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A distinctive new subspecies of the Royal Sunangel (Aves: Trochiliformes; *Heliangelus regalis*) from the Cordillera Azul, northern Peru

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Abstract

A recently discovered and morphologically distinct population of the poorly known Royal Sunangel from the Cordillera Azul, Department of Loreto, Peru, is described as a new subspecies, *Heliangelus regalis johnsoni*. Males of *johnsoni* differ from those of nominate *regalis* in exhibiting intense indigo iridescence, particularly on the crown, throat and upper breast.

Key words: Cordillera Azul, *Heliangelus regalis johnsoni* new subspecies, hummingbirds, Loreto, Peru, Royal Sunangel

Introduction

The Andean region from southern Ecuador (3º S latitude) to northern Peru (8º S latitude) hosts one of the world's most diverse avifaunas (Rahbek & Graves, 2001), as well as the foremost concentration of avian species with small geographic ranges in South America (Graves & Rahbek, 2005). Despite more than 150 years of ornithological exploration in this region (Taczanowski, 1884; Chapman, 1926), several spectacular new species have been discovered in recent decades (O'Neill & Graves, 1977; Robbins, *et al.*, 1994; Krabbe, *et al.*, 1999; O'Neill, *et al.*, 2000), including two new hummingbirds (Fitzpatrick, *et al.*, 1979; Graves, 1980). Although the geographic ranges and taxonomy of hummingbirds inhabiting the main axis of the Andes in northern Peru and southern Ecuador are relatively well known (Parker, *et al.*, 1985; Fjeldså & Krabbe, 1990; Rahbek & Graves, 2000; Ridgely & Greenfield, 2001; Schulenberg, *et al.*, 2007), the composition of hummingbird assemblages from outlying ridges on the Amazonian versant is still poorly known (Davis, 1986; Seddon, *et al.*, 1996; Schulenberg & Awbrey, 1997; Hornbuckle, 1999; Schulenberg, *et al.*, 2001).

In April 2000, a joint expedition from the Museum of Natural Sciences, Louisiana State University (LSUMZ) and Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos (MUSM) surveyed the montane avifauna of the Cordillera Azul between the Huallaga and Ucayali rivers, Department of Loreto, Peru (Schulenberg, *et al.*, 2001). Surprisingly, the commonest species of hummingbird observed in the stunted ridgetop forests (1300–1700 m) was the Royal Sunangel (*Heliangelus regalis*), which at the time was known from four restricted sites in northern Peru (Fitzpatrick, *et al.*, 1979; Davis, 1986; Seddon, *et al.*, 1996; Hornbuckle, 1999). The Cordillera Azul population represents a new strikingly distinctive subspecies.

Methods

Heliangelus regalis was previously known from 16 specimens collected at the type locality in the Cordillera del Cóndor (Department of Cajamarca; E side of ridge ENE above San José de Lourdes, 1950–2200 m; Fitzpatrick, *et al.*, 1977) and from two specimens obtained on an isolated ridge east of Moyobamba (Department of San Martín: ca 20 km by trail NE Jirillo on trail towards Balsapuerto; Davis, 1986). We compared the newly collected speci-

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mens from the Cordillera Azul with specimens of nominate *regalis* from the type locality (Fig. 1) and from the Department of San Martín. Measurements were taken with digital calipers and rounded to the nearest 0.1 mm: wing chord; bill length (from anterior extension of feathers); and rectrix length (from point of insertion of the central rectrices to the tip of each rectrix). Rectrices (R1 to R5) are numbered from the innermost to the outermost. Specimens were compared under diffuse light transmitted by a frosted skylight. Color descriptions of iridescence are unusually subjective, as color perceived by an observer or measured by a spectrometer varies according to the angle of inspection and direction of light. For this reason we use general color descriptions in the diagnosis and description of holotype.

We measured color spectra (300–800 nm) of crown feathers of the holotype of *Heliangelus r. johnsoni* (MUSM 22613) and a representative specimen of *Heliangelus r. regalis* (LSUMZ 81851) with a diode-array spectrometer (Ocean Optics S2000) using a reflectance probe (Ocean Optics R-400) and xenon light source (Ocean Optics PX-2) calibrated with a white standard (Ocean Optics WS-1). The probe was held at an angle that maximized reflectance. Reflectance spectra represent mean values of three independent measurements for each specimen (Fig. 2).

Heliangelus regalis johnsoni new subspecies

Holotype. Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos (MUSM), No. 22613. Adult male from about 86 km SE of Juanjuí (7º 34’S; 75 º55’ W; ca 1400 m above sea level) on the east bank of the Río Pauya, Department of Loreto, Peru. Collected and prepared by Manuel Sánchez S. (field number 3647) on 22 July 2000.

Diagnosis. Males of *johnsoni* differ from those of nominate *regalis* in exhibiting intense indigo iridescence, particularly on the crown, throat, and upper breast. These parts are bluish-black to violet-black with only slight iridescence in nominate *regalis*. Rectrices of both sexes of *johnsoni* are metallic indigo rather than metallic violet-purple as in nominate *regalis*.

FIGURE 1. From left to right, frontal views of male *Heliangelus regalis regalis* (LSU 81851, LSU 81849) and *Heliangelus regalis johnsoni* (LSU 170736, LSU 170735).

Description of holotype. Body plumage is bluish-black, displaying strong indigo iridescence on the crown, throat, and upper breast, especially when viewed head-on (Fig. 2). Rectrices are metallic indigo on ventral and dorsal surfaces, bluer distally. Inner vanes of rectrices are flushed with violet-purple. Primaries and outer secondaries are brownish-black showing faint violet iridescence. Inner secondaries exhibit violet-purple iridescence. Scattered feathers on carpal edge of wing are tipped with rufous. Downy feathers on lower flanks and around vent are tipped white. Bill and feet are black.

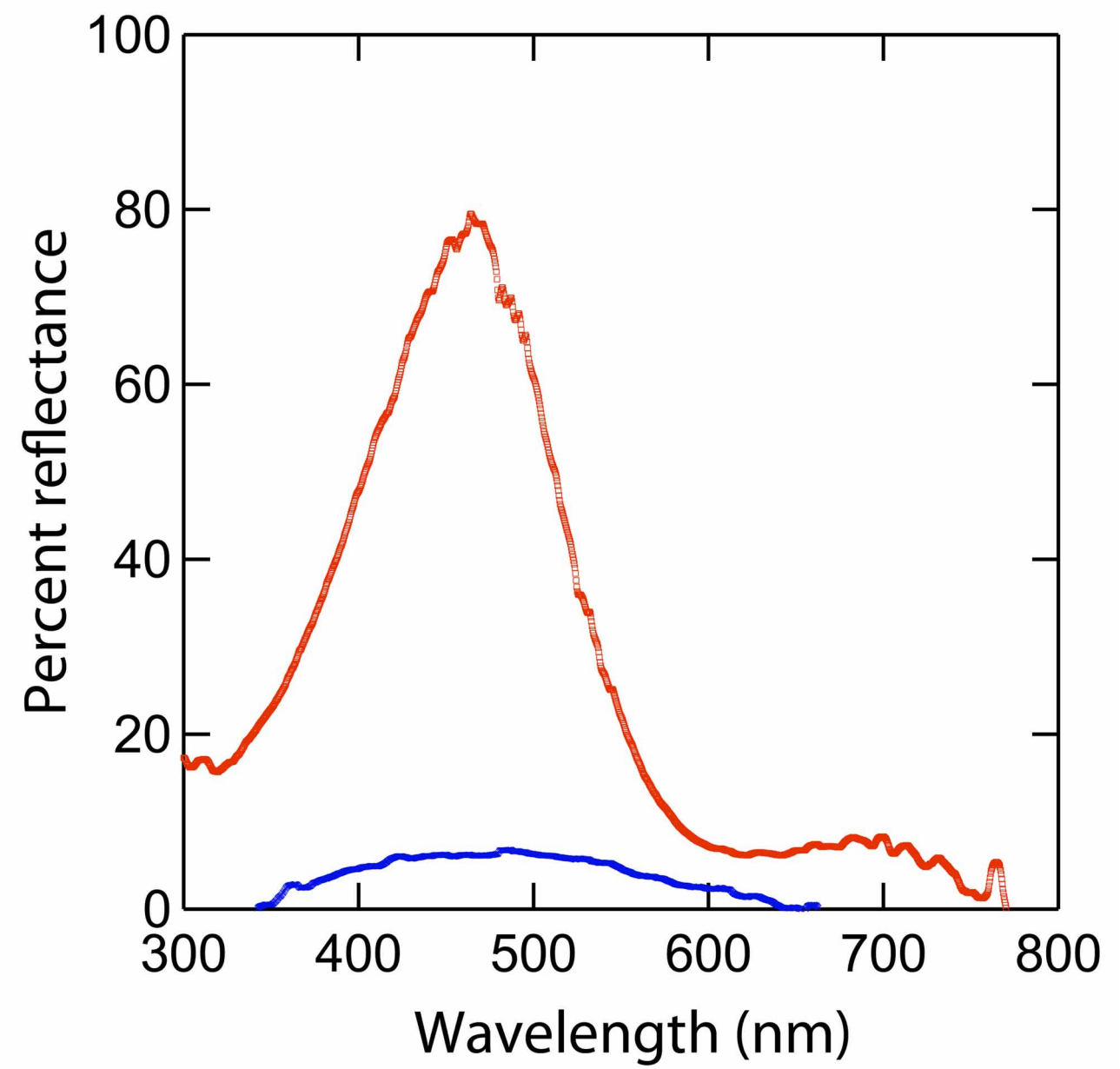

FIGURE 2. Reflectance spectra from crown feathers of the holotype (top) of *Heliangelus r. johnsoni* (MUSM 22613) and a representative specimen (bottom) of *Heliangelus r. regalis* (LSUMZ 81851). Reflectance extends into the ultraviolet (300–400 nm) in both specimens. The holotype of *Heliangelus regalis johnsoni* exhibits a sharp reflectance peak at 464 nm. Crown feathers of all male *H. r. regalis* are only dimly reflective and the reflectance spectra are relatively flat (peak at ~486 nm).

Measurements (mm) of holotype. See Table 1. Weight: 3.7 g. Testes: 3 x 4 mm. Maxillary ramphotheca smooth.

Paratypes. (a) LSUMZ 170735, subadult male. PERU: Department of Loreto; ca 85 km SE of Juanjuí on E bank upper Río Pauya, 7°34’ S, 75°54’ W, ca 1700 m. Collected and prepared by Daniel F. Lane (field number 1291) on 27 June 2000. Iridescence of breast, flanks, and belly plumage is a slightly deeper shade of indigo than in the holotype. Feathers of the back, scapulars, and upper rump are narrowly edged with green. Weight 3.4 g.

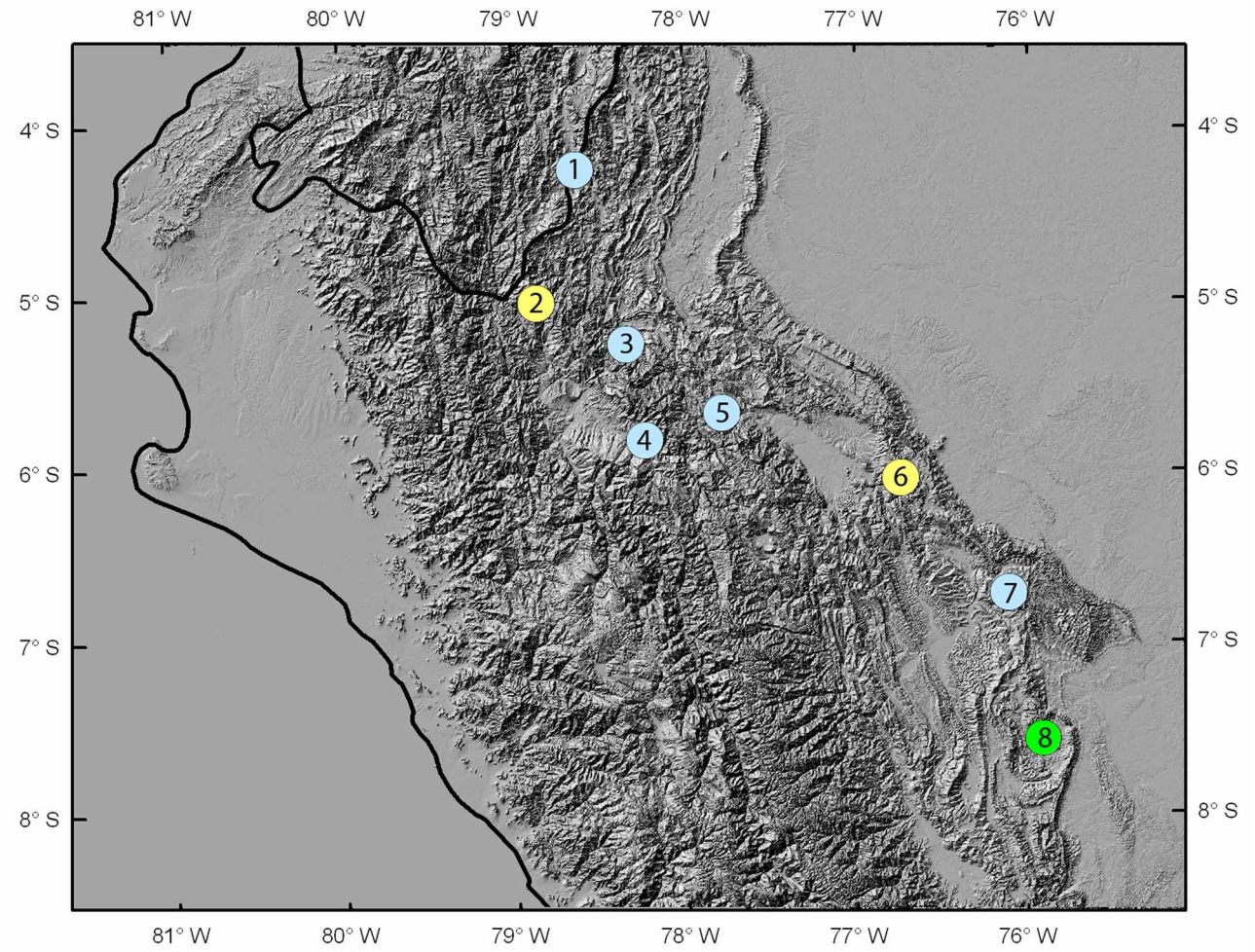

FIGURE 3. Distribution of the Royal Sunangel (*Heliangelus regalis*) in the Andes Mountains of Peru and Ecuador: *H. regalis regalis* (yellow circles); *H. regalis johnsoni* (green circle); published sight records, subspecies unknown (blue circles). Symbols may cover two or more closely spaced localities: (1) Yankuam Lodge, Prov. Zamora-Chinchipe (4º 15' S; 78º 37' W) (Freile, *et al.*, 2011; Krabbe & Ahlman, 2009); (2) San Jose de Lourdes, Dpt. Cajamarca (5º 02' S; 78º 51' W) (Fitzpatrick, *et al.*, 1979); (3) Duran, Dpt. Amazonas (5º 16' S; 78º 20' W) (Dauphiné, *et al.*, 2008); (4) San Cristobal, Dpt. Amazonas (5º 50' S; 78º 13' W) (Seddon, *et al.*, 1996); (5) Garcia, Dpt. San Martín (5º40'S; 77º46'W) (Hornbuckle, 1999); (6) NE Jirillo, Dpt. San Martín (6º 03' S; 76º 44' W) (Davis, 1986); (7) Sianbal, Dpt. San Martín (6º 43' S; 76º 06' W) (Merkord, *et al.*, 2009); (8) Pauya, Dpt. Loreto (7º 34' S; 75º 54' W) (Schulenberg, *et al.*, 2001).

(b) LSUMZ 170736, adult male. PERU: Department of Loreto; ca 80 km SE of Juanjuí on E bank upper Río Pauya, 7°34' S, 75°54' W, ca 1600 m. Collected and prepared by Thomas Valqui (field number 65) on 27 June 2000. Nearly identical to the holotype but indigo iridescence on crown, throat and upper breast is slightly paler. Weight 3.6 g.

(c) LSUMZ 170737, adult female. PERU: Department of Loreto; ca 80 km SE of Juanjuí on E bank upper Río Pauya, 7°35' S, 75°53' W, ca 1700 m. Collected and prepared by J. W. Armacost (field number 109) on 13 July 2000. Weight 4.4 g. Females exhibit considerable individual variation, some of which may be related to age. Sample sizes were insufficient to characterize possible body plumage color differences between female *H. r. regalis* and *H. r. johnsoni*.

(d) LSUMZ 170738, adult female. PERU: Department of Loreto; ca 86 km SE of Juanjuí on E bank upper Río Pauya, 7°33' S, 75°55' W, ca 1400 m. Collected and prepared by Daniel F. Lane (field number 1386) on 19 July 2000. Weight 3.8 g.

(e) MUSM 22615, adult male. PERU: Department of Loreto; ca 80 km SE of Juanjuí on E bank upper Río Pauya, 7°34' S, 75°54' W, ca 1700 m. Collected by Abraham Urbay T. and prepared by Daniel F. Lane (field number 1350) on 11 July 2000. Nearly identical to holotype but indigo iridescence on crown, throat and upper breast is slightly paler. Weight 3.6 g .

(f) MUSM 22611, adult female. PERU: Department of Loreto; ca 80 km SE of Juanjuí on E bank upper Río Pauya, 7°34’ S, 75°55’ W, ca 1740 m. Collected and prepared by Thomas Valqui (field number 76) on 30 June 2000. Weight 3.4 g.

Table 1. Selected measurements (lengths) of specimens of *Heliangelus regalis regalis* and *Heliangelus r. johnsoni*. Localities: (1) Peru: Department of Cajamarca; E side of ridge ENE above San José de Lourdes, 1950-2200 m; (2) Peru: Department of San Martín: ca 20 km by trail NE Jirillo on trail towards Balsapuerto, 1450 m; (3) Peru: Department of Loreto; ca 80-86 km SE Juanjuí on E bank of upper Río Pauya, 1400–1740 m. [a]Traces of subadult plumage. AMNH = American Museum of Natural History; LSUMZ = Louisiana State University Museum of Zoology

Museum number	Subspecies	Sex	Locality	Date	Culmen	Wing chord	Rectrix 1	Rectrix 2	Rectrix 3	Rectrix 4	Rectrix 5
AMNH 823987	*regalis*	male	1	14 July 1976	14.2	52.9	28.7	34.2	45.4	54.6	53.1
AMNH 823988	*regalis*	male	1	20 June 1976	13.8	56.6	25.8	31.5	38.6	44.3	43.4
LSUMZ 81849	*regalis*	male	1	17 July 1976	14.5	53	24.8	30.5	39.6	45.4	47.6
LSUMZ 81850	*regalis*	male[a]	1	20 July 1976	13.9	53.7	27.5	31.7	41.2	46.5	45.9
LSUMZ 81851	*regalis*	male	1	21 July 1976	14.6	55.6	26.7	33.6	43.4	50.5	49.4
AMNH 823989	*regalis*	female	1	17 July 1976	15.7	49.9	24.8	31	39.1	40.7	40.5
LSUMZ 81853	*regalis*	female	1	25 July 1976	15.5	51.2	27	30.5	36.7	37.7	37.9
LSUMZ 81848	*regalis*	female	1	15 July 1976	16.2	50.1	24.6	28.1	34.1	38.7	37.7
LSUMZ 81852	*regalis*	female	1	24 July 1976	15.4	50.2	26.3	30.4	35.7	37.5	35.9
LSUMZ 116681	*regalis*	male	2	28 Oct. 1983	15	53.2	28.8	34.9	44.7	na	na
LSUMZ 116682	*regalis*	male[a]	2	15 Nov. 1983	15.2	56.9	27.6	31.8	41.6	47.5	46.8
LSUMZ 170735	*johnsoni*	male[a]	3	27 June 2000	13.8	52.6	26.4	29.9	35.7	40.1	41.1
LSUMZ 170736	*johnsoni*	male	3	27 June 2000	13.5	51	25.9	29.8	40	47.4	na
MUSM 22613	*johnsoni*	male	3	22 July 2000	14.2	53.5	26.7	29.6	39.1	46.9	44.8
MUSM 22615	*johnsoni*	male	3	11 July 2000	14.9	51.8	25.5	29.6	38.8	45.7	46.4
LSUMZ 170738	*johnsoni*	female	3	19 July 2000	15.6	51.5	24.9	28.6	34.4	37.5	35.7
LSUMZ 170737	*johnsoni*	female	3	13 July 2000	14.9	46.6	26	30.5	34.8	36.4	35.8
MUSM 22611	*johnsoni*	female	3	30 June 2000	14.6	48.2	25.7	29.7	35.4	37.6	36.3

Other specimens examined. *Heliangelus r. regalis:* PERU: Department of Cajamarca; E side of ridge ENE above San José de Lourdes, 5º 02' S, 78º 51' W, 1950–2200 m (AMNH 823987 [holotype], male; AMNH 823988, male; AMNH 823989, female; LSUMZ 81848, female; LSUMZ 81849, male; LSUMZ 81850, male; LSUMZ 81851, male; LSUMZ 81852, female; LSUMZ 81853, female; USNM 81847, male); Department of San Martín: ca 20 km by trail NE Jirillo on trail towards Balsapuerto, 6º 03' S, 76º 44' W, 1450 m (LSUMZ 116681, male; LSUMZ 116682, male).

Etymology. We take pleasure in naming this beautiful new taxon for the late Ned K. Johnson (University of California, Berkeley) in recognition of his many contributions to avian systematics and biogeography.

Distribution. Recent fieldwork in southern Ecuador (Krabbe & Ahlman, 2009; Freile, *et al.*, 2011) and Peru (Schulenberg, *et al.*, 2001; Dauphiné, *et al.*, 2008; Merkord, *et al.*, 2009) brings to eight the number of known populations of *Heliangelus regalis* (Fig. 3). Five of the eight localities are represented only by sight records or photographs. So far as is known, *Heliangelus r. johnsoni* is restricted to the Cordillera Azul; however, the geographic range of this well-differentiated subspecies likely extends north and well south of the type locality. *H. regalis* has a relatively wide altitudinal range (1250–2200 m) compared to other species of hummingbirds with restricted geographic ranges in the Peruvian Andes (Graves, 1985). Reports at lower altitudes (550–700 m) in the Cordillara Colán (Dauphiné, *et al.*, 2008) are well outside the documented altitudinal range of *Heliangelus regalis* and should be regarded as questionable until specimens or diagnostic photographs are obtained. The species reaches its greatest abundance in habitat variously described as brushy slopes bordered by cloud forest (Fitzpatrick, *et al.*, 1979), elfin scrub (Seddon, *et al.*, 1996), stunted forest (Hornbuckle, 1999; Schulenberg, *et al.*, 2001), stunted shrubland (Freile, *et al.*, 2011), and mossy stunted forest (Davis, 1986).

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