

**A TAXONOMIC UPDATE 20 YEARS AFTER THE BOOK RELEASE
“THE AMPHIBIANS AND REPTILES OF A LOWLAND FOREST RESERVE
IN VIETNAM”- HO KE GO: IMPLICATIONS FOR CONSERVATION**

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ABSTRACT

We provide a taxonomic update of the herpetofauna of the Ke Go Nature Reserve, Ha Tinh province, north-central Vietnam, 20 years after the book release “The amphibians and reptiles of a lowland forest reserve in Vietnam”. In this work, Ziegler (2002) recorded 31 amphibians and 57 reptiles. Since then 30 changes in the generic assignment of species took place, five of six unnamed identifications could be solved, three unclear identifications clarified, and 12 taxa were newly described. This review has not only significance for updated names of taxa listed in the book and follow-up papers, but also for conservation. Reviews and descriptions resulted in taxa with more restricted distributions, such as, e.g., *Gekko reevesii* (formerly *G. gekko*, listed on CITES Appendix II and in the Red Data Book) and *Pelodiscus variegatus* (formerly *P. sinensis*, listed in the IUCN Red List, and split off taxa on CITES Appendix II). More species meanwhile are listed as threatened (in total 25), and for some of them, the threat status has increased in the meantime. In addition to the 88 amphibian and reptile species recorded by Ziegler (2002), three further records are added herein, resulting in 91 proven species. There is also evidence for the occurrence of 10 further reptile species, which would increase the herpetofauna list to 101. One half of these 10 additional reptile species are threatened which would increase the threatened herpetofauna to 30 species. This highlights the need for improved conservation, both concerning the official protection status of so far not yet officially listed threatened taxa and IUCN’s One Plan Approach conservation, covering *in situ* conservation measures and *ex situ* conservation breeding approaches. Representing one of Vietnam’s last remaining lowland forests with a high biodiversity and conservation value, the Ke Go Nature Reserve highly deserves reinforced conservation measures.

Keywords: Ha Tinh province, conservation, herpetofauna, new records, taxonomy.

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INTRODUCTION

20 years ago the book “The amphibians and reptiles of a lowland forest reserve in Vietnam” was published by Ziegler (2002). The work deals with the herpetofauna of the Ke Go Nature Reserve in north-central Vietnam. Ke Go Nature Reserve (Ho Ke Go) comprises 24,801 ha and is located in southern Ha Tinh province with 98% of the total area being natural forest. The area is comprised of low, gently undulating hills, with elevations ranging between 50 and 497 m, although most of the nature reserve is below 300 m. The region is noted for the occurrence of several endemic and globally threatened bird species, and thus qualifies as an important bird area. The establishment of a nature reserve was approved by Ha Tinh Provincial People's Committee on 3 May 1997. Ke Go Nature Reserve is contiguous with a large area of natural forest in northern Quang Binh province. Together, the two sites contain one of the largest remaining areas of natural forest in the Annamese lowlands. However, the forest has been selectively logged in the past, so that 76% of it is classified as heavily disturbed, and undisturbed primary forest is virtually absent. According to Tordoff et al. (2004), 46 species of mammals, 270 species of birds and 562 species of plants have been recorded at Ke Go Nature Reserve. Several globally threatened mammal species, in particular the Asian Elephant, Gaur and Tiger, may already have been reduced to relict populations or be extinct as a result of hunting (Le et al., 1999). The major threats to biodiversity at the Ke Go Nature Reserve are hunting, illegal timber extraction, charcoal production, fuelwood collection and fragrant oil extraction (Le et al., 1999; Tordoff et al., 2004). Ziegler (2002) documented 88 amphibian and reptile species from the Ke Go Nature Reserve in Ha Tinh province. At the time, 112 species

of amphibians and 273 species of reptiles were known in total from Vietnam (Ziegler, 2002), thus constituting the herpetofauna from the Ke Go Nature Reserve in Ha Tinh province to represent more than one fifth (22.9 %) of Vietnam’s known amphibian and reptile fauna at the time. Meanwhile, at least 759 species of herpetofauna are known from the country (Krzikowski et al., 2022; Stenger, 2022). Thus, since the book by Ziegler (2002), not only a substantial number of species descriptions took place, but also a number of revisions were published from this and other provinces in central and northern Vietnam, resulting in many distribution restrictions of taxa and name changes. It thus was the aim of the current work to provide a taxonomic update of the amphibian and reptile species inventory of that lowland forest reserve two decades after the release of the book.



Figure 1. Ke Go Nature Reserve (red star), Ha Tinh province, north-central Vietnam



Figure 2. The transformed forest adjacent to a village (upper left) and old forest inside Ke Go Nature Reserve in 1997 [Photos: T. Ziegler]



Figure 3. Ke Go Nature Reserve and surroundings today: Bridge to the Le Duan Temple (top), forest stream inside Ke Go Nature Reserve (lower left) and waterfall in the Chin Xai region (lower right) [Photos: A. V. Ong]

MATERIALS AND METHODS

Records and species names given in Ziegler (2002), which were based on field work in the Ke Go Nature Reserve in Ha Tinh province in 1997 and 1998, were updated based on the online references “Amphibian species of the world” (Frost, 2021) and “Reptile data base” (Uetz et al., 2022) and generic assignment corrected where necessary. In the case specific names have changed in the meantime or in the case of new species descriptions, references were indicated.

For an update of amphibian and reptile records, the herpetological collection of the Biological Museum of Vinh University, Nghe An province, was examined in April 2022 for newly collected specimens (viz. after Ziegler, 2002) from the Ke Go Nature Reserve.

Abbreviations of threat statuses are as follows: CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened.

CITES = Convention on International Trade in Endangered Species of Wild Fauna and Flora.

Decree 64 (2019) = Governmental Decree No. 64/2019/NĐ-CP dated on 16 July 2019 by the Government of Vietnam: I. Endangered species with high priority of conservation.

Decree 84 (2021) = Governmental Decree No. 84/2021/ND-CP, dated on 22 September 2021, by the Government of Vietnam on the management of endangered wild flora and fauna: Group IB = prohibit exploitation and use for commercial purposes and Group IIB = limit exploitation and use for commercial purpose.

RESULTS

Ziegler (2002) recorded 31 amphibian species (Ichthyophiidae 1, Megophryidae 3, Bufonidae 2, Microhylidae 6, Ranidae 12 and Rhacophoridae 7) and 57 reptile species (Testudines 10, Sauria 14 and Serpentes 33) for Ke Go Nature Reserve. In the following overview tables species identifications/names given in Ziegler (2002) are opposed to current names/taxonomy.

Of the 12 newly described taxa since Ziegler (2002) (Table 2), one third was published from our group: the tree frog species *Rhacophorus orlovi*, the softshell turtle *Pelodiscus variegatus*, the colubrid snake *Hebius leucomystax* and the lizard subspecies *Takydromus kuehnei vietnamensis*. Another species (an odd-scaled snake of the genus *Achalinus*) currently is under description by our group (Pham et al. submitted).

Table 1. The updated list of amphibians and reptiles recorded in Ke Go Nature Reserve, Ha Tinh province, Vietnam

Name in Ziegler (2002)	Current name	Reference
Class Amphibia		
Order Gymnophiona		
Ichthyophiidae		
<i>Ichthyophis</i> sp.	<i>Ichthyophis kohtaoensis</i> Taylor, 1960	Nishikawa et al. (2021)
Order Anura		
Megophryidae		
<i>Leptobrachium chapaense</i> (Bourret, 1937)	<i>Leptobrachium chapaense</i> (Bourret, 1937)	
<i>Leptolalax pelodytoides</i> (Boulenger, 1893)	<i>Leptobrachella aerea</i> (Rowley, Stuart, Richards, Phimmachak, and Sivongxay, 2010)	Ohler et al. (2011), Rowley et al. (2010)
<i>Megophrys lateralis</i> (Anderson, 1871)	<i>Xenophrys major</i> complex: <i>X.</i> cf. <i>maosonensis</i> (Bourret, 1937)/ <i>Xenophrys</i> sp.	Mahony et al. (2018), Poyarkov et al. (2021), Luong et al. (2022)

Name in Ziegler (2002)	Current name	Reference
Bufonidae		
<i>Bufo galeatus</i> Günther, 1864	<i>Ingerophrynus galeatus</i> (Günther, 1864)	
<i>Bufo melanostictus</i> Schneider, 1799	<i>Duttaphrynus melanostictus</i> (Schneider, 1799)	
Microhylidae		
<i>Microhyla</i> cf. <i>annamensis</i> Smith, 1923	<i>Nanohyla marmorata</i> (Bain and Nguyen, 2004)	Bain & Nguyen (2004)
<i>Microhyla butleri</i> Boulenger, 1900	<i>Microhyla butleri</i> Boulenger, 1900	
<i>Microhyla heymonsi</i> Vogt, 1911	<i>Microhyla</i> sp.	Garg et al. (2018), Poyarkov et al. (2020), Hoang et al. (2021)
<i>Microhyla ornata</i> (Duméril & Bibron, 1841)	<i>Microhyla mukhlesuri</i> Hasan, Islam, Kuramoto, Kurabayashi, and Sumida, 2014	Hasan et al. (2014)
<i>Microhyla pulchra</i> (Hallowell, 1861)	<i>Microhyla pulchra</i> (Hallowell, 1861)	
<i>Micryletta inornata</i> (Boulenger, 1890)	<i>Micryletta inornata</i> (Boulenger, 1890)	
Ranidae		
<i>Hoplobatrachus rugulosus</i> (Wiegmann, 1835)	<i>Hoplobatrachus rugulosus</i> (Wiegmann, 1835)	
<i>Limnonectes kuhlii</i> (Tschudi, 1838)	<i>Limnonectes bannaensis</i> Ye, Fei, Xie, and Jiang, 2007	Pham et al. (2017, 2018)
<i>Limnonectes limnocharis</i> (Gravenhorst, 1829)	<i>Fejervarya limnocharis</i> (Gravenhorst, 1829)	
<i>Occidozyga lima</i> (Gravenhorst, 1829)	<i>Occidozyga lima</i> (Gravenhorst, 1829)	
<i>Phrynoglossus martensii</i> Peters, 1867	<i>Phrynoglossus</i> cf. <i>martensii</i> Peters, 1867	Köhler et al. (2021)
<i>Rana guentheri</i> Boulenger, 1882	<i>Sylvirana guentheri</i> (Boulenger, 1882)	
<i>Rana johnsi</i> Smith, 1921	<i>Rana johnsi</i> Smith, 1921	
<i>Rana livida</i> (Blyth, 1856)	<i>Odorrana chloronota</i> (Günther, 1876)	Bain et al. (2003)
<i>Rana maosonensis</i> (Bourret, 1937)	<i>Sylvirana maosonensis</i> (Bourret, 1937)	
<i>Rana nigrovittata</i> (Blyth, 1856)	<i>Sylvirana annamitica</i> Sheridan and Stuart, 2018	Sheridan & Stuart (2018)
<i>Rana</i> cf. <i>schmackeri</i> Boettger, 1892	<i>Odorrana bacboensis</i> (Bain, Lathrop, Murphy, Orlov, and Ho, 2003)	Bain et al. (2003), Hecht et al. (2013), Pham et al. (2017)
<i>Taylorana hascheana</i> (Stoliczka, 1870)	<i>Limnonectes</i> cf. <i>limborgi</i> (Sclater, 1892)	Pham et al. (2019, 2020), Köhler et al. (2021)

Name in Ziegler (2002)	Current name	Reference
Rhacophoridae		
<i>Chirixalus vittatus</i> (Boulenger, 1887)	<i>Rohanixalus vittatus</i> (Boulenger, 1887)	
<i>Polypedates dennysi</i> (Blanford, 1881)	<i>Zhangixalus dennysi</i> (Blanford, 1881)	
<i>Polypedates leucomystax</i> (Gravenhorst, 1829)	<i>Polypedates megacephalus</i> Hallowell, 1861	Luu et al. (2013), Pham et al. (2017)
<i>Polypedates</i> sp.	<i>Polypedates mutus</i> (Smith, 1940)	Hecht et al. (2013), Luu et al. (2013)
<i>Rhacophorus reinwardtii</i> (Schlegel, 1837)	<i>Rhacophorus kio</i> Ohler and Delorme, 2006	Ohler & Delorme (2006)
<i>Rhacophorus verrucosus</i> Boulenger, 1893	<i>Kurixalus</i> sp.	Yu et al. (2017)
<i>Rhacophorus</i> sp.	<i>Rhacophorus orlovi</i> Ziegler and Köhler, 2001	Ziegler & Köhler (2001)
Class Reptilia		
Order Testudines		
Bataguridae		
<i>Cuora galbinifrons</i> Bourret, 1939	<i>Cuora galbinifrons</i> Bourret, 1939	
<i>Cyclemys tcheponensis</i> (Bourret, 1939)	<i>Cyclemys oldhamii</i> Gray, 1863	Fritz et al. (2008)
<i>Mauremys mutica</i> (Cantor, 1842)	<i>Mauremys mutica</i> (Cantor, 1842)	
<i>Ocadia sinensis</i> (Gray, 1834)	<i>Mauremys sinensis</i> (Gray, 1834)	
<i>Pyxidea mouhotii</i> (Gray, 1862)	<i>Cuora mouhotii</i> (Gray, 1862)	
<i>Sacalia quadriocellata</i> (Siebenrock, 1903)	<i>Sacalia quadriocellata</i> (Siebenrock, 1903)	
Platysternidae		
<i>Platysternon megacephalum</i> Gray, 1831	<i>Platysternon megacephalum</i> Gray, 1831	
Testudinidae		
<i>Indotestudo elongata</i> (Blyth, 1853)	<i>Indotestudo elongata</i> (Blyth, 1853)	
Trionychidae		
<i>Palea steindachneri</i> (Siebenrock, 1906)	<i>Palea steindachneri</i> (Siebenrock, 1906)	
<i>Pelodiscus sinensis</i> (Wiegmann, 1834)	<i>Pelodiscus variegatus</i> Farkas, Ziegler, Pham, Ong and Fritz, 2019	Farkas et al. (2019)
Order Squamata		
Suborder Sauria		
Gekkonidae		
<i>Gekko gecko</i> (Linnaeus, 1785)	<i>Gekko reevesii</i> (Gray, 1831)	Rösler et al. (2011)
<i>Hemidactylus frenatus</i> Duméril & Bibron, 1836	<i>Hemidactylus frenatus</i> Duméril & Bibron, 1836	

Name in Ziegler (2002)	Current name	Reference
Agamidae		
<i>Acanthosaura lepidogaster</i> (Cuvier, 1829)	<i>Acanthosaura lepidogaster</i> (Cuvier, 1829)	
<i>Calotes emma</i> Gray, 1845	<i>Calotes emma</i> Gray, 1845	
<i>Draco maculatus</i> (Gray, 1845)	<i>Draco maculatus</i> (Gray, 1845)	
<i>Physignathus cocincinus</i> Cuvier, 1829	<i>Physignathus cocincinus</i> Cuvier, 1829	
Varanidae		
<i>Varanus salvator</i> (Laurenti, 1768)	<i>Varanus salvator macromaculatus</i> Deraniyagala, 1944	
Lacertidae		
<i>Takydromus kuehnei</i> Van Denburgh, 1909	<i>Takydromus kuehnei vietnamensis</i> Ziegler and Bischoff, 1999	Ziegler & Bischoff (1999)
Scincidae		
<i>Mabuya longicaudata</i> (Hallowell, 1856)	<i>Eutropis longicaudatus</i> (Hallowell, 1856)	
<i>Mabuya macularia</i> (Blyth, 1853)	<i>Eutropis macularius</i> (Blyth, 1853)	
<i>Mabuya multifasciata</i> (Kuhl, 1820)	<i>Eutropis multifasciatus</i> (Kuhl, 1820)	
<i>Scincella reevesii</i> (Gray, 1838)	<i>Scincella rufocaudata</i> (Darevsky and Nguyen, 1983)	Nguyen et al. (2011), Luu et al. (2013)
<i>Sphenomorphus indicus</i> (Gray, 1853)	<i>Sphenomorphus indicus</i> (Gray, 1853)	
<i>Tropidophorus</i> sp.	<i>Tropidophorus</i> sp.	
Suborder Serpentes		
Typhlopidae		
<i>Ramphotyphlops braminus</i> (Daudin, 1803)	<i>Indotyphlops braminus</i> (Daudin, 1803)	
Xenopeltidae		
<i>Xenopeltis unicolor</i> Boie, 1827	<i>Xenopeltis unicolor</i> Boie, 1827	
Pythonidae		
<i>Python reticulatus</i> (Schneider, 1801)	<i>Malayopython reticulatus</i> (Schneider, 1801)	
Colubridae		
<i>Ahaetulla prasina</i> (Boie, 1827)	<i>Ahaetulla prasina</i> (Boie, 1827)	
<i>Amphiesma</i> sp.	<i>Hebius leucomystax</i> (David, Bain, Nguyen, Orlov, Vogel, Vu and Ziegler, 2007)	David et al. (2007, 2021)
<i>Boiga kraepelini</i> Stejneger, 1902	<i>Boiga kraepelini</i> Stejneger, 1902	

Name in Ziegler (2002)	Current name	Reference
<i>Calamaria pavementata</i> Duméril, Bibron & Duméril, 1854	<i>Calamaria pavementata</i> Duméril, Bibron & Duméril, 1854	
<i>Cyclophiops multicinctus</i> (Roux, 1907)	<i>Ptyas multicincta</i> (Roux, 1907)	
<i>Dendrelaphis ngansonensis</i> (Bourret, 1935)	<i>Dendrelaphis ngansonensis</i> (Bourret, 1935)	
<i>Dinodon</i> cf. <i>rufozonatum</i> (Cantor, 1842)	<i>Lycodon paucifasciatus</i> Rendahl in Smith, 1943	Ziegler et al. (2004, 2006)
<i>Elaphe radiata</i> (Boie, 1827)	<i>Coelognathus radiatus</i> (Boie, 1827)	
<i>Elaphe taeniura</i> Cope, 1861	<i>Elaphe taeniura</i> Cope, 1861	
<i>Lycodon ruhstrati</i> (Fischer, 1886)	<i>Lycodon futsingensis</i> (Pope, 1928)	Vogel et al. (2009), Luu et al. (2013)
<i>Oligodon</i> sp.	<i>Oligodon cinereus</i> (Günther, 1864)	David et al. (2011), Luu et al. (2013)
<i>Ptyas korros</i> (Schlegel, 1837)	<i>Ptyas korros</i> (Schlegel, 1837)	
<i>Ptyas mucosus</i> (Linnaeus, 1758)	<i>Ptyas mucosa</i> (Linnaeus, 1758)	
<i>Rhabdophis chrysargos</i> (Schlegel, 1837)	<i>Rhabdophis chrysargos</i> (Schlegel, 1837)	
<i>Rhabdophis subminiatus</i> (Schlegel, 1837)	<i>Rhabdophis siamensis</i> (Mell, 1931)	David & Vogel (2021)
<i>Sinonatrix percarinata</i> (Boulenger, 1899)	<i>Trimerodytes percarinatus</i> (Boulenger, 1899)	Guo et al. (2020)
<i>Xenochrophis piscator</i> (Schneider, 1799)	<i>Fowlea flavipunctata</i> (Hallowell, 1860)	
Homalopsidae		
<i>Enhydria chinensis</i> (Gray, 1842)	<i>Myrrophis chinensis</i> (Gray, 1842)	
<i>Enhydria plumbea</i> (Boie, 1827)	<i>Hypsiscopus plumbea</i> (Boie, 1827)	
Pareidae		
<i>Pareas hamptoni</i> (Boulenger, 1905)	<i>Pareas formosensis</i> (van Denburgh, 1909)	You et al. (2015), Ding et al. (2020)
<i>Pareas margaritophorus</i> (Jan, 1866)	<i>Pareas margaritophorus</i> (Jan, 1866)	Vogel et al. (2020)
Pseudaspidae		
<i>Psammodynastes pulverulentus</i> (Boie, 1827)	<i>Psammodynastes pulverulentus</i> (Boie, 1827)	
Xenodermidae		
<i>Achalinus rufescens</i> Boulenger, 1888	<i>Achalinus</i> sp. n.	Wang et al. (2019), Ziegler et al. (2019), Huang et al. (2021), Pham et al. (2022)

Name in Ziegler (2002)	Current name	Reference
Elapidae		
<i>Bungarus fasciatus</i> (Schneider, 1801)	<i>Bungarus fasciatus</i> (Schneider, 1801)	
<i>Bungarus multicinctus</i> Blyth, 1861	<i>Bungarus multicinctus</i> Blyth, 1861	
<i>Naja atra</i> Cantor, 1842	<i>Naja atra</i> Cantor, 1842	
<i>Ophiophagus hannah</i> (Cantor, 1836)	<i>Ophiophagus hannah</i> (Cantor, 1836)	
Viperidae		
<i>Protobothrops mucrosquamatus</i> (Cantor, 1839)	<i>Protobothrops mucrosquamatus</i> (Cantor, 1839)	
<i>Trimeresurus albolabris</i> (Gray, 1842)	<i>Trimeresurus albolabris</i> (Gray, 1842)	
<i>Trimeresurus stejnegeri</i> Schmidt, 1925	<i>Trimeresurus vogeli</i> David, Vidal and Pauwels, 2001	David et al. (2001), Ziegler et al. (2004)



Figure 4. New amphibian species descriptions after Ziegler (2002): *Leptobrachella aerea* (upper left), *Nanohyla marmorata* (upper right), *Odorrana bacboensis* (lower left), *Rhacophorus orlovi* (lower right), all pictures from Ke Go Nature Reserve [Photos: T. Ziegler]



Figure 5. Previously unnamed (sp.) identifications: *Ichthyophis kohtaoensis* (upper left), *Polypedates mutus* (upper right), *Oligodon cinereus* (lower left); name change: *Scincella rufocaudata* (lower right), all pictures from Ke Go Nature Reserve [Photos T. Ziegler]

Table 2. Summary of taxonomic changes since Ziegler (2002)

Taxonomic change	Amphibians	Reptiles
New descriptions since Ziegler (2002)	8	4
Identification as sp. in Ziegler (2002)	3 (all identified meanwhile)	3 (2 identified meanwhile)
Identification as cf. in Ziegler (2002)	2 (all identified meanwhile)	1 (identified meanwhile)
Generic changes since Ziegler (2002)	15	15

Name changes or changes of identification also are of relevance for anuran call descriptions and larval descriptions provided in Ziegler (2002). This also concerns follow-up papers which have been published based

on data from Ziegler (2022), e.g., Ziegler & Vences (2002). The new name assignments also resulted in range extensions, such as the southernmost record of *Odorrana bacboensis* (Pham et al., 2017).



Figure 6. New reptile species descriptions after Ziegler (2002): *Pelodiscus variegatus* (upper left), *Takydromus kuehnei vietnamensis* (upper right), *Hebius leucomystax* (lower left), *Trimeresurus vogeli* (lower right), all pictures from Ke Go Nature Reserve [Photos: T. Ziegler]



Figure 7. New *Achalinus* from Ke Go Nature Reserve (upper left); new records for the Ke Go Nature Reserve: *Kalophrynus interlineatus* (upper right, photographed in Quang Binh province), *Hylarana macrodactyla* (lower left) and *Hyla simplex* (lower right), both photographed in Nghe An province [Photos: T. Ziegler]

In addition to the 88 amphibian and reptile species recorded by Ziegler (2002), three further records (all amphibians) are added herein, based on new collections from Ke Go Nature Reserve: *Hyla simplex* Boettger, 1901 (Hylidae), *Kalophrynus interlineatus* (Blyth, 1855) (Microhylidae) and *Hylarana macrodactyla* Günther, 1858 (Ranidae). These species also were recorded and diagnosed by us from adjacent Nghe An and Quang Binh provinces, including the description of the advertisement call of *Hyla simplex* (Ziegler & Weitkus, 1999a, b; Ziegler et al., 2004). These

new findings bring the amphibians recorded from Ke Go Nature Reserve to 34 and the herpetofauna list for the reserve in total to 91 proven species.

With 25 species listed as nationally or globally threatened according to IUCN (2022), CITES Appendices, Vietnam Red Data Book (Tran et al., 2007), and the Decrees in Vietnam (Table 3), a considerable number of species that have been recorded from Ke Go Nature Reserve have a conservation concern.



Figure 8. Meanwhile additional species were listed as threatened, for example *Rhacophorus kio* (upper left), *Palea steindachneri* (upper right); a number of species also have received a higher threat status in the meantime: *Cuora galbinifrons* (middle left), *Indotestudo elongata* (middle right), *Ptyas mucosa* (lower left), *Ophiophagus hannah* (lower right), all pictures from Ke Go Nature Reserve [Photos T. Ziegler]

Table 3. Threat status of amphibians and reptiles recorded from Ke Go Nature Reserve: IUCN (2022) status, CITES (2019) Appendices, RBVN (2007)/Vietnam Red Data Book (Tran et al., 2007), Governmental Decrees 64/2019 and 84/2021 in Vietnam

Taxon name	IUCN (2022)	CITES (2019)	Vietnam Red Data Book	Decree 64/2019	Decree 84/2021
Ichthyophiidae					
<i>Ichthyophis kohtaoensis</i>			VU (as <i>I. bannanicus</i>)		
Bufonidae					
<i>Ingerophrynus galeatus</i>			VU		
Rhacophoridae					
<i>Rhacophorus kio</i>			EN		
Bataguridae					
<i>Cuora galbinifrons</i>	CR	II	EN	I	IB
<i>C. mouhotii</i>	EN	II			IIB
<i>Cyclemys oldhamii</i>	EN	II			IIB
<i>Mauremys mutica</i>	CR	II			IIB
<i>M. sinensis</i>	CR	III			
<i>Sacalia quadriocellata</i>	CR	II			IIB
Platysternidae					
<i>Platysternon megacephalum</i>	CR	I	EN	I	IB
Testudinidae					
<i>Indotestudo elongata</i>	CR	II	EN		IIB
Trionychidae					
<i>Palea steindachneri</i>	CR	II	VU		IIB
<i>Pelodiscus variegatus</i>	VU (as <i>P. sinensis</i>)				
Gekkonidae					
<i>Gekko reevesii</i>		II (as <i>G. gecko</i>)	VU (as <i>G. gecko</i>)		IIB (as <i>G. gecko</i>)
Agamidae					
<i>Physignathus cocincinus</i>	VU		VU		
Varanidae					
<i>Varanus salvator</i>		II	EN		IIB
Pythonidae					
<i>Malayopython reticulatus</i>		II	CR		IIB
Colubridae					
<i>Coelognathus radiatus</i>			VU		
<i>Elaphe taeniura</i>	VU				
<i>Lycodon paucifasciatus</i>	VU				
<i>Ptyas korros</i>	NT		EN		
<i>Ptyas mucosa</i>		II	EN		IIB
Elapidae					
<i>Bungarus fasciatus</i>			EN		
<i>Naja atra</i>	VU	II	EN		IIB
<i>Ophiophagus hannah</i>	VU	II	CR	I	IB

Compared to Ziegler (2002), also additional species meanwhile were listed as threatened (Tran et al., 2007), such as, e.g., the amphibians *Ichthyophis kohtaoensis* and *Rhacophorus kio*, as well as the softshell turtle *Palea steindachneri*. A number of species also has received a higher threat status compared with Ziegler (2002) in the meantime (Tran et al., 2007), e.g., the turtle species *Cuora galbinifrons* (from VU to EN) and *Indotestudo elongata* (from VU to EN), and the snake species *Ptyas mucosa* (from VU to EN) and *Ophiophagus hannah* (from EN to CR).

Ziegler (2002) further provided evidence for other reptile species that might be found in the reserve in the future (Table 4), but lacking confirmation at the time.

In addition, a legless or leg-reduced skink or representative of the family Dibamidae that

was seen by Ziegler (2002) but could not be identified could represent *Lygosoma siamensis* (see Siler et al., 2018) (as *L. quadrupes* in Luu et al., 2013), a common leg-reduced skink in the leaf litter. Ziegler (2002) also provided evidence for other reptile species that might occur in the reserve (Table 5).

Thus, there is a high probability that more than the 91 definitely recorded amphibian and reptile species are occurring in the Ke Go Nature Reserve. Summarizing the data from Tables 4 and 5 and adding the aforementioned legless lizard at least there are indications of another 10 species occurring there, which would lead the total list of amphibians and reptiles for Ke Go Nature Reserve to 101.

One half of these 10 additional reptile species are listed as threatened (Table 6) which would increase the threatened taxa occurring in Ke Go Nature Reserve even to 30.

Table 4. Snake species documented in Ziegler (2002), which were collected in the surroundings of the reserve and have thus high probability to occur in the reserve as well

Name in Ziegler (2002)	Current name	References
<i>Ahaetulla nasuta</i> (Lacépède, 1789)	<i>Ahaetulla fusca</i> David, Nadolski, Ganesh, Adhikari and Srikanthan, 2022	Mallik et al. (2020), David et al. (2022)
<i>Chrysopelea ornata</i> (Shaw, 1802)	<i>Chrysopelea ornata</i> (Shaw, 1802)	
<i>Elaphe porphyracea</i> (Cantor, 1839)	<i>Oreocryptophis porphyraceus</i> (Cantor, 1839)	
<i>Rhynchophis boulengeri</i> Mocquard, 1897	<i>Gonyosoma boulengeri</i> (Mocquard, 1897)	Peng et al. (2021)

Table 5. Reptile species which might occur in the reserve after Ziegler (2002) but at the time without any voucher specimen nor photographic record; information derived from the local animal trade

Name in Ziegler (2002)	Current name	Reference
<i>Cuora trifasciata</i> (Bell, 1825)	<i>Cuora cyclornata</i> Blanck, Mccord & Le, 2006	Blanck et al. (2006)
<i>Manouria impressa</i> (Günther, 1882)	<i>Manouria impressa</i> (Günther, 1882)	
<i>Varanus bengalensis</i> (Daudin, 1802)	<i>Varanus bengalensis</i> (Daudin, 1802)	
<i>Python molurus</i> (Linnaeus, 1758)	<i>Python bivittatus</i> Kuhl, 1820	
<i>Bungarus candidus</i> (Linnaeus, 1758)	<i>Bungarus candidus</i> (Linnaeus, 1758)	

Table 6. Threat status of amphibians and reptiles for which evidence was provided in Ziegler (2002) to be recorded as well from Ke Go Nature Reserve: IUCN (2022) status, CITES (2019) Appendices, RBVN (2007)/Vietnam Red Data Book (Tran et al., 2007), and Decree 06/2019 in Vietnam

Taxon name	IUCN (2022)	CITES (2019)	Vietnam Red Data Book	Decree 64/2019	Decree 84/2021
Bataguridae					
<i>Cuora cyclornata</i>	CR (as <i>C. trifasciata</i>)	II	CR	I	IB
Testudinidae					
<i>Manouria impressa</i>	EN	II	VU		IIB
Colubridae					
<i>Oreocryptophis porphyraceus</i>			VU		
Varanidae					
<i>Varanus bengalensis</i>		I	EN (as <i>V. nebulosus</i>)		IB (as <i>V. nebulosus</i>)
Pythonidae					
<i>Python bivittatus</i>	VU	II	CR (as <i>P. molurus</i>)		IIB

DISCUSSION

Although most of the previous taxonomic uncertainties in Ziegler (2002) could be dealt with meanwhile, and new herpetofauna records could be added to the list provided by Ziegler (2002), new questions arose in the meantime. For amphibians, diverse taxa showed up to be complexes of species in the meantime, e.g. *Microhyla heymonsi* and *Micryletta inornata*, that need range-wide revision. Also *Xenophrys* cf. *maosonensis* / *Xenophrys* sp., *Limnonectes* cf. *limborgi*, *Phrynoglossus* cf. *martensii*, and *Kurixalus* sp. need further taxonomic revision. In reptiles, e.g., *Trimeresurus albolabris* includes several lineages (Ziegler et al., 2018) and the *Achalinus* from Ha Tinh currently is under the description, as *A. rufescens*, originally described from Hong Kong, China, revealed to represent a complex of diverse taxa (e.g., Ziegler et al., 2019).

Altogether, this review has not only significance for updated name allocation of taxa listed in Ziegler (2002) and follow-up papers, but it also clearly underlines that taxonomic changes, reviews and species descriptions have consequences for

conservation, such as the splitting of previously widespread species into locally restricted taxa. Such cases are e.g., *Gekko reevesii* (formerly *G. gekko*, and already listed on CITES Appendix II and in the Red Data Book of Vietnam as Vulnerable) and *Pelodiscus variegatus* (formerly *P. sinensis*, listed in the IUCN Red List as Vulnerable). The latter species, which was described also based on specimens from Ziegler (2002), only occurs in northern Vietnam and in Hainan and certainly deserves an official protection status, as the species that were split off from *P. sinensis* before (*P. axenaria*, *P. maackii* and *P. parviformis*) meanwhile also are listed on CITES Appendix II (Farkas et al., 2019). This highlights the need for improved conservation measures, both concerning the official protection status of so far not yet officially listed threatened taxa and IUCN's One Plan Approach conservation measures, covering *in situ* conservation measures (viz. conservation improvements directly in Ke Go Nature Reserve) and *ex situ* conservation breeding approaches, as recently initiated by our team for the Spotted softshell turtle, for which a conservation breeding program in Vietnam has been started (Ziegler et al., 2020).



Figure 9. Complexes of species: *Microhyla heymonsi* (upper left), *Xenophrys* cf. *maosonensis* (upper right) and *Kurixalus* sp. (lower left), as well as still unidentified taxa such as *Tropidophorus* sp. (lower right), of which a sample is lacking until today and only this photographic record available, all pictures from Ke Go Nature Reserve [Photos: T. Ziegler]



Figure 10. Previously *Gekko gecko*, now after the revision of the taxon *G. reevesii* from Ke Go Nature Reserve (left), and the recently described *Pelodiscus variegatus* (previously regarded as the widespread *P. sinensis*), here offspring from the recently established Vietnamese conservation breeding programme (right) [Photos: T. Ziegler, C. T. Pham]

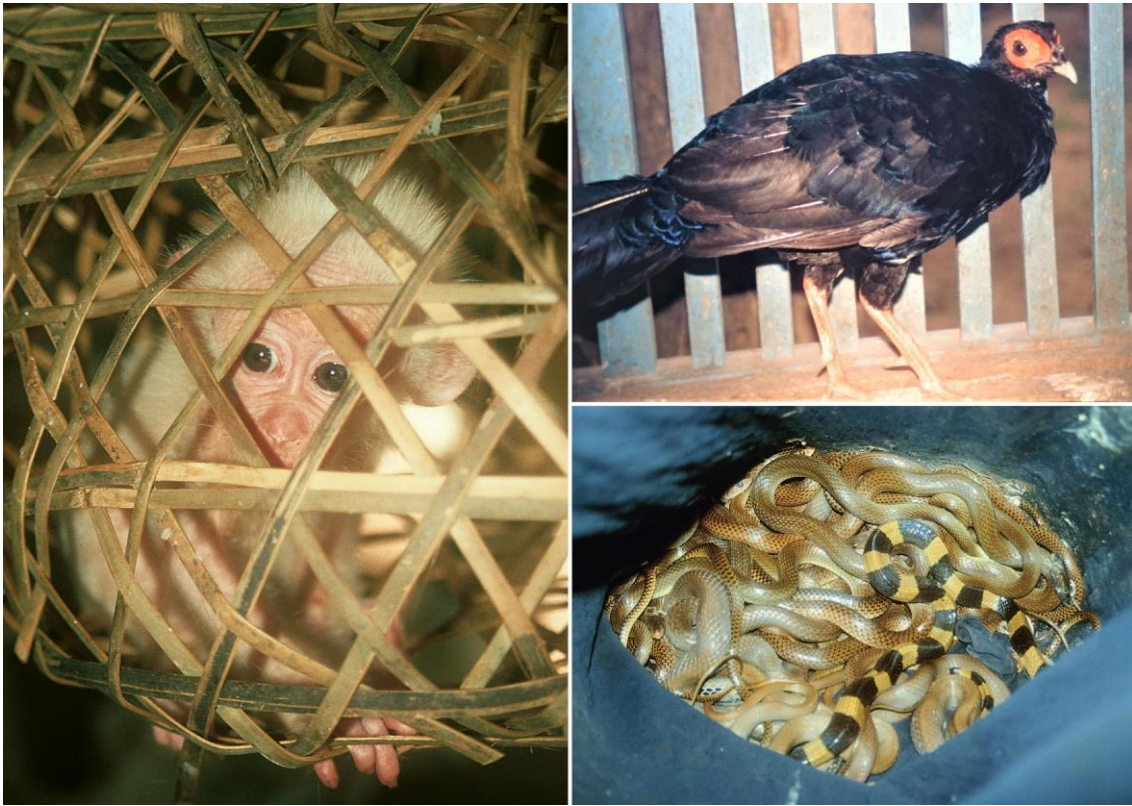


Figure 11. In 1997 and 1998, there existed massive local trade with vertebrates around Ke Go Nature Reserve: young macaque (*Macaca* sp.) (left), the pheasant species *Lophura edwardsi* (previously *Lophura hatinhensis*) (upper right), and the colubrid and elapid snake species *Ptyas korros* and *Bungarus fasciatus* (lower right), all photographed in the local animal trade [Photos: T. Ziegler]

CONCLUSION

As the Ke Go Nature Reserve, as one of the largest remaining areas of natural forest in the Annamese lowlands, not only houses a considerable number of amphibian and reptile species, which was already documented by Ziegler (2002), but also a number of only recently discovered species, species with restricted range only and a considerable number of species of conservation concern, the current findings from this review paper support and highlight the need for reinforced conservation activities in the region. And this concerns not only amphibians and reptiles but also other terrestrial vertebrate groups. For example, the Ke Go white-toothed shrew, *Crocidura kegoensis* Lunde, Musser and Ziegler, 2004, is still known only from its type

locality (Lunde et al., 2004), underlining the peculiarity of this area. Representing one of Vietnam's last remaining lowland forest regions with a high biodiversity and conservation value, the Ke Go Nature Reserve and its biodiversity merit all available nature conservation measures.

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