The occurrence and morphological characteristics of the wild pear lower taxa in Slovakia

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ABSTRACT: The occurrence of 10 lower taxa within species *Pyrus pyraster* L. (Burgsd.) was confirmed in Slovakia. Among 507 of the evaluated plants on 64 localities, there were recorded 2 sub-species of the wild pear – *Pyrus pyraster* subsp. *pyraster* and *Pyrus pyraster* subsp. *achras.* Subspecies *pyraster* was represented by 4 varieties (*pyraster, elongata, pénzesiana, brachypoda*) and 5 forms (*populifolia, cordifolia, rhomboidea, ovata, slovenica*). All lower taxa were visually classified according to the leaf and fruit characteristics. Numerical classification based on discriminant analysis according to quantitative traits was done. Some discrepancies were found up to 16.7% between visual and numerical classification on particular levels of the lower taxa identification.

Keywords: wild pear; lower taxa; occurrence; morphology; leaves; fruits

In Slovakia, wild pear belongs among rare woody plants. Often appears in the scattered vegetation of the landscape, but also on the forest margins mainly in the warm oak-tree communities. In many European countries wild pear is in the centre of interest of the landscape designers and foresters, because this species has aesthetic influence in the landscape, good growth rate and valuable timber.

Within taxonomical classification of pears, morphological traits of the leaves, shoots and fruits were applied, as well as presence of thorns on shoots (Hecker 1985; Wagner 1995, 1996; Müller, Litschauer 1996; Aas 1999; Rotach, Baume 2004).

Pear leaves are different in their size, shape, leaf margin, shape of the leaf tip and base, and also in petiole length. These differences are considered to be characteristics for separation of the many lower taxa. Several analyses however showed leaf variability not only within the taxon, but also within an individual plant (according to the position of the leaves on shoots).

The occurrence of lower taxa of wild pear besides the other topics was studied in 1994–1999 within the study of wild pear *Pyrus pyraster* (L.) Burgsd. variability in Slovakia. The lower taxa of this species were studied in details and described by Terpó (1960, 1985, 1992) on territory of Hungary and with respect to geographic connection the occurrence at least few of lower taxa was expected also in Slovakia.

Several authors elaborated various systems of the lower taxa differentiation on subspecies, varieties, or forms of wild pear, according to variability the leaf and fruit morphological characteristics. Classifications are built mainly on shape and covering of the leaves and also on shape and size of the pear fruits. However, opinions about the authenticity of the particular morphological characteristics are different. The leaf covering was considered to be an important trait according to Wallroth (1822), Koch (1869), Rou, Camus (1901) and Domin (1917), the fruit shape according to Ascherson-Graebner (1906), who considered the leaf covering to be only accessory morphological trait. On the other hand, Schneider (1906) considers fruit shape to be a very inconstant characteristic and he refers to Décaisne (1858), in whose opinion the pear-shape and globular fruits can appear on the same individual. These opinions were applied within the systematic classification of the pear also by Maleev (1939), Rehder (1951) and others (Domin 1917, 1944; *ex* Terpó 1960, 1985, 1992).

The leaf shape was considered to be the main and terminative characteristic in the pear systematic according to Terpó (1960). According to this author the fruit shape is less important morphological

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Table 1. List of the morphological traits used for description of the wild pear lower taxa

Leaf quantitative traits	Acronym	Fruit quantitative traits	Acronym
Leaf blade length (mm)	LBL	Fruit length (mm)	FL
Leaf blade width (mm)	LBW	Fruit maximum diameter (mm)	FMD
Position of maximum width (mm)	PMW	Position of maximum diameter (mm)	PMD
Angle of leaf blade tip	ALB	Length of stalk (mm)	LS
Petiole length (mm)	PL	Ratio length/diameter of fruit	Q1
Ratio length/width	K1	Ratio position of maximum diameter/ length	Q2
Ratio position of maximum width/length	K2		

trait, because of its high variability. The fruit shape occurs in at least two types within majority of the pear individuals. He supposes also, that the division of the wild pear in two groups – naked and pubescent pears is not an accurate, because frequently certain form has naked and also pubescent individuals.

The leaf characteristics are regarded as important taxonomic traits by several authors (Wallroth 1822; Koch 1869; Ascherson, Graebner 1906; Domin 1917; Maleev 1939; Terpó 1960, and others), who were concerned in the wild pear taxonomy. However, according to Voltas et al. (2007) leaf traits alone are insufficient for taxonomic classification of *Pyrus pyraster* and cultivated *P. communis*. These authors applied multivariate techniques for analysis of the leaf-shoot and fruit morphometric data of wild pear and cultivated pears. Their results showed a limited success in identifying genuine wild individuals based on morphometric data. According to Voltas et al. (2007), fruit traits are the most useful tree characteristics for identification purposes. Similarly, Rotach and Baume (2004) reported high significance of the fruit data for correct classification of the pear trees. Authors classified 220 wild pears from natural populations and 30 cultivars with discriminant analysis and achieved correct results for 97% of the classified tress. According to these authors, wild and cultivated pears can be distinguished with very high precision when fruit traits are available. However, pears growing on forest stands under competition of the other species often lack fructification, their classification is done with far less accuracy.

The presence of wild pear lower taxa in Slovakia and reliability of the leaf and fruit morphological traits in visual classification are discussed.

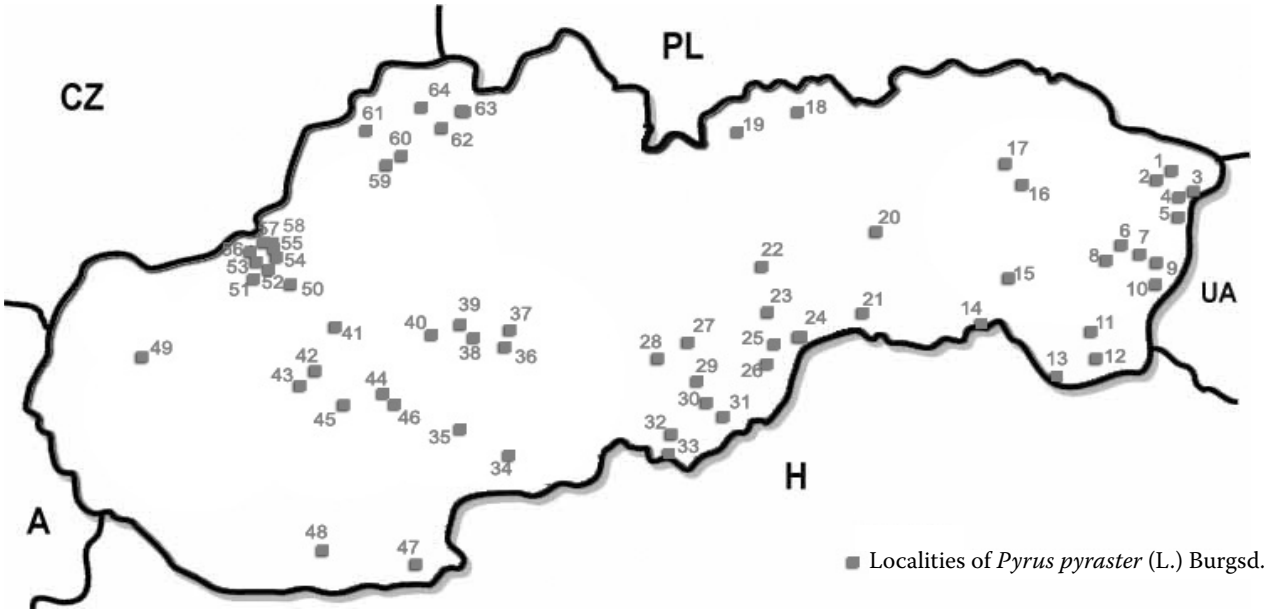

Fig. 1. Distribution of the stands with native populations of the wild pear in Slovakia

MATERIAL AND METHODS

On 64 localities there were obtained the basic data for study of the *Pyrus pyraster* (L.) Burgsd. variability in Slovakia (Fig. 1). The distribution of the pear populations and their ecology were discussed in separate paper (Paganová 2003). The majority of localities (76%) were found at altitudes 201–500 m on south exposed stands.

Number of analyzed trees on particular localities varied from 7 to 48. In total, there were evaluated 507 individuals. Concerning variability of the pear leaves within the single tree, there was an ambition to provide the highest comparative value of their traits. Therefore, five leaves from each analyzed tree were collected always from the same position. The most representative (shape and size) are leaves on brachyblasts. Always the third leaf from the top of the brachyblast, was harvested for the next classification and measurements, so it was recommended by Terpó (1960) and Hofmann (1993).

Within the fieldwork, the leaves were collected for herbarium and their qualitative characteristics (shape, base and margin) were recorded. Then indoor measurements of some quantitative characteristics of the leaves were done (Table 1). There were measured length of leaf blade (x_1), leaf blade diameter (x_2), and angle of the leaf blade tip (x_4), position of the maximum width from the leaf base (x_3) and length of the leaf petiole (x_5). The additional leaf traits (ratios) were calculated additional leaf traits: slenderness quotient (K1 = x_1/x_2) and shape quotient (K2 = x_3/x_1) were calculated from the basic measurements. The measured leaf characteristics are shown on Fig. 2

Within the fieldwork also two fruits were collected from each tree. Qualitative characteristics of the pear fruits were recorded: shape and type of the fruit base, lasting of the calyx and length of the fruit petiole. Besides mentioned records, there were made also ink imprints of the cross and longitudinal fruit sections. Then indoor measurement of the quantitative fruit characteristics was done. Indoor measurements of fruit quantitative characteristics were done (Table 1, Fig. 3): fruit length (x_1) and fruit maximum diameter (x_2), the length of stalk and position of maximum diameter (x_3). Also two additional fruit traits were calculated slenderness quotient (Q1 = x_1/x_2) and shape quotient (Q2 = x_3/x_1) were calculated.

All evaluated individuals were classified into lower taxonomic units according Terpó (1960, 1985, 1992), which is based on the leaf and fruit morphological traits (quantitative and qualitative characteristics). The basic statistical characteristics and the rate of their variability were calculated from the obtained data. These characteristics are used for identification of the *Pyrus pyraster* (L.) Burgsd. and its lower taxonomic units according to classification described by Terpó (1960, 1985, 1992). The taxonomical reliability of the quantitative morphological traits was analyzed by discriminant analysis of the wild pear lower taxa.

RESULTS AND DISCUSSION

The morphological traits of the leaves and fruits were used for identification of the wild pear lower taxa in Slovakia. All analyzed plants had small fruits up to 30 mm, what is a typical size for wild pear fruits according to Wagner (1995, 1996) and Hoffmann (1993). All of the analyzed plants had thorns on their shoots. However, presence or absence of thorns is not a reliable indicator of wildness, because they were found also in naturalized edible varieties (Voltas et al. 2007).

Visual classification of wild pear lower taxa

Some lower taxa were recorded within study of the wild pear variability in Slovakia. From whole number of 507 individuals, there were classified 2 subspecies of wild pear – *Pyrus pyraster* subsp. *pyraster* and *Pyrus pyraster* subsp. *achras.* The subspecies *pyraster* was represented by 4 varieties (*pyraster, elongata, pénzesiana, brachypoda*) and 5 forms (*populifolia, cordifolia, rhomboidea, ovata* and *slovenica)* mentioned by Terpó (1992) from Hungary (Table 2).

The most abundant varieties were *pyraster* (265 individuals) and *elongata* (185 individuals). Other varieties had low frequency – var. *pénzesiana* (21 plants) what represents 3.5% and var. *brachypoda* represented by 3 plants (0.5%).

The highest number of plants (133) was classified as f. *ovata* and quite high number of trees was classified as f. *cordifolia* (128).

All mentioned lower taxa of the wild pear were found by Terpó (1985, 1992) in Hungary. On the contrary, f. *slovenica* (originally described by Domin (1917, 1944) was found just on Slovak territory. This form has very little spherical fruits and small orbicular leaves. Within study in Slovakia, just 9 individuals from whole collection analyzed pear trees (1.5%) were classified under this form.

Also other lower taxa of wild pear were represented with just low number of trees. Only 17 individuals were regarded to f. *populifolia* (3%) and

Table 2. Visual classification of the wild pear lower taxa in Slovakia according to leaf and fruit traits

Lower taxa	Number of analyzed trees	Percentage	Number of trees within variety
Pyrus pyraster* Burgsd. subsp. *pyraster	**472**	**93.0**	
Pyrus pyraster Burgsd. var. *pyraster*	111	22.0	265
Pyrus pyraster Burgsd. f. *populifolia* Terpó	17	3.5	
Pyrus pyraster Burgsd. f. *cordifolia* Terpó	128	25.5	
Pyrus pyraster Burgsd. f. *slovenica* (DOMIN) Terpó	9	1.5	
Pyrus pyraster Burgsd. var. *elongata* (NYÁRDY) Terpó	20	4.0	185
Pyrus pyraster Burgsd. f. *rhomboidea* Terpó	32	6.5	
Pyrus pyraster Burgsd. f. *ovata* (Terpó) Terpó	133	26.0	
Pyrus pyraster Burgsd. var. *pénzesiana* Terpó	19	3.5	19
Pyrus pyraster Burgsd. var. *brachypoda* (KERN) Terpó	3	0.5	3
***Pyrus pyraster* Burgsd. subsp. *achras* (WALLR.) Terpó**	**35**	**7.0**	
Total	507	100.0	472

33 individuals were regarded to f. *rhomboidea* (5.5%). The subspecies *achras* was represented by 35 individuals (6%).

Any of the mentioned lower taxa had strong abundance within analyzed number of trees, what refers to quite large variability of the wild pear. Several

Table 3. Mean values of leaf and fruit traits of the wild pear lower taxa – result of discriminant analysis

Classification	Subspecies of *Pyrus pyraster*			Varieties of *Pyrus pyraster*				
	achras	*pyraster*	*F*-value	*brachy-poda*	*elongata*	*pénze-siana*	*pyraster*	*F*-value
Visual (N)	35	472		3	185	19	265	
Discriminant function (N)	116	391		7	174	30	261	
Leaves								
LBL	43.86	40.91	5.20*	64.00	45.72	41.89	37.21	89.87***
LBW	34.71	35.25	0.37	38.33	32.65	37.10	36.89	32.07***
PMW	18.14	17.88	0.18	25.33	19.36	23.15	16.38	63.85***
ALB	108.00	121.00	8.49*	82.00	96.00	154.00	137.00	271.03***
PL	35.06	34.03	0.43	47.00	36.37	36.05	32.10	12.43***
K1	1.27	1.18	4.66*	1.67	1.41	1.13	1.01	288.1***
K2	0.41	0.44	6.31*	0.39	0.42	0.55	0.44	37.26***
Fruits								
FL	28.14	24.50	14.27**	24.33	26.149	28.37	23.08	15.87***
FMD	25.89	26.43	0.45	26.33	27.31	29.10	26.63	6.59***
PMD	17.17	13.54	27.34***	1.15	4.61	4.75	3.02	11.22***
LS	28.00	25.00	4.10*	32.0	25.03	25.53	24.90	0.74
Q1	1.09	0.93	41.46***	0.92	0.96	0.99	0.91	5.54**
Q2	0.61	0.55	24.13***	0.78	0.55	0.55	0.54	1.24

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$

lower taxa were usually identified on stands with larger number of plants in analyzed population.

The results showed distinctive shape and dimensional variability of the leaves and fruits of wild pear. Following own information obtained within the evaluation of the large basic data, there is absolute agreement with opinion of Terpó (1960), that systematic processing of *Pyrus pyraster* can not be done only according one single characteristic. Similarly, Wagner (1995) suggests a set of morphological criteria for the identification of *Pyrus pyraster*.

Numerical classification of wild pear lower taxa

After visual classification of the analyzed pears into lower taxonomical units, the numerical classification based on discriminant analysis according to quantitative traits was done.

The stepwise discriminant analysis showed that three variables were significant within classification of subspecies *achras* and *pyraster*. These were (by order of inclusion in the model) K2, Q1, Q2. Especially additional traits determining fruit shape (Q1 and Q2) had high significance for classification of pear subspecies. Subspecies *achras* has rather wedge or whirl shaped fruits Q1 = 1.09, Q2 = 0.61 and ovate leaves, K2 = 0.41 (Table 3). The rate of correctly classified plants within subspecies *pyraster* was 80.39% and within subspecies *achras* 74.29%. The overall discrepancy between visual and numerical classification was 19.53%.

The visual classification of the *Pyrus pyraster* varieties was more accurate. Discrepancy between visual and numerical classification is 5.51%. Varieties *brachypoda* and *pénzesiana* were the most properly classified (100% accuracy). The rate of correctly classified trees in var. *elongata* was 92.43%, in var. *pyraster* 95.47%. According to stepwise discriminant analysis seven variables contributed to the differentiation among varieties. Ranked by order of inclusion in the model these are: K1, ALB, K2, LBL, LBW, PMW, PMD. In numerical classification of the wild pear varieties both, leaf and fruit characteristics are significant. The leaf and fruit characteristics were

Table 4. Mean values of leaf and fruit traits of the wild pear forms – result of discriminant analysis

Classification	Forms of variety *elongata*				Forms of variety *pyraster*				
	elongata	*ovata*	*rhombo-idea*	*F*-value	*cordi-folia*	*populi-folia*	*pyraster*	*slove-nica*	*F*-value
Visual (N)	20	133	32		128	17	111	9	
Discriminant function (N)	27	116	42		130	19	98	18	
Leaves									
LBL	54.20	43.86	48.16	25.81***	37.89	35.82	37.29	29.22	10.94***
LBW	30.85	32.39	34.84	6.25*	36.20	43.24	37.45	28.00	29.02***
PMW	22.95	18.25	21.75	40.08***	15.22	17.29	17.75	14.33	29.21***
ALB	76.00	98.00	96.00	26.88***	125.00	163.00	146.00	142.00	7.26***
PL	41.90	35.59	36.19	4.20*	31.83	31.12	33.09	25.67	3.12*
K1	1.77	1.36	1.40	62.07***	1.05	0.83	0.99	1.04	45.12***
K2	0.42	0.42	0.45	22.26**	0.40	0.48	0.48	0.49	71.05***
Fruits									
FL	26.70	25.24	29.53	5.84*	23.29	23.17	23.24	17.78	5.83**
FMD	26.95	27.01	28.78	1.64	26.36	23.94	25.46	20.56	6.65**
PMD	15.05	13.95	16.75	5.12*	12.80	12.82	12.86	9.11	4.58*
LS	27.15	23.86	28.53	4.14*	24.13	27.06	25.60	23.11	1.34
Q1	1.00	0.93	1.02	5.88*	0.89	0.98	0.92	0.87	3.38*
Q2	0.56	0.55	0.56	0.68	0.54	0.55	0.55	0.51	0.95

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$

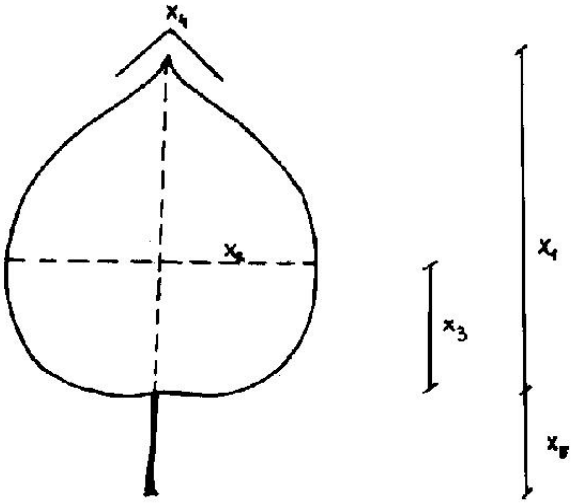

Fig. 2. Leaf dimensions measure within pear study in Slovakia

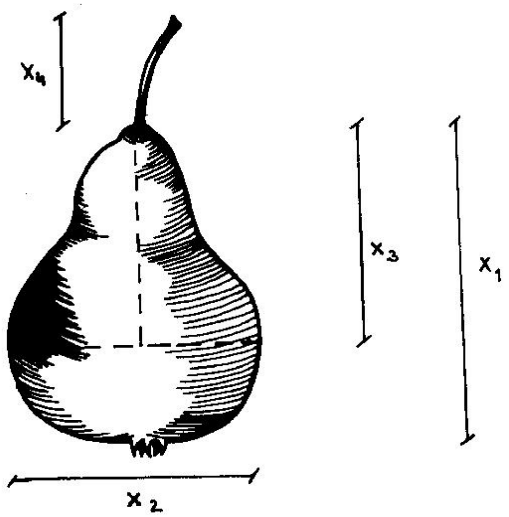

Fig. 3. Fruit dimensions measured on analyzed pear individuals

confirmed as suitable criteria for systematic classification of pear already by several authors (Wallroth 1822; Koch 1869; Ascherson, Graebner 1906; Domin 1917; Maleev 1939; Terpó 1960).

Within variety *elongata*, there were visually identified three forms: *elongata*, *ovata* and *rhomboidea* (Table 4). The rate of correctly classified plants was 76.22%, so discrepancy between visual and numerical classification of the particular forms was quite high 23.78%. Leaf traits: K1, PMW, K2, LBL were significant for numerical classification of the forms.

Within variety *pyraster*, there were classified four forms: *cordifolia*, *populifolia*, *pyraster* and *slovenica* (Table 4), with rate of correctly classified plants 81.89%. The discrepancy between visual and numerical classification was 18.11%. According to stepwise discriminant analysis, leaf traits were significant for numerical classification of the mentioned forms: ALB, K2, LBW, PMW, K1, LBL.

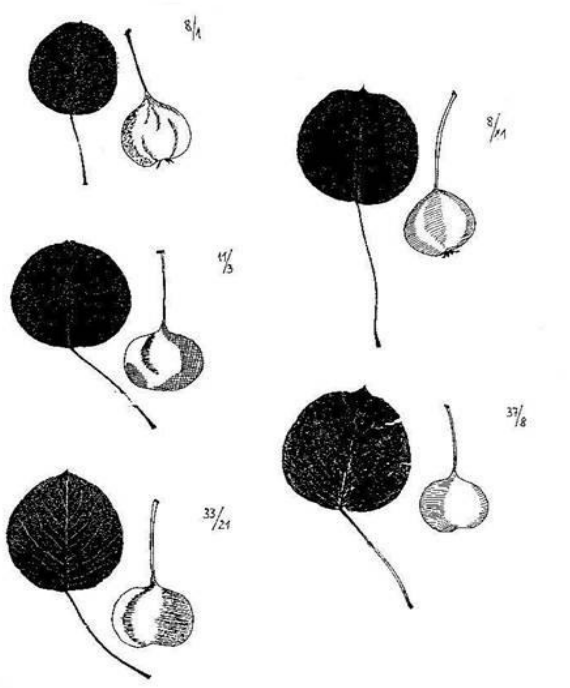

Fig. 4. Leaves and fruits of *Pyrus pyraster* var. *pyraster* collected in Slovakia

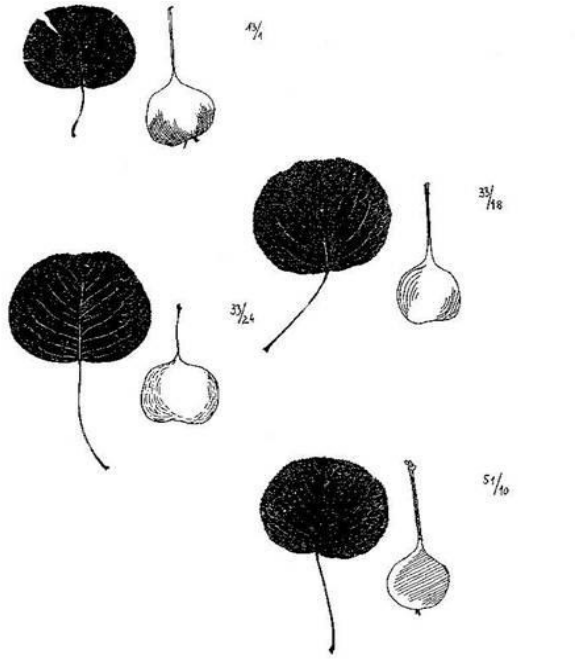

Fig. 5. Leaves and fruits of *Pyrus pyraster* f. *populifolia* collected in Slovakia

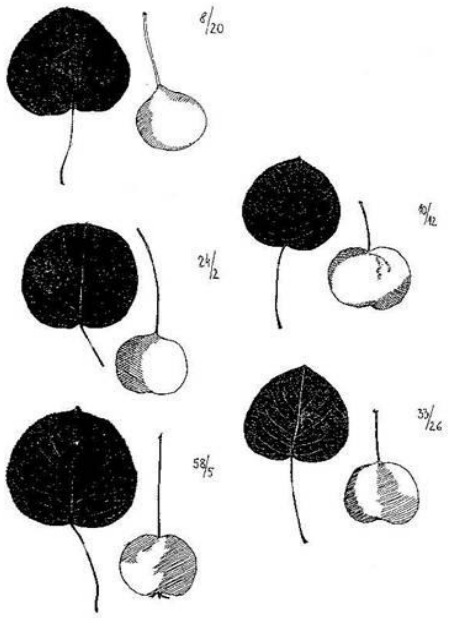

Fig. 6. Leaves and fruits of *Pyrus pyraster* f. *cordifolia* collected in Slovakia

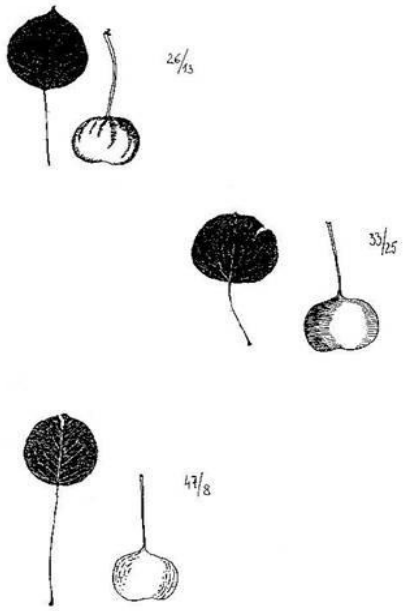

Fig. 7. Leaves and fruits of *Pyrus pyraster* f. *slovenica* collected in 1998

The leaf traits were significant for classification of the lower taxonomical units (forms) in both cases, within variety *pyraster* and *elongata*.

The overall discrepancy rate between visual classification of the analyzed lower taxa and the discriminant analysis was quite low 16.7%. The highest differences were found in classification of the forms within variety *elongata* (nearly 24%). Similar success obtained Voltas et al. (2007) who analyzed wild and cultivated pears. Within their study of pears on Iberian Peninsula, the discrepancy rate between field and discriminant classification was 17.4%.

The morphological characteristic of the identified wild pear lower taxa is given below as they were described by Terpó (1960).

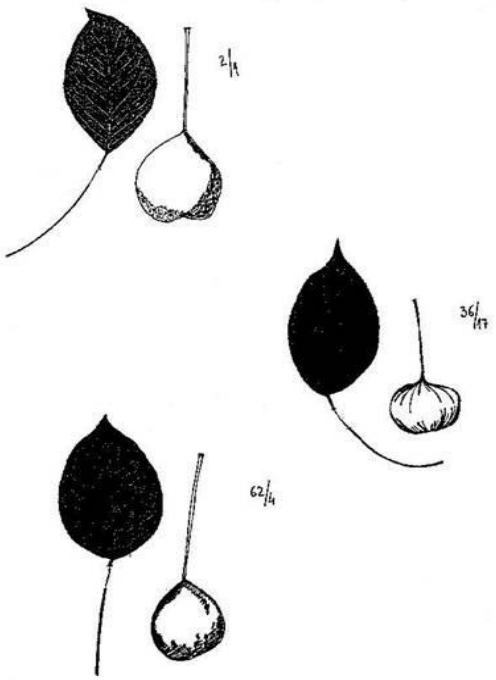

Fig. 8. Leaves and fruits of *Pyrus pyraster* var. *elongata*

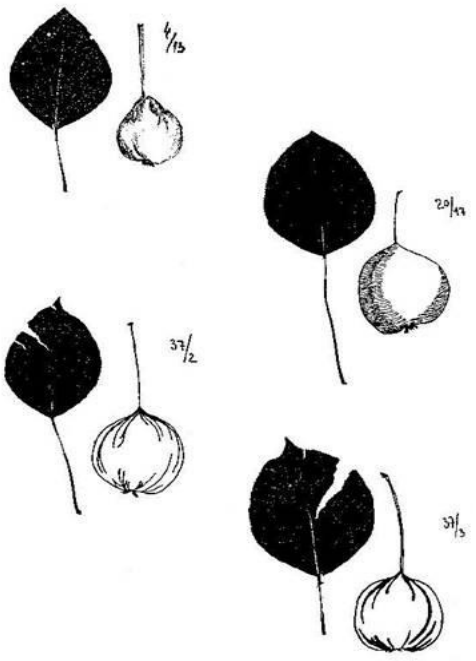

Fig. 9. Leaves and fruits of *Pyrus pyraster* f. *rhomboidea*

Review of the *Pyrus pyraster* (L.) Burgsd. lower taxa identified in Slovakia

Pyrus pyraster Burgsd. var. *pyraster* Terpó

Leaves are orbicular, leaf blades are 30–48 mm long and 32–48 mm wide, with the base top, sometimes rounded off, rarely cordate, on the top rounded, inconspicuously cuspidate, or impressed with a short tip. The top part of leaf blade margin is mostly serrulate, mature leaves uncoated, leaf petiole is 24–26 mm long. Fruit is 17–20 × 20–30 mm globular, sometimes short convergent, fruit petiole is 20–40 mm long (Terpó 1960).

Data from Slovakia

Leaves are orbicular, average value of the leaf blade length is 37.21 mm and it ranges within the interval 27–47 mm, the average value of the leaf blade width is 37.50 mm and it ranges within the interval 27–47 mm, base of the leaf blade is mostly truncate (58%) top, less frequently obtuse (30%) and cordate (12%). The angle of the leaf blade tip has average mean value 137°, with values from interval 104–175°. The leaf blade margin was mostly (74%) serrate to 1/3 and (26%) it was serrate to 1/2 of its perimeter. An average length of the leaf petiole was 32.10 m and its values ranged 9–51 mm. The average value of the slenderness quotient (K1) was 1.01 with range of the values 0.85–1.25 and average value of the shape quotient (K2) was 0.44 with range of the values 0.33–0.57.

Fruits were apple-shaped (70%), whirl-shaped (29%) alternatively pear shaped (1%). The mean value of the fruit length was 23.08 mm with range 16–35 mm and mean value of the fruit diameter was 26.63 mm with rage 18–36 mm. Fruit base was wedge-shaped (50%), flat (37%), or concave (13%). Calyx was always persistent. The average length of stalk was 24.90 mm with range 7–53 mm. The average slenderness quotient (Q1) was 0.91 with range 0.76–1.50 and average shape quotient (Q2) was 0.54 with range 0.40–0.80.

Pyrus pyraster Burgsd. f. *populifolia* Terpó

Leaves are compressed orbicular. The leaf blades are 26–41 mm long and 35–47 mm wide, on the base and on the top they are truncate. The margin of the leaf blade is elongate serrate. Leaves are naked in maturity. Leaf petiole is 26–45 mm long. Fruits are not known for the author. From type it differs with compressed orbicular leaves (Terpó 1960).

Data from Slovakia

Leaves are always compressed, mean value of the length of leaf blade was 35.82 mm with range 29–48 mm and mean value of the leaf blade width was 43.24 mm with range 37–56 mm. Leaf base was mostly truncate (65%) rarely cordate (29%), or obtuse (6%). The angle of the leaf blade tip had mean value 163° with range 147–190°. The leaf margin was serrate to 1/2 (65%) or along the whole leaf blade (35%). Mean length of the leaf petiole was 31.12 mm with range 12–42 mm. The slenderness quotient of the leaf blade (K1) had mean value 0.83 with range 0.78–0.93 and shape quotient (K2) had mean value 0.48 with range 0.44–0.54.

The fruits are mostly (59%) pear-shaped, less frequent (29%) they are apple-shaped and whirl-shaped (12%). Mean value of the fruit length was 23.18 mm with range 18–37 mm and width 23.94 mm by your leave span 13–36 mm. The fruit base was always wedge-shaped and calyx persistent. The mean value of length of stalk was 27.06 mm with range 16–33 mm. Mean value of the fruit slenderness quotient (Q1) was 0.98 with range 0.72–1.32 and mean value of the fruit shape quotient (Q2) was 0.55 with range 0.48–0.68.

Pyrus pyraster Burgsd. f. *cordifolia* Terpó

Leaves are cordate, 34–50 mm long and 35 to 52 mm broad. They have cordate leaf base and obtuse or flat terminated. On leaf margin they are mostly in the top denticulate and naked in maturity. Leaf petiole is 24–65 mm long. Fruits are spherical, or whirl-shaped, 19–23 mm long and 22–29 mm broad. Fruit petiole is 17–39 mm long. From type it differs with cordate shape of the leaf blade and leaf base (Terpó 1960).

Data from Slovakia

Leaves are always cordate, the mean value of the length of leaf blade was 37.89 mm with range 22–52 mm and of the area 36.20 mm and it ranged within the interval 28–46 mm. The leaf base was always cordate. The angle of the leaf blade tip had mean value 125 with range 98–154°. About 38% of the evaluated pear individuals had the margin of the leaf blade serrate to 1/2 of its perimeter and 37% of them were serrate to 1/3 of the leaf blade. 9% of the plants had serrate all margin of the leaf blade and 16% of the plants had entire leaf margin. Average length of the leaf petiole was 31.83 mm with range 11–48 mm. The average value of the leaf blade slenderness quotient (K1) was 1.05 with range 0.71–1.33. The average value of leaf shape quotient (K2) was 0.40 with range 0.29–0.50.

Fruits were mostly (72%) apple shaped, less frequently (26%) wedge-shaped and seldom (approximately 1%) pear-shaped and cherry-shaped

(spherical). Mean value of the fruit length was 23.29 mm with range from 17–36 mm and mean value of the fruit diameter was 26.36 with range from 15–40 mm. Fruit base was mostly (45%) wedge-shaped, less frequently flat (33%) or concave (22%), calyx always persistent. Mean length of the stalk was 24.13 mm with range 9–50 mm. The mean value of fruit slenderness quotient (Q1) was 0.89 with range 0.68–1.45 and mean value of shape quotient (Q2) 0.54 with range 0.38–0.79.

Pyrus pyraster Burgsd. f. *slovenica* (DOMIN) Terpó

The leaves are small, orbicular even cordate, glossy. The margin of the leaf blade is denticulate. Leaves are naked. Fruits are very small, spherical (Terpó 1960).

Data from Slovakia

The leaves are always orbicular. Mean value of the leaf length was 29.22 mm with range from 25 to 33 mm and mean value of the leaf width was 28.0 mm with range 26–31 mm. Leaf base was mostly obtuse (78%), only in one case it was cordate and truncate. The angle of the leaf blade tip had mean value 143° with range 128–155°. The margin of the leaf blade had mean value 142 with range 128–155. The margin of the leaf blade was mostly serrate to 1/3 of its perimeter (45%) to 1/2 of its perimeter (22%) and in three cases (33%) it was entire. The average length of leaf petiole was 26.67 mm. Average leaf slenderness quotient (K1) was 1.04 and shape quotient (K2) was 0.49. Fruits were small, mostly spherical with concave fruit base. The mean value of fruit length was 17.78 mm and mean value of fruit diameter was 20.56 mm. The average length of stalk was 23.11 mm. Mean value of the fruit slenderness quotient (Q1) was 0.87 with range 0.77–1.00 and mean value of the shape quotient was 0.51 with range 0.41–0.59.

Pyrus pyraster Burgsd. var. *elongata* (NYÁRADY) Terpó

The leaves are ovate, even wide lanceolate. The leaf blades are 35–63 mm long and 25–37 mm wide. They are widely cuneate, or obtuse on the leaf base. The leaf top is acuminate. The margin of the leaf blade is elongate dentate. Mature leaves are naked. The leaf petiole is 22–15 mm long. The fruit is mostly spherical or whirl-shaped. It is 15–24 mm long and 18–28 mm wide. The fruit petiole is 29–34 mm long (Terpó 1960).

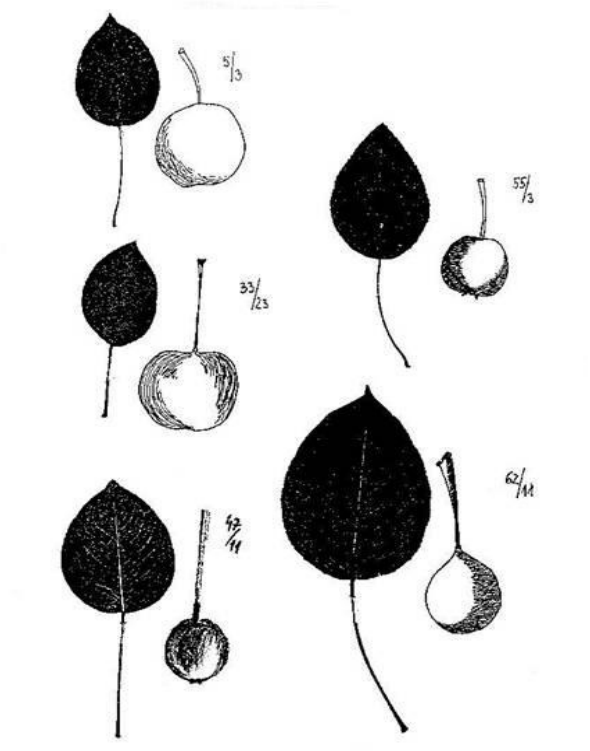

Fig. 10. Leaves and fruits of *Pyrus pyraster* f. *ovata*

Data from Slovakia

The leaves are always lanceolate. The mean value of the length of leaf blade was 54.20 mm with range 44–65 mm and mean value of the leaf blade width was 30.85 mm with range 23–37 mm. The base of leaf blade was mostly ovate (82%), or cuneate (18%). The average value of the angle of the leaf blade tip was 76° with range 84–103°. The margin of the leaf blade was variable, mostly (32%) serrate along whole leaf margin and to 1/3 of its perimeter. Rarely was serrate to 1/2 of its perimeter (27%) or entire (9%). The mean length of the leaf petiole was 41.90 mm with range 18–56 mm. The mean value of the leaf slenderness quotient (K1) was 1.77 with range 1.50–2.00 and mean value of the leaf shape quotient (K2) was 0.42 with range 0.34–0.51.

The fruits were mostly (50%) whirl-shaped, often they were apple shaped (40%) and rarely spherical (5%) or pear-shaped (5%). The mean value of the fruit length was 26.70 mm with range 16–34 mm and mean value of the fruit diameter was 26.95 with range 18–35 mm. The fruit base was mostly (60%) wedge shaped, less frequent (25%) was flat and rarely concave (10%), calyx always persistent. The average length of stalk was 27.15 mm with range 15–45 mm. The mean value of the fruit slenderness quotient (Q1) was 1.00 with range 0.69–1.25 and mean value of the fruit shape quotient (Q2) was 0.56 with range 0.38–0.79.

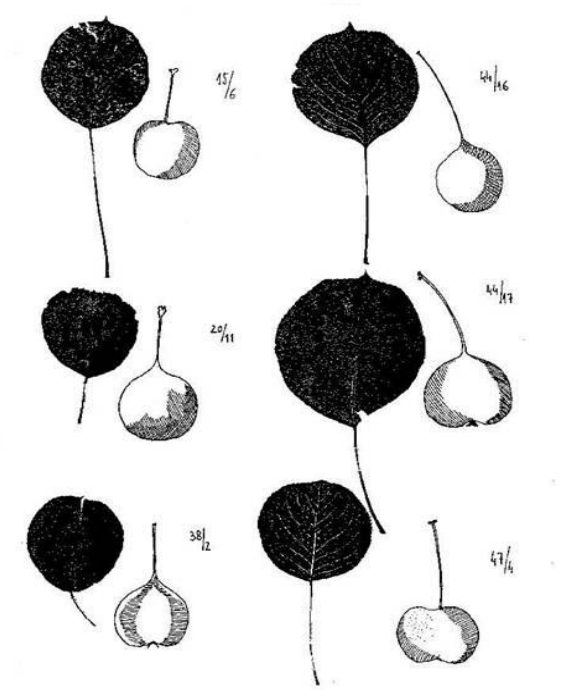

Fig. 11. Leaves and fruits of *Pyrus pyraster* var. *pénzesiana* collected in Slovakia

Pyrus pyraster Burgsd. f. *rhomboidea* Terpó

The leaves are rhomboid. The broadest they are in the middle of the leaf blade. The leaf blades are 30–54 mm long and 29–43 mm wide. The leaves are widely cuneate on the base. The top of the leaf blade is acuminate and its margin is elongate dentate. Mature leaves are naked. The leaf petiole is thin, 30 to 70 mm long. The fruit is whirl-shaped; rarely is spherical, 22–30 mm long and 18–30 mm wide. The fruit petiole is 28–45 mm long (Terpó 1960).

Data from Slovakia

The leaves are always rhomboidal. The mean value of the length of leaf blade was 48.16 mm with range 37–72 mm and mean value of the leaf blade width was 34.84 mm with range 26–53 mm. The base of leaf blade was always cuneate. The average value of the angle of the leaf blade tip was 96° with range 70–144°. The margin of the leaf blade was mostly (58%) serrate to 1/2 of its perimeter, less often (15%) to 1/3 of its perimeter and rarely serrate along whole leaf margin (9%) or entire (18%). Mean length of the leaf petiole was 36.19 mm with range 10–68 mm. Mean value of the leaf slenderness quotient (K1) was 1.40 with range 1.03–2.10 and mean value of the leaf shape quotient was 0.45 with range 0.40–0.52.

The fruits were mostly (56%) whirl-shaped and apple shaped (44%). The mean value of fruit length was 29.53 mm with range 18–49 mm and mean value of the fruit diameter was 28.78 with range 20–40 mm. The fruit base was wedge shaped (59%), flat (28%) and concave (13%), calyx always persistent. The mean length of stalk was 28.53 mm with range 2–48 mm. The mean value of fruit slenderness quotient (Q1) was 1.02 with range 0.74–1.32 and mean value of the shape quotient was 0.56 with range 0.42–0.77.

Pyrus pyraster Burgsd. f. *ovata* (Terpó) Terpó

The leaves are ovate, leaf blades are 33–35 mm long and 28–40 mm wide. They are obtuse on the base and aristate on the top. The margin of the leaf blade is elongate dentate. Mature leaves are naked. The leaf petiole is 30–64 mm long. The fruit is spherical, or it is wedge shaped toward the petiole. Its length is 17–37 mm and diameter is 18–28 mm. The fruit petiole is 20–34 mm long. From "type" it differs with ovate shape of the leaf blade (Terpó 1960).

Data from Slovakia

The leaves are always ovate. The mean value of the length of leaf blade was 43.86 mm with range 23–57 mm and mean value of the leaf blade width was 32.39 mm with range 21–42 mm. The base of leaf blade was always obtuse. The average value of the angle of the leaf blade tip was 98° with range 68–129°. The margin of the leaf blade was variable. Mostly it was serrate along whole leaf margin (40%) or to 1/2 of its perimeter (36%). Respectively it was serrate to 1/3 of its perimeter (10%) or entire (14%). The mean length of leaf petiole was 35.59 mm with range 13–54 mm. The mean value of leaf slenderness quotient (K1) was 1.36 with range 0.74–2.19 and mean value of the leaf shape quotient (K2) was 0.42 with range 0.33–0.74.

The fruits were mostly (71%) apple-shaped and also whirl-shaped (26%). Rarely were spherical (2%) or pear-shaped (1%). The mean value of the fruit length was 25.24 mm with range 15–44 mm and mean value of the fruit diameter was 27.02 with range 15–41 mm. The fruit base was mostly (41%) flat, wedge-shaped (37%), or concave (22%), calyx mostly persistent (98%). The average length of stalk was 23.86 mm with range 10–52 mm. The mean value of the fruit slenderness quotient (Q1) was 1.09 with range 0.66–1.40 and mean value of the fruit shape quotient (Q2) was 0.55 with range 0.39–0.76.

Pyrus pyraster Burgsd. var. *pénzesiana* Terpó

The leaves are obovate leaf blades are 28–42 mm long and 27–43 mm wide. They are attenuate on the base. The leaf tip is often mucronate, or retuse.

The margin of the leaf blade is entire, or denticulate. Mature leaves are uncoated. The leaf petiole is 20 to 60 mm long. The fruits are spherical or whirl-shaped. They are 15–35 mm long and 17–31 mm wide. The fruit petiole is thin, 20–36 mm long. From type it differs with ovate leaves and attenuate leaf base (Terpó 1960).

Data from Slovakia

The leaves are always obovate. The mean value of the length of leaf blade was 41.89 mm with range 30–61 mm and mean value of the leaf blade width was 37.10 mm with range 30–50 mm. The base of leaf blade was always attenuate. The average value of the angle of the leaf blade tip was 154° with range 127–171°. The margin of the leaf blade was mostly (72%) serrate to 1/3 of its perimeter, less frequent it was serrate to 1/2 of its perimeter (14%) and similarly it was entire (14%). The mean length of leaf petiole was 36.05 mm with range 22–60 mm. The mean value of the leaf slenderness quotient (K1) was 1.13 with range 0.94–1.56 and mean value of the leaf shape quotient (K2) was 0.55 with range 0.49–0.61.

About 58% of fruits were apple-shaped, or whirl-shaped (42%). The mean value of the fruit length was 28.37 mm with range 20–32 mm and mean value of the fruit diameter was 29.10 with range 23 to 32 mm. The fruit base was mostly wedge-shaped or flat (equally 42%), or concave (16%), calyx always persistent. The average length of stalk was 25.53 mm with range 13–37 mm. The mean value of the fruit slenderness quotient (Q1) was 0.99 with range 0.93–1.50 and mean value of the fruit shape quotient (Q2) was 0.55 with range 0.40–0.63.

Pyrus pyraster Burgsd. var. *brachypoda* (KERN) Terpó

The leaves are elongate ovate or elongately lanceolate. The leaf blades are 45–67 mm long and 30 to 45 mm wide. They are obtuse, or slightly attenuate. The leaf tip is acute. The margin of the leaf blade is elongately denticulate and ciliate. Mature leaves are naked. The leaf petioles are stiff, 22–52 mm long. The fruits are spherical or wedge-shaped toward the petiole. They are 20–27 mm long and 22–30 mm wide. The fruit petioles are 15–22 mm long. From type it differs with elongate leaves and short, stiff fruit petioles (Terpó 1960).

Data from Slovakia

The leaves are elongate ovate. The mean value of the length of leaf blade was 64.00 mm with range 61–70 mm and mean value of the leaf blade width was 38.33 mm with range 38–39 mm. The base of leaf blade was obtuse. The average value of the angle of the leaf blade tip was 82° with range 72–90°. The margins of the leaf blade mostly (67%) entire and serrate (33%). The mean length of the leaf petiole was 47 mm with range 41–56 mm. The mean value of the leaf slenderness quotient (K1) was 1.67 with range 1.56–1.84 and mean value of the leaf shape quotient (K2) was 0.39 with range 0.39–0.40.

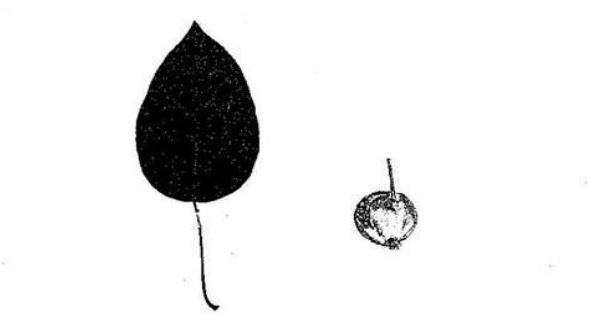

Fig. 12. Leaves and fruits of *Pyrus pyraster* var. *brachypoda* collected in Slovakia in 1998

The fruits were always apple-shaped. Mean value of the fruit length was 24.33 mm with range 19–31 mm and mean value of the fruit diameter was 26.33 with range 21–34 mm. The fruit base was wedge-shaped (67%) or concave (33%), calyx always persistent. The average length of stalk was 32 mm with range 28 to 35 mm. The mean value of the fruit slenderness quotient (Q1) was 1.08 with range 1.04–1.11. Mean value of the shape quotient (Q2) was 0.48 with range 0.39–0.53.

Pyrus pyraster subsp. *achras* (WALLR.) Terpó

The leaves are ovate, leaf blades are 33–55 mm long and 26–43 mm wide. They are obtuse or rarely truncate on the base. The leaf tip is mostly acute. The margin of the leaf blade is slightly elongate – denticulate. Young leaves are ciliate or slightly pubescent, later they are naked. The leaf petiole is 24–55 mm long. The fruits are pear-shaped and wedge shaped toward the petiole. They are 18–22 mm long and 15–20 mm wide. The fruit petiole is 20–35 mm long (Terpó 1960).

Data from Slovakia

The leaves are always ovate. Mean value of the length of leaf blade was 43.86 mm with range 30 to 57 mm and mean value of the leaf blade width was 34.71 mm with range 24–42 mm. The base of leaf blade was always obtuse. The average value of the angle of the leaf blade tip was 108° with range 85–139°. The margin of the leaf blade was variable, mostly (46%) was serrate to 1/2 of its perimeter, less frequently was serrate to

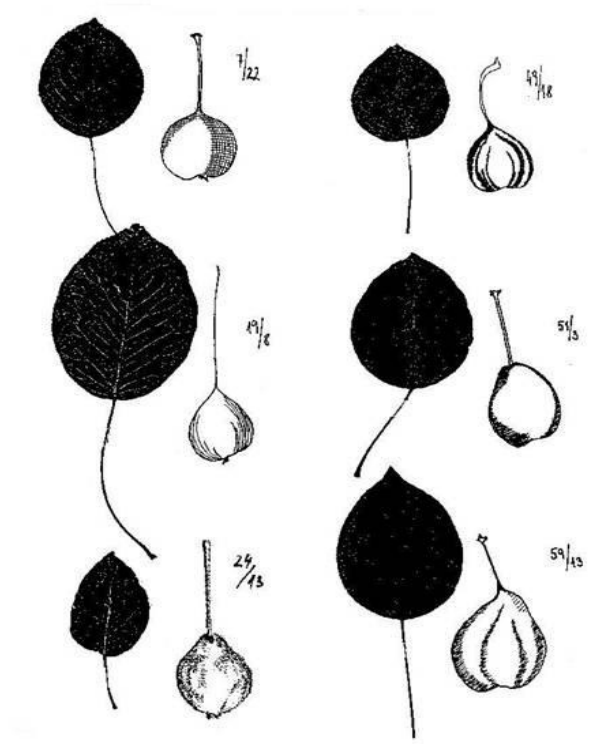

Fig. 13. Leaves and fruits of *Pyrus pyraster* subsp. *achras* collected in Slovakia

1/3 of its perimeter (17%), exceptionally serrate along whole leaf margin (3%). Some leaves had also entire leaf margin (34%). The mean length of leaf petiole was 35.06 mm with range 11–58 mm. Mean value of the leaf slenderness quotient (K1) was 1.27 with range 0.93–1.47 and mean value of the leaf shape quotient (K2) was 0.42 with range 0.33–0.51.

The fruits were mostly (60%) pear-shaped and whirl-shaped (40%). Mean value of the fruit length was 28.14 mm with range 21–48 mm and mean value of the fruit diameter was 25.85 with range 20–35 mm. The fruit base was always wedge-shaped and calyx persistent. The average length of stalk was 28.00 mm with range 12–41 mm. The mean value of the fruit slenderness quotient (Q1) was 1.09 with range 0.63–1.38 and mean value of the fruit shape quotient (Q2) was 0.61 with range 0.48–0.73.

CONCLUSIONS

Within our study there were analyzed 507 plants from 64 natural populations in different regions of Slovakia. There were identified 10 lower taxa of *Pyrus pyraster* on the territory of Slovakia, which were described by Terpó (1960, 1985, 1992).

All analyzed plants had very small fruit dimensions up to 30 mm and thorns on shoots. According to the field assessment trees were classified as wild or cultivated pears and later a more detailed visual classification of the wild pear lower taxa was done according to morphological traits of their leaves and fruits.

The majority of trees (93%) were classified as subspecies *pyraster*, only 35 trees were classified as subspecies *achras*. Within subspecies *pyraster* there were identified 4 varieties – *pyraster*, *elongata*, *pénzesiana* and *brachypoda*. The most abundant group (56%) represented taxa of variety *pyraster* and 39% taxa of variety *elongata*. The presence of analyzed lower taxa on particular localities was wide-ranging even on such, with relatively small number of trees in population.

The most abundant forms were *ovata* and *cordifolia* (both represented with 26% of all analyzed plants) and form *pyraster* represented with 22% of individuals. The majority of mentioned lower taxa of the wild pear were found by Terpó (1985, 1992) in Hungary, only f. *slovenica* (very little orbicular fruits) was found just on territory of Slovakia.

The numerical classification based on discriminant analysis of quantitative morphological data confirmed visual assessment of the wild pear lower taxa within our study. However, some discrepancies between the visual and numerical classification were found (up to 16.7 %).

The most representative characteristics within numerical classification of the wild pear lower taxa were:
- length of leaf blade,
- position of the maximum width on leaf,
- ratio length/width of the leaf blade,
- ratio position of maximum width/length of the leaf blade.

These quantitative traits represent rather shape of the leaf blade, than its dimension.

The multivariate method used for analysis of morphometric data referred to some failures within visual classification of pears.

For future proper classification of the pear taxa, molecular markers are essential. The reliability of the particular morphological traits should be then verified in connection with genetic markers.

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Výskyt a morfologická charakteristika nižších taxónov hrušky planej na Slovensku

ABSTRAKT: Na Slovensku sa potvrdil výskyt desiatich nižších taxónov *Pyrus pyraster*. Medzi 507 jedincami hrušky zo 64 lokalít sa zaznamenali dva poddruhy – *Pyrus pyraster* subsp. *pyraster* a *Pyrus pyraster* subsp. *achras.* Subspécia *pyraster* bola reprezentovaná štyrmi varietami (*pyraster, elongata, pénzesiana, brachypoda*) a piatimi formami (*populifolia, cordifolia, rhomboidea, ovata, slovenica*). Všetky nižšie taxóny boli vizuálne klasifikované na základe znakov listov a plodov. Numerická klasifikácia sa realizovala diskriminačnou analýzou kvantitatívnych morfologických charakteristík. Medzi vizuálnou a numerickou klasifikáciou sa zistili odchýlky v rozpätí do 16,7 % na rôznych úrovniach klasifikácie nižších taxónov.

Kľúčové slová: hruška planá; nižšie taxóny; výskyt; morfológia; listy; plody

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