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BIOMETRICAL AND MORPHO-ANATOMICAL OBSERVATIONS ON *ACER MONSPESSULANUM* L. (ACERACEAE) LEAVES

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Abstract: In this paper, the leaf, as a vegetative organ of a plant, is defined not only by morpho-anatomic features but also by mathematical criteria, which is not an easy task allowing for their polymorphism, introducing a new method of research in the Romanian botany – the biometrical one. The present investigation was focused on the rare *Acer monspessulanum* L. leaves, characteristic for the South Banat zone of Romania. The biometrical calculations have been performed according to the literature. Anatomically, the leaf blade and petiole reveal certain features of anatomical interest such as the presence of a collenchymatous tissue beneath the petiole epidermis, the circular arrangement of the vascular bundles and the sclerenchymatous ring around the stele for the petiole strengthening. The blade possesses the usual succession of tissues, a heterogeneous mesophyll and a well-developed mechanical tissue. We consider that this methodology used for the characterization of leaves - the morphometrical method - completes the knowledge of this taxon.

Key words: *Acer monspessulanum*, leaf biometry, anatomy, actinodrome, craspedodrome venation, microphyllum.

Introduction

Acer monspessulanum L. (syn.: *A. trifolium* Duham., *A. trilobatum* Lam., *A. rectangulum* Dulac), native to southern Europe and North-west Africa, is a small tree or shrub 10-15 m high (rarely up to 20 m) with a large and wide canopy. In Romania it is a rare species and occurs only in the southern part of Banat region in wood clearings, on shiny cliffs and calcareous substratum [7]. The trunk is up to 75 cm in diameter, with dark grey bark, smooth on young trees, becoming finely fissured on older trees and exhibiting long cracks on old ones. It has thin, smooth and brown branches with evident lenticels. Small brownish red buds with smooth ciliated edges, diverge slightly from the branches. The naturally small, long petiolate leaves are dark green on their upper surface and grey-green on the lower one. The flowers are yellowish green, produced in spring in pendulous, greenish yellow, 2-3 cm long corymbs. They appear before the leaves. Fruits – samaras -, each with two seeds, with almost parallel wings, are 2-3 cm long. The plant produces plentiful fruits which are normally very ornamental, turning bright-red before the changing the color of foliage in autumn [15, 16].

This paper shows, especially based on criteria, that a leaves may be characterized not only by the morphological – anatomical features but also by biometrical ones. The main anatomical features are also described and discussed.

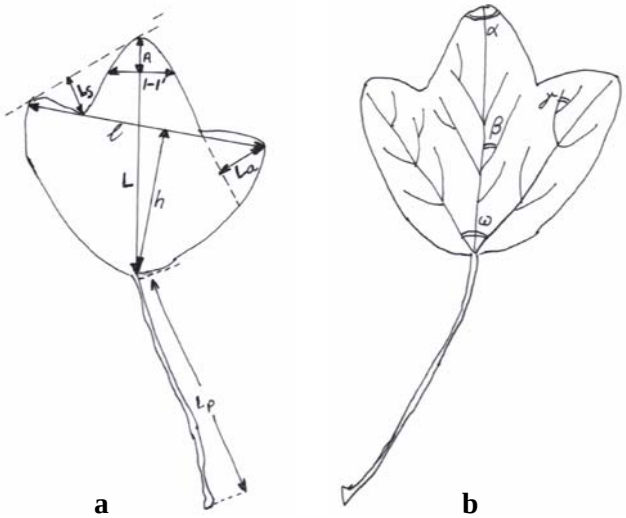
Material and Methods

The biometrical and morpho-anatomical observations were based and carried out on 40 mature leaves, collected from the "Alexandru Borza" Botanical Garden, Cluj-Napoca. The biometrical observations were obtained based on the published biometrical calculation methods [4, 9-14]. Histological samples obtained classical methods, were stained with carmine alum and iodine green [3]. The histological observations and micrographs where performed with a

BIOROM- T light microscope equipped with a TOPICA 6001A video camera, connected to a computer.

Results and Discussion

The biometrical measurements are: the linear measurements: the leaf length (L), the leaf width (l), the height of the maximum width (h); the tip's length (A), the tip's width (I-I'); the lobe length (La), the incision depth (Ls), the petiole length; the percentage ratio (Lp), the leaf finesse (L/l); the acuminate ratio (A/L), the oval ratio (h/L); the tip's finesse (A/I-I'); the relative sinus depth (s); the angular measurements such as: the acuminate angle (α), the emergent angle of the secondary veins (β) and the emergent angle of the primary lateral veins (ω) and other measurements such as the blade surface (S) and the pairs semi sum of the secondary veins (Np) (Tab. 1, Fig. 1).



a **b**

Fig. 1: Diagram showing the linear (a) and angular measurements (b).

Morpho-biometrical observations. The leaf blades of this species are small – microphylla (S = 7.73-15 cm^2), palmate-partite, 3-lobed with entire margins and cordate base [2]. The lobes are equal in size and each of them form an acute to obtuse angle tip (α = 65^o-89^o- 92^o). The blade is bright green on the upper side and opaque underneath. The sinus lobes are open and slightly engrossed. Leaves are membranous in texture. The blade venation is actinodrome basally, with 3 evident primary veins. The secondary veins are rare, derive from the primary ones. The lobes possess pinnate-craspedodrome venation [1, 6]. The emergent angle among the primary and secondary veins is narrowly (β = 39^o-45^o) to moderately acute (β = 45^o-62^o).

The normal petiole is cylindrical, long (Lp = 18-120 mm) and yellowish-green (Fig. 2)

Sizes: L = 23-46 mm; l = 37-60 mm.

Anatomical observations. Cross sections of the petiole exhibit the epidermis with strongly thickened walled cells, followed by collenchymatous tissue (4-5 layers of cells). The stele consists of 6 vascular bundles (3,a). The abaxial vascular bundle is larger than the lateral and adaxial bundles, separated by slightly sclerenchymatous rays. Each close collateral bundle consists of xylem vessels, embedded in a partially parenchymatous tissue, and phloem elements (large sieve vessels, companion cells and phloem parenchyma). Remarkable are the perivascular fibers [8] found on the periphery of the stele, with mechanical role. Centrally, the parenchymatous pith is present (3,b).

Table 1: Biometrical measurements of *Acer monspessulanum* L. leaves

Leaf number	L mm	l mm	h mm	A mm	I-I' mm	La mm	Ls mm	Lp mm	L/l %	A/L %	h/L %	A/I-I' %	s %	α^0	β^0	ω^0	Np	S (cm^2)	Size class
1	40	47	25	15	20	11	10	65	85	32	62	75	9	67	51	83	18	10,40	Microphyll
2	43	48	26	14	20	15	12	40	89	32	60	70	20	72	61	87	20	10,42	Microphyll
3	31	45	23	12	18	13	10	61	70	38	74	66	23	74	55	85	14	12,07	Microphyll
4	39	47	22	14	20	15	8	35	82	35	56	70	46	71	49	71	9	11,93	Microphyll
5	33	47	17	6	23	6	4	46	70	18	51	26	33	80	50	78	15	9,82	Microphyll
6	37	45	24	16	20	167	48	82	43	64	80	56	60	60	82	82	25	11,76	Microphyll
7	33	40	25	12	17	12	9	52	82	36	75	70	25	67	51	69	15	10,34	Microphyll
8	39	50	24	16	21	16	10	40	78	41	61	76	37	70	41	82	18	9,14	Microphyll
9	34	42	19	15	18	15	9	23	80	44	55	83	40	62	49	100	29	10,34	Microphyll
10	35	44	22	15	18	15	10	32	79	49	62	83	33	68	46	91	20	7,73	Microphyll
11	39	46	24	7	8	17	9	55	84	18	61	87	47	79	64	88	19	10,11	Microphyll
12	41	49	29	5	11	15	12	61	83	12	70	45	20	80	52	81	17	11,32	Microphyll
13	46	53	30	9	18	20	14	44	86	19,5	65,2	50	30	68	41	81	23	12,91	Microphyll
14	31	49	21	7	9	14	10	35	63,2	22,5	67,7	77,7	28,5	81	51	95	23	11,03	Microphyll
15	31	37	20	6	12	10	8	41	83,7	19,3	64,5	50	20	66	39	88	19	7,65	Microphyll
16	32	40	18	6	11	13	9	37	80	18,7	56,2	54,5	30	61	63	92	21	7,85	Microphyll
17	43	50	30	9	14	18	12	14	86	20,9	69,7	64,2	33	65	46	81	22	12,96	Microphyll
18	41	60	22	5	16	20	14	35	68,3	12,1	53,6	31,2	30	88	41	108	25	14,51	Microphyll
19	43	56	24	9	18	20	10	34	76,7	20,9	55,8	50	50	68	41	103	17	13,84	Microphyll
20	40	57	20	8	16	20	14	30	70,1	20	50	50	30	62	47	108	18	12,55	Microphyll
21	43	49	31	6	16	18	13	58	87,7	13,9	72	37,5	27,7	60	31	76	11	13,06	Microphyll
22	40	49	22	9	16	18	12	42	81,6	22,5	55	56,2	33	72	54	104	13	10,81	Microphyll
23	23	44	21	5	12	13	10	48	75	15	63,6	41,6	23	58	45	94	11	19,35	Microphyll
24	41	52	30	5	12	18	12	43	78,8	12,1	73,1	41,6	33	67	31	80	17	12,25	Microphyll
25	35	48	19	7	15	16	12	47	72,9	20	54,2	46,6	25	71	41	100	15	9,28	Microphyll
26	44	52	28	8	15	14	50	84,6	18	63,6	53,3	22	65	43	89	89	15	12,65	Microphyll
27	35	51	29	6	16	15	10	21	68,6	17	82,8	37,5	33	89	41	106	19	8,94	Microphyll
28	35	45	27	4	11	12	7	52	77,7	11,4	77,1	36,6	41,6	73	41	80	10	15,00	Microphyll
29	35	47	21	4	12	15	10	32	74,4	11,4	60	33,3	33,3	65	48	97	18	8,94	Microphyll
30	44	60	23	6	13	21	15	35	73,,3	1,63	52,2	46,1	28,5	75	50	108	25	13,29	Microphyll
31	43	56	22	8	16	20	15	33	76,7	18,6	51,1	50	25	41	95	95	19	13,29	Microphyll
32	46	53	31	6	12	15	10	55	86,7	13	67,3	50	33	77	41	89	20	13,80	Microphyll
33	39	50	23	7	15	15	12	34	78	17,9	58,9	46,6	20	65	40	98	23	9,54	Microphyll
34	35	42	22	7	14	12	10	47	83	20	62	50	16	57	57	87	13	9,07	Microphyll
35	32	45	24	7	13	14	10	60	71	21	75	53	28	56	57	91	18	12,06	Microphyll
36	37	50	22	7	14	14	11	36	74	18,9	59,4	50	21,4	59	51	95	13	11,29	Microphyll
37	36	40	16	6	15	17	8	50	90	16,6	44	40	52,9	75	45	92	24	10,26	Microphyll
38	39	45	24	7	8	14	7	32	86	17,9	61,5	87,5	50	46	47	84	15	10,94	Microphyll
39	39	41	28	6	15	12	7	38	95	15,3	71,7	40	41,6	65	41	72	25	10,90	Microphyll
40	29	40	18	4	11	12	7	31	72,5	13,7	62	36,3	41,6	69	52	91	24	6,96	Microphyll

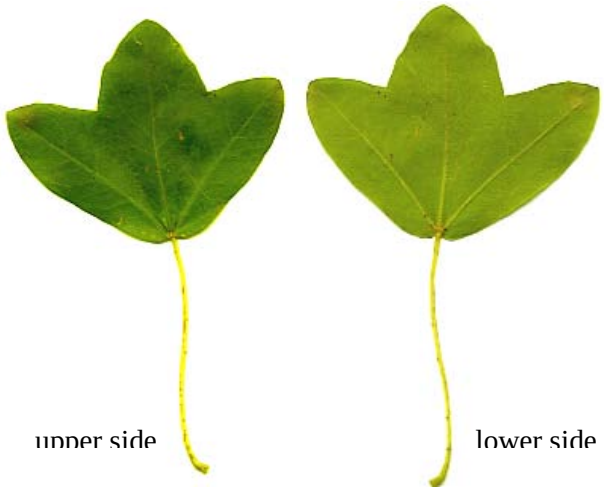


Fig. 2: The leaf of *Acer monspessulanum* L..

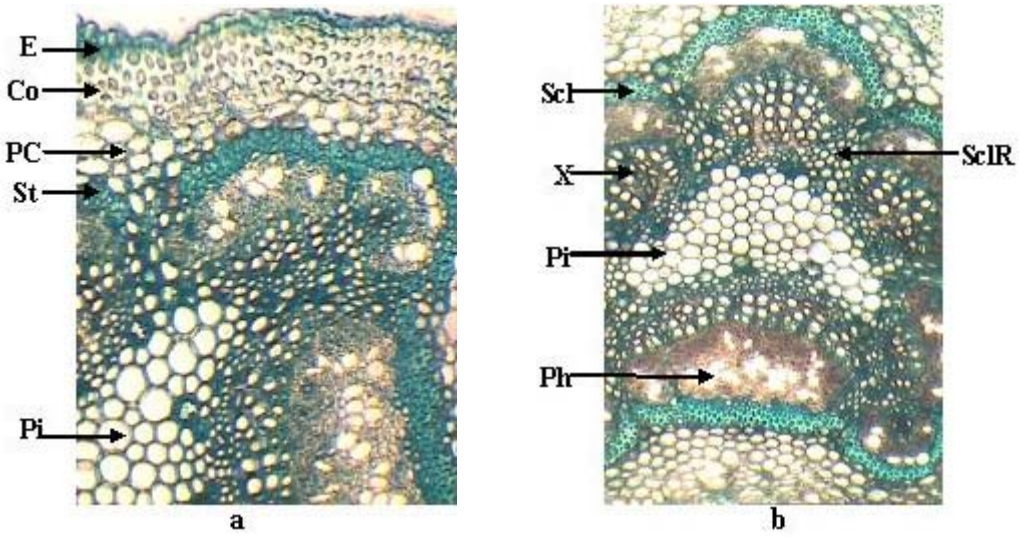


Fig. 3: Cross sections of the petiole. Portion with epidermis and cortex (a). Portion of the stele (b): Co- collenchyma, E- epidermis, Pi- pith, Ph- phloem, PC- parenchyma cortex, Scl- sclerenchyma, SclR- sclerenchymatous ray, St- stele, X- xylem (orig.).

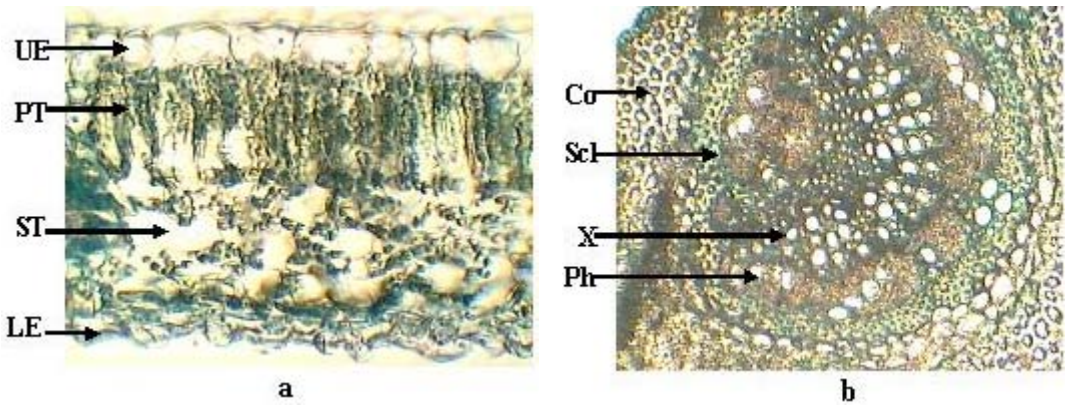


Fig. 4: Cross sections of the blade. Portion with mesophyll (a). A midrib vein vascular bundle (b): Co- collenchyma, LE- lower epidermis, Ph- phloem, PT- palisade tissue, Scl- sclerenchyma, ST- spongy tissue, UE- upper epidermis, X- xylem (orig.).

The blade, in cross sections, exhibits the usual succession of tissues [1, 2, 5]. The upper epidermis, such as the lower one, possesses a single layer of large cells. The mesophyll is heterogeneous, differentiated into palisade and a spongy tissues (Fig. 4,a). However, the occurrence of both palisade and spongy tissues is limited to the two sides of the leaf and are absent in the midrib region. In this region the mesophyll is represented by few layers of collenchymatous cells, occurring on outer and inner sides of the bundle, connecting the upper and lower epidermis. These cells may together be called as bundle sheath extension [5]. It is followed by compactly arranged parenchymatous cells surrounding the vascular zone. The midribs are represented by well developed vascular bundles. Each vascular bundle is crescent-shaped in cross section and more or less bicollateral with the protoxylem facing the upper epidermis. Phloem is formed of sieve vessels, companion cells and phloem parenchyma. Xylem consists of vessels and xylem parenchyma. Metaxylem elements are located next to the phloem and protoxylem towards the upper sides (Fig. 4,b). The same vascular bundles are present in the laminar region, especially the mid rib, surrounded by a. sclerenchymatous ring. All around the vascular system a parenchymatous sheath is present.

Conclusions

Acer monspessulanum possesses simple, symmetrical, glabrous and 3-lobed leaves. The sinus between the lobes is open and slightly engrossed. The leaves are microphylla with membranous texture. The lobe tips are acute to moderate obtuse and the emergent angle among the primary and secondary veins is narrowly to moderately acute. The blade possesses perfect actinodromous basal venation whereas the lobes venation is crospedodromous. The petiole is normal, cylindrical, short and hairless.

Anatomically, the petiole possesses one-layered epidermis with highly cutinized cells, a collenchymatous hypodermis and some vascular bundles in ring like arrangement. The mechanical tissue of the petiole is represented by a sclerenchymatous ring, near by the collenchymas, surrounding the vascular bundles of the stele.

The blade possesses both upper and a lower epidermis and a heterogeneous mesophyll. In the mesophyll there are embedded the veins of the vascular system, represented by well developed vascular bundles. Remarkable is the blade strengthening, represented by a well-developed collenchymatous tissue and the sclerenchymatous ring (sheath), located around the vascular zone.

The present authors consider that the methodology used for the leaf characterization – the biometrical method - completes the description of this taxon.

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OBSERVAŢII DE ORDIN BIOMETRIC ŞI MORFO-ANATOMIC ASUPRA FRUNZELOR DE *ACER MONSPESSULANUM* L. (ACERACEAE)

(Rezumat)

Prin această lucrare, frunza, ca organ vegetativ al unei plante, este definită nu numai după criterii morfo-anatomice dar şi matematice, sarcină deloc uşoară având în vedere polimorfismul acestui organ vegetativ. Pentru exemplificare ne-am oprit asupra frunzelor unei specii rare de *Acer* L., caracteristică zonei sudice a Banatului *Acer monspessulanum* L. arbore originar din sudul Europa şi N-V Africii. La noi în ţară este cunoscut sub numele de jugastru de Banat, fiind localizat în zona sudică a Banatului unde apare sporadic în luminişurile pădurilor, pe coaste stâncoase însorite şi pe substrat calcaros. Este un arbore înalt de până la 10-15 m, rar atinge 20 m, cu coroana des foliată şi scoarţa netedă brun roşietică.

Observaţiile biometrice, asupra frunzelor acestei specii, cuprind măsurători lineare: lungimea (L) şi lăţimea laminei (l), înălţimea lăţimii maxime a limbului (h), lungimea vârfului limbului (A), lăţimea vârfului (I-I'), lungimea lobului (La), adâncimea inciziei (Ls), lungimea peţiolului (Lp) (Fig. 1,a); raporturile procentuale (fineţea frunzei (L/l), raportul acuminal (A/L), raportul de ovalitate (h/L), fineţea vârfului (A/I-I'), adâncimea relativă a sinusului (s);.măsurători angulare: unghiul acuminal (α), unghiul de emergenţă al nervurilor secundare(β) şi unghiul de emergenţă al nervurilor primare laterale (ω) (Fig. 1,b). S-au mai efectuat şi măsurători care includ semisuma perechilor de nervuri secundare (Np) şi suprafaţa laminei (S). Cele 18 măsurători biometrice efectuate pe 40 de frunze ale speciei luate în consideraţie (Tab., 1) au contribuit la descrierea morfologica completă a frunzelor speciei (Fig. 2). Astfel, limbul frunzelor este mic - microfil (S = 7.73-15cm), palmat trilobat, glabre, cu lobii aproape egali ca formă şi mărime. Lobii se termină într-un vârf acut spre obtuz (α = 65 – 89 - 92). Marginea lobilor este întreagă. Limbul are culoarea verde deschis pe faţa dorsală şi verde mai închis pe cea ventrală. Baza limbului este uşor cordată. Sinusul dintre lobi este deschis şi cu adâncime redusă. Consistenţa limbului membranoasă. Nervaţiunea limbului este de tip actinodrom bazal perfect, cu 3 nervuri primare evidente de pe care pornesc nervuri secundare rare. Nervaţiunea lobilor este de tip penat-craspedodrom. Unghiul de emergenţă dintre nervurile primare şi cele secundare este acut îngust (β = 39 – 45) până la moderat (β = 45 – 62). Peţiol de tip normal, verde-gălbui, relativ scurt (Lp = 18-120 mm). Dimensiuni: L = 23- 46 mm; l = 37-60 mm (Fig. 2).

Pentru a evidenţia structura anatomică foliară s-au efectuat secţiuni transversale prin peţiol şi limb, după metodele clasice. Anatomic, peţiolul prezintă sub epiderma unistratificată, scoarţa parenchimatică pluristratificată iar stelul este polistelic. Ţesutul mecanic este bine reprezentat prin colenchimul hipodermic şi prin inelul de sclerenchim (teacă de sclerenchim) ce înconjoară, la exterior, liberul fiecărui fascicul vascular colateral închis (Fig. 3,a,b). Limbul are mezofil heterogen iar fasciculele vasculare bine dezvoltate, remarcându-se vasele de metafloem foarte mari. Ţesutul mecanic al limbului este reprezentat prin colenchim şi sclerenchim, acesta din urmă situat de jur-împrejurul fasciculelor vasculare ale nervurilor mediane (Fig. 4a,b). Consideram că observaţiile de ordin biometric întregesc studiul asupra acestui taxon.

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