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On the origin of *Pyrus*×*georgica* KUTH. (pro sp.)

O původu *Pyrus*×*georgica* KUTH. (pro sp.)

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DOSTÁLEK J. (1983): On the origin of *Pyrus*×*georgica* KUTH. (pro sp.). – Preslia, Praha, 55 : 299–314.

A proof is given that *Pyrus*×*georgica* KUTH. (pro sp.) is of hybrid origin. It arose from a hybridization of *P. caucasica* FED. in GROSSG. with *P. salicifolia* PALL. *P. georgica* KUTH. var. *glabra* KUTH. (*P. demetrii* KUTH.) is only a nothomorph differing in reduced indumentum of leaves: *P.*×*georgica* KUTH. nm. *glabra* KUTH. (pro var.). A great number of plants with intermediary characters of the hybrid *P. salicifolia* PALL. ×*P. syriaca* BOISS. grew up from the seeds of *P. salicifolia* PALL. imported from Armenia. Hybridization appears to be one of the most important factors influencing the diversity of Transcaucasian pear-trees. Some of the other described species from Transcaucasia may also be only nothomorphs.

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S. KUTHATHELADZE (1939) concluded that the *Pyrus* species occurring in Georgia (U.S.S.R.) and described by Caucasian authors mostly as *P. elaeagrifolia* PALL. or *P. salicifolia* PALL. is a new species and named it *P. georgica* KUTH. In the history of the problem she mentioned that SOSNOVSKIJ had foreseen the existence of the species already in 1922–23.

According to KUTHATHELADZE (1939), *P. georgica* is closely related to *P. salicifolia* and *P. elaeagrifolia*. It frequently grows together with *P. salicifolia*; mostly as individual trees, but also in smaller or larger groups.

Back in 1966 I brought from Transcaucasia some seeds of *P. caucasica* FED. in GROSSG. From one of them a plant identical with *P. georgica* grew up. My interpretation was that one of the ovules was pollinated with a pollen grain from *P. salicifolia*. This paper gives a proof that *P. georgica* is a hybrid of *P. caucasica* with *P. salicifolia*.

MATERIALS AND METHODS

A hybrid identical with *P. georgica* was grown in the Botanical Garden of the Botanical Institute of the Czechoslovak Academy of Sciences at Průhonice from seeds of *P. caucasica* imported from Transcaucasia. The hybrid was compared with the description of *P. georgica* by KUTHATHELADZE (1939) and with a specimen brought from the Botanical Garden in Tbilisi. Other specimens included in the study were:

1. Syntype *P. georgica* from the herbarium of the Botanical Institute in Tbilisi (TBI): Herb. caucasium, Georgia (U.S.S.R.), near Tbilisi, on a bare slope Msaldidi, July 3, 1960, leg. KECCHOVELI, det. KUTHATHELADZE. The specimen was designated as syntype by KUTHATHELADZE.
2. Syntype *P. demetrii* KUTH. [*P. georgica* var. *glabra* KUTH.] from TBI: Herb. caucasicum, Georgia (U.S.S.R.), district of Sagaredzho, near villages Chaschmi and Tsitlobi, Sept. 22, 1939, leg. et det. KUTHATHELADZE. The specimen was also designated as syntype by KUTHATHELADZE.
3. Six specimens of *P. georgica* deposited in the herbarium of the Institute of Dendrology in Kórnik (KOR); one of the specimens comes from a classical locality.

In 1971 I carried out a reciprocal hybridization of *P. pyraster* BURGSD. with *P. salicifolia* PALL. at Průhonice. Later I used the results for the verification of *P. georgica*'s origin. The idea was based on the knowledge that *P. caucasica* and *P. pyraster* are closely related to each other. Soviet and Polish authors did not in most instances accept *P. pyraster*. They consider it to be part of *P. communis* L. s.l. in the original LINNEAN conception. FEDOROV (GROSSGEJM 1952) separated *P. caucasica* from *P. communis* in a similar way in which *P. pyraster* was separated from it. SINSKAJA (1969) critically commented on the separation and BROWICZ (1972) also considered *P. caucasica* to be only a subspecies of *P. communis*. In a broad sense it seems possible to consider *P. pyraster* and *P. caucasica* to be part of *P. communis* L. s.l.

In his Latin description FEDOROV (GROSSGEJM 1952, p. 422) notes that *P. caucasica* differs from *P. communis* (in our conception *P. pyraster*, as far as wild plants are concerned) mainly by entire leaves and geographic area. According to the Russian description (GROSSGEJM 1952, p. 21), however, the leaves are entire only on brachyblasts while on "autoblasts" they are sharply dentate. The specimens I brought from the Small Caucasus had some leaves with serrulate apexes even on the brachyblasts. On some other specimens, mostly at their lamina apexes, I also found indications of serrateness, serrulateness or crenato-serrateness. The character is then potentially contained in the genome of *P. caucasica*. It is very conspicuous on *P. pyraster*, and yet, some of its populations, for example the population from Krupinská Vrchovina in Slovakia (N.E. of Luboreč village, N.W. to S.E. of the elevation point Háj), had 8 percent of trees with entire leaves from brachyblasts. In Rumania (N. Dobrudja, W. of Somova community), there were as much as 39 percent of them. The leaves of *P. caucasica* are essentially entire; serrateness is developed on almost a negligible scale or in a rudimental form. This is in the essence the only morphological difference emphasized by FEDOROV (GROSSGEJM 1952). BROWICZ (1972) also considers the indumentum of the lamina margin to be a diacritical character in which *P. communis* subsp. *communis* (in our conception *P. pyraster*) differs from *P. caucasica* (in his conception *P. communis* subsp. *caucasica* (FED.) BROWICZ). It is, of course, possible to find leaves with an indumentum on the lamina margins of *P. pyraster* as well. However, the indumentum is by far not as striking and persistent as that on *P. caucasica*. For example, at the locality cited earlier (Krupinská Vrchovina in Slovakia) there were 28 percent of plants with an indumentum of a various degree on the lamina margins, ranging from solitary hairs on the apex margins of some laminas to hairiness of margins on others. The Rumanian population mentioned earlier had only 3 percent of plants with solitary hairs on lamina margins; the rest was glabrate. Even among *P. caucasica* plants, of course, individuals can be found with a less intensive indumentum on lamina margins. On the whole, however, this character is marked.

These data are not to prove that *P. caucasica* and *P. pyraster* are morphologically identical. However, the differences examined so far are of such a nature that they do not seem to be an obstacle in testing the presumption that *P. georgica* is of hybrid and not mutation origin in which *P. pyraster* would be used as one of the parents instead of *P. caucasica*. Experimental work with woody plants is slow and the hybrids *P. pyraster* × *salicifolia* were available.

The leaves used for evaluation and drawings were taken from brachyblasts.

RESULTS AND DISCUSSION

P. georgica does not deviate from *P. caucasica* × *salicifolia* in the leaf length (Table 1). Neither does it from *P. pyraster* × *salicifolia* (Table 3) if we take into consideration the variability of individuals and, in particular, if we consider that the average length of leaves on *P. georgica* specimens from TBI and KOR varies from 60.0 to 87.9 mm. Similar is the case of the leaf width (on the specimens from TBI and KOR from 16.4 to 22.3 mm) and the length of the petiole (on the specimens from TBI and KOR from 15.5 to 29.9 mm). The spontaneous hybrid *P. caucasica* × *salicifolia* as well as the experimental hybrids *P. pyraster* × *salicifolia* have these quantitative characters within the variability of *P. georgica*. In the case of the syntype from TBI and six specimens from KOR, one of which comes from a classical locality, it was not possible without causing some damage to obtain quantitative data from such a number of measurements that would permit a comparison with the hybrids where n = 100. For this reason they are mentioned here only in general terms, but they are not shown in the tables. However, they do have some value for orientation.

Table 1. — Characters of the leaf of *Pyrus* × *georgica* and the spontaneous hybrid *P. caucasica* × *salicifolia*

Character		*P.* × *georgica* according to the description by KUTHATHELADZE (1939)	*P.* × *georgica* from the Botanical Garden in Tbilisi	*P. caucasica* × *salicifolia*
Leaf length in mm	x̄	[75]*	82.92	76.14
	min.	50	65	57
	max.	100	105	105
Leaf width in mm	x̄	20.96	22.08	18.64
	min.	15	19	14
	max.	30	24	23
Petiole length in mm	x̄	26.00	27.46	24.52
	min.	15	19	15
	max.	45	38	35
Lamina length/width index		[2.34]*	2.51	2.77
Lamina shape		broadly elliptic-lanceolate	narrowly elliptic to elliptic	narrowly elliptic and transitional shapes, sporadically up to elliptic
Lamina apex		elongated into a sharp spike	mostly acute, but also transitional shapes approaching acuminateness	long acuminate to acute
Lamina base		not described, according to the drawing mostly cuneate	mostly cuneate, but also angustate	cuneate to convexly attenuate
Lamina margin		usually entire, infrequently slightly serrate	entire, here and there minutely crenato-serrate	serrulate, lower part entire
Indumentum	Lamina adaxial surface	indumentum almost entirely disappears or is very uneven	hairy to densely hairy (magn. glass)	hairy to densely hairy (magn. glass)
	Lamina abaxial surface	appressedly tomentose	tomentose	subtomentose
	Lamina margin	not described	hairy to densely hairy, here and there glabrescent	hairy, glabrescent
	Petiole	frequently more or less arachnoid	tomentose to subtomentose	subtomentose, glabrescent
Deflection angle of 2nd vein in degrees	x̄	49.66	34.31	37.20
	min.	40	28	33
	max.	60	42	44

* KUTHATHELADZE gives only the minimum and maximum values. The average value was calculated from these values and after discounting the length of the petiole used to determine the length/width index of the lamina.

Table 2. — Characters of the flower of *Pyrus* × *georgica* and the spontaneous hybrid *P. caucasica* × *salicifolia*

Character	*P.* × *georgica* according to the description by KUTHATHELADZE (1939)	*P. caucasica* × *salicifolia*
No. flowers in inflorescence	4—10	7—9*
Peduncle:		
length in mm	15—35	13—25
indumentum	dense indumentum	subtomentose
Calyx teeth:		
number	5	5
shape	triangular, acute, reflexed	triangular, acute, reflexed
indumentum	outer surface greyish-tomentose, yellow indumentum on inner surface	outer surface greyish-tomentose, yellowish to rusty indumentum on inner surface
Petal shape	obovate to broadly elliptic, apex rounded, at base forming a small claw	mostly narrowly rotund, sporadically also broadly obovate, apex rounded, at base forming a small claw
Number of stamens	15—20	16—21
Styles:		
number	3—5	4—5
indumentum	indumentum at base	indumentum at base
Indumentum of hypanthium	densely tomentose	tomentose
Bracts:		
shape	subulate	subulate
indumentum	orange	rusty, white on margins

* Some flowers withered, but included in the total.

Neither are there any substantial differences between *P. georgica* and the hybrids with regard to the length/width index of the lamina, which is to some extent an indicator of the leaf shape. KUTHATHELADZE (1939) did not mention it directly in her description and, therefore, I calculated it for Table 1 from basic data; it is 2.3. Only when she compared *P. georgica* with *P. salicifolia* and with *P. elaeagrifolia* KUTHATHELADZE stated (p. 19) that the lamina length of *P. georgica* was 3.5 times greater than its width. This is a certain discrepancy. However, on a drawing from her work the index of the laminas amounts to 3.1 and the specimen from KOR which comes from a classical locality has exactly the same value. The index of the syntype from TBI is 2.7. The whole range of average values determined on the specimens from KOR is between 2.6 and 3.7. It can be, therefore, concluded that the lamina length/width index of *P. georgica* is variable according to individuals and the indexes of the hybrids do not exceed limits of this variability (Table 1 and 3).

The variability of quantitative characters considered from the viewpoint of mathematical statistics is of such a nature that even the differences between the characters of the hybrids derived from one combination are in most cases highly significant, as demonstrated on *P. pyraster* × *salicifolia* (Table 5). A similar situation exists in the case of the differences between *P. caucasica* × *salicifolia* and *P. pyraster* × *salicifolia*. Both the differences between the quantitative characters of individual plants derived from the hybridization of *P. pyraster* with *P. salicifolia* and the differences between *P. caucasica* × *salicifolia* and *P. pyraster* × *salicifolia* are of a similar character.

The deflection angle of the lamina second vein is variable. It was almost 50° on *P. georgica* (KUTHATHELADZE 1939). A similar angle was also found on the hybrid *P. pyraster* × *salicifolia* A2. The angle on *P. georgica* from the Botanical Garden in Tbilisi was 34.3°, on the syntype 37.0° and on the specimens from KOR it varied from 29.0 to 38.0°. On *P. caucasica* × *salicifolia* it was almost the same as on the syntype (37.2°) and on the hybrids *P. pyraster* × *salicifolia* (except A2) it varied between 33.8 and 35.2°.

The laminas of *P. georgica* are, according to the description by KUTHATHELADZE (1939), broadly elliptic-lanceolate. On a drawing from her work they are narrowly elliptic. That she described the shape as broadly elliptic was probably caused by a different idea about the length/width ratio of this shape. A tendency toward lanceolateness or lanceolate leaves do not occur, according to the specimens I examined, so frequently. *P. georgica* from the Botanical Garden in Tbilisi has laminas narrowly elliptic (length/width ratio 3 : 1) to elliptic (2 : 1). The specimens from KOR have laminas more or less narrowly elliptic or transitional up to almost elliptic. The laminas of the syntype from TBI are also narrowly elliptic to elliptic, although sporadically they can be narrowly obovate (2 : 1) or even have a tendency toward lanceolateness (3 : 1). Also all the hybrids have narrowly elliptic, transitional or truly elliptic laminas. Only on the hybrid *P. pyraster* × *salicifolia* A2 the elliptic shape prevails over the narrowly elliptic one, as it is also indicated by the length/width index. Thus, there is no real difference between *P. georgica* and *P. caucasica* × *salicifolia*.

The lamina apex on *P. georgica* (including the specimens from KOR and TBI) as well as on the hybrids is acute or acuminate. This observation is in agreement with the formulation by KUTHATHELADZE (Table 1).

The lamina base was not described by KUTHATHELADZE (1939). According to her drawing it is mostly cuneate. On the specimens from the Botanical Garden in Tbilisi it is cuneate or angustate (as cuneate, but sides slightly convex). On the specimens from KOR the base is besides that also attenuate (straight sides slowly taper off in a very acute angle, smaller than 30°). On the syntype from TBI it is not only cuneate, but also concavely angustate (concave sides) to concavely attenuate. These shapes occur altogether also on the hybrids, so that there are not any differences here. Only on *P. pyraster* × *salicifolia* A2, which split off with somewhat broader leaves so that the elliptic shape prevails over the narrowly elliptic one, the base is not only angustate and cuneate, but also narrowly rounded.

The lamina margin on *P. georgica* and on the spontaneous hybrid *P. caucasica* × *salicifolia* is entire, a little serrate or, eventually, minutely crenato-serrate. A similar situation exists among the specimens from KOR; however, in two cases the margins were entire. On the contrary, minute serrulateness

Table 3. — Characters of the leaf of the experimental hybrids *Pyrus pyraster* × *salicifolia* and their parents

Character		*P. pyraster* A ♀	*P. pyraster* B ♀	*P. pyraster* × *salicifolia*				*P. salicifolia* ♂
				A1	A2	B1	B2	
Leaf length in mm	x̄	73.86	67.83	74.72	73.88	82.19	65.32	71.62
	min.	55	54	57	53	65	51	50
	max.	97	83	95	106	108	86	96
Leaf width in mm	x̄	26.92	28.43	17.34	19.77	21.49	16.84	10.47
	min.	22	21	12	15	16	13	8
	max.	31	36	22	24	28	24	12
Petiole length in mm	x̄	42.11	31.67	29.03	29.11	26.06	17.91	9.9
	min.	29	23	17	16	17	10	4
	max.	61	44	43	48	38	26	17
Length/ /width index	x̄	1.18	1.28	2.63	2.27	2.64	2.84	5.93
	min.	0.83	1.00	2.14	1.86	2.00	2.23	4.55
	max.	1.38	1.86	3.38	2.67	3.63	3.77	7.40
Lamina shape		broadly ovate or ovato-rotund, sporadically narrowly to transversely rotund	broadly ovate, ovato-rotund, sporadically rotund and narrowly rotund	narrowly elliptic to almost elliptic	elliptic, transitional shapes approaching narrowly elliptic	narrowly elliptic to elliptic	mainly narrowly elliptic, but also transitional shapes approaching elliptic	very narrowly elliptic
Lamina apex		acuminate, apiculate	acuminate	transitional shapes between acute and acuminate to almost acute	acuminate to almost acute	acuminate to acute	acuminate to acute	acute, convexly acute
Lamina base		shallowly to very shallowly cordate	rounded, constricted, sporadically very shallowly cordate	cuneate, angustate	angustate, narrowly rounded, sometimes also cuneate	cuneate, angustate	cuneate	attenuate

Table 3. — (Contd.)

Character		*P. pyraster* A ♀	*P. pyraster* B ♀	*P. pyraster* × *salicifolia* A1	A2	B1	B2	*P. salicifolia* ♂
Lamina margin		entire with indication of serrateness, apex here and there very shallowly serrate	serrate, obtusely serrate, shallowly serrate, at base entire	entire	entire	very shallowly serrate, or indication of serrateness to almost entire	entire	entire
Indumentum	Lamina adaxial surface	glabrate	glabrate, solitary little hairs at apex of some leaves (magn. glass)	hairy (even with unaided eye)	sparsely hairy (magn. glass)	glabrate, solitary hairs, sometimes sparse hairs along lamina margin (magn. glass)	solitary to sparse hairs, hairy along margin (magn. glass)	hairy, densely hairy along margin (magn. glass)
	Lamina abaxial surface	glabrate, sometimes solitary to sparse remnant hairs along midrib (magn. glass)	glabrate	tomentose	tomentose, subtomentose	subtomentose to densely hairy	subtomentose	tomentose
	Lamina margin	glabrate, or at apex remnant hairs often only solitary (powerful magn. glass)	glabrescent, solitary hairs to hairy, at base glabrate (magn. glass)	densely hairy, here and there glabrescent	hairy to solitary hairs	hairy, here and there glabrescent	hairy, here and there glabrescent	hairy, here and there glabrescent
	Petiole	glabrate	glabrate	tomentose to densely hairy	densely hairy	densely hairy to solitary hairs	subtomentose to sparsely hairy	densely hairy to tomentose
Deflection angle of 2^{nd} vein in degrees	$\bar{x}$	67,2	53,5	35.2	50.1	34.1	33.8	28.0
	min.	61	45	29	41	28	28	22
	max.	72	64	44	58	38	39	44

Note:
The length/width ratios of less usual shapes of the lamina: broadly ovate 6 : 5, ovate-rotund 1 : 1, narrowly rotund 6 : 5, transversely rotund 5 : 6, narrowly elliptic 3 : 1, very narrowly elliptic 6 : 1.
Constricted base: slightly convex sides taper off in right or obtuse angle.

Table 4. — Characters of the flower of the experimental hybrids *Pyrus pyraster* × *salicifolia* and their parents

Character	*P. pyraster* A ♀	*P. pyraster* B ♀	*P. pyraster* × *salicifolia*				*P. salicifolia* ♂
			A1	A2	B1	B2	
No. flowers in inflorescence	8–10	9–13	5–8*	3–10	7–10	8–14	5–9*
Peduncle:							
length in mm	15–33	16–30	20–26	15–18	15–23	14–22	10–17
indumentum	glabrate	glabrate	tomentose	tomentose	subtomentose	tomentose	tomentose
Calyx teeth:							
number	5	5	5	5–6	5	5	5(–6)
shape	triangular, acute, reflexed, long	triangular, acute, reflexed, longer	triangular, acute, reflexed, mostly short, but also longer	triangular, acute, reflexed, short to long	triangular, acute, reflexed, middle long	triangular, acute, reflexed, longer	triangular, acute, reflexed, short
indumentum	solitary little white hairs on outer surface, inner surface rusty-tomentose	outer surface glabrate, inner surface rusty-tomentose, whitish hairs on margins	outer surface grey-tomentose, inner surface yellowish- to rusty-tomentose	both surfaces grey-tomentose	outer surface grey-tomentose, inner surface also grey-tomentose, only here and there a little rusty	outer surface grey-tomentose, inner surface yellowish- to rusty-tomentose	both surfaces grey-tomentose, here and there a little rustish
Petal shape	broadly elliptic, narrowly rotund to rotund, sporadically also broadly ovate apex rounded	broadly obovate or narrowly rotund to rotund, apex rounded, sometimes not quite evently	broadly elliptic to rotund, sporadically also broadly ovate, apex rounded	rotund to narrowly rotund, sporadically also rotund-ovate or broadly ovate	broadly elliptic to narrowly rotund, sporadically also broadly ovate, apex rounded	broadly elliptic, sporadically also broadly ovate to ovate, apex rounded	ovato-rotund to broadly ovate, or also rotund to narrowly rotund
No. of stamens	20	15–20	19–25	21–29	16–20	21–29	20–26

Table 4. — (Contd.)

Character	*P. pyraster* A ♀	*P. pyraster* B ♀	*P. pyraster × salicifolia*				*P. salicifolia* ♂
			A1	A2	B1	B2	
Styles:							
number	5	4 – 5	5	4 – 5(– 6)	4 – 5	4 – 5	3 – 5
indumentum	sporadic indumentum at base	glabrate and sporadic little hairs at base	indumentum at base	indumentum at base	indumentum at base	indumentum at base	dense indumentum on lower half, sometimes sparse or solitary hairs also higher
Indumentum of hypanthium	glabrate	glabrate	tomentose	tomentose	tomentose	tomentose	tomentose
Bracts:							
shape	subulate	subulate	subulate	subulate	subulate	subulate	subulate, sometimes upper part a little broader
indumentum	rusty; sporadic white hairs on margins	rusty; white hairs on margins	rusty; white hairs on margins	rusty; white hairs on margins	rusty; white hairs on margins	rusty; white hairs on margins	rusty; white hairs on margins

* Some flowers withered, but included in the total.

to crenato-serrateness and indications of serrateness prevail over the entireness of margins on the specimens from TBI. It is interesting that on the hybrids *P. pyraster* × *salicifolia* the entireness markedly prevails (3 out of 4 cases), although according to the difference between *P. caucasica* and *P. pyraster* the serrateness should have been expressed more strongly. The substitution of *P. pyraster* for *P. caucasica*, therefore, did not have any effect on this character.

The lamina adaxial surface of *P. georgica* is hairy to densely hairy, or the indumentum is uneven and almost absent (Table 1). The lamina adaxial surface of the specimens from KOR and TBI is also hairy, densely or thinly, or, eventually, glabrescent to almost glabrate. It is also hairy to densely hairy on the spontaneous hybrid *P. caucasica* × *salicifolia*, so that in this respect the hybrid does not deviate from *P. georgica* (Table 1). A similar indumentum can be observed on *P. pyraster* × *salicifolia* (Table 3). The adaxial indumentum is poorly visible with an unaided eye and, therefore, it is necessary to examine it with a magnifying glass. The lamina abaxial indumentum is also the same on *P. georgica*, including the specimens from KOR and TBI, as on all observed hybrids. KUTHATHELADZE (1939) did not describe indumentum on lamina margins. On the specimen from the Botanical Garden in Tbilisi the margins are hairy to densely hairy, here and there glabrescent. A similar situation can be observed on the specimens from KOR (on one plant it was glabrate) and from TBI. The indumentum on the lamina margins of *P. caucasica* × *salicifolia* is not different. We are particularly interested in this indumentum on the lamina margins of the hybrids *P. pyraster* × *salicifolia*, because it is, in addition to serrateness, the second character in which *P. caucasica* differs from *P. communis* s.l. (in our conception *P. pyraster*). However, there is not any difference between *P. caucasica* × *salicifolia* and *P. pyraster* × *salicifolia*. Indumentum of the petiole is at the peak of the growing season already considerably changeable. KUTHATHELADZE (Table 1) described it as arachnoid. On the specimen from the Botanical Garden in Tbilisi it appeared to me as tomentose to subtomentose, on the specimens from KOR and TBI it was besides that also densely hairy, hairy, with solitary hairs, or in some cases here and there glabrate. *P. caucasica* × *salicifolia* does not differ in indumentum of the petiole from *P. georgica* and the same applies to *P. pyraster* × *salicifolia*.

The characters of leaves, including indumentum, were evaluated on the specimens from the peak of the growing season. Indumentum is more intensive in the spring, during the time of blossom.

Characters of the flower were available neither on *P. georgica* from the Botanical Garden in Tbilisi, nor on the specimens from KOR and TBI. For this reason the flower of *P. caucasica* × *salicifolia* was compared only with the original description of the flower of *P. georgica*. In addition, data on *P. pyraster* × *salicifolia* were informatively used.

The number of flowers in the inflorescence has a somewhat narrower range on *P. caucasica* × *salicifolia* than it does according to the original description of *P. georgica*, but it does not much deviate from it in the average number. It is obvious from Table 4 that the number of flowers in the inflorescence and its range are to a certain extent properties of individual plants and, therefore, variable. The peduncle of *P. georgica* occurs also longer, namely by 10 mm. However, this is less important, because the peduncle is variable likewise

Table 5. — Significance of the differences among the quantitative characters of hybrids

Hybrid		Leaf length				Leaf width				Petiole length				Lamina length/width index			
Serial no.	Combination	2	3	4	5	2	3	4	5	2	3	4	5	2	3	4	5
1	*P. caucasica* × *salicifolia*	—	—	++	++	++	++	++	++	++	++	+	++	++	++	++	—
2	*P. pyraster* A1		—	++	++		++	++	—		—	++	++		++	—	++
3	× *salici-* A2			++	++			++	++			++	++			++	++
4	*folia* B1				++				++				++				++
5	B2																

— = difference not significant.
+ = difference significant (P ≦ 0.05).
++ = difference highly significant (P ≦ 0.01).
n = 100.
Evaluated by t — test.
Numbers in column headings refer to serial numbers at left.

later the whole fruit is. The indumentum of the peduncle, which is less variable and, therefore, a more important character, is the same on *P. georgica* as on all the hybrids. A certain difference is only in the formulation used in the original description. The number of calyx teeth, their shape and indumentum are the same. On the hybrids the indumentum of the inner

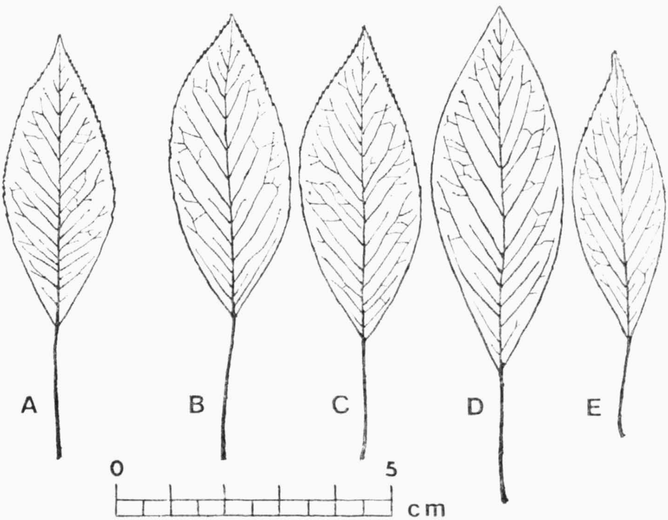

Fig. 1. — Leaves from the brachyblasts of *Pyrus* × *georgica*: A — a leaf of a plant grown from *P caucasica* pollinated with pollen of *P. salicifolia*. B to E — leaves from various trees of *Pyrus* × *georgica*.

surface of these teeth was not only yellow, but even rusty. On one hybrid *P. pyraster* × *salicifolia* (A2) the teeth were grey on the inner surface, that is, of a similar colour as on the outer surface. The colour of petals was white in all cases and the differences in their shape were, with respect to the variability of individuals, small; besides, we do not exactly know what length/ /width ratio Kuthatheladze recognizes. On the hybrids *P. pyraster* × *salicifolia* ovate shapes occur instead of the obovate ones. However, the obovate shape is also contained in the genome of *P. pyraster* B (Table 4). It is, therefore, possible to presume that the hybrids have it, too, but it would be necessary to evaluate more individuals to find it. The number of stamens is on *P. georgica* as well as on *P. caucasica* × *salicifolia* essentially the same. It is interesting that on *P. pyraster* × *salicifolia* the number can be even higher than on the parent plants (Table 4). However, it is not the same even on only two *P. pyraster* (A, B) individuals. There are 3—5 styles on *P. georgica* and 4—5 on *P. caucasica* × *salicifolia* as well as on *P. pyraster* × *salicifolia* (on the plant A2 exceptionally up to 6). *P. salicifolia* has 3—5 of them (Table 4); it is, therefore, understandable that individuals having flowers with three styles can occur among *P. georgica* plants, too. The styles have an indumentum at the base not only on *P. georgica*, but also on all observed hybrids.

On the bases of the data presented here it is possible to conclude that *P. georgica* is of hybrid origin and that it arose from the hybridization of *P. cau-*

casica with *P. salicifolia*. *P. georgica* var. *glabra* KUTH. (*P. demetrii* KUTH.) is only its nothomorph, conspicuous by a considerably reduced indumentum of leaves. Without a magnifying glass it appears almost glabrate. The taxa should be, therefore, designated as follows:

P. × *georgica* KUTH. (Notul. Syst. Geogr. Inst. Bot. Thbilissiensis 8 : 13, 1939) (pro sp.) (*P. caucasica* FED. in GROSSG. × *P. salicifolia* PALL.)

1. nm. *georgica*

Leaf indumentum: The lamina adaxial surface more or less hairy, or glabrescent and on some leaves up to almost glabrate. The abaxial surface

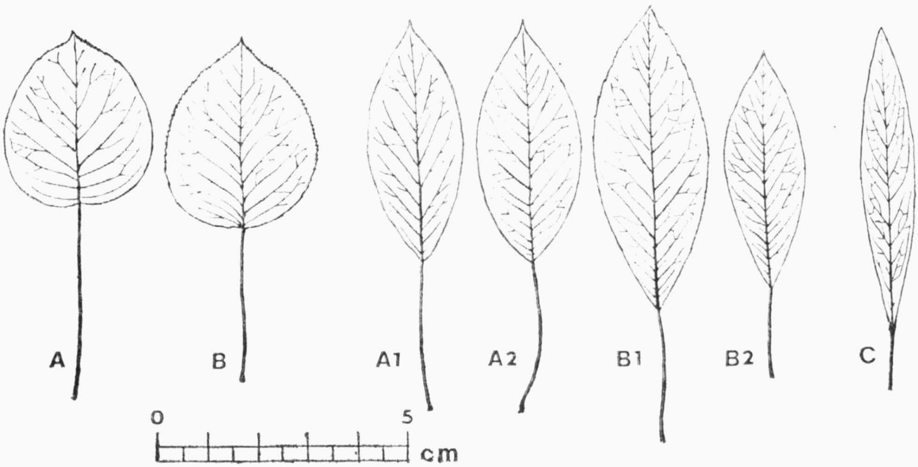

Fig. 2. — *Pyrus pyraster* (A, B), *P. salicifolia* (C), in the centre their hybrids: *P. pyraster* A × *salicifolia* (A 1, A 2) and *P. pyraster* B × *salicifolia* (B 1, B 2).

tomentose to subtomentose. Margin hairy to densely hairy, here and there glabrescent, sporadically almost glabrate. The petiole subtomentose to tomentose, hairy to densely hairy, on some leaves only solitary hairs or here and there up to glabrate.

2. nm. *glabra* KUTH. (Notul. Syst. Geogr. Inst. Bot. Thbilissiensis 8 : 16, 1939) (pro var.).

Syn.: *P. demetrii* KUTH. Notul. Syst. Geogr. Inst. Bot. Thbilissiensis 13 : 25, 1947.

Leaf indumentum: The lamina adaxial surface glabrate, sometimes sparsely hairy at apex (magnifying glass). The abaxial surface glabrate, hairs only near the midrib (magnif. glass). Margin hairy, sparsely hairy, with solitary hairs or glabrate. The petiole hairy, with solitary hairs (magnif. glass) or glabrate.

Note: These two nothomorphs do not differ in other characters (including the quantitative ones). The spines do not have a great diacritical value. They are peculiar to juvenile plants, but later their number and properties change.

Table 6. — Results of the hybridization of *Pyrus pyraster* with *P. salicifolia*

Combination of parental plants	No. of pollinated flowers	Percentage of developed fruits	Average no. of seeds in fruits	Percentage of seed germination	Percentage of one-year-old plants from the total no. of germinated ones
P. pyraster A × *P. salicifolia*	100	*	7.5	91.7	71.0
P. pyraster B × *P. salicifolia*	100	22	7.6	82.4	68.1
P. salicifolia × *P. pyraster* A	100	35	3.3	6.3	40.0**
P. salicifolia × *P. pyraster* B	100	38	4.8	1.8	66.7**

* Evaluation not reliable since flowers were partly damaged by frost.
** Owing to poor germination of seeds the percentage was calculated from only a small number of plants.

The hybrids of *P. pyraster* with *P. salicifolia* were also used to verify that *P.* × *georgica* Kuth. (pro sp.) was not a result of mutation. Altogether 92 of them were grown from the hybridization which took place in 1971. Nowadays, there are 58 of them in the Botanical Garden of the Botanical Institute of the Czechoslovak Academy of Sciences at Průhonice. The results of the reciprocal hybridization of *P. pyraster* with *P. salicifolia* are shown in Table 6. The percentage of fruits obtained from this hybridization was good (up to 38 percent). The average number of seeds was lower from *P. salicifolia* pollinated with pollen from *P. pyraster* than it was from the reciprocal combination (up to 7.6 seeds). Germination of seeds from *P. salicifolia* pollinated with *P. pyraster* was rather bad, whereas it was very good (up to 91.7 percent) in the case of the reciprocal combination. It is interesting that the morphological difference between *P. pyraster* × *salicifolia* and *P. caucasica* × *salicifolia* did not become evident. This is particularly true about the entireness and indumentum of lamina margins, in which *P. caucasica* should differ from *P. pyraster*. It was only *P. pyraster* × *salicifolia* A2 plant that split off according to the length/width index with broader laminas, which is also evident on the shape of the base of some leaves.

I brought from Transcaucasia the seeds of not only *P. caucasica*, but also *P. salicifolia*. In only one case the hybrid *P. caucasica* × *salicifolia* arose from the seeds of *P. caucasica*. In no case a plant like that arose from the seeds of various plants of *P. salicifolia*, however, a surprising number of plants with the characters of *P. syriaca* Boiss. grew up from them. They are the hybrids of *P. salicifolia* with *P. syriaca*. The seeds came from Armenia.

P. caucasica is mesophilous, whereas *P. salicifolia* xerophilous. They should not, therefore, occur in the same habitat and should not have any opportunity for mutual pollination. However, the fact is that I personally observed the rise of the hybrid from the seeds of *P. caucasica*. The pollination then must have taken place. We must realize that fruits of wild *P. caucasica* are utilized by local people and up to the present time sold on markets in Transcaucasia.

Besides, there are some cultivated and semi-cultivated forms of *P. caucasica* which may be grown in other places than in their original habitats. However, the hybridization of *P. caucasica* with *P. salicifolia* would be explicable even without humen interference, since, according to RUBZOV (1939) the areas of *P. communis* (in more recent conception *P. caucasica*, as far as wild plants are concerned) and *P. salicifolia* can interlock. Thus the distances between the potential parental plants can be overcome by insects capable of pollination.

The time of flowering was observed on plants growing on one plot (Botanical Garden of the Botanical Institute at Průhonice), so that microclimatic differences due to different habitats were absent. Both species blossom at the same time, so that there is no obstacle to pollination here, either.

Pears easily cross among themselves. It appears that in Transcaucasia there are only a few basic species, the other taxa being mainly their hybrids or mutants. If we omit the border regions, the main species could be *P. caucasica*, *P. salicifolia* and *P. syriaca*. It is possible that various nothomorphs from hybridization of two species were described as true species. Also, more nothomorphs than just *P.×georgica* nm. *glabra* derived from the hybridization of *P. caucasica* with *P. salicifolia* may have been described as species. Even *P. sachokiana* KUTH. or *P. takhtadzhianii* FED., for example, could be suspicious. *P.×georgica* differs from *P. sachokiana* in the shape of the leaf, however, there is no hiatus between them. Some of the specimens are intermediary and only incline toward either *P.×georgica* or *P. sachokiana*. On the syntype *P.×georgica* that I studied in detail there were also some leaves peculiar to *P. sachokiana*. A similar shape occurred neither on the spontaneous hybrid *P. caucasica×salicifolia* nor on the experimental hybrids *P. pyraster×salicifolia*. *P. takhtadzhianii* may have originated from the hybridization of the cultivated form of *P. caucasica* or even *P. communis* with *P. salicifolia*.

The distribution of some species in Transcaucasia is surprisingly small; they are almost without an adequate area. That may also indicate their lower taxonomic value.

Solving the problem of Transcaucasian pears without genetic analysis is difficult. Such analysis, however, would be very demanding and slow. That is why I paid so much attention to the hybrid that split off from *P. caucasica*. And to prove that *P.×georgica* did not originate from mutation and that hybridization has had considerable importance in the development of Transcaucasian pears, I demonstrated the rise of the hybrids from the hybridization in which I used *P. pyraster* instead of closely related *P. caucasica*.

SUMMARY

Pyrus×georgica KUTH. (pro sp.) arose from the hybridization of *P. caucasica* FED. in GROSSG. with *P. salicifolia* PALL. Its hybrid origin was recognized on a plant which grew up from seeds of *P. caucasica* FED. in GROSSG. Because of long term nature of genetic work with woody plants, the hybrids of *P. salicifolia* PALL. with *P. pyraster* BURGSD., which is closely related to *P. caucasica* FED. in GROSSG., were used to prove that hybridization and not mutation gave rise to *P.×georgica* KUTH. Hybridization of ecologically different species such as the mesophilous *P. caucasica* FED. in GROSSG. and xerophilous *P. salicifolia* PALL. is possible when their areas occur at distances that can be overcome by insects capable of pollination. Both *P. caucasica* FED. in GROSSG. and *P. salicifolia* PALL. bloom at the same time.

P. georgica KUTH. var. *glabra* KUTH. (*P. demetrii* KUTH.) is only a nothomorph, conspicuous by reduced indumentum of leaves: *P.×georgica* KUTH. nm. *glabra* KUTH. (pro var.). *P. sacho-*

kiana KUTH. and *P. takhtadzhianii* FED. may also be nothomorphs of *P.*×*georgica* KUTH., however, more evidence is needed.

Among the progenies of *P. salicifolia* grown from seeds imported from Armenia a great number of plants had intermediary characters of the hybrid *P. salicifolia* PALL.×*P. syriaca* BOISS. Hybridization appears to have had a strong influence on the diversity of Transcaucasian pear-trees. With the exception of border regions, the main participants in it were *P. caucasica* FED. in GROSSG., *P. salicifolia* PALL. and *P. syriaca* BOISS. Some of the other described species from Transcaucasia may also be only nothomorphs which originated from hybridization at various levels. Mutations may have playod a role in the origin of some taxa. However, it is difficult to solve the problem of Transcaucasian pears without genetic analysis.

SOUHRN

Pyrus×*georgica* KUTH. (pro sp.) je hybridního původu a vznikl křížením *P. caucasica* FED. in GROSSG. s *P. salicifolia* PALL. Jeho hybridní původ byl zjištěn podle rostliny vyštěpené ze semen *P. caucasica* FED. in GROSSG. Pro dlouhodobost genetické práce s dřevinami byli k ověření, že nejde o mutaci, ale o křížení, použiti i kříženci *P. salicifolia* PALL. s *P. pyraster* BURGSD., který je *P. caucasica* FED. in GROSSG. velice blízký. Vysvětlit křížení ekologicky odlišných druhů jako je mezofilní *P. caucasica* FED. in GROSSG. a xerofilní *P. salicifolia* PALL., lze přiblížením se jejich areálů na takovou vzdálenost, kterou je hmyz schopen překonat. *P. caucasica* FED. in GROSSG. i *P. salicifolia* PALL. kvetou ve stejnou dobu.

P. georgica KUTH. var. *glabra* KUTH. (*P. demetrii* KUTH.) je jen notomorfou, která je nápadná redukovaným oděním listů: *P.*×*georgica* KUTH. nm. glabra KUTH. (pro var.). Jako další notomorfy přicházejí v úvahu i *P. sachokiana* KUTH. a *P. takhtadzhianii* FED. K ověření tohoto předpokladu bude třeba získat více informací.

Mezi potomstvy *P. salicifolia* PALL. ze semen z Arménie bylo značné množství rostlin, které měly intermediární znaky křížence *P. salicifolia* PALL.×*P. syriaca* BOISS.

Na rozmanitost zakavkazských hrušní mělo vliv křížení. Pomineme-li okrajové oblasti, zúčastnil se ho hlavně *P. caucasica* FED. in GROSSG., *P. salicifolia* PALL. a *P. syriaca* BOISS. Je pravděpodobné, že i některé další druhy popsané ze Zakavkazska jsou jen notomorfami vzniklými z křížení různého stupně. Při vzniku některých forem se mohly uplatnit i mutace. Bez genetické analýzy je problém zakavkazských hrušní jen obtížně řešitelný.

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