

# The herpetofauna of Hon Khoai Island, Ca Mau Province, Vietnam

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## ABSTRACT

We provide the first checklist of the herpetofauna from Hon Khoai Island, Ca Mau Province, southern Vietnam, comprising two species of amphibians, eleven species of lizards, and six species of snakes. The herpetofauna of Hon Khoai Island harbors a high level of conservation concern with one species endemic to Vietnam, two species listed on appendices I and II of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), one globally endangered species listed in the IUCN Red List and three nationally threatened species listed in the Vietnam Red Data Book and two in the Governmental Decree. This study not only fills a gap in the biodiversity knowledge of Hon Khoai Island but also underlines the urgent need of conservation measures for the herpetofauna, in particular for the endangered endemic Psychedelic Rock Gecko (*Cnemaspis psychedelica*).

## KEY WORDS

Amphibians; conservation; diversity; reptiles; threatened species.

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## INTRODUCTION

Hon Khoai Island is located in the Rach Gia Bay, approximately 14.6 km from the mainland of Ngoc Hien District, Ca Mau Province in southern Vietnam. This is the largest of 92 islands in the Rach Gia Bay with the highest peak reaching 318 m above the sea level and composing a surface area of approximately 4 km<sup>2</sup> (<http://www.camau.gov.vn>). The terrestrial ecosystem mainly comprises granite basements and thick forests including relatively small and medium trees (Ngo et al., 2016, 2018).

In terms of the herpetofaunal diversity, Grismer

et al. (2010) described a new species of gecko, namely the Psychedelic Rock Gecko, *Cnemaspis psychedelica* Grismer, Ngo et Grismer, 2010, and recorded 14 other species of reptiles from Hon Khoai Island. In this study, we provide an updated checklist of amphibians and reptiles from this island, including morphological and natural history data.

## MATERIAL AND METHODS

Field surveys were conducted during the wet season (1–12 November 2015) and the dry season

(6–22 January 2016 and 2–10 January 2017) on Hon Khoai Island, Ca Mau Province, southern Vietnam (Fig. 1). Field excursions were undertaken between 10:00 h and 24:00 h. Survey transects, ranging from 0.3 to 1.1 km in length, were selected along forest paths scattered with granitic cliffs and boulders in the forest on Hon Khoai Island (Figs. 2, 3). Collected specimens were photographed in life at the ranger station using a digital camera (Canon PowerShot G15). Specimens were euthanized with a piece of cotton wool containing ethylene acetate (Simmons 2002). Amphibian specimens were fixed for 4–6 hours in 80% ethanol and subsequently injected with 70% ethanol while reptile specimens were injected with 90% ethanol. After fixation, specimens were transferred to 70% ethanol solution for permanent storage (Ziegler, 2007). Voucher specimens were deposited in the collection of the Institute of Ecology and Biological Resources (IEBR), Hanoi, Vietnam.

Taxonomic identification was based on the following literature: Smith (1943), Taylor (1963),

Yang (1984), Chan and Norhayati (2010), Grismer et al. (2010), Orlov et al. (2011), Rösler et al. (2011), Vogel et al. (2013), Geissler et al. (2014) and Vassilieva et al. (2015). Additional references were provided in the individual species accounts. Systematic classification followed Nguyen et al. (2009), Das (2010) and Rösler et al. (2011).

## RESULTS

### Systematics

Classis AMPHIBIA Gray, 1825

Ordo ANURA Duméril, 1806

Familia RHACOPHORIDAE Hoffman, 1932

Genus *Polypedates* Tschudi, 1838

*Polypedates megacephalus* Hallowell, 1861 (Fig. 4)

**SPECIMENS EXAMINED.** Two adult females IEBR 4700, 4701 (HK 2016.19, HK 2016.20) and three adult males IEBR 4702–4704 (HK 2015.27, HK 2015.47, HK 2015.62).

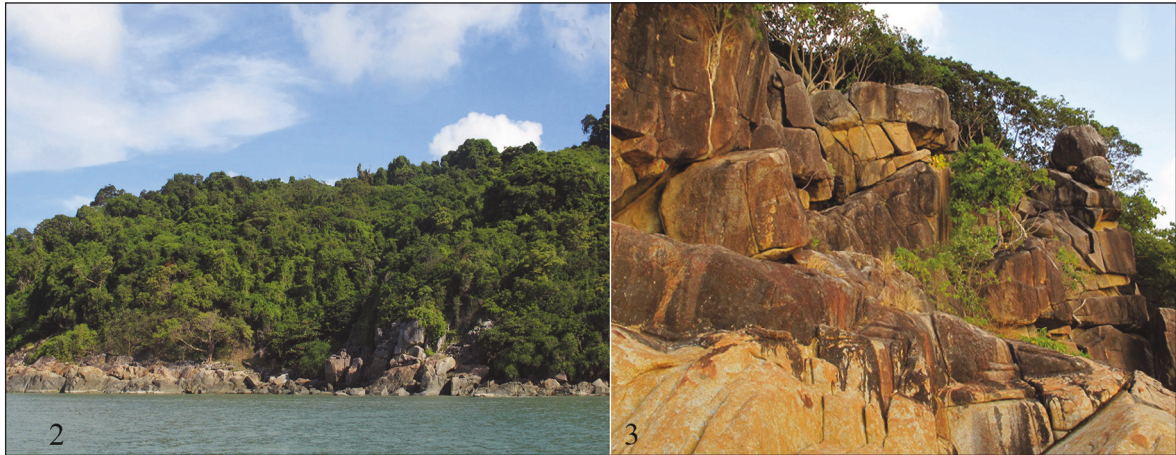
**MORPHOLOGICAL FEATURES.** Morphological characters of specimens from Hon Khoai Island match the descriptions of Liu et al. (2018) and Le et al. (2014).

Adult females SVL 59.8–66.99 mm (n=2), adult males SVL 47.14–50.63 (n=3); head longer than wide (HL 15.6–25.3 mm, HW 13.75–22.76 mm), vomerine teeth present; snout pointed, triangular in shape; loreal region vertical; pupil horizontal; tympanum distinct; first and second fingers short, third and fourth fingers long; relative length of fingers I<II<IV<III, fingers expanded into wide discs, with small rudiments of webbing at base; toes moderately long; relative length of toes I<II<III<V<IV; tips of toes widened into discs, smaller than those of fingers, toes webbed for two-thirds of their lengths; subarticular tubercles prominent, rounded/oval: I–1, II–1, III–2, IV–3, V–2; limbs without dermal appendages; dorsal skin smooth with small tubercles, rough; belly and ventral side of thighs granular; with co-ossified skin on head.

**COLORATION IN LIFE.** Dorsum light brown, with or without dark blotches, a X-shaped pattern some-



Figure 1. Map showing locality of Hon Khoai Island at the southernmost tip of Vietnam.



Figures 2, 3. Habitats on Hon Khoai Island.



Figures 4, 5. Amphibians. Fig. 4: *Polypedates megacephalus*. Fig. 5: *Ichthyophis* cf. *bannanicus* (photos by T.V. Nguyen).

times present on neck; dark stripe bordering supratympanic fold from eye beyond arm; limb with grey transverse bars; belly yellowish white; throat mottled or spotted.

**NATURAL HISTORY NOTES.** *Polypedates megacephalus* was found during night excursions. The species was observed resting on small branches and leaves near small streams in the forest.

**DISTRIBUTION.** This is a widespread species in Vietnam. Elsewhere, the species is known from India, China, Taiwan, Japan, Myanmar, Laos, Cambodia and Thailand (Nguyen et al., 2009).

Ordo GYMNOPIHIONA Müller, 1832  
Familia ICHTHYOPHIIDAE Taylor, 1968

Genus *Ichthyophis* Fitzinger, 1826

*Ichthyophis* cf. *bannanicus* Yang, 1984 (Fig. 5)

**SPECIMENS EXAMINED.** Three adults (unknown gender) IEBR 4736, 4705, 4706 (HK 2015.1, HK 2015.24-25).

**MORPHOLOGICAL FEATURES.** Morphological characters of specimens from Hon Khoai Island match the descriptions of Yang (1984), Nishikawa et al. (2012), Hecht et al. (2013) and Geissler et al. (2014).

Specimens SVL 365–381 mm (n=3), TaL 4.2–5.0 mm, maximum body width 15.71–17.33 mm, head length (HL) 13.66–15.00 mm, orbital diameter



1–1.25 mm; body annuli (dorsal count) 342–343, caudal annuli 8; tail tip pointed.

**COLORATION IN LIFE.** Dorsal surface of head, body and tail chocolate brown; lateral stripe bright yellow, broad, interrupted posteriorly, extending from behind tentacle on upper jaw to posterior end of vent; ventral surface chocolate brown.

**NATURAL HISTORY NOTES.** Individuals of *I. cf. bannanicus* were observed in the evening on the wet forest ground.

**DISTRIBUTION.** In Vietnam, this species has been known from Cao Bang Province, southwards to Kien Giang and Ca Mau provinces. Elsewhere, the species is known from China, Laos, Cambodia and Thailand (Nguyen et al., 2009).

Classis REPTILIA Laurenti, 1768

Ordo SQUAMATA Oppel, 1811

Familia AGAMIDAE Gray, 1827

Genus *Draco* Linnaeus, 1758

***Draco maculatus* (Grey, 1845) (Fig. 7)**

**SPECIMENS EXAMINED.** Two adult females IEBR 4707, 4708 (HK 2015.52, HK 2016.10), adult and sub-adult males IEBR 4709, 4710 (HK 2015.13, HK 2015.51).

**MORPHOLOGICAL FEATURES.** Morphological characters of specimens from Hon Khoai Island match the descriptions of Inger (1983), Das (2010), Hecht et al. (2013), and Le & Dinh (2013).

Adult females SVL 66.92–72.12 mm, TaL 100.42–111.36 mm ( $n = 2$ ), males SVL 52.75–69.66 mm, TaL 87.06–109.48 mm ( $n = 2$ ); head small, longer than wide (HL 11.59–15.57 mm, HW 7.11–9.46 mm); nostrils lateral, directed more or less outwards; tympanum covered with small scales; scales on upper head unequal, strongly keeled; supralabials 8–11; infralabials 9–10; males with triangular gular pouch, covered by small scales; patagium supported by five ribs; dorsal scales 122–136, unequal, smooth or feebly keeled; number of scales along the midbody from mental shield to anterior edge of cloaca 92–98, strongly keeled.

**COLORATION IN LIFE.** Dorsal head and body gray or greyish brown with dark markings; black bands present in interorbital region or on nape; wing-

membranes orange or reddish brown above with scattered black spots which are variable in size, and often arranged in longitudinal lines; below pale yellow with irregular black spots.

**NATURAL HISTORY NOTES.** Individuals of *D. maculatus* were observed resting on large trees, about 2 m above the forest floor.

**DISTRIBUTION.** This is a widespread species in Vietnam. Elsewhere, the species is known from India, southern China, Myanmar, Laos, Thailand, Cambodia and Malaysia (Nguyen et al., 2009).

Familia GEKKONIDAE Gray, 1825

Genus *Cnemaspis* Strauch, 1887

***Cnemaspis psychedelica* Grismer, Ngo et Grismer, 2010 (Fig. 6)**

**MORPHOLOGICAL FEATURES.** Morphological measurements, scalation, and colour pattern observed from our records match well the original description by Grismer et al. (2010).

**NATURAL HISTORY NOTES.** The Psychedelic Rock Gecko (*C. psychedelica*) was found active during the day and night surveys in both the wet and dry seasons. The species was mainly found on granite rocks, cliffs, branches, leaves on tree, and on the forest floor at the mean height of  $0.71 \pm 0.6$  m above the ground and resided under a mean canopy coverage of  $85.2 \pm 25.5\%$  (Ngo et al., 2018).

**DISTRIBUTION.** This is an endemic species found only on two small islands (e.g., Hon Khoai and Hon Tuong) in Ca Mau Province, southern Vietnam (Grismer et al., 2010; Ngo et al., 2016).

Genus *Cyrtodactylus* Gray, 1827

***Cyrtodactylus leegrimeri* Chan et Norhayati, 2010 (Fig. 8)**

**MORPHOLOGICAL FEATURES.** Morphological measurements, scalation and colour pattern observed from our records match well the original description by Chan & Norhayati (2010).

**NATURAL HISTORY NOTES.** *Cyrtodactylus leegrimeri* is abundant throughout the entire Hon Khoai Island. The species was observed during night surveys, occurring in different micro-habitats, such as



granite boulders, branches, leaves on trees above the ground about 0.1–2 m, and on the forest floor (H. N. Ngo, pers. obs.).

**DISTRIBUTION.** This species has been found on Hon Khoai and Hon Tuong islands in Ca Mau Province, southern Vietnam (Grismer & Grismer 2017). Elsewhere, the species is further known from Malaysia (Chan & Norhayati, 2010).

Genus *Gehyra* Gray, 1834

***Gehyra mutilata*** (Wiegmann, 1834) (Fig. 9)

**SPECIMENS EXAMINED.** One adult female IEBR 4711 (HK 2015.40) and four adult males IEBR 4712–4715 (HK 2015.3; HK 2015.18; HK 2015.39; HK 2015.56).

**MORPHOLOGICAL FEATURES.** Morphological characters of specimens from Hon Khoai Island match the descriptions of Das (2010).

Adult female SVL 56.49 mm, TaL 42.54 mm; adult males SVL 45.67–53.87 mm, TaL 39.6–53.36 mm ( $n = 4$ ); body depressed; rostral wider than high; nasal scales 5–6; supralabials 8–10; infralabials 7–9; mental triangular; upper head and back covered with granular scales; ventral scales in 29–33 rows, larger,

imbricate; number of scales along the midbody from mental shield to anterior edge of cloaca 121–126; skin folds present on flanks; hind limb short, with a fold of skin along posterior margin; digits webbed at base; terminal phalanges of outer four toes long, clawed, free, rising angularly from within expanded portion; inner toe without free distal phalanx and claw; lamellae under fourth finger 6–7 pairs, toe 7–8 pairs, oblique; tail strongly depressed and denticulated laterally; medial subcaudals widened; males with continuous, angular series of 22–36 precloacal and femoral pores in males.

**COLORATION IN LIFE.** Pale grayish or yellowish brown above, uniform or with dark spots, a dark streak sometimes present behind eye.

**NATURAL HISTORY NOTES.** Individuals of *G. mutilata* were observed resting and foraging on the wall of houses of the local ranger station, about 1–3 m above the ground.

**DISTRIBUTION.** This is a widespread species in Vietnam. Elsewhere, the species has been known from India, Sri Lanka, China, Taiwan, Myanmar, Cambodia, Malaysia, Indonesia, Japan, the Philippines, Australia and Madagascar (Nguyen et al., 2009).



Figure 6. *Cnemaspis psychedelica* photographed *in situ* on Hon Khoai Island (photo by H.N. Ngo).

Genus *Gekko* Laurenti, 1768

***Gekko gecko*** (Linnaeus, 1758) (Fig. 10)

**SPECIMEN EXAMINED.** One adult male IEBR 4716 (HK 2016.15).

**MORPHOLOGICAL FEATURES.** Morphological characters of the specimen from Hon Khoai Island match the descriptions of Rösler et al. (2011) and Yu et al. (2011).

Adult male SVL 148.88 mm, TaL 96.69 mm; nare not in contact with rostral; nasal scales 8; internasals 1; supralabials 14/14; infralabials 12–12; dorsum with granular scales intermixed with large tubercles; dorsal tubercles in 12 rows, granular scales surrounding dorsal tubercles 9; number of scales along the midbody from mental shield to anterior edge of cloaca 93; fingers and toes not webbed; subdigital lamellae under fourth finger 21, under fourth toe 20; tubercles present on forearms and hindlimbs; lateral fold without tubercles; precloacal pores 14 in males; femoral pores present; subcaudals enlarged, in two parallel rows.

**COLORATION IN LIFE.** Iris yellow; body pale gray or blue-gray above with 7–8 transverse series of whitish spots, brick-red spots sometimes present; venter whitish with small pinkish spots.

**NATURAL HISTORY NOTES.** The individual of *G. gecko* was found during night survey. The individual was resting on surface of a loose granite rock about 1.5 m above the forest floor.

**DISTRIBUTION.** This is a widespread species in Vietnam. Elsewhere, the species has been known from Bangladesh, India, Nepal, Bhutan, Myanmar, Thailand, Cambodia, Laos, Malaysia, China, Hong Kong, the Philippines, Indonesia and Timor Leste (Nguyen et al., 2009).

Genus *Hemidactylus* Oken, 1817

***Hemidactylus frenatus*** Duméril et Bibron, 1836 (Fig. 11)

**SPECIMENS EXAMINED.** Four adult males IEBR 4717–4720 (HK 2015.15, HK 2015.20, HK 2015.22, HK 2015.44).

**MORPHOLOGICAL FEATURES.** Morphological characters of specimens from Hon Khoai Island

match the descriptions of Das (2010), Nguyen (2011), Hecht et al. (2013) and Vásquez-Restrepo & Lapwong (2018).

Adult males SVL 52.04–57.09 mm, TaL 35.15–45.89 mm (n = 4); head longer than wide (HL 15.22–16.73 mm; HW 8.55–11.01 mm) covered with small scales; snout obtuse; nasal scales 4–8; internasals 1–2; eye covered by transparent membrane, without moveable eyelid; tympanum small, rounded; supralabials 12–14; infralabials 10–11; nasal scales 4–8; dorsal scales small, ventral scales imbricate, grainy; ventral scales in 30–32 rows; number of scales along the midbody from mental shield to anterior edge of cloaca 133–136; fingers more or less paddle-like, broadened at base, with divided transverse or oblique lamellae on underside; 3–4 divided lamellae under thumb; 7–8 divided lamellae under finger IV; terminal segments of finger I to V free, with claw; 8–9 broadened lamellae under toe IV; 13–15 broadened femoral scales on each side; tail strongly dorsoventrally compressed, with lateral denticulation.

**COLORATION IN LIFE.** Body gray or pinkish brown above, darker markings sometimes present; a dark streak present on dorsal head, body and tail.

**NATURAL HISTORY NOTES.** Individuals of *H. frenatus* were observed resting and foraging on walls of houses in the local ranger station about 1–1.5 m above the ground.

**DISTRIBUTION.** This is a widespread species in Vietnam. Elsewhere, the species has been known from India, Sri Lanka, China, Taiwan, Myanmar, Cambodia, Malaysia, Indonesia, Japan, the Philippines, Australia and Madagascar (Nguyen et al., 2009).

Familia SCINCIDAE Gray, 1825

Genus *Eutropis* Fitzinger, 1843

***Eutropis multifasciatus*** (Kuhl, 1820) (Fig. 12)

**SPECIMENS EXAMINED.** One adult female IEBR 4721 (HK 2016.17), four adult males IEBR 4722–4725 (HK 2016.7, HK 2016.18, HK 2016.20, HK 2016.25).

**MORPHOLOGICAL FEATURES.** Morphological characters of specimens from Hon Khoai Island match the description of Amarasinghe et al. (2018).



Adult female SVL 113.75 mm, TaL +116.0 mm; adult males SVL 90.55–123.54 mm, TaL 122.47–241.11 mm (n = 4); snout short, obtuse; rostral wider than long; postnasal single; prefrontals usually in contact; nuchals in 1 pair; supralabials 7/7; infalabials 6–7; lower eyelid scaly; external ear openings with small projecting lobules; loreals 2; midbody scales in 31 rows; ventral scales 45–46; subdigital lamellae under fourth finger 15–16, under fourth toe 17–18.

COLORATION IN LIFE. Body brown above, dorsal scales uniform or with black lateral margin; lower zone of flanks with dark brown or black stripe, upper zone with deep orange, white spots sometimes present.

NATURAL HISTORY NOTES. Individuals of *E. multifasciatus* were observed basking in the morning on the ground close to the local ranger station and resting on a small branch about 0.3 m above the forest ground during night excursion.

DISTRIBUTION. This is a widespread species in Vietnam. Elsewhere, the species has been known from India, China, Taiwan, Myanmar, Laos, Thailand, Cambodia, Malaysia, Indonesia and the Philippines (Nguyen et al., 2009; Amarasinghe et al., 2018).

Familia VARANIDAE Merrem, 1820

Genus *Varanus* Merrem, 1820



Figures 7–10. Reptiles. Fig. 7: *Draco maculatus*. Fig. 8: *Cyrtodactylus leegrimeri*. Fig. 9: *Gehyra mutilata*. Fig. 10: *Gekko gecko* (photos by H.N. Ngo & T.V. Nguyen).



***Varanus salvator*** (Laurenti, 1768) (Fig. 13)

**SPECIMENS EXAMINED.** An individual was captured by a local fisherman and kept in a small cage. The animal was photographed on 10 November 2015.

**NATURAL HISTORY NOTES.** According to local rangers, the monitor lizard was found resting in a small cave in the forest. However, the species was frequently observed in the shore of small streams.

**DISTRIBUTION.** This is a widespread species in Vietnam. Elsewhere, the species has been known from Sri Lanka, India, Bangladesh, Myanmar, Cambodia, Laos, Vietnam, China, Thailand, Malaysia, Singapore, and Indonesia (Nguyen et al., 2009).

Subordo SERPENTES Linnaeus, 1758  
 Familia COLUBRIDAE Oppell, 1811  
 Genus *Ahaetulla* Link, 1807

***Ahaetulla prasina*** (Boie, 1827) (Fig. 14)

**SPECIMENS EXAMINED.** Three adult females IEBR 4726–4728 (HK 2015.10, HK 2015.11, HK 2016.5), one adult male IEBR 4729 (HK 2015.46).

**MORPHOLOGICAL FEATURES.** Morphological characters of specimens from Hon Khoai Island match the description of Das (2010).

Adult females SVL 867.5–1087 mm, TAL 475–587 mm ( $n = 3$ ); adult male SVL 843.5 mm, TAL 471.5 mm; body slender; head long and narrow, with a pointed snout; eyes large, with horizontal pupil; loreals 2–4; supralabials 8–9, fourth, fifth and sixth in contact with eye; infralabials 9/9; preoculars 1–2; postoculars 2; temporals 2+2/3; dorsal scales smooth, in 15:15:13 rows; ventral plates 204–211; subcaudal plates 168–175, paired; cloacal scale divided.

**COLORATION IN LIFE.** Bluish-green dorsolaterally, with a yellowish-white line on both sides of the ventral part, interstitial skin in the neck region black and white.

**NATURAL HISTORY NOTES.** Snakes were found resting at night on branches of small trees, about 2.0–5.0 m above the forest ground near the local ranger station.

**DISTRIBUTION.** This is a widespread species in Vietnam. Elsewhere, the species has been known from India, Bangladesh, Bhutan, China, Myanmar, Laos, Thailand, Cambodia, Malaysia, Singapore, Brunei Darussalam, Indonesia and Philippines (Nguyen et al., 2009).

Genus *Chrysopelea* Boie, 1826

***Chrysopelea ornata*** (Shaw, 1802) (Fig. 15)

**SPECIMENS EXAMINED.** Two adult females IEBR 4730, 4731 (HK 2015.45, HK 2016.22).

**MORPHOLOGICAL FEATURES.** Morphological characters of specimens from Hon Khoai Island match the description of Das (2010).

Adult females SVL 613.0–725.0 mm, TAL 150–262 mm ( $n = 2$ ); body slender; snout truncated; head elongate, depressed; eyes large with round pupil; loreal 1/1; supralabials 9–10, fifth and sixth in contact with eye; infralabials 10; preocular single; postoculars two; temporals 2+2/3; dorsal scales in 17:17:13 rows; ventral plates 220–224; subcaudal plates 132, paired; cloacal scale divided.

**COLORATION IN LIFE.** Dorsum light green with alternate black crossbars and large flower-shaped reddish vertebral spots. Flattened head painted with black and yellow cross-bands. Ventrals light green, series of spots on side.

**NATURAL HISTORY NOTES.** Individuals were observed during a night survey, on the forest ground close to the local ranger station.

**DISTRIBUTION.** This is a widespread species in Vietnam. Elsewhere, the species has been known from India, Nepal, Sri Lanka, Bangladesh, Myanmar, Thailand, West Malaysia, Laos, Cambodia, China and the Philippines (Nguyen et al., 2009).

Genus *Lycodon* Fitzinger, 1826

***Lycodon capucinus*** (Boie, 1827) (Fig. 16)

**SPECIMENS EXAMINED.** One adult female IEBR 4732 (HK 2015.14), three adult males IEBR 4733, 4133, 4134 (HK 2015.12, HK 2015.37, HK 2016.1)

**MORPHOLOGICAL FEATURES.** Morphological characters of specimens from Hon Khoai Island

match the descriptions of Das (2010), Vogel et al. (2013) and O'Shea et al. (2018).

Adult female SVL 354 mm, TaL 75 mm; adult males SVL 330–479 mm, TaL 79–114 mm ( $n = 3$ ); body slender; head flat and narrow, triangular, slightly wider than the neck; rostral broad; eyes round; loreal 1/1; preocular 1/1; postoculars 2/2; temporals 2+2/3; supralabials 9/9, 3<sup>rd</sup>–5<sup>th</sup> in contact with orbit; infralabials 10–11; dorsal scale rows 17–17–15, all smooth; ventrals 194–200; cloacal single; subcaudals 73–81, divided.

**COLORATION IN LIFE.** Head dark purplish back to level of light brownish parietals; light band on the occipital region, each scale with a purplish spot, brown band follows the light band; labials yellowish mottled with a large purplish brown spot, dorsum of body chocolate brown with each brown scale edged in white or cream; ventrals, cloacal plate, and subcaudals are immaculate off-white to pale cream; tail nearly uniform brown; dull white on venter.

**NATURAL HISTORY NOTES.** Individuals were found in different rocky sites within the small tree forest. They were moving or resting on rocks about 1–2 m above the forest ground during night surveys.

**DISTRIBUTION.** In Vietnam, this species is known from Da Nang southwards to Kien Giang Province. Elsewhere, the species has been known from India, Maldives, China, Myanmar, Laos, Cambodia, Thailand, Malaysia, Singapore, Indonesia, the Philippines and Australia (Nguyen et al., 2009).

*Lycodon davisonii* (Blanford, 1878) (Fig. 17)

**SPECIMENS EXAMINED.** One adult female IEBR 4062 (HK 2015.38), two adult males IEBR 4735, 4063 (HK 2015.70, HK 2016.14).

**MORPHOLOGICAL FEATURES.** Characters of specimens from Hon Khoai Island match the descriptions of Das (2010), Orlov et al. (2011) and Nguyen et al. (2018).



Figures 11–14. Reptiles. Fig. 11: *Hemidactylus frenatus*. Fig. 12: *Eutropis multifasciata*. Fig. 13: *Varanus salvator*. Fig. 14: *Ahaetulla prasina*. (photos by H.N. Ngo & T.V. Nguyen).



Adult female SVL 658.0 mm, TaL 151.0 mm; adult males SVL 430–597 mm, TaL 118–166 mm ( $n = 2$ ); head distinct from neck; nasal undivided; loreal 1/1, touching the eye; preocular absent; postocular 1/1; temporals 1+2; supralabials 7/7, third and fourth entering orbit; infralabials 8/8; dorsal scale rows 13–13–13, all smooth; ventrals 250–254; cloacal single; subcaudals 77–99, divided.

**COLORATION IN LIFE.** Dorsum black with 31–37 white crossbars and 17–24 other bars on tail; white cross-bar narrower at posterior part of body; head dark brown with pale cream-colored elongated spots on each side, from parietal shield to supraorbital; venter cream anteriorly, grey posteriorly.

**NATURAL HISTORY NOTES.** Individuals were found on the forest ground near the ranger station.

**DISTRIBUTION.** In Vietnam, this species is known from Hoa Binh, Quang Binh, Quang Tri, Khanh Hoa, Binh Thuan, Dong Nai, Tay Ninh, Kien Giang provinces and Ho Chi Minh City. Elsewhere, the species has been known from Myanmar, Thailand, Cambodia and Laos (Nguyen et al., 2009).

Familia XENOPELTIDAE Bonaparte, 1845  
Genus *Xenopeltis* Reinwardt, 1827

*Xenopeltis unicolor* Reinwardt, 1827 (Fig. 18)

**SPECIMENS EXAMINED.** One adult female IEBR 4735 (HK 2016.12).

**MORPHOLOGICAL FEATURES.** Morphological characters of the specimen from Hon Khoai Island match the descriptions of Taylor (1963), Das (2010) and Nguyen et al. (2019).

Adult female SVL 684 mm, TaL 80.6 mm; a wedge-shape head, indistinct from neck, internasal single, nasal divided; preocular 1/1; postoculars 2/2; temporals 2+2; supralabials 8/8, fourth and fifth in contact with orbit; infralabials 8/8; dorsal scale rows 15–15–15, all smooth; ventrals 184; cloacal divided; subcaudals 28, divided.

**COLORATION IN LIFE.** Scales highly iridescent; dorsal scales brown, the first row creamy-white edged in brown, the second to fourth rows brown edged in creamy-white, ventral scales creamy-white, brown at outer edges posteriorly.

**NATURAL HISTORY NOTES.** One individual of *Xenopeltis unicolor* was observed during a night

survey. The snake was moving a few meters on the forest ground.

**DISTRIBUTION.** This is a widespread species in Vietnam. Elsewhere, the species has been known from India, China, Myanmar, Laos, Thailand, Cambodia, Malaysia, Singapore, Indonesia and, Philippines (Nguyen et al., 2009).

## DISCUSSION

Oceanic archipelagos hold a central role to study the fundamental mechanisms of speciation in terrestrial organisms (Heaney, 2007). High levels of local endemism were discovered on island ecosystems due to complex topography, isolation and variable climatic conditions (Clements et al., 2006; Kier et al., 2009). Thus, studies on the herpetofauna of tropical rainforests on offshore islands in Vietnam have recently received special attention. Nguyen et al. (2011) recorded 40 species of reptiles from Cat Ba Island, Hai Phong Province, northern Vietnam. Surveys on main islands of Bai Tu Long National Park in Quang Ninh Province, northern Vietnam, documented 51 species of reptiles and 14 species of amphibians (Nguyen et al., 2009; Gawor et al., 2016). Nguyen et al. (2016) recorded 43 species of amphibians and reptiles from Con Dao Island, Ba Ria-Vung Tau Province, southern Vietnam. Grismer et al. (2010) recorded 15 species of reptiles on Hon Khoai Island in Ca Mau Province. In this study, we added two species of amphibians (*Polypedates megacephalus*, *Ichthyophis* cf. *bannanicus*) and two species of reptiles (*Xenopeltis unicolor*, *Lycodon davisonii*) to the herpetofaunal list of Hon Khoai Island. Our new records increase the total number of the herpetofauna of Hon Khoai Island to 19 species (Table 1). Among them Gekkonidae is the most diverse family with six recorded species, followed by Colubridae (four species), Scincidae (three species), Agamidae, Varanidae, Xenopeltidae and Pythonidae (one species each), and we further recorded two species of amphibians (Rhacophoridae and Ichthyophiidae).

The species composition raises further questions, for example why some species occur on the mainland but not on the island, how island inhabitants reached Hon Khoai Island, for example through separation from mainland populations during Pliocene (Nguyen et al., 2018), or actively or





Figures 15–18. Reptiles. Fig. 15: *Chrysopelea ornata*. Fig. 16: *Lycodon capucinus*. Fig. 17: *Lycodon davisonii*. Fig. 18: *Xenopeltis unicolor* (photos by H.N. Ngo & T.V. Nguyen).

passively through humans. And of course why only in some groups new taxa evolved on Hon Khoai Island.

Although the area of Hon Khoai Island is relatively small (approximately 4 km<sup>2</sup> only) (<http://www.camau.gov.vn>), the island harbors a high level of conservation concern (Nguyen et al., 2021). Besides the endemic gecko species, *Cnemaspis psychedelica* described by Grismer et al. (2010), a new endemic mammal species, the Hon Khoai Squirrel *Callosciurus honkhoaiensis* Nguyen, Oshida, Dang, Bui et Motokawa, 2018, was recently described from this island (Nguyen et al. 2018). The forest of Hon Khoai Island is also the habitat of some threatened taxa (21% of the total number of recorded species): *Cnemaspis psychedelica* is listed in the IUCN Red List (2019) as Endangered and on CITES Appendix I (CITES 2020); three species (*I. cf. bannanicus*, *Gekko gekko*, *Varanus salvator*) are listed in the Vietnam Red Data Book (Tran et al., 2007); two species, *C. psychedelica* and *V. salvator*, are listed in the Gov-

ernmental Decree No 06/2019/ND-CP; and two species *V. salvator* and *G. gekko* are listed in the CITES Appendix II (Table 1). Among the terrestrial mammal fauna occurring on Hon Khoai Island, which is officially ranked being threatened, two species are listed on CITES Appendix II, two species are listed as Vulnerable on the IUCN Red List, two species are included in the Vietnam Red Data Book and three species in the Governmental Decree (Nguyen et al., 2021).

The biodiversity on Hon Khoai Island is currently at risk due to habitat degradation and wildlife hunting (Ngo et al., 2016, 2018; Nguyen et al., 2018, 2021). Reduction in resource availability, altered species interactions, and even local extirpation in some species can take place in the context of severe anthropogenic pressures due to drastic fragmentation of habitats recorded on Hon Khoai Island through isolation, reduction of forest size, and physical alteration of remaining natural habitat. Thus, proper conservation measures should be taken into account to protect the remaining habitats and living

No.	Taxon name	Grismer et al. (2010)	This study	IUCN RL (2020)	Vietnam RB (2007)	Decree No. 06 (2019)	CITES (2020)
	<b>AMPHIBIA</b>						
	<b>Anura</b>						
	<b>Rhacophoridae</b>						
1	<i>Polypedates megacephalus</i> Hallowell, 1861		S				
	<b>Gymnophiona</b>						
	<b>Ichthyophiidae</b>						
2	<i>Ichthyophis</i> cf. <i>bannanicus</i> Yang, 1984		S		VU		
	<b>REPTILIA</b>						
	<b>Squamata</b>						
	<b>Agamidae</b>						
3	<i>Draco maculatus</i> (Gray, 1845)	x	S				
	<b>Gekkonidae</b>						
4	<i>Cnemaspis psychedelica</i> Grismer, Ngo et Grismer, 2010*	x	S	EN		IB	I
5	<i>Cyrtodactylus leegrimeri</i> Chan et Norhayati, 2010	x	S				
6	<i>Gehyra mutilata</i> (Wiegmann, 1834)	x	S				
7	<i>Gekko gecko</i> (Linnaeus, 1758)	x			VU		II
8	<i>Hemidactylus frenatus</i> Duméril et Bibron, 1836	x	S				
9	<i>Hemidactylus platyurus</i> (Schneider, 1797)	x					
	<b>Scincidae</b>						
10	<i>Dasia olivacea</i> Gray, 1839	x					
11	<i>Eutropis multifasciatus</i> (Kuhl, 1820)	x	S				
12	<i>Scincella</i> cf. <i>reevesii</i> (Gray, 1838)	x					
	<b>Varanidae</b>						
13	<i>Varanus salvator</i> (Laurenti, 1768)	x	P		EN	IIB	
	<b>Colubridae</b>						
14	<i>Ahaetulla prasina</i> (Boie, 1827)	x	S				
15	<i>Chrysopelea ornata</i> (Shaw, 1802)	x	S				
16	<i>Lycodon capucinus</i> (Boie, 1827)	x	S				
17	<i>Lycodon davisonii</i> (Blanford, 1878)		S				
	<b>Xenopeltidae</b>						
18	<i>Xenopeltis unicolor</i> Reinwardt, 1827		S				
	<b>Pythonidae</b>						
19	<i>Malayopython reticulatus</i> (Schneider, 1801)	x	I				

Table 1. List of amphibian and reptile species recorded from Hon Khoai Island, Ca Mau Province, Vietnam (S = specimen, P = Photo record, I = Interview record, \* = endemic species, IUCN RL = IUCN Red List of Threatened Species, Vietnam RB = Vietnam Red Data Book, EN: Endangered, VU: Vulnerable; Decree No. 06 = Governmental Decree No. 06/2019/ND-CP of Vietnam: IB = Group IB [prohibited exploitation and use for commercial purpose], IIB = Group IIB [limited exploitation and use for commercial purpose], CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora, I, II = Appendices I, II).



creatures on Hon Khoai Island. We herein recommend some conservation measures: (1) establishment of a Species and Habitat Conservation Area (SHCA) for the globally endangered species (*Cnemaspis psychedelica*) and other species on Hon Khoai Island; (2) improvement of patrolling work and forest fire prevention by providing equipment and facilities for forest rangers; and (3) development of a sustainable tourist plan on the island with a special focus on disturbance (e.g. waste and other impacts) control. As a result of the collaboration program in biodiversity research and conservation in Vietnam among Cologne Zoo, Institute of Ecology and Biological Resources (Hanoi) and Wildlife at Risk (Ho Chi Minh City), a conservation breeding program was already initiated for *Cnemaspis psychedelica* in order to create an assurance (ex-situ) population of this endangered species in southern Vietnam (see Ziegler et al., 2016).

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