

## *Norops macrophallus* (WERNER, 1917), a valid species of anole from Guatemala and El Salvador (Squamata: Sauria: Iguanidae)

*Norops macrophallus* (WERNER, 1917), eine valide Art aus Guatemala und El Salvador  
(Squamata: Sauria: Iguanidae)

GUNTHER KÖHLER & JÖRG KREUTZ

### KURZFASSUNG

Bedeutsame Unterschiede in der Hemipenis-Morphologie von *Anolis*-Populationen aus El Salvador und Guatemala gegenüber solchen aus Nicaragua und Costa Rica, die bislang alle als eine Art, *Norops cupreus* (HALLOWELL, 1860), angesehen wurden, werden als Beleg dafür gewertet, daß *N. macrophallus* (WERNER, 1917) Artstatus erhalten muß. Unterschiede in der Kehlfahnenfärbung der Männchen (im Leben) unterstützen diese Auffassung. Folglich wird *macrophallus* aus der Synonymie von *N. cupreus* genommen und in den Artstatus erhoben.

### ABSTRACT

Striking differences in hemipenis morphology between populations of anoles from El Salvador and Guatemala versus Nicaragua and Costa Rica, which were all previously referred to a single species, *Norops cupreus* (HALLOWELL, 1860), as well as differences in the dewlap colouration of males (in life), warrant the recognition as a valid species of *Norops macrophallus* (WERNER, 1917). Consequently, the latter taxon is resurrected from the synonymy of *N. cupreus*.

### KEY WORDS

Squamata, Sauria, Iguanidae, *Norops macrophallus*, *N. cupreus*, taxonomic status, hemipenis morphology, distribution, Guatemala, El Salvador

### INTRODUCTION

In 1917, WERNER described *Anolis macrophallus* based on a single adult male from "S. José de Guatemala" (= Puerto San José, Departamento Escuintla, Guatemala). BARBOUR (1934) retained species status for WERNER's taxon and assumed that it is "apparently allied to *A.* [= *Norops*] *cupreus* or *A.* [= *Norops*] *godmani*". STUART (1955) regarded *macrophallus* to be synonymous with *A. cupreus* HALLOWELL, 1860 (type locality: "Nicaragua") but stated that "*macrophallus* is available for the northern population" if "subspecific recognition of the two may eventually prove necessary". All subsequent authors considered the nominal species *macrophallus* and *cupreus* to be conspecific (MERTENS 1952; STUART 1963; PETERS & DONOSO-BARROS 1970; VILLA & al. 1988; CAMPBELL & VANNINI

1989) except FITCH and co-workers who raised *macrophallus* to subspecific rank (FITCH & al. 1972; FITCH & SEIGEL 1984).

Studying the variation of hemipenis morphology in the genus *Norops* (we prefer using *Norops* over *Anolis* for the generic name of these anoles following the arguments of GUYER & SAVAGE 1992), we found striking differences in the male genital organs among specimens previously referred to *N. cupreus* by which the populations of El Salvador and Guatemala can clearly be distinguished from those of Nicaragua and Costa Rica. Peculiarities in the dewlap colouration of males (in life) provide additional evidence for the species status of *N. macrophallus*. In all pholidosis and metric characters examined, the ranges overlap broadly in the two species.

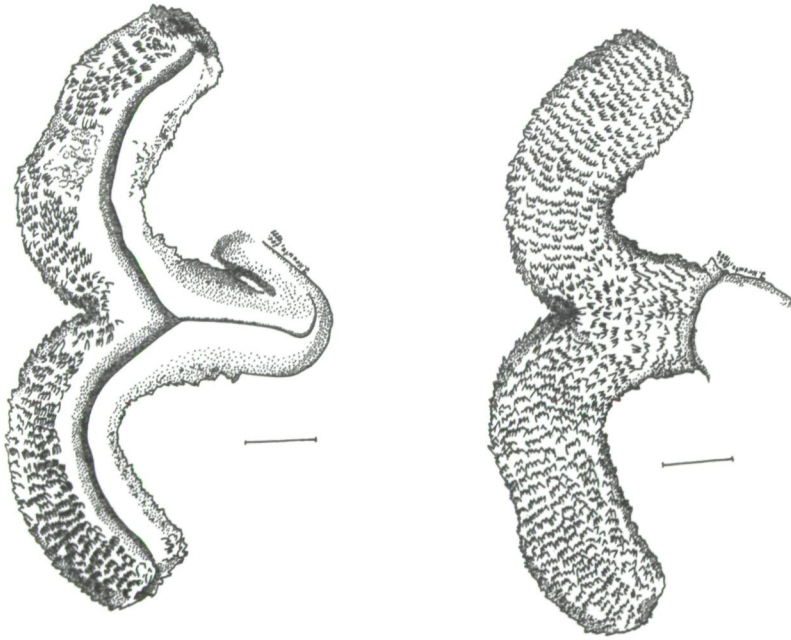


Fig. 1: *Norops macrophallus* (KU 184050), hemipenis.

a (top) - sulcate view; b (bottom) - asulcate view. Scale bar represents 1 mm.

Abb. 1: *Norops macrophallus* (KU 184050), Hemipenis.

a (oben) - Sulkale Ansicht; b (unten) - Asulkale Ansicht. Balkenlänge entspricht 1 mm.

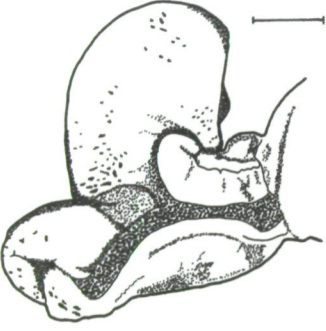


Fig. 2: *Norops cupreus* (SMF 77545), hemipenis.

a (top) - sulcate view; b (bottom) - asulcate view. Scale bar represents 1 mm.

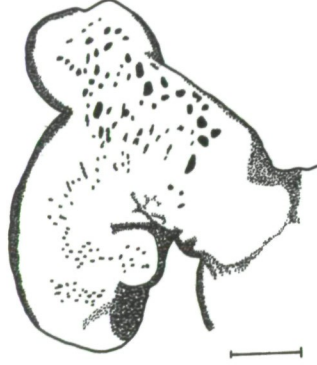


Abb. 2: *Norops cupreus* (SMF 77545), Hemipenis.

a (oben) - Sulkale Ansicht; b (unten) - Asulkale Ansicht. Balkenlänge entspricht 1 mm.

## MATERIALS AND METHODS

A list of the specimens examined is provided in the appendix. Abbreviations for museum collections follow LEVITON & al. (1985). SMITHE's (1975-1981) Naturalist's Color Guide was used as a reference for colour notes. Terminology for the description of hemipenis morphology follows BÖHME (1988), MYERS & al. (1993), and SAVAGE (1997). For the description and illustration of everted hemipenes the copulation organs were separated from the specimens. A longitudinal incision of 5-10 mm was performed medially on the ventral side of the base of the tail. A transverse incision of 3-5 mm was made at the distal end of the first incision. The skin along the posterior edge of the cloaca was then cut on one side to access the hemipenis and the retractor muscle which were then lifted and

separated. To achieve complete eversion, the hemipenis with the retractor muscle was placed in 2 % potassium hydroxide for 2-3 days at 25°C to soften the organ. The consistency of the tissue was checked twice daily. Then a rounded hypodermic needle was gently inserted into the hemipenis through its base. With the aid of liquid pressure complete eversion was usually achieved easily. After complete eversion the organ was placed in 40 % formalin for fixation. After 3-5 days, the organ was transferred stepwise into 70 % ethanol for permanent storage. Drawings were done with the aid of a stereo microscope with a camera lucida. Scanning electron microscopy (SEM) was used for examination and documentation of the fine structure of the hemipenial surface.

Table 1: Comparison of morphometric and pholidosis characters in *Norops cupreus* (n = 71) and *N. macrophallus* (n = 44); range is followed by mean value and one standard deviation in parentheses. f - female; IP - interparietal plate; m - male; SL - shank length; SO - subocular scales; SPL - supralabial scales; SS - supraorbital semi-circles; SVL - snout-vent length; TL - tail length.

Tab. 1: Vergleich von morphometrischen Angaben und Pholidosewerten zwischen *Norops cupreus* (n = 71) und *N. macrophallus* (n = 44); der Spannweite folgen in Klammern der Mittelwert und die einfache Standardabweichung. f - Weibchen; IP - Interparietalschild; m - Männchen; SL - Unterschenkelänge; SO - Subocularschilde; SPL - Supralabialschilde; SS - Supraorbitale Halbkreise; SVL - Kopf-Rumpflänge; TL - Schwanzlänge.

Parameter	Sex	<i>Norops cupreus</i>	<i>Norops macrophallus</i>
max. SVL	m	50.0 mm	44.0
	f	49.0 mm	45.0
TL / SVL	m	1.84-2.05 (1.93 ± 0.08)	1.83-2.05 (1.98 ± 0.08)
	f	1.78-2.09 (1.95 ± 0.12)	1.71-1.92 (1.79 ± 0.08)
SL / SVL	m	0.26-0.32 (0.28 ± 0.02)	0.27-0.32 (0.29 ± 0.02)
	f	0.24-0.29 (0.27 ± 0.01)	0.23-0.34 (0.27 ± 0.03)
Number of scales between SS Anzahl Schuppen zwischen SS	m+f	0-3 (2.02 ± 0.56)	1-3 (1.55 ± 0.50)
Number of scales between IP and SS Anzahl Schuppen zwischen IP und SS	m+f	2-5 (3.12 ± 0.71)	2-3 (2.25 ± 0.42)
Number of scales between second canthals Anzahl Schuppen zwischen den zweiten Canthalia	m+f	7-16 (10.98 ± 1.97)	8-19 (12.05 ± 2.07)
Number of scales between SO and SPL Anzahl Schuppen zwischen SO und SPL	m+f	0-1 (0.93 ± 0.25)	1 (1.00 ± 0.00)
Number of supralabial scales to level below center of eye Anzahl Supralabialschilde bis auf Höhe der Augenmitte	m+f	5-8 (6.81 ± 0.66)	6-8 (7.01 ± 0.51)
Number of loreal scale rows Anzahl lorealer Schildreihen	m+f	4-7 (5.83 ± 0.75)	5-8 (6.91 ± 0.54)
Number of dorsal scales in one head length Anzahl Dorsalia auf eine Kopflänge	m+f	26-47 (34.59 ± 5.87)	28-37 (32.91 ± 2.06)
Number of ventral scales in one head length Anzahl Ventralia auf eine Kopflänge	m+f	26-46 (35.20 ± 5.71)	22-46 (32.19 ± 6.89)
Number of lamellae underneath 4 <sup>th</sup> toe Anzahl Lamellen an der Unterseite der vierten Zehe	m+f	27-32 (29.33 ± 2.25)	28-34 (30.81 ± 1.59)

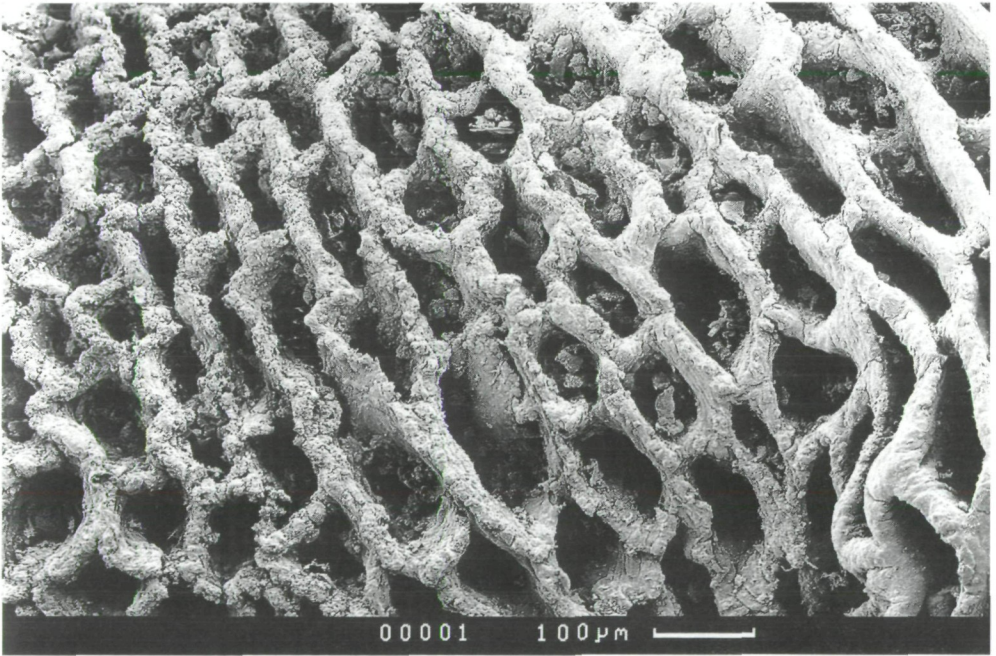
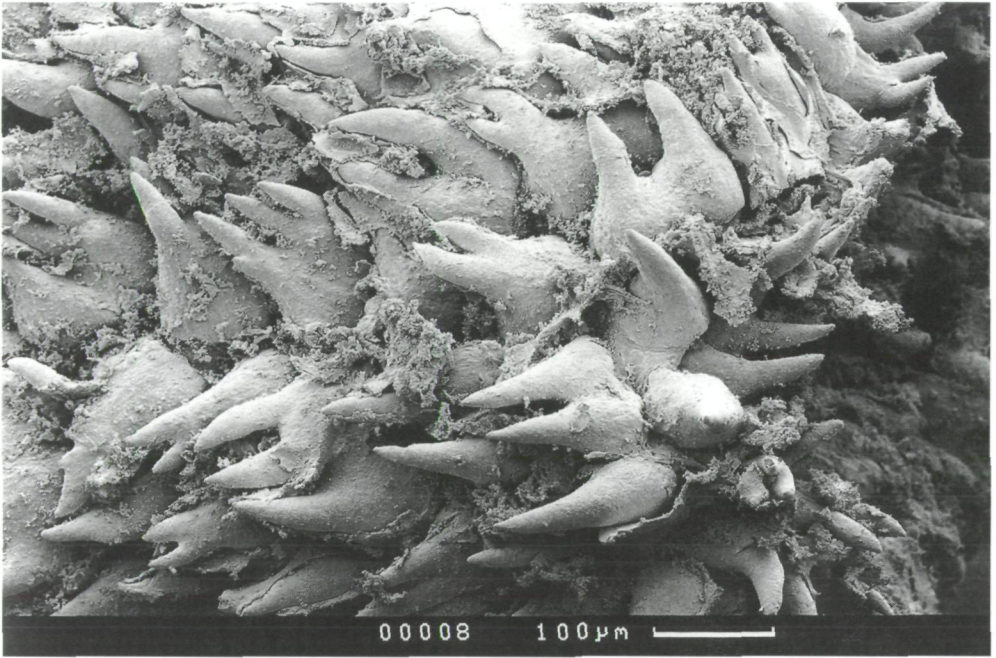


Fig. 3: SEM micrographs of hemipenis surface. Scale bar represents 100  $\mu\text{m}$ .  
a (top) - *Norops macrophallus* (SMF 79032); b (bottom) - *N. cupreus* (SMF 77545).

Abb. 3: Rasterelektronenmikroskopische Aufnahmen der Hemipenisoberfläche. Balkenlänge entspricht 100  $\mu\text{m}$ .  
a (oben) - *Norops macrophallus* (SMF 79032); b (unten) - *N. cupreus* (SMF 77545).

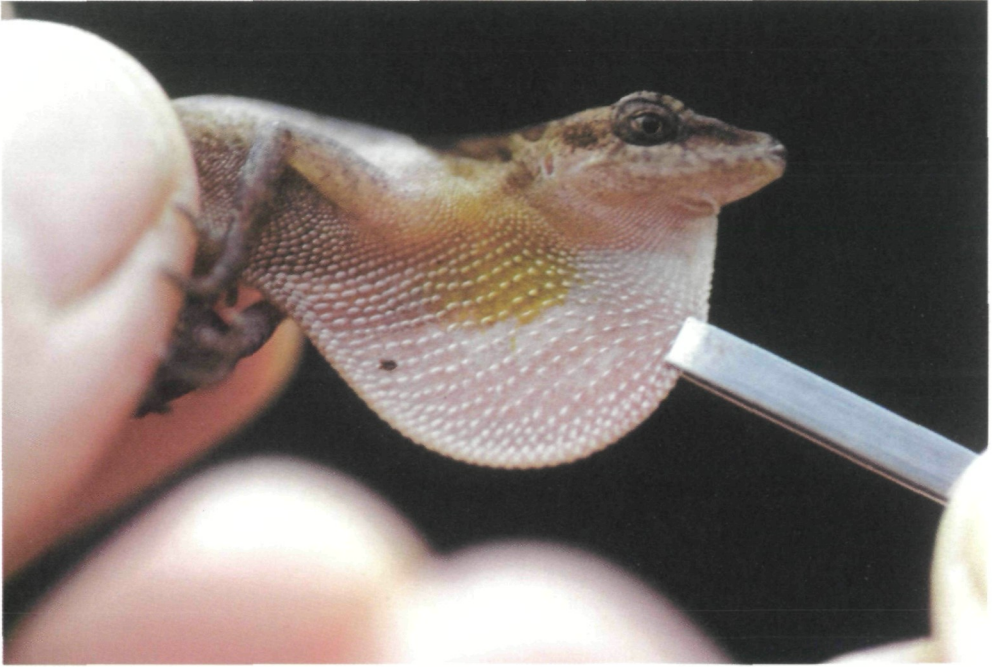


Fig. 4: Live males with extended dewlaps.

a (top) - *Norops macrophallus* (SMF 79039); b (bottom) - *N. cupreus* (SMF 77549).

Abb. 4: Lebende Männchen mit aufgespannten Kehlfahnen.

a (oben) - *Norops macrophallus* (SMF 79039); b (unten) - *N. cupreus* (SMF 77549).

## RESULTS

## Hemipenis morphology

The hemipenes of specimens from El Salvador and Guatemala (in the following called „northern populations“) differ from those originating from Nicaragua and Costa Rica (in the following called “southern populations“) in both gross structure and ornamentation (figs. 1-3). Although the hemipenes are bilobed in both regions and lack any additional processes (like crotch flaps or knobs), the hemipenes of specimens from the northern population differ from those of the southern population in (1) the extremely Y-shaped gross structure with very elongate truncus and lobes (versus a rather stout and bulging appearance) and (2) by the presence of numerous small conical spines (some spines fused with each other at their bases) on the surface of truncus and lobes (versus an aspinous surface; most of the truncus and the lobes covered with calyces). No variation in hemipenis morphology within either population was observed (see appendix for sample sizes and localities). The asymmetry in fig. 2 is due to incomplete eversion.

## Dewlap colouration

Detailed colour notes in life are available for two adult males from either population (figs. 4a,b). The dewlap of a specimen (SMF 79039) from Departamento Ahuachapán, El Salvador, was recorded as Flesh Color (colour 5) with shades of Vinaceous (colour 3) and a basal Orange Yellow (colour 18) blotch. Dewlap colouration of a specimen (SMF 78401) from Departamento Jinotega, Nicaragua, was recorded as Vinaceous (colour 3) with a basal Pratt's Rufous (colour 132C) blotch. More obvious than these rather subtle colour differences is the different distribution of these colours on the dewlaps of the respective populations: in males from the northern population the darker basal area is relatively small, only about half the size of that in the southern population.

## Morphometry

In all pholidosis and metric characters examined, the ranges overlap broadly in the two species (see table 1).

## CONCLUSIONS

Based on the above observations we conclude that the northern and southern populations previously referred to *N. cupreus* actually represent two distinct species. There is a gap of more than 200 km between the two populations which includes the eastern part of El Salvador, the Honduran coast at the Gulf of Fonseca and the northwestern part of Nicaragua.

The correct name for the southern population is *N. cupreus* (HALLOWELL, 1860), type locality “Nicaragua“. *Norops cupreus* ranges from north-east Caribbean Honduras through central and Pacific Nicaragua to Pacific Costa Rica. As pointed out by STUART (1955), the name *macrophallus* is available to the northern population. We have examined one specimen (SMF 79035) from near the type locality of the latter and it resembles the El Salvadoran specimens in all characters. The holotype of *Norops macrophallus*, formerly stored in Zoologisches Museum Hamburg (ZMH), was de-

stroyed in World War II (FITCH & al. 1972; HALLERMANN in litt. 1997). *Norops macrophallus* as defined here is completely in accordance with WERNER's original description of the taxon. Consequently, we resurrect *N. macrophallus* (WERNER, 1917) from the synonymy of *N. cupreus*.

To avoid future confusion of these externally so similar species we herewith designate the specimen SMF 79035 as neotype of *N. macrophallus*. SMF 79035 is an adult male with everted hemipenes collected 18.2 km from Puerto San José on the road to Escuintla, Guatemala, 14°04.35' N, 90°46.59' W, 20 m a.s.l. by GÜNTER PRAEDICOW on 16 May, 1998.

Judging from the very different hemipenis morphology, these two species may not even be closely related. In fact, none among more than 60 species of anoles we have examined so far, possesses a hemipenis ornamentation of small spines as observed in *N. macrophallus*.

*Norops macrophallus* (WERNER, 1917) comb. nov.

*Anolis macrophallus* WERNER, 1917, Mitteilungen aus dem Zoologischen Museum Hamburg 34: 31; type locality: "S. José de Guatemala" (= Puerto San José, Departamento Escuintla, Guatemala).

*Anolis cupreus*: SCHMIDT 1928: 195 (in part.), AHL 1940: 245 (in part.), MERTENS 1952: 41 (in part.), STUART 1955: 15 (in part.), STUART 1963: 62 (in part.), PETERS & DONOSO-BARROS 1970: 52 (in part.).

*Anolis cupreus macrophallus*: FITCH & al. 1972: 16, FITCH & SEIGEL 1984: 6.

*Anolis macrophallus*: BARBOUR 1934.

*Norops cupreus*: VILLA & al. 1988: 48 (in part.), CAMPBELL & VANNINI 1989: 10 (in part.).

**D i a g n o s i s:** A medium-sized species (maximum SVL in males 50 mm, in females 46 mm) differing from all other *Norops* (sensu GUYER & SAVAGE 1987, 1992) by the following combination of

characters: tail length / SVL ratio of 1.7-2.1; 2-4 rows of medial dorsal scales slightly enlarged; flank scales homogeneous; ventral scales distinctly keeled but usually not mucronate; shank length / SVL ratio of 0.25-0.32; 1-2 scales separating supraorbital semicircles; 4-6 rows of loreal scales; suboculars and supralabials separated by one scale row; 28-33 lamellae underneath phalanges II to IV of fourth toe; no enlarged postanal scales; male dewlap Flesh Color (colour 5) with shades of Vinaceous (colour 3) and a basal Orange Yellow (colour 18) blotch; hemipenis extremely Y-shaped with very elongate truncus and lobes and covered with numerous small spines on the surface of truncus and lobes.

**D i s t r i b u t i o n:** *N. macrophallus* ranges from southern Guatemala (Puerto San José, Departamento de Escuintla) along the Pacific as far as central El Salvador (fig. 5). It occurs from sea level to about 1350 m elevation.

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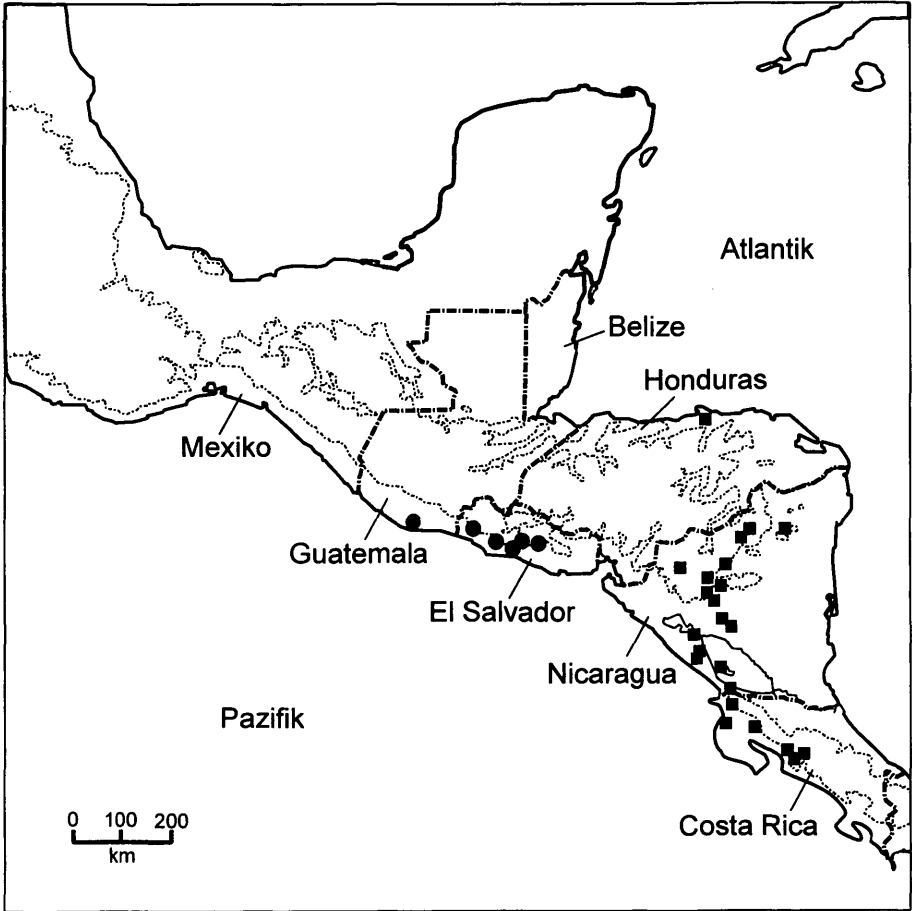


Fig. 5: Distribution of *Norops macrophallus* (●) and *N. cupreus* (■). Dashed lines indicate elevations above 1000 m.

Abb. 5: Verbreitung von *Norops macrophallus* (●) und *N. cupreus* (■). Höhenlinien über 1000 m sind gestrichelt.

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## APPENDIX Specimens examined

Specimens examined for hemipenial morphology are indicated by "[h]"

### *Norops cupreus* (n = 71)

**Costa Rica:** Guanacaste: Ojatal, ca. 2 km SW El Coco, 0 m: KU 66860-61 [h]; Río Bebedero, 2-5 km S Bebedero, 5 m: KU 66862 [h], 66864 [h]; Taboga Camp, 20 km SE Las Canas, 38 m: KU 102406-07 [h]; Parque Nacional Guanacaste: ZFMK 57768, 57770; Parque Nacional Guanacaste, Station Maritza, 600 m: ZFMK 57769; San José: San José: SMF 10993-94; Sta. Ana: LSUMZ 52325, 152364; Sta. Ana, Imin: LSUMZ 52378; Cangrejal: LSUMZ 52374, 52377; Caspirola: LSUMZ 52381-83;

**Honduras:** Colón: 1 km SSW Trujillo, 80 m: KU 101394 [h];

**Nicaragua:** Atlántico Norte: Bonanza, 260 m: KU 85650; Boaco: Boaco: SMF 77316; Puente Carlos F. Amador, W side divide between Boaca and Camoapa: KU 195081-88; 1 km N Camoapa: KU 195060; 2 km S Las Latas, Puente Río Grande: KU 195061-63; Carazo: Santa Teresa, about 15 km SW Diriamba: ZFMK 51856; Chontales: 1 km N, 2.5 km W Villa Somoza, 320 m: KU 112985-87; Estelí: Finca Venecia, 7 km N and 16 km E Condega, 1200 m: KU 85645; Granada: Volcán Mombacho, ca. 2.5 km WSW Cutirre (11°49.55'N, 85°57.16'W), 600 m: SMF 78400-1; Jinotega: Finca Berlin (13°32.26'N, 85°41.50'W), 1015 m: SMF 78978-79; 3 km SSE Jinotega on the road to Matagalpa: KU 195057-59; Cordillera Isabelia 13°19.99'N, 85°41.52'W: SMF 77545-46 [h], 77547, 77548-49 [h]; Reserva Biosfera Bosawas, ca. 0.5 km SE Ayapal, 195 m: SMF 78402; Reserva Biosfera Bosawas, Ayapal (13°46.61'N, 85°24.14'W), 200 m: SMF 78403; Managua: 2 km N Sabana Grande, 50 m: KU 85637 [h]; Matagalpa: 12 km NE Matagalpa, 1100 m: KU 195064-68; 2 km N and 6 km E Equipulas: KU 124989-90; Finca Tepeyac, 10.5 km N and 9

km E Matagalpa, 960 m: KU 85646-49; Rivas: Río Javillo, 3 km N and 4 km W Sapoá, 40 m: KU 85638, 85639-40 [h], 85717; Isla Ometepe, within 3 km S Moyogalpa, 40m: KU 85641, 85720.

### *Norops macrophallus* (n = 44)

**El Salvador:** A h u a c h a p á n : Parque Nacional El Imposible, La Fincona, 13°50.80'N, 89°58.80'W, 720 m: SMF 79031 [h], 79032, 79038 [h], 79044 [h]; Parque Nacional El Imposible, Distrito San Benito, El Caschal, 500 m: SMF 79040; El Refugio (vicinity of Mariposario of Dr. Francisco Serrano, 13°49.46'N, 89°59.98'W, 225 m: SMF 79039 [h], 79041-42; Parque Nacional El Imposible, Distrito San Benito, Piedra Selada, 520 m: SMF 79036-37; C a b a ñ a s : Ilobasco: SMF 51983; C u s c a t l a n : Finca near San Martín, 700 m: SMF 42303-5, 42376-7; 0.5 km NE Tenancingo, Santa Rita: KU 184050 [h]; La Libertad: Atami, 13°30.20'N; 89°25.00'W, 40 m: SMF 79030 [h]; Hacienda Miramar near Zaragoza: SMF 42180-1; Finca Los Cedros, about 1000 m: SMF 42894; La Bomba, Finca Los Naranjos near Santa Tecla, about 900 m: SMF 42882; Finca El Paraiso near Santa Tecla: SMF 42590, 42713, 43146, 43158, 45025, 45402-3; Río San Antonio, 2 km E La Libertad: SMF 43113; S a n S a l v a d o r : San Salvador, Barranco on the 65th Avenida Sur: SMF 42603; San Salvador, Instituto Tropical: SMF 42179, 51982, 51991; San Vicente: E part of Volcán San Vicente, Finca El Carmen, 1319 m: SMF 44321, 51984-5; S o n s o n a t e : Finca La Joya, km 48 on road from San Salvador to Sonsonate, 600 m: SMF 44317-20;

**Guatemala:** Escuintla: no specific data: MNHN 1980.1302; 18.2 km on road from Puerto San José to Escuintla, 14°04.35'N, 90°46.59'W, 20 m: SMF 79034, 79035 [h].

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