

# Two new species of *Japalura* (Squamata: Agamidae) from the Hengduan Mountain Range, China

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## ABSTRACT

Until recently, the agamid species, *Japalura flaviceps*, was recognized to have the widest geographic distribution among members of the genus occurring in China, from eastern Tibet to Shaanxi Province. However, recent studies restricted the distribution of *J. flaviceps* to the Dadu River valley only in northwestern Sichuan Province, suggesting that records of *J. flaviceps* outside the Dadu River valley likely represent undescribed diversity. During two herpetofaunal surveys in 2013 and 2015, eight and 12 specimens of lizards of the genus *Japalura* were collected from the upper Nujiang (=Salween) Valley in eastern Tibet, China, and upper Lancang (=Mekong) Valley in northwestern Yunnan, China, respectively. These specimens display a unique suite of diagnostic morphological characters. Our robust comparisons of phenotype reveal that these populations can be distinguished readily from *J. flaviceps* and all other recognized congeners. Herein, we describe the two *Japalura* lineages as new species, *Japalura laeviventris* sp. nov. and *Japalura iadina* sp. nov.. In addition, we provide updated conservation assessments for the new species as well as imperiled congeners according to the IUCN criteria for classification, discuss the importance of color patterns in the diagnosis and description of species in the genus *Japalura*, and discuss directions for future taxonomic studies of the group.

**Keywords:** Coloration; Conservation; Hengduan Mountains; Hydropower development; *Japalura flaviceps*

## INTRODUCTION

The family Agamidae, a radiation of more than 300 species of iguanian lizards, is one of the most taxonomically diverse lizard groups in Eurasia, with members of the family pos-

sessing a wide range of morphologies and life history traits (Manthey, 2010; Moody, 1980; Townsend et al., 2011). Due to this large variation in phenotype, agamid lizards represent a great system for comparative studies in multiple fields of biology, including phylogeography (Macey et al., 1998; Melville et al., 2009; Moody, 1980), ethology (Kastle & Schleich, 1998; Murphy et al., 1978; Qi et al., 2011; Wei & Lin, 1981), and evolutionary biology (Grismer, 2010; Schulte et al., 2002; Stuart-Fox & Ord, 2004). Across mainland Asia, China harbors the greatest diversity of agamid lizards, currently possessing 52 currently recognized species in the country representing four subfamilies (Ananjeva et al., 2011). Of this diversity, nearly half (25 species) are believed to be endemic to China, including majority of the enigmatic Mountain Dragons of the genus *Japalura* Gray, 1853 (Ananjeva et al., 2011; Wang et al., 2015).

To date, the genus *Japalura* is composed of 30 species, distributed across much of Asia (Wang et al., 2015). The vast majority of this diversity occurs in the territory of Greater China (16 species found in Mainland China, five species on the islands of Taiwan; Ota et al., 1998; Wang et al., 2015). Until recently, *Japalura flaviceps* Barbour & Dunn, 1919 was recognized as having the widest geographic range in China, with populations distributed from eastern Tibet to Gansu Province in central China (Pope, 1935; Zhao et al., 1999). However, subsequent examinations of morphological variation among populations of *J. flaviceps* not only revealed the widespread species to be a complex of distinct evolutionary lineages, but also restricted the range of true *J. flaviceps* to the valleys of the Dadu River in northwestern Sichuan only (Gao & Hou, 2002; Li et al.,

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2001; Manthey et al., 2012; Wang et al., 2015). Furthermore, Manthey et al. (2012) and Wang et al. (2015) suggested that unexamined populations of *J. cf. flaviceps* outside of the Dadu River drainage may represent additional, unique evolutionary lineages within the species complex, worthy of additional systematic study.

During herpetofaunal surveys of eastern Tibet in 2013 and of northwestern Yunnan in 2015, we captured eight and 12 specimens of lizards in the upper Nujiang (=Salween) Valley, eastern Tibet, China, and the upper Lancang (=Mekong) Valley, northwestern Yunnan, China, respectively. All individuals were identified to the genus *Japalura*. Although these populations are considered to be part of the *J. flaviceps* species complex, they can be distinguished readily from true *J. flaviceps* sensu Manthey et al. (2012) and other members of the genus by suites of distinct morphological characters. In this study, we describe these populations as two distinct, new species within the genus. We review the taxonomic history of the *J. flaviceps* species complex, comment on the importance of coloration for species delimitation in the genus and discuss directions for future taxonomic studies of the group. Additionally, we assess the new species and other imperiled congeners against the IUCN criteria for classification (IUCN, 2013).

## MATERIALS AND METHODS

Eight specimens of one new species were collected from the upper Nujiang Valley near the Nujiang Bridge at Baxoi, Qamdo Prefecture of eastern Tibet, China, including two adult males, four adult females, and two juveniles. Twelve specimens of a second new species were collected from the upper Lancang Valley at Ninong, Deqin, northwestern Yunnan, China, including 11 adult males and one adult female.

Following euthanasia, tissue samples were taken from livers and preserved in 95% ethanol, and voucher specimens were fixed in 10% buffered formalin and later transferred to 70% ethanol for long-term preservation. With the exception of a single female specimen collected from Tibet that possesses an incomplete tail (KIZ 014040), all adult specimens were chosen as the type series. All specimens (including KIZ 014040) are deposited in the Museum of Kunming Institute of Zoology, Chinese Academy of Sciences (KIZ).

Measurements were made with digital calipers to the nearest 0.1 mm, except for snout-vent length (SVL) and tail length (TAL), which was made with a ruler to the nearest 1 mm. With the exception of several new traits measured in this study, focal characters and character definitions follow Wang et al. (2015): snout-vent length (SVL), tail length (TAL), head width (HW), snout-eye length (SEL), fore-limb length (FLL), hind limb length (HLL), supralabial count (SL), infralabial count (IL), middorsal scale (MD), Toe IV subdigital lamellae (T4S), Toe IV length (T4L), trunk length (TRL), interorbital distance (IOD), number of scales between nasal and first supralabials (NSL), supraciliary count (SCL), and number of scale rows between sixth supralabial and orbit circle (SOR). Additionally, in this study we examined the following morphometric characters (definitions provided after colon): enlarged, conical, post-tympanic scale

count (PTY); large conical scales posterior to tympanum; and enlarged, conical, post-rectal scale count (PRS): large conical scales posterior to the rictus. Values for paired characters (SL, IL, NSL, SOR) were recorded from both sides of the body, with counts provided in left/right order.

Summaries of specimens examined are listed in Appendix I. For comparisons, morphological data of the following phenotypically similar species were collected from vouchered specimens (from type or topotype specimens when available): *J. batangensis*, *J. dymondi*, *J. micangshanensis*, *J. flaviceps*, *J. splendida*, *J. varcoae*, *J. vela*, *J. yunnanensis*, and *J. zhaoermii*. Currently, with recognized populations of *J. splendida* distributed across multiple distinct zoogeographic regions of China (Xie et al., 2004; Zhao et al., 1999), and known to possess considerable variability in morphological characters (Manthey et al., 2012; Yang & Rao, 2008; Zhao et al., 1999), it is likely that the widespread species represents a complex of unique evolutionary lineages. Therefore, to avoid unnecessary confusion in drawing comparisons with potentially unique but undescribed diversity, we include morphological data from the type specimen of *J. splendida* as well as specimens from localities geographically proximate to the species' type locality along the Yangtze River (e.g. Chongqing). Morphological data of the following species were obtained from the literature: *J. brevicauda* (Manthey et al., 2012), *J. kumaonensis* (Schleich & Kästle, 2002), *J. luei* (Ota et al., 1998), *J. makii* (Ota, 1989), and *J. yulongensis* (Manthey et al., 2012).

Comparisons of coloration in life are based on type descriptions and available color photographs (Manthey, 2010; Yang & Rao, 2008; Zhao et al., 1999). Museum abbreviations for specimens examined follow Sabaj Perez (2015), and include: Chengdu Institute of Biology, Chinese Academy of Sciences (CIB); Kunming Institute of Zoology, Chinese Academy of Sciences (KIZ); Museum of Comparative Zoology at Harvard University (MCZ), Boston, MA, USA; and National Museum of Natural History (USNM), Washington D.C., USA.

The topographic map shown in Figure 1 was created by N. A. Huron in ArcMap v.10.3.1 using the digital elevation model (DEM) layers based on NASA's Shuttle Radar Topographic Mission (SRTM). The SRTM data are available for free at approximately 90 meters resolution (3 arc-second projections; Reuter et al., 2007; CIAT-CSI SRTM, 2015).

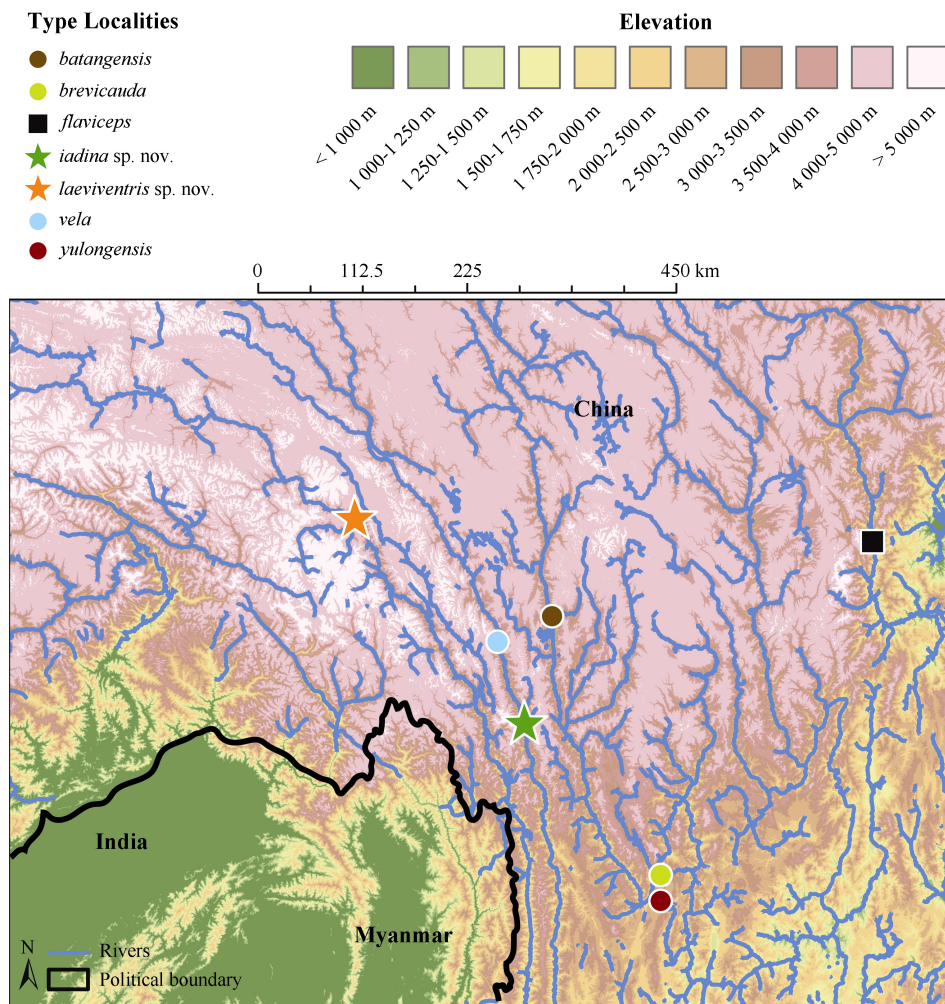
## RESULTS

### *Japalura laeviventris* sp. nov. Wang, Jiang, Siler, and Che (Figures 1-4)

#### Synonyms

*Japalura flaviceps* Pope, 1935: 467; Zhao & Jiang, 1977: 293-298; Hu et al., 1987: 112; Zhao et al., 1999: 111-115; Li et al., 2010: 115.

**Holotype:** KIZ 014038, adult male, collected near the Nujiang Bridge in the upper Nujiang Valley at Baxoi (=Basu), Qamdo (=Changdu), eastern Tibet (=Xizang), PR China (N30.10034°, E97.22787°, 2 739 m elevation); collected by Ke JIANG on 3 July 2013.



**Figure 1** Distribution map of *Japalura* in the Hengduan Mountain Range, southwest China (Map created by Nicholas A. HURON and Cameron D. SILER)

Color-coded shapes show the distribution of type localities for the new species (stars), true *J. flaviceps* sensu Wang et al. (2015) (square), and other referenced members of the *J. flaviceps* Species Complex (circles).

**Paratopotypes:** One adult male (KIZ 014037) and three adult females (KIZ 014041-43); collected by Ke JIANG, Kai WANG, and Ya-Qiang SUN.

**Diagnosis:** Following Inger's definition of the genus (Inger, 1960), the new species is assigned to the genus *Japalura* based on a number of diagnostic characters, including: (1) dorsal scales unequal in size; (2) enlarged crest scales present; (3) gular pouch present; (4) lateral fold of skin in axilla-groin region present; (5) supraciliary scales greatly imbricate; (6) head relatively long, flat; (7) tail long, slender; (8) tail cylindrical in shape; and (9) precloacal and femoral pores absent.

*Japalura laeiventris* sp. nov. can be distinguished from all congeners by the combination of the following suite of morphological characteristics: (1) small adult body size (SVL 67-72 mm in males, 64-70 mm in females); (2) moderate TAL (TAL/SVL 168%-200%); (3) moderate HLL (HLL/SVL 64.3%-78.4%); (4)

NSL 1; (5) T4S 22-26; (6) SOR 3; (7) strongly-protuberant, conical, post-tympanic scale absent; (8) strongly-protuberant, conical, post-rectal scale absent; (9) tympanum concealed; (10) nuchal crests relatively raised on weak skin folds; (11) dorsal crests weakly developed without distinct skin folds in males; (12) transverse gular fold present; (13) gular pouch distinct, present; (14) scales of ventral surface of body smooth or weakly keeled; (15) MD 57-59, (16) ground dorsal coloration off-white in males, brownish-gray in females; (17) dorsal, lateral, and ventral surface of head, dorsal forelimbs, and lateral surface of body speckled with black; (18) distinct radial streaks around eyes; (19) dorso-lateral stripes present, smooth-edged, pale-yellow in males; (20) dark-brown, "M"-shaped pigmentation patterns along dorsal midline in males; and (21) small, triangular, orange gular spots in adults of both sexes.

**Description of holotype:** Adult male, SVL 67 mm, TAL 133 mm,

FLL 30.6 mm, HLL 49.8 mm, HW 15.5 mm, HL 21.3 mm. Rostral rectangular, three times broader than high, in contact with six small scales excluding supralabial. Nasal sub-circular, bordered by 10/9 small scales. Single scale between rostral and first supralabial. Supralabials 7/8, smooth, posteriormost longest. Loreal scales irregularly arranged and weakly keeled. Ciliaries circular, much smaller than other dorsal scales, forming orbit circle; supraciliaries 9/11, prominent, elongated, above orbit; first 5/7 supraciliaries overlapping one-half to two-third of its length with subsequent ones, last four slightly overlapping; three rows of scales between orbit circle and sixth supralabials on both sides of head, all weakly keeled, with scales of middle row largest. Scales posterior to eyes strongly keeled; five enlarged scales between orbit and tympanum on both sides; tympanum covered with much smaller scales. Dorsal head scales heterogeneous in size, approximately circular shaped, mildly keeled, convex, somewhat granular in appearance; single row of five scales forming a weak ridge along snout midline from one scale posterior rostral to mid-point between anterior corner of eyes; parietal smooth, enlarged, with a distinct pineal eyespot; post-occipital and posterior lateral head scales strongly keeled; conical scale 1/0 on occipital region, weakly developed; no large conical scales posterior to tympanum or rictus.

Ventral head scales homogeneous in size, mostly smooth, weakly keeled posterolaterally; transverse gular fold distinct, well developed; gular pouch present; shoulder fold posterior to gular fold on each side, from ventral surface of neck to just about 5 mm above pectoral joint; axillary fold present on each side of body. Middorsal crest scales 59, roughly equal in size to neighboring scales, imbricate along body midline; nuchal crest relatively raised on skin fold, while dorsal crest weakly developed without skin folds. A row of enlarged and distinctively keeled scales running parallel to dorsal crest from pectoral region of body to pelvis on each side of crest above dorsolateral stripes. Ground dorsal scales heterogeneous in size; scales of axilla much smaller than remaining dorsals; large, distinct, flat scales distributed irregularly across dorsal surface of body, circular in shape, roughly four times larger than ground scales, at times arranged in proximally transverse rows. Dorsal limb scales distinctively keeled, roughly equal in size to ventral scales, homogeneous in size on forelimbs, heterogeneous on hind limbs; Toe IV subdigital lamellae 25/24. Tail scales keeled in lateral rows; cloaca scales small. Ventral scales of body and limbs mostly homogeneous in size, smooth or weakly keeled close to lateral sides.

**Coloration of holotype in life:** In life, the dorsal surface of the head is light yellowish, speckled with small black scales, of which some connect to form dark X-shaped patterns. Two of these X-shaped patterns are observed on the snout, and another can be observed on the dorsal surface of the head between the orbits. The lateral surface of the head is off-white and is also speckled with black scales. Some black scales form radial stripes around the eyes, with the stripes directed posteriorly being the broadest. The ground coloration of the dorsal and lateral surfaces of the body is off-white. Smooth-edged, pale-yellow dorsolateral stripes run along the entire length of the body on each side of the vertebral crest. Black vermiculate pigmentation patterns are present on the lateral

surfaces of the body, beneath and proximate to the dorso-lateral stripes. A series of three V-shaped brownish-black patterns of dark pigmentations are observed on the dorsal surface of the body, distributed from the occipital region of the head to the pectoral joint of the body along the dorsal midline. These shapes are followed posteriorly by a series of four brownish-black, M-shaped pigmentations, of which the last one is gradually faded and somewhat unclear. Numerous brownish-gray, transverse bands are present on the posteriormost two-thirds of the tail. The bands do not form complete rings around the tail ventrally. The dorsal surfaces of the forelimbs are off-white and speckled with black scales. The black scales in this region are connected in places by gray-blotched scales, and together, these colors create irregular transverse bands of dark coloration. The dorsal surfaces of the hind limbs are light gray, with dark-gray transverse patterns similar to those observed on the forelimbs. The ground coloration of the ventral surface of the head is uniform white, but heavily speckled with black scales. Sporadically, small series of these black scales form short, longitudinal, vermiculate stripes. A triangular, bright orange gular spot is present in the center of the gular pouch. The ventral surfaces of the body, limbs, and tail are uniform white, except for the ventral surfaces of the hands and feet, which are more yellowish (Figure 2).

**Coloration of holotype in preservative:** The coloration of the holotype in preservative closely matches its coloration in life; however, the following differences are observed: (1) the ground coloration of the dorsal surface of the head as well as the coloration of the dorsolateral stripes is light gray, and (2) the triangular orange gular spot turns white (Figure 3).

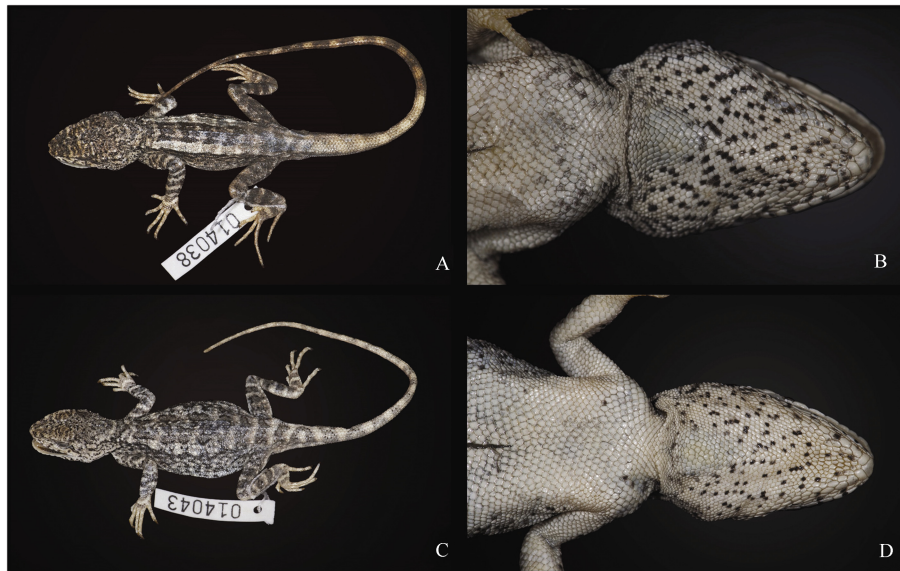
**Variation and sexual dimorphism:** Variations in pholidosis and measurements are summarized in Table 1. The male paratopotype (KIZ 014037) is slightly darker in dorsal coloration than the holotype in preservative. Females are sexually dimorphic from males by having shorter snouts (SEL/HL), less speckled ventral surfaces of the heads (v.s. heavily speckled), more consistently arranged transverse rows of enlarged scales on the dorsal surfaces of the body (v.s. irregularly distributed), smaller orange gular spots (v.s. larger), much more distinct transverse patterns of pigmentations at bases of the tails (v.s. less distinct), as well as by the absences of M-shaped dark pigmentation patterns along the dorsal midline of the body (v.s. presence), and the presence of dark transverse bands on the dorsal surface of the body that extend to the lateral surfaces of the body (v.s. absence). Yellow dorsolateral stripes are absent in most females, except for a single individual (KIZ 014043), which has wavy dorsolateral stripes. Juveniles (KIZ 014039, 014044) closely resemble adult females, except for the absence of orange gular spots. A single juvenile (KIZ 014039) was observed to possess a light-gray, dorsal, vertebral stripe from the pectoral region of the body to pelvis. This trait was not observed in any adult females.

**Comparisons:** Populations of the new species were identified previously as *J. flaviceps*. However, the new species can be



**Figure 2** Lateral and ventral views of adult male holotype KIZ 014038 (A and B) and adult female paratopotype KIZ 014043 (C and D) of *Japalura laeviventris* sp. nov. in life (Photos by Kai WANG)

Note the dark reddish orange color posterior to the shoulder fold in the lateral view is the color of ectoparasites and not a coloration pattern of the new species.



**Figure 3** Dorsolateral views and ventral close-ups views of adult male holotype KIZ 014038 (A and B) and adult female paratopotype KIZ 014043 (C and D) of *Japalura laeviventris* sp. nov. in preservative (Photos by Kai WANG)

distinguished readily from the latter by having smooth or weakly keeled scales on the ventral surface of the head and the body (v.s. distinctively keeled), a greater number of MD (57-59 v.s. 43-48), heavily speckled ventral surfaces of the head, with speckles rarely forming short lines (v.s. speckles absent, but broad, dark stripes present and interconnected into a mosaic pattern), as well as by the absence of strongly-protuberant, conical, post-rectal scale (v.s. presence), presence of X-shaped

patterns of dark pigmentation on the dorsal surface of the head (v.s. absence, or presence of few transverse streaks), presence of distinct radial patterns around the eyes (v.s. absence), presence of M-shaped patterns of dark pigmentation along the dorsal midline between the two dorsolateral stripes in males (v.s. rhombus-shaped patterns with distinct yellow centers), and presence of distinct orange gular spots in both sexes (v.s. absence in both sexes).

**Table 1 Meristic and mensural data of the type series of *Japalura laevis* sp. nov.**

No.	Status	Sex	SVL	TAL	TAL/SVL	HL	HL/SVL	HW	HW/SVL	SEL	SEL/HL	IOD	
KIZ 014038	Holotype	Male	67	133	1.99	21.3	0.32	15.5	0.23	7.1	0.33	9.8	
KIZ 014037	Paratopotype	Male	72	142	1.97	22.7	0.32	16.3	0.23	8.0	0.35	10.9	
	Range		67-72	133-142	1.97-1.99	21.3-22.7	0.32	15.5-16.3	0.23	7.1-8.0	0.33-0.35	9.8-10.9	
	Average		70	138	1.98	22.0	0.32	15.9	0.23	7.6	0.34	10.4	
KIZ 014041	Paratopotype	Female	64	118	1.84	18.2	0.28	12.4	0.19	6.5	0.36	9.0	
KIZ 014042	Paratopotype	Female	70	128	1.83	20.6	0.29	13.7	0.20	7.0	0.34	9.8	
KIZ 014043	Paratopotype	Female	70	118	1.69	20.2	0.29	13.5	0.19	7.6	0.38	10.2	
	Range		64-70	118-128	1.69-1.84	18.2-20.6	0.28-0.29	12.4-13.7	0.19-0.20	6.5-7.6	0.34-0.38	9.0-10.2	
	Average		68	121	1.79	19.7	0.29	13.2	0.19	7.0	0.36	9.7	
No.	FLL	FLL/SVL	HLL	HLL/SVL	T4L	TRL	SL	IL	NSL	MD	T4S	SCL	SOR
KIZ 014038	30.6	0.46	49.8	0.74	12.3	30.7	7/8	9/9	1/1	59	25/24	10/10	3/3
KIZ 014037	32.0	0.44	50.7	0.70	12.4	35.4	8/8	11/11	1/1	57	25/25	9/10	3/3
	30.6-32.0	0.44-0.46	49.8-50.7	0.70-0.74	12.3-12.4	30.7-35.4	7 or 8	9-11	1	57-59	24 or 25	9 or 10	3
	31.3	0.45	50.3	0.72	12.4	33.1	8	10	1	58	25	9.8	3
KIZ 014041	30.3	0.47	47.4	0.74	10.3	33.3	9/9	9/9	1/1	59	22/24	10/10	3/3
KIZ 014042	30.3	0.43	50.1	0.72	12.5	35.7	7/8	8/7	1/1	58	23/23	10/10	3/3
KIZ 014043	31.0	0.44	44.4	0.63	11.0	33.3	8/9	7/8	1/1	58	23/24	8 or 9	3/3
	30.3-31.0	0.43-0.47	44.4-50.1	0.63-0.74	10.3-12.5	33.3-35.7	7-9	7-9	1	58 or 59	22-24	8-10	3
	30.5	0.45	47.3	0.70	11.3	34.1	8.3	8	1	58	23	10	3

Measurements of SVL, TAL, HL, HW, T4L, TRL, FLL, and HLL are in millimeters (mm), all meristic data are given in decimals, and paired meristic characters are given in left/right order. Summary statistics are provided for male and female specimens separately. For average calculation of paired measurements, each one of the paired measurements is treated independently. Abbreviations: SVL: snout-vent length; TAL: tail length; HL: head length; HW: head width; SEL: snout-eye length; IOD: interorbital distance; FLL: fore-limb length; HLL: hind limb length; T4L: Toe IV length; TRL: trunk length; SL: supralabial count; IL: infralabial count; NSL: number of scales between nasal and first supralabials; MD: middorsal scale; T4S: Toe IV subdigital lamellae; SCL: supraciliary count; SOR: number of scale rows between sixth supralabial and orbit circle.

**Table 2 Meristic and mensural data of the type series of *Japalura iadina* sp. nov.**

No.	Status	Sex	SVL	TAL	TAL/SVL	HL	HL/SVL	HW	HW/SVL	SEL	SEL/HL	IOD	
KIZ 019321	Holotype	Male	60	116	1.95	18.5	0.31	12.4	0.21	6.9	0.38	9.1	
KIZ 019328	Paratopotype	Male	63	118	1.89	20.0	0.32	13.4	0.21	7.0	0.35	10.1	
KIZ 09402	Paratopotype	Male	58	102	1.78	17.0	0.30	11.9	0.21	6.3	0.37	8.2	
KIZ 09403	Paratopotype	Male	62	122	1.98	20.0	0.32	13.9	0.22	7.8	0.39	10.0	
KIZ 019322	Paratopotype	Male	62	—	—	20.3	0.33	13.7	0.22	7.8	0.38	9.9	
KIZ 019327	Paratopotype	Male	54	97	1.80	16.9	0.31	10.9	0.20	6.2	0.37	7.9	
KIZ 019320	Paratopotype	Male	63	109	1.73	19.3	0.31	13.0	0.21	7.5	0.39	9.0	
KIZ 019326	Paratopotype	Male	64	—	—	19.7	0.31	13.6	0.21	7.0	0.36	9.0	
KIZ 019325	Paratopotype	Male	64	—	—	19.7	0.31	13.1	0.21	7.0	0.36	10.0	
KIZ 09401	Paratopotype	Male	56	110	1.98	17.1	0.31	11.7	0.21	6.9	0.40	8.7	
KIZ 019323	Paratopotype	Male	65	127	1.96	20.6	0.32	13.7	0.21	7.2	0.35	9.4	
	Range		54–65	97–127	1.73–1.98	16.9–20.6	0.30–0.33	10.9–13.9	0.20–0.22	6.2–7.8	0.35–0.40	7.9–10.1	
	Average		61	113	1.88	19.0	0.31	12.8	0.21	7.1	0.37	9.2	
KIZ09398	Allotype	Female	62	107	1.73	19.0	0.31	12.8	0.21	6.7	0.36	8.8	
No.	FLL	FLL/SVL	HLL	HLL/SVL	T4L	TRL	SL	IL	NSL	MD	T4S	SCL	SOR
KIZ 019321	28.8	0.48	44.3	0.74	10.3	28.3	9/10	9/10	1/1	40	20/21	6/6	3/3
KIZ 019328	28.6	0.46	43.6	0.70	10.5	28.8	7/8	10/10	1/1	35	20/23	6/7	3/3
KIZ 09402	26.3	0.46	41.4	0.72	9.3	24.1	9/10	10/11	0/1	40	23/22	6/6	3/3
KIZ 09403	30.5	0.49	49.6	0.80	11.7	29.4	9/8	9/10	1/1	42	22/22	6/7	3/4
KIZ 019322	29.9	0.48	45.4	0.73	11.7	28.0	8/8	9/9	2/1	44	24/23	7/7	3/3
KIZ 019327	25.1	0.46	41.5	0.77	9.3	24.5	9/10	10/11	1/1	44	22/22	6/6	3/3
KIZ 019320	29.5	0.47	48.7	0.77	14.4	28.5	8/8	10/8	1/1	46	22/22	7/6	3/3
KIZ 019326	30.2	0.47	47.5	0.74	10.6	29.2	8/9	9/10	0/0	40	20/21	6/6	3/3
KIZ 019325	28.9	0.45	48.3	0.76	10.9	30.4	8/8	9/10	1/1	46	21/21	6/6	3/3
KIZ 09401	27.0	0.49	41.2	0.74	10.4	25.3	8/9	9/10	0/1	39	21/21	6/6	4/4
KIZ 019323	30.5	0.47	50.9	0.78	11.3	30.2	8/8	9/10	1/1	45	21/21	6/6	3/3
	25.1–30.5	0.45–0.49	41.2–50.9	0.70–0.80	9.3–14.4	24.1–30.4	7–10	8–11	0 or 1	35–46	20–23	6 or 7	3 or 4
	28.7	0.47	45.7	0.75	10.9	27.9	8	10	1	42	22	6	3
KIZ 09398	28.5	0.46	45.6	0.74	9.7	30.3	8/7	9/9	1/1	41	19/19	7/7	3/3

For measurements and calculation details see Table 1. Summary statistics are provided for male and female specimens separately. Abbreviations: SVL: snout–vent length; TAL: tail length; HL: head length; HW: head width; SEL: snout–eye length; IOD: interorbital distance; FLL: fore-limb length; HLL: hind limb length; T4L: Toe IV length; TRL: trunk length; SL: supralabial count; IL: infra-labial count; NSL: number of scales between nasal and first supralabials; MD: middorsal scale; T4S: Toe IV subdigital lamellae; SCL: supraciliary count; SOR: number of scale rows between sixth supralabial and orbit circle.

**Table 3 Morphological comparisons of *Japatura laeiventris* sp. nov., *J. iadina* sp. nov., and phenotypically similar congeners.**

Sex	<i>laeiventris</i> sp. nov.			<i>iadina</i> sp. nov.			<i>batangensis</i>				
	Male n=2	Female n=3	Male n=11	Female n=1	Male n=6	Female n=5					
SL	7 or 8	7-9	8	7-10	9	7 or 8	8	9-11	10	9-11	10
IL	9-11	7-9	8	8-11	10	9	9	9-12	11	9-12	10
SCL	9 or 10	8-12	10	6 or 7	6	7	7	7-9	8	7 or 8	8
NSL	1	1	1	0-2	1	1	1	1 or 2	2	1 or 2	2
SOR	3	3	3	3 or 4	3	3	3	3 or 4	3	3 or 4	4
MD	57-59	58 or 59	58	35-46	42	41	41	39-54	44	40-44	42
PTY	0	0	0	1-3	1	2	2	1-3	2	0-2	2
PRS	0	0	0	1 or 2	2	1 or 2	2	0	0	0	0
T4S	24 or 25	22-24	23	20-24	22	19	19	20-22	21	21-24	22
SVL	67-72	64-70	68.0	54-65	61.0	61.8	61.8	50-62	58.5	53-64	58.6
TAL	133-142	118-128	121.3	97-127	112.6	107.1	107.1	85-115	105.6	95-111	104.7
TRL	30.7-35.4	33.3-35.7	34.1	24.1-30.4	27.8	30.3	30.3	20.5-30.3	26.7	25.3-31.7	28.2
HL	21.3-22.7	18.2-20.6	19.7	16.9-20.6	19.0	19.0	19.0	16.0-19.3	17.8	17.2-19.4	18.3
HW	15.5-16.3	12.4-13.7	13.2	10.9-13.9	12.8	12.8	12.8	11.4-13.9	12.8	12.5-14.8	13.4
SEL	7.1-8.0	6.5-7.6	7.0	6.2-7.8	7.0	6.7	6.7	6.1-7.6	6.8	6.4-7.6	6.9
IOD	9.8-10.9	9.0-10.2	9.7	7.9-10.1	9.2	8.8	8.8	8.0-9.7	8.8	7.9-9.4	8.6
FLL	30.6-32.0	30.3-31.0	30.5	25.1-30.5	28.5	28.5	28.5	21.7-29.7	26.6	25.9-30.8	27.8
HLL	49.8-50.7	44.4-50.1	47.3	41.2-50.9	45.7	45.6	45.6	38.5-44.8	42.3	42.0-48.8	44.4
T4L	12.3-12.4	10.3-12.5	11.3	9.3-14.4	11.1	9.7	9.7	8.6-11.4	10.2	9.6-11.4	10.4
TRL/SVL	0.46-0.49	0.48-0.52	0.50	0.42-0.48	0.46	0.49	0.49	0.41-0.51	0.46	0.46-0.49	0.47
TAL/SVL	1.97-1.99	1.69-1.84	1.79	1.73-1.97	1.87	1.73	1.73	1.65-1.95	1.81	1.64-2.04	1.84
HL/SVL	0.32	0.28-0.29	0.29	0.29-0.33	0.31	0.31	0.31	0.29-0.32	0.3	0.29-0.32	0.31
HW/HL	0.72-0.73	0.67-0.68	0.67	0.64-0.70	0.67	0.68	0.68	0.68-0.77	0.72	0.71-0.77	0.73
SEL/HL	0.33-0.35	0.34-0.38	0.36	0.35-0.40	0.37	0.36	0.36	0.35-0.41	0.38	0.35-0.40	0.37
IOD/HL	0.46-0.48	0.48-0.50	0.49	0.46-0.51	0.49	0.46	0.46	0.45-0.53	0.5	0.45-0.50	0.47
FLL/SVL	0.44-0.46	0.43-0.47	0.45	0.45-0.49	0.47	0.46	0.46	0.43-0.50	0.45	0.42-0.51	0.47
HLL/SVL	0.70-0.74	0.63-0.74	0.70	0.69-0.80	0.75	0.74	0.74	0.69-0.77	0.72	0.68-0.80	0.75
T4L/HLL	0.24-0.25	0.22-0.25	0.24	0.22-0.30	0.24	0.21	0.21	0.22-0.26	0.24	0.23-0.25	0.24
VSK	A	A	0.24	P	P	P	P	P	P	P	P
TGF	P	P	P	P	P	P	P	P	P	P	P
GS	P	P	P	P	P	P	P	P	P	P	P
CGS	Orange	Orange	Orange	Blue	Yellowish green	Yellowish green	Yellowish green	Bluish green	Bluish green	Bluish green	Bluish green
TSDH	P	P	P	P	P	P	P	P	P	P	P
RPAE	P	P	P	P	P	P	P	P	P	P	P
DSVH	P	P	P	A	A	A	A	A	A	A	A
VSVH	P	P	P	P	P	P	P	S	S	S	S



Sex	<i>flaviceps</i>			<i>micangshanensis</i>			<i>splendida</i>		
	Male n=5	Female n=3	Male n=6	Female n=3	Male n=4	Female n=3	Male n=4	Female n=2	
SL	9-11	10	6-10	8	7	7	7-9	8	8 or 9
IL	10 or 11	11	7-9	8	9	9	7-9	8	9 or 10
SCL	7 or 8	7	7 or 8	7	7	7	7 or 8	7	7
NSL	1 or 2	2	1	1	1	1	0 or 1	0	1
SOR	4	4	3	3	3	3	3	3	3
MD	43-48	45	38-43	40	40	37-42	44-48	45	46-48
PTY	2-5	3	3-8	4	3	1-3	1 or 2	2	4
PRS	4-7	5	3-7	5	3	1-4	0-2	2	2-5
T4S	23-24	24	23-27	25	25	23-26	24-28	27	25-27
SVL	72-75	74.0	55-67	60.1	63.6	57-69	59-92	76.1	64-81
TAL	122-144	135.2	112-143	124.8	123.7	114-133	152-225	187.8	140-181
TRL	31.9-36.1	33.9	24.0-29.6	26.2	31.3	30.1-32.9	26.1-40.3	31.9	32.3-42.0
HL	22.6-23.7	23.1	16.6-20.0	18.1	17.9	15.1-20.2	18.0-28.8	23.5	19.3-23.8
HW	16.7-17.4	17.1	11.2-14.1	12.7	13.1	11.8-14.8	12.8-22.0	17.0	13.1-15.4
SEL	8.8-10.1	9.6	5.9-8.0	7.2	7.4	6.9-7.7	7.3-11.1	9.0	8.2-10.1
IOD	10.4-10.9	10.7	8.3-10.4	9.5	9.5	8.6-10.4	9.7-13.3	11.2	9.6-11.9
FLL	29.3-31.5	30.4	26.0-29.7	27.6	26.7	25.0-29.0	25.3-44.2	34.6	29.0-36.9
HLL	46.5-52.6	50.6	43.9-52.1	46.8	44.8	43.7-46.6	47.4-73.8	61.0	44.9-62.3
T4L	12.3-13.5	12.8	11.7-12.9	12.4	11.6	10.8-12.8	13.8-17.8	15.4	11.4-15.4
TRL/SVL	0.44-0.49	0.46	0.41-0.48	0.44	0.49	0.47-0.53	0.33-0.45	0.41	0.50-0.52
TAL/SVL	1.70-1.91	1.82	1.92-2.22	2.08	1.95	1.79-2.04	2.39-2.58	2.47	2.17-2.23
HL/SVL	0.30-0.32	0.31	0.30-0.31	0.30	0.28	0.27-0.29	0.29-0.32	0.31	0.29-0.30
HW/HL	0.72-0.76	0.74	0.68-0.72	0.70	0.74	0.70-0.78	0.66-0.76	0.71	0.65-0.68
SEL/HL	0.39-0.44	0.41	0.36-0.42	0.40	0.41	0.38-0.45	0.31-0.44	0.38	0.42
IOD/HL	0.45-0.48	0.47	0.50-0.55	0.53	0.53	0.51-0.57	0.39-0.54	0.47	0.5
FLL/SVL	0.39-0.44	0.41	0.44-0.51	0.47	0.42	0.40-0.44	0.42-0.48	0.45	0.45
HLL/SVL	0.65-0.71	0.68	0.74-0.85	0.78	0.71	0.68-0.77	0.79-0.81	0.80	0.70-0.77
T4L/HLL	0.23-0.27	0.25	0.24-0.28	0.27	0.26	0.24-0.27	0.25-0.29	0.27	0.25
VSK	P	P	P	P	P	P	P	P	P
TGF	P	P	A	A	A	A	P	P	P
GS	A	A	A	A	A	A	A	A	A
CGS	A	A	A	A	A	A	A	A	A
TSDH	S	S	P	P	P	P	P	P	P
RPAE	A	A	P	P	P	P	P	P	P
DSVH	A	A	A	A	A	A	S	A	A
VSVH	P	P	A	A	A	A	P	P	P

Sex	<i>vela</i>			<i>yunnanensis</i>			<i>zhaomii</i>			
	Male n=9	Female n=2	Male n=5	Female n=3	Male n=5	Female n=2				
SL	7-10	9	6-8	8	8	8	9 or 10	10	8-10	9
IL	9-11	10 or 11	6 or 9	7	7	8	9-11	10	9 or 10	9
SCL	7	7 or 8	7-9	8	8	8	6 or 7	7	7	7
NSL	1 or 2	1 or 2	0	0	0	0	1	1	1	1
SOR	3 or 4	3	2 or 3	2	2	2	3 or 4	3	3-5	4
MD	41-47	44	43-45	44	44	44	41-45	43	40-42	41
PTY	2 or 3	0-3	0	0	0	0	2-5	3	3 or 4	4
PRS	0	0	1	1	1	1	1-3	1	1	1
T4S	24 or 25	24 or 25	27-29	27	27	27	24 or 25	25	24 or 25	25
SVL	56-69	62.1	56-70	63.6	63.6	63.6	68-77	72.5	60-64	61.9
TAL	110-136	123.1	145-202	177.2	177.2	177.2	128-151	138.3	94-97	95.6
TRL	25.3-33.0	28.8	19.0-20.9	19.8	19.8	19.8	29.8-36.3	33.1	26.3-32.4	29.4
HL	17.3-20.8	19.1	12.9-14.4	13.7	13.7	13.7	20.8-26.1	23.4	18.1-19.0	18.6
HW	12.2-14.5	13.5	7.9-9.3	8.6	8.6	8.6	14.7-20.3	17.1	11.7-12.9	12.3
SEL	6.5-7.7	7.1	10.1-12.4	11.7	11.7	11.7	8.5-8.9	8.7	7.0-7.4	7.2
IOD	8.4-9.6	9.1	29.9-37.1	32.4	32.4	32.4	9.9-11.3	10.6	8.6	8.6
FLL	25.5-31.5	29.2	44.5-54.7	50.1	50.1	50.1	29.1-37.1	32.1	25.4-28.8	27.1
HLL	43.9-50.8	46.9	11.1-17.1	14.5	14.5	14.5	47.6-55.0	51.5	39.4-43.8	41.6
T4L	11.3-13.2	12.2	25.8-29.4	28.1	28.1	28.1	12.8-14.5	13.8	11.1-11.8	11.4
TRUSVL	0.42-0.48	0.46	0.42-0.46	0.44	0.44	0.44	0.43-0.49	0.46	0.44-0.50	0.47
TALUSVL	1.92-2.06	1.99	2.59-2.89	2.77	2.77	2.77	1.81-2.20	1.94	1.51-1.57	1.54
HL/SVL	0.30-0.34	0.31	0.29-0.35	0.31	0.31	0.31	0.30-0.34	0.32	0.29-0.30	0.30
HW/HL	0.68-0.72	0.71	0.66-0.72	0.69	0.69	0.69	0.62-0.80	0.72	0.62-0.71	0.66
SEL/HL	0.36-0.39	0.37	0.41-0.45	0.43	0.43	0.43	0.34-0.41	0.37	0.39	0.39
IOD/HL	0.42-0.53	0.48	0.52-0.59	0.56	0.56	0.56	0.44-0.50	0.47	0.45-0.47	0.46
FLL/SVL	0.45-0.50	0.47	0.46-0.54	0.51	0.51	0.51	0.41-0.48	0.44	0.43-0.45	0.44
HLL/SVL	0.72-0.81	0.76	0.78-0.80	0.79	0.79	0.79	0.67-0.79	0.72	0.66-0.68	0.67
T4L/HLL	0.24-0.29	0.26	0.25-0.31	0.29	0.29	0.29	0.25-0.29	0.27	0.27-0.28	0.28
VSK	P	P	P	P	P	P	P	P	P	P
TGF	P	P	A	A	A	A	P	P	P	P
GS	A	A	P	S	S	S	P	P	A	A
CGS	A	A	Yellow	Yellow	Yellow	Yellow	Yellowish green	Yellowish green	A	A
TSDH	P	P	P	P	P	P	P	P	P	P
RPAE	P	P	P	P	P	P	P	P	P	P
DSVH	A	A	A	A	A	A	A	A	A	A
VSVH	P	P	P	P	P	P	S	S	P	P

For measurements and calculation details see Table 1. Abbreviations: SL, supralabial count; IL, infraorbital count; SCL, supraciliary count; NSL, number of scales between nasal and first supralabials; SOR, number of scale rows between sixth supralabial and orbit circle; MD, middorsal scale; PTY, enlarged, conical, post-tympanic scale count; PRS, enlarged, conical, post-rectal scale count; T4S, Toe IV subdigital lamellae; SVL, snout-vent length; TAL, tail length; TRL, trunk length; HL, head length; HW, head width; SEL, snout-eye length; IOD, interorbital distance; FLL, fore-limb length; HLL, hind limb length; T4L, Toe IV length; VSK, ventral scales distinctively keeled; TGF, transverse gular fold; GS, gular spot; CGS, coloration of gular spot; TSDH, distinct transverse streaks on dorsal head; RPAE, distinct radial patterns around eyes; DSVH, distinct dark speckles on ventral head; VSVH, distinct vermiculate stripes on ventral head; P, present; A, absent; S, sometimes present.

*Japalura laeiventris* sp. nov. is most similar to *J. kumaonensis* (Annandale, 1907) and *J. yunnanensis* Anderson, 1879 in coloration patterns. All three species possess radial patterns of dark pigmentation around the eyes and light dorsolateral stripes in males. However, the new species can be distinguished readily from the latter two by having smooth or weakly keeled scales on the ventral surfaces of the head and the body (v.s. distinctively keeled), a greater number of MD ( $\geq 57$  v.s.  $\leq 52$ ), as well as by the absence of strongly protuberant, conical, post-tympanic scales (presence and in high numbers) and absence of strongly-protuberant, conical, post-riatal scale (v.s. presence). Additionally, *Japalura laeiventris* sp. nov. differs from *J. kumaonensis* by having a greater number of SL (7-9 v.s. 5 or 6), a concealed tympanum (v.s. exposed), a relatively well developed gular pouch (v.s. weakly developed), M-shaped patterns along the dorsal-midline in males (v.s. chevron-shaped), the posteriorly directed radial-stripes of the eyes less prominent and short, ending before reaching the tympanums (v.s. distinct, broad, enclosing the tympanums), as well as by the presence of a transverse gular fold (v.s. absence) and presence of orange gular spots in both sexes (v.s. absence in both sexes); and from *J. yunnanensis* by having a shorter tail (TAL/SVL  $\leq 200\%$  v.s.  $\geq 235\%$ ), fewer T4S (22-26 v.s. 27-31), greater number of NSL (1 v.s. 0), broad dorsolateral stripes with smooth edges in males (v.s. narrow and jagged), an off-white ground coloration on the dorsal surface of the body (v.s. green or brown), the terrestrial lifestyle (v.s. arboreal), as well as by the presence of a transverse gular fold (v.s. absence) and presence of orange gular spots in both sexes (v.s. light yellow gular spots in males, sometimes absence in females).

In addition to the four species compared above, the new species can be diagnosed from all remaining congeners by having smooth or weakly keeled scales on the ventral surfaces of the head and the body (v.s. distinctively keeled), an off-white ground coloration of the body (brown, black, or green), heavily speckled surfaces of the head and lateral surfaces of the body (v.s. absence or weakly speckled lateral body only), M-shaped dark patterns of pigmentations along the dorsal midline of the body between the two dorsolateral stripes in males (v.s. rectangular blotches of dark pigmentations), and the orange gular spots in both sexes in life (v.s. other colorations, in males only), as well as by the absence of large, conical post-riatal and post-tympanic scales (v.s. presence and in high numbers).

**Distribution and Natural History:** *Japalura laeiventris* sp. nov. is known only from its type locality in the upper Nujiang Valley (Figure 1); however, the species may also occur along geographically proximate stretches of Nujiang. Little vegetation exists in the Hot-and-Dry Valley (Figure 4). The new species is terrestrial, with individuals have been observed on the sandy hills alongside the river, utilizing rock crevices and rodent burrows as shelters. No larger reptiles have been recorded from the area. Males of the new species are more conspicuous in behavior than females, and can be observed basking for greater lengths of time in open habitat. In contrast, females appear to stay in closer proximity to shelters.



**Figure 4** Preferred microhabitat of *Japalura laeiventris* sp. nov. near the Nujiang Bridge, Baxoi County, Qamdo Prefecture, eastern Tibet, China (Photo by Ya-Qiang SUN)

**Etymology:** We derive the new species name from the Latin word “*laeiventris*,” meaning “smooth venter,” in reference to one of the major diagnostic characteristics of the new species: smooth or weakly keeled ventral body scales. Suggested common name: Smooth-venter Mountain Dragon (English); Hua Fu Pan Xi (Chinese; 滑腹攀蜥).

***Japalura iadina* sp. nov. Wang, Jiang, Siler, and Che (Figures 5-7)**

**Synonyms**

*J. flaviceps* Zhao et al., 1999: 293-298; Yang and Rao, 200: 200-201; 8; Xu and Zhang 2011: 202-203; *J. splendida* Xu and Zhang 2011: 202-203; *J. cf. flaviceps* Manthey et al., 2012

**Holotype:** KIZ 019321, adult male, collected by Kai WANG on 27 May 2015, from the Lancang Valley at Ninong, Deqin, northwest Yunnan, China (N28.370255°, E98.865287°, 2 062 m elevation).

**Allotopotype:** KIZ 09398, adult female. Collected by Da-Hu ZOU. Specimen shares the same locality and collection information as the holotype.

**Paratopotypes:** KIZ 09401-03, 019322, 019323, 019325-28, all adult males. Collected by Kai WANG, Ke JIANG, and Da-Hu ZOU.

**Diagnosis:** Following Inger’s (1960) definition of the genus, the new species is assigned to *Japalura* based on a number of diagnostic characters, including: (1) dorsal scales unequal in size; (2) enlarged crest scales present; (3) gular pouch present; (4) lateral fold of skin in axilla–groin region present; (5) supraciliary scales greatly imbricate; (6) head relatively long, flat; (7) tail long, slender; (8) tail cylindrical in shape; and (9) precloacal and femoral pores absent.

The new species differs from all congeners by a combination of the following morphological characters: (1) gular fold present; (2) distinct gular pouch present; (3) relative hind-limb length moderate HLL/SVL 69.6%-80.1%; (4) relative tail length



Figure 5 Dorsolateral (A), ventral (B), and ventral head close-up views (C) of the adult male holotype (KIZ 019321) of *Japalura iadina* sp. nov. in life (Photos by Kai WANG)

moderate TAL/SVL 173%-198%; (5) F4S 15-17; (6) T4S 19-25; (7) MD 35-46; (8) three lateral rows of enlarged scales present on the dorsal surface of the body parallel to the dorsal crest; (9) nuchal and dorsal crests moderately raised on skin folds; (10) nuchal and dorsal crests relatively low and discontinuous in males; (11) dorsal and lateral surfaces of body emerald green in males, yellowish brown speckled with large, light yellow scales in females; (12) tail yellowish green in males, brownish in females; (13) ventral surface of body bluish or whitish gray, sometimes with black speckles, in males, uniform yellow in females; (14) two smooth-edged, light-green, dorso-lateral stripes present in males; (15) vermiculate stripes on ventral surface of head present, distinct, blackish blue in males, black in females; (16) gular region dark blue in males, yellow in females.

**Description of holotype:** Adult male, SVL 60 mm, TAL 116 mm, TrL 28.3 mm, HL 18.5 mm, HW 12.4 mm, IOD 9.1 mm, SEL 6.9 mm, FLL 28.8 mm, HLL 44.3 mm, T4L 10.3 mm. Rostral rectangular, three times broader than high, in contact with six small scales excluding supralabial; nasal sub-circular; single scale between



Figure 6 Dorsolateral (A), ventral (B), and ventral head close-up views (C) of the adult female allotype of *Japalura iadina* sp. nov. (KIZ 09398) in life (Photos by Kai WANG)



Figure 7 Habitat of *Japalura iadina* sp. nov. in the Dry-Hot Valley of Lancang River, Deqin, Northwest Yunnan, China (Photo by Kai WANG)

nasal and first supralabial; supralabials eight on both sides of head, weakly keeled; loreal scales irregularly arranged and moderately keeled; ciliaries circular, much smaller than other scales of lateral head, forming orbit circle; supraciliaries six on both sides of head, prominent, elongated; three rows of scales between orbit circle and sixth supralabial on both sides of head, all weakly keeled; scales posterior to eyes strongly keeled; orbit

and tympanum separated by five enlarged scales on both sides of head; tympanum covered with small scales; dorsal head scales heterogeneous in size, distinctively keeled, convex; single row of five scales forming weak ridge along snout midline from just posterior to rostral to point in line with anterior corner of eyes; parietal keeled, enlarged; pineal eyespot present; post-occipital and posterior lateral head scales strongly keeled; conical scales on occipital region numerous, strongly protuberant; conical scales posterior to tympanum two, large; conical scale posterior to tympanum or rictus single, large, on each side of head.

Ventral head scales homogeneous in size, distinctively keeled; transverse gular fold present, distinct; gular pouch present; shoulder fold posterior to gular fold on each side of body present, distributed from ventral surface of throat to dorsolateral stripes; axillary fold present on each side of body. Mid-dorsal scales 40, larger than neighboring scales, imbricate along dorsal midline; nuchal and dorsal crests slightly raised on skin folds, with distinct break separating regional folds; three dorsolateral rows of enlarged, distinctively keeled scales running parallel to dorsal crest from pectoral region of body to pelvis on each side of body, with one dorsal to dorsolateral stripe and two along upper and lower edges of dorsolateral stripe; ground dorsal scales heterogeneous in size; scales of axilla smaller than dorsal scales; large conical scales present, on dorsal and lateral surface of body, distinctly keeled, randomly scattered; dorsal limb scales distinctively keeled, slightly larger than ventral scales, homogeneous in size on fore-limbs, heterogeneous on hind limbs; F4S 16/16; T4S 20/21. Tail scales keeled, in lateral rows; cloaca scales small. Ventral scales of body and limbs near homogeneous in size, distinctively keeled.

**Coloration of holotype in life:** The ground coloration of the dorsal, lateral, and ventral surfaces of the head is emerald green. Four broad, black transverse bands are observed on the dorsal surface of the head, and are equally spaced across the region between the nares and a point in line with the posterior edge of the orbits. Black reticulated patterns are observed posterior to the last transverse bands on the dorsal surface of the head. Nine black streaks are observed radiating around the eye on each side of the head. The streaks extend ventrally to the supralabial scales, with the posteriormost streaks broadest. The infralabial scales and the margin of the lower jaw are emerald green with black bars present on several of the infralabial scales. These infralabial bars match up with streaks present on the supralabial scales, and extend further posteroventrally, gradually transitioning into blackish blue, vermiculate stripes on the ventral surface of the head. The vermiculate stripes connect posteriorly with the large, triangular shaped, blue gular spot located in the center of the gular pouch.

A black vertebral stripe runs from the occipital region of the head to the pelvis along the dorsal midline of the body. Several crest scales and a few small, ground scales along the vertebral stripe are green. The lateral and dorsolateral surfaces of the body are emerald green, with reticulated patterns of black pigmentation on the lateral surfaces of the body. These reticulated patterns of pigmentation form a thin, black, dorsolateral line

along the ventral edge of the dorsolateral stripe on each side of the body. The dorsolateral stripes are green and smooth-edged, running from the posterior occipital region of the head to the pelvis. A series of enlarged, distinctively keeled, green scales are observed in a dorsolateral series on each side of the dorsal crest, running from the neck to the pelvis and distributed along the black vertebral stripe. The ventral surface of the body is uniform whitish blue and is slightly lighter anteriorly.

The ground coloration of the dorsal surfaces of the limbs is emerald green, with numerous transverse bands running from the proximal to distal regions of the limbs. The ventral surfaces of the fore-limbs and hind limbs are whitish blue and greenish yellow, respectively. The ventral surfaces of the hands and feet are gray in coloration.

The dorsal surface of the tail is greenish yellow, with numerous dark gray, transverse bands running along its length. The transverse bands do not form complete rings around the tail ventrally. The ventral side of the tail is significantly duller gray in coloration (Figure 5).

**Coloration of holotype in preservative:** The coloration of the holotype in preservative closely resembles its coloration in life; however, the following differences are observed: 1) the emerald green coloration on some parts of the dorsal surfaces of the head, body, and limbs changed to light blue, and 2) the blue coloration of the gular spot on the ventral surface of the head and body faded significantly.

**Variation and sexual dimorphism:** Variation in morphometric characters and pholidosis patterns is summarized in Table 2. The new species is sexually dimorphic, with females possessing distinct coloration and pigmentation patterns from males. The female allotype of the new species differs from males by having light, yellowish brown ground coloration on the dorsal surfaces of the head, body, and limbs (v.s. emerald green), distinct, light brown transverse bands on the dorsal surface of the body (v.s. single, black vertebral stripe), a greenish yellow gular spot (v.s. blue), and a white ground coloration on the ventral surfaces of the body and limbs (v.s. blue; Figure 6).

**Comparisons:** The new species *Japalura iadina* sp. nov. has been confused previously with *J. flaviceps*; however, it can be distinguished readily from the latter by having a smaller adult body size (SVL 54-65 mm v.s. 64-75 mm), a tendency towards a shorter relative snout length (SEL/HL 34.9%-40.2% v.s. 40.0%-44.2%), smaller, less protuberant nuchal and dorsal skin folds in males (v.s. strongly protuberant), distinct ground coloration on the dorsal surfaces of the head, limbs, and body in males (emerald green v.s. brown), and distinct patterns of pigmentation along the dorsal midline of the body in males (vertebral black stripes v.s. a series of dark rhomboid-shaped patterns of pigmentation), as well as by the presence of distinct gular spots in both sexes (v.s. absence), and by the presence of distinct black radial stripes around the eyes (v.s. absence).

The new species is morphologically most similar to *J. splendida*, *J. makii*, and *J. luei*, of which all four species have the green

background coloration. However, *Japalura iadina* sp. nov. can be diagnosed from *J. splendida* by having a terrestrial life style (v.s. arboreal), a smaller adult body size (SVL 54-65 mm v.s. 59-92 mm), fewer T4S (19-24 v.s. 24-28), a shorter relative tail length (TAL/SVL  $\leq 198\%$  v.s.  $\geq 217\%$ ), distinct tail coloration in males (greenish yellow v.s. brownish gray), as well as by the absence of white lip stripes (v.s. presence), presence of gular spots in both sexes (v.s. absence), and absence of green coloration on the dorsal surfaces of the body in females (v.s. presence); from *J. makii* by having a smaller adult body size (SVL 54-65 mm v.s. 61-79 mm), a relatively shorter tail (TAL/SVL 1.73-1.98 v.s. 2.09-2.61), fewer T4S (19-24 v.s. 24-30), a pink coloration of tongue and oral cavity in life (v.s. yellow), a terrestrial lifestyle (vs. arboreal), as well as by the absence of a gular fold (v.s. presence), absence of green, transverse bands across the dorsal surface of body (v.s. presence), and absence of lip strips below eyes (v.s. presence); and from *J. luei* by having a smaller adult body size (SVL 54-65 mm v.s. 65-75 mm), a relatively shorter tail (TAL/SVL 1.73-1.98 v.s. 2.31-2.48), fewer T4S (19-24 v.s. 24-28), a terrestrial lifestyle (v.s. arboreal), continuous dorsolateral stripes in males (v.s. a dorsolateral series of disconnected, irregular, large markings), as well as by the absence of a gular fold (v.s. presence), and absence of lip stripes below eyes (v.s. presence).

*Japalura iadina* sp. nov. differs from *J. laeiventris* by having a smaller adult body size (SVL 54-65 mm v.s. 64-72 mm), distinctively keeled ventral scales of head and body (v.s. smooth or weakly keeled), fewer MD (35-46 v.s. 57-59), distinct ground coloration of the dorsal surfaces of head and body in males (emerald green v.s. off-white), distinct coloration of gular spots (blue in males, greenish yellow in females v.s. orange in both sexes), and distinct patterns of pigmentations on the dorsal surfaces of the body along the dorsal midline (black vertebral stripes speckled with green v.s. M-shaped patterns of dark brown pigmentation).

Additionally, when compared with species distributed in close geographic proximity along the Lancang River, *J. iadina* sp. nov. can be distinguished from *J. vela* by having less protuberant, discontinuous vertebral crests in males (v.s. sail-like, strongly protuberant, continuous), distinct ground coloration on the dorsal surfaces of the body (emerald green v.s. black) and tail (yellow v.s. gray) in males, uniquely shaped dorsolateral stripes in males (smooth edged v.s. strongly jagged), as well as by the presence of gular spots in both sexes (v.s. absence in both sexes), and by the absence of weakly defined, reddish dorsolateral lines in females (v.s. presence); and from *J. yunnanensis* by having a terrestrial lifestyle (v.s. arboreal), shorter relative tail length (TAL/SVL  $\leq 198\%$  v.s.  $\geq 237\%$ ), fewer T4S (19-24 v.s. 27-31), distinct coloration of gular spots (blue in males, greenish yellow in females vs. yellow in both sexes when present or absence in females), as well as by the presence of a transverse gular fold (v.s. absence).

**Distribution and natural history:** Although locally abundant, *Japalura iadina* sp. nov. is known only from the type locality (Figure 1). The new species is terrestrial, inhabiting dry, rocky habitats along the Lancang River (Figure 7). The emerald green

coloration of the males makes them stand out from the rocky, environmental background. Tail autotomy has been observed for this population.

**Etymology:** The Latin name “*iadina*” means “emerald like,” which describes the diagnostic emerald green body coloration of males of the new species. Suggested common name: Emerald Mountain Dragon (English), Fei Cui Pan Xi (Chinese; 翡翠攀蜥).

## DISCUSSION

Body coloration, particularly the coloration of the gular region, has been suggested to play an important role in the recognition of conspecifics, sexual selection, and the general diversification of agamid lizards in general (Bastiaans et al., 2014; LeBas & Marshall, 2000; Stuart-Fox & Ord, 2004), particularly members of the genus *Japalura* (Kästle & Schleich, 1998; Wei & Lin, 1981). Within the genus *Japalura*, color patterns vary among species from mainland Asia, but appear to be conservative within species, and hence serve as good diagnostic characters for systematic studies of species diversity (Wang et al., 2015). However, to date, detailed descriptions of coloration in life, have not been published for many species in the genus, including *J. brevicauda*, *J. chapaensis*, *J. grahami*, *J. hamptoni*, *J. otai*, *J. yulongensis*; (Mahony, 2010; Manthey, 2010; Manthey et al., 2012; Ota & Weidenhöfer, 1992; Zhao et al., 1999). Since specimen coloration is recognized to fade significantly after preservation for many specimens in natural history collections, color descriptions of preserved specimens may not be as applicable to diagnostic comparisons. Therefore, we recommend future research focusing on describing coloration patterns based on new observations of species of *Japalura* in life.

Despite the importance of the coloration patterns in the taxonomic studies of members of the genus *Japalura*, the diagnostic coloration of *J. flaviceps* has been historically confused, which has continued to the species' recognized wide spread distribution. Originally described by Barbour & Dunn (1919) from the Tung River Valley (today Dadu River Valley) in northwest Sichuan Province, *J. flaviceps* was described as possessing a uniform, “dusky brown” dorsal head coloration and lacked “strongly marked stripe from the eye to the angle of the mouth.” Together with photographs of the holotype of *J. flaviceps* (MCZ R-12469) and topotypic males from the Dadu River Valley, Manthey et al. (2012) argued that *J. flaviceps* did not possess dorsal and lateral pigmentation patterns on the head, and proposed that the absence of such patterns should be used as a diagnostic feature of the species. Although most topotypic specimens of *J. flaviceps* that we examined possess no distinct, radial pigmentation patterns around the eyes, we did observe several individuals, particularly subadults, that possess several distinct transverse bands of darker pigmentation across the dorsal region of the head (CIB 2333 and 2549). Therefore, we suggest that the absence of radial patterns of darker pigmentation around the eyes may be a more consistent feature of *J. flaviceps* for use in diagnostic comparison. Furthermore, we propose that the diagnostic feature of the true *J. flaviceps* should be restricted to the following combination of morphological char-

acters: SVL 70-83 mm in adult males, 58-78 mm in adult females; TAL/SVL 165%-192%; HLL/SVL 62%-78%; SEL/HL 39%-43%; SOR 4; SL 9-11; IL 9-11; MD 43-54; T4S 21-24; tympanum concealed; distinct gular fold present; distinct gular pouch present; enlarged, conical, post-riotal, post-occipital, and post-tympanic scales present, numerous, prominent; ventral scales distinctively keeled; dorsal ground coloration of head and body brownish gray; distinct radial stripes around eyes absent; dark, broad, interconnected, vermiculated stripes on the ventral surface of head present; gular spot absent; smooth-edged, yellow dorsolateral stripes in males present; a series of rhomb-shaped patterns of dark brown pigmentation with distinct yellow centers present along the dorsal midline of the body.

Due to the continued taxonomic confusion over comparisons of populations of the *J. flaviceps* species complex, *J. flaviceps* was thought to be a widespread species, and its conservation status was assessed as Least Concern (IUCN, 2013). However, because of the absence of data allowing for confirmation of species level diversity within the *J. flaviceps* Species Complex, and the paucity of available information about intraspecific ecological and genetic diversity, we recommend that *J. flaviceps* and all conspecifics in the species complex be considered Data Deficient, and recommended immediate research be focused on better understanding this unique complex of agamid lizards.

Unfortunately, habitats in the Hengduan Mountain Range are experiencing currently considerable human-mediated modifications as a result of the rapid development of hydropower plants (Pan et al., 2002; Chen & Rao, 2010; *personal communication* with Mr. Li CHENG). Although populations of *Japalura* can be abundant, continued alteration of these valley habitats could result in the extirpation of micro-endemic populations, or worse, unique evolutionary lineages not yet recognized formally as species. Additionally, many species of *Japalura* are experiencing over-exploitation through the illegal pet-trade, both domestically and internationally (*personal communication* with Mr. Jia-Wei WU and Mr. Mian HOU). Therefore, it is critical that researchers and conservation and government agencies work together to assess the conservation statuses and ecological requirements of species in the genus, particularly species and populations endemic to the river valleys in the range of the Hengduan Mountain Range.

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## APPENDIX

The following specimens were examined:

- J. batangensis** (n=16): CIB 2227, 2233, 2243, 1902-1908, KIZ 84011, 801081, Batang, Sichuan, P.R. China; KIZ 019314, KIZ 09404, 019311, 019312, Markam, Tibet, China.
- J. dymondi** (n=7): CIB 87234, 1869, Panzhuhua, Sichuan, P.R. China; KIZ 9511001, 1002, 1016, 1018, 1022, Dayao, Yunnan, China.
- J. grahami** (n=1): USMN 65500 (holotype), Yibin, Sichuan, China.
- J. micangshanensis** (n=9): CIB 86351, 86348, Xianyang, Shaanxi, P.R. China; CIB 86360, 86361, 86356, 86357, Luonan, Shaanxi, China; CIB 2572, 2578, 2582, Wenxian, Gansu, China.
- J. flaviceps** (n=13): CIB 2234, 2332, 2333, 2341, 2354, 2355, 2549, 2554, 2556, 2561, 2567; KIZ 05181, 05182; Luding, Sichuan, China.
- J. splendida** (n=6): USNM 35522 (holotype), Yichang, Hubei, PR China; CIB 2588, 2591, 2596, 72468, 72469, Chongqing, China.
- J. varcoae** (n=3): CIB 2651, 2650, KIZ 85110006, Kunming, Yunnan, China.
- J. vela** (n=11): KIZ 013801 (holotype), KIZ 013802, 013813, 013800, 013805–013811 (paratopotypes), Jerkalo, Tibet, China.
- J. yunnanensis** (n=8): CIB 2684, 2686, 2687, 2689, KIZ 82081, Longling, Yunnan, PR China; KIZ 74110240, 0248, 791469, Tengchong, Yunnan, China.
- J. zhaermii** (n=12): CIB 86432, 86435, 85721, 85722, 86433, 86434, 86436, Wenchuan, Sichuan, PR China; CIB 2232, 2244, 2240, KIZ 84032, 85030, Lixian, Sichuan, China.