

***HYPODEMATIUM ZHANGII* (HYPODEMATIACEAE) – A NEW SPECIES RECORDED FROM CHINA**

XIAOJUAN LI¹, CHAO ZHANG², RUIGUI LIU³, JIANXIU LI⁴ AND JING SHU^{1*}

Shandong Agriculture and Engineering University, Jinan, 250100, China

Keywords: Hypodematium zhangii, H. crenatum, Hispidulous, Spore ornamentation, SEM

Abstract

Hypodematium zhangii J. X. Li & X. J. Li, a new species of *Hypodematium* is recorded from Guangxi Zhuang Autonomous Region, China. It is similar to *H. crenatum* (Forssk.) Kuhn & Decken, but differs greatly from it by its stipe glabrous, rachis and fronds sparsely covered with hispidity adaxially, indusia and fronds densely coated with hispidity abaxially and spores perispore with tuberculate and massive protrusions, surface with scaly ornamentation. The description and photographs of *H. zhangii* as well as their notes are provided.

Introduction

Hypodematium is the only genus of Hypodematiaceae (Kunze 1833, Ching 1975). Iwatsuki (1964) reviewed the genus and recognized four species and one subspecies. China is regarded as the centre of distribution for this genus (Zhang and Iwatsuki 2013). The genus is characterized by a distinctively swollen scaly stipe base and grows only in limestone habitats (Zhang and Iwatsuki 2013). More than 25 species of *Hypodematium* have been described (Tsai and Shieh 1994, Shing *et al.* 1999), including three more recently described species from China and Japan (Li *et al.* 2018, Fan *et al.* 2020, 2021); according to Shing *et al.* (1999), taxa are mainly distributed in subtropical and (sub) temperate areas of Asia and Africa. Previous research on systematics, palynology and biogeography of *Hypodematium* (Ching 1935, 1940, 1963, 1975, 1978a, b, Li *et al.* 1989, Shing *et al.* 1999, Zhou *et al.* 1999, Wang *et al.* 2010, Li *et al.* 2018, Li *et al.* 2022) provided an important background that allowed the recognition of the present new species.

Materials and Methods

The experimental materials were collected in Du'an County, Dongmiao Township, Guangxi Zhuang Autonomous Region and deposited in PE (Herbaria acronyms according to Thiers 2016).

Select well-developed leaves and spores, they were examined under an optical microscope; ten spores were selected from each species and moderate leaves. The polar axis and equatorial axis of spores were measured, their average values were taken respectively, and the spore size was recorded. The hair types of stipes, rachis and costae, both sides of leaves and indusia were observed under anatomic microscope. Select non-polluting spores and leaves and evenly sprinkle them on the double-sided adhesive specimen holder. Each specimen should be sprinkled with only one sample, strictly prevent contamination, serial number record, the specimens were placed on SC7620 gold spray coating for 2 mins, and then observed under SUPRATM55 thermal field emission scanning electron microscopy (SEM). When the voltage is stabilized at 15 KV, the focal length was adjusted, and the leaves and spore polar view and equatorial view were selected

*Author for correspondence: <shujing79@163.com>. ¹College of Forestry Engineering, Shandong Agriculture and Engineering University, Jinan, 250100, China. ²Traditional Chinese Medicine Hospital, Tongliang, Chongqing, 402560, China. ³Yinan Country Market Supervision administration of Shandong Province, Yinan, Shandong, 276300, China. ⁴Shandong University of Traditional Chinese Medicine, Jinan, 250014, China.

respectively. Overall magnification of spores were 1500 times, local magnification 5000 times photograph, chose 3–5 particle on each side, and took 3 photos on each side.

Hypodematium zhangii J. X. Li & X. J. Li, sp. nov.

Diagnosis: *Hypodematium zhangii* is similar to *H. crenatum*, from which it differs by its stipe glabrous, rachis and fronds sparsely covered with hispidity adaxially, indusia and fronds densely covered with hispidity abaxially (Figs 2-3) and spores perispore with tuberculate and massive protrusions, surface with scaly ornamentation (Figs 4A–D).

Type: China, Guangxi Zhuang Autonomous Region: Du'an County, Dongmiao Township, shady slopes, limestone crevice, 23°58'59.31"N, 107°59'34.48"E, 630.0 m a.s.l., 22 May 2004, H. M. Liu 01383347 (Holotype: PE). **(Fig. 1)**



Fig. 1. The typus of new species.

Description: Plant height is 45–52 cm. Rhizomes densely scaly, scales linear-lanceolate, 1.8 cm×1.6 mm, apex acuminate with a few slender teeth. Stipe 25–30 cm× 2 mm; base with scales similar to those of the rhizome, above the base sparsely set with hispidity; lamina ovate–triangular, 20–22×13–15 cm, 3–pinnate to 4–pinnatifid, base broad–cordate, apex acute to acuminate; pinnae 10–12 pairs, basal pinnae opposite, alternate upward, basal pinnae largest, 8–10×5–6 cm; pinnules 6–7 pairs, basiscopic pinnule larger than acroscopic pinnule; ultimate segments ovate–orbicular, 10 × 5–6 mm, apex obtuse, base more or less connate with the rachis. Veins distinct on both surfaces, upper concave and lower convex, lateral veins pinnate, uni- or bifurcate, ultimate lobes with 2–3 pairs of veins. Rachis and fronds coated with hispidity adaxially, costae and fronds densely covered with hispidity abaxially. Sori round, fixed in the middle of the lateral veinlet; indusia densely covered with hispidity. Spores spherical, perispore with tuberculate and massive protrusions, surface with scaly ornamentation. (Figs 4A–D).

Results and Discussion

Hypodematium is a special group of ferns, the leaves of this plant are ovate–oblong to pentagonal, 3–4 pinnatifid or 5-pinnatifid and the final pinnule are oblong, small, and very similar, it brings great difficulty to the classification and identification of this genus. The leaf appendages and their types are the protective organs on the plant body of this genus, and have special significance in the classification and identification of plant species. The hair is divided into two types: one is rod–shaped glandular hairs, which is composed of a round, single celled head containing secretions and a single celled stalk; the other is non–glandular hairs, which is a single cell without secretions. According to the shape of the hair, apex acute, hard and straight, is called acicular hair, and the soft and curved hair is called pubescence. The glandular hairs and non–glandular hairs (acicular hairs and pubescence) usually distributed on stipe, rachis and costae, upper and lower epidermis of leaves and the back of indusia in species. In these parts, there were great differences in hair type, hair length and density. The hair type and density on the same population individual were a very stable important feature, and there were significant differences in different population individuals, which is the consensus of plant researchers of this genus. Therefore, this important feature has become an important basis for the study of the classification and identification of plants of this genus. Such as *H. fordii* and *H. sinense* were only covered with rod–shaped glandular hairs, *H. crenatum* and *H. guilinense* were only covered with non–glandular hairs, the plants were covered with both glandular hairs and non–glandular hairs, such as *H. gracile*, *H. glanduloso–pilosum* and *H. squamuloso–pilosum*. The stipe of *Hypodematium zhangii* was glabrous, rachis and fronds sparsely covered with hispidity adaxially. The costae, indusia and fronds densely covered with hispidity abaxially. Therefore, the two species have different hair types and hair density in the same part, which were very stable in the same population, and significantly different in different populations. This provided an important scientific basis for the classification and identification of *H. zhangii* and its related species, and supported the establishment of new species of *H. zhangii*. A comparison of *H. zhangii* and *H. crenatum* is given in Table 1 and Figs 2–3.

Palynology is an important discipline in the study of seed plant pollen and spore. It is an important part of the plant reproduction organ, and it is the place where the genetic material of the plant is concentrated, and the morphology of the genetic material DNA is concentrated. The morphology of fern spores is of great significance in the study of taxonomy and phylogeny. Before the 1980s, Academician Wang Fuxiong and Professor Zhang Yulong of the Chinese Academy of Sciences had done a lot of research on palynology by means of optical microscopy. Due to the limitation of the optical microscopy, the characteristics of perispore ornamentations cannot play a proper role in the classification and identification of the population. After the 1980s, scanning

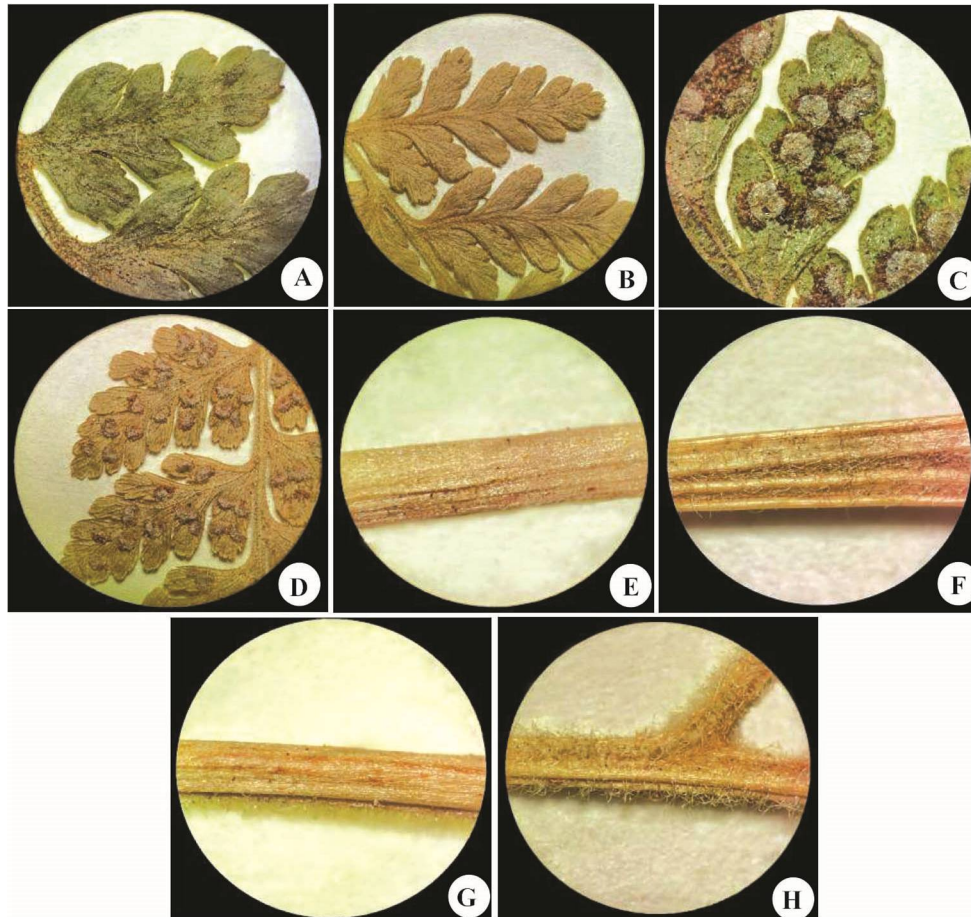


Fig. 2. A. *H. zhangii* fronds sparsely covered with hispidity adaxially B. *H. crenatum* fronds densely covered with pubescence adaxially C. *H. zhangii* fronds densely covered with hispidity abaxially D. *H. crenatum* fronds densely covered with pubescence abaxially E. *H. zhangii* stipe glabrous F. *H. crenatum* stipe densely covered with pubescence G. *H. zhangii* rachis sparsely covered with hispidity H. *H. crenatum* rachis and costae densely coated with pubescence.

Table 1. Morphological comparison of two species.

Species name	Stipe	Rachis	Costae	Lamina shape	Adaxial fronds	Abaxial fronds	Indusia	Ornamentation of perispore SEM
<i>H. zhangii</i>	Glabrous	Sparsely hispidulous	Densely hispidulous	Ovate-triangular	Sparsely hispidulous	Densely hispidulous	Densely hispidulous	Tuberculate and massive protrusions, surface with scaly ornamentation
<i>H. crenatum</i>	Densely pubescent	Densely pubescent	Densely pubescent	Pentagonal	Densely pubescent	Densely pubescent	Densely pubescent	Few, individual folds with venulate subpattern

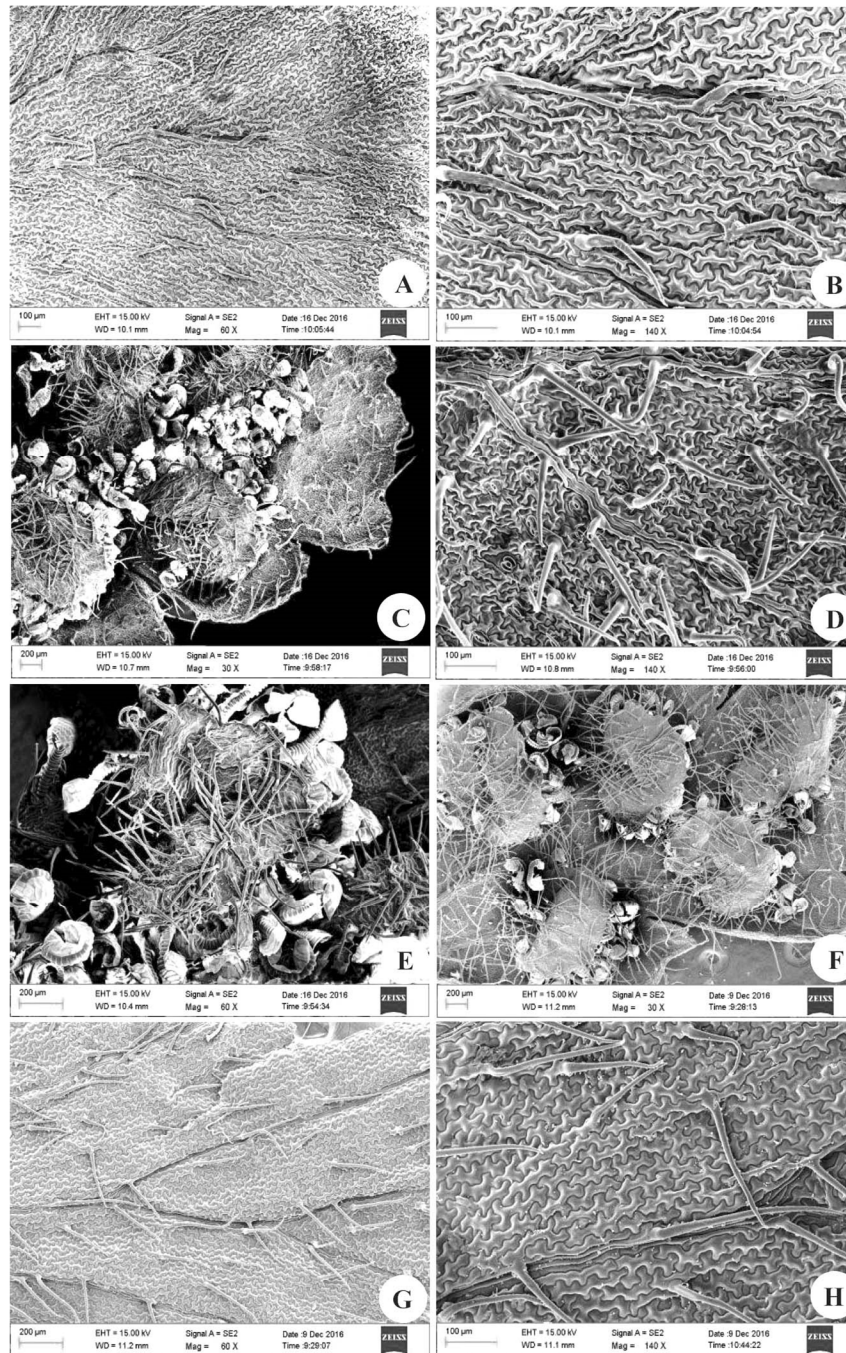


Fig. 3. A-B. *H. zhangii* fronds sparsely covered with hispidity adaxially (60x, 140x) C-D. *H. zhangii* fronds densely covered with hispidity abaxially (30x, 140x) E. *H. zhangii* indusia densely covered with hispidity abaxially (60x) F. *H. crenatum* fronds and indusia densely covered with pubescence abaxially (30x) G-H. *H. crenatum* fronds densely covered with pubescence adaxially (60x, 140x).

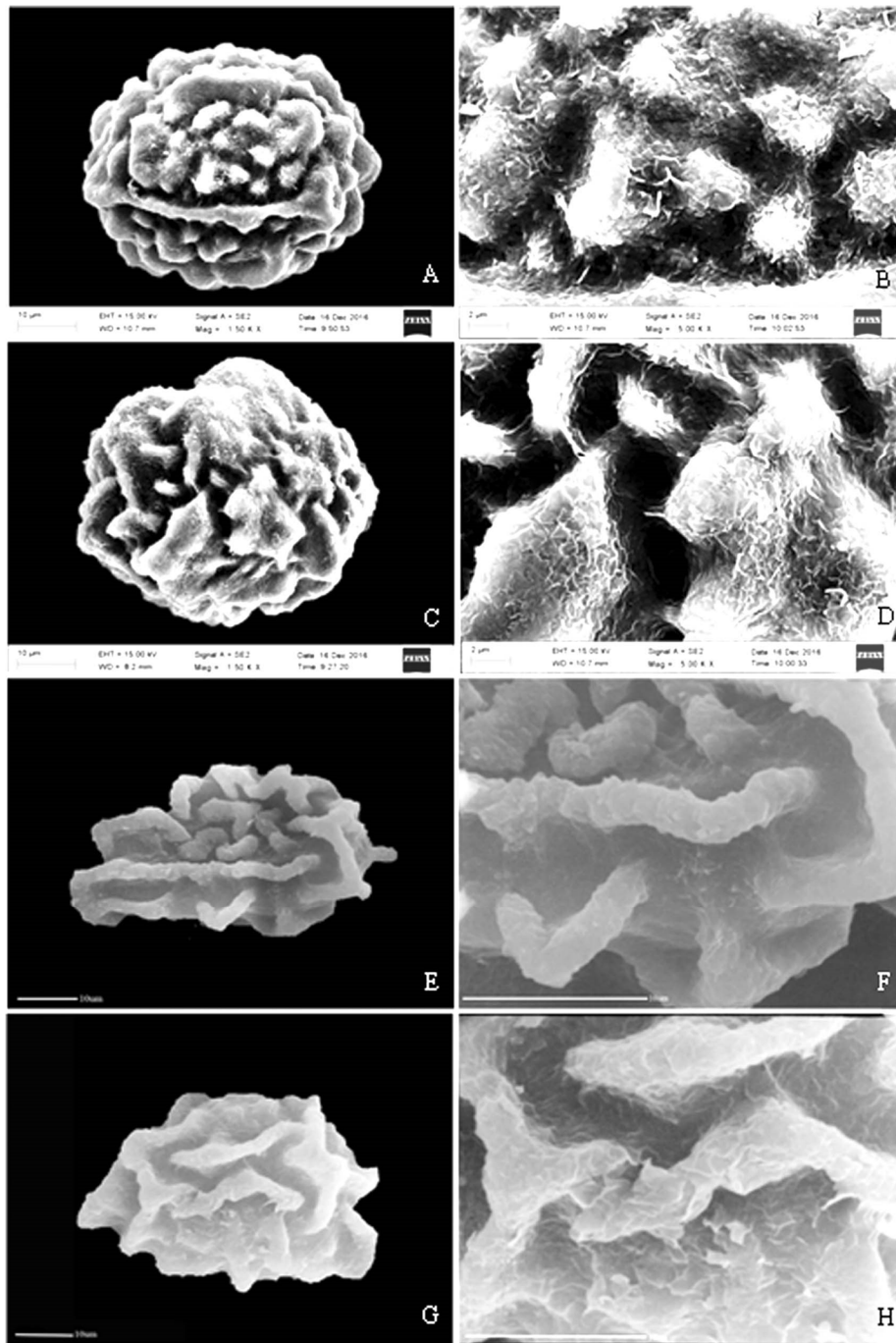


Fig. 4. A-B. Spore in polar view of *H. zhangii* (1500x, 5000x) C-D. Spore in equatorial view of *H. zhangii* (1500x, 5000x) E-F. Spore in polar view of *H. crenatum* (1500x, 5000x) G-H. Spore in equatorial view of *H. crenatum* (1500x, 5000x).

electron microscopy was introduced into China and applied in palynology, Professor Li *et al.* (1989) used scanning electron microscopy for the first time to study the submicroscopic structure of spores of 12 species of *Hypodematium*, gave full play to the advantages of high magnification, high resolution and high reliability of scanning electron microscopy, which can give people a clear effect, it provided the scientific basis of palynology for the classification and identification of *Hypodematium*. The subsequent studies on palynology of ferns genera caused some domestic scholars to participate. The study of palynology has developed from the stage of optical microscopy to a new stage and a new level of scanning electron microscope sub-microstructure. After many scholars and years of ferns palynology research data, it has been proved that the characteristics of perispore ornamentations were not affected by any external factors, were very stable within the species, and there were significant differences between species, which can be used as an important basis for species classification and identification, and have been highly recognized by scholars at home and abroad. In the classification and identification of new species of ferns, many scholars have used the scanning electron microscopy (SEM) features of perispore ornamentations as an important scientific basis for the establishment of new species. The spores perispore of *H. zhangii* with tuberculate and massive protrusions, surface with scaly ornamentation. However, the spores perispore of *H. crenatum* are individual and isolated ridges with a venulate subpattern, which were two completely different types of ornamentation. It provided the scientific basis of palynology for the establishment of a new species of *Hypodematium zhangii* (Fig. 4).

Acknowledgment

This work was supported by the introduction, screening and intensive breeding of *Ziziphus jujuba* varieties (GG202402).

References

- Ching RC 1935. On the genus *Hypodematium* Kunze. *Sunyatsenia* **3**(1): 3-15. [pl. 2]
- Ching RC 1940. On natural classification of the family Polypodiaceae. *Sunyatsenia* **5**(4): 201-268.
- Ching RC 1963. A reclassification of the family Thelypteridaceae from the mainland of Asia. *Acta Phytotaxon. Sin.* **8**(4): 289-335.
- Ching RC 1975. Two new fern families. *Acta Phytotaxon. Sin.* **13**(1): 96-98.
- Ching RC 1978a. The Chinese fern families and genera: systematic arrangement and historical origin. *Acta Phytotaxon. Sin.* **16**(3): 1-19.
- Ching RC 1978b. The Chinese fern families and genera: systematic arrangement and historical origin (Cont.). *Acta Phytotaxon. Sin.* **16**(4): 16-37.
- Fan XP, Gao XF and Zhang LB 2020. Taxonomy of the fern genus *Hypodematium* (Pteridophyta: Hypodemiaceae) from Japan. *Phytotaxa* **455**(2): 161-166.
- Fan XP, Zhang L, Ralf K, He H, Gao XF and Zhang LB 2021. *Hypodematium shingii* sp. nov. (Hypodemiaceae; Polypodiales): Replacing the misapplied "*H. crenatum*", a widespread fern from Asia. *Phytotaxa* **482**(1): 87-92.
- Iwatsuki K 1964. On *Hypodematium* Kunze. *Acta Phytotaxon. Geobot.* **21**: 43-54.
- Kunze, G. 1833. *Hypodematium*, eine neue Farngattung. *Flora* **16**: 689-691.
- Li JX, Li XJ and Liu Q 2022. Atlas of Pteridophytes Resource in Shandong Province. China Medical Science Press, Beijing, pp. 190-213.
- Li JX, Zhou FQ and ZhangYL 1989. Studies on the spore morphology of *Hypodematium* in China. Proceedings of the international symposium on systematic pteridology. China Science and Technology Press, Beijing.

- Li XJ, Li JX and Meng FY 2018. A new species of *Hypodematium* (Hypodematiaceae) from China. *Phytokeys* **92**: 37-44.
- Shing KS, Chiu PS, and Yao GH 1999. Hypodematiaceae. In: Shing KS (Ed.) *Flora Reipublicae Popularis Sinicae*, volume **4**(1). Science Press, pp. 151-191.
- Thiers B 2016. *Index Herbariorum*: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium.
- Tsai JL and Shieh WC 1994. Aspidiaceae. In: Huang, T.C. (ed.) *Flora of Taiwan*, Second Edition. Vol. **1**. Editorial Committee of the Flora of Taiwan, Taipei, pp. 290.
- Wang FG, Liu DM and Xing FW 2010. Two new species of *Hypodematium* (Hypodematiaceae) from limestone areas in Guangdong, China. *Bot. Stud.* **51**(1): 99-106.
- Zhang GM and Iwatsuki K 2013. *Hypodematium* Kunze. *Flora of China*, Vol. **2-3**. Science Press, Beijing & Missouri Botanical Garden Press, St. Louis, pp. 535-539.
- Zhou FQ, Gao CF, Zhang ZR and Li JX 1999. Studies on the morphology and anatomy of Hypodematiaceae from Shandong and its taxonomic significance. In: Shing K-H (Ed.) *Ching Memorial Volume*. China Forestry Publishing House, pp. 357-369.

(Manuscript received on 26 April, 2024; revised on 26 September, 2024)