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Cover: Tonkin snub-nosed monkey (*Rhinopithecus avunculus*), adult male. Photo: Nguyen Van Truong.

The status of the habitat in an occurrence area of Tonkin snub-nosed monkeys (*Rhinopithecus avunculus*) - Quang Ba District, Ha Giang Province

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Key words: Tonkin snub-nosed monkey, *Rhinopithecus avunculus*, habitat status, Quan Ba District, Ha Giang Province.

Summary

This study was conducted from 2019 to 2022. The study area in Quan Ba District, Ha Giang Province, Northeast Vietnam has a presence of a Tonkin snub-nosed monkey population. Of the 5000 ha habitat where Tonkin snub-nosed langurs occur, 4213.16 ha are natural forest. The forest coverage is 92.3%. A distinction can be made between 2 forest types: montane evergreen broadleaf forest (2280.35 ha, 54.1% of the total forest area) and limestone evergreen broadleaf forest (1,932.81 ha, 45.9%). Most of the natural forest has been affected by livelihood activities of local people and transformed into rich, medium, poor and rehabilitation status. Rich forest includes 223.12 ha (5.3% of the total forest area), medium forest 2366.66 ha (56.17%), poor forest 512.01 ha (12.15%) and rehabilitation forest 1111.37 ha (26.38%).

Four main habitat types for the Tonkin snub-nosed monkeys were identified: Type 1 - little and moderately affected limestone evergreen broadleaf forest (920.09 ha; 21.8%); Type 2 - little and moderately affected montane evergreen forest (1669.69 ha; 39.6%); Type 3 - strongly affected limestone evergreen forest (1012.72 ha; 24.0%) and Type 4 - strongly affected montane evergreen forest (610.66 ha; 14.6%).

The snub-nosed monkeys are most frequently occured in type 1, less in type 2, very rarely in type 3 and not found in type 4. Totally, the suitable habitats for the snub-nosed monkeys (type 1 and type 2) comprises about 2589.78 ha (61.47%). However, current core active area of the population is about 1000 ha of type 1 in Hill 754, Doi Vau, Ta Sin Ho mountain, Then Chu Phin mountain, Dao Dan Chai mountain. Main features of each habitat type are described in detail including forest types, forest area, forest layer structure, and dominant tree species in each layers.

Four main threats to habitats were identified. Ranking scores indicate that that "*farming of cardamom under the forest canopy*" is the most influential threat with "very high" rank level, then follow "*selective cutting of trees with high economic value*" with "high" rank level "*exploiting firewood to dry Cardamom products*" with "medium" rank level and "*exploiting non-timber forest products*" with "low" rank level.

Five urgent measures to protect the important habitat for the Tonkin snub-nosed monkeys are recommended: 1. Implementing strict measures to control cardamom farming under the forest canopy in the important habitat areas; 2. Implementing regular forest protection patrol and monitoring of the snub-nosed monkeys; 3. Implementing a community-based conservation program; 4. Increasing awareness of local people on forest protection, snub-nosed monkey and biodiversity conservation; 5. The early designation of a species and habitat conservation area to support protection and conservation.

Hiện trạng sinh cảnh quần thể Voọc mũi hếch (*Rhinopithecus avunculus*) ở huyện Quản Bạ, tỉnh Hà Giang

Tóm tắt

Nghiên cứu này được thực hiện từ năm 2019 đến năm 2022. Khu vực nghiên cứu là nơi sinh sống hiện tại của quần thể Voọc mũi hếch (VMH) *Rhinopithecus avunculus* tại rừng Quản Bạ, tỉnh Hà Giang, Đông Bắc Việt Nam. Trong khoảng 5.000 ha sinh cảnh hiện tại của quần thể VMH có 4.213,16 ha là rừng tự nhiên, tỷ lệ che phủ của rừng là 92,3%. Có 2 kiểu rừng chính: Rừng lá rộng thường xanh núi đất (2280,35 ha, chiếm 54,1% tổng diện tích rừng) và Rừng lá rộng thường xanh núi đá vôi (1.932,81 ha, chiếm 45,9%). Hầu hết rừng nguyên sinh đã bị tác động bởi các hoạt động sinh kế của người dân địa phương và chuyển sang các trạng thái: giàu, trung bình, nghèo và phục hồi. Diện tích "rừng giàu" là 223,12 ha (5,3% tổng diện tích rừng), "rừng trung bình" là 2366,66 ha (56,17%), "rừng nghèo" là 512,01 ha (12,15%) và "rừng phục hồi" là 1111,37 ha (26,38%).

Đã xác định được 4 kiểu sinh cảnh chính của VMH, bao gồm: Hab.1 - Rừng lá rộng thường xanh trên núi đá vôi bị tác động ít và trung bình (920,09 ha; 21,8%); Hab.2 - Rừng lá rộng thường xanh trên núi đất bị tác động ít và trung bình (1669,69 ha; 39,6%); Hab.3 - Rừng lá rộng thường xanh trên núi đá vôi bị tác động mạnh (1012,72 ha; 24,0%) và Hab.4 - Rừng lá rộng thường xanh trên núi đất bị tác động mạnh (610,66 ha; 14,6%). VMH xuất hiện nhiều nhất ở sinh cảnh Hab.1, ít hơn ở sinh cảnh Hab.2, rất hiếm khi ở sinh cảnh Hab.3 và không gặp ở sinh cảnh Hab.4. Tổng cộng, diện tích các sinh cảnh thích hợp cho VMH (Hab.1 và Hab.2) khoảng 2589,78 ha (61,47%). Tuy nhiên, khu vực hoạt động chính hiện tại của quần thể VMH khoảng 1000 ha của sinh cảnh Hab.1 ở Đồi 754, Đồi Vầu, núi Tà Sìn Hồ, núi Thèn Chu Phìn, núi Dào Dần Chải. Các đặc điểm chính của từng kiểu sinh cảnh được mô tả chi tiết bao gồm: kiểu rừng, diện tích rừng, cấu trúc rừng, loài chiếm ưu thế trong từng tầng rừng.

Bốn mối đe dọa chính đối với sinh cảnh sống của VMH đã được xác định và mô tả. Điểm xếp hạng cho thấy "Trồng thảo quả dưới tán rừng" là mối đe dọa có ảnh hưởng lớn nhất với mức xếp hạng "rất cao", tiếp đến là "Chặt cây chọn lọc có giá trị kinh tế cao" với mức xếp hạng "cao"; "Khai thác gỗ sấy sản phẩm thảo quả" với mức xếp hạng "trung bình" và "Khai thác lâm sản ngoài gỗ" với mức xếp hạng "thấp".

Năm biện pháp cấp bách để bảo vệ sinh cảnh VMH được khuyến nghị, bao gồm: Thực hiện các biện pháp kiểm soát chặt chẽ việc trồng Thảo quả dưới tán rừng trong khu vực sinh cảnh của VMH; Thực hiện thường xuyên công tác tuần tra bảo vệ rừng, giám sát VMH; Thực hiện chương trình bảo tồn dựa vào cộng đồng; Nâng cao nhận thức của người dân địa phương về bảo vệ rừng, bảo tồn TSM và đa dạng sinh học; Sớm công bố khu vực nghiên cứu là Khu bảo tồn VMH để tối ưu hóa tình trạng bảo tồn đa dạng sinh học của khu vực.

Introduction

The Tonkin snub-nosed monkey *Rhinopithecus avunculus* is endemic to Vietnam. Previously, the species occured in many provinces in the North-East region (Pham Nhat 2002; Nadler et al. 2003). However, over-hunting and widespread forest loss and degradation have caused the species decline to near-extinction. Currently, the occurance of the species is confirmed only in two locations in Ha Giang and Tuyen Quang Provinces with a total of 200 to 250 individuals (Covert et al. 2008; Le Khac Quyet et al. 2009). The species is listed as 'Critically Endangered' in the Vietnam Red Data Book (Ministry of Science and Technology & Vietnam Academy of Science and Technology 2007a) and the IUCN Red List of Threatened Species (IUCN 2023). Strong management measures must be applied to protect the species from extinction.

In the watershed protected forest in Quan Ba District, Ha Giang Province exists a population of the species. This population was discoveed in 2007 and is now estimated at 30-35 individuals (Le Khac Quyet & Covert 2010). This is the second largest population after the population in Khau Ca Tonkin snub-nosed monkey Conservation Area, Ha Giang Province with estimated 120 individuals (Nguyen Van Truong & Pham Cong Linh 2017). The most significant threat to the population is a

progressive forest degradation caused by activities of local residents (Nguyen Xuan Dang et al. 2019). Thus, during 2019-2022, we carried out various field studies in the habitat of the snub-nose monkey population in order to understand the habitat features and threats to the habitat and to continue previous studies (Nguyen Xuan Dang et al. 2022). These data should be used as a scientific basis for the habitat protection and the conservation of Tonkin snub-nosed monkey population in this area.

Materials and Methods

Study area

This study focused on an area of about 5,000 ha of natural forests that the Tonkin snub-nosed monkey population inhabits. The study area is located within the eastern part of Quan Ba District, Ha Giang Province, sharing 3 communes (Cao Ma Po, Ta Van and Tung Vai) and and has a national border with Malipo District in China. The terrain of the study area is characterized by steep limestone mountains with deep narrow valleys, and the altitude ranges from 900 to 1,700 m asl. The study area has a humid tropical climate, influenced by monsoon (Quan Ba District statistical Yearbook 2017). There are two distinct seasons: the rainy season from May to October, with the heaviest rain in July and August and an average rainfall of 246 mm/month. In the dry season from November to April, the average rainfall is 44.8 mm/month. The average annual rainfall is 1,768 mm.

Line transect method

The transect method followed Buckland et al. (2007). In each habitat type, transects of 500 m or more were established, depending on the topography and habitat size. The information and data collected on the transects were: tree species, canopy structure, and tree phenology. The width of a transect varied from 5 to 20 m depending of the thickness of forests. A total of 15 transects with a total length of 30.7 km were established.

Sampling plot method

According to Brockelman & Ali (1987), when studying the habitat of primates, the plots are arranged scattered in the habitat, but must be in the most concentrated distribution area of the studied species. Due to very steep and rugged terrain of the study area, plots of size 10 x 10 m were used. A total of 23 sampling plots were established. The plots were randomly established on the transects in different habitat types and at least 500 m apart. In each plot, one sub plot of size 5 x 5 m was established to survey shrubs and regenerated trees and one sub plot of size 1 x 1 m to survey herbaceous plants. In the plots, data were collected on trees with breast circumference C1.3 ≥ 19 cm and height Hvn ≥ 5m. including common names or local names, breast girth (C1.3) and height (Hvn). Recorded were the common and local names of the tree species and the names of extra-layer plant species as well. In the 5 x 5 m sub plots, collected data included species names and the height Hvn of all trees having C1.3 < 19 cm and Hvn < 5 m. In the herbaceous sub-plots, we identified the species' names and counted the number of plants of each species.

Plant species identification and data analysis

Species identification was carried out mostly in the field. For plants that could not be identified in the field, specimens were collected for later identification at the laboratories at the Institute of Ecology and Biological Resources, Hanoi. Key documents used for the species identification include Pham Hoang Ho (1999, 2000, 2003), Ministry of Science and Technology & Vietnam Academy of Science and Technology (2000 - 2017) and Chen & Gilbert (2006). The obtained data were stored and analyzed using Word, Excel, MapInfor 10.5 programs.

Investigating and ranking direct threats to the Tonkin snub-nosed monkey habitats

Data on direct threats are collected using following methods: - referring to the reports of previous biodiversity survey in the study area; - interviewing local people; and - field observation along forest routes in the Tonkin snub-nosed monkey habitat area. Ranking threats followed Margoluis & Salafsky

(1998) based on 3 criteria: 1) *Scope of impact* - The proportion of the population (proportion of ecosystem and proportion of populations) that will be affected by the threat within ten years; 2) *Severity* - The degree of damage to an object (ecosystem or population) by the impact of the threat within the said impact area, and 3) *Urgency* - Importance of taking immediate action to respond to the threat, considering the following factors: - is the threat occurring today, or will it only become important in the future (5 years or 25 years later)?; - can the investment of a significant resource to address the threat in the future be avoided by acting today? For each criterion, the highest score is equal to the number of assessed threats and decreases to 1. The most influential threat has the highest score and the lowest impact threat has a score of 1. For each threat, total threat score = (impact score + severity score) x 2 + urgency score. Based on the score (from high to low) threats are ranked in 4 levels: very high, high, medium and low.

Results and Discussion

Tonkin snub-nosed monkey habitat types

Research results show that in the area of 4,563.46 ha of study area, 4213.16 ha is natural forest, only 350.3 ha is non-forested land; the forest coverage rate is 92.3%. There are 2 types of forests: montane evergreen broadleaf forest (2280.35 ha, 54.1% of the total forest area) and limestone evergreen broadleaf forest (1,932.81 ha, 45.9%). Most of the primary forest has been affected by livelihood activities of local people and transformed into rich, medium, poor and rehabilitation status (Table 1). Rich forest is 223.12 ha, accounting for 5.3% of the total forest area, medium forest is 2366.66 ha, (56. 17%), poor forest is 512.01 ha (12.15%) and rehabilitation forest is 1111.37 ha (26.38%).

Observations of Tonkin snub-nosed monkeys since 2007 show, that they prefer forest areas with low impact, with many large trees, thick forest canopy, far from residential areas. Four main habitat types can be identified: 1) little and moderately affected limestone evergreen broadleaf forest (Type 1); 2) little and moderately affected montane evergreen forest (Type 2); 3) strongly affected limestone evergreen broadleaf forest (Type 3); strongly affected montane evergreen broadleaf forest (Type 4) (Table 1, Fig. 1). The largest habitat belongs to Type 2, accounting for 39.6% of the total forest area; followed by Type 3 (24.0%), Type 1 (21.8%) and Type 4 (14.6%) (Table 1).

Table 1. Forest types and status in the study area.

Forest type (area, % per total forest area)	habitat type	Code	Area (ha)	Ratio (%)
1. Rich limestone evergreen broadleaf forest (173.42 ha; 4.12%)	Little and moderately affected limestone evergreen broadleaf forests	Type 1	920.09	21.8
2. Medium limestone evergreen broadleaf forest (746.67, 17.72%)				
3. Rich montane evergreen broadleaf forest (49.7 ha; 1.18%)	Little and moderately affected montane evergreen broadleaf forests	Type 2	1669.69	39.6
4. Medium montane evergreen broadleaf forest (1619.99 ha; 38.45%)				
5. Poor limestone evergreen broadleaf forest (151.98 ha; 3.61%)	Strongly affected limestone evergreen broadleaf forests	Type 3	1012.72	24.0
6. Rehabilitation limestone evergreen broadleaf forest (860.74 ha; 20.43%)				
7. Poor montane evergreen broadleaf forest (360.03 ha; 8.55%)	Strongly affected montane evergreen broadleaf forests	Type 4	610.66	14.6
8. Rehabilitation montane evergreen broadleaf forest (250.63 ha; 5.95%)				
Total			**4213,16**	**100**

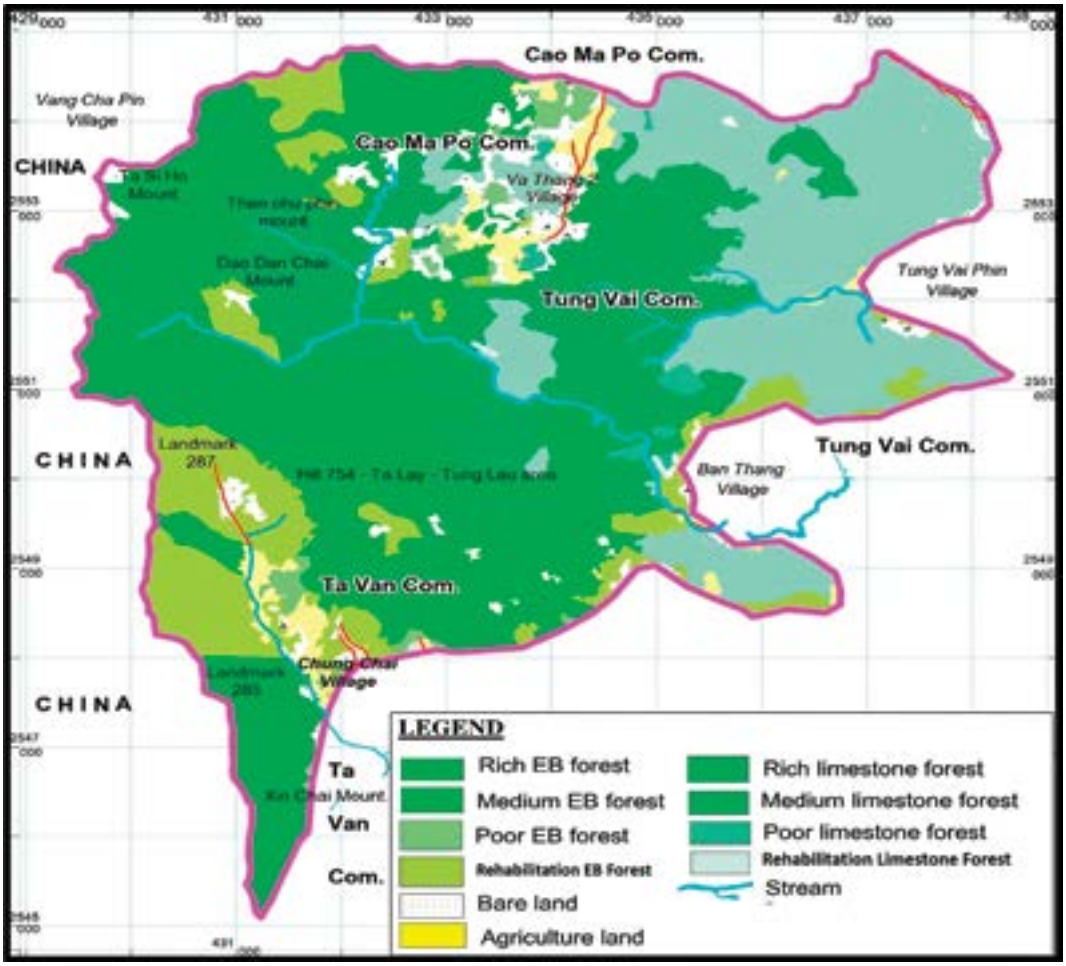

Fig.1. Tonkin snub-nosed habitat types in the study area.

An analysis of all localities where observations of Tonkin snub-nosed monkeys have been made (Covert et al. 2008; Le Trong Dat 2010; Nguyen Xuan Dang 2019) and of interviews from three community conservation groups that carry out regular patrols and also observations from locals show that the preferred area of residence is Habitat Type 1, less so Habitat Type 2, very rarely Habitat Type 3 and no observations are available from Habitat Type 4. Habitat Types 1 and 2 therefore offer the best conditions for the Tonkin snub-nosed monkeys. The significantly degraded habitats, with high intensity of human encroachment of Type 3 offer worse conditions, and Type 4 no longer offers suitable habitat. Totally, the suitable habitat Type 1 and 2 is about 2589.78 ha, accounting for 61.47% of the total forest area. However, the current main active area of the population comprises about 1000 ha of Type 1 in Hill 754, Doi Vau, Ta Sin Ho Mountain, Then Chu Phin Mountain and Dao Dan Chai Mountain (Fig. 1).

Main features of each habitat type

Habitat Type 1

Little and moderately affected limestone evergreen broadleaf forest

The habitat Type 1 covers an area of 920.09 ha, accounting for 21.8 % of the total forest area, and is the third largest habitat after Type 2 and Type 3. Type 1 is distributed in the central area of study area, in the territory of Tung Vai and Cao Ma Po Communes. It occurs on the slopes and high mountains

such as Hill 754, Tung Lau, Then Chu Phin Mountain, Dao Dan Chai Mountain, Ta Sin Ho Mountain. The habitat consists of 2 forest types: 1) rich limestone evergreen broadleaf forest (173.42 ha) and 2) medium limestone evergreen broadleaf forest (746.67 ha). The area of rich forest is small (173.42 ha) accounting for only 18.9% of the total Type 1 area. The rich forest has a three-story tree structure (A1, A2 and A3), with canopy coverage reaching over 0.7. The trees have a diameter at breast height (DBH) of 40-60 cm and a height of 20-40 m. The medium forest also has a three-story tree structure, but the canopy coverage is only about 0.6, the trees DBH are mainly 20-35 cm, and height is 20-35m (Fig. 2).

Fig.2. Little affected limestone evergreen broadleaf forest Type 1. Photo: Pham Van The.

The emergent layer (A1 layer) consists of trees of over 20 m tall, which belong to a few species such as *Ternstroemia japonica* (Thunb.) Thunb., *Magnolia foveolata* (Merr. ex Dandy) Figlar, *Machilus platycarpus* Chun, *Quercus macrocalyx* Hickel & A. Camus, *Sloanea sinensis* (Hance) Hemsl, *Magnolia foveolata* (Merr. ex Dandy) Figlar.

The main canopy layer (A2 layer) consists of large trees with average height of 10-20 m, straight stems, and wide canopy. The most dominant species are *Magnolia grandis* (Hu & Cheng) V.S. Kumar, *Beilschmiedia fordii* Dunn, *Linociera macrothyrsa* Merr., *Quercus macrocalyx* Hickel & A. Camus, *Reevesia pubescens* Mast., *Elaeocarpus griffithii* (Wight) A. Gray, *Toona sureni* (Blume) Merr., *Castanopsis tonkinensis* Seemen, *Acer oblongum* Wall. ex DC.

The undercanopy layer (A3 layer) consists of trees of 5-10 m high, scattered, and belonging to the following species *Castanopsis chinensis* (Spreng.) Hance, *Canarium album* (Lour.) DC., *Viburnum cylindricum* Buch.- Ham. ex D. Don, *Ilicium griffithii* Hook.f. & Thomson, *Gomphandra mollis* Merr., *Elaeocarpus fleuryi* A. Chev. ex Gagnep, *Syzygium levinei* (Merr.) Merr. & Perry, *Psychotria bonii* Pit., *Garcinia gracilis* Pierre, *Reevesia pubescens* Mast.

The shrub layer consists of trees of less than 8 m tall. Species with the highest densities include *Garcinia gracilis* Pierre (640 trees/ha), *Turpinia montana* (Blume) Kurz (480 trees/ha), *Machilus bonii* Lecomte (440 trees/ha), *Archidendron robinsonii* (Gagnep) I. Nielsen (360 plants/ha), *Gomphandra mollis* Merr. (360 plants/ha), *Schefflera heptaphylla* (L.) Frodin (280 plants/ha), *Garcinia oblongifolia* Champ. ex Benth. (280 plants/ha), *Psychotria bonii* Pit. (280 plants/ha), *Platycarya strobilacea* Sieb. & Zucc. (240 plants/ha), *Lindera balansae* Lecomte (240 plants/ha), *Syzygium cuminii* (L.) Skells (240 plants/ha), *Aucuba japonica* Thunb. (200 plants/ha), *Litsea rubescens* Lecomte (200 plants/ha), *Linociera macrothyrsa* Merr. (200 plants/ha).

The herbaceous layer consists of herbaceous plants less than 2 m tall. In the 10 sampling plots, 25 species belonging to 18 genera and 11 families have been identified. Species density is 2.3 species/m^2, and plant density is 9 plants/m^2. Common species include *Deparia boryana* (Willd.) M. Kato, *Pseudostachyum polymorphum* Munro, *Begonia villifolia* Irmsch, *Elatostema simplicissimum* Q.Lin, *Anoectochilus roxburghii* (Wall.) Lindl.

The non-layering plants include vines such as *Tetrastigma* sp., *Gynostemma pentaphyllum*, *Stephania sinica*, *Stephania tetrandra*, *Iodes cirrhosa*. The dermatophytes and parasitic plants belong to the Orchidaceae and Loranthaceae.

Habitat Type 2

Little and moderately affected montane evergreen broadleaf forest

The habitat Type 2 covers an area of 1669.69 ha, accounting for 39.6 % of the total forest area in the study area, the largest of the four habitat types. The habitat is distributed mainly in the South of the study area in Ta Van Commune and a small part in the area near the Vietnam-China border of Tung Vai and Cao Ma Po Communes (Fig. 3). Habitat Type 2 includes 2 types of forest status: 1) rich montane evergreen broadleaf forest and 2) medium montane evergreen broadleaf forest land. The area of rich forest is very small, about 49.7 ha, accounting for nearly 3% of the total habitat area.

Fig.3. Moderately affected montane broadleaf forest forest (SC2). Photo: Nguyen Tien Dat.

The forest has 3 layers of tall trees, canopy coverage is 0.5-0.6, and trees are mainly 10-20 cm in diameter, 10-15 m high. The emergent layer (A1 layer) includes trees of over 20 m tall, the number of trees is very small and mainly from the following species: *Lithocarpus garrettianus* (Craib) *A.Camus*, *Beilschmiedia laevis* Allen, *Castanopsis tonkinensis* Seemen Hainan, *Cryptocarya hainanensis* Merr., *Castanopsis chinensis* (Spreng.) Hance.

The main canopy layer (A2 layer) consists of trees about 10-20 m tall with straight stems, wide and narrow crown. The most dominant species include *Castanopsis fissa* (Champ. ex Benth.) Rehder & EH Wilson, *Schefflera macrophylla* (Dunn) R. Vig, *Toona sureni* (Blume) Merr., *Reevesia pubescens* Mast., *Syzygium cuminii* (L.) Skells, *Alseodaphne tonkinensis* Liou, *Machilus chinensis* (Champ. ex Benth.) Hemsl, *Elaeocarpus griffithii* (Wight) A. Gray, *Schefflera ciliata* Cuatrec., *Diospyros susarticulata* Lecomte.

The undercanopy layer (A3 layer) is not clear, 8-10 m high, consisting of small shade-tolerant trees scattered under the forest canopy and regenerating trees of the upper two layers. Some representatives of this layer are *Schima wallichii* (DC.) Korth, *Magnolia citrata* Noot. & Chalermglin, *Cinnamomum verum* Presl., *Acer oblongum* Wall. ex DC, *Rhododendron delavayi* Franch., *Homalium ceylanicum* (Gardn.) Benth., *Memecylon edule* Roxb.

The shrub layer is 2-8 m high. The trees with highest density include *Amentotaxus yunnanensis* H.L.Li (880 plants/hectare), *Psychotria tonkinensis* Pit. (480 plants/ha), *Psychotria curviflora* Wall. (480 plants/ha), *Illicium difengpi* B.N. Chang (240 plants/ha), *Garcinia gracilis* Pierre (160 trees/ha), *Gomphandra mollis* Merr. (160 plants/ha), *Schefflera heptaphylla* (L.) Frodin (160 plants/ha), *Lindera balansae* Lecomte (160 plants/ha), *Aucuba japonica* Thunb. (160 trees/ha), *Castanopsis tonkinensis* Seemen (160 trees/ha).

The Herbaceous layer is not more than 2 m high. Species with highest density include *Elatostema veronicoides* (Gagnep.) H.Schroet., *Deparia boryana* (Willd.) M.Kato, *Elatostema olaniae* Gagnep., *Pseudostachyum polymorphum* Munro, *Pseudostachyum polymorphum* Munro, etc. Out-layer plants include species in the family Orchidaceae, *Gnetum* sp, *Smilax* sp.

Habitat Type 3

Strongly affected limestone evergreen broadleaf forest

The habitat Type 3 has an area of 1012.72 ha, accounting for 24.0% of the total forest area in study area, the second largest after Type 2. The habitat is mainly distributed in the eastern part of the study area in Tung Vai and Cao Ma Po Communes. The habitat consists of 2 types of forest status: 1) poor limestone evergreen broadleaf forest (360.03 ha) and 2) rehabilitation limestone evergreen broadleaf forest (250.63 ha) (Fig. 4). The canopy coverage is low (0.4), with many gaps.

Fig.4. Strongly affected limestone broadleaf forest Type 3. Photo: Nguyen Tien Dat.

The forest has only 2 tall tree layers, the main canopy layer (A2 layer) of 10-20 m high and the undercanopy layer (A3 layer) of 5-10 m high. There is no emergent layer (A1 layer). The tree species have a DBH from 6-78 cm with the majority (80.0%) reaching less than 20 cm. Species with a highest dominance include: *Castanopsis chinensis* (Spreng.) Hance, *Archidendron robinsonii* (Gagnep) I. Nielsen, *Machilus bonii* Lecomte, *Sloanea tomentosa* (Benth.) Rehd. & Wils, *Debregeasia longifolia* (Burm.f.) Wedd., *Cornus hongkongensis* subsp. *tonkinensis* (W.P.Fang) Q.Y.Xiang, *Acer oblongum* Wall. ex DC, *Linociera* sp., *Lithocarpus gigantophyllus* (Hickel & A.Camus), A.Camus, *Platycarya strobilacea* Sieb. & Zucc.

The shrub layer is less than 8 m high. Species with highest densities include *Archidendron robinsonii* (Gagnep) I. Nielsen (350 plants/ha), *Acer laurinum* Hassk., *Acer laurinum* Hassk. (350 trees/ha), *Oreocnide obovata* (C.H. Wright) Merr. (300 plants/ha), *Psychotria balansae* Pit. (300 plants/ha), *Drypetes perreticulata* Gagnep (300 plants/ha), *Gomphandra mollis* Merr. (250 plants/ha), *Ficus abelii* Miq. (250 plants/ha), *Wendlandia* sp. (250 plants/ha), *Benkara depauperata* (Drake) *Ridsdale* (250 plants/ha), *Garcinia gracilis* Pierre (200 plants/ha), *Schefflera heptaphylla* (L.) Frodin (200 plants/ha), *Acer brevipes* Gagnep (200 plants/ha).

Herbaceous layer is quite rich in number of plants as well as species composition. Species with highest densities include *Selaginella* sp., *Geophila repens* (L.) IM Johnst., *Nephrolepis falcata* (Cav.) C.Chr., *Carex cryptostachys* Brongn., *Begonia villifolia* Irmsch., *Deparia boryana* (Willd.) M.Kato, *Selaginella ornata* Spring, *Begonia villifolia* Irmsch.

The common species of non-layering plants include *Iodes cirrhosa* Turcz., *Asplenium nidus*, *Tricholepidium normale*, *Pothos* spp. and species of the genera *Tetrastigma*, *Rhizophora*, and *Rhaphidophora*.

Habitat Type 4

Strongly affected montane evergreen broadleaf forest

The habitat Type 4 has the smallest area with about 610.66 ha, accounting for 14.6% of the total forest area in the study area. This habitat is fragmented and scattered in all 3 communes, most concentrated in the area near Chung Chai Village of Ta Van Commune. The habitat includes 2 forest status: 1) poor montane evergreen broadleaf forest (360.03 ha) and 2) rehabilitation montane evergreen broadleaf forest (250.63 ha). The forest has been exploited for most of the large trees; the canopy is broken into a large array. The forest has usually only one layer, rarely two layers of tall trees (A2 and A3 layers), the canopy is not continuous. Most of the forest area has been cleared to grow cardamom and rosemary. Many large trees were cut down, so the canopy coverage was only 0.4-0.5, in some places even lower. The trees are sparse, with an average height of 10-20 m, an average stem diameter of 10-20 cm, few trees reaching 25-30 cm. The species composition in the tall tree layer includes species from *Lithocarpus* (Fagaceae), *Litsea* spp. (Lauraceae), *Magnolia* spp. (Magnoliaceae), *Canarium album* (Burseraceae), *Ficus* spp. (Moraceae). The shrub and herbaceous layer is cleared in many places to grow cardamom. Non-layering plants have such representatives as *Smilax* spp. (Smilacaceae), *Argyreia* sp. (Convolvulaceae), *Tetrastigma* spp. (Vitaceae), *Gnetum montanum* (Gnetaceae).

Threats to Tonkin snub-nosed monkey habitats

The direct threats to habitat in Quan Ba watershed forest have been documented in previous studies (Trinh Dinh Hoang et al. 2015, Trinh Dinh Hoang 2018, Nguyen Xuan Dang et al. 2019) and continue to be recorded in this study. The main threats include: 1) farming of cardamom under the forest canopy, 2) Exploiting firewood to dry cardamom products, 3) selected cutting of trees with high economic value and 4) exploiting non-timber forest products

Table 2 is the result of the threat ranking using 3 criteria “scope”, “severity” and “urgency”. The results show that farming of cardamom under the forest canopy is the most influential threat with “very high” rank level, followed with “high” rank level selective cutting of trees with high economic value, with “medium” rank level exploiting firewood to dry cardamom products with with “low” rank level exploiting non-timber forest products.

Table 2. Ranking of threats to the habitat of the Tonkin snub-nosed monkey population in Quan Ba District.

Threat	Scope (x2)	Severity (x2)	Urgency	Total score*	Rank
1. Farming of cardamom under the forest canopy	4	4	4	**20**	Very high
2. Exploiting firewood to dry cardamom products	2	2	2	**10**	Medium
3. Selected cutting trees of high economic value	3	3	3	**15**	High
4. Exploiting non-timber forest products	1	1	1	**5**	Low
Total	**10**	**10**	**10**		

Forest farming of cardamom

Cardamom (*Amomum tsao*) is a perennial crop that makes an important contribution to the income of many local households (Trinh Dinh Hoang et al. 2015). Most of the mountain slopes have been affected by cardamom farming, leaving only a few patches of forest regenerated after shifting cultivation. Forests at altitudes above 1000 m are less affected by cardamom due to the steep terrain and far distance from residential areas. To create a suitable environment for cardamom to grow, the trees were pruned to reduce the canopy coverage to 0.4-0.6. Tree pruning reduces tree density, resulting in discontinuous canopy that may no longer support arboreal movement of the Tonkin snub-nosed monkwys. In addition, the resilience and sustainable development of forests have been seriously reduced. The regeneration trees are almost gone due to clearing along with vegetation clearing/weeding for cardamom. The presence of people in forests to carry out cardamom farming activities causes significant disturbance to the habitat and some of them may also hunt wild animals including snub-nosed monkeys.

Exploiting firewood to dry cardamom products

When harvesting, the local people dry the cardamom products directly in the fields before brought it home. In the harvest season (3-4 months) people cut down many live trees around their fields to dry the cardamom. According to many local people, to dry a ton of fresh cardamom, it is necessary to burn 10-12 m^3 of firewood. A simple calculation shows that with 100 ha of cardamom, the annual yield will reach 300-400 tons, required amount of firewood for drying is 3000-4200 m^3, equivalent to 10 ha of rich forest will be lost each year (Trinh Dinh Hoang et al. 2015).

Selective cutting trees of high economic value

This threat widespreads in most of forests, including both montane and limestone forests. The limestone forest is more seriously affected because it takes a long time to restore. The timbers are harvested by local people to build houses, dry cardamom and trade the timber. As a result, the natural structure of forest was seriously damaged due to the felling of large trees, leading to the absence of the imergent layer (A1 layer). The main canopy layer (A2 layer) and the undercanopy layer (A3 layer) were also strongly affected and even disappeared in some limestone areas. This leads to great negative impact on aboreal movement and also food resource of the snub-nosed monkeys.

Exploiting non-timber forest products

Non-timber forest product exploitation still continues in the study area although not as strongly as other threats. The consequences of this threat can be very serious for some threatened plant

species such as *Anoectochilus roxburghii* (Wall.) Lindl., *Paphiopedilum hirsutissimum* (Lindl.) Stein, *Paphiopedilum micranthum* Tang & F.T.Wang, *Paris polyphylla* Sm. and other orchids. There are still exploiting medicinal plants such as the exploitation of *Dysosma difformis* (Hemsl. & E.H.Wilson) T.H.Wang, *Mahonia nepalensis* DC., *Gomphandra mollis* Merr., *Stephania tetrandra* S.Moore. Presence of non-timber products collectors in snub-nosed monkey habitat threatens normal life of animals and they may also hunt wild animals including snub-nosed monkeys.

Proposed measures to protect the Tonkin snub-nose monkey habitat

In order to protect the habitat of the TSM population and other species in the study area, it is necessary to implement following urgent measures:

1) Implementing strict measures to control cardamom farming under the forest canopy in the study area. Do not allow further expansion of cardamom cultivation. In the cardamom plantations, people are required to keep the regenerated trees so that the forest can develop sustainably. Re-planting trees on abandoned cardamom fields to restore the forests. Encouraging people to change the method of drying cardamom products instead of using forest firewood to protect the forest trees and not affect the environment.

2) Implementing regular forest protection patrol, and monitoring of the snub-nosed monkeys with focus on the core area of the snub-nosed monkeys population including Dao Dan Chai, Then Chi Phin, Doi Vau, Ta Din Ho, Doi 754 and the upstream area between landmarks 286 and 288.

3) Implementing a community-based conservation program, attracting people to participate in biodiversity conservation activities, applying solutions to improve livelihoods for local people, so that people are not dependent too much on forest resources.

4) Intensifying education for raising awareness of local people on forest protection,TSM and biodiversity conservation. In particular, it is necessary to raise the awareness of cardamom growers about the role of the regenerating trees on forest maintenance and development and the harm to the forest of growing cardamom under forest canopy.

5) As soon as possible gazetting the study area as a Tonkin snub-nosed Conservation Area to optimize the biodiversity conservation institution of the area. With the current watershed protection forest status, the forest protection and conservation of endangered species living in the area cannot be effective, because biodiversity conservation is not the main function of watershed protection forests, meanwhile the forest protection force is very weak, so people often ecroach in the forest for agricultural cultivation, timber logging and exploitation of non-timber forest products.

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Long-term partnerships offer hope for the 'Critically Endangered' Tonkin snub-nosed monkeys (*Rhinopithecus avunculus*) of Ha Giang Province

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Summary

The Tonkin snub-nosed monkey (*Rhinopithecus avunculus*) is an endemic Vietnamese primate which has a historical distribution restricted to the northern part of Vietnam. Recent surveys indicate the occurrence of this species is currently limited to Tuyen Quang and Ha Giang Provinces, with the biggest population inhabiting the Khau Ca Species and Habitat Conservation Area of the Du Gia–Dong Van Plateau National Park. As a sanctuary for the largest population of 'Critically Endangered' Tonkin snub-nosed monkeys, Khau Ca forest is considered the most important protected area for the species. However, the remaining residents are faced with pressure from surrounding local human communities. In order to protect the biggest population of the Tonkin snub-nosed monkeys, staff from the Denver Zoological Foundation has been collaborating with local and international partners over the past 15 years to understand the most significant threats and implement priority conservation activities within and surrouding the protected area. Key of the conservation interventions include studying the monkeys and the forest, monitoring human activities within Khau Ca, raising awareness among local communities, and enhancing livelihoods of the people living around the protected area – largely through a successful fuel-efficient stove campaign launched in partnership with key collaborators from the New Nature Foundation. Through these activities, Denver Zoological Foundation has helped local communities enhance the protection of Tonkin snub-nosed monkeys and the Khau Ca forest since 2009.

Những hợp tác lâu dài mang lại hy vọng cho loài Voọc mũi hếch (*Rhinopithecus avunculus*) cực kỳ nguy cấp tại Hà Giang

Tóm tắt

Voọc mũi hếch (*Rhinopithecus avunculus*) là loài linh trưởng đặc hữu của Việt Nam với lịch sử phân bố khu vực bắc Việt Nam. Những cuộc điều tra gần đây đã chỉ ra sự xuất hiện của loài này hiện giới hạn tại hai tỉnh Tuyên Quang và Hà Giang với quần thể lớn nhất hiện đang sinh sống tại khu vực rừng Khau Ca thuộc Vườn Quốc gia Du Già – cao nguyên đá Đồng Văn. Là nơi trú ẩn cho quần thể Voọc mũi hếch lớn nhất này, Khau Ca được coi là khu vực quan trọng nhất đối với loài. Tuy nhiên, quần thể này cũng đang phải đối mặt với áp lực từ cộng đồng địa phương. Nhằm bảo vệ quần thể Voọc mũi hếch lớn nhất này, trong 12 năm qua, Quỹ Động vật Denver (DZF) đã thực hiện các hoạt động trong và xung quanh khu vực này bao gồm tuần tra giám sát, nâng cao nhận thức và nâng cao mức sống của người dân địa phương. Thông qua các hoạt động này, DZF đã và đang đóng góp tích cực vào công tác bảo tồn Voọc mũi hếch tại Khau Ca.

Introduction

According to the IUCN Red List of Threatened Species (Le Khac Quyet et al. 2020), the Tonkin

snub-nosed monkey (*Rhinopithecus avunculus*) is 'Critically Endangered' and endemic to Vietnam, with an historical distribution in areas East of the Red River across the northern part of Vietnam (Fooden 1996; Nadler et al. 2003). However, under significant pressure from human activities, the species is now believed to have fewer than 200 individuals inhabiting two Vietnamese provinces: Tuyen Quang and Ha Giang (Nadler et al. 2003; Le Khac Quyet & Covert 2010; Nadler 2022). While a small, remnant population is thought to remain in Tuyen Quang, the biggest subpopulation of this species is estimated at around 150 individuals (Le Khac Quyet 2019 pers. comm.) and is found in the small, isolated forest of Khau Ca, Ha Giang Province, which belongs to the Du Gia–Dong Van Plateau National Park. The Khau Ca forest was established in 2009 as Species and Habitat Conservation Area with a primary aim to conserve this species (Covert et al. 2011).

The 1,000 ha tract of fairly healthy, sub-tropical limestone karst forest in Khau Ca is surrounded by local, primarily subsistence-based communities of Tay, Dao, Kinh and Hmong ethnic groups (Levine 2016). Local communities living in this remote area have relied heavily on the forest for many generations. Traditional ways of life for these ethnic minorities include hunting, shifting cultivation, small-scale timber harvest and collection of non-timber forest products. Although a partner-led gun confiscation program in 2005 significantly reduced the threat of hunting. Other activities continue to place high levels of anthropogenic pressure on the Khau Ca protected area and its wildlife.

Understanding the critical situation of the Tonkin snub-nosed monkey population in Ha Giang, Denver Zoological Foundation and key collaborators including the New Nature Foundation have been partnering with local communities to implement priority conservation activities within and surrounding the Khau Ca protected area since 2009. Conservation interventions have included studying the biology of the snub-nosed monkeys and the forest, raising awareness, and improving sustainable livelihoods of the local communities – primarily through a highly successful, grass-root fuel-efficient stove campaign. Given the size of the snub-nosed population at Khau Ca has increased by 60% over the past 15 years. We believe our collaborative, long-term local-global partnership has contributed significantly to the continued persistence of this critically endangered species.

Studying and monitoring the Tonkin snub-nosed monkeys and the forest

From 2011 to 2013, Denver Zoological Foundation staff partnered with local research assistants to carry out an 18 months comprehensive study, simultaneously looking at human and monkey use of forest resources in and around Khau Ca (Fig. 1). The goal of this research was to understand the most critical human-caused pressures to the snub-nosed monkeys and to the Khau Ca forest. Following the monkeys, observing evidence of human use of forest resources (such as tree-cuttings), and conducting household interviews, we gained a clear picture of the most important forest resources being used by the monkeys and the local people (Levine 2016). Not surprisingly, the investigation confirmed that snub-nosed monkeys and local people both rely heavily on large forest timber species. Whereas the relatively large-bodied monkeys (8 to14 kg) depend upon big forest trees for food, travel and resting,

Fig.1. Research assistant group at basecamp before daily patrol. Photo: Luu Tuong Bach.

local community members need the same large tree species, primarily for home construction and fuelwood. In fact, the average household with an open fireplace was using over 15,000 kg of timber as fuelwood each year, about 45 kg per day. The study also demonstrated that the winter months (November to February) were those when people most often went to the forest to harvest timber and other forest products. We then used this type of spatially and temporally specific information about human and monkey resource importance and harvest timing to design and prioritize a suite of conservation actions aimed at raising awareness about the dire state of the global population of Tonkin snub-nosed monkeys, reducing demand for forest timber, and timing our activities to coincide with the months when human collection of forest products was at its peak.

Fig.2. Night time records seem be impossible by normal survey that will be solved by camera traps.

Fig.3. First photo recorded the *ad-libitum* behaviour of Tonkin snub-nosed monkeys on ground by camera trapping.

In the years since this comprehensive study, Denver Zoological Foundation and New Nature Foundation have continued to support monkey and forest monitoring efforts in a number of ways. In 2018, we began to deploy camera traps at key locations throughout Khau Ca forest for the purpose of improving our understanding of its faunal biodiversity. This program has led to some important discoveries, such as records of other species in the area and behaviour of the Tonkin snub-nosed monkeys (Fig. 2, 3).

In addition, Denver Zoological Foundation has continued supporting the Ha Giang Forest Protection Department's team of local research assistants, who are responsible to participate in annual snub-nosed monkey population counts, collect monthly data on the snub-nosed monkeys and human presence in the forest, and collaborate with local authorities to report and prevent illegal activities such as hunting, cultivating within the protected area and timber harvesting. It is due to the hard work of these research assistants that we have a good understanding of snub-nosed monkey behavioral ecology, and reliable knowledge of Khau Ca's population size. While the team has not encountered a full super-group since 2019, when between 144-160 individuals were spotted at once, they did come across two groups simultaneously in March 2022, counting a total 95 monkeys (Nadler 2022); and when combining this with consistent observations of 8 to15 infants/year, our team is confident the recent estimate of 144-160 individuals remains quite accurate (Table 1, 2).

Table 1. Records of the Research Assistant group about violation within Khau Ca Species and Habitat Protected Area.

Date	Violator	Activity	Location	Evidence	Solutions
15	None	Illegal logging	0513234 2527513	Nghien: Diameter: 0.7m, length: 19m Nghien: Diameter: 0.7m, length: 8m	Reported to CPC of Du Gia and the Management Board of Du Gia NR
26	None	Illegal logging	0515981 2527471	A Muong tree was cut to 9 planks of 7m x 0.38m x 0.4m	Reported to CPC of Du Gia and the Management Board of Du Gia NR
	Mr. Truong Van Mien and Ly Van Dai (Phia Deng hamlet, Minh Son commune)	Illegal seting up basecamp inside the protected area	0515979 2527769		Under investigation

Table 2. Records of the Research Assistant group about Tonkin Snub-nosed Monkey (TSNM).

Date	Species	Track	Time	Group size	Note
03	TSNM	1800 A	11h00' - 12h15'	13	
	TSNM	800 A	13:40' - 14:00'	09	01 infant
08	Assamese macaque	200 B	9:45'	11	
	TSNM	800 D	10:42' - 10:45'	12	
17	TSNM	A 0	13:30' - 17h30'	21	02 infants
20	Stump-tailed macaque	500 B	15:25'	13	01 infant
21	TSNM	1800 A	12:30' - 15:10'	25	02 infants

Conservation calendar

When Denver Zoological Foundation team members first visited Ha Giang Province in 2009, we were surprised to learn that many of the local people we spoke with believed the Tonkin snub-nosed monekys were no longer in need of protection because they hadn't received an annual conservation awareness calendar like they had for several years prior. Hearing this, Denver Zoological Foundation spearheaded a multi-partner collaboration to launch what is now a 14-year long snub-nosed monkey conservation awareness calendar campaign (Fig. 4). In the early days, our goal for this campaign was simply to keep snub-nosed monkey protection in the forefront of community members' minds. As we learned more about the key threats to the Khau Ca population, we tailored our visual and written messaging to achieve specific awareness-raising goals focused on what local people can do every day to help protect the snub-nosed monkeys. Calendar evaluations reveal that over 80% of recipients feel positive about snub-nosed monkey conservation (Blanton et al. 2019). Each year, we produce 5,000 calendars, which are hand-delivered as a traditional Tet Holiday gift to families, partners and local businesses. Calendar distribution events help welcome the lunar New Year in January or February each year, and also serve as a reminder of the importance of protecting the forest to protect the Tonkin snub-nosed monkeys during winter months when visits to the forest are most frequent.

Fig.4. Denver Zoo staff and local teacher were handing new year calendars to the pupils. Photo: Luu Tuong Bach.

Conservation education

Local people living around Khau Ca forest self-identify as belonging to Tay, Dao, Hmong or Kinh ethnic groups. The first three groups are well-known as ethnic minorities that have depended upon the forest for many generations; especially those in the most remote areas close to the Khau Ca forest boundary (Levine 2016). There is little doubt that these communities have and will continue to play a critical role in snub-nosed monkey conservation. Knowing this, in 2012 Denver Zoological Foundation began partnering with local schools to develop and deliver a conservation education program for primary school pupils designed to enhance students' knowledge about the relationship between people and nature, as well as improve attitudes and change behaviors relating to the role of people in snub-nosed monkey and forest conservation (Fig. 5, 6).

Fig.5. Members of the Ha Giang Forest Protection Department in the Forest Appreciation Program. Photo: Luu Tuong Bach.

Fig.6. Pupils participating Forest Appreciation Program by outdoor activities. Photo: Luu Tuong Bach.

Whereas Vietnamese school teachers rely mainly upon lectures and repetition to teach their classes, Denver Zoological Foundation – an organization with over 30 full time professional educators – developed two, rotating sets of student-driven, inquiry-based curricula. Designed to meet Vietnamese science education benchmarks, these single-day summer programs are held annually for 4th to 5th grade students. Guided by our Vietnamese education coordinator, local teachers are trained to lead pupils through fun, interactive games and nature activities. Program evaluations indicate that the majority of participants feel an intrinsic appreciation for the monkeys and the forest, learn basic ecological principles and the importance of monkey conservation, and pledge to protect monkeys by sharing their knowledge with family and friends.

In addition to ensuring local youth develop intrinsic value for the forest and the monkeys; this youth education program is also one that can be delivered for pupils who attend the main primary school campuses, as well as for satellite schools attended by children living in the remote communities closest to Khau Ca forest. With a Covid-19 pandemic-driven hiatus in 2020-2021, this "Forest Appreciation Program" has been held every summer from 2012-2022. Over that time, a total of more than 2,700 students from five schools in four communes within Ha Giang Province have participated (Table 3). And in 2019 alone, 87% of students described clear, accurate pledges for how they and their families could help protect snub-nosed monkeys and Khau Ca forest.

Table 3. Annual Forest Appreciation Program participation.

Year	Students	Schools
2012	250	4 main schools
2013	250	4 main schools
2014	250	4 main schools
2015	255	4 main schools
2016	292	4 main schools and 1 satellite school
2017	348	4 main schools and 2 satellite school
2018	324	4 main schools and 2 satellite schools
2019	375	5 main schools and 2 satellite schools
2020	Cancelled by Covid-19 pandemic	
2021	Cancelled by Covid-19 pandemic – distributed 2,200 conservation activity books	
2022	357	5 main schools and 2 satellite schools
TOTAL	**2,701 students**	

In recent years, we have also bolstered our reach to primary school pupils by developing and distributing classroom conservation kits and a conservation activity booklet. In 2018, one of our partner school districts asked Denver Zoological Foundation staff to co-develop conservation science curricula for 2nd and 3rd grade students. In response, we partnered with local school teachers to create kits containing benchmark-aligned lesson plans and materials that could be shared by 2nd and 3rd grade teachers, and delivered as part of their standard science curriculum. These kits not only helped meet the needs of the local school districts, they also provided foundational lessons for younger pupils prior to joining our 4th to 5th grade Forest Appreciation Program. Additionally, when the pandemic forced us to cancel our summer programs in 2020-2021, we re-allocated our resources to develop a conservation activity book designed to help teachers promote pro-conservation knowledge, attitudes and behaviors in their students in the absence of the Forest Appreciation Program. A total of 2,200 activity books were distributed to all 3rd to 5th grade students in each of the schools we work with. The activity books provided a unique learning and awareness opportunity that expanded our reach beyond our traditional in-person Forest Appreciation Program classroom activities. Like the conservation calendars, the activity books were brought home so that children could share their awareness of snub-nosed monkey conservation with family members. Both the classroom conservation kits and the conservation activity books allowed students and teachers to remain engaged in snub-nosed monkey conservation activities throughout the worst of the pandemic, when foundation staff and educators could not be present.

'Monkey Days' and Virtual Conservation Events

To promote the protection of snub-nosed monkey and Khau Ca forest more broadly across the community of more than 3,000 households, we initiated annual community conservation events in 2017. Each November – which is the beginning of the winter months when human use of forest resources is at its peak – Denver Zoological and New Nature Foundations and local community members host a snub-nosed monkey celebration named 'Monkey Day' (Fig. 7). With few exceptions, each of our two annual events (held in two different communities) have attracted over 1,000 attendees, for a total attendance of over 7,000 people from 2017 to 2022. To draw in important local and regional decision-makers, community leaders and government officials act as VIP- attendees, judges and masters of ceremonies. In 2022, the events also attracted the attention of provincial news media. 'Monkey Days' engage attendees of all ages, ethnicities and genders in hands-on activities, cooking demonstrations and friendly art, dance, song and racing competitions – all designed to reinforce the key message "*Save the Forest to Save the Monkeys*". As an amalgamation of tradition, culture and conservation action, 'Monkey Days' celebrate the community's partnership in protecting endangered species while inspiring continued action. Pledges collected during these events indicate that 54% of program attendees promise to protect snub-nosed monkeys and 41% intend to help stop deforestation.

Fig.7. The local people were celebrating Tonkin snub-nosed monkeys in the 'Monkey Day'. Photo: Luu Tuong Bach.

While the Covid-19 pandemic prevented us from organizing in-person 'Monkey Days' in 2020 and 2021, we initiated 'Virtual Conservation Events'. By 2020, many residents owned either smart phones or smart TV's and we discovered a large local contingent was using Facebook to stay connected with friends and family. We therefore utilized this familiar Facebook platform to hold part-live/partly pre-recorded virtual events featuring musical performances, VIP appearances, videos and competitive trivia games. Local Youth Union partners coordinated small "watch parties" across the community and snub-nosed monkey-masked teams at each party competed for prizes – much like during our in-person 'Monkey Day' events. In 2021 alone, this virtual event resulted in over 6,000 engagements from six provinces in Vietnam, as well as participants from five other countries. In 2022, when we were able to resume our annual in-person 'Monkey Days' we continued to use our Facebook fanpage: (https://www.facebook.com/NgayHoiBaoTon.MonkeyDay) to announce and promote the event, generate excitement, and engage both local and international audiences in our effort to help save snub-nosed monkeys and Khau Ca forest.

Efficient stove campaign

Fuel wood demand has been identified as one of the main drivers of timber harvesting within the communities surrounding the Khau Ca forest (Levine 2016). When Denver Zoological Foundation began partnering in the region in 2009, the vast majority of households were using wood-burning open hearths to cook food for people, livestock and business, as well as for sterilizing water, making rice wine, and heating the home in chilly winter months. With the knowledge that snub-nosed monekys also rely heavily upon large trees for survival, Denver Zoological Foundation felt it was imperative to take action to reduce the significant human timber demand (Fig. 8).

Fig.8. Local demand on fuelwood for daily activities. Photo: Luu Tuong Bach.

In 2014, almost immediately following our 2011/2013 study, Denver Zoological Foundation recruited partners from New Nature Foundation to develop a fuel efficient stove project. Based on the success of New Nature Foundation in Uganda, the goal of this program is to help local people design, build and use highly efficient “rocket stoves” and significantly reduce their reliance on fuel wood (Fig. 9, 10). Because an open hearth set in the middle of the home has been the tradition in most ethnic minority communities in the region for many generations, we anticipated acceptance of this new technology would not occur overnight. This was especially true for households with elderly family members who often act as primary household chef, as their adherence to cultural traditions and distrust of new cooking methods is especially strong. Thus, rather than offering free commercially-available stoves that degrade within a decade and are not designed specifically to meet the needs of local people, our stove campaign was co-designed by international and local experts.

Fig.9, 10. International and local experts were collaborating in designing stoves. Photo: Luu Tuong Bach.

From day one, our campaign has operated at the grassroots level, with an aim to build trust in the efficient technology and grow the program slowly from within the community. Our focus has been on training community partners to become experts in efficient rocket stove design, construction, use and maintenance so that there is knowledge built into the community when it comes time to rebuild degraded stoves. Initial stove designs were built in 2014/2015 within households of willing research assistants, our new "stove ambassadors", local officials and other close partners, as well as at local schools. This allowed our team to experiment with a variety of designs in an atmosphere where there was pre-existing trust. These households and schools then became models for others in the community, helping demonstrate the benefits of rocket stoves compared to traditional open hearths. Not long after launching the campaign, it became clear that fuel efficient stoves would not only benefit snub-nosed monkeys through timber demand reduction, but would offer many advantages for local people, as well. The most populous Tay and Dao communities in the region had been using simple open hearth cooking methods for centuries and suitable fuelwood sources have become less and less available. People in some communities near Khau Ca forest walk as far as 2 km or more to access timber appropriate for use in an open hearth.

Plus, compared to open hearths, rocket stoves produce less smoke and soot, reduce the chances of uncontained fire and fire-related injuries, retain heat – which is appreciated in the warm months (March to October), produce less charcoal, consume significantly less fuelwood in general, require only small, lightweight tree branches that are easy to gather and carry, and are inexpensive. Materials for building the stoves (cement, sand, rice husks, metal grate or rebar, and wood planks) are all locally available and cost less than $5 per stove. This is a price point that is reachable for most local households; and to improve buy-in, owners are asked to purchase the materials and help build the stove. While inexpensive, the stove design is very robust, with our largest models being capable of supporting heavy pots up to 150 kg (Fig. 11). We have also worked with our local partners to develop several different rocket stove designs, from small household kitchen models to large industrial-sized models, and from one to as many as three different burners. Perhaps the biggest disadvantage of our rocket stove design is its heavy weight (our largest stoves must be constructed in place, as they are not moveable). However, surveys conducted with current stove users confirm that, in their view, the benefits far outweigh the costs of owning and using one of our efficient rocket stove models. In addition, during our most recent trips to the area, we have learned about several rocket stoves that have been constructed not by our stove ambassadors, but were built as a result of local people observing the incredible benefits of rocket stoves, and taking it upon themselves to shift from an open hearth to an efficient stove design. We consider this to be incredible evidence demonstrating that our goal of building a grassroots efficient stove campaign has taken hold from within the community. After hearing of the program's success, other conservation organizations active in surrounding areas have also initiated stove campaigns, which amplify the positive benefits of this technology for habitat protection.

Fig.11. Newest stove design is welcome at the local family. Photo: Luu Tuong Bach.

To assess the efficiency of our rocket stoves, we conduct approximately 100 household surveys per year. During these surveys, our stove ambassador team measures the amount of fuelwood used by local families for specific purposes (i.e. cooking food for people or livestock, cooking rice wine, etc.) and compares fuelwood use rates between households with efficient stoves and those relying upon traditional open hearths (Fig. 12). Our assessments indicate that rocket stoves used to prepare human food use 35% less wood, stoves used to make rice wine use 43% less, and those used to cook food for pigs use 50% less. Calculating fuelwood savings on a per-pig basis shows an amazing level of efficiency: households with our efficient stoves use 77% less wood per pig than those using other wood-consuming cooking methods. Given that cooking food for pigs represents the most intensive use of fuelwood in the region, our campaign now focuses primarily on building large pig stoves. Over the past seven years, despite a slightly slower stove construction rate during the Covid-19 pandemic, we have built more than 1,170 rocket stoves in the communities surrounding Khau Ca forest.

Fig.12. Stove ambassador was measuring fuelwood use for accuracy assessment. Photo: Luu Tuong Bach.

At a rate of 3.3 members/household (Levine 2016), this equates to approximately 33% of the households in the community. All three stove designs in Vietnam continue to save large amounts of wood. This year's surveys reveal wine stoves use 32% less wood; family stoves use 60% less; animal stoves use 35% less overall, and savings are even better on a per-animal basis (because families with efficient stoves tend to have more animals, the per-animal savings is 55%, or nearly 2.3 kg of wood saved per animal per day.) All told, New Nature Foundation Vietnam stoves saved over 2.04 tons of wood in 2022 (Goldstone & Stern 2022) (Table 4).

Table 4. Number of efficient stoves built in the communities surrounding Khau Ca protected area.

Year	Communes				Total
	Tung Ba	Minh Son	Yen Dinh	Adjacent communes	
2014	2	2	0		4
2015	0	15	3		18
2016	33	45	6		84
2017	68	23	37		128
2018	37	135	37		209
2019	28	200	4		232
2020	6	126	42	8	182
2021	0	71	42	10	123
2022	1	151	41		193
TOTAL	**173**	**751**	**209**	**18**	**1173**

Conclusion

Over the past 15 years, the Denver Zoological Foundation has been fortunate to have built long-term, trusting relationships with both local and international partners who are effectively working together in northern Vietnam towards the shared purpose of protecting the largest population of 'Critically Endangered' Tonkin snub-nosed monkey and the essential Khau Ca forest habitat. Together, we have engaged and raised awareness with the majority of the 10,000 community members in the region, had the opportunity to interact with over 2,700 youth, supported an incredible team of local research assistants, stove ambassadors and teachers, helped people improve their livelihoods via reducing the massive physical and temporal effort required for gathering fuelwood, and made over 1,200 household chefs happier and healthier with their new heat and smoke-retaining cooking methods. Assuming at least 95% of the stoves built through our campaign in 2017 or later is still in use, the co-developed and community-led efficient stove campaign has cumulatively saved over 13 tons of timber in just nine years. Given that trees are not only important resources for local people but are also essential for snub-nosed monkey survival, we consider this to be an incredible achievement when it comes to reducing the threat timber demand places on the forest and the monkeys.

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Recent discovery of a Hatinh langur population (*Trachypithecus hatinhensis*) in Quang Tri Province, Vietnam

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Summary

The Hatinh langur (*Trachypithecus hatinhensis*) is an endangered and a restricted range species, found in northern central Vietnam and eastern Laos. The known distribution of the Hatinh langurs in Vietnam extends along the border with Laos from 18º N, roughly on the border between Hatinh and Quang Binh Provinces, southwards to about 16º 50' in the northern Quang Tri Province. In Vietnam, five isolated populations are known. In Quang Binh Province in the Special Use Forest Tuyen Hoa District, the nature reserves Nui Giang Man and Khe Nuoc Trong and the National Park Phong Nha-Ke Bang, and in the Quang Tri Province in the Bac Huong Hoa Nature Reserve. However, there is no recent information on other former populations in the nature reserves of Ke Go, Hatinh Province and Khe Net, Quang Binh Province and it is assumed that they are eradicated. The size of the individual populations is largely unknown. Another isolated population was recently discovered on the border of Cam Lo and Da Krong Districts, Quang Tri Province. The occurrence is limited to two nearby limestone blocks known as Rockpile and Razorback. One or two groups, with a total of 8 - 12 individuals, were observed on the Rockpile. According to information from locals, a larger population exists on Razorback. A population of rhesus macaques (*Macaca mulatta*) was also observed in both the Rockpile and Razoback area. The detection of Hatinh langurs in this area extends the previously known occurrence of the species to the Southeast. Detailed surveys of the area are needed to provide a basis for further conservation activities.

Ghi nhận mới quần thể Voọc Hà tĩnh (*Trachypithecus hatinhensis*) tại tỉnh Quảng Trị, Việt Nam

Tóm tắt

Loài linh trưởng đang có nguy cơ đe dọa bị tuyệt chủng Voọc Hà Tĩnh (*Trachypithecus hatinhensis*) phân bố giới hạn từ Bắc miền Trung Việt Nam và phía Đông Lào. Loài này phân bố dọc theo biên giới Việt Nam và Lào từ 18° Bắc, gần ranh giới giữa hai tỉnh Hà Tĩnh và Quảng Bình, đến 16° 50' Nam ở phía Bắc tỉnh Quảng Trị. Ở Việt Nam, một số quần thể cô lập được ghi nhận tại tỉnh Quảng Bình bao gồm rừng đặc dụng huyện Tuyên Hóa, Khu bảo tồn thiên nhiên Núi Giăng Màn, Khu bảo tồn thiên nhiên Động Châu - Khe Nước Trong, Vườn Quốc gia Phong Nha - Kẻ Bàng và Khu bảo tồn thiên nhiên Bắc Hướng Hóa, tỉnh Quảng Trị. Tuy nhiên, không có thông tin về các quần thể được ghi nhận trước đây tại Khu bảo tồn thiên nhiên Kẻ Gỗ, tỉnh Hà Tĩnh và Khe Nét, tỉnh Quảng Bình, và một số giả định cho rằng chúng đã bị tuyệt chủng. Kích thước quần thể ghi nhận tại các khu vực này phần lớn chưa được xác định. Một quần thể bị cô lập khác mới được ghi nhận ở khu vực núi đá vôi, Rockpile và Razorback, nằm trên ranh giới huyện Cam Lộ và Đakrông, tỉnh Quảng Trị. Có một đến hai đàn Voọc Hà Tĩnh với số lượng 8 - 12 cá thể đã được quan sát tại khu vực núi Rockpile. Theo thông tin phỏng vấn, một quần thể lớn hơn có thể đang sinh sống tại khu vực núi Razorback.Ngoài ra, một quần thể

Khỉ Vàng (*Macaca mulatta*) cũng được quan sát tại Rockpile và Razorback. Việc phát hiện quần thể Voọc Hà Tĩnh ở khu vực này đã mở rộng sự phân bố của loài này về phía Đông Nam. Do vậy, cần tiến hành thêm các cuộc điều tra, đánh giá toàn diện quần thể Voọc Hà Tĩnh tại khu vực này làm cơ sở cho các hoạt động bảo tồn tiếp theo.

Introduction

The presence of a small population of Hatinh langurs was recently discovered on the border between Cam Lo and Da Krong Districts, Quang Tri Province. This discovery extends the known area of occurrence in Quang Tri Province to the Southwest and is possibly the southernmost occurrence of the species (Fig. 1). The known distribution of the Hatinh langurs in Vietnam extends along the border with Laos from 18º N, roughly on the border between Ha Tinh and Quang Binh Provinces, southwards to about 16º 50' in the northern Quang Tri Province (Nadler et al. 2003). The area along the border with Laos is dominated by an almost continuous limestone massif with elevations up to 1000 and 1300 m asl. The northernmost known occurrence is in the Nui Giang Man Nature Reserve, Quang Binh Province (Le Khac Quyet 2004). To the East of this Annamite Mountain range are some isolated limestone massifs with records of Hatinh langurs, both from long ago and recent evidence as well. Older records – about 30+ individuals - exist from Khe Net Nature Reserve, Quang Binh Province (Le Trong Trai et al. 2001), but this population is probably extinct. A population exists in Khe Nuoc Trong Nature Reserve, South of Phong Nha-Ke Bang National Park (Minh Phong 2022). There is also information of occurrence from the Ke Go Nature Reserve, Hatinh Province (Tran Huu Vy 2013) and an attempt to establish a population in this area was made in 2015, but failed (Nadler et al. 2019). A population of the species exists im Special Use Forest Tuyen Hoa District, Quang Binh Province (Dong Thanh Hai & Thao A Tung 2018; CIRD 2020). The southernmost known population in the Annamite Mountain range, along the border with Laos, exists in the Bac Huong Hoa Nature Reserve, Quang Tri Province (BirdLife International 2005; Nguyen Manh Ha 2006; Nguyen Ai Tam 2012). Also in Quang Tri Province are smaller isolated limestone areas to the East of the Annamite Mountain range, where the population has now been discovered (Fig. 2).

Fig.1. The currently known occurrences of Hatinh langurs in Quang Binh and Quang Tri Provinces, Vietnam: 1 - Special Use Forest Tuyen Hoa District; 2 - Nui Giang Man Nature Reserve; 3 - Phong Nha-Ke Bang National Park; 4 - Khe Nuoc Trong Nature Reserve; 5 - Bac Huong Hoa Nature Reserve; 6 - recent discovered population in Cam Lo / Da Krong Districts.

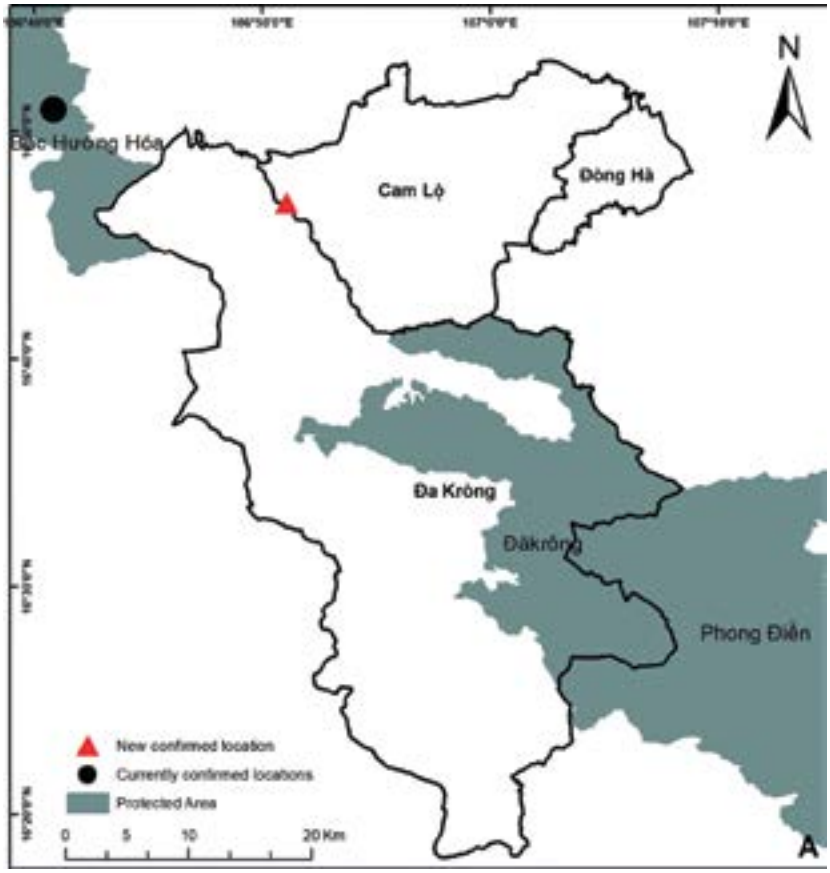

Fig.2. The recently discovered Hatinh langur population on the border between the Cam Lo and Da Krong Districts, Quang Tri Province.

Across the border - in Laos - and following the Annamite Mountain range, Hatinh langurs occur from the Nakai Nam Theun National Biodiversity Conservation Area (NBCA) in the North to the Hin Namno NBCA to the South. There are also occurrences on separate limestone formations to the West in Khammouane Province. These occurrences largely comprise the black morph of Hatinh langur (*T. hatinhensis* morph *ebenus*) (Nadler 2009). So far, there is no reliable information on the population size of the species, neither for Laos nor for Vietnam. In Vietnam, the largest population exists in Phong Nha-Ke Bang National Park, Quang Bing Province. However, the numbers are not very reliable. The population is estimated to range from 520 to 750 individuals (Le Xuan Canh et al. 1997), with a maximum of 800 individuals (Pham Nhat et al. 2002) to 2143 (±467) (Haus et al. 2009). The population in the Special Use Forest, Tuyen Hoa District, Quang Binh Province comprises 156 individuals (CIRD 2020). Figures from other areas are not available or not comprehensive.

Material and methods

Discovery of the species and study area

During botanical surveys of the Institute for Scientific Research at the Vietnam National Museum of Nature Hue, carried out by Le Tuan Anh the occurence of Hatinh langurs were discovered in February 2023 on one limestone block known as Rockpile in Cam Lo District, Quang Tri Province (Fig. 3). An interview survey of locals confirmed the observations.

Fig.3. The limestone block called Rockpile with about 250 m asl.

The occurrence of the Hatinh langurs is limited to an area of about 250 ha and to two limestone blocks, the Rockpile with 36 ha and the so-called Razorback with 188 ha (6°46'-16°48'N/106°49'-106°51'E) (Fig. 4). The Rockpile, with several peaks, has a height of about 250 m asl, the Razorback reaches a height of about 450 m asl. The two areas lie at a distance of about 500 m (Fig. 5). The connected area is relatively flat and has a height of 50 to 70 m asl. It is used as a plantation for Rubber and Acacia. Limestone was mined in both areas. However, mining activities ceased about 10 years ago. The mining sites are still clearly visible and not covered with vegetation (Fig. 6, 7, 8). On the east side of the Rockpile, a well-preserved forest formation still stands (Fig. 9). The mining sites on the South and West sides are mostly shrub. The East side of Razorback shows bare rock at the former mining sites, as well as natural shrub vegetation on steep rock. On the north side there is a relatively undamaged forest stand (Fig. 10). Water, as a necessary resource for the existence of the langurs, is available through springs on the rock, through smaller rivulets and streams. A constructed pond also exists in the area connecting the two limestone blocks (Fig. 6).

Fig.4. The limestone block called Razorback with up to 450 m asl.

Fig.5. The location of the two Limestone blocks.

Fig.6. View from the foot of the Rockpile to the Razorback. The relatively flat area between the limestone blocks is used for rubber and acacia plantations.The East flank of Razorback with former quarry area. Photo: Tilo Nadler

Fig.7. The Razorback with vegetation-free area of the former quarry. Photo: Tilo Nadler.

Fig.8. West flank of Rockpile with former quarry area. Photo: Tilo Nadler.

Fig.9. East flank of Rockpile with partially intact forest cover. Photo: Tilo Nadler.

Fig.10. North-eastern flank of the Razorback with relatively intact forest cover. Agricultural use for acacia plantations extends directly to the foot of the limestone block.

Survey activities

Following the discovery of the population, several short surveys were conducted between February and August 2023 to assess the population size and status of the Hatinh langurs in the area. More intensive surveys were conducted at Rockpile from 11th to 20th September and 23rd to 30th September 2023. One group with 8 individuals which included three juveniles, about one year old was observed on 19th September and another group with four individuals observed on 23rd and 30th September

(Fig. 11, 12, 13). But these groups are most probably in exchange with animals from the Razorback area. Locals informed that a larger population exists there and there were also observations that animals moved through the rubber plantation between these two areas. Additionally, the presence of a population of Rhesus macaques (*Macaca mulatta*) was recorded in both areas. Observed were 3-4 groups with estimated 15-20 individuals in total (Fig. 14).

Fig.11. A group Hatinh langurs with 8 individuals which included three juveniles. Photo: Le Tuan Anh.

Fig.12. Hatinh langur male of a group of four individuals. Photo: Tilo Nadler.

Fig.13. Three females of the group of four individuals. Photo: Tilo Nadler.

Fig.14. Rhesus macaque from a group on the Rockpile. Photo: Le Tuan Anh.

Negative impacts found on the area and the occurrence of langurs

Hunting activities on the langurs could not be detected during the stays in the area and according to local people they do not pose a threat to the langurs. However, free-ranging goats in the limestone blocks are a food competition for the langurs and a larger number contributes to a significant reduction of the vegetation. Limestone quarrying in the area ceased about 10 years ago and currently poses no direct threat to the habitat. Logging of larger trees also leads to a change in the vegetation structure. Two endangered tree species, Agarwood (*Aquilaria crassna*; Vietnamese: Trầm hương) and the Cambodian dragon tree (*Dracaena cambodiana*) were overexploited in this area.

The area near the former demarcation line between North and South Vietnam was a heavily contested area. The presence of ammunition poses a danger to humans, animals and the environment (Fig. 15).

Fig.15. UXO - Unexploded ordnance is found in the area and still pose a risk of detonation. Even if it does not explode, environmental pollutants are released as it degrades.Photo: Le Tuan Anh.

Necessary further investigations

A detailed survey of the area, focusing on the Razorback, is needed to assess the size of the population and to take conservation measures. To conduct field surveys of this endangered species to confirm status and distribution in Vietnam is also a requirement set out in the "Urgent Conservation Action Plan for Primates in Vietnam to 2025, Vision to 2030" and approved by the Prime Minister with the Decision 628/QD-TTg from May 10th 2017. Special attention in future surveys should be paid to negative influences on the area that could threaten the existence of this population.

Conclusions

The discovery of a population of Hatinh langurs requires further surveys to determine the population size. Recommendations for the protection of the population are to be worked out and coordinated with the local authorities and the local population. Plans to develop the area for tourism apparently existed, but were not implemented. If the area is to be developed for tourism, appropriate protection conditions for the langur population should be included in the planning. A protection status for the area should be provided in order to exclude negative impacts on the population.

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The development of care protocols for pygmy lorises (*Xanthonycticebus pygmaeus*) from 2008 to 2023 at the Dao Tien Endangered Primate Species Centre, Cat Tien National Park, Vietnam

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Key words: Pygmy Loris, *Xanthonycticebus pygmaeus*, rescue, Dao Tien Endangered Primate Species Centre, husbandry.

Summary

In-situ rescue centres play a key role in the mitigation of the illegal wildlife trade, delivering facilities to partner law enforcement and receive confiscated animals. From July 2008 to July 2023 the Dao Tien Endangered Primate Species Centre cared for 182 lorises: 174 pygmy lorises (*Xanthonycticebus pygmaeus*) and 8 Bengal slow lorises (*Nycticebus bengalensis*). Of these 146 individuals (80%) were rescued from the illegal wildlife trade, and 36 individuals (20%) were born in captivity. Focussing on pygmy loris, rescues occurred continuously, with 8 or less individuals at any one confiscation. After health examination at time of rescue 92 from 142 individuals (65%) were assessed in 'good' health and 50 Individuals (35%) in 'poor' condition. Of individuals assessed in 'poor' health, 72% were assessed as underweight, then followed by those with a snare injury 8%, skin conditions 8%, eye damage 6%, overweight 4% and gum disease 2%. Greatest morbidity occurred with infants less than four months of age from excessive maternal licking, resulting in organ failure, assumed from toxin poisoning. With information gained from captive care observations, data from post-release monitoring (58 pygmy lorises deployed fitted with VHF collars) and post-mortems; specialist infrastructure and protocols have developed. These include increased enclosure size, >50% exudate diet, specific gastro-intestinal parasite management and greater consideration for social management. This has led to improved captive welfare and release success. We hope other rescue centres can learn from our experience and help manage these small primates with their welfare needs met, contributing too successful release back to the wild and reinforcement of dwindling wild populations.

Xây dựng quy trình chăm sóc cu li nhỏ (*Xanthonycticebus pygmaeus*) từ năm 2008 đến năm 2023 tại Trung tâm Cứu hộ Linh trưởng Nguy cấp Đào Tiên, Vườn Quốc gia Cát Tiên, Việt Nam

Tóm tắt

Các trung tâm cứu hộ chuyển vị đóng một vai trò quan trọng trong việc giảm thiểu buôn bán động vật hoang dã bất hợp pháp, cung cấp các cơ sở cho cơ quan thực thi pháp luật và tiếp nhận động vật bị tịch thu. Từ tháng 7/2008 đến tháng 7/2023, Trung tâm Cứu hộ Linh trưởng Nguy cấp Đào Tiên đã chăm sóc 182 cá thể của hai loài cu li: 174 cá thể cu li nhỏ (*Xanthonycticebus pygmaeus*) và 8 cá thể cu li lớn Bengal (*Nycticebus bengalensis*). Trong số này, 146 cá thể (80%) đã được giải cứu khỏi nạn buôn bán động vật hoang dã bất hợp pháp và 36 cá thể (20%) được sinh ra trong điều kiện nuôi nhốt. Mối quan tâm chính cho loài cu li nhỏ, các cuộc giải cứu diễn ra liên tục, với 8 cá thể trở xuống tại bất kỳ một vụ tịch thu nào. Sau khi kiểm tra sức khỏe tại thời điểm giải cứu, 92 trong số 142 cá thể (65%) được đánh giá có sức khỏe 'tốt' và 50 cá thể (35%) trong tình trạng 'kém'. Trong số những cá thể được đánh giá có sức khỏe 'kém', 72% được đánh giá là thiếu cân, sau đó là những cá thể bị chấn thương do bẫy 8%, tình trạng da bị tổn thương 8%, mắt bị tổn thương 6%, thừa cân 4% và bệnh nướu

rằng 2%. Tỷ lệ mắc bệnh cao nhất xảy ra với đối tượng sơ sinh dưới bốn tháng tuổi do bị con mẹ liếm quá mức, dẫn đến suy nội tạng, được cho là do ngộ độc độc tố. Với những số liệu thu được từ các quan sát chăm sóc nuôi nhốt, dữ liệu từ giám sát sau khi thả (58 cá thể cu li nhỏ được triển khai có gắn vòng cổ VHF) và khám nghiệm tử thi; Các số liệu chuyên môn và các hướng dẫn cơ bản đã được xây dựng. Bao gồm tăng kích thước chuồng nuôi, >50% chế độ ăn tiết dịch, kiểm soát ký sinh trùng dạ dày-đường ruột và cân nhắc nhiều hơn trong việc quản lý quan hệ xã hội. Điều này đã cải thiện phúc lợi nuôi nhốt và thành công sau tái thả. Chúng tôi hy vọng các trung tâm cứu hộ khác có thể học hỏi kinh nghiệm của chúng tôi và giúp quản lý những loài linh trưởng nhỏ này với nhu cầu phúc lợi của chúng được đáp ứng, góp phần cho việc tái thả đạt kết quả thành công cao sau khi chúng được trở về tự nhiên và tăng cường số lượng cũng như nguồn gen cho các quần thể hoang dã đang suy giảm.

Introduction

Due to a lack of funds, knowledge and capacity, rescued in-situ wildlife can often be kept in inappropriate conditions that violate the five freedoms of animal welfare (Bergin & Nijman 2019), and ultimately reduce survival in captivity and post-release back to the wild. If rescue centres are to fulfil their role in combating the wildlife trade, these aspects need to be improved. Within Southeast Asia, and specifically Vietnam, a trend for more specialised rescue centres has developed for species such as bears, turtles, pangolins and primates, mostly located in the North. In 2008 the Dao Tien Endangered Primate Species Centre was the first specialised centre to be established in the South, in Cat Tien National Park, 180 km from Ho Chi Minh City. The centre was founded by the NGO's Monkey World - Ape Rescue Centre (UK), Pingtung Rescue Centre (Taiwan) and the Endangered Asian Species Trust (UK), in direct collaboration with the Cat Tien National Park and the Vietnamese Ministry of Agriculture and Rural Development. The mission was to develop protocols for rehabilitation and release of the endangered primates of South Vietnam (Kenyon et al. 2012; Kenyon et al. 2014). It is clear that within these taxa, certain genera require more specialist care, such as douc langurs and lorises (Ruempler 2008, McEwan et al. 2021).

Lorises, as specialised exudate feeders primarly feeding on plant fluids and secretions, fail to thrive on standard fruit diets (Cabana et al. 2017) and, due to their production of venom (Nekaris et al. 2013), require greater care with social management.

Lorises are nocturnal primates, of which two genera are native to Vietnam. Firstly pygmy lorises (*Xanthonycticebus*) (Nekaris & Nijman 2022), with a northern and southern species (*X. intermedius* & *X.pygmaeus*) (Blair et al. 2023) and a single species from the *Nycticebus* genus, the Bengal slow loris (*N. bengalensis*). In the North of Vietnam, northern pygmy loris is sympatric with Bengal slow loris, while South of the Van Hai pass the southern pygmy loris distribution starts (Fig. 1). *Xanthonycticebus* and *Nycticebus* populations are in decline due to loss of habitat and poaching (Blair et al. 2020). In Vietnam the poaching and trade in loris demonstrates a dynamic complexity between illegal hunting for meat, traditional medicine and the pet trade (Thach et al. 2018), primarily opportunistic for domestic consumption.

In the context of the challenges faced by lorises and the broader efforts to protect endangered wildlife in Southeast Asia, we present in the present paper an overview of pygmy loris rescue data from the Dao Tien Endangered Primate Species Centre, highlighting how protocol adjustments have

Fig.1. Pygmy loris distribution in Vietnam and the location of the Dao Tien Endangered Primate Species Centre.

improved the quality of care. These improvements have proven critical for the enhanced captive care and increased post-release survival of these endangered primates.

Materials and Methods

Rescue data for pygmy lorises was gathered from collection records and TRACKS © database from July 2008 to July 2023. The Dao Tien Endangered Primate Species Centre is located on a 56 ha island in Lam Dong Province, Cat Tien National Park (112524 N/1072543 E) (Fig. 2). Climate is tropical monsoon with a dry season from November to March and a wet season from April to October. Seasonal variation in temperatures is not extreme; the hottest day-time temperature in April is 35°C, with average night-time temperatures 24°C. The coolest months, December and January, average a minimum night-time temperature of 20°C, but anomalies of 11°C are becoming more common. The habitat is secondary forest with deciduous, evergreen trees mixed with large areas of bamboo. All lorises received by the centre are directly rescued by the Forest Protection Department of the national park in cooperation with Provincial Forest Protection Department or the Ho Chi Minh City Environmental Police.

Fig.2. The island of Dao Tien with the Dao Tien Endangered Primate Species Centre. All Photos: Marina Kenyon.

Individuals at time of rescue are given an intake examination; sex, age, weight, obvious injuries, parasite screenings. Followed later by a full examination under veterinary supervision (blood screening, TB test, body biometrics, DNA and microchips), although since COVID lockdown veterinary examination has not always been possible. Pygmy loris health was assessed as either “good” or “poor”. Assessments of ‘good’ health indicated no injuries, good overall body and coat condition and, for adult pygmy lorises, a weight between 320g and 500g. Based on data collected at the centre, the health of adults weighing 320g to 500g are classified as “good” while weighing less than 320g or more than 500g are classified as “poor” incurring greater health problems while in care or post-release. Primate care staff observes the animals through the day from 08:30 to 16:30 during cleaning and general maintenance. Night-time staff (instated in 2015) observes through the night from 17:50 to 05:00, administering oral medical treatments, feeding, providing enrichment and monitoring introductions and behaviour. All night-time work is carried out using a head torch fitted with a red filter. When individuals die, post-mortems are carried out by a veterinarian.

Pygmy lorises have been housed in four types of enclosures since 2008; all outdoor on a natural light cycle. Initially when the centre opened in 2008 small loris cages were constructed (8 m^3) (Fig. 3). After increased confiscations of pygmy lorises a quarantine house was built (16 m^3) (Fig. 4). Then followed a loris complex (60 m^3) (Figs. 5, 6, 7) with connecting tunnels (Fig. 8) and an open topped forested enclosure (11.000 m^2) (Fig. 9).

Fig.3. In 2008 the centre started with small loris cages.

Fig.4. Quarantine house.

Fig.5. Loris complex.

Fig.6. Loris complex.

Fig.7. Loris complex.

Fig.8. Connecting tunnels in the loris complex.

Fig.9. Open topped forested enclosure with fence.

Results

The numbers of pygmy lorises received per year varied. The greatest confiscation in 2015 driven by trading via social media (Fig. 10). Most common confiscation number was a single individual, and the largest confiscation contained 8 individuals. Confiscations were all from south-central provinces and chiefly from Dong Nai Province (Fig. 11).

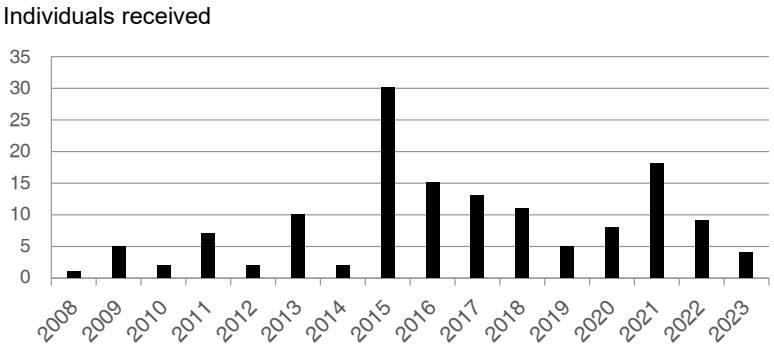

Fig.10. Confiscated pygmy lorises (*Xanthonycticebus pygmaeus*) received by the Endangered Primate Species Centre from July 2008 to July 2023 (n=142).

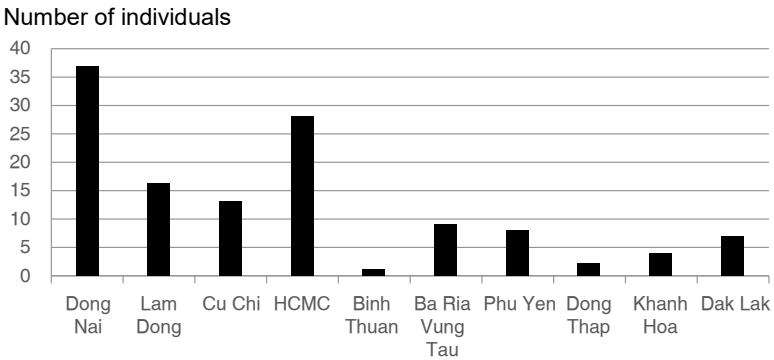

Fig.11. Vietnamese provinces where pygmy lorises (*Xanthonycticebus pygmaeus*) were confiscated.

The health of every rescued pygmy loris was assessed on arrival. Overall, 65% (92 individuals from 142) were assessed as in 'good' health based on the following factors: weight within acceptable range, dentition with normal wear and tear, and no obvious injury or skin problem. Based on night-time observations from the staff, only a small percentage (4%) (6 individuals from 142) displayed abnormal behaviours, classified as Abnormal Repetitive Behaviour (ARB). The ARB observed involved head spinning and repetitively fast locomotion in a loop. Two females who maintained ARB had spent at least seven years at a tourist attraction. ARB individuals went on to be released successfully, fitted with VHF collars for post-release tracking. Thus ARB individuals were classified as in 'good' health.

Of the 35% (50 individuals from 142) of pygmy lorises rescued in 'poor' health. From these 72% (36 individuals from 50) were assessed as underweight. When faecal screens were carried out, gastro-intestinal pathogens were frequently found in high prevalence (*ascaris* and *strongyloides*). In addition to inappropriate nutrition; most pygmy lorises arrived with no water and banana offered as the only food. With anthelminthic treatment and appropriate nutrition, weight is gained and overall health improved. Exudate diets (*Sterculia foetida*) of over 50% were introduced between 2010 and 2014 (Fig. 12) improving blood calcium, weight gain, and gastro-intestinal parasite management. The remaining health issues were snare injury (8%), skin problem (8%), eye damage (6%), overweight (4%) and gum disease (2%).

Fig.12. Pygmy loris eating exudate pre-release.

Most active eye injuries were believed to have occurred during hunting or transit. Unfamiliar individuals placed together in confined space during transit often fight, resulting in corneal scratches, infection of the inner eye or tissue damage caused by venom (Fig. 13). Other injuries presented were snare damage and lesions to the limbs. Finally, hair loss, skin inflammation and burn injuries to fingers, the latter suggested from electric wires or the burning of trees during cashew plantation management. In 2018 a pygmy loris with white hair was confiscated from Ho Chi Minh City. Within six months her hair regrew a normal colour and the animal was successfully released. It is suggested the hair had been bleached for the pet trade (Fig. 14).

Fig.13. Pygmy loris with a venom strike.

Fig.14. Pygmy loris rescued with bleached hair.

Greatest morbidity was with infants. Of rescued females, 12 were rescued pregnant, infants "wild conceived", with four females "captive conceived". All gave birth to twins. Of the 16 pygmy loris which gave birth, 94% (15 individuals from 16) were born between the 27th January and 26th March (Fig. 15). One female birthed ('captive conceived') outside of this period, during the wet season in August. In total 16 females gave birth to 32 infants, of which 18 infants died. Three cases of maternal neglect occurred with highly stressed females. Two females gave birth during transit and one on day three after arrival at the centre. Females who gave birth during transit attempted to care for infants, but then neglected. The female that gave birth on day three post-rescue, was found in the morning with her infants cannibalised (by the mother or adult in adjoining cage). For all other births, the mothers showed excellent maternal care; either solitarily when females arrived after "wild conceived" or females with males after "captive conceived". For pairings with father present, the males were observed to be aware of the female's dominant role, but over time offered support in parenting, often seen caring and sleeping with the infants (Fig. 16).

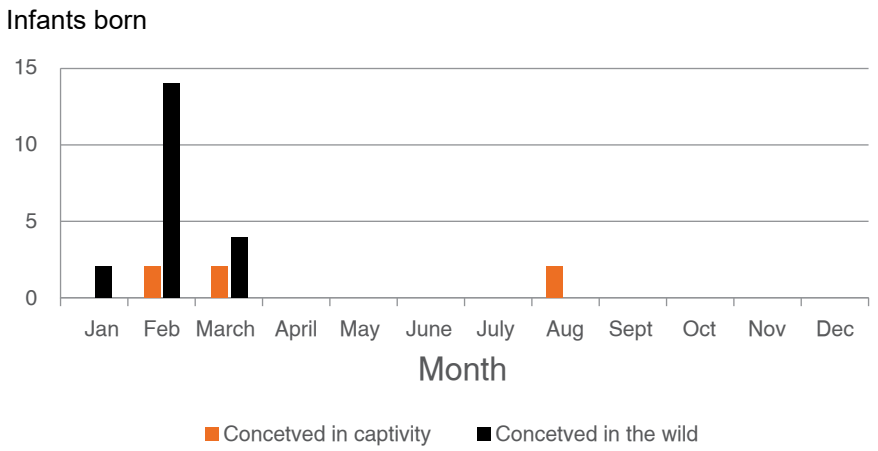

Fig.15. Born infants of rescued pygmy lorises (*Xanthonycticebus pygmaeus*) From July 2008 to July 2023, captive and wild conceived (n=32).

Fig.16. Pygmy loris mother, father and twin infants sleeping site during the day at Dao Tien Endangered Primate Species Centre.

Greatest infant morbidity was observed with infants aged two to four months experiencing sudden death (10 individuals from 18). The infants were assessed as normal size and weight for age (indicating no feeding issue), observed well the day before, yet were found dead on the floor the following morning. In four cases injuries from rats and ants were observed, preventing post-mortem investigation, but believed secondary to the primary cause of death. Not until 2016 when infant cadavers were retrieved in good condition could post-mortems be undertaken. All post-mortems reported internal organ-haemorrhaging, consistent with toxic overload. The females were observed to be continually close to infants and licking; unable to park their babies and travel any significant distance away for foraging as would naturally happen in the wild. The size of enclosure was considered a major factor contributing to infant death; all cases were in the small loris cages built in 2008. With new larger enclosures developed, no further deaths occurred. *Ad lib* observations revealed mothers and infants in larger enclosures frequently were observed apart most of the night, while still sleeping together through the day. All new enclosures had connecting tunnels/slides added between enclosures, enabling rapid expansion of space when needed, especially with breeding females.

Protocols for socialisation were introduced due to mixed results from placing pygmy lorises quickly together in pairs after rescue. To reduce the risk of injury and time needed for a safe introduction, the evaluation of 'good or 'poor' health dictates the care protocol followed. If individuals arrive with a companion they are kept together, however if they arrive solitary and are assessed in 'good' health, they remain solitary until release. Generally, for pygmy loris in 'good' health with less than four years in captivity, only a short time of three to six weeks is needed in captive care before release, enough time to re-establish an exudate diet. The centres' post-release tracking data of paired pygmy loris reported they do not stay together, thus it is not essential for release success. However, individuals identified as in 'poor' condition or greater than four years in captivity require greater time in captive care to re-establish an exudate diet, gain condition and heal from injury. For these individuals the welfare benefit of a companion is important.

Safe protocols for socialisation were developed, such as placing pygmy loris in neighbouring cages with mesh divides that allow the option to safely sleep side by side at the mesh pre-introduction. Only when observations of sleeping close together would introductions go ahead; taking from two days to two months. If mesh-mesh sleeping was not observed, an alternative social partner was considered. Observations over time in captivity and post-release showed a seasonal affinity in associations depending on sex. In the mating season (August to October) when the males have enlarged testicles, males will easily pair with females. But outside of the mating season, male to male associations and female to female associations can be more positive, especially with an older and younger individual. Post-release tracking data of male pygmy loris positively interacting with wild males in the dry season has been observed. Thus season must be factored in when carrying out socialisation.

Discussion

Total numbers of pygmy lorises rescued by the Dao Tien Endangered Primate Species Centre are small; only 142 individuals over a 15-year period. It is generally accepted that numbers confiscated rarely represent the true scale of the illegal hunting taking place (Fuller et al. 2018, Nekaris & Bergin 2017, Thach et al. 2018, Khudamrongsawat et al. 2018). It does not represent the numbers of pygmy loris that are (1) killed at the point of hunting (2) die during transit (3) consumed locally as meat before interception, and (4) released directly after confiscation. Yet it does give an indication that, compared to other pygmy and slow loris nations, the trade in Vietnam is of smaller scale. The drivers of the illegal pygmy loris trade in Vietnam are not as defined as in neighbouring range countries. Cambodian pygmy lorises are hunted predominantly for traditional medicine (Nekaris & Starr 2015), and slow loris in Thailand for the pet/photo prop trade (Osterberg & Nekaris 2015). In Vietnam, as with other range countries, there is greater opportunity for pygmy loris hunting due to the shared anthropogenic landscape (Nekaris & Starr 2015), yet, with limited demand and low monetary value, the hunting has remained opportunistic (Thach et al. 2018). The present trend in Vietnam is to rescue pygmy loris when found in plantation forest (rubber or cashew); this is the situation for many rescues, with pygmy loris frequently caught in Dong Nai plantations and buffer zone of the national parks. Plantation and Agroforestry has been identified as important shared habitat for loris and humans (Nekaris et al. 2017) as with other primates (Payne & Zainuddin 2023). The research and community awareness on needs to continue working to support the development of a culture of sharing this landscape, highlighting the benefits of pygmy loris with pest control.

Surprisingly, a high percentage (65%) of pygmy lorises rescued by our centre was classified as in 'good' health, a starkly different finding to other rescue centres in Asia. Indonesian rescue centres have reported only two individuals from 77 slow loris confiscated in good health (Fuller et al. 2018). At International Animal Rescue, Indonesia, 64% of the 180 slow lorises admitted are deemed unsuitable for reintroduction based on poor health (Moore 2012). Several reasons are suggested for this difference in 'condition at point of rescue'. Firstly, the scale of the trade, i.e. the actual numbers in one confiscation. The largest rescue by our centre was only 8 individuals at once, while rescue centres in Indonesia can be much higher, into the hundreds (Fuller et al. 2018, Moore et al. 2015). In Vietnam the trade is local and small in scale, often no more loris than one night's

hunting. Contrastingly in Indonesia, the trade is on a large scale for export, thus more time is needed to gather large numbers, resulting in longer transit time and greater health deterioration. Loris can be aggressive, displaying strong inter-fighting (with teeth and venom), therefore placing unfamiliar individuals together for transit can result in injuries. Fuller et al. (2018) reported 33.1% of rescued slow loris with external wounds, creating the greatest source of morbidity. From our data set, even with two unfamiliar individuals placed together for transit, eye damage occurred. This is especially important as *Xanthonycticebus* have the highest number of volatile and semi-volatile components identified in the venom, compared to *Nycticebus* (Hagey et al. 2007).

One significant absence was injury linked to dental trauma. Significant injury pre-rescue in particular occurs in countries where "end-use" is the pet trade (Moore 2012). Trade in Indonesia is predominantly for the pet trade, resulting in a high percentage with teeth removed or broken: 19.3% reported with dental problems on arrival (Fuller et al. 2018). In Thailand, surveys of the photo-prop trade showed 6 out of 10 slow lorises had teeth cut (Osterberg & Nekaris 2015), compared to the centre with no present culture observed to pull or cut teeth in the South. Smaller pygmy loris are targeted more for food and traditional medicine in Vietnam (Thach et al. 2018), this factor alone significantly increases health status and potential for successful pygmy loris release in Vietnam.

Our centre received 35% of pygmy lorises in 'poor' health, of which 72% (36 individuals from 50) assessed as underweight. For underweight individuals quickly identifying causal factors is vital; checking teeth and screening faeces for gastro-intestinal parasites. Parasite load is naturally high in wild lorises (Rode-Margono et al. 2015), especially when in disturbed (Kenyon 2007) or anthropogenic landscapes (Rode-Margono et al. 2015). A high prevalence of *trichuris* and *strongyloides* was observed at time of rescue. It is accepted that hunting and transit create high levels of stress, raising gastro-intestinal parasite burden (Dickens et al. 2010). Additionally lorises in the trade are either often not fed or fed an inappropriate diet, such as sweet banana which encourages parasites to flourish. Lorises are obligate exudativores (Nash & Burrows 2010, Swapna et al. 2009, Starr & Nekaris 2013), with wild pygmy loris eating 63% exudate (Streicher 2004). Exudate possesses ethnobotanical properties that naturally reduce gastro-intestinal parasite load (Das et al. 2014, Ahmed 2018). Using standard fruit and vegetable diets, a weekly parasite screening protocol was carried out, with regular anthelminthic treatment required. Protocol now is to provide anthelminthic treatment to all pygmy lorises on arrival, during the high period of stress and transition from inappropriate diet. Once re-established on high exudate diets, generally no further anthelminthic treatment required.

Exudate is also a valuable source of carbohydrate and calcium, preventing metabolic bone disease. An improvement of blood calcium profiles were observed at the centre on a high exudate diet. Re-establishment of high exudate diet is also important for post-release success. Based on post-mortem of deceased pygmy lorises post-release, high levels of fat around the heart and acidosis have been reported as cause of death. Suggesting releasing pygmy loris quickly while still eating inappropriate rich fruit diets will compromise survival post-release. Thus protocols to re-establish pygmy loris on exudate diets pre-release are crucial.

Protocols for socialisation have been developed with seasonal variation factored in. In the mating season the males testicles enlarge, as observed in other prosimians (Kappeler 1987). Male-female socialisation is generally positive, while male to male more aggressive. This seasonal variation in social affinities must be factored in when managing introductions or long-term reproductive units in captivity, especially with the high prevalence of morbidity of pygmy loris in ex-situ centres from trauma injuries (Simpson et al. 2018).

The centre does not strive to actively breed pygmy loris, however females do arrive at the centre pregnant, and some individuals - before we established good release protocols - spent extended periods on Dao Tien and 'captive conceived'. All pygmy loris births were twins corroborating earlier data (Fitch-Synder & Ehlrich 2003). Before specialist facilities were built, the greatest morbidity at the centre was infants, agreeing with data from other captive centres (Fuller et al. 2013, Streicher 2004, Debyser 1995, Nekaris pers.comm); Streicher (2004) stated 42% of sanctuary animals die

during the first year of life. Maternal neglect is frequently reported (Streicher 2004, Debyser 1995), due to stress with infanticide reported (Sushadi et al. 2021). The centre's data supports this, with neglect and infanticide reported at times of extreme stress, such as females giving birth during or immediately after rescue. After this stage however, we have no cases of maternal neglect, with all mothers observed to show excellent maternal instinct. Some females who "wild conceived" gave birth without a male, while others who "captive conceived" at the centre had the father present. The females proved good mothers with or without the father present, supporting findings with slender loris on the positive benefits of paternal care (Nekaris 2003). Based on our data we suggest that this high morbidity in the first year is not linked to female neglect or inadequacies in, but the opposite: the mothers providing too much care and attention, leading to excessive licking and "toxic poisoning".

Conclusion

In Vietnam with high numbers of pygmy loris assessed in 'good' health at the time of rescue, with good infrastructure, nutrition and social management, good captive welfare; successful rehabilitation and managed release protocols can be achieved. However, the development of specialist knowledge and improvement of rescue protocols must be continuous. Factoring in new genetics (Blair et al. 2023), techniques in assessing body condition (Ghassani et al. 2023), and climate change (Reinhardt et al. 2016, Stewart et al. 2020) influencing feeding behaviour (Streicher 2004, Ruf et al. 2015). The future for the adaptable loris is of particular concern as they live in a changing landscape (Oliver 2019, Nekaris et al. 2017). This is especially of concern for South Vietnam, a landscape dominated by rubber and cashew plantation. It is a landscape that potentially carries an increased risk due to high densities of pygmy loris, changed nutrition and high risk of human harm.

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Hand rearing and development of douc langurs (*Pygathrix* sp.) at the Endangered Primate Rescue Center, Vietnam

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Key words: Hand rearing, douc langurs, Endangered Primate Rescue Center, Vietnam.

Summary

Douc langurs are nutritionally very sensitive primates. This is especially true for the rearing of young animals. The Endangered Primate Rescue Center has raised a total of about 80 young of all three douc langur species, 8 of them from the first day of life. A feeding system has been established that has led to successful rearing in most cases. Normal ordinarily UHT-cow milk, 3,5 % fat is used for feeding in a mixture with oak bark tea in a proportion 3:1. The housing conditions of the animals, accommodation, temperature and hygiene are a prerequisite for successful rearing. Housing in a community of young animals and possibly mixing faeces from healthy animals in the milk feed can bring about the necessary change in the microbiomes in the digestive tract and thus avoid digestive problems and diarrhoea. Recording of feeding amounts, animal weight and behaviour is necessary to detect negative development. The average feeding amounts and weight gain of several individuals give an indication of the rearing of young animals.

Chăm sóc nuôi bộ và phát triển voọc chà vá (*Pygathrix* spec.) tại Trung tâm Cứu hộ Linh trưởng Nguy cấp, Việt Nam

Tóm tắt

Voọc chà vá là nhóm loài linh trưởng rất nhạy cảm về mặt dinh dưỡng. Thực sự chính xác đối với việc nuôi bộ động vật còn non. Trung tâm Cứu hộ Linh trưởng Nguy cấp đã chăm nuôi bộ khoảng 80 cá thể con non của cả ba loài voọc chà vá, 8 trong số đó từ ngày đầu sơ sinh. Một quy trình cho ăn đã được xây dựng và đưa đến việc nuôi thành công trong hầu hết các trường hợp. Thông thường sữa bò UHT, 3,5% chất béo được sử dụng để cho ăn trong hỗn hợp với trà vỏ cây sồi theo tỷ lệ 3:1. Điều kiện chỗ ở của động vật, chuồng nuôi, nhiệt độ và vệ sinh là điều kiện tiên quyết để nuôi thành công. Trong khu chuồng nuôi chung động vật còn bé, có thể lấy phân của động vật khỏe mạnh trộn vào trong thức ăn sữa cho động vật sức khỏe yếu ăn, điều này có thể mang lại sự thay đổi cần thiết trong hệ vi sinh vật trong đường tiêu hóa và do đó tránh được các vấn đề tiêu hóa và tiêu chảy. Ghi chép lại lượng thức ăn, trọng lượng và hành vi của động vật là cần thiết để phát hiện các dấu hiệu không tốt. Số lượng cho ăn trung bình và tăng cân của một số cá thể cho thấy một dấu hiệu tốt về việc nuôi động vật còn non.

Introduction

Douc langurs, genus *Pygathrix*, occur only in Indochina, East of the Mekong. The three species red-shanked, grey-shanked and black shanked douc langurs (*P. nemaeus*, *P. cinerea*, *P. nigripes*) are distributed generally allopatric in geographically separated regions of Vietnam, Laos and Cambodia, but with small parapatric zones between red- and grey-shanked douc langurs (Nadler & Brockman 2014, Bui Van Tuan et al. 2019). Douc langurs are rarely kept in zoos and often not succesfully over a longer period (Ruempler 1991). The grey-shanked douc langur, the last discovered species (Nadler 1997), and the black-shanked douc langur are never kept legally in facilities outside of Vietnam.

The gastrointestinal tract in douc langurs differs from other langurs (Kuhn 1964; Chivers 1994) which is probably a reason, that these species are very sensitive feeders (Otto 2005). Hand rearing

of young individuals is a special challenge and little is known and documented about successful attempts. The experiences with hand rearing on a high number of individuals at the EPRC should provide information for other facilities and also call for an exchange of experiences on methods, food and keeping conditions.

Material and Methods

A number of immature douc langurs of all three douc langur species arrived at the EPRC, confiscated from forest protection authorities in several provinces in central and southern Vietnam where douc langurs occur (Fig. 1, 2, 3). The animals are victims of poaching, hunting with snare traps or guns. The females which carried immatures were killed and used for meat or traditional medicine. The immatures - if they survived - are "useless" for such purposes and mostly offered alive to the illegal trade as pets. This is now also more and more practiced via internet, using several platforms. Although not only hunting and trading, also possession and keeping of all primate species is in Vietnam illegal and punishable by law, but it exists still a market for such animals. However, the chance of survival for immatures and juvenile douc langurs as a pet is close to zero.

Fig.1. Red-shanked douc langur (*Pygathrix nemaeus*) one month old. Photo: Tilo Nadler.

Fig.2. Grey-shanked douc langur (*Pygathrix cinerea*) one month old. Photo: Tilo Nadler.

Fig.3. Black-shanked douc langur (*Pygathrix nigripes*) one month old. Photo: Tilo Nadler.

The Endangered Primate Rescue Center (EPRC) kept all three douc langur species.

Since its foundation in 1993, a total of 110 red-shanked douc langurs, 112 grey-shanked douc langurs and 9 black-shanked douc langurs were kept.

In total 34 immature and juvenile douc langurs arrived at the EPRC until end of 2022; 18 red-shanked douc langurs, 12 grey-shanked douc langurs and 4 black-shanked douc langurs. Additional 12 douc langurs which are born at the EPRC were also hand reared, including 8 individuals from its first day of life. One red-shanked douc langur female had missing or dwarfish respectively milk glands but involved in a group and has given birth. After this anatomical feature was recognized the newborn were hand reared.

A douc langur is refered to as juvenile until the age of about one year until it's depends from milk feeding. This period of milk feeding we defined it as hand rearing. It needs a close and direct contact of the keepers to the animals. After this period the animals are normally involved in groups, fed on leaves and not in a dircet "hand contact" with the keepers.

Conditions about the acquirement of confiscated animals and transportation

After information to the EPRC about the confiscation of a young douc langur, one animal keeper started immediately by car to pick up the animal. The distance to travel is usually 500 to 1000 km, often close to the distribution area of the species. If the animals already kept at a ranger station of forest protection authorities the rangers get information about handling and feeding of the animal prior arrival of the animal keeper. After many years of work and closer connections to the forest protection authorities the necessary documents for taking over the animal and permits for the transport are now usually faster issued and the return of the transport can arrange immediately.

For the transport of the young animals, a transport box with a hot water bottle and soft pads is carried along, as well as special baby milk bottles with nipples, which are commercially available for the rearing of small animals, and milk for feedings on the way. If the young animal already very weak, the animal keeper holds the animal by its body during transport to better control the health status.

Housing and Temperature

When a confiscated young animal reaches the EPRC, it is placed in isolation in quarantine. Hand rearing of an animal requires steady regulation but also involves a process of trial and change. It is very important to note all measures in order clearly to see their effects. Only with accurate reporting

it is possible to correct undesired developments. The care of the animals with similar management and good exchange of information should be limited to 2, maximum 3 persons.

For a newborn or very young animal in the beginning a small cage is used with a floor made of a thick polystyrene layer, covered with a clean fresh cloth/towel. A rubber hot-water bottle is wrapped in a towel and should provide body temperature. The water bottle should be so organized that the baby can sit more upright, easy to eructate. A furnishing of the cage, like branches or ropes is not necessary.

The room temperature should be regulated between 28-30 °C.

After about one month, slowly reduce temperature so that the cage is warmer at night than during the day. If weather permits, a window should be opened during the day time, but draught is absolutely to avoid.

Feeding

For the feed we opted for normal UHT cow milk, with the following data per 100 ml: energy 60 kcal, fat 3.5%, protein 3 g, carbohydrates 4.1 g, calcium 110 mg. Milk powder for human babies has a slightly higher energy value, around 67 kcal, a much higher carbohydrate content of 7 to 8 g and a lower calcium content of 53 to 66 mg. The UHT cow milk is used for feeding in a mixture with oak bark tea in a proportion 3:1. The oak bark tea is prepared in a strong dissolution, about 2 teaspoons per 100 ml water, boiled for five minutes, and infused for another 10-20 minutes. The tea works as an astringent and should prevent diarrhea. Very important that the milk/tea mixture in the bottle for feeding should be brought to body temperature.

For a newborn or very young animal 12 feeding times a day are arranged, which means every two hours during day and night time. Usually starts with 6 ml mixture per meal. If the animal finishes the offered amount it can increased slowly. With an increase of the amount, a change of the feces should be observed. With an increase of the amount of the food the number of feedings, can be reduced, preferably the night feeding.

Roughly, at an age of three months, the animal seems to be hungry at all time. The hand reared langurs request a much higher quantity of milk than mother fed juveniles, but a feeding of more than 60 ml per meal was not practiced. If the intake of liquid food is too high mostly it causes diarrhea. On age of around six months the milk feeding can be reduced slowly to force the baby to feed on leaves.

After the baby finishes the milk/tea meal it's to keep upright and to force to a burp by softly tapping its back. In the very beginning, it also is necessary to massage the anus and softly the belly to stimulate excretion. In the age of about one month the animals get also bundle of leaves. At this age, the animals play mainly with the foliage, but also begin to nip at it.

Hygiene

Important is to keep the environment of the animal and all tools flawless hygienic clean. A minimum of keeper personnel should be working directly with the animal and any contact with persons not involved in the keeping should be avoided. Careful hand cleaning is necessary before any contact with the animal and a change of clothings where the animal has contact with is necessary.Tools for feeding, like bottles, nipples should be rinsed with hot water before every use. Clothing which is used for the keeping and towels and cloth which is use in the cage should be washed by 90 degrees.

Weighing

It is strongly recommended the daily weighing of the infants. The time is dependent from management of the work, but it should be at the same time and following the frequency of feeding – before or after feeding.

To keep the animals calm on the scale it is helpful to give them a thin slice of carrot or sweet

potato in the hand. This is usually taken by douc langurs with pleasure.

Monitoring / recording

The weight and observations of the animal's development should be recorded. This allows changes to be identified and appropriate responses to be made. Counting daily feed intake and recording fecal consistency are helpful in making decisions about feeding. Physical development should be recorded, e.g., tooth development, behavioral changes, beginning to walk, climb, vocalizations, etc.

Digestion problems / Diarrhea

The experience with the number of hand-reared animals showed a more problematic period at the age of three to four months. The reason is probably the energetic difference between cow's milk and natural breast milk. However, this difference cannot be compensated by a higher fluid intake. But a higher amount than 40 ml per meal cannot be recommended. Exceeding this amount sometimes leads to vomitting or diarrhea. This is also the time the animals start to feed more intensively on leaves.

This change in the diet also changes the microbiome in the digestive tract of the animals. This change in the microbiome can be supported by adding faeces from healthy older animals, preferably of the same species. A very small amount of faeces can be dissolved in water and added to the milk feed.

To support the development of the microbiome in the alimintary tract, necessary for the digestion of the leaves, to convert cellulose into proteins the animals at the EPRC, where young animals are regularly kept, are moved to a group with other youngsters, called 'kindergarden'. The animals in this 'kindergarden' are hand reared orphans in different age, confiscated from the illegal trade. It's assumed that the close contact to these animals has also a positive influence to the microbiome development.

A practiced support by young cows is also the additive of feaces from healthy adult individuals to the food. It is supposed that it could be also helpful for duoc langurs in this age and was also practized oaccasionally by the EPRC with a positive result, but without the proof about the effective impact.

Development of weight and milk intake

The weights of newborn red-shanked douc langurs in the EPRC show quite considerable differences. This concerns both the births of different females and the births of one female. The birth weights of four males range from 407 to 577 g, with an average of 495 g. The birth weights of 6 females range from 304 to 465 g, with an average of 394 g. Two red-shanked douc langurs born at Cologne Zoo also showed a marked difference in weight, one male weighing 324 g and one female 462 g (Ruempler 1991). These large differences also continue in the further development of the animals (Fig. 4). The increase in the amount of milk fed is greatest in the first week after birth. On the first day of life, between 22 and 40 ml was fed, with an average of 28 ml. After one week, the amount of milk fed was already between 110 and 148 ml, with an average of 130 ml. An adult female in the EPRC allowed her baby to be handed over to a keeper without any problems, which made it possible to record the weight gain during natural rearing. There was a clear difference in weight gain between natural and artificial rearing in the first twelve months (Fig. 4).

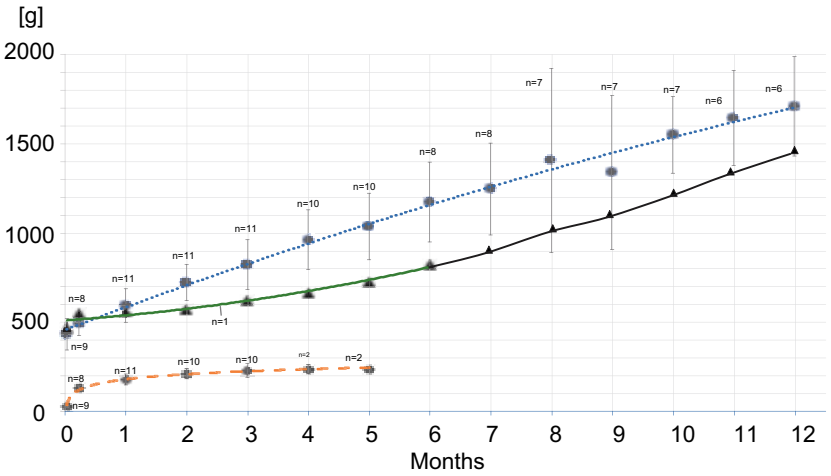

Fig.4. Weight (g) and Milk intake (ml) in relation to the age of the juveniles. Each data point represents the mean value for juveniles at a specific time, and 'n' represents the number of sampled juveniles at each time point. The error bars represent the standard deviation (SD) from the mean, indicating data variability within each group. A polynomial regression analysis for weight when handfed in relation to age produced a well-fitting model with an R^2 value of 0.9925, resulting in the equation $y = -2.1502x^2 + 129.61x + 455.79$. A polynomial regression analysis for weight when motherfed in relation to age produced a well-fitting model with an R^2 value of $R^2 = 0.9531$, resulting in the equation $y = 4.3515x^2 + 23.642x + 509.77$. A logarithmic regression analysis for milk intake when handfed in relation to age resulted in a strong fit with an R^2 value of 0.9906, yielding the equation $y = 40.912\ln(x) + 178.96$ for the relationship. (y = weight in g; x = months). Dats-hand reared; Triangles-mother reared.

Ruempler (1991) reports on the hand rearing, food composition and weight development of 2 newborn red-shanked douc langurs at Cologne Zoo. The amount and composition of food given there caused the animals to gain weight even more rapidly (Fig. 5).

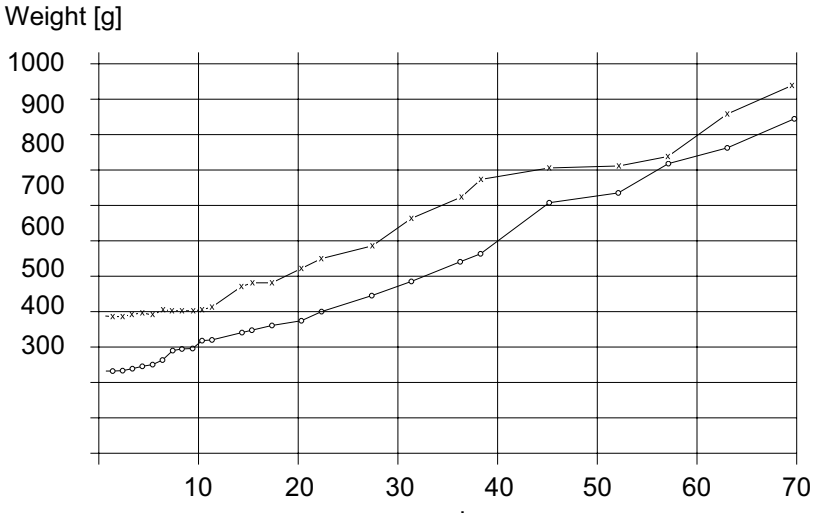

Fig.5. Weight development of two red-shanked douc langurs at Cologne Zoo. (Female upper line, male lower line). From Ruempler (1991).

Discussion

Some of the procedures in feeding and management of the animals are undertaken intuitive and don't have a scientific justified background. Some changes probably don't reduce the success, but can also increase the risk for a failure. This is the reason that a nearly stable procedure retained over years at the Endangered Primate Rescue Center.

The reason for the significant difference in weight development between natural and hand

rearing is unclear, although the data from natural rearing is based on only one individual. However, this juvenile showed completely normal and active behaviour, so that abnormalities cannot be regarded as the cause. The juvenile did not reach the same average weight of several hand reared animals until it was well over a year old. The individual differences in the weight gain of the hand reared animals are considerable. This is mainly due to the different individual behaviour of the young animals. Some animals are very greedy eaters, while others are less interested in eating and often need to be stimulated. Short-term digestion problems or diarrhea can lead to rapid weight loss, which is only recovered more slowly.

It is not possible to determine the age of young animals by weight alone, as the possible deviations are too great.

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The effectiveness of SMART software in patrolling and monitoring grey-shanked douc langurs (*Pygathrix cinerea*) in Kon Ka Kinh National Park, Gia Lai Province, Vietnam

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Key words: Grey-shanked douc langur, *Pygathrix cinerea*, SMART software, patrols, population density.

Summary

This study presents a comparative presentation of data collected through SMART software-based patrolling and through independent monitoring, focusing on the grey-shanked douc langurs (*Pygathrix cinerea*) in Kon Ka Kinh National Park, Gia Lai Province, Vietnam. From January 2019 to December 2021, the SMART program was implemented in 9 forest ranger stations throughout Kon Ka Kinh National Park. Park rangers used the SMART Mobile app. version 6.3 for data collection during forest patrols. During this time rangers conducted 1,216 patrols, spending 1,310 days in the field and covering 7,998 km of forest paths. A total of 382 park rangers participated, recording and addressing 534 human impact events, removing 1,768 wire traps, and confiscating 34 firearms. A detailed map showing forest paths and impact locations was created. From May to June 2020, an expert team independently surveyed the density and distribution of the grey-shanked douc langurs. They established 24 line transects (3.8 km on average) at elevations ranging from 950 m to 1400 m. Each transect was surveyed three times over consecutive days. Using Distance Software Version 7.3, the analysis revealed a density of 1.18 groups/km^2 for the langur species. The estimated population in Kon Ka Kinh National Park is around 248.3 (± 107.3) groups with 1,557 (± 696.2) individuals, showing higher density and larger groups in certain areas. The forest compartments harboring the highest concentration of grey-shanked douc langurs appeared more intensively patrolled in terms of frequency and ranger participation, as evidenced by the patrol data. The research demonstrates the efforts in using the SMART application for patrols to protect the population of grey-shanked douc langurs.

Hiệu quả của phần mềm Smart trong tuần tra, giám sát Voọc chà vá chân xám (*Pygathrix cinerea*) tại Vườn quốc gia Kon Ka Kinh, tỉnh Gia Lai, Việt Nam

Tóm tắt

Từ tháng 1 năm 2019 đến tháng 12 năm 2021, chương trình SMART được áp dụng cho 9 trạm Kiểm lâm của VQG Kon Ka Kinh để tuần tra bảo vệ rừng và giám sát bảo tồn loài Voọc chà vá chân xám (*Pygathrix cinerea*). Ứng dụng Smart Mobile phiên bản 6.3 đã được các Kiểm lâm viên sử dụng để thu thập dữ liệu tuần tra rừng. Kết quả có 1.216 đợt tuần tra được thực hiện, với 1.310 ngày ngoài thực địa, tổng số 7.998km đường đã được tuần tra và có 382 lượt Kiểm lâm viên tham gia tuần tra. Ghi nhận và xử lý 534 lượt tác động của con người, tịch thu tháo gỡ 1.768 bẫy dây phanh, bẫy kẹp các loại, 34 khẩu súng được tịch thu. Một bản đồ chi tiết thể hiện các lối đi trong rừng, vị trí tác động (bẫy và các hoạt động trái pháp luật) đã được hoàn thành. Từ tháng 5 đến tháng 6 năm 2020, nghiên cứu thực địa về mật độ và vùng phân bố loài Chà vá chân xám (*Pygathrix cinerea*) được thực hiện độc lập bởi nhóm chuyên gia. 24 tuyến điều tra (độ dài trung bình 3,8 km) đi qua nhiều sinh cảnh khác nhau, với độ cao trung bình từ 950 m đến 1400 m. Mỗi tuyến điều tra được khảo sát lặp lại ba lần trong ba ngày liên tiếp. Quần thể Chà vá chân xám được ước lượng bằng phương pháp lấy mẫu khoảng cách (Distance sampling). Phần mềm khoảng cách phiên bản 7.3 được sử dụng để phân

tích mật độ quần thể Chà vá chân xám. Kết quả nghiên cứu cho thấy mật độ là 1,18 đàn/km^2. Ước tính có khoảng 248,3 (± 107,3) đàn với khoảng 1.557 (± 696,2) cá thể trong Vườn Quốc gia Kon Ka Kinh. Khu vực phân bố tập trung tại các tiểu khu 433, 414, 105, 104, 95, 91, 79, 78, 71. Qua số liệu nghiên cứu cho thấy Chà vá chân xám tại VQG Kon Ka Kinh được phát hiện và ghi nhận tại các tiểu khu được tuần tra tốt, có nhiều đợt tuần tra của lực lượng kiểm lâm. Kết quả nghiên cứu cho thấy việc sử sụng ứng dụng SMART trong tuần tra thể hiện nổ lực trong việc bảo vệ quần thể Voọc chà vá chân xám.

Introduction

The preservation of biodiversity and the protection of endangered species heavily rely on the establishment and management of protected areas. Within these areas, effective patrolling and monitoring efforts are of utmost importance to ensure the continued protection and survival of these species. This is particularly critical for the grey-shanked douc langur (*Pygathrix cinerea*), a primate species that is classified as 'Critically Endangered' and predominantly found in Vietnam (Ha Thanh Long et al. 2020). The grey-shanked douc langur faces significant threats, including habitat loss, poaching, and other human activities, making it increasingly vulnerable to extinction. Therefore, robust patrolling and monitoring programs are essential to combat these threats and secure the future of this species.

Kon Ka Kinh National Park, located in Gia Lai Province, Vietnam, is a designated conservation area for the grey-shanked douc langur. The park's diverse habitat and favorable conditions make it an important stronghold for the survival of this species. However, ensuring the langur's protection within the park poses numerous challenges, including the vast area with limited resources available for patrolling and monitoring.

To address these challenges, the Spatial Monitoring and Reporting Tool (SMART) program was implemented in Kon Ka Kinh National Park. The SMART program combines innovative technology and data-driven approaches to enhance the efficiency and effectiveness of wildlife conservation efforts. Utilizing the SMART Mobile app. version 6.3, park rangers were equipped with a powerful tool for collecting and analyzing data during their forest patrols (SMART 2022).

This study aims to evaluate the effectiveness of the SMART program in patrolling and monitoring grey-shanked douc langur populations in Kon Ka Kinh National Park. From January 2019 to December 2021 extensive patrols were conducted across the park's forest ranger stations. The data collected during these patrols provide valuable insights into the frequency and coverage of patrols, the nature and extent of human impact events, and the measures taken to address them.

In addition to the patrol data, independent field surveys were conducted to assess the density and distribution of grey-shanked douc langurs. In order to estimate the population densities and facilitate a deeper comprehension of the habitat preferences of the langur species, researchers' utilized line transects at different elevations and employed the use of advanced analytical tools such as Distance Software Version 7.3.

By comparing SMART data of patrol activities to the distribution data of grey-shanked douc langurs collected through the independent surveys, this study aims to assess the effectiveness of the SMART program in creating a comprehensive analysis of the distribution of the grey shanked douc langur species. These findings will also contribute valuable insights into the effectiveness of the SMART technology in enhancing conservation efforts and inform future strategies for protecting endangered species in Kon Ka Kinh National Park and similar conservation areas.

By combining technology, data collection, and on-ground monitoring, this study seeks to improve conservation practices and contribute to the long-term survival of the grey-shanked douc langur.

Methods

Study area

Kon Ka Kinh National Park, located at coordinates 14°09' to 14°30' N and 108°16' to 108°28' E,

covers a total area of approximately 41,780 ha, with over 33,500 ha consisting of natural forest. The park is divided among five communes: Dakrong, Kroong, Kon Pne (Kbang District), Ha Dong (Dak Doa District), and Ayun (Mang Yang District) (Kon Ka Kinh National Park 2021).

Situated at an elevation ranging from 570 m to 1,748 m, the park experiences two distinct weather seasons. The rainy season spans from May to November, encompassing seven months, while the dry season lasts from December to April, totaling five months. The average annual rainfall in the area is around 1,700 mm, with the heaviest precipitation occurring in July or August, reaching 400-450 mm. The peak of the dry season, typically in January or February, is characterized by the absence of rainfall (Ha Thang Long 2009). The park is located within the primary watershed of two major rivers, the Ba River and the Dak Pne River.

Kon Ka Kinh National Park boasts a rich biodiversity, housing numerous well-preserved forest ecosystems. A total of 687 plant species, including 11 that are endemic, have been recorded. Kon Ka Kinh National Park also hosts 34 rare species listed in the Red Data Book of Vietnam (Ministry of Science and Technology & Vietnamese Academy of Science and Technology 2007) and the IUCN Red List of Threatened Species. Notably, there is a 2,000 ha area of mixed forest comprising both broadleaf and coniferous species, such as the Fujian cypress (Vietnamese: Pơmu) (*Fokienia hodginsii*), found at elevations above 1,300 m. The park is home to 428 identified animal species, including 42 mammal species, with 5 endemics to Indochina. Recognized as a global priority area for biodiversity conservation (WWF 2010), the park is inhabited by six primate species: pygmy loris (*Nycticebus pygmaeus*), stump-tailed macaque (*Macaca arctoides*), rhesus macaque (*Macaca mulatta*), pig-tailed macaque (*Macaca leonina*), grey-shanked douc langur (*Pygathrix cinerea*), and the northern yellow-cheeked gibbon (*Nomascus annamensis*).

Data collection

SMART data from patrolling

From January 2019 to January 2021, a total of 1,216 patrols were carried out, with 1,310 days of field patrols, covering a total distance of 7,998 km in the field. The patrol routes at the ranger stations usually follow trails through the sub-areas managed by the station. Patrol information is recorded and stored on the SMART Mobile app. (SMART 2022) (Fig.1). The system records information about the patrol route, human impacts, capture and removal of traps, as well as observations of animals and plants. The SMART Mobile application system is used for this purpose.

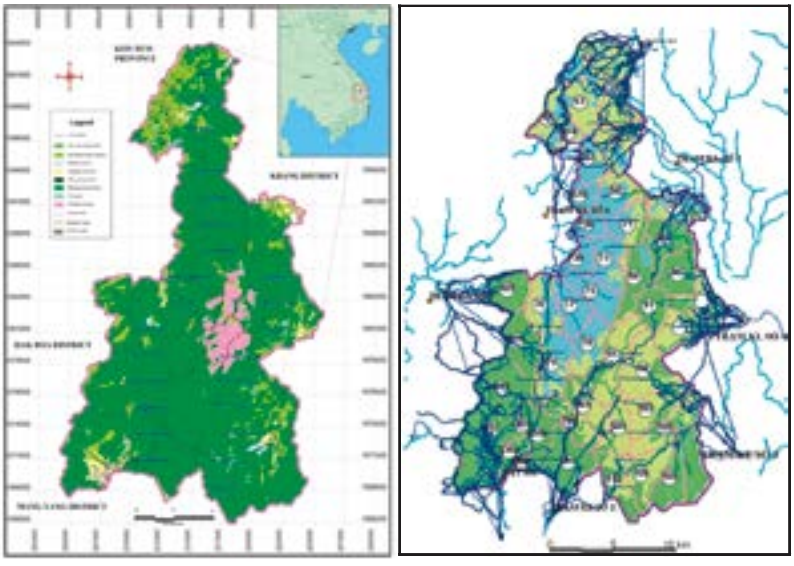

Fig.1. Map of 24 survey routes for grey-shanked douc langurs and patrol efforts at nine ranger stations of Kon Ka Kinh National Park on SMART 6.3 software.

Independent survey data

Surveys were conducted in May and June 2020. The survey team conducted these surveys in the early morning (6:00 - 11:30 am) and afternoon (1:30 - 6:30 pm) to coincide with the active period of grey-shanked douc langurs during the day (Nguyen Thi Tinh 2012). The survey routes covered habitat types ranging from 950 m to 1,400 m asl. Each survey line was repeated for 3 days. During the field survey, the team marked a straight line to facilitate travel over the 3 field days. The width of each route was 2 km, with a permissible error width of 100 m on either side of the survey route. A total of 288 km of field roads were surveyed along 24 line transects (Buckland et al. 2010).

SMART software version 6.3 was implemented for patrol activities at 9 ranger stations within Kon Ka Kinh National Park. This software was used to establish crucial information about the area, including geographical location, patrol rangers, positions, patrol stations, coordinate system, map, and data model. The data model encompassed various aspects such as direct human impacts (e.g., tree cutting, traps, orchid picking, and hunting huts), animal observations, and plant recordings.

Forest rangers utilized the SMART Mobile platform to collect these observations and make records during patrols. The collected data was then transferred to the SMART software, generating comprehensive patrol reports. The data collection for patrols spanned from January 2019 to December 2021 across the 9 ranger stations.

To gather further data on the distribution of grey-shanked douc langurs, an independent survey was conducted from May 12th to June 28th, 2020. A total of 24 transect lines were established throughout Kon Ka Kinh National Park, with each transect being repeated for 3 consecutive days. The transect lines covered elevations ranging from 950 m to 1,400 m asl. The length of each transect was 4 km, with a 2 km distance to neighboring transects. Data were collected at a 100 m distance on both sides of the transect line. In total, the combined length of all transects amounted to 288 km.

The data collection took place under favorable weather conditions, from 6:00 am to 5:00 pm, with an average observer speed of approximately 0.5 km/h along the transect lines. Both direct and indirect observations, including food marks, were recorded. The survey participants received training from experienced field biologists to ensure accurate and reliable data collection.

Data analysis

SMART data from patrolling

The collected SMART data was thoroughly reviewed to ensure its accuracy and completeness. Any missing or inaccurate entries are identified and corrected to maintain data integrity. Subsequently, the data is organized and categorized according to specific parameters of interest, such as patrol frequency, coverage, human impact events, population dynamics, and habitat conditions. This systematic organization allowed for a comprehensive analysis of the data, facilitating the identification of patterns, trends, and correlations.

Independent survey data

During the surveys, a total of 21 observations of grey-shanked douc langur groups were recorded. To estimate the density and number of langur groups, Distance Software Version 7.3 (Thomas et al. 2010; Buckland et al. 2015) was used. The recorded number of grey-shanked douc groups was processed to calculate population density. A countable width of 960 m was used to simulate the distribution function of the langur. To estimate the density of objects, the investigator needs to estimate the probability of detection and use that index to correct the actual density. The detection probability is estimated based on the frequency distribution of observations made at different distances to the survey line or observer (Fig. 2).

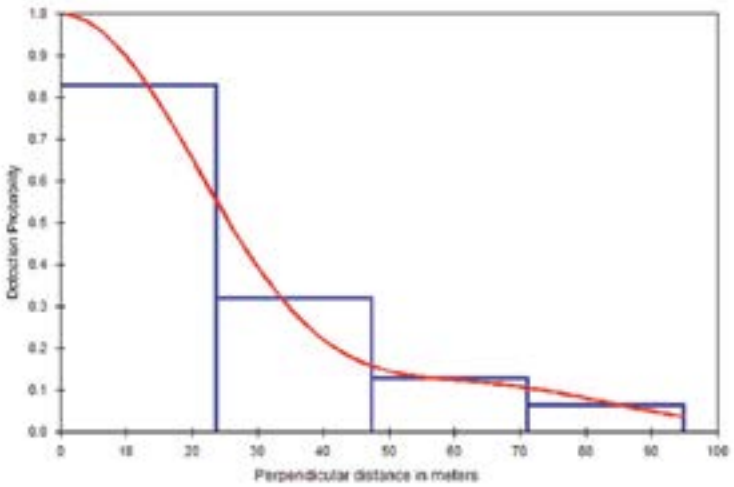

Fig.2. Detection Function of Half - Normal/Cosin.

The best function to estimate the probability of detection is selected based on the AIC criteria (Anderson 2007). The function with the lowest AIC value is chosen using the Kullback Liebler information theory. The principle of balance between standard deviation and variance, known as the "Parsimony principle," is applied to avoid discrepancies between the estimate and the actual value. The agreement of the function with the experimental frequency distribution is checked using the X^2 criterion. Once the function that best simulates the relationship between detection probability and distance is selected, the detection probability (pa) is estimated and used to correct the density. The density of groups is estimated based on the area of two types of rich forest and medium forest.

The perpendicular distances data were plotted in a frequency histogram with 10 m intervals to select five interval cut-off points (15.8 m, 31.6 m, 47.4 m, 63.2 m, 79.1 m, and 94.9 m, corresponding to the largest recorded value) and create a group dataset. Six models with different combinations of key functions and adjustment terms were then run (1) Half-normal + cosine, (2) Half-normal + polynomial, (3) Half-normal + polynomial, (4) Uniform + polynomial, (5) Half-normal + Hermite, and (6) Uniform + Hermite. The best model was chosen based on the Akaike information criterion (AIC) and the coefficient of variation of the estimate of group density (Buckland et al. 2001) (Table 1).

Table 1. Distance analysis results for different models, calculated with 21 observations (n=21) with group density estimate, probability of detection, coefficient of variation, and AIC value (Akaike Information Criterion).

Model (key function + adjustment term)	Group density estimate (per km^2)	Probability of detection	Coefficient of Variation	AIC
Half-normal + cosine	1.18	0.33	0.447	177.78
Half-normal + polynomial	0.91	0.43	0.423	178.19
Half-normal + polynomial	0.98	0.40	0.450	177.18
Uniform + polynomial	0.96	0.41	0.451	179.32
Half-normal + Hermite	0.91	0.43	0.428	178.19
Uniform + Hermite	0.76	0.52	0.483	180.21

The distance analysis results for different models were calculated using 21 observations and data groups. The results include density estimates, coefficients of variation, and probabilities of detection, AIC values, and X^2 goodness-of-fit P values. The suitable habitat for the grey-shanked

douc langur was determined using the minimum convex polygons (MCP) method (Burgman & Fox 2003). To identify suitable habitats, occurrence records from this study and annual langur monitoring data were entered ArcGIS 10.2 software for analysis and measurement.

Results

SMART data from patrolling

Through the statistics obtained from the SMART software, the patrols conducted from January 2019 to December 2021 have yielded the following results: a total of 1,216 patrols were carried out, involving 1,310 days of field patrols and covering 7,998 km (Table 2). These patrols, lasting from 1 to 5 days, primarily focused on entering the core areas of the park. Analysis of the patrol data reveals that the southwest area exhibits a higher density of patrols compared to other regions (Fig. 3).

Table 2. Data of patrols at nine ranger stations of Kon Ka Kinh National Park in the phase of 2019-2021 using SMART 6.3 application.

General objective	2019	2020	2021
Patrol station	3	9	9
Number of patrols	27	537	652
Days of patrol	121	537	652
Patrol distance (km)	976	2.507	4.515
Number of violators	73	268	193
Number of traps removed	723	272	773
Number of guns confiscated	8	9	17

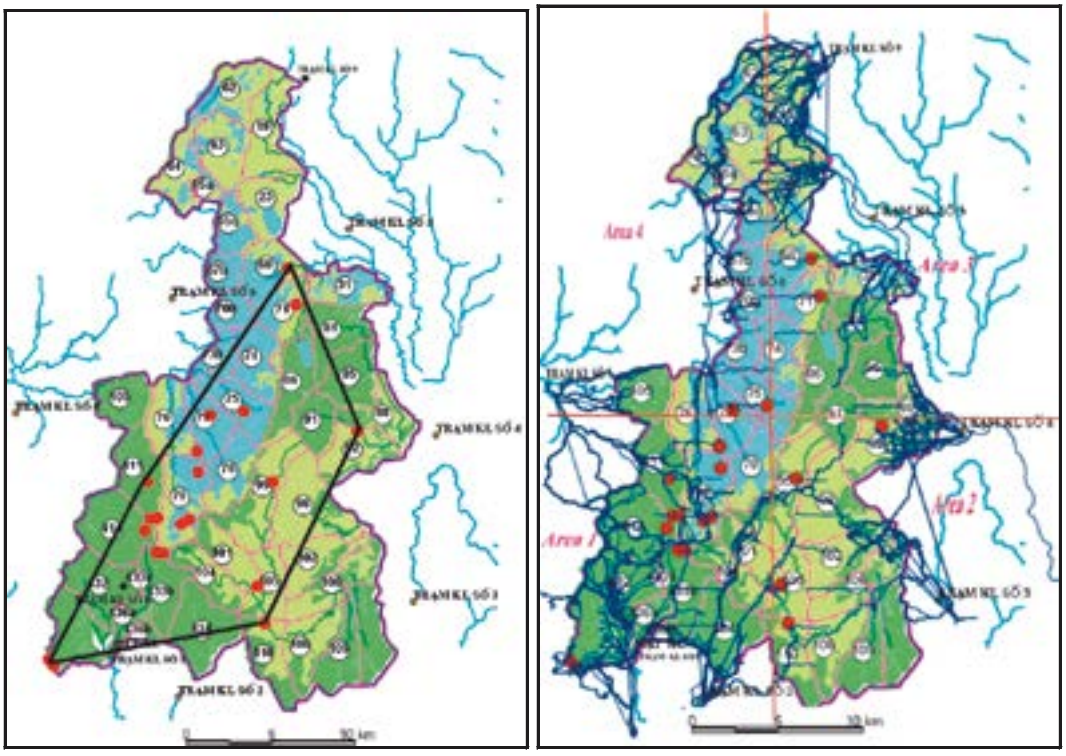

Fig.3. Distribution map of grey-shanked douc langurs and patrol areas from nine ranger stations in Kon Ka Kinh National Park on SMART 6.3 software.

During the patrols, the detection and recording of human impacts in the park were documented. The records indicate that over 534 local individuals were detected engaging in various activities within the forest. These activities primarily involved mushroom collection, orchid picking, honey gathering, as well as other pursuits such as searching for agarwood, harvesting wood and firewood, setting traps, and hunting. Additionally, a total of 1,768 traps of various types were discovered and removed, while 34 guns, including homemade and sports guns, were confiscated (Table 2).

Through the information from the SMART 6.3 software, it shows that Stations 1, 7, and 8 have a dense patrol level at areas, 433, 434, 435, 79, 105, 95.

Independent survey data

Using the minimum convex polygons (MCP) method, the suitable habitat for the grey-shanked douc langur in Kon Ka Kinh National Park was estimated to be approximately 210.44 km^2, which corresponds to 51% of the park's total area.

Based on the analysis conducted using Distance Software Version 7.3, the model that best fits the field data for the grey-shanked douc langur is the half-normal + cosine model (Fig. 2). The chi-square test results for this function indicate its suitability for the characteristics of the probability of detection concerning the observed distance (X^2 = 2.47, with p-value = 0.48). According to this model, the estimated density is 1.18 (± 0.51) groups per square kilometer. The mean group size is approximately 6.23 (± 0.74) individuals. The park is estimated to be home to around 248.3 (± 107.3) groups, comprising a population of 1,557 (± 696.2) individuals (Table 3). The calculations were based on the presence of langur species in two types of forest, namely, rich forest and medium forest, located between an altitude of 1,100 m and 1,500 m.

Table 3. Distance analysis result with estimated group density and individual density of grey-shanked douc langurs with standard error (SE n=21). DG: Density of groups; E: Estimated group size; DI: Density of individuals; N: Estimated individuals in the suitable habitat (210.44 km^2).

Parameter	Point Estimate	Point Estimate	Percent Coef. of Variation	95% Percent Confidence Interval	
DG	1.1863	0.5112	43.10	0.5120	2.7485
E	6.2381	0.7429	11.91	4.8701	7.9903
DI	7.4004	3.3089	44.71	3.1168	17.571
N	1557.0	696.18	44.71	656.00	3698.0

Distribution forest compartment of grey-shanked douc langur: 435, 414, 433, 79, 411, 78, 77, 75, 68, 71, 92, 95, 105, 110. Focus on sub-areas: 79, 414, 433, are the areas with the distribution of grey-shanked douc langurs with large density, a large number of individuals in the groups.

Discussion

The results of the patrols conducted using the SMART program in Kon Ka Kinh National Park demonstrate the efforts made by park rangers in safeguarding the park and protecting the critically endangered grey-shanked douc langur population. Over a period of three years, park rangers carried out 1,216 patrols, covering 7,998 km over 1,310 days (Table 4). The increased quality level of SMART patrols is clearly demonstrated over the survey period from 2019 to 2021, showing a focus on protecting the crucial distribution areas in Kon Ka Kinh National Park. In the Southwest area (Stations 1 and 7) the patrol team covered 31.17% of the total patrol routes, recorded guns, and traps at a rate of 48.30%. This region recorded a total of 13 groups of langurs. In the Southeast area (Stations 2, 3, and 4), the patrol coverage was 27.96%, recorded guns, and traps at a rate of 11.88%, and the team observed 4 groups. In the Northeast area (Stations 5 and 9), the patrol coverage was 24.26%, with recorded guns and traps of 42.70%, and 2 groups of langurs were recorded. The remaining Northwest area (Station 6) had a patrol coverage rate of 16.61%, with recorded guns and traps of 17.31%, and 2 groups were observed. We observed that the two areas with a large number

of groups are in the Southeast and Northeast regions, indicating significant conservation impact in these concentrated distribution areas. SMART patrols provided valuable data on patrol frequency, coverage, and human impact events in the park.

Table 4. The data of patrolling in each area through SMART software corresponds to the distribution of grey-shanked douc langurs in Kon Ka Kinh National Park.

Areas	Number of patrols			Duoc langur Groups	Forest compartment
	Patrols	Days of Patrols	Distance (km)		
Area 1	379	415	2,936	13	435, 433, 414, 411, 79, 76
Area 2	340	348	2,253	4	110, 105, 95, 92
Area 3	295	305	1,135	2	68, 71
Area 4	202	242	1,674	2	75, 77
	1,216	**1,310**	**7,998**	**21**	

Incidents of human impacts, such as tree cutting, traps, and hunting huts, highlight the ongoing threats faced by the langur population. The large number of patrols and the comprehensive data collected through the SMART program demonstrate the dedication of park rangers to safeguarding the species. The collected data enabled rangers to take appropriate actions, including removing wire traps and confiscating firearms, to address these human impact events, contributing to the protection of the langurs and their habitat.

In addition, the creation of a detailed map depicting forest paths and impact locations has provided valuable information for future monitoring and conservation efforts. This map serves as a useful tool to identify areas that require increased attention and intervention to ensure the long-term survival of grey-shanked douc langurs in the national park.

Independent field surveys assessing the density and distribution of the langurs complemented the patrol data and provided insights into the status and distribution of the population of grey-shanked douc langurs. The surveys revealed a density of 1.18 groups/km^2, estimating approximately 248.3 (± 107.3) groups and 1,557 (± 696.2) individuals in Kon Ka Kinh National Park. These findings suggest higher density and larger groups in specific areas, providing information on the prefered habitat conditions for the langurs (Ha Thanh Long et al. 2021).

The observations of grey-shanked douc langurs showed that they mainly inhabit core areas with little human impact, thick vegetation, and an abundance of food. Approximately 90% of observations were made in the core area of the park, with 71% of observations in the western part and 29% in the eastern part. The difference in distribution reflects the regional impacts within the park. During the survey period, six types of human impacts were recorded, including gunfire, logging camps, logging trees, traps, encroachment on the forest, and people in the forest.

The distribution of grey-shanked douc langurs within the park primarily concentrates in forest compartments 435, 414, 433, 79, 411, 78, 77, 75, 68, 71, 92, 95, 105, and 110. Specifically, sub-areas 79, 414, and 433 exhibit a high density of langur groups and a large number of individuals. These areas correspond to the dense patrol level of ranger stations 1, 7, 8 and in regions 433, 434, 435, 79, 105, and 95. Cases of violations from local people, such as hunting and collecting forest by-products, were detected and confiscated more frequently in these areas.

The comparison between patrol activities and the distribution of grey-shanked douc langurs indicates a positive impact of the SMART program on the species' population. The extensive patrols and timely response to human impact events contribute to minimizing disturbances to the langurs' habitat and reducing the risks posed by poaching and other illegal activities. These findings underscore the effectiveness of the SMART program in enhancing conservation efforts and

safeguarding the critically endangered grey-shanked douc langur population.

Integrating technology, such as the SMART program into data collection, coupled with on-ground monitoring, provides a comprehensive approach to wildlife conservation. The utilization of the SMART Mobile app. version 6.3 enables efficient data collection and analysis, empowering park rangers to make informed decisions and take necessary actions to mitigate threats. The integration of innovative tools like the SMART Mobile app. enhances the efficiency and effectiveness of patrols, resulting in improved protection of endangered species and their habitats.

The findings of this study have significant implications for the conservation of grey-shanked douc langurs and other threatened wildlife species in Kon Ka Kinh National Park and similar conservation areas. The success of the SMART program in patrolling and monitoring showcases the potential of technology-driven approaches in enhancing conservation practices. It is crucial to continue monitoring the population dynamics of grey-shanked douc langurs and evaluate the effectiveness of conservation measures for long-term sustainability. Long-term monitoring will provide valuable insights into the langur population's response to ongoing conservation efforts and help assess the sustainability of the SMART program.

While the core zone of the park, characterized by limited human impact, dense vegetation, and abundant food, supports a concentration of grey-shanked douc langur groups, challenges related to human impacts persist in the buffer zone surrounding the park. Communities heavily rely on forest resources in the buffer zone, leading to activities such as hunting, trapping, and capturing animals. Strengthening patrols and monitoring efforts in the buffer zone is essential to address these issues.

The application of SMART software, particularly the SMART Mobile app, can significantly enhance the effectiveness of patrols and monitoring. It empowers park rangers to detect and promptly prevent illegal actions that harm plant and animal species, including the grey-shanked douc langur. Therefore, continuous support and intensive training for national park staff in utilizing the Smart software for patrolling, monitoring, and controlling impacts from buffer zone communities is crucial for the future.

In summary, the results of the patrols conducted through the SMART programme provide essential support for ranger actions to minimise negative impacts on the area and the langur population. Continuous monitoring and evaluation of langur population dynamics and the effectiveness of conservation measures is necessary to ensure the long-term survival of grey-shanked douc langurs and other threatened wildlife species in the park.

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The population status of the black-shanked douc langurs (*Pygathrix nigripes*) in Chua Chan Mountain, Dong Nai Province, Vietnam

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Key words: Black-shanked douc langur, *Pygathrix nigripes*, Chua Chan Mountain.

Summary

To determine the population size and population structure of the black-shanked douc langurs at Chua Chan Mountain, in Dong Nai Province, field surveys were conducted from April 2020 to November 2021 in four phases, each lasting 30 days. In the first year of the survey, seven groups with a total of 126 individuals were detected. In the second year of the survey, the population increased by 34 individuals (27%) and therefore comprised a total of 160 individuals, with no new groups being formed. The group size ranged in 2020 from 4 to 42 individuals, and in 2021 from 6 to 49 individuals. One group with 44 individuals in 2020 and with 54 individuals in 2021 was found to have split into 5 subgroups. The structure of the groups was determined and recorded according to the age of the animals in four categories, separately for males and females. The sex ratio males:females for the total population changed with the increase of the population from 1:2.1 in 2020 to 1:1.8 in 2021.

A number of measures to protect the black-shanked douc langur population are proposed. The granting of a 'Species and Habitat Conservation Area' would be an urgent and important measure to ensure the long-term existence of the species.

Hiện trạng quần thể của voọc chà vá chân đen (*Pygathrix nigripes*) ở núi Chùa Chan, tỉnh Đồng Nai, Việt Nam

Tóm tắt

Để xác định quy mô quần thể và cơ cấu số lượng của voọc chà vá chân đen tại Núi Chứa Chan, tỉnh Đồng Nai đã tiến hành điều tra số lượng từ tháng 4/2020 đến tháng 11/2021 với 7 đợt, mỗi đợt 30 ngày. Trong năm đầu tiên cuộc khảo sát, bảy đàn với tổng số 124 cá thể đã được phát hiện. Trong năm thứ hai khảo sát, số lượng đã tăng 35 cá thể (28%) và tổng cộng là 159 cá thể, nhưng không có đàn mới nào. Quy mô đàn dao động từ 4 đến 42 cá thể. Một đàn với 43 cá thể được chia thành 5 đàn nhỏ. Cấu trúc của các đàn được xác định và ghi lại theo độ tuổi của động vật có 4 nhóm loại, xếp con đực và con cái riêng biệt. Tỷ số giới tính đực:cái không thay đổi khi cộng thêm số lượng và là 1:1,8 trên tổng số lượng.

Một số biện pháp bảo vệ quần thể voọc chà vá chân đen ở đây được đề xuất. Việc thiết lập một 'Khu bảo tồn loài và sinh cảnh' sẽ là một biện pháp cấp bách và quan trọng để đảm bảo sự tồn tại lâu dài của loài.

Introduction

Black-shanked douc langurs are listed as a 'Critically Endangered' species in the IUCN Red List of Threatened Species (Duc et al. 2021), and also in the Red Data Book of Vietnam (Ministry of Science and Technology & Vietnamese Academy of Science and Technology 2007). The species is listed in Appendix 1 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2020). In Vietnam the species holds the highest protection status, following Decree 06/2019/ND-CP, and is listed as a species requiring urgent conservation attention in the 'Urgent Conservation Action Plan for Primates in Vietnam to 2025, Vision to 2030' (Decision No. 628/2017/

QD–TTg – Prime Minister). Until now, there has been no information about the size and structure of the black-shanked douc langur population in the Chua Chan Mountain, Dong Nai Province. From the results of the surveys, recommendations for the protection of the area and its black-shanked douc langur population are being provided.

Study area

Chua Chan Mountain is located in five administrative units including the four communes Suoi Cat, Xuan Hiep, Xuan Tho, Xuan Truong and Gia Ray Town in Xuan Loc District, Dong Nai Province. It is located 110 km Northeast of Ho Chi Minh City. Chua Chan Mountain with a summit of 837 m, has the second highest elevation in the Southeast region of Vietnam after the Ba Den Mountain with 986 m asl (Fig. 1, 2). Chua Chan Mountain encompasses an area of 1,792 ha of forest and forested land, with poor evergreen broadleaf forest of 0.93 ha and poor evergreen broadleaf on rocky mountains of 248.98 ha (Information provided by Xuan Loc District People's Committee), along with substantial areas of bare land, rocks and shrubs. (Fig. 3, 4, 5).

Fig.1. The Chua Chan Mountain, Dong Nai Province.

Fig.2. The summit of Chua Chan Mountain. In 2012 it was designated by the Ministry of Culture, Sports and Tourism as a national scenic spot.

Fig.3. The largest areas of the Chua Chan Mountain are covered by heavily degraded forest on rocky terrain.Photo: Tilo Nadler.

Fig.4. Large areas are exclusively covered with shrub. Photo: Tilo Nadler.

Fig.5. Areas with evergreen broadleaf forest are fragmented by degraded forest areas and areas with bare granite blocks.. Photo Nguyen Hai Ha.

Research time and methods

Survey time

Field surveys were conducted in four phases, each lasting 30 field days:

1st phase - 6 May to 16 June 2020

2nd phase - 1 October to 29 October 2020

3rd phase - 1 April to 30 April 2021

4th phase - 1 November to 29 November 2021

Interview surveys

Before the surveys started, 73 local people knowledgeable about the area were interviewed. Out of these, 60 people (82%) had observed black-shanked douc langurs in the area. Based on this information, the survey routes were determined.

Surveys methods

Black-shanked douc langurs are known to live in groups and have peak activities and movement periods twice a day, in the morning and in the afternoon, as they travel between their sleeping and feeding areas. Sleeping places are typically large, dense trees with many branches, a dense canopy, and vines. Transect surveys involved systematically walking predefined routes through the study area to observe and document black-shanked douc langur sightings (Brockelman & Ali 1987), while point observation concentrated on monitoring specific locations, particularly near sleeping sites.

Technical equipment

The survey teams had 4 Nikon Coolpix P1000 cameras at their disposal for voucher photos and 8 infrared binoculars with cameras for observations in the dawn and at night at the sleeping places. Two Diji 2.0 drones were used for observation of the groups. The coordinates of the observations were determined and recorded with GPS 78Cs.

Line transect survey

A total of 27 transects were established in the investigation area. The transects were set randomly, passing through preferred habitats and active areas, where many plant species serve as source of food for the black-shanked douc langurs. The route length ranged from 1 to 3 km, depending on the terrain and accessibility. Each of the four investigation groups, comprised of three individuals per group, followed the trails from 5am to 11am and from 2pm to 7pm. The number of repetitions of each transect varied between 2 to 3 times per transect depending on the frequency of encounters or the season of investigation. The investigators moved slowly (1.5 to 2 km/h), maintained silence, refrained from smoking, and wore dark clothing. When a langur group was discovered, the number of animals, their sex and age were noted, and, if possible, documented with photographs. In challenging or inaccessible areas, drones were used to help assist in counting individuals, determining their sex and age.

Point observation

In areas frequently visited by black-shanked douc langur groups, mostly near sleeping sites, 30 observation points were established. The points were chosen to maximise visibility. Whenever a langur group appeared, the observers noted the number of animals, sex, age and also the behaviour (moving, resting, grooming) and, if possible, documented this with photos (Paterson 2001) (Fig. 6, 7, 8).

Fig.6. From the observation points, the number of individuals per group and the structure of the groups could be determined. Photo: Nguyen Hai Ha.

Fig.7. The male of a group. The groups very often use the granite blocks as resting places as well as preferred routes when walking between the fragmented parts of the forest. Photo: Nguyen Hai Ha.

Fig.8. A group of black-shanked douc langurs together with a female long-tailed macaque carrying a young. Photo: Nguyen Hai Ha.

In addition, 10 camera traps were installed at sites regularly visited by the groups, which automatically recorded 10 photos in succession.

Data analysis

GPS Coordinates

The coordinates recorded in the field via GPS were transferred to a map scale 1:25.000 usable via MapInfo10.5 or Google map.

Age determination of the black-shanked douc langur individuals

The observed individuals were assigned to four categories, for males and females separately: adults, subadults, immatures and juveniles. The pelage coloration of sexes, adult males/females and subadult males/females is indistinguishable (Nadler & Brockman 2014).

Adult males exhibit a massive physique, a large and clearly visible bluish scrotum and a pink penis. The physique of subadult males is less massive, scrotum and the penis significantly smaller. The body structure of adult/subadult females is more slender, although adult females can reach the body size of adult males. Adult females often have clearly visible long nipples in contrast to subadult females.

Juveniles already display the fur coloration of adults, with a body length corresponding to about half of an adult animal.

Newborns and immatures have a pale grey-agouti colored back and a light grey belly. From the forehead up to the crown, the hair is light chestnut. The tail is greyish-white and has a thin tassel. There is a wide variation in facial coloration, ranging from a dark slate-grey color with more or less extended yellow patches under and over the eyes to wider yellow eyerings. With increasing age - about 6 to 12 months - the coat coloration of immature animals resembles more and more adult animals.

Results

Total population and population structure of the black-shanked douc langurs in the Chua Chan Mountain

In 2020 (Table 1), seven groups totaling 126 individuals were recorded, and the same number of seven groups with a total of 160 individuals was recorded in 2021 (Table 2), with no new groups formed. The total population increased by 34 individuals, representing a 27% increase. The sex ratio in the total population (male:female) was 40:84 in 2020 (1:2.1), which changed to 52:93 in 2021 (1:1.8). Within different age classes, the sex ratios were as follows in 2020 and 2021, respectively: adult male:adult female (1:2.15 and 1:1.84), subadult male:subadult female (1:1.82 and 1:1.36), juvenile male:juvenile female (1:5 and 1:3.33), and immature male:immature female (1:1.5 and 1:67). It is unlikely that this sex ratio will change significantly if the sex of the remaining 15 individuals (in 2021) is determined. The sex ratios in the groups vary (Table 3), and the group structures are different (Table 1, 2). These ratios provide favorable conditions for a positive population development, with most young being born from April to August.

Table 1. Group structure of the black-shanked douc langur population on Chua Chan Mountain from April to December 2020.

Groups	Coordinates		direct observation	adult male	adult female	subadult male	subadult female	immature male 0 - 8 weeks	immature female 0 – 8 weeks	juvenile male 9 – 72 weeks	juvenile female 9 – 72 weeks	individuals sex unknown
	North	East										
Group 1			44	10	20	3	6	1	1	1	1	1
Subgroup 1.1	457281	1208876	5	1	3	0	1	0	0	0	0	1
Subgroup 1.2	457133	1208986	4	2	2	0	0	0	0	0	0	0
Subgroup 1.3	457334	1209388	22	4	10	2	3	1	1	1	0	0
Subgroup 1.4	457688	1208824	6	1	2	1	1	0	0	0	1	0
Subgroup 1.5	457230	1208946	6	2	3	0	1	0	0	0	0	0
Group 2	459201	1209331	13	2	4	1	3	0	0	0	2	1
Group 3	457667	1210004	6	2	2	1	1	0	0	0	0	0
Group 4	460265	1209170	42	6	21	4	7	1	2	0	1	0
Group 5	459923	1209408	9	2	4	2	1	0	0	0	0	0
Group 6	460113	1210928	5	2	2	0	1	0	0	0	0	0
Group 7	460071	1209876	7	2	3	0	1	0	0	0	1	0
Total			**126**	**26**	**56**	**11**	**20**	**2**	**3**	**1**	**5**	**2**

Table 2. Group structure of the black-shanked douc langur population on Chua Chan Mountain from January to November 2021.

Groups	Coordinates		direct observation	adult male	adult female	subadult male	subadult female	immature male 0 - 8 weeks	immature female 0 – 8 weeks	juvenile male 9 – 72 weeks	juvenile female 9 – 72 weeks	individuals sex unknown
	North	East										
Group 1			54	15	19	5	4	1	1	2	2	5
Subgroup 1.1	457281	1208876	6	3	1	1	0	0	0	0	0	1
Subgroup 1.2	457133	1208986	6	2	2	0	0	0	0	1	0	1
Subgroup 1.3	457334	1209388	28	7	11	2	3	1	1	1	1	1
Subgroup 1.4	457688	1208824	7	1	2	2	0	0	0	0	1	1
Subgroup 1.5	457230	1208946	7	2	3	0	1	0	0	0	0	1
Group 2	459201	1209331	16	3	4	1	3	0	0	1	2	2
Group 3	457667	1210004	7	2	2	1	1	0	0	0	0	1
Group 4	460265	1209170	49	6	21	4	7	1	2	0	4	4
Group 5	459923	1209408	10	2	4	2	1	0	0	0	0	1
Group 6	460113	1210928	16	2	6	1	2	1	2	0	1	1
Group 7	460071	1209876	8	2	3	0	1	0	0	0	1	1
Total			**160**	**32**	**59**	**14**	**19**	**3**	**5**	**3**	**10**	**15**

Table 3. The sex ratio abult male:adult female in each group 2020 and 2021.

Year	2020	2021
Group 1	1:2.0	1:2.6
Subgroup 1.1	1:1.3	1:0.3
Subgroup 1.2	1:1.0	1:1.0
Subgroup 1.3	1:2.5	1:3.0
Subgroup 1.4	1:2.0	1:2.0
Subgroup 1.5	1:1.5	1:1.5
Group 2	1:2.0	1:1.3
Group 3	1:1.0	1:1.0
Group 4	1:3.5	1:3.5
Group 5	1:2.0	1:2.0
Group 6	1:1.0	1:3.0
Group 7	1:1.5	1:1.5

Group 1 is a conglomerate of five subgroups, often having separate feeding areas but congregating at the sleeping area.

Available food reserves for the groups

The largest groups (group 1 and 4) have limited food reserves. This may have contributed to the splitting of group 1 into five subgroups to better utilize of the available food reserves.

Observations of other primate species in the area

A population of 51 long-tailed macaques (*Macaca fascicularis*) and a population of 21 pig-tailed macaques (*Macaca leonina*) were recorded in the area. There were also 2 individuals of pygmy lorises (*Nycticebus* [*Xanthonycticebus*] *pygmaeus*) observed.

Recommendations for protection and conservation of the black-shanked douc langurs in Chua Chan Mountain

1. It is recommended that the People's Committee of Dong Nai Province initiate a rapid designation of the area as a 'Species and Habitat Protected Area'.

2. The Forest Protection Departments of Dong Nai Province and Xuan Loc District should develop a plan for the reforestation of the area, especially with trees that can be used as a forage resource by the black-shanked douc langurs.

   Human impact on the area should be minimised, and the use of forest resources, hunting and trapping should be prohibited.

   In the habitat of the black-shanked douc langurs, especially groups 4, 5, 6, a corridor should be created in the area of the cable line extending from pillar 66 to pillar 6. The cable line running from Gia Ray Town to Xuan Hiep Commune is now followed by a road which is used by visitors to reach the summit of Chua Chan Mountain. It is essential to cover treeless land with forest and prevent activities that prevent the growth of trees (Fig. 9, 10).

Fig.9. The area of the cable line is used by tourists to reach the summit of the mountain.

Fig.10. Tourists close to the summit of the mountain.

3. The survey should be followed by a long-term monitoring of the population to document its development and to record negative influences on the population.
4. Warning signs to prevent forest fires should be erected along the paths that cross the area, as well as information boards every 500 metres or so indicating the presence of the black-fronted douc langur. Litter bins should be placed along the paths to avoid littering the area.
5. Cameras should be installed along the preferred routes of the black-shanked douc langur groups to record any changes in the groups.
6. Tourists should be prohibited from using loudspeakers and radios, as well as from setting up campfires for pick nick and grilling, which is particularly common at the summit.
7. The approach of tourists to the black-shanked douc langurs, especially in the summit region, should be strictly prohibited in order to prevent disease transmission. Feeding of the animals should be strictly prohibited, especially concerning the macaques.

Conclusion

The comprehensive surveys conducted in the Chua Chan Mountain region of Dong Nai Province have provided valuable insights into the population size and structure of the 'Critically Endangered' black-shanked douc langurs. The findings underscore the urgency of designating the area as a 'Species and Habitat Protected Area' to safeguard the species and its habitat. Furthermore, recommendations for reforestation, habitat preservation, and responsible tourism management have been outlined to ensure the long-term existence of the black-shanked douc langurs. It is our hope that these findings and recommendations will serve as a foundation to urgently establishes conservation measures to protect this remarkable species and its ecosystem.

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The population status of the black-shanked douc langurs (*Pygathrix nigripes*) in Nui Chua National Park, Ninh Thuan Province, Vietnam

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Key words: Black-shanked douc langur, *Pygathrix nigripes*, population status, Nui Chua National Park

Summary

The black-shanked douc langur (*Pygathrix nigripes*) is classified as 'Critically Endangered' in the IUCN Red List of Threatened Species. From August 2022 to May 2023, a population survey was conducted in the 23,658 ha Nui Chua National Park to provide data and information for conservation activities. As a result of the survey, 59 groups with a total of 889 individuals were counted and the total population was estimated at around 1100 individuals. Five threats to the population and habitat were identified: Poaching; logging for choar coal production; grazing of domestic animals within the national park; utilisation of non-timber products; forest fragmentation. An intensification of law enforcement and education campaigns for the local population is necessary. Regulation of livestock grazing and reforestation of corridors to connect forest islands should contribute to improving the habitat for the douc langurs.

Hiện trạng quần thể của voọc chà vá chân đen (*Pygathrix nigripes*) ở Vườn Quốc gia Núi Chúa, tỉnh Ninh Thuận, Việt Nam

Tóm tắt

Voọc chà vá chân đen (*Pygathrix nigripes*) được phân loại là 'Cực kỳ Nguy cấp' trong Sách đỏ IUCN về các loài bị đe dọa. Từ tháng 8/2022 đến tháng 5/2023, một cuộc điều tra quần thể đã được thực hiện tại Vườn Quốc gia Núi Chúa với diện tích 23.658 ha để cung cấp dữ liệu và thông tin cho các hoạt động bảo tồn. Kết quả của cuộc khảo sát có 59 đàn với tổng số 889 cá thể đã được quan sát và tổng số lượng ước tính khoảng 1100 cá thể. Năm mối đe dọa đối với động vật và môi trường sống đã được xác định: Săn bắt trộm; khai thác gỗ trái phép để đốt than; chăn thả gia súc trong vườn quốc gia; sử dụng các sản phẩm ngoài gỗ; rừng bị chia cắt và phân mảnh. Việc tăng cường các chiến dịch thực thi pháp luật và giáo dục cho người dân địa phương là cần thiết. Quy định chăn thả gia súc và tiếp tục trồng rừng tại các hành lang để kết nối các dải rừng phân mảnh góp phần cải thiện môi trường sống cho voọc chà vá ở nơi đây.

Introduction

The black-shanked douc langur is found exclusively east of the Mekong, in eastern Cambodia and southern Vietnam. The species is classified as 'Critically Endangered' in the IUCN Red List of Threatened Species. In Vietnam, it has the highest protection status under Decree 06/2019/ND-CP. The species was first recorded in Nui Chua National Park in 1994. 38 groups with a total of 470 individuals were recorded in an initial survey in 2002/2003 (Hoang Minh Duc 2003; 2007). A further survey was carried out in 2012/2013 with the result of 18 groups and 420 individuals (Truong Thanh Trinh 2013). Recently, another survey was conducted to update the data as well as to identify threats to the population of black-shanked douc langurs (Fig. 1).

Fig.1. A group of black-shanked douc langurs in Nui Chua National Park. Photo: Truong Thanh Trịnh.

Locality

Nui Chua National Park is located in the southern Vietnamese province of Ninh Thuan, directly on the coast of the East Sea (South China Sea) and covers 23,658 hectares (11°35' 11°48' N and 109°03' - 109°14 E) (Fig. 2). The topography is mountainous, with elevations ranging from sea level to 1,040 m (Fig. 3).

Fig.2. Location of Nui Chua National Park in Ninh Thuan Province, Vietnam.

Fig.3. Fragmented habitat for the black-shanked douc langurs in Nui Chua National Park. Photo: Truong Thanh Trinh.

The original vegetation of the Nationalpark was a mixture of evergreen forest, semi-deciduous forest and deciduous forest. However, most of the forest was destroyed end of the 1990's as a result of forest overexploitation. Currently the only primary forest remaining is evergreen forest, distributed in the North of the park, at elevations above 800 m. At lower elevations, there are extensive areas of secondary forest. The southern part of the park, at elevations between 150 and 800 m support shrub dominated with thorny trees. This habitat type is only found at sites with hot and dry climates (Birdlife International and Forest Inventory and Planning Institute 2001) (Fig. 4). The average annual temperature is around 27°C, the absolute lowest temperature is 14.4°C and the absolute highest temperature is 41.7°C. In the dry season (January, February) the average humidity is <65%, in the rainy season (September, October, and November) around 80% and the annual average relative humidity is 71%. The Nationalpark is situeted in an area that receives the lowest rainfall in south-central Vietnam, and receives an aveage of only 650 mm of rain per year. Due to the low humidity and relatively low rainfall, the dry forest typical of Nui Chua National Park has developed.

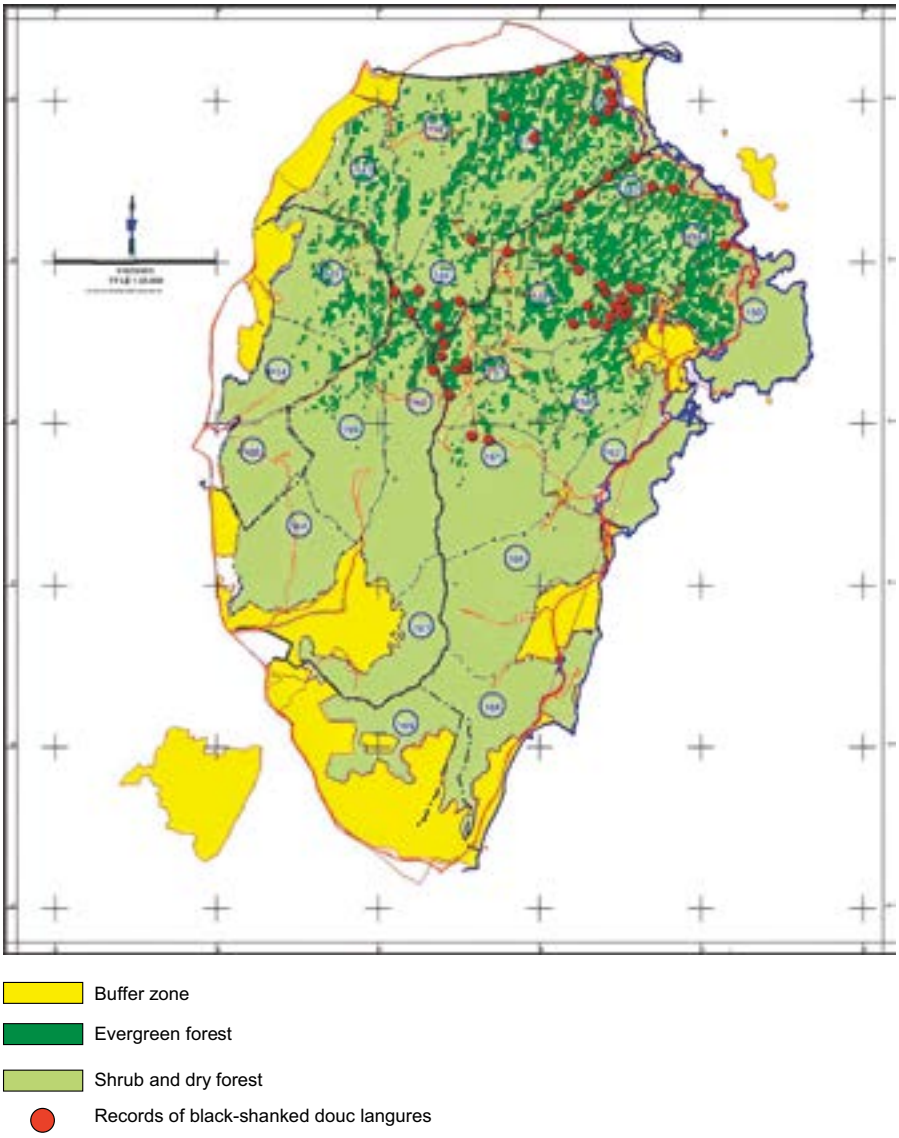

Fig.4. Habitatstructures in Nui Chua National Park and records of black-shanked douc langurs.

Methods

Field survey

The transect routes for the survey were determined based on interviews with the local population and information about the distribution of langurs in the national park. Each of the 2 to 4 km long transects was walked 10 times and the observation of langurs was recorded.

Results

Population structure of the black-shanked douc langur and its distribution within the national park

As a result of the survey, 59 groups with a total of 889 individuals were counted. A total of 122 adult males and 204 adult females were identified, 369 adult individuals could not be sexed. This means that the total population comprises 78.18% adult animals.

Furthermore, 124 immature individuals (13.95% of the total population) and 70 juvenile individuals (7.87% of the total population) were counted.

With the sexually assigned adult individuals, the male:female ratio was 122:204 individuals, which corresponds to a ratio of 1:1.67.

The largest group comprised 60 individuals, the smallest group four individuals. A total of 59 groups were counted (Table 1). The groups are found in the evergreen forest, which was classified into 6 habitat types (Table 2; Fig. 4). The favoured habitat is evergreen forest near the top of the mountain, far from residential areas. In this habitat, 22 groups were registered and a total of 335 individuals were recorded, with an estimated population of 428 individuals. Another favoured habitat is evergreen forest along a stream. Here 21 groups with 333 individuals were counted. A significantly smaller number of groups are found in the vicinity of settlements, fields and roads. There are fewer groups near settlements, but they have similar group strength as in the optimal habitats. In contrast, groups in the vicinity of fields and roads also have lower group strength.

Table 1. Number and structure of the black-shanked douc langur groups recorded in Nui Chua National Park.

Groups	Coordinates (UTM, 49P)		Observed individuals						total number estimated
	X	Y	adult males	adult females	immatures	juveniles	adult individuals of unknown sex	total number observed	
1	301827	1298419	1				4	5	10
2	301632	1298767	1				2	3	10
3	301611	1298693	1	3		1	4	9	15
4	301512	1298536	1	1			1	3	5
5	301629	1298637	3	5	2	1	9	20	25
6	301156	1299158		1	1			2	4
7	301229	1298955	2	4		1	9	16	20
8	301406	1298193	3				14	17	20
9	301687	1298407	1	6	7	1	5	20	25
10	301772	1298762	1	5	3	1		10	12
11	301993	1299086			2		1	3	5
12	302277	1299036	6	10	5	3	6	30	35
13	301288	1297882					2	2	4
14	301797	1298220	2	5	4	1	5	17	20
15	301729	1298424	1	3		1	6	11	15
16	302077	1303140	3	4	3	1	7	18	20
17	301412	1305130	1				1	2	5
18	300495	1306208	5	2	3	2	3	15	20
19	301397	1305827	4	6	5	1	10	26	35
20	300495	1306208	5	4	3	2	4	18	20
21	301282	1305673	7	6	3	2	18	36	40
22	302151	1303102	3	2	2	1	7	15	20

23	300495	1306208	3	4	2	1	4	14	20
24	300495	1306208	2	7	2	1	3	15	20
25	302077	1303140	4	6	3	2	8	23	30
26	301362	1302644	1	4	4	1	4	14	16
27	301312	1302533	2	5	2	4	6	19	20
28	301326	1304552	4	7	15	5	20	51	60
29	301461	1304832	1	3			3	7	10
30	299195	1305799	1			3	15	19	25
31	303357	1302149	3		1		13	17	23
32	304940	1300519	1	1	2	0	6	10	15
33	304919	1300412	1	4			5	10	15
34	300394	1299642	1	4			5	10	15
35	300163	1300032	2	3		1	3	9	15
36	300167	1299996	2	6			3	11	15
37	299744	1300237					2	2	5
38	300704	1298530	3	10	8	2	2	25	30
39	298215	1300216				1	1	2	5
40	297102	1300566	1	2		2	8	13	15
41	299052	1303719	1	10	2	2	10	25	30
42	298102	1304372	3	3	2	3	9	20	25
43	302666	1302201	1	10	2	2	10	25	30
44	300055	1301571	3	10	7	2	3	25	30
45	296723	1298686	2	2	3	2	9	18	23
46	294724	1298947	2	3	2	3	10	20	25
47	295299	1298428	2	2	3	1	4	12	15
48	295222	1298328	3	6	3	2	10	24	30
49	295465	1298984	2	4	5	1	8	20	25
50	296049	1298529	2	2	3		3	10	15
51	296217	1298423	1	3	1	1	5	11	15
52	296236	1297346	6	4	3	2	15	30	35
53	296139	1296969	1				5	6	8
54	296041	1296807	1				5	6	8
55	295935	1296555	1				2	3	5
56	296214	1296787	4	6	1	2	17	30	38
57	297078	1294493	2	3	2	4	12	23	25
58	296909	1296600					2	2	5
59	297629	1294389	2	3	3	1	1	10	13
Total			**122**	**204**	**124**	**70**	**369**	**889**	**1139**
Percentage of the total population (%) (observed individuals)			**13.72**	**22.95**	**13.95**	**7.87**	**41.51**	**889**	
Percentage of the total population (%) (estimated individuals)			**10.71**	**17.91**	**10.89**	**6.15**	**32.40**		**1139**

Table 2. Frequency of observations of black-shanked douc langurs in different habitats.

Habitat	individuals observed	Estimated number of individuals	Number of groups	average group size
1. Evergreen forest near the top of the mountain, far from residential areas	335	428	22	15…19
2. Evergreen forest near residential areas	83	100	4	20…25
3. Evergreen forest near fields	60	90	6	10…15
4. Evergreen forest along the road	26	35	3	9…12
5. Evergreen forest lined with grass	52	65	3	17…22
6. Evergreen forest along a stream	333	421	21	16…20
Total	**889**	**1139**	**59**	**15…19**

Threats to the black-shanked douc langur population and countermeasures

Five threats to the black-shanked douc langurs in Nui Chua National Park and their habitat have been identified: 1. poaching; 2. logging for choar coal production; 3. grazing of domestic animals within the national park; 4. use of non-timber products; 5. forest fragmentation.

Strict law enforcement is necessary to reduce the negative impact on the douc langur population. Hunting and trapping must be completely stopped, as well as illegal logging. Education campaigns for the local population should help to reduce the pressure on the population and the habitat. The grazing of domestic animals destroys regrowing forest. In order to support the livelihood of the local population, special grazing areas should be designated so that forest corridors can be created and forest islands can be connected in the long term. To further prevent fragmentation and to create forest corridors, areas should be reforested primarily with the typical food tree species of the douc langurs.

The „Urgent Conservation Action Plan for Primates in Vietnam to 2025, Vision to 2030“ endorsed by the Prime Minister (Decision 628/QD-TTg) calls for the integration of monitoring programmes for the black-shanked douc langurs into operational programs of protected areas. These should contain conservation awareness raising programs for local communities, authorities and social organizations and scientific studies of behavior and ecology as basis for long-term conservation.

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Unique copulatory postures in douc langurs (*Pygathrix* sp.)

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Key words: Douc langurs, *Pygathrix*, copulatory postures.

Summary

Observations on all three douc langur species, red-shanked, grey-shanked and black-shanked douc langurs (*Pygathrix nemaeus*, *P. cinerea*, *P. nigripes*) at the Endangered Primate Rescue Center, Vietnam and in the wild show a similarity in an unique copulatory posture among the Cercopithecidae. While in the most common dorsoventral copulation the male grab the calves or ankles of the standing female with his hind feet or stands with its feet on the ground in species with a larger gender difference in size. Copulation in douc langurs takes place with the female lying down and the male kneeling behind her. The copulatory postures of proboscis monkeys (*Nasalis larvatus*) correspond to the known scheme of the Cercopithecidae. Little detailed information is available for two other two genera of the odd-nosed group *Rhinopithecus* and *Simias*.

Các tư thế giao phối độc đáo ở chi Voọc chà vá (*Pygathrix* sp.)

Tóm tắt

Điểm tương đồng trong những quan sát trên cả ba loài voọc chà vá chân nâu, chân xám và chân đen (*Pygathrix nemaeus*, *P. cinerea*, *P. nigripes*) tại Trung tâm Cứu hộ Linh trưởng Nguy cấp, Việt Nam và trong tự nhiên cho thấy chi Chà vá có tư thế giao phối độc đáo so với các loài thuộc họ Cercopithecidae. Ở quá trình giao phối lưng-bụng phổ biến nhất, cá thể đực dùng bàn chân sau để tóm phần bắp chân hoặc cổ chân của cá thể cái đang đứng. Ở những loài có sự khác biệt lớn về kích cỡ giữa cá thể đực và cái, cá thể đực sẽ đứng bằng chân trên mặt đất. Còn quá trình giao phối ở các loài voọc chà vá diễn ra khi cá thể cái ở tư thế nằm và cá thể đực quỳ xuống ở đằng sau. Tư thế giao phối ở loài Khỉ mũi dài (*Nasalis larvatus*) tương đồng với mẫu chung ghi nhận được ở họ Cercopithecidae. Có rất ít thông tin chi tiết về tư thế giao phối ở hai chi *Rhinopithecus* và *Simias* thuộc nhóm khỉ mũi lạ.

Introduction

Compare to a rather considerable overview about primate mating systems (Dixon 1991; 2012; Dunbar 2000; Strier 2000; Pereira et al. 2000; Sterck & van Hooff 2000; Kappeler & van Schaik 2002; Barelli et al. 2008; Shultz et al. 2011; Opie et al. 2012; Roberts & Roberts 2015) information about copulatory postures with a detailed description are limited and focuses on a higher number on studies on apes and gibbons, including also some photo documetations (Brandes 1939: Ford & Beach 1952; Hutzelsieder 1937; Tutin 1979a; 1979b; Tutin & McGinnis 1981; Hashimoto 1997; Barelli et al. 2008; Balcombe 2011; Dixon 2012; Roberts & Roberts 2015). Detailed information about copulatory postures in Old World Monkeys (Cercopithecidae) is scare (Harms 1956; Napier & Napier 1997; Reagan 2017) and this is especially true for the genera of the odd-nosed group. Only one report (Kavanagh 1978) described in more detail the copulatory posture from captive red-shanked doucs langurs (*Pygathrix nemaeus*) in San Diego Zoo.

Material

Observations on copulatory postures on red-, grey- and black-shanked douc langurs (*Pygathrix nemaeus*, *P. cinerea* and *P. nigripes*) were made at the Endangered Primate Rescue Center (EPRC),

Vietnam and in the wild. The EPRC keeps a large captive breeding population of red-shanked douc langurs and is also the only facility which keeps a captive breeding population of the grey-shanked douc langurs. Since establishment of the EPRC in 1993, in total 110 red-shanked and 112 grey-shanked and 7 black-shanked douc langurs were kept in several breeding groups. A high number of douc langurs were born at the EPRC - 55 red-shanked and 49 grey-shanked douc langurs. Observations of copulations at the EPRC were made in nine cases by red-shanked douc langurs and on in six cases by grey-shanked douc langurs.

Additional observations on red-shanked douc langurs were made at the Zoological Gardens Singapore and as well in the wild on Son Tra Nature Reserve, Danang, Vietnam. Observations on black-shanked douc langurs were made only in the wild on Hon Heo Peninsula, Khanh Hoa Province, Vietnam.

Copulatory postures in langurs and douc langurs

Most common copulatory posture in Cercopithecidae is the dorsoventral copulation. For species with less gender difference in size, like macaques and langurs, the double-foot clasp is common in which the male grab the calves or ankles of the female with his hind feet to copulate (Fig. 1, 2). In species where the male is much larger as the female, the male will keep both feet on the ground. For Southeast Asian species is it the case for the proboscis monkey (*Nasalis larvatus*) (Boonratana 2011) (Fig. 3) and probably also for the snub-nosed monkeys (Liang-Wei Cui & Wen Xiao 2004; Baoguo Li & Dapeng Zhao 2007; Thanh Hai Dong et al. 2011).

Fig.1. Rhesus macaques (*Macaca mulatta*) show the common copulatory postures in Cercopithecidae for species with less gender difference in size; Myanmar. Photo: Tilo Nadler.

Fig.2. Copulatory postures of Cat Ba langurs (*Trachypithecus poliocephalus*); Cat Ba Island. Photo: Andy Nguyen.

Fig.3. Copulatory postures of proboscis monkeys (*Nasalis larvatus*); Chimelong Park, China. Photo: Tilo Nadler.

If in langurs a female offer mating by presenting her hindquarter to the male in a quadrupedal position with stiff legs, the tail lifted and the head moving rhythmic sidewards. For copulation the male mounts from behind and grabs the calves or ankles with his hind feet (Figs. 4, 5, 6, 7, 8).

Fig.4. Cat Ba langur female (right) invites copulation with stiff extended legs and lateral head movements. Photos: Tilo Nadler.

Fig.5. The female presents her hind quarter directly to the male, but the male seems uninterested.

Fig.6. The female jumpts closer to the male….

Fig.7. …and presents directly in front of the male.

Fig.8. The male rides up to copulate.

The copulatory initiation, the offer for copulation and posture for douc langurs is different. The female lie down on the ground or also on a more or less horinzontal thicker branch, to tuck up one's legs and lift the tail up or sidewards. The mail crouches or kneels behind the female to execute the intromission (Fig. 9, 10, 11, 12, 13, 14, 15, 16, 17).

Fig.9. A red-shanked douc langur female lying on a bamboo structure inside a cage and offers for copulation; Endangered Primate Rescue Center, Vietnam. Photos: Jochen Menner.

Fig.10. During copulation the female actively hangs her head downwards.

Fig.10. A grey-shanked douc langur female lies down on a thick, nearly horizontal branch to invite copulation; semi-wild area at the Endangered Primate Rescue Center, Vietnam. Photo: Tilo Nadler.

Fig.12. Black-shanked douc langur female invites copulation with stiff extended legs close to the mail on the tree; Hon Heo Peninsula, Kien Giang Province, Vietnam. Photos: Tilo Nadler.

Fig.13. The female lays down on a platform and invites copulation.

Fig.14. The male move from the tree to copulate.

Fig.15. During mating the female move down from the platform.

Fig.16. After ejaculation the female move her body from the platform….

Fig.17. …and moves away.

Fig.18. Douc langurs also show the typical copulation posture on thinner branches - here a couple black-shanked douc langurs. Photo: Marc Gölkel.

Discussion

For an overview and comparison of the copulatory postures of the four odd-nosed monkeys genera *Pygathrix*, *Rhinopithecus*, *Nasalis* and *Simias*, sufficient information is lacking.

The copulatory postures of the three *Pygathrix* species are apparently the same and clearly different from the Asian langurs and macaques. The proboscis monkeys (*Nasalis larvatus*) show a copulatory posture similar to the macaques, but the male stands with its hind feet on the ground due to the considerable difference in size to the female.

There is little detailed information on the genera *Rhinopithecus* and *Simias*. From very brief descriptions of copulation in *Rhinopithecus bieti* (Liang-Wei Cui & Wen Xiao 2004) *Rhinopithecus roxellana* (Baoguo Li & Dapeng Zhao 2007), *Rhinopithecus avunculus* (Thanh Hai Dong et al. 2011) it might be assumed that it is similar to langurs and macaques. However, the photo of a copulation of *R. bieti* in an enclosure shows more similarity to the copulatory postures of *Pygathrix* (Fig. 19). It seems that the genus *Pygathrix* has a unique copulation posture within the Cercopithecidae.

Fig.19. Copulation posture in Yunnan snub-nosed monkeys (*Rhinopithecus bieti*) in an enclosure show similarity with *Pygathrix*; Kunming Institute of Zoology Photo: Cyril Grüter.

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Establishment of the ELISA method for the diagnosis of *Echinococcus* spp. infection in primates

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Key words: *Echinococcus*, primates, ELISA.

Summary

Echinococcus tapeworm disease is a dangerous infectious disease that can develop in the body for years without typical manifestations. Cystic disease caused by *Echinococcus ortleppi* at the Endangered Primate Rescue Center (EPRC), Cuc Phuong National Park is one of the main causes affecting the health and life of primates. The existence of *Echinococcus* cyst with a very high infection rate was detected, especially in two species of langurs (*Trachypithecus* sp.) and in douc langurs (*Pygathrix* sp.) with a cyst infection rate on average for langurs 63,4% (n=15) and for douc langurs 87,5% (n=26). The study was conducted to establish an ELISA reaction having disease diagnostic value in the primates, using antigens from cystic fluid. The studied results showed that sensitivity and specificity of ELISA method were identified with 100% and 91.67%, respectively, with a cutoff value is 0.25. This ELISA method would be applied to diagnose cysticercosis to minimize the loss of primates at the EPRC.

Thiết lập phương pháp ELISA chẩn đoán *Echinococcus* spp. ở linh trưởng

Tóm tắt

Bệnh ấu trùng sán dây do *Echinococus* gây ra là một căn bệnh nguy hiểm có thể nhiễm trong cơ thể động vật hàng năm mà không biểu hiện triệu chứng. Căn bệnh gây ra do *Echinococcus ortleppi* tại Trung tâm Cứu hộ Linh trưởng Nguy cấp (EPRC), ở Vườn Quốc gia Cúc Phương là nguyên nhân chính ảnh hưởng đến sức khỏe của linh trưởng. Đã phát hiện được nhiễm nang sán Echinococus với tỷ lệ cao ở hai giống linh trưởng (*Trachypithecus* sp.) với tỷ lệ nhiễm tới 63,4% (n=15) và (*Pygathrix* sp.) với tỷ lệ nhiễm tới 87,5% (n=26). Nghiên cứu này đã tiến hành thiết lập phương pháp ELISA phát hiện kháng thể ở linh trưởng sử dụng kháng nguyên từ dịch tiết của nang sán thu được trên linh trưởng. Kết quả cho thấy, độ nhạy và độ đặc hiệu của phản ứng cao tương ứng 100% và 91.67% với giá trị ngưỡng là 0.25. Phương pháp này có thể ứng dụng để chẩn đoán sớm bệnh nang sán nhằm giảm thiệt hại cho linh trưởng tại EPRC.

Introduction

Echinococosis is a dangerous infectious disease that can develop in the body for years without typical manifestations (Deplazes & Eckert 2001). When the intermediate host digests the pathogen, the larvae can imigrate in many organs such as the liver, kidneys, lungs, even heart and brain. The larvae develop into cysts (Kamenetzky et al. 2002), and form water capsules which can compressing organs and affecting organ function, causing long-term pain for the host and can causing death (Kvascevicius et al. 2016). Host cyst infection is primarily caused by ingestion of food, soil, or water contaminated with pathogens from dog feces.

Many non-human primate species are susceptible to infection with *Echinococcus*. Many cases have been reported including gorilla (*Gorilla gorilla*), ring-tailed lemur (*Lemur catta*) (Kondo et al. 1996,

Umhang et al. 2016), orangutan (*Pongo pygmaeus*) (Taniyama et al. 1996), Japanese macaques (*M. fuscata*) (Sato et al. 2005; Yamano et al. 2009). An outbreak at the Obihiro Zoo, Japan resulted in infections of 12 monkeys in a group of 57 individuals testing positive for *E. multilocularis*. An infection of a number of three macaque species (*M. fascicularis*, *M. mulatta*, *M. silenus*) was reported from a breeding colony in Germany (Tappe et al. 2007) and also for a *Macaca fascicularis* breeding colony in Switzerland (Rehmann et al. 2005). In Hokkaido Zoo a diana monkey (*Cercopithecus diana*) and a crested black macaque (*Macaca nigra*) were infected with *E. multilocularis* (Yamano et al. 2014)

The Endangered Primate Rescue Center (EPRC) at Cuc Phuong National Park, Ninh Binh Province, also detected the existence of *Echinococcus* cysts especially in 2 species of langurs (*Trachypithecus* sp.) and douc langurs (*Pygathrix* sp.) with a very high cyst infection rate. On average in langurs 63,4% (n=15) and up to 87,5% (n= 26) in douc langurs (Vo Duy Thanh et al. 2020). Examination of dead individuals and molecular biological diagnostics have identified only *E. ortleppi* species (Plesker et al. 2009). While infections in humans with *E. multilocolaris* and *granulosis* are widespread across all continents (Rojas et al. 2014), infections with *E. ortleppi* are limited to very few cases (Grenouillet et al. 2014). *E. ortleppi* cysts have been reported in humans in Thanh Hoa Province, Vietnam (Nguyen Van De & Duyet Le Van 2017), the area adjacent to Ninh Binh Province the location of the Endangered Primate Rescue Center, indicating the circulation of the pathogen in the region. But despite a special study, the transmission routes have not yet been clarified (Vo Duy Thanh et al. 2020). One case of *E. ortleppi* infection in humans has also been recorded in China (Yunliang Shi et al., 2019).

To diagnose the disease, imaging methods, either through ultrasound and x-rays, or modalities such as computer tomography (CT) and magnetic resonance imaging (MRI) are common methods (Brunetti et al. 2018, Kalogeropoulu et al. 2023). However, these methods can only detect the disease when cysts have formed inside the host's body, causing severe symptoms, even life-threatening (Fig. 1, 2).

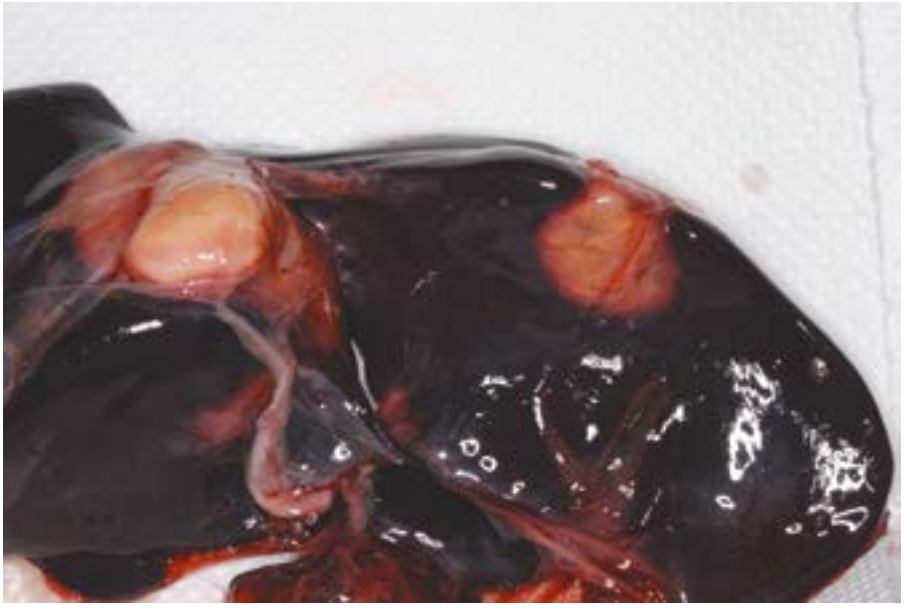

Fig.1. *Echonococcus* cysts in the liver of a black-shanked douc langur (*Pygathrix nigripes*). Photo: Tilo Nadler.

Fig.2. An exceptionally heavy infestation with *Echinococcus* cysts in a red-shanked douc langur (*Pyganthix nemaeus*) in the lungs and free-floating cysts in the abdomen. Photo: Tilo Nadler.

ELISA method (enzyme-linked immunosorbent assay) which has been commercially made into kits, providing results with sensitivity and consistency high efficiency when applied (Mughees Aizaz Alvi et al. 2023). Most diagnostic studies use ELISA due to its high accuracy and rapidity in diagnosing *Echinococcus* cysticercosis, but the subjects of diagnosis are mainly domestic animals and humans (Aydin et al. 2018). Wild animals such as primates have received little attention in diagnosing the disease, while rates of infection in primates may be much higher than in domestic animals and humans. Therefore, it is necessary to establish an ELISA diagnostic method for early detection of *Echinococcus*-induced cysticercosis in the primate population, contributing to the proposal of timely treatment and preventive measures, as well as minimizing the risk of transmission. The study established the ELISA method with the goal of early diagnosis of *Echinococcus* cyst disease in primates, contributing to the rescue and conservation work of the center's highly endangered primates.

Material and Methods

Antigen

The antigen used is antigen from the cystic fluid collected from the lungs of dead langurs. The cyst, after being separated from the body, sucks all the cystic fluid into a 1.5ml tube. The suspension was then centrifuged at 6,000 rpm for 10 minutes to collect floating fluid and store in – 20^{o}C.

Yin and positive serums

Serum samples collected from primates at the rescue center including 8 positive (cyst-forming) and 12 negative (non-capsule-forming) samples were identified by non-comprehensive surgical examination. The blood sample is centrifuged 3,000 times in 5 minutes, collected on top of the serum and stored in – 20^{o}C until used.

Setting up the indirect ELISA method

Appropriate diluted concentrations of antigens and antibodies are carried out according to the method of Bruno Gottstein (University of Bern, Switzerland). Dilute EgHF antigen (1mg/ml) to 5µg/

ml antigen with 0.1M pH=9.6 sodium carbonate buffer by aspiration of 75 µl of EgHF and 15ml of sodium carbonate buffer, mixing well and dripping onto a dish of 96 wells of 120µl each. Incubate overnight at 4°C then wash 2 times with 300µl/1 well with PBS-T solution. Lock non-protein-binding sites with a blocking buffer solution (PBS containing 5% skimmilk), 300µl per well, incubated at 37°C for 30 minutes. Antibodies are diluted with PBS-T solution in a ratio of 1/100. Aspirate 100 µl of diluted antibodies into each well and incubate at 37°C for 1 hour. Then wash 3 times with PBS-T, 300 µl each. Antibody resistance (Goat anti-Primate IgG (H+L) was diluted with PBS-T at a concentration of 1/5000, dripped at 100 µl per well, incubated at 37°C for 1 hour. Small 100 µl of substrate (2 tablets of pNPP substrate with 12.8 ml substrate buffer, mixed, incubated at 37°C for 10 min) diluted into each well and incubated at 37°C for 15 min. Stop the reaction with 3M NaOH, sucking 50 µl of 3M NaOH into each well. Read the result at 450nm/630nm.

Non-comprehensive surgical examination

The dead langurs underwent a non-comprehensive examination according to the method of Skrjabin (1928). Cysts of flukes obtained washed in physiological saline and labeled, brought back to the laboratory for antigen collection.

Data processing

Data is recorded and processed by Microsoft Excel 2019 software. ROC (receiver operating characteristic curve) analysis, sensitivity, and specificity of reactions using Graphpad Prism 9.0 software.

Results and Discussion

Serological tests are important in the differential diagnosis of tumors such as simple cysts, abscesses, and tumors, and to aid in preoperative diagnosis, monitoring for postoperative recurrence, and successful treatment (Kishimoto et al. 2009). The sensitivity and specificity of serological tests can vary depending on many factors such as the type and form of preparation of the antigen used, various positive criteria, cyst viability, cyst location and parasite strain (Karadag et al. 2013). The ELISA method uses a cut-off value to distinguish between positive and negative results, and depending on the different threshold value, the sensitivity and specificity of the reaction are different. The goal of the experiment is to determine the cut-off value for the highest sensitivity value, suitable for the test subjects are rare animals, which need to diagnose the disease. The cut-off values, sensitivity and specificity of the ELISA reaction are presented in Fig. 3 and Table 1.

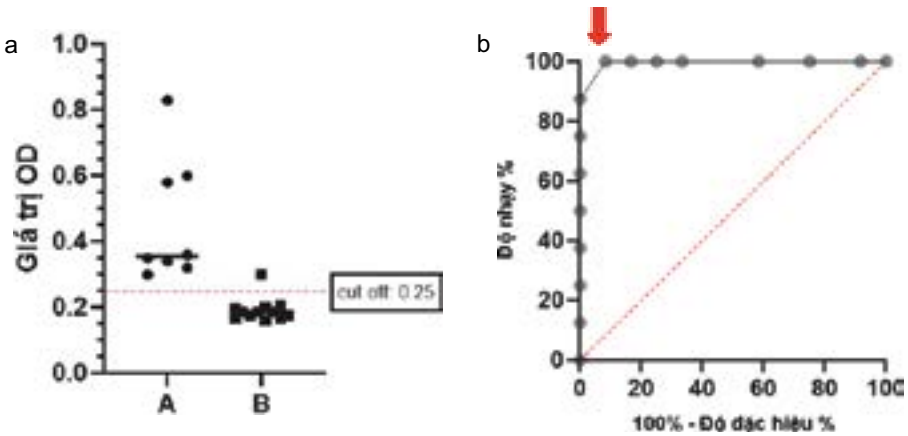

Fig.3. OD value results of 20 serum samples and ROC analysis.
(a) The OD value result of 20 serum samples, the red line shows a cut-off value of 0.25; A is the group of individuals that give positive results by ultrasound method, B is the group of individuals that give negative results.
(b) Correlation between sensitivity and specificity of ELISA using ROC analysis. Body arrow the point corresponding to the sensitivity value is 100%; specificity 91.67%; the cut-off value is 0.25.

Table 1. Confusion matrix table results with a cut-off value of 0.24.

ELISA	Surgery		
	positiv	negativ	Total
positiv	8	1	9
negativ	0	11	11
Total	8	12	20

We identified 8 primates with cystic formation in various organs in the body, of which 4 individuals were found to be cystic in the chest area, and the remaining individuals were found mainly in the kidney area, where the highest OD value recorded was 0.83 for a grey-shanked douc langur (*Pygathrix cinerea*). This individual died in the center, through the examination of which an *Echinococcus* cyst was found in the internal organ (Fig. 4). Normally, cysts grow but do not cause symptoms for a long time until the cyst develops. Large enough, they will squeeze the parasitic organ, leading to death. If the cyst ruptures, it can cause an allergic reaction to the parasite's antigens or spread daughter cysts throughout the body (Yilmaz et al. 2012).

Fig.4. *Echonococcus* cyst in the liver of a grey-shanked douc langur (*Pygathrix cinerea*). Photo: Tilo Nadler.

The results of the ROC analysis in Fig. 3b show, with a cut-off value of 0.25; the sensitivity of the reaction was 100%, which corresponded to the fact that all individuals that detected the cyst gave a positive ELISA result. The corresponding specificity was 91.67 %.

This ELISA method can be used to screen primates in the center. Individuals that test positive for ELISA can be isolated, and ultrasound performed and possibly also treated (Kalogeropoulu et al. 2023). Due to the center's conservation regulations and interventions, the conduct of anesthesia and ultrasound on all individuals is difficult to proceed quickly. Initial screening with an ELISA test helps identify individuals who need priority diagnosis and treatment.

The ultrasound method for detecting cysts caused by *Echinococcus* spp. (CE) has been standardized to promote uniform diagnostic and treatment standards and can be applied to clinical treatment as well as to field surveys. Late-stage cysts have calcified walls in the form of eggshells

or are completely calcified with a matte shade, and they are easily misdiagnosed in most cases, or cysts are in the early stages of formation so they are difficult to identify by ultrasound (Brunetti et al. 2018). However, in this experiment, all primates whose tumors identified by ultrasound were positive on the ELISA test. In addition, the subjects of the study are highly endangered primates that need to be protected to avoid extinction. Therefore, although performing an examination to find bright follicles in the body is a method to confirm whether an individual is infected or not, this method cannot be applied to all individuals studied to find uninfected individuals for standard negative samples. Individuals sampled for standard negative sampling in the experiment were in good health.

The time spent nurturing at the center did not show signs of abnormal pathology, and a thorough ultrasound was carried out to confirm that there were no cysts in the body.

For a better overview, we proceed onion comparing test results obtained using ELISA method and surgical method, with cut-off value = 0.24. The results of the confusion matrix table are shown in Table 1, showing that there is 1 false positive case (corresponding rate of 12.5%).

The false-positive case has an OD value of 0.3; quite close to the cut-off threshold of 0.24 and also the closest to the cut-off of individuals that tested positive in this experiment. The OD values of this individual were consistent with the 0.3 to 0.35 range of 4 positive individuals with both test methods. Therefore, it may happen that this individual has *cysticercosis*, but the cyst is not detected in the body through examination, because the cyst is at a new stage of formation.

Serological tests are useful to confirm the results of imaging diagnostics. If an individual is found to have no cysts in the body by examination, and at the same time gives a positive ELISA test result, it is more likely that the individual has *cysticercosis* (CE) but has not yet developed into a tumor at an early stage. However, the limitations of serological diagnosis in CE must be borne in mind in order to accurately interpret the results. CE should not be diagnosed using serological testing as the only diagnostic method, especially when the cyst is not identified by ultrasound, since the positive value of ELISA for this disease can be influenced by many factors. These include factors related to the laboratory (use of antigens), factors related to the individual (immune status) and factors related to cysts (location, stage, size, quantity, previous treatment and complications) (Tappe et al. 2007). The antigens used for CE serological diagnosis are not standardized, resulting in large differences in reported diagnostic outcomes and difficulties in comparing results from different groups. In general, ELISA methods using crude hydatid fluid (HCF) antigen showed better sensitivity (80-99% sensitivity and 60-97% specificity), while assays based on purified or recombinant proteins showed better specificity (38-93% sensitivity and 80-100% specificity) (Li et al. 2004). False-negative test results may occur in hepatic follicular presence with newly formed follicles (30-58%), dormant phase cysts (50-87%), and in cases where cysts are elsewhere in the body other than the liver; in which up to 50% of individuals have lung cysts, and individuals have cysts in other locations. Individuals with cysts at the active and transitional stages show lower seronegative rates (5-20%), and individuals with multiple cysts often show seropositive results (Aydin et al. 2018).

Tests that detect specific antibodies or use certain recombinant proteins have been suggested (Hernández et al. 2018). However, to date there is no diagnostic method using recombinant antigens commercialized in the market. False-positive results may occur in individuals infected with other fluke species, especially in *cysticercosis* caused by *E. multilocularis* infection (Mihmanli et al. 2016). Less common are false-positive cases that can be detected with other noncommunicable diseases, such as cancer and chronic immune disorders. Serological testing may remain positive for many years even after treatment or surgical intervention, limiting the use of serology to assess response to treatment (Manzano et al. 2015). In addition, this can lead to confusion that the individual is still suffering from the disease and continues to undergo treatment, affecting the individual's health.

However, the observation that OD levels decrease over time (months to years) after treatment, can still be used as an indicator of the degree of remission of the disease. OD values may increase with reinfection, although this is uncommon, suggesting that the pathogen is still present in primate

habitats, and is more likely to be present in feed, so appropriate adjustments need to be made regarding hygiene and feed delivery in the center.

Conclusions

Using an OD threshold value of 0.25, the corresponding sensitivity and specificity of the reaction were determined to be 100% (when using serum samples from 8 individuen detected by ultrasound) and 91.67% (when using serum samples from 12 individuen no cysts were detected by ultrasound). The established ELISA method can serve as an initial screening measure, making the diagnosis process more accurate.

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An aggressive Francois' langur (*Trachypithecus francoisi*) attacks passers-by at Kim Hy Nature Reserve, Bac Kan Province, Vietnam

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Key words: Francois' langur, *Trachypithecus francoisi*, aggression.

Summary

At Kim Hy Nature Reserve, Bac Kan Province, Vietnam, passers-by were attacked and bitten by an aggressive Franois' langur male (*Trachypithecus francoisi*) in July 2023. After repeated attacks, the animal was anaesthetised by a team from the Endangered Primate Rescue Centre EPRC in October 2023 and transported to the EPRC for further keeping. The reason for this abnormal behaviour is unclear. In Vietnam, there are only a few small and isolated remaining populations of the species whose long-term existence is questionable. According to the results of a survey in 2001, around 10 to 15 individuals were still living in Kim Hy Nature Reserve. More recent information on the species' existence from Kim Hy Nature Reserve is lacking.

Một cá thể voọc đen má trắng hung dữ (*Trachypithecus francoisi*) tấn công người qua đường tại Khu bảo tồn thiên nhiên Kim Hy, tỉnh Bắc Kạn, Việt Nam

Tóm tắt

Tại Khu bảo tồn thiên nhiên Kim Hy, tỉnh Bắc Kạn, Việt Nam, người đi đường đã bị một cá thể đực voọc đen má trắng hung dữ (*Trachypithecus francoisi*) tấn công và cắn vào tháng 7/2023. Sau nhiều lần tấn công cong người, con vật đã được nhóm chuyên gia Trung tâm Cứu hộ Linh trưởng Nguy cấp EPRC bắn gây mê trong tháng 10/2023 và bàn giao cho EPRC để tiếp tục chăm sóc. Lý do cho hành vi bất thường này là không rõ ràng. Ở Việt Nam, chỉ còn một vài quần thể nhỏ và biệt lập còn lại của loài mà sự tồn tại lâu dài của chúng vẫn còn nhiều nghi vấn. Theo kết quả của một cuộc khảo sát vào năm 2001, khoảng 10 đến 15 cá thể vẫn đang sống trong Khu bảo tồn thiên nhiên Kim Hy. Thông tin gần đây từ Kim Hy về sự tồn tại của loài này còn thiếu rất nhiều.

At Kim Hy Nature Reserve, Bac Kan Province, Vietnam, passers-by were attacked and bitten by an aggressive Franois' langur in July 2023. One passer-by required medical treatment at the hospital (Fig. 1). The aggressive langur, an adult male, ambushed motorcyclists from a tree stand along a road, chased them and tried to bite them (Fig. 2). Adult males of this species have exceptionally long and very sharp canines that can cause deep wounds (Fig.3). After repeated attacks, the Kim Hy Nature Reserve finally asked the Endangered Primate Rescue Centre (EPRC) for help. In October 2023, a team from the EPRC anaesthetised the animal with a blowpipe anaesthetic, had it examined on the spot by a vet and transported it to the EPRC for further care (Fig. 4). The EPRC manages a captive breeding programme for this species and this individual may be involved in this programme. Captive born individuals from this programme will be released into the wild in the future to strengthen populations reduced by poaching.

Fig.1. Bite wounds of a passer-by caused by an aggressive Francois' langur male. Photo: Author unknown.

Fig.2. The Francois' long male lurks on the side of the road and attacks passing motorcyclists. Photo: Author unknown.

Fig.3. Adult Francois' langur males have very long and sharp canines. Photo: Tilo Nadler.

Fig.4. The veterinarian from the Endangered Primate Rescue Center Ho Phuoc Ngoc Khanh examines the anaesthetised Francois' langur before transporting it to the Center. Photo: TTXVN – Vietnam News.

Francois' langurs are leaf-eating primates and their behaviour is generally extremely restrained. Even when kept in the EPRC, these animals hardly show any aggressive behaviour towards humans. A very similar aggressive behaviour of a male of the closely related Hatinh langurs (*Trachypithecus hatinhensis*) was recently reported (Nadler 2020). In both cases, the reason for this abnormal behaviour is unclear.

Francois' langurs are listed as 'Endangered' in the IUCN Red List of Threatened Species. The largest, albeit fragmented, populations of the species exist in China. Around 10 smaller isolated populations still exist in Vietnam, whose long-term existence is questionable. Without strict conservation measures, there is a risk that the species will disappear from Vietnam. This species has been recorded in the Kim Hy Nature Reserve. In 1998, about 20 animals may have existed the area. It is known that eight individuals were shot in 1999 and two animals were illegally traded alive in 2000 (Nadler et al. 2003). According to the results of a survey, around 10 to 15 individuals were still living in the nature reserve in 2001 (La Quang Trung & Trinh Dinh Hoang 2001). More recent information on the occurrence of the species in the nature reserve is lacking.

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Developing the capacity of students in primate conservation in Vietnam

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Key words: Frankfurt Zoological Society, Danang University, capacity building, nature conservation, primate conservation.

Summary

Frankfurt Zoological Society (FZS), in collaboration with the University of Danang, has organised annual primate training courses for students from 2006 to 2021. So far, 15 courses have been held and 324 students have participated. Based on the courses, the FZS has awarded 19 small research grants with primatological tasks to participants of the courses.

We conducted an online survey to analyse the impact of the primate training course on students' career, orientation and scientific research capacity. The link to the survey was available in September 2021. Of the 100 people we contacted, we received 95 responses. The training courses were often crucial for the students' career orientation in conservation. By 2021, 11% of the trained students were assisted in finding a job in conservation. Almost all respondents (95%) indicated that their knowledge, attitude and awareness of primate conservation had improved. 74% of the graduates said that they use the skills and knowledge learned in the course in their studies and in their jobs. 83.2 % of the participants said that they are more involved in local conservation activities, projects and primate conservation research. 49.5 % of the respondents said that they have more ideas for their university work on primate research. As a result, 32 theses and 12 scientific papers on primates were conducted in Vietnam. Former participants founded one local non-governmental organisation (NGO) and three environmental groups dedicated to conservation. The cooperation between FZS and Danang University in the field of scientific research and training has led to a high level of efficiency in training professionals for nature conservation, especially primate conservation in Vietnam.

Phát triển năng lực của sinh viên trong bảo tồn thú linh trưởng ở Việt Nam

Tóm tắt

Tổ chức Frankfurt Zoological Society (FZS) hợp tác với ĐH Đà Nẵng tổ chức khóa tập huấn thường niên về thú linh trưởng cho sinh viên từ năm 2006 đến 2021. Đến nay, đã có 15 khóa học được tổ chức với sự tham gia của 324 sinh viên. Từ các khóa tập huấn, FZS cũng đã trao 19 học bổng nghiên cứu nhỏ về thú linh trưởng cho sinh viên tham gia khóa tập huấn.

Chúng tôi đã tiến hành một cuộc khảo sát trực tuyến để phân tích tác động của khóa tập huấn linh trưởng đối với nghề nghiệp, định hướng và năng lực nghiên cứu khoa học của sinh viên. Khảo sát được thực hiện vào tháng 9 năm 2021. Chúng tôi đã nhận được 95 câu trả lời, trong số 100 người mà chúng tôi đã liên hệ. Kết quả cho thấy, khóa tập huấn có vai trò rất quan trọng đối với định hướng nghề nghiệp của sinh viên trong lĩnh vực bảo tồn. Đến năm 2021, 11% sinh viên được đào tạo, hỗ trợ tìm việc làm trong lĩnh vực bảo tồn. Hầu hết tất cả những người được hỏi (95%) cho biết kiến thức, thái độ và nhận thức của mình về bảo tồn linh trưởng đã được cải thiện. 74% sinh viên tốt nghiệp cho biết đã sử dụng các kỹ năng và kiến thức học được từ khóa học trong học tập và trong công việc. 83,2% người được khảo sát trả lời họ đã tham gia nhiều hơn vào các hoạt động, dự án bảo tồn tại địa

phương và tham gia vào hoạt động nghiên cứu bảo tồn linh trưởng sau khi tham gia tập huấn. 49,5 % số người được hỏi nói rằng họ có nhiều ý tưởng hơn cho đề tài nghiên cứu về thú linh trưởng ở trường đại học. Kết quả cho thấy, 32 luận án và 12 bài báo khoa học về linh trưởng đã được thực hiện tại Việt Nam. Cựu sinh viên của khóa tập huấn đã thành lập một tổ chức phi chính phủ (NGO) địa phương và ba câu lạc bộ môi trường hoạt động trong lĩnh vực bảo tồn. Sự hợp tác giữa FZS và Đại học Đà Nẵng trong nghiên cứu khoa học và đào tạo đã mang lại hiệu quả cao trong việc đào tạo cán bộ có chuyên môn cho công tác bảo tồn thiên nhiên, đặc biệt là bảo tồn linh trưởng ở Việt Nam.

Introduction

Vietnam has - with 26 species - the highest diversity of primate species on the Southeast Asian mainland,. However, more than 90% of Vietnam's primates are listed as threatened in the IUCN Red List of Threaetened Species (IUCN 2014). Seven taxa are listed as 'Critically Endangered', ten taxa listed as 'Endangered' and six taxa listed as 'Vulnerable'. Five species were listed under the "The World's 25 Most Endangered Primates" (Schwitzer et al. 2014), meaning that 20% of the world's most endangered primates exist in Vietnam. Hunting for food and traditional medicine and the pet trade, habitat loss as a result of deforestation are the main causes for the decline of primate populations.

The average demand for conservation scientists and foresters is predicted to rise by 7% between 2020 and 2030, roughly in line with the industrial development. There will always be an increasing need for biologists, ecologists, and conservationists. (U.S. Bureau of Labor Statistics 2020). However, due to the lack of universities training young conservationists in biodiversity management, there are limited human resources available to meet conservation priorities.

To deal with the lack of human resources in wildlife conservation, especially in primate conservation, Frankfurt Zoological Society and Danang University agreed to collaborate in building capacity for young researchers and conservationists in Vietnam. As a result, an annual training course on primate conservation is offered by the two institutions and a research funding program to support students in primate research is established (Fig. 1). Primate conservation is known as a top priority in wildlife conservation in Vietnam. Presently, FZS with Danang University has conducted 15 annual training courses for 324 Vietnamese students. The training course includes three days of studying about theories of primate diversity and primatological research methods and six days of field training (Fig. 2). The field training is to allow students to practice the research methods on primates in the natural habitat (Fig. 3, 4). One to two student research projects on primate conservation or communication events will be supported to conduct as the results of the follow up activities of each course.

Fig.1. Students of a primate training course at Danang University. Photo: Tilo Nadler.

Fig.2. Theoretical training of students during a primate training course at Danang University. Photo: Tilo Nadler.

Fig.3. One-week practical training of different techniques during the primate training course. Photo: Tilo Nadler.

Fig.4. Practical training in the field also takes place under conditions that require work in the field. Photo: Ha Thang Long.

It is necessary to assess the impact of 15 training courses on the career orientation, the effectiveness of the training course and the FZS research funding program on building capacity for young conservationists in primates. The research provides data for building the next plan in developing human resources in primate as well as wildlife conservation in Vietnam.

Methods

We conducted an online survey to examine the impact of the primate trainig courses on student research, capacity and career orientation on the participants who took on of the courses from 2006 to 2021. A survey link was available in September 2021.

We received 95 responses from 100 persons we contacted. We also interviewed and collected the statistics on the number of publications and the number of students working in nature conservation. Extensive interviews with trainers were conducted to assess students' progress in primate and conservation knowledge through the training courses.

Results

Effect of primate conservation training courses on human resources for nature conservation

The training course is critical for student's conservation career orientation. Until 2021, there are 34 alumni of the training course, equivalent of 11% total trained students, working in the field of nature conservation, biodiversity at NGO's, national parks, nature reserves, and forest protection departments. Of those, 15 alumni are involved in a primate conservation program for non-governmental organizations (Table 1).

Table 1. Milestones and impact of the primate conservation training courses and the small grants for research on primates.

Milestones and impact	Number
The total number of training courses	15 courses
Number of participants	324 students
Number of participating universities	15 Universities
Number of students working in nature and wildlife conservation after training course	34 students
NGOs working in nature conservation was established	1 organization
Number of students project, communication events after training course	8 projects/events
Number of clubs working on wildlife conservation as a results of training course	3 clubs
Number of publications on primate research	12 scientific papers
Small grants were awarded to students to conduct research on primates	19 small grants
Number of graduate theses on primates after training course	32

One of the outstanding results of the cooperation between the two institutions in human resources for nature conservation is the establishment of the first local NGO in Danang working on conservation named "GreenViet Biodiversity Conservation Center". Since its inception in 2012, the center has made significant contributions to nature conservation in the central and Central Highlands regions.

Almost all students (94.7%) responded that their knowledge, attitudes, and awareness of primate conservation had improved. 83.2% of respondents said they were more active in local primate and nature conservation projects. Students also started volunteering for various non-governmental organizations, including "Education for Nature Vietnam" (ENV), the "GreenViet Biodiversity Conservation Center", taking part in campaigns to stop consuming wildlife meat and monitor the illegal wildlife trade.

Research themes varied from field research on primates to increasing awareness of conservation and building an important primate data base. Additionally, students founded local environmental clubs and non-governmental organizations (NGO's) devoted to protecting the environment. 40% of students answered they can do their own independent research on primates in a national park.

Applying of the training course in alumni's study and job

We questioned trainees about various training course applications in their jobs in order to evaluate the training course's long-term effectiveness on alumni studies and jobs. In their jobs and studies, 74% of respondents claimed they applied the skills and knowledge they had received throughout the training course.

The training course's knowledge and skills are applied in several majors such as field biology research, ecotourism, conservation education, biology teaching, wildlife rescuing. More specifically, the prospective teachers applied their knowledge to the curriculum for teaching biology in secondary schools and grammar schools. Tour guides said that skills and knowledge of primate, nature, and conservation can be useful in guiding ecotourism in which they are covering. Following the training course, they held a communication event on nature and wildlife conservation. 100% of students said the training course helped them improve essential skills like teamwork, communication, interviewing, and data analysis. 85.3% of participants indicated they shared their course skills and knowledge with friends and coworkers. In this way, it is hoped that the stories shared will help to raise community understanding of nature and wildlife conservation (Table 2).

Table 2. What students obtain as a result of taking the course.

Category	Number of students	Percentage (95 answers)
Gain more knowledge about nature and primate conservation.	90	94,7%
Have a positive attitude toward animals and nature protection.	87	91,6%
Know how to organize a field trip and have the ability to use field equipment	82	86,3%
Participate in environmental and wildlife conservation activities on a volunteer basis	79	83,2%
Improved communication with partners and the community.	77	81,1%
Connect and develop network with students from different universities	60	63,2%
More ideas and creativity in educational and teaching activities	49	51,6%
Improve scientific reports/articles.	47	49,5%
More ideas for scientific research projects, graduation theses	47	49,5%
Capability to plan and coordinate communication and volunteer activities	45	47,4%
Be able to do independent research on primates at National Park	38	40%
Capability to write grant or scholarship applications	22	23,2%

Students research on primate conservation and training course effective in improving students research capacity

Thirtytwo graduate theses on primates have been conducted from 2009 to 2021 at the University of Danang for Science and Education as a result of the training courses and the research funding program of Frankfurt Zoological Society.

75% of research objects focus on three species: rhesus macaque (*Macaca mulatta*), grey shanked douc langur (*Pygathrix cinerea*) and red shanked douc langur (*Pygathrix nemaeus*) (Table 3). Most of research was conducted in the center and Central Highlands of Vietnam, such as Son Tra Nature Reserve, Kon Ka Kinh National Park, Tam My Tay forest area. The studies cover a wide range of topics, including genetic diversity, primate distribution, behavior, and ecology.

Table 3. Objective primate species in graduate theses of students.

No	Species	The number of research	Percentage
1	Rhesus macaque (*Macaca mulatta*)	9	28,1
2	Grey shanked douc langur (*Pygathrix cinerea*)	8	25
3	Red shanked douc langur (*Pygathrix nemaeus*)	7	21,8
4	Pygmy slow loris (*Nycticebus pygmaeus*)	3	9,4
5	Black shanked douc langur (*Pygathrix nigripes*)	2	6,3
6	Northern yellow-cheeked gibbon (*Nomascus annamensis*)	1	3,1
7	Hatinh langur (*Trachypithecus hatinhensis*)	1	3,1
8	Tonkin snub-nosed monkey (*Rhinopithecus avunculus*)	1	3,1

Frankfurt Zoological Society awarded 47 small grants for students, of those, 19 grants for research on primates and provided scientific advice for the small research projects on biodiversity and nature conservation.

Discussion

11% trained students working in nature and wildlife conservation is a modest number. There is a fact that 53.4% trained students said that they get hard when seeking for a job in nature conservation. According to interview result, there are several reasons for this situation. On the one hand, conservation-related career ambitions necessitate people with passion, skills, and relevant experience. On the other hand, many people believe that current recruitment information for the nature conservation sector is still restricted; most organizations recruit volunteers, other positions demand experience and professional knowledge, and new grads believe they lack the necessary skills and knowledge to apply. Furthermore, gender stereotypes and language barriers limit the number of persons working in the field of nature protection.

The number of research articles is small, and the research is in its early stages. Diversifying primate research toward practical applications in primate conservation is essential.

Vietnam may face a human resource shortage in wildlife conservation due to a lack of academic institutes that educate young conservationists in biodiversity management. It is crucial to establish a collaboration system with employers' associations, international non-governmental organizations, and research institutes, in order to increase training quality and bring it closer to actual demands. Field activities should be strengthened in curriculum so that students have more opportunities for practicing. At the same time, students are urged to become involved in nature conservation organizations and associations, as well as to assist local and international conservation organizations. Encourage students to enhance their foreign language skills and to meet and exchange academics with many scientists from various regions and countries to gain more knowledge and experience in

the field of environmental conservation and biodiversity.

Conclusion

The success of conservation depends on the quality of human resources to carry out the long term objectives. Building capacity on research and communication for young conservationist is vital importance. The collaboration approach between Frankfurt Zoological Society and Danang University of Science and Education has contributed in enhancing the quality of university training and research, particularly in conservation of primates and career orientation in nature conservation.

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Fostering Collaboration and Conservation Efforts: Highlights from the 8th Asian Primate Symposium and the 3rd Gibbon Health, Husbandry, and Conservation Conference

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Key words: 8th Asian Primate Symposium 3rd Gibbon Health, Husbandry, and Conservation Conference, Vietnam.

Summary

In 2020 on the 7th Primate Symposium in Guwahati, India Vietnam was chosen as the organizing site for the 8th Asian Primate Symposium. Seizing the event as an opportunity to leverage collective expertise on gibbons, the symposium was immediately followed by the 3rd Gibbon Health, Husbandry, and Conservation Conference. Both events were held from November 13th to 19th, 2023 and were organized by the international NGO Three Monkeys Wildlife Conservancy (TMWC) in cooperation with Vietnam National University of Forestry (VNUF).

The Symposium brought together approximately 200 attendees, representing 91 organizations spanning 20 different countries. Over the course of two days, a total of 62 presentations were expertly delivered, spanning a wide array of topics, including ethology, ecology, genetics, taxonomy, survey methods, and primate and non-primate interactions. Attendees also enjoyed a day excursion to Ninh Binh Province, visiting the Endangered Primate Rescue Center, Turtle Conservation Center, and Small Carnivore and Pangolin Conservation Program. The horizon beckons to the 9th Asian Primate Symposium, slated to convene from November 20th to 23rd 2024, in Medan, North Sumatra, Indonesia.

Thúc đẩy các nỗ lực hợp tác và bảo tồn: Điểm nổi bật từ Hội nghị Chuyên đề Linh trưởng Châu Á lần thứ 8 và Hội nghị Chuyên đề về Sức khỏe, Chăn nuôi và Bảo tồn Vượn lần thứ 3

Tóm tắt

Năm 2020, tại Hội nghị Chuyên đề Linh trưởng lần thứ 7 tại Guwahati, Ấn Độ, Quốc gia Việt Nam đã được đề cử làm nơi tổ chức Hội nghị Chuyên đề Linh trưởng Châu Á lần thứ 8. Nắm bắt sự kiện này như một cơ hội để chia sẻ thêm chuyên môn về nhóm các loài vượn, kế tiếp là Hội nghị chuyên đề lần thứ 3 về Sức khỏe, Chăn nuôi và Bảo tồn Vượn cũng được tổ chức. Cả hai sự kiện được tổ chức liên tục từ ngày 13 đến 19/11/2023 và do tổ chức phi chính phủ quốc tế Three Monkeys Wildlife Conservancy (TMWC) hợp tác với Học viện Lâm nghiệp Việt Nam (ĐHQGHN) tổ chức.

Hội nghị chuyên đề quy tụ khoảng 200 đại biểu tham dự, đại diện cho 91 tổ chức trải dài trên 20 quốc gia khác nhau. Trong suốt hai ngày, đã có 62 bài thuyết trình đã được trình bày một cách chuyên nghiệp, trải dài trên một loạt các chủ đề, bao gồm đạo đức học, sinh thái học, di truyền học, phân loại, phương pháp khảo sát và tương tác linh trưởng và phi linh trưởng. Các đại biểu tham dự cũng được tận hưởng một chuyến tham quan trong ngày đến tỉnh Ninh Bình, thăm Trung tâm Cứu hộ Linh trưởng Nguy cấp, Trung tâm Bảo tồn Rùa, và Chương trình Bảo tồn Động vật ăn thịt và Tê tê nhỏ. Nơi chân trời vẫy gọi Hội nghị chuyên đề linh trưởng châu Á lần thứ 9, dự kiến được tổ chức từ ngày 20 - 23 tháng 11 năm 2024, tại Medan, Bắc Sumatra, Indonesia.

According to the IUCN/SSC Primate Specialist Group, our planet hosts a remarkable diversity of 533 primate species distributed worldwide. Among these, the Asian continent stands out as a biodiversity hotspot, with a total of 133 recognized primate species. However, this distinction is overshadowed by the alarming rate to which primate populations in that region of the world are collapsing, reflecting the ongoing global biodiversity crisis. In order to protect these endangered primate species in Asia effectively, it is imperative to continue promoting cross-border interdisciplinary communication, sharing invaluable experiences, and fostering collaboration. Recognizing this pressing need, the Asian Primate Symposium was inaugurated two decades ago.

In 2020 on the 7th Primate Symposium in Guwahati, India Vietnam was chosen as the organizing site for the 8th Asian Primate Symposium as it holds the unique distinction of being home to 26 primate species, the highest diversity in primate fauna on the Southeast Asian mainland. Seizing the event as an opportunity to leverage collective expertise on gibbons, the symposium was immediately followed by the 3rd Gibbon Health, Husbandry, and Conservation Conference. Both events were held from November 13th to 19th, 2023 and were organized by the international NGO Three Monkeys Wildlife Conservancy (TMWC) in cooperation with Vietnam National University of Forestry (VNUF).

The symposium's opening ceremony was initiated by senior representatives from the Vietnam National University of Forestry and the Ministry of Agriculture and Rural Development. Opening remarks were also given by representatives of Three Monkeys Wildlife Conservancy, who further emphasized the importance to urgently implement the Conservation Action Plan for Primates in Vietnam by 2025, with a vision extending to 2030. The head of IUCN Indo-Burma Jake Brunner further shed light on the ongoing biodiversity crisis in Asia. The opening ceremony reached its pinnacle with a plenary session by Prof. Dr. Christian Roos from the German Primate Centre, focusing on the 'Genomics of Asian Primates,' setting the stage for in-depth dialogues during the event (Fig 1).

Fig.1. Prof. Dr. Christian Roos presenting plenary session on genomics of Asian primates Photo: Nguyen Thi Thuy Anh.

The Symposium brought together approximately 200 attendees, representing 91 organizations spanning 20 different countries (Table 1; Fig. 2, 3). This diverse gathering exemplified the global collaborative spirit necessary to tackle the intricate challenges in primate conservation (Fig. 4). Over

the course of two days, a total of 62 presentations were expertly delivered, spanning a wide array of topics, including ethology, ecology, genetics, taxonomy, survey methods, and primate and non-primate interactions, many of which were deeply rooted in the context of conservation needs and applications (Fig. 5). The presentations were further enriched through a poster session that fostered engaging conversations and knowledge exchange.

Table 1. List of attending organizations at the 8th Asian Primate Symposium.

- Aaranyak - India
- Academy of Journalism and Communication – Vietnam
- Adam Mickiewicz University - Poland
- Animals Asia - Vietnam
- Ar-Raniry State Islamic University - Indonesia
- Aristotle University of Thessaloniki - Greece
- Assam University - India
- Borneo Nature Foundation International - Indonesia
- BOS - Germany
- Cat Ba Langur Conservation Project -Vietnam
- Cat Tien National Park - Vietnam
- CBES - Vietnam
- Center for Nature Conservation and Development - Vietnam
- Centre for Orangutan Protection - Indonesia
- Centre for Resources, Environment and Climate Change -Vietnam
- Centre for Wildlife Studies - India
- Chances for Nature - Germany
- Chulalongkorn University - Thailand
- Cloud Mountain Conservation - China
- Denver Zoo - USA
- Denver Zoological Foundation - USA
- MONRE - Vietnam
- IUCN Vietnam
- STICD, VNFOREST - Vietnam
- Douc Langur Foundation - Vietnam
- EAST
- Endangered Asian Species Trust - Vietnam
- Endangered Primate Rescue Center - Vietnam
- Ewha Womans University - South Korea
- Fauna & Flora International
- Fauna & Flora International - Vietnam
- Forum Orangutan Indonesia
- Frankfurt Zoological Society - Vietnam
- Friedrich Löffler Institute - Germany
- Gauhati University - India
- German Primate Center
- Green Pilgrims - Czech
- Green Viet - Vietnam
- Institute of Ecology and Biological Resources - Vietnam
- Institute of Zoology, Zoological Society of London - UK
- Jagannath University - Bangladesh
- Javan Wildlife Institute - Indonesia
- King Mongkut's University of Technology Thonburi - Thailand
- Lao Conservation Trust for Wildlife - Laos
- Malaysian Primatological Society
- Mandai Nature - Singapore
- Nanjing Forestry University - China
- National Primate Research Center of Thailand
- Nature Conservation Society - Myanmar
- Nông Lâm university - Vietnam
- Nong Lam University of Ho Chi Minh City - Vietnam
- Northwest University - China
- Orangutan Indonesia Forum
- Ostrava Zoo - Czech
- Oxford Brookes University - UK
- Plumploris e.V - Germany
- Prigen Conservation Breeding Ark/Taman Safari Indonesia
- Primate Conservation Inc - USA
- Primate Research Centre India
- Primate Research Institute - japan
- Sristi Manipal Institute of Arts - India
- Sun Yat-sen University - China
- Sustainable Forest Management and Certification Institute - Vietnam
- Swaraowa - Indonesia
- The Association of Indonesian Primatologists
- The Indonesian Orangutan Conservation Forum
- Three Monkeys Wildlife Conservancy -Vietnam
- Traditional Music
- Université de Liège -Belgium
- University College London & ZSL's Institute of Zoology, UK
- University East Kalimantan - Indonesia
- University Malaysia Terengganu
- University of California, Davis - USA
- University of Colorado - USA
- University of Copenhagen - Danmark
- University of Delhi - India
- University of Leicester - UK
- University of Mysore - India
- University of Science - Vietnam
- University of Science HCMC -Vietnam
- Usti nad Labem Zoo - Czech
- Vietnam Administration of Forestry - MARD
- Vietnam Association for Conservation of Nature and Environment
- Vietnam National University of Agriculture
- Wildlife Research and Conservation Unit - Bangladesh
- World Hope International
- WWF - Vietnam
- Yayasan IAR - Indonesia
- Yayasan Palung / Gunung Palung Orangutan Conservation Program - Indonesia
- Zoo Leipzig - Germany
- Zoological Survey of India

Fig.2. The participants attending the 8th Asian Primate Symposium. Photo: Nguyen Thi Thuy Anh.

Fig.3. Participants in front of the welcoming banner of the 8th Asian Primate Symposium. Photo: Nguyen Thi Thuy Anh.

Fig.4. Audience during the opening ceremony of 8th Asian Primate Symposium. Photo: Nguyen Thi Thuy Anh.

Fig.5. Presentation during the 8th Asian Primate Symposium. Photo: Nguyen Thi Thuy Anh.

To promote career advancement in primate conservation and research, the organizing committee offered grants to support Vietnamese university students and early-career conservationists/ researchers in attending the 8th Asian Primate Symposium. These grants fully covered expenses such as transportation, registration, meals, and accommodation for 12 selected individuals from across Vietnam. This initiative provided grantees with a unique opportunity to immerse themselves in the world of primate conservation and research while facilitating networking with renowned experts in the field of primatology.

To add a creative touch to the symposium, renowned Vietnamese wildlife artist Dao Van Hoang exhibited his primate-themed artwork, alongside a photo exhibition featuring all 26 species of primates in Vietnam (Fig. 6, 7). Attendees also enjoyed a day excursion to Ninh Binh Province, visiting the Endangered Primate Rescue Center, Turtle Conservation Center, and Small Carnivore and Pangolin Conservation Program (Fig. 8). Though heavy rain forced the cancellation of a planned boat trip to spot the Delacour's langur in Van Long Nature Reserve.

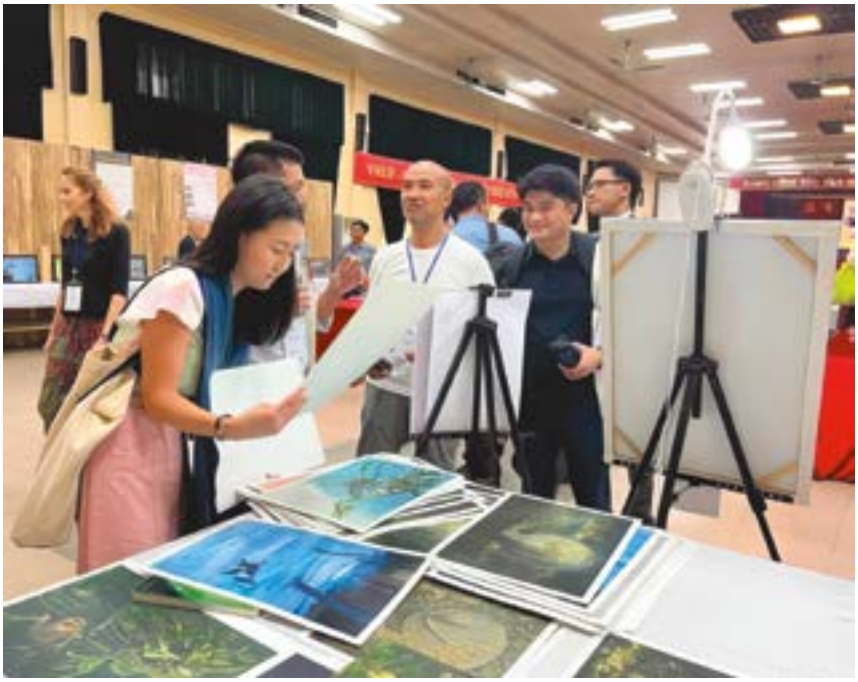

Fig.6. Artwork of Dao Van Hoang during the 8th Asian Primate Symposium. Photo: Long Vu/CBES.

Fig.7. Vietnamese primate exhibition during the 8th Asian Primate Symposium. Photo: Long Vu/CBES.

Fig.8. Excursion to rescue centers in Ninh Binh, including the Endangered Primate Rescue Center.

Concurrently, the symposium provided a pivotal backdrop for the 3rd Gibbon Health, Husbandry, and Conservation Conference, taking place from November 16th to 19th November. This specialized gathering brought together 40 dedicated delegates. Hailing from 12 organizations, these delegates represent a global consortium committed to the protection and preservation of gibbons.

Overall, the vibrant social environment of the Primate Symposium and the Gibbon Conference offered participants an unique platform to showcase the relevance of their work. It provided an engaging stage for attendees to disseminate their research findings, exchange ideas, and foster new collaborative partnerships. Networking opportunities abounded, inspiring future collaborations among individuals and cultivating partnerships among diverse organizations.

As we reflect upon these gatherings, it is imperative to acknowledge the invaluable contributions of donors who made the 8th Asian Primate Symposium possible. These generous benefactors include re:wild, WWF-Vietnam, Frankfurt Zoological Society, Margot Marsh Foundation, the American Society of Primatologists, The Little Chalcraft Fund, and Zoo Leipzig. Additionally, the 3rd International Gibbon Conference received vital funding from IUCN - Section on Small Apes (Fig. 9). We would also like to extend our heartfelt appreciation to the dedicated volunteers who played a crucial role in ensuring the smooth execution of these events.

Fig.9. Attendees of the 3rd Gibbon Health, Husbandry and Conservation Conference.

Looking ahead, we are convinced that the legacy of collaboration and dedication forged during these events will continue to flourish. The horizon beckons to the 9th Asian Primate Symposium, slated to convene from November 20th to 23rd 2024, in Medan, North Sumatra, Indonesia. As the baton of organization passes to Indonesia, a consortium of dedicated organizations such as the Orangutan Information Centre (OIC), Indonesia Orangutan Conservation Forum (FORINA) and Yayasan Konservasi Ekosistem Alam Nusantara (KIARA) will unite under the banner of the 'APS Indonesia Secretariat,' ensuring the continued success of this forthcoming gathering.

INSTRUCTIONS FOR CONTRIBUTORS

The *Vietnamese Journal of Primatology* is a peer reviewed journal. It welcomes manuscripts from all areas related to the conservation and research of non-human primate taxa which occur in Vietnam and the neighboring countries of Cambodia, China and Laos. The journal publishes both original research papers and short communications.

Submission: Submit English manuscripts electronically (as unformatted Microsoft Word file attachments) to Tilo Nadler or Christian Roos:

Tilo Nadler
Cuc Phuong Commune
Nho Quan District/Ninh Binh Province
Vietnam
e-mail <t.nadler@hust.edu.vn>

Christian Roos
German Primate Centre,
Göttingen,
Germany
e-mail <croos@dpz.eu>

Manuscript Preparation: Manuscripts should be divided into the major divisions given below in the order indicated.

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The first page of the manuscript should include the title of the paper.

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Each paper must include a summary of no more than 300 words, which clearly summarizes the contents of the paper. The Summary will be presented in English and Vietnamese.

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Papers published in periodicals

Dao Van Tien (1989): On the trends of the evolutionary radiation on the Tonkin Leaf monkey (*Presbytis francoisi*) (Primates: Cercopithecidae). J. of Human Evolution 4, 501-507.

Fooden J (1996): Zoogeography of Vietnamese Primates. Int. J. Primatol. 17, 845-899.

Books and Monographs

Groves CP (2001): Primate Taxonomy. Smthsonian Institution Press, Washington DC.

Edited books and book chapters

Groves CP (2004): Taxonomy and Biogeography of Primates in Vietnam and Neighbouring Regions. In: Nadler T, Streicher U. & Ha Thang Long (eds.): Conservation of Primates in Vietnam; pp. 15-22. Frankfurt Zoological Society, Hanoi.

Dissertations

Otto C (2005): Food intake, nutrient intake, and food selection in captive and semi-free Douc langurs. PhD thesis, University Cologne, Germany.

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