THE STELAR ANATOMY OF STIPE AND ITS TAXONOMIC SIGNIFICANT IN DIPLAZIUM (ATHYRIACEAE)

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Titien Ngatinem Praptosuwiryo & Dedy Darnaedi. 2014. Anatomi Stele pada Tangkai Daun dan Makna Taksonominya dalam *Diplazium* (*Athyriaceae*). *Floribunda* 4(8): 195–201. —. Pengamatan anatomi irisan melintang tangkai daun dekat lembaran daun telah dilakukan pada 27 jenis *Diplazium* Malesia Barat. Tujuan studi ini adalah untuk menguji karakter anatomi stele untuk menyokong batasan jenis dalam marga *Diplazium.* Bentuk berkas pembuluh irisan melintang tangkai daun *Diplazium* bervariasi di antara jenis dan tetap di antara individu-individu dewasa dalam satu jenis. Bentuk berkas pembuluh pada irisan melintang *Diplazium* dapat dikelompokkan dalam lima tipe utama: Tipe-1, bentuk V tidak terputus; Tipe-2, bentuk V terputus; Tipe-3, bentuk U tidak terputus; Tipe-4, bentuk U terputus dan Tipe-5 bentuk W. Tiap tipe membentuk beberapa variasi bentuk turunan yang memungkinkan untuk menentukan jenis di antara jenis berkerabat dekat. Oleh karena itu bentuk berkas pembuluh merupakan ciri penting untuk menyokong pembatasan jenis dalam *Diplazium.*

Kata Kunci: Anatomi stele, bentuk runutan daun, *Diplazium*, Malesia Barat, pembatasan jenis.

Titien Ngatinem Praptosuwiryo & Dedy Darnaedi. 2014. The Stelar Anatomy of Stipe and its Taxonomic Significant in *Diplazium* (*Athyriaceae*). *Floribunda* 4(8): 195–201. —. Anatomical study on transection of stipe near lamina were carried out on 27 species of *Diplazium* from Western part Malesia (Java, Sumatra, Kalimantan). The aim of this study is to examine stelar anatomical characters for supporting species delimitation in *Diplazium*. The leaf-trace shape of *Diplazium* stipe is varying among species and constant among the adult individuals in a species. Leaf-trace shapes of *Diplazium* can be classified into five main types: (1) uninterrupted V-shaped, (2) interrupted V-shaped, (3) uninterrupted U-shaped, (4) interrupted U-shaped, and (5) W-shaped. Each type diversifies into some different derivative forms that enable to determine a species among closely related species. Therefore the leaf-trace shapes are important diagnostic character which support species delimitation in *Diplazium.*

Keywords: Stelar anatomy, leaf-trace shape, *Diplazium*, West Malesia, species delimitation.

Diplazium is a large genus consisting of about 400 species (Ching 1964). It occur mainly in the tropics (Ching 1964; Copeland 1947; Tagawa & Iwatsuki 1988), sparingly in the sub tropic and only locally extending into temperate (Kramer *et al* 1990). This genus are characterized by the following diagnostic characters: Groove of frond axis open to admit the groove of axis of lower order; frond axes U-shaped with a flat base in most species; acroscopic basal pinnules equal or smaller, laminar margin not cartilaginous; sori linear, double (diplazioid) or single, the single ones opening toward the main veins or the central veins of the ultimate segments, the double ones in opposite directions (van Alderwerelt van Rosenburgh 1908; Holttum 1966; Kato 1977; Tagawa & Iwatsuki 1988; Kramer *et al* 1990).

Diplazium is very difficult group and it is quite insufficiently known. It is in great need of monographic study. The young plants may be fertile and difficult to assign to a species (Kramer *et al* 1990).

Anatomical studies of the ferns have had a long and historically significant place in the professional literatures (Bower 1912, 1913). These anatomical studies in particular, played a large part in the conclusions concerning fern systematic relationships and evolution drawn by Bower (1923–1928). Between the years of 1960–2000, anatomical data have emerged once again as important to an accurate understanding of relationships and evolution among ferns (Holttum & Sen 1961; Bir 1969; Kato 1972; Nishida & Nishida 1982; White & Weidlich 1995; Qiu *et al* 1995).

Detailed anatomical investigation can serve several useful purposes including the addition of new knowledge about particular taxa and the useful application of these kind of data on the problems of relationships among fern taxa (White 1974). Broad and detailed comparative anatomical studies are important in understanding of fern systematic and evolution.

One of the kinds of comparative studies usually used in the anatomical studies on the ferns is vascular (stelar) pattern (White 1974). The importance of the vascular tissue as a unified tissue system (the stele) was recognized in the late 19th century (Tiegham & Douliot 1886). Reviewing from the many cases studies on vascular pattern of ferns, White (1974) came in a concussion that stelar anatomy is a potentially powerful tool in systematic although the vascular tissue data alone do not provide the basis on which systematic (or taxonomic) conclusions are based.

Stipe characters have been recognized to be very important and have been used to distinguish between difficult taxonomic groups, for example, between *Athyrium* and *Asplenium* (Milde 1866), *Thelypteris* and *Dryopteris* (Ching 1936), and the subdivision of the *Polypodiaceae sensu lato* (Ching 1940). Lin & DeVol (1977) stated that stipes of ferns are of considerable of taxonomic interrest. Based on the study of stipe characters Lin & DeVol (1977) have provided a multiple choice key for the Taiwan ferns. Characters used included the number and shape of vascular bundles, distribution of the schlerenchyma, the presence or absence of grooves, aeration structures and hairs or scales.

The stelar anatomy of *Athyrioid* ferns and their relatives has been studied in detail by some pteridologist (Tardieu-Blot 1932, Bir 1969, Kato 1972). All of these studies came to the concussion that anatomical evidence is important to support taxa delimitation. This paper presents the anatomical data of stipe on 27 species of West Malesian *Diplazium*. The aim of this study was to examine stelar anatomical data to support species delimitation in fern genus *Diplazium*.

MATERIALS AND METHODS

Transection of frond axis, stipe near lamina (upper portion of stipe), were studied on 27 species collected from Western part of Malesia. A piece of stipe near blade of fresh material were hand sectioned with a sharp razor blade. The sections were embedded in glycerine jelly after staining them with 0.5% methyl green to obtain semi permanent slides.

RESULTS AND DISCUSSION

All species under observation have strand of vascular tissue termed amphicribal vascular bundles. This structure consist of a central strip of xylem completely surrounded by phloem (Praptosuwiryo 1999). Foster & Gifford (1959) termed meristele for this such concentric strand of vascular tissue. The meristele in the stipe is embedded within a conjunctive parenchyma which posses large intercellular spaces. Between the cortical parenchyma and the single layered cuticularized epidermis is a band of hypodermal schlerenchyma whose fiber are heavily lignified. Meristele structure in the rhizome and leaf strands is the usual type for *Diplazium, Athyrium, Diplaziopsis,* etc. (Tardieu-Blot 1932, Bir 1969). Therefore this structure is not an important for diagnostic feature which supports the taxonomic separation among the species of *Diplazium*.

Leaf-trace are binary. As showed in figure 1, the xylem of a leaf-trace of most species are same hippocampus-shaped bundle in transaction. The shape and position of this vascular bundle are varying among species. In *D. polypodioides* and *D. subpolypodioides*, the xylem of the leaf-trace develop ridges and grooves become somewhat W-shaped. This shape is similar with *D. latifolium* illustrated by Bir (1969). The similar anatomy is illustrated by Tardieu-Blot (1932) and Kato (1977).

The leaf-trace shapes of the stipe, as a whole, are varying among species and constant among the adult individuals within species (Figure 2 and 3). The shapes are comprised of five types: Type-1, uninterrupted V-shaped; Type-2, interrupted V-shaped; Type-3, uninterrupted U-shaped; Type-4, interrupted U-shaped, and Type-5, W-shaped. These types similar those illustrated by Tardieu-Blot (1932), Kato (1977) and Bir (1969).

Type-1, the uninterrupted V-shaped leaf-trace is seen in *D. tomentosum, D. angustipinna*, and *D. cordifolium*. Type-2, interrupted V-shaped is shown in *D. silvaticum*. Type-3, interrupted U-shaped leaf-trace is seen in *D. accedens* var. *spinosum, Diplazium* sp.1 and D. *D. subserratum*. Type-4, uninterrupted U-shaped leaf trace is found in most of *Diplazium* species, such *Diplazium* sp.2, *D. procumbens, D. sorzogonense, D. speciosum, D. subserratum, D. umbrosum* and *D. vestitum*. As mentioned above, W-shaped leaf trace is found in

D. subpolypodioides and *D. polypodioides*. Some species may have intermediate shape between two types. For example, *D. riparium* and *D. crenato-serratum* have the intermediate shape between type-1 and type-4.

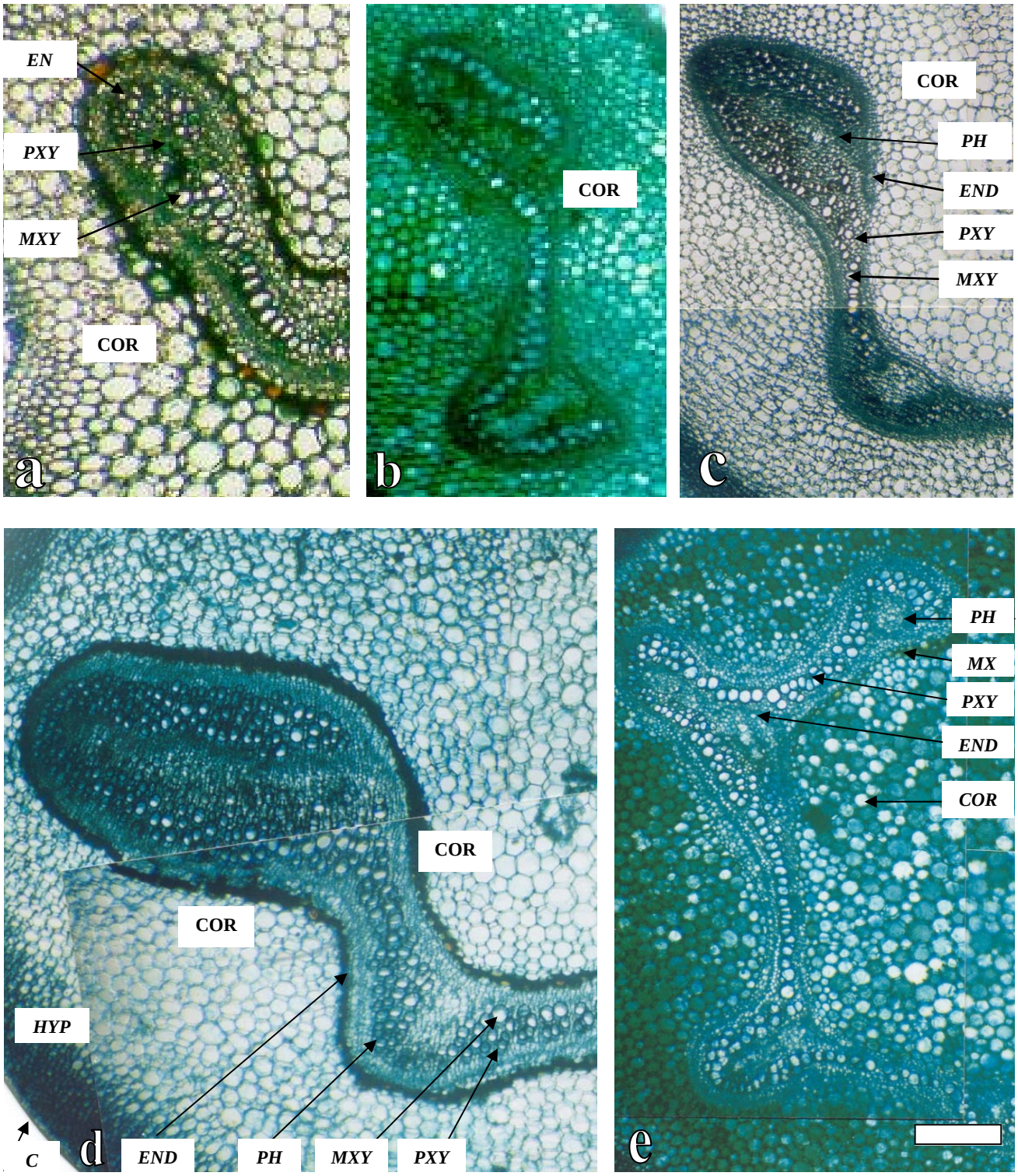

Figure 1. Vascular structure of the leaf axis (transversal section of stipes near the base). *COR*: cortex. *CU*: Cuticle *HYP*: hypodermis. *MXY*: metaxylem. PXY: protoxylem. a. *D. cordifolium*; b. *D. esculentum*; c. *D. umbrosum*; d. *D. procumbens*. e. *D. polypodioides*. Bar = 1 mm for b, c, d, and e. Bar = 0.4 mm for a.

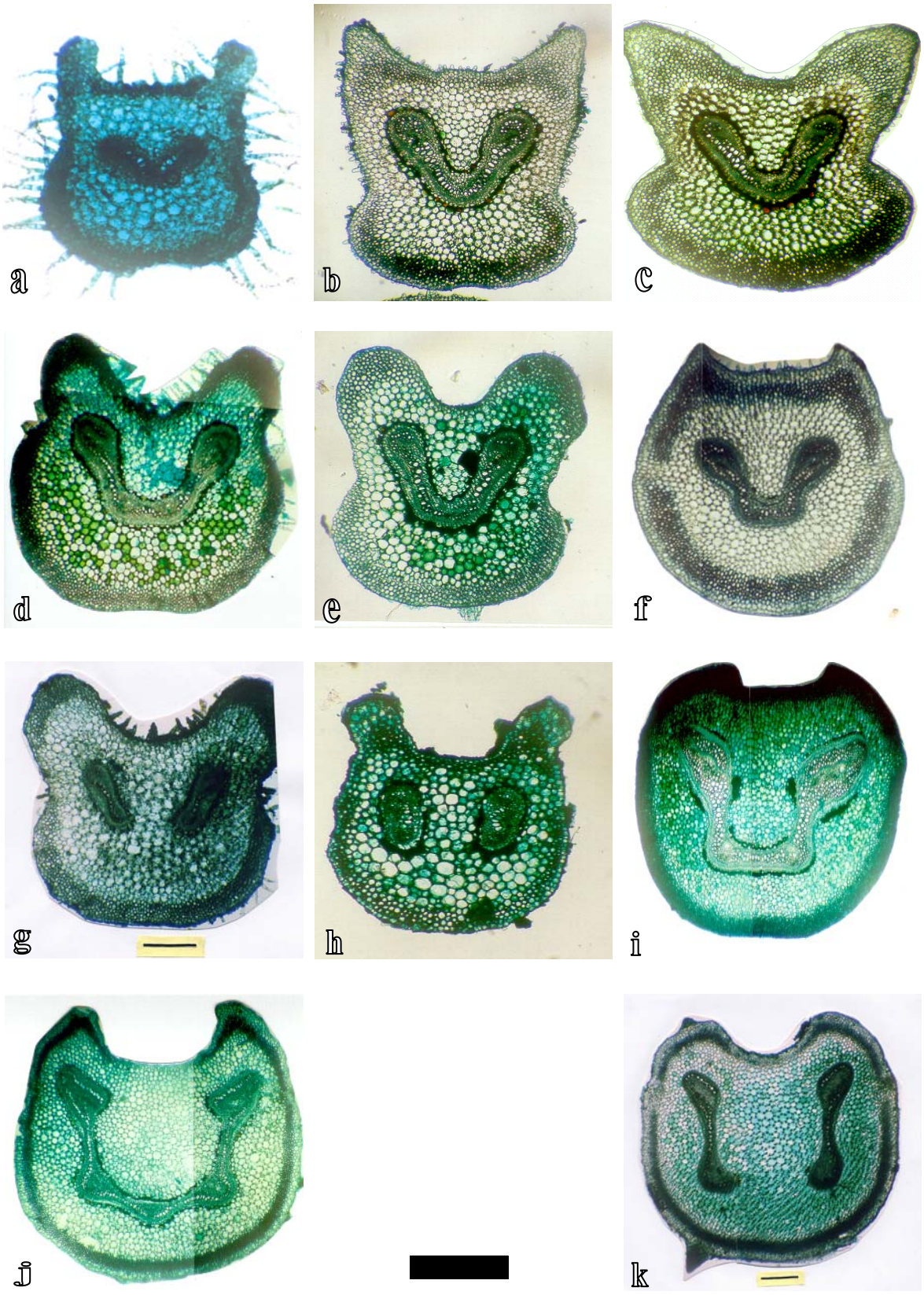

Figure 2. Leaf-trace shapes in *Diplazium.* Groove U-shaped with flat base. a. *D. tomentosum;* b. *D. cordifolium* (simple frond)*;* c. *D. angustipinna;* d. *D. silvaticum* var. *silvaticum;* e. *D. riparium;* f. *D. xiphophyllum*; g. *D. crenatoserratum*; h. *D. subserratum;* i. *Dplazium* sp.1; j. *D. accedens* var. *accedens;* k. *D. accedens* var. *spinosum.* Bar = 1.5 mm for a – h. Bar = 2 mm for i. Bar = 3.5 mm for j and k.

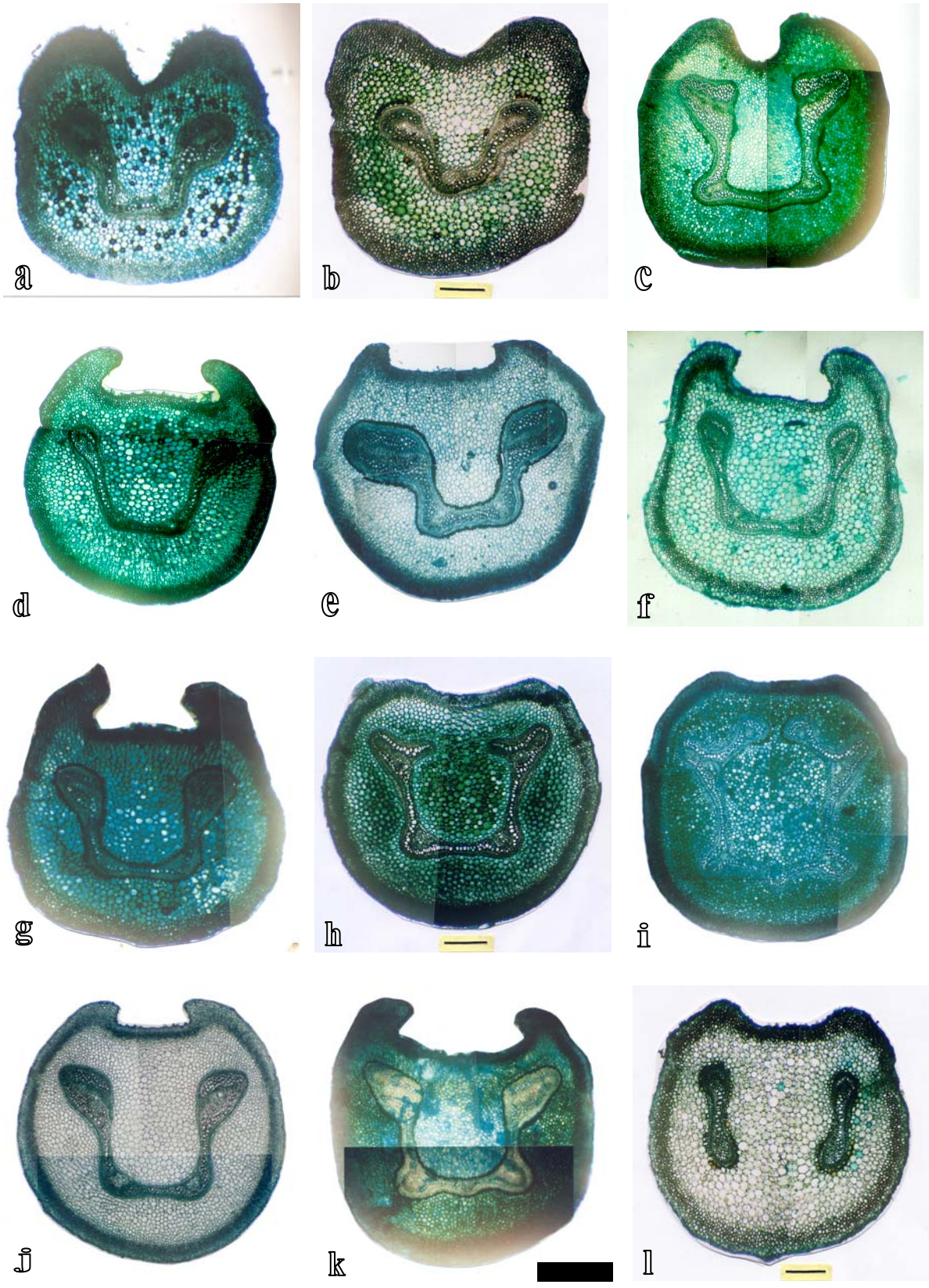

Figure 3. Leaf-trace shapes in *Diplazium*. a. *Diplazium* sp.2; b. *D. donianum*; c. *D. simplicivenium*; d. *D. sorzogonense*; e. *D. procumbens*; f. *D. vestitum*; g. *D. speciosum*; h. *D. subpolypodioides*; i. *D. polypodioides*; j. *D. umbrosum*; k. *D. spiniferum*; l. *Diplazium* sp.1. Bar = 1.5 mm for a, b, d, and g. Bar = 1 mm for l. Bar = 2 mm for c, e, f, h, I, j, and k.

Each type of the leaf traces or the vascular bundle may diversify into the derivative forms. These character variations can be used to determine a species among closely related species. *D. speciosum* and *D. sorzogonense* are morphologically very similar. Anatomically, the two species share characters: leaf traces form uninterrupted U-shaped, flat base on the two directions, inward and outward (Figure 3). But, the U-shaped leaf trace of first species is with an angle 90º and end slightly ridge, whereas the second species with an angle 110º and end almost simple. Even, the leaf trace type of *D. accedens* var. *accedens* (Figure 2 j) is different from *D. accedens* var. *spinosum* (Figure 2 k). Var. *accedens* has an uninterrupted U-shaped leaf trace with ridges that formed at the outward of lower base, angles, and ends. Meanwhile var. *spinosum* has an interrupted U-shaped with more blunt ridges on the angle and end. Therefore the leaf-trace shapes are important diagnostic features that support species delimitation in *Diplazium.*

CONCLUSIONS

The leaf-trace shape of *Diplazium* stipe is varying among species and constant among the adult individuals within a species. It is concluded that the leaf-trace shapes of *Diplazium* can be classified into five main types: Type-1, uninterrupted V-shaped, Type-2, interrupted V-shaped, Type-3, uninterrupted U-shaped, Type-4, interrupted U-shaped, and Type-5, W-shaped. Each type of leaf trace seems to vary among the species. Each type may diversify into some different derivative forms that enables to determine a species among closely related species. Therefore the leaf-trace shapes are important diagnostic features which support species delimitation in *Diplazium.*

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