



The Clausiliidae (Gastropoda: Stylommatophora) of the Tam Dao National Park, Vietnam

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Abstract: The Tam Dao National Park protects one of the best-preserved natural forest remnants of Northern Vietnam, which belongs to the diversity centres of the subfamilies Phaedusinae and Garnieriinae (Clausiliidae). Based on published records and our new data, we provide an overview the clausiliids of this important protected area and discuss their zoogeographical significance. The recent survey led to the rediscovery of *Synprosphyra gastrum*, an endemic species that has not been found since the end of the 19th Century. Three other species of the national park, *Notoptychia polydona*, *Oospira semipolita* and *Phaedusa dichroa*, are rare, sporadically occurring clausiliids that are confined to remnants of natural forests in Northern Vietnam.

Key words: biodiversity, land snails, Southeast Asia, Phaedusinae, Garnieriinae

Introduction

Southeast Asia is one of the Earth's most biodiverse regions, which is the home of 20–25% of the planet's plant and animal species (Woodruff 2010). Its continental part, the Indo-Burma biodiversity hotspot, houses around 20,000–25,000 species of vascular plants and 2200 vertebrate species, of which 33% and 24%, respectively, are endemic (Myers et al. 2000, Koh et al. 2014). However, this impressive diversity is threatened by rapid loss of the native habitats because of overpopulation and defor-

estation. One of the most severely affected countries is Vietnam where an estimated 85% of the original forest cover was lost (Brook 2006). This highlights the importance of government efforts aimed at protecting the country's remaining natural forests areas.

One of the best-preserved forest areas in Northern Vietnam (Bac Bo) is the Tam Dao Mountain Range, which is situated at about 50 km northwest of Hanoi. After its designation as a protected forest in 1977, it became the core of the Tam Dao National Park (hereafter, Tam Dao N. P.) declared in 1996. About 70% of the park area of 370 km² are covered

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with humid tropical broadleaf forests, which provide a wide variety of microhabitats and are home to more than 2000 plant and 280 animal species, several of which are local endemics (Vu & Nguyen 2000, Sterling et al. 2007). Whereas the park's vertebrate fauna has been well documented, its invertebrates have received less attention. Numerous publications include records from the Tam Dao N. P. but only a few of them consider the local diversity of particular groups, such as those of ants (Eguchi et al. 2005), butterflies (Vu 2009) or oribatid mites and collembolans (Vu & Nguyen 2000). A previous report on a field survey recorded 52 species of terrestrial snails from this national park, including seven species of the family Clausiliidae (Hoang et al. 2012).

The family Clausiliidae is one of the most species-rich land snail groups in Vietnam; its species, exhibiting diverse habitat preferences, are useful indicators of the palaeo-zoogeographic trends (Nordsieck 2011). The present assessment of the clausiliid fauna of the Tam Dao N. P. was based on materials collected by Alexander Napolov (Riga) in 1998 and by us in 2023, as well as on data published by Hoang et al. (2012). Our records provide georeferenced locality data and hitherto unavailable microhabitat information on some of the species recorded in this national park.

Materials and Methods

During our survey in 2023, samples were hand-collected in undisturbed or slightly disturbed submontane forests at the beginning of the dry season (October 16–19). All specimens were found on and under tree bark or inside moist, decaying tree trunks. Imaging of the shells was carried out using a Keyence LHX5000 digital microscope. The referred samples have been deposited in the invertebrate collection of the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences.

Results

The following review of the clausiliids in the Tam Dao N. P. is based on the results published by Hoang et al. (2012), as well as on specimens provided by A. Napolov (Riga) and specimens sampled during our field trip in 2023.

Subfamily Garnieriinae

Genus *Tropidauchenia* Lindholm, 1924

Tropidauchenia Lindholm, 1924: 70

Type-species: *Clausilia bavayi* Lindholm, 1924, by original designation.

Tropidauchenia giardi (Fischer, 1898)

(Fig. 1A)

Clausilia giardi Fischer, 1898: 323, fig. 2, pl. 18, figs 22–27

Type locality: Ma Phuc Pass (Cao Bang Province).

Locality data: Tam Dao N. P. (Hoang et al. 2012).

Distribution: In Vietnam, this species has been known from the provinces of Cao Bang (eastern part) and Lang Son (northern part). It also occurs in the neighbouring Longzhou County, Guangxi Province (China).

Habitat: Limestone cliffs.

Remark: The reported occurrence record from the Tam Dao N. P. (Hoang et al. 2012) is surprising because of the relatively large distance from the hitherto known distribution area of *T. giardi*. Furthermore, the predominantly volcanic Tam Dao Range and some of the habitats (i.e., wastelands and farmlands) reported by Hoang et al. (2012) are not suitable for this obligate limestone-dwelling species. Therefore, this locality information needs confirmation.

Subfamily Phaedusinae

Genus *Notoptychia* Ehrmann, 1927

Notoptychia Ehrmann 1927: 36

Type species: *Clausilia polydona* Mabilie, 1887, by original designation.

Notoptychia polydona (Mabilie, 1887)

(Fig. 1B)

Clausilia polydona Mabilie, 1887a: 45

Type locality: “Tonkin”.

Locality data: Tam Dao N. P., rain forest, 800–900 m, leg. A. Napolov 1998; Tam Dao N. P., forest – 1 km NE of the centre of the resort (21.4607°N 105.6488°E), 1060 m, leg. R. Bekchiev, I. Dedov, M. Langurov & N. Simov 2023 (Fig. 2A, B); Tam Dao N. P., forest 2.1 km north of the centre of the resort (21.4733°N 105.6394°E), 980 m, leg. R. Bekchiev, I. Dedov, M. Langurov & N. Simov 2023 (Fig. 2C); Tam Dao N. P., forest 1.4 km north of the centre of the resort (21.4672°N 105.6440°E), 1010 m, leg. R. Bekchiev, I. Dedov, M. Langurov & N. Simov 2023.

Distribution: The species occurs sporadically in Bac Kan, Lang Son, Thai Nguyen, Son La and Hoa Binh Provinces.

Habitat: Undisturbed forests, under and inside decaying tree trunks.

Remark: This species was described from a gastropod material collected by Benedict Balansa in Tonkin and provided without more precise locality data (Mabilie 1887a, 1887b). However, the species diversity of Balansa's material suggests that all of the samples originate from the central part of Lang Son Province. So far, *N. polydona* is known only from Vietnam but occurrence data near the borders suggest its possible presence in Guangxi Province (China) and Houaphanh Province (Laos).

Genus *Oospira* Blanford, 1872

Oospira Blanford 1872: 205

Type species: *Clausilia philippiana* Pfeiffer, 1847, by original designation.

***Oospira semipolita* (Bavay & Dautzenberg, 1899)**
(Fig. 1C)

Clausilia semipolita Bavay & Dautzenberg, 1899: 288, pl. 12, fig. 9

Type locality: Between Bac Kan and That Khe (Lang Son Province).

Locality data: Tam Dao N. P., rain forest, 800–900 m, leg. A. Napolov 1998.

Distribution: Hanoi Municipality and Bac Kan, Lang Son, Tuyen Quang and Vinh Phuc Provinces.

Habitat: Undisturbed forests.

Remark: This species is known only from a few localities in the eastern part of Northern Vietnam.

***Oospira vanbuensis* (Bavay & Dautzenberg, 1899)**
(Fig. 1D)

Clausilia vanbuensis Bavay & Dautzenberg, 1899: 38, pl. 2, fig. 1

Type locality: Between Son La and Van Bu (present Ta Bu, Son La Province).

Locality data: Tam Dao N. P. (Hoang et al. 2012); Tam Dao N. P., rain forest, 800–900 m, leg. A. Napolov 1998; Tam Dao resort, yard of the hotel Quang Minh (21.4580°N 105.6449°E), 970 m, leg. R. Bekchiev, I. Devod, M. Langurov & N. Simov 2023 (Fig. 2D).

Distribution: Hanoi Municipality and Ha Giang, Tuyen Quang, Vinh Phuc, Son La, Thanh Hoa, Ninh Binh and Nghe An Provinces.

Habitat: Various types of forest and anthropogenic environments.

Remark: All the known occurrence records of this species are from Vietnam but its distribution range may extend to neighbouring areas of Yunnan Province (China) and Houaphanh Province (Laos).

Genus *Phaedusa* Adams & Adams, 1855

Phaedusa Adams & Adams 1855: 205

Type species: *Clausilia corticina* Pfeiffer, 1842, by subsequent designation (Martens in Albers 1860).

***Phaedusa dichroa* (Bavay & Dautzenberg, 1899)**
(Fig. 1E)

Clausilia dichroa Bavay & Dautzenberg 1899: 287, pl. 12, fig. 8

Type locality: Bac Kan.

Locality data: Tam Dao N. P., rain forest, 800–900 m, leg. A. Napolov 1998; Tam Dao N. P. (21.4553°N 105.6386°E), leg. Luong Van Hao 2006.

Distribution: Bac Kan, Lang Son, Vinh Phuc, Son La and Ninh Binh Provinces.

Habitat: Undisturbed forests.

Remark: This species is known only from a few localities in Northern Vietnam.

***Phaedusa lypra* (Mabille, 1887)**
(Fig. 1F)

(Fig. 1F)

Clausilia lypra Mabille 1887b: 117

Type locality: “Tonkin”.

Locality data: Tam Dao N. P., rain forest, 800–900 m, leg. A. Napolov 1998.

Distribution: This species is known to occur in eastern India (Manipur State), Myanmar (Shan State and Mandalay Region), Thailand (Tak Province), southern China (Yunnan and Guangxi Provinces) and large parts of Northern Vietnam (Ha Giang, Cao Bang, Bac Kan, Lang Son, Thai Nguyen, Vinh Phuc, Son La, Thanh Hoa and Ninh Binh Provinces).

Habitat: Forests and cliff vegetation, as well as anthropogenic environments.

Remark: *Phaedusa lypra* is one of the most widely distributed Asiatic clausiliids. Its local forms show considerable variation in size and sculpture (Szekeres et al. 2021).

***Phaedusa paviei* (Morlet, 1892)**
(Fig. 1G)

(Fig. 1G)

Clausilia paviei Morlet 1892: 319, pl. 7, fig. 1

Type locality: Muong Lay (Dien Bien Province).

Locality data: Tam Dao N. P., rain forest, 800–900 m, leg. A. Napolov 1998.

Distribution: Hanoi Municipality and Dien Bien, Lai Chau, Lao Cai, Tuyen Quang, Bac Kan, Lang Son, Vinh Phuc, Son La and Hoa Binh Provinces.

Habitat: Forests, cliff vegetation and anthropogenic environments.

Remark: So far, all the known localities of this species are in Vietnam. However, its range may extend to north-eastern Laos and to Yunnan Province (China).

***Phaedusa phongthoensis* Loosjes & Loosjes-van Bemmelen, 1949**
(Fig. 1H)

(Fig. 1H)

Phaedusa (Phaedusa) phongthoensis Loosjes & Loosjes-van Bemmelen, 1949: 31, figs 1–3, pl. 4

Type locality: Phong Tho (Lai Chau Province).

Locality data: Tam Dao N. P. (Hoang et al. 2012).

Distribution: Except for the Tam Dao record, all the known localities of *P. phongthoensis* are in Lai Chau and Lao Cai Provinces.

Habitat: Unknown.

Remark: The Tam Dao locality reported by Hoang et al. (2012) is quite far from the few other occurrences of this species in the most northwestern provinces of Vietnam. This record needs confirmation; because, as its description points out (Loosjes & Loosjes-van Bemmelen 1949), *Phaedusa phongthoensis* is easily confused with *P. paviei*.

***Phaedusa stenothyra* Möllendorff, 1901**
(Fig. 1I)

(Fig. 1I)

Phaedusa (Pseudononia) stenothyra Möllendorff 1901: 116

Type locality: Cai Bau Island (Quang Ninh Province).

Locality data: Tam Dao N. P. (Hoang et al. 2012).

Distribution: Lang Son, Vinh Phuc, Quang Ninh, Hoa Binh and Ninh Binh Provinces.

Habitat: Cliff vegetation.

Remarks: This species is endemic to eastern regions of Northern Vietnam.

Genus *Selenophaedusa* Lindholm, 1924

Selenophaedusa Lindholm, 1924: 72

Type species: *Clausilia porphyrostoma* Bavay & Dautzenberg, 1909, by original designation.

***Selenophaedusa thatkheana* (Bavay & Dautzenberg, 1899)**

(Fig. 1J)

Clausilia thatkheana Bavay & Dautzenberg 1899: 285, pl. 12, fig. 7

Type locality: That Khe (Lang Son Province).

Locality data: Tam Dao N. P. (Hoang et al. 2012).

Distribution: Lao Cai, Ha Giang, Cao Bang, Tuyen Quang, Bac Kan, Lang Son, Yen Bai and Phuc Yen Provinces, as well as Guangxi Province (China).

Habitat: Forests and areas with high ground vegetation.

Remarks: *Selenophaedusa thatkheana* is a widely distributed, morphologically diverse species (Nordsieck 2011).

Genus *SynprospHYma* Wagner, 1920

SynprospHYma Wagner 1920: 12

Type species: *Clausilia suilla* Bavay & Dautzenberg, 1909, by subsequent designation (Lindholm 1924).

***SynprospHYma gastrum* (Möllendorff, 1901)**

(Fig. 1K)

Phaedusa (*Hemiphaedusa*) *gastrum* Möllendorff, 1901: p. 77

Type locality: “Than-moi” (Thanh Moi; presently Lang Thanh, Lang Son Province).

Locality data: Tam Dao N. P., forest 1 km NE of the centre of the resort (21.4607°N 105.6488°E), 1060 m, leg. R. Bekchiev, I. Dedov, M. Langurov & N. Simov 2023 (Fig. 2A, B); Tam Dao N. P., forest 1 km E of the centre of the resort (21.4562°N 105.6519°E), 1150 m, leg. R. Bekchiev, I. Dedov, M. Langurov & N. Simov 2023.

Distribution: Apart from its type locality, the sites in the Tam Dao N. P. are the only known occurrences of the species.

Habitat: Undisturbed forest, on and under tree bark, as well as in decaying wood.

Remarks: Our data from the Tam Dao N. P. are the only well-defined locality records of this rare endemic species of Northern Vietnam.

Discussion

Northern Vietnam is situated at a contact zone between the North Indochinese, Sikang-Yunnan and South Chinese floristic provinces (Averyanov et al. 2003). Its diverse flora, landscape and geology provide a variety of habitats for a rich malacofauna sharing elements with the South Chinese, Malaysian and Eastern Himalayan zoogeographic regions (Páll-Gergely et al. 2017, Do et al. 2019).

Early malacological studies by Mabilie (1887a), Fischer (1898), Bavay & Dautzenberg (1899, 1909)

and Möllendorff (1901) have already revealed a remarkable richness of Northern Vietnam’s Clausiliidae fauna. Recent publications (Maassen & Gittenberger 2007, Schileyko 2011, Nordsieck 2011, 2016) contributed further data, faunistic assessments and descriptions of numerous new clausiliids. Regional surveys addressed the malacological diversities of protected areas (Vermeulen & Maassen 2003, Do et al. 2010, Hoang et al. 2012, Do et al. 2021), whereas one focused specifically on the clausiliid species of Son La Province (Do & Do 2015).

The publication by Hoang et al. (2012) on the land snail fauna of the Tam Dao N. P. listed seven clausiliid species. Of those, our data confirm the occurrence of *Oospira vanbuensis*. The available distribution records suggest the likely presence of *Phaedusa stenothyra* and *Selenophaedusa thatkheana*, too. However, as we pointed out, the records of *Tropidauchenia giardi* and *Phaedusa phongthoensis* seem to be erroneous. In addition to the taxa mentioned by Hoang et al. (2012), our data demonstrate the presence of six further clausiliid species in the Tam Dao N. P. area. Among these, *Notoptychia polydona*, *Oospira semipolita* and *Phaedusa dichroa* are rare, sporadically occurring species, which seem to be confined to isolated remnants of natural forests. An important result of our 2023 survey was the re-discovery of *SynprospHYma gastrum*. This species had been collected only in 1900 by the German entomologist Hans Fruhstorfer near Chi Lang in Lang Son Province (Möllendorff 1901). Ever since then it could not be found, therefore presently our two geolocated sites are the only reliable localities of this species.

The Tam Dao N. P. is an important clausiliid refuge in Northern Vietnam, a region that is home of 73 species of this family, representing 82% of the species in the entire country. This remarkable richness makes Northern Vietnam, together with Yunnan Province (China), the Asiatic centre of clausiliid diversity (Nordsieck 2011). Of the species of Northern Vietnam, 51 are considered endemic to his region. However, upon more thorough surveying, some of these are expected to be found along the bordering areas in China and Laos. However, despite being one of the malacologically best-studied regions, the Clausiliidae fauna of Northern Vietnam is not yet explored sufficiently. Even after the rediscovery of *SynprospHYma gastrum*, eight further species of this family have not been found again during the past century. Moreover, 22 of the local species have only been described during the past three decades. One can expect the discovery of further new species, especially in the poorly explored Lai Chau and Lao Cai Provinces.

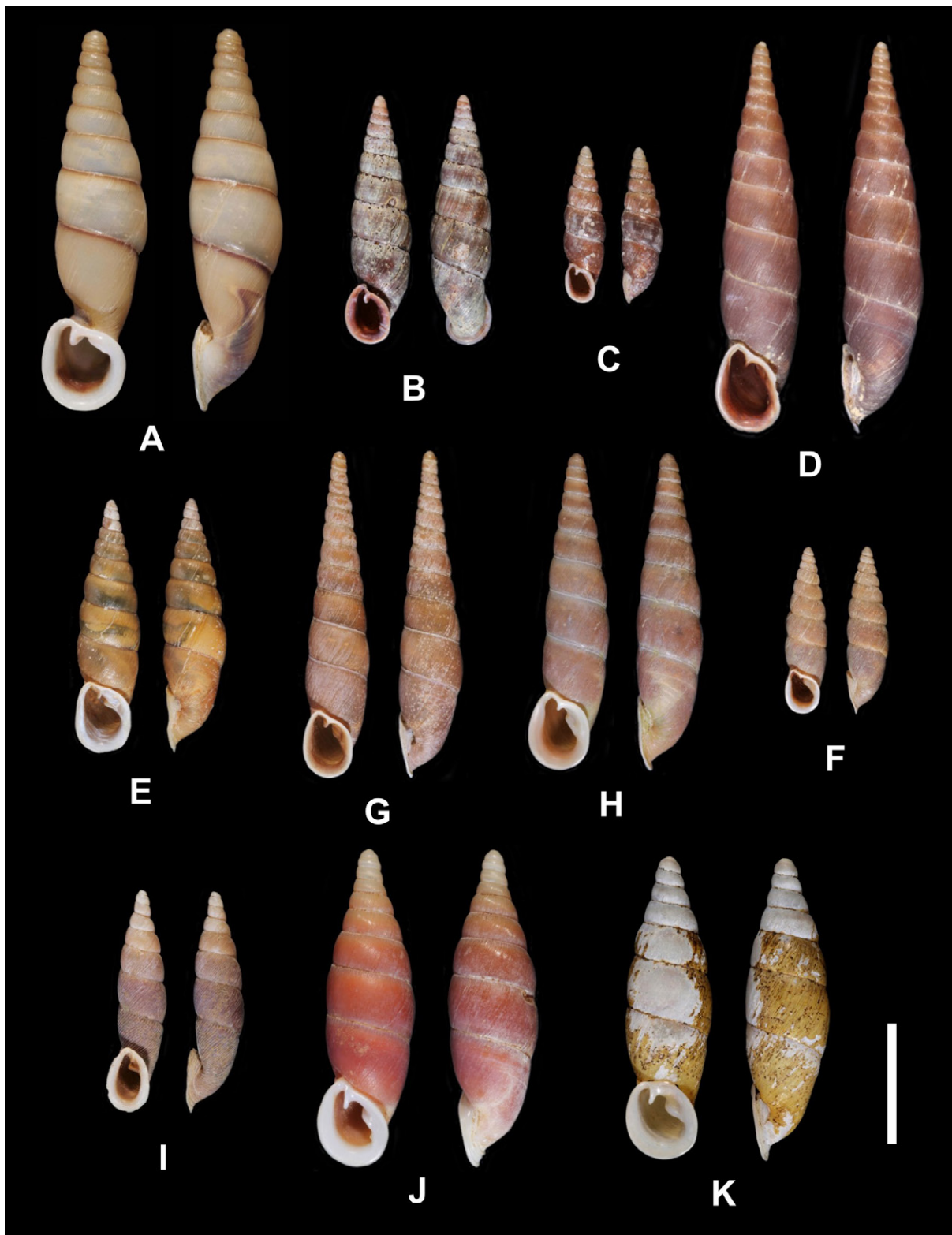


Fig. 1. Species of the family Clausiliidae. A. *Tropidauchenia giardi* (comparative material, China, Guangxi Province, Longzhou County, Wude Xiang). B. *Notoptychia polydona*, Tam Dao N. P., 1 km NE of the centre of the resort, 1060 m. C. *Oospira semipolita*, Tam Dao N. P., 800–900 m. D. *Oospira vanbuensis*, Tam Dao N. P., 800–900 m. E. *Phaedusa dichroa*, Tam Dao N. P., 800–900 m. F. *Phaedusa lypra*, Tam Dao N. P., 800–900 m. G. *Phaedusa paviei*, Tam Dao N. P., 800–900 m. H. *Phaedusa phongthoensis* (comparative material, Lai Chau Province, Phong Tho). I. *Phaedusa stenothyra* (comparative material, Ninh Binh Province, Cuc Phuong National Park). J. *Selenophaedusa thatkheana* (comparative material, Yen Bai Province, Luc Yen District). K. *Synprosphyra gastrum*, Tam Dao N. P., 1 km NE of the centre of the resort, 1060 m. Scale bar: 10 mm.



Fig. 2. Habitats sampled during the 2023 survey. A. Habitat of *Notoptychia polydona* and *Synprosphyra gastrum*, 1 km NE of the centre of Tam Dao Resort, 1060 m. B. Microhabitats with decaying wood and tree fungi at the same site. C. Habitat of *Notoptychia polydona*, 2.1 km north of the centre of Tam Dao Resort, 980 m. D. Habitat of *Oospira vanbuensis* in the yard of the Quang Minh Hotel in Tam Dao Resort, 970 m.

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