

PREPRINT

Author-formatted, not peer-reviewed document posted on 26/04/2021

DOI: <https://doi.org/10.3897/arphapreprints.e67869>

Distribution and identification of the species in the genus *Helicops* Wagler, 1830 (Serpentes, Colubridae, Xenodontinae)

 **Yannis Schöneberg, Gunther Köhler**

Disclaimer on biological nomenclature and use of preprints

The preprints are preliminary versions of works accessible electronically in advance of publication of the final version. They are not issued for purposes of botanical, mycological or zoological nomenclature and **are not effectively/validly published in the meaning of the Codes**. Therefore, nomenclatural novelties (new names) or other nomenclatural acts (designations of type, choices of priority between names, choices between orthographic variants, or choices of gender of names) **should NOT be posted in preprints**. The following provisions in the Codes of Nomenclature define their status:

International Code of Nomenclature for algae, fungi, and plants (ICNafp)

Article 30.2: "An electronic publication is not effectively published if there is evidence within or associated with the publication that its content is merely preliminary and was, or is to be, replaced by content that the publisher considers final, in which case only the version with that final content is effectively published." In order to be validly published, a nomenclatural novelty must be effectively published (Art. 32.1(a)); in order to take effect, other nomenclatural acts must be effectively published (Art. 7.10, 11.5, 53.5, 61.3, and 62.3).

International Code of Zoological Nomenclature (ICZN)

Article: 21.8.3: "Some works are accessible online in preliminary versions before the publication date of the final version. Such advance electronic access does not advance the date of publication of a work, as preliminary versions are not published (Article 9.9)".

Distribution and identification of the species in the genus *Helicops* Wagler, 1830 (Serpentes, Colubridae, Xenodontinae)

Yannis Schöneberg^{‡,§}, Gunther Köhler[§]

[‡] Johann Wolfgang Goethe-University, Frankfurt am Main, Germany

[§] Senckenberg Society for Nature Research, Frankfurt am Main, Germany

Corresponding author: Yannis Schöneberg (yannis.schoeneberg@gmx.de)

Abstract

Background

The aquatic snakes of the genus *Helicops* are widely distributed throughout northern South America but understudied concerning many aspects, including morphological traits and distribution. The most recent publication that provided an identification key to all species of *Helicops* is more than 50 years old. The key is of limited value today since it includes taxa no longer recognized and lacks 8 of the 19 species currently recognized. There never was a publication trying to summarize the distribution information of all species of *Helicops*. Most of the knowledge on these species is distributed over many small publications, like observation notes.

New information

Here we present point distribution maps, an identification key and comments on identification for all species in this genus based on the results of a comprehensive literature review of over 300 scientific publications and own examinations. Our examinations comprise 190 specimens of 10 of the 19 currently recognized species and one *Helicops* sp. Furthermore, we report range extensions for the species *H. angulatus*, *H. danieli*, *H. infrataeniatus*, *H. leopardinus*, *H. pastazae* and *H. polylepis*.

Keywords

annotated list, aquatic snakes, distribution maps, identification key, morphology, neotropics, pholidosis, taxonomy

Introduction

The water snakes of the genus *Helicops* are widely distributed in the northern half of South America. The genus consists of 19 species of aquatic snakes inhabiting nearly all kinds of waterbodies in their distribution range. They seem to be rather generalist, inhabiting various bodies of water, from small ponds and puddles to slow flowing streams also in urban areas (Koski et al. 2016, Hernández-Ruiz et al. 2014, França et al. 2012). However, for many species not much more than the species description is known. The genus *Helicops* forms the Hydropsini together with the genera *Hydrops* and *Pseudoeryx*. The Hydropsini are part of the subfamily Dipsadinae, and characterized by the wide origin of the adductor mandibulae externus superficialis (Di Pietro et al. 2014). The genus *Helicops* consists of 19 species which all share the combination of having the eyes and nostrils directed dorsally on the top of the head, a single internasal scale, a divided cloacal shield, and at least some dorsal scales keeled (Costa et al. 2016). The first description of the species in this genus was *Helicops angulatus*, which was described as *Coluber angulatus* and *C. alidras* by Linnaeus (1758). In 1830, *C. angulatus*, and other species of the genera *Coluber* and *Natrix* were assigned to the newly created genus *Helicops* by Wagler (1830). At the time the last identification key was published by Peters and Orejas-Miranda (1970), 13 species were recognized, including the no longer recognized *H. hogeï* and *H. pictiventris* (Rossman 2002). Since then, *H. infrataeniatus* has been raised to species level again and seven new species have been described (*H. apiaka*, *H. boitata*, *H. nentur*, *H. phantasma*, *H. petersi*, *H. tapajonicus*, *H. yacu*), more than half of them in the past 10 years (*H. apiaka*, *H. boitata*, *H. nentur*, *H. phantasma*). For all these seven species not much more than the species description is known. This and the amount of recently described new species shows the incompleteness of the taxonomic knowledge for this genus. Most of the knowledge is scattered across numerous publications. Especially distribution information is mostly contained in observation notes. Therefore, we want to present a basis for further taxonomic studies, by providing point distribution maps, an annotated checklist, and an identification key based on a comprehensive literature review and own observations.

Materials and methods

The assessment of the status of the species in the genus *Helicops* is based on the morphological examination of 190 specimens of 10 of the 19 currently recognized species in this genus as well as on a comprehensive literature review. The specimens are located in six herpetological museum collections in Germany: Senckenberg Research Institution Frankfurt (SMF); Senckenberg Naturhistorische Sammlungen Dresden (MTKD); Zoologisches Forschungsmuseum Alexander König in Bonn (ZFMK); Zoologische Staatssammlung München (ZSM); Staatliches Museum für Naturkunde Stuttgart (SMNS); Naturkundemuseum Berlin (NMB).

The examined morphologic characters were: snout-vent length (SVL), tail length (TL), the ratio between tail length and snout-vent length (TL/SVL), number of ventral shields (VE), number of subcaudal scales (SC), presence of subcaudal keels (SCK); number of preoculars (PRO), number of postoculars (PSO), number of loreals (LO), number of anterior temporals (AT), number of posterior temporals (PT), number of supralabials (SL), number of supralabials in contact with the eye (SL+E), number of infralabials (IL), number of dorsal scale rows at midbody (DSM), presence of dorsal keels at midbody (DKM), number of dorsal scale rows approximately a head length prior to cloaca (DSP), presence of dorsal keels approximately a head length prior to cloaca (DKP), if cloacal plate is divided (CL), if nasal scale is divided, semidivided or entire (NA), presence of intergenials (IG). The number of ventral scales, number of subcaudal scales, snout-vent length, tail length and the ratio between snout vent length and tail length were recorded separately for male and female specimens. Measurements were taken using a tape measure with the accuracy of 0.1 cm. Ventrals were counted as proposed by Dowling (1951). The sex of the specimens was determined by exterior examination of the shape of the base of tail (tail bulge caused by presence of hemipenes in males, such bulge absent in females). The results of our examinations are available in Suppl. material 1. For specimens with a damaged tail, no tail measurements were done. The head scutellation was recorded for each side separately.

The presented information on the species distribution is based on the locality data of the specimens examined and on literature data. One species locality was found browsing iNaturalist, the identification was made on the unique coloration of that species. Only records were included for which a reliable description of the locality or coordinates were available. All information on the literature references to the respective distribution point is listed in Suppl. material 2.

The distribution maps were created using QGIS 3.12.2 (Bucureşti) and the maps freely available at naturalearthdata.com.

The identification key was created using the morphological data gathered by specimens of *Helicops* examined by Y.S. and literature data. The literature references used for morphology are listed in Suppl. material 3.

Data resources

The Suppl. materials 2, 1 are tables in a tab delimited text format. Suppl. material 1 contains the examination results for each specimen. It has columns with following headers: Species; Catalog numb.; Sex; Snout-vent length [mm]; Tail length [mm]; TL/SVL; Ventrals; Subcaudals; Subcaudal keels; Preoculars right; Preoculars left; Loreals right; Loreals left; Postoculars right; Postoculars left; Anterior Temporals right; Anterior Temporals left; Posterior Temporals right; Posterior Temporals left; Supralabials right; Supralabials left; Supralabials + Eye right; Supralabials + Eye left; Sublabials right; Sublabials left; Dorsal scale rows at midbody; Dorsal keels at midbody; Dorsal scale rows at posterior body; Dorsal keels at posterior body; Analplate; Intergenials. The content of the columns follows the description of the examined morphological characters in the Methods section. Suppl.

material 2 contains all distribution points extracted from literature und their reference. It has columns with following headers: Species; Country; Province; Locality; Locality notes; Latitude (DD); Longitude (DD); Latitude (DMS); Longitude (DMS); Literature; Online version. Most of the columns are selfexplanatory. The columns Latitude (DD) and Longitude (DD) contain the coordinates in Decimal degree and the columns Latitude (DMS) and Longitude (DMS) contain the coordinates in Degrees Minutes Seconds format.

Suppl. material 3 is a plain text file containing all the references used for the morphological assessment. It contains each reference in a seperate line.

Taxon treatments

Helicops angulatus (Linnaeus, 1758)

Materials

- a. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Brazil; individualCount: 1; sex: male; catalogNumber: MTKD 15294; recordedBy: Fritzsche leg.; institutionID: MTKD
- b. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Brazil; stateProvince: unknown province; locality: Ega ad Amazonas; year: 1831; individualCount: 1; sex: female; catalogNumber: MTKD 15509; recordedBy: Poeppig leg.; institutionID: MTKD
- c. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Peru; individualCount: 1; sex: female; catalogNumber: MTKD 41670; institutionID: MTKD
- d. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Bolivia; stateProvince: Santa Cruz; locality: Nuflo de Chavez, RPPN San Sebastian; verbatimLocality: 524; verbatimLatitude: -16°23.263; verbatimLongitude: -61°59.983; year: 2006; individualCount: 1; sex: female; catalogNumber: SMF 100016; recordedBy: M. Jansen leg.; institutionID: SMF
- e. scientificName: *Helicops angulatus* (Linnaeus, 1758); individualCount: 1; sex: female; catalogNumber: SMF 17817; institutionID: SMF
- f. scientificName: *Helicops angulatus* (Linnaeus, 1758); individualCount: 1; sex: female; catalogNumber: SMF 17818; institutionID: SMF
- g. scientificName: *Helicops angulatus* (Linnaeus, 1758); individualCount: 1; sex: female; catalogNumber: SMF 17819; institutionID: SMF
- h. scientificName: *Helicops angulatus* (Linnaeus, 1758); individualCount: 1; sex: male; catalogNumber: SMF 17820; institutionID: SMF
- i. scientificName: *Helicops angulatus* (Linnaeus, 1758); individualCount: 1; sex: female; catalogNumber: SMF 32409; institutionID: SMF
- j. scientificName: *Helicops angulatus* (Linnaeus, 1758); individualCount: 1; sex: female; catalogNumber: SMF 32410; institutionID: SMF
- k. scientificName: *Helicops angulatus* (Linnaeus, 1758); individualCount: 1; sex: female; catalogNumber: SMF 40029; institutionID: SMF
- l. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Peru; stateProvince: Ucayali; locality: Bolognesi (Campamento); verbatimLocality: 230; verbatimLatitude: -10°6.217; verbatimLongitude: -73°49.033; year: 1998; individualCount: 1; sex: female; catalogNumber: SMF 80033; recordedBy: Edgar Lehr leg.; institutionID: SMF
- m. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Ecuador; stateProvince: Pastaza; locality: Arutam, km 48 Transamazonica; verbatimLocality: 880; verbatimLatitude: -1°47.07; verbatimLongitude: -77°49.96; year: 1996; individualCount: 1;

- sex: female; catalogNumber: SMF 90947; recordedBy: Gunther Köhler, R. Seipp, S. Moya leg.; institutionID: SMF
- n. scientificName: *Helicops angulatus* (Linnaeus, 1758); individualCount: 1; sex: male; catalogNumber: SMF 91832; institutionID: SMF
- o. scientificName: *Helicops angulatus* (Linnaeus, 1758); individualCount: 1; sex: female; catalogNumber: SMF 91833; institutionID: SMF
- p. scientificName: *Helicops angulatus* (Linnaeus, 1758); individualCount: 1; sex: female; catalogNumber: SMF 91834; institutionID: SMF
- q. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Suriname; year: 1893; individualCount: 1; sex: female; catalogNumber: SMNS 13438; recordedBy: Hartmann leg.; institutionID: SMF
- r. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Brazil; stateProvince: Bahia; year: 1854; individualCount: 1; sex: female; catalogNumber: SMNS 3063; recordedBy: F. Glocker leg.; institutionID: SMNS
- s. scientificName: *Helicops angulatus* (Linnaeus, 1758); year: 1843; individualCount: 1; sex: female; catalogNumber: SMNS 3064.1; recordedBy: A. Kappler; institutionID: SMNS
- t. scientificName: *Helicops angulatus* (Linnaeus, 1758); individualCount: 1; sex: male; catalogNumber: SMNS 3064.2; institutionID: SMNS
- u. scientificName: *Helicops angulatus* (Linnaeus, 1758); year: 1985; individualCount: 1; sex: male; catalogNumber: SMNS 6394; recordedBy: A. Schlüter leg.; institutionID: SMNS
- v. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Guyana; stateProvince: unknown province; locality: Roraima-Gebiet; individualCount: 1; sex: female; catalogNumber: ZFMK 47670; institutionID: ZFMK
- w. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Brazil; stateProvince: Amazonas; locality: Jurua; individualCount: 1; sex: male; catalogNumber: ZFMK 8403; institutionID: ZFMK
- x. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Brazil; stateProvince: Amazonas; locality: Jurua; individualCount: 1; sex: female; catalogNumber: ZFMK 8404; institutionID: ZFMK
- y. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Brazil; stateProvince: Maranhao; individualCount: 1; sex: male; catalogNumber: ZMB 10854; recordedBy: S. Eye leg.; institutionID: ZMB
- z. scientificName: *Helicops angulatus* (Linnaeus, 1758); individualCount: 1; sex: female; catalogNumber: ZMB 2303; recordedBy: M. Bloch leg.; institutionID: ZMB
- aa. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: French Guiana; individualCount: 1; sex: female; catalogNumber: ZMB 2305; institutionID: ZMB
- ab. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Suriname; stateProvince: Paramaribo; locality: Paramaribo; individualCount: 1; sex: female; catalogNumber: ZMB 25975A; recordedBy: K. Heller leg.; institutionID: ZMB
- ac. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Suriname; stateProvince: Paramaribo; locality: Paramaribo; individualCount: 1; sex: male; catalogNumber: ZMB 25975B; recordedBy: K. Heller leg.; institutionID: ZMB
- ad. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Suriname; stateProvince: Paramaribo; locality: Paramaribo; individualCount: 1; sex: male; catalogNumber: ZMB 26382; recordedBy: K. Heller leg.; institutionID: ZMB
- ae. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Brazil; individualCount: 1; sex: male; catalogNumber: ZMB 27783; recordedBy: Aq. Zoo. leg.; institutionID: ZMB
- af. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Brazil; stateProvince: Para; locality: Rio Caramarapy; individualCount: 1; sex: male; catalogNumber: ZMB 47771; recordedBy: K. Lako leg.; institutionID: ZMB

- ag. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: French Guiana; individualCount: 1; sex: female; catalogNumber: ZMB 54167; institutionID: ZMB
- ah. scientificName: *Helicops angulatus* (Linnaeus, 1758); individualCount: 1; sex: female; catalogNumber: ZMB 64697; recordedBy: Anat. Sammlung leg.; institutionID: ZMB
- ai. scientificName: *Helicops angulatus* (Linnaeus, 1758); individualCount: 1; sex: female; catalogNumber: ZMB 64698; recordedBy: Anat. Sammlung leg.; institutionID: ZMB
- aj. scientificName: *Helicops angulatus* (Linnaeus, 1758); individualCount: 1; sex: female; catalogNumber: ZMB 89648; institutionID: ZMB
- ak. scientificName: *Helicops angulatus* (Linnaeus, 1758); individualCount: 1; sex: female; catalogNumber: ZMB 89649; institutionID: ZMB
- al. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Suriname; year: <1858; individualCount: 1; sex: male; catalogNumber: ZSM 1525/0; institutionID: ZSM
- am. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Brazil; year: <1907; individualCount: 1; sex: male; catalogNumber: ZSM 1526/0; institutionID: ZSM
- an. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Brazil; locality: in provinciae Bahiae adjacentibus; year: 1817-1820; individualCount: 1; sex: male; catalogNumber: ZSM 1528/0; recordedBy: Spix & Martius leg.; institutionID: ZSM
- ao. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Brazil; stateProvince: Pará; locality: Peixeboi (an der Bragançabahn); year: 1910; individualCount: 1; sex: female; catalogNumber: ZSM 247/1983; recordedBy: L. Müller leg.; institutionID: ZSM
- ap. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Brazil; stateProvince: Pará; locality: Rio Branco bei Obidos; year: 1912; individualCount: 1; sex: female; catalogNumber: ZSM 264/2017; recordedBy: E. Snethlage leg.; institutionID: ZSM
- aq. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Peru; stateProvince: Huánuco; locality: Biologische Station Panguana (unterer Rio Yuyapichis, ca. 140 km SSW Pucallpa); year: 1982; individualCount: 1; sex: female; catalogNumber: ZSM 37/2015; recordedBy: E.-G. Burmeister leg.; institutionID: ZSM
- ar. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Bolivia; stateProvince: Chapare; year: 1949; individualCount: 1; sex: male; catalogNumber: ZSM 516/2003; recordedBy: R. Zischka leg.; institutionID: ZSM
- as. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Columbia; stateProvince: Guainía; locality: Inirida; year: 1976; individualCount: 1; sex: male; catalogNumber: ZSM 518/2003; recordedBy: H. Herkner leg.; institutionID: ZSM
- at. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Peru; stateProvince: Ucayali; locality: Yarina Cocha bei Pucallpa; year: 1982; individualCount: 1; sex: female; catalogNumber: ZSM 59/1985; recordedBy: Maulhardt leg.; institutionID: ZSM
- au. scientificName: *Helicops angulatus* (Linnaeus, 1758); country: Brazil; stateProvince: Sao Paulo; locality: Puerto Tiberica am Rio Parana [= Porto Tibirica]; year: 1938; individualCount: 1; sex: male; catalogNumber: ZSM 595/2003; recordedBy: O. Schindler leg.; institutionID: ZSM

Diagnosis

Helicops angulatus can be distinguished from all its congeners except *H. scalaris* and *H. apiaka* by having subcaudal keels, 17–20 dorsal scale rows at midbody, and 103–123 ventrals. From *H. scalaris* it differs in having no intergenials (for information on references see Suppl. material 3; for summarized pholidosis information of the examined specimens see Table 1). For differentiation from *H. apiaka* see identification of *H. apiaka*.

Distribution

The distribution of *H. angulatus* extends over nearly the complete northern part of South America. As shown in Fig. 1a, the distribution range extends from Columbia to the east coast of Brazil and from Venezuela and offshore islands to the Brazilian province Sao Paulo.

Helicops apiaka Kawashita-Ribeiro et al., 2013

Diagnosis

According to the information given in Kawashita-Ribeiro et al. (2013), *H. apiaka* can be distinguished from all its congeners except *H. angulatus* and *H. hagmanni* by the following combination of characteristics: absent intergenials, subcaudal keels present, and 21–22 dorsal scale rows at midbody. From *H. hagmanni* it differs in having 79–103 subcaudal scales (versus 50–59 in *H. hagmanni*). From *H. angulatus* it differs by having 21–24 dorsal scale rows at anterior body, 21–22 at midbody and 17–19 at posterior body (versus 19–21/19–20/17–19 in *H. angulatus*) and by having 118–127 ventral scales in males and 124–132 in females (versus 105–123 in male and 109–123 in female *H. angulatus*) as well as hemipenes morphology. The specimens examined in this study originated from neighbouring areas to the *H. apiaka* locations. Our own examinations revealed that males of *H. angulatus* possess 103–119 ventrals in males and 104–125 in females. There is considerable overlap especially between female specimens of the two species. This would exclude this character as identification character. In addition to that we came across two specimens having the morphology of *H. angulatus* but showing considerably more ventrals than usual (SMF 17819, a female, with 156 ventrals and ZSM 0595/2003, female, with 130 ventrals). There is no locality information for SMF 17819. ZSM 0595/2003 was collected at the Rio Parana in Porto Tibiriça, Sao Paulo, Brazil. This is approximately 1300 km apart from the distribution range of *H. apiaka*. The distribution area of *H. apiaka* probably presents important information for the distinguishing of the two species, since the variation throughout the whole distribution range of *H. angulatus* might be considerably bigger than the variation of the populations neighbouring *H. apiaka* populations (for information on references see Suppl. material 3).

Distribution

The only known specimens of *H. apiaka* are from northern Mato Grosso and southern Pará (Fig. 1b).

Morphology remark

Moraes-da-Silva et al. (2019) states that *H. apiaka* has 19–21 dorsal scale rows at midbody, which would eliminate this character as a diagnostic character to distinguish it from *H. angulatus*. This would leave only the number of ventrals in females as a

diagnostic trait. However, the before mentioned publication examined the same specimens for *H. apiaka* as in the original species description (Kawashita-Ribeiro et al. 2013). Therefore, at this point we trust the data given in the original species description.

***Helicops boitata* Moraes-da-Silva, Amaro, Sales-Nunes, Strüssmann, Teixeira, Andrade, Sudré, Recoder, Rodrigues, Curcio, 2019**

Diagnosis

Helicops boitata differs from all its congeners by the presence of an entire nasal scale and 25 dorsal scale rows at midbody, reducing to 21 anterior to cloaca (for information on references see Suppl. material 3).

Distribution

Helicops boitata is only known from the Pantanal at Transpantaneira road in the municipality of Pocone, Mato Grosso, Brazil (Fig. 1c).

***Helicops carinicaudus* (Wied-Neuwied, 1825)**

Materials

- a. scientificName: *Helicops carinicaudus* (Wied-Neuwied, 1825); country: Brazil; individualCount: 1; sex: male; catalogNumber: MTKD 15295; recordedBy: Fritzsche leg.; institutionID: MTKD
- b. scientificName: *Helicops carinicaudus* (Wied-Neuwied, 1825); country: Brazil; individualCount: 1; sex: male; catalogNumber: MTKD 15505; institutionID: MTKD
- c. scientificName: *Helicops carinicaudus* (Wied-Neuwied, 1825); country: Brazil; stateProvince: Rio Grande do Sul; locality: Rio Grande; year: 1886; individualCount: 1; sex: female; catalogNumber: SMF 17799; recordedBy: H. Ihering leg.; institutionID: SMF
- d. scientificName: *Helicops carinicaudus* (Wied-Neuwied, 1825); country: Brazil; year: 1838; individualCount: 1; sex: male; catalogNumber: SMF 17800; recordedBy: C.v.Heyden leg.; institutionID: SMF
- e. scientificName: *Helicops carinicaudus* (Wied-Neuwied, 1825); country: Brazil; stateProvince: Pernambuco; year: 1913-1914; individualCount: 1; sex: female; catalogNumber: SMF 34035; recordedBy: E. Bresslau leg.; institutionID: SMF
- f. scientificName: *Helicops carinicaudus* (Wied-Neuwied, 1825); country: Brazil; stateProvince: Rio Grande do Sul; locality: Porto Alegre; year: 1935; individualCount: 1; sex: female; catalogNumber: SMF 37925; recordedBy: A. Adolff leg.; institutionID: SMF
- g. scientificName: *Helicops carinicaudus* (Wied-Neuwied, 1825); country: Brazil; stateProvince: Sao Paulo; locality: Umgebung von Sao Paulo; year: 1955; individualCount: 1; sex: male; catalogNumber: SMF 49723; recordedBy: M. Schetty leg.; institutionID: SMF
- h. scientificName: *Helicops carinicaudus* (Wied-Neuwied, 1825); country: Brazil; stateProvince: Sao Paulo; locality: Rinopolis; year: 1954; individualCount: 1; sex: female; catalogNumber: SMF 51208; recordedBy: R. Mertens leg.; institutionID: SMF

- i. scientificName: *Helicops carinicaudus* (Wied–Neuwied, 1825); country: Argentina; stateProvince: Buenos Aires; locality: Punta Lara; individualCount: 1; sex: female; catalogNumber: ZFMK 30350; institutionID: ZFMK
- j. scientificName: *Helicops carinicaudus* (Wied–Neuwied, 1825); individualCount: 1; sex: female; catalogNumber: ZMB 2296; institutionID: ZMB
- k. scientificName: *Helicops carinicaudus* (Wied–Neuwied, 1825); country: Brazil; individualCount: 1; sex: female; catalogNumber: ZMB 2298; recordedBy: I. v. Olfers leg.; institutionID: ZMB
- l. scientificName: *Helicops carinicaudus* (Wied–Neuwied, 1825); country: Brazil; year: <1907; individualCount: 1; sex: female; catalogNumber: ZSM 2585/0; institutionID: ZSM

Diagnosis

Helicops carinicaudus can be distinguished from all its congeners except *H. danieli*, *H. infrataeniatus*, *H. leopardinus* and *H. phantasma* by the following combination of characteristics: 17–19 dorsal scale rows at midbody, reducing to 17 anterior to cloaca, 128–141 ventrals in males, and 128–148 ventrals in females. From *H. danieli* and *H. leopardinus* it differs in having a striped or uniform dorsum, versus blotched pattern in *H. danieli* and *H. leopardinus*. From *H. infrataeniatus* and *H. phantasma* it differs in having a yellow or cream venter with two series of black semilunar marks, between these, small, irregular black spots (for information on references see Suppl. material 3).

Distribution

The distribution of *H. carinicaudus* extends from the estuary of the Rio de La Plata along the shoreline of Brazil to the province Pernambuco (Fig. 1d).

Helicops danieli Amaral, 1937

Materials

- a. scientificName: *Helicops danieli* Amaral, 1937; country: Columbia; stateProvince: Barranquilla; year: 1958; individualCount: 1; sex: female; catalogNumber: SMF 55074; recordedBy: A. Werner leg.; institutionID: SMF
- b. scientificName: *Helicops danieli* Amaral, 1937; country: Columbia; stateProvince: Barranquilla; year: 1958; individualCount: 1; sex: female; catalogNumber: SMF 55115; recordedBy: A. Werner leg.; institutionID: SMF
- c. scientificName: *Helicops danieli* Amaral, 1937; country: Columbia; stateProvince: Barranquilla; year: 1958; individualCount: 1; sex: female; catalogNumber: SMF 55695; recordedBy: A. Werner leg.; institutionID: SMF
- d. scientificName: *Helicops danieli* Amaral, 1937; country: Brazil; individualCount: 1; sex: male; catalogNumber: ZMB 9490; institutionID: ZMB
- e. scientificName: *Helicops danieli* Amaral, 1937; country: Columbia; stateProvince: Bolivar; locality: Jesus del Rio; year: 1937; individualCount: 1; sex: female; catalogNumber: ZSM 596/2003; recordedBy: W. Hellmich leg.; institutionID: ZSM

Diagnosis

Helicops danieli is readily distinguished from its congeners by its spotted dorsum in combination with a ventral pattern consisting of 2 rows of semilunar marks on a light background (for information on references see Suppl. material 3).

Distribution

Helicops danieli is only present in Colombia. In Colombia it seems to range mainly west of the Andes. There is a report from the lowland in the east near the Brazilian border (Yuki and Castano 1998, Fig. 1e). Specimen ZMB 9490 has the country-level locality Brazil without a precise locality given.

Helicops gomesi Amaral, 1921

Diagnosis

Helicops gomesi is distinguished from all its congeners except *H. angulatus* by having subcaudal keels, no intergenials, and 19 dorsal scale rows throughout its body. From *H. angulatus* it differs in having 125–132 ventrals in males and 128–132 in females (for information on references see Suppl. material 3).

Distribution

The distribution of *H. gomesi* extends from the Brazilian province Sao Paulo to the provinces Mato Grosso, Mato Grosso do Sul and Goias (Fig. 1f).

Helicops hagmanni Roux, 1910

Materials

- a. scientificName: *Helicops hagmanni* Roux, 1910; country: Brazil; stateProvince: Amazonas; year: 1831; individualCount: 1; sex: male; catalogNumber: MTKD 7801; recordedBy: Poeppig leg.; institutionID: MTKD
- b. scientificName: *Helicops hagmanni* Roux, 1910; country: Brazil; stateProvince: Para; locality: Umgebung von Para; individualCount: 1; sex: female; catalogNumber: ZMB C-826; recordedBy: A. Freiherr v. Dungen leg.; institutionID: ZMB

Diagnosis

Helicops hagmanni is distinguished from all its congeners by having subcaudal keels, 21–29 dorsal scale rows at midbody, and 50–59 subcaudals (for information on references see Suppl. material 3).

Distribution

The distribution of *H. hagmanni* ranges from the estuary of the Amazonas to the Brazilian province Amazonas and the Venezuelan province Amazonas. There is also one record from northern Rondônia (Silva Jr 1993, Fig. 2a).

Morphologic remark

The examined specimens had smooth subcaudal scales on the anterior part of the tail, changing to weakly keeled scales at posterior tail (see also Table 1).

Helicops infrataeniatus Jan, 1865

Materials

- a. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; stateProvince: Entre Rios; individualCount: 1; sex: female; catalogNumber: MTKD 29826; recordedBy: Strauss-Hiller leg.; institutionID: MTKD
- b. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; year: 1898; individualCount: 1; sex: female; catalogNumber: SMF 17795; recordedBy: P. Werner leg.; institutionID: SMF
- c. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; stateProvince: Parana; locality: Curitiba; year: 1905; individualCount: 1; sex: female; catalogNumber: SMF 17796; recordedBy: A. Haas leg.; institutionID: SMF
- d. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; stateProvince: Parana; locality: Curitiba; year: 1905; individualCount: 1; sex: female; catalogNumber: SMF 17797; recordedBy: A. Haas leg.; institutionID: SMF
- e. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; stateProvince: Rio Grande do Sul; year: 1888; individualCount: 1; sex: female; catalogNumber: SMF 17801; recordedBy: H. Ihering leg.; institutionID: SMF
- f. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; stateProvince: Rio Grande do Sul; locality: Espumoso Via Carasinho; year: 1954; individualCount: 1; sex: male; catalogNumber: SMF 51209; recordedBy: R. Mertens leg.; institutionID: SMF
- g. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; stateProvince: Rio Grande do Sul; locality: Espumoso Via Carasinho; year: 1954; individualCount: 1; sex: female; catalogNumber: SMF 51210; recordedBy: R. Mertens leg.; institutionID: SMF
- h. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; stateProvince: Chaco; locality: Roque Saenz Pena; year: 1965; individualCount: 1; sex: male; catalogNumber: SMF 67327; recordedBy: Foerster leg.; institutionID: SMF
- i. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; year: 1889; individualCount: 1; sex: female; catalogNumber: SMNS 3065; recordedBy: Umlauff leg.; institutionID: SMNS
- j. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; stateProvince: Rio Grande do Sul; locality: Cachoeira do Sul; year: 1995; individualCount: 1; sex: female; catalogNumber: SMNS 9038; recordedBy: A. Kwet leg.; institutionID: SMNS
- k. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; stateProvince: Rio Grande do Sul; locality: Sao Leopoldo; individualCount: 1; sex: female; catalogNumber: ZFMK 102469; recordedBy: leg.; institutionID: SMNS

- l. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; stateProvince: Buenos Aires; locality: Punta Lara; individualCount: 1; sex: female; catalogNumber: ZFMK 102499; institutionID: ZFMK
- m. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: female; catalogNumber: ZFMK 102500; institutionID: ZFMK
- n. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: female; catalogNumber: ZFMK 102501; institutionID: ZFMK
- o. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: female; catalogNumber: ZFMK 102502; institutionID: ZFMK
- p. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: male; catalogNumber: ZFMK 102503; institutionID: ZFMK
- q. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: female; catalogNumber: ZFMK 102504; institutionID: ZFMK
- r. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: male; catalogNumber: ZFMK 102505; institutionID: ZFMK
- s. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: female; catalogNumber: ZFMK 102506; institutionID: ZFMK
- t. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: female; catalogNumber: ZFMK 102507; institutionID: ZFMK
- u. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: female; catalogNumber: ZFMK 102508; institutionID: ZFMK
- v. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: female; catalogNumber: ZFMK 102509; institutionID: ZFMK
- w. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; stateProvince: Rio Grande do Sul; locality: Campo Bom (wahrscheinlich); individualCount: 1; sex: female; catalogNumber: ZFMK 102630; institutionID: ZFMK
- x. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; individualCount: 1; sex: female; catalogNumber: ZMB 16436; recordedBy: Mücke leg.; institutionID: ZMB
- y. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; individualCount: 1; sex: male; catalogNumber: ZMB 16437; recordedBy: Mücke leg.; institutionID: ZMB
- z. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; individualCount: 1; sex: female; catalogNumber: ZMB 16438; recordedBy: Mücke leg.; institutionID: ZMB
- aa. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; individualCount: 1; sex: male; catalogNumber: ZMB 20606A; recordedBy: R. Hauthal leg.; institutionID: ZMB
- ab. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; individualCount: 1; sex: female; catalogNumber: ZMB 20606B; recordedBy: R. Hauthal leg.; institutionID: ZMB
- ac. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; individualCount: 1; sex: female; catalogNumber: ZMB 20606C; recordedBy: R. Hauthal leg.; institutionID: ZMB
- ad. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; individualCount: 1; sex: male; catalogNumber: ZMB 20607; recordedBy: R. Hauthal leg.; institutionID: ZMB
- ae. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; individualCount: 1; sex: male; catalogNumber: ZMB 20608A; recordedBy: R. Hauthal leg.; institutionID: ZMB
- af. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; individualCount: 1; sex: male; catalogNumber: ZMB 20608B; recordedBy: R. Hauthal leg.; institutionID: ZMB
- ag. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; individualCount: 1; sex: female; catalogNumber: ZMB 20608C; recordedBy: R. Hauthal leg.; institutionID: ZMB

- ah. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; individualCount: 1; sex: male; catalogNumber: ZMB 20609A; recordedBy: R. Hauthal leg.; institutionID: ZMB
- ai. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; individualCount: 1; sex: female; catalogNumber: ZMB 20609B; recordedBy: R. Hauthal leg.; institutionID: ZMB
- aj. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; individualCount: 1; sex: male; catalogNumber: ZMB 20609C; recordedBy: R. Hauthal leg.; institutionID: ZMB
- ak. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: female; catalogNumber: ZMB 20610A; institutionID: ZMB
- al. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: female; catalogNumber: ZMB 20610B; institutionID: ZMB
- am. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; individualCount: 1; sex: male; catalogNumber: ZMB 20613A; recordedBy: R. Hauthal leg.; institutionID: ZMB
- an. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; individualCount: 1; sex: female; catalogNumber: ZMB 20613B; recordedBy: R. Hauthal leg.; institutionID: ZMB
- ao. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; individualCount: 1; sex: female; catalogNumber: ZMB 20613C; recordedBy: R. Hauthal leg.; institutionID: ZMB
- ap. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; individualCount: 1; sex: female; catalogNumber: ZMB 20613D; recordedBy: R. Hauthal leg.; institutionID: ZMB
- aq. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; individualCount: 1; sex: female; catalogNumber: ZMB 20613E; recordedBy: R. Hauthal leg.; institutionID: ZMB
- ar. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Argentina; individualCount: 1; sex: female; catalogNumber: ZMB 20613F; recordedBy: R. Hauthal leg.; institutionID: ZMB
- as. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; stateProvince: Rio Grande do Sul; locality: Porto Alegre; individualCount: 1; sex: male; catalogNumber: ZMB 6373; recordedBy: R. Hensel leg.; institutionID: ZMB
- at. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; stateProvince: Rio Grande do Sul; locality: Porto Alegre; individualCount: 1; sex: female; catalogNumber: ZMB 6840A; recordedBy: R. Hensel leg.; institutionID: ZMB
- au. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; stateProvince: Rio Grande do Sul; locality: Porto Alegre; individualCount: 1; sex: female; catalogNumber: ZMB 6840B; recordedBy: R. Hensel leg.; institutionID: ZMB
- av. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: female; catalogNumber: ZMB 79245; institutionID: ZMB
- aw. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: female; catalogNumber: ZMB 79246; institutionID: ZMB
- ax. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: male; catalogNumber: ZMB 79247; institutionID: ZMB
- ay. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: male; catalogNumber: ZMB 79248; institutionID: ZMB
- az. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; stateProvince: Rio Grande do Sul; locality: Porto Alegre; individualCount: 1; sex: male; catalogNumber: ZMB 79249; recordedBy: R. Hensel leg.; institutionID: ZMB

- ba. scientificName: *Helicops infrataeniatus* Jan, 1865; country: Brazil; stateProvince: Rio Grande do Sul; locality: Porto Alegre; individualCount: 1; sex: male; catalogNumber: ZMB 79250; recordedBy: R. Hensel leg.; institutionID: ZMB
- bb. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: male; catalogNumber: ZMB 89646; institutionID: ZMB
- bc. scientificName: *Helicops infrataeniatus* Jan, 1865; individualCount: 1; sex: male; catalogNumber: ZMB 89647; institutionID: ZMB

Diagnosis

This species can be distinguished from all other congeners except *H. carinicaudus*, *H. nentur* and *H. tapajonicus* by the combination of 17–20 dorsal scale rows at midbody, and a uniform or longitudinally striped dorsum. From *H. nentur* it differs in having a semidivided nasal scale, whereas *H. nentur* has an entire nasal scale. From *H. carinicaudus* it differs in having a cream or red venter with 1–3 dark stripes or darkly checkered or black with light spots. Sometimes the patterns shift into each other. From *H. tapajonicus* it differs in having strongly keeled dorsal scales, whereas *H. tapajonicus* has only a weak dorsal keeling. Additionally, *H. tapajonicus* possesses a ventrolateral greenish stripe, which is absent in *H. infrataeniatus* (for information on references see Suppl. material 3). Furthermore, these two species have allopatric distribution ranges.

Distribution

Helicops infrataeniatus is present in the southern Brazilian states Mato Grosso do Sul, Sao Paulo, Parana, Santa Catarina, Rio Grande do Sul and northwest Argentina. For Uruguay Carreira Vidal et al. (2005) described the presence of *H. infrataeniatus* from the north of the department of Rocha through the department of Cerro Largo continuing to the north of the country, being frequent in the departments of Artigas and Salto (Fig. 2b).

Morphology remark

Kawashita-Ribeiro et al. (2013) reported subcaudal keels in *H. infrataeniatus*. In contrast, 57 of the 58 examined specimens during this study showed smooth subcaudal scales. Only SMNS 3065 had subcaudal keels (see Table 1).

Helicops leopardinus (Schlegel, 1837)

Materials

- a. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Columbia; individualCount: 1; sex: female; catalogNumber: MTKD 15506; institutionID: MTKD
- b. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Argentina; stateProvince: Cordoba; locality: San Francisco; individualCount: 1; sex: female; catalogNumber: MTKD 27443; recordedBy: Strauss-Hiller leg.; institutionID: MTKD
- c. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Argentina; stateProvince: Cordoba; locality: San Francisco; individualCount: 1; sex: female; catalogNumber: MTKD 28115; recordedBy: Strauss-Hiller leg.; institutionID: MTKD

- d. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Argentina; locality: Central Chaco; individualCount: 1; sex: male; catalogNumber: MTKD 28716; recordedBy: Strauss-Hiller leg.; institutionID: MTKD
- e. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Argentina; stateProvince: Chaco; locality: Resistencia; individualCount: 1; sex: female; catalogNumber: MTKD 29825; recordedBy: Strauss-Hiller leg.; institutionID: MTKD
- f. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Bolivia; stateProvince: Santa Cruz; locality: Velasco, Campamento; verbatimLocality: 185; verbatimLatitude: -15°10.493; verbatimLongitude: -61°0.968; year: 2007; individualCount: 1; sex: female; catalogNumber: SMF 100015; recordedBy: M. Jansen leg.; institutionID: SMF
- g. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Brazil; stateProvince: Mato Grosso; locality: Cujapa; year: 1885; individualCount: 1; sex: female; catalogNumber: SMF 17807; recordedBy: I. Schumacher leg.; institutionID: SMF
- h. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Brazil; locality: Northern Brazil; year: 1897; individualCount: 1; sex: male; catalogNumber: SMF 17809; recordedBy: O. Boettger leg.; institutionID: SMF
- i. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; year: 1972; individualCount: 1; sex: female; catalogNumber: SMF 67860; recordedBy: M. Schetty leg.; institutionID: SMF
- j. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; year: 1972; individualCount: 1; sex: female; catalogNumber: SMF 67861; recordedBy: M. Schetty leg.; institutionID: SMF
- k. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; year: 1972; individualCount: 1; sex: female; catalogNumber: SMF 67862; recordedBy: W.v.d. Wall leg.; institutionID: SMF
- l. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Brazil; individualCount: 1; sex: male; catalogNumber: ZFMK 36339; institutionID: ZFMK
- m. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; stateProvince: Asunción; locality: Pilcomayo; individualCount: 1; sex: female; catalogNumber: ZFMK 59774; institutionID: ZFMK
- n. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; stateProvince: Asunción; locality: Pilcomayo; individualCount: 1; sex: male; catalogNumber: ZFMK 59775; institutionID: ZFMK
- o. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Bolivia; stateProvince: Santa Cruz; locality: between Florida & Meura, Rio Paraguay; individualCount: 1; sex: male; catalogNumber: ZFMK 60153; institutionID: ZFMK
- p. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Bolivia; stateProvince: Beni; locality: Campamento Encanto; individualCount: 1; sex: female; catalogNumber: ZFMK 62836; institutionID: ZFMK
- q. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; individualCount: 1; sex: male; catalogNumber: ZMB 10749; recordedBy: R. Rohde leg.; institutionID: ZFMK
- r. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Argentina; individualCount: 1; sex: female; catalogNumber: ZMB 20611A; recordedBy: R. Hauthal leg.; institutionID: ZMB
- s. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Argentina; individualCount: 1; sex: female; catalogNumber: ZMB 20611B; recordedBy: R. Hauthal leg.; institutionID: ZMB

- t. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Argentina; stateProvince: Salta; locality: Tartagal; individualCount: 1; sex: male; catalogNumber: ZMB 26040A; recordedBy: Neumayer leg.; institutionID: ZMB
- u. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Argentina; stateProvince: Salta; locality: Tartagal; individualCount: 1; catalogNumber: ZMB 26040B; recordedBy: Neumayer leg.; institutionID: ZMB
- v. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Brazil; stateProvince: Bahia; individualCount: 1; sex: male; catalogNumber: ZMB 7545; recordedBy: O. Wucherer leg.; institutionID: ZMB
- w. scientificName: *Helicops leopardinus* (Schlegel, 1837); individualCount: 1; sex: female; catalogNumber: ZMB 89665; institutionID: ZMB
- x. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; stateProvince: Alto Paraguayo; locality: Puerto Sastre; year: 1931; individualCount: 1; sex: female; catalogNumber: ZSM 1026/2010; recordedBy: G. Walter leg.; institutionID: ZMB
- y. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; stateProvince: Alto Paraguayo; locality: Puerto Sastre; year: 1931; individualCount: 1; sex: male; catalogNumber: ZSM 1027/2010; recordedBy: G. Walter leg.; institutionID: ZSM
- z. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; stateProvince: Alto Paraguayo; locality: Puerto Sastre; year: 1931; individualCount: 1; sex: male; catalogNumber: ZSM 1028/2010; recordedBy: G. Walter leg.; institutionID: ZSM
- aa. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; stateProvince: Alto Paraguayo; locality: Puerto Sastre; year: 1931; individualCount: 1; sex: female; catalogNumber: ZSM 1029/2010; recordedBy: G. Walter leg.; institutionID: ZSM
- ab. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; stateProvince: Alto Paraguayo; locality: Puerto Sastre; year: 1931; individualCount: 1; sex: female; catalogNumber: ZSM 1030/2010; recordedBy: G. Walter leg.; institutionID: ZSM
- ac. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; stateProvince: Alto Paraguayo; locality: Puerto Sastre; year: 1931; individualCount: 1; sex: female; catalogNumber: ZSM 1031/2010; recordedBy: G. Walter leg.; institutionID: ZSM
- ad. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; stateProvince: Alto Paraguayo; locality: Puerto Sastre; year: 1931; individualCount: 1; sex: female; catalogNumber: ZSM 1032/2010; recordedBy: G. Walter leg.; institutionID: ZSM
- ae. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; stateProvince: Alto Paraguayo; locality: Puerto Sastre; year: 1931; individualCount: 1; sex: female; catalogNumber: ZSM 1033/2010; recordedBy: G. Walter leg.; institutionID: ZSM
- af. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; stateProvince: Alto Paraguayo; locality: Puerto Sastre; year: 1931; individualCount: 1; sex: female; catalogNumber: ZSM 1034/2010; recordedBy: G. Walter leg.; institutionID: ZSM
- ag. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; stateProvince: Alto Paraguayo; locality: Puerto Sastre; year: 1931; individualCount: 1; sex: female; catalogNumber: ZSM 1035/2010; recordedBy: G. Walter leg.; institutionID: ZSM
- ah. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; stateProvince: Alto Paraguayo; locality: Puerto Sastre; year: 1931; individualCount: 1; sex: male; catalogNumber: ZSM 1036/2010; recordedBy: G. Walter leg.; institutionID: ZSM
- ai. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; stateProvince: Alto Paraguayo; locality: Puerto Sastre; year: 1931; individualCount: 1; sex: female; catalogNumber: ZSM 1037/2010; recordedBy: G. Walter leg.; institutionID: ZSM
- aj. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; stateProvince: Alto Paraguayo; locality: Puerto Sastre; year: 1931; individualCount: 1; sex: female; catalogNumber: ZSM 1038/2010; recordedBy: G. Walter leg.; institutionID: ZSM

- ak. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; stateProvince: Alto Paraguayo; locality: Puerto Sastre; year: 1931; individualCount: 1; sex: female; catalogNumber: ZSM 1039/2010; recordedBy: G. Walter leg.; institutionID: ZSM
- al. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Paraguay; stateProvince: Alto Paraguayo; locality: Puerto Sastre; year: 1931; individualCount: 1; sex: female; catalogNumber: ZSM 1040/2010; recordedBy: G. Walter leg.; institutionID: ZSM
- am. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Bolivia; stateProvince: Departamento Beni; locality: Rio Madre de Dios; year: <1923?; individualCount: 1; sex: female; catalogNumber: ZSM 134/1947; recordedBy: Zimmermann leg.; institutionID: ZSM
- an. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Brazil; year: 1817-1820; individualCount: 1; sex: male; catalogNumber: ZSM 1523/0; recordedBy: Spix & Martius leg.; institutionID: ZSM
- ao. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Bolivia; stateProvince: Santa Cruz; locality: San Fermin (100 km nördlich Puerto Suarez); year: 1926; individualCount: 1; sex: female; catalogNumber: ZSM 172/1929; recordedBy: I. Deutsche Chaco-Expedition leg.; institutionID: ZSM
- ap. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Argentina; stateProvince: Santa Fe; locality: Rosario de Santa Fe; year: 1903-1906; individualCount: 1; sex: female; catalogNumber: ZSM 268/2017; recordedBy: K. König leg.; institutionID: ZSM
- aq. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Argentina; stateProvince: Santa Fe; locality: Rosario de Santa Fe; year: 1907; individualCount: 1; sex: female; catalogNumber: ZSM 269/2017; recordedBy: von Stromer leg.; institutionID: ZSM
- ar. scientificName: *Helicops leopardinus* (Schlegel, 1837); country: Argentina; stateProvince: Santa Fe; locality: Rosario de Santa Fe; year: 1907; individualCount: 1; sex: female; catalogNumber: ZSM 270/2017; recordedBy: von Stromer leg.; institutionID: ZSM

Diagnosis

Helicops leopardinus is distinguished from all its congeners except *H. danieli* and *H. gomesi* by the combination of grayish-olive to grayish-brown dorsum with 4–5 series of alternating dark spots, 18–22 dorsal scale rows at midbody, and absent intergenials. From *H. danieli* it differs in having a cream, yellow or red venter, checkered or banded black or both (versus cream venter with two medial rows of black semilunar marks). From *H. gomesi* it differs in having no subcaudal keels (for information on references see Suppl. material 3).

Distribution

Helicops leopardinus is present from the northwest of Argentina to the estuary of the Amazon and from Ecuador to the Brazilian state Bahia. There are no records of this species in the central Amazon Basin (Fig. 2c).

Morphology remark

ZSM 134/1947, a female, possesses 109 subcaudals (versus 53–88 in females of *H. leopardinus*). We interpret this as an abnormality (see also Table 1).

Helicops modestus Günther, 1861

Materials

- a. scientificName: *Helicops modestus* Günther, 1861; country: Brazil; stateProvince: Sao Paulo; year: 1881; individualCount: 1; sex: female; catalogNumber: SMF 17802; recordedBy: I. Duschaneck leg.; institutionID: SMF
- b. scientificName: *Helicops modestus* Günther, 1861; country: Brazil; stateProvince: Sao Paulo; year: 1881; individualCount: 1; sex: female; catalogNumber: SMF 17803; recordedBy: I. Duschaneck leg.; institutionID: SMF
- c. scientificName: *Helicops modestus* Günther, 1861; country: Brazil; stateProvince: Sao Paulo; year: 1876; individualCount: 1; sex: female; catalogNumber: SMF 17804; recordedBy: C. Müller leg.; institutionID: SMF
- d. scientificName: *Helicops modestus* Günther, 1861; country: Brazil; stateProvince: Sao Paulo; year: 1876; individualCount: 1; sex: female; catalogNumber: SMF 17805; recordedBy: C. Müller leg.; institutionID: SMF
- e. scientificName: *Helicops modestus* Günther, 1861; country: Brazil; stateProvince: Sao Paulo; individualCount: 1; sex: male; catalogNumber: SMF 17806; institutionID: SMF
- f. scientificName: *Helicops modestus* Günther, 1861; country: Brazil; stateProvince: Sao Paulo; locality: Umgebung von Sao Paulo; year: 1955; individualCount: 1; sex: female; catalogNumber: SMF 49724; recordedBy: M. Schetty leg.; institutionID: SMF
- g. scientificName: *Helicops modestus* Günther, 1861; country: Brazil; stateProvince: Sao Paulo; locality: Umgebung von Sao Paulo; year: 1955; individualCount: 1; sex: female; catalogNumber: SMF 49725; recordedBy: M. Schetty leg.; institutionID: SMF
- h. scientificName: *Helicops modestus* Günther, 1861; country: Brazil; stateProvince: Sao Paulo; locality: Umgebung von Sao Paulo; year: 1955; individualCount: 1; sex: female; catalogNumber: SMF 49726; recordedBy: M. Schetty leg.; institutionID: SMF
- i. scientificName: *Helicops modestus* Günther, 1861; country: Brazil; stateProvince: Sao Paulo; locality: Umgebung von Sao Paulo; year: 1955; individualCount: 1; sex: female; catalogNumber: SMF 49727; recordedBy: M. Schetty leg.; institutionID: SMF
- j. scientificName: *Helicops modestus* Günther, 1861; country: Brazil; stateProvince: Sao Paulo; locality: Sao Miguel Paulista; year: 1955; individualCount: 1; sex: female; catalogNumber: SMF 51207; recordedBy: R. Mertens leg.; institutionID: SMF
- k. scientificName: *Helicops modestus* Günther, 1861; country: Brazil; stateProvince: Embu; locality: 25 km von Sao Paulo; year: 1954; individualCount: 1; sex: female; catalogNumber: SMF 91211; recordedBy: F. Weidinger leg.; institutionID: SMF
- l. scientificName: *Helicops modestus* Günther, 1861; country: Brazil; individualCount: 1; sex: male; catalogNumber: ZMB 2266; recordedBy: Reinhardt leg.; institutionID: ZMB

Diagnosis

Helicops modestus differs from all its congeners except *H. carinicaudus*, *H. danieli*, *H. infraeniatus*, *H. leopardinus* and *H. tapajonicus* by having 19 dorsal scale rows at anterior body and 17–20 at midbody, and the absence of subcaudal keels. From the remaining species it differs in having a black to dark green dorsum with indistinct longitudinal stripes and a nearly uniform light cream venter, sometimes with faint flecks (for information on references see Suppl. material 3).

Distribution

Helicops modestus is present from the Brazilian province Bahia to the province Paraná and seems to range from the east shore of Brazil to the south of Mato Grosso. There is also one specimen from the southern shore of Uruguay and one literature report from Volta Grande do Xingu in the Brazilian province Para, near its estuary into the Amazon (Vaz-Silva et al. 2015, Fig. 2d).

Helicops nentur Costa, Santana, Leal, Koroiva & Garcia, 2016

Diagnosis

Helicops nentur differs from all its congeners by the combination of an entire nasal scale, and 17 dorsal scale rows at midbody (for information on references see Suppl. material 3).

Distribution

Helicops nentur is known only from the eastern half of the Brazilian Province Minas Gerais (Fig. 2e).

Helicops pastazae Shreve, 1934

Material

- a. scientificName: *Helicops pastazae* Shreve, 1934; country: Ecuador; stateProvince: Napo; locality: Virgilio Davila (Borja), Quijos; year: <1952; individualCount: 1; sex: female; catalogNumber: ZSM 519/2003; recordedBy: J. Foerster leg.; institutionID: ZSM

Diagnosis

Helicops pastazae can be distinguished from all other congeners except *H. hagmanni* and *H. yacu* by the combination of having subcaudal keels, intergenials present, and 23–25 dorsal scale rows at midbody. From *H. hagmanni* it differs in having 72–117 subcaudal scales (versus 50–59 in *H. hagmanni*). From *H. yacu* it differs in having a semidivided nasal scale (entire in *H. yacu*; for information on references see Suppl. material 3).

Distribution

Helicops pastazae is present in the northern part of Ecuador and the eastern part of Venezuela. There are no reports from Colombia (Fig. 2f).

***Helicops petersi* Rossman, 1976**

Diagnosis

Helicops petersi can be distinguished from all its congeners except *H. pastazae* by the combination of 21–23 dorsal scale rows at midbody, reducing to 16 anterior to cloaca, and 135–150 ventrals (for information on references see Suppl. material 3).

Distribution

Helicops petersi is known only from a very small area in the Ecuadorian province Napo (Fig. 3a).

***Helicops phantasma* Moraes-da-Silva, Amaro, Nunes, Rodrigues & Curcio, 2021**

Diagnosis

Helicops phantasma can be distinguished from all other congeners by having a dorsal pattern of dark spots fusing to irregular black bands, having 19/19/17–19 dorsal scale rows with moderate keels and hemipenial morphology (Moraes-da-Silva et al. 2021) (for information on references see Suppl. material 3).

Distribution

The species is only known from the Tocantins-Araguaia River Basin in the provinces Tocantins, Mato Grosso and Maranhão in northern Brazil (Moraes-da-Silva et al. 2021, Fig. 3b).

***Helicops polylepis* Günther, 1861**

Materials

- a. scientificName: *Helicops polylepis* Günther, 1861; country: Columbia; individualCount: 1; sex: female; catalogNumber: MTKD 15507; institutionID: MTKD
- b. scientificName: *Helicops polylepis* Günther, 1861; country: Columbia; individualCount: 1; sex: female; catalogNumber: MTKD 15508; institutionID: MTKD
- c. scientificName: *Helicops polylepis* Günther, 1861; country: Bolivia; stateProvince: Chaco; individualCount: 1; sex: female; catalogNumber: SMF 17821; recordedBy: F. Werner leg.; institutionID: SMF
- d. scientificName: *Helicops polylepis* Günther, 1861; country: Bolivia; individualCount: 1; sex: female; catalogNumber: SMF 17822; recordedBy: C.A. Hahn leg.; institutionID: SMF
- e. scientificName: *Helicops polylepis* Günther, 1861; country: Brazil; stateProvince: Bahia; individualCount: 1; sex: male; catalogNumber: ZMB 17428; institutionID: ZMB

- f. scientificName: *Helicops polylepis* Günther, 1861; country: Bolivia; stateProvince: La Paz; locality: La Paz; individualCount: 1; sex: male; catalogNumber: ZMB 26215; recordedBy: Stoecker leg.; institutionID: ZMB
- g. scientificName: *Helicops polylepis* Günther, 1861; individualCount: 1; catalogNumber: ZMB 30993; institutionID: ZMB

Diagnosis

Helicops polylepis can be distinguished from all its congeners by the combination of 23–26 dorsal scale rows at midbody, the absence of intergenials, and a semidivided nasal scale (for information on references see Suppl. material 3).

Distribution

Helicops polylepis is present from southern Bolivia to the Amazon estuary and from southeastern Peru to the Brazilian province Bahia (Fig. 3c).

Helicops scalaris Jan, 1865

Diagnosis

This species can be distinguished from all its congeners except *H. trivittatus* by the combination of having intergenials, 110–119 ventrals in males and 113–125 in females, and 67–95 subcaudals. From *H. trivittatus* it differs in having a blotched dorsum, versus striped in *H. trivittatus* (for information on references see Suppl. material 3).

Distribution

Helicops scalaris is known only from a small area in the northern border area between Colombia and Venezuela, western and northern of Lake Maracaibo in Venezuela (Fig. 3d).

Helicops tapajonicus da Frota, 2005

Diagnosis

This species can be distinguished from all its congeners by the combination of a uniform moss-green dorsum, laterally with a greenish-yellow stripe and a black and greenish-yellow banded venter (for information on references see Suppl. material 3).

Distribution

Helicops tapajonicus is known only from two localities at the river Tapajos close to its confluence with the Amazon in the Brazilian state Pará (Fig. 3e).

Helicops trivittatus (Gray, 1849)

Materials

- a. scientificName: *Helicops trivittatus* (Gray, 1849); year: 1915; individualCount: 1; sex: female; catalogNumber: SMF 17798; recordedBy: Z.G. leg.; institutionID: SMF
- b. scientificName: *Helicops trivittatus* (Gray, 1849); country: Brazil; stateProvince: Para; locality: Amazonas; year: 1953; individualCount: 1; sex: male; catalogNumber: SMF 45434; recordedBy: K. Müller leg.; institutionID: SMF
- c. scientificName: *Helicops trivittatus* (Gray, 1849); country: Brazil; stateProvince: Pará; locality: Insel Marajó, Cachoeira am mittleren Arary; year: 1910; individualCount: 1; sex: female; catalogNumber: ZSM 272/2017; recordedBy: L. Müller leg.; institutionID: ZSM
- d. scientificName: *Helicops trivittatus* (Gray, 1849); country: Brazil; stateProvince: Pará; locality: Insel Marajó, Cachoeira am mittleren Arary; year: 1910; individualCount: 1; sex: female; catalogNumber: ZSM 273/2017; recordedBy: L. Müller leg.; institutionID: ZSM

Diagnosis

This species can be distinguished from all congeners by the combination of having five narrow light stripes on the dorsum and a light venter with black semilunar markings, which extend onto the tail (for information on references see Suppl. material 3).

Distribution

Helicops trivittatus is present from the eastern part of the Brazilian province Para to approximately its borders with Maranhao and Tocantins and the northern Mato Grosso. There are no reports of this species from western Para (Fig. 3f).

Morphology remark

The presence of intergenials seems to be a reliable identification character in the remaining species in this genus, whereas in *H. trivittatus* this character shows considerable variation. Intergenials are sometimes present, and there is no geographical pattern perceivable (pers. Com. Antonio Moraes).

Helicops yacu Rossman & Dixon, 1975

Diagnosis

Helicops yacu can be distinguished from all congeners by the combination of having an entire nasal scale, and intergenials present (for information on references see Suppl. material 3).

Distribution

Helicops yacu is known only from the Isla Yanamono in the Peruvian province Loreto (Rossman and Dixon 1975, Fig. 4).

Taxonomic remark

In Rossman and Abe (1979) the authors express their doubt that *H. yacu* represents an own species. In this publication the authors suggest that it might represent a subspecies of *H. pastazae*. No further examination of this suggestion has been made since then.

Helicops sp.

Material

- a. scientificName: *Helicops* sp.; country: Brazil; stateProvince: Pernambuco; year: 1913-1914; individualCount: 1; sex: female; catalogNumber: SMF 34035; recordedBy: E. Bresslau leg.; institutionID: SMF

Diagnosis

The female specimen SMF 34035 is distinguished from all other congeners except *H. infrataeniatus* by having 17 dorsal scale rows at midbody and posterior body and 124 ventrals. It differs from *H. infrataeniatus* in having a black venter with cream, narrow transversal bands, which are approximately a ventral scale wide, often left and right halves are shifted one ventral scale, forming a pattern resembling a chessboard. *Helicops infrataeniatus* has a venter either with three black stripes on a cream background or checkered black and cream, sometimes red. Additionally, the specimen is separated from *H. infrataeniatus* by its distribution. It originates from the Brazilian province Pernambuco, whereas *H. infrataeniatus* is occurring not further north than Mato Grosso do Sul in Brazil (Pholidosis of specimen 34035 see Table 2; for information on references see Suppl. material 3).

Distribution

The specimen originates from the province Pernambuco in Brazil, no exact locality given.

Identification keys

Identification key to the species of <i>Helicops</i> Wagler, 1830		
Dichotomous identification key created based on own examinations and literature listed in Suppl. material 3.		
1	Dorsum uniform or with longitudinal stripes	2
–	Dorsum with blotches, spots, or transverse bars	8

2	Dorsum tan to dark brown with five rows of narrow light stripes, ventral cream with 2 uniform rows of dark brown to black semilunar marks	<i>Helicops trivittatus</i>
–	Coloration not as above	3
3	Venter cream or yellow with 2–3 rows of black semilunar marks, 9–10 infralabials, 128–141 ventrals in males and 128–148 ventrals in females	<i>H. carinicaudus</i>
–	Coloration and pholidosis not as above	4
4	Nasal entire	7
–	Nasal semidivided	5
5	Ventral body cream, with or without faint brown flecks	<i>H. modestus</i>
–	Venter contrastingly checkered or with dark longitudinal stripes	6
6	Dorsum uniform moss green, dorsal weakly keeled	<i>H. tapajonicus</i>
–	Venter cream or red with 1–3 dark stripes or darkly checkered or black with light spots or intermediate forms; dorsal strongly keeled; dorsum dark brown with pale brown stripes	<i>H. infrataeniatus</i>
7	Dorsal scale rows at midbody 17, reducing to 15 anterior to cloaca; 56 subcaudals in single known male, 41–52 in females; dorsum uniform dark olive, dark brown, or dark gray	<i>H. nentur</i>
–	Dorsal scale rows at midbody 25, reducing to 21 anterior to cloaca; 68 subcaudals in single known male, unknown in females; dorsum greenish copper brown with three longitudinal chainlike rows of dark spots, Venter light greyish brown with two lateral rows of light orange spots	<i>H. boitata</i>
8	Intergenials present	9
–	Intergenials absent	13
9	Nasal entire; 85–96 subcaudals in females, unknown in males; 25–28 dorsal scale rows at midbody, reducing to 18–20 anterior to cloaca; dorsum light to medium gray brown with 4 alternating rows of relatively small dark spots	<i>H. yacu</i>
–	Nasal semidivided; 55–117 subcaudals in males, 51–97 in females; 19–29 dorsal scale rows at midbody, reducing to 16–23 anterior to cloaca; coloration variable	10
10	55–67 subcaudals in males, 50–53 in females; dorsum gray brown with alternating light and dark circular blotches; northern South America	<i>H. hagdmani</i>

–	83–117 subcaudals in males, 50–97 in females; coloration variable	11
11	110–119 ventrals in males, 113–125 in females; subcaudal keels absent; dorsum grayish tan with 3–5 rows of irregular dark blotches, the vertebral blotches larger than laterals, all 3 usually fused longitudinally; northern South America	<i>H. scalaris</i>
–	121–142 subcaudals in males, 130–150 in females; subcaudal keels present; coloration variable	12
12	Weak subcaudal keels present, 121–134 ventrals in males, 130–145 in females; 93–117 subcaudals in males, 72–97 in females; 23–25 dorsal scale rows at midbody, reducing to 16–19 anterior to cloaca; ventral coloration cream with a series of dark crossbands or alternating checks, light ventral color extending onto several dorsal scale rows; northern South America	<i>H. pastazae</i>
–	Subcaudal keels absent, 135–142 ventrals in males, 137–150 in females; 85–91 subcaudals in males, 67–73 in females; 21–23 dorsal scale rows at midbody, reducing to 16 anterior to cloaca; ventral coloration cream with a lateral series of dark checks; eastern Andean foothills of Ecuador	<i>H. petersi</i>
13	Subcaudal keels present	14
–	Subcaudal keels absent	16
14	103–123 ventrals in males, 104–125 in females; 17–20 dorsal scale rows at midbody	<i>H. angulatus</i>
–	118–132 ventrals in males, 124–132 in females, or if fewer than 124 ventrals in males, then 21–22 dorsal scale rows at midbody	15
15	19 dorsal scale rows at midbody; dorsum with dark blotches; one anterior temporal; 71–86 subcaudals in males, 67–73 in females; 125–132 ventrals in males, 128–132 in females	<i>H. gomesi</i>
–	21–24 dorsal scale rows at midbody; dorsum with dark transverse bands; 2–3 anterior temporals; 79–103 subcaudals in males, 80–84 in females; 118–127 ventrals in males, 124–132 in females; northern Mato Grosso, Brazil	<i>H. apiaka</i>
16	Dorsum scale rows at midbody 23–26, reducing to 17–21 anterior to cloaca; 71–101 subcaudals in males, 71–88 in females; 10–13 infralabials; venter dark with pale spots	<i>H. polylepis</i>

–	Dorsum scale rows at midbody 19–22, reducing to 16–19 anterior to cloaca; 64–89 subcaudals in males, 53–76 in females; 8–11 infralabials; venter checkered or banded black and red, or cream with two medial rows of black semilunar marks, sometimes fused midventrally	17
17	19 dorsal scale rows at anterior and midbody and 17–19 dorsal scale rows anterior to cloaca; dorsal scales with moderate keels; dark dorsal spots fusing to transversal bands	<i>H. phantasma</i>
–	Number of dorsal scale rows different	18
18	Venter checkered or banded black and red; 108–129 ventrals in males, 108–138 in females	<i>H. leopardinus</i>
–	Venter cream with two medial rows of black semilunar marks, sometimes fused midventrally; 125–135 ventrals in males, 130–141 in females	<i>H. danieli</i>

Discussion

Taxonomic discussion

We were unable to find a pholidosis character for distinguishing the species *H. carinicaudus* and *H. infrataeniatus*, but found them to differ in the coloration of the venter. *Helicops carinicaudus* has a yellow or cream venter with two series of black semilunar marks with small, irregular black spots between these marks, versus venter red to white, with three black stripes, checkered black and light, or black with light spots in *H. infrataeniatus*. Obviously, these species need a closer examination using molecular methods. A similar assessment for *H. infrataeniatus* was made by Achaval Elena (2001), who evaluated the systematics and distribution of most reptile species in Uruguay. A further hint for the necessity of revisionary work on these species is the documentation of *Helicops* sp. reported in this publication. As described, it resembles *H. infrataeniatus*, but has a considerably different ventral coloration.

Geographical distribution

When comparing the examined specimens to the literature used to create the point distribution maps we can report range extensions for six species. For *H. angulatus* we here report the first records in French Guyana (ZMB 2305 and ZMB 54167), the province Chapare in Bolivia (ZSM 516/2003) and the province Maranhao in Brazil (ZMB 10854). All four specimens did not possess a precise locality description. For *Helicops danieli* we report the first specimen originating from Brazil. The specimen ZMB 9490 has no preciser locality description. The nearest literature report of this species to Brazil is only 20 km away from the Columbian-Brazilian border at Mitu, in the Columbian province Vaupes (Yuki and Castano 1998). We report two range extensions for *H. infrataeniatus*. We report the extension of the distribution range more than 600 km to the South from the nearest

literature report by Entiauspe-Neto et al. (2016) with the specimens ZFMK 102499 and ZFMK 30350, which were collected at Punta Lara, Buenos Aires, Argentina. The specimen SMF 67327 extends the distribution range of this species over 400 km further north from the nearest report by Arzamendia and Girauco (2002). It was collected in Roque Saenz Pena, Chaco, Argentina. For the species *H. leopardinus* we report the extension of the distribution range to the departamento Beni in Bolivia with the specimens ZFMK 62836, collected at Campamento Encanto, Beni, Bolivia, and ZSM 134/1947, collected at the Rio Madre de Dios, Beni, Bolivia. The specimen MTKD 27443 was found near San Francisco, Cordoba, Argentina. This specimen represents the first record of this species in this province, extending the distribution range around 150 km from the nearest encounter report by Taub (1967). We extend the distribution range of *Helicops pastazae* to the province Napo, Ecuador with the specimen ZMB 519/2003. It was collected in Virgilio Davila, Quijos, Napo, Ecuador. This is around 90 km east from the nearest literature report at Yachana Reserve, Orellana, Ecuador by Whitworth and Beirne (2011). It is conspicuous, that there are specimens from Eastern Venezuela and from northern Ecuador, but no specimens or reports from Columbia. It is likely, that *H. pastazae* is present in Columbia, but has not been reported, due to missing research and fieldwork. For the species *H. polylepis* we report the first record from the province La Paz in Bolivia. The specimen SMF 17821 was collected in La Paz, La Paz, Bolivia. This extends the known distribution of the species about 400 km to the south from eastern Madre de Dios, Peru (Flores et al. 2010). Furthermore, we report the first specimen from the province Chuquisaca in Bolivia. The specimen ZMB 26215 was collected in Chaco, Chuquisaca, Bolivia. This extends the known distribution range over 800 km to the southwest from the nearest record by Griffin (1916) in southern Mato Grosso. The last range extension we report for this species is to the province Bahia in Brazil. The specimen ZMB 17428 was collected there, but no exact locality description is available.

The number of range extensions we report here is a sign, that the distribution range of the species in this genus is not well known. To get a better knowledge about the distribution a comprehensive examination of collection material on an international level and especially field work in the aquatic habitat of this genus is required.

Acknowledgements

We particularly want to thank Linda Mogk, Martin Jansen, Marcel Nebenführ and Joseph Vargas (all SMF), who always provided a honest opinion and friendly support. Furthermore, we thank Antonio Moraes da Silva, Rafaela França, Ricardo Alexandre Kawashita-Ribeiro, Omar Entiauspe, Santiago Carreira and Pier Cacciali for corresponding with us and sharing their knowledge with us. Furthermore we thank the curators/collection managers permitting us access to their collections and providing additional information: Raffael Ernst (MTKD), Markus Auer (MTKD), Alexander Kupfer (SMNS), Mark Oliver Rödel (ZMB), Frank Tillack (ZMB), Claudia Koch (ZFMK), Morris Flecks (ZFMK), Frank Glaw (ZSM), Michael Franzen (ZSM).

Author contributions

YS did the literature research, examination of the specimens and the writing of the publication. GK was the academic supervisor and revised the manuscript.

References

- Achaval Elena F (2001) Systematic update and maps of distribution of the reptiles of Uruguay. Actualizacion sistematica y mapas de distribucion de los reptiles del Uruguay. Smithsonian Herpetological Information Service 129.
- Arzamendia V, Giraud AR (2002) Lista y distribución de los ofidios (Reptilia: Serpentes) de Santa Fe, Argentina. Cuadernos de Herpetología 16 (1). URL: http://sedici.unlp.edu.ar/bitstream/handle/10915/6363/Documento_completo.pdf?sequence=1
- Carreira Vidal S, Meneghel M, Achaval F (2005) Reptiles de Uruguay. Universidad de la República, Facultad de Ciencias, Montevideo.
- Costa H, Santana D, Leal F, Koroiva R, Garcia PA (2016) A new species of *Helicops* (Serpentes: Dipsadidae: Hydropsini) from southeastern Brazil. Herpetologica 72 (2): 157-166. <https://doi.org/10.1655/HERPETOLOGICA-D-15-00059>
- Di Pietro DO, Alcalde L, Williams JD (2014) Nasal cartilages, hyobranchial apparatus, larynx, and glottal tubes in four species of Hydropsini (Serpentes: Dipsadidae: Xenodontinae). Vertebrate Zoology 64 (1): 103-111.
- Dowling H (1951) A proposed standard system of counting ventrals in snakes. British Journal of Herpetology 1: 97-99.
- Entiauspe-Neto OM, Perleberg TD, de Freitas MA (2016) Herpetofauna from an urban Pampa fragment in southern Brazil: composition, structure and conservation. Check List 12 (5). <https://doi.org/10.15560/12.5.1964>
- Flores E, Jadin R, Orlofske S (2010) *Helicops polylepis* (Norman's Keelback). Diet and intraspecific competition. Herpetological Review 41 (1): 93-94.
- França RCd, Germano CE dS, França FGR (2012) Composição de uma taxocenose de serpentes em uma área urbana na Mata Atlântica da Paraíba, Nordeste do Brasil. Copeia 12 (3): 183-195. <https://doi.org/10.1590/S1676-06032012000300019>
- Griffin LE (1916) A catalog of the Ophidia from South America at present (June, 1916) contained in the Carnegie Museum, with descriptions of some new species. Carnegie Institute, Pittsburgh.
- Hernández-Ruiz EJ, Wariss Figueiredo M, Brito Pezzuti JC (2014) Bycatch of *Helicops angulatus* (Linnaeus, 1758) (Reptilia: Squamata: Colubridae) in hoop-traps used to capture fresh water turtles on the coast fo Pará, Brazil. Acta Biológica Colombiana 19 (1): 119-120.
- Kawashita-Ribeiro RA, Ávila RW, Morais DH (2013) A new snake of the Genus *Helicops* Wagler, 1830 (Dipsadidae, Xenodontinae) from Brazil. Herpetologica 69 (1): 80-90. <https://doi.org/10.1655/HERPETOLOGICA-D-12-00013>
- Koski DA, Monico AT, Koski AP (2016) *Helicops angulatus* (Brown-banded Watersnake). Predation. Herpetological Review 47 (3): 478-479.

- Linnaeus C (1758) *Systema naturae* (*Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. Tomus I. Editio decima, reformata). 10, 1. Lars Salvi, Stockholm.
- Moraes-da-Silva A, Amaro RC, Nunes Sales P, Strüssmann C, Teixeira Junior M, Andrade A, Sudre V, Recoder R, Rodrigues Trefaut M, Curcio FF (2019) Chance, luck and a fortunate finding: a new species of watersnake of the genus *Helicops* Wagler, 1828 (Serpentes: Xenodontinae), from the Brazilian Pantanal wetlands. *Zootaxa* 4651 (3): 445-470. <https://doi.org/10.11646/zootaxa.4651.3.3>
- Moraes-da-Silva A, Amaro RC, Nunes PS, Rodrigues MT, Curcio FF (2021) Long known, brand new, and possibly threatened: a new species of watersnake of the genus *Helicops* Wagler, 1828 (Serpentes; Xenodontinae) from the Tocantins-Araguaia River Basin, Brazil. *Zootaxa* 4903 (2): 217-241. <https://doi.org/10.11646/zootaxa.4903.2.3>
- Peters JA, Orejas-Miranda B (1970) Catalogue of the Neotropical Squamata: Part I. Snakes. United States National Museum Bulletin 297.
- Rossman DA, Dixon JR (1975) A new colubrid snake of the genus *Helicops* from Peru. *Herpetologica* 31 (4): 412-414.
- Rossman DA, Abe AS (1979) Comments on the taxonomic status of *Helicops yacu* (Serpentes: Colubridae). *Proceedings of the Louisiana Academy of Sciences* 42 (7-9).
- Rossman DA (2002) Variation in the xenodontid water snake *Helicops scalaris* Jan, and the status of *H. hoguei* Lancini. *Occasional Papers of the Museum of Natural Science* 78: 1-18.
- Silva Jr NJ (1993) The snakes from Samuel hydroelectric power plant and vicinity, Rondônia, Brazil. *Herpetological Natural History* 1 (1): 37-86.
- Taub A (1967) Comparative histological studies on Duvernoy's gland of colubrid snakes. *Bulletin of the American Museum of Natural History* 138.
- Vaz-Silva W, Oliveira R, Gonzaga A, Pinto K, Poli F, Bilce T, Penhacek M, Wronski L, Martins J, Junqueira T, Cesca L, Guimarães V, Pinheiro R (2015) Contribuições para o conhecimento de anfíbios e répteis da Volta Grande do Xingu, norte do Brasil. *Brazilian Journal of Biology* 75 (3): 205-218. <https://doi.org/10.1590/1519-6984.00814BM>
- Whitworth A, Beirne C (2011) Reptiles of the Yachana Reserve. *Global Vision International, Exeter*. <https://doi.org/10.13140/RG.2.1.4130.6968>
- Yuki RN, Castano OV (1998) Geographic distribution note of water-snake *Helicops danieli* Amaral, 1937 (Colubridae: Xenodontinae). *The Snake* 28 (1-2): 90-92.

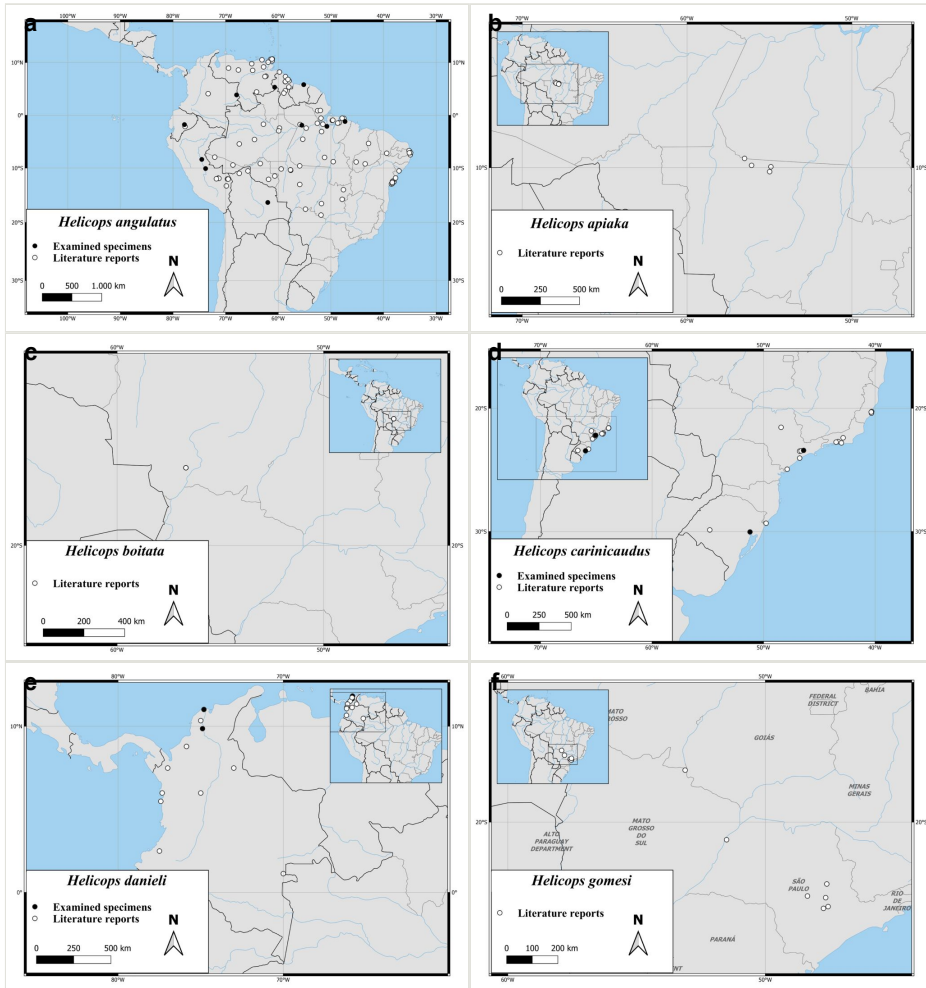


Figure 1.

Distribution maps of **A** *Helicops angulatus* **B** *H. apiaka* **C** *H. boitata* **D** *H. carinicaudus* **E** *H. danieli* **F** *H. gomesi*. Black circles indicate examined specimens and white circles literature reports. For the coordinates and references of the distribution points from literature see Suppl. material 2.



Figure 2.

Distribution maps of **A** *Helicops hagmanni* **B** *H. infrataeniatus* **C** *H. leopardinus* **D** *H. modestus* **E** *H. nentur* **F** *H. pastazae*. Black circles indicate examined specimens and white circles literature reports. For the coordinates and references of the distribution points from literature see Suppl. material 2.

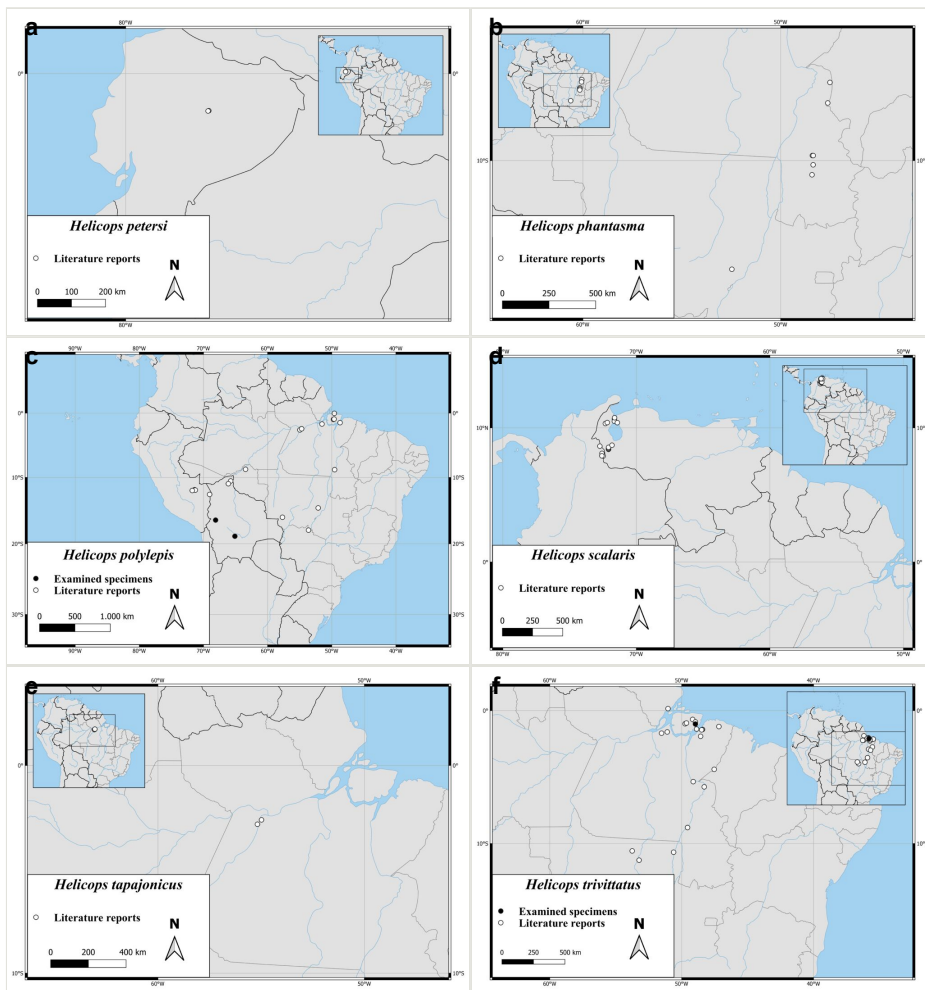


Figure 3.

Distribution maps of **A** *Helicops petersi* **B** *H. phantasma* **C** *H. polylepis* **D** *H. scalaris* **E** *H. tapajonicus* **F** *H. trivittatus*. Black circles indicate examined specimens and white circles literature reports. For the coordinates and references of the distribution points from literature see Suppl. material 2.

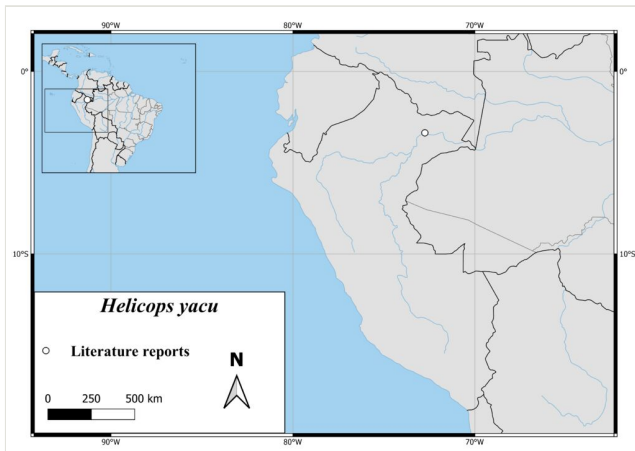


Figure 4.

Distribution of *Helicops yacu*. White circles represent literature reports. For the coordinates and references of the distribution points from literature see Suppl. material 2.

LO	1	1-2	1	1	0-3	0-2	0-2	
PRO	1-2	1-2	1	1	1-2	1-2	1-2	
PSO	2-3	2	2	1-2	2	1-2	2	
AT	1-3	1	1	1	1-2	1-2	1	
PT	2-4	1-2	2-3	3	1-3	1-3	2	
SL	8-9	7-8	7-8	8	7-8	7-9	7-8	
SL+E	IV	IV, III-IV	IV, IV-V	IV	III, III-IV, IV	III-IV, IV, IV-V	III-IV, IV	
IL	9-11	9-10	9-12	11-12	9-12	9-11	9-11	10
DSM	17-20	17-19	18-19	25-27	17-20	18-19	17-20	2
DSM	present	present	present	present	present	present	present	pre
DRP	16-17	17	17	21	15-17	16-19	15-19	1
DKP	present	present	present	present	present	present	present	pre
CL	div	div	div	div	div	div	div	c
IG	absent	absent	absent	present	absent	absent	absent	pre
NA	sdiv	sdiv	sdiv	sdiv	sdiv	sdiv	sdiv	s

Table 2.

Pholidosis characters of the female specimen SMF 34035. Abbreviations: SVL: snout-vent length; TL: tail length; VE: ventrals; SC: subcaudals; presence of subcaudal keels (SCK); PRO: preoculars; PSO: postoculars; LO: loreal; AT: anterior temporals; NA: nasal; PT: posterior temporals; SL: supralabials; SL+E: supralabials in contact with the eye; IL: infralabials; DSM: dorsal scale rows at midbody; DKM: dorsal keels at midbody; DSP: dorsal scale rows at posterior body; DKP: dorsal keels at posterior body; CL: cloacal plate; IG: presence of Intergenials; Decimal values were rounded to the third decimal place, lengths are in millimeters. See Suppl. material 1 for data of all specimens.

SVL	365	PT right	2
TL	189	PT left	2
TL/SVL	0,518	SL right	8
VE	124	SL left	8
SC	75	SL+E right	IV
SCK	absent	SL+E left	IV
PRO right	1	IL right	10
PRO left	1	IL left	10
LO right	1	DSM	17
LO left	1	DKM	present
PSO right	2	DSP	17
PSO left	2	DKP	present
AT right	1	CL	divided
AT left	1	IG	absent
NA	semidivided		

Supplementary materials

Suppl. material 1: Examination results

Authors: Yannis Schöneberg, Gunther Köhler

Data type: morphological

Brief description: Examination results of all 190 specimens examined in this study.

[Download file](#) (26.03 kb)

Suppl. material 2: References for all locality records extracted from literature

Authors: Yannis Schöneberg, Gunther Köhler

Data type: occurrences

Brief description: This table contains the description, coordinates and the reference of all used distribution points, which were extracted from literature.

[Download file](#) (112.61 kb)

Suppl. material 3: References for the morphological data

Authors: Yannis Schöneberg, Gunther Köhler

Data type: morphological

Brief description: This file contains all references used for the assessment of the morphological traits.

[Download file](#) (11.98 kb)