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Biodiversity and composition of the herpetofauna from the Tien Hai Wetland Nature Reserve, North Vietnam

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ABSTRACT: Based on the novel data collected during the field surveys in 2019, we here in provided a checklist of eight species of amphibians belonging to seven genera (five families, one order) and nine species of reptiles belonging to eight genera (seven families, two orders) from Tien Hai Wetland Nature Reserve in Thai Binh Province. The species *Hemidactylus stejnegeri* is reported for the first time from Thai Binh Province. In terms of distribution pattern most of recorded species were found in the canal and aquaculture pond habitat (nine species of amphibians and reptiles, 52.94% of the total number of species). The diversity of amphibian and reptile species recorded from Tien Hai Wetland Nature Reserve is lower than the other wetland areas in North Vietnam. In this nature reserve, the number of species change according to salinity of amphibians is higher than of reptiles.

KEYWORDS: Checklist, Distribution, Salinity, Amphibians, Reptiles, Tien Hai.

INTRODUCTION

Mangroves form unique ecological environments which provide an appropriate habitat for a rich assemblage of species. A large amount of organisms like insects, reptiles, amphibians, birds and mammals thrive in this habitat and contribute with its lifestyle to its unique character [1]. In accord to this, Guebas et al. (2005) states that mangrove ecosystems are among the most productive and biologically complex ecosystems on the planet [2].

Tien Hai Wetland Nature Reserve (WNR) was established in 2014 by the People's Committee of Thai Binh an area of 12,500 ha. The major habitat of this area is mangrove forest, consists wetland [3]. However, nothing is known about biodiversity of the Tien Hai Nature Reserve, including the amphibian and reptile fauna. In this paper, we herein provide the first list of amphibians and reptiles from the conservation area and new record of additional species of the Thai Binh Province' herpetofauna.

MATERIALS AND METHODS

Sampling

Field surveys (Figure 1 and 2) were conducted in the following areas of Tien Hai WNR, Thai Binh Province, North Vietnam on 3-8 March, 2019 and 4-9 August, 2019 by Le DT, Lo NT, Do YT, and Tran HN. Sampling locations are along puddles, small ponds, swamps, rotting carpets in casuarina and pulse forests around residential areas. The coordinates of the study sites are determined by Garmin 60CX GPS satellite positioning machine. The study area was subdivided into four zones, Zone 1 (House garden and rice field habitat), Zone 2 (Canal and aquaculture pond habitat), Zone 3 (Mangrove forest habitat), Zone 4 (Habitat casuarina forest habitat). Each month of March and August, a herpetofaunal survey at each breeding site were conducted. Each survey method was performed once during each month at all five sites TH 1-5 (TH1: N20°18.872' E106°35.622'; TH2: N20°18.988' E106°35.770'; TH3: N20°17.192' E106°34.956'; TH4: N20°17.198' E106°34.991'; TH5: N20°18.342' E106°35.605').

Water temperature (°C), salinity (psu) and turbidity (NTU) were measured at each station during the sampling period using a Water Quality Checker (WQC-22A, TOA DDK).

Specimens were collected from 19:00 to 24:00. In addition, specimens can be active during the day so they can be collected from 9:00 am to 16:00 pm, mainly collected by hand. Night surveys within the study sites were conducted using boots, hand lamps and powerful torches to avoid dangerous snakes. After taking photographs specimens were euthanized in a closed vessel with a piece of cotton wool containing ethyl acetate, fixed in 85% ethanol and subsequently stored in 70% ethanol [4]. Specimens were deposited in the Museum of Biology, Hanoi National University of Education (HNUE), Hanoi, Vietnam.

Figure 1. Map showing the geographical location of Tien Hai Wetland Nature Reserve in the North Vietnam

Figure 2. The picture depicts a detailed view of the Tien Hai Wetland Nature Reserve with numbered collection localities

Checklist

Identification of amphibians and reptiles according to Taylor (1962); Smith (1935, 1943); Nguyen (2007); and updated documents. Compare the morphology of collected specimens with identified specimens stored in Biological Museum (Hanoi National University of Education) [5-10]. Checklist, scientific name and English name of species according to documents of Nguyen et al. (2009), Frost (2019), and Uetz et al. (2019) [11-13].

Statistical analysis

The data was analyzed using Microsoft excel software 2007 and PAST as described by Hammer et al, 2001 [13].

RESULTS

Species composition

Based on our field surveys in Tien Hai WNR in 2019, identified a total of 17 species, including eight amphibian species and nine reptile species of which 11 species have samples and six species recorded through observation.

Results show that this area has a low diversity of amphibians and reptiles. Because the majority of the surveyed area is arable land (aquaculture ponds, rice fields, ponds) frequently affected by human activities. Brackish water environment is not a good environment for many amphibians and reptiles, especially amphibians that mainly breathe through the skin. Because the survey site is small, the survey time is not long, so there are undetected species.

Table 1. List of amphibia and reptilia species recorded from Tien Hai Wetland Nature Reserve **(**O: Obserbed, S: Sample, *: New record species for Thai Binh Province**)**

	Species	English name	Sources
	AMPHIBIA		
	ANURA		
	Bufonidae		
1	*Duttaphrynus melanostictus* (Schneider, 1799)	Black-spined toad	S
	Microhylidae		
2	*Microhyla fissipes* Boulenger, 1884	Ornate pigmy frog	S
	Dicroglossidae		
3	*Ferervarya cancrivora* (Gravenhorst, 1829)	Marsh frog	O
4	*F. limnocharis* (Gravenhorst, 1829)	Grass frog	S
5	*Hoplobatrachus rugolosus* (Wiegmanh, 1834)	Common lowland frog	S
	Ranidae		
6	*Sylvirana guentheri* (Boulenger, 1882)	Guenther's frog	S

7	*Hylarana macrodactyla* (Günther, 1876)	Stripe-backed frog	O
	Rhacophoridae		
8	*Polypedates mutus* (Smith, 1940)	Burmese whipping frog	S
	REPTILIA		
	SQUAMATA		
	Gekkonidae		
9	*Hemidactylus frenatus* Duméril & Bibron, 1836	Common house gecko	S
10	*H. stejnegeri* Ota & Hikida, 1989*	Stejneger's leaf-toed gecko	S
	Scincidae		
11	*Eutropis longicaudata* (Hallowell, 1857)	Long-tailed mabuya	O
	Typhlopidae		
12	*Indotyphlops braminus* (Daudin, 1803)	Common blind snake	S
	Homalopsidae		
13	*Hypsiscopus plumbea* (Boie, 1827)	Plumbeous water snake	S
	Colubridae		
14	*Fowlea flavipunctatus* (Hallowell, 1860)	Yellow-spotted keelback	S
	Elapidae		
15	*Bungarus fasciatus* (Schneider, 1801)	Banded krait	O
16	*Naja atra* Cantor, 1842	Chinese cobra	O
	TESTUDINATA		
	Chelonniidae		
17	*Lepidochelys olivacea* (Eschscholtz, 1829)	Olive ridley turtle	O

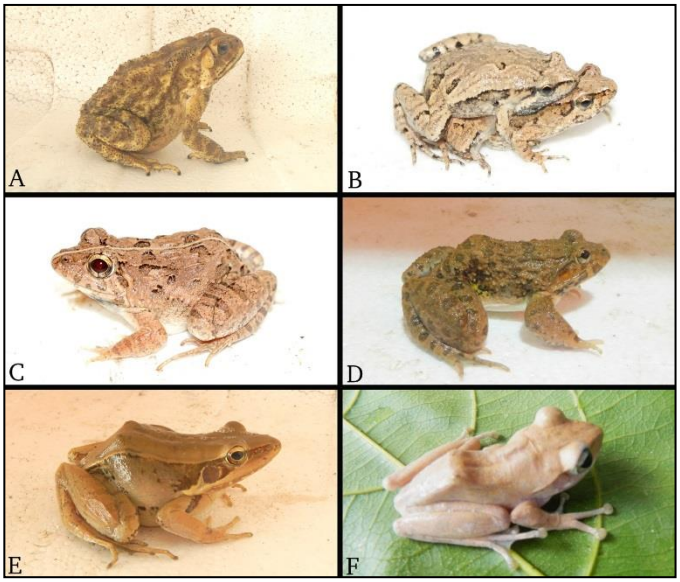

Figure 3. (A) *Duttaphrynus melanostictus*, (B) *Microhyla fissipes*, (C) *Ferervarya limnocharis*, (D) *Hoplobatrachus rugolosus*, (E) *Sylvirana guentheri*, and (F) *Polypedates mutus*.

Figure 4. (A) *Hemidactylus frenatus*, (B) *Hemidactylus stejnegeri*, (C) *Hypsiscopus plumbea*, (D) *Fowlea flavipunctatus*, and (E) *Lepidochelys olivacea.*

Comparison

Comparing the herpetofauna of Tien Hai WNR with mangrove areas in northern Vietnam, including Xuan Thuy National Park (Le et al., 2004), Bai Tu Long National Park (Gowor et al, 2016), Bach Long Vy Island

(Bui et al., 2013) , Cat Ba National Park (Nguyen et al., 2011), there was a remarkable difference in species number of amphibians and reptiles between studied areas [14-17]. In which, the total number of amphibian and reptile species was highest in Cat Ba National Park (23 amphibian species and 40 reptile species), following up by Xuan Thuy National Park (13 amphibian species and 24 reptile species), Bai Tu Long National Park (eight amphibian species and 21 reptile species) and Bach Long Vy Island (5 amphibian species and 15 reptile species). Tien Hai WNR has lowest amphibian and reptile species diversity (eight amphibian species and nine reptile species).

Habitat distribution

Based on habitat fragmentation of Ngo and Hoang (2002) [12], mangrove habitat division of Phan et al. (2004) [19] and based on natural characteristics of Tien Hai WNR, four main habitats in the study area were divided: House garden and rice field habitat, canal aquaculture pond habitat for seafood ponds, mangrove forest habitat, habitat casuarina forest habitat.

Figure 5. Habitats from Tien Hai Wetland Nature Reserve: A) Mangrove forest; B) Canal and aquaculture pond; C) Casuarina forest

Mangrove forest habitat (image of Figure 5A): Consisting of mangrove forests in conservation areas, affected by high tide. Three species have been identified, accounting for 17.65% of the total species (Figure 6).

Canal and aquaculture pond habitat (image of Figure 5B): Habitats include large and small canals and aquaculture ponds in the reserve, areas with tide and current. Nine species have been identified, accounting for 53.94% of the total species (Figure 6).

Casuarina forest habitat (image of Figure 5C): This habitat includes litter, trail in casuarina forest, scrub. Nine species have been identified, accounting for 53.94% of the total species of the system (Figure 6).

House garden and rice field habitat: Including areas surrounding residential areas, vegetable gardens, fields and habitats greatly influenced by daily human activities and production activities. Six species have been identified, accounting for 35.29% of the total species (Figure 6).

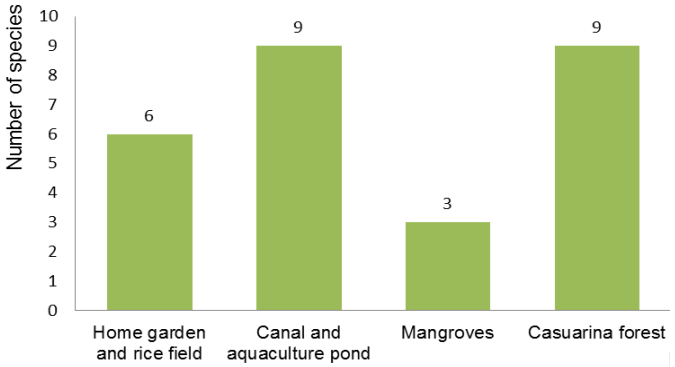

Figure 6. Species diversity of amphibians and reptiles associated with habitat types in Tien Hai Wetland Nature Reserve, Thai Binh Province.

Salinity distribution

It is generally understood that amphibians breed and associate with freshwater habitats such as ponds, lakes and other small water bodies. Many scientific studies have demonstrated that amphibians are particularly vulnerable to saline conditions at embryo, larval and adult stages, for example, research by Hopkins et al. (2015) [20]. In this study we conducted field survey to collect samples and measure salinity at 5 locations TH1, TH2, TH3, TH4, and TH5 as shown in Figure 2. Salinity measurements are conducted in two seasons, the dry season in March 2019 and the rainy season in August 2019.

Based on the results of the field survey, the distribution of some amphibians and reptiles adapted to saline soils in the WNR are as follows: *Duttaphrynus melanostictus, Ferervarya cancrivora, F. limnocharis, Sylvirana guentheri, Hemidactylus frenatus, H. stejnegeri, Eutropis longicaudata* are present in pale brackish to marine brackish, salinity ranges from 2.7-20.3, salinity from 2.7-13.8 in the rainy season and from 13.6 to 20.3 in the dry season. *Microhyla fissipes, Hoplobatrachus rugolosus, Polypedates mutus* are present in waters with salinity of 2.7 to 20.3, salinity of 2.7 to 4 in the rainy season and from 20 to 20.3 in the dry season. *Bungarus fasciatus, Naja atra* are present in waters with salinity from 2.7 to 20.3, salinity from 2.7 to 13.8 in the

rainy season and from 11 to 20.3 in the dry season. *Fowlea flavipunctatus* is present in waters with salinity of 4 to 20.3, salinity from 4 to 11.4 in the rainy season and from 11 to 20.3 in the dry season. *Indotyphlops braminus*, *Enhydris plumbea* are present in saline areas of 4 in the rainy season and 20.3 in the dry season. *Lepidochelys olivacea* is present in waters with a salinity of 11.

Results showed that most species in Tien Hai WNR were able to tolerate salinity from 2.7 to 13.8 in the rainy season and salinity from 11 to 20.3 in the dry season.

The number of reptile species varies according to salinity at TH1, TH2, TH3, TH4, TH5. The salinity level is relatively stable at TH1 and TH2 sites in the rainy and dry seasons, due to the location close to the sea, the number of amphibian reptiles is low. Through field survey, there was no appearance of amphibians at TH1 and TH2 sites, the number of reptiles was low compared to TH3, TH4 and TH5. The salinity and water content of the Th4 and TH5 are significantly different in the dry and rainy seasons due to the location adjacent to the Ba Lat estuary in the rainy season, freshwater from upstream reduces salinity, in the dry season the amount of water decreases salinity increases. The TH4 and TH5 sites have the highest number of amphibians and reptiles due to their low salinity and are farther from the sea than TH1 and TH2. At the TH3 site the number of reptiles is moderate.

The results showed that the increase in salinity decreased the number of reptile and amphibians

Through Figure 7 shows that the number change according to salinity of amphibians is higher than that of reptiles. The number of amphibians is more volatile because amphibians are well known as osmotically sensitive organisms due to their highly permeable skin and eggs, complex life cycles and salt water tends to disrupt the ionic and water exchange across permeable membranes. Reptiles are less affected by salinity, so the fluctuations are low.

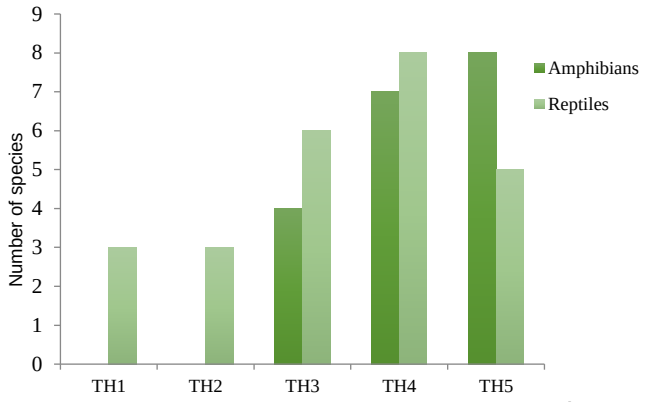

Figure 7. Relationship between number of amphibia, reptile species and survey areas in Tien Hai Wetland Nature Reserve, Thai Binh Province.

DISCUSSION

Vietnam is one of the most well-known countries in the world in terms of amphibians and reptiles diversity with a total of about 780 recognized species [1,13]. However, there are many areas with poorly studied such as high mountains and mangrove areas [2,17]. The checklist of eight species of amphibians belonging to seven genera (five families, one order) and nine species of reptiles belonging to eight genera (seven families, two orders) from Tien Hai Wetland Nature Reserve in Thai Binh Province. This result is low compared to the wetland areas in northern Vietnam. Future herpetological surveys in Tien Hai Wetland Nature Reserve are urgently needed and likely to reveal the existence of further species. If time, team size and preparation are sufficient should be applied to detect more secretive species.

In terms of species richness, the Zone 4 casuarina forest and the Zone 2 canal and aquaculture pond habour the highest number of recorded species (nine species, accounting for 53.94% of total species of the WNR), follow by the Zone 1 house garden and rice field (six species, 35.29% of total species of the WNR), the Zone 3 mangrove forest (three species, 17.65% of the total species of the WNR). The number change according to salinity of amphibians is higher than of reptiles.

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AUTHOR CONTRIBUTIONS

Le DT, Lo NT, Tran HN, and Do YT designed the experiment, Lo NT and Tran HN performed experiments, Le DT and Do YT analyzed the data. Le DT, Lo TN, Tran HN, and Do YT drafted the manuscript and critically revised the manuscript.

CONFLICTS OF INTEREST

Authors declared that they have no conflict of interest.

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