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Original Research Article

A Comparative Study of Some Anatomical and Morphological Characteristics of the Stems of Some Aquatic Plants in Salah Al-Din Governorate

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Abstract: In this study, which was conducted on the Tigris River in Salah al_Din Governorate at five stations (Al_Dhuluiya, Al_Alam, Al_uwainat, Balaj Tikrit, and Baiji) the differences were identified through morphological and anatomical comparisons of the following species: *Typha domingensis, Eichhornia crassipes, Nasturtium officinale*, using the electron microscope. The study included the anatomy of cross sections of the stem of the studied species .The results showed a difference in the internal structure of the stem, especially in the cortex area, as the cortex in *Eichhornia crassipes* contained a much larger aerial tissue than *Typha domingensis,* species, which contained a larger aerial tissue than the Water hyacinth species *Nasturtium officinale* .The morphological study included the shape of the stem, The stem of *Typha domingensis* plant is cylindrical and straight, reaching a length of about 1-3 meters, and most of its types are unbranched. As for the stem of *Eichhornia crassipes* plant, it is short, reaching a length of about 10 cm, while the stem of *Nasturtium officinale* plant is about 60 cm long.

Keywords: Supporting Tissues, Aerobic Tissues, Environmental Adaptations, Invasive Species.

INTRODUCTION

In this study, which was conducted on the Tigris River in Salah al_Din Governorate at five stations (Al_Dhuluiya, Al_Alam, Al_uwainat, Balaj Tikrit, and Baiji) the differences were identified through morphological and anatomical comparison of the following species: *Typha domingensis, Eichhornia crassipes, Nasturtium officinale* using the electron microscope.

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Biology of the Species under Study

First: *Eichhornia Crassipes*

It is a fast-growing aquatic plant belonging to the Pontedraceae family [10]. Its original habitat is South America, especially the Amazon region [11]. It has spread to many regions of the world, especially Asia. It reproduces in two ways: sexually through seeds and asexually through creeping stems that produce new plants [12]. It is considered an invasive plant that spreads widely due to its great ability to spread [13]. Its original habitat is South America, especially the Amazon region [14]. It has spread to many regions of the world, especially Asia, Africa and Australia, through importation for use as an ornamental plant [15]. It is characterized by its tolerance to high temperatures and high humidity [16], which makes it suitable for tropical and subtropical environments [17]. It grows in freshwater bodies such as rivers, ponds and swamps [16]. It prefers stagnant or slow-flowing water [10].

Second: Typha Domingensis

It is a perennial aquatic plant belonging to the Typhi family [18]. It is widespread in humid areas as well as water bodies, commonly as southern papyrus or southern reed [19]. Its original habitat is tropical and subtropical regions [20]. It grows in moist soil rich in water and tolerates moderate salinity, which led to its spread in coastal environments [21]. It is widely spread in swamps, river banks, lakes, as well as irrigation canals, as well as in wetlands found in Africa, South America and Asia [22]. It needs full or partial light [23].

Third: *Nasturtium Officinale*

It is an aquatic plant and belongs to the cruciferous family [24], which is grown in humid areas and has many nutritional and therapeutic benefits [25]. Watercress is a plant that grows on the banks of rivers and streams, or in shallow water [26], its original home is Asia and Europe [19], and it is cultivated in many parts of the world [27]. Watercress prefers fresh water bodies such as rivers and streams, and also grows in shallow water with slow flow [28]. It reproduces in two ways: sexually through seeds produced by flowers after pollination. The second method is asexually by cutting a stem from the plant and placing it in water to stimulate the growth of new roots. *Nasturtium* is known to have many benefits as it contains vitamins such as vitamin C and K, and is rich in minerals such as magnesium, iron and calcium, which leads to strengthening bones and blood [29]. It also contains powerful antioxidants that help protect the body from damage caused by free radicals [30].

Material and Methods

First: Collecting samples

Samples of the studied species were collected from the banks of the Tigris River in the areas of Al-Dhuluiya, Al-Alam and Uwaynat in addition to the Tikrit and Baiji plazas.

Second: Laboratory work

The external appearance of the vegetative group was studied, as well as an anatomical study of the stem manually after the samples were collected using a razor blade. Cross-sections of the stem were prepared, specifically in the area between the nodes. After that, the samples were placed for about two minutes in a diluted solution of methyl blue (31) after which they were examined using a microscope (Olympus) type, then photographed using a camera type Sony.

Results and Disscusion

The Morphological Study

A- The Species *Eichhornia Crassipes*

The stems are short, thick, and rounded in shape, which helps the plant to float in the water, reaching a length of about 10 cm and they are hollow from the inside. The color of the stem is light green or bluish green.

B-The Species *Typha Domingensis*

The stems of the Typha plant are usually very long, the length of the stems of this type reaches 2-4 meters. This type is characterized by the shape of its swords, which are straight, cylindrical, and hollow from the inside. This feature helps the plant to survive in water. The stem of this type is characterized by a green color at first, and as the plant ages, the stem begins to change color to light brown or gray.

C- The Species *Nasturtium Officinale*

The stem of this species is characterized by being short to medium in length, and the length of the stem of this species can reach 25-60 cm, and is covered with a very thin layer of fine hairs, and the stem is characterized by a light green to dark green color, while the shape of the stem in this species is straight, thin and smooth, in addition to that it contains small leaves along the stem, which makes it easy to distinguish.

The current study, Figure (1), shows that the stem of the *Eichhornia crassipes* plant contains air spaces that act as buoyancy bags that help the plant float on the surface of the water, and what facilitates the movement of the plant with water currents is that the stem is light and flexible.

The stem of the *Typha domingensis* plant is characterized by containing air spaces that transfer oxygen from the aerial parts to the submerged parts. It contains supportive tissues that help it grow in shallow aquatic environments, as it is characterized by being thick, and the stem of the *Typha domingensis* plant helps the plant tolerate partial or complete submersion in water for long periods. The stem of the *Nasturtium officinale* plant can grow either creeping or erect, and can adapt to living in humid or partially submerged environments. In addition, it contains advanced vascular tissues to transport water and nutrients efficiently, even in aquatic environments. It also branches continuously, which increases the area of exposure of the plant to light and water.

From what has been mentioned, we conclude that the stem of *Typha domingensis* plant is strong and erect, containing ventilation tissues suitable for living in shallow water, while the stem of *Eichhornia crassipes* plant is thin and not hollow, suitable for creeping growth in moist soil. The stem of *Nasturtium officinale* plant differs from the two previous types in that it is hollow and swollen, helping it to float on the surface of the water.

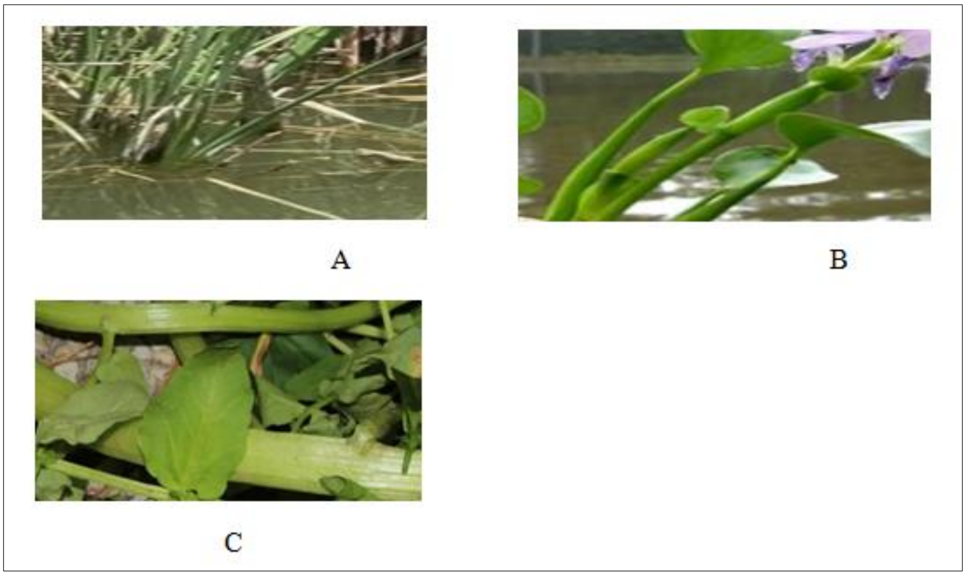

Figure 1: Study of the following types :A(Typha domingensis), B(Eichhornia crassipes),C(Nasturtium officinale)

The results of the current study showed that the cross-section of the stem of the species (*Typha domingensis*) shows that the outer layer is the epidermis layer, which is a thin layer, while the cortex layer that follows the epidermis layer appears to be composed of large parenchyma cells with clear air gaps (Aerenchyma), which highlights the plant's adaptation to the aquatic environment. The vascular cylinder (a group of vascular tissues, xylem and phloem is also clearly visible, distributed simply in the center.

The epidermis of the species (*Eichhornia crassipes*) is the outer layer of the plant and is covered with a layer of cuticle, a waxy layer that reduces water loss. The cells in the epidermis are usually flat and cohesive, and some species may contain cells containing calcium crystals. The cortex layer consists of parenchyma cells that are large and filled with water, which support the plant. The cortex layer is characterized by containing air spaces (aerenchyma) that help the plant float in water and also work to exchange gases between the different parts of the plant. The vascular tissue consists of wood and bark, the central tissue (pith). As for the species (*Nasturtium officinale*), the epidermal cells are a thin layer consisting of flat cells characterized by their thin walls, while the cortex layer consists of parenchyma cells with air spaces (aerenchyma) between the cells, and as for the vascular tissues, they are in the form of rings in the stem. As for the vascular tissues, they are usually present in the form of rings or irregularly in the stem.

We conclude from this (Figure 2) that the plant (*Eichhornia crassipes*) has a thicker epidermis and cuticle layer compared to the two species *(Nasturtium officinale)* and (*Typha domingensis*), while species (*Typha domingensis*) has a thicker epidermis and cuticle layer than species (*Nasturtium officinale)*. Species (*Eichhornia crassipes*) contains light parenchyma cells in the cortex layer with larger air spaces (aerenchyma) compared to (*Nasturtium officinale*) and (*Typha domingensis*), while species (*Typha domingensis*) contains smaller air spaces compared to (*Eichhornia crassipes*) and

(*Nasturtium officinale*). The air spaces in the cortex are mainly used to support the floating structure of the plant. The stem in species (Nasturtium *officinale*) contains a simple central tissue that is less developed compared to species (*Eichhornia crassipes*) which includes a solid central tissue that helps support the floating structure, while species (*Typha domingensis*) contains a central tissue composed of parenchyma cells with the presence of supporting tissues.

When comparing the results of this study with previous studies on the structural adaptations of aquatic plants, we find that there is clear agreement with research that has dealt with the characteristics of aquatic plant stems and their ability to adapt to different environments.

Previous studies have shown that *Eichhornia crassipes* has large air spaces in the stem, which act as buoyancy sacs, helping it to stay afloat on the surface of the water [32].

These results are consistent with the study by [33], which also showed that the flexible and light stem of *Eichhornia crassipes* enables it to adapt to water currents, which prevents the plant from being damaged by these currents.

As for *Typha domingensis*, it contains aerating tissues (aerenchyma) that help in transporting oxygen from the aerial parts to the submerged parts [34], which is consistent with the results of this study.

Nasturtium officinale is characterized by having a flexible stem that can adapt to different water levels, as confirmed by previous studies, and depending on environmental conditions, it can grow in an upright or creeping position [35, [36], proved that the hollow stems found in the *Nasturtium officinale* plant increase its buoyancy, which is consistent with the results of this study, which indicated that the stem is swollen and helps the plant to stay on the surface of the water.

The *Nasturtium officinale* plant supports rapid growth and continuous branching, which increases its ability to absorb nutrients and light, as stated in [37].

Comparing this study with previous research, it agrees with most published results on the adaptations of aquatic plants. All studies agree that air spaces are of great importance and play a fundamental role in buoyancy and respiration in aquatic plants, and the support tissues in the stem enable some species to grow in shallow water as well as to face water currents. This comparison supports the validity of the current results.

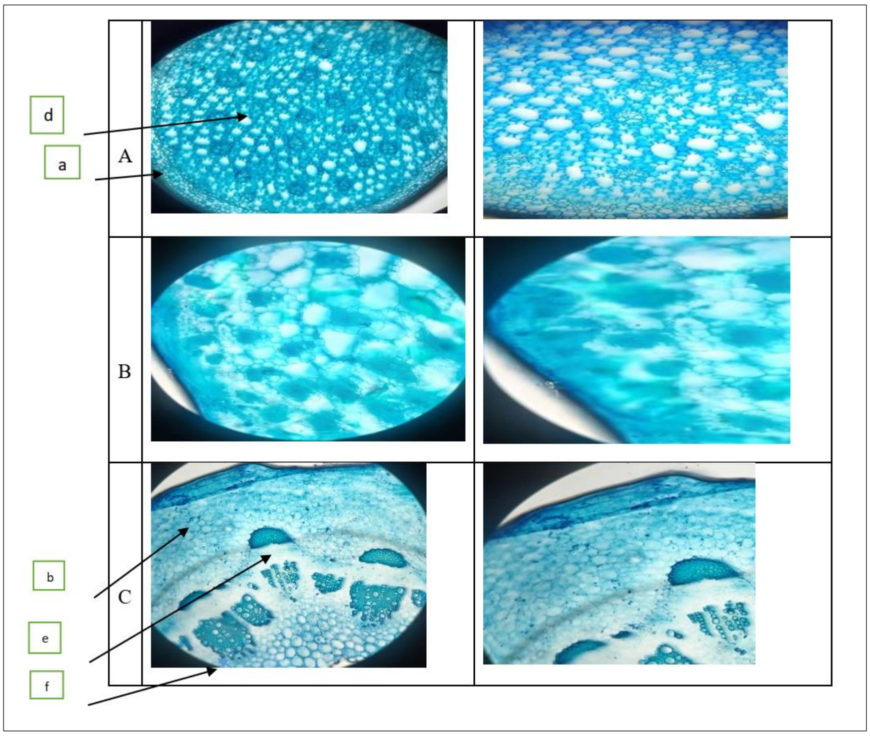

Figure 2: Cross-sections of the stem of the following species: A(*Typha domingensis*), ((*Eichhornia crassipes*), C(*Nasturtium officinale*)

(a: Epidermis, b: Collenchyma, c: Aerenchyma, d: Parenchyma, e: Phoelm, f: Xylem).

Table of variations in quantitative and qualitative characteristics of cross-sections in the stems of species

(*Measured by micrometer)

	Spices	Cuticle thickness	Skin thickness	Crust thickness	Wood thickness	Bark thickness	Number of vascular bundles	Core thickness
1	*Typha domingensis*	3.3 (3,5-3,1)	9.05 (10.3-7.8)	143 (154-132)	189 (223-155)	67 (83-51)	16	391 (432-350)
2	*Eichhornia crassipes*	4.2(5.18-3.35)	19.25 (21.5-17)	162.75(181.5-144)	147(162-132)	91.5 (111-72)	23	530(651-409)
3	*Nasturtium officinale*	(3.42-3) 3.21	(11.25-8) 9.625	135(145-125)	215.6 (247-190)	58.4(67.5-49.3)	25	527 (622-522)

CONCLUSION

In conclusion, *Eichhornia crassipes*, *Typha domingensis*, and *Nasturtium officinale* are three aquatic plant species that were gathered from the Tigris River in the Salah al-Din Governorate. The morphological and anatomical characteristics of these species were studied in this study. The findings showed that each species' stem structure varied significantly, indicating how well they adapted to their various habitats. Large aerial tissues in *Eichhornia crassipes* help with buoyancy, whereas supporting tissues on *Typha domingensis*' stem allow it to thrive in shallow water. However, *Nasturtium officinale's* thin, branching stem allows it to grow in damp, partially submerged conditions. This study highlights how crucial anatomical and morphological adaptations are to aquatic plants' ability to endure and proliferate in a variety of settings. The biological balance of water bodies can be impacted by invasive species like *Eichhornia crassipes*, which our discoveries may assist manage. They may also help us understand aquatic organisms better.

Conflict of Interest: We declare no conflict of interest regarding this manuscript.

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REFERENCES

1. Beck, C.B. (2010). An Introduction to Plant Structure and Development: Plant Anatomy for the Twenty-First Century Second Edition Cambridge University Press, 441 p.
2. Salman, J.M. and Hussain, H.A. (2012). Water quality and some heavy metals in water and sediment of Euphrates River, Iraq, J. of Environ. Sci. and Eng. A1.1(9):1088-1095.
3. Wilson J, R, Holst N, and Rees M 2005, Determinants and patterns of population growth in water hyacinth, Aquatic Botany, 81, 51-67.
4. Muyodi, F, J, Rubindamayug, M, ST, and Semesi, AK 2004, Effect of water hyacinth on distribution of sulphate-reducing bacteria in sediments of Lake Victoria, water SA, 30(3), 421 -, http, //www, were, org, za,426.
5. Visser EJW, Bögemann GM, Steeg HMVD, Pierik R, Blom CWPM (2000a) Flooding tolerance of Carex species in relation to field distribution and aerenchyma formation. New Phytol 148: 93- 103.
6. Callow, M. E and Callow, J.A (2002). Marine Biofouling: a Sticky Problem. Biologist; 49: 1-5. 8.Desikachary, T. V. (1959). Cyanophyta. Indian Council of Agricultural Research, New Delhi, pp 686.
7. Sudhakaran M V 2020 Botanical pharmacognosy of Bacopa monnieri (Linn.) Pennell Pharmacogn. J. 12 1559–72.
8. Halberstein RA, Medicinal plants: historical and cross-cultural usage patterns, Ann.Epidemiol, 15, 2005, 686–699. Hedge IC and Lamond JM, Brassicaceae in Guest E, and Townsend C.C, Flora of Iraq, Ministry of Agriculture, Iraq, 4 (2), 1980, 827-1085.
9. Cervi AC, Bona C, Moço MCC, Linsingen L (2009) Aquatic macrophytes of the municipality of General Carneiro, Paraná, Brazil. Biota Neotrop 9:215–222.
10. AL-Zaidi, S. A. A. (2017). Assessment of the Status of Submersible Aquatic Plants in Some Areas of Eastern AlHammar Marsh and Shatt Al-Arab River Southern Iraq Using Some Indicators of Biodiversity, MSc thesis, College of Science, University of Basra.89pp.
11. Sorrell, B.K., Boon, P.I., 1994. Convective gas flow in Eleocharis sphacelata R. Br.: methane transport and release from wetlands. Aquat. Bot. 47, 197–212.
12. Hegazy AK, Abdel-Ghani NT, El-Chaghaby GA. 2011. Phytoremediation of industrial wastewater potentiality by *Typha domingensis*. *International Journal of Environmental Science and Technology* 8: 639-648. DOI: 10.1007/BF03326249.
13. Yahya, M.N., 1990. The absorption of metal ions by *Eichhornia crassipes*.*Chem. Speciation Bioavailability*,2:82–91.
14. Sooknah, R. D. and Wilkie, A.C. (2004). Nutrient removal by floating aquatic macrophytes cultured in anaerobically digested flushed dairy manure wastewater. Ecological Engineering, 22:27-42.

15. Gundersen HJG (1977): Notes on the estimation of the numerical density of arbitra ry profiles: the edge effect. Journal of Microscopy 111, 219-23.
16. Sack L, Tyree MT (2005) Leaf hydraulics and its implications in plant structure and function. In NM Holbrook, MA Zwieniecki, eds, Vascular Transport in Plants. Academic Press, Burlington, MA, pp 93–114.
17. CURTIS, OTIS I; The Upward Translocation of Foods in Woody Plants. I. Amer. Journal Bot. 7, pp. 101-124. 1920.
18. Nobel PS (1980) Leaf anatomy and water use efficiency. In: Turner NC, Kramer PJ (eds) Adaptation of plant to water and high temperature stress. Wiley, New York, pp 43–55.
19. Artschwager, E., 1948. Vegetative characteristics of some wild forms of Saccharum and related grasses. U. S. Dep…
20. Schweingruber F H, Börner A and Schulze E-D 2013 Atlas of Stem Anatomy in Herbs, Shrubs and Trees (Cham: Springer Nature.
21. Wetzel, R.G. (2001). Limnology: Lake and River Ecosystems, 3rd ed. Academic Press, San Diego. 1006 p.
22. Genet WBM, Van Schooten CAM (1992) Water requirement of Aloe vera in a dry Caribbean climate. Irrig Sci 13:81–85.
23. KRAUS, C. Untersuchungen uber den Saftedruck der Pflanzen. Flora, 82, 65 Jahrg. N.R. 40, pp. 2, 17, 49, 1% 145. 277. 419, 435. 520 and 565. Also, Flora, 83, 66 Jahrg. N.K. 41, pp. 2, 25, 81 and 129.
24. Rockwell F, Holbrook NM, Stroock AD (2014) The competition between liquid and vapor transport in transpiring leaves. Plant Physiol 164: 1741–1758.
25. Svoboda K, Denk W, Kleinfeld D, Tank DW (1997): In vivo dendritic calcium dynamics in neocortical pyramidal neurons. Nature 385: 161-165.
26. Post GE, Flora of Syria, Palaestine and Sinai, Vol.II, Amer. Press, Beirut, 1933, 658. Radford AE, Dickison WC, Massey JR and Bell CR, Vascular plant systematics, Harper & Row, New York, 1974.
27. Barrett S C H and Strother J L 1978 Taxonomy and Natural History of Bacopa (Scrophulariaceae) in California Syst. Bot. 3 408—419.
28. Tornbjerg, T., Bendix, M., Brix, H., 1994. Internal gas transport in Typha latifolia L. and Typha angustifolia L. Convective through-flow pathways and ecological significance. Aquat. Bot. 49, 91–105.
29. Stewart, I.H. (2011). Development of Real-Time PCR to Identify Cyanobacteria Populations in Lakes. Ph. D Thesis to the Faculty of the Graduate School / The University of North Carolina at Greensboro. USA.
30. Tamire, G., and Mengistou, S. (2013). Macrophyte species composition, distribution and diversity in relation to some physicochemical factors in the littoral zone of Lake Ziway, Ethiopia. African J. of Ecol., 51(1): 66-77.
31. Kaplan, Z. and Symoens, J. (2005). Taxonomy, Distribution and Nomenclature of Three Confused Broad-leaved Potamogeton Species Occurring in Africa and on Surrounding Islands". Botanical Journal of the Linnean Society, 148: 329-357.
32. Barrett, S. C. H. (1989). Waterweed invasions. Scientific American, 261(4), 90-97.
33. Sculthorpe, C. D. (1967). The Biology of Aquatic Vascular Plants. Edward Arnold, London.
34. Piedade, M. T. F., Junk, W. J., & Long, S. P. (2000). The Productivity of the C4 Grass *Echinochloa polystachya* on the Amazon Floodplain. Ecology, 81(3), 728-742.
35. Armstrong, W., Armstrong, J., & Beckett, P. M. (1996). Pressurized aeration in wetland macrophytes: some theoretical aspects of humidity-induced convection and thermal transpiration. *Aquatic Botany*, 54(3), 177-190.
36. Brix, H., Sorrell, B. K., & Lorenzen, B. (2010). Are Phragmites-dominated wetlands a net source or net sink of greenhouse gases? *Aquatic Botany*, 69(2-4), 313-324.