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Use of coconuts (*Cocos nucifera*: Arecaceae) as nutrient source by Northern Tamandua (*Tamandua mexicana*: Myrmecophagidae)

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ABSTRACT
Northern Tamandua relies on a diet primarily composed of eusocial insects. We have observed this species interacting with coconuts on the ground at Corcovado National Park, Costa Rica. The Tamandua inserts its snout into the coconuts and apparently drinks their contents. Occasionally we have observed the Tamandua holding the coconut, using its largest claws to open it from the side and consuming from the inside. However, besides potential drinking, it was not possible to determine precisely what else it ate, if anything. Coconut water serves as a source of essential elements, including iron and selenium, from which tamanduas may benefit.

Keywords: anteaters, coconut palm tree, Corcovado National Park, Costa Rica, fruits

RESUMEN – Uso de cocos (*Cocos nucifera*: Arecaceae) como fuente de nutrientes por parte del tamandúa (*Tamandua mexicana*: Myrmecophagidae). El tamandúa basa su dieta principalmente en insectos eusociales. Hemos observado a esta especie interactuando con cocos en el suelo del Parque Nacional Corcovado, Costa Rica. El Tamandúa introduce su hocico en los cocos y aparentemente bebe su contenido. En algunas ocasiones, lo hemos observado sosteniendo el coco con sus garras para abrirlo por un costado y consumir su interior. Sin embargo, además de, quizás beber, no nos fue posible determinar con precisión qué más comió, si es que comió algo. El agua de coco es una fuente de elementos esenciales, incluidos hierro y selenio, de los cuales los tamandúas pueden beneficiarse.

Palabras clave: Costa Rica, frutos, hormigueros, palma de coco, Parque Nacional Corcovado

Northern Tamandua (*Tamandua mexicana* Saussure, 1860: Myrmecophagidae) is distributed from Mexico to Peru and Venezuela, ranging from sea level to 1,600 m a. s. l. (Reid 2009). Although it inhabits various habitat types, it is most commonly found along watercourses, where there may be a higher concentration of prey, mainly ants

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and termites (Mora 2000). It measures 560 mm in head and body length and 400-675 mm in tail length, with a weight of 3-6 kg (Bertassoni 2018). The Northern Tamandua has a body covered in short, hard hair that can range in color from golden to brown, often featuring a distinctive black "V" marking on its back (Reid 2009). The skull is tubular and elongate, with small eyes, a toothless snout, and an elongated nose, which is a specialized adaptation aiding in foraging and feeding on their primary prey (Mora 2000; Navarrete & Ortega 2011). Tamanduas morphological alterations are most likely the result of their feeding style, which primarily consists of termites and ants (Patterson et al. 1992).

Northern Tamandua primarily relies on a diet composed almost entirely of ants and termites, occasionally supplemented with small amounts of fruit (Navarrete & Ortega 2011). They show a preference for relatively large insects measuring over 4 mm in length, such as *Camponotus*, *Azteca*, *Crematogaster*, and *Nasutitermes*, among others (Cuarón 2014). It has been observed that they can consume up to 9,000 insects per day, derived from approximately 50-80 different nests (Bertassoni 2018). Using their keen sense of smell, they locate the nests and then employ their powerful claws to dig into them. The ants are extracted using their long, slender, adhesive tongues, while the tamanduas appear to cause minimal permanent damage to the nests using only part of the nests to feed themselves. Besides, possibly their foraging time spent at each nest is limited before being repelled by the insects' natural defenses (Navarrete & Ortega 2011). When inactive, tamanduas rest in hollow trees, burrows of other animals, or any other natural shelter (Cuarón 2014). While foraging, it anchors its prehensile tail firmly to branches, allowing it to use both hands for tasks such as breaking termite nests (Mora 2000). Northern Tamandua is both diurnal and nocturnal, semi arboreal, and solitary (Reid 2009). When agitated, it emits an unpleasant odor (Rodrigues et al. 2008).

Coconut palm (*Cocos nucifera* L., 1753: Arecaceae) is a monotypic palm species (Gunn et al. 2011) with an uncertain origin, as there is ongoing debate regarding its precise nativity to either the tropical coasts of the Indo-Pacific or the Americas (Srivastava & Srivastava 2014). Recent genetic studies have provided insights into the central Indo-Pacific as the probable origin of the coconut palm, with its cultivation and dispersal closely associated with the early migrations of Austronesian peoples who carried coconuts during their voyages (Perera et al. 2008; Baudouin & Lebrun 2009). It has a pan-tropical distribution, occurring in coastal areas between the latitudes 20° north and south of the equator and at altitudes between sea level and 1,200 m (Perera et al. 2008), likely facilitated by the exceptional durability of its seed, which is well adapted for long-distance dispersal by oceanic currents (Foale 2003).

Coconut palm has been cultivated for centuries for its ornamental value, timber production, and its versatile fruit, the coconut. This palm tree can reach heights of up to 30 m (Pradeepkumar 2008). Its pinnate leaves have a yellowish-green hue and can grow to be 4 to 6 m long (Pradeepkumar 2008). The inflorescence, approximately 1 m in length, consists of yellow flowers arranged in panicles, with both male and female flowers present on the same inflorescence (Willmer 2011). The coconut is a drupe that starts off green or yellow and turns brown as it matures. It is highly valued for its pulp

and juice, the coconut water. This interior coconut water can remain in the closed fruit for up to eight months while retaining all of its qualities (Chan & Elevitch 2006). The fruit is also used in the manufacturing of soaps, oils, and various other products (Chan & Elevitch 2006).

The coconut fruit has an ovoid shape, measuring around 25 cm in length and weighing approximately 2.5 kg. The mesocarp is fibrous and brown, while the endocarp is woody and brown, containing three germination pores, these are small indentations or "eyes" on one end (Chan & Elevitch 2006). A single seed is attached to the endocarp, with the edible white flesh and the drinkable coconut water (Chan & Elevitch 2006). A coconut palm tree can produce up to 75 fruits per year, although more commonly it yields fewer than 30. It takes 5-6 months for the coconuts to reach their maximum size and they mature at around 10-13 months (Grimwood 1975). In the Caribbean islands, Central America and other countries, it is common to open green coconuts with a machete to extract the water from the fruit and consume it as a refreshing beverage (Chan & Elevitch 2006). Coconut palms are abundant in Corcovado National Park (CNP) in southwest Costa Rica, and coconuts are frequently found on the ground. This suggests that they could be exploited as a food resource by some vertebrates. Here, we present the first report of Northern Tamandua using coconuts, apparently for drinking coconut water and perhaps ingesting pulp.

We regularly lead guided hikes with tourists at Corcovado National Park (CNP), equipped with binoculars and a small telescope to observe wildlife. For the past 12 years, we have dedicated countless hours to hiking in the park and conducting observations. Corcovado National Park is situated in the Puerto Jiménez county on the southwestern coast of the Osa Peninsula in Costa Rica (Fig. 1). Established in 1975, this park serves as a vital sanctuary for the largest remaining expanse of lowland tropical rainforest on the Pacific side of Central America, boasting exceptional biodiversity (Foerster & Vaughan 2002). The mean annual temperature at CNP varies from 23 to 26.58 °C, influenced by elevation (Foerster & Vaughan 2002). This protected area receives 5,500–6,000 mm of precipitation annually, primarily during the rainy season in April through December (Kappelle 2016). We have encountered numerous Northern Tamanduas in CNP throughout our years of observation. Among these sightings, we have observed several instances of tamanduas interacting with coconuts including the apparent consumption of coconut water and even coconut pulp, but this behavior has not been reported before. The most recent observation occurred on 28 June 2023, along the Naranjos trail (latitude 8.4725; longitude -83.5905, datum: WGS84; Fig. 1). The included figures are frames from several videos that we have captured in CNP showing different aspects of tamanduas interacting with coconuts.

On at least nine occasions, we have observed Northern Tamandua interacting with coconuts on the ground. The Tamandua approaches the coconut from the end of the fruit where it appears soft (or possibly rotten) and takes hold of the coconut (Fig. 2A). On seven occasions, the Tamandua inserted its snout into the coconuts and apparently drank their contents (Fig. 2B). During these instances, the Tamandua used its largest claws to manipulate the coconuts, simultaneously flicking its tongue in and out of the

fruit seemingly to drink coconut water. It also utilized its prehensile tail to hold onto the coconut. While its apparent drinking, the Tamandua closed its eyes and remained in that position for several seconds (Fig. 2B). If undisturbed, it repeated the same process two or three times before leaving the coconut. On at least two occasions, the Tamandua was observed holding the coconut, using its largest claws to open it from the side and consuming from the inside (Fig. 3). We do not know if it consumed anything besides the coconut water, or even the water. The individual held the coconut using one forepaw and opened the fibrous exocarp and the woody endocarp by ripping it with its largest two claws against the ground. During this process, it used the claws on the opposite forepaw to pinch, scoop, and maybe scrape pulp out of the fruit while inserting its snout inside the coconut. However, it was not possible to determine precisely what it ate if anything. Nevertheless, in one of the videos, it seems clear to see the Tamandua drinking. This video can be viewed on the Costaricaguide/TikTok page (https://www.tiktok.com/@costaricaguide/video/7249201934022774021?is_from_webapp=1&sender_device=pc&web_id=7241231254254994949).

While anteaters are obligate specialist predators of ants and termites, there have been observations of Northern Tamanduas consuming the much smaller fruits of the palm tree *Attalea butyracea* (Mutis ex L.f.) Wess. Boer, 1988 (Brown 2011). However, there have been no previous reports of Northern Tamanduas consuming coconut, either its pulp or water. It is possible that fruit consumption in general by anteaters in the wild is a common event. Seeds have been found in fecal samples of the giant anteater *Myrmecophaga tridactyla* Linnaeus, 1758, and in fecal and stomach samples of the Southern Tamandua *Tamandua tetradactyla* Linnaeus, 1758 (Corrêa Vaz et al. 2018). Diet of this last species is also based on social ants and termites, mimics of social insects, along with occasional fruit (Hayssen 2011). Their mouth morphology makes it difficult for them to ingest seeds; however, they can consume pulp. Consequently, it is challenging to find seeds in their feces as evidence of fruit consumption (Corrêa Vaz et al. 2018). This may explain why such behavior is perceived as uncommon (Brown 2011). An alternative explanation is that seeds were incidentally consumed while feeding on insects, including those living inside the fruit of *Attalea butyracea* in the case of the Northern Tamandua (van Eijk 2005; Corrêa Vaz et al. 2018). Nevertheless, anteaters in captivity are regularly maintained on diets that include a wide variety of fruits, in addition to other foods. It remains unclear how fruits became part of the standard captive diet since reports of wild anteaters consuming fruit are exceedingly scarce (Brown 2011).

The consumption of coconut water (and pulp) by anteaters could be a response to seasons of reduced availability and variability of food sources and other essential resources. The proportion in which anteaters consume ants and termites often varies based on seasonality and their availability (Navarrete & Ortega 2011). During the wet season in Panama, tamanduas consume fewer termites (Montgomery 1985). Feeding at carton nests primarily occurs when these nests contain winged reproductives, nymphs, or ants living in association with the termites (Lubin & Montgomery 1981). Termites (*Nasutitermes*) in nests are not preferred but are eaten when found in wood (Montgomery & Lubin 1977).

Additionally, anteaters ingest significant amounts of inorganic material such as sand and soil, from which ant and termite colonies are constructed (Bertassoni 2018). This author noted that some studies found that the concentration of iron was four times higher in tamanduas that had consumed such material. It was suggested that the additional iron, as well as selenium, might come from the soil or termite nest material (Bertassoni 2018). The need for these types of essential nutrients by anteaters, their availability, and their seasonality remain unknown in PNC.

We are not sure if the Northern Tamandua is consuming pulp or something else from coconuts in CNP; however, it seems evident it drinks coconut water. Coconut water can remain undamaged inside fruits on the ground for up to eight months (Chan & Elevitch 2006). There is a possibility that some insects or their larvae have entered the coconuts that have been on the ground for several weeks or months, and this is what the Tamandua is consuming. Although fly larvae were observed trying to escape from the ripe fruits of *Attalea butyracea* that the Northern Tamandua consumed on a Panamanian rain forest (van Eijk 2005), no fly larvae were apparent in the detailed observations of the anteaters feeding on the fruits of the same palm species also in Panama (Brown 2011). Additionally, in this last case, five discarded fruits showed no evidence of insect infestation (Brown 2011).

In any case, we noted in CNP that at least part of the coconut water is extracted and consumed by Northern Tamandua. Coconut water has been shown to be a source of essential elements, including iron and selenium (Lima et al. 2015; Zulaikhah 2019; Alchoubassi et al. 2020). It contains plenty of other minerals such as potassium, calcium, magnesium, sodium, phosphorus, zinc, manganese, copper, sulfur, aluminum, boron, and chlorine (Yong et al. 2009). Therefore, coconut water could potentially serve as a source of essential minerals for tamanduas. Selenium, for example, is one of the micronutrients that form the GPx enzyme (Zulaikhah 2019), and its deficiency is responsible for cardiomyopathies, muscular dystrophy, and reproductive disorders in several animal species (Lima de Paiva Medeiros & Madeiros 2012).

We observed a Northern Tamandua at the Punta Mala Wildlife Refuge in the Central Pacific region of Costa Rica sitting on a bunch of green coconuts in March 2023 (Pers. Obs.). Although the Tamandua was moving over the small young coconuts, we could not determine if it was attempting to open or consume the fruits. It should be noted that at least the iron content of coconut water does not vary at different stages of coconut development (Appaiah et al. 2015). Therefore, tamanduas could be utilizing coconut water and perhaps pulp, or even other related fruits, more frequently than previously observed. Northern Tamanduas are commonly found in CNP, where coconut and other palm trees are abundant. Additionally, termite nests are prevalent in the area, serving as a food source not only for this species but also for several others. Anteaters complement their primary food resources with essential nutrients found in coconuts, which demonstrates a more significant utilization of the resources available in this location. The information provided here suggests a greater dietary flexibility among anteaters than we had previously imagined, and this may be the case for several other species in the area.

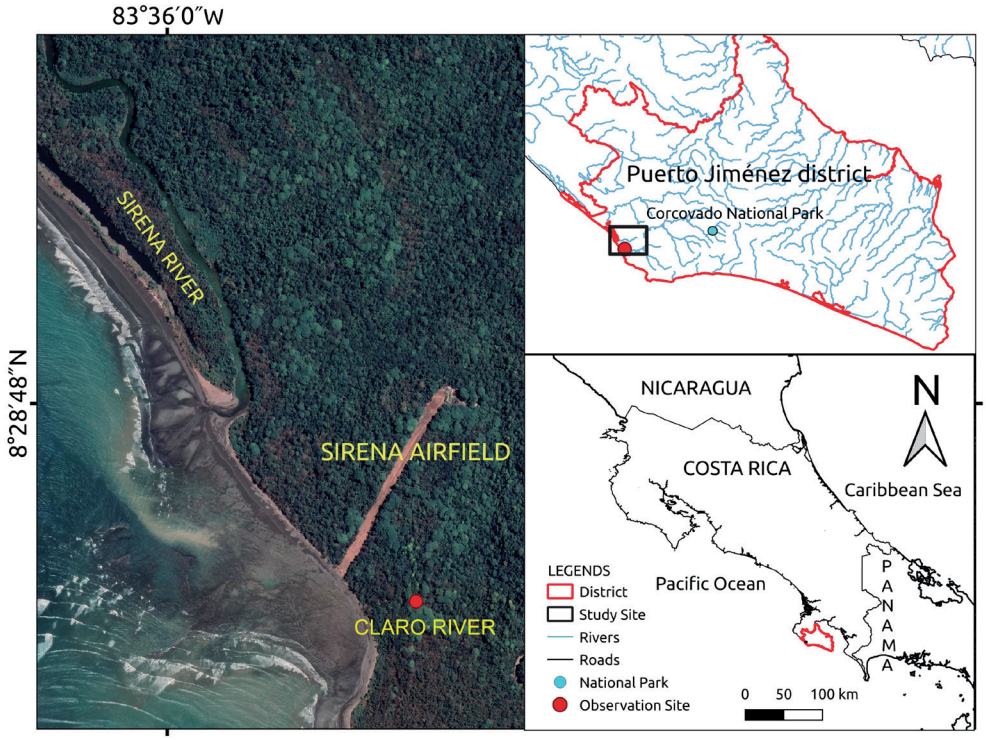

Figure 1. One of the sites (red dot) where Northern Tamandua (*Tamandua mexicana*) used coconuts as nutrient source at the Sirena sector of Corcovado National Park, Costa Rica. Map designed by G. Chaves.

Figure 2. Frame from video showing A) A Northern tamandua (*Tamandua mexicana*) has found a coconut and apparently is ready to drink coconut water; B) the tamandua during an apparent drinking interval. Sirena sector, Corcovado National Park, Costa Rica. Video by Dionisio Paniagua.

Figure 3. Frame from video showing a Northern tamandua (*Tamandua mexicana*) opening a coconut by the side using its largest claws to manipulate the fruit. Sirena sector, Corcovado National Park, Costa Rica. Video by Dionisio Paniagua.

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