

A preliminary assessment of chelonian diversity in the montane forests of two areas in northern Vietnam

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ABSTRACT - Very little is known of the ecology and distribution of Vietnamese tortoises and freshwater turtles, even though Vietnam is one of the world's hotspots of chelonian diversity and, according to the International Union for the Conservation of Nature (IUCN), almost all its species are threatened. We report the diversity of chelonians for two distinct areas of northern Vietnam (in three provinces) characterised by forested hills and mountains, with ponds and streams. We observed ten species in Lang Son/Bac Giang provinces and 11 species in Lao Cai province. Reportedly, the two most frequently recorded species were *Pelodiscus sinensis* and *Cuora mouhotii*. Most species were Endangered or Critically Endangered according to IUCN, thus making the protection of the forest habitats of these provinces of crucial relevance for the survival of these species. Reliable records for the almost extinct *Rafetus swinhoei* were collected, but all of them refer to the end of the 1970s.

INTRODUCTION

There are currently about 90 species of Asian turtles, which belong to just four families Geomydidae, Testudinidae, Trionychidae, and Platysternidae. This chelonian fauna is among the most diverse and the most threatened in the world (Rhodin et al., 2018; Stanford et al., 2018), with many species listed as Critically Endangered by the World Conservation Union (IUCN, 2022). Since most of the Critically Endangered (CR) and Endangered (EN) species are found in south-eastern China, south-east Asia, Indonesia, northern India and Vietnam (Rhodin et al., 2018), these regions need to be particularly well studied in order to evaluate more precisely the distribution and the ecology of the various species. However, the information available is still scarce, and relatively wide territories, especially in mountainous and comparatively difficult-to-access areas, have to date remained practically unexplored.

In order to cover, at least partially, these mountain territories on which accurate research has never been published, we document in this article the specific diversity of tortoises and freshwater turtles in three provinces of northern Vietnam. The method of investigation (interviews with local hunters and specimens observed in villages) and the short timespan of the study (two missions of a few weeks) prevent us from providing indications on the status of the

populations. However, the data presented here significantly increase our knowledge of chelonian communities in the areas in question, and may be useful as a baseline for future surveys and more detailed field studies.

MATERIALS & METHODS

Study areas

There were two study areas; Lang Son province (21° 50.357' N, 106° 44.579' E), including a small part of Bac Giang province, and Lao Cai province (22° 20.285' N, 104° 8.922' E). These are mountainous areas of northern Vietnam near the Chinese border (Fig. 1). Lang Son and Bac Giang province are characterised by hilly forests and limestone forests with altitudes of 252–1541 m a.s.l. (BKHDT, 2022). The temperature range is about 17–22 °C, mean humidity about 80 % and with annual rainfall in the range of 1200–1600 mm. The forest cover is about 300,000 ha with the Huu Lien Nature Reserve being the most important area for wildlife (Bui et al., 2019; Lunde et al., 2007). In Lao Cai, the altitude range is 100–3143 m a.s.l., with the Hoang Lien National Park being the most important protected area of the region. Temperature range 15–29 °C, mean humidity is about 80 %, and the annual rainfall is in the range of 1400–2000 mm (Lao Cai, 2022). This province also contains several big river systems such as the Red and Chay rivers.

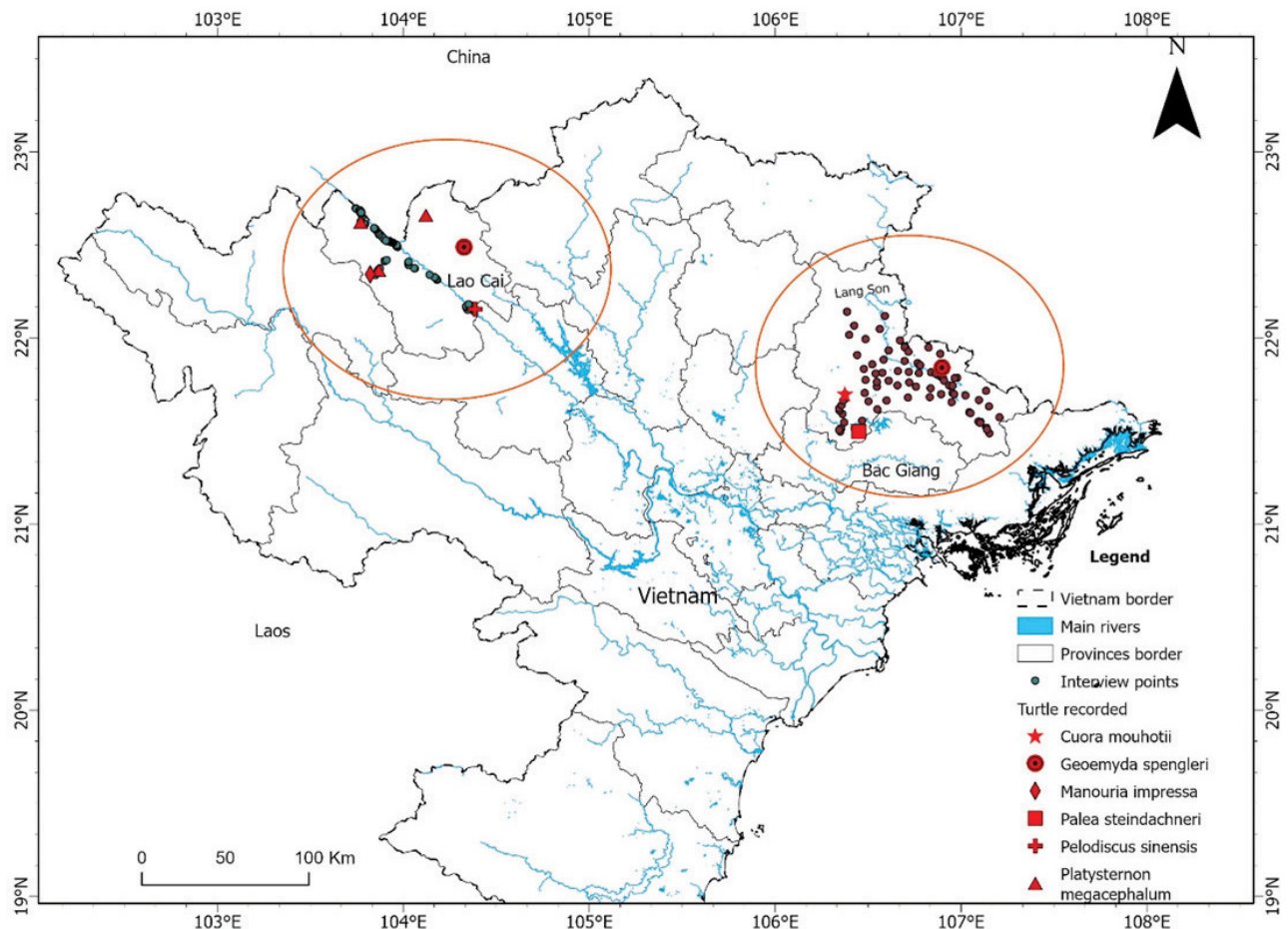


Figure 1. Map of northern Vietnam showing the interview localities and the sites where chelonians were observed directly (as reported in Table 2)

Protocol

This study was based on questionnaire surveys within villages in the study areas. The first survey was conducted in Lang Son and Bac Giang provinces from 8–22 June 2018, and the second survey (Lao Cai) was from 12–28 August 2018. The field team consisted of two persons who conducted semi-structured interviews, in Vietnamese language. The initial interviewees were used to help recruit other knowledgeable interviewees (snowball procedure) who were then interviewed separately. The interviewees were all males, all over 30 years old and were previously hunters or even providers of turtles to traders. The interviewees were informed of the scope of the study in advance and their identities were kept anonymous. Interviews lasted on average 40 minutes, but sometimes up to two hours if the person appeared particularly well aware of the status of turtles in his area. All interviews followed ethical rules (British Sociological Association, 2017).

The interview was based on a semi-structured questionnaire and asked the following questions: (i) Do you know any turtles from your area? (ii) If yes, what are their local names? (iii) What do they look like (carapace colour, hard or softshell, size of the animal, aquatic or terrestrial)? (iv) Which morphological characteristics do you use to determine the different species e.g. hinged (for *Cuora* spp.), serration, size of the head, length of the tail (for *Platysternon*

megacephalum)? (v) In what habitats are the various species of turtle found?

After completing the interview, we showed interviewees ID photos of chelonian species to cross-check their description and to ensure uniformity in the descriptions used in their answers. In order to gather further evidence of the various chelonian species found in the area, we also examined any specimens they had in their houses.

In order to evaluate whether the sample size of interviewees was sufficient to obtain an accurate assessment of the total number of species of the two study areas, we applied a saturation curve methodology, calculating the 95 % confidence intervals by 9,999 random bootstraps (Hammer, 2012). Bootstrapping is a re-sampling statistical methodology that uses random sampling with replacement (e.g. mimicking the sampling process) to assign measures of accuracy such as bias, variance, confidence intervals, prediction error, to sample estimates (e.g. Varian, 2005).

RESULTS

Overall, we obtained reliable data on turtle occurrences from 98 interviewees in Lang Son and 138 interviewees in Lao Cai. In Lang Son, a total of ten turtle species were clearly described by interviewees, with the greater number of positive

Table 1. A list of all the chelonian species that have been accurately described during interview surveys in northern Vietnam with the number (and percentage) of interviewees describing each given species, and the districts where they were described

Turtle species	IUCN (2022) red list status	No. and (%) of interviews in which the species was mentioned	Locations (Districts)
Lang Son & Bac Giang province (98 interviews)			
<i>Cuora mouhotii</i>	EN	40 (40.8)	Dinh Lap, Loc Binh, Chi Lang, Huu Lung, Bac Son, Binh Gia, Van lang, Cao Loc
<i>Cuora trifasciata</i>	CR	6 (6.1)	Huu Lung
<i>Cuora galbinifrons</i>	CR	14 (14.3)	Loc Binh, Dinh Lap, Binh Gia, Bac Son, Chi Lang
<i>Mauremys mutica</i>	CR	12 (12.3)	Dinh Lap, Son Dong (Bac Giang province), Luc Ngan (Bac Giang province), Huu Lung, Bac Son, Binh Gia
<i>Geoemyda spengleri</i>	EN	12 (12.3)	Mau Son, Cao Loc
<i>Pelodiscus sinensis</i>	VU	44 (44.9)	Dinh Lap, Loc Binh, Chi Lang, Bac Son, Binh Gia, Lang Son city, Van Quan, Van Lang
<i>Palea steindachneri</i>	CR	12 (12.3)	Dinh lap, Loc Binh, Chi Lang, Bac Son
<i>Cyclemys oldhamii</i>	EN	3 (3.1)	Chi Lang, Bac Son, Binh Gia
<i>Sacalia quadriocellata</i>	CR	13 (13.3)	Dinh lap, Loc Binh, Chi Lang, Bac Son
<i>Indotestudo elongata</i>	CR	8 (8.2)	Dinh Lap, Loc Binh
Lao Cai province (138 interviews)			
<i>Cuora mouhotii</i>	EN	55 (39.9)	Bat Xat, Van Ban, Bac Ha, Bao Yen, Bao Thang, Sa Pa
<i>Cuora galbinifrons</i>	CR	20 (14.5)	Bat Xat, Van Ban, Bac Ha
<i>Geoemyda spengleri</i>	EN	10 (7.3)	Bac Ha
<i>Cyclemys oldhamii</i>	EN	5 (3.6)	Bat Xat, Bac Ha, Bao Yen
<i>Sacalia quadriocellata</i>	CR	12 (8.7)	Van Ban, Bat Xat, Bac Ha, Sa Pa
<i>Pelochelys cantorii</i>	CR	4 (2.9)	Bao Yen, Bao Thang
<i>Rafetus swinhoei</i>	CR	4 (2.9)	Bat Xat
<i>Pelodiscus sinensis</i>	VU	73 (52.9)	Bat Xat, Lao Cai city, Bao Thang, Bao Yen, Bac Ha, Sapa, Van Ban
<i>Palea steindachneri</i>	CR	23 (16.7)	Bat Xat, Van ban, Sapa, Bac Ha
<i>Manouria impressa</i>	EN	20 (14.5)	Sapa, Van Ban, Bac Ha
<i>Platysternon megacephalum</i>	CR	32 (23.2)	Sapa, Muong Khuong, Van Ban, Bat Xat

descriptions for *Cuora mouhotii* and *Pelodiscus sinensis* and the fewest accurate descriptions for *Cyclemys oldhamii* and *Cuora trifasciata* (Table 1). In Lao Cai, 11 turtle species were clearly described by interviewees, with *C. mouhotii* and *P. sinensis* being the most frequently mentioned and three, *C. oldhamii*, *Pelochelys cantorii* and *Rafetus swinhoei*, being the least frequently mentioned (Table 1). All the turtle species found in the two study areas are threatened according to IUCN (2022).

Many interviewees from both study areas concurred in saying that ponds within the mountain forests were the most likely habitats to encounter turtles. A typical example of this type of habitat is presented in Figure 2.

Interestingly, in Lao Cai province, different interviewees mentioned that very large softshell turtles (locally called “Giài mép vàng” that means “yellow mouth corner” clearly referring to *Rafetus swinhoei*) were caught and consumed by local people in Bat Xat district. These turtles were 60–70 kg, and were caught in a muddy swamp right next to the Red river in the late 1970s. Local traders in Bao Yen and



Figure 2. Typical pond habitat where turtles are captured by local hunters in the study areas

Bao Thang districts claimed to have bought two individuals of “Đấm Đấm” (meaning “punching softshell turtle”, thus

Table 2. Synopsis of the chelonians that were observed directly during interview surveys in northern Vietnam, including the geographic coordinates of the various observations

Species name	No. observed/ total no.	Observation types	District	Lat.	Long.
Lao Cai province					
<i>Platysternon megacephalum</i>	2/30	The owner claimed to keep 30 individuals in his pond. He caught these individuals in forest streams near his village	Bat Sat	22.62581	103.7708
<i>Platysternon megacephalum</i>	5	Observed in Hoang Lien rescue center	Sapa	22.34088	103.8221
<i>Platysternon megacephalum</i>	1	Observed in market where it was offered for sale	Muong Khuong	22.66334	104.1213
<i>Manouria impressa</i>	2	Observed in Hoang Lien rescue center	Sapa	22.34088	103.8221
<i>Geoemyda spengleri</i>	1	Observed in Bac Ha town and kept as a pet	Bac Ha	22.48781	104.327
<i>Pelodiscus sinensis</i>	12/100	Observed with a local hunter, and kept in captivity. He claimed to have about 100 individuals in his pond, which were all caught by himself in water bodies around his village	Bao Ha	22.15401	104.3859
Lang Song province					
<i>Geoemyda spengleri</i>	5	Offered for sale	Mau Son	21.84003	106.8978
<i>Cuora mouhotii</i>	3	Observed with a local trader near Huu Lien Nature reserve	Huu Lung	21.69848	106.3759
<i>Palea steindachneri</i>	1/100	Observed in a Palea farm. The farmer claimed to have about 100 individuals in his farm, but they did not necessarily come from the surrounding area	Huu Lung	21.49686	106.4501

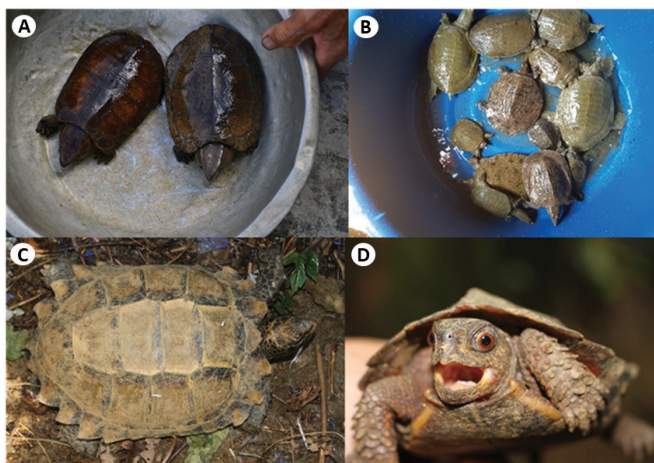


Figure 3. Some of the turtles actually observed in the study areas - **A.** *Platysternon megacephalum* in Bat Xat district, **B.** *Pelodiscus sinensis* in Bao Ha district, **C.** *Manouria impressa* in Sapa district, and **D.** *Geoemyda spengleri* in Bac Ha district

referring to the typical defensive behavior of *P. cantorii*) weighing 29 kg and 40 kg in 2009 and 2012 respectively. These two individuals were captured in the Chay river, and then sold to China across the border in Lao Cai city.

Direct observations were made of 32 turtles, these belonged to six different species (Table 2). *Pelodiscus sinensis*, *Platysternon megacephalum* and *Geoemyda spengleri* were being kept by several interviewees (Fig. 3). All these species had local names fitting exactly with those obtained in the interviews, thus confirming that our interviewees had a good and reliable knowledge of the turtle fauna of their areas. The saturation curves for the number of interviewees (= sample

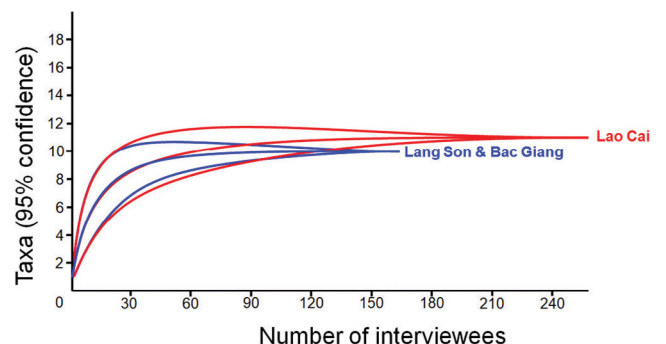


Figure 4. Saturation curves for the two study areas Lang Son (blue) and Lao Cai (red) showing that the number of interviewees was sufficient to adequately capture the turtle diversity. Curves are provided with 95 % confidence intervals, generated from 9,999 random bootstraps.

size) against the number of detected species revealed that the sample size was sufficient for obtaining a reliable estimate of the number of turtle species in the two study areas (Fig. 4).

DISCUSSION

Our study detected a remarkable species richness of turtles in both areas (Lang Son/Bac Giang and Lao Cai), with respectively ten and 11 species reliably described by our interviewees. However, some of these species may now be extirpated. For example, *R. swinhoei* has been accurately described to occur in the area until the end of the 1970s, but there is no recent report showing its survival to the present day. *Rafetus swinhoei* is a gigantic species occurring in large

river systems and associated ponds/lakes/marshlands (Le Duc et al., 2020; Van Pham et al., 2022). Given its large size it is much more likely to be known by hunters than the other smaller species and therefore the absence of any recent reports is likely to be a more accurate assessment. In addition, the other smaller sized species are linked to mountainous forest habitat and associated water bodies and streams (e.g. Ihlow et al., 2012; Wanchai et al., 2012; Ly et al., 2013; Pham et al., 2018; Seateun et al., 2019), and these habitats are often difficult to access and relatively remote, thus making an even greater difference in the reliability of absence reports.

The number of species detected in this study was slightly lower than that previously observed in Bac Giang province (n=12, see Pham Van et al., 2018). Results from this survey showed a higher number of species than in Thanh Hoa province (n=9) (Pham Van et al., 2020) but less than in Binh Dinh province in central Vietnam (n=15) (Nguyen et al., 2014). By comparison, in the ecologically similar Hainan province (China), a total of eight native species were recorded so far in villages and local markets (Shiping et al., 2006).

With regard to the habitat types in our study areas, of particular interest are the ponds that are interspersed within the forest patches (such as that shown in Fig. 2). According to the interviewees, these support a remarkable variety of species. Considering that all the species of the two study areas are listed as Threatened by IUCN (2022), careful management of these forest ponds is required by the competent authorities if further declines of these species are to be prevented. Although officially protected by law, these turtles are still frequently offered for sale even on social media (Pham Van et al., 2019), thus some effective protection from hunting/collection should be assured. We would urge the competent authorities to enhance the monitoring of the forested territory by rangers and wildlife soldiers.

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