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. The most of them are distributed in the high mountains of Vietnam. The resource values of this species were found as the medicine, precious wood and an ornamental. So, looking back to the long history of use as well as overall research on species of the *Taxus* L. genus, the up-to-date reporting on *Taxus chinensis* is relatively much less extensive. These studies aims to understand the anatomical delimitation of *Taxus chinensis* species with the morphological characteristics. *Taxus chinensis* has dominant characteristic 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 from the Taxaceae family and is also known by the synonyms as *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 of them were distributed in limestone areas with 900-1500 m altitude. *Taxus chinensis* recognized for its ability to give wood with the red color and unique wood grain, it can withstand water immersion, so it 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
been shown to prevent proliferation and metastasis in lung carcinoma [6, 7]. The *Taxus chinensis* species is considered a rare and precious gymnosperm species with small populations in the world. Currently populations with mature individuals are still on the decline, so it has been included in the list of endangered species. 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 Red Data Book of Vietnam 2007 [9]. In Vietnam, there have been some studies on *Taxus chinensis* which has been reported focusing on morphological characteristics, phylogenetic analysis and phytochemistry activity [2, 3, 10-12], that 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, Quan Hoa commune, Thanh Hoa district which are belonging to the Pu Luong Nature Reserve, Thanh Hoa).

In addition, the taxonomy research is also compared with samples which have been keeping 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 currently kept in the herbarium as 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 using comparative morphological method are based on structural characteristics of the plant’s organs to identify species [13]. The most importantly the reproductive organs because its characteristics are closely related to the genetic code and less changed by the influence of the environment.

Using anatomical research method, double-staining method to study stems and leaves structure, according to [14, 15]. Taxonomy and anatomy works 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 very deep 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 far 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 branchlet axis, shortly pedunculate about 0.2-0.5 mm long; ovoid, 6-7 mm long; light whitist green. The seed is at end of branchlet axis, 9-10 mm long, when maturity arillate coat up to orange and then red. Seeds drupe-like, flattened ovoid or flattened obovoid, Seeds yellow-brown, the apex with a short acuminate. Cones ripe usually in autumn and winter.
In Vietnam, *Taxus* genus has 2 species as *Taxus chinensis* and *T. wallichiana*. In some documents, these are considered two separate species as *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 the leaves linear, thick textured and *T. wallichiana* has leaves linear to lanceolata, thin and soft.
*Taxus chinensis* is recognized scattered in primary closed evergreen tropical seasonal coniferous submontane forests on the top ridges of high limestone mountains and steep slopes. In the forests, frequently on the top the mountain; 890-1700 m (mainly 900-1200 in Pu Luong NR, mainly 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 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 primary stem is round, with very deep longitudinal grooves, edge. Epidermis contains 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.](image)

E: epidermis; C: collenchyma; P: parenchyma; Ph: phloem; Sp: empty space containing air; X: xylem; Es: essential oil. Bar = 100µm.
Collenchyma cells concentrate in round under the epidermis, contribute to the rigidity of stem, has relatively large intercellular space into empty space containing air, sometimes there are cells that carry essential oils (Figure 2c). Vascular bundles are round. Parenchyma in the center consists of big polygonal cells (Figure 2d). In secondary stem longitudinal grooves gradually shallower, with xylem arranged arounds the stem, phloem consists of many layers of small rectangular cells arranged closely together. That allows the plant to adapt to harsh environment on high mountain (Figure 2b).

- Leaf blade: Leaf surface is covered by 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. Mesophyll region is composed of 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, reduce the heat in the leaves. That indicates the plant is in a sunny environment on high mountain (Figure 3b, c).

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 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).

- Leaf vein: Leaf vein is convex in the underside and straight in the upper side. Below epidermis in underside, there are 1-2 layers of collenchyma, contributing the rigidity. There is an open vascular bundle in the center of the vein that plays the role of transportation. Below epidermis in upper-side is palisade mesophyll, which helps plant leaves photosynthesize (Figure 3d).

- Taxus chinensis have anatomical characteristics that allow them to adapt to a habitat with intensive insolation. A thick cuticle in 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 provides them with the ability to grow in habitat with abundance of light condition.

![Image](image-url)
4. Conclusion

*Taxus chinensis* has dominant characteristic 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 th...