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BIOMETRIC AND MORPHOLOGIC OBSERVATIONS ON *HOYA CARNOSA* (L.F.) R BR. (APOCYNACEAE) LEAVES

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ABSTRACT
The paper discloses a research model of leaf investigation, based on biometric measurements and morphologic observations. In literature there are only a few examples of this type of biometrical investigation and analysis model applied on spontaneous and even cultivated plants leaves. The article comprises biometrical and morphologic investigations on species Hoya carnosa (L.f) R. Br. (Apocynaceae) *leaves. The measurements and observations were performed on 40 mature leaves of the studied species, including linear measurements, percentage ratio, angular measurements and other measurements such as: the number semi-sum of secondary pairs of veins and the leaf surface as well. The biometric measurements were the basis of a mathematical calculation of the average values on the studied leaves species.*
KEY WORDS *biometry, measurements, lamina, mathematical calculation formula*, *Hoya carnosa*

INTRODUCTION

Hoya carnosa (L.f.) R. Br. (syn. *Asclepias carnosa, Cynanchum carnosum, Schollia carnosa)* is known as porcelain flower or wax plant is a vining succulent, virescent, pendent (climbing), springy plant belonging to Apocynaceae family, native to India, East Asia, Australia. The name comes from the English gardener Thomas Hoy. The rots are along it branching stems. In the wild it climbs trees and scrambles over rocks, growing continuously and reaching lengths of 6 m or more. The stems are slightly lignified. The oval leaves are glossy on the upper face, smooth, thick and fleshy up to 7.5 cm long. The flowers are grouped in 10-30 flowers. The flowers emanates, especially in the evening and at night, a special fragrance, perceptible from 2 m (Fig. 1). Sometimes, if it's hot, it removes drops of nectar, sweet like honey. The plant reaches 2 m high in pots. The leaves and the flowers are often described as "waxy" (Miaulane, 2004; Web 1; Web 2).

The plant longevity is 2-8 years. The plant heavily bear the sun directly and prefer semi-dark places at room temperature, even warmer. The plant dry air humidity is supported in the summer and it is good to be sprinkled with the vaporizer 2 times a week, not the flowers. Specific requirements: The plant blooms only on stems longer than 30 cm. It does not support air currents and temperature oscillations. The plant should be balanced after flowering. Do not cut stems that have flourished because they can flourish the following year. Transplantation: rarely 2-3 years in April, with great attention. When the buds are formed, the place does not

change. It leaves the flower peduncle because it gives birth to new flowers. Propagation: stem cuttings of 10 cm spring in heat and in sand and peat (Miaulane, 2004).

This species has also other species and c.v. In addition to *Hoya carnosa* is *H. carnosa* 'Bella', growing as a suspended plant. It needs more heat. There are also quotations of *H. coronaria*, *H. multiflora* with white flowers and white butter, very rare, *H. carnosa* 'Dapple Gray' with bright pink and bright lumber gray flowers margins and *H. pubicalyx* 'Strange Red Buttons', with cherry-colored cherry blossoms (Phillips, 1997). In Romania *Hoya carnosa* is cultivated as a fast-growing ornamental plant.

Many sets of terms and methods have been devised for describing leaves (e.g. Dale *et al.* 1971; Dickinson *et al.,* 1987; Hickely, 1973; Melville, 1976; Roth & Dilcher, 1978). In Romanian literature there are few examples of this type of leaf investigation and analysis model applied on spontaneous plants leaves (Bercu, 2005; Bercu 2013a,b; Bercu, 2015), mostly of them being paleontological studies (Givulescu, 1999, Givulescu & Soltesz, 2000). Some data refers to general biometric features such as lamina venation, mentioned in lectures and manuals of Anatomy and morphology of plants or Morphology of plants (e.g. Andrei, 1997; Buia & Péterfi, 1965; Ianovici *et al*. 2009; Ianovici *et al*, 2012; Ianovici *et al*, 2015; Ianovici *et al*, 2017).

The purpose of this paper is to highlight the features of the leaf of *Hoya carnosa* and to contribute with more information to complete the morphologic foliar characterization of this more or less important ornamental species.

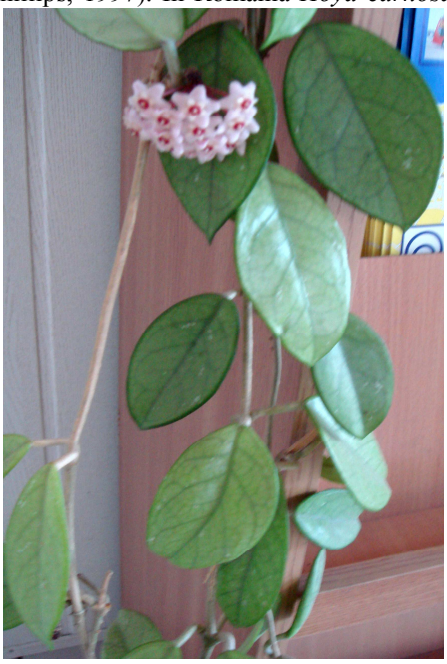

FIG. 1. Natural view of *Hoya carnosa* (L.f.) R. Br. (original).

MATERIALS AND METHODS

The morphological observations and biometric measurements were performed on 40 mature leaves of *Hoya carnosa*, collected from SC "International Iris" SRL in August 2017. The methods and terms for the leaves description form, size, margin and venation follow the leaf architectural system of Givulescu (1999), Mounton (1966a,b, 1976) and Roth & Dilcher (1978). The terminology of foliar architecture was taken from Melville (1976).

The biometrical measurements, which had been calculated, are: a. the linear measurements: L- leaf length, l- leaf width, h- the height of the maximum width of lamina; A- the tip length, I-I'- the apex width; Lp- the petiole length, followed by b. the percentage ratios: L/l- the finesse of leaf; A/L- the acuminate ratio, h/L- the ovality ratio; A/I-I'- the lamina apex finesse. c. The angular measurements: α- the apical angle, β- the emergent angle of the secondary veins with primaries, ɣ- the emergent angle of the tertiary veins related to the

primary one and finally for other measurements. The number semi-sum of secondary pairs of veins (Np) and the lamina surface (S). For each leaf were carried out 15 measurements, amounting 600 determinations, performed for all *Hoya carnosa* 40 leaves.

RESULTS AND DISCUSSIONS

Biometric measurements. The 40 leaves were collected from the S.C. "Iris International" SRL. The biometric measurements (Table 1, 2), represented the base for a mathematical calculation formula for the average values of measurements for all *Hoya carnosa* leaves (Table 3, 4).

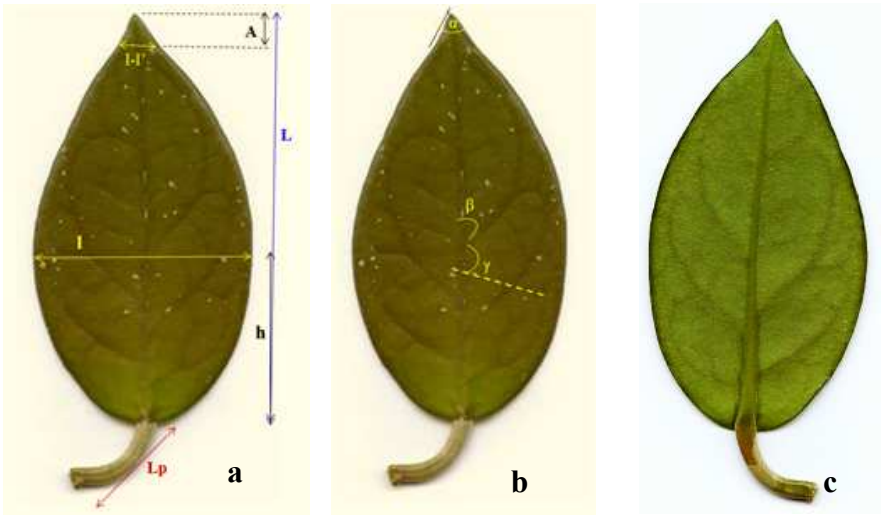

FIG. 2. *Hoya carnossa* leaf. Ventral lamina surface with liniar (a) and angular measurements (b). Dorsal lamina surface (c).

1. The average of biometric measurements of *Hoya carnosa* leaves. (1 = 40).

Linear measurements:

$$\overline{L_{Hc}} = \sum_{n=1}^{n} \frac{L_{Hc}}{n} = \frac{L_1 + L_2 + \ldots\ldots\ldots + L_n}{n} = \frac{97 + 75 + \ldots\ldots\ldots + 100}{40} = 95.93mm$$

$$\overline{l_{Hc}} = \sum_{n=1}^{n} \frac{l_{Hc}}{n} = \frac{l_1 + l_2 + \ldots\ldots\ldots + l_n}{n} = \frac{44 + 37 + \ldots\ldots\ldots + 50}{40} = 59.80mm$$

$$\overline{h_{Hc}} = \sum_{n=1}^{n} \frac{h_{Hc}}{n} = \frac{h_1 + h_2 + \ldots\ldots\ldots + h_n}{n} = \frac{50 + 40 + \ldots\ldots\ldots + 42}{40} - 43.92mm$$

$$\overline{A_{Hc}} = \sum_{n=1}^{n} \frac{A_{Hc}}{n} = \frac{A_1 + A_2 + \ldots\ldots\ldots + A_n}{n} = \frac{9 + 4 + \ldots\ldots\ldots + 12}{40} = 11.65mm$$

$$\overline{I-I'_{Hc}} = \sum_{n=1}^{n} \frac{I-I'_{Hc}}{n} = \frac{I-I'_1+I-I'_2+.....+I-I'_n}{n} = \frac{15+13+.....+14}{40} = 15.27mm$$

$$\overline{Lp_{Hc}} = \sum_{n=1}^{n} \frac{Lp_{Hc}}{n} = \frac{Lp_1+Lp_2+.....+Lp_n}{n} = \frac{15+20+.....+26}{40} = 23.02mm$$

Percentage ratios:

$$\overline{\frac{L}{l}_{Hc}} = \sum_{n=1}^{n} \frac{\left(\frac{L}{l}\right)_{Hc}}{n} = \frac{\left(\frac{L}{l}\right)_{Hc1}+\left(\frac{L}{l}\right)_{Hc2}+.....+\left(\frac{L}{l}\right)_{Hcn}}{n} = \frac{2.20+2.02+.....+1.82}{40} = 1.88\%$$

$$\overline{\frac{h}{L}_{Hc}} = \sum_{n=1}^{n} \frac{\left(\frac{h}{L}\right)_{Hc}}{n} = \frac{\left(\frac{h}{L}\right)_{Hc1}+\left(\frac{h}{L}\right)_{Hc2}+.....+\left(\frac{h}{L}\right)_{Hcn}}{n} = \frac{0.51+0.53+.....+0.50}{40} = 0.46\%$$

$$\overline{\frac{A}{L}_{Hc}} = \sum_{n=1}^{n} \frac{\left(\frac{A}{L}\right)_{Hc}}{n} = \frac{\left(\frac{A}{L}\right)_{Hc1}+\left(\frac{A}{L}\right)_{Hc2}+.....+\left(\frac{A}{L}\right)_{Hcn}}{n} = \frac{0.09+0.05+.....+0.14}{40} = 0.16\%$$

$$\overline{\frac{A}{I-I'_{Hc}}} = \sum_{n=1}^{n} \frac{\left(\frac{A}{I-I'}\right)_{Hc}}{n} = \frac{\left(\frac{A}{I-I'}\right)_{Hc1}+\left(\frac{A}{I-I'}\right)_{Hc2}+.....+\left(\frac{A}{I-I'}\right)_{Hcn}}{n} = \frac{0.60+0.30+.....+0.93}{40} = 0.78\%$$

Anglar measurements:

$$\overline{\alpha_{Hc}} = \sum_{n=1}^{n} \frac{\alpha_{Hc}}{n} = \frac{\alpha_{Hc1}+\alpha_{Hc2}+.....+\alpha_{Hcn}}{n} = \frac{40+25+.....+30}{40} = 29.75^o$$

$$\overline{\beta_{Hc}} = \sum_{n=1}^{n} \frac{\beta_{Hc}}{n} = \frac{\beta_{Hc1}+\beta_{Hc2}+.....+\beta_{Hcn}}{n} = \frac{30+35+.....+35}{40} = 36.90^o$$

$$\overline{\gamma_{Hc}} = \sum_{n=1}^{n} \frac{\gamma_{Hc}}{n} = \frac{\gamma_{Hc1}+\gamma_{Hc2}+.....+\gamma_{Hcn}}{n} = \frac{155+115+.....+150}{40} = 140.45^o$$

Other measurements:

$$\overline{Np_{Hc}} = \sum_{n=1}^{n} \frac{Np_{Hc}}{n} = \frac{Np_{Hc1}+Np_{Hc2}+.....+Np_{Hcn}}{n} = \frac{8+7+.....+8}{40} = 8/\sec veins$$

$$\overline{S_{Hc}} = \sum_{n=1}^{n} \frac{S_{Hc}}{n} = \frac{S_{Hc1} + S_{Hc2} + ... + S_{Hcn}}{n} = \frac{28.59 + 27.75 + ... + 33.50}{40} = 29.80 cm^2$$

Size class – **Notophyll**

Morphologic observations. Laminas are mostly notohyll (S = 20.63 – 38.86 cm^2), ocasionaly microphyll (S = 16.85 – 20.10 cm^2) and rare mesophyll (S = 43.05 – 48.50 cm^2) (Fig. 2, b; Table 2). Such as Mouton reported (1966a) the leaves size class values are registered as: leptophyll (S = 0 - 0.25 cm^2), nonophyll (S = 0.25 - 2.25 cm^2), microphyll (S= 2.25 - 20.25 cm^2), notophyll (S = 20.25 - 40.00 cm^2), mesophyll (S = 40.00 - 182.25 cm^2), macrophyll (S = 182 - 1640.2 cm^2) and megaphyll (over S = 1600.20 cm^2) (Givulescu, 1999). Al laminas are ended in a narrow acuminate apex with an average $\alpha = 29.75^o$ (Fig. 2, a, b). The lamina has fleshy texture. The lamina is thick and glabrous with the ventral surface dark green and slightly light green on the dorsal one (Fig. 2, a, b). The percentage ratio of all *Hoya carnosa* leaves indicate a thick leaf (average L/l = 1.88%) but a fine apex (average A/I-I' = 0.78%) (Table 3).

The mid vein is right and lamina venation is eucaptodromous (Andrei, 1997; Givulescu, 1999). From the primary veins are detached the secondaries with a number around 8/sec. vains (Np) and rare tertiary veins (Fig. 2, a, b; Table 4).

The emergent angle between the primary and the secondary veins (β) is norrow acute for all leaves (average, $\beta = 36.85^o$) and the values decrease from the leaf base to the apex of the leaf (Fig. 2; Table 3). The tertiary veins are oblique constant towards the secondary's, forming an obtuse angle with the primaries ($\gamma = 115 – 155^o$) (Fig. 2., b; Table 4).

The green or light green glabrous leaves petiole is more or less short with a lenght (Lp) between 13 - 30 mm. The lamina size average: L = 95.93 mm, l = 59.80 mm (Table 3).

CONCLUSIONS

Concerning the surface (S), the leaves are included in the notophyll and microphyll, rare mesophyll size class. The linear measurements of *Hoya carnosa* laminas have high values concerning the length (L) and lower for the apex length (A). The percentage ratios of all leaves indicate a fineness of leaf (L/l) and a fineness apex (A/I-I'). Lamina has eucaptodromous venation. Concerning the leaves angular measurements of *Hoya carnosa*, the apex is narrow acuminate (α). The emergent angle between the primary and the secondary veins (β) is narrow acute whereas the tertiary to the primaries (γ) are obtuse. Fleshy texture. The petiole is green or light green and more or less short (Lp). The morphological and biometric features such as the leaves size class, the ovality ratio, the fleshy texture, the venation type and the preponderant notophyll and occasionally microphyll size class, allow *Hoya carnosa* to be adaptable nor only for the greenhouse conditions and also for semiarid and arid zones.

TABLE 1. Linear measurements and percentage ratio of all *Hoya carnosa* of all 40 leaves

Leaf no	L mm	l mm	h mm	A mm	I-I' mm	Lp mm	L/l %	h/L %	A/L %	A/I-I' %
1	97	44	50	9	15	15	2.20	0.51	0,09	0.60
2	75	37	40	4	13	20	2.02	0.53	0.05	0.30
3	97	50	52	12	15	29	1.94	0.53	0.12	0.80
4	95	45	40	13	20	14	2.11	0.42	0.13	0.65
5	87	38	50	14	17	16	2.28	0.57	0.16	0.82
6	105	47	45	15	15	20	2.11	0.42	0.13	0.65
7	103	45	50	15	13	21	2.28	0.48	0.14	1.15
8	75	38	37	11	16	18	2.27	0.49	1.14	0.54
9	80	43	40	11	19	20	1.86	0.50	0.13	0.57
10	78	41	40	9	18	28	1.90	0.51	0.11	0.50
11	80	50	42	11	22	25	1.60	0.52	0.13	0.50
12	90	40	50	14	18	30	2.25	0.55	0.16	0.77
13	82	50	35	10	20	29	1.64	0.43	0.12	0.50
14	77	40	40	11	18	25	1.93	0.52	0.14	0.61
15	102	51	53	9	15	22	2.00	0.52	0.09	0.60
16	103	43	53	11	11	23	2.39	0.52	0,11	1.00
17	74	34	42	13	13	21	2.17	0.57	0.18	1.00
18	73	40	40	10	15	25	1.83	0.55	0.14	0.66
19	105	47	60	13	17	22	2.23	0.58	0.13	0.76
20	101	42	55	12	13	23	2.40	0.54	0.11	0.92
21	78	42	42	11	14	27	1.85	0.54	0.14	0.79
22	90	35	30	5	10	13	2.57	0.33	0.05	0.50
23	75	42	45	15	20	24	1.78	0.60	0.20	0.75
24	102	63	43	12	27	26	1.61	0.46	0.16	0.44
25	100	44	50	12	12	18	2.27	0.50	0.12	1.00
26	98	43	44	11	15	25	2.27	0.45	0.11	0.73
27	110	50	50	12	13	18	2.20	0.45	0.11	0.92
28	100	52	45	13	14	20	1.66	0.53	0.17	1.36
29	90	54	48	15	11	25	1.66	0.53	0.17	1.36
30	85	56	47	14	12	24	1.51	0.55	0.16	1.17
31	90	60	46	15	14	20	1.50	0.51	0.17	1.07
32	100	50	50	12	13	19	1.72	0.50	0.12	0.92
33	115	50	48	8	10	23	2.10	0.50	0.09	1.00
34	75	40	38	8	15	30	1.15	0.45	0.14	0.93
35	90	50	35	12	16	28	1.60	0.43	0.16	1.30
36	90	53	32	15	18	28	1.31	0.45	0.15	1.10
37	100	54	31	14	16	30	1.40	0.41	0.17	1.08
38	95	51	32	13	15	27	1.62	0.50	0.14	1.03
39	110	48	45	10	12	24	1.92	0.40	0.13	0.92
40	100	50	42	12	14	26	1.82	0.50	0.14	0.93

TABLE 2. Angular measurements, other measurements and the size class of all *Hoya carnosa* of all 40 leaves

Leaf no.	α°	β°	γ°	Np	S (cm²)	Size class
1	40	30	155	8	28.59	Notophyll
2	25	35	115	7	27.75	Notophyll
3	30	35	130	7	48.50	Mesophyll
4	30	35	125	7	28.40	Notophyll
5	34	44	145	7	22.15	Notophyll
6	40	45	150	8	33.06	Notophyll
7	35	32	142	10	31.05	Notophyll
8	32	42	145	6	19.09	Microphyll
9	30	45	147	6	23.04	Norophyll
10	38	33	147	7	21.42	Notophyll
11	36	40	141	7	26.80	Notophyll
12	39	18	152	8	24.12	Notophyll
13	30	50	135	8	37.47	Notophyll
14	20	30	155	7	20.63	Notophyll
15	40	45	152	9	35.18	Notophyll
16	30	40	140	9	29.67	Notophyll
17	25	45	150	8	16.85	Microphyll
18	30	42	135	9	19.56	Microphyll
19	32	41	140	7	33.06	Notophyll
20	30	40	135	9	28.42	Notophyll
21	35	42	141	8	21.92	Notophyll
22	30	35	150	9	21.11	Notophyll
23	31	38	120	7	21.11	Notophyll
24	30	37	135	8	43.05	Mesophyll
25	35	40	140	10	29.48	Notophyll
26	32	41	130	9	28.23	Notophyll
27	25	28	148	8	36.85	Notophyll
28	30	31	150	9	34.84	Notophyll
29	35	30	135	7	32.56	Notophyll
30	35	34	142	7	31.89	Notophyll
31	28	32	145	8	36.18	Notophyll
32	29	35	132	9	38.86	Notophyll
33	25	30	149	9	38.52	Notophyll
34	32	35	145	8	20.10	Microphyll
35	32	30	135	8	30.15	Notophyll
36	34	36	140	9	31.95	Notophyll
37	25	30	145	9	36.18	Notophyll
38	25	30	130	8	32.46	Notophyll
39	21	25	140	9	38.52	Notophyll
40	30	35	150	8	33.50	Notophyll

TABLE 3. The average of the linear measurements and percentage ratio of all *Hoya carnosa* leaves

Species	L (mm)	l (mm)	h (mm)	A (mm)	I-I´ (mm)	Lp (mm)	L/l (%)	h/L (%)	A/L (%)	A/ I-I´ (%)
Hoya carnosa	95.93	59.80	11.65	19.05	15.27	23.02	1.88	0.46	0.16	0.78

TABLE 4.The average of angular measurements, other measurements and size class of all *Hoya carnosa* leaves

Specia	α^o	β^o	γ^o	Np	S (cm^2)	Size class
Hoya carnosa	29.75	36.90	104.95	8	29.80	Notophyll, ocasionaly microphyll

REFERENCES

- Andrei M. 1997. *Morfologia generală a plantelor*, Edit. Enciclopedică, Bucureşti.
- Bercu R. 2005. *Biometrical and anatomical observations of some Acer* L. *genus species leaves* (monograph), Belgrade University Press, Faculty of Forestry, University of Belgrade, Belgrade, Serbia-Montenegro, Yugoslavia.
- Bercu R. 2013a. Biometrical observations on the spontaneous species *Syringa vulgaris* L. (Oleaceae) leaves, *Annals of the Romanian Society for Cell Biology*, vol. XVIII, (2): 165-171.
- Bercu R. 2013b. Biometrical observations on *Ficus benjamina* L. 'Starlight' leaves, *Annals of the Romanian Society for Cell Biology,* vol. XVIII, (1): 217-222.
- Bercu R. 2015. Biometrical observations on *Quercus robur* L. (Fagaceae) leaves. *Annals of West University of Timişoara, ser. Biology*, vol 18(1): 19-26.
- Buia Al., Péterfi Şt. 1965. *Botanica agricolă*, *Morfologia*. vol. I., Edit. Agro-Silvică, Bucureşti.
- Dale M.B., Groves R.H., Hull V.J., O'Callaghan J.F. 1971. A new method for describing leaf shape. *New Phytologist*, 70: 437-442.
- Dickinson T.A., Parker W.H., Strauss R.E. 1987. Another approach to leaf shape comparisons. *Taxon*, 36: 1-20.
- Givulescu R. 1999. *Flora mică ilustrată a terţiarului din România*, Edit. Casa Cărţii de Stiinţă, Cluj-Napoca.
- Givulescu R., Soltesz A. 2000. Observaţii de ordin biometric şi anatomic asupra frunzelor unor specii de *Tilia*. *Nymphaea*, *Folia nature Bihariae* (Oradea), XVIII: 83-89.
- Hickely L.J. 1973. Classification of the architecture of dicotyledonous leaves. *Amer. J. Bot.,* 60: 17-33.
- Ianovici N., Ciocan G.V., Matica A., Scurtu M., Şesan T.E. 2012. Study on the infestation by *Cameraria ohridella* on *Aesculus hippocastanum* foliage from Timişoara, Romania, *Annals of West University of Timişoara, ser. Biology*, 15 (1): 67-80
- Ianovici N., Latis A.A., Radac A.I. 2017. Foliar traits of *Juglans regia, Aesculus hippocastanum* and *Tilia platyphyllos* in urban habitat. *Romanian Biotechnological Letters*. 22 (2), 12400-12408
- Ianovici N., Novac I.D., Vlădoiu D., Bijan A., Ionaşcu A., Sălăşan B., Rămuş I. 2009. Biomonitoring of urban habitat quality by anatomical leaf parameters. *Annals of West University of Timişoara, ser. Biology*, 12:73-86.
- Ianovici N., Vereş M., Catrina R.G., Pîrvulescu A.-M., Tănase R.M., Datcu D.A.2015. Methods of biomonitoring in urban environment: leaf area and fractal dimension. *Annals of West University of Timişoara, ser. Biology*, 18 (2):169-178.
- Melville R. 1976. The terminology of leaf architecture, *Taxon*, 25: 549-561.
- Miaulane P. 2004. *Enciclopedia Truffaut-Grădini şi plante de interior*. Edit. Enciclopedia Rao, Bucureşti.
- Mouton A. 1966b. Sur la systématique foliaire en paléobotanique. *Bull. Soc. Bot.* (Paris), 113(9), 492-503.
- Mouton J.A. 1966a. Les types biologiques foliaires de Raunkiaer. Etat actuel de la question. *Bull. Soc. Bot.* (*Paris*), 125: 145-158.
- Mouton J.A. 1976. La biométrie du limbe mise au point de nos connaissances. *Bull. Soc. Bot*. (Paris), 113: 28-36.
- Phillips R. 1997. *The Random House Book of Indoor and Greenhouse Plants.* vol. 2. Random House, New York, U.S.A.
- Roth L.L., Dilcher D.L. 1978. Some considerations in leaf size and leaf margin analysis in fossil leaves. *Cour. Forsch. Indst. Senckenberg*, 30: 265-171.
- Web 1 http://worldofsucculents.com/hoya-carnosa-wax-plant/
- Web 2 http://www.horticultorul.ro/flori-de-apartament-gradina/flori-de-ceara-hoya-carnosa/