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PLATINUM
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A report on the herpetofauna of Tengchong Section of Gaoligongshan National Nature Reserve, China

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Abstract: We present the results from a series of herpetological surveys conducted in the Tengchong Section of Gaoligongshan National Nature Reserve, Yunnan Province, China between April 2014 and November 2018. A total of 59 species of amphibians and reptiles (one salamander, 30 batrachians, four lizards, and 24 snakes) were recorded during the surveys including three newly described amphibian species and 17 new records for Tengchong, 10 of which also represent new generic records for the area. Natural history notes of some little-known species are presented. Our survey results clearly demonstrate that the herpetofauna diversity of this mountain range is still underestimated and warrants further systematic study.

Keywords: Amphibians, ecology, new record, new species, reptiles, species accounts, Yunnan.

Chinese 摘要： 2014 年 4 月至 2018 年 11 月期间，我们对中国云南省高黎贡山国家级自然保护区腾冲辖区内的两栖爬行动物多样性进行野外调查。本次调查共记录 59 种两栖爬行动物，包括有尾类 1 种，无尾类 30 种，蜥蜴类 4 种及蛇类 24 种；其中 3 种两栖动物为此次调查所发现的科学新种，17 种为腾冲地区首次记录的物种，当中 10 种更是腾冲地区的属级新纪录。根据野外调查的数据，本文亦提供部分罕见物种的基础生态学资料。本次调查结果显示高黎贡山地区的两栖爬行动物多样性仍然被低估，尚待进一步的深入调查。

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Author contribution: J-HY: conceived and designed the biodiversity survey, conducted field surveys,analyzed the data, contributed reagents/materials/analysis tools, prepared figures and/ortables, authored or reviewed drafts of the paper, approved the final draft. X-YH: conceived and designed the biodiversity survey, conducted field surveys. J-FY: conducted field surveys, contributed reagents/materials/analysis tools. S-PY: conducted field surveys, contributed reagents/materials/analysis tools. X-CZ: conducted field surveys, contributed reagents/materials/analysis tools. BP-LC: conceived and designed the biodiversity survey, conducted field surveys, authored or reviewed drafts of the paper.

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INTRODUCTION

The Gaoligongshan Mountains (hereafter GLGS) is a sub-range at the southwestern end of the Hengduan Mountains, lying along the west bank of the Nujiang River (The Salween) in the western part of Yunnan Province, China. GLGS is renowned for its unique geography and significant biodiversity (Stattersfield et al. 1998; Chaplin 2005; Dumbacher et al. 2011). The first herpetofauna research of GLGS dates back to the 1860s when western zoologist John Anderson explored the region (Anderson 1876, 1878). Subsequent herpetological surveys were conducted from time to time by Chinese herpetologists, yielding a number of new species endemic to the region (Zhao & Yang 1997; Stotz et al. 2003; Yang & Rao 2008; Fei et al. 2009; Chan & Bi 2016).

The Tengchong Section of Gaoligongshan National Nature Reserve (hereafter TC-GLGS) refers to the reserve area within the Tengchong county-level District, geographically located on the western slope of southern GLGS draining the Irrawaddy River (24.933–25.833 ^{0}N). For more details of the geography and ecology of Tengchong and the nature reserve, readers should refer to Chan et al. (2019, this special issue). In April 2014, a biodiversity survey team, led by Kadoorie Farm and Botanic Garden, started to conduct a biodiversity inventory of TC-GLGS. We herein provide a report on the herpetofauna of TC-GLGS based on our fieldwork.

MATERIALS AND METHODS

From April 2014 to November 2018, we conducted a series of herpetological surveys in the following 10 sites in or adjacent to TC-GLGS: Site 1: Nankang; Site 2: Xiaodifang; Site 3: Dahaoping; Site 4: Hujianglin (the protected riparian forest along Longchuan River); Site 5: Linjiapu; Site 6: Tiantaishan; Site 7: Xiaotianhe; Site 8: Dahetou; Site 9: Dazhuba; and Site 10: Cizhuhe (see Fig. 1). For detailed information on survey sites see Table 1. We followed the taxonomic treatments of Fei et al. (2009) and Frost (2018) for amphibians, and Zhao et al. (1998, 1999) and Uetz et al. (2018) for reptiles. Some voucher specimens are temporarily kept at the herpetology collection of Kadoorie Farm and Botanic Garden, Hong Kong [KFBG] for further studies, and others are deposited at the Museum of Biology, Sun Yat-sen University, Guangzhou [SYS]. For the identification of species, references used include Yang (1991), Zhao et al. (1998, 1999), Fei et al. (2005, 2009, 2012), Zhao (2006), Yang & Rao (2008), Guo & Deng (2009), Fei & Ye (2016), Yang et al. (2016a, 2016b), Yang & Huang (2019).

RESULTS

In total, we documented the presence of 59 species of amphibians and reptiles in TC-GLGS, including one salamander, 30 batrachians, four lizards and 24 snakes; voucher specimens were collected for all but 12 species (see Appendix 1 for the list of voucher specimens). *Leptobrachium tengchongense*, *Leptolalax tengchongensis*, and *Scutiger tengchongensis* were revealed to be new species described by our team (Yang et al. 2016a,b; Yang & Huang 2019). A further 17 species have not been previously reported in TC-GLGS (Xue 1995; Yang & Rao 2008), and 10 genera were new records for the area. A species checklist of herpetofauna based on our survey is provided in Table 2. Voucher photographs were taken for all species recorded, a selection of species are illustrated below (Images 1–7). In the following, selected species of special interest are dealt with in detail, including newly described species, globally threatened species, unidentified species, and those with taxonomic issues, and where our field data provided additional information on natural history of little-known species.

Remarks

Tylototriton shanjing **(Image 1a)**

This is the only tailed amphibian known from Tengchong. It was found at three sites during the surveys but is believed to be more widespread, because outside breeding season it disperses into forests, which makes detection difficult. From April to June adults congregate to mate in clear puddles and pools in forest as well as nearby farmland below 2,400m. The taxonomic chaos between *Tylototriton shanjing* and its sister-taxon *T. verrucosus* is still not fully resolved (Nishikawa et al. 2014; Khatiwada et al. 2015), and the distribution boundary between these two species is not determined (Fei et al. 2012; Fei & Ye 2016). In this paper, we retain the validity of *T. shanjing* and regard the population in Tengchong as *T. shanjing* following Fei et al. (2012). It is collected as a traditional medicine in most of its range, and is listed as Near Threatened in the IUCN Red List.

Bufo tuberospinius **(Image 1d)**

Compared with its sympatric congener *B. gargarizans*, this toad species is more common in montane forest habitats up to 2,700m throughout TC-GLGS. It is associated with small streams where adults

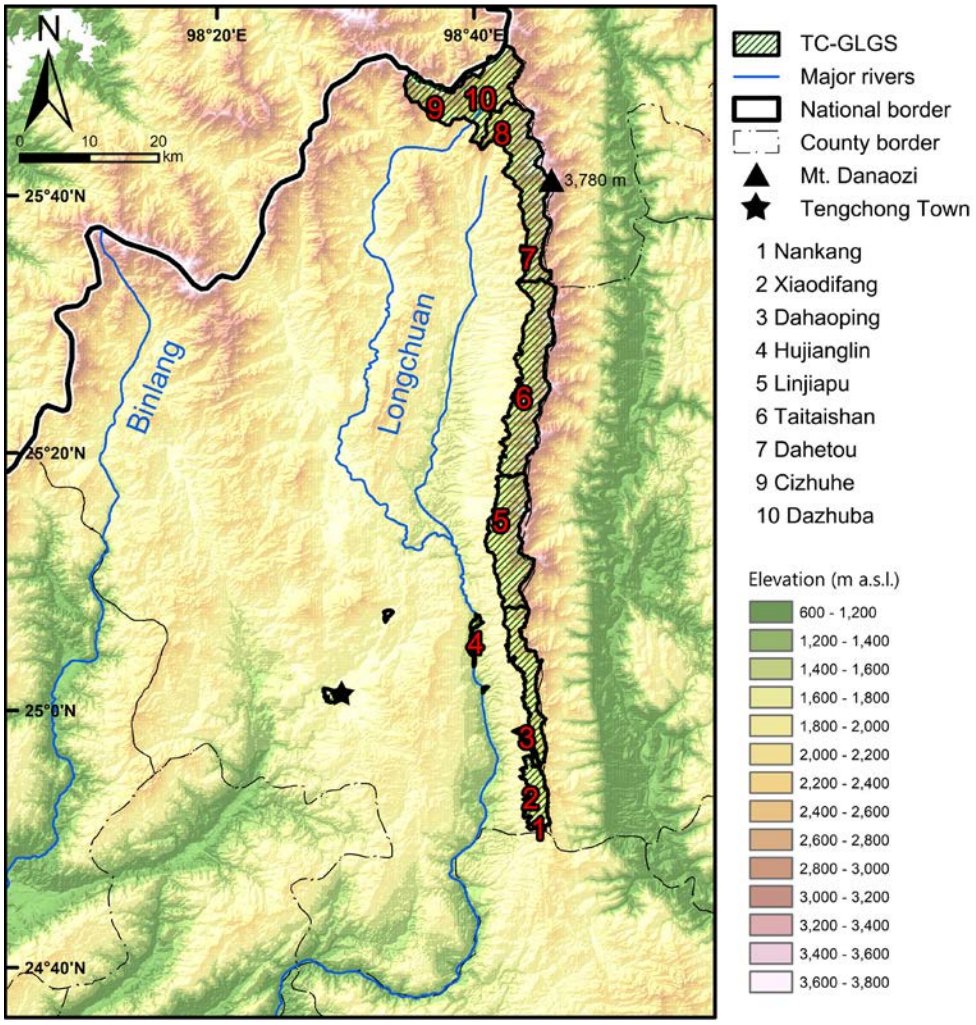

Figure 1. Map of Tengchong, Yunnan Province, China, showing the surveyed localities in this study.

breed and lay eggs in pool sections in between April and July. There has been much debate for the validity of *B. tuberospinius* since its description; while some researchers insisted *B. tuberospinius* is a valid taxon (Yang et al. 1996; Yang & Rao 2008), others regarded it as a synonym of *B. burmanus* distributed in northeastern Myanmar (Fei et al. 2005, 2009, 2012). This has not been fully resolved to date, thus in this paper we retain the validity of *B. tuberospinius* following Frost (2018).

Leptobrachium huashen **(Image 2b)**

This species is found in the southern portion of TC-GLGS. Representatives of the genus *Leptobrachium* from TC-GLGS were previously regarded as *L. chapaensis* (Yang 1991; Xue 1995; Yang & Rao 2008), but recent morphological and molecular research has shown that the population consists of two distinct species, namely *L. huashen* in the south and the newly-described *L. tengchongense* from the northern portion (Fei et al. 2005; Rao & Wilkinson 2008; Yang et al. 2016b).

Leptobrachium tengchongense **(Image 2c)**

This is a new species discovered by our team, which occurs in the northern portion of TC-GLGS between 2,200–2,500 m (Yang et al. 2016b). According to our fieldwork the two species of *Leptobrachium* from TC-GLGS, *L. huashen* and *L. tengchongense*, are allopatric but their ecological niches, distribution limits and contact zone require further investigation. *L. tengchongense* can be easily distinguished from *L. huashen* by having a bicolored iris with upper parts light blue, while the iris is uniformly dark brown in *L. huashen*; the black bands on dorsal surfaces of the limbs are relatively wider in *L. tengchongense* than in *L. huashen* (Yang et al. 2016b).

***Leptolalax tengchongensis* (Image 2d)**

This species was described during a recent survey (Yang et al. 2016a). *Leptolalax tengchongensis* is characterized by having dorsal skin scattered with fine, reddish tubercles; almost entirely black tympanum; large black blotches present on flanks; iris not bicolored, uniform dark brown and scattered with minute, coppery reticulations. *Leptolalax tengchongensis* was found along a clear-water rocky stream and nearby seepage in well-preserved montane moist evergreen broadleaf forest at 2,100m at Site 5; male calls were heard during the April and May surveys.

***Leptolalax* sp. (Image 2f)**

This taxon was recorded along clear-water rocky streams at Sites 3 and 5. At Site 3 male calls were heard in March when night time air temperature was ca. 3°C. At Site 5, this species was sympatric with *L. tengchongensis*, but can be easily distinguished by the male advertisement calls (peak frequency of male calls 4.1–4.3 kHz in *Leptolalax* sp. while 4.5–4.8 kHz in *L. tengchongensis*; each call contains 4–6 notes in *Leptolalax* sp. while consisting of only two notes in *L. tengchongensis* (Jian-Huan Yang, unpublished data, 10 April 2019.) and morphology: *L. tengchongensis* has a uniform dark brown iris in life, while *Leptolalax* sp. has a bi-colored iris with orange-yellow upper half and silvery white lower half. Further molecular and morphological studies are needed to clarify the taxonomic status of *Leptolalax* sp.

***Leptolalax* cf. *ventripunctatus* (Image 2e)**

This species is temporarily allocated to *L. ventripunctatus* by having longitudinal skin folds on dorsum; irregular black spots present on venter; dermal fringes on toes narrow; flank with distinct black spots; and a bicolored iris with orange-yellow upper half and silvery white lower half (Fei et al. 2009; Yang et al. 2018); however, its peak frequency of male calls (6.8–7.1 kHz) is remarkably higher than those of *L. ventripunctatus* from Yingjiang county (6.1–6.4 kHz; see Yang et al. 2018). Due to the great morphological similarity of *Leptolalax* species (Rowley et al. 2015), further molecular analysis is needed in order to obtain the accurate identification. This is the first record of this species for Tengchong while the two congeneric species *L. tengchongensis* and *Leptolalax* sp. were recorded in high-altitude montane areas above 2,100m in TC-GLGS, *Leptolalax* cf. *ventripunctatus* was recorded at 1,360m with subtropical climate/biome at Site 4.

Table 1. Survey localities and dates in Tengchong Section of Gaoligongshan National Nature Reserve for this study, sorted by latitude from south to north.

Site no.	Location	Elevation covered (m)	Survey dates
Site 1	Nankang	2,180	24–25.iv.2014 13–14.ix.2018
Site 2	Xiaodifang	2,150–2,400	10.iii.2015
Site 3	Dahaoping	2,020–2,400	23–24.ix.2014 11–12.iii.2015
			15–17.v.2015 27–28.vii.2015 22–23.v.2018
Site 4	Hujianglin	1,360	9.v.2016 24–26.vi.2017
Site 5	Linjiapu	1,900–3,000	28–30.iv.2014 9–10.xii.2014 15–17.v.2015
Site 6	Tiantaishan	1,850–2,300	29–30.vii.2015
Site 7	Xiaotianhe	2,000–3,100	22–23.vi.2017
Site 8	Dahetou	2,000–2,300	26–27.iv.2014 13–14.iii.2015 17–18.iii.2016 24.vii.2017 23–4.iii.2018 24–25.v.2018
Site9	Dazhuba	2,070–2,200	20–21.v.2015
Site 10	Cizhuhe	2,050–2,920	26–28.ix.2014 11–12.xii.2014 18–19.v.2015 31.vii.–1.viii.2015 20–21.iii.2016 10–11.v.2016

***Megophrys* cf. *minor* (Image 2g)**

This small-sized *Megophrys* species appears to be very common throughout TC-GLGS, and was recorded from all surveyed sites between 2,000–2,300 m. The cryptic behavior of this species makes visual detection a real challenge, but male calls were commonly heard along small streams and seepages in well-preserved forests at 1,900–2,300 m between April and September. In view of the taxonomic chaos of small-sized *Megophrys* in southern China (Chen et al. 2017), we cannot easily assign this species to any known species on the basis of morphology. Further study incorporating molecular, morphological and acoustic methods is needed to solve this problem. In this paper, we temporarily allocate this species to *Megophrys minor* (see also Xue 1995; Yang & Rao 2008; Fei et al. 2009).

***Oreolalax* sp. (Image 3a)**

A sub-adult and a juvenile were collected from Site 8 in May 2015. Subsequent molecular study revealed a sister relationship to *Oreolalax jingdongensis* in the 16S rRNA gene fragment, but *Oreolalax* sp. still presents a certain degree of genetic divergence (Jian-Huan Yang,

Image 1. Herpetofauna recorded in the Tengchong Section of Gaoligongshan National Nature Reserve from 2014–2018. For site details refer to Table 1: a—*Tylototriton shanjing* from Site 1 | b—adult male *Bombina maxima* from Site 10 | c—a pair of *Bufo gargarizans* in amplexus from Site 10 | d—*Bufo tuberospinius* from Site 9 | e—*Duttaphrynus melanosticus* from Site 4 | f—an adult male *Nanorana yunnanensis* from Site 5 | g—a pair of *Fejervarya multistriata* in amplexus from Site 4 | h—a pair of *Hyla annectans* in amplexus from Site 10.

Image 2. Herpetofauna recorded in the Tengchong Section of Gaoligongshan National Nature Reserve from 2014–2018. For site details refer to Table 1: a—an adult *Brachytarsophrys feae* from Site 3 | b—an adult male *Leptobrachium huashen* from Site 5 | c—adult male holotype SYS a004603 of *Leptobrachium tengchongense* from Site 8 | d—adult male holotype SYS a004600 of *Leptolalax tengchongensis* from Site 5 | e—an adult male *Leptolalax ventripunctatus* from Site 4 | f—an adult male *Leptolalax* sp. from Site 3 | g—*Megophrys* cf. *minor* from Site 3 | h—an adult male *Megophrys glandulosa* from Site 5.

unpublished data, 10 April 2019.). Morphological comparisons are not possible as adult specimens with secondary sexual characteristics are lacking, which is essential for species identification in this genus. Adult specimens are needed to clarify its taxonomic status. *Oreolalax* sp. is a new record for Tengchong.

***Scutiger tengchongsnsis* (Image 3b)**

This species was described by our team during a previous survey (Yang & Huang 2019). *S. tengchongensis* is very distinct from local anurans by dorsum having large conical-shaped and longitudinal tubercles covered by numerous tiny black spines; adult males have a pair of pectoral glands and a pair of axillary glands present on the chest, which are covered by dense tiny black spines; adult males have inner three fingers with black nuptial spines (Yang & Huang 2019). It was found in streamlets and surrounding areas along the main ridge at 3,000m close to Site 7, which represents the southernmost distribution limit of the genus *Scutiger* worldwide. Previous southernmost locality known for the genus was in Fugong County of middle-GLGS, 145km north of Site 7 (Fei & Ye 2016).

***Amolops bellulus* (Image 3d)**

This torrent frog was found in large rocky streams in well-preserved forest at elevations between 2100–2350 m, and currently is only recorded in the northernmost portion of TC-GLGS at sites 8 and 10. This species can be easily distinguished from other stream frogs by dorsum yellowish-brown above; lower flanks olive-green or blueish-green; upper lips light brown and unspotted. Adults were usually found perching on rocks and streamside bushes during surveys in May and June. This species is to date only recorded from GLGS in Lushui County and Tengchong City (Yang & Rao 2008; Fei et al. 2012). Due to the lack of information about its distribution, population and ecology, it is listed as Data Deficient in the IUCN Red List.

***Amolops jinjiangensis* (Image 3e)**

A new record for Tengchong, this species is rarely recorded in TC-GLGS and has been only found twice from Site 7 in August and October 2018. During the survey in October, females were found being gravid and males had distinct nuptial pads on fingers, suggesting they may be breeding at that season. Molecular analyses revealed this population to be identical with *Amolops jinjiangensis*: there was no genetic divergence in the 16S rRNA gene fragment between our specimens and a sequence of *A. jinjiangensis* from the Genbank database (Genbank No. EF453741). The TC-GLGS population represents a new distribution record of this rarely known species and is far away from its known distribution areas in north-western Yunnan Province and adjoining areas in Sichuan Province (Fei et al. 2009). *A. jinjiangensis* is now listed as Vulnerable in the IUCN Red.

***Odorrana graminea* (Image 4a)**

A new record for Tengchong, this large stream frog is widely distributed in southern China and very common in stream areas (Fei et al. 2009); however, this species was only found at Site 4 (ca. 1400m), although intensive surveys at other sites (mostly above 2000m) have been made, suggesting that it may be restricted to relatively low altitude forest areas.

***Polypedates braueri* (Image 4c)**

Recent molecular studies suggested that the species in the *Polypedates leucomystax* complex from Tengchong, which was previously treated as *P. megacephalus* (Yang & Rao 2008; Fei et al. 2009), is actually *P. braueri* (Kuraishi et al. 2013; Pan et al. 2013).

***Rhacophorus puerensis* (Image 4d, 4e)**

This species was recorded from the southernmost and northernmost portions of TC-GLGS at Sites 1, 2 and 10 at 2,100–2,880 m elevation, suggesting that it is widely distributed in TC-GLGS. During the breeding season from late April to May, male calls were heard from the ground in puddle and grassland at forest edge, and eggs were laid in foam nests in soft mud around still water. Due to the lack of information about its distribution, population and ecology, it is listed as Data Deficient in the IUCN Red List.

***Gracixalus* sp. (Image 4h)**

This is the first record of the genus *Gracixalus* from GLGS (Fei et al. 2009; Fei & Ye 2016). Male calls of this species were widely recorded from south to north in TC-GLGS during surveys between April to July. The frogs were very difficult to collect, however, because all males were calling from the upper layers of small trees/shrubs ca. 3m from above the ground. Only one pair (one calling male and one gravid female) was found together inside a small tree hole from Site 3 in May 2018. Subsequent molecular study revealed a sister relationship to *Gracixalus tianlinensis* from northwestern Guangxi in the 16S rRNA gene fragment, but *Gracixalus* sp. still presents a certain degree of genetic divergence (Jian-Huan Yang, unpublished data, 10 April 2019). Detailed integrative taxonomical studies incorporating

Table 2. Amphibians and reptiles recorded in Tengchong Section of Gaoligongshan National Nature Reserve, 2014–2018. For site details refer to Table 1.

Taxon	Chinese common name	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
AMPHIBIA											
Bombinatoridae											
Bombina maxima (Boulenger, 1905)*	大蹼铃蟾*										X
Bufonidae											
Bufo gargarizans Cantor, 1842*	中华蟾蜍*								X		X
Bufo tuberospinius (Yang, Liu & Rao, 1996)	疣棘溪蟾			X		X		X	X	X	X
Duttaphrynus melanosticus (Schneider, 1799)	黑眶蟾蜍			X	X						
Dicroglossidae											
Fejervarya multistriata (Hallowell, 1861)	泽蛙				X			X			
Nanorana yunnanensis (Anderson, 1879)	双团棘胸蛙		X	X		X	X	X	X	X	X
Hylidae											
Hyla annectans (Jerdon, 1870)	华西雨蛙				X		X	X	X	X	X
Megophryidae											
Brachytarsophrys feae (Boulenger, 1887)	费氏短腿蟾			X							
Leptobrachium huashen Fei & Ye, 2005	华深拟髭蟾			X		X					
Leptobrachium tengchongense Yang, Wang & Chan, 2016**	腾冲拟髭蟾**							X	X		X
Leptolalax tengchongensis Yang, Wang, Chen & Rao, 2016**	腾冲掌突蟾**					X					
Leptolalax cf. *ventripunctatus* Fei, Ye & Li, 1990*	腹斑掌突蟾*				X						
Leptolalax sp.*	掌突蟾属一种*			X		X					
Megophrys glandulosa Fei, Ye & Huang, 1990	腺角蟾			X	X	X		X	X	X	X
Megophrys cf. *minor* Stejneger, 1926	小角蟾（暂定）		X	X		X	X	X	X	X	X
Oreolalax sp.*	齿蟾属一种*							X	X		X
Scutiger tengchongensis Yang & Huang, 2019**	腾冲齿突蟾**							X			
Microhylidae											
Microhyla fissipes Boulenger, 1884	饰纹姬蛙			X	X						
Ranidae											
Amolops bellulus Liu, Yang, Ferraris & Matsui, 2000	丽湍蛙								X		X
Amolops jingjiangensis Su, Yang & Li, 1986*	金江湍蛙*								X		
Amolops viridimaculatus (Jiang, 1983)	绿点湍蛙			X		X		X	X		
Babina pleuraden (Boulenger, 1904)	滇蛙	X	X	X		X	X	X	X		X
Odorrana andersonii (Boulenger, 1882)	云南臭蛙		X		X	X		X	X	X	X
Odorrana graminea (Boulenger, 1900)*	大绿臭蛙*				X						
Rana chaochiaoensis Liu, 1946	昭觉林蛙			X		X		X	X		X
Rhacophoridae											
Gracixalus sp.*	纤树蛙属一种*			X					X	X	X
Polypedates braueri (Vogt, 1911)	布氏树蛙			X	X		X	X	X	X	X
Rhacophorus burmanus (Andersson, 1939)	缅甸树蛙			X		X			X	X	X
Rhacophorus puerensis (He, 1999)	普洱树蛙	X	X								X
Rhacophorus rhodopus Liu & Hu, 1960	红蹼树蛙			X	X			X	X		
Salamandridae											
Tylototriton shanjing Nussbaum, Brodie & Yang, 1995	红瘰疣螈	X		X							X

Taxon	Chinese common name	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
REPTILIA											
Agamidae											
Japalura yunnanensis Anderson, 1878	云南攀蜥	X		X		X		X			
Pseudocalotes kakhienensis (Anderson, 1879)	蚌西拟树蜥							X			
Scincidae											
Scincella doriae (Boulenger, 1887)*	长肢滑蜥*	X		X							
Sphenomorphus indicus (Gray, 1853)	印度蜓蜥	X					X	X			
Colubroidea											
Archelaphe bella (Stanley, 1917)*	方花小头蛇*			X					X		
Coelognathus radiatus (Boie, 1827)	三索锦蛇				X						
Elaphe carinata (Günther, 1864)	王锦蛇						X	X	X		
Hebius octolineatum (Boulenger, 1904)	八线腹链蛇								X	X	X
Hebius modestum (Günther, 1875)	腹斑腹链蛇								X	X	
Lycodon fasciatus (Anderson, 1879)	双全链蛇			X					X		
Lycodon cf. *septentrionalis* (Günther, 1875)*	白链蛇*								X		
Oreocryptophis porphyraceus (Cantor, 1839)	紫灰锦蛇			X					X		
Orthriophis taeniurus (Cope, 1861)	黑眉锦蛇			X				X	X		
Psammodynastes pulverulentus (Boie, 1827)	紫砂蛇				X						
Pseudoxenodon macrops (Blyth, 1855)	大眼斜鳞蛇			X				X	X		X
Ptyas nigromarginata (Blyth, 1854)	黑线乌梢蛇				X						
Rhabdophis leonardi (Wall, 1923)	缅甸颈槽蛇			X		X		X	X	X	X
Rhabdophis himalayanus (Günther, 1864)*	喜山颈槽蛇*				X						
Rhabdophis subminiatus (Schlegel, 1837)	红脖颈槽蛇				X						
Sibynophis collaris (Gray, 1853)	黑领剑蛇								X		
Elapidae											
Bungarus multicinctus Blyth, 1861	银环蛇			X							
Ophiophagus hannah (Cantor, 1836)*	眼镜王蛇*				X						
Sinomicrurus kelloggi (Pope, 1928)*	福建丽纹蛇*			X							
Pareatidae											
Pareas sp.*	钝头蛇属一种*									X	
Pareas nigriceps Guo & Deng, 2009*	黑顶钝头蛇*			X							
Viperidae											
Ovophis monticola (Günther, 1864)	山烙铁头			X		X	X	X	X	X	X
Protobothrops jerdonii (Günther, 1875)*	菜花烙铁头*			X				X		X	
Trimeresurus yunnanensis Schmidt, 1925	云南竹叶青					X		X	X		

Remarks: Species distribution is based on our own field data, and do not represent true distribution range of these species in Tengchong Section of Gaoligongshan National Nature Reserve.
* represents newly recorded species for Tengchong (refers to Xue 1995; Yang & Rao 2008); ** represents new species discovered during the surveys.

morphological, molecular and acoustic data is underway in order to clarify its taxonomic status.

***Lycodon fasciatus* (Image 6a)**

One sub-adult specimen was collected from Site 7 in October 2018, which matches the diagnosis of *Lycodon fasciatus* by having one small preocular; loreal elongate, not in contact with eye on left side while in narrow contact with eye on right side; temporals: 2+3; supralabials eight, 2nd to 4th ones touching the eye; dorsal scale rows 17:17:15, keeled on dorsal rows 7–9; solid black above with 34 and 16 transverse pinkish-brown bands (in 2–3 scales wide) on body and tail respectively; ventrals 195; and subcaudals 86, paired (Zhao et al. 1999; Zhao 2006).

***Lycodon* cf. *septentrionalis* (Image 6b)**

A new record for Tengchong. One adult female specimen (snout-vent length 955mm, tail length 210mm) was collected from Site 7 in Oct 2018, which matches the diagnosis of *Lycodon septentrionalis* by having one preocular; loreal not in contact with eye; temporals: 2+2; supralabials seven, 3rd and 4th ones touching the eye; dorsal scale rows 17:17:15, smooth throughout the body (however, versus feebly keeled in the original description); ventrals 221; subcaudals 74, paired; solid black above with 29 and 13 narrow white transverse bands on body and tail respectively (Zhao et al. 1999; Zhao 2006).

***Rhabdophis himalayanus* (Image 7a)**

A new record for Tengchong. A single juvenile specimen (snout-vent length 256mm, tail length 78mm) was collected from Site 4 at 1,360m in June 2017, which matches the diagnosis of *Rhabdophis himalayanus* by having one preocular, postoculars three; temporals: 2+2, supralabials 8/8, 4th and 5th touching the eye; dorsal scale rows 19:19:17; ventrals 163; subcaudals 82, paired; two distinct narrow orange yellow transverse bands at nuchal region, narrow and short dark brown transverse bands present on dorsum of body (Zhao 2006). In China, this rare species was previously only known from southeastern Tibet and Gongshan County in northern GLGS (Zhao et al. 1999; Zhao 2006).

Ophiophagus hannah

A new record for Tengchong. Three adults were encountered at Site 4 at 1,360m between 13.00h and 16.00h on 9 May 2017. Intensive surveys at other sites failed to detect this large-sized species, suggesting that it may be restricted to relatively low altitude forest areas in Tengchong. Despite its wide distribution range worldwide, the King Cobra faces great pressures from habitat loss and over-exploitation (Stuart et al. 2012), and it is now listed as Vulnerable in the IUCN Red List.

***Sinomicrurus kelloggi* (Image 7c)**

This is the first record of the genus *Sinomicrurus* from GLGS. A photo of an individual of *Sinomicrurus* species was taken by a TC-GLGS warden at 2,020m from Site 3, but the specimen was not collected. The snake matches the diagnosis of *Sinomicrurus kelloggi* by having reddish-brown dorsum and narrow transverse cross-bars above body and tail, an inverted V shape of creamy white band present on head (Zhao et al. 1998; Zhao 2006). It is the third record of the species from Yunnan Province (Yang & Rao 2008; Sun et al. 2015).

***Pareas nigriceps* (Image 7e)**

This is a new generic record for GLGS. A single individual was recorded at Site 3 in May 2015, found at night on shrub in old-growth forest at 2,050m. *Pareas nigriceps* is a newly-described snake species from adjacent Xiaoheishan in Longling County, with the type locality reported as 24.83671°N, 98.76185°E (2,067m) (Guo & Deng 2009). Our record represents the second documented locality for the species, and a slight northern range expansion. Brief measurements and scalation characters of the specimen: SYS r001222, SVL: 525.9mm; tail length: 133.1mm. Supralabials 7/7, 7th elongate and largest; infralabials 7/7; preocular one; subocular one; postocular absent; temporals: 1+2; ventrals 184; subcaudals 73, paired; dorsal scale rows 15:15:15, dorsal five rows slightly keeled; vertebrate scale slightly enlarged. Due to the lack of information on distribution, status and ecology of this recently described species, it is listed as Data Deficient in the IUCN Red List.

***Pareas* sp. (Image 7d)**

A single specimen was collected from Site 9 which cannot be allocated to any known species in the genus. Brief measurements and scalation characters of the specimen: nasal one; loreal touching the eye; prefrontal touching the eye; subocular and postocular fused; infralabials seven; anterior temporals two, posterior temporials three; 11 middle rows of dorsal scales keeled at mid-body; vertebral scales not enlarged; ventral scales 173; subcaudals 62, paired. More specimens and genetic analyses are needed to clarify the taxonomic status of this taxon.

Image 3. Herpetofauna recorded in the Tengchong Section of Gaoligongshan National Nature Reserve from 2014–2018. For site details refer to Table 1: a—an subadult of *Oreolalax* sp. from Site 9 | b—adult male hototype SYS a005793 of *Scutiger tengchongensis* from Site 7 | c—*Microhyla fissipes* from Site 3 | d—an adult male *Amolops bellulus* from Site 10 | e—an adult female *Amolops jinjiangensis* from Site 8 | f—*Amolops viridimaculatus* from Site 5 | g—*Babina pleuraden* from Site 3 | h—*Odorrana andersonii* from Site 9.

Image 4. Herpetofauna recorded in the Tengchong Section of Gaoligongshan National Nature Reserve from 2014–2018. For site details refer to Table 1: a—an adult female *Odorrana graminea* from Site 4 | b—*Rana chaochiaoensis* from Site 7 | c—an adult male *Polypedates braueri* from Site 10 | d —an adult male *Rhacophorus rhodopus* from Site 3 | e—an adult male *Rhacophorus rhodopus* from Site 7, note the coloration variation on dorsum in life | f—an adult male *Rhacophorus burmanus* from Site 10 | g—a pair of *Rhacophorus puerensis* from Site 9 | h—an adult male *Gracixalus* sp. from Site 3.

Image 5. Herpetofauna recorded in the Tengchong Section of Gaoligongshan National Nature Reserve from 2014–2018. For site details refer to Table 1: a—an adult female *Japalura yunnanensis* from Site 1 | b—*Pseudocalotes kakhienensis* from Site 7 | c—an adult *Scincella doriae* from Site 3 | d—*Sphenomorphus indicus* from Site 6 | e—*Archelaphe bella* from Site 8 | f—*Elaphe carinata* from Site 6 | g—*Hebius octolineatum* from Site 10 | h—*Hebius modestum* from Site 7.

Image 6. Herpetofauna recorded in the Tengchong Section of Gaoligongshan National Nature Reserve from 2014–2018. For site details refer to Table 1: a—*Lycodon fasciatus* from Site 7 | b—*Lycodon septentrionalis* from Site 7 | c—*Oreocryptophis porphyraceus* from Site 7 | d—freshly-killed *Orthriophis taeniurus* from Site 3 | e—*Psammodynastes pulverulentus* from Site 4 | f—an adult *Pseudoxenodon macrops* from Site 3 | g—a juvenile *Pseudoxenodon macrops* from Site 8, noted the coloration variation | h—*Rhabdophis leonardi* from Site 8.

Image 7. Herpetofauna recorded in the Tengchong Section of Gaoligongshan National Nature Reserve from 2014–2018. For site details refer to Table 1: a—a juvenile *Rhabdophis himalayanus* from Site 4 | b—*Sibynophis collaris* from Site 8 | c—*Sinomicrurus kelloggi* from Site 3 | d—*Pareas* sp. from Site 9 | e—*Pareas nigriceps* from Site 3 | f—*Ovophis monticola* from Site 5 | g—an adult *Protobothrops jerdonii* from Site 9 digesting large prey | h—*Trimeresurus yunnanensis* from Site 5.

DISCUSSION

Our survey greatly enhances our understanding of the herpetofauna diversity of TC-GLGS, with discoveries of at least three species new to science and a series of new regional records, including 10 new generic records. A number of collected species are yet to be thoroughly identified due to the lack of specimen series, and some of these may prove to be new when more collections or genetic data become available in the future. Information for most recorded species can also be found in Chan & Bi (2016). Since we focused our efforts on well-protected montane forests at the elevation band between 1900m and 3000m (see table 1), a number of herpetofauna previously recorded from Tengchong (Xue 1995; Zhao & Yang 1997; Yang & Rao 2008) were not detected during our survey: *Hoplobatrachus rugulosus* (Wiegmann), *Microhyla heymonsi* Vogt, *Hemidactylus bowringii* (Gray), *Hemiphyllodactylus yunnanensis* (Boulenger), *Acanthosaura lepidogaster* (Cuvier), *Calotes emma* Gray, *Calotes jerdoni* Günther, *Sphenomorphus incognitus* (Thompson), *S. maculatus* (Blyth), *Ahaetulla prasina* (Boie), *Atretium yunnanensis* Anderson, *Plagiopholis blakewayi* Boulenger, *Ptyas korros* (Schlegel), *P. mucosa* (Linnaeus), *Naja kaouthia* Lesson, and *Trimeresurus albolabris* Gray. Most of these missing species occur at lower elevations and/or in disturbed habitats, where we invested little survey effort. Further surveys in these habitats are needed to ascertain the current status and distribution of these species. Our results clearly highlight the fact that the herpetofauna of GLGS remains imperfectly studied and its diversity is undoubtedly underestimated. Future herpetological expeditions will probably uncover more exciting findings in TC-GLGS, especially in higher altitude habitats of the reserve.

The natural forests of Gaoligongshan National Nature Reserve have been well protected, and we found few anthropogenic activities which are threatening the survival of amphibians and reptiles, however, local populations of certain large-sized frogs are being suppressed by over-collecting for human consumption, in particular *Nanorana yunnanensis* which fetches high prices (USD 30–40 per kilogram) in local markets; its wild population has declined dramatically and is now listed as Endangered in the IUCN Red List. Our interviews also revealed that local people opportunistically collect large "rat snakes" from the genera *Elaphe* and *Orthriophis* for consumption. Education outreach targeting this issue is called for if populations of the affected species are to recover to a natural level.

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Appendix 1. Voucher specimens collected during the survey. See materials and methods for museum abbreviations.

Bombina maxima: SYS a003798–3800, coll. 18 May 2015, from Site 10 by Jian-Huan Yang (JHY, hereafter); KFBG 14446–14447, coll. 18 May 2015, from Site 10 by JHY.
Bufo tuberospinius: SYS a003811, coll. 17 May 2015, from Site 3 by Jian Wang (JW, hereafter); KFBG 14350, coll. 27 July 2015, from Site 3 by JHY.
Duttaphrynus melanosticus: KFBG 14457, coll. 25 June 2017, from Site 4 by JHY.
Nanorana yunnanensis: SYS a003763, coll. 18 May 2015, from Site 5 by JHY; SYS a003796, coll. 17 May 2015, from Site 3 by JW; SYS a003843–3844, coll. 18 May 2015, from Site 10 by JHY; KFBG 14117, coll. 13 March 2015, from Site 8 by JHY.
Hyla annectans: SYS a003816–3818, coll. 22 May 2015, from Site 10 by JHY.
Leptobrachium huashen: SYS a003751–3752, coll. 15 May 2015, from Site 5 by JHY; SYS a003779–3781, coll. 17 May 2015, from Site 3 by JW; KFBG 14301–14302, coll. 15 May 2015, from Site 5 by JHY.
Leptobrachium tengchongense: SYS a004603, coll. 13 March 2015, SYS a004623–4627, coll. 17–18 March 2016, from Site 8, by YJH; SYS a004628–4632, coll. 20–21 March 2016, from Site 10, by JHY.
Leptolalax tengchongensis: SYS a004956, coll. on 29 April 2014, SYS a004957–4602, coll. on 16 May 2015, from Site 5, by JHY
Leptolalax* cf. *ventripunctatus: KFBG 14462–14464, coll. 25 June 2017, from Site 4 by JHY.
***Leptolalax* sp.**: KFBG 14111–14115, coll. on 11 March 2015, from site 3 by JHY; KFBG 14295–14296, coll. on 15 May 2015, from Site 5 by JHY.
Megophrys glandulosa: SYS a003757–3758, SYS a003762, coll. 15 May 2015, from site 5 by JHY; SYS a003792–3795, coll. 17 May 2015, from Site 3 by JW.
Megophrys* cf. *minor: SYS a003755, SYS a00376–3761, SYS a003767, coll. 15 May 2015, from Site 5 by JHY; SYS a003782–3798, coll. 17 May 2015, from Site 3 by JW; SYS a003821–3827, SYS a003837–3839, coll. 18 May 2015, from Site 10 by JHY.
***Oreolalax* sp.**: KFBG 14356–14357, coll. 18 May 2015, from Site 10 by JHY.
Scutiger tengchongensis: SYS a005793–5797, coll. on 22 June 2017, from Site 7, by JHY and Shen-Pin Yang (SPY).
Microhyla fissipes: KFBG 14354, coll. 17 July 2015, from Site 3 by JHY; KFBG 14465, coll. 9 May 2016, from Site 4 by JHY.
Amolops bellulus: KFBG 14425–14427, coll. 11 May 2016, from Site 10 by JHY.
Amolops jinjiangensis: KFBG 14561–14567, coll. 20 October 2017, from Site 8, by SPY.
Amolops viridimaculatus: SYS a003753–3754, coll. 15 May 2015, from Site 5 by JHY; SYS a003797, SYS a003812–3813, coll. 17 May 2015, from Site 3 by JW.
Babina pleuraden: SYS a003775–3778, coll. 17 May 2015, from Site 3 by JW.
Odorrana andersoni: SYS a003820, SYS a003831–3834, coll. 18 May 2015, from Site 10 by JHY.
Odorrana graminea: KFBG 14429, coll. 9 May 2016, from Site 4 by JHY.
Rana chaochiaoensis: SYS a003819, coll. 18 May 2015, from Site 10 by JHY; KFBG 14460–14461, 29 April 2014, from Site 5 by JHY.
***Gracixalus* sp.**: KFBG 14558–15559, coll. 22 May 2018, from Site 3 by JHY.
Polypedates braueri: SYS a003770, SYS a003774, SYS a003814–3815 coll. 17 May 2015, from Site 3 by JW; SYS a003835–3836, SYS a003841–3842, coll. 18 May 2015, from Site 10 by JHY.
Rhacophorus rhodopus: KFBG 14352--14353, coll. 27 July 2015, from Site 3 by JHY.
Rhacophorus burmanus: SYS a003764, coll. 15 May 2015, from Site 5 by JHY; SYS a003829–3830, SYS a003840, coll. 18 May 2015, from Site 10 by JHY.
Rhacophorus puerensis: SYS a003771–3772, coll. 17 May 2015, from Site 3 by JW.
Tylototriton shanjing: SYS a003768–3769, coll. 17 May 2015, from Site 3 by JW.
Japalura yunnanensis: SYS r001215, coll. 15 May 2015, from site 5 by JHY; SYS r001220, coll. 17 May 2015, from Site 3 by JW; KFBG 14389–14390, coll. 15 May 2015, from Site 5 by JHY.
Pseudocalotes kakhienensis: KFBG 14391–14392, coll. February 2018, from Site 7 by SPY.
Scincella doriae: KFBG 14361, coll. 24 April 2014, from Site 1 by JHY; KFBG 14362, coll. 17 May 2015, from Site 3 by JW.
Sphenomorphus indicus: KFBG 14459, coll. February 2018, from Site 7 by SPY.
Archelaphe bella: KFBG 14466–14467, coll. 23 May 2018, from Site 3 by JHY.
Hebius octolineatum: SYS r001223, coll. 18 May 2015, from Site 10 by JHY; SYS r001225, coll. 20 May 2015, from Site 9 by JHY.
***Hebius modestum*:** KFBG 14557, coll. 11 May 2018, from Site 7 by SPY.
***Lycodon fasciatus*:** KFBG 14578, coll. 22 October 2018, from Site 7 by SPY.
Lycodon* cf. *septentrionalis: KFBG 14579, coll. 22 October 2018, from Site 7 by SPY.
Oreocryptophis porphyraceus: KFBG 14576, coll. 13 July 2018, from Site 7 by SPY.
Psammodynastes pulverulentus: KFBG 14456, coll. 25 June 2017, from Site 4 by JHY.
Pseudoxenodon macrops: KFBG 14450, coll. June 2017, from Site 3 by Philip Lo; KFBG 14451, coll. 13 March 2015, from Site 7 by JHY.
Rhabdophis leonardi: SYS r001221, Dahaoping; SYS r001224, Site 9; KFBG 14344, coll. September 2014, from Site 8 by JHY; KFBG 14345, coll. 20 May 2015, from Site 9 by JHY; KFBG 14346, coll. 27 April 2014, from Site 8 by JHY; KFBG 14347, coll. 17 May 2015, from Site 10 by JHY; KFBG 14348, coll. on 19 July 2015, from Site 8 by JHY.
Rhabdophis himalayanus: KFBG 14458, coll. 25 June 2017, from Site 4 by JHY.
***Pareas* sp.**: KFBG 14360, coll. 20 May 2015, from Site 9 by JHY
Pareas nigriceps: SYS r001222, coll. 17 May 2015, from Site 3 by JW.
Ovophis monticola: SYS r001217, coll. 15 May 2015, from Site 5 by JHY.
Protobothrops jerdonii: SYS r001218, coll. 17 May 2015, from Site 3 by JW.
***Trimeresurus yunnanensis*:** SYS r001216, coll. 15 May 2015, from Site 5 by JHY.

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