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Full Length Research Paper

Ecological anatomy of some hydrophytes in Nigeria

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Structural features were studied in ten common hydrophytes from divergent groups, sampled from the Opa-Lake of Obafemi Awolowo University, Ile Ife and the creeks of the River Ramos in Ogbotogbo Nigeria. The preponderance of parenchyma tissue is striking in all the species whereas specialized tissues such as treachery elements, sclerieds and fibres are scanty and restricted. Lacuna varies in size from as large 8000 - 11000 µm in *Scleria depressa* to as small as 3 - 400 µm in Onagraceae sp., *Commelina diffusa*, *Ludwigia suffruticosa* and *Zebrina pendula*. Presence of multicellular trichomes distinguishes *Lemna pausicoststa* and *L. suffruticosa* from the remaining species. Chloroplasts were observed in various regions of stems in other species except *S. depressa*. These attributes represent different degrees of adaptation to aquatic life and are widely convergent among aquatic groups. The observed structural similarity may be related to uniformity of the aquatic habitat. All the same, variation in characters show sufficient discontinuity to support separation of the species studied for taxonomic evaluation.

Key words: Hydrophytes, structure, parenchyma, mechanical, chloroplasts, lacuna, convergence.

INTRODUCTION

Aquatics plants are species that perpetuate their life cycle in still or moving water or on inundated or non-inundated hydric soils (Philbrick and Donald, 1996), a phenomenon achieved by only 2% of the 360,000 angiosperm species (Cook, 1990). This group of plants has their whole vegetative body adapted for a successful life cycle in water. Also, unlike in xerophytes, water provides a uniform habitat and therefore the anatomical structures of these plants are less varied than those of the xerophytes. Nonetheless, aquatic habitats tend to be stable (Tiffney, 1981). Indeed, water exhibits greater chemical and thermal stability than air, and it buffers against many types of catastrophic disturbance that characterize the terrestrial habitats, such as rapid temperature changes, fires, floods and strong winds. It is evidently clear that the factors that influence water plants are principally temperature, air, concentration and composition of salts in the water. The most striking structural adaptive features of organs of water plants are reduction of supporting protective and conductive tissues, presence of air chambers called lacunae in the leaves which is continuous with those of the stems and roots (Hulbary, 1944).

Aquatic plants indirectly affect mankind economically while the edible ones are important source of vitamin and food for man. In spite of the economic significance, the hydrophytes are difficult to identify most especially soon after they are taken out of water.

The main objective of this study is to survey the anatomical characters of the commonly found hydrophytes with a view to using such characters to enhance their identification.

MATERIALS AND METHODS

Ten species of hydrophytes were collected at the following sites: in Opa-Lake and in the tributary river in Ile Ife (7º 28'N and 4º 34 E') the creeks of the River Warri at Ogbotogbo (4º 98' N and 5º 53' E) in the Niger Delta. The samples were identified at the Obafemi Awolowo Univeri\sity herbarium (IFE), and Forest Herbarium (FHI), Ibadan. In order to study the structure of the stem, 25 µm thick transverse sections were obtained using the microtome. Best sections were selected, stained in Safranin toidentify lignified tissues and counter stained in Aniline Blue to increase contrast. Sections were viewed with microscope equipped with the ocular eye-piece at 100 x magnification. When measurements were made, it was ensured that they correspond to the two major levels of discontinuity. All plant names are according to the Flora of West Tropical Africa (Hutchinson and Dalziel, 1963), while names of her-

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Table 1. Pattern and distribution of tissues in some hydrophytes ū.

Species name and family	Lacunae size, location and distribution (n=20)			Distribution of chloroplast in the stem		Type of mechanical tissues
	Diameter range (µ); ū=mean	Location	Distribution pattern	Location	Pattern	
Impatense balsamina Balsaminaceae	40-300; ū=53	Sub-epidermis and cortex	Organized and densely packed	Cortex	Sparse	Collenchyma
Lemna pausicotata Lemnaceae	400-1800; ū=1200	Cortex and pith	Organized and sparse	Epidermal region and sheath	Dense	Sparse xylem
Zebrina pendula Commelinaceae	50-100; ū=45	Cortex and centre	Scattered and sparse	Cortex	Sparse	Dense collenchyma
Ludwigia suffruticose Onagraceae	30-100; ū=34	Sub-epidermis and cortex	Scattered and sparse	Epidermis	Sparse	Patches of fibres
Acroceras zizaniodes Poaceae	400-500 ; ū=4500	Sub-epidermis	Scattered and sparse	Cortex	Dense	Thickened parenchyma and dense collenchyma
Scleria depresa Poaceae	8000-11000; ū=1000	Epidermis and pith	Organized and densely packed	Absent	None	Sparse xylem Xylary fibres
Jussiaea suffricticosa Onagraceae	200-600; ū=400	Cortex	Scattered and densely packed	Cortex and pith	Sparse	Sparse xylem
Pistia stratiotes Araceae	300-800; ū=700	Pith	Scattered and Sparse	Epidermis	Dense	sparse xylem
Commelina diffusa Commelinace ae	20-300; ū=34	Sub-epidermis Cortex and pith	Scattered and sparse	Cortex	Dense	Sparse sclereids
Onagraceae sp.	5-400; ū=25	Cortex and pith	Scattered and sparse	Cortex	Dense	Sparse xylem

baria are according to Kueken and Schofied (1990).

RESULTS

Structure of the stems of ten hydrophytes in Transverse sections is illustrated in Figures 1a-j and described in Table 1. The same parameters are found from species to species. While there is an overall structural similarity in the stems, yet each species differs in detail from the other. The epidermis is generally uniseriate with thin cell wall without appendages except in *Lemna pausicostata* and *Ludwigia suffructicosa* where there are appendages as observed as observed in Figures 1b and 1d; in *Pistia stratiotes* and *L. suffructicosa,* the cell wall is thickened. There is preponderance of parenchyma tissue while other tissues are less well differentiated.

Lacuna diameter is relatively wide measuring about 8000-11000 µm in *Scleria depressa,* 400-1800 µm in *L. pausicostata,* 400-5000 µm in *Acroceras zizaniodes,* 300-800 µm in *Pistia stratoites*, 200-600 µm in *Jussiaea suffricticosa* whereas they are narrower in other species, measuring 5-400 µm in *Onagraceae* sp., 50-100 µm in *Zebrina pendula,* 50-100 µm *in L. suffructicosa*, 40-300 µm in *Impatens balsaminas*, 20-300 µm in *Commelina diffusa.* Lacunae are not scattered but located within a zone of tissue in *L. pausicostata, I. balsamina, A. zizaniodes* and *C. diffusa* whereas they are scattered in *Z. pendula*, *L. suffructicosa, J. suffricticosa, P. stratoites* and *Onagraceae* sp. Lacunae are densely packed in *I. balsaminas, S. depressa* and *J. suffricticosa*, but loose in the other species. Chloroplasts are associated with various regions of the stem, being found in the cortex in *I. balsamina, Z. pendula, A. zizaniodes*, *C. diffusa* and *A. zizaniodse* but found in the epidermis in *L. pausicostata* and in the pith of *J. suffricticosa*. While parenchyma tissue is the predominant tissue and well diverse in all the species ranging from oval to polygonal, other tissues, most especially the mechanical group, tend to be restrict-ted in distribution. Xylem is the only form of mechanical tissue observed in *S. depressa*, *L. suffructicosa*, *J. suffri-cticosa, P. stratoites* and *Onagra-ceae* sp., but scleren-chyma or/and collenchyma are present in *I. balsamina* and *A. zizaniodes*; sclereids were observed in *C. diffusa* but none was observed in *L. pausicostata* and *Z. pendula.* The various distribution patterns as seen in

Figure 1a. *Impatens balsamina*.

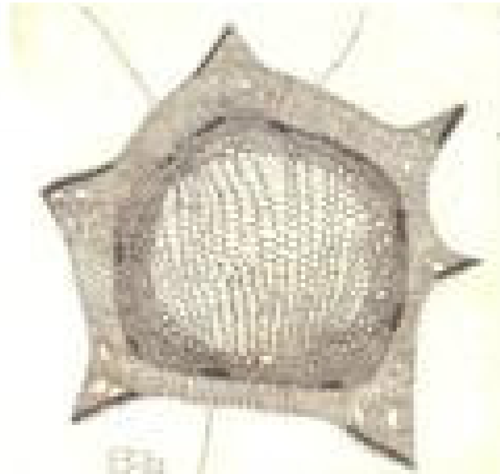

Figure 1d. *Ludwigia suffructicosa*

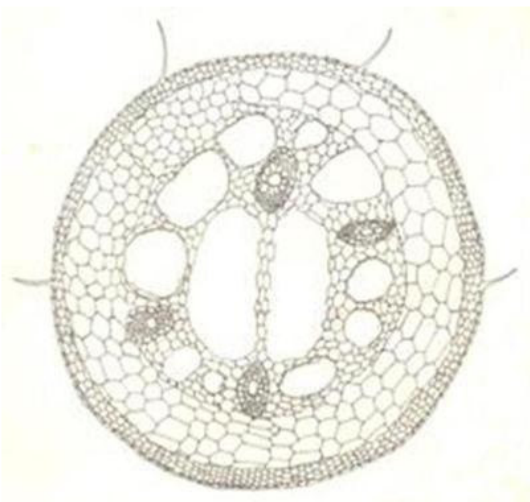

Figure 1b. *Lemna pausicosta*.

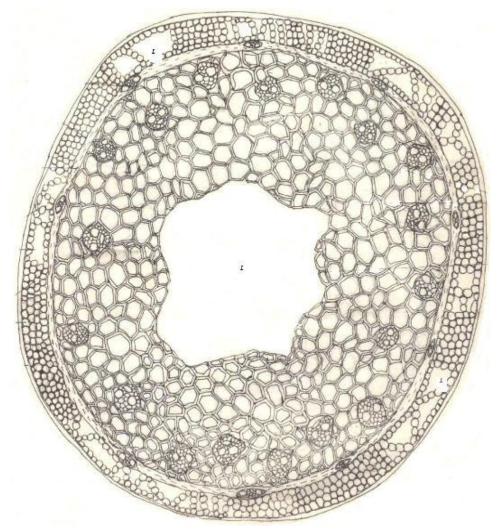

Figure 1e. *Acroceras zizanoides*.

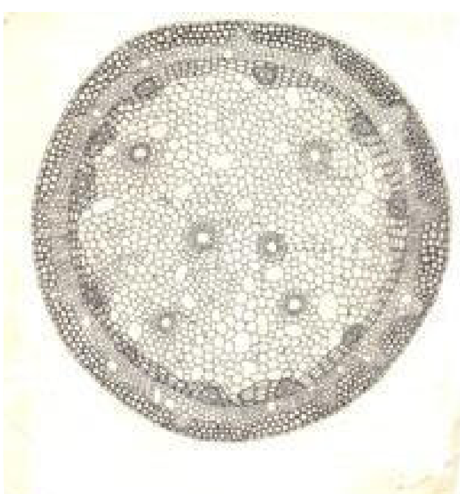

Figure 1c. *Zebrina pendula*.

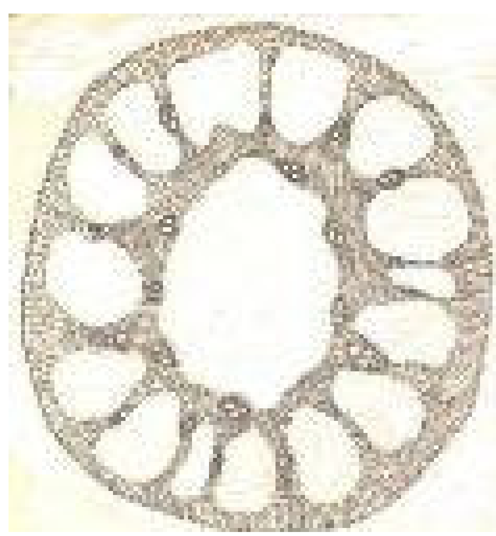

Figure 1f. *Scleria depresa*.

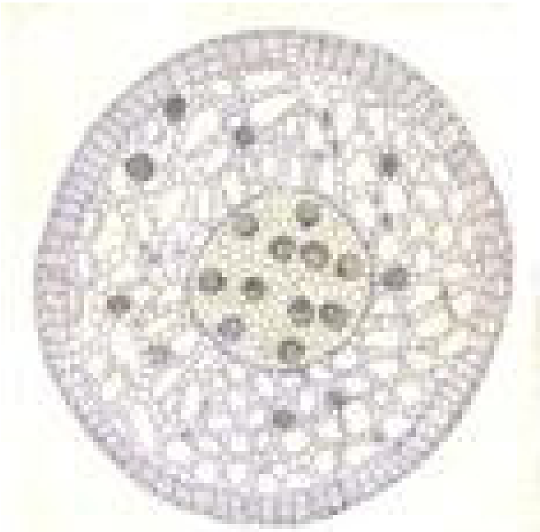

Figure 1g. *Jussiaea suffricticosa.*

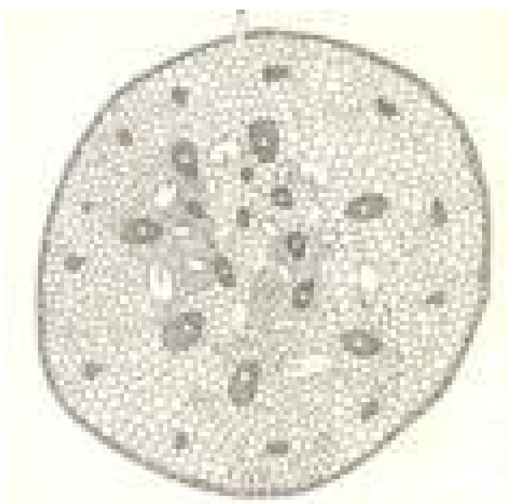

Figure 1h. *Pistia stratiotes.*

Figure 1i. *Commelina diffusa.*

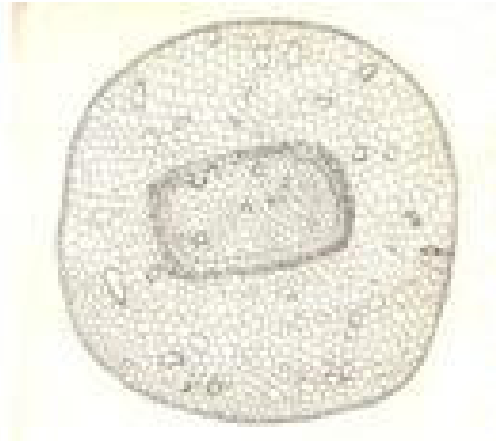

Figure 1j. *Onagraceae* sp.

transversev sections were used for taxonomic and diagnostic purposes (Table 2).

DISCUSSION

In discussing the result of this study, it is important to pay attention to structure and function together in a phylogenetic context with a view to providing some insight into the relationship between anatomy, ecology and evolution.

Ecological anatomy

Representative hydrophytes from widely vergent Families are structurally similar in the study of tenaquatic species as illustrated by Figures 1a-1j. Indeed, Sifton 1945) and Williams and Barbers (1961) point out that structural similarity may be related to uniformity/similarity of the habitat of plants. The parameters common to all the ten aquatic plants are possession of lacuna, preponerance of parenchyma cells, reduction in mechanical tissues, possession of accessory chloroplast and thin cuticle. These parameters represent different degrees of adapta-tion to aquatic life and are widely convergent among aquatic angiosperms. Lacunae density and width tend to follow habitat gradient with those species which lacunae are wide in diameter being found usually in permanently hydric habitats where buoyancy and aeration to plants are required. The occurrence of strengthening tissue in *P. stratoites*, *L. suffruticosa* and *Onagracaea* sp., which are free-floating plants, is perhaps, for mechanical support than for water conservation. Mechanical tissues are not essential in hydrophytes because they function to reduce excessive transpiration and to provide resistance for the much need fragmentation of parts for vegetative reproduction which are not critical in aquatic habitats. It has been observed by Metcalfe and Chalk (1979) that the dead polyderm tissue

Table 2. Identification key based on anatomy of the ten hydrophytes.

Identification key	Hydrophyte
1a. Lacuna delimited by narrow or thick pillars of parenchyma tissue	
2a. Large central lacuna present, up to 11000 µ diameter	
3a. Central lacuna partitioned	*Lemna paucicostata*
3b. Central lacuna not partitioned	
4a. Vascular bundles borne on column of parenchyma tissue	*Scleria depressa*
4a. Vascular bundles embedded in ground parenchyma	*Acroceras zizaniodes*
2b. Small lacuna, up to 500 µ diameter, dense under the epidermis	
5a. Vessel elements numerous, no sheath around xylem	*Impatense balsamina*
5b.Vessel elements with dense sheath	*Commelina diffusa*
1b. Lacuna not delimited by narrow or thick pillars of parenchyma cells	
6a. Trichomes present	
7a. Cells are storied in all regions, stem angular	*Ludwigia suffructicosa*
7a. Cells not storied, stem terete	*Pistia stratoites*
6b. Trichomes absent	
8a. Caps of collenchyma tissue under the epidermis	*Zebrina pendula*
8b. Caps of collenchyma tissue absent	*Onagraceae* sp.

which occurs in Onagraceae, Hypreicaceae, Lythraceae, Melastomataceae and Myrtaceae lacks strength or elasticity, and in submerged parts of aquatic plants it may become lacunar and then serves as aerenchyma. The preponderance of parenchyma tissue in these free-floating plants could indicate the retention of ancestral characters after movement from land to water. Cladistic analysis supports the conclusion that the Orcuttieae tribe of C4 grasses reflects evolution from a terrestrial ancestry into seasonal pools (Reed, 1978).

The occurrence of chloroplast in the sub-epidermis, cortex and pith may be explained by the need toincrease photosynthetic tissue in a habitat of poor irradiance as in turbid water or even submerged conditions. Plants inhabiting low-light habitats, such as the forest under-storey, for instance, are known to possess more chloroplasts than their counterparts in open spaces. In the studies of different species of C3 plants, the rate of net photosynthesis increased withirra-diance (Hay and Porter, 2006).

Evolution of tissues in aquatic plants

As angiosperms diversified in terrestrial ecosystems, colonization of various habitats began. Perhaps, during movementt from land to water, there was reduction in redundant tissues such as the xylem, sclereids and fibres; and this progressed at different rates in different groups. Perhaps in the course of evolution, and conses-quent adaptation to life in water, massive parenchyma cells arose, with some becoming chlorenchyma, aeren-chyma and the bulk of them remaining as packing tissue.

Aquatic plants appear less structurally diversified than their land counterparts; because water provides a uniform habitat and therefore the anatomical structures of these plants are less varied than those of the xerophytes. Complex or heterogeneous environment with a variety of physical features provide a variety of microhabitats; such environments generally show higher species diversity than do simple ones (Hall et al., 1970). Nonetheless, variation in the characters provided sufficient discontinuity to enable separation of the species for taxonomic evaluation.

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