

A new species of *Homonota* (Squamata, Gekkonidae) from Paraguay, with a key to the genus

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Abstract

A new species of *Homonota* (Squamata, Gekkonidae) from Paraguay, with a key to the genus. A new species of *Homonota* from Paraguay is described. The new taxon can be differentiated from other species in the genus by the body and head pholidosis as well as the coloration. *Homonota* sp. nov. seems to be very similar to *H. uruguayensis*, with which it shares the ecological preference of rocky environments, but both are different in their pholidosis. *Homonota* sp. nov. is currently only known from the type locality and is the only gekkonid lizard that inhabits the Alto Paraná Atlantic Forest of Paraguay. An identification key for the species of the genus *Homonota* is provided.

Keywords: Squamata, Gekkonidae, *Homonota*, *Homonota rupicola* sp. nov., Paraguay, taxonomy.

Resumen

Una nueva especie de *Homonota* (Squamata, Gekkonidae) del Paraguay, con una clave para el género. Se describe una nueva especie de *Homonota* procedente de la Región Oriental de Paraguay. El nuevo taxón se diferencia de las restantes especies del género por la lepidosis corporal y cefálica, así como por la coloración. *Homonota* sp. nov. resulta sumamente similar a *H. uruguayensis*, con la cual comparte además las preferencias ecológicas por ambientes rocosos, sin embargo es claramente diferente en la lepidosis. Hasta el momento *Homonota* sp. nov. es conocido únicamente de la localidad tipo. Este hallazgo resulta muy importante porque es el único gekónido conocido del Bosque Atlántico del Alto Paraná de Paraguay. Al final del trabajo, se presenta una clave para la identificación de las especies del género *Homonota*.

Palabras clave: Squamata, Gekkonidae, *Homonota*, *Homonota rupicola* sp. nov., Paraguay, taxonomía.

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Introduction

The genus *Homonota* Gray, 1845 is confined to South America. It occurs on both sides of the Andes (Peters and Donoso-Barros 1970) and is the most southerly-distributed genus of gekkonids (Abdala 1998). *Homonota* can be distinguished easily from other South American gekkonids by the absence of femoral pores (Carreira *et al.* 2005) and of dilations in the digital lamellae (Peters and Donoso-Barros 1970). This last trait is shared only with other widely-allopatric genera of gekkonids including *Narudasia* from South Africa, *Tropiocolotes* from North Africa, Arabia and the Middle East, and *Alsophylax* from the southeast and Central Asia (Carreira *et al.* 2005). *Homonota* is further distinguished from these by its infradigital pholidosis.

Species of this genus are nocturnal, oviparous insectivores. In contrast to the arboreal habits of other gekkonids, *Homonota* is mainly terrestrial, and is rarely seen in trees (Cei 1986).

Only one member of the genus has previously been recorded in Paraguay: *H. fasciata* (Duméril and Bibron, 1836), cited on numerous occasions under the name of *H. horrida* (Burmeister, 1861). Synonymy of this nominal species with *H. fasciata* was demonstrated by Abdala and Lavilla (1993).

H. fasciata was first reported by Kluge (1964) from Paraguay, in the Department of Alto Paraguay, and later by Talbot (1978) from the Dry Chaco, in the surroundings of the Defensores del Chaco National Park ($20^{\circ}14'S$, $60^{\circ}09'W$) (Acevedo *et al.* 1993). This species was later included in a list of Paraguayan reptiles by Talbot (1979). Aquino *et al.* (1996) recorded the species' presence at six localities (all in Dry Chaco) based upon specimens in the collection of the Museo Nacional de Historia Natural del Paraguay. Areskoug (2001) cites the species from Fortín Toledo (Department of Boquerón), also in the Dry Chaco. Although in Paraguay *H. fasciata* seems to be associated

with xeric environments, it shows great ecological versatility throughout its geographical range, being present from southeastern Bolivia and Mato Grosso (Brazil), to northern Argentina (Peters and Donoso-Barros 1970, Dirksen and De la Riva 1999).

Three additional gekkonids occur in Paraguay: *Hemidactylus mabouia*, an introduced species that has colonized Asunción, Concepción and Ciudad del Este (Duré Rodas 1995, Aquino *et al.* 1996), *Lygodactylus wetzeli*, a small species endemic to the Dry Chaco, and *Phyllopezus pollicaris*. Two subspecies of the latter are known to be present in Paraguay: *P. p. pollicaris*, of the dry zones of Caatingas and of the Cerrado (present in Paraguay in this latter ecosystem), and *P. p. przewalskii* (Norman 1994), sympatric with *H. fasciata* and *L. wetzeli*.

Four species of geckos therefore inhabit the western part of the Chacoan region of Paraguay, whilst in the humid Oriental region there is only the eastern subspecies of *P. pollicaris* and the introduced *H. mabouia*.

In addition to the species reported from Paraguay, the genus *Homonota* comprises the following species: *H. andicola* Cei, 1978, *H. borelli* (Peracca, 1897), *H. darwini* Boulenger, 1885, *H. underwoodi* Kluge, 1964, *H. uruguayensis* (Vaz Ferreira and Sierra de Soriano, 1961), and *H. whitii* Boulenger, 1885. The two species of the genus *Garthia* are closely-related to *Homonota*: *G. gaudichaudii* and *G. penai*. Kluge (1964) considered *Garthia* to be congeneric with *Homonota*, but split them in later publications (Donoso-Barros 1966, Peters and Donoso-Barros 1970). Abdala (1996) supports this later, stated that is a monophyletic clade with genus *Vanzoia*.

During a review of the specimens in the collection of Zoology of Facultad de Ciencias Exactas y Naturales (CZ-FaCEN), a specimen belonging to the genus *Homonota* was discovered that clearly differs from all known species (Appendix I). This discovery encouraged a more detailed study of the genus in the field. This new species is described here.

Materials and Methods

Specimens of the new taxon were compared with specimens of *Homonota uruguayensis* from the Sección de Zoología de Vertebrados (Facultad de Ciencias) of Montevideo (ZVC-R) as this was the species considered to be most similar in appearance.

Tiny measurable characters were recorded using a stereoscopic magnifying glass. Pholidosis measurements were taken using a slide-caliper (0.01 mm). A standard millimeter ruler was used for body measurements. We took the following measurements: total length (TL; from the tip of the snout to the tip of the tail), snout-vent length (SVL; from the tip of the snout to the anal opening), caudal length (CL; from the anal opening to the tip of the tail), head length (HL; from the tip of the snout to the narrowest section of the neck), head width (HW; at the widest section), eye diameter (ED), ear-

opening diameter (TD; measured at the widest section of the opening), nostril-eye length (NEL; from the posterior edge of nasal opening to the anterior edge of the orbit), eye-ear length (ETL; from the posterior edge of the orbit to the anterior edge of the ear-opening), and vent width (VW).

Counts of paired structures as supralabials, infralabials and scales around the ear-opening are given in left/right direction.

Species Description

Homonota rupicola sp. nov.

Holotype - CZ 0285, an adult male from Departamento Cordillera, Piribebuy, Compañía Los Naranjos, Cerro Pedregal, ($25^{\circ} 31' 07''S$, $57^{\circ} 02' 53''W$) (Figure 1).

Paratypes - CZ 0210, an adult female. CZ 0286 and CZ 0287 subadult and juvenile females respectively, all from the same locality as the holotype.

Etymology - From the Latin *rupes* stone + suffix *icola* meaning property. “*Homonota* of the stones”. In allusion to the environment in which the species lives.

Diagnosis - *Homonota rupicola* sp. nov. is distinguished from *H. andicola*, *H. darwini*, *H. whitii* and *H. underwoodi* by the dorsal body scales, being the dorsal surface of these species covered by granular scales, whereas *H. rupicola* sp. nov. has small granular scales with series of enlarged and keeled scales. Also from *H. borelli*, because this species shows keeled scales smaller than in *H. rupicola* sp. nov., showing a longitudinal pattern rather than transversal as in *H. borelli*. From *H. borelli*, *H. fasciata*, *H. darwini* and *H. whitii* by dorsal color pattern consisting in black irregular lines on a grey ground color, with some small white tips. From *H. underwoodi* because his ventral coloration is immaculate, being spotted with small melanophores in the new taxon. From *H. uruguayensis* by the presence in this species of some enlarged

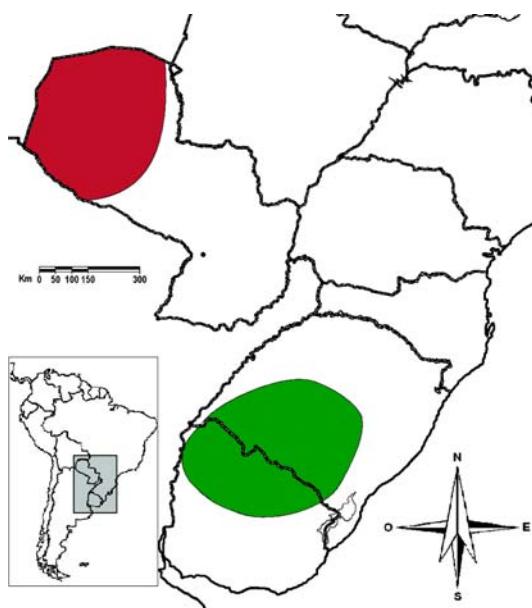


Figure 1 - Approximate distribution of *Homonota fasciata* in Paraguay (red area) and *H. uruguayensis* (green area). The black dot represents the type locality of *H. rupicola*.

keeled scales at the sides of the head and the anterior region of the thigh covered with keeled scales, whereas *H. rupicola* sp. nov. always has smooth scales in the sides of the head as well as in the thigh (Figure 2).

Description of the holotype - Body small and slender. Head sub-triangular, neck well defined. Eyes moderately large with vertical clip-shaped pupil. Small oval ear-opening. When stretched backwards the forelimbs reach more than half the body length. Hind limbs stretched forwards reach close to the axilla. The transverse vent opening is very large, almost crossing the caudal base section. Autotomous tail long, with posterior half regenerated.

Total length is 82 mm, with the tail (46 mm) longer than the body (36 mm). The tail is complete, but only 22 mm of it is original, the remaining 14 mm consisting of regenerated tissue. Eye-width twice the width of the ear-opening. Eye-ear length longer than nostril-eye length. Head longer than wide. Hemipenis small. The hemipenis measures 2.80 mm in length and 1.87 wide, but is not completely everted.

Dorsal surface of the head covered by tiny, granular scales which are rather homogenous in size. Rostral pentagonal, wider than high, with barely evident posterior groove. Eight supralabial scales on each side. Nasals bordered by the first pair of supralabials, rostral, internasals and two scales of the loreal region. Orbit edged by supraciliary flap in its antero-superior side. Parietal and temporal regions covered by almost-equal granular scales. Fifteen scales around ear-opening on the left side and 16 on the right side. Mental large, longer than wide. Two postmentals. Six infralabials on each side. Scales of the ventral side of the head and throat are of equal size and tend to be hexagonal in shape.

Along the vertebral line are rows of rounded, imbricate, slightly granular scales (not perfectly rounded). Ten rows of keeled scales are located on each side of the dorsum, with four additional rows where keels are scarcely noticeable at each

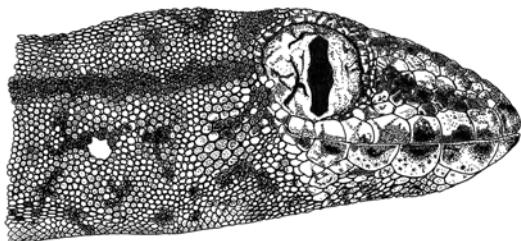


Figure 2 - Lateral view of the holotype showing homogeneous scales, a character that distinguishes it from *H. uruguayensis*.

side. The first four longitudinal scale rows on each side of the vertebral line are separated by groups of small granular scales. Rows of keeled scales begin 1 mm behind the neck and reach backwards to 0.5 mm beyond the caudal base. Laterally, scales become gradually juxtaposed downward. Axillary and inguinal zones are covered with small scales. Ventral scales slightly hexagonal and elongate, with posterior edge faintly sawed.

Scales on the anterior region of the arm and forearm are smooth and large. On the posterior and inner regions of the arms the scales are very small and granular. Scales on forelegs are enlarged all around and some are slightly keeled. Five to 11 infradigital lamellae in the forearm and five to 14 in the hind arm.

Dorsal and lateral regions of the tail have enlarged and juxtaposed scales with four keeled longitudinal rows until the eighth scale of the tail. Ventrally there are 66 enlarged caudal scales. Two postcloacal conical scales are present laterally at the base of the tail.

Variation - Measurements are given on Table 1. Ear-opening subtriangular or rhomboidal, but always small. In CZ 0287 the rostral groove is more developed. Supralabials on each side 7/8 in CZ 0286, 9/8 in CZ 0287 and 8/7 in CZ 0210. Scale number around ear-opening 16/19 in CZ 0287, 15/19 in CZ 0286. CZ 0286 has two postmentals as does the holotype, but CZ 0287 has three. Postmental region of 0210 is damaged. Infralabials always 6/6.

Table 1 - Measurements (in mm) of the characters of specimens examined. TL, total length; SVL, snout-to-vent length; CL, caudal length; HL, head length; HW, head width; ED, eye diameter; TD, ear-opening diameter; NEL, nostril-eye length; ETL, eye-ear length; VW, vent width. Specimens with amputated tail are indicated with a “+”; regenerated tails are indicated as original segment + regenerated segment. D, damaged. Holotype is indicated with a “H”.

	CZ 0285 (H)	CZ 0210	CZ 0286	CZ 0287
SVL	36.00	35.36	26.50	33.50
CL	46.00	4.03 +	2.50 + 19.00	8.00 + 26.50
HL	11.82	11.35	8.95	11.57
HW	7.63	6.70	5.76	7.08
ED	2.33	1.99	1.91	2.20
TD	0.80	0.78	0.72	0.89
NEL	2.82	3.02	2.23	2.58
ETL	3.41	2.92	2.29	3.01
VW	3.67	D	2.20	3.46

Dorsally CZ 0286 has four barely-evident pairs of keeled scale rows. CZ 0287 has three pairs and CZ 0210 11 pairs of keeled scales rows. Keeled scale rows extend from the level of the axilla up to four (CZ 0286) or six (CZ 0287) scales beyond the vent. In the most lateral scales near the groin, keels may disappear. Variation in the number of infradigital lamellae is given on Table 2.

Coloration in life - Holotype has light grey base colour with black irregular spots that in certain parts of the sides of the body form winding longitudinal lines (Figure 3A). Some small white tips are scattered over the dorsum. Dorsal coloration extends to the sides where black spots form a diffuse line extending from the axilla to the groin. White spots are most evident on the sides. Subadult female CZ 0287 has prominent white spots on the dorsum. Juvenile specimen CZ 0286 has a light brown base color with light grey (almost white) spotting. In the centre of the dorsum these spots fuse to form irregular bands.

Table 2 - Infradigital lamellae of specimens examined. Because specimen CZ 0210 was damaged it was not included in the counts. Data are presented in left/right order. f: forelimbs, h: hindlimbs. Roman numerals represent the digit number.

	Holotype CZ 0285	Juvenile CZ 0286	Subadult CZ 0287
f I	5/5	6/5	5/5
f II	9/9	8/9	10/10
f III	10/10	10/11	11/11
f IV	11/10	11/12	12/12
f V	9/9	7/8	9/7
h I	5/6	5/6	6/6
h II	8/8	9/8	10/9
h III	12/11	11/11	15/13
h IV	14/14	13/14	15/15
h V	14/12	12/12	12/12

A



B



Figure 3 - Dorsal (A) and ventral (B) pattern of the holotype of *Homonota rupicola*.

Thoracic region of the holotype light grey, darkest towards the lower belly. Ventral scales are pigmented with small black tips (melanophores) and are scattered randomly. Specimen CZ 0210 has a uniform ventral surface and shows less black pigmentation than the holotype. Juvenile CZ 0286 has a white belly.

Dorsally the head and body are light grey, profusely spotted with black and scattered white dots. Supraocular scales unmarked. A black chevron is present between the eyes and in front of each eye is a black line, of which the uppermost do not meet, but the lowermost join on the rostral scale. Supra- and infralabials white cream spotted with black, the ventral surface of the mouth being immaculate white, and the throat dark. Iris brownish-yellow. Female CZ 0287 shows rather similar coloration to holotype, but in the former the lines that begin in front of each eye are more diffuse and the black spots of the supra- and infralabials are less evident. The juvenile (CZ 0286) has the head light brown with clear lines running from the nares, crossing the eyes, and joining on the nape. Below these lines are other two dark brown lines running parallel to them. Supra- and infralabials spotted.

On the lateral sides of the neck the holotype has a black stripe beginning behind the eye and continuing backwards to the dorsal spots. This stripe is edged with white dots. In addition there is another stripe, thinner and more diffuse than the former, that begins behind the eye, crosses the tympanic membrane and combines with the lateral body coloration. Specimen CZ 0287 has no white dots on the sides.

Ventral side of limbs is light grey with the palmar and plantar darker grey (Figure 3B). The dorsum of the extremities shows an irregular reticulated pattern of black and grey with a few scattered white dots. Paratypes shows almost no variation in these characters.

Tail of the holotype has irregular transversal black and grey blotches on the basal (original) portion. Ventrally the background color is light grey with an incursion of dorsal black blotches.

The regenerated portion of the tail is dark grey with small, diffuse black blotches on the dorsal and ventral sides of the tail. Specimen CZ 0287 has the caudal coloration and pattern identical to the holotype. CZ 0286 is similar dorsally, but ventrally shows an immaculate light grey coloration.

Coloration in preservative - Coloration not very different in preserved specimens. CZ 0210, which has been preserved for a long time, is dorsally reddish-brown with pinkish spots. The belly is immaculate whitish-cream.

Natural history and ecology – To date known only from Cerro Naranjo, a rocky hill, set amongst humid Alto Paraná Atlantic Forest. Specimens were found at 289 m above the sea level.

All individuals encountered were found on the ground in rocky areas lacking vegetation. Some specimens attempted to flee by running towards patches of low bushy forest, scattered on the hill. The only vegetation present on the hill was composed of low shrubs and some grasses. Inferior stratum was covered mainly with leaf litter.

Coloration of the species seems to be highly mimetic with the rocky substrate in which they live. Like other members of the family it appears to be nocturnal, with activity highest after 22:00 h. This was observed in January and August, during field trips to the type locality.

Discussion

Characteristics exhibited by *H. rupicola* suggests a narrow relationship with the Group I of Kluge (1964), which includes *H. borelli*, *H. uruguayensis*, *H. fasciata* and *H. horrida* – the last a synonym of *H. fasciata* (Abdala and Lavilla, 1993). This group is differentiated by the presence of keeled dorsal body scutellation, forming regular longitudinal rows (Kluge 1964). Nevertheless Abdala (1998) places *H. borelli* in a different clade, separate from *H. fasciata* and *H. uruguayensis*, in a trichotomy shared with *H.*

andicola and *H. whitii*. Both Kluge (1964) and Abdala (1998) place *H. fasciata* and *H. uruguayensis* together, which is supported by their phylogenetic relationship. Although a phylogenetic analysis that includes *H. rupicola* is required to confirm the relationship, it seems that there is great affinity between this species and *H. fasciata* and *H. uruguayensis*.

Kluge (1964) pointed out that the presence of keeled scutellation is a plesiomorphic character, and that maybe *H. uruguayensis* would be similar in appearance to the common ancestor. On the other hand, Abdala (1998) found that the most evolved clade was that containing *H. fasciata* and *H. uruguayensis*. *H. rupicola* shows intermediate characteristics to the condition of *H. uruguayensi*.

Among species in this clade, *H. rupicola* and *H. uruguayensis* can be easily differentiated from *H. fasciata* because this last species shows a unique pattern that is not seen in any other member of the genus. Although coloration is similar between *H. rupicola* and *H. uruguayensis*, the presence of some enlarged keeled scales at the sides of the head behind the eye and keeled scales in the thigh in this last species are the main differences with *H. rupicola* that do not have keeled scales in the head or in the thighs. In addition, juveniles of *H. uruguayensis* exhibit strongly dorsal keeled scales, whereas keels in hatchlings of *H. rupicola* are less conspicuous.

Paraguayan geckoes, excluding the introduced *Hemidactylus mabouia*, reach their greatest diversity in the Occidental Region. Only one subspecies of *Phyllopezus pollicaris* reaches the cerrado of the northern Oriental Regions. The only species of *Homonota* previously known from Paraguay is *H. fasciata*, distributed almost exclusively in the Dry Chaco and widely allopatric with *H. rupicola* (Figure 1). The species which seems most closely related to *H. rupicola*, *H. uruguayensis*, is distributed more than 500 km to the south, and no native geckos is known to occur in the intervening region (Figure 1).

Biogeographically the type locality of *H. rupicola* is located in the Humid Chaco biome, in a transitional zone with the Alto Paraná Atlantic Forest according to Dinerstein *et al.* (1995). Del Castillo and Clay (2005) disagreed with this opinion, stating that for birds the Humid Chaco is restricted to the western bank of the Paraguay River. The environment in which *H. rupicola* occurs does not correspond to Chaco, the dominant ecosystem being tall forest with abundant low vegetation and almost no grass or herbaceous vegetation. In this region there are several important chains of rocky hills covered by patches of low forests. This environment is similar to those in which *H. uruguayensis* occurs, raising the possibility that *H. rupicola* represents a relict population of a more continuous ancestral distribution.

Key for identification of species of the genus *Homonota*

Based in the works of Vaz Ferreira and Sierra de Soriano (1961), Kluge (1964), Peters and Donoso-Barros (1970), Cei (1986) and Abdala (1998).

- 1 Dorsum covered with granular scales, not keeled 2
- 1' Dorsum with longitudinal rows of keeled scales at least in part 4
- 2 Belly without chromatophores *H. underwoodi*
- 2' Belly with chromatophores 3
- 3 With intermediate scales among or above supralabials; 43 to 49 scales around the mid body *H. andicola*
- 3' Without intermediate scales; 55 to 58 scales around the mid body *H. whitii*
- 4 Keeled scale rows only on the posterior half of the body *H. darwini*
- 4' Keeled scales rows along the whole body .. 5
- 5 Dorsum uniform covered by enlarged series of keeled scales *H. borelli*
- 5' Dorsum heterogeneous, with keeled scale rows alternating with small granular scales 6

- 6 Dorsal scales strongly keeled; square dorsal pattern (brownish background with white lines) *H. fasciata*
- 6 Dorsal scales less keeled; irregular dorsal pattern of white, grey and black spots 7
- 7 Scales of the thigh keeled; lateral region of the head, behind the eyes, covered by granular scales interspersed with large keeled scales *H. uruguayensis*
- 7 Scales of the thigh smooth; lateral region of the head covered by homogeneous granular scales *H. rupicola* sp. nov.

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Appendix I – Specimens Examined

Homonota uruguayensis - URUGUAY: Rivera: Arroyo Lunarejo (ZVC-R 5115, 5128). Salto: Ruta 31, Km 109 (ZVC-R 5443).

INSTRUCTIONS TO AUTHORS

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