

DIVERSITY OF JUGLANDACEAE IN CUC PHUONG NATIONAL PARK

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SUMMARY

This paper provides information regarding diversity and conservation of Juglandaceae in Cuc Phuong National Park. Based on inventory and measurement of general characters, results indicated that there were four walnut species distributed in Cuc Phuong National Park, belonging to four genera. *Alfaroa roxburghiana* (Lindl. ex Wall.) Iljinsk, *Carya sinensis* Dode & Zucc, *Platycarya strobilacea* Siebold and *Pteracarya tonkinensis* Dode. The number of Walnut species in Cuc Phuong national park account for 36% of the total Walnut species and 57% of general species in Vietnam. Most species are distributed between 100 m – 600 m above sea level in the study site. Juglandaceae species in Cuc Phuong are of high conservation value with three species on the IUCN Red List (2020) and one species in Viet Nam Red Data Book (2007). The *Platycarya strobilacea* Siebold is not listed on the IUCN Red List and Viet Nam Red Data Book, but it is known to be very rare in the park. This research also provides information on the morphological and ecological characteristics of four walnut species in the study site.

Keywords: conservation, Cuc Phuong National Park, diversity, Juglandaceae, walnut species.

1. INTRODUCTION

The Juglandaceae is one of the most emblematic angiosperm families composed entirely of woody species (Kozłowski et al., 2018; Simpson, 2010; Sam et al., 2021). Vietnam is one of the main centres of genetic diversity for Juglandaceae worldwide with 11 species belonging to seven genera have been recorded (Kozłowski et al., 2018; Mostajeran et al., 2017; Sam et al., 2021). Of them, some species are relic trees with high conservation and economic value. Cuc Phuong National Park is the first National park that was established in Vietnam. The park is located in three provinces of North Vietnam including Ninh Binh, Hoa Binh, Thanh Hoa. It covers a total area of 22,480 hectares of relatively undisturbed limestone forest and has a rich flora rainforest (Thu, 1995; Chien, 2008). The park is a hotspot of biodiversity in Vietnam with more than 2000 vascular plants species and many threatened species (Thu, 1995). Walnut plant species naturally occur in Cuc Phuong National Park. However, information of this family is very limited. Therefore, to understand the diversity, distribution and conservation status of Juglandaceae in the park is an urgent need. This paper is the result a the study from 2019 to 2021.

2. RESEARCH METHODOLOGY

2.1. Content

- To identify species diversity and conservation status of Juglandaceae in Cuc Phuong National Park.

- To study basic morphological and ecological characteristics of the species Juglandaceae in Cuc Phuong National Park.

2.2. Methodology

- Establishing 10 transects in the research area with a total length of about 70 km. Additionally, a total of 30 plots of 500 m² (25 x 20 m) have been established in the study site. Within the transects and plots, walnut plant species were collected and documented. Specimens were deposited in the herbarium of the Vietnam National University of Forestry (VNUF).

- Morphology characteristics were described based on living trees, herbarium specimens and literature (Chan & Huyen, 2000; Dung, 1996; Ho, 1992; 2003; Sam et al., 2021). Identification of Juglandaceae species by experts and morphology characteristics comparison method.

- Conservation status of endangered species were identified based on the Vietnam Red Data Book (2007), the IUCN Red List (2020).

3. RESULT AND DISCUSSION

3.1 Species diversity of Juglandaceae in Cuc Phuong National Park

A total of four species of Juglandaceae were found in Cuc Phuong National Park including, *Alfaroa roxburghiana* (Lindl. ex Wall.) Iljinsk,

Carya sinensis Dode & Zucc, *Platycarya strobilacea* Siebold, *Pterocarya tonkinensis* Dode. They belong to four genera *Alfaropsis*, *Carya*, *Platycarya*, and *Pterocarya*. The number of species in Cuc Phuong National Park accounts for 36% of the total number of Walnut species and 57% of general species in Vietnam (Kozłowski et al., 2018; Sam et al., 2021).

a. *Alfaropsis* Iljinsk.

Engelhardieae (Juglandaceae) consists of four extant genera *Alfaroa*, *Engelhardia*, *Oreomunnea*, and *Alfaropsis* (Yunfa Chen, Steven R. Manchester, Zhuqiu Song, Hongshan Wang, 2014). However, Iljinskaya (1993) proposed *Alfaropsis* as a distinct genus in subsequent phylogenetic investigations of the Juglandaceae (Manos et al., 2007; Stone, 2010). Both of *Engelhardia* and *Alfaropsis* have the trilobite wing in each lobe, pinnate venation fruits, but those of *Alfaropsis* also have a tendency to possess some additional radiating veins from the base of the wing. (Iljinskaya, 1993). There is only one species *Alfaroa roxburghiana* with the former name of *Engelhardia roxburghiana* (Kozłowski et al., 2018). The species that belong to *Alfaropsis* is a large evergreen or rarely semi-evergreen tree up to 30 m tall with leaves even-pinnate and alternate. Branchlets with solid pith. Plants monoecious. Inflorescences forming androgynous panicle (sometimes separate), terminal on new wood (occasionally lateral, and if so on old wood). Fruiting spike elongate, pendulous. Fruit a 3-winged, small and glabrous nutlet, prophyllum absent (Kozłowski et al., 2018).

b. *Carya* Nuttall

This is the second largest genus of the Juglandaceae, it contains 17 species distributed in subtropical and tropical regions of Eastern Asia and subtropical to temperate regions of eastern North America. In spite of *Carya*, it is sometimes treated as a monotypic genus (*Annamocary sinensis*), they have all the essential features of *Carya* genera (Kozłowski et al., 2018; Song et al., 2020). The *Carya* species are deciduous trees up to 30(-50) m height. Solid pith branchlets. Leaves alternate, odd-

pinnate. They are monoecious plants with male and female spikes separate. The male spike in clusters of three, lateral at the base of new growth, pendulous. Female spike terminal on new growth and erect. Fruiting spike erect. The fruit is a drupaceous large nut with a thick, 4-valved husk containing a smooth or wrinkled shell with two or four compartments. Husks completely or partially dehiscent (Lu et al., 1999; Kozłowski et al., 2018; Sam et al., 2021).

c. *Platycarya* Siebold & Zucc.

Platycarya is a genus of flowering plants in the family Juglandaceae, usually treated as a single species, *Platycarya strobilacea* (Lindley, 1843). Species of *Platycarya* are deciduous trees up to 15 m tall with alternate and odd-pinnate leaves. Branchlets with solid pith. Plants monoecious. In terms of its flowers and fruits, this is one of the most unusual members of the Juglandaceae. The cylindrical male catkins are erect and clustered around the female cone-like catkin in a candelabra style arrangement. Female flowers are subtended by an entire bract. The mature bracts are almost black, rigid and persistent. Fruits are very small, flattened, narrowly 2-winged nutlets (Kozłowski et al., 2018).

d. *Pterocarya* Kunth

The genus *Pterocarya* is the oldest confirmed fruits which date from the early Oligocene epoch of North America (Kozłowski et al., 2018; Song et al., 2020). This genus is divided into two sections: *Platyptera* and *Pterocarya* genera which contains the taxa *Pterocarya tonkinensis* Dode (Manos et al., 2007; Manos & Stone, 2001). Species of *Pterocarya* genera are deciduous trees. Leaves alternate, odd- or even-pinnate. Male and female spikes, inflorescences, separate, pendulous. Male spike solitary, lateral on old growth or at the base of new growth. Female spike terminal on new growth. Fruiting spike elongated and pendulous, 15 - 45 cm long with 20 - 80 fruits. Fruit is a 2-winged nutlet with four compartments (Kozłowski et al., 2018).

3.2. Conservation status of Juglandaceae in Cuc Phuong National Park

A total of four Juglandaceae species were found in Cuc Phuong National Park. There are three species listed on the IUCN Red List 2020 and one species in the Vietnam Red Data Book 2007 as Endangered (EN) (table 01). *Platycarya strobilacea* Siebold & Zucc is not listed in either the IUCN Red List or the Vietnam Red Data Book. However, this species is rare and only distributed in a small area of

Cloudy Silver peak (Mây Bạc peak), Cuc Phuong National park. This species has been recorded in some provinces in the Northern part of Vietnam, but it also occurs very rare in their area. Therefore, we propose this species as vulnerable (VU) for both the IUCN Red List and the Red Data Book of Vietnam (Sam et al., 2021).

Table 1. Conservation status of Juglandaceae in Cuc Phuong National park

| No | Vietnamese name | Latin name | Conservation status | |
|----|-----------------|---|----------------------------|------------------------|
| | | | IUCN Red List (IUCN, 2020) | Vietnam Red Book, 2007 |
| 1 | Chẹo | <i>Alfaroa roxburghiana</i> (Lindl. ex Wall.) Iljinsk | LC | |
| 2 | Chò đái | <i>Carya sinensis</i> Dode | EN | EN |
| 3 | Coi | <i>Pteracarya tonkinensis</i> Dode | VU | |

Note: LC- Least Concern, VU – Vulnerable, EN- Endangered.

3.3 Juglandaceae species in Cuc Phuong National Park

3.3.1. *Alfaroa roxburghiana* (Lindl. ex Wall.) Iljinsk

Synonyms: *Engelhardia roxburghiana* Lindl.; *Engelhardia chrysolepis* Hance., *Engelhardia wallichiana* Lindl.,

Vietnamese name: Chẹo, Chẹo trắng, Chẹo tía

a. Morphology

Alfaroa roxburghiana is an evergreen tree up to 25 m tall, trunk longitudinally fissured bark yellowish grey, longitudinally fissured. Leaves even-pinnate, alternate, petiole 1 - 5 cm, glabrous, leaflets 2 - 5 pairs, and entire. Asymmetrical at the base, apex acuminate, margin often revolute, secondary vein 7 - 16

pairs, prominent below; petioles of 0.5 – 1 cm. Inflorescence terminal, often bisexual, in panicles of kittens 5 – 6 cm, reddish red. Male flowers dense, sessile or short pedicellate; bract and glandular bracts forming 3 teeth; sepals 4, on a short receptacle, dorsally glandular; stamens 4 - 8; anther glabrous. Female flowers pedicellate, bracts partly enclosed at the base of the ovary. Ovary globose, stigma 4-lobed. Infructescence 15 – 25 cm, with tomentose rachis, scaly, winged fruit, pediculate; wing 3-lobed glandular, terminal lobe 2 – 6.5 x 0.6 – 1.6 cm, the lateral half shorter. Fruits a globose nut, bracts developed into wings, enclosing the base of the fruit, dark brown, with yellowish brown scales, the middle wings 2.5 – 4 cm long.



Figure 1. Fruits and young leaves *Alfaroa roxburghiana* (Lindl. ex Wall.) Iljinsk

(Source: Dao Cong Anh, Hoang Van Sam)

b. Ecology and conservation

Alfaroa roxburghiana is a slow growing tree. This species is distributed in limestone mountain at an elevation between 200 - 600 m in Cuc Phuong National park, which has often mixed with *Lithocarpus sp*, *Castanopsis sp*, *Cinnamomum sp*, *Pygeum arboretum* and *Edospermum sinensis* on loam, and dry slopes such as in the road along the direction to Sliver Cloud Mountain. But the common areas of these trees are in terrain areas in Mac Lake, Bong Center, Cui Tren, Ma valley, O Tue field. A total 25 mature tree and 36 seedling have been found in the area. Flowering from April to June and fruiting July – October. *Alfaroa roxburghiana* was listed in the IUCN Red List (2020) as Least Concern.

3.3.2. *Carya sinensis* Dode

Synonyms: *Annamocarya indochinensis* A.Chev.; *Juglans indochinensis* A.Chev.

Vietnamese name: Chò đăi.

a. Morphology

Carya sinensis is a large deciduous tree, up to 30 m tall with 140 cm in diameter.

Cylindrical bole, smooth and often has buttresses at stump height. Bark greenish and longitudinally fissured along the bole. Twigs horizontal, very gross, scatteredly tomentose. Leaves imparipinnate compound, alternate 30 – 40 cm long; Rachis 13 – 30 cm, glabrous; petioles 5 – 7 cm long, cylindrical, swollen at the base. Leaflets generally 7, ovate-lanceolate to elliptic, 12 – 14 cm long and 5 – 7 cm wide, slightly swollen at the base, nearly rounded or asymmetrical, acuminate at apex, margin entire or wavy, glabrous on the two sides with tufts of hair at the insertion of the midrib vein below; secondary veins 15 – 18 pairs; petiolule 3 – 7 (–10) mm. Male inflorescences axillary in fascicles of 5 (–8) kittens at the base of young shoots; isolated, short stalk or sessile; sepals absent; stamens 5 – 15. Female inflorescences terminal. Female flowers glandular: perianth formed of 4 – 6 teeth; stigmas 2. Nuts ovoid, 6 – 8 x 5 cm, apiculate-rostrated at the apex; dehiscent by 4 – 6 valves opening from the top, keeled. Globular to ovoid starch, 3 – 5 mm long, 3-lobed cotyledons.



Figure 2. Leaves of *Carya sinensis* Dode
(Source: Hoang Van Sam, Dao Cong Anh)

b. Ecology and conservation

The natural distribution of this species in Cuc Phuong is mainly in valleys or sometimes at the foot of Limestone Mountains at an elevation between 100 - 400 m. This species often mixes with *Sterbulus macrophyllum* Blame, *Sacara dives* Pierre, *Hydnocarpus kurzii* (King) Warb. Every year, this species develops sprouts first and when the sprouts are completed in March-

April, flowers in April-July and fruits mature in September-October. A total of 31 mature trees were found in the study site. *Carya sinensis* naturally regenerates in Cuc Phuong National Park and eight seedlings were recorded during the field inventory. *C. sinensis* is listed in the IUCN Red List (2020) and Viet Nam Red Data Book (2007) as Endangered (EN).

3.3.3. *Platycarya strobilacea* Siebold & Zucc

Synonyms: *Fortunaea chinensis* Lindl., *Platycarya longipes* Wu.

Vietnamese names: H \acute{o} a hương, Hương núi.

a. Morphology

Platycarya strobilacea is a deciduous tree, up to 15m tall with 40 cm in diameter. Bark ash-grey, irregularly longitudinally fissured. Young branches terete, brown initially densely pubescent, later glabrescent. Old branches brown, glabrous with elliptic lenticels. winter buds ovoid, axillary, brown. Buds scales numerous, triangular, 5 – 7 mm long, margin ciliate. Crown globose and thin. Leaves odd-pinnate, alternate, 15 – 35 cm long, petiole terete, slightly pubescent, dilated at base with 7 – 23 leaflets; Leaflets opposite or subopposite, sessile, 4 – 12 cm by 2 – 4 cm,

lanceolate-ovate or lanceolate elliptic, attenuate toward tip, base subrounded, oblique, margin clearly serrate, dark green and glabrous above, greenish beneath and pubescent at axils of veins. Penninerved, lateral veins 10 – 12 pairs. Flowers monoecious, minute, naked, arranged into catkin-spikes. Male catkins 6 – 10 cm long, many flowered, erect, terminal, stalk 2 cm long, brown pubescent, stamens often 8, the length of filament unequal; anthers yellow, globose, 2-celled. Female catkins about 2cm long, subglobose, stalk 6mm long with brown tomentum, often occurs above the male catkins. Bracts broadly ovate, acute; ovary flat, style short; stigma pubescent. Infructescence subglobose, brown, 3 – 4 cm long, 2 – 3 cm wide. Fruits a small, two winged, about 5 mm long and yellow brown.



Figure 3. Leaves and fruit of *Platycarya strobilacea* Siebold & Zucc
(Source: Hoang Van Sam)

b. Ecology and conservation

Platycarya strobilacea only growing as scattered individuals at the Cloudy Silver Peak, two km from Bong Center in Cuc Phuong National Park. This species usually mixes in the evergreen forest on limestone mountain, elevation 600 m a.s.l. Low regeneration and a narrow distribution contributes to the limited number of species. Only 9 mature trees and 5 seedlings have been recorded in the area. This

species is not listed on the IUCN Red List (2020) and Vietnam Red Data Book (2007). However, this species is rare in the Park, with low natural regeneration. Therefore we propose this species as vulnerable (VU) for both the IUCN Red List and the Red Data Book of Vietnam (Sam et al., 2021).

3.3.4. *Pterocarya tonkinensis* Dode

Vietnamese name: C \acute{o} i, C \acute{o} i bắc bộ.

a. Morphology

Pterocarya tonkinensis are up to 25 m tall with a trunk up to 50 cm in diameter. The bark is grey-brown or dark gray and flaky. Twigs brown or yellowish-brown with yellow scattered hairs. Leaves odd-pinnate compound, alternate. Petioles with yellow scaled hairs, glabrescent. Leaflets 5 – 7, opposite, ovate or lanceolate; apex acuminate or tapering into a sharp point, margin serrulate; terminal leaflets are big, gradually attenuate toward both ends, base cuneate; two basal leaflets are small and asymmetric; midrib tomentose, petiolules very

short. Flowers unisexual. Male inflorescence is a catkinspike, usually having 3 pendulous spikes on terminal leaflets branches; male flowers with pedicels 5 mm long, perianth with 2 – 3 in regular lobes. Stamens 5 – 6, filaments short. Female inflorescence short, few-flowered. Female flowers perianth cup-shaped with 4 irregular dents, tomentose outside, ovary inferior without style, stigmata 2. Fruits a compressed globose drupe, 2.8 cm in diameter with 4 grooves later dehiscing into 4 valves.



Figure 4. Fruit, leaves and tree of *Pterocarya tonkinensis* Dode
(Source: Hoang Van Sam)

b. Ecology and conservation

Pterocarya tonkinensis is naturally distributed in terrain area which is surrounded by agricultural land (Cui Tren - Hoa Binh province), and wet areas along mountain streams (Buoi River) where there is elevation from 200 – 400 m asl. This species mixes with *Anogeissus acuminata*, *Sambucus hookeri*, *ficus sp* in Cuc Phuong National Park. The population of this species is negative impacted by human activities. A total of 16 mature trees and 31 seedlings have been recorded in the area. This species is listed in the IUCN Red List as Vulnerable (VU). Flowering from March to May and fruiting from May to June.

4. CONCLUSION

A total of four Juglandaceae species were recorded in Cuc Phuong National Park, belonging to four genera, including *Alfaroa roxburghiana* (Lindl. ex Wall.) Iljinsk, *Carya*

sinensis Dode & Zucc, *Platycarya strobilacea* Siebold and *Pterocarya tonkinensis* Dode. The number of Walnut species in Cuc Phuong national park account for 36% of the total number of Walnut species and 57% of the general species in Vietnam. Most species are distributed between 100 – 600 m above sea level in the study site. Juglandaceae species in Cuc Phuong is not only of high diversity but also of high conservation value with three species on the IUCN Red List (2020) and one species in the Viet Nam Red Data Book (2007). This research also provides information of morphological and ecological characteristics of four walnut species in the study site.

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REFERENCE

1. Ban, N.T. (editor) (1996). Red data book of Vietnam. Vol. 2. Plants. Science & Technics Publishing House, Hanoi, Vietnam.
2. Chan, L.M. & L.T. Huyen (2000). Forest plants of Vietnam. Agriculture Publishing house. Hanoi, Vietnam.
3. Chien, P.D. (2008). Demography of threatened tree species in Vietnam. PhD thesis in Utrecht University.
4. Dung, V.V. (editor) (1996). Vietnam Forest Trees. Agriculture Publishing house. Hanoi, Vietnam.
5. Sam, H.V., Tung D.Q., Anna K. Jasińska, François Rion, Tuyen P.T., Ngoc D.T.B., Tam D.T., Sébastien Bétrisey, Yi-Gang Song, Gregor Kozłowski (2021). Diversity, distribution, and threats of the Juglandaceae in Vietnam. Dendrobiology, vol. 86, 39-55. DOI: 10.12657/denbio.086.005.
6. Ho, P.H. Flore du Laos, du Cambodge et du Vietnam (1992). Vol. 26. Muséum National d'Histoire Naturelle, Laboratoire de Phanérogamie, Paris, France.
7. Ho, P.H. (2003). Flora of Vietnam, Vol. 2. Youth Publishing house. Ho Chi Minh, Vietnam.
8. Kozłowski, G., Betrisey S, Song Y-G, Víquez Alvarado E (2018). Wingnuts (Pterocarya) & walnut family : relict trees : linking the past, present and future. Fribourg : Natural History Museum.
9. Iljinskaya, I. A. (1993). "Alfaropsis, a new genus of the Juglandaceae", Bot. Zhurm. 78 (10) 79-83.
10. Lu Anmin, Donald E. Stone, L. J. Grauke (1999). Juglandaceae - Flora of China. Volumn 4. (E-flora).
11. IUCN. (2020). <https://www.iucnredlist.org/>
12. Manos PS, Soltis PS, Soltis DE, Manchester SR, Oh S-H, Bell CD, Dilcher DL & Stone DE (2007). Phylogeny of extant and fossil Juglandaceae inferred from the integration of molecular and morphological data sets. Systematic Biology 56: 412-430.
13. Manos PS & Stone DE (2001). Evolution, phylogeny, and systematics of the Juglandaceae. Annals of the Missouri Botanical Garden 88: 231-269.
14. Mostajeran, H. Yousefzadeh, N. Davitashvili, G. Kozłowski (2017). Phylogenetic relationships of Pterocarya (Juglandaceae) with an emphasis on the taxonomic status of Iranian populations using ITS and trnH-psbA sequence data. Plant biosystems. 151. 1012-1021.
15. Simpson M (2010). Plant Systematics 2nd Edition, Academic Press, San Diego State University, California, USA, p.752. ISBN: 9780123743800.
16. Song, Y-G, Łukas W., Marta K., Hoang V. S., Hamed Y., Tolga, O., Vahid, F., Grzegorz W., Elżbieta W., Renata S., Kozłowski, Adam B. G., Krystyna, B., Anna K. J. (2020). Global biogeographic synthesis and priority conservation regions of the relict tree family Juglandaceae Journal of Biogeography 47:643-657.
17. Thu, N.B. (1995). Plant diversity of Cuc Phuong National Park. PhD thesis at Vietnam National University of Forestry.

ĐA DẠNG THÀNH PHẦN LOÀI THUỘC HỌ HỒ ĐÀO (JUGLANDACEAE) TẠI VƯỜN QUỐC GIA CÚC PHƯƠNG

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TÓM TẮT

Bài báo là kết quả nghiên cứu về đa dạng thành phần loài và hiện trạng bảo tồn thực vật thuộc họ Hồ đào (Juglandaceae) tại vườn quốc gia Cúc Phương. Tổng số loài thuộc họ Hồ Đào được ghi nhận là bốn loài, thuộc bốn chi bao gồm: Chẹo - *Alfaroa roxburghiana* (Lindl. ex Wall.) Iljinsk; Chò đái - *Carya sinensis* Dode & Zucc; Hóa hương - *Platycarya strobilacea* Siebold Cơi bắc bộ - *Pteracarya tonkinensis* Dode. Số loài ghi nhận chiếm 36% tổng số loài và 57% tổng số chi họ Hồ đào tại Việt Nam. Tại Cúc Phương, các loài được phân bố chủ yếu ở đai cao 100 m – 600 m so với mực nước biển. Các loài thuộc họ Hồ đào tại vườn quốc gia Cúc Phương có giá trị bảo tồn cao với ba loài được ghi nhận trong danh lục đỏ thế giới IUCN năm 2020 và một loài trong sách đỏ Việt Nam năm 2007. Loài *Platycarya strobilacea* Siebold chưa được ghi nhận trong danh lục đỏ IUCN và sách đỏ Việt Nam nhưng cũng hiếm gặp và có phân bố hẹp nên cũng được đề xuất cần quan tâm bảo tồn. Bài báo cung cấp thông tin về đặc điểm hình thái và sinh thái của bốn loài được ghi nhận tại khu vực nghiên cứu.

Từ khóa: bảo tồn, đa dạng, họ Hồ đào, Vườn quốc gia Cúc Phương.

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