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ANIMAL SCIENCE

Historical natural history collections allow the description of a new and presumably extinct species of dwarf gecko (Squamata: Gekkonidae: *Lygodactylus* Gray, 1864) from Fernando de Noronha Island, Brazil

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Abstract: A series of specimens of an unidentified species of the genus *Lygodactylus* from Fernando de Noronha Island were found in the herpetological collections of the Museu Nacional, Rio de Janeiro (Brazil). No species of this genus were known to occur in the archipelago. A review of the historical reports regarding the herpetofauna of the island failed to provide evidence regarding the presence of the species in the last centuries. Morphological comparisons with the two other species of the genus occurring in South America, *L. klugei* and *L. wetzeli*, allowed us to confidently confirm that the Fernando de Noronha population belonged to a putatively new species. Here we describe this population as a new species and discuss its possible extinction causes in the archipelago. We also debate the importance of historical natural history collections to the study of biodiversity.

Key words: Taxonomy, reptiles, Herpetofauna, species discovery, museums.

INTRODUCTION

Natural history museums and its collections are a tool of uttermost importance for biological research, as they serve as an unparalleled database on the occurrence and geographic and temporal distribution of life on our planet (Suarez & Tsutsui 2004). Contrary to the widespread idea that museums are mostly a place for running exhibitions or that the research interest of its collections is now mostly diminished, these institutions play an ever-growing decisive role in the study and protection of the world's biodiversity (Watanabe 2019). Currently, novel approaches, such as museomics or computer-tomography (CT) scannings are being able to retrieve new layers of data from these collections, helping researchers worldwide to tackle both fundamental scientific research to the modern-day challenges such as climate change, pandemics or the ongoing mass extinction (Hilton et al. 2021). Taxonomic work remains, however, one of the main activities associated with museums and natural history collections. Since the establishment of the first modern and scientifically oriented collections in the mid-eighteenth century, museums have been intrinsically associated with taxonomic works, and taxonomy itself cannot survive without such institutions. This obviously roots in the fact that taxonomists rely on the existence of collections for comparative studies, but also due to the need of the deposit the name-bearing specimens, i.e. the types, of their newly described taxa in such collections in order to

fulfill the two main requirement of the scientific method: objectivity and replicability (Mayr & Ashlock 1991).

With thousands of specimens to review and a considerable small taxonomic workforce, many specimens housed in natural history museums still await to be reviewed by experts. Fontaine et al. (2012) showed that many new species wait for decades on museum shelves until they are properly studied by taxonomists and subsequently described. Proving Fontaine et al. (2012) results, in the recent years several vertebrate species have been found and described based on the reexamination of historical collections hold in natural history museums across the world (Gippoliti & Amori 2011, Helgen et al. 2013, Velazco & Patterson 2014, Ceríaco 2015, Koch et al. 2019, Marques et al. 2020, Ceríaco et al. 2021). The present study presents a similar case, in which specimens were forgotten for an extraordinary period of almost 150 years.

While going through historical specimens at the herpetological collections of the Museu Nacional, Universidade Federal do Rio de Janeiro (MNRJ; see Sabaj 2020), we found two jars containing specimens of an unidentified species of the genus *Lygodactylus* Gray, 1864, from Fernando de Noronha archipelago, northeastern Brazil. Fernando de Noronha, a small volcanic archipelago in the equatorial South Atlantic, has been inhabited since the 17th century, when the outcasts of the Pernambuco Hereditary Captaincy established there in 1612 (D'Abbeville 1874). The archipelago is an important breeding site for several marine birds, including regionally threatened species such as *Puffinus lherminieri* Lesson, 1839, *Sula sula* Linnaeus, 1766, *Phaethon aethereus* Linnaeus, 1758, and *Phaethon lepturus* Daudin, 1802 (Micheletti et al. 2020). It also hosts a series of endemic species, such as the *Trachylepis atlantica* (Schmidt, 1945), *Amphisbaena ridleyi* Boulenger, 1890, or birds such as *Elaenia ridleyana* Sharpe, 1888, and *Vireo gracilirostris* Sharpe, 1890 (Micheletti et al. 2020). Such as the case of other oceanic islands, Fernando de Noronha native fauna is threatened by the introduction of several invasive species, such as domestic cats, dogs, brown and black rats (*Rattus norvegicus* Berkenhout, 1769, and *R. rattus* Linnaeus, 1758), house mice (*Mus musculus* (Linnaeus, 1758)), cururu-toads (*Rhinella diptycha* (Cope, 1862)), tegu lizards (*Salvator merianae* Duméril & Bibron, 1839), tropical house geckos (*Hemidactylus mabouia* (Moreau de Jonès, 1819)), cattle egrets (*Bubulcus ibis* (Linnaeus, 1758)), little fire ant (*Wasmannia auropunctata* (Roger, 1863)), rock cavys (*Kerodon rupestris* (Wied-Neuwied, 1820), and the and the mimosoid tree *Leucaena leucocephala* (Dias et al. 2017, Russel et al. 2018, Micheletti et al. 2020, Toledo et al. 2023). Zoonotic diseases, like salmonella and toxoplasmosis, have been linked to some of these invasive species (Micheletti et al. 2020).

Both of the jars bear the information that these specimens were collected by the North-American geologist John Casper Branner (1850–1922) in 1876 during the Comissão Geológica do Império (the Geological Commission of the Empire). One of the jars had a total of 10 specimens and nine eggs, presenting an old metal identification tag with the catalog number 1139. The label wrongly noted that the specimens were representatives of the Fernando de Noronha endemic *Mabuya punctata* [currently *Trachylepis atlantica*] studied by the ichthyologist Haroldo Travassos in 1942. The second jar contained a total of 42 specimens (41 adults and one neonate), also presenting an old metal identification tag with the catalog number 1194. Contrary to the first jar, there was no taxonomic identification.

According to the data available in the historical catalog of the reptile collection of

the MNRJ, all the lizard specimens that Branner collected in Fernando de Noronha in 1876 were originally in a single jar with the catalog number MNRJ 1094. No information exists about how many specimens were originally in this lot, but the catalog indicates that the lot was divided and new numbers were provided to the individual specimens and other lots. Currently, besides specimen MNRJ 1094, Branner's 1876 reptiles are distributed through the catalog numbers MNRJ 1101–1216, 12523–12568, and 12605–12632, corresponding to 192 specimens of *Trachylepis atlantica* and through MNRJ 27806–27815 (formerly 1139), MNRJ 27816 (formerly 1139), and MNRJ 27817–27858 (formerly 1194), corresponding to 52 specimens and nine eggs of *Lygodactylus* sp.

Species of the genus *Lygodactylus* may be characterized as small ("dwarf") diurnal geckos, usually arboreal and/or rupicolous, which occur throughout sub-Saharan Africa (including the oceanic islands of the Gulf of Guinea and Madagascar), and parts of South America (Gippner et al. 2021). It currently comprises 71 recognized species (Uetz et al. 2023), of which only two are endemic to continental South America. The first records of the genus in South America were provided in the late 1960s by Vanzolini (1968a, b). Vanzolini (1968a) referred to a few Brazilian specimens from the state of Baía, in Barreiras and Senhor do Bonfim, and one specimen from the state of Mato Grosso in Urucum. Subsequent papers (Vanzolini 1968b, 1974) discussed the biogeographic distribution of the genus in South America and provided additional records of specimens from Carnaubeira and Fazenda Campos Bons in the state of Pernambuco, and an additional "not very well preserved juvenile" from S. Luis de Cáceres in the State of Mato Grosso (Vanzolini 1974). According to Vanzolini (1974), all of these specimens belong to the same then yet unnamed species.

In the late 1970s Smith et al. (1977) described a new South American genus, *Vanzoia* Smith, Martin & Swain, 1877, which included two new species, *Vanzoia klugei* Smith, Martin & Swain, 1877, and *V. wetzeli* Smith, Martin & Swain, 1877. According to the authors, the new genus was "most closely related to *Lygodactylus*" from which it was "trenchantly distinctive in one respect – the possession of a very distinct escutcheon in males". The species descriptions were based on part of the specimens previously reported by Vanzolini (1968a, b, 1974). *Vanzoia klugei* was described based on specimens from the State of Pernambuco, of which 9 where from Carnaubeira (holotype + 8 paratypes) and one specimen (one paratype) from Fazenda Campos Bons in Floresta do Navio. *Vanzoia wetzeli* was described based on the specimen from Urucum, state of Mato Grosso, previously referred by Vanzolini (1968a), and which became the holotype, and an additional specimen (paratype) from Colonia Fenheim Filadelfia, in Paraguay. Vanzolini et al. (1980) presented additional morphological and natural history data for *Vanzoia klugei*, noting that the species was distributed in the Caatingas habitat, from Paraíba to northern Baía.

The validity of the genus *Vanzoia* has been questioned since its creation (Bons & Pasteur 1977). The first molecular confirmation that the South American species belonged to the genus *Lygodactylus* was presented by Gamble et al. (2011), who noted that the genus has arrived to the continent via trans-Atlantic dispersal around 25 Mya. Lanna et al. (2018) results confirmed the monophyly of South American *Lygodactylus*, estimating the divergence between the African and South American taxa in about 29 Mya, reaching South American from a single colonization event. Lanna et al. (2018) also found considerable cryptic divergence within South American *Lygodactylus*, with three putative new species (two in the Caatinga - *L.* sp. 1 and *L.* sp. 2

– and one endemic to the seasonally dry tropical forest enclaves within the Cerrado habitat - *L.* sp. 3). In the most recent and complete molecular phylogeny of the genus, Gippner et al. (2021) grouped the *L. klugei* group within a group including African taxa, such as the *L. picturatus*, *L. fischeri* and *L. angularis* groups. Gippner et al. (2021) estimated that the trans-Atlantic dispersal event of the South American *Lygodactylus* took place during the early Miocene (21.9 mya; 15.1-29.7 mya), about 7 my earlier than estimated by Lanna et al. (2018). Gippner et al. (2021) also suggested that the divergence between some of the putative new species presented by Lanna et al. (2018) (e.g. *L. wetzeli* and *L.* sp. 3) could be too low to represent a species level divergence. This is apparently also supported by the results of Lanna et al. (2020). In the last decades, the number of known localities where the South American *Lygodactylus* taxa occur increased considerably (see Lanna et al. 2018, 2020).

There are currently no known records of the presence of a population of the genus *Lygodactylus* in the island of Fernando de Noronha and Branner's specimens appear to belong to a population that has been extirpated from the island, similar to what happened to several other Fernando de Noronha endemic vertebrate (Olson 1981, Carleton & Olson 1999). Here we review the specimens and present evidence that support that they belong to undescribed and possibly extinct species from Fernando de Noronha.

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MATERIALS AND METHODS

We combined historical analysis with traditional morphological examination of the specimens. For the historical analysis, we reviewed the reports of previous naturalists who explored and provided data regarding the herpetofauna of Fernando de Noronha since the early 1500 to the present day (Webster 1834a, b, Thomson & Murray 1885, Branner 1888, Ridley 1888, 1890, Olson 1981, Oren 1984).

For mensural and meristic comparisons we examined 73 specimens of *Lygodactylus* specimens deposited in the collections of the MNRJ as well as in the collection of Museu de Zoologia da Universidade de São Paulo (MZSP), the Carnegie Museum of Natural History (CM), the American Museum of Natural History (AMNH), and the University of Colorado Museum of Natural History (UCM). All specimens examined are listed in the taxonomic accounts below and in the Appendix. Information on morphological characters of species that could not be examined, as well as supplemental data was obtained from the relevant literature (e.g., Smith et al. 1977, Vanzolini et al. 1980).

External morphological analyses followed the procedures of Marques et al. (2020). Dorsal and ventral background color and pattern, including throat were also observed. Morphometric data were recorded from preserved specimens, using Mitutoyo® digital calipers (0.1 mm) under a Zeiss® Stemi 2000C stereo-microscope. Measurements were collected on the right side of each specimen, or on the left side if the specimen was damaged: snout–vent length (SVL), measured from the tip of snout to anterior margin of vent; trunk length (TrunkL), distance between the fore- and hindlimbs; tail length (TL), measured from cloaca to tip of tail; tail width (TW), measured in the most thickness part of tail; head length (HL), measured form tip of snout to anterior tympanum border; head width (HW), measured at the broadest part; head height (HH), measured from the base of the lower jaw to the top of head; ear length (EarL); forearm

length (ForeaL), measured from the elbow to the wrist; eye diameter (ED); nostrils-eye distance (NE), measured from the nostril to the anterior margin of eye; snout-eye distance (SE), measured from the tip of snout to the anterior margin of eye; eye-ear distance (EE) distance between the posterior margin of eye to the anterior margin of ear; inter-nostril distance (IN). Meristic data were also collected on the right side of each specimen, or on the left side if the specimen was damaged, except for precloacal pores and generation gland counts if field/museum tags obscured the right thigh. Scale counts included: number of precloacal pores (PCL); midbody row of dorsal scales (MRDS); midbody row of ventral scales (MRVS); fourth finger lamellae (FFingL), number of divided subdigital lamellae below fourth finger; fourth toe lamellae (FToeL), number of divided subdigital lamellae below fourth toe; conditions of mental scale: undivided or semi-divided by a suture; number of scales entering nostril; number of postmental; number of supralabials (SL); number of infralabials (IL); condition of contact of first infralabial with postmental or postpostmental. Terminology for hemipenis description follows Puente et al. (2009). Locality data are reported in the form of decimal degrees and use the WGS 84 map datum.

RESULTS

The revision of the available historical records on the herpetofauna of Fernando de Noronha archipelago fails to provide any previous record regarding the existence of a population of *Lygodactylus* on the island. Most of the authors extensively refer the population of the two currently known endemic species, the skink *Trachylepis atlantica* and the amphisbaenid *Amphisbaena ridleyi* and the introduced population of the tropical house gecko, *Hemidactylus mabouia*. Records a species currently not known to exist in the island, such as basilisks (genus *Basiliscus* Laurenti, 1768) are reported in some of the early nineteenth century reports, while the presence other invasive vertebrates (rats, cats, other reptiles and amphibians) start to be thoroughly reported. A detailed description of these reports is provided below.

The morphological revision of the extant specimens indicates that the Fernando de Noronha specimens differ from their mainland counterparts (*L. klugei* and *L. wetzeli*) in several diagnostic morphological characters (see Systematic account below). The combination of its geographic distribution and morphological distinctiveness, we confidently consider the Fernando de Noronha population as distinct taxon.

Historical reports on the herpetofauna of Fernando de Noronha

The first explorer to land on Fernando de Noronha was the Italian-born navigator Americo Vespúcio (1451–1512) in 1503. Vespúcio provided a brief report on the fauna of the island in which he noted that he had observed "green lizards with two tails and some snakes" (Vespúcio *in* Carleton & Olson 1999). The "green lizards with two tails" can be confidently assigned to the endemic *Trachylepis atlantica*, while the snake almost may represent the endemic *Amphisbaena ridleyi*.

In the early nineteenth century the expedition of the H.M.S. Chanticleer landed on the Island on two occasions, the first in 20 June 1828, with the party being in the island for six days and a second time between 12 June and 18 July 1830. The trip was reported by Webster (1834a, b), but there was no reference to the observation or collection of reptile specimens. However, some specimens were collected, as

Gray (1845) makes reference to the presence of some specimens "half grown, in spirits" of *Thysanodactylus bilineatus* [currently a synonym *of Basiliscus basiliscus* (Linnaeus, 1758)] and an adult and a juvenile "in spirits" of *Euprepis punctatus* [= *Trachylepis atlantica*] in the collections of the British Museum and collected in Fernando de Noronha by the team of the H.M.S. Chanticleer.

A subsequent report was made by Thomson & Murray (1885), from the H.M.S. Challenger expedition, who visited the Island on 1 and 2 September 1873. According to this report:

> "Two Lizards which are South American in their affinities occur in the islands, *Thysanodactylus bilineatus*, one of the Iguanidae, occurs also in South America; the genus is distinguished by a scaly projection on the outer side of the hinder toes; this Lizard, which was originally obtained on the island by the officers of H.M.S. "Chanticleer", was not met with. The other Lizard, *Euprepes punctatus*, belongs to the Scincidae, and is peculiar to Fernando Noronha, its nearest ally, *Euprepes maculatus*, inhabiting Demerara; it is very abundant on the main Island, and especially so on Mount St. Michael; some specimens are more than a foot in length."

While the records of the presence of *T. atlantica* on the island are unsurprising, the records of a juvenile *Basiliscus basiliscus* are considerably strange, as the species is endemic to Central America and not known to occur in the region (see Uetz et al. 2023). The specimens reported to Gray (1845) are apparently lost, so we can either speculate if they represented indeed some juveniles of *B. basiliscus* with a mislabeled locality, another possible currently extinct form, or simply a case of misidentification.

As part of his report on the 1876 Geological Commission of the Empire, Branner (1888) dedicates a good trench of text to his observations of the reptiles in Fernando de Noronha:

> "Perhaps the most interesting vertebrate found on Fernando is a species of lizard – *Mabina* [sic] *punctatas* [=*Trachylepis atlantica*]. The cultivation of almost all the tillable land on the island has had the tendency to drive these lizards into the rocky corners and uncultivated places, where they exist in such great numbers as to cause one to wonder how so many of them manage to live on so small an island. As they are but little disturbed and have no natural enemies here, they are not very timid. Walking over the open, rocky places where there is no vegetation one may see the lizards withdrawing down the sides of the rock fragments apparently with much reluctance, at a distance of from three to six feet ahead of him. If he turn and look behind he will find them rapidly closing up the space yielded him for a passage. While seated upon the bare rocks I have often observed these little animals watching me, apparently with as much curiosity as I watched them, turning their heads from side to side as if in an effort to be wise. If I kept quiet for a few minutes they would creep up to me and finally up on me; if I moved, they ran down the faces of the rocks, and turning, stuck their heads above the edges to watch me. I caught a great many of them by keeping quiet until they came within easy reach and then snatched them. They bite freely but their teeth are too short and weak to inflict a severe wound. Upon one occasion when climbing with my photographic

> apparatus up a steep bluff, where great care and attention had to be given to every step and motion, my movements were not sufficiently rapid and decided to keep the lizards off my person, and as neither of my hands was free, they became offensively familiar. Several of them crawled leisurely over me examining my clothing and my person, and one even got up the leg of my trousers and for nearly an hour crept around and around my waist just below the band of my trousers. I was told by the inhabitants that there was another kind of a lizard on the island which had two tails. I found, however, that the so-called forked-tailed lizard was the same as the above mentioned one. The tail of this species is long and slender, and is so easily broken that it was quite difficult to catch one without breaking off a portion of its tail. If the piece broken does not fall off entirely the break may heal over sufficiently to hold it securely, while the growing out of the new tail gives the lizard a forked or double one. I have seen it stated, I believe in the Challenger reports that this species has never been found elsewhere in the world than upon Fernando de Noronha, and that the species to which it is most nearly related occurs in Demerara. I saw no snakes upon the island, and the old residents say there are none, save what is known in Brazil as the *cobra cega* (blind snake) or *cobra de duas cabeças* (double-headed snake). I found one specimen of this. It is a species of *Amphisbaena*".

According to Branner (1888), all of the specimens collected in Fernando de Noronha were deposited in the MNRJ. Surprisingly, no geckos were noted by the author. Ridley (1888) also visited the island in August of 1887 and provided some additional data on the occurring reptiles. According to the author:

> "... there are three species of terrestrial reptiles – a Skink, *Mabuia punctata*; a new species of *Amphisbaena*; and the Common House Gecko. The Skink is very common, and occurs on all the islands; it is about six inches in length, and of an iridescent-brown colour; it is very tame, and if the observer remains montionless will approach very close: it is apparently omnivorous. On one occasion when I had blown some doves' eggs, a Skink ran forward and drank up the yelk; another time, on throwing away the skins of some bananas we had been eating, the lizards ran up and carried them off, or ate them on the spot. The Amphisbaena lives under stones and in the soil, as is the general habit of these animals; a number we found in digging sweet potatoes on Rat Island. The House Gecko was very common in the houses, where it did good service against the mosquitos, and it also lived during the day between the petioles of the bananas. We found its eggs on one or two occasions, either lying loosely on the ground in the garden or in a hole in the stem of a papaw-tree: they were perfectly globular and white, about the size of a pea, and rather large for the size of the animal".

Interestingly, Ridley (1888) already raises concerns about the impacts of introduced rats and cats. According to the author "The Black Rat, which has been introduced, is exceedingly abundant and destructive, climbing the cocoa-nut palms and papaw-trees and devouring the fruit, and haunting the melon patches, where it does much mischief" while "The domestic cat has run wild in some of the islands. There was

one on Rat Island which had escaped from an Italian vessel wrecked there, and was living on the mice and doves". In a subsequent report, Ridley (1890) refers again the introduction of alien species to the islands:

> "... a considerable number of animals have been introduced by man into the islands intentionally and by accident: such, for instance, as the Gecko (*Hemidactylus mabouia*), the American cockroach (*Blatta americana*), and its curious parasite *Evania*, a spider, centipede, scorpion, rats and mice, and *Sitoplidus oryzae*. These, though usually plentiful on the main island around the houses, are markedly absent from the smaller islets.".

The reptile specimens collected by Ridley were examined and published by Boulenger *in* Ridley (1890): "Only three species were found, viz. a Gecko (*Hemidactylus mabouia*, Mor.), a Skink (*Mabuia punctata*, Gray) [= *Trachylepis atlantica*], and an *Amphisbaena*, described below [= *Amphisbaena ridleyi* Boulenger, 1890]. The Gecko is of a widely-distributed species, ranging over the greater part of Tropical America and Africa". Similarly to his contemporary authors and explorers of Fernando de Noronha, no reference was ever made to the presence of a species of the genus *Lygodactylus*.

The subsequent reports on the herpetofauna of Fernando de Noronha were only published almost a century later by Olson (1981) and Oren (1984). According to Olson (1981):

"The endemic lizard *Mabuya maculata* was extremely common, and in the late afternoon more than 40 individuals catching the last rays of the evening sun could be seen on each utility pole along certain sections of road. Since Ridley's report in 1890, a toad (*Bufo paracnemis* [=*Rhinella diptycha*]), the tegu lizard (*Tupinambis teguixin* [=*Salvator merianae*]), and a caviomorph rodent (*Kerodon rupestris*) have been successfully introduced to the island."

While Oren (1984) notes:

"The endemic lizard *Mabuya maculata* [=*Trachylepis atlantica*] is abundant in habitat with a good bush and arboreal cover, but it almost completely substituted by the Teju, *Tupinambis teguixin* [=*Salvator merianae*] in areas dominated by sheep and goats. According to the islanders, we were informed that a single couple of *T. teguixin* was introduced in 1960. In 1982 the species was dominant in certain parts of the Ilha Grande, although it was known to be used as a food item by the inhabitants. The juveniles were very common in the ground in fields dominated by sheeps and goats, running rapidly when a human approached. Contranstingly, the *Mabuya maculata* preferred tree and vertical surfaces, and showed a very gentle behavior, allowing humans to approach closely, even crawling in people who were seated. The gecko *Hemidactylus mabouia* was occasionally seen in houses at night. Its presence in the archipelago dates back at least from the nineteenth century, as Boulenger (1890) reported specimens collected by Ridley in 1887. Olson (1981) indicated that the endemic *Amphisbaena ridleyana*, the "two headed lizard", was common during his visit in 1973. However, we looked for the species in several places and we only found it once, hiding under the rocks in the front yard of the Governor. It is possible that *A. ridleyana* population is declining in the archipelago. The two amphibian species introduced, *Bufo paracnemis* [=*Rhinella diptycha*] and *Hyla ruber* [=*Scinax x-signatus*]are nocturnal. The number of Bufo individuals was impressive at night, when they crawled out of the sewers and other hiding places near the houses. Some of them reach impressive sizes, with more than 20 cm. The frog (*H. ruber*) was present in anthropogenic habitats, preferring bathrooms and other humid

environments inside houses. These two species of amphibians are not present in the previous reports on the zoology of the archipelago, and most likely were introduced during this century."

Modern revisions of the fauna of the archipelago have not cited any species of the genus *Lygodactylus* in Ferrnando de Noronha (Micheletti et al. 2020, Toledo et al. 2023).

Systematics

(Reptilia: Squamata: Gekkonidae)

***Lygodactylus neglectus* sp. nov.**

(Table I, Figs. 1-8)

ZooBank Life Science Identifier (LSID) - lsid:zoobank.org:act:0A151DAD-C06B-48B9-B3E3-54EC4CA90F41

Holotype. An adult male (MNRJ 27809, Figs. 1–8) collected at Fernando de Noronha Island, State of Pernambuco, northeastern Brazil [-3.8690º N, -32.4249 ºE], collected by John Casper Branner in 1876.

Paratypes. Fifty-one specimens, of which 18 are female (MNRJ 27812, 27814, 17818, 27819, 27823, 27824, 27825, 27828, 27832. 27834, 27838, 27840, 27841, 27842, 27849, 27851, 27853, 27857) and 33 are males (MNRJ 27806, 27807, 27808, 27810, 27811, 27813, 27815, 27817, 27820, 27821, 27822, 27826. 27827, 27829, 27830, 27830, 27831, 27833, 27835, 27836, 27837, 27839, 27843, 27844, 27845, 27846, 27847, 27848, 27850, 27852, 27854, 27855, 27856). All paratypes have the same collecting data as the holotype.

Diagnosis. A small sized *Lygodactylus* species, identified to genus by the following combination of characters: fully limbed, short and cylindrical body, short and rounded snout, small and granular dorsal scales, rudimentary inner toe, and precloacal pores present (Loveridge 1947, Pasteur 1965 [1964]). *Lygodactylus neglectus* **sp. nov.** is immediately distinguishable from the South American congener, *L. klugei* by a higher number of precloacal pores (7–8 in *L. neglectus* **sp. nov.** versus 3–5 in *L. klugei*). These pores are in an inverted V-shape row in *L. neglectus* **sp. nov.** while in *L. klugei* they are disposed of in an almost linear row (Fig. 2). *L. klugei* occurs in the Caatinga biomes in Bahia, Ceará, Piauí and Rio Grande do Norte states, while *L. neglectus* **sp. nov.** is only known from Fernando de Noronha archipelago. The new species can also be distinguished from *L. wetzeli* by the scalation on the top of the head. While in *L. neglectus* **sp. nov.** these scales are somewhat larger, in *L. wetzeli* the scales are about twice as small. This is particularly well visible on the internasals, in which in *L. neglectus* **sp. nov.** there are three internasals, while in *L. wetzeli* there are usually four to six (Fig. 3). The chin and gular regions of the males of *L. neglectus* **sp. nov.** are marked with a considerable number of irregular dark spots, while in *L. wetzeli* this coloration is not common. *L. wetzeli* is endemic to southwestern Brazil (Mato Grosso do Sul state), northern Paraguay and eastern Bolivia, while *L. neglectus* **sp. nov.** is only known from Fernando de Noronha archipelago.

Description of holotype. SVL 26.5 mm; TrunkL: 11.6 mm; CrusL 4.1 mm; TL: 26.6 mm; TW: 3.4 mm; HL: 8.1 mm; HW: 5.2 mm; HH: 3.3 mm; EarL: 0.5 mm; ED: 1.8 mm; NE: 2.5 mm; SE: 3.2 mm; EE: 2.2 mm; IN: 1.3 mm; IO: 2.3 mm. Head broad and slightly distinct from neck (Fig. 4); snout longer than broad, the distance from its edge to the anterior border of the eye greater than the interorbital distance anteriorly, and than the distance between the eye and ear opening (Fig. 5); ear opening small and roundish (Fig. 5); snout covered with enlarged flattened granular scales, larger anteriorly on snout, medium-sized on head of crown, becoming smaller laterally above the eye (Fig. 4); scales on the snout larger than those on the occiput (Fig. 4); canthus rostralis not prominent (Fig. 5); rostral pentagonal-shape, about as high as wide; two scales (one

Table I. Measurements and scale counts of the type series of *Lygodactylus neglectus* sp. nov. Abbreviations as indicated in the Materials and Methods section. All specimens from the MNRJ collection.

Catalogue number	Sex	SVL	TrunkL	TL	TW	HL	HW	HH	EARL	ED	NE	SE	EE	IN	PCL	MRDS	MRVS	FFingL	FToeL	SL	IL
27809 (holotype)	male	26,5	11,6	26,6	3,4	8,1	5,2	3,3	0,5	1,8	2,5	3,2	2,2	1,3	7	21	55	5	5	8/8	7/7
27806 (paratype)	male	28,3	12,7	26,8	3,5	7,4	5,2	3,8	0,5	1,8	3,1	3,6	2,8	1,4	8	22	57	5	5	9/9	8/8
27807 (paratype)	male	28	12,3	26,9	3,4	8	4,7	3,7	0,5	2	2,7	3,5	2,3	1,1	7	17	57	5	5	9/9	7/7
27808 (paratype)	male	29,1	13,6	27,8	3,7	8,2	5,1	3,3	0,5	1,8	3,1	3,4	2,5	1,3	8	22	58	5	5	8/8	7/7
27810 (paratype)	male	26,7	11,5	22,1	3	7,8	4,9	3,3	0,5	1,6	2,5	3,5	2,3	1,2	7	20	53	5	5	8/8	7/7
27811 (paratype)	male	27,5	12	22,8	3,5	7,9	5,2	3,5	0,5	1,6	2,5	3,5	2,3	1,4	7	22	56	5	5	7/7	7/7
27812 (paratype)	female	29,4	14,9	25,4	3,3	7,2	5,2	3,8	0,5	1,7	2,6	3,3	2,2	1,4	–	22	52	5	5	7/7	7/7
27813 (paratype)	male	28,7	12,8	27,1	3,4	8,2	5,3	3,6	0,5	1,8	2,9	3,4	2,6	1,2	6	25	49	5	5	8/8	7/6
27814 (paratype)	female	29,7	13,9	28,2	3,6	8,5	5,3	3,8	0,5	1,9	2,9	3,2	2,4	1,2	–	26	50	5	5	7/8	6/6
27815 (paratype)	male	29,1	14,2	26,1	3,5	8,3	5,7	3,9	0,5	2,1	2,6	3,4	2,5	1,1	7	25	51	5	5	7/8	7/7
27817 (paratype)	male	25,9	10,4	–	3,1	6,6	5,1	3,9	0,4	1,4	2,8	3,3	2,4	1,4	7	15	58	5	5	7/7	6/6
27818 (paratype)	female	28,2	14,3	–	3,3	7,4	5	3,5	0,5	1,5	2,8	3,5	2,4	1,3	–	21	57	5	5	7/7	6/6
27819 (paratype)	female	26,4	12,4	–	3,1	8,6	5,4	3,8	0,5	1,3	3,3	3,3	2,3	1,5	–	19	56	5	5	7/–	6/–
27820 (paratype)	male	27,1	12,6	–	3,4	8,1	5,1	3,9	0,5	1,6	2,9	3,7	2,4	1,2	7	20	58	5	5	8/8	7 /7
27821 (paratype)	male	27,8	12,6	–	3,3	6,9	4,9	3,7	0,6	1,4	2,7	3,5	2,4	1,5	7	19	56	5	5	8/8	6/6
27822 (paratype)	male	27,3	11,4	26,3	3,6	8	5,1	3,5	0,5	1,4	2,7	3,3	2,2	1,2	7	21	57	5	5	8/8	7/7
27823 (paratype)	female	29,1	12,8	–	3,6	8,3	5,2	3,7	0,5	1,6	2,9	3,6	2,7	1,3	–	18	55	5	5	7 /8	7/ 7
27824 (paratype)	female	27,4	11,5	–	2,9	7,3	5	3,6	0,4	1,6	2,7	3,5	2,4	1,4	–	20	61	5	5	8/7	6/6
27825 (paratype)	female	28,2	12,3	–	2,8	7,6	5,1	3,9	0,5	1,5	2,4	3,4	2,3	1,5	–	18	56	5	5	8/8	7/7
27826 (paratype)	male	28,8	12,3	–	3,3	7,2	5,3	3,9	0,5	1,5	2,8	3,7	2,6	1,4	7	17	54	5	5	7/8	7/7
27827 (paratype)	male	26,3	11,5	–	3,6	6,5	5,3	3,6	0,5	1,6	3,4	3,6	2,3	1,5	7	18	61	5	5	8/8	7/7
27828 (paratype)	female	27,8	12,8	–	3,1	6,5	5,5	3,9	0,5	1,6	3	3,5	2,3	1,5	–	19	57	5	5	8/8	6/6
27829 (paratype)	male	26,8	11	25,5	3,5	6,9	5,2	3,7	0,5	1,5	3,4	3,8	2,3	1,5	7	19	56	5	5	7/7	6/6
27830 (paratype)	male	27,5	12,1	11,1	3,2	7,1	4,8	3,8	0,5	1,5	2,6	3,5	2,2	1,4	7	20	57	5	5	7/7	7/7
27831 (paratype)	male	26,5	10,2	–	3	6,7	4,9	3,4	0,5	1,5	3,2	3,4	2,4	1,6	7	19	57	5	5	7/7	6/6
27832 (paratype)	female	29,1	13	–	3	8,7	5,4	4	0,5	1,7	3,3	3,8	2,4	1,2	–	18	50	5	5	7 /8	7 /6
27833 (paratype)	male	26,8	11,7	–	3,3	7,8	5	3,8	0,5	1,4	2,7	3,4	2,1	1,5	6	21	60	5	5	7/7	6/6
27834 (paratype)	female	26,2	11,2	19,6	2,8	7,4	4	3,2	0,5	1,3	2,5	3	2,3	1,4	–	17	58	5	5	6/7	6/5
27835 (paratype)	male	27,4	12	20	3,7	7,3	5,3	3,8	0,5	1,4	3,2	3,8	2,3	1,4	7	20	57	5	5	8/7	6/6
27836 (paratype)	male	26,6	12,2	–	3,1	7,2	5	4,1	0,7	1,5	3,1	3,6	2,2	1,6	–	17	58	5	5	7/–	6/–

Table I. Continuation.

27837 (paratype)	male	27,1	11,1	–	3,6	7	5	3,8	0,5	1,5	3,3	3,3	2,1	1,3	7	20	55	5	5	8/7	6/6
27838 (paratype)	female	29,4	12,8	18,7	2,5	7,4	4,6	3,8	0,5	1,5	3,3	3,6	2,4	1,5	–	19	58	5	5	7/7	6/7
27839 (paratype)	male	25,3	10,4	25,7	3,6	7,6	5,2	3,7	0,5	1,3	2,6	3,5	2,1	1,3	7	19	61	5	5	7/7	6/6
27840 (paratype)	female	25	12,3	22,3	3	6,7	4,9	3,9	0,5	1,6	3,2	3,5	2,4	1,5	–	19	58	5	5	8/8	7/7
27841 (paratype)	female	28,6	13,1	–	3,3	7,7	5	3,2	0,5	1,5	3	3,4	2,1	1,3	–	19	60	5	5	7/7	7/6
27842 (paratype)	female	27,2	12,7	–	3,1	7,4	5,1	3,9	0,5	1,5	2,8	3,5	2,3	1,3	–	15	62	5	5	7/7	7/7
27843 (paratype)	male	28,9	14,2	–	3,6	8,1	5	3,7	0,5	1,5	3,1	3,7	2,6	1,4	8	19	56	5	5	8/8	6/7
27844 (paratype)	male	24,7	11	–	2,6	7,2	4,4	3,3	0,5	1,4	2,7	3,1	2,2	1,3	8	20	58	5	5	7/7	6/6
27845 (paratype)	male	24,8	11,4	–	2,6	7,1	4,4	3,8	0,5	1,3	2,6	3	2	1,3	7	20	58	5	5	7/7	6/–
27846 (paratype)	male	25,7	11	–	3,1	7,1	4,7	3,7	0,5	1,5	2,5	3	2,2	1,6	7	19	53	5	5	8/7	7/6
27847 (paratype)	male	24,1	9,7	–	3,1	6,3	4,4	3,6	0,4	1,3	2,5	3,2	2,2	1,4	7	22	51	5	5	8/8	7/7
27848 (paratype)	male	26,7	11,3	20	3,2	6,7	–	–	0,4	1,4	2,6	3,4	2,3	1,4	7	17	56	5	5	8/8	7/–
27849 (paratype)	female	25	11	20	3,2	6	4,9	3,4	0,6	1,4	2,9	3,5	2,2	1,4	–	19	60	5	5	8/8	6/6
27850 (paratype)	male	22,8	9	–	3	6,2	4,7	3	0,5	1,5	2,6	3,2	–	1,4	7	19	58	5	5	7/7	6/–
27851 (paratype)	female	26,7	13,3	–	2,9	7	4,9	3,5	0,5	1,4	2,4	3,5	2,1	1,5	–	19	59	5	5	8/8	7/7
27852 (paratype)	male	25,3	11,3	25	3,6	–	–	–	–	–	3	–	–	–	7	17	58	5	5	7/–	6/–
27853 (paratype)	female	24,9	10,3	13,6	1,9	6	3,7	2,3	0,5	1,4	2,8	3,2	2,2	1,3	–	20	56	5	5	7/7	6/6
27854 (paratype)	male	23,5	8,6	–	1,6	5,9	3,4	2	0,5	1,3	2,8	3,2	2,1	1,4	7	22	58	5	5	7/7	6/6
27855 (paratype)	male	23,9	12	20,1	3,1	6	5,1	3,3	0,4	1,2	2,9	3,4	2,3	1,2	7	21	60	5	5	8/8	8/7
27856 (paratype)	male	24	9,4	–	3,2	6,6	4,7	3,6	0,5	1,5	3	3	2,2	1,2	7	17	56	5	5	7/7	6/6
27857 (paratype)	female	27,1	13	20,8	2,8	7,6	5,2	3,7	–	1,6	3,2	3,7	–	1,5	–	18	61	5	5	8/8	7/8

supranasal and 1st supralabial) entering the nostril (Fig. 5); nostrils pierced in the suture between supranasal and first supralabial (Fig. 5); nostril not in contact with rostral (Fig. 5); supranasals separated by a three internasal granular scales (Fig. 4); mental followed by enlarged scales, decreasing in size towards base of the throat and increasing on chest and belly (Fig. 6); supralabials 8/8; infralabials 6/6 (Fig. 5); smooth gulars, enlarged and forming transverse rows posteriorly, 25 between posterior extent of the infralabials/jaws; 21 midbody row of ventral scales (Fig. 6); 55 rows across dorsal midbody; limbs short but well developed, pentadactyl extremities; 1stdigit of both manus and pes extremely reduced and lacking claw, distal portions of remaining digits expanded, bearing claw; 5 pairs of lamellae under 4thdigit manus (Fig. 7) and 5 pairs of lamellae beneath 4th digit pes; dorsum with small, homogeneous, granular and smooth scales with a similar size to those on trunk, the scales on limbs are slightly larger; venter with homogeneous smooth scales; scales on ventral surface of the forelimbs smaller, granular and imbricate, hindlimbs scales are similar to those on venter, although the surface scales of thighs are smaller and imbricate, similar to those on the arm; precloacal pores 7 arranged

Figure 1. General view of the dorsal and ventral side of the holotype of *Lygodactylus neglectus* sp. nov. (MNRJ 27809). Photo by LMPC.

in a chevron shape; 38 to 40 generation glands – enlarged, glandular scales present along the ventral surface of each thigh (Fig. 8); tail cylindrical to slightly hexagonal; caudal scales dorsally enlarged, flattened and homogeneous; median subcaudal scales the same size as the remaining caudal scales, flattened and smooth. Coloration (in ethanol) is brown to above, with a narrowing continuous cinnamon brown band on the flanks from the neck to the base of the tail. Both band and dorsum irregularly marked by a series dark brown. The head same color as body and limbs, with two faint and thin darker brown bands extending from the anterior central part of the eye towards the upper nasal. The venter is cream to white with no markings or speckling. The chin and gular regions white to cream with a considerable number of irregular dark marking (Fig. 6). Dorsal part of the tail light brown, ventrally cream.

Variation. Variation in scalation and body measurements of the type series is reported in Table I. All the paratypes present are morphologically very similar to the holotype, without any relevant difference. Females don't present the precloacal pores and lack the irregular dark markings in the chin and gular regions, otherwise, they agree entirely with the holotype and male paratypes.

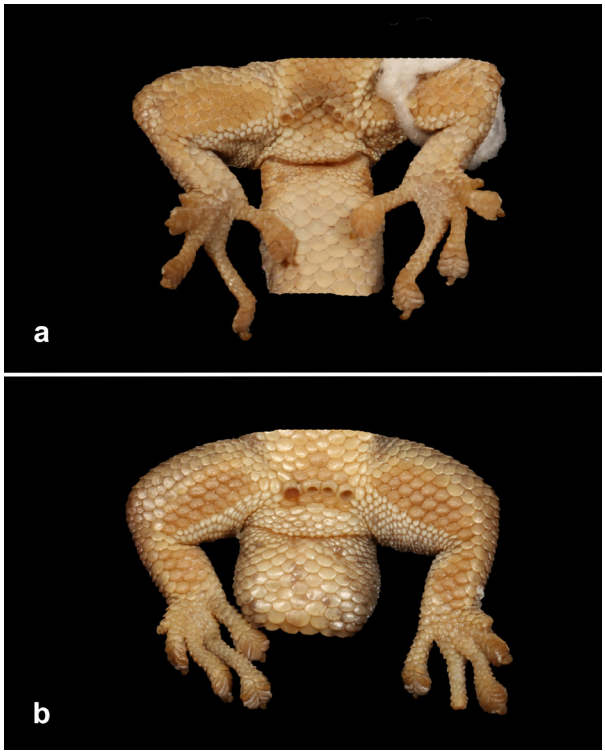

Figure 2. Comparison between the precloacal pores of the holotype *Lygodactylus neglectus* sp. nov. (MNRJ 27809; a) and those of the holotype of *L. klugei* (MZSP 22531; b).

Hemipenial morphology. Based on the partially everted hemipenis (MNRJ 27837; distal portion of each lobe remain inverted and tissue unfortunately is fragile to allow fully eversion procedure). Organ semi-everted and almost maximally expanded renders a slightly bilobed and subcylindrical hemipenis; hemipenial body nude without ornamentation, except for basal region of organ covered with pointed irregular papillae; papillae arranged into three longitudinal series to middle of organ; lobular region twice as wide as hemipenial body; lobes with serrated ridges (sensu Puente et al. 2009), most conspicuous on the asulcate face of lobes; sulcus spermaticus bifurcates on distal

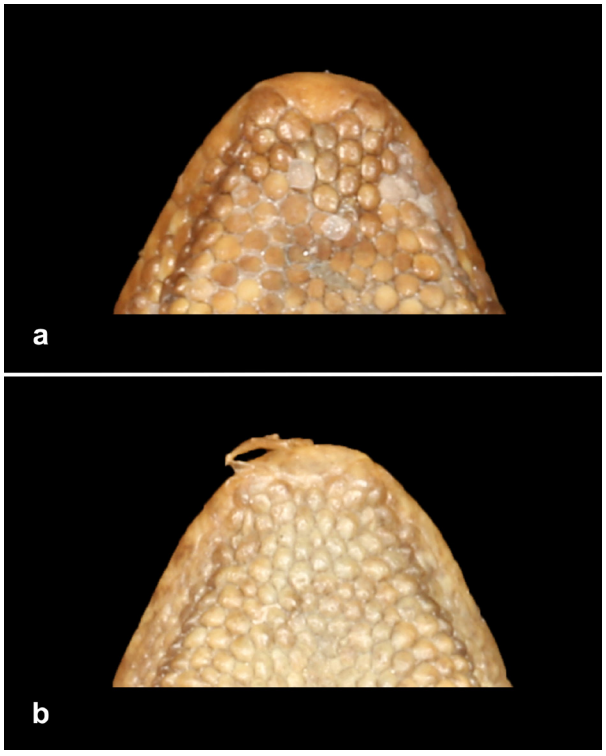

Figure 3. Comparison between the dorsal scales on the snout of the holotype *Lygodactylus neglectus* sp. nov. (MNRJ 27809; a) and those of the holotype of *L. wetzeli* (MZSP 7722; b).

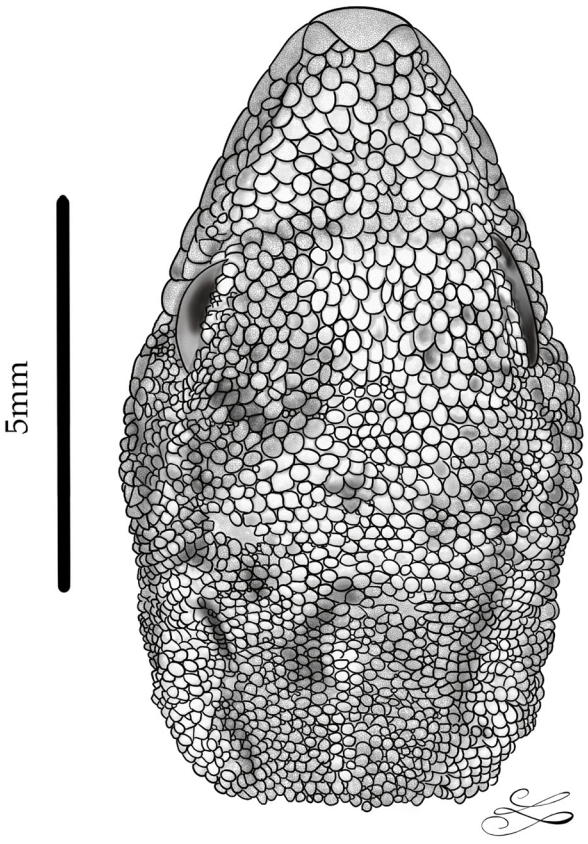

Figure 4. Drawing of the dorsal view of the head of the holotype *Lygodactylus neglectus* sp. nov. (MNRJ 27809).

part of organ with each branch centrifugally oriented, running to tip of lobes; sulcus spermaticus margins smooth and deep, with no ornamentation along its length.

Distribution and natural history. The new species is known only from Fernando de Noronha Island. The nine ellipsoid eggs (6.0–7.0; mean = 6.55; SD = 0.34) contained embryos. Most of these eggs present one of the ends symmetrically severed, probably due to the union with another egg from the same clutch, while two eggs remain connected to each other. Considering the relatively large size of each egg and high number of the offspring, it is possible that there was communal posture in *Lygodactylus neglectus* **sp. nov.**.

Etymology. The specific epithet "*neglectus*", used here as a nominative adjective, refers to the almost 150 years in which the type series of this species has been overlooked in the collections of the MNRJ. We suggest the English common name of Fernando de Noronha Dwarf Gecko, and the Portuguese common name of Briba de Fernando de Noronha.

DISCUSSION

The surprising discovery of a new endemic and putatively extinct species of gecko of the genus *Lygodactylus* from Fernando de Noronha island based on specimens collected more than 150 years ago is an important reminder of the importance of natural history collections as repository of the past and present biodiversity of our planet. These collections work as time-capsules, unrepeatable glimpses about the biota of a given place and time. The Branner

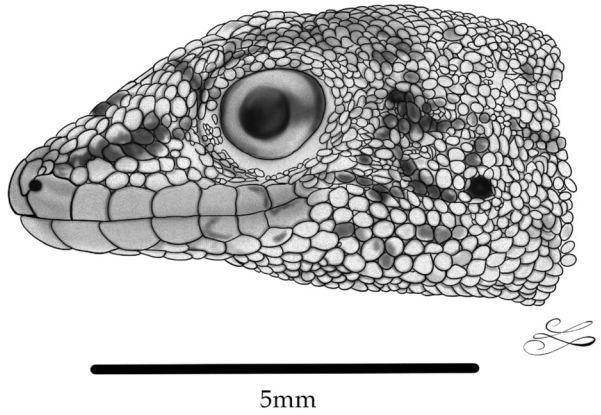

Figure 5. Drawing of the lateral view of the head of the holotype *Lygodactylus neglectus* sp. nov. (MNRJ 27809).

specimens, housed in the collections of the MNRJ and forgotten for decades, serve not only as the type series of a newly described species and, therefore, an important addition to our knowledge of Fernando de Noronha biodiversity, but also act as an important reminder of the impacts that humans have on the planet.

These impacts are especially felt in oceanic islands. Oceanic islands are unique reservoirs for biological diversity but have routinely been heavily negatively impacted following their discovery (Norder et al. 2020). The introduction of many alien species has led to a wave of extinctions following each major human colonization event, with the loss of endemic species (Doherty et al. 2016, Russel et al. 2017, 2018). Human commensal rodents have been the most unintentional introduced species (Jones et al. 2013). The rodent's introduction is usually followed by the arrival of domestic cats, which are used to control the rodents, causing further negative impacts on native endemic species (Nogales et al. 2013).

Several species are known to have been extirpated from Fernando de Noronha, such as the case of the extinct endemic sigmodontine rodent *Noronhomys vespuccii* Carleton & Olson, 1999. This species was described in the late 1990s by Carleton & Olson (1999) based on

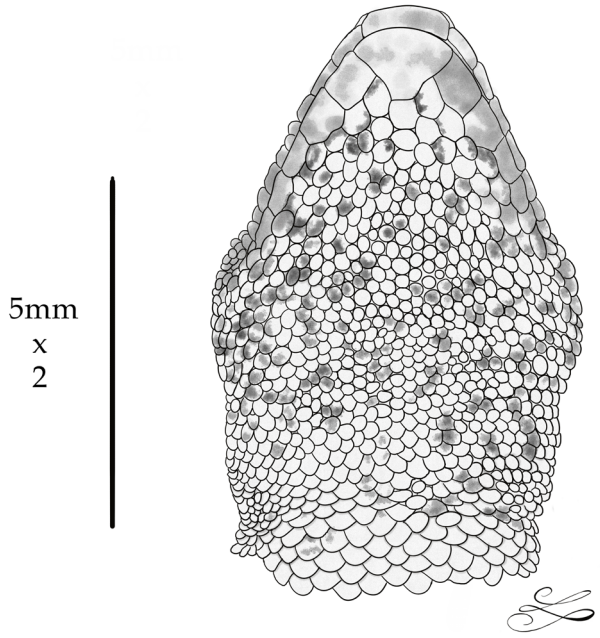

Figure 6. Drawing of the ventral view of the head of the holotype *Lygodactylus neglectus* sp. nov. (MNRJ 27809).

several crania, many mandibles with intact or partial tooth rows, and numerous postcranial elements collected in 1973 at beach dunes of the main island. According to the authors, Amerigo Vespucci itself has reported sightings of this species in the early 1500s, and argue that the introduction of other rodents, such as *Rattus rattus*, may have caused the species extinction. Olson (1981) also reported on the bones of a putative extinct endemic bird of the family Rallidae. The combination of deforestation, habitat loss and the introduction of other gecko species that compete with its habitat (*Hemidactylus mabouia*), and the invasive predators such as rats and domestic cats most likely explains the extinction of *Lygodactylus neglectus* **sp. nov.** This situation is very similar to that of the ecologically similar Reunion island endemic geckos *Phelsuma inexpectata* Mertens, 1966, which has almost been pushed to extinction due to the similar reasons (Sanchez & Probst 2011, 2014, Sanchez 2021).

The lack of historical reports regarding this species should be interpreted with caution. On

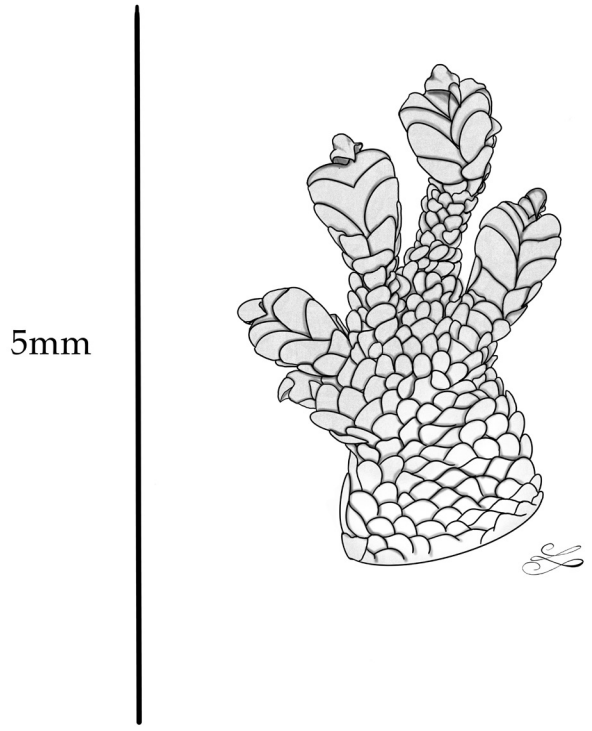

Figure 7. Drawing of the dorsal view of the manus of the holotype *Lygodactylus neglectus* sp. nov. (MNRJ 27809).

one hand, it can simply mean that the species was overlooked and neglected by Amerigo Vespucci and most of the nineteenth century explorers who visited the island. After all, the species is considerably small, and if it shares the same behavior and habitat selection as its South American congeners, it can easily be unnoticed by someone that is not actively looking for it. The first records of the continental species, *L. klugei* and *L. wetzeli*, have only been reported in the late 1960s (Vanzolini 1968a, b), which clearly show how animals of these species can go unnoticed by both scientists and the local population. Other hypothesis for the lack of reports could be the fact that the species was already rare or on the brink of extinction in the late nineteenth century. A much more intriguing issue is the fact that Branner (1888) himself has not referred to the species in his long and detailed account on the fauna of Fernando de Noronha. It is beyond reasonable doubt that the specimens were collected by Branner. Both the catalog information, the type of original tags, and the general appearance of the specimen point to the fact that these are indeed specimens collected by him during the Comissão Geológica do Império and appear to rule out the possibility that this is a case of specimen mislabeling. Given this, the explanation for lack of reference about these animals in Branner's accounts must lie in the fact that he was a geologist and either considered the *Lygodactylus* specimens as juveniles of *T. atlantica*, or simply was unsure about its identity and preferred to omit them for his accounts.

Guedes et al. (2020) modeled the time to description using biological and sociological variables in a time-to-event analysis. They found that the time lag was shorter when the collector of the type-series was an author of the species description, and that the species collected by non-taxonomists were "shelved" in scientific collection and remained to be properly identified for a much longer time. We believe Travassos (1946), an ichthyologist, confounded (or simply neglected) the presence of *Lygodactylus* specimen in Branner collections' and identified all of the lizards of Fernando de Noronha as *Trachylepis atlantica* (see Travassos 1946). This case reinforces the importance of preserving, reviewing and updating databases of historical collections in order to reduce the Linnean shortfall on Earth's biota.

While the newly described species can be readily distinguished from *L. klugei* based on its precloacal pores, it is however morphologically similar to *L. wetzeli*. We assume that this may be due to a possible close relationship between *L. neglectus* **sp. nov.** and *L. wetzeli*, maybe even belonging to the species complex found by the work of Lanna et al. (2018). The genus is known to harbor considerable cryptic diversity (Lanna et al. 2018, Gippner et al. 2021) and members

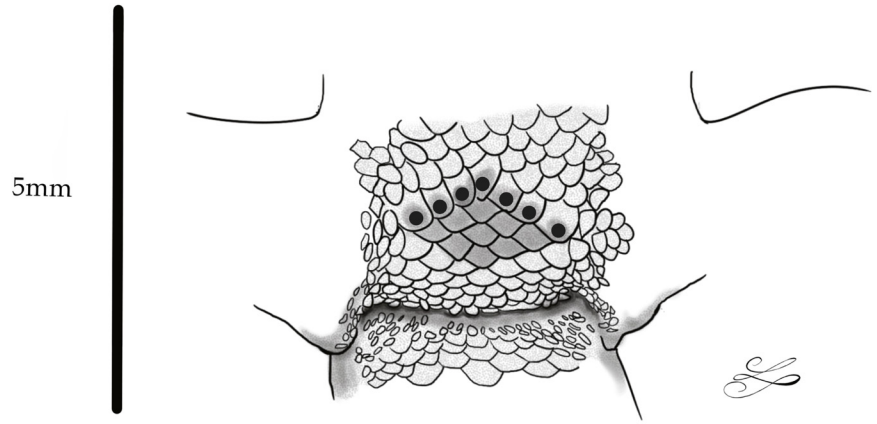

Figure 8. Drawing of the cloacal view area of the holotype *Lygodactylus neglectus* sp. nov. (MNRJ 27809).

of the same species complexes usually are morphologically very conservative (Gippner et al. 2021). Nonetheless, its presence in Fernando de Noronha archipelago make biogeographically sense, as the islands also harbor another member of a mostly African genus, *Trachylepis atlantica*. Fernando de Noronha could have acted as a first steppingstone for the *Lygodactylus*' colonization of South America directly from Africa.

Attempts to sequence DNA from the type series of *Lygodactylus neglectus* **sp. nov.** and CT-Scans techniques are currently underway in order to provide the systematic placement of the newly described species, as well as better glimpses to its ecology and natural history. Additional fieldwork is required to confirm the extinction of the species in Fernando de Noronha archipelago.

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APPENDIX

List of examined specimens (excluding the type series of *Lygodactylus neglectus* **sp. nov.**)

Lygodactylus wetzeli: MZSP 7722 (holotype), Urucum, Mato Grosso [Brazil]; CM 94180-94181, Filadelfia, Bóqueron [Paraguay]; UCM 514242, 55598, Filadelfia, Bóqueron [Paraguay]; AMNH 141616-141627, Santa Cruz [Bolívia].

Lygodactylus klugei: MZSP 22531 (holotype), Carnaubeira, Pernambuco [Brazil]; CM 65043, Carnaubeira, Pernambuco [Brazil]; MNRJ 26682, Morro do Chapéu, Baía [Brazil]; MNRJ 19638, Central, Belo Horizonte [Brazil]; MNRJ 17874-17880, Arreiroz (próximo de Vaqueijada), Ceará [Brazil]; MNRJ 18600-18609, unknown locality.

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