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The herpetofauna of the Bai Tu Long National Park, northeastern Vietnam

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Abstract. We present a comprehensive inventory checklist of the herpetofauna of the Bai Tu Long National Park, Quang Ninh Province, northeastern Vietnam. As a result of our herpetological surveys in 2008, 2009, and 2011, a total of 29 species were recorded from the national park, comprising eight species of frogs, eleven species of lizards, and ten species of snakes. Thirteen species (or 44.8% of the total number of recorded species) were recorded for the first time from Bai Tu Long National Park, including six frog, four lizard, and three snake species. We provide first information on species richness and frequency of occurrence. The taxonomic status of three species (*Hylarana* sp., *Limnonectes* cf. *bannaensis*, and *Gekko* cf. *palmatus*) still needs further clarification.

Key words. Amphibians, reptiles, new records, island diversity, karst topography, granite formations.

Introduction

The Bai Tu Long National Park is located in the Bai Tu Long Archipelago, Quang Ninh Province, northeastern Vietnam, next to Ha Long Bay, which has been classified as a World Heritage Site since 1994 (Fig. 1A–B). This national park comprises 40 islands, and lies in the vicinity of three communes, namely Minh Chau, Van Yen, and Ha Long, all of which belong to the Van Don District. The total area of the national park is 15,784 ha, consisting of 9,659 ha of marine area and 6,125 ha of terrestrial forest (Frontier Vietnam Newsletter 2002b, Le 2008). The islands are characterised by karst topography (limestone rocks and caves) and granite formations, which form the basis of diverse natural landscapes (Fig. 2). The dominant forest type is evergreen forest, including both tropical broad-leaved and bamboo vegetation (Figs. 3A–B). The coastal areas are covered with mangroves (Sterling et al. 2006, Le 2008). The description of both the marine and terrestrial fauna of the Bai Tu Long National Park remains incomplete. Marine conservation efforts in the area have been carried out since 2001 and preliminary biodiversity research results so far recorded 391 species from the park, e.g., plankton, seabed species, corals, and fish (Frontier Vietnam Newsletter 2002a). Regarding the terrestrial ecosystem and its conservation, the first faunistic survey produced a brochure dealing with the area's mammals (Frontier Vietnam Newsletter 2002a, b). Regarding its herpetofauna, Le & Vo (2005) mentioned in their overview of the terrestrial vertebrates of the Bai Tu Long National Park eight species of amphibians representing six families, and 19 species of reptiles representing 11 families. Based on recent herpetological field research conducted in the Bai Tu Long Archipelago, we herein expand this list of amphibians and reptiles and present for the first time a comprehensive inventory checklist for the herpetofauna of this national park, including ecological information.

Material and methods

Field surveys were conducted on the two main islands of the Bai Tu Long National Park, viz. Ba Mun and Large Tra Ngo (Cai Lim area). While preliminary field surveys were conducted in the years 2008 (17–21 September 2008) and 2009 (16–17 May and 20–23 September), the major-

ity of amphibian and reptile specimens examined within this study were collected during the survey period from 13 May through 10 July 2011 (surveys in total: seven diurnal and 29 nocturnal species). The surveys were started directly from the ranger stations or different points along the coastline next to ranger stations (coordinates: Ba Mun Island 21°04'33.38" N, 107°35'29.77" E; Large Tra Ngo Island: 21°06'29.76" N, 107°34'42.38" E). Surveys were executed in different forest types (bamboo, mixed forest of shrubs and hardwood) by following the courses of forest streams or walking along forest paths mainly at night (Figs. 3A–B; 4A–B). Evaluation of species diversity was based on the specimens collected during 2011 to which end ecological notes and numbers of specimens caught were documented. Based on the field data from 2011, a cluster analysis was performed using the software PAST (version 2.16, Hammer et al. 2001) to compare the species composition between different limestone- and granite-dominated areas in Vietnam, namely Bai Tu Long, Cat Ba, and Phong Nha-Ke Bang National Parks. In addition, similarity indices were calculated by using the logarithm of Dice similarity with 100 bootstrap values (Hammer et al. 2001). Bai Tu Long and Cat Ba National Parks are islands in northeastern Vietnam, whereas Phong Nha-Ke Bang National Park is situated in mainland central Vietnam (Sterling et al. 2006, Le 2008). While numerous herpetodiversity studies were already conducted in Phong Nha-Ke Bang during the past decade, corresponding research in Bai Tu Long and Cat Ba

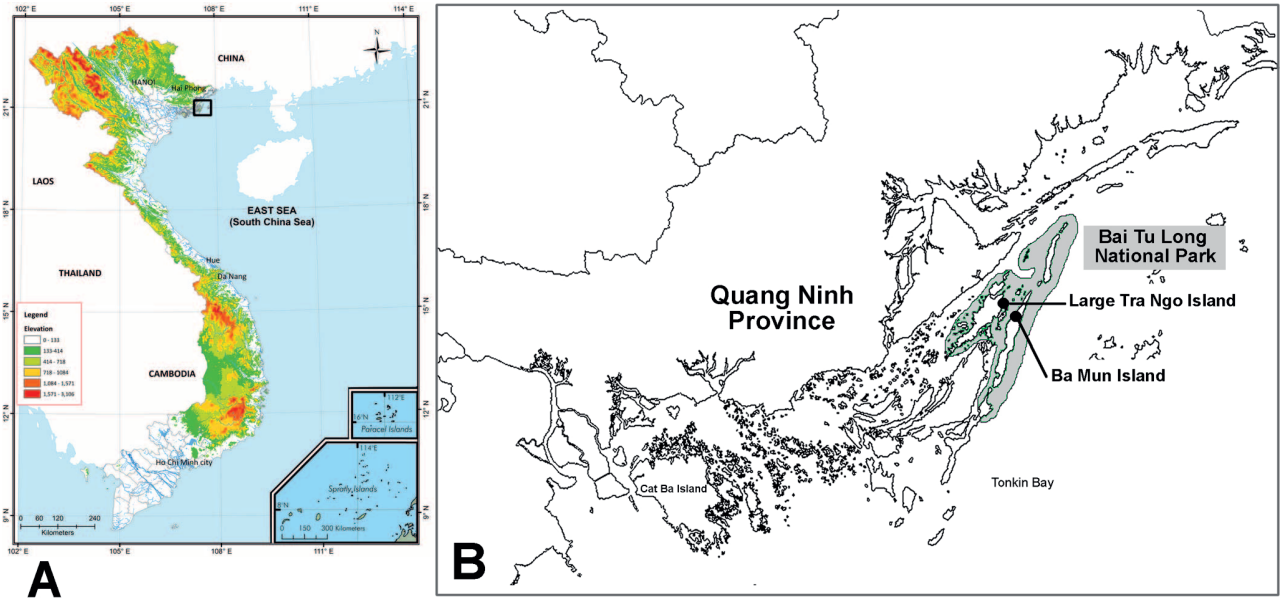

Figure 1. A) Map showing the collecting sites; B) Ba Mun Island and Large Tra Ngo Island (Cai Lim area), Bai Tu Long National Park, Quang Ninh Province, northeastern Vietnam.

Figure 2. Limestone karst islands in the Bai Tu Long National Park.

only commenced in recent years (e.g., Ziegler et al. 2004, 2006, 2007, Nguyen et al. 2011a, b, Luu et al. 2013).

Detailed morphological examination of specimens took place in the laboratories of the Cologne Zoo (Germany). Voucher specimens were subsequently deposited in the collections of the Institute of Ecology and Biological Resources (IEBR), Vietnam National Museum of Nature (VNMN), Hanoi, Vietnam, and Zoologisches Forschungsmuseum Alexander Koenig (ZFMK), Bonn, Germany.

Collected voucher specimens from 2011 were photographed in life at the ranger stations using a digital camera (Pentax K-x, 12 mpix; Sigma DG Macro 105 mm; Sigma DC 18–200 mm) by the senior author (or as remarked in parentheses). Specimens were subsequently anaesthetised and euthanised with a piece of cotton wool containing ethylene acetate. Amphibian specimens were fixed for 6 to 12 hours in 40% ethanol and subsequently injected with 70% ethanol while reptile specimens were injected with 96% etha-

Figure 3. Surveyed habitats on Ba Mun Island: A) Dried-out streambed with granite formations; B) Mixed forest of bamboo and broad-leaved trees.

Figure 4. Surveyed habitats on Large Tra Ngo Island: A) Coastal area; B) Limestone rocks and cave formations near the coast.

nol. After fixation, specimens were transferred to a 70% ethanol solution for permanent storage (Ziegler 2007).

Taxonomic identification was based on the following literature: Boulenger (1920), Pope (1935), Smith (1935, 1943), Bourret (1936, 1942, 2009), Taylor (1962), Duellman & Trueb (1994), Rösler (1995), Manthey & Grossmann (1997), Hallermann & McGuire (2001), Malkmus et al. (2002), Ziegler (2002), Ziegler et al. (2006, 2007), Manthey (2008), Nguyen et al. (2009, 2011a, 2011b), and Rösler et al. (2011). Additional references are provided in the individual species accounts. Systematic classification followed Nguyen et al. (2009), Zaher et al. (2009), Frost (2013), and Uetz & Hošek (2014). Abbreviations are as follows: a.s.l. = above sea level, BTL NP = Bai Tu Long National Park, NP = National Park, SVL = Snout–vent length (from snout tip to cloaca), TAL = Tail length (from cloaca to tip of tail), TL = Total length (SVL + TAL).

Results

Amphibia

Anura

Microhylidae

Microhyla heymonsi Vogt, 1911 (Fig. 5A)

Specimens examined: Six adult females (VNMN 928, VNMN 947, ZFMK 95199–95202), two subadult males (ZFMK 95203–95204), one juvenile (ZFMK 95205).

Morphological features: Adult females SVL 23.3–26.6 mm (n = 6), subadult males SVL 20.1–26.6 mm (n = 2), and single juvenile SVL 16.1 mm; body flattened, cuneiform in profile; head small with a bluntly pointed snout; pupil round; tympanum concealed; supratympanic fold distinct; skin smooth above; fingers free of webbing, tips of fingers widened into small discs, with median longitudinal grooves; outer metatarsal tubercle distinct, relative lengths of fingers: I < II < IV < III; toes webbed for less than one-third of their length, tips of toes enlarged into discs, larger than those of fingers, third toe longer than fifth toe; two distinct metatarsal tubercles; tibiotarsal articulation reaching anterior edge of eye or tip of snout.

Coloration in life: Uniform greyish or light brown above, with a thin, white vertebral line and one or two small black spots in middle of back, head and body with a black lateral band extending from tip of snout to near groin, distinct blackish triangular cloacal spot, hind limbs with brown crossbars, ventral side of body white, mottled with brown on throat and chest, hind limbs reddish (identified after Bourret 1942, Taylor 1962, Manthey & Grossmann 1997, Ziegler 2002, Bain & Nguyen 2004).

Natural history notes: *Microhyla heymonsi* is common on both islands. This species was frequently observed on the forest ground during every night survey from May through July 2011.

Distribution: *Microhyla heymonsi* has previously been recorded from Uong Bi Township, Quang Ninh Province (Nguyen et al. 2009). Our find of *M. heymonsi* is the first record for Bai Tu Long NP.

Dicroglossidae

Hoplobatrachus rugulosus (Wiegmann, 1834) (Fig. 5B)

Specimens examined: One adult female (ZFMK 95206), two subadult males (VNMN 933, ZFMK 95207).

Morphological features: Adult female SVL 112.7 mm, subadult males SVL 58.1–73.9 mm (n = 2); head as long as or broader than long, strongly depressed; snout oval in dorsal view; tympanum distinct, supratympanic fold distinct; arms short; fingers without webbing, rather short, tips of fingers obtusely pointed, first finger longer than second; outer metatarsal tubercle absent; hind limbs short; tibiotarsal articulation reaching beyond the eye; toes nearly fully webbed, toe tips pointed, subarticular tubercles small; skin smooth or granular on dorsum and flanks, with up to ten irregular rows of elongate ridges; ventral side of body smooth with a few small tubercles.

Coloration in life: Subadult male brownish with larger dark blotches on dorsum, adult female brighter in coloration than subadult male, dorsum olive with dark greenish blotches, dorsal face of head, body, and limbs of the adult female covered with small dark dots, which are absent in the subadult males (identified after Bourret 1942, Taylor 1962, Ziegler 2002).

Natural history notes: The subadult male of *H. rugulosus* was found in a wet streambed within a disturbed forest dominated by bamboo on Large Tra Ngo Island during a night survey (19 May 2011). The adult female was found at the edge of a water basin near the ranger station on Ba Mun Island in the evening (6 June 2011).

Distribution: According to Nguyen et al. (2009), the species is common in Vietnam. *Hoplobatrachus rugulosus* was recorded from Bai Tu Long NP by Le & Vo (2005).

Limnonectes cf. *bannaensis* Ye, Fei & Jiang, 2007 (Fig. 5C)

Specimens examined: Eight adult females (IEBR A.2013.35, IEBR A.2013.38–40, ZFMK 95208–95211), two subadult females (IEBR A.2013.34, ZFMK 95212), three adult males (IEBR A.2013.37, ZFMK 95213–95214), two subadults (VNMN 938–939).

Morphological features: Adult females SVL 52.8–62.5 mm (n = 8), subadult females SVL 37.3–39.2 mm (n = 2), adult males SVL 62.7–83.6 mm (n = 3), subadults SVL 35.1–44.0 mm (n = 2); head large, flattened; snout rounded; vomerine teeth on two oblique ridges; tongue deeply notched posteriorly; lower jaw with two tooth-like, bony structures; tympanum concealed, supratympanic fold distinct; forelimbs short, fingers without webbing; toes short, without discs, nearly fully webbed; tibiotarsal articulation reaching labial angle; all specimens examined with smooth skin above, except one specimen: with short longitudinal folds above (IEBR A.2013.34); skin on ventral side of body smooth.

Coloration in life: Dorsum brown or green, uniform or with small dark blotches; all specimens without yellowish vertebral line; dorsal surface of limbs with brown bars; a short, dark transverse line between eyes distinct; upper and lower lips with vertical dark stripes; venter white or yellowish, with numerous light grey or brownish blotches

Figure 5. Amphibians: A) *Microhyla heymonsi* (ZFMK 95203); B) *Hoplobatrachus rugulosus* (ZFMK 95207); C) *Limnonectes* cf. *bannaensis* (IEBR A.2013.34); D) *Occidozyga martensii* (ZFMK 95215); E) *Hylarana guentheri* (ZFMK 95220); F) *Hylarana* sp. (IEBR A.2013.27); G) *Polypedates mutus*; H) *Theloderma asperum* (IEBR A.2013.28).

on throat, chest, and limbs (identified after Ye et al. 2007; also compared with descriptions of the *L. kuhlii* complex in Bourret 1942, Taylor 1962, Ziegler 2002).

Comments: McLeod (2010) demonstrated that the *L. kuhlii* complex consisted of more than 22 well-supported evolutionary lineages, 16 of which are currently subsumed under the nominal *L. kuhlii* and the "true" *L. kuhlii* is only known from the type locality in Java (Indonesia). Moreover, the population of *L. kuhlii* from Yunnan Province in southern China was described as *Limnonectes bannaensis* by Ye et al. (2007). However, McLeod (2010) expanded the known distribution range of this species to northern and central Vietnam, and eastern Laos. Therefore, we provisionally refer the population from Bai Tu Long NP to *L. bannaensis*.

Natural history notes: Specimens of *L.* cf. *bannaensis* were collected on Large Tra Ngo Island during the survey period from May through July 2011. The frogs were found in swampy habitats within a forest predominantly consisting of bamboo and small hardwood trees, never in fast-flowing rocky streams with cascades.

Distribution: *Limnonectes bannaensis* is known from throughout southern China, Myanmar, Laos, and Vietnam (Ye et al. 2007, McLeod 2010, Frost 2013). This is the first record of the species from Bai Tu Long NP.

Occidozyga martensii (Peters, 1867) (Fig. 5D)
Specimens examined. One adult male (ZFMK 95215), collected on 18 June 2011 by Vinh Quang Luu.

Morphological features: Single adult male with SVL 24.6 mm; head flattened in profile; canthus rostralis absent; vomerine teeth absent; tympanum indistinct, supratympanic fold distinct; fingers without webbing, relative lengths of fingers: II = IV < I < III; toes webbed for three quarters to four-fifths of their lengths, tips of toes with small terminal discs, but without median longitudinal grooves; outer metatarsal tubercle absent; tibiotarsal articulation reaching eye; dorsum with small scattered tubercles; ventral side of body smooth.

Coloration in life: Brownish above and with a few darker blotches; head with a thin transverse dark line between eyes, dorsum without a broad dark or thin bright vertebral line; limbs with dark transverse bars dorsally; ventral side of body creamy with a dark marbled throat, more distinct in males (identified after Taylor 1962, Ziegler 2002).

Comments: Morphologically, *O. martensii* is similar to *O. laevis* (Bourret 1942, Taylor 1962, Ziegler 2002). However, *O. martensii* can be distinguished from *O. laevis* by the following features: distinctly smaller size, smaller terminal discs on tips of digits without dorsal longitudinal grooves, a larger inner metatarsal tubercle, and more strongly notched webbings between toes than in *O. laevis* (see Taylor 1962, Manthey & Grossmann 1997, Ziegler 2002).

Natural history notes: The adult male was collected on the bank of a forest stream on Ba Mun Island during the night (18 June 2011).

Distribution: This is the first record of *O. martensii* from Bai Tu Long NP as well as Quang Ninh Province.

Ranidae
Hylarana guentheri (Boulenger, 1882) (Fig. 5E)
Specimens examined: Three adult females (ZFMK 95216–95218), three adult males (VNMN 929, ZFMK 95219–95220), seven subadult males (ZFMK 95221–95227).

Morphological features: Adult females SVL 54.6–76.4 mm (n = 3), adult males SVL 65.1–76.7 mm (n = 3), and subadult males SVL 33.3–59.4 mm (n = 7); head depressed, slightly longer than broad; tip of snout acute or obtusely pointed, strongly projecting beyond mouth opening; vomerine teeth in two oblique series between choanae; canthus rostralis distinct; tympanum distinct; fingers slender and rather long, tips swollen, first longer than second, third finger longer than snout, subarticular tubercles large and prominent, fingers without webbing; hind limbs long, tibiotarsal articulation reaching between eye and tip of snout; toes webbed for three quarters of their lengths, long, tips of toes dilated into small discs, with a median groove; subarticular tubercles small; inner metatarsal tubercle distinct, outer metatarsal tubercle very small and sometimes indistinct; dermal fringe absent, skin smooth above and below, narrow to broad glandular dorsolateral fold from above tympanum to the groin distinct.

Coloration in life: Dorsal surface of head and body greyish brown, golden to reddish brown, uniform or with dark brown spots, a dark line or band present on either side of head and upper part of flanks, bordering dorsolateral fold below; tympanum dark brown or reddish; limbs with brown crossbars, rear side of thighs yellow with black mottling; white or yellowish below, throat or chest speckled with brown (identified after Boulenger 1920, Bourret 1942, Liu 1950, Ziegler 2002).

Natural history notes: *Hylarana guentheri* is common on both islands. We observed many individuals and heard advertisement calls at stream banks or in large ponds every night during the survey from May through July 2011.

Distribution: According to Nguyen et al. (2009), *H. guentheri* has been reported from throughout Vietnam, including Bai Tu Long NP.

Hylarana sp. (Fig. 5F)
Specimens examined: Two adult females (IEBR A.2013.41, VNMN 946), nine adult males (IEBR A.2013.27, IEBR A.2013.29–30, IEBR A.0935, VNMN 192, ZFMK 95228–95230, ZFMK 89563), one juvenile (ZFMK 95231).

Morphological features: Adult females SVL 57.2–65.2 mm (n = 2), adult males 47.8–52.8 mm (n = 9), one juvenile SVL 35.4 mm.

Comments: For specific identification, the adult *Hylarana* from Bai Tu Long were compared with their congeners from Vietnam (Frost 2013). Morphological comparisons revealed that the Ba Mun *Hylarana* is most similar to *H. spinulosa*, a species endemic to Hainan Island (China) (see IUCN 2013). However, the taxonomic status of the *Hylarana* from Bai Tu Long needs further clarification.

Natural history notes: *Hylarana* sp. is common on Ba Mun Island. Juvenile, subadult, and adult specimens were observed within disturbed primary forest (predominately in evergreen forest), whereas this species was never found in bamboo forest. In particular, frogs were abundant in streams, on stream banks or large ponds. In addition, *Hylarana* sp. occurs in syntopy with *H. guentheri*.

Rhacophoridae

Polypedates mutus (Smith, 1940) (Fig. 5G)

Specimens examined: Seven adult males (VNMN 200, VNMN 208, VNMN 931–932, VNMN 944, ZFMK 95232–95233), one juvenile (VNMN 945).

Morphological features: Adult males SVL 52.8–74.6 mm (n = 7), one juvenile SVL 33.6 mm; snout pointed, triangular in shape; pupil horizontal; tympanum distinct; fingers expanded into wide discs, with small rudiments of webbing at their bases; tips of toes widened into discs, smaller than those of fingers, toes webbed for two-thirds of their lengths; limbs without dermal appendages; dorsum with small tubercles, rough; belly and ventral side of thighs granular; with co-ossified skin on head; single tubercles beneath cloaca; males with light nuptial pads that are covered with small spikes.

Coloration based on preserved material: Dorsum light brown: uniform (VNMN 932, ZFMK 95232), with darker vertebral stripes (VNMN 200, VNMN 208, VNMN 944, VNMN 945, ZFMK 95233), or with an X-shaped mark on head as well as in neck area and single dark blotches; sides of head and flanks with a dark band extending from posterior corner of eye, running above tympanum to above arm pit or middle of flank; flanks bright brown with dark blotches; inner and outer parts of thighs brown with large bright blotches; ventral surface of body white or beige, uniform (ZFMK 95232–95233) or with darker spots on throat, chest and hind limbs (identified after Ziegler 2002, Ziegler et al. 2006).

Natural history notes: *Polypedates mutus* is common on both islands. It occurs in syntopy with *Microhyla heymonsi*, *Hylarana guentheri*, and *Hylarana* sp. We frequently observed amplectant specimens, heard mating calls, and discovered foam nests throughout field surveys between May and July 2011. This species was mainly found on bamboo branches.

Distribution: Nguyen et al. (2009) reported this species from the following provinces in Vietnam: Lang Son, Hai Phong, Bac Giang, Nghe An, and Quang Binh. This is the first record of this species from Bai Tu Long NP as well as Quang Ninh Province. Previous records of *P. leucomystax* from Vietnam were based on misidentified *P. mutus* and *P. megacephalus* (Kuraishi et al. 2013).

Theloderma asperum (Boulenger, 1886) (Fig. 5H)

Specimens examined: Four adult males (IEBR A.2013.28, VNMN 941, VNMN 2013.11, ZFMK 95234).

Morphological features: Adult males SVL 28.3–30.8 mm (n = 4); head broader than body; snout rounded; tympanum distinct; vomerine teeth absent; fingers free of webbing, with large discs; toes webbed for three quarters of their lengths or more, tips of toes with large discs, smaller than tympanum; inner metatarsal tubercle indistinct; tibiotarsal articulation reaching tip of snout; skin on dorsum and flanks with small rough granular tubercles; throat smooth; venter granular.

Coloration in life: Dorsal surface of head and body brown-blackish or greyish, with whitish, creamy or light brown blotches in dorsolateral region of snout, interorbital area, dorsal side of head; each side of body with a cream-coloured band starting off on neck, running above armpits and along flanks to groin; hind limbs with dark transverse bars; head with a short transverse brown line between eyes (IEBR A.2013.28, VNMN 2013.11) or with a dark blotch (ZFMK 95234); ventral surface of body and limbs blackish with whitish marbling (identified after Bourret 1942, Taylor 1962).

Natural history notes: Mating calls were regularly heard during night surveys on Ba Mun Island, but frogs were only observed on 13 May 2011. Adult males and tadpoles of *Theloderma asperum* were seen in a tree hole approximately 80 cm above the ground, 15–20 cm in diameter, and filled with turbid water. The males were perched on the edge of the tree hole. A second tree hole containing tadpoles and eggs of *T. asperum* was detected in a disturbed broad-leaved forest during a night survey (16 May 2011).

Distribution: *Theloderma asperum* is known from northern Vietnam (Nguyen et al. 2009). This is the first record from Bai Tu Long NP as well as Quang Ninh Province.

Reptilia

Agamidae

Acanthosaura lepidogaster (Cuvier, 1829) (Fig. 6A)

Specimens examined: One adult female (ZFMK 95187), three adult males (IEBR A.2013.31, VNMN 930, VNMN 943).

Morphological features: Adult female SVL 69.8 mm, TAL 115.0 mm; adult males SVL 62.9–71.0 mm, TAL 94.3–113.5 mm (n = 3); head large; body slender, tail compressed and long; nuchal crest of nine spines, dorsal crest distinct, low; gular sac absent; fold in front of the shoulder absent; tympanum distinct; canthus rostralis and supraciliary edge distinct; postorbital and nuchal spines distinct; supralabials 10–12; infralabials 11–13; lamellae under fourth finger 15–21; dorsum with heterogeneous scales; femoral pores absent.

Coloration in life: Males with a dark greyish head, dorsum and sides of body greenish with irregular grey bands; limbs and tail with grey transverse bars; ventral side of head, body and tail white or yellowish with irregular greyish blotches; single female reddish to brown above (identified after Ziegler 2002, Bourret 2009, Nguyen et al. 2011b).

Comment: Due to morphological differences among its populations, the taxon *A. lepidogaster* currently refers to a species complex (Manthey 2008, Wood et al. 2010).

Natural history notes: *Acanthosaura lepidogaster* is common on both islands. The lizards were discovered predominately in evergreen forest resting on vines, usually at a height of 1.5–2.5 m above or next to a forest stream.

Distribution. This species has previously been reported from Quang Ninh Province by Nguyen et al. (2009).

Pseudocalotes brevipes (Werner, 1904) (Fig. 6B)
Specimens examined: One adult female (IEBR A.2013.44), one adult male (ZFMK 95188).

Morphological features: Adult female SVL 63.4 mm, TAL 125.5 mm; adult male SVL 66.3 mm, TAL 138.2 mm; head large; body slender; supralabials 8–10; infralabials 7–10; nuchal crest of seven spines, dorsal crest spines absent; subdigital lamellae of fourth toe 18; subdigital lamellae of third toe modified, keels on anterior edge enlarged, keels on posterior edge reduced; fold in front of shoulder absent; midbody scale row points straight backwards, lateral scales keeled, ventral scales strongly keeled; gular region with keeled scales; gular sac small but distinct.

Coloration in life: Head and body greyish to light brown dorsally; head with four brownish streaks laterally, radiating from below eye to lower lip; venter white with light grey or light beige marbling; gular region of adult male with a dark brown blotch, framed by a light yellow-greenish area, female without dark brown blotch but with a small light yellowish blotch; limbs of adult male light yellowish green dorsally; both specimens with light spots on elbows and knees; oral cavity blue (identified after Hallermann & McGuire 2001, Hallermann et al. 2010, Nguyen et al. 2011b).

Comment: The adult female contained three white eggs with a maximum length of 9.2–9.5 mm.

Natural history notes: The adult female (IEBR A.2013.44) was found at night on a thin branch of a shrub, approximately one meter above the ground. The adult male (ZFMK 95188) was found next to a forest stream during a night survey.

Distribution: This is the first record from Bai Tu Long NP as well as Quang Ninh Province.

Eublepharidae
Goniurosaurus lichtenfelderi (Mocquard, 1897) (Fig. 6C)
Specimen examined: One adult female (ZFMK 95189).

Morphological features: Adult female SVL 89.5 mm, TAL 40.2 mm; head large, triangular in dorsal view; body slender; neck distinct; rostral large, broader than high; supralabials eight; infralabials eight; postmentals not enlarged; ear-opening distinct; pupil vertical; fingers and toes clawed, with transverse lamellae beneath; tail regenerated, shorter than SVL; snout with tiny rounded granules, anterior area of head with single larger rounded tubercles; dorsum with small scales and larger rounded tubercles, more densely arranged on flanks; ventral side with small scales, larger on belly; adult female with 21 precloacal pores.

Coloration in life (photo taken from another specimen collected in BTL NP): Dark brown, dark grey, or blackish marbled above, with four narrow whitish, yellowish transverse crossbars; tail with seven narrow white bands (preserved specimen with regenerated tail, without white bands on tail); iris rust-coloured, eye framed with orange; pale greyish below (identified after Smith 1935, Ziegler et al. 2008, Bourret 2009).

Natural history notes: *Goniurosaurus lichtenfelderi* is common on both islands. Specimens were frequently seen under, between or near huge rock boulders along the edge of streams in mixed forest of bamboo and broad-leaved trees.

Distribution: *Goniurosaurus lichtenfelderi* is known from the Gulf of Tonkin and Hai Duong and Bac Giang provinces, both of which border Quang Ninh Province (Nguyen et al. 2009, Nguyen 2011).

Gekkonidae
Hemidactylus frenatus Duméril & Bibron, 1836 (Fig. 6D)
Specimens examined: Three adult females (IEBR A.2013.47, VNMN 948, ZFMK 95190), one adult male (ZFMK 95191).

Morphological features: Adult females SVL 51.1–56.4 mm, TAL 50.0–62.7 mm (n = 3); adult male SVL 50.4 mm, TAL 47.2 mm; head and body strongly depressed dorsolaterally; ventrolateral folds weakly developed; head elongated, oval, and slightly distinct from neck; rostral notched and in contact with nares; supralabials eleven; infralabials eight or nine; adult male with 26 preanofemoral pores; dorsum and limbs with small scales; limbs short; inner fingers and toes clawed; subdigital lamellae paired, five to eight; tail strongly depressed dorsolaterally and with small spines laterally.

Coloration in life: Dorsal surface light grey, beige, or yellow; ventral surface white to light yellow, tips of fingers and toes darker than rest of body (identified after Nguyen et al. 2011b).

Natural history notes; Three specimens of *Hemidactylus frenatus* (IEBR A.2013.47, ZFMK 95190–95191) were collected in the ranger stations on both islands during the night. Two females contained two eggs each (ZFMK 95190: maximum lengths: 8.6 and 9.2 mm, n = 2; IEBR A.2013.47: maximum lengths: 5.9 and 5.5 mm, n = 2).

Distribution: This species was previously reported from Bai Tu Long NP by Le & Vo (2005).

Gekko reevesii (Gray, 1831) (Fig. 6E)
Specimens examined: One adult male (VNMN 950)

Morphological features: Adult male SVL 120.8 mm, TAL 119.3 mm; head large and somewhat depressed dorsolaterally; snout obtusely pointed; nares not in contact with rostral; supralabials 12; infralabials 11; ventrolateral folds weakly developed; fingers and toes broadly widened, no webbing between fingers and toes; subdigital lamellae undivided; inner fingers and toes well-developed, without claws, other fingers and toes clawed; dorsum, tail and limbs with enlarged tubercles; precloacal pores 21.

Coloration of preserved specimen: Dorsal face mottled with greyish, venter cream in colour, tail with dark grey transverse bars (identified after Rösler et al. 2011).

Natural history notes: A single adult male was collected during the survey in September 2009, but the species was frequently heard calling during the survey period in 2011.

Distribution: Rösler et al. (2011) revalidated the taxon *G. reevesii* and gave this species' distribution in northern Vietnam as extending southwards to Quang Binh Province.

Gekko cf. *palmatus* Boulenger, 1907 (Fig. 6F)

Specimens examined: Two adult females (IEBR A.2013.50, IEBR A.2013.52), three adult males (IEBR A.2013.48–49, IEBR A.2013.51).

Morphological features: Adult females SVL 65.2–71.4 mm, TAL 70.1–78.5 mm (n = 2); adult males SVL 64.6–

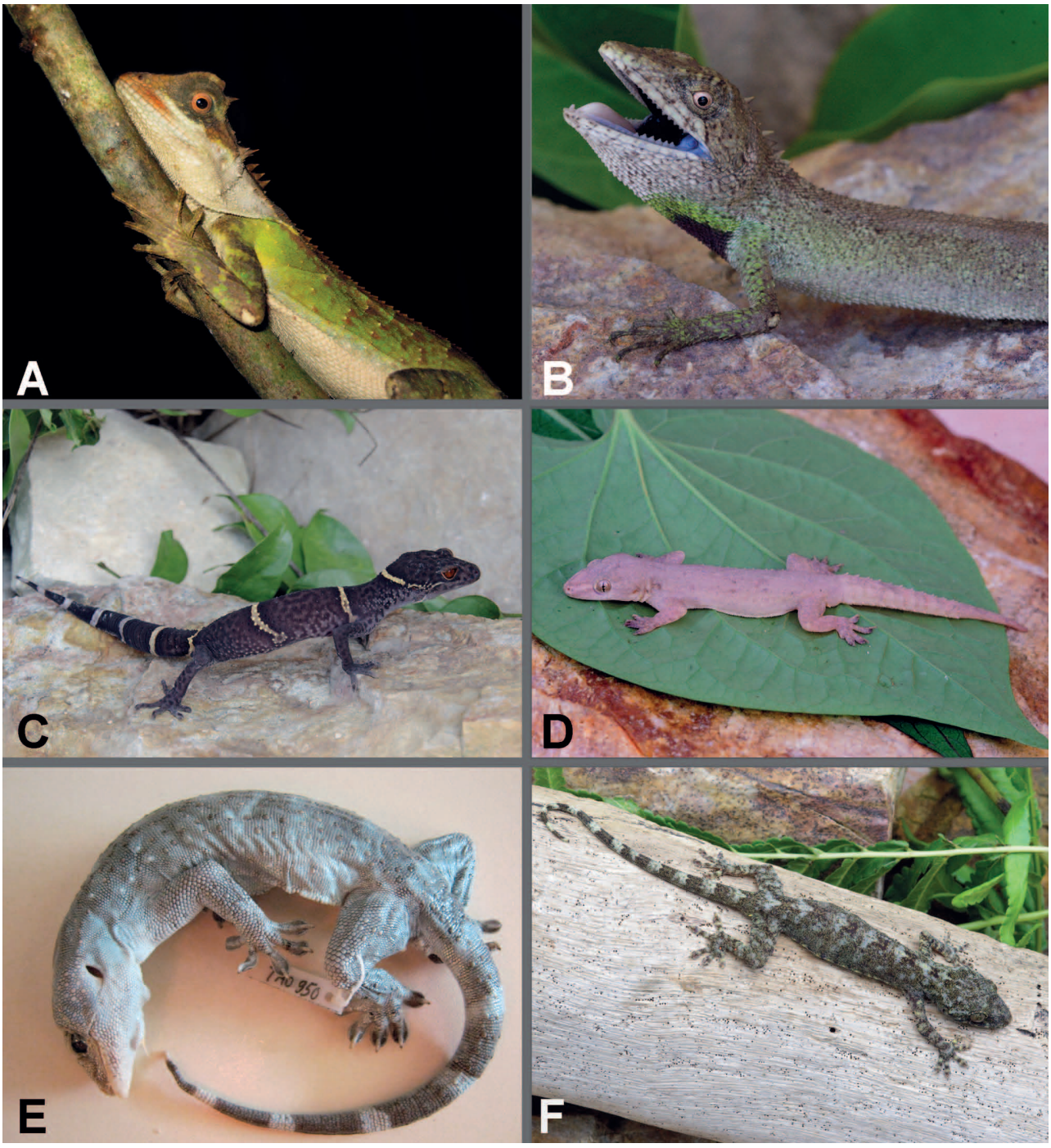

Figure 6. Reptiles: A) *Acanthosaura lepidogaster*; B) *Pseudocalotes brevipes* (ZFMK 95188); C) *Goniurosaurus lichtenfelderi*; D) *Hemidactylus frenatus* (ZFMK 95191); E) *Gekko reevesii* (VNMN 950); F) *Gekko* cf. *palmatus* (IEBR A.2013.52).

70.7 mm, TAL 65.9–77.0 mm (n = 3); body and tail slightly depressed dorsoventrally; ventrolateral folds weakly developed; supralabials 14 or 15; infralabials 9–12; nostril in contact with rostral; internasals one or two; tubercles on dorsum and limbs distinct; males with 27 or 28 precloacal pores; subdigital lamellae under fourth toe 14–16; toes webbed.

Coloration in life: Head, body, and tail with greyish, olive-green, brownish marbling dorsolaterally, with light greyish middorsal blotches, tail and limbs with light greyish and dark crossbars; venter dirty white with grey or beige spots (identified after Smith 1935, Rösler et al. 2005, Ziegler et al. 2006, Nguyen et al. 2011b).

Comments: Specimens collected on Large Tra Ngo Island had a rostral scale that was posteriorly notched in the middle. This feature was reported previously by Ziegler et al. (2006) based on a single adult female from Quang Binh Province (Phong Nha-Ke Bang National Park, Vietnam). Our specimens also have small tubercles on the dorsum and limbs, which are lacking in *Gekko palmatus* sensu stricto. At present, only detailed molecular analysis together with further morphological investigations will show whether *Gekko palmatus* or a morphologically similar taxon inhabits Large Tra Ngo Island (Cai Lim area) in Bai Tu Long NP.

Natural history notes: Five specimens of *Gekko* cf. *palmatus* were collected in a karst forest area on Large Tra Ngo Island (Cai Lim area) during the night (13 June 2011) (Fig. 4B). The adult female (IEBR A.2013.52) contained two yellowish eggs with a maximum length of 6.7–7.5 mm.

Distribution: Nguyen et al. (2009) reported this species from Quang Ninh Province (Cu Lao Phon Vong Island), but ours is the first record from Bai Tu Long NP.

Scincidae

Eutropis longicaudatus (Hallowell, 1857) (Fig. 7A)

Specimens examined: One specimen photographed on Large Tra Ngo Island (25 May 2011).

Morphological features: Scalation of head and colour pattern observed from photographic records agree well with the descriptions by Smith (1935) and Ziegler (2002).

Natural history notes: Frequently observed near ranger stations on Ba Mun and Tra Ngo islands during the day.

Distribution: *Eutropis longicaudatus* has already been recorded from Bai Tu Long NP (Le & Vo 2005, Nguyen et al. 2009).

Ateuchosaurus chinensis Gray, 1845 (Fig. 7B)

Specimens examined: One adult female (ZFMK 95178), one adult male (IEBR A.2013.43).

Morphological features: Adult female SVL 74.6 mm, TAL 71.1 mm; adult male SVL 80.4 mm, TAL 94.1 mm; snout short and obtuse; frontonasal slightly broader than long, in contact with rostral and frontal; prefrontals small, widely separated from each other; frontal truncated anteriorly; frontoparietals as large as interparietal, not in contact with each other; nuchals absent; supraoculars four, first, and second in contact with frontal; tympanum deeply sunk; supralabials six; infralabials six or seven; body scales subequal, dorsal scales slightly smaller than ventrals; midbody scale rows 28; ventrals in 52–55 transverse rows, smooth; tail thick at base, tapering to a fine point; limbs short, pentadactyl; subdigital lamellae under fourth toe 16–18.

Coloration in life: Dorsal head, body, and tail brown, each scale with a slightly darker central spot; flanks paler and spotted with black and white, black spots preceding the white ones; neck blackish with white spots laterally; limbs brown dorsolaterally; ventral sides of head and body whitish to cream, ventral side of tail whitish to cream and with brown spots (identified after Smith 1935, Nguyen et al. 2008).

Natural history notes: Both specimens of *Ateuchosaurus chinensis* were discovered at the edge of a rotting tree trunk during a night survey on Ba Mun Island (14 May 2011).

Distribution: In Vietnam, this species is known from Lang Son, Ha Giang, Bac Giang, and Nghe An Provinces (Nguyen et al. 2008, 2009). This is the first record from Bai Tu Long NP as well as Quang Ninh Province.

Plestiodon quadrilineatus Blyth, 1853 (Fig. 7C)

Specimens examined: One adult female (IEBR A.2013.42), one adult male (ZFMK 95179).

Morphological features: Adult female SVL 62.9 mm, TAL 103.3 mm; adult male 88.4 mm, TAL 116.6 mm; body slender; snout obtuse; second supraocular larger than first; frontoparietals well developed, in contact with each other; interparietal as large as frontoparietal; nasal small, followed by one postnasal; anterior loreal higher than long, shorter than the posterior one, in contact with the supranasal; supralabials eight, first in contact with postnasal; postmental undivided; midbody scale rows 20 or 21; paravertebral scales 45; tail thin; limbs well-developed, pentadactyl; subdigital lamellae under fourth toe 20 or 21.

Coloration in life: The adult male is greyish-olive above with two broad dorsolateral stripes, extending from posterior corner of eye to middle of tail, head with reddish-orange bands dorsally and laterally, light greyish to cream below; adult female dark brown to black on head and dorsum, with four longitudinal stripes: dorsolateral pair from the tip of snout to the end of tail, lateral pair from upper lip along the flanks to the groin, stripes yellowish to orange in head and neck region, cream on body, and metallic blue on tail; whitish to greyish below (identified after Smith 1935, Nguyen et al. 2011b).

Natural history notes: The adult male was discovered together with *Ateuchosaurus chinensis* and *Sphenomorphus tonkinensis* at the edge of a rotting tree trunk within a mixed forest of bamboo and broad-leaved trees during a night survey (14 May 2011). The adult female was found along a forest path during the day (5 June 2011).

Distribution: *Plestiodon quadrilineatus* has previously been recorded from Bai Tu Long NP, Quang Ninh Province (Nguyen et al. 2009).

Sphenomorphus tonkinensis Nguyen, Schmitz, Nguyen, Orlov, Böhme & Ziegler, 2011 (Fig. 7D)

Specimens examined: One adult female (ZFMK 95180), six adult males (IEBR A.2013.32–33, ZFMK 95181–95184).

Morphological features: Adult female SVL 48.9 mm, TAL 65.1 mm; adult males SVL 34.1–47.9 mm, TAL 39.7–67.4 mm (n = 6); body slender; head longer than wide; snout obtuse; rostral wider than high, visible from above; supranasals absent; frontonasal wider than long, in contact with rostral; prefrontals in contact with each other medially; supraoculars four; lower eyelid movable, scaly; supralabials seven; tympanum slightly sunk; postmental undivided; midbody scales in 32–34 rows; dorsal scales smooth; limbs well developed, pentadactyl; subdigital lamellae under fourth toe 15–17.

Figure 7. Reptiles: A) *Eutropis longicaudatus* (Photo: A. Dogra); B) *Ateuchosaurus chinensis* (IEBR A.2013.43); C) *Plestiodon quadrilineatus* (IEBR A.2013.42); D) *Sphenomorphus tonkinensis* (Photo: T. Ziegler); E) *Tropidophorus hainanus* (IEBR A.2013.36).

Coloration in life: Head, dorsum and tail brown with one dark discontinuous vertebral stripe (from neck to tail base) and one dark dorsolateral stripe on either side of body (from nostril to first third of tail or to tip of tail), limbs dark brown with light spots; supralabials and infralabials whitish with dark bars; head, body, limbs and tail cream below (identified after Nguyen et al. 2011a).

Natural history notes: *Sphenomorphus tonkinensis* is common on both islands. This species prefers moist loamy ground covered with dead leaves, roots or rotten branches.

Distribution: In Vietnam, this species has been reported from the following localities: Vinh Phuc and Quang Ninh Provinces as well as Hai Phong City (Nguyen et al. 2011a).

Tropidophorus hainanus Smith, 1923 (Fig. 7E)
Specimens examined: One adult female (IEBR A.2013.36), one subadult female (IEBR A.2013.53), two adult males (ZFMK 95185–95186).

Morphological features: Adult female SVL 57.8 mm, TAL 62.1 mm; subadult female SVL 35.3 mm, TAL 44.4 mm; adult males SVL 43.0–44.1 mm, TAL 37.9–56.3 mm (n = 2); snout obtuse; rostral wider than high; upper head scales striated; frontonasal undivided; prefrontals separated from each other; nuchals absent; loreals four; superciliaries five or six, superciliary row incomplete along the entire length of lateral edge of supraoculars; supraoculars four; supralabials five; infralabials four or five; postmental undivided; midbody scales in 32–35 rows; ventrals in 49–52 transverse rows; tail thick at base, tapering to a fine point; fourth toe with 17–20 subdigital lamellae.

Coloration in life: Head, dorsum, limbs, and tail brown; snout slightly reddish dorsally, slightly yellowish laterally, supralabials and infralabials with dark bars; dorsum, flanks, and tail with beige to orange bands or V-shaped blotches; limbs with beige yellowish bars or spots; venter cream to greyish, ventral side of tail marbled with greyish to brownish (identified after Smith 1935, Bourret 2009, Nguyen et al. 2010).

Natural history notes: Specimens of *T. hainanus* were only found within predominantly bamboo forest on Large Tra Ngo Island in 2011.

Distribution: This is the first record of this species from Bai Tu Long NP as well as Quang Ninh Province.

Serpentes
Colubridae
Ahaetulla prasina (Boie, 1827) (Fig. 8A)
Specimens examined: One subadult specimen (VNMN 942), another specimen (unknown gender) was observed on 19 May 2011.

Morphological features: Subadult specimen TL 333 mm, TAL 99 mm; with slender body and tail; snout tapered to a point; eyes large, transversely oval with horizontal pupil; loreals two; supralabials eight, fourth, and fifth in contact with eye; preocular one; postoculars two; temporals 2+2; dorsal scales smooth, in 13:15:13 rows; ventrals 197; subcaudals 125, paired; anal scute divided.

Coloration in life: Greyish to light beige dorsolaterally, with yellowish area on neck and white and black single streaks, forming bands in anterior third of body; venter whitish (identified after Pope 1935, Manthey & Grossmann 1997, Ziegler 2002, Ziegler et al. 2007).

Natural history notes: Another specimen of *A. prasina* was observed during a night survey on Large Tra Ngo Island (19 May 2011). The snake was resting on a branch three to four metres above the ground in a forest dominated by bamboo.

Distribution: This species has previously been recorded from Quang Ninh Province (Nguyen et al. 2009).

Coelognathus radiatus (Boie, 1827) (Fig. 8B)
Specimens examined: One adult male (ZFMK 95192).

Morphological features: Adult male TL 1,040 mm, TAL 207 mm; snout twice as long as eye; loreal slightly longer than high; preoculars single; postoculars two; temporals 2+2; supralabials nine, fourth to sixth entering orbit, sixth in contact with temporal; dorsal scales keeled, in 21:19:18 rows; ventrals 225; subcaudals 93, divided; anal scute undivided.

Coloration in life: Brown above with two wide, blackish middorsal stripes and four narrow, blackish lateral ones, lower pair broken into a series of elongated lines, from behind neck to midbody; ventral face greyish, cream in first third of body; head brown dorsolaterally, with a thin black bar across occiput and three black streaks radiating from below and behind eye (identified after Pope 1935, Bourret 1936, Smith 1943, Manthey & Grossmann 1997, Ziegler 2002, Ziegler et al. 2007).

Natural history notes: The adult male was found near the ranger station on Ba Mun Island on the morning of 16 June 2011.

Distribution: This species has previously been recorded from Bai Tu Long NP (Le & Vo 2005).

Lycodon meridionalis Bourret, 1935 (Fig. 8C)
Specimens examined: One adult female (ZFMK 95193).

Morphological features: Adult female TL 1,113 mm, TAL 242 mm; head elongate, depressed, distinct from neck; body elongate, slender; rostral nearly twice as long as high, slightly visible from above; internasals distinctly shorter than prefrontals; loreal elongate, separated from eye; preoculars single; postoculars two; temporals 2+3; supralabials eight, third to fifth entering orbit; dorsal scales feebly keeled, in 10–12 median rows, smooth in outer rows, in 17:17:15 rows; ventrals 227; subcaudals 98; anal scute divided.

Coloration in life: Blackish with yellow thin crossbars above, bifurcated on sides, enclosing dark spots; flanks yellowish, marbled with black; ventral face whitish with irregular black blotches; head blackish dorsally, with symmetrical yellowish markings (identified after Bourret 1936, Smith 1943).

Comments: Siler et al. (2013) synonymised *Dinodon* with the genus *Lycodon*.

Figure 8. Reptiles: A) *Ahaetulla prasina*; B) *Coelognathus radiatus* (ZFMK 95192); C) *Lycodon meridionalis* (ZFMK 95193); D) *Oligodon chinensis* (IEBR A.2013.46); E) *Psammodynastes pulverulentus* (ZFMK 95196); F) *Opisthotropis lateralis* (IEBR A.2013.54); G) *Bungarus fasciatus*; H) *Pareas margaritophorus* (ZFMK 95197).

Natural history notes: The adult female was collected in a limestone cave on Large Tra Ngo Island at night (13 June 2011).

Distribution: Our record is the first from Bai Tu Long NP as well as Quang Ninh Province.

Oligodon chinensis (Günther, 1888) (Fig. 8D)
Specimens examined: One subadult specimen (ZFMK 95194), one adult male (IEBR A.2013.46).

Morphological features: Subadult specimen TL 377 mm, TAL 66 mm; adult male TL 483 mm, TAL 105 mm; head short, not distinct from neck; eyes moderately large, with round pupil; body cylindrical; rostral large, extending well onto upper face of snout; loreal square in shape, separated from eye; preocular single; postoculars two (three in ZFMK 95194); temporals 1+1; supralabials eight, fourth, and fifth entering orbit; dorsal scales smooth, in 17:17:15 rows; ventrals 177–180; subcaudals 54–63, paired; anal scute entire.

Coloration in life: Brown-reddish above, with a series of narrow black-edged blotches, separated by three more or less distinct dark cross-bars; ventral face white with squarish spots on the outer margins of the ventrals (whole body in ZFMK 95194 or first third of body followed by nearly completely dark scales to cloaca in IEBR A.2013.46), in both specimens the tail is white with dark spots ventrally (identified after Bourret 1936, Smith 1943, Ziegler et al. 2007, David et al. 2008).

Natural history notes: Both individuals were found during nightly surveys on Ba Mun Island in 2011. The snakes were resting on the branches of a shrub approximately two metres above the ground, next to a forest stream.

Distribution: This species has previously been recorded from Quang Ninh Province (Nguyen et al. 2009).

Lamprophiidae
Psammodynastes pulverulentus (Boie, 1827) (Fig. 8E)
Specimens examined: Three adult females (IEBR A.2013.45, ZFMK 95195–95196).

Morphological features: Adult females TL 400–446 mm, TAL 76–90 mm (n = 3); body cylindrical; head "viper-like", distinctly broader than neck; eyes large, pupil vertically elliptic; snout short, truncated in dorsal view; nostril in a single nasal; rostral a little broader than high; internasals distinctly smaller than prefrontals; frontal narrow, elongate, longer than the distance to the tip of snout; loreal single, as long as high, separated from eye; preocular single; postoculars two; temporals 2+2/3; supralabials seven, third to fifth entering orbit; fourth very large; genials in three pairs; dorsal scales smooth, in 17:17:15 rows; ventrals 162; subcaudals 56–62; anal scute entire.

Coloration in life: Light brown, greyish brown to ochre above, with dark brown or light brown spots, blotches, or short bands on either side; dorsal face of head with three or four, long, dark, symmetrical lines and a bright Y-shaped marking; flanks with the same colour pattern as dorsum (IEBR A.2013.45), with a brownish (ZFMK 95195) or yellowish ochre longitudinal band (ZFMK 95196); ventral face cream in ground colour, densely peppered with brown or with brown longitudinal lines (ZFMK 95195–95196) (identified after Pope 1935, Bourret 1936, Smith 1943, Malkmus et al. 2002, Ziegler 2002, Ziegler et al. 2007).

Natural history notes: In 2011, specimens of *Psammodynastes pulverulentus* were sighted on Ba Mun Island at night. The snakes were resting on shrubs, two to five metres from a forest stream.

Distribution: *P. pulverulentus* has previously been recorded from Quang Ninh Province (Nguyen et al. 2009).

Natricidae
Opisthotropis lateralis Boulenger, 1903 (Fig. 8F)
Specimen examined: One adult female (IEBR A.2013.54).

Morphological features: Adult female TL 462 mm, TAL 75 mm; internasals as broad as long; loreal longer than high, not touching internasal; preoculars two; postoculars two; temporals 1+2; supralabials ten, fifth, and sixth entering orbit; anterior genials longer than posterior ones; dorsal scales smooth anteriorly, keeled posteriorly, in 17:17:17 rows; ventrals 166; subcaudals 45.

Coloration in life: Uniform dark brown dorsally and laterally, venter yellowish (identified after Bourret 1936, Smith 1943, David et al. 2011b).

Natural history notes: The specimen was found in a stream next to the ranger station on Ba Mun Island (16 June 2011) and contained five yellowish eggs with maximum lengths from 19.1 to 21.2 mm.

Distribution: *O. lateralis* has previously been recorded from Quang Ninh Province (Nguyen et al. 2009).

Elapidae
Bungarus fasciatus (Schneider, 1801) (Fig. 8G)
Specimens examined: One specimen was observed on Large Tra Ngo Island (21 May 2011) and another on Ba Mun Island (21 June 2011).

Morphological features: Scalation of head and colour pattern as observed from photographic records agree with the descriptions by Ziegler (2002), Malkmus et al. (2002), and Ziegler et al. (2007).

Natural history notes: The first specimen was seen on Large Tra Ngo Island (21 May 2011) while it was resting on the ground amongst dead bamboo leaves approximately 25 m from the ranger station. The second specimen was seen during a nightly survey on Ba Mun Island (21 June 2011) while it was crawling along a forest stream.

Distribution: This species has previously been recorded from Quang Ninh Province (Nguyen et al. 2009).

Pareatidae
Pareas margaritophorus (Jan, 1866) (Fig. 8H)
Specimens examined: One adult female (ZFMK 95197).

Morphological features: Single adult female TL 359 mm, TAL 53 mm; eyes moderately large; internasals half as long as prefrontals; prefrontal in contact with eye; frontal as long as broad; loreal longer than high, not in contact with eye; preoculars two; postocular single, elongated; temporals 2+3; supralabials eight; dorsal scales smooth, in 15:15:15 rows; ventrals 146; subcaudals 37, paired; anal scute entire.

Coloration in life: Dorsal surfaces of head, body, and tail dark greyish with short transverse bars composed of black and white spots on sides of body, scales white anteriorly and black posteriorly; supralabials cream and peppered with greyish; neck with a cream transverse band; ventral surface white, speckled with dark blotches (identified after Bourret 1936, Smith 1943, Manthey & Grossmann 1997, Ziegler 2002, Ziegler et al. 2007).

Natural history notes: The adult female was collected at night on 18 June 2011 and contained four yellow eggs (two eggs damaged, 14.5 and 16.2 mm in maximum length).

Distribution: This is the first record of the species from Bai Tu Long NP and Quang Ninh Province.

Viperidae

Protobothrops mucrosquamatus (Cantor, 1839) (Fig. 9A)

Specimens examined: Two adult males (VNMN 951, ZFMK 95198).

Morphological features: Adult males TL 838–969 mm, TAL 170–199 mm (n = 2); head rather elongated, triangular in shape; upper scales very small, unequal, obtusely keeled on the posterior part of head; supraoculars long and narrow, entire, separated from each other by 14–16 scales; internasals small, separated by small scales, separated from supraocular by two enlarged scales; supralabials nine, first completely separated from the nasal, third largest; subocular elongated, separated from supralabial by two or three series of small scales; two or three rows of temporal scales above the labials, enlarged, smooth, upper scales smaller, strongly keeled; midbody dorsal scales in 23 rows; ventrals 217–223; subcaudals 96–101; hemipenis morphology largely agrees with the description by Pope (1935).

Coloration in life: Dorsal ground colour brown; head with dark blotches; a zigzag middorsal row of large dark brown blotches, framed with yellow, flanks with smaller dark brown blotches; ventral face light grey or brown with pale yellow spots (identified after Pope 1935, Bourret 1936, Smith 1943, Ziegler 2002, Ziegler et al. 2007).

Natural history notes: In 2011, four specimens of *Protobothrops mucrosquamatus* were seen during nightly surveys. The snakes were each resting a few metres from forest streams.

Distribution: This species has previously been recorded from Quang Ninh Province (Nguyen et al. 2009).

Trimeresurus stejnegeri (Schmidt, 1925) (Fig. 9B)

Specimens examined: One specimen was observed on Large Tra Ngo (Cai Lim) Island in 2009.

Morphological features: Scalation of head and colour pattern, as observable from the photographic record, agree with the descriptions by Ziegler et al. (2007) and Nguyen et al. (2011b).

Distribution: This is the first record of this species from Bai Tu Long NP (Nguyen et al. 2009).

Species diversity

In this study, we record a total of 29 amphibian and reptile species from Bai Tu Long NP: eight frogs, eleven lizards, and ten snakes. Thirteen of these species (44.8%) were recorded for the first time from Bai Tu Long (Fig. 10).

Concerning dominance structures and present abundance data, 163 anuran and 168 reptile individuals were observed during the survey period in 2011. In terms of species richness, Dicroglossidae was the most diverse family of amphibians with three recorded species. Regarding the frequency of occurrence, *Hylarana* sp., *H. guentheri*, and *Polypedates mutus* were the most frequently observed frogs on Ba Mun Island. In constrast, *Hylarana guentheri*, *Limnonectes* cf. *bannaensis,* and *Microhyla heymonsi* were the most common species observed on Large Tra Ngo Island. As far as the numbers of reptile species at family level are concerned, Colubridae and Scincidae were the most diverse families (four and five recorded species, respectively). However, with one to three individuals per colubrid species encountered, the frequency of occurrence was low. Besides, based on individuals counted for each reptile species, only one skink species, viz. *Sphenomorphus tonkinensis*, was really common on Ba Mun Island, followed by an

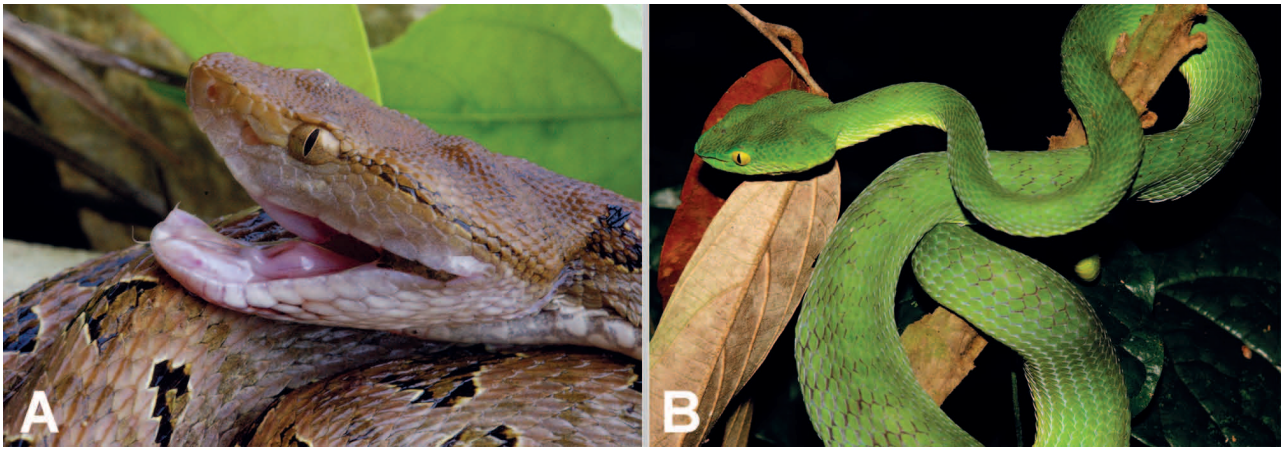

Figure 9. Reptiles: A) *Protobothrops mucrosquamatus* (ZFMK 95198); B) *Trimeresurus stejnegeri* (Photo: T. Ziegler).

eublepharid species (*Goniurosaurus lichtenfelderi*) and one agamid species (*Acanthosaura lepidogaster*). Two skinks (*S. tonkinensis*, *T. hainanus*) and one gecko (*G.* cf. *palmatus*) were the most frequent species on Large Tra Ngo Island.

In terms of habitat occupancy, most frog and reptile species were found along streams in mixed forests of bamboo and hardwood (e.g., *Microhyla heymonsi*, *S. tonkinensis*) near the coast up to an altitude of 120 m a.s.l. However, no more detailed differentiation between evergreen and bamboo forest dwellers is possible due to the lack of a clear-cut delimitation between evergreen and bamboo forest. Seasonal phases of activity were also recorded throughout the sampling period in 2011: it was dry (with the first rains at the beginning of June) with average night temperatures ranging from 27 to 31°C in May. The frog species *Polypedates mutus* and *Hylarana guentheri*, for example, were reproductively active, which explains the high number of records. Both species were frequently observed in amplexus, mating calls were heard regularly, and tadpoles of *Polypedates mutus* were found. Furthermore, with increasing humidity at the beginning of June, most of the reptile species (and some of them even for the first time) were sighted, e.g., *Psammodynastes pulverulentus* and *Oligodon chinensis*.

Discussion

Le & Vo (2005) recorded a total of eight species of amphibians and 19 species of reptiles from the Bai Tu Long NP. Nguyen et al. (2009) recently reported 40 species of reptiles from the Bai Tu Long Archipelago. Of the eight frog species recorded by us between 2008 and 2011, only two common species had previously been recorded from the archipelago by Le & Vo (2005) and Nguyen et al. (2009), i.e. *Hoplobatrachus rugulosus* and *Hylarana guentheri*. Thus, six of the frog species found by us proved to be new records for Bai Tu Long (*Microhyla heymonsi*, *Occidozyga martensii*, *Limnonectes* cf. *bannaensis*, *Hylarana* sp., *Polypedates mutus*, and *Theloderma asperum*). Hence, the number of frog species currently known from Bai Tu Long has increased from eight to 14. Among the 21 recorded reptile species, seven are new records for Bai Tu Long NP (*Pseudocalotes brevipes*, *Gekko* cf. *palmatus*, *Ateuchosaurus chinensis*, *Tropidophorus hainanus*, *Lycodon meridionalis*, *Pareas margaritophorus*, and *Trimeresurus stejnegeri*). The current number of reptile species known from Bai Tu Long is 51. Comparing the 14 recorded frog species from Bai Tu Long NP with the 19 currently recorded species from the geographically close Cat Ba NP (see Nguyen et al. 2009, Le & Vo 2005 and own data), ten species occur in both national parks (similarity index 0.70588; Tab. 1). Comparing our data with the list of amphibians provided by Luu et al. (2013) (n = 50), Bai Tu Long NP shares 11 species with Phong Nha-Ke Bang NP, which is situated in mainland central Vietnam (similarity index 0.36923; Tab. 1).

Concerning reptiles, a total of 51 species are currently known from the Bai Tu Long NP (Nguyen et al. 2009, Le & Vo 2005 and own data). Comparing the updated reptile list from Bai Tu Long NP with the 42 records from Cat Ba (Nguyen et al. 2009), there are 21 corresponding species (similarity index 0.47423; Tab. 2). In contrast, the recently updated reptile list by Luu et al. (2013) reported 100 species. The Bai Tu Long NP is currently known to share 25 reptile species with the Phong Nha-Ke Bang NP (similarity index 0.30872; Tab. 2).

The higher level of species similarity between Bai Tu Long and Cat Ba National Parks, which is also well supported by the PAST-Statistic cluster analysis (Hammer et al. 2001; see Figs 11, 12), can be explained by zoogeographical factors, as both archipelagos are located in the north-

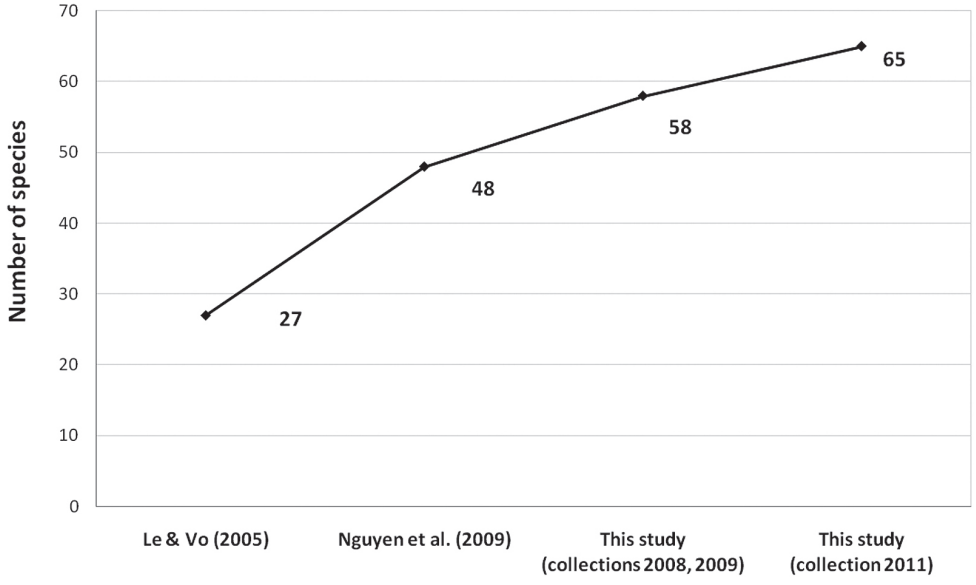

Figure 10. Species accumulation curve for amphibians and reptiles reported from Bai Tu Long National Park, Vietnam (2005–2011).

Table 1. Similarity indices (Dice similarity) of the amphibian faunas of Bai Tu Long, Cat Ba and Phong Nha-Ke Bang National Parks, Vietnam.

	Bai Tu Long NP	Cat Ba NP	Phong Nha-Ke Bang NP
Bai Tu Long NP	–		
Cat Ba NP	0.70588	–	
Phong Nha-Ke Bang NP	0.36923	0.43478	–

Table 2. Similarity indices (Dice similarity) of the reptile faunas of Bai Tu Long, Cat Ba and Phong Nha-Ke Bang National Parks Vietnam.

	Bai Tu Long NP	Cat Ba NP	Phong Nha-Ke Bang NP
Bai Tu Long NP	–		
Cat Ba NP	0.47423	–	
Phong Nha-Ke Bang NP	0.30872	0.41892	–

eastern parts of Vietnam whereas the Phong Nha-Ke Bang National Park is located in mainland central Vietnam, has a different geological and topographic background and thus also offers different climatic and vegetational conditions (e.g., Ziegler et al. 2007).

Looking at biodiversity research in Vietnam in general, it emerges that most studies deal with mainland forest ecosystems (e.g., Ziegler et al. 2006, Hendrix et al. 2008, Tran et al. 2010, Ananjeva et al. 2011, Grismer et al. 2011). So far, only a few papers have focused on island ecosystems and corresponding diversity studies in this country (e.g., Nguyen et al. 2011b). According to Myers et al. (2000), nine of the 25 acknowledged global "hotspots" encompass islands or archipelagos. Additionally, the coastal regions of Vietnam, in particular in the north, are known for their island systems containing both limestone karsts and granite formations (Sterling et al. 2006). Moreover, studying island biodiversity is not only important because distinctive species compositions allow insights into speciation (due to high levels of endemism and restricted geographic ranges), but also because these island characteristics render them unique and thus notably vulnerable to threats, such as habitat loss and climate change (see also Maki et al. 2003, Mulongoy et al. 2006, Gillespie 2006, Witt & Maliakal-Witt 2007, Kreft et al. 2008, Kier et al. 2009).

In conclusion, since this is the first comprehensive herpetofaunal inventory list for the Bai Tu Long Archipelago in northeastern Vietnam, it can be expected that further surveys, other sampling seasons and different sampling areas and islands will yield more data, and thus increase the number of records of species occurring in the Bai Tu Long NP.

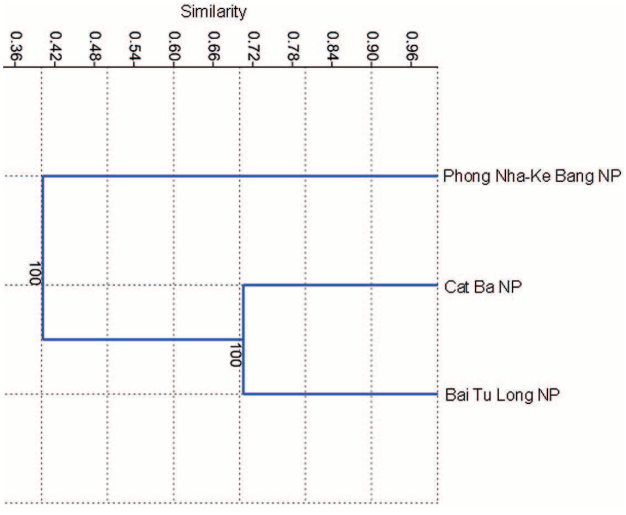

Figure 11. Similarity cluster analysis (Dice index with 100 bootstraps) of the amphibian faunas of Bai Tu Long, Cat Ba and Phong Nha-Ke Bang National Parks, Vietnam.

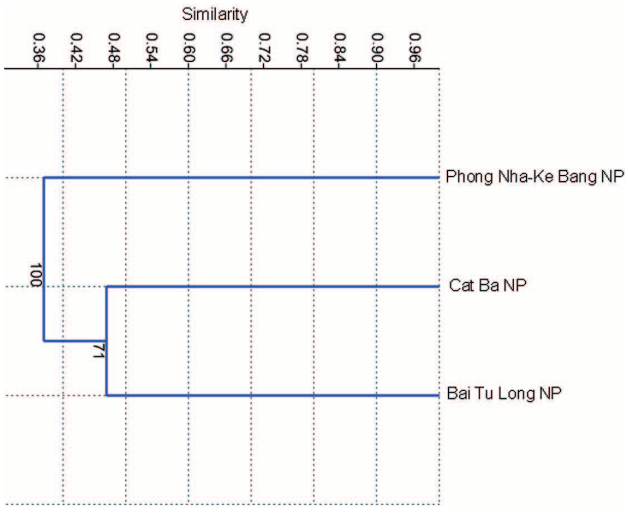

Figure 12. Similarity cluster analysis (Dice index with 100 bootstraps) of the reptile faunas of Bai Tu Long, Cat Ba and Phong Nha-Ke Bang National Parks, Vietnam.

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