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Angiosperms of Senegal: Determination Key and Diversity of Families of the Class Monocotyledons

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Abstract **Original Research Article**

The Angiosperms represent the best known and most diverse group in Senegal. Even though a lot of work has been done to gain a good knowledge of this group, more work remains to be done. The main objective of this work is to contribute to a better knowledge of the class of monocotyledons in Senegal. More specifically, this work seeks to propose a determination key for the families of this class in order to facilitate their identification. Based on bibliographical research, a rough table and a summary table listing the different characters of the vegetative and reproductive systems of the Monocotyledonous family of Senegal were drawn up. These tables made it possible to propose dichotomous keys. This study showed that in the flora of Senegal, the Monocotyledons are distributed in 230 genera and 37 families. This work made it possible to propose determination keys essentially based on the stable characters of the vegetative and reproductive systems of these families.

Keywords: Angiosperms, Monocotyledons, Dicotyledons, Families, Identification key.

INTRODUCTION

In Senegal, flowering plants are relatively well known and comprise about 2500 species (MEPN, 1997, Bâ & Noba, 2001). However, even if most of the flora is known, some geographical areas have yet to be surveyed. This is the case in Africa south of the Sahara where flowering plants constitute the most diverse group. In this area, the identification of plant species presents particular difficulties since identification tools, in particular local or regional floras, are lacking, in addition to a very high plant diversity.

Compared to the temperate zone, where the flora has been studied for several decades, this zone is the poor relation of research. In addition, flowering does not occur at the same time in plants and the samples collected are often sterile, which makes it difficult to determine the species name during a short mission (Spichiger *et al*., 2000). Thus, in poorly surveyed areas, only a specialist of the family can guarantee an exact determination of the species (Spichiger *et al*., 2000). Indeed, the main work of the botanist in the field is to identify the material up to the family level, as specialists generally work at this level and it is to them that the material should be sent for a definitive determination (Spichiger *et al*., 2000). In Senegal, although Berhaut (1967) proposed a species key, a family key is not yet available.

The main objective of this work is to contribute to a better knowledge of the biodiversity of Monocotyledons in Senegal. More specifically, this work seeks to propose determination keys for this class in order to facilitate their identification.

The best and simplest way would probably be to be able to compare an observed plant with the descriptions and detailed illustrations (drawings and colour photographs) of a book that would present all the plant species living in West and Central Africa.

MATERIAL AND METHODS

Material

This work was carried out at the Laboratory of Botany and Biodiversity (LBB) of the University Cheikh Anta Diop of Dakar (UCAD). The sources of

information are: the University Library (BU), the Dakar herbarium and the Botanical Garden.

This work was carried out using

- Flora (Aubreville, 1950; Hutchinson & Dalziel, 1954 and 1972; Hutchinson *et al*., 1958; Berhaut, 1967 and 1979; Merlier & Montegut, 1982; Jonhson, 1997; Le Bourgeois & Merlier, 1995)
- The results of the work of the Laboratoire de Botanique et Biodiversité (Noba & Ba, 1992; Noba *et al*., 1994; Sambou, 2000; Ba & Noba, 2001, Mbaye *et al*., 2001; Sarr *et al.,* 2001) and those of Poilecot (1995 and 1999)
- Observations made in the herbarium and the Botanical Garden.

METHODOLOGY

For the elaboration of the determination key of the families, we proceeded by listing in rough tables the different vegetative and reproductive characters for all the families of the classes Monocotyledons and Dicotyledons.

The following vegetative and reproductive characters have been used because of their easy observation, and their high taxonomic value.

For the vegetative apparatus, these are the following characters:

- The habit: the type of habit, the size, the appearance...
- The trunk: bark, hairiness, colour, latex, trunk shape, etc.
- Leaves: types of leaves, arrangement of leaves, length, width, petiole, blade, stipules, venation...
- Leaflets: rachis, petioles, number of leaflets, arrangement of leaflets, pilosity, shape of leaflets, length, width, base, apex, margin...

For the reproductive characteristics, the observations were made on the following organs:

- Inflorescence: type of inflorescence, length of inflorescence...
- The flower: nature, shape, colour, length, width, size, meristem, calyx, corolla, tepals, stamens, gynoecium, peduncle, pedicels...
- The fruit: shape, colour, size, hairiness, length, width, apex, peduncle, pedicel, type of fruit, number of valves...
- The seed: shape, size, number, colour...

From these raw tables, we have drawn up summary tables in which, for each family, the various characteristics are either present and noted + or absent and noted - .

These summary tables make it possible to obtain tables that are neither too condensed nor too detailed, to group similar families together and to separate families.

The key proposed in this work is a dichotomous key, proposed essentially from the stable characters of the vegetative and reproductive apparatus, which are those that can be observed most frequently, in nature or on herbarium specimens (Lavie, 1990).

The principle of the key is to oppose two contradictory possibilities. We have tried to construct a key that first takes into account macroscopic morphological characters, giving preference to dichotomous character pairs such as herbs/woody, erect/rampant habit, opposite/alternate leaves or simple/composite leaves, presence/absence of latex, or stipules, through the relevance of perianth or ovary characters. In many cases, these characters allow to unambiguously and quickly arrive at a family (Friedmann, 1994).

RESULTS

The results concern the establishment of a determination key for the families of the class Monocotyledons, which is made up of 37 families. The analysis of the different families, based on the above-mentioned characteristics, has made it possible to propose the following determination key:

1 - families in which plants are either woody or herbaceous

2 - woody plants

3 - leaf blade sessile; shrubs monocaules with lignified stipe; leaves simple, basal rosette or stipulate, rigid, ribboned or linear, often succulent, inermic or barbed, persistent; leaf blade fleshy, may be entire or toothed; inflorescence indefinite; flowers hermaphroditic; ovary superect or inferiate; fruit is a loculicidal capsule or berry.....***Agavaceae***

3' - leaf blade petiolate; exceptionally branched monocot trees or shrubs with a lignified stipe reaching very large sizes and terminating in a rosette of leaves; dioecious or monoecious plant, sometimes spiny; leaves very large, palmate (fan-shaped) or pinnate, sheathing, arranged in a terminal bunch; erect or climbing; leaves simple or compound; alternate; petiole spiny; blade toothed; inflorescence indefinite, axillary or terminal; flowers sessile; stamens free or fused; ovary supereous; fruits fleshy... .....***Arecaceae (Palmeae)***

2' - Herbaceous plants

4 - latex plants; leaves simple, alternate; white latex herb; leaves erect up to 50 cm high; petiole long, blade lanceolate; flowers white, 1 to 1.5 cm wide; fruit is a group of follicles surrounded by a persistent perianth; each follicle contains many seeds.....***Butomaceae***

4' - plants without latex

5 - plants with narrow leaves, 1 to a few cm long, more or less denticulate at the edge, grouped in 2 or 3; submerged spindly herbs, with thin, brittle stems, attached to the bottom or floating freely between two waters; leaves simple, opposite or whorled with sessile blade; flowers tiny, unisexual, sessile, both sexes borne on the same stem; the male flower reduced to an anther, the female to a carpel; the fruit is a small achene 2 to 3 mm long..... ..... ***Najadaceae***

5' - broad-leaved plants

6 - plants lacking chlorophyll and saprophytic; herbaceous, annual or perennial; leaves either reduced to scales or simple and linear, alternate or arranged in a rosette; flowers solitary or united in a cyme, hermaphroditic, with several planes of symmetry or with weakly bilateral symmetry; tepals fused; stamens free; ovary infere; fruit dry.....***Burmanniaceae***

6' - green plants

7 - rosette-shaped leaves

8 - creeping plant; small submerged herb, formed by a rosette of simple leaves about 4 cm long; blade may be sessile or petiolate; stipules present or absent; unisexual flowers borne by different individuals: a single rosette bears only one kind of flower; white male flowers, grouped in twos in a spathe that opens on the water, at the top of a thread-like pedicel; isolated female flowers, sessile between the leaves of the rosette, extended at the top into a beak that reaches the level of the water: fertilisation is aerial; dry or fleshy fruit…….***Hydrocharitaceae***

8' - non-creeping plant

9 - leaf blade sessile; rooted herbs with simple filiform or ribbon-like leaves; the flowers are grouped in roughly spherical, white or black, often hairy-lain heads terminating a naked stem; the flowers, unisexual, are hidden between bracts of the same inflorescence; ovary supereous; fruit dry..... ***Eriocaulaceae***

9' - leaf blade petiolate

10 - flowers sessile; herbs with fleshy stump, the tuber capped by roots set in the mud; simple narrowly linear or petiolate leaves with floating lanceolate blade; simple or forked spikes floating on the surface of the water, borne on flexible stems; flowers small, white, yellowish or purple, usually hermaphroditic; stamens free; ovary supereous; fruit dry……***Aponogetonaceae***

10' - pedicellate flowers

11 - fleshy, often barbed, channelled leaves forming a reservoir in the leaf axil; aculeate, epiphytic or terrestrial herbs; leaves simple, often xerophytic, sometimes coloured in the centre of the rosette; blade may be entire or toothed; inflorescence indefinite; unisexual hermaphroditic flowers; ovary supere or inferere; fruit dry or fleshy.....***Bromeliaceae***

11' - leaves not fleshy

12 - erect flowering stems; simple-leaved perennials or annuals, growing in swamps; leaves arranged in a rosette at the base of the stem or inserted along the stem, simple, variously shaped; inflorescence a terminal pseudo-dove or axillary fascicles, sometimes single flowers; flowers hermaphroditic; ovary supere; fruit dry.....,.....***Limnocharitaceae***

12' - flower stalks not erect

13 - bright yellow flowers; 3 united petals in a fleeting tube; erect herbs, narrow, acute, often reddish single leaves; inflorescences in small brown heads terminating bare stems arising from the stump; zygomorphic hermaphroditic flowers; ovary superect; the fruit, hidden between the brown bracts of the inflorescence, contains numerous seeds; fruit dry..... ***Xyridaceae***

13' - differently coloured flowers

14 - basal leaves alternate, sagittate or cordate; aquatic herbs, rooted at the bottom of the water; rhizomes; simple leaves; schizogenous laticifers; well-developed petiole, sheathing; indefinite inflorescence; unisexual hermaphroditic flowers; tepals free or fused; stamens free; fruit dry..... ***Alismataceae***

14' - basal leaves rosette-like, distichous or sometimes spiral; floating aquatic herbs; leaves simple, broad, with a basal sheath; petiole sometimes swollen into a float; no stipules; perianth blue with 6 lobes united into a tube at the base; the upper lobe, slightly larger than the others, bears a yellow spot; inflorescence indefinite; flowers hermaphroditic actinomorphic; stamens free; ovary superect; fruit dry.....***Pontederiaceae***

7' - leaves not rosetted

15 - plants reduced to green blades called thallus; very small, floating freely on the surface of the water; these are the "duckweeds", whose flowering, rare, is almost indistinguishable; they multiply by vegetative budding of the small thallus; indefinite inflorescence; unisexual flowers; dry fruit .....***Lemnaceae***

15' - plants with vegetative apparatus with roots, stems and leaves

16 - plants with aerial roots surrounded by a velamen; epiphytic plants, terrestrial herbs (rhizomes, tubers) or, rarely, saprophytes; epiphytes have stem internodes

thickened into pseudobulbs, tissue absorbing ambient moisture; erect or climbing habit; leaves simple; blade sessile or petiolate, entire; inflorescence terminal; flowers hermaphroditic; ovary inferior; fruit dry.....***Orchidaceae***

16' - plants without aerial roots

17 - flowers with involucral bracts; herbaceous perennials with tuberous roots or rhizomes; leaves simple opposite or alternate, broad, entire or lobed; flowers actinomorphic, hermaphrodite; blade entire; inflorescence indefinite; ovary inferiate; fruit fleshy..... ***Taccaceae***

17' - flowers without involucre

18 - herbs with a thick, stiff scape, erects a cluster of large white flowers; submerged plant with rooted bulbous stump and ribbon-like leaves, up to 1 m long, soft, embossed, floating in the current, simple opposite or alternate leaves, blade sessile or petiolate, entire, fragrant hermaphroditic flowers, above water; indefinite inflorescence; tepals free or fused; ovary inferior; fruit dry or fleshy.....***Amaryllidaceae***

18' - herbs without scape

19 - herbs with gnarled, more or less succulent stems and cauline leaves; perennial herbs, rarely annual, sometimes aquatic; creeping or climbing habit; tubers or rhizomes, simple alternate or whorled leaves; blade entire, sessile or petiolate, sheathing, more or less narrowly oval; inflorescence definite or indefinite; flowers hermaphroditic; calyx dialypalect, corolla gamopetal or dialypetal; ovary superect; fruit dry or fleshy... .....***Commelinaceae***

19' - not knotty herbs

20 - leaves sessile; herbs often perennial by rhizomes, bulbs or tubers; sometimes plants in rosettes of more or less fleshy and barbed leaves; sometimes lignified stipe; leaves simple, alternate or more rarely opposite, parallelogrammed, ribboned; inflorescence indefinite; flowers hermaphroditic; tepals free or fused; stamens free; ovary superecious; fruit dry..... ***Liliaceae***

20' - petiolate leaves

21 - small, greenish, sessile flowers; leafy, sometimes very long, flexible stems; simple opposite or alternate submerged translucent membranous leaves; the tops of the stems may bear floating, petiolate leaves with lanceolate leathery blades spread over the water; flowers in spikes 1 to a few cm long, pedicellate, erect above the water; 1 seed in each carpel; inflorescence indefinite; flowers hermaphrodite.....***Potamogetonaceae***

21' - pedicellate flowers

22 - sheathing leaves with ligule at base of sheath; herbaceous, simple leaves opposite or alternate; leaves sometimes reduced to a sheath; inflorescence axillary, defined or indefinite; fruit dry..... ***Zannichelliaceae***

22' - leaves not sheathing

23 - leaves all or nearly all inserted at the base of the plant, sometimes attenuated into a petiole; herbaceous perennials, usually with tuberous rhizome; leaves simple with linear or lanceolate, often hairy, veined blade; inflorescence indefinite; flowers hermaphroditic; tepals free or fused; ovary inferere; fruit, capsule or an indehiscent, fleshy or dry fruit.....***Hypoxidaceae***

23' - leaves not inserted at base of plant

24 - brown spike inflorescence terminating a long naked scape; herbs with long linear leaves 1 to 1.5 cm wide; herbaceous stout with thick, spongy, erect, stiff leaves; flowers unisexual, small, densely packed, the males at the top of the spike, the females at the base; the fruits, cottony tufts containing the small achenes.....***Typhaceae***

24' - inflorescence of various types

25 - superect ovary

26 - herbaceous with knotty stems; herbaceous perennials with simple leaves, bulbous or rhizome; leaves with veins more or less parallel to each other; umbellate inflorescence surrounded by 1-2 membranous bracts, forming a sometimes deciduous spathe; flowers hermaphroditic; fruit dry..... ***Alliaceae***

26' - herbaceous without nodes; annuals or perennials with rhizomes and stolons; stem usually triangular in cross-section, solid; stem and leaves usually contain silica grains that make them sharp; plants monoecious (male and female spikes on the same individual) or sometimes dioecious; leaves, tristichous, ribboned or linear, sheath closed; ligule usually absent; inflorescence in spike; leaves simple; flowers hermaphroditic unisexual; fruit dry..... ***Cyperaceae***

25' - inferior ovary

27 - hermaphroditic flowers

28 - leaves ligulate cauline, distichous; large perennial rhizome herbs; stems bearing many leaves; simple sheathing leaves, pinnatinervate, inflorescences terminal or produced by rhizome; dry fruit..... ***Zingiberaceae***

28'- leaves without ligule, spiral; rhizome-bearing perennial herbs, leaves simple, broad, without pulvinus,

open-sheathed, pinnatinervate; inflorescence terminal, spike or thyrse often biflorous, without bracts.....***Cannaceae***

27' - unisexual flowers; giant, single-stemmed, arborescent perennial herbs; erect habit, simple leaves; underground stem (rhizome); herbaceous stipe consisting of the base of spirally inserted petioles; leaves large, oblong, pinnately-veined, spiral, with long petioles; inflorescence definite or indefinite; tepals free or fused; fruit dry.....***Musaceae***
1' - families in which habit is variable with woody plants that may be herbaceous or lianascent

29 - leaf blade sessile; herbaceous, rarely sublinear, annual or perennial; stems cylindrical or compressed, frequently with spongy pith; leaves alternate or arranged in a rosette, sheathing base; leaves sometimes reduced to a sheath, usually with a well-developed leaf blade; this one, cylindrical, canaliculate or flat, narrowly linear, with veins parallel to each other; inflorescence indefinite panniculate, sometimes contracted, or, exceptionally, solitary flowers; flowers hermaphrodite; stamens free, ovary superect; fruit dry.....***Juncaceae***

29' - leaf blade petiolate

30 - leaves rosetted ;

31 - spiny petiole; lianas or perennial herbs, terrestrial, often spotted on the leaves and on the spathes (display apparatus); rarely floating plant; secretion of essence or latex; leaves simple or compound, sagittate or more or less broadly elliptic, pennate or palmatinervate, sometimes open-ended; petioles sheathing, often with a pulvinus (bulge) at the junction with the blade; very large leaves; inflorescence indefinite; unisexual hermaphroditic sessile flowers; tepals free or fused; stamens free or fused; ovary superect; fruit fleshy... .....***Araceae***

31' - petiole not thorny; perennial herbs caulescent or aculeate, rhizomatous or tuberous; leaf blade often spotted with dark coloured spots (assimilated in a dark environment), pennatinervate ; petiole distinct, sheathing, sometimes winged, often articulated at the base of the blade by a pulvinus; flowers often geminate; leaves simple; blade entire; terminal inflorescence indefinite; flowers hermaphroditic; calyx dialepal and corolla gamopetal; ovary inferior; fruit dry... .....***Marantaceae***

30' - leaves not arranged in a rosette

32 - stigma sessile; berry-like fruit containing 1-3 seeds; herbaceous or herbaceous lianas latifoliate; no thickening at joint between petiole and blade; leaves simple opposite or alternate, cordate, elliptic or oval; tubers often very large; axillary inflorescence indefinite; flowers hermaphroditic; ovary superecious; fruit fleshy ... .***Smilacaceae***

32' - stigma not sessile

33 - long-stalked leaves; woody, herbaceous, or large-tubercled lianas; dioecious plant; leaves simple or compound alternate, rarely opposite, latifoliate cordate or palmatilobed, palmatinervate; axillary inflorescence indefinite; flowers unisexual; tepals fused, ovary inferere; fruit dry or fleshyu.....***Dioscoreaceae***

33' - leaves sessile

34 - basal rosette leaves; woody or herbaceous perennial, bulbous, tuberous or short and often robust rhizome ; leaves undifferentiated in petiole and blade, simple, sabre-shaped or linear, with veins parallel to each other, often distichous (inserted in 2 rows) and sheathing-equating, i.e. longitudinally folded and with bases inserted in each other; indefinite terminal inflorescence; flowers hermaphroditic; tepals fused; ovary infertile; fruit dry... ..... ***Iridaceae***

34' - alternate leaves
35 - plants with aerial prostrate roots; woody or creeping plants, remarkable for their spindly shafts, and terminated by hanging tufts of large linear spiny leaves; the shaft is sparsely branched; leaves simple; axillary or indefinite terminal inflorescence; ovary supereous; fleshy fruitu..... ***Pandanaceae***

35' - plants without aerial roots

36 - leaves reduced to small scales frequently with a sting on the back; perennials, often rhizomatous, with roots sometimes tuberized; stems erect or ascending-clasping, sometimes voluble, either herbaceous and destroyed annually, or sub-woody and more or less perennial, often branched ; cladodes, usually stiff needle-like, acute-spiny at the apex, inserted in the axils of reduced leaves, usually fasciculate, sometimes grouped 2 by 2; axillary inflorescence indefinite; flowers hermaphroditic or unisexual; stamens free; ovary superect; fruit fleshy.....***Asparagaceae***

36' - leaves developed; annual or perennial woody or herbaceous by a rhizome, often cespitose. Culm (stem) cylindrical, hollow, except at nodes; leaves alternate, distichous, blade banded; ligule membranous or hairy; split sheath formed by lower leaf surrounding stem; leaves inserted at nodes; habit glabrous or pubescent; leaves simple or compound; inflorescence indefinite; flowers sessile or stalked, unisexual hermaphrodite; ovary superecious; fruit dry ..... ***Poaceae (Gramineae)***

CONCLUSION

This study, whose aim was to contribute to a better knowledge of the plant biodiversity of Senegal, showed that the class of Monocotyledons of Senegal is rich in 37 families.

The families differ from each other by a certain number of characters elucidated in the determination key. Indeed, this work has made it possible to propose a determination key based on the distinctive characters of the vegetative and reproductive systems of the Monocotyledons.

This work has made it possible to develop a determination key for the families of Monocotyledons inventoried in Senegal. In addition, the determination key should be improved by taking into account the new phylogenetic classification of Angiosperms. This document can serve as a basic tool for species identification. Indeed, the determination of the family of the collected sample will facilitate the unambiguous identification of the species with existing floras such as those of Berhaut.

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