

Taxonomic studies on the genus *Placodiscus* (Tribe: *Lepisantheae*) in West Africa and Cameroon

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Abstract. A taxonomic study was carried out on members of the genus *Placodiscus* represented in West Africa and Cameroon, in order to present complementary data on adequate recognition of the species. A total of thirteen species were assessed based on quantitative and qualitative macro-morphological and foliar epidermal characters. The findings have shown that the distinctive characters of the species are chiefly quantitative and vary greatly between the species. Hence, they serve as useful characters for delimitation of the species. A systematic description and a descriptive key for identification of the studied species are presented.

Key words: epidermis, identification, light microscopy, *Placodiscus*, *Sapindaceae*, systematics, West Africa

Introduction

The genus *Placodiscus* Radlk. is the second largest genus within the family *Sapindaceae* found in West Africa. It is represented by 13 species (Onuminya & al. 2017). Member species can be found in West and Central Africa, including Benin, Central African Republic, Zaire Congo, Gabon, Ghana, Guinea, Equatorial Guinea, Nigeria, Guinea-Bissau, Côte d'Ivoire, Liberia, Cameroon, Sierra Leone, and Tanzania (Dro & al. 2014; Burgess & al. 2015; Ajayi & Obi 2016). Many species are important timber trees and are used for production of building material, namely house poles and planks (Burkhill 2000), others are applied in herbal medicine (Lebbiel & al. 2017). Therefore, they are threatened and in danger of extinction due to farming, logging, fuel wood collection, and forestry planting (Bosch 2011; IUCN 2020). Several attempts have been made to study

the genus *Placodiscus* in the past, with a focus on general morphology (Hutchinson & Dalziel 1958; Acevedo-Rodriguez & al. 2010; Bosch 2011), wood anatomy (Metcalf & Chalk 1979; Klaassen 1999) and pollen morphology (Müller & Leenhouts 1976), but only a few species were described. Buerki & al. (2009) maintained that data from as many sources as possible should be employed to produce a reliable and good taxonomic account. Thus, species that were insufficiently investigated in the past are now explored in this study so as to ensure adequate identification of the various taxa according to their intrinsic values. Essentially, macromorphological and foliar epidermal assessment of 13 known species (excluding synonyms) represented in West Africa and Cameroon is made in this study, in order to document useful taxonomic data for species identification, even when only leaf fragments are available.

Material and methods

The systematics used in this study is centered on morphological and anatomical features of the collected plants, as obtained from herbaria studies. Dried leaves from herbaria in West Africa and Cameroon (Table 1) of *P. attenuatus* J.B. Hall, *P. bacoensis* Aubreville & Pellegrin, *P. boya* Aubreville & Pellegrin, *P. bracteosus* J.B. Hall, *P. caudatus* Pierre ex Radlk., *P. angustifolius* Radlk., *P. glandulosus* Radlk., *P. leptostachys* Radlk., *P. oblongifolius* J.B. Hall, *P. opacus* Radlk., *P. pseudostipularis* Radlk., *P. pynaertii* De Wild., and *P. turbinatus* Radlk. were used.

Morphological assessment: Qualitative characters of leaf and petiole were visually examined, while quantitative characteristics were measured by thread and meter rule. The reproductive characters of plants, such as flowers, fruits and seeds were assessed.

Leaf epidermis: Foliar epidermal preparations were made by boiling the herbaria samples in water for 10 min to revive the cells. The specimens were transferred individually into small McCartney bottles and treated with concentrated nitric acid (Conc. HNO₃) for at least 5 h so as to macerate the leaf mesophyll. Thereafter, the specimens were placed in Petri dishes containing sterile water and the adaxial and abaxial surfaces were carefully separated. The epidermides were stained in Safranin O, excess stains were removed by 70% ethanol, and mounted in glycerin. The slides were covered with 0.2 mm cover slips and the edges were sealed with nail varnish.

Microscopy: The prepared slides were viewed under a compound light microscope and

photomicrographs of the epidermides showing diagnostic characters of the adaxial and abaxial surfaces were taken using Motic image Plus version 2.0 ml, with MC camera attached to a PIV computer system, at magnification of ×600. Randomly selected cells and stomata in 20 different fields of view were also studied. Measurements were taken by a calibrated micrometer eyepiece, and descriptive statistics of the mean and standard error were calculated for all variables. The stomata index was computed following Stace (1965).

Data analysis: Pair-wise distance matrices were computed for all studied characters, according to Rohlf (1993). Sequential, hierarchical and nested (SAHN) clustering analysis was done using NTSYS-pc 2.02j software package. Based on Nei genetic distances, dendograms were generated following Sneath & Sokal (1973).

Results and discussion

Morphologically, the species of genus *Placodiscus* can be described as trees with compound paripinnate leaves with a smooth or glossy surface. Leaf shape is oblong, margin entire, venation reticulate, arrangement alternate, base cuneate, apex acuminate, except in *P. bacoensis*, *P. oblongifolius* and *P. turbinatus*, where it is cuspidate; petiole is glabrous, except in *P. bacoensis*. The quantitative characters of the leaves vary widely among the studied species, with leaf length ranging between 7 cm and 45 cm, leaf width 3–10 cm, leaf blade 10–70 cm, number of leaflets

Table 1. Provenance of the *Placodiscus* species included in the study

Species	Name of collector	Date of collection	Collection site	Voucher number
<i>P. angustifolius</i>	de Wilde	21-Nov-63	Yaoundé, Cameroon	SRFK 27427
<i>P. attenuatus</i>	Hall, J.B	2-Mar-75	Kissi, Côte d'Ivoire	GCH 47087
<i>P. bacoensis</i>	Hall, J.B & Abbiw	6-Apr-76	Yakossi, Ghana	GCH 3193
<i>P. boya</i>	Letouzey, R	08-Feb-71	Yokadouma, Cameroon	SFRK 23551
<i>P. bracteosus</i>	Vigne, G	30-Jan-50	Ashanti, Ghana	GCH 2694
<i>P. caudatus</i>	Binuyo, A	12-May-59	Cross river, Nigeria	FHI 41293
<i>P. glandulosus</i>	Letouzey, R	8-Jan-72	Ndikinimiki, Cameroon	SFRK 28397
<i>P. leptostachys</i>	Adeyemi, T.O	19-Sep-09	Bimbia Forest Reserve, Cameroon	LUH 3454
<i>P. oblongifolius</i>	Leewenberg, A.J.	23-Feb-59	Beberi, Côte d'Ivoire	GCH 2796
<i>P. opacus</i>	Latilo, M.G.	16-May-52	Calabar, Nigeria	FHI 30970
<i>P. pseudostipularis</i>	Hall, J.B & Abbiw	20-Aug-75	Beberi, Côte d'Ivoire	GCH 45568
<i>P. pynaertii</i>	Abbiw & Hall, J.B.	14-Sep-46	Bikoro, Congo	FHI 15475
<i>P. turbinatus</i>	Odewo, T.K	3-Apr-88	Korup, Cameroon	FHI 10543

Source: Adapted from Onuminya & Ogundipe (2014).

3–8, and petiole length 3–15 cm. The inflorescence is a 5–30 cm long raceme, with flowers containing five white petals and five green sepals, except in *P. glandulosus*, where the petal is pink, and *P. turbinatus*, where the petal is purple and sepal is pink. The fruit is an orange, trilobed, indehiscent drupe, 3–8 cm in size, with three black globose seeds, each measuring 2 cm in size and without aril (Tables 2 & 3). These observations corroborate the earlier reports of Hutchinson & Dalziel (1958), Acevedo-Rodriguez & al. (2010), Adeyemi & al. (2013), and Onuminya & al. (2017) on the attributes of the genus. Our results also provide further information on the earlier reports.

The results obtained from the epidermal study indicate that the adaxial surface of the *Placodiscus* species differs from their abaxial surface, both in quantitative and qualitative characters and, hence, serve as a useful tool in delimitation of the species. This corroborates the opinion of Abdulrahman & al. (2011), who reported that epidermal features are important in the delimitation, recognition and establishment of the affinities between individual taxa.

Foliar epidermal assessment has shown that the species of the genus *Placodiscus* are all hypostomatic, with stomata found only on the abaxial surfaces. This is consistent with the reports of Metcalfe &

Table 2. Qualitative macromorphological characters of the *Placodiscus* species in West Africa and Cameroon.

Species	Habit	Leaf type	Leaf surface	Leaf shape	Leaf margin	Leaf apex	Leaf base	L. venation	L. arrangement	Petiole	Inflorescence	Petal colour	Sepal colour	Fruit type	Fruit colour	Fruit shape	Seed shape	Seed colour
<i>P. angustifolius</i>	t	cp	sg	ob	en	ac	cu	r	al	g	ra	w	gr	id	or	tl	gl	b
<i>P. attenuatus</i>	t	cp	sg	ob	en	ac	cu	r	al	g	ra	w	gr	id	or	tl	gl	b
<i>P. bacoensis</i>	t	cp	sg	ob	en	ac	cu	r	al	p	ra	w	gr	id	or	tl	gl	b
<i>P. boya</i>	t	cp	sg	ob	en	ac	cu	r	al	g	ra	w	gr	id	or	tl	gl	b
<i>P. bracteosus</i>	t	cp	sg	ob	en	ac	cu	r	al	g	ra	w	gr	id	or	tl	gl	b
<i>P. caudatus</i>	t	cp	sg	ob	en	ac	cu	r	al	g	ra	w	gr	id	or	tl	gl	b
<i>P. glandulosus</i>	t	cp	sg	ob	en	ac	cu	r	al	g	ra	pk	gr	id	or	tl	gl	b
<i>P. leptostachys</i>	t	cp	sg	ob	en	ac	cu	r	al	g	ra	w	gr	id	or	tl	gl	b
<i>P. oblongifolius</i>	t	cp	sg	ob	en	c	cu	r	al	g	ra	w	gr	id	or	tl	gl	b
<i>P. opacus</i>	t	cp	sg	ob	en	ac	cu	r	al	g	ra	w	gr	id	or	tl	gl	b
<i>P. pseudostipularis</i>	t	cp	sg	ob	en	ac	cu	r	al	g	ra	w	gr	id	or	tl	gl	b
<i>P. pynaertii</i>	t	cp	sg	ob	en	ac	cu	r	al	g	ra	w	gr	Id	or	tl	gl	b
<i>P. turbinatus</i>	t	cp	sg	ob	en	c	cu	r	al	g	ra	p	pk	id	or	tl	gl	b

Key: t – tree, cp – compound paripinnate, **sg** – smooth and glossy, **ob** – oblong, **en** – entire, **ac** – acuminate, **c** – cuspidate, **cu** – cuneate, **re** – reticulate, **al** – alternate, **g** – glabrous, **p** – pubescent, **ra** – raceme, **w** – white, **gr** – green, **pk** – pink, **pp** – purple, **id** – indehiscent drupe, **or** – orange, **tl** – trilobed, **gl** – globose, **b** – black, **ab** – absent.

Table 3. Quantitative macromorphological characters of the *Placodiscus* species in West Africa and Cameroon.

Species	LL	LB	LW	NL	PL	IL	SS	NS	FS	NP	NS
<i>P. angustifolius</i>	8-18	22-40	3-8	12	10-15	20-30	2.0	3	4-8	5	5
<i>P. attenuatus</i>	8-15	20-32	6-8	10	3-5	10-15	2.0	3	3-6	5	5
<i>P. bacoensis</i>	20-30	30-70	3-8	10	3-5	10-15	2.0	3	3-8	5	5
<i>P. boya</i>	7-20	12-40	3-8	8	3-7	5-10	2.0	3	3-7	5	5
<i>P. bracteosus</i>	10-25	30-60	5-8	10	3-5	12-30	2.0	3	3-6	5	5
<i>P. caudatus</i>	15-18	35-40	3-6	10	3-5	15-20	2.0	3	4-8	5	5
<i>P. glandulosus</i>	10-25	28-65	3-9	10	3-10	15-25	2.0	3	3-5	5	5
<i>P. leptostachys</i>	10-30	18-62	4-10	10	3-4	18-25	2.0	3	5-8	5	5
<i>P. oblongifolius</i>	30-45	32-70	4-6	10	3-4	15-30	2.0	3	3-5	5	5
<i>P. opacus</i>	10-18	20-40	5-8	10	3-7	15-20	2.0	3	3-8	5	5
<i>P. pseudostipularis</i>	3-15	10-35	3-6	6	3-6	10-18	2.0	3	3-8	5	5
<i>P. pynaertii</i>	30-45	32-70	4-6	10	3-4	15-30	2.0	3	3-5	5	5
<i>P. turbinatus</i>	6-30	24-58	3-8	16	3-7	12-25	2.0	3	3-5	6	2

Key: LL – Leaf length, LB – Leaf blade length, LW – Leaf width, NL – Number of leaflets, PL – Petiole length, IL – Inflorescence length, SS – Seed size, NS – No of seeds, FS – Fruit size, NP – Number of petals, NS – Number of sepals. *Unit of measurement in centimeters (cm).

Chalk (1979) and of Adeyemi (2011), where stomata are reportedly confined to the abaxial surface in the species. The stomata are anomocytic, with the exception of *P. leptostachys* with the paracytic stomata type. Trichomes are generally absent, except for the adaxial surface of *P. bacoensis*, where stellate trichomes have been found (Table 4).

On the adaxial surface, cells are polygonal, with a straight anticlinal wall pattern (Plate 1). Exceptions have been found in *P. leptostachys*, where the epidermal cells are irregular and the anticlinal wall pattern is sinuous on both surfaces (Plate 1H, 2H). On the abaxial surface, epidermal cells are irregular, with undulate anticlinal wall pattern in *P. bacoensis*, *P. oblongifolius*, *P. opacus*, and *P. pseudostipularis* (Plates 2B, 2I, 2J & 2K); irregular, with sinuous anticlinal wall pattern in *P. attenuatus*, *P. bracteosus*, *P. angustifolius*, and *P. leptostachys* (Plates 2A, 2C, 2F & 2H), and polygonal, with straight anticlinal wall pattern in *P. boya*, *P. caudatus*, *P. glandulosus*, *P. pynaertii*, and *P. turbinatus*, respectively (Plate 2D, 2E, 2G, 2L & 2M).

Cells are generally mucilaginous on both surfaces. All species varied quantitatively in their epidermal characters, as shown in Table 5. Frequency of occurrence of the epidermal cells was generally higher on the adaxial, than on the abaxial surface, while the highest stomata index (SI) value was recorded in *P. oblongifolius*. Variations observed in the stomata index among the studied plant species according to Abdulrahman & al. (2011) are another valuable tool for their delimitation, since no two species have the same value. A similarity analysis of the combined

morphological and anatomical data has shown close affinities between the studied taxa (Fig. 1).

A description of each studied species is given below, followed by a diagnostic key for their identification.

Placodiscus angustifolius Radlk. in Engler, Pflanzenreich, *Sapindaceae* 813 (1932).

Syn.: *Placodiscus cuneatus* Radlk. ex Engl. Engl. Pflanzenw. Afr. 3(11): 277. (1921).

Specimen examined: Cameroon: Yaoundé – de Wilde 21 Nov, 1963. SRFK 27427; Eseka – J.J. de Wilde & B.E. de Wilde, 21 Nov, 1963. SRFK 27427,

Habitat: Forest; 200-300 m a.s.l.

Distribution: Tropical Africa.

Description: Tree 6–18 m tall; leaves 8–18 cm long, 3–8 cm wide, leaflets in pairs of six, petiole 10–15 cm, inflorescence 20–30 cm. Leaf hypostomatic, epidermal cells 555–700, polygonal, 7–12 × 5–7 µm, thickness 2–3 µm, anticlinal wall pattern straight, trichomes absent on the adaxial surface. On the abaxial surface, epidermal cells 471–570, irregular, 8–11 × 5–8 µm, thickness 2–3 µm, anticlinal wall pattern sinuous, stomata 34–45, anomocytic, 8–12 × 5–8 µm, trichomes absent.

Placodiscus attenuatus J.B. Hall in Adansonia, sér. 2, 20(3): 290 (1980).

Specimen examined: Cote d'Ivoire: Kissi. Hall, J.B. 2 March 1975. GCH 47087, Cape Coast, J.B. Hall, 22 Sept 1962 GCH 2352,

Habitat: Forest, on rocky hills and stream banks; also in moist semi-deciduous and moist evergreen forests.

Table 4. Qualitative foliar epidermal characteristics of the *Placodiscus* species in West Africa and Cameroon.

Characters Species	Cell shape		Anticlinal wall		Stomata type		Trichome	
	Adaxial	Abaxial	Ad	Ab	Ad	Ab	Ad	Ab
<i>P. angustifolius</i>	Polygonal	Irregular	Straight	Sinuous	Abs	Anomocytic	Abs	Abs
<i>P. attenuatus</i>	Polygonal	Irregular	Straight	Sinuous	Abs	Anomocytic	Abs	Abs
<i>P. bacoensis</i>	Polygonal	Irregular	Straight	Undulate	Abs	Anomocytic	Stellate	Abs
<i>P. boya</i>	Polygonal	Polygonal	Straight	Straight	Abs	Anomocytic	Abs	Abs
<i>P. bracteosus</i>	Polygonal	Irregular	Straight	Sinuous	Abs	Anomocytic	Abs	Abs
<i>P. caudatus</i>	Polygonal	Polygonal	Straight	Straight	Abs	Anomocytic	Abs	Abs
<i>P. glandulosus</i>	Polygonal	Polygonal	Straight	Straight	Abs	Anomocytic	Abs	Abs
<i>P. leptostachys</i>	Irregular	Irregular	Sinuous	Sinuous	Abs	Paracytic	Abs	Abs
<i>P. oblongifolius</i>	Polygonal	Irregular	Straight	Undulate	Abs	Anomocytic	Abs	Abs
<i>P. opacus</i>	Polygonal	Irregular	Straight	Undulate	Abs	Anomocytic	Abs	Abs
<i>P. pseudostipularis</i>	Polygonal	Irregular	Straight	Undulate	Abs	Anomocytic	Abs	Abs
<i>P. pynaertii</i>	Polygonal	Polygonal	Straight	Straight	Abs	Anomocytic	Abs	Abs
<i>P. turbinatus</i>	Polygonal	Polygonal	Straight	Straight	Abs	Anomocytic	Abs	Abs

Key: Ad – Adaxial surface, Ab – Abaxial surface, Abs – Absent

Table 5. Quantitative foliar epidermal characteristics of the *Placodiscus* species in West Africa and Cameroon.

Species	ECN	ECL	ECW	ECT	SN	SL	SW	SI
<i>P. angustifolius</i>	635.6±12.3	9.2±0.6	5.7±0.2	2.4±0.2	–	–	–	–
	504.0±10.7	9.9±0.4	6.2±0.3	2.4±0.2	74.5±2.0	7.5±0.2	7.9±0.1	12.9
<i>P. attenuatus</i>	530.6±9.2	10.2±0.3	5.2±0.3	2.2±0.1	–	–	–	–
	342.8±5.4	10.9±0.3	7.0±0.3	2.7±0.2	27.5±1.0	7.8±0.1	7.8±0.1	7.6
<i>P. bacoensis</i>	464.0±9.8	7.7±0.8	7.2±0.8	2.3±0.2	–	–	–	–
	288.0±5.1	9.20±0.6	8.0±0.4	2.5±0.2	24.0±0.9	7.7±0.2	7.8±0.1	7.8
<i>P. boya</i>	501.0±7.2	10.0±0.7	7.7±0.5	2.6±0.2	–	–	–	–
	259.0±7.0	9.7±.5	7.4±0.5	2.2±0.1	50.5±1.7	8.9±0.1	8.0±0.1	16.4
<i>P. bracteosus</i>	580.0±5.4	8.0±0.5	6.3±0.3	2.2±0.1	–	–	–	–
	406.1±5.2	8.5±0.5	7.8±0.4	2.5±0.2	58.8±1.9	9.7±0.2	9.5±0.2	12.7
<i>P. caudatus</i>	669±7.8	7.1±0.4	6.4±0.3	2.6±0.2	–	–	–	–
	340.0±6.2	6.8±0.3	10.3±0.4	2.3±0.2	44.9±1.2	7.3±0.2	7.3±0.2	11.7
<i>P. glandulosus</i>	713.9±13.3	10.3±0.4	6.9±0.2	2.5±0.2	–	–	–	–
	458.6±12.1	9.0±0.5	6.3±0.4	2.2±1.3	52.4±2.0	7.0±0.0	7.0±0.0	10.3
<i>P. leptostachys</i>	492.8±10.6	10.5±0.5	6.4±0.4	2.5±0.2	–	–	–	–
	374.0±14.5	11.1±0.3	7.1±0.3	2.2±0.1	40.7±1.3	7.6±0.2	7.6±0.2	9.9
<i>P. oblongifolius</i>	472.0±12.1	10.0±0.4	7.0±0.3	2.0±0.2	–	–	–	–
	309.2±15.2	9.9±0.4	9.5±0.4	2.4±0.2	64.6±2.5	9.8±0.1	9.8±0.1	17.5
<i>P. opacus</i>	480.5±12.6	10.0±0.3	6.7±0.3	2.3±0.2	–	–	–	–
	390.0±10.1	10.0±0.4	6.9±0.5	2.3±0.2	96.7±2.3	6.0±0.0	6.0±0.0	19.9
<i>P. pseudostipularis</i>	509.0±5.8	10.3±0.3	7.0±0.5	2.3±0.2	–	–	–	–
	419.0±6.5	10.4±0.3	6.5±0.5	2.2±0.1	52.8±1.7	7.8±0.1	7.0±0.1	11.2
<i>P. pynaertii</i>	687.0±15.9	8.5±0.5	7.6±0.4	2.7±0.2	–	–	–	–
	493.7±7.9	9.7±0.5	6.5±0.3	2.6±0.2	29.0±1.7	7.0±0.0	7.0±0.0	5.6
<i>P. turbinatus</i>	386.8±9.5	9.9±0.6	8.1±0.5	2.6±0.2	–	–	–	–
	315.9±8.6	10.8±0.6	9.2±0.48	2.6±0.2	41.6±0.8	8.9±0.1	8.9±0.1	11.7

Key: ECN – epidermal cell number, ECL – epidermal cell length, ECW – epidermal cell width, ECT – epidermal cell thickness, SN – stomata number, SL – stomata length, SW – stomata width, SI – stomata index. *Values represent mean ± standard error, Stomata Index is in percentage.

Distribution: Cote d'Ivoire, Tropical Africa.

Description: Tree 3–5 m tall; leaves 8–15 cm long, 6–8 cm wide, leaflets in pairs of five, petiole 3–5 cm, bark smooth, inflorescence 10–15 cm. Leaf hypostomatic, epidermal cells 492–576, polygonal, 9–12 × 4–7 µm, thickness 2–3 µm, anticlinal wall pattern straight, trichomes absent on the adaxial surface. On the abaxial surface, epidermal cells 318–373, irregular, 10–12 × 6–8 µm, thickness 2–3 µm, anticlinal wall pattern sinuous, stomata 23–32, anomocytic, 7–8 × 7–8 µm, trichomes absent.

Placodiscus bacoensis Aubrév. & Pellegr., Fl. Forest. Cote d'Ivoire. 2: 200 (1936).

Specimen examined: Ghana: Yakossi. Vigne 6 April 1976. GCH 3193; Achowa. Hall, J.B & Abbiw 6 April 1973. GCH 44329.

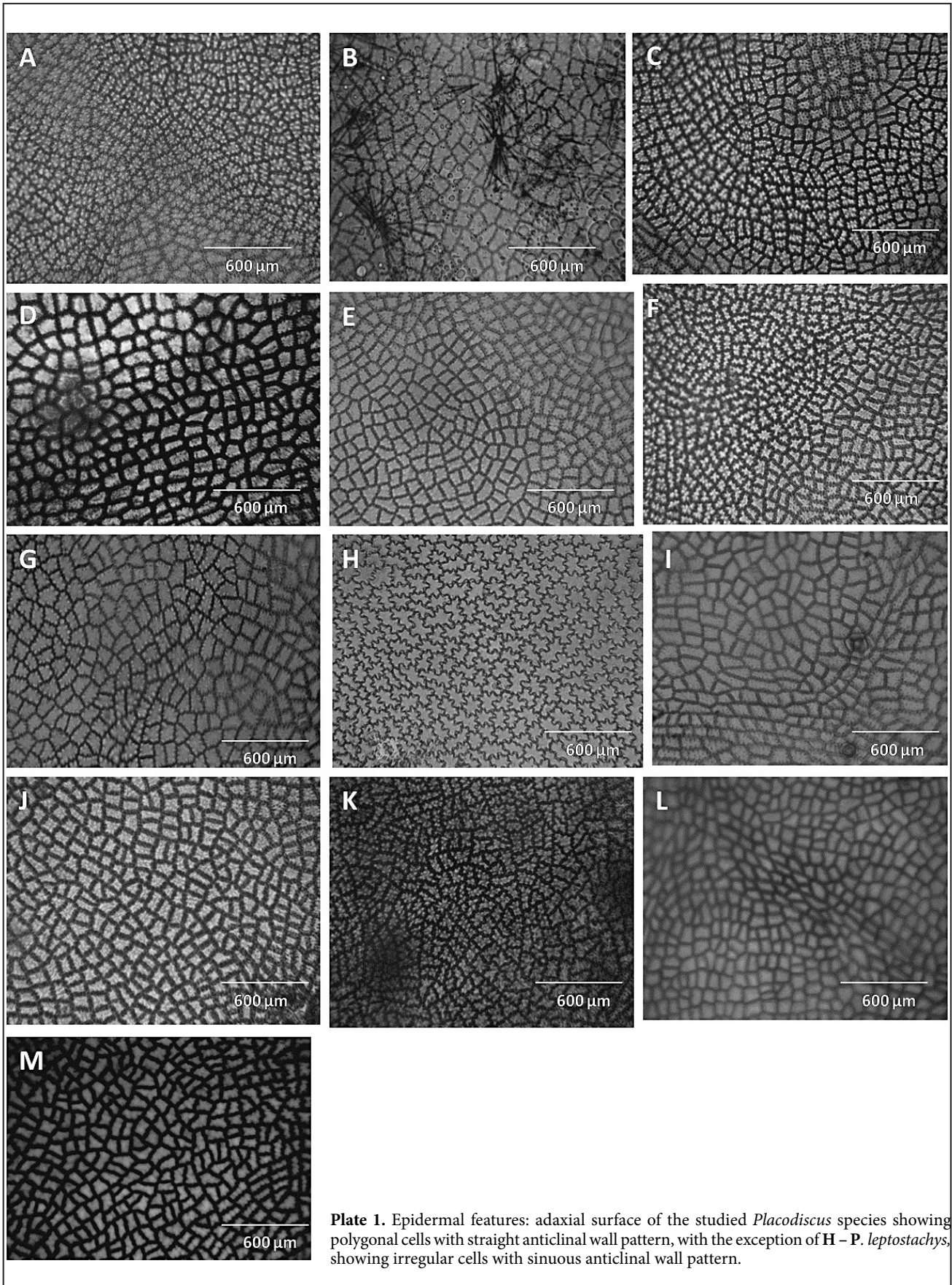
Habitat: Moist evergreen forest.

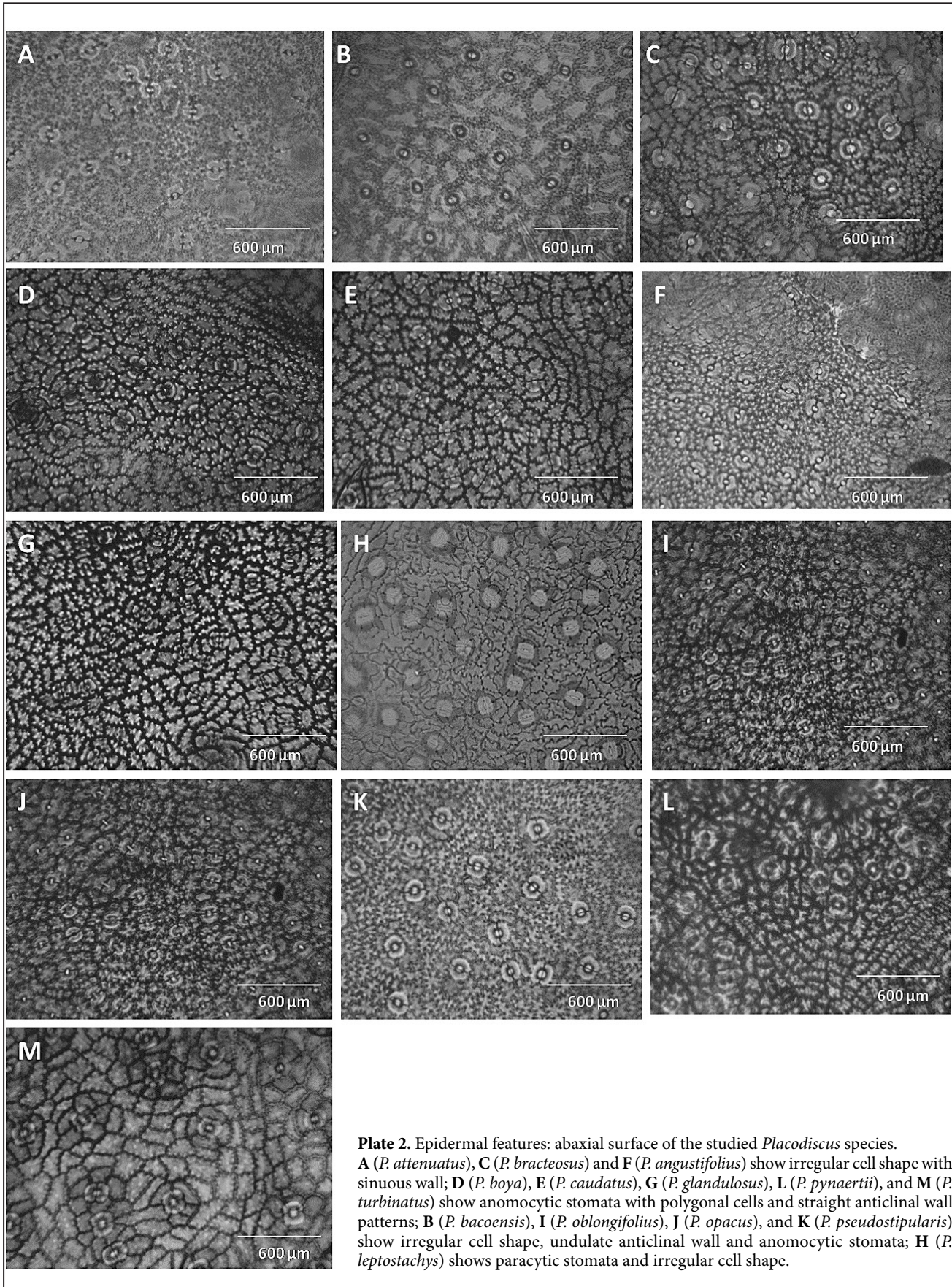
Distribution: Cote d'Ivoire.

Description: Tree 16 m tall; leaves 20–30 cm long, 3–8 cm wide, leaflets in pairs of five, petiole 3–5 cm, bark smooth, inflorescence 10–15 cm. Leaf hypostomatic, epidermal cells 417–503, polygonal, 5–13 × 4–11 µm, thickness 2–3 µm, anticlinal wall pattern straight, trichomes stellate on the adaxial surface. On the abaxial surface, epidermal cells 259–311, irregular, 7–12 × 6–10 µm, thickness 2–3 µm, anticlinal wall pattern undulate, stomata 20–28, anomocytic, 7–8 × 7–8 µm, trichomes absent.

Placodiscus boya Aubreville & Pellegrin., Fl. For. Côte d'Ivoire 2: 200 (1936).

Specimen examined: Cameroun: Medoun – Letouzey, 9 Aug 1963, SRFK 7353; Yokadouma –





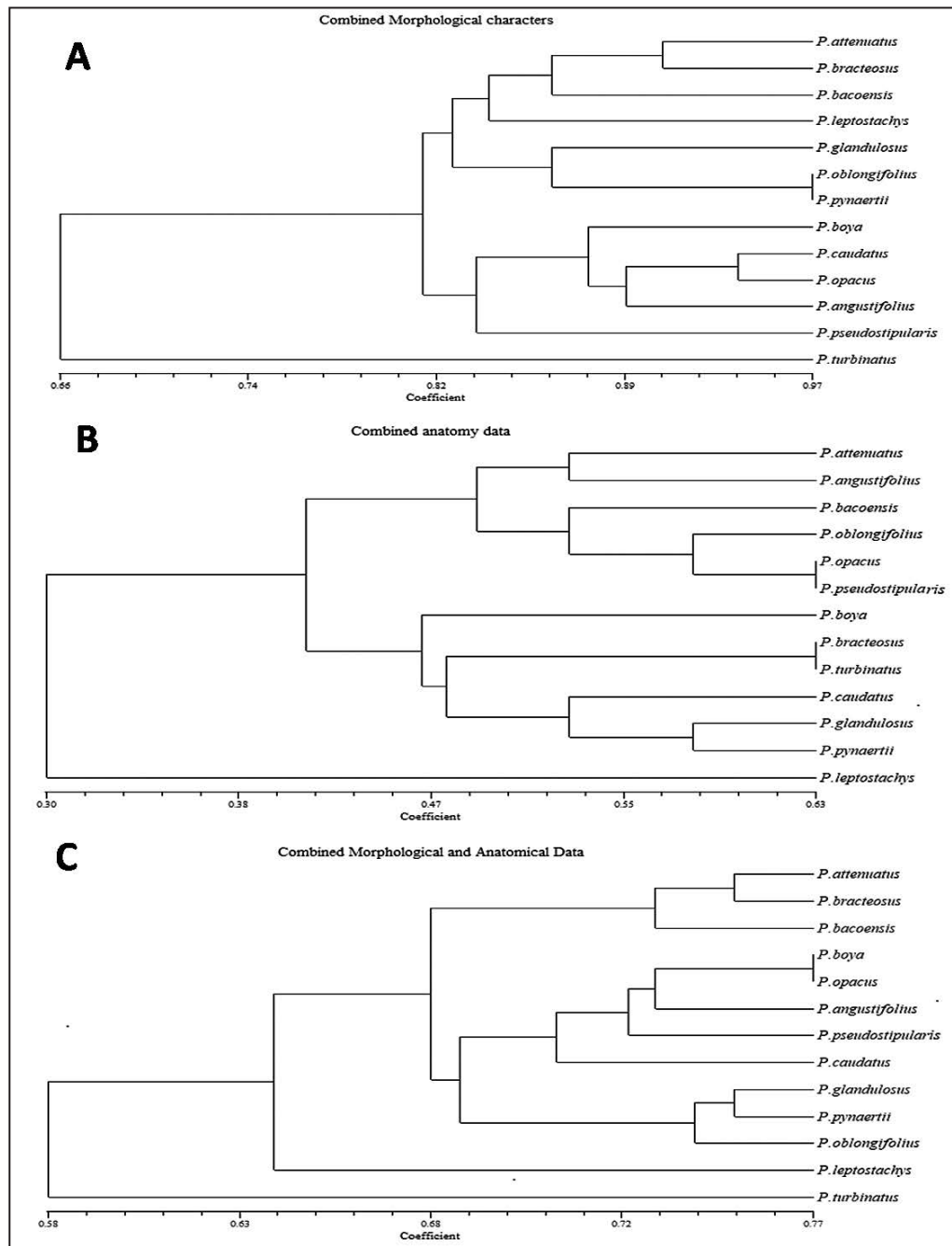


Fig. 1. UPGMA Similarity Tree of relationships among the studied taxa. **A** – based on quantitative and qualitative morphological characters only; **B** – based on combined quantitative and qualitative anatomical characters; **C** – based on combined morphological and molecular characters.

Letouzey, 18 Feb 1971, SRFK 23351; Ghana: Ejian – C. Vigne, 1 Jan 1930, GC 1791; Bia-Tano – Hall & Abinno, 20 Jun 1973, GC 44551

Habitat: Closed forest; dry forest; evergreen and semi-deciduous forests; in understory; very common in places, occasionally dominant; 350–586 m a.s.l.

Distribution: West Tropical Africa, Cameroon, Gabon.

Description: Tree 20 m tall; leaves 7–20 cm long, 3–8 cm wide, leaflets in pairs of four, petiole 3–7 cm, bark rough, inflorescence 5–10 cm. Leaf hypostomatic, epidermal cells 457–531, polygonal, 6–13 × 5–10 μm,

thickness 2–3 μm, anticlinal wall pattern straight, trichomes absent on the adaxial surface. On the abaxial surface, epidermal cells 224–291, polygonal, 8–12 × 5–10 μm, thickness 2–3 μm, anticlinal wall pattern straight, stomata 43–61, anomocytic, 8–9 × 8–9 μm, trichomes absent.

Placodiscus bracteosus J.B. Hall in *Adansonia* sér. 2, 20(3): 289 (1980).

Specimen examined: Ghana: Ashanti, Vigne, G. 30 Jan 1950. GCH 2694; Ashanti, Vigne, G. 29 Dec 1949. GCH 1612

Habitat: Semi-deciduous forest, dry forest, in rocky wet places, especially on stream banks.

Distribution: Nigeria, Ghana, Côte d'Ivoire.

Description: Tree 5–7 m tall; leaves 30–60 cm long, 5–8 cm wide, leaflets in pairs of five, petiole 3–5 cm, bark smooth, inflorescence 10–15 cm. Leaf hypostomatic, epidermal cells 559–610, polygonal, 5–10 × 5–8 µm, thickness 2–3 µm, anticlinal wall pattern straight, trichomes absent on the adaxial surface. On the abaxial surface, epidermal cell 383–436, irregular, 6–11 × 6–10 µm, thickness 2–3 µm, anticlinal wall pattern sinuous, stomata 49–67, anomocytic, 9–10 × 8–10 µm, trichome absent.

Placodiscus caudatus Pierre ex Radlk. in Mem. Soc. Linn. Normandie 26(2): 70 (1924).

Syn.: *Placodiscus riparius* Keay Bull. Jard. Bot. Etat Bruxelles 26: 194. (1956).

Specimen examined: Sierra Leone: Njala – Deighton, 17 Sep 1951, FHI 39473; Nigeria: Cross River – Binuyo, A. 12 May 1959 FHI 41293

Habitat: Forest; 50 m a.s.l.

Distribution: Gabon.

Description: Small tree 1–3 m tall; leaves 15–18 cm long, 3–6 cm wide, leaflets in pairs of five, petiole 3–5 cm, inflorescence 15–20 cm. Leaf hypostomatic, epidermal cells 636–701, polygonal, 5–9 × 5–8 µm, thickness 2–3 µm, anticlinal wall pattern straight, trichomes absent on the adaxial surface. On the abaxial surface, epidermal cells 308–362, polygonal, 8–12 × 6–8 µm, thickness 2–3 µm, anticlinal wall pattern straight, stomata 36–53, anomocytic, 6–9 × 5–8 µm, trichomes absent.

Placodiscus glandulosus Radlk. in Engler, Pflanzenw. Afr. 3(11): 277 (1921).

Specimen examined: Cameroun: Bakundu – Onochie, 20 Mar 1953, FHI 30870; Victoria Gardens – Thal, 1929, FHI 9311; Masoka – Leewenberg, 31 Mar 1965, SRFK 25493; Yingui – Letouzey, 8 Jan 1972, SRFK 28397.

Habitat: Forest, in understory; 1–300 m a.s.l.

Distribution: Tropical Africa, Nigeria, Cameroon, Gabon, Equatorial Guinea.

Description: Tree 4–8 m tall; leaves 10–25 cm long, 3–9 cm wide, leaflets in pairs of five, petiole 3–10 cm, bark rough, inflorescence 15–25 cm, petal pink. Leaf hypostomatic, epidermal cells 655–800, polygonal, 7–11 × 6–8 µm, thickness 2–3 µm,

anticlinal wall pattern straight, trichomes absent on the adaxial surface. On the abaxial surface, epidermal cells 420–517, polygonal, 7–11 × 5–8 µm, thickness 2–3 µm, anticlinal wall pattern straight, stomata 41–60, anomocytic, 7 × 7 µm, trichomes absent.

Placodiscus leptostachys Radlk. in Sitzungsber. Bayer. Akad. Wiss. Munchen 9: 606 (1879).

Specimen examined: Nigeria: Ibadan – Sieferhi, 27 Jun 1954, FHI 23646; Ogoja – J.O Amachi, Apr 1958, FHI 38253; Obudu – Jones, 21 May 1946, FHI 18633; Cameroon: Bimbia – ADEYEMI, T.O 19 Sep 2009 LUH 3454

Habitat: Forest; 600–800 m a.s.l.

Distribution: Nigeria, Cameroon and Gabon.

Description: Tree 7 m tall; leaves 10–30 cm long, 4–10 cm wide, leaflets in pairs of five, petiole 3–4 cm, inflorescence 18–25 cm. Leaf hypostomatic, epidermal cells 450–550, irregular, 9–13 × 5–8 µm, thickness 2–3 µm, anticlinal wall pattern sinuous, trichomes absent on the adaxial surface. On the abaxial surface, epidermal cells 300–430, irregular, 10–13 × 6–8 µm, thickness 2–3 µm, anticlinal wall pattern sinuous, stomata 34–47, paracytic, 7–8 × 7–8 µm, trichomes absent.

Placodiscus oblongifolius J.B. Hall in Adansonia sér. 2, 20(3): 291 (1980).

Specimen examined: Côte d'Ivoire: Beberi – Leewenberg, A.J. 23 Feb 1959 GCH 2796; Ghana: Achowa. J.B. Hall, 6 April 1973, GCH 44191.

Habitat: Evergreen (moist) forest.

Distribution: West Tropical Africa.

Description: Tree 7 m tall; leaves 30–45 cm long, 4–6 cm wide, apex cuspidate, leaflets in pairs of five, petiole 3–4 cm, bark rough, inflorescence 15–30 cm. Leaf hypostomatic, epidermal cells 420–525, polygonal, 8–12 × 6–9 µm, thickness 2–3 µm, anticlinal wall pattern straight, trichomes absent on the adaxial surface. On the abaxial surface, epidermal cells 222–369, irregular, 8–12 × 8–11 µm, thickness 2–3 µm, anticlinal wall pattern undulate, stomata 51–75, anomocytic, 7–11 × 5–7 µm, trichomes absent.

Placodiscus opacus Radlk. in Engler, Pflanzenreich, Sapindaceae: 814 (1932).

Syn.: *Placodiscus letestui* Pellegrin. Bull. Soc. Bot. France 102: 229. (1955).

Specimen examined: Nigeria: Cross River – Latilo, 28 Feb 1973, FHI 67759; Calabar – Latilo, M.G. 16 May 1952 FHI 30970

Habitat: Riverine forest, forest; 225–770 m a.s.l. (Gabon).

Distribution: Nigeria, East Tropical Africa.

Description: Tree 3–6 m tall; leaves 10–18 cm long, 5–8 cm wide, leaflets in pairs of five, petiole 3–7 cm, inflorescence 15–20 cm. Leaf hypostomatic, epidermal cells 424–531, polygonal, 9–12 × 5–8 µm, thickness 2–3 µm, anticlinal wall pattern straight, trichomes absent on the adaxial surface. On the abaxial surface, epidermal cells 343–447, irregular, 8–12 × 5–9 µm, thickness 2–3 µm, anticlinal wall pattern undulate, stomata 85–108, anomocytic, 6 × 6 µm, trichomes absent.

Placodiscus pseudostipularis Radlk. in Sitzungsber. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. München 20: 242 (1890).

Specimen examined: Ghana: Ankasa – Hall & Enti, 5 Apr. 1968, GCH 38404; Côte d'Ivoire: Grand Bereby, Hall & Abbiw, 20 Aug 1975, GCH 45568

Habitat: Closed forest, rain-forest, commonly in understory.

Distribution: West Tropical Africa.

Description: Tree 15 m tall; leaves 3–15 cm long, 3–6 cm wide, leaflets in pairs of three, petiole 3–6 cm, bark rough, inflorescence 10–18 cm. Leaf hypostomatic, epidermal cells 485–540, polygonal, 8–12 × 5–9 µm, thickness 2–3 µm, anticlinal wall pattern straight, trichomes absent on the adaxial surface. On the abaxial surface, epidermal cells 303–446, irregular, 9–12 × 5–9 µm, thickness 2–3 µm, anticlinal wall pattern undulate, stomata 46–63, anomocytic, 7–8 × 7–8 µm, trichomes absent.

Placodiscus pynaertii De Wild. in Bull. Jard. Bot. Etat Bruxelles 4: 371 (1914).

Specimen examined: Congo: Bikoro – J. Leonard, 14 Sept 1946 FHI 15475.

Habitat: Riverbanks in forest, swamp forest, on islands in rivers, often also in water.

Distribution: Central African Republic, Congo Democratic Republic.

Description: Tree 5–10 m tall; leaves 30–45 cm long, 4–6 cm wide, leaflets in pairs of five, petiole 3–4 cm, bark rough, inflorescence 15–30 cm. Leaf hypostomatic, epidermal cells 671–780, polygonal,

7–10 × 6–9 µm, thickness 2–3 µm, anticlinal wall pattern straight, trichomes absent on the adaxial surface. On the abaxial surface, epidermal cells 456–531, polygonal, 7–12 × 5–80 µm, thickness 2–3 µm, anticlinal wall pattern straight, stomata 23–38, anomocytic, 7–11 × 5–7 µm, trichomes absent.

Placodiscus turbinatus Radlk. in Sitzungsber. Bayer. Akad. Wiss. München 7: 332 (1878).

Specimens examined: Nigeria: Benin – Odewo T.K. 29 Jun 1984, FHI 101699; Calabar – Binuyo, 29 Jan 1962, FHI 45461; Ogoja – Binuyo, 12 May 1959, FHI 41293; Calabar – Okafor, 22 Feb 1957, FHI 36423; Calabar – Onochie, 18 Jan 1957, FHI 36040; Cameroun: Korup National Park – Odewo T.K., 3 Apr 1988, FHI 105431; Kumba – Ejiofor, 23 Feb 1946, FHI 14075

Habitat: Forest.

Distribution: Nigeria and Cameroon.

Description: Tree 5–12 m tall; leaves 6–30 cm long, 3–8 cm wide, leaflets in pairs of eight, apex cuspidate, petiole 3–7 cm, bark rough, inflorescence 12–25 cm, petals purple, sepals pink. Leaf hypostomatic, epidermal cells 336–431, polygonal, 8–13 × 6–10 µm, thickness 2–3 µm, anticlinal wall pattern straight, trichomes absent on the adaxial surface. On the abaxial surface, epidermal cells 283–361, polygonal, 8–13 × 8–11 µm, thickness 2–3 µm, anticlinal wall pattern straight, stomata 38–46, anomocytic, 8–9 × 8–9 µm, trichomes absent.

Key to identification of the studied *Placodiscus* species

Trees, leaves paripinnate, apex acuminate, occasionally cuspidate, leaflets 3–8 pairs, less than 45 cm long, petiole up to 15 cm long, fruit indehiscent drupe, trilobed, seeds without aril, leaf epidermis hypostomatic, stomata abaxial anomocytic, occasionally paracytic *Placodiscus*

- 1a. Leaflets eight pairs, sepals pink *P. turbinatus*
- 1b. Leaflets less than eight pairs, sepals green 2
- 2a. Stomata paracytic, adaxial epidermal cells irregular and sinuous *P. leptostachys*
- 2b. Stomata anomocytic, adaxial epidermal cells polygonal and straight 3
- 3a. Petiole pubescent, trichomes stellate . *P. bacoensis*
- 3b. Petiole glabrous, trichomes absent 4
- 4a. Leaf apex cuspidate, mean adaxial cell number 472 *P. oblongifolius*

- 4b. Leaf apex acuminate, mean adaxial cell number exceeds 472 5
- 5a. Abaxial cells irregular in shape, anticlinal wall pattern sinuous or undulate 6
- 5b. Abaxial cells polygonal in shape, anticlinal wall pattern straight 10
- 6a. Anticlinal wall sinuous, number of leaflets 5–6 pairs 7
- 6b. Anticlinal wall undulate, number of leaflets 3–5 pairs 9
- 7a. Fruit size 3–6 cm, petiole length up to 5 cm 8
- 7b. Fruit size 4–8 cm, petiole length 10–15 cm
..... *P. angustifolius*
- 8a. Leaf length 10–25 cm, inflorescence length exceeds 15 cm *P. bracteosus*
- 8b. Leaf length up to 15 cm, inflorescence length below 15 cm *P. attenuatus*
- 9a. Leaf width 3–6 cm, mean stomata number 53
..... *P. pseudostipularis*
- 9b. Leaf width 5–10 cm, mean stomata number 97 ...
..... *P. opacus*
- 10a. Petal color pink, average adaxial cell number exceeds 700 *P. glandulosus*
- 10b. Petal color white, average adaxial cell number below 700 11
- 11a. Inflorescence 20–30 cm long, leaf length 30–40 cm *P. pynaertii*
- 11b. Inflorescence up to 20 cm long, leaf length below 30 cm 12
- 12a. Leaf width under 35 cm, number of leaflets four pairs *P. boya*
- 12b. Leaf width at least 35 cm, number of leaflets five pairs *P. caudatus*

Conclusion

In this study, it was found out that the species of genus *Placodiscus* vary widely in their attributes and thus can be used to differentiate, reliably recognize and identify the various species. Therefore, this study is a useful contribution to the taxonomic knowledge of the various species within genus *Placodiscus* in Africa.

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