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The use of numerical methods in the systematics of hawthorns occurring in Poland

The genus *Crataegus*, besides such variable and polyspecific genera as *Rosa*, *Rubus*, *Salix*, *Alchemilla* or *Hieracium*, is very difficult to treat taxonomically. It belongs to the family *Rosaceae*, subfamily *Maloidae* (*Pomoidae*). The kariological studies of G l a d k o v a (1967, 1968) have shown that genera from this subfamily frequently form in nature poliploidal complexes with an intergradation of morphological characters. Besides, the hawthorns are also capable of easy apomictic reproduction (G l a d k o v a, 1968). This leads to the formation of colonies, micropopulations frequently originating from only one individual. Hybridization, polyloidy nad apomixis are the main reasons behind the great polymorphism in the genus *Crataegus*. Insufficient consideration of intraspecific and interspecific variability has led to the recognition within the genus of a very large number of different taxa. Thus for example within the span of only 25 years, only from the region of North America in all almost 1100 new species have been described. With time this number was considerably decreased, because it proved that many of these have been known before under different names, or that they are only hybrids or taxa of a lower order. Presently the tendency to describe numerous new taxa manifests itself in the studies of some European taxonomists. Among these one could mention P o j a r k o v a (op. plur.), K l o k o v (1954), H r a b ě t o v a - U h r o v a (op. plur.) and C i n k o v s k i s (1971). On the other hand the species is being considered in a wide sence (eg. B u i a, 1956; P é n z e s, 1956), and in these cases usually only *C. oxyacantha* L. and *C. monogyna* Jacq. are being recognized and the remaining species are being treated as taxa of a lower order.

When undertaking the study of the systematic status of hawthorns existing in Poland I have employed both the classical methods of analysing morphological differences and numerical methods, namely the dendritic method and the discrimination analysis of Fisher. Use was made for the purpose of both living material and herbarium collections available in Polish and neighbouring (USSR, Czechoslovak) herbaria. The effect of the studies was to obtain an answer to the questions: 1° Which hawthorns occur in Poland and what are their interrelations, 2° What is

the relation of certain individuals difficult to place by classical morphological methods, to the clearly defined taxa occurring in Poland.

In order to obtain appropriate materials for biometric studies and mathematical evaluations 62 samples were collected each consisting of 50 leaves and 50 fruits, from localities distributed througout the country, in regions of abundant occurrence and fruiting of hawthorns. After having made a detailed morphological description of the plants I have selected for the biometric studies 17 charaters of seed (Tab. 1), 25 chara-

Table 1

Characters of fruit and seed used n the biometric studies

No.	Seed characters	No.	Fruit characters
1	One stone	1	Outline cylindrical
2	Two stones	2	Outline pear-shaped
3	Three stones	3	Outline elliptic
4	Stone flat from ventral side	4	Outline circular
5	Stone not flat from ventral side	5	With bulges at base
6	Stone spherical-roundish	6	Without bulges at base
7	elliptic	7	length: 8 - 11
8	elongated narrowing towards the base	8	11 - 13
9	elongated, truncated at base	9	13 - 15
10	Stone furrowed on dorsal side	10	15 - 18
11	Stone not furrowed on dorsal side	11	width: 7 - 9.5
12	Stone furrowed on ventral side	12	9.5 - 12
13	Stone not furrowed on ventral side	13	12 - 14.5
14	Ventral furrows shallow	14	14.5 - 17
15	Ventral furrows deep	15	Sepals on fruit: erect
16	Ventral furrows not branched	16	horizontal
17	Ventral furrows branched	17	recurved
		18	scattered-variously positioned
		19	recurved and adhereing to fruit
		20	Sepals: widely triangular
		21	triangular
		22	narrowly triangular
		23	lanceolate
		24	persistent
		25	deciduous

cters of the fruits (Tab. 1), 42 characters of leaves (Tab. 2) and 4 characters of stipules (Tab. 2). In order to prepare tables of charaters for the construction of a dendrite I have selected 19 representative individuals. They include the group of hawthorns with a single stone, the group with two stones, and the group with 1 - 2 stones. The percentage values of some characters have been calculated relative to 50 fruits, 50 leaves and 20 stipules in each case. Thus for example for. *C. monogyna* no. 1 a result has been obtained from measurements made on four individuals, for *C. monogyna* no. 2 and no. 3, for *C. oxyacantha* no. 1 and no. 2, for *C. lindmanii* no. 1 and no. 2, *C. curvisepala* no. 1 and no. 2, for *C. palmstruchii, C. macrocarpa* and *C. heterodonta* from measurements made on 2 individuals and for *C. poloniensis* on one individual. The individuals, both in

the case of species and hybrids either originated from one stand, or from widely separated places. Basing on the value of the sum of all differences jointly for characters of fruits and seeds (Tab. 3) and on the basis of leaf and stipule characters (Tab. 4) dendrites were drawn (Fig. 1a, 1b). Then

Table 2

Characters of leaves and stipules used in the biometric studies

No.	Characters of leaf	No.	Characters of leaf
1	Leaves: unicoloured	22	Leaves: without lobes
2	discolorous	23	with indistinct lobes
3	lustrous above		
4	dull	24	with distinct lobes
5	leathery	25	Lobes 3
6	fine	26	5
7	Leaf base: narrowly cuneate	27	7
8	cuneate	28	more
9	widely cuneate	29	Sinuses shallow
		30	Sinus depth: to 1/2 od distance to midrib
10	rounded		
11	slightly arched towards petiole	31	almost to midrib
		32	Lobes above 1/2 of blade
12	Margin entire	33	Lobes distributed over whole blade
13	Margin completly dentate	34	Lobes: acuminate
14	lower lobe dentate	35	obfuse
	for full length	36	slightly rounded
15	Dentate margin upper half of lower lobe	37	Leaves: pubescent in vein crotch
16	Teeth: small	38	pubescent along margins
17	large		and veins
18	sharp	39	glabrous
19	slightly blunted	40	Petiole: longer than blade
20	even	41	as long as blade
21	uneven	42	shorter than blade
	Characters of stipules:		
1	Stipules: large	3	Dentate
2	small	4	Margin entire

the difference sums were calculated jointly for the characters of fruits, seeds, leaves and stipules (Tab. 5) and on this basis a joint dendrite was drawn (Fig. 1c).

The general split up of the analysed material was in all three cases analogous. There are distinct divisions into the groups of individuals representing recognized species growing in Poland: nos. 1, 2 and 3 (*C. monogyna* Jacq. *s.str.*), to which are related individuals no. 18 (*C. heterodonta* Pojark.) and no. 19 (*C. poloniensis* Cinov.), then individuals nos. 8 and 9 (*C. curvisepala* Lindm.), nos. 10 and 14 (*C. palmstruchii* Lindm.). Individual no. 11 on the dendrite based on seed and fruit characters appears related to representatives of *C. lindmanii* Hrabět.-Uhr., while on the dendrite based on leaf and stipule characters to *C. curvisepala*. A similar position is taken by the specimen on the joint dendrite. However the statistical distance between this individual and the other is such that it can

be assigned species rank. This is a hawthorn recently found in Poland identified as *C. macrocarpa* Hegetschw. (Gostyńska-Jakuszewska, 1970). Separate groups are also formed by *Crataegus* nos. 4 and 5 (*C. oxyacantha* L.em.Jacq.) and *Crataegus* nos. 6 and 7 (*C. lindmanii*).

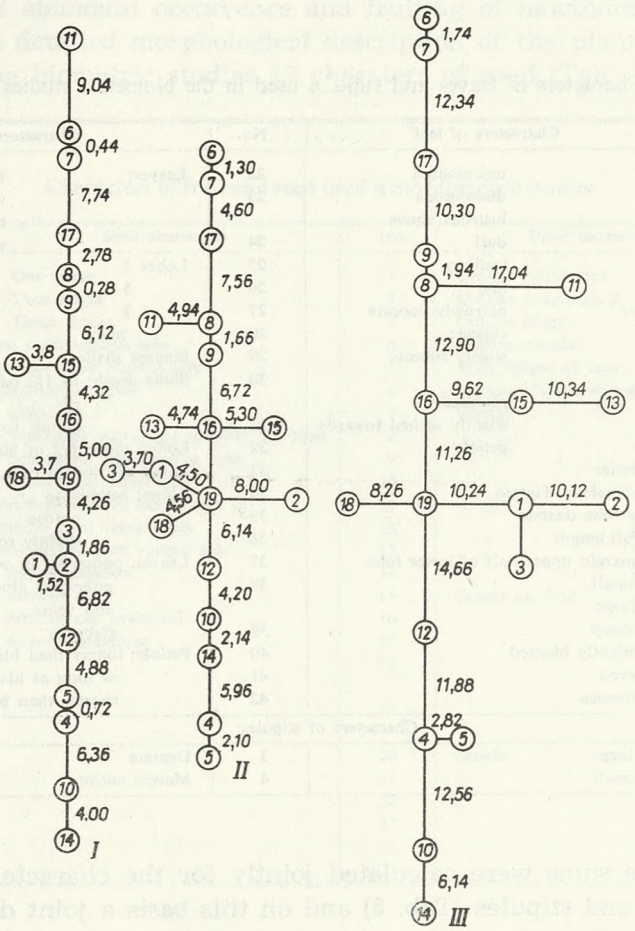

Fig. 1

a — dendrite based on fruit and seed characters, *b* — dendrite based on leaf and stipule characters, *c* — dendrite based on all characters jointly

The rest of the studied representatives were located between the above mentioned groups of hawthorns. They are therefore interspecific hybrids. In that numebr there are *C.* × *media* Bechst. (no. 12), *C.* × *fallacina* (Klok) Gost.-Jak. comb. nova (nos. 16 and 13 = *C. plagiosepala* Pojark.). *C.* × *dunensis* Cinov (no. 17) and *C* × *pseudooxyacantha* Cinov (no. 15).

An analogous split up of the individuals in all three dendrites indicates that the characters of leaves and stipules are strongly related to the characters of seed and fruits. Thus it is possible to identify hawt-

Table 3

Value of sum of differences for fruit and seed characters

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
–	1,52	2,14	9,72	9,20	9,94	9,92	10,38	10,48	12,12	14,60	7,40	8,44	12,54	8,72	6,68	10,80	7,02	5,74
	–	0,86	9,54	9,08	10,32	10,30	9,34	9,40	11,78	14,92	6,82	7,92	11,86	7,74	5,72	9,88	5,82	4,86
		–	10,04	9,56	10,06	10,10	8,90	9,00	12,04	14,84	7,28	7,22	11,80	7,26	5,38	9,50	5,46	4,26
			–	0,72	15,06	14,84	14,60	14,54	6,36	15,50	5,28	11,92	8,58	11,20	12,62	15,14	13,58	12,06
				–	14,54	14,38	14,04	13,98	6,84	15,10	4,88	11,42	8,36	10,70	12,12	14,60	13,08	11,60
					–	0,44	10,08	9,08	13,76	9,04	12,76	11,08	12,14	9,88	9,86	7,78	11,26	11,16
						–	9,04	9,04	13,62	9,28	12,86	11,44	12,32	9,84	9,74	7,74	11,64	11,54
							–	0,28	12,18	12,10	11,68	6,56	10,56	6,28	6,24	2,78	7,84	8,84
								–	12,12	12,24	11,60	6,40	10,38	6,12	6,20	2,86	8,00	8,90
									–	12,20	9,08	14,12	4,00	11,96	12,00	11,78	13,16	13,16
										–	13,72	15,22	10,60	14,06	14,10	10,90	14,52	15,42
											–	9,18	9,50	8,46	8,92	12,40	9,64	8,52
												–	12,48	3,84	6,72	7,42	7,02	5,80
													–	10,22	10,46	9,68	11,48	11,28
														–	4,32	6,54	7,50	7,30
															–	6,70	5,68	5,00
																–	8,40	9,22
																	–	3,70
																		–

Table 4

Value of sum of differences for leaf and stipule characters

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
–	8,60	3,70	15,40	16,10	16,00	16,40	13,44	13,40	14,00	14,90	11,20	13,26	14,26	13,20	10,60	16,20	6,90	4,50
	–	11,20	17,00	17,10	14,80	14,70	13,84	14,00	15,30	12,20	13,50	14,16	15,46	15,10	13,20	14,96	10,50	8,00
		–	14,60	14,60	18,20	18,50	16,16	16,52	14,20	16,90	11,30	13,20	14,56	15,30	12,00	18,80	4,80	6,06
			–	2,10	20,50	21,00	12,56	12,62	6,20	13,90	6,60	9,60	5, 96	9,50	11,90	18,60	10,70	10,46
				–	21,20	21,40	13,76	13,82	7,40	14,50	7,10	11,00	7,16	10,90	13,10	19,20	11.20	11,16
					–	1,30	9,24	8,90	17,90	10,00	16,50	14,46	18,46	15,10	13,20	4,90	19,30	15,10
						–	9,54	9,40	18,30	10,00	16,90	14,76	18,86	15,50	13,70	4,60	19,70	15,40
							–	1,66	11,14	4,94	10,06	7,58	11,70	7,26	6,66	7,56	13,86	9,34
								–	11,00	5,80	10,12	7,30	11,26	7,32	6,72	7,50	14,02	9,40
									–	10,40	4,20	8,30	2,14	9,70	10,70	15,90	10,10	8,46
										–	10,90	8,90	10,76	9,90	8,60	8,80	14,80	10,40
											–	9,40	5,06	8,50	9,10	14,50	8,80	6,14
												–	8,86	6,50	4,74	12,96	9,60	8,16
													–	10,26	11,56	16,66	11,26	8,90
														–	5,30	13,00	12,60	8,86
															–	10,90	10,10	6,26
																–	18,30	13,50
																	–	4,56
																		–

Table 5

Value of sum of differences for fruit, seed, leaf and stipule characters

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
–	10,12	5,84	25,12	25,30	25,94	26,32	23,52	23,88	26,42	29,50	18,60	21,70	26,80	21,92	17,28	27,00	13,92	10,24
	–	12,06	26,52	26,18	25,12	25,00	23,18	23,40	27,08	27,12	20,32	22,08	27,32	22,84	18,92	24,84	16,32	12,86
		–	24,60	25,16	28,26	28,60	25,06	25,52	26,24	31,74	18,58	20,42	26,36	22,56	17,38	28,30	10,26	10,32
			–	2,82	35,56	35,84	27,16	27,16	12,56	29,40	11,88	21,52	14,54	20,70	24,52	33,74	24,28	22,52
				–	35,74	35,78	27,80	27,80	14,24	29,60	11,98	22,42	15,32	21,60	25,22	33,80	24,28	22,76
					–	1,74	19,32	17,98	31,66	19,04	29,26	25,54	30,60	24,98	23,06	12,68	30,56	26,26
						–	18,58	18,44	31,92	19,28	29,76	26,20	31,18	25,34	23,44	12,34	31,34	26,94
							–	1,94	23,32	17,04	21,70	14,14	22,26	13,54	12,90	10,34	21,70	18,18
								–	23,12	18,08	21,72	13,70	21,64	13,44	12,92	10,30	22,02	18,30
									–	22,60	13,28	22,42	6,14	21,66	22,70	27,68	23,26	21,62
										–	24,62	24,12	21,36	23,96	22,70	19,70	29,32	25,82
											–	18,58	14,56	16,96	18,02	26,90	19,44	14,66
												–	21,34	10,34	11,46	20,38	16,62	13,96
													–	20,48	22,02	26,34	22,74	20,18
														–	9,62	19,54	20,10	16,16
															–	17,60	15,78	11,26
																–	26,70	22,37
																	–	8,26
																		–

horns correctly both on the basis of generative and on vegetative characters.

In the discrimination analyses, to which 62 samples were subjected, use was made of 17 characters of high diagnostic value (Tab. 6). Assuming that in the Polish flora the well recognized and at the same time the most commonly found four species are *C. monogyna, C. curvisepala, C. lindmanii* and *C. oxyacantha,* the unusual individuals referred to above were compared to these four species. The calculated values of the discri-

Table 6

Characters considered in the discrimination analysis

No.	Character
1	Length of leaf blade
2	Width of leaf blade
3	Number of lobes
4	Depth of sinus between first and second lobe
5	Angle of leaf blade base
6	Number of teeth on the lower margin of the first lobe
7	Ratio of blade length to width
8	Length of petiole
9	Ratio of blade length to petiole length
10	Ratio of blade width to depth of sinus between first and second lobe
11	Distance of sinus base between first and second lobe from blade base
12	Fruit length
13	Ratio of fruit length to width
14	Positioning of sepals on the fruit: erect, horizontal, recurved positioned variously
15	Ratio of sepal length to width
16	Stone length
17	Number of furrows on dorsal stone surface

Table 7

Value of the Fisher discriminant function

Between	For species	Value of function from	Value of function to	Distance between species
C. monogyna	*C. monogyna*	−191	−145	107
:				
C. oxyacantha	*C. oxyacantha*	−308	−298	
C. lindmanii	*C. lindmanii*	−171	−156	232
:				
C. monogyna	*C. monogyna*	+ 76	+135	
C. curvisepala	*C. curvisepala*	−161	−155	43
:				
C. monogyna	*C. monogyna*	− 83	−112	
C. lindmanii	*C. lindmanii*	+ 18	+ 34	29
:				
C. oxyacantha	*C. oxyacantha*	+ 63	+ 72	
C. curvisepala	*C. curvisepala*	+ 69	+ 97	92
:				
C. oxyacantha	*C. oxyacantha*	+189	+195	
C. curvisepala	*C. curvisepala*	−393	−376	392
:				
C. lindmanii	*C. lindmanii*	+ 16	+ 60	

minant function for individual species pairs are presented in table 7. Then the value of the discriminant function was calculated for the 24 uncertain individuals separately for each discrimination between every species pair.

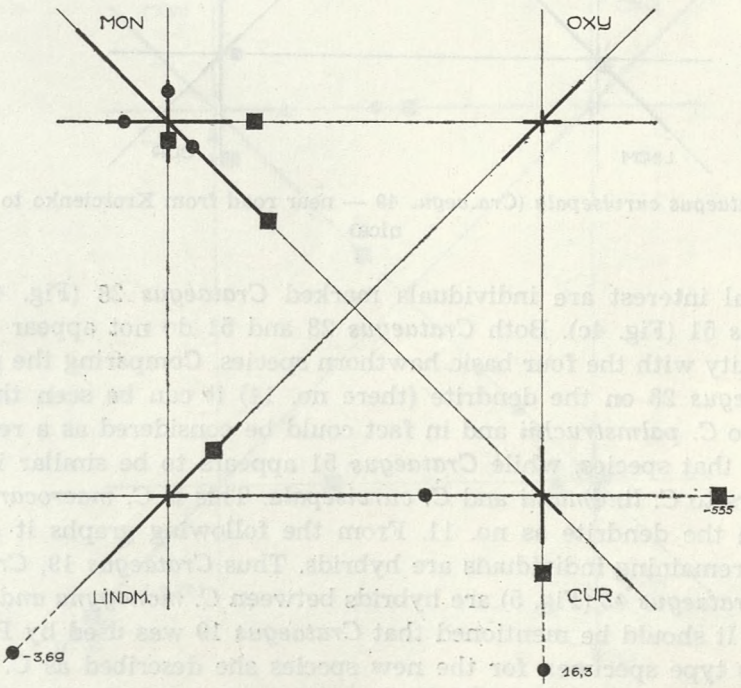

Fig. 2

a — *Crataegus monogyna* (*Crataegus* 37 — Złotniki Kujawskie), *b* — *Crataegus heterodonta* (*Crataegus* 1 — Kulin on the Vistula, near Włocławek)

It turned out that 6 of these lie within the scale of variability of *C. monogyna*. Among these are the materials used by Pojarkova for the description of a new species for Poland — *C. heterodonta*. Similarily as in the discrimination analysis the location of this hawthorn on the dendrites is almost in complete agreement with *C. monogyna* (Fig. 2a, and 2b). The further graphs show that 3 individuals are close to *C. curvisepala* (Fig. 3) and 4 lie within the limits of *C. oxyacantha* (Fig. 4a). In the latter however some influence of *C. monogyna* seems to be detectable.

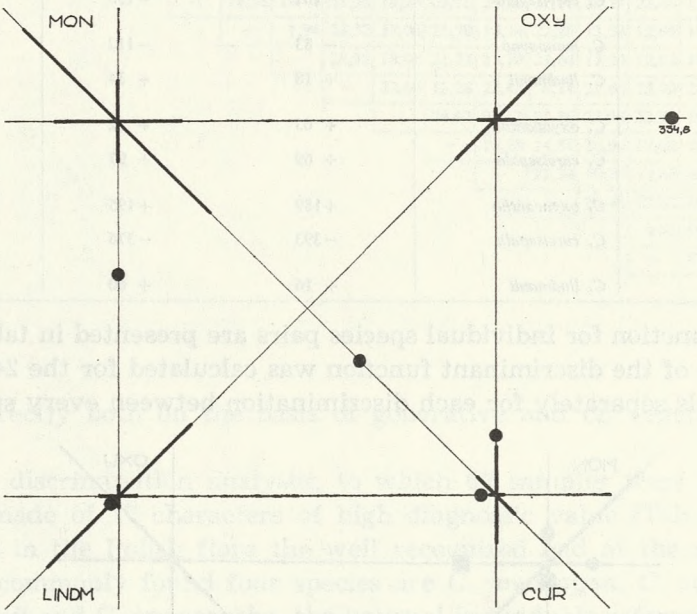

Fig. 3. *Crataegus curvisepala* (*Crataegus* 49 — near road from Krościenko to Szczawnica)

Of special interest are individuals marked *Crataegus* 28 (Fig. 4b) and *Crataegus* 51 (Fig. 4c). Both *Crataegus* 28 and 51 do not appear to bear any affinity with the four basic hawthorn species. Comparing the position of *Crataegus* 28 on the dendrite (there no. 14) it can be seen that it is nearest to *C. palmstruchii* and in fact could be considered as a representative of that species, while *Crataegus* 51 appears to be similar in some characters to *C. lindmanii* and *C. curvisepala*. This is *C. macrocarpa* presented in the dendrite as no. 11. From the following graphs it appears that the remaining individuals are hybrids. Thus *Crataegus* 19, *Crataegus* 25 and *Crataegus* 43 (Fig. 5) are hybrids between *C. monogyna and C. curvisepala*. It should be mentioned that *Crataegus* 19 was used by Pojarkova as type specimen for the new species she described as *C. plagiosepala*. It appears to have more characters in common with *C. curvisepala* than the other two hybrids. Comparing herbarium materials, diagnoses

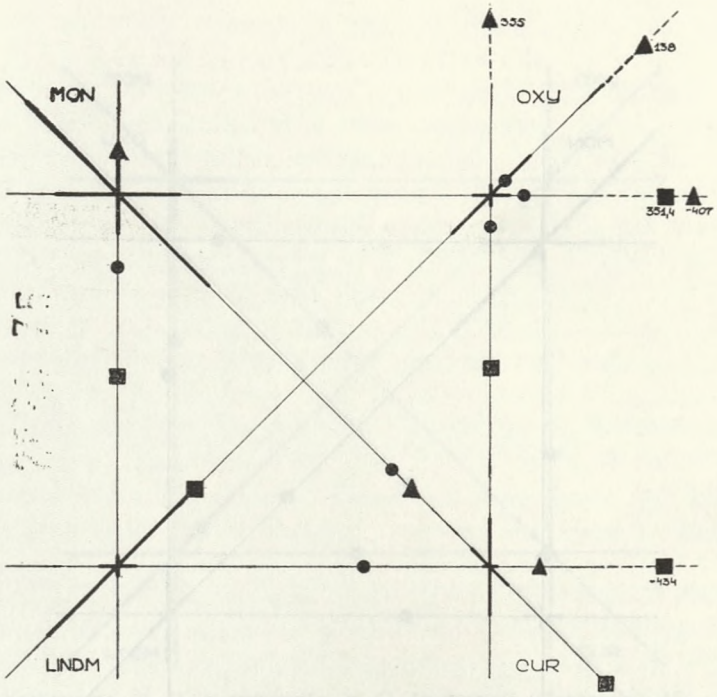

Fig. 4

a — *Crataegus oxyacantha* (*Crataegus* 13 — Grudziądz), *b* — *Crataegus palmstruchii* (*Crataegus* 28 — Trzebnica), *c* — *Crataegus macrocarpa* (*Crataegus* 51 — Życzanów near Rytro on the Poprad

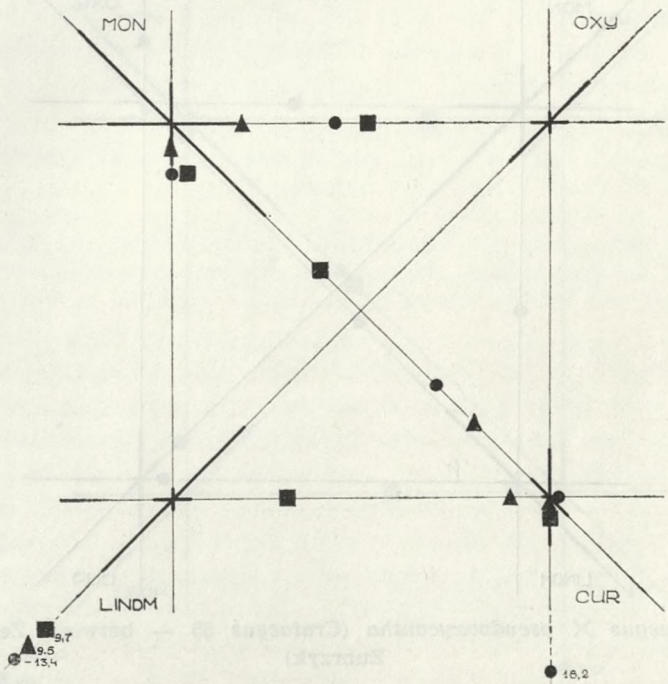

Fig. 5. *Crataegus* × *fallacina*

a — *Crataegus* 19 — Ciecierzyn near Lublin = *C. plagiosepala*, *b* — *Crataegus* × *fallacina* (*Crataegus* 56 — Przegorzały near Kraków), *c* — *Crataegus* × *fallacina* (*Crataegus* 43 — Pieskowa Skała)

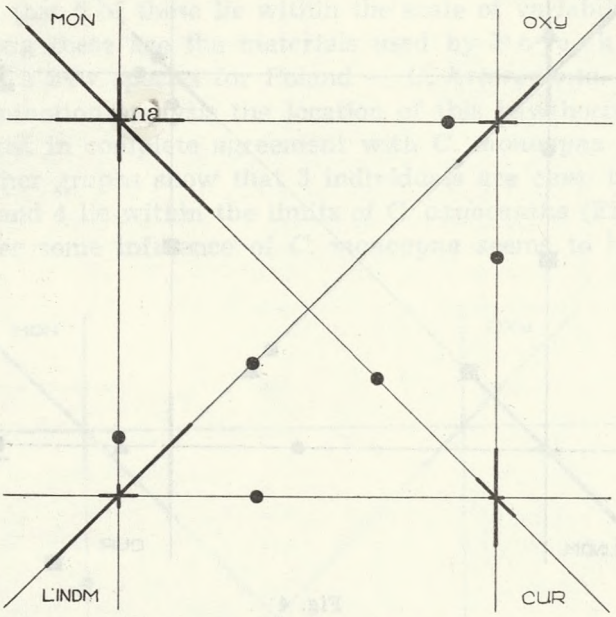

Fig. 6. *Crataegus* × *calycina* (*Crataegus* 30 — Trzebnica)

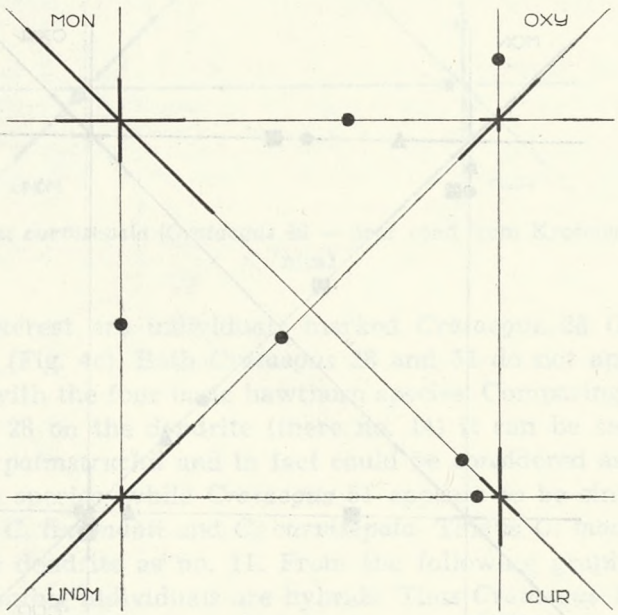

Fig. 7. *Crataegus* × *pseudooxycantha* (*Crataegus* 55 — between Żegiestów and Zubrzyk)

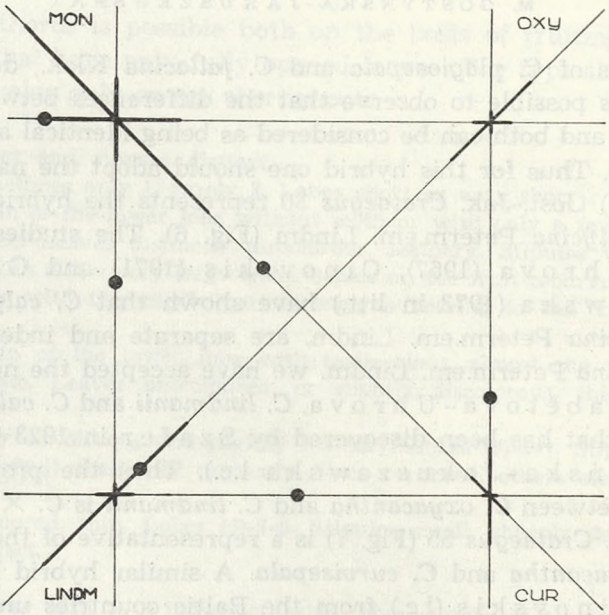

Fig. 8. *C. monogyna* × *C. curvisepala* × *C. lindmanii* (*Crataegus* 45 — Pieskowa Skała)

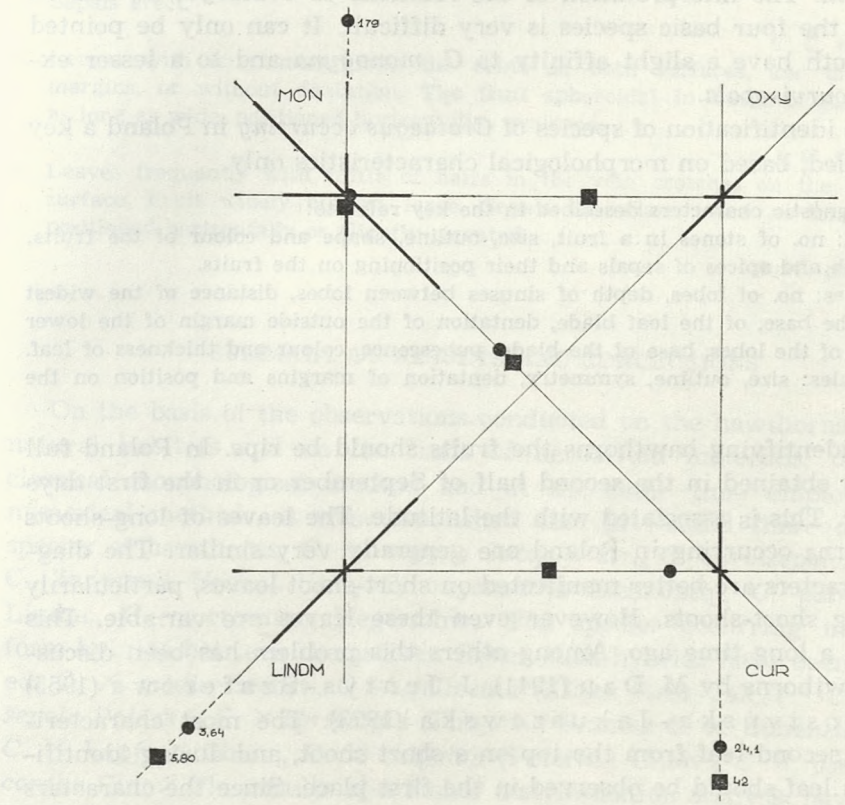

Fig. 9

a — *C. monogyna* × *C. curvisepala* ? (*Crataegus* 33 — Chabsko), *b* — *C. monogyna* × ? (*Crataegus* 44 — Pieskowa Skała)

and drawings of *C. plagiosepala* and *C. fallacina* Klok., described from Ukraine, it is possible to observe that the differences between them are insignificant and both can be considered as being identical and the names as synonyms. Thus for this hybrid one should adopt the name *C.* × *fallacina* (Klok.) Gost.-Jak. *Crataegus* 30 represents the hybrid *C. oxyacantha* × *C. calycina* Peterm.em. Lindm (Fig. 6). The studies of C. Hrabětova-Uhrova (1967), Cinovskis (1971) and Gostyńska-Jakuszewska (1973 in litt.) have shown that *C. calycina* Peterm. and *C. calycina* Peterm.em. Lindm. are separate and independent taxa. For *C. calycina* Peterm.em. Lindm. we have accepted the new name proposed by Hrabětova-Uhrova, *C. lindmanii* and *C. calycina* Peterm. is a hybrid that has been discovered by Szafer in 1923 (Cinovskis l.c., Gostyńska-Jakuszewska l.c.). Thus the proper name for the hybrid between *C. oxyacantha* and *C. lindmanii* is *C.* × *calycina* (Peterm.) Cinov. *Crataegus* 55 (Fig. 7) is a representative of the hybrids between *C. oxyacantha* and *C. curvisepala*. A similar hybrid has been described by Cinovskis (l.c.) from the Baltic countries under the name *C* × *pseudooxyacantha*. Finally *Crataegus* 45 (Fig. 8) is a triple hybrid, in which links are detectable between *C. monogyna, C. curvisepala* and *C. lindmanii*. The interpretation of the relations of *Crataegus* 33 and 44 (Fig. 9) to the four basic species is very difficult. It can only be pointed out that both have a slight affinity to *C. monogyna* and to a lesser extent to *C. curvisepala*.

For the identification of species of *Crataegus occurring* in Poland a key was compiled, based on morphological characteristics only.

The diagnostic characters described in the key refer to:

1° Fruit: no. of stones in a fruit, size, outline, shape and colour of the fruits, length, width and apices of sepals and their positioning on the fruits.

2° Leaves: no. of lobes, depth of sinuses between lobes, distance of the widest part from the base, of the leaf blade, dentation of the outside margin of the lower lobe, apices of the lobes, base of the blade, pubescence, colour and thickness of leaf.

3° Stipules: size, outline, symmetry, dentation of margins and position on the shoot.

When identifying hawthorns the fruits should be ripe. In Poland full ripeness is obtained in the second half of September or in the first days of October. This is associated with the latitude. The leaves of long-shoots of hawthorns occurring in Poland are generally very similar. The diagnostic characters are better manifested on short-shoot leaves, particularily on fruiting short-shoots. However even these leaves are variable. This was noted a long time ago. Among others this problem has been discussed for hawthorns by M. Dau (1941), J. Jentys-Szaferowa (1955) and M. Gostyńska-Jakuszewska (1973). The most characteristic is the second leaf from the top on a short shoot, and during identification this leaf should be observed in the first place. Since the characters of fruits and leaves are closely related to each other, a correct identifi-

cation of hawthorns is possible both on the basis of fruiting specimens and on those that have only fully opened leaves. The typical stipules for the species develop only on the short shoots.

1. Stone 1, Lobes and sinuses distinct 2
1. Stones 2, sometimes only 1, rarely 3, Lobes short or very short . . . 4
2. Outside margin of the lower lobe without teeth or with only a few teeth at the tip of the lobe. Leaves distinctly discolorous, leathery. Stipules without teeth, more rarely with a few very large teeth. Sepals on the fruit recurved downwards and frequently with the middle part strongly adhereing to the fruit.
1. *C. monogyna (s. str.)*
2. Outside margin of the lower lobe with teeth along almost the whole length. Stipules dentate. Leaves unicoloured, or slightly discolorous, thin or slightly leathery 3
3. Leaves slightly discolorous and slightly leathery. Lobes (3)-5-7. Stipules dentate. Sepals on the fruit positioned unevenly, some recurved, others elevated.
2. *C. curvisepala*
3. Leaves unicoloured, thin. Lobes (5)-7-9. Stipules small, sharply dentate. Sepals on the fruit erect.
3. *C. lindmanii*
4. Stones 2. Leaves with 3 - 5 indistinct, wide lobes, obtuse at the top or weakly acuminate 5
4. Stones 2 or 1 (occasionally 3). Leaves with 3 - 7 rather narrrow lobes, cuspidate or acuminate. Fruit cylindrical with five large distinct bulges at the base. Sepals erect.
6. *C. macrocarpa*
5. Leaves with long hairs along the veins on both surfaces, and on the leaf margins, or without dentation. The fruit spheroidal in outline, sepals almost as long as wide, positioned horizontally, recurved.
4. *C. Oxyacantha*
5. Leaves frequently with tuffts of hairs in the vein crotches on the lower leaf surface. Fruit widely elliptic, large. Sepals lanceolate twice as long as wide positioned horizontally or slightly elevated.
5. *C. palmstruchii*

SUMMARY OF RESULTS AND CONCLUSIONS

On the basis of the observations conducted on the hawthorns in their natural habitats and on the basis of herbarium materials, using the classical morphological method and at the same time employing the numerical methods, it was established that in Poland there occur six species of hawthorns: *C. monogyna* Jacq. *s. str.*, *C. curvisepala* Lindm., *C. lindmanii* Hrabět.-Uhr., *C. oxyacantha* L.em.Jacq., *C. palmstruchii* Lindm., *C. macrocarpa* Hegetschw.. The species occurring in Poland form hybrids between themselves. Seven such hybrids have been observed: *C.* × *media* Bechst., *C* × *fallacina* (Klok). Gost.-Jak. (= *C. plagiosepala* Pojark.), *C.* ×*kyrtostyla* (Fingerh.) Franco, *C.* × *dunensis* Cinov., *C.* × *kupfferi* Cinov., *C.* × *calycina* (Peterm.) Cinov., *C* × *pseudooxycantha* Cinov. The results of a Fisher discrimination analysis have shown

that the hawthorns form also polyspecific hybrids, such as for example *Crataegus* 45 = *C. monogyna* × *C. curvisepala* × *C. lindmanii*. The dendrite drawn from the material distinguishes well the recognized Polish species and interspecific hybrids. *C. curvisepala*, *C. lindmanii*, *C. oxyacantha* and *C. palmstruchii* constitute independent taxa and are in fact independent species. Thus they cannot be considered as subspecies or varieties as has been done by Hrabětova-Uhrova (op. plur.) and Franco (1968). Also the newely found in Poland *C. macrocarpa* is an independent and good species. The new species of hawthorns described for the flora of Poland by Pojarkova (1965) and Cinovskis (1971) cannot be considered as independent species. Thus *C. heterodonta* Pojark. and *C. poloniensis* Cinov. lie completely within the range of *C. monogyna* variation, and therefore are either taxa of a lower rank (*C. monogyna* var. *heterodonta* (Pojark.) Gost.-Jak. *comb. nova* (1973 in litt.) or synonyms (*C. poloniensis* Gostyńska-Jakuszewska, 1973 l.c.). *C. plagiosepala* Pojark. both in the dendrite and as a result of the discrimination analysis made by the method of Fisher takes up an intermediate position between *C. monogyna* and *C. curvisepala*, and on this basis it should be considered as a hybrid between these species. Since such a hybrid has been described as a species by Klokov (1954) in the Ukraine under the name *C. fallacina*, it should be given the name *C.* × *fallacina* (Klok.) Gost.-Jak. (1973, l.c.).

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MARIA GOSTYŃSKA-JAKUSZEWSKA

Zastosowanie metod numerycznych do systematyki głogów występujących w Polsce

Streszczenie

Rodzaj *Crataegus*, obok takich rodzajów jak: *Rosa*, *Salix*, *Rubus*, *Alchemilla*, i *Hieracium*, reprezentuje grupę roślin odznaczających się wyjątkową zmiennością i skomplikowanymi stosunkami systematycznymi. Przyczyną wielkiego polimorfizmu jest łatwa zdolność krzyżowania się, poliploidalność oraz apomiksja. Próby opracowania systematyki tego rodzaju klasycznymi metodami morfologicznymi doprowadziły do opisania znacznej liczby taksonów różnego rzędu. Ich wartość systematyczna oraz ranga jest przez różnych autorów różnie ujmowana. Aby uzyskać odpowiedź na pytanie, jakie gatunki występują w Polsce, jaka jest ich zmienność i wzajemne ustosunkowanie, posłużono się klasyczną metodą formologiczną, przy jednoczesnym zastosowaniu metod numerycznych — metody dendrytowej oraz analizy dyskryminacyjnej Fishera. Badania oparto na obserwacjach materiałów żywych oraz zielnikowych. W wyniku pomiarów biometrycznych i obliczeń matematycznych sporządzono tabele cech, na podstawie których wykreślono dendryty dla cech owoców i nasion, dla cech liści i przylistków oraz dendryt zbiorczy dla wszystkich cech łącznie. Wyniki obliczeń wartości funkcji dyskryminacyjnej przedstawiono graficznie. Wykreślony dendryt dobrze wydziela wyróżnione w Polsce gatunki i mieszańce. Ustalono, że gatunków jest 6: *C. monogyna* Jacq. *s.str.*, *C. curvisepala* Lindm., *C. lindmanii* Hrabět.-Uhr., *C. oxyacantha* L.em.Jacq., *C. palmstruchii* Lindm. i *C. macrocarpa* Hegetsch. Mieszańców wyróżniono 7: *C.×media* Bechst., *C.× fallacina* (Klok.) Gost.-Jak., *C.×kyrtostyla* (Fingerh.) Franco, *C.×dunensis* Cinov., *C.×kupfferi* Cinov., *C.×calycina* (Peterm.) Cinov. oraz *C.×pseudooxyacantha* Cinov.

Wyniki analizy dyskryminacyjnej wykazały również, że głogi tworzą także mieszańce wielokrotne. Jako przykład można wymienić *Crataegus* 45, który jest mieszańcem *C. monogyna* × *C. curvisepala* × *C. lindmanii*. Zarówno *C. curvisepala*, *C. lindmanii*, *C. oxyacantha*, jak i *C. palmstruchii* stanowią samodzielne taksony,

a zatem nie mogą być uznane za podgatunki czy też za odmiany, jak je traktują np. Hrabětova-Uhrová (op. plur.) i Franco (1968). Niezależnym i samodzielnym gatunkiem jest znaleziony w Polsce po raz pierwszy w 1968 r. *C. macrocarpa* (Gostyńska-Jakuszewska, 1970). Opisane ostatnio przez Pojarkovą (1965) i Cinovskisa (1971) nowe dla flory Polski gatunki głogu nie znalazły potwierdzenia w przeprowadzonych badaniach. *C. heterodonta* Pojark. i *C. poloniensis* Cinov. leżą całkowicie w granicach zmienności cech *C. monogyna* i wobec tego są bądź to jego niższymi taksonami (np. *C. heterodonta* = *C. monogyna* var. *heterodonta* (Pojark) Gost.-Jak. *comb. nova*), bądź synonimami (*C. poloniensis*), *C. plagiosepala* Pojark., zarówno na wykreślonym dendrycie, jak i w wyniku analizy dyskryminacyjnej położony jest pośrednio pomiędzy *C. monogyna* i *C. curvisepala*, zatem powinien być uznany za mieszańca tych gatunków.

Na podstawie wydzielonych, diagnostycznie ważnych cech morfologicznych, sporządzono klucz do oznaczania głogów występujących w Polsce.

МАРИЯ ГОСТЫНЬСКА-ЯКУШЕВСКА

Применение цифровых методов для систематики боярышника, выступающего в Польше

Резюме

Род *Crataegus* наряду с такими родами, как *Rosa, Salix, Rubus, Alchemilla* и *Hieracium*, представляет группу растений, отличающихся исключительной изменчивотсью и сложными систематическими отношениями. Причиной большого полиморфизма является способность легко скрещиваться, полиплоидия и апомиксис. Попытки обработать систематику этого рода классическими морфологическими методами привели к описанию значительного числа таксонов разного порядка. Их систематическое значение и положение восприняты разными авторами по-разному. Чтобы ответить на вопрос, какие виды выступают в Польше, какова их изменчивость и взаимоотношения, был использован классический морфологический метод при одновременном применении цифровых методов — дендритного метода и анализа различения Фишера. Исследования опирались на наблюдениях живого материала и материалов гербариев. В результате биометрических измерений и математических расчетов составлены таблицы признаков, на основании которых вычерчены дендриты для признаков плодов и семян, для признаков листьев и прилистников, а также собирательный дендрит для всех признаков вместе. Результаты вычислений значения функции различения представлены графически. Вычерченный дендрит хорошо выделяет отмеченные в Польше виды и гибриды. Установлено, что видов есть 6: *C. monogyna* Jacq, *s. str.*, *C. curvisepala* Lindm., *C. lindmanii* Hrabět.-Uhr., *C. oxyacantha* L. em. Jacq., *C. palmstruchii* Lindm. и *C. macrocarpa* Hegetschw., а гибридов 7: *C.×media* Bechst., *C.×fallacina* (Klok.) Gost.-Jak., *C.×kyrtostyla* (Fingerh.) Franco, *C×dunensis* Cinov., *C.×kupfferi* Cinov., *C.×calycina* (Peterm.) Cinov., *C.×pseudooxyacantha* Cinov.

Результаты анализа различения показали также, что боярышники тоже создают многократные гибриды. В качестве примера можно привести *Crataegus* 45, который является гибридом *C. monogyna×C. curvisepala×C. lindmanii*. Как *C. curvisepala, C. lindmanii, C. oxyacantha*, так и *C. palmstruchii* представляют собой самостоятельные таксоны и поэтому их нельзя принять за подвиды или разновидности, как это делают, например, Hrabětova-Uhrova (op. plur.) и Franco (1968). Независимым и самостоятельным видом является найденный в первый раз в Польше в 1968

году *C. macrocarpa* (Gostyńska-Jakuszewska, 1970). Описанные в последнее время Поярковой (1965) и Циновскизом (1971) новые для флоры Польши виды боярышника не нашли подтверждения в проведенных исследованиях. *C. heterodonta* Pojark. и *C. poloniensis Cinov.* целиком находятся в границах изменчивости признаков *C. monogyna* и вследствие этого являются либо его низшими таксонами (напр., *heterodonta=C. monogyna* var. *heterodonta* (Pojark) Gost.-Jak. comb, nova), либо синонимами (*C. poloniensis* Cinov.). Как на вычерченном дендрите, так и в результатах анализа различения *C. plagiosepala* Pojark. занимает промежуточное положение между *C. monogyna* и *C. curvisepala* и, следовательно, должен быть узнан за гибрида этих видов.

На основое выделенных диагностически важных морфологических признаков составлена определительная таблица боярышника, выступающего в Польше.