

# Taxonomic Evaluation of Fifteen Species of *Ipomoea* L. (*Convolvulaceae*) from South-Western Nigeria using Foliar Micromorphological Characters

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## Abstract

Foliar micromorphological study was carried out on *I. triloba*, *I. eriocarpa*, *I. alba*, *I. hederifolia*, *I. muricata*, *I. intrapilosa*, *I. asarifolia*, *I. batatas*, *I. aquatica*, *I. mauritiana*, *I. carnea*, *I. involucrata*, *I. nil*, *I. heterotricha* and *I. obscura* to determine the patterns of variation in their epidermal characteristics and search for useful and stable anatomical characters for the identification of the species. Leaf epidermal features that provided useful specific distinctions are cell shape, anticlinal wall pattern, stomata shape, stomata type, trichome, cuticular striations, crystal, granular periclinal wall, stomata size, stomata index, scale and tannin. The characters revealed interrelationships among the *Ipomoea* species and also suggest their monophyly.

**Keywords:** characters, epidermal, *Ipomoea*, leaf, micromorphology

## Introduction

*Ipomoea* is an exceptionally large and diverse genus in the family *Convolvulaceae*, it consists of about 600 species in strict and traditional concepts of the group (Austin and Huáman, 1996) or up to 1000 species in recent phylogenetic conceptions of the group (Manos *et al.*, 2001; Miller *et al.*, 2002; Wilkin, 1999). It is known that 38 species have been reportedly found in West Africa of which 30 have been recognized present in Nigeria. These species are commonly found in the Southern region, a few are found in the Northern location in the Savanna zones (Hutchinson and Dalziel, 1963). *Ipomoea* are good flagship species and possible good environmental indicator's (Gill, 1988). *Ipomoea* species are generally of vital economic importance ranging from ornamental, medicinal to culinary value.

*Ipomoea* species are highly variable in nature, most especially in Nigeria where they have received little attention when compared with the species from other countries and this has led to the description of intraspecific species. The high variability in *Ipomoea* species has created identification problems, a better system of classification and delimitation of the species using anatomical and biochemical characters is desirable. Previous works in the family revealed that pollen characteristics have been used as important criteria for generic delimitation. Spinose pollen of *Ipomoea* has been used to separate it from related genera, like *Meremia* and *Operculina* which have smooth pollen (Olorode, 1984). Shinner (1965) exploited the pollen character together with fruiting materials to dump both *Meremia* and *Operculina* into *Ipomoea*. However, gross similarities in the pollen characteristics of the different species of *Ipomoea* have been reported by Vij and Sachdeva

(1975), thus pollen characteristics cannot be used for species delimitation.

The objectives of this present work are to determine the patterns of variation in epidermal characteristics and use the foliar anatomical characters in the identification and classification of the *Ipomoea* species.

## Materials and methods

Fresh leaves of fifteen species of *Ipomoea* namely *I. triloba*, *I. eriocarpa*, *I. alba*, *I. hederifolia*, *I. muricata*, *I. intrapilosa*, *I. asarifolia*, *I. batatas*, *I. aquatica*, *I. mauritiana*, *I. carnea*, *I. involucrata*, *I. nil*, *I. heterotricha*, *I. obscura* were collected from different locations in Obafemi Awolowo University Campus (7° 47' N, 4° 57' E), Osun State, South West Nigeria. Species identification and confirmation was done at the Herbarium (IFE) in Obafemi Awolowo University Campus and Forestry Research Institute of Nigeria Herbarium (FHI), Ibadan. Voucher specimens were deposited in these herbaria.

Portions of the leaves were taken from the median part (midway between the tip and the base) from ten accessions of each species. These were put into Jeffrey's maceration mixture (10% chromic acid and concentrated hydrochloric acid) and kept in oven at 60°C for about 15 minutes. Each sample was then washed thoroughly in 5 changes of water.

The adaxial and abaxial epidermis were separated by means of dissecting needle and forceps. The epidermal surfaces were stained in 1% safranin O for about five minutes, washed with 4 changes of water to remove excess stain and then temporary mounts were made in 25% glycerol. Stomatal index was calculated according to Dilcher (1974).

All processed materials were preserved in 50% ethyl alcohol until when required. Photomicrographs of slides were taken with Amscope MT microscope camera version 3.001 attached to a light microscope. All measurements were made with the aid of ocular micrometer and final figure obtained with ocular constant.

**Results**

There are anatomical variations among the fifteen species of *Ipomoea* studied, and the characteristics of leaf epidermis of the *Ipomoea* are listed in Tab. 1 and 2. Light microscopic features of both abaxial and adaxial leaf surfaces are illustrated in Fig. 1 and 2.

*Epidermal cells*

The epidermal cells on both surfaces of the *Ipomoea* are polygonal to irregular in shape with anticlinal walls straight to wavy. On the abaxial surface, granular periclinal wall is present in all the species except in *I. batatas* and *I. aquatica*. Similarly, on the adaxial surface, granular periclinal wall is present in all the species except in *I. intrapilosa*, *I. aquatica*, *I. heterotricha* and *I. triloba*.

*Stomatal apparatus*

Stomatal shape is largely elliptic in most of the species but oval in *I. batatas*, *I. carnea* and circular in *I. alba* and *I. involucrata*. Brachyparacytic stomata predominantly occur on both surfaces of the species except in *I. hederifolia*,

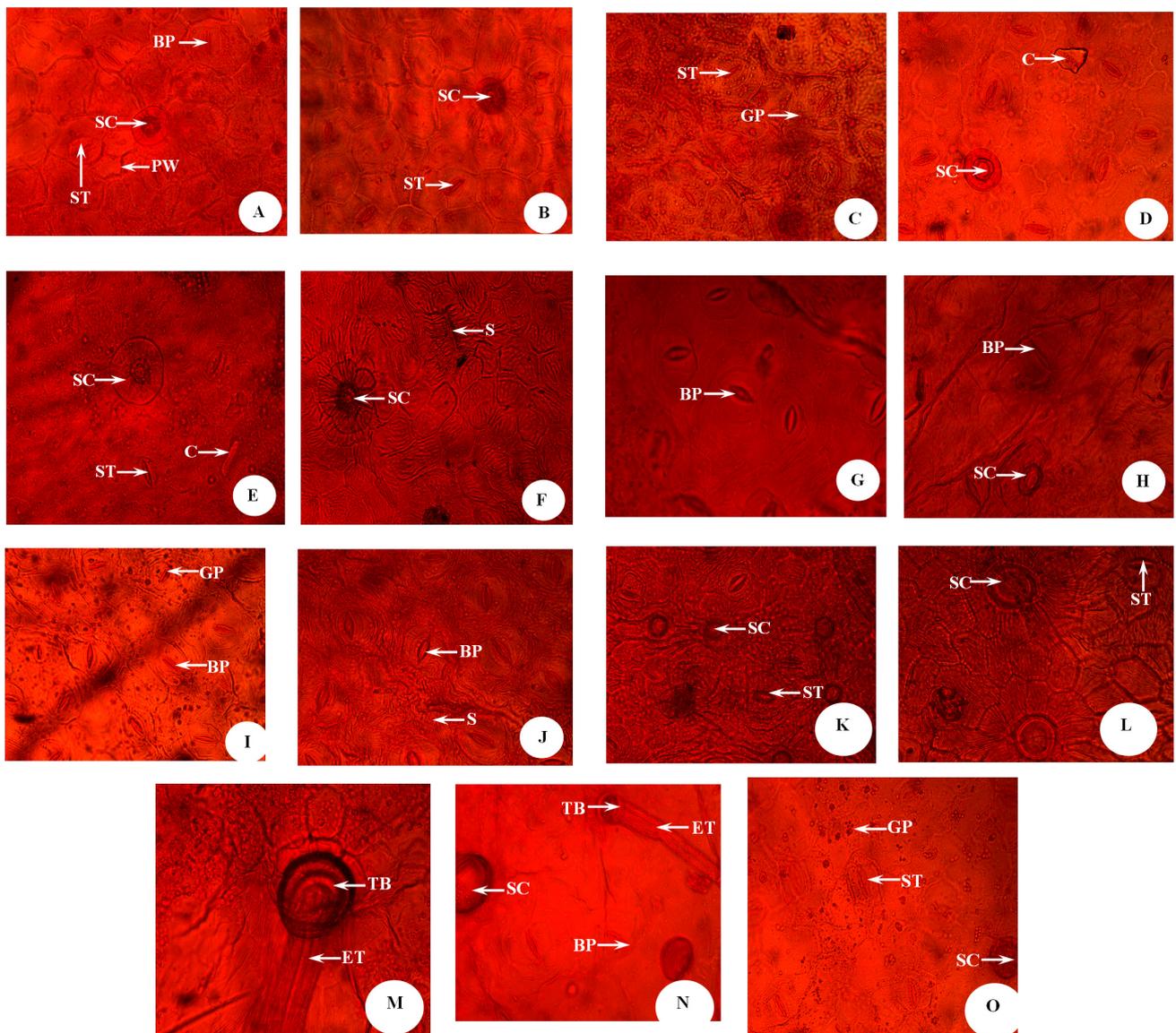


Fig. 1. Adaxial surface of *Ipomoea* species. A) *I. triloba*, B) *I. eriocarpa*, C) *I. alba*, D) *I. hederifolia*, E) *I. muricata*, F) *I. intrapilosa*, G) *I. asarifolia*, H) *I. batatas*, I) *I. aquatica*, J) *I. mauritiana*, K) *I. carnea*, L) *I. involucrata*, M) *I. nil*, N) *I. heterotricha*, O) *I. obscura*.; BP = Brachyparacytic stoma, SC = Scale, PW = Periclinal wall, ST = Stoma, GP = Granular periclinal wall, C = Crystal, S = Striae, TB = Trichome base, ET = Eglandular trichome, Scale = 0.85 µm

*I. nil*, *I. eriocarpa*, *I. muricata* and *I. heterotricha* where the stomata are paracytic.

*Stomatal index*

On the abaxial surface, the highest stomata index was in *I. involucreta* with the lowest in *I. nil*. Similarly, on the adaxial surface, the highest stomatal index was in *I. alba* with the lowest in *I. triloba*.

*Stomatal size*

*I. triloba* has the largest stomatal size while *I. mauritiana* has the smallest stomatal size on the abaxial size. On the adaxial surface, *I. eriocarpa* has the largest stomatal size

while *I. carnea* and *I. muricata* are with the smallest stomatal size.

*Trichomes*

Glandular trichomes are present in *I. batatas*, *I. carnea*, *I. intrapilosa* and *I. aquatica* in the form of peltate scales but in the remaining species they are largely eglandular, simple and uniseriate.

*Cuticular striation*

There is cuticular striation on both surfaces of *I. carnea*, *I. intrapilosa*, *I. asarifolia*, *I. mauritiana*, *I. aquatica* and *I. involucreta*, the other species have no cuticular striation.

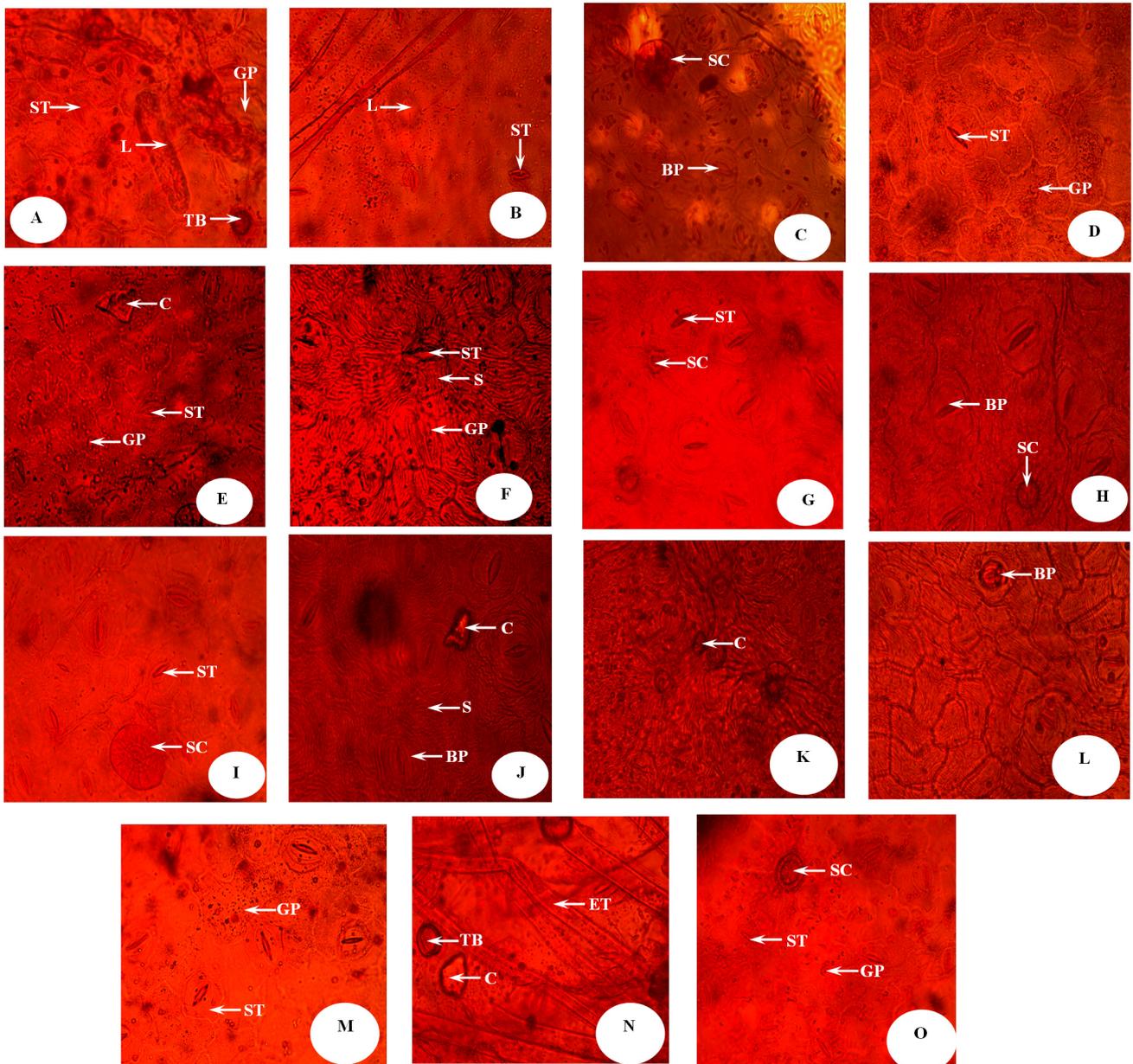


Fig. 2. Abaxial surface of *Ipomoea* species. A) *I. triloba*, B) *I. eriocarpa*, C) *I. alba*, D) *I. hederifolia*, E) *I. muricata*, F) *I. intrapilosa*, G) *I. asarifolia*, H) *I. batatas*, I) *I. aquatica*, J) *I. mauritiana*, K) *I. carnea*, L) *I. involucreta*, M) *I. nil*, N) *I. heterotricha*, O) *I. obscura*; BP = Brachyparacytic stoma, SC = Scale, L = Laticifer, ST = Stoma, GP = Granular periclinal wall, C = Crystal, S = Striae, TB = Trichome base, ET = Eglandular trichome, Scale = 0.85 μm

Tab. 1. Adaxial epidermal features of the South Western Nigerian *Ipomoea* species

Species/ Characters	CSH	AWP	SSH	ST	TR	C	T	CST	SG	SC	GP	L	CS(L/W)	SS	SI
<i>I. triloba</i>	Polygonal	Straight	Elliptic	Brachyparacytic	Eglandular	-	-	+	-	+	-	-	3.93-6.07/1.79-4.99	2.68-10.20	1.51-3.50
<i>I. eriocarpa</i>	Polygonal	Straight	Elliptic	Paracytic	Eglandular	+	-	-	-	+	+	+	2.87-3.93/1.07-2.14	4.28-26.99	20.00-29.37
<i>I. alba</i>	Irregular	Straight	Circular	Brachyparacytic and Paracytic	Eglandular	-	+	-	-	+	+	-	3.57-6.07/2.14-3.93	1.28-4.08	26.53-42.86
<i>I. hederifolia</i>	Irregular	Wavy	Elliptic	Paracytic	Eglandular	+	-	-	-	+	+	-	2.50-3.21/0.71-2.14	1.53-4.59	13.9-22.5
<i>I. muricata</i>	Irregular	Wavy	Elliptic	Paracytic	Eglandular	+	-	-	-	+	+	-	5.36-11.78/1.79-5.00	0.43-2.50	26.53-38.54
<i>I. intrapilosa</i>	Rectangular to polygonal	Wavy	Elliptic	Brachyparacytic	Glandular	+	+	+	-	+	-	-	3.57-6.07/1.79-2.86	1.57-3.86	13.79-16.67
<i>I. asarifolia</i>	Polygonal	Straight	Elliptic	Brachyparacytic	Eglandular	+	-	+	-	+	+	-	1.07-2.50/0.71-2.14	1.78-8.03	9.47-19.62
<i>I. batatas</i>	Rectangular to polygonal	Straight to wavy	Oval	Brachyparacytic	Glandular	+	+	-	+	+	+	-	3.93-8.21/1.79-3.57	3.93-6.93	16.22-20.00
<i>I. aquatic</i>	Irregular	Wavy	Elliptic	Brachyparacytic	Glandular	+	+	+	-	+	-	-	3.57-8.21/1.43-5.36	2.29-17.21	18.93-24.40
<i>I. mauritiana</i>	Irregular	Wavy	Elliptic	Brachyparacytic	Eglandular	+	-	+	-	+	+	-	5.00-7.50/1.43-4.28	1.07-3.21	32.54-33.06
<i>I. carnea</i>	Rectangular to polygonal	Straight to wavy	Oval	Brachyparacytic	Glandular	+	-	+	-	+	+	-	2.50-4.64/1.07-2.14	0.43-2.78	12.50-16.91
<i>I. involucrata</i>	Rectangular to polygonal	Straight	Circular	Brachyparacytic	Absent	+	-	+	-	+	+	-	3.57-5.36/1.79-3.21	1.91-6.88	23.05-36.99
<i>I. nil</i>	Irregular	Wavy	Elliptic	Brachyparacytic/Paracytic	Eglandular	+	-	-	-	+	+	-	2.14-4.64/0.71-1.79	2.04-6.12	6.98-17.97
<i>I. heterotricha</i>	Irregular	Wavy	Elliptic	Paracytic	Eglandular	+	-	-	-	+	-	-	1.79-2.50/0.71-1.07	4.46-15.42	27.13-32.05
<i>I. obscura</i>	Irregular	Wavy	Elliptic	Paracytic	Eglandular	+	-	-	-	+	+	-	2.50-7.14/1.43-3.57	2.68-5.20	27.27-36.00

Csh = Cell shape, AWP = Anticlinal wall pattern, SSH = Stomata shape, ST = Stomata, TR = Trichome, C = Crystal, T = Tannin, CST = Cuticular striations, SG = Starch grains, SC = Scale, GP = Granular periclinal wall, CS = Cell size, SS = stomata size, S.I. = Stomata index, L = Laticifer

Tab. 2. Abaxial epidermal features of the South Western Nigerian *Ipomoea* species

Species/ Characters	CSH	AWP	SSH	ST	TR	C	T	CST	SG	SC	GP	L	CS(L/W)	SS	SI
<i>I. triloba</i>	Rectangular to polygonal	Straight	Elliptic	Brachyparacytic	Eglandular	-	-	-	-	+	+	+	4.28-6.07/1.79-3.57	3.06-15.29	24.28-30.00
<i>I. eriocarpa</i>	Polygonal	Straight	Elliptic	Paracytic	Eglandular	+	-	-	-	+	+	+	2.86-5.71/1.07-3.57	1.79-9.42	16.55-16.61
<i>I. alba</i>	Polygonal to Irregular	Straight	Circular	Brachyparacytic and Paracytic	Absent	+	+	-	-	+	+	-	2.49-5.36/1.43-2.49	1.91-5.74	29.59-44.59
<i>I. hederifolia</i>	Polygonal	Wavy	Elliptic	Paracytic	Eglandular	+	-	-	-	+	+	-	2.86-4.64/0.71-1.43	2.04-5.61	13.7-17.5
<i>I. muricata</i>	Irregular	Wavy	Elliptic	Paracytic	Eglandular	+	-	-	-	+	+	-	2.50-5.36/0.71-2.50	0.75-3.43	23.38-30.49
<i>I. intrapilosa</i>	Rectangular to polygonal	Straight	Elliptic	Brachyparacytic	Glandular	+	-	+	-	+	+	-	2.50-6.43/1.43-3.57	0.86-3.00	16.21-19.23
<i>I. asarifolia</i>	Polygonal	Straight	Elliptic	Brachyparacytic	Eglandular	+	-	+	-	+	+	-	1.07-3.21/0.71-1.43	3.44-6.12	11.07-22.06
<i>I. batatas</i>	Rectangular to polygonal	Wavy	Oval	Brachyparacytic	Glandular	+	+	-	-	+	-	-	3.57-10.71/1.43-2.50	3.14-6.85	12.41-19.84
<i>I. aquatic</i>	Irregular	Wavy	Elliptic	Brachyparacytic	Glandular	+	+	+	+	+	-	-	2.50-7.14/1.43-3.57	2.04-10.71	27.14-37.87
<i>I. mauritiana</i>	Polygonal	Wavy	Elliptic	Brachyparacytic/Paracytic	Eglandular	+	-	+	-	+	+	+	3.57-6.43/1.07-2.50	0.57-2.14	25.24-32.92
<i>I. carnea</i>	Rectangular to polygonal	Wavy	Oval	Brachyparacytic	Glandular	+	-	+	-	+	+	-	2.86-8.57/1.07-2.14	1.43-4.86	15.38-20.00
<i>I. involucrata</i>	Rectangular to polygonal	Straight	Circular	Brachyparacytic	Absent	+	+	+	-	+	+	-	3.21-4.99/1.79-3.57	2.29-3.57	32.34-45.79
<i>I. nil</i>	Irregular	Wavy	Elliptic	Paracytic	Eglandular	+	-	-	-	-	+	-	2.86-6.07/1.07-2.14	3.06-7.65	6.80-16.52
<i>I. heterotricha</i>	Irregular	Wavy	Elliptic	Paracytic	Eglandular	+	-	-	-	+	-	-	2.50-8.93/1.43-3.57	2.04-10.71	18.07-32.89
<i>I. obscura</i>	Irregular	Wavy	Elliptic	Brachyparacytic	Glandular	+	+	-	+	-	+	-	0.60-4.64/1.79-2.86	1.27-10.32	24.06-36.00

Csh = Cell shape, AWP = Anticlinal wall pattern, SSH = Stomata shape, ST = Stomata, TR = Trichome, C = Crystal, T = Tannin, CST = Cuticular striations, SG = Starch grains, SC = Scale, GP = Granular periclinal wall, CS = Cell size, SS = stomata size, S.I. = Stomata index, L = Laticifer

*Laticifer*

Laticifer is present only in *I. triloba*, *I. eriocarpa* and *I. mauritiana* on the abaxial surface while it is absent on both surfaces in the other species of *Ipomoea*.

**Discussion**

The data recorded in this study showed that there are many anatomical variations between the 15 species of *Ipomoea* studied. Each species showed marked consistency for the anatomical characters examined. On the adaxial surface, the presence of rectangular to polygonal cell shape, straight to wavy anticlinal wall, oval stomatal shape, brachyparacytic stomata type, glandular trichome, granular periclinal wall, scale and crystal unit *I. batatas* and *I. carnea*. *I. involucreta* is more closely related to them except with the presence of circular stomatal shape, absence of trichome, scale and granular periclinal wall. *I. hederifolia*, *I. muricata*, *I. heterotricha* and *I. obscura* are closely related with the presence of irregular cell shape, wavy anticlinal wall, elliptic and paracytic stomata, eglandular trichomes except for some few characters which are different in them.

Stomata type separates the *Ipomoea* species into two groups. The presence of brachyparacytic stomata is diagnostic in *I. batatas*, *I. carnea*, *I. intrapilosa*, *I. asarifolia*, *I. nil*, *I. mauritiana*, *I. aquatica*, *I. triloba*, *I. alba* and *I. involucreta*, the remaining species have paracytic stomata type. As reported by Adedeji (2004), stomatal index is highly constant for a certain species and can be used for species delimitation. Similarly, Abdulrahman and Oladele (2012) reported that the rate of transpiration affects stomata type and size, according to them, leaf having higher rate of transpiration are with larger stomata sizes than those having lower rate of transpiration. On the adaxial surface, *I. alba* has the highest stomatal index while *I. triloba* is with the lowest stomatal index. Stomatal size is not correlated with stomatal index in the species studied. For instance, *I. eriocarpa* has the largest stomata size and hence higher rate of transpiration while both *I. carnea* and *I. muricata* are with the smallest stomata size on the adaxial surface and therefore having the lowest rate of transpiration.

The findings in this work support previous studies where leaf anatomical characters have been used as a taxonomic tool (Adedeji, 2004; Akçin and Binzet, 2010; Ogundipe and Olatunji, 1991; Illoh, 1995; Ogundare and Saheed, 2012). The presence of cuticular striations delimit the *Ipomoea* species into two main groups, this is noticeable in *I. carnea*, *I. intrapilosa*, *I. asarifolia*, *I. mauritiana*, *I. aquatica* and *I. involucreta*. Cuticular striations are special architectural structures on the epidermal surfaces of these species and could be performing vital protective functions. The presence of a particular type of trichome can frequently delimit species, genera or even whole families (Metcalfe and Chalk, 1979). On the basis of trichome, the species fall into three groups; those with glandular trichomes are

*I. batatas*, *I. carnea*, *I. intrapilosa*, *I. aquatica* and *I. obscura*, the remaining species have eglandular trichomes except in *I. involucreta* where trichome is absent. This supports the view that trichomes are of considerable importance in comparative systematics of angiosperms (Theobald *et al.*, 1979).

This study supports the observation of earlier worker that micromorphological characters and other epidermal characters could be employed for species delimitations.

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Taxonomic Key for the identification of *Ipomoea* species studied

Trichome glandular	<i>I. batatas</i> , <i>I. carnea</i> , <i>I. intrapilosa</i> , <i>I. aquatica</i>
Stomata shape elliptic	<i>I. intrapilosa</i> , <i>I. aquatica</i>
Cell shape irregular	<i>I. aquatica</i>
Cell shape rectangular	<i>I. intrapilosa</i>
Stomata shape oval	<i>I. batatas</i> , <i>I. carnea</i>
Trichome present	<i>I. batatas</i>
Trichome absent	<i>I. carnea</i>
Trichome eglandular or absent	<i>I. involucreta</i> , <i>I. asarifolia</i> , <i>I. mauritiana</i> , <i>I. eriocarpa</i> , <i>I. triloba</i> , <i>I. alba</i> , <i>I. nil</i> , <i>I. heterotricha</i> , <i>I. muricata</i> , <i>I. obscura</i> , <i>I. bederifolia</i>
Trichome absent	<i>I. involucreta</i>
Trichome eglandular	<i>I. asarifolia</i> , <i>I. mauritiana</i> , <i>I. eriocarpa</i> , <i>I. triloba</i> , <i>I. alba</i> , <i>I. nil</i> , <i>I. heterotricha</i> , <i>I. muricata</i> , <i>I. obscura</i> , <i>I. bederifolia</i>
Cuticular striation present	<i>I. asarifolia</i> , <i>I. mauritiana</i>
Cell shape polygonal	<i>I. asarifolia</i>
Cell shape irregular	<i>I. mauritiana</i>
Cuticular striation absent	<i>I. eriocarpa</i> , <i>I. triloba</i> , <i>I. alba</i> , <i>I. nil</i> , <i>I. heterotricha</i> , <i>I. muricata</i> , <i>I. obscura</i> , <i>I. bederifolia</i>
Cell shape polygonal	<i>I. eriocarpa</i> , <i>I. triloba</i>
Stomata paracytic	<i>I. eriocarpa</i>
Stomata Brachyparacytic	<i>I. triloba</i>
Cell shape irregular	<i>I. alba</i> , <i>I. nil</i> , <i>I. heterotricha</i> , <i>I. muricata</i> , <i>I. obscura</i> , <i>I. bederifolia</i>
Anticlinal wall straight	<i>I. alba</i>
Anticlinal wall wavy	<i>I. nil</i> , <i>I. heterotricha</i> , <i>I. muricata</i> , <i>I. obscura</i> , <i>I. bederifolia</i>
Stomata Brachyparacytic	<i>I. nil</i>
Stomata Paracytic	<i>I. heterotricha</i> , <i>I. muricata</i> , <i>I. obscura</i> , <i>I. bederifolia</i>
Stomata size above 5.20 $\mu\text{m}^2$	<i>I. heterotricha</i>
Stomata size below 5.20 $\mu\text{m}^2$	<i>I. muricata</i> , <i>I. obscura</i> , <i>I. bederifolia</i>
Stomata index above 38.00%	<i>I. muricata</i>
Stomata index below 38.00%	<i>I. obscura</i> , <i>I. bederifolia</i>
Epidermal cell length above 3.50 $\mu\text{m}$	<i>I. obscura</i>
Epidermal cell length below 3.50 $\mu\text{m}$	<i>I. bederifolia</i>