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LEAF MORPHOLOGY AND ANATOMY OF SELECTED PHILIPPINE *Dischidia* R. Br. (APOCYNACEAE: ASCLEPIADOIDEAE)

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Abstract: The epiphytic genus *Dischidia* R.Br. known for its close association to *Hoya* R.Br., remains poorly understood genus particularly in the Philippines. Though many are uniquely found in the country, many are still inadequately documented for conservation nor advance research purposes. As many discoveries are identified only by herbarium materials and out of date, particularly its morphology and anatomy aspects. So far in the Philippines, no studies had discussed specifically the leaf morphological and anatomical characteristics of these genera undermining any potential taxonomic usefulness of both attributes. This study seeks to determine more on the morphological and anatomical features of *Dischidia* leaves. For leaf stomata and epidermal structure an impression approach was done using nail polish. Leaf anatomy were studied by preparing transverse sections of the midrib by hand cut free sectioning method. The study shows that leaf morphology of the selected Philippine *Dischidia* agrees well to other literatures but to no avail for significant taxonomic characters. As for the anatomical area of the leaves, isopalisade and homogenous mesophyll type were determined, the first to report about the nature of *Dischidia* mesophyll type. For its systematic value, this mesophyll characterization is a gray feature due to its environmental susceptibility.
Key Words: *Dischidia*; Leaf; Philippines; Taxonomy

1. INTRODUCTION

The genus *Dischidia* R.Br. consists of c. 80 species of epiphytic climbers some with common association with ants, predominantly growing in Indochina, Malesia, Melanesia and the east Pacific. *Dischidia* has laticiferous opposite leaves as common in the milkweed family. It shares morphological characters with *Hoya* R.Br. as its closest sister genus. With both pseudo-umbelliform inflorescences, *Dischidia* differs by having urceolate or campanulate shape of corolla, while *Hoya* has usually salver or revolute shape of corolla lobes. This genus is further classified into three sections: (1) section *Dischidia* characterized by laminar leaves, (2) section *Conchophylla* with shell-shaped leaves, (3) section *Ascidifera* with pitcher-leaves. Inclusion of genus *Dischidiopsis, Oistonema, Conchophyllum* and *Leptostemma* to *Dischidia* is proposed. (Livshultz, 2003).

There are taxonomic studies done for this genus (e.g. Lu & Kao, 1980; Rintz, 1980; Forster et al., 1996; Jagtap & Singh, 1999; Livshultz et al., 2005) and these studies are confined to specific areas. Still there is a gap regarding the taxonomy and ecology of *Dischidia* at large (Livshultz et al., 2005) particularly in the Philippines. In the Philippines, significant contributions for this genus were made by Pearson (1902), Merrill (1904, 1923), Schlechter (1915), Elmer (1938) and the latest study was done by Livshultz (2003). To this date, 21 species are identified, 16 of which are considered endemic and 8 species remains uncertain due to

invalid publication. From hence, less attention has been given to *Dischidia* judging from the fact that recent comprehensive updates and revisions have not been made. The level of taxonomic knowledge for Philippines *Dischidia* are hardly elementary. Taxonomic knowledge, species distribution, taxonomic keys, diagnostic illustrations and ecology of Philippine *Dischidia* are lacking and most of the species needed to be "rediscovered" for clarification due to the fact that many remain uncertain and out of date.

Even though reproductive characters have greater role for familial up to genus delimitation still vegetative morphology can further strengthen the restriction particularly in *Dischidia*. In which, leaf morphology has been utilized to further classify the species into three sections. Leaf shape of the *Dischidia* plays a sectional taxonomic importance but still its morphological and anatomical attributes remain poorly understood. So far, no studies had discussed specifically the leaf morphological and anatomical characteristics of these genera particularly in the Philippines undermining any potential taxonomic usefulness of both attributes. This study seeks to determine more on the leaf morphological and anatomical features of *Dischidia* and to assess its taxonomic value in delimitation for Philippine *Dischidia* species.

2. METHODOLOGY

2.1 Plant Acquisition

Dischidia species were collected specifically from Kalinga Province, Nueva Vizcaya, Daraitan, Rizal, Mt. Banahaw de Majayjyay and Polillio Quezon. Collection of samples were done from August to November 2016. A total of twelve living *Dischidia species* were collected (Table 1). Moreover, herbarium specimen examination was conducted at the Philippine National Herbarium (PNH) of the National Museum in Manila (See Appendix, Table 5).

2.2 Leaf Morphological Studies

Mature leaves were measured and described in both dry and living conditions. Quantitative characters (e.g. petiole length, leaf length and width, number of nerves) were measured using a ruler (if necessary) while qualitative characters (e.g. leaf apex, margin, base, shape, leaf texture on both surface) were observe under the stereomicroscope (Nikon SMZ 745T) for observing minute qualitative characters (e.g. petiole and leaf indumentum). Botanical terminology was based from the Kew Plant Glossary (2010).

Table 1. Collected *Dischidia* Species

Species Collected	Location	Collection #
D. sp1	Kalinga	K-001
D. sp2	Mt. Banahaw de Majaviay	Q-001
D. sp3	Polillio, Quezon	Q-002
D. sp4	Nueva Vizcaya	NV-001
D. sp5	Polillio, Quezon	Q-003
D. sp6	Daraitan, Rizal	DR-001
D. hirsuta (Blume) Decne.	Daraitan, Rizal	DR-002
D. lancifolia Merr.	Daraitan, Rizal	DR-003
D. nummularia R. Br.	Daraitan, Rizal	DR-004
D. ojantha Schltr.	Manila	MNL-001
D. platyphylla Schltr.	Lucban, Quezon	Q-004
D. ruscifolia Decne ex Becc.	Nueva Vizcaya	NV-002

2.3 Leaf Surface and Anatomical Studies

To examine and determine the leaf stomata and epidermal structure an impression approach was done using nail polish. Both sides of the leaf were covered and three fields per leaf side were randomly selected and photomicrographed. Leaf area was determined using ImageJ 1.50i (Rasband, USA). Stomatal patterns of the leaf epidermis were examined and stomatal index were calculated and estimated using:

$$[s/ (e + s)] \times 100 \qquad \text{(Eq. 1)}$$

Where:
s = the number of stomata
e = the number of epidermal cells (Radoglou and Jarvis, 1990; Xu and Zhou, 2008).

Leaf anatomy was studied by preparing transverse sections of the midrib by hand cut free sectioning method. Light microscopic (Nikon DS-Fi2) observations were used to observe the specimens from both studies.

3. RESULTS AND DISCUSSION

3.1 Leaf Morphology

The leaf of twelve live *Dischidia* species were morphologically examined. The leaf characteristics presented (Table 2.1-2.2) were based from the usual leaf diagnostic analysis for this genus. Leaf external features typically includes the

leaf arrangement, leaf shape (e.g. apex, margin, base) and indumentum hair presence and types.

Table 2.1 Leaf Characteristics of Fresh Specimens

Leaf Morphology	*D. sp* 1	*D. sp* 2	*D. sp* 3	*D. sp* 4	*D. sp* 5	*D. sp* 6
Sectional delimitation	Sect. *Dischidia*	Sect. *Dischidia*	Sect. *Dischidia*	Sect. *Ascidifera*	Sect. *Dischidia*	Sect. *Dischidia*
Leaf Arrangement	opposite and decussate	opposite and decussate	opposite and decussate	opposite and decussate	opposite and decussate	opposite and decussate
Leaf Shape	elliptic	elliptic to lanceolate	elliptic to lanceolate	obovate to lanceolate	Ovate	ovate
Leaf Apex	obtuse	obtuse		attenuate	acute to attenuate	acute to attenuate
Leaf Base	subcordate	obtuse	cuneate to attenuate	cuneate to attenuate	rounded	rounded
Leaf Margin	entire	entire	entire	entire	entire	entire
Leaf Texture	thin and smooth	thick and smooth	thick and smooth	thick and smooth	thick and smooth	thick and slightly smooth
Number of Visible Nerves	5 pairs	inconspicuous	4pairs	inconspicuous	3-4 pairs	inconspicuous
Leaf Width	1.2-1.7 cm	2.5-3 cm	2.6-3 cm	1-1.2 cm; (ML 3-5 cm)	1-1.9 cm	0.8- 1 cm
Leaf Length	2-2.8 cm	5-7 cm	4.5-5.6 cm	2-2.5 cm; (ML 4-6 cm)	2-2.5 cm	1.2-1.4 cm
Leaf thickness	0.26 X .001"	0.54 X .001"	0.41 X .001"	0.28 X .001"	0.51 X .001"	1.27 X .001"
Adaxial Leaf Hair Presence	absent	absent	absent	absent	absent	present
Adaxial Leaf Hair Type						puberulous
Abaxial Leaf Hair Presence	absent	absent	absent	absent	absent	present
Abaxial Leaf Hair Type						puberulous
Petiole Length	0.5 cm	0.8- 1 cm	1-2 cm	0.2-0.4 cm	0.3-0.6 cm	0.1-0.3 cm
Petiole Hair Presence	absent	absent	absent	absent	absent	present
Petiole Hair Types						puberulous

Leaves: From the collections made, all three sections were represented namely: Sect. *Dischidia*, Sect. *Conchophylla,* and Sect. *Ascidifera*. Leaves were all opposite, entire, with variable leaf shapes ranging from orbicular, ovate, obovate, elliptic to lanceolate types, leaf apices tend to have an obtuse, attenuate, acute to acuminate forms, leaf bases ranges from subcordate, attenuate, cuneate, rounded to obtuse types. Living specimen textures were mostly smooth due to the presence of cuticle unlike the preserved specimens that tends to loss in time. Generally, leaf width ranges from 0.4 – 7 cm, leaf height from 0.5 – 7 cm; all have petiole with sizes ranging from 0.1 – 1 cm. Leaf nerves seven of the live specimens have inconspicuous nerves, the nerves were hardly visible maybe due to the leaf thickness. For the remaining leaf samples, leaf nerves range from 3-5 nerve pairs.

Leaf surface and nerves: All of the species shades were green to dark green. Utmost leaves have glabrous surface both sides except for *D. sp* 6 with puberulous hairs, *D. hirsuta* with hirsute type, *D. nummularia* with pilose hair and subglabrous with few hirsute hairs on the adaxial and petiole area for *D. platyphylla.* Same remark was seen for the petiole hair presence and types. Leaf nerves seven of the live specimens have inconspicuous nerves, the nerves were hardly visible maybe due to the leaf thickness. For the remaining leaf samples, leaf nerves range from 3-5 nerve pairs.

Table 2.2 Leaf Characteristics of Fresh Specimens (cont.)

Leaf Morphology	*D. hirsuta* (Blume) Decne	*D. lancifolia* Merr.	*D. nummularia* R. Br.	*D. gigantha* Schltr.	*D. platyphylla* Schltr.	*D. ruscifolia* Decne ex Becc
Sectional delimitation	Sect. *Dischidia*	Sect. *Dischidia*	Sect. *Dischidia*	Sect. *Dischidia*	Sect. *Conchophylla*	Sect. *Dischidia*
Leaf Arrangement	opposite and decussate	opposite and decussate	opposite	opposite and decussate	opposite	opposite and decussate
Leaf Shape	ovate to lanceolate	lanceolate	orbicular	obovate	orbicular	ovate
Leaf Apex	acute	acute	acute to acuminate	obtuse	rounded	attenuate to acuminate
Leaf Base	rounded to obtuse	attenuate	rounded to obtuse	attenuate	rounded	rounded
Leaf Margin	entire	entire	Entire	entire	entire	entire
Leaf Texture	thick and slightly smooth	thick and smooth	thick and smooth	thick and smooth	thick and slightly smooth	thick and smooth
Number of Visible Nerves	inconspicuous	4-5 pairs	inconspicuous	inconspicuous	3pairs	inconspicuous
Leaf Width	0.9-1.1 cm	0.9-1.5 cm	0.4-0.6 cm	1.4-1.9	4-7 cm	0.6-0.8 cm
Leaf Length	1.9-2.2 cm	3.5-6 cm	0.5-0.7 cm	2.6-3.4	3-5 cm	0.8-1 cm
Leaf thickness	0.71 X .001"	0.70 X .001"	1.02 X .001"	0.65 X .001"	0.61 X .001"	0.88 X .001"
Adaxial Leaf Hair Presence	present	absent	present	absent	subglabrous	glabrous
Adaxial Leaf Hair Type	hirsute		Pilose		hirsute (few)	
Abaxial Leaf Hair Presence	present	absent	present	absent	absent	absent
Abaxial Leaf Hair Type	hirsute		Pilose			
Petiole Length	0.2-0.4 cm	0.9-1 cm	0.1-0.2 cm	0.5-1 cm	0.3-0.4 cm	0.2 cm
Petiole Hair Presence	present	absent	present	absent	semi glabrous	absent
Petiole Hair Types	hirsute		Pilose		hirsute (few)	

3.2 Stomatal Characteristics

Stomata: The stomatal diagnosis of the twelve fresh samples were microscopically observed. The specimen with the smallest area were as follows respectively, *D. ruscifolia* (0.48 cm^2), *D. nummularia* (0.59 cm^2) and *D. species* 6 (0.97 cm^2) while the largest was *D. platyphylla* with 16.11 cm^2. Distribution of paracytic and anomocytic stomatal types were determined and presented in Table 3 and Fig. 1.

Stomatal outline: General outline was elliptic either narrow and broad. Narrowly elliptic in *Dischidia*

species 1, 2, 3, *D. lancifolia*, *D. nummularia*, *D. oiantha*, *D. platyphylla*; broadly elliptic in *Dischidia species* 4, 5, 6, *D. hirsute* and *D. ruscifolia* (Fig. 1). Also, stomatal size was generally decreased.

Table 3. Stomatal Characteristics of Fresh Specimens

Species	Leaf Area (cm2)	Epidermal cell count		Stomatal count		Stomatal index		Stomatal type
		Adaxial	Abaxial	Adaxial	Abaxial	Adaxial	Abaxial	
D. sp1	2.66	587	513	16	17	2.65	3.21	Paracytic
D. sp2	15.02	378	426	15	9	3.82	2.07	Paracytic
D. sp3	14.08	400	358	11	13	2.68	3.50	Paracytic
D. sp4	2.7	421	483	5	10	1.17	2.03	Anomocytic
D. sp5	2.45	486	292	13	15	2.61	4.89	Paracytic
D. sp6	0.97	340	477	12	13	3.41	2.65	Anomocytic
D. lancifolia Merr.	5.27	264	403	7	14	2.58	3.36	Paracytic
D. hirsuta (Blume) Decne.	1.99	362	323	8	14	2.16	4.15	Paracytic
D. nummularia R. Br.	0.59	462	396	16	13	3.35	3.18	Anomocytic
D. oiantha Schltr.	4.86	430	462	17	14	3.80	2.94	Anomocytic
D. platyphylla Schltr.	16.11	500	517	17	16	3.29	3.00	Paracytic
D. ruscifolia Decne ex Becc	0.48	398	411	20	19	4.78	4.42	Anomocytic

Stomatal index: For the leaf sides, highest for the epidermal and stomatal count were found in abaxial sides. As for the leaf area in relation to its stomatal index (adaxial, abaxial), the largest leaf area, *D. platyphylla* has 3.29 and 3.00 index respectively while *D. ruscifolia*, having the smallest leaf area, has 4.78, 4. 42 stomatal index respectively, this means this species have more compact stomata regardless of its small leaf area.

Epidermal cells: More or less epidermal cells of most species have rectangular to polygonal shapes (e.g. *Dischidia* species 1, 4, *D. lancifolia, D. hirsuta, D. ruscifolia*). While the rest have unclear epidermal cells (Fig.1).

Leaves: From the collections of the Philippine National Herbarium (PNH), three sections were also denoted namely: Sect. *Dischidia,* leaves laminar e.g. *D. hirsute, D. luzonica, D. merrillii, D. nummularia, D. oiantha, D. ruscifolia*; Sect. *Conchophylla,* shell-shaped leaves e.g. *D. platyphylla* and *D. purpurea* and Sect. *Ascidifera,* pitcher leaves e.g. *D. major*. Leaves were all opposite, entire, with variable leaf shapes ranging from orbicular, obovate, ovate to lanceolate types, leaf apices tend to have an obtuse, attenuate, acute to acuminate forms, leaf bases ranges from obtuse, cuneate to attenuate, rounded to obtuse types. Preserved specimen textures were mostly coriaceous, few chartaceous. Commonly, leaf width ranges from 0.4 – 6 cm, leaf height from 0.4 – 7.5 cm; all have petiole with sizes extending from 0.1– 1 cm (Tables 4.1-4.2).

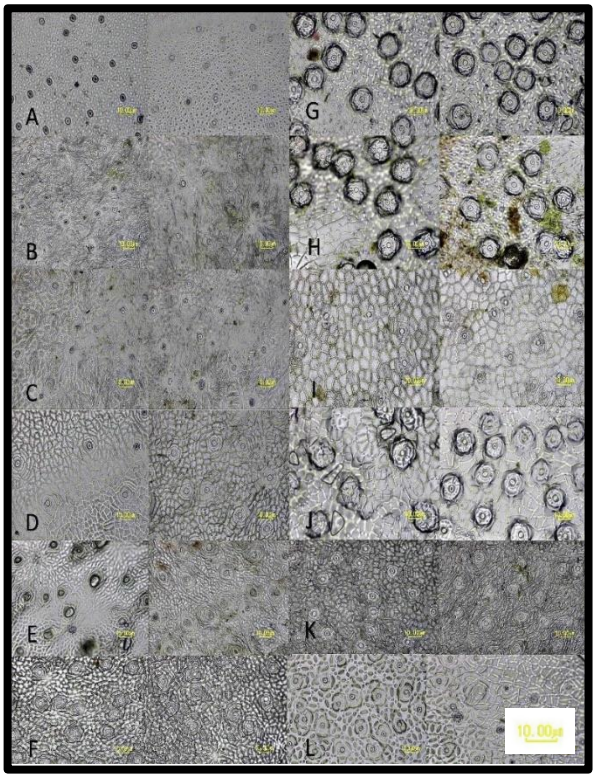

Fig. 1. Stomata of the twelve collected *Dischidia species.* (A) *Dischidia sp.* 1. (B) *Dischidia sp.* 2. (C) *Dischidia sp.* 3. (D). *Dischidia sp. 4.* (E). *D. nummularia.* (F). *D. oiantha.* (G.) D. *Dischidia sp.* 5. (H). *Dischidia sp.* 6. (I). *D. lancifolia.* (J). *D. hirsuta.* (K). *D. platyphylla.* (L). *D. ruscifolia.*

Leaf surface and nerves: All of the species shades were light brown to dark brown. Most of the leaves have glabrous surface on both sides except for *D. hirsuta* with hirsute hairs, *D. nummularia* with pilose hair on the abaxial surface, *D. platyphylla* with adaxial few pilose hair, *D. purpurea*, minimal hirsute hair type, and *D. ruscifolia* with few hirsute hairs on the abaxial surface (Fig. 2). Petiole hair types were usually hirsute e.g. *D. hirsuta*, *D. platyphylla* and *D. ruscifolia*; for D. *nummularia*, pilose hair was seen. Leaf nerves seven of the live specimens have inconspicuous nerves, the nerves are

hardly visible maybe due to the leaf thickness. For the remaining leaf samples, leaf nerves range from 3-5 nerve pairs.

Table 4.1 Leaf Characteristics of Philippine *Dischidia* PNH Specimens

Leaf Morphology	*D. hirsuta* Decne	*D. luzonica* (Schltr.) Livshultz	*D.major* (Vahl.) Merr.	*D. merrillii* Schltr.	*D. nummularia* R. Br.
Sectional delimitation	Sect. *Dischidia*	Sect. *Dischidia*	Sect. *Acidifera*	Sect. *Dischidia*	Sect. *Dischidia*
Leaf arrangement	opposite	opposite	opposite	opposite	opposite
Leaf Shape	ovate to lanceolate	lanceolate	ovate, modified leaf (ML)- oblong-elliptical	lanceolate	orbicular to ovate
Leaf Apex	acute	acute	acute	acuminate	acute to acuminate
Leaf Base	rounded to obtuse	cuneate to attenuate	rounded to obtuse	cuneate	rounded to obtuse
Leaf Margin	entire	entire	entire	entire	entire
Leaf Texture	coriaceous	chartaceous	coriaceous	chartaceous (dry)	chartaceous
Number of Visible Nerves	lateral nerves 2-4 pairs	lateral nerves 4 pairs (opposite, hardly visible)	lateral nerves inconspicuous	lateral nerves 4-5 pairs	lateral nerves inconspicuous
Leaf Width	0.5-1.3 cm	1- 2.1 cm	0.8-1.2 cm, ML- 1-3.7 cm	0.9-1.2 cm	0.4-0.8 cm
Leaf Length	1-2.6 cm	3.1- 7.5 cm	1.2-2.3 cm, ML- 4.3-12.5 cm	2-2.9 cm	0.4-1.2 cm
Leaf Thickness	0.90 X .001"	0.21 X .001"	0.32 X .001"	0.15 X .001"	0.30 X .001"
Adaxial Leaf Hair Presence	present	absent	absent	absent	absent
Adaxial Leaf Hair Type	hirsute				
Abaxial Leaf Hair Presence	present	absent	absent	absent	present
Abaxial Leaf Hair Type	hirsute				pilose
Petiole Length	0.1-0.3 cm	0.6- 1 cm	0.1-0.3 cm	0.2-0.4 cm	0.1- 0.2 cm
Petiole Hair Presence	persisting	not seen	not seen	not seen	seen
Petiole Hair Types	hirsute				pilose

Table 4.2 Leaf Characteristics of Philippine *Dischidia* PNH Specimens (cont.)

Leaf Morphology	*D. oiantha* Schltr.	*D. platyphylla* Schltr.	*D. purpurea* Merr.	*D. ruscifolia* Decne ex Becc
	Sect. *Dischidia*	Sect. *Conchophylla*	Sect. *Conchophylla*	Sect. *Dischidia*
Leaf arrangement	opposite	opposite,	opposite	opposite
Leaf Shape	obovate	orbicular	orbicular	ovate
Leaf Apex	obtuse	rounded	rounded	attenuate to acuminate
Leaf Base	attenuate	rounded	rounded	rounded
Leaf Margin	entire	entire	entire	entire
Leaf Texture	coriaceous	coriaceous	coriaceous	coriaceous
Number of Visible Nerves	lateral nerves inconspicuous	lateral nerves 3-4 pairs	hardly visible lateral nerves (3pairs)	lateral nerves 5 pairs
Leaf Width	0.8- 2.1 cm	2.8-6 cm	1.5-4 cm	0.5- 1 cm
Leaf Length	2-5 cm	2.5- 4.5 cm	1.7-3 cm	0.8- 1.7 cm
Leaf Thickness	0.37 X .001"	0.30 X .001"	0.4 X .001"	0.16 X .001"
Adaxial Leaf Hair Presence	absent	present	present	absent
Adaxial Leaf Hair Type	glabrous	semi-glabrous to hirsute (few)	hirsute (few)	glabrous
Abaxial Leaf Hair Presence	absent	absent	present	present
Abaxial Leaf Hair Type	glabrous	glabrous	hirsute (very few)	hirsute (few)
Petiole Length	0.5- 1 cm	0.3-0.4 cm	0.1cm	0.1-0.2 cm
Petiole Hair Presence	absent	present	not seen	seen
Petiole Hair Types		hirsute (few)		hirsute

Fig. 2. Sample Leaf Hairs from PNH Herbarium Specimens. (A) *D. hirsuta*. (B) *D. nummularia*. (C) *D. platyphylla*. (D) *D. ruscifolia*

Epidermal surface: Common *Dischidia* epidermis were thick and compact. Prominent epidermal thickness was shown clearly in *D. species 1, D. species 6, D hirsute, D. lancifolia, D. nummularia, D. oiantha* and *D. ruscifolia* (Fig. 3-3.1).

Mesophyll: Two types of mesophyll had been identified; (1) isopalisade for *D. species* 1,2,5,6, *D. lancifolia* ,*D. nummularia*, *D. oiantha*, and *D. ruscifolia* , (2) homogenous mesophyll symmetry *D. species* 3,4, *D. hirsute, D. platyphylla* (Fig. 3-3.1). While *D. species* 1 has bifacial symmetry. Both mesophyll types have undifferentiated cells but differs on the cell shape, for isopalisade it was characterized by having elongated to elliptical cells while homogenous types have rounded shape cells (P'yankov and Kondrachuk, 2001).

3.3 Philippine Dischidia Leaf Morphology

To our knowledge, there were no initial observation nor study regarding the leaf morphology and anatomical aspects of *Dischidia* particularly in the Philippines. This study was the first attempt for such endeavor. Morphological plasticity often occurs due to environmental adaptation and response particularly seen in its vegetative parts like the leaves. Some of this plasticity can be seen in external

and anatomical features of leaves. With regards to the morphological features stated in this paper (Tables 2-2.2 & 4-4.1) most of the characters were similar to that of Malayan species of *Dischidia* that recognizes that most leaves are opposite and glabrous (Rintz, 1980; Omino, 1996).

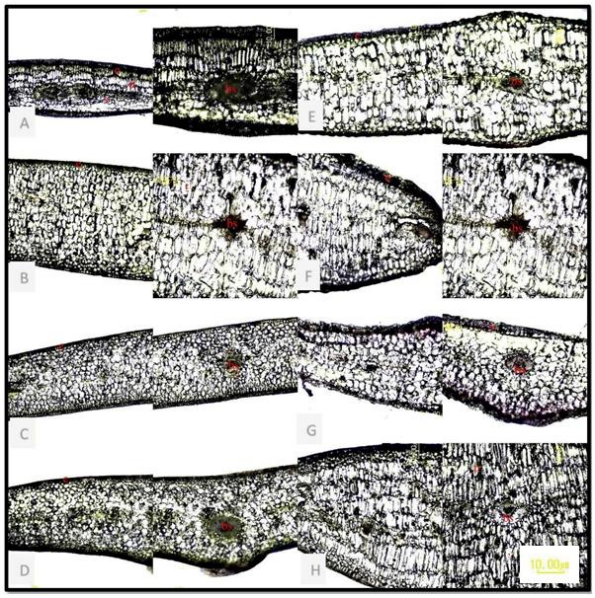

Fig. 3. *Dischidia* Leaves Cross Section Photomicrographs; Mesophyll type:(A-B, E-F, H) Isopalisade; (C,D,G) Homogenous type; e= epidermis; p,s= mesophyll; bs= bundle sheath. (A-F) *Dischidia* species 1-6 respectively. (G). *D. hirsuta*. (H) *D. lancifolia*.

The most frequent stomatal type is paracytic which corroborates on the study of Freire et al. (2005). For the mesophyll, there were no known study regarding the mesophyll characteristics of this genus making this study first to gather such information that has typical isopalisade and homogenous mesophyll symmetry.

Diagnostic Value: Anatomical parts like stomata and mesophyll features in relation to its identificatory value remains uncertain due to the fact that most of these parts are highly variable and susceptible to environmental changes like altitude and climatic events. Making this characters less useful when delimiting species identification. This features are not conserved and adapting easily as supported by the findings of P'yankov & Kondrachuk (2003), Xu & Zhou (2008), Pyakurel & Wang (2014).

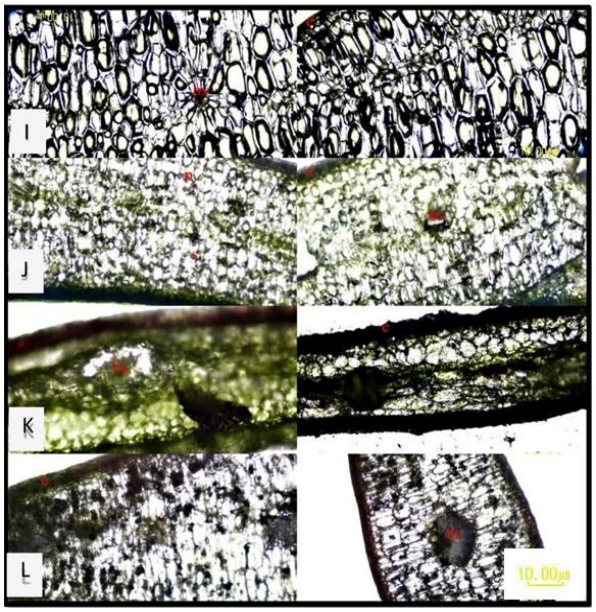

Fig. 3.1. *Dischidia* Leaves Cross Section Photomicrographs Mesophyll type: (I,J,L) Isopalisade; (K) Homogenous; e= epidermis; p,s=mesophyll; bs= bundle sheath. (I) *D. nummularia*. (J) *D. oiantha*. (K) *D. platyphylla*. (L). *D. ruscifolia*.

3.4 Leaf Physiological Aspect

External Morphology: *Dischidia* tends to have narrow and generally thick leaves compared to other plants. It gives reinforcement to endure hot climates and dry environment. Knowing that this genus is an epiphytic, this kind of plant structure is an adaptation. Moreover, most of the species collected have smaller leaf area (e.g. *D. sp.* 1-6, *D. hirsuta*, *D. merrillii, D. nummularia*, *D. ruscifolia*) that enables this aerial plant to track air temperature compare to broader leaves that can overheat easily. As for the leaf hairs, this feature enables less transpirational loss in which some of the *Dischidia* species possess but not at large (Tables 2-2.2; 4-4.1). Reduced leaf size and hair presence are common morphological modification for plants with water deficiency (Xu & Zhou, 2008; Pyakurel & Wang, 2014).

Stomata: Vital intercellular opening in the leaf surface that regulate gases between the atmosphere and the plant tissue are called stomata. This research revealed despite having less leaf area of the *Dischidia* studied it doesn't limit the opacity of the stomata in both leaf sides but highest stomatal count was found in abaxial sides (Table 3) but with prominent small stomatal sizes. With connection to the epiphytic state of the genus that leads to increases water loss it validates other studies about having water deficiency tends to increase stomatal density and reduced stomatal size (Xu & Zhou, 2008; Pyakurel & Wang, 2014). Also, large influence can be directed on the environment where it can affect the leaves developments such as stomatal density (Radoglou and Jarvis, 1990).

Mesophyll: Photosynthesis occurs mainly in these cells (palisade and spongy cells) containing chloroplast. The compactness of the mesophyll tissues allows the maximum effort to trap sunlight for photosynthesis as shown in Fig. 3-3.1. Isopalisade mesophyll are common from plants that are surviving in dry or water deficit conditions (Ivanova and Pyankov, 2000; P'yankov and Kondrachk, 2003) which includes *Dischidia* known for its epiphytic and water lacking environment. While some of the *Dischidia* species exhibit homogenous structure that are common in shady conditions (Ivanova and Pyankov, 2000). The differences between the mesophyll types between species can be due to altitude and environmental conditions (P'yankov and Kondrachuk, 2003) making these mesophylls structure a feature in characterizing a plants ecological condition (Ivanova and Pyankov, 2000). But in relation to its photosynthetic pathway there were no known direct correlation between the two. Though, referencing from other study can somehow classify some *Dischidia* as a Crassulacean Acid Metabolism (CAM) plant. This water-conserving pathway is usually observed in plants prone to dryness or drought. Primarily in epiphytes, which is largely represented throughout the tropical angiosperms. This highly links to the epiphytic traits to conserve water (Tsen and Holtum, 2012). Furthermore, there is a known obligate CAM plant from this genus, the *D. formosa* and its sister genus *Hoya*, *H. carnosa* (Martin et al., 2009).

5. CONCLUSION

Initial leaf morphology and anatomy of selected Philippine *Dischidia* were examined. External leaf characteristics agrees well with the other literatures but without any unique leaf features with identificatory value were observed. As for the anatomical parts, the present study identifies the presence of two types of mesophyll namely, isopalisade and homogeneous mesophyll tissues but this feature were susceptible to environmental and ecological adaptation making these parts a grim diagnostic feature for systematics of *Dischidia*. To extend the diagnostic dimension of the taxon comprehensive morphological observation must be made knowing that this genus remains understudied particularly in the Philippines.

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8. Appendix

Table 5. List of Specimen Examined at the Philippine National Herbarium

Dischidia species	PNH Voucher Number	Location of Collection
D. hirsuta Decne	PNH55690	Mt. Pulgar, Palawan
	PNH3534	Mt. Halcon, Mindoro
	PNH119979	Baybay, Leyte
D. luzonica (Schltr.) Livshultz	PNH1685	Mt. Bulusan, Sorsogon
	PNH18542	Banao, Guinobatan, Albay
D.major (Vahl.) Merr.	PNH17	Mt. Bacungan, PP, Palawan
	PNH35920	Mangrove swamp, Yagaw, Mindoro
	PNH42131	Tungao, Butuan, Agusan
D. merrillii Schltr.	PNH4093	Mt. Kuyapo, Bataan
D. nummularia R. Br.	PNH40768	Near Ondol. Bohol
	PNH10481	Mt. Apo, Davao
	PNH42385	Tungao, Butuan, Agusan
D. platyphylla Schltr.	PNH161732	Mangrove wamp, Jawili, Tangalan, Aklan
	PNH55291	Patag,Sorsogon
	PNH161288	Magdiwang, Sibuyan
D. oiantha Schltr.	PNH8980	Polillo Isld
	PNH34112	Manila
	PNH8320	Zamboanga Mindanao
D. purpurea Merr.	PNH165854	Palawan
	PNH34463	Mt. Malinao Albay
	PNH36491	Mona's Garden Pasay