



Original Article

# Morphological and Anatomical Characteristics of *Taxus chinensis* (Pilg.) Rehder in Thanh Hoa Province, Vietnam

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**Abstract:** The *Taxus chinensis* (Pilg.) Rehder belongs to the Taxaceae family, conifer plants, and is a rare and precious species of Vietnam, which was recognized for its use value. Most of them are distributed in the high mountains of Vietnam. The resource values of this species were found as medicine, precious wood, and ornamental. So, looking back to the long history of use and overall research on the *Taxus* L. genus species, the up-to-date reporting on *Taxus chinensis* is relatively much less extensive. These studies aim to understand *Taxus chinensis* species' anatomical delimitation with morphological characteristics. *Taxus chinensis* has dominant characteristics with winter bud scales, gather into a cone shape, early deciduous; leaves linear, thick textured; pale to white at abaxially because of the thick stomata bands.

**Keywords:** Anatomy, Morphology, *Taxus chinensis*, Thanh Hoa.

## 1. Introduction

The *Taxus chinensis* (Pilg.) Rehder, or another name, is the Northern Red Pine. The Chinese Yew is from the Taxaceae family and is known by the synonym *Taxus baccata* subsp. *cuspidata* (Siebold and Zuccarini) Pilg. var. *chinensis* Pilg. in Engler; *T. baccata* var. *sinensis*, A. Henry; *T. cuspidata* Siebold and Zuccarini

var. *chinensis* (Pilg.) C. K. Schneider, which was distributed in the China and Vietnam [1]. In Vietnam, *Taxus chinensis* was found in Lao Cai, Ha Giang, Son La, Tuyen Quang, Cao Bang, Hoa Binh, Thanh Hoa and Nghe An provinces [2-4]. Most were distributed in limestone areas with 900-1500 m altitude. *Taxus chinensis* is recognized for its ability to give wood with the red color and unique wood grain. It can withstand water immersion, so it is used to make high-class furniture. The tree can also be used as an ornamental or bonsai. The seeds, leaves, and bark are used as medicine [2, 3, 5]. Especially recently, this species has

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been shown to prevent proliferation and metastasis in lung carcinoma [6, 7]. The *Taxus chinensis* species is a rare and precious gymnosperm species with small populations worldwide. Currently, populations with mature individuals are declining, so it has been included in the endangered species list. The world's extinction threat at the level of classification EN (IUCN, 2022-2) [8]. At the national assessment level, *Taxus chinensis* was listed as VU - Vulnerable in the Red Data Book of Vietnam 2007 [9]. In Vietnam, some studies on *Taxus chinensis* have been reported focusing on morphological characteristics, phylogenetic analysis and phytochemistry activity [2, 3, 10-12], and works on detailed morphological and anatomical features are almost absent. In this article, we presented the morphological and anatomical study to serve the conservation and development of *T. chinensis*, as well as related studies.

## 2. Material and Methods

### 2.1. Material

Includes individuals of the species *Taxus chinensis* (Pilg.) Rehder in Vietnam. The fresh samples were collected in Thanh Hoa province (No. KHTV 01, altitude: 890 m; Coordinates: 20 30'44.9"N and 105 03'12.2"E; Location: Muong Mu peak, in sub-zone 56, Tan Phuc village, Phu Le commune, Quan Hoa district, which is belonging to the Pu Luong Nature Reserve, Thanh Hoa).

In addition, the taxonomy research is also compared with samples that have been kept at the herbarium such as the herbarium of the VNU University of Science (HNU); Institute of Ecology and Biological Resources (HN), Academy of Science and Technology; Institute of Medicinal Materials (HMPM), Ministry of Health. The specimens are currently kept in the herbarium in Ha Giang province (D. K. Harder et al., DKH 4979, HN, HNU); Hoa Binh province (N.T. Hiep et al., HAL 626, HN, HNU); Thanh Hoa province (Averyanov et al., HAL 3284 (HNU).

### 2.2. Research Method

The comparative morphological method is based on the structural characteristics of the plant's organs to identify species [13]. Most importantly, the reproductive organs because their characteristics are closely related to the genetic code and less changed by the influence of the environment.

Using the anatomical research method is a double-staining method to study stems and leaves structure, according to [14, 15]. Taxonomy and anatomy were carried out at the Department of Plant Science, VNU University of Sciences.

## 3. Results and Discussion

### 3.1. Morphological Characteristics of *Taxus Chinensis* (Pilg.) Rehder

*Life form:* Timber tree, up to 20 m high, with a dbh to 20 - 30 cm. Bark grayish brownish or purplish, cracking and falling off as thin scales; young branches often have intense longitudinal grooves, glabrous; winter bud scales early deciduous, corn shape (Figure 1a, b, c, d). The leaves at 50-70° to branch axis, close together, sessile or with petioles 1 mm long. Leaves linear, near straight to slightly crescent-shaped, falcate, usually 1.6-2.5 cm × 2-4 mm, thick blade, textured, midvein protrudes and the same color as stomatal band, densely and evenly papillate, stomatal bands for 1 mm from the leaf margin, lateral vein unknown; leaf apex acuminate, with short acute as thorns; base acute or cuneate; margin flat in living state, entire; blade dark green with many prominent dots of essential oil at adaxially, paler to white at abaxially (Figure 1e, f). Pollen cones scattered on the branchlet axis, shortly pedunculate about 0.2-0.5 mm long; ovoid, 6-7 mm long; light whitish green. The seed is at the end of the branchlet axis, 9-10 mm long, when maturity arillate coats up to orange and then red. Seeds drupe-like, flattened ovoid or flattened obovoid, Seeds yellow-brown, the apex with a short acuminate. Cones are ripe, usually in autumn and winter.



Figure 1. Branches and leaves of *Taxus chinensis* (Pilg.) Rehder: a. Branches with leaf; b. Winter bud scales; c. Bark; d. young branch; e. Leaves (adaxially); f. Leaves (abaxially).

In Vietnam, the *Taxus* genus has two species: *Taxus chinensis* and *T. wallichiana*. In some documents, these are considered two separate species, *T. chinensis* and *T. wallichiana* [7, 10]. *Taxus wallichiana* from the Da Lat plateau and *T. chinensis* from the karst limestone areas in northern and north-western as Son La (in areas that have not been designated as a protected area: Muong Lum, Yen Chau), Ha Giang (Bat Dai Son Nature Reserve (NR); Thai Phin Tung, Dong Van), Tuyen Quang (Cham Chu NR, Na Hang NR), Cao Bang (Xuan Truong, Bao Lac), Bac Kan

(Nam Xuan Lac species and habitat protected area), Hoa Binh (Hang Kia-Pa Co NR), Lao Cai (Hoang Lien national park) and Thanh Hoa province (Pu Luong NR; Nam Dong species and habitat protected area), Nghe An (Pu Mat National Park; Pu Huong NR) [2, 3, 11, 16]. *Taxus chinensis* has linear leaves, thick textured, and *T. wallichiana* has leaves linear to lanceolata, thin and soft.

*Taxus chinensis* is scattered in primary closed evergreen tropical coniferous submontane forests on the top ridges of high limestone mountains and steep slopes. In the

forests, frequently on the top the the mountain, 890-1700 m (mainly 900-1200 in Pu Luong NR, especially 1200-1300 in Dong Van, Ha Giang) [16]. The populations of *Taxus chinensis* are much smaller in size, and many have been logged. So, this species was listed as VU - Vulnerable in the Red data Book of Vietnam 2007 [9]. Currently, the population of Northern Red Pine with the largest diameter tree has been recorded in Hoang Lien National Park with a dbh of 45-50 cm. While the diameter of individuals seen in Pu Luong NR is only 20-30 cm in diameter. The group of individuals with a diameter of 20-30 cm is dominant in Pu Luong, similar to the group of individuals with this diameter in Muong La (Son La) (21-40 cm) [17]. Leaves in the Pu Luong population (1.6-2.5 cm) had less

variation in length than in Dong Van (1.2-2.7 cm) [16].

### 3.2. Anatomical Characteristics of *Taxus Chinensis* (Pilg.) Rehder

Samples obtained on different individuals were anatomized. It can be seen that the samples have the homogeneity of the microscopic structure of the stem (primary structure, secondary structure) leaves. There were no significant differences between different individuals in the population.

*Stem:* The cross-section of the primary stem is round, with intense longitudinal grooves edge. The epidermis is covered by a thin layer of cuticle (Figure 2a, b). The epidermis includes uniseriate small round cells arranged regularly single layer (Figure 2a).

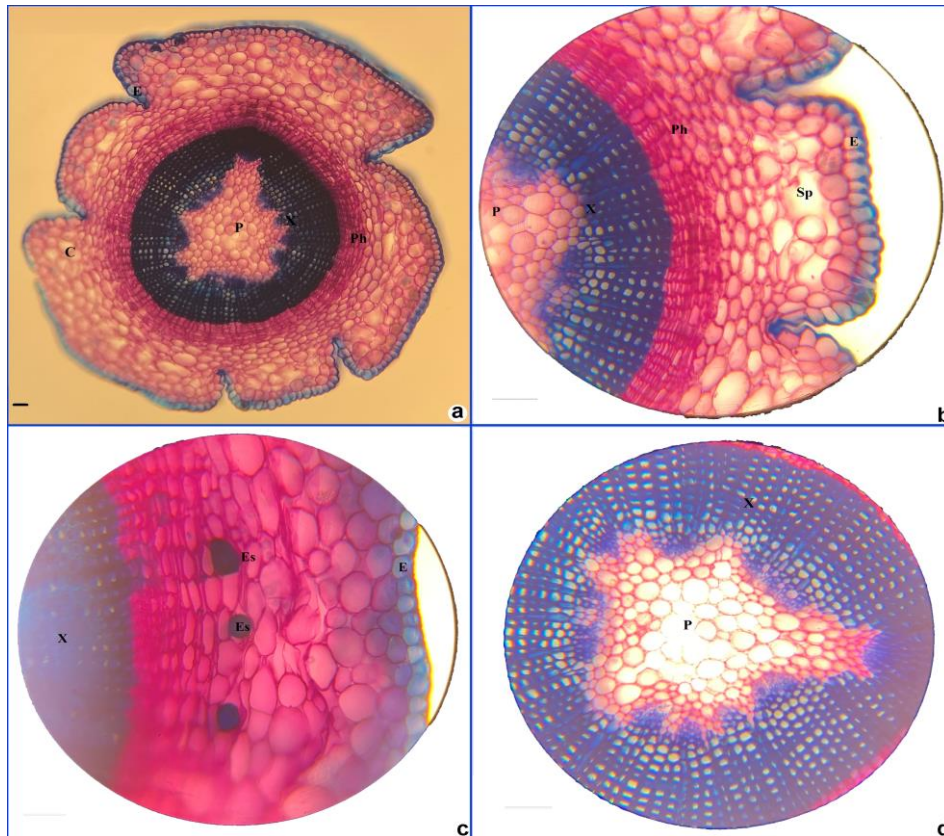


Figure 2. The transverse section of the stem of *Taxus chinensis* (Pilg.) Rehder.  
E: epidermis; C: collenchyma; P: parenchyma; Ph: phloem; Sp: empty space containing air;  
X: xylem; Es: essential oil. Bar = 100  $\mu$ m.

Collenchyma cells concentrate in the round under the epidermis, contribute to the rigidity of the stem, and have relatively large intercellular space in empty space containing air, sometimes there are cells that carry essential oils (Figure 2c). Vascular bundles are round. The parenchyma in the center consists of big polygonal cells (Figure 2d). In the secondary stem, longitudinal grooves gradually shallower, with the xylem arranged around the stem; the phloem consists of many layers of small rectangular cells arranged closely together. That allows the plant to adapt to harsh environments on high mountains (Figure 2b).

- *Leaf blade:* The leaf surface is covered by a thick cuticle, restricting the evaporation to adapt to extensive insolation (Figure 3). Therefore, this plant often lives on the top of the mountain. The upper epidermis consists of large round cells arranged regularly. The Mesophyll region comprises only one layer of elongated rectangular palisade cells and 3-4 layers of irregular large spongy mesophyll cells with large intercellular space into empty space containing air, reducing the heat in the leaves. That indicates the plant is in a sunny environment on a high mountain (Figure 3b, c).

The lower epidermis consists of large round cells nearly the same upper epidermis. The stomata are round or near the pea, densely and evenly distributed on the underside of the leaf. The stomata bands are as thick as the epidermis and palisade mesophyll; these stomata are sunken into the leaf surface. Essential oils in the spongy mesophyll region (Figure 3b, d).

i) *Leaf vein:* The leaf vein is convex in the underside and straight in the upper side. Below the epidermis in the underside are 1-2 layers of collenchyma, contributing to rigidity. An open vascular bundle in the center of the vein plays the role of transportation. Below the epidermis on the upper side is palisade mesophyll, which helps plant leaves photosynthesize (Figure 3d);

ii) *Taxus chinensis* have anatomical characteristics that allow them to adapt to a habitat with intensive insolation. A thick cuticle in the leaf that prevents evaporation of water from the epidermal surface under the sunlight. The thick stomata bands help control evapotranspiration. In addition, a relatively developed intercellular space system allows them to grow in a habitat with abundant light conditions.

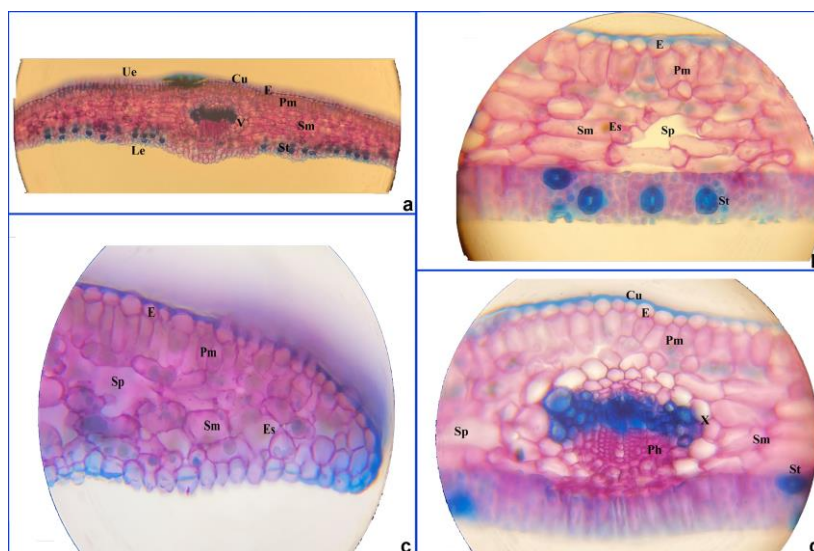


Figure 3. The transverse section of the leaf of *Taxus chinensis* (Pilg.) Rehder.

E: epidermis; Le: lower epidermis; Ue: Upper epidermis; Ph: phloem; Pm: palisade mesophyll; Cu: cuticle; Sm: spongy mesophyll; V: Vascular bundle; X: xylem; Es: essential oil; St: stomata.

#### 4. Conclusion

*Taxus chinensis* has dominant characteristics by morphological features with winter bud scales, gather into a cone shape, early deciduous; leaves linear, thick textured; pale to white at abaxially because of the thick stomata bands.

The cross-section of the stem is round, with deep longitudinal grooves. The stomata are round or near the pea, densely and evenly distributed on the underside of the leaf. The stomata bands are as thick as the epidermis and palisade mesophyll. Essential oils and large intercellular space into space containing air in the spongy mesophyll region and collenchyma layers of the stem. *Taxus chinensis* adapts to a habitat with abundant light conditions, and harsh environment. Therefore, this species often lives on the top of the mountain.

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