CHAPTER 4

THE STELAR ANATOMY OF STIPE AND ITS TAXONOMIC SIGNIFICANT IN DIPLAZIUM

4.1. Introduction

Anatomical studies of the ferns have had a long and historically significant place in the professional literatures (e.g. Bower 1912, 1913). These anatomical studies in particular, played a large part in the conclusions concerning fern systematic relationships and evolution drawn by Bower. Between the years of 1960 – 2000, anatomical data have emerged once again as important to an accurate understanding of relationships and evolution among ferns (e.g. Holttum & Sen 1961; Bir 1969; Kato 1972; Tryon 1970; 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 data on the problems of relationships among fern taxa (White 1974). Broad and detailed comparative anatomical studies are important in problems solving 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 (e.g. 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.

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

Transection of frond axis, stipe near lamina (upper portion of stipe), were studied on 27 species collected from West Malesia. A pieces 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.

4.3. Results and Discussion

As also reported by Praptosuwiryo (1999), this study resulted that 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. 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 4.1, 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. The similar anatomy is illustrated by Tardieu-Blot (1932) and Kato (1977). 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 leaf-trace shapes of the stipe, as a whole, are varying among species and constant among the adult individuals in a species (Figure 4.2. and 4.3.). The shapes are comprised of five types: (1) uninterrupted V-shaped (Figure 4.2.a-c, e.), (2) interrupted V-shaped (Figure 4.2.g.), (3) uninterrupted U-shaped (Figure 4.2.i.), (4) interrupted U-shaped (Figure 4.2.h & k), and (5) W-shaped (Figure
4.3.i.). These types similar those illustrated by Tardieu-Blot (1932), Kato (1977) and Bir (1969).

The uninterrupted V-shaped leaf-trace is seen in *D. tomentosum*, *D. angustipinna*, and *D. cordifolium*. Interrupted V-shaped is shown in *D. silvaticum*. Interrupted U-shaped leaf-trace is seen in *D. accedens* var. *spinosum*, *D. batuayauense* and *D. D. subserratum*. Most species are possessing
uninterrupted U-shaped leaf trace, such as *D. halimunense*, *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. crenatoserratum* have the intermediate shape between type one and four.

Figure 4.2. 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. *D. subvirescens*; j. *D. accedens* var. *accedens*; k. *D. accedens* var. *spinosum*. Bar = 2 mm for a, c, d, g, and h. Bar = 1.6 mm for b and e. Bar = mm for f and d. Bar = 2.5 mm for j and k.
Figure 4.3. Leaf-trace shapes in Diplazium. a. *D. halimunense*; 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. *D. batuayauense*. 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: vascular bundle form uninterrupted U-shaped, flat base on the two directions, inward and outward (Figure 4.3.). But, the U-shaped vascular bundle 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 vascular bundle type of *D. acedens* var. *acedens* (Figure 4.2.j.) is different from *D. acedens* var. *spinosum* (Figure 4.2.k.). Var *acedens* has an uninterrupted U-shaped vascular bundle 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.*

### 4.4. Conclusions

The leaf-trace shape of *Diplazium* stipe is varying among species and constant among the adult individuals in a species. Based on the result of this study and also previous authors (Tardieu-Blot 1932, Bir 1969, Kato 1977) it is concluded that the 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 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.*