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假瘤蕨属(水龙骨科)植物鳞片特征的分类学意义

邵 文[1],陆树刚[1]*,商清春[2]

(1.云南大学 地植物学与生态学研究所,昆明 650091;2.牡丹江医学院 影像系,黑龙江 牡丹江 157011)

摘 要:光镜下比较研究了假瘤蕨属(水龙骨科)2系、5亚系36种植物鳞片的显微特征。结果表明:该属植物的鳞片具有3种形状:卵状盾形、卵状钻形和披针形;3种边缘:全缘、微缘毛及纤维状毛。鳞片特征在系间具有一定的区别:不裂系具有卵状钻形或卵状盾形、全缘或具微缘毛的鳞片;羽裂系具有卵状盾形和披针形的鳞片,边缘以具微缘毛及纤维状毛为主。鳞片的形状及边缘具有一定的对应关系。另外,鳞片的边缘与叶片的边缘也有一定的对应关系。该文研究并图示了这两种对应关系。

关键词:水龙骨科;假瘤蕨属;鳞片特征

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Taxonomic significance of scale characteristics in the fern genus *Phymatopteris* (Polypodiaceae)

SHAO Wen[1], LU Shu-Gang[1]*, SHANG Qing-Chun[2]

(1. *Institute of Ecology and Geobotany, Yunnan University*, Kunming 650091, China; 2. *Department of Physics, Mudanjiang Medical College*, Mudanjiang 157011, China)

Abstract: Characters of scales of 36 species, representing 2 series and 5 subseries of the genus *Phymatopteris* (Polypodiaceae), are examined by means of light microscopy. There are three types of scale shapes in this genus: ovate-peltate, ovate-subulate and lanceolate. Also three types of scale margin are presented: entire, ciliolate and fimbriate. Scales characters are different between the series: the ovate-subulate or ovate-peltate scales with entire or ciliolate margin often occur in simple series I; while the ovate-peltate and lanceolate scales with ciliate or fimbriate in margin usually present in pinnatifid series II. The correlations among the shape and margin of the scale and between the margins of blade and scale were found. At last, these two correlations were discussed and illustrated.

Key words: Polypodiaceae; *Phymatopteris*; scale characters

Phymatopteris was established by Pichi sermolli in 1973, to replace the illegal name of *Phymatopsis* J. Smith in 1875. It is a natural taxon, including more than 60 species, the majority of which are from the mainland of Asia and epiphytic or terraphytic on the evergreen broad-leaved forest. It was confused with *Microsorum*, *Crypsinus* and *Selliguea* by Copeland (1947), Holttum(1954) and Hovenkamp(1998). Ching (1964) treated *Phymatopsis* as a separated genus. In fact, there were several characteristics that can be used to distinguish these four genera(Shao & Lu,2009).

Ching(1964) recognized 2 series and 5 subseries within *Phymatopteris* based on characteristics of the frond shape and the frond margin: simple series I (*Hastatae* Ching), including entire subseries 1(*Griffithianae* Ching) and notch subseries 2(*Hastatae* Ching), and pinnatifid series II(*Oxylobae* Ching), including entire subseries 3(*Oxylobae* Ching), notch subseries 4 (*Ebenipedes* Ching) and serrate subseries 5 (*Malacodontes* Ching).

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Biography: SHAO Wen(1979-), Ph. D, female, mainly engaged in Systematic Taxonomy of Ferns, (E-mail) shaowen19792005@163.com.

* Author for correspondence, E-mail: shuganglu@163.com

The characters of scale: shape and margin are of potential taxonomical importance, and thus have been utilized for intergeneric or infrageneric taxonomic segregations, especially in the Polypodiaceous genera. Actually, there are some correlations among the scale shape and margin in ferns. However, few researches were made in this aspect.

Species in *Phymatopteris* have one of three scale shapes and three scale marginal types. Because of this, it is a good genus to study the correlations of these character states. The aims of this study are to analyze the characters of scales of *Phymatopteris* and to search the correlations between the characters.

1 Materials and methods

36 specimens of *Phymatopteris* in PYU and PE were chosen as materials (Table 1). The scale (on the rhizome) shape and margin, and the margin of blade were checked and compared by the light microscopy.

2 Results and analysis

There are four types of blade margins in *Phymatopteris*: entire, notched, shallowly serrate, and sharply biserrate. Also, three types of scale margin exist in *Phymatopteris*: entire, ciliolate, and fimbriate. There are three types of scale shapes: ovate-peltate, ovate-subulate and lanceolate. The taxa are in the sequence of the series and the subseries of Ching (1964). All the results are shown in the Table 2.

Scale shape-Three types of scale shapes: ovate-subulate, ovate-peltate and lanceolate are present in this genus. Ovate-subulate scales occur in *Phymatopteris rhynchophylla* (Fig. 1: d), *P. wuliangshanensis* (Fig. 1: e), *P. oblongifolia* (Fig. 1: h), *P. dactylina* (Fig. 1: i) and *P. hirtella* (Fig. 1: n). Ovate-peltate scales present in *P. likiangensis* (Fig. 1: l), *P. subebenipes* (Fig. 2: b) and *P. ebenipes* (Fig. 2: c). Lanceolate scales are found in *P. cruciformis* (Fig. 1: o), *P. cartilagineo-serrata* (Fig. 2: l), *P. stewartii* (Fig. 2: m) and *P. nigropaleacea* (Fig. 2: n).

Scale margin-Three types of scale margin exist in *Phymatopteris*: entire, ciliolate, and fimbriate. Entire scale margin are found in *P. dactylina* (Fig. 3: 3), *P. hainanensis* (Fig. 3: 4) and *P. oxyloba* (Fig. 3: 5). Margins with ciliates are present in *P. likiangensis* (Fig. 3: 1), *P. cruciformis* (Fig. 3: 6), *P. malacodon* (Fig. 3: 8). Fimbriate scale margins occur in *P. kingpingensis* (Fig. 3: 2), *P. roseomarginata* (Fig. 3: 7) and *P. stewartii*

Table 1　The locality information of scales specimens in *Phymatopteris*

Taxa	Voucher (Herbarium)	Location
Phymatopteris albopes	Anonymous 342 (PE)	Guangxi
P. cartilagineoserrata	Xizang plant collect group 1609 (PE)	Xizang
P. conjuncta	Kiou 51524 (PE)	Guizhou
P. commixta	Shao W 003 (PYU)	Yunnan
P. connexa	Shao W 001 (PYU)	Yunnan
P. crenatopinata	Shao W 004 (PYU)	Yunnan
P. cruciformis	To Kang Peng *et al*. 429 (PE)	Guangdong
P. dactylina	Shao W 009 (PYU)	Yunnan
P. daweishanensis	Lu SG 28885 (PYU)	Yunnan
P. ebenipes	Shao W 015 (PYU)	Yunnan
P. engleri	Mitsuta S 267 (PYU)	Yakushima Island, Japan
P. glaucopsis	Chu WM 23013 (PYU)	Yunnan
P. hainanensis	Russ-China associated-exped. 7998 (PE)	Yunnan
P. hastata	Shao W 002 (PYU)	Yunnan
P. hirtella	Liu SE 19908 (PE)	Yunnan
P. likiangensis	Zhao YX 21426 (PE)	Yunnan
P. kingpingensis	CN-Russia Associated collect group 2472 (PE)	Yunnan
P. malacodon	Shao W 028 (PYU)	Yunnan
P. majoensis	Chu WM 4898 (PYU)	Sichuan
P. nigropaleacea	Zhang XC 2234 (PE)	Yunnan
P. nigrovenia	Chu WM 26458 (PYU)	Yunnan
P. oblongifolia	Xizang plant collect group 9118 (PE)	Yunnan
P. omeiensis	Kong XX 3969 (PYU)	Sichuan
P. oxyloba	Shao W 013 (PYU)	Yunnan
P. pianmaensis	Chu WM 11350 (PYU)	Yunnan
P. rhynchophylla	Forrest G 29490 (PE)	Yunnan
P. roseomarginata	Feng KM 9003 (PE)	Yunnan
P. shensiensis	Kong XX 6235 (PYU)	Sichuan
P. stewartii	Shao W 019 (PYU)	Yunnan
P. stracheyi	Yu TT 17193 (PE)	Yunnan
P. subebenipes	Shao W 005 (PYU)	Yunnan
P. tenuipes	Liu ZY 13816 (PYU)	Sichuan
P. tibetana	Chu WM 23725 (PYU)	Yunnan
P. trisecta	Chu WM 03651 (PYU)	Yunnan
P. wuliangshanensis	Chu WM 9413 (PYU)	Yunnan
P. yakushimensis	Murata s. n. (PYU)	Yakushima Island, Japan

Table 2 The characters of frond and scale of *Phymatopteris*

S. and subs.	Taxon	Blade margin				Scale shape			Scale margin			Fig.
		Entire	Notches	Shallowly serrate	Sharply biserrate	Ovate-peltate	Ovate-subulate	Lanceolate	Entire	Ciliolate	Fimbriate	
	① *P. hainanensis*	+					+		+			1:a
	P. majoense		+					+	+			1:b
	P. omeiensis		+					+	+			1:c
	P. engleri		+					+	+			1:d
I	*P. yakushimensis*		+					+	+			
	② *P. rhynchophylla*		+				+		+			1:e
	P. wuliangshanensis		+				+		+			1:f
	P. tenuipes		+				+		+			1:g
	P. oblongifolia		+				+		+			1:h
	P. dactylina		+				+		+			1:i
	P. hastata		+			+		+		+		1:j
	③ *P. oxyloba*	+						+		+		1:k
	P. trisecta	+						+		+		
	P. likiangensis	+				+		+		+		1:l
	P. pianmaensis		+					+	+			
	P. albopes		+					+	+			1:m
	P. hirtella		+					+		+		1:n
	P. daweishanensis		+					+			+	
	④ *P. nigrovenia*			+				+			+	
	P. cruciformis			+		+		+		+		1:o
	P. tibetana			+				+		+		2:a
II	*P. subebenipes*			+		+		+			+	2:b
	P. ebenipes			+		+		+	+		+	2:c
	P. kingpingensis			+		+					+	2:d
	P. connexa			+			+	+		+	+	2:e
	P. crenatopinnata			+				+		+		2:f
	P. shensiensis			+				+		+		
	P. stracheyi			+				+		+		2:g
	P. conmixta				+			+		+		2:h
	⑤ *P. malacodon*				+			+		+		2:i
	P. conjuncta				+			+		+		2:j
	P. roseomarginata				+			+		+	+	2:k
	P. cartilagineo-serrata				+			+		+	+	2:l
	P. stewartii				+			+			+	2:m
	P. nigropaleacea				+		+	+			+	2:n
	P. glaucopsis				+			+			+	2:o

Note: S. and subs. = series and subseries, I = simple series I(*Hastatae* Ching), ① = entire subseries 1(*Griffithianae* Ching), ② = notch subseries 2 (*Hastatae* Ching), II = Pinnatifid Series II(*Oxylobae* Ching), ③ = entire subseries 3(*Oxylobae* Ching), ④ = notch subseries 4(*Ebenipedes* Ching), ⑤ = serrate subseries 5(*Malacodontes* Ching).

(Fig. 3:9).

3 Discussions

The scale characters were supported to have taxonomic importance. Correlations between the scale shape and margin, also between the margins of the blade and scale are found in *Phymatopteris*.

(1) Three scale shapes: ovate-peltate, ovate-subulate and lanceolate exist in *Phymatopteris*. We differentiate the ovate-peltate to lanceolate scales by the proportion of length to wide(in the widest place) that if L : W ≦ 2, the scale shape is ovate-peltate, otherwise is lanceolate. There are three scale margins: entire, ciliolate and fimbriate present in this genus. We examine more than 3000 specimens of the 36 species in this genus, and draw the scales emphasizing the shapes and the margins, and then choose 9 representative types

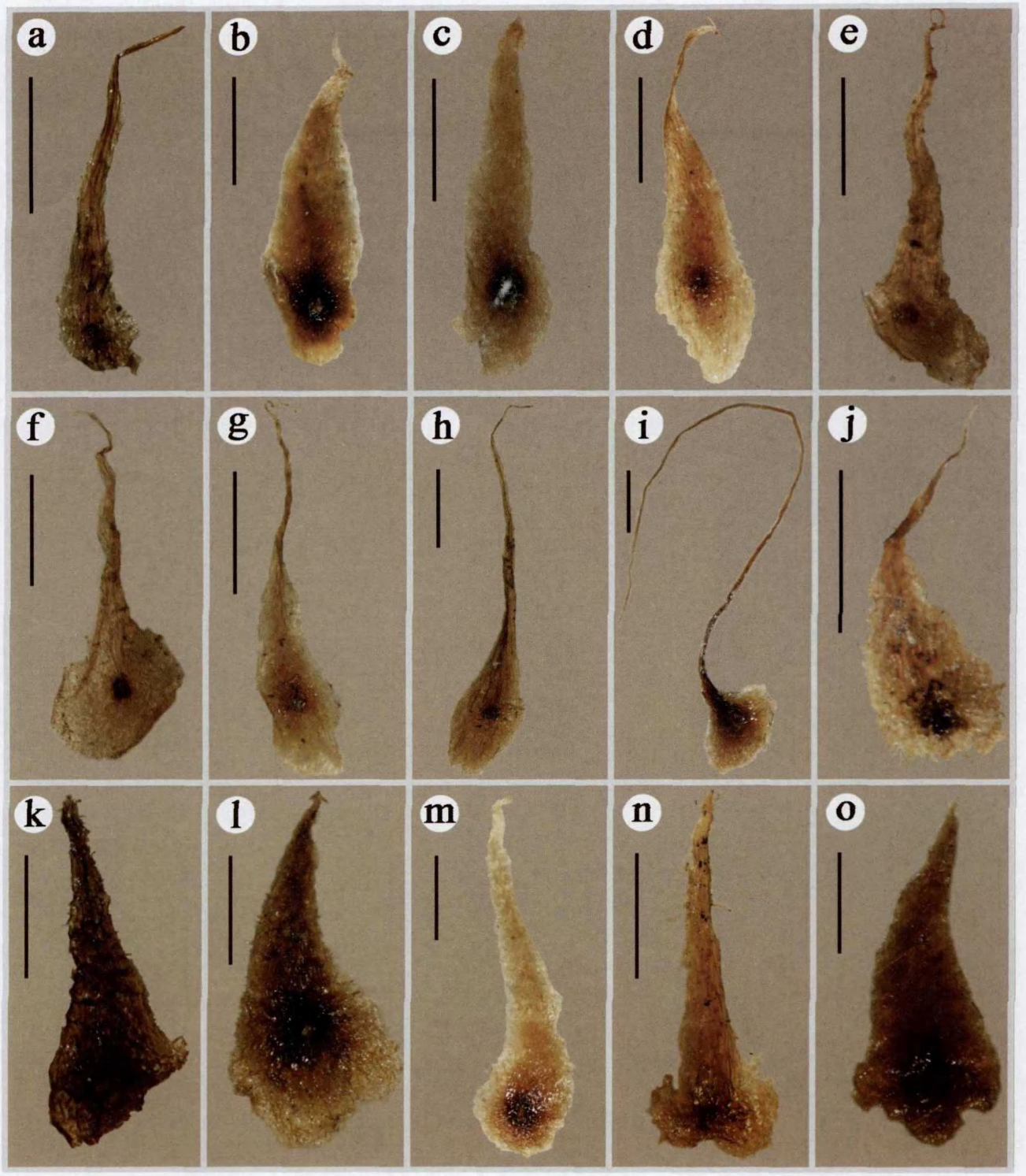

Fig. 1　Scales of the *Phymatopteris*　**a**. *P. hainanensis*; **b**. *P. majoense*; **c**. *P. omeiensis*; **d**. *P. engleri*; **e**. *P. rhynchophylla*; **f**. *P. wuliangshanensis*; **g**. *P. tenuipes*; **h**. *P. oblongifolia*; **i**. *P. dactylina*; **j**. *P. hastata*; **k**. *P. oxyloba*; **l**. *P. likiangensis*; **m**. *P. albopes*; **n**. *P. hiutella*; **o**. *P. cruciformis*. bar=1 mm.

interpreting the shapes and margins of scales in *Phymatopteris*. The diagram is followed(Fig. 3). From the diagram and the results above, we can support a correlation between the shape and the margin of the scale: most ovate-subulate or ovate-peltate scales have entire margin; while the lanceo-

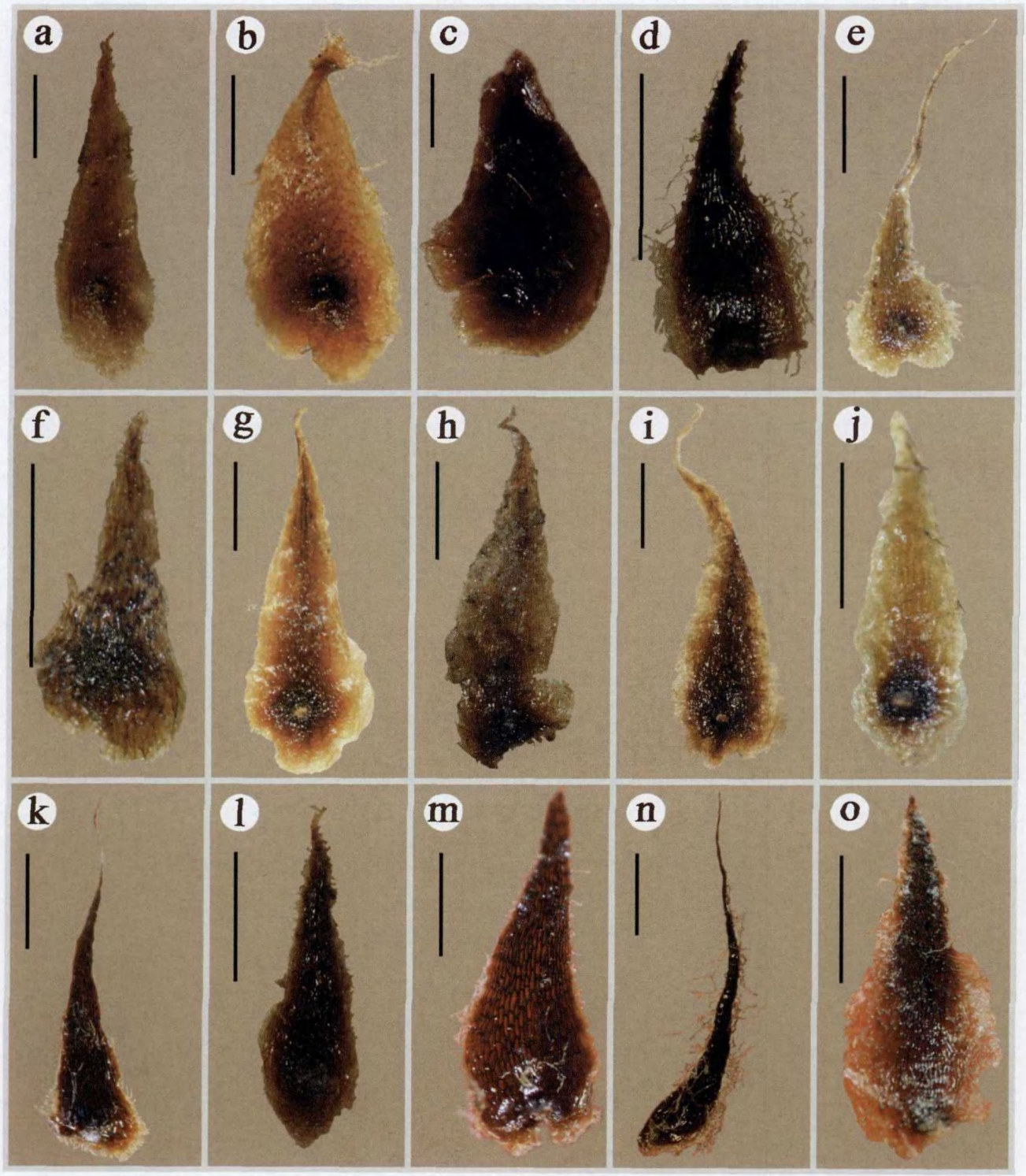

Fig. 2 Scales of the *Phymatopteris* **a.** *P. tibetana*; **b.** *P. subebenipes*; **c.** *P. ebenipes*; **d.** *P. kingpingensis*; **e.** *P. connexa*; **f.** *P. crenatopinnata*; **g.** *P. stracheyi*; **h.** *P. conmixta*; **i.** *P. malacodon*; **j.** *P. conjuncta*; **k.** *P. roseomarginata*; **l.** *P. cartilagineo-serrata*; **m.** *P. stewartii*; **n.** *P. nigropaleacea*; **o.** *P. galucopsis*. bar=1 mm.

late scales usually with ciliate or fimbriate margin. However, a few exceptions and intermediate states exist in the scales of this genus: species with scales that have more than one shape type and different margins in one specimen. *Phymatopteris* connexa (Fig. 2-e), for example, have scales with ovate-su-

bulate or lanceolate in shape and ciliate or fimbriate in margin. Furthermore, these exceptions do not deny the correlation between the shape and the margin of the scale, for the most species in this genus support that correlation.

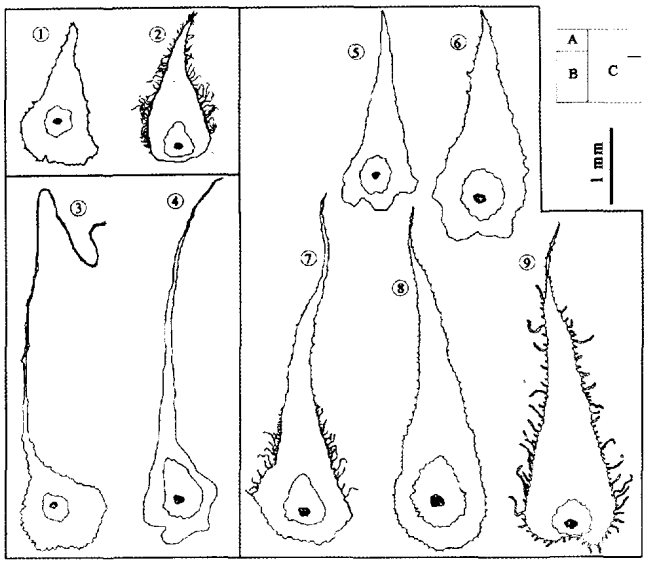

Fig. 3　Shapes and margins of scales of *Phymatopteris*
A-C. scale shape　**A.** ovate-peltate; **B.** ovate-subulate; **C.** lanceolate
1-9. scale margin; **3-5.** entire; **1,6,8.** ciliolate; **2,7,9.** fimbriate
1. *P. likiangensis*; **2.** *P. kingpingensis*; **3.** *P. dactylina*; **4.** *P. hainanensis*; **5.** *P. oxyloba*; **6.** *P. cruciformis*; **7.** *P. roseomarginata*; **8.** *P. malacodon*; **9.** *P. stewartii*.

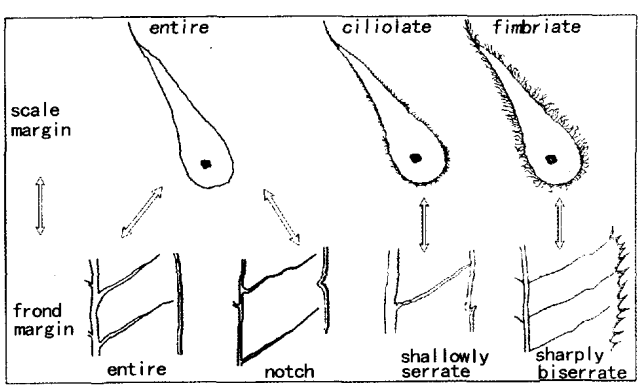

Fig. 4　The correlation between the margins of frond and scale of *Phymatopteris*.

(2) A correlation between the margins of blade and scale is found. Entire scale margins often correlate with notched or entire frond blade margins; ciliolate scale margins often correlate with shallowly serrate blade margins, and fimbriate scale margins occur with biserrate blade margins. The diagram interpreting the correlation among these two margins is followed(Fig. 4).

Lamina characters have been emphasized on the past taxonomic studies. We reveal that scale characters also have some taxonomic importance and more correlation to the blade characters. More than 3 500 specimens are examined in PYU, PE, and KUN, and we believed that the different characters of scales cited in this paper are decided by the genetic elements, rather than the environmental modification. However, the scales of one species in different environments and altitude maybe have some differentiates in morphology, but these are not the main points effected the characters of scales in this paper. *Phymatopteris* is a fern genus mainly distributed in the E. Asia and epiphytic or terraphytic on the evergreen broad-leaved forest, which is from 2 000 m to more than 3 000 m in altitude. The scale characters were also supported to have some ecology significance to the environmental adaptation.

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