and fruit pulps available on the ground (Sick 1984, Cabot 1992). Forest birds which

feed on fruits and seeds may, directly or indirectly, contribute to seed dispersion in the ecosystem, carrying seeds through both flight and ground displacements (Andrade 1997, Sick, 1997, Pizo & Galetti 2010). Several bird groups play such role in forest environments, such as the families Cracidae, Psittacidae, Tyrannidae, Turdidae and Thraupidae (Sick 1984, Aspiroz 2001, Krügel *et al.* 2006, Pizo & Galetti 2010), as well as many species of the family Tinamidae (Cabot 1992), thus providing an ecosystem service.

Considering the lack of information regarding the diet and feeding habits of the Yellow-legged Tinamou, in this study we aimed to analyze the stomach content of *C. n. noctivagus* and to identify food items at specific level, in order to contribute to the knowledge about Tinamidae trophic ecology in seasonal deciduous forest. The study area is located in a forest fragment (30°05'35.3"S, 53°36'22.9"W) between the municipalities of São Sepé and Formigueiro (Figure 1), central portion of the Rio Grande do Sul state, Brazil (Corrêa *et al.* 2010). The region climate is considered as temperate, with an average annual temperature of 19°C and average annual precipitation of 1,750mm (Alvares *et al.* 2013). The region belongs to the Pampa Biome and presents seasonal deciduous forest, and is under intense anthropogenic pressure due to the expansion of the agriculture frontier (IBGE 2004).

Between 2015 and 2016, we conducted field work in order to collect ecological information of *C. n. noctivagus* in the study area. In November 2016, when individuals were captured using a bell-trap (Corrêa & Petry 2018) and manipulated by researchers in order to collect biological samples, one specimen (adult female) came to death. The specimen was frozen and brought to the Laboratório de Ornitologia e Animais Marinhos at the Universidade do Vale do Rio dos Sinos, Rio Grande do Sul state, Brazil. Then, the specimen was deposited in the scientific collection of the Museu de Zoologia of the Universidade do Vale do Rio dos Sinos (MZU-973). The specimen presented the following measures: 29.53 mm of bill length, 65.51 mm of head length, 59.22 mm of tarsus length, 180 mm of wing length, 60 mm of tail length, 333 mm of total body length and 670 g of total body mass.

The stomach content was removed from the ventriculus and proventriculus of the specimen and separated into categories, using tweezers and Petri



**Figure 1.** Study area, forest remnant with about 450 ha located between São Sepé and Formigueiro municipalities, in the Pampa Biome, Rio Grande do Sul state, Brazil.

dishes, and identified using a stereomicroscope. Items were separated into the following categories: arthropods, seeds and rock fragments. For arthropod identification we followed Specht *et al.* (2008) and Triplehorn & Johnson (2011). In the following year, 2017, during the same season when the *C. n. noctivagus* specimen was collected, we randomly searched for fruits and seeds on the ground in the study area, for further comparison with the vegetable items found in the stomach content. We followed Longhi (1995), Lorenzi (2000) and Backes & Irgang (2002) for fruit and seed identification. All food items were quantified and weighed using a precision balance Bel-modelo MARK M 1003. The capture techniques were both approved by System of Authorization and Information of Biodiversity (SISBIO, Nº 47126-3) and by the Ethics Committee on the Use of Animals in Research (CEUA, number PPECEUI0.2014), Universidade do Vale do Rio dos Sinos.

Plant items were found, composed by seeds of Lauraceae (*Nectandra megapotamica*) and Myrtaceae (*Myrcianthes gigantea*). Two seeds and a few fragments were not possible to identify. Seeds were the most representative items in the

stomach content of *C. n. noctivagus*, specially *N. megapotamica* (1.773 g). We found two insect Orders in the diet of *C. n. noctivagus*: Coleoptera and Lepidoptera, besides fragments of insects of the same Orders which were not possible to identify at a specific level. We found one specimen of the family Curculionidae, order Coleoptera. Representing the Order Lepidoptera, one larval specimen of *Dirphia muscosa* (Family Saturniidae) was identified. Rock fragments were also found (Table 1).

Regarding vegetable items, *N. megapotamica* was the predominant species in the diet of this *C. n. noctivagus* specimen. According to Krügel *et al.* (2006), in a study conducted in the Rio Grande do Sul state, *N. megapotamica* fruits were consumed by bird species that forage during flight (*e.g.*, Tyrannidae and Trogonidae), and also by those that forage landed (*e.g.*, Cracidae, Psittacidae and Emberizidae), especially during spring and summer, which comprises the fruiting period. Therefore, *N. megapotamica* may represents an important food resource for the avifauna (Frisch & Frisch 2005), thus contributing to the forest ecosystem maintenance through consumer-resource interactions. To a lesser extent, among vegetable items, we found *M. gigantea* composing the diet of *C. n. noctivagus*. *Myrcianthes gigantea* is also an abundant species in the central portion of the state of Rio Grande do Sul, presenting fruiting period between spring and summer (Longhi 1995). The presence of this species in the stomach content indicates that, during this period of the year, it represents an important food resource for large birds such as *C. n. noctivagus*. Especially because

these seasons coincides with the species breeding period, when the energy demands of individuals are higher in order to perform courtship, egg laying, incubation and chick rearing (*e.g.*, Sick 1984, Cabot 1992).

The Yellow-legged Tinamou provides important ecosystem services, since it is considered a seed disperser due to the great amount of seeds found in the species diet, along with the high capacity of locomotion within the forest, thus promoting seed dispersion over long distances. It is known that forest tinamous present great viewing capacity, using this sense to explore foraging environments, searching for fruits, seeds and potential prey on the ground (Cabot 1992, Sick 1997). Frugivorous birds explore a wide variety of fruits, which may be available on the ground or in the trees, according to the period, in order to attend its trophic demands (Andrade 1997, Sick 1997, Pizo & Galetti 2010). Fruits of *N. megapotamica* are about 1.5 cm length, when ripe are aromatic and attractive, presenting reddish coloration. Each fruit presents one seed, which is greenish/brownish (Longhi 1995). *Myrcianthes gigantea* fruits, when ripe, are about 1 cm length, reddish, and may contain up to two seeds of yellowish tones (Lorenzi 2000, Backes & Irgang 2002). Our results corroborate such information, since the vegetable items found in the stomach content of *C. n. noctivagus* were derived from reddish-colored fruits. Fruits of both species fall on the ground when reach maturity (Longhi 1995, Backes & Irgang 2002), becoming a foraging resource for the terrestrial local fauna.

**Table 1.** Food items found in the stomach content of *Crypturellus noctivagus noctivagus* (Tinamiformes, Tinamidae) in the Rio Grande do Sul state. UN = Number of items; BI =total biomass in each category.

| Category        | Order        | Family        | Species                       | UN       | BI (g) |
|-----------------|--------------|---------------|-------------------------------|----------|--------|
| Seeds           | Myrtales     | Myrtaceae     | <i>Myrciathes gigantea</i>    | 05       | 0.250  |
|                 | Lurales      | Lauraceae     | <i>Nectandra megapotamica</i> | 30       | 1.773  |
|                 | Undetermined |               |                               | 02       | 0.100  |
| Seeds fragments | Undetermined |               |                               | 09       | 0.136  |
| Insects         | Lepidoptera  | Saturniidae   | <i>Dirphia muscosa</i>        | 01       | 0.608  |
|                 |              | Undetermined  |                               | 05 frag. | 0.002  |
|                 | Coleoptera   | Curculionidae | Undetermined                  | 01       | 0.020  |
| Insect fragmens | Undetermined |               |                               | 12       | 0.007  |
| Rock fragments  |              |               |                               | 54       | 1.741  |

During the breeding season, when a higher energy demand is required, some bird species may complement their diets by feeding on invertebrates/arthropods, being considered as opportunistic frugivorous (Krügel *et al.* 2006). The low arthropod biomass found in our study for this single specimen indicates that invertebrates were consumed as supplementary resources, which suggests that the Yellow-legged Tinamou is a large frugivorous bird. However, it is important to investigate the diet of other specimens to infer such conclusion. Bugs of the family Curculionidae feed on live and dead plants and adult individuals may penetrate and remain within fruits for a certain time (Triplehorn & Johnson 2011). Considering that the Yellow-legged Tinamou forages on the ground (Berlepsch & Ihering 1885, Sick 1984), it is possible that the bug found in the stomach content was ingested as an indirect resource, along with a consumed fruit, or even among the litter. Lepidoptera, even in low occurrence, was present in the diet of *C. n. noctivagus*, represented by one larval specimen of *D. muscosa*. It is an abundant species in southern Brazil, which uses native and/or exotic plants as hosts during larval development (Specht *et al.* 2005, Specht *et al.* 2008). Most caterpillars of this group become pupae in silk chrysalises fixed in leaves on the trees, although some species becomes pupae in leaves on the ground (Specht *et al.* 2008, Triplehorn & Johnson 2011), where it probably has been ingested by *C. n. noctivagus*. Rock fragments presented the second largest mass among all items found in the stomach content. The ingestion of such fragments by birds improves the digestive process by aiding the trituration of food items. The behavior of ingesting rocks is common in tinamous species due to the habit of such birds of feeding on seeds (Cabot 1992, Sick 1997).

Among forest birds, large frugivorous such as the Yellow-legged Tinamou are among the most threatened species (Sick 1984, Cabot 1992), since they need fruit availability over the whole year (Willis 1979, Gray *et al.* 2007). Thus, management measures are extremely needed for the conservation of frugivorous biodiversity in forest remnants in the Rio Grande do Sul state. In our study, *C. n. noctivagus* presented a seed-based diet, specially derived from *N. megapotamica* fruits, as well as arthropods as complementary resources.

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