

假瘤蕨属(水龙骨科)植物叶片 附属结构的生态意义

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摘要: 电镜下观察并研究了假瘤蕨属植物的叶片附属结构。报道了蜡质颗粒、片层、柔毛和鳞片。叶片附属结构在数量及性质上的差别显示出种类与环境的适应性不同。结果表明, 假瘤蕨属植物中土生的种类具有较多的蜡质颗粒、柔毛及鳞片, 而附生的种类具有较多的颗粒及片层, 这些叶片特征均与亚热带常绿阔叶林的生态环境相适应。

关键词: 叶片附属结构; 生态适应性; 假瘤蕨属

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Ecological significance of leaf appendage in the fern genus *Phymatopteris* Pichi-Serm. (Polypodiaceae)

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Abstract: Detailed morphological study of the leaf appenages of the fern genus *Phymatopteris* in China under SEM is presented. The study reveals the wax granules, stripes, apophysis and hairs. Leaf appendages are constant in some species and variable in others in the aspects of quantities and characteristics and thus of great significance in understanding the relationships between the species and the ecological environments adaptable. The results support that there are more wax granules, hairs and scales on the terrestrial species, and more granules and stripes on the epiphytic ones of this genus. All the frond appendage characters reveal an adaptation to ecological conditions of the fern genus *Phymatopteris* to the subtropical evergreen broad-leaf forest.

Key words: leaf appenages; ecological adaptable; *Phymatopteris*

Phymatopteris Pichi-Serm. (Polypodiaceae) is characterized by simple, trifid, palmatifid, pinnatifid leaves of usually chartaceous texture, superficial or slightly immersed large sori. This genus is of considerable size, more than 60 species, the majority of which are from the mainland of Asia, terrestrial, lithophytic or epiphytic in evergreen broad-leaved forest (Ching, 1964). *Phymatopteris* (Pichi, 1973) is a natural group,

which has been confused with *Microsorium*, *Crypsinus* and *Selliguea* by Copeland (1947), Holttum (1954) and Hovenkamp (1998), but there are several characteristics (Table 1) that can be used to distinguish these four genera (Shao & Lu, 2009).

From Table 1, we can distinguish these four genera by several characteristics. However, some taxonomic revisions in the infrageneric range and basic experi-

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Table 1 Comparison among *Crypsinus*, *Phymatopteris*, *Selliguea* and *Microsorium*

	<i>Microsorium</i>	<i>Crypsinus</i>	<i>Selliguea</i>	<i>Phymatopteris</i>
Rhizome	carnose	woody	woody	woody
Scale	clathrate	non-clathrate	non-clathrate	non-clathrate
Lamina shape	monomorphic	dimorphic or subdimorphic	monomorphic or subdimorphic	monomorphic or dimorphic
Lamina texture	chartaceous or coriaceous	rigidly coriaceous	coriaceous	chartaceous
Venation	goniophlebioid	goniophlebioid	goniophlebioid	drynarioid
Sori shape and Distribution	round, separated on either side of the midrib	round or elliptic, immersed, two lines	linear, superficial, one line between two lateral veins	round, superficial or slightly immersed, two lines
Basic Number	x=36,37	x=33	x=37	x=36

ments need to be done.

Leaf appendage such as depositions of wax granules, hairs, stripes and scales are of potential ecological significance, which provides an important source of environmental adaptability. No research about this genus, describing the characteristics of leaf appendages, has been reported. The purpose of this paper is to provide a detailed study under SEM, and that might assist in understanding of the ecological adaptation of the fern genus *Phymatopteris* to the evergreen broad-leaved forest.

1 Materials and methods

Total of 20 taxa of *Phymatopteris* were gathered from the specimens of PYU (in Addendix), materials for SEM observation were directly affixed on stubs by double-sided adhesive tape without any treatment. After gold sputtering by IB-5 particle spraying apparatus, the specimens were examined and photographed under AMARY-1000B SEM.

2 Results

The characteristics of leaf epidermal appendages are listed in Tables 2. It appears that epidermal appendage features are constant within species and thus may be used in analysis and discussion.

Granules, stripes and apophyses, hairs and scales are presented in the leaf epidermis under SEM observation.

Granules. Lots small granules ($d \approx 2 \mu\text{m}$) are scattered on both sides of epidermis of *Phymatopteris chrysotricha* (Fig. 1:1), *P. tenuipes* (Fig. 1:2) and *P. hastata* (Fig. 1:3). Granules ($d \approx 20 \mu\text{m}$) are evident on

both sides of the leaf epidermis of *P. dactylina* (Fig. 1:4); on the abaxial epidermis of *P. ebenipes* (Fig. 1:5) and *P. subebenipes* (Fig. 1:6).

Table 2 Leaf epidermal characters of *Phymatopteris* under SEM

Taxa	Cuticular layer	Fig.
<i>Phymatopteris chrysotricha</i>	many granules (Ad & Ab), few apophysis (Ab)	1
<i>P. tenuipes</i>	many apophysis and granules (Ad & Ab)	2
<i>P. hastata</i>	many granules (Ad & Ab), few apophysis (Ab)	3
<i>P. dactylina</i>	many granules (Ad & Ab), few apophysis (Ad)	4
<i>P. ebenipes</i>	many stripes (Ad), many granules (Ab)	5
<i>P. subebenipes</i>	few stripes (Ad), many granules (Ab)	6
<i>P. engleri</i>	few stripes (Ad), few apophysis (Ab)	7
<i>P. yakushimensis</i>	many stripes (Ad & Ab)	8
<i>P. majoensis</i>	apophysis and granules, many in Ab; few in Ad	9
<i>P. omeiensis</i>	few rounded apophysis (Ada & Aba)	10
<i>P. trisecta</i>	many stripes and long hairs (Ad & Ab)	11
<i>P. oxyloba</i>	many stripes (Ad & Ab)	12
<i>P. pianmaensis</i>	few stripes and many hairs (Ad & Ab)	13
<i>P. dawuishanensis</i>	few stripes (Ad & Ab)	14
<i>P. nigrovenia</i>	few stripes and many hairs (Ad & Ab)	15
<i>P. shensiensis</i>	few stripes (Ad & Ab)	16
<i>P. stracheyi</i>	few stripes (Ad & Ab)	17
<i>P. conmixta</i>	few stripes and long hairs (Ad & Ab)	18
<i>P. glaucopsis</i>	few stripes (Ad & Ab)	19
<i>P. stewartii</i>	few stripes (Ad), many apophysis (Ab)	20

Ad=adaxial epidermis; Ab=abaxial epidermis

Stripes and apophyses. Stripes and apophysis are presented in most species of this genus. Many stripes are found in *Phymatopteris engleri* (Fig. 1:7) and *P. oxyloba* (Fig. 1:12). Few stripes are presented in *P. yakushimensis* (Fig. 1:8), *P. dawuishanensis* (Fig. 1:14), *P. shensiensis* (Fig. 1:16), *P. stracheyi* (Fig. 1:17) and *P. glaucopsis* (Fig. 1:19). Few apophyses are found in *P. majoensis* (Fig. 1:9) and *P. stewartii* (Fig. 1:20). Rounded apophyses occur in *Phymatopteris*

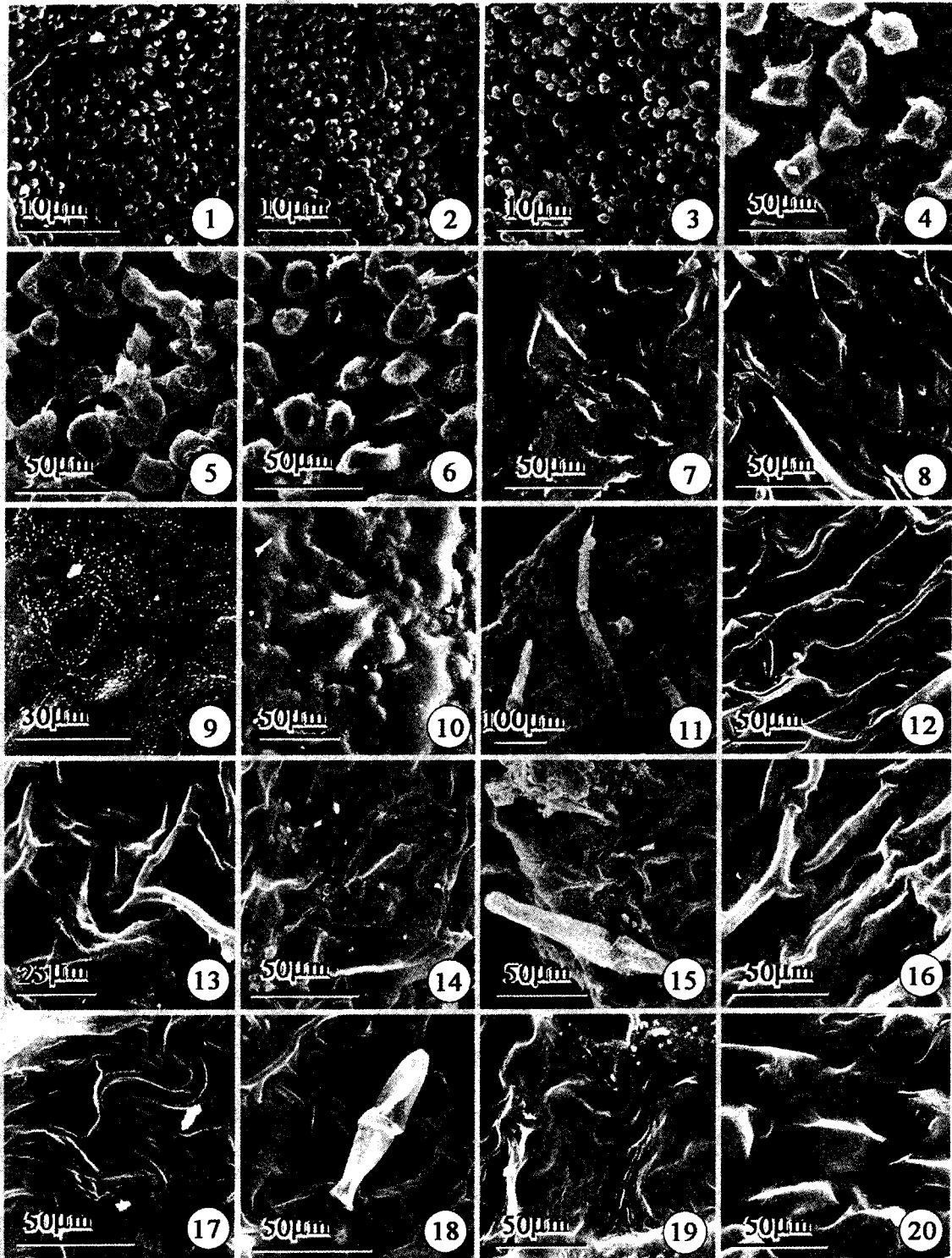


Fig. 1-20. Characters of leaf epidermis of *Phymatopteris* under SEM. 1. *Phymatopteris chrysotricha*; 2. *P. tenuipes*; 3. *P. hastata*; 4. *P. dactylina*; 5. *P. ebenipes*; 6. *P. subebenipes*; 7. *P. engleri*; 8. *P. yakushimensis*; 9. *P. najaensis*; 10. *P. omeiensis*; 11. *P. trisecta*; 12. *P. oxyloba*; 13. *P. pianmaensis*; 14. *P. dawweishanensis*; 15. *P. nigrovenia*; 16. *P. shensiensis*; 17. *P. stracheyi*; 18. *P. conmixta*; 19. *P. glaucopsis*; 20. *P. stewartii*.

omeiensis(Fig. 1:10).

Hairs. Lots of long hairs are found on both

sides of the epidermis of *Phymatopteris trisecta* (Fig. 1:11) and *P. nigrovenia* (Fig. 1:15). A few

hairs are distributed on the abaxial epidermis of *P. pianmaensis* (Fig. 1: 13) and *P. conmixta* (Fig. 1: 18).

Scales. Considering the occurrence of scales not only on the frond but also on the rhizome, we would not present the figures of scales here. However, the value of scales would be discussed later.

3 Discussions

Some species have appendage on the one or two sides of leaf epidermal cells, such as granules (*Phymatopteris dactylina*, *P. subebenipes* and *P. ebenipes*), small granules (*P. tenuipes*, *P. hastate*), hairs (*P. conmixta*, *P. nigrovenia* and *P. trisecta*), and scales (*P. subebenipes* and *P. ebenipes*). Considering the living environment of the above mentioned species, we notice that they all spread mainly in the dry regions of southwest China, and are terrestrial or epiphytic on rocks or trunks of evergreen broad-leaved forest under alt. 2 500 m. To prevent the cold temperature (≤ 0 °C) in winter, the species should have some dress to adapt such environment. We also notice that the terrestrial species have more appendages than the epiphytic ones; perhaps the terrestrial ones need more protections to adapt the colder environment.

The original function of stomata is the limitation of water loss in land plants and the maintenance of homeohydry, while allowing gas exchange. The guard cells of stomatal apparatus in this paper are all slightly sunken, and most stoma pores are closed under the layer of wax granules and stripes, which may be limited to the water loss and keep it warmer, and thus could endure the cold winter safely.

A special terrestrial species is *Phymatopteris trisecta*, distributing in the shade area of Yun-Gui Plateau mainly, has the more multi-lined hairs, which indicated an adaptation to the shade and cold environment.

Leaf epidermal appendage features are constant within species and thus have taxonomic importance. Lots of hairs occurred on both sides of the epidermis of *P. trisecta* and *P. nigrovenia*, which is the constant characteristic to identify these two species.

In short, the leaf appendages of ferns are of great existed significance and can provide an important source of environmental adaptability, and thus have some ecological adaptations of the fern genus *Phymatopteris* to the evergreen broad-leaved forest.

Addendum: Voucher informations of materials used for study

- Phymatopteris chrysotricha* (C. Chr.) Pichi-Serm.
CHINA: Yunnan, Pianma, Shao W. 025
- P. conmixta* (Ching) Pichi-Serm.
CHINA: Yunnan, Xiping, Mt. Ailaoshan, Shao W. 004
- P. dactylina* (Christ) Pichi-Serm.
CHINA: Yunnan, Deqin, Shao W. 009
- P. dawweishanensis* S. G. Lu
CHINA: Yunnan, Pingbian, Mt. Daweishan, Lu S. -G. 28885
- P. ebenipes* (Hook.) Pichi-Serm.
CHINA: Yunnan, Pianma, Shao W. 021
- P. engleri* (Luerss.) Pichi-Serm.
JAPAN: Yakushima Island, S. Mitsuta 267
- P. glaucopsis* (Franch.) Pichi-Serm.
CHINA: Yunnan, Dali Eryuan, Chu W. -M. 23013
- P. hastata* (Thunb.) Pichi-Serm.
CHINA: Yunnan, Pingbian, Mt. Daweishan, Shao W. 002
- P. majoensis* (C. Chr.) Pichi-Serm.
CHINA: Yunnan, Dali Yongshan, Chu W. -M. 4898
- P. nigrovenia* (Christ) Pichi-Serm.
CHINA: Yunnan, Deqin, Chu W. -M. 26458
- P. omeiensis* (Ching) Pichi-Serm.
CHINA: Sichuan, Daxiangling, Kong X. -X. 3971
- P. oxyloba* (Wall. ex Kunze) Pichi-Serm.
CHINA: Yunnan, Xiping, Mt. Ailaoshan, Shao W. 013
- P. pianmaensis* W. M. Chu
CHINA: Yunnan, Pianma, Chu W. -M. 11350
- P. shensiensis* (Christ) Pichi-Serm.
CHINA: Sichuan, Kangding, Kong X. -X. 6235
- P. steuartii* (Bedd.) Pichi-Serm.
CHINA: Yunnan, Pianma, Shao W. 019
- P. stracheyi* (Ching) Pichi-Serm.
CHINA: Yunnan, Pianma, Shao W. 018
- P. subebenipes* (Ching) Pichi-Serm.
CHINA: Yunnan, Dali, Mt. Cangshan, Shao W. 005
- P. tenuipes* (Ching) Pichi-Serm.
CHINA: Sichuan, Chongqing, Mt. Jinfoshan, Liu Z. -Y. 3547
- P. trisecta* (Baker) Pichi-Serm.
CHINA: Yunnan, Kunming, Shao W. 024
- P. yakushimensis* (Makino) Pichi-Serm.
JAPAN: Yakushima Island, Murata s. n.

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