

CHARACTERISTICS OF ACHENES IN *POTENTILLA COLLINA* GROUP (ROSACEAE)

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ABSTRACT

Achenes morphology in taxa from *Potentilla collina* s.l. i.e. *P. collina* Wibel s.s., *P. leucopolitana* P.J. Müller, *P. thyrsoflora* Hülsen ex Zimmet. *P. thyrsoflora* var. *isosepala* Th. W., *P. silesiaca* Uechtr. And *P. wimanniana* Günther & Schummel was examined with stereoscope and scanning electron microscopy. Achenes of these taxa varied slightly in shape, size and colour, while marked differences among them appeared in the surface sculpture and in the dimensions of aril, dorsal ridge and ribs. SEM analyses allowed to distinguish two distinct morphological types of achenes. Type I – with ruminant sculpture and aggregates of some material, various in shape and size, at the surface of partly destroyed epidermal cells covering fruit wall in *P. leucopolitana*, *P. wimanniana* and *P. thyrsoflora*. Type II – with ruminant-reticulate sculpture due to well preserved epidermal cells in *P. collina*, *P. silesiaca* and *P. thyrsoflora* var. *isosepala*. The obtained results have supported Błocki's suggestion to treat *P. thyrsoflora* var. *isosepala* as a separate species named *P. isosepala*. However, similarities in the surface sculpture of achenes in some taxa of *P. collina* group did not facilitate their classification, therefore this feature may be a valuable taxonomical criterium only in combination with others.

KEY WORDS: achenes, fruit wall sculpture, SEM, *Potentilla collina* group, taxonomy.

INTRODUCTION

The *Potentilla collina* group (Rosaceae), due to its changeability and related to it diversity of forms, belongs to the “critical” plant taxa. The causes of this changeability are the occurrence of polyploids, easiness of developing interspecies hybrids and ability to reproduce both sexually and apomictically, in the form of facultative apomixis (Müntzing 1928, 1931, 1958; Asker and Fröst 1970; Asker 1966, 1970, 1985, 1986; Eriksson et al 1998; Gregor et al. 2003). Hence, the division of this species aggregate in an intermediate one between taxa of the sections Argenteae (*P. argentea* group and *P. inclinata*) and Aureae (most probably *P. tabernaemontani* and *P. incana*), according to exclusively morphological criteria is complicated (Wolf 1908; Szafer and Pawłowski 1955; Gerstberger 2002; Kurtto et al. 2004). Differences between apomictic microspecies (agamic species) are most frequently slight, but usually stable. Because agamic taxa are more stable than microspecies of selffertilizing taxa, there is a temptation to ascri-

be the rank of taxonomic species to apomictic microspecies (Stace 1989).

In Poland between 5 and 8 species of the *Potentilla collina* group have been identified i.e. *P. collina* Wibel, *P. isosepala* Błocki, *P. leucopolitana* P.J. Müll., *P. silesiaca* Uechtr., *P. sordida* Zimmet., *P. thyrsoflora* Zimmet., *P. wimanniana* Günth. et Schumm and *P. wimannioides* (Szafer and Pawłowski 1955; Zajac and Zajac 2001; Mirek et al. 2002). They were classified as microspecies, subspecies or rarely varieties (Ascherson and Graebner 1904-1905; Wolf 1908; Szafer and Pawłowski 1955; Gerstberger 2002; Kurtto et al. 2004).

Identification of most of the taxa from *Potentilla collina* group is based on the length ratio of sepals to corolla petals, the shape of carpel style, the number of leaflets on basal leaves, the pattern of pubescence of upper and lower surfaces of leaf blades (Wolf 1901, 1903, 1908; Juzepczuk 1941; Ball et al. 1968; Borhidi and Isépy 1965; Soják 1995), as well as on the type of trichomes and the anatomy of leaves (Kołodziejek and Gabara 2003).

It is known that fruit and seeds are very useful in identification and classification of plant taxa (Karcz 1996; Liu and Lin 1999; Özcan 2004; Maciejewska-Rutkowska and Bednarz 2004; Fagúndez and Izco 2004). Description of achenes from taxa of *P. collina* group is limited to their length, shape and colour (Wolf 1908; Juzepczuk 1941; Kelley 1953; Szafer and Pawłowski 1955; Soják 1995). These features, however, are not sufficient to identify the particular taxa.

Fruit in *Potentilla* named also achene is dry, not dehiscent and monospermous, small in size and brown in colour (Wolf 1908; Juzepczuk 1941; Kelley 1953; Szafer and Pawłowski 1955; Ball et al. 1968; Leht 1990; Andenberg 1994; Soják 1995; Gerstberger 2002). This latter feature is a good criterion of its maturity, since an unripe fruit is more light brown than a mature one.

Therefore, the purpose of the present paper was the complex morphometric analysis of the achenes from 6 taxa of *P. collina* group together with their shape, colour and surface sculpture.

MATERIAL AND METHODS

The following taxa from *P. collina* s.l. i.e. *P. collina* s.s., *P. leucopolitana*, *P. thyrsoflora*, *P. thyrsoflora* var. *isosepala*, *P. wimanniana* and *P. silesiaca* were analysed. The nomenclature of taxa was used according to Wolf (1908) and Kurtto et al. (2004). Plant material originated from natural habitat in Poland except *P. silesiaca* and *P. thyrsoflora* var. *isosepala* which came from herbaria (LE and BP).

Only mature, fully developed achenes, intensively brown in colour were used in the investigations while distinctly smaller and deformed ones were discarded.

Colour of the achenes was determined in day light on the basis of colour scale recommended by Berggren (1969). Dimensions – length, width and thickness of the achenes, width of the aril, width and thickness of the ribs and width and height of dorsal ridge were measured according to the description presented in Figure 1. Morphometric analysis of the achenes except, aril and rib dimensions, was made using a stereoscope microscope Nikon SMZ 800 with mil-

limeter scale (exact to 0.05 mm). At least 30 individual achenes were analyzed for each taxon.

For scanning electron microscopy (SEM) samples were mounted on metal stubs, sputtered with technical gold (Pelco S.C 6 coating system), examined and photographed using a Tesla BS 340 scanning electron microscope. Shape of achenes, dimensions of aril and ribs as well as the pattern of surface sculpture of the fruit wall were analyzed on 5 photographs for each taxon.

The obtained data were statistically analyzed by means of the Student's *t* test. A difference was considered statistically significant when $P < 0.01$.

RESULTS

The achenes in *Potentilla collina* group are bilateral, their shapes vary from almost oval in *P. leucopolitana* and *P. thyrsoflora* var. *isosepala* (Fig. 2 and 7) to bean-like in *P. wimanniana*, *P. silesiaca*, *P. collina* and *P. thyrsoflora* (Figs 3-6).

Three types of achenes are distinguished: small, typical of *P. leucopolitana* and *P. wimanniana*, large, present in *P. thyrsoflora* var. *isosepala* and medium in size observed in the remaining taxa (Table 1).

Achene colour varies slightly from light brown in *P. leucopolitana* through nut-brown in *P. collina*, *P. silesiaca*, *P. thyrsoflora* and *P. wimanniana* to orange-brown in *P. thyrsoflora* var. *isosepala* (Table 1).

Scar attachment i.e. the point of achene attachment to the receptacle is surrounded by an aril slightly visible in *P. collina* and *P. silesiaca* or clearly – in *P. leucopolitana*, *P. wimanniana*, *P. thyrsoflora* and *P. thyrsoflora* var. *isosepala* with their respective widths being 10 μm and 40 μm (Table 2).

A clear dorsal ridge about 80-40 μm wide and 20-40 μm thick was present in achenes of *P. leucopolitana* (Fig. 2), *P. wimanniana* (Fig. 3), *P. collina* (Fig. 5) and *P. thyrsoflora* var. *isosepala* (Fig. 7) while an unclear one, about 40 μm wide and 20 μm thick was observed in *P. silesiaca* and *P. thyrsoflora* (Table 2).

Ribs seen at achene surfaces are brown in colour in *P. collina* and *P. silesiaca* or yellow in *P. leucopolitana*, *P. thyrsoflora*, *P. thyrsoflora* var. *isosepala* and *P. wimanniana* (Table 1). Distinct ribs, very sharp in shape were seen in achenes of *P. silesiaca* (Fig. 4A, B), *P. collina* (Fig. 5A, B) and *P. thyrsoflora* var. *isosepala* (Fig. 7A, B) or oval in shape – in *P. leucopolitana* (Fig. 2A, B), *P. thyrsoflora* (Fig. 6A, B) and *P. wimanniana* (Fig. 3A, B). Width of ribs varied from 10-20 μm in *P. silesiaca* through 40 μm in *P. collina* up to 80 μm in *P. leucopolitana*, *P. thyrsoflora*, *P. thyrsoflora* var. *isosepala* and *P. wimanniana* (Table 2). Similarly rib height was the lowest (10 μm) in *P. silesiaca* while the largest (40-60 μm) in *P. leucopolitana*, *P. thyrsoflora*, *P. thyrsoflora* var. *isosepala* and *P. wimanniana* (Table 2).

SEM analyses of the surface sculpture revealed two types of achenes:

I. With ruminant sculpture, characterized by oval ribs and epidermal cells partly destroyed and covered with numerous aggregates of some material (probably waxes etc.), various in shape and size. This type of achenes was typical for *P. leucopolitana* (Fig. 2), *P. wimanniana* (Fig. 3) and *P. thyrsoflora* (Fig. 6).

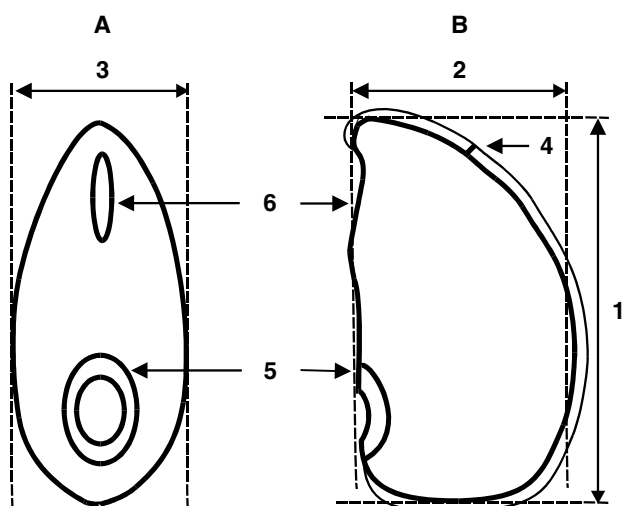
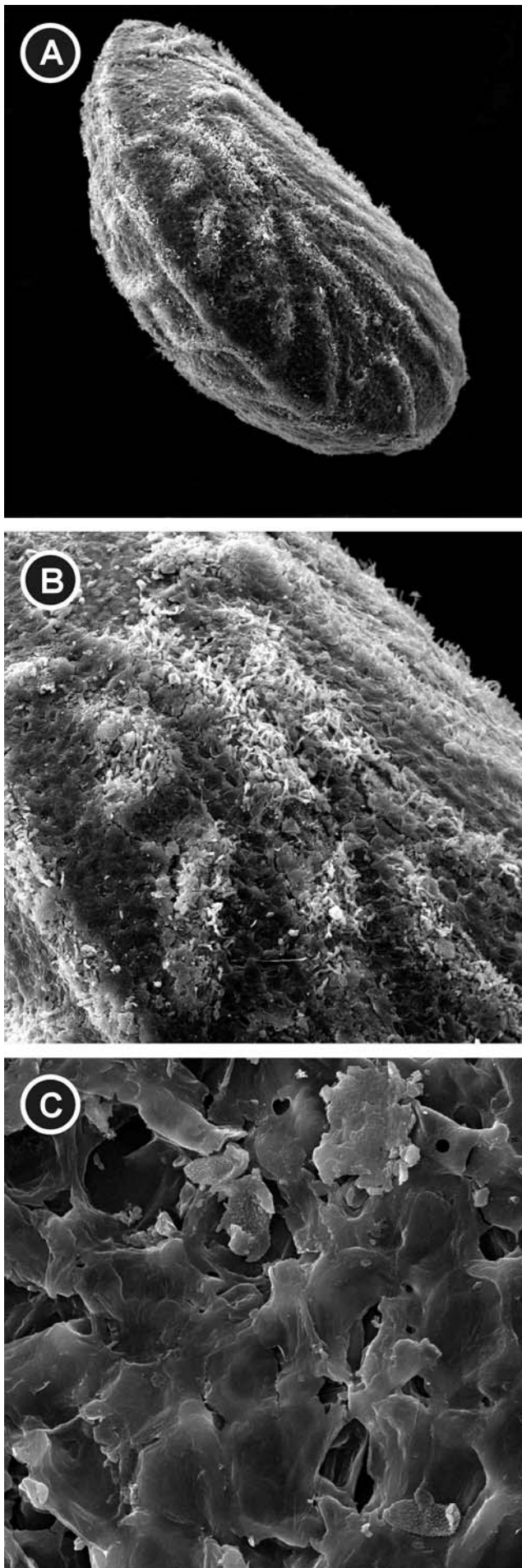


Fig. 1. Achene of *Potentilla* sp. [A] ventral and [B] lateral view; [1] length; [2] width; [3] thickness; [4] dorsal ridge; [5] aril around scar attachment; [6] style scar [after Anderberg (1994), modified].



II. With ruminately-reticulate sculpture; among distinct and sharp ribs well preserved epidermal cells, hexagonal in shape were visible. Achenes of this type were characteristic of *P. silesiaca* (Fig. 4), *P. collina* (Fig. 5) and *P. thrysiflora* var. *isosepala* (Fig. 7).

DISCUSSION

Taxonomy of *P. collina* group treated as a collective species is controversial because of lack of criteria to evaluate the systematic position of the particular taxa. Moreover, the problem of their taxonomic rank and phylogenetic relationships is also not defined. Therefore, in *P. collina* group an extensive and complicated synonymy appeared in consequence of various systematic classifications (Wolf 1908; Hegi 1923; Szafer and Pawłowski 1955; Ball et al. 1968; Szafer et al. 1976; Kurtto et al. 2004) and classification of many taxa to a lower order and then permanent changes in their rank. For example, Wolf (1908) divided the species aggregate of *P. collina* (as *Potentilla* Subgex Collinae) into 16 microspecies (of which 11 in Europe), later Juzepczuk (1941) (as *Potentilla* subsect. Collinae) distinguished 6 microspecies. A similarly narrow concept of species was presented by Kurtto et al. 2004, according to whom *P. collina* s.l. consists of 13 separate species in the area of Europe.

Therefore, besides difficulties in taxonomy, plants of *P. collina* group were improperly classified or simply unnoticed. For example, *P. thrysiflora* var. *isosepala* was described by Błocki (1896) as "*P. isosepala* Bł". Later Wolf (1908) on the basis of features such as large flowers, significantly larger and longer stem, its dense foliage, seven leaflets on basal leaves, pattern of leaf blade crenation Wolf (1908) classified this taxon as variety of *P. thrysiflora*.

Our investigations of taxa from *P. collina* group revealed differences in colour and shape of achenes, as well as in their sizes. According to our measurements the lengths of achenes, 1.2-1.3 mm, were similar to those described by Soják (1995), although significantly differed from the results obtained by Andenberg (1994), 1.4-1.9 mm.

Scanning electron microscopic analysis of achenes from *P. collina* group allowed to distinguish new additional features such as aril, dorsal ridge and aril dimensions, useful in taxonomy of this difficult collective species. These features of achenes in addition to the anatomy of leaves (Kołodziejek and Gabara 2003) proved to be of high systematic importance in taxonomy of *Potentilla* species. On the other hand, contrary to our expectations the surface sculpture cannot be a good criterium in classification of taxa from *P. collina* group in achenes *P. collina*, *P. silesiaca* and *P. thrysiflora* var. *isosepala* it was almost identical although different from that of *P. leucopolitana*, *P. wimanniana* and *P. thrysiflora*.

Fig. 2-7. Surface sculpture of the achenes of *P. collina* group, at different magnifications [A] $\times 500$; [B] $\times 1000$; [C] $\times 3000$. Arrow indicates dorsal ridge. Fig. 2. *P. leucopolitana* P.J. Müller; Fig. 3. *P. wimanniana* Günther and Schumme; Fig. 4. *P. silesiaca* Uechtr; Fig. 5. *P. collina*; Fig. 6. *P. thrysiflora* Hülsen ex Zimmerman; Fig. 7. *P. thrysiflora* var. *isosepala* Th. W. Specimens used in the morphological treatment:

Fig. 2. *P. leucopolitana* – Kujawy-Pomorze prov., Maksymilianowo near Bydgoszcz 55°13'N/17°58'E, pine coniferous forest, 12.08.2005, J. Kołodziejek.

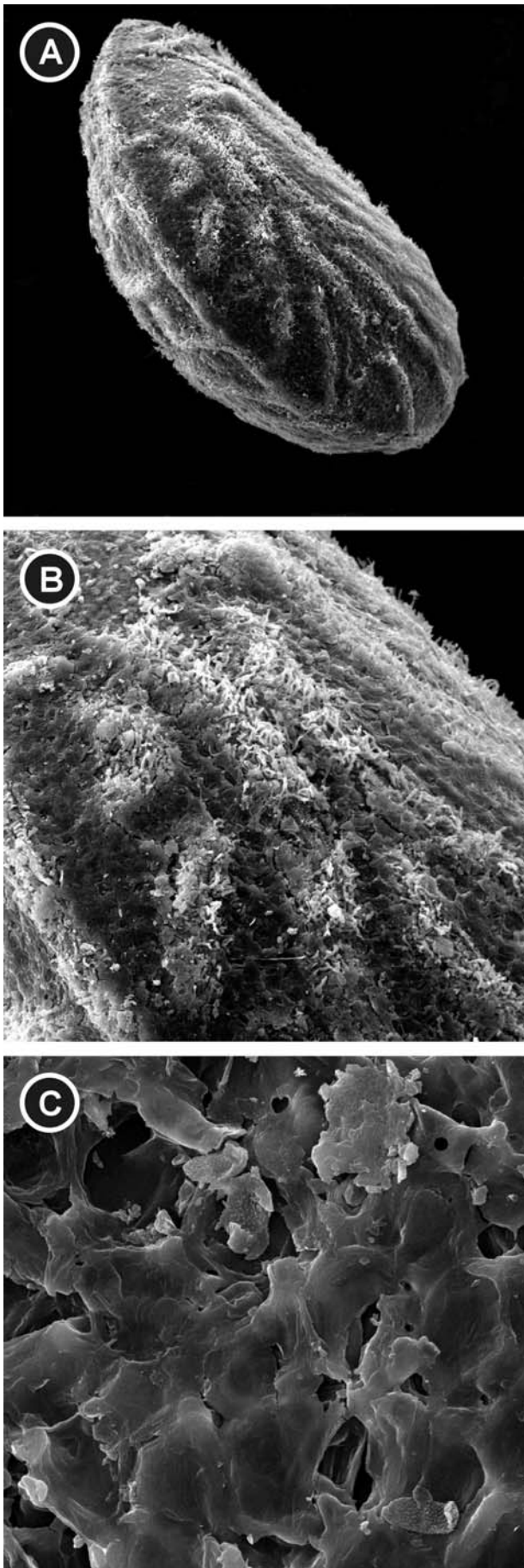


Fig. 3. *P. wimanniana* – Śląsk prov., Ogrodzieniec Podzamcze (region of Silesia-Cracow) 50°27'N/19°33'E, xerothermic grassland, 26.06.2004, J. Kołodziejek.

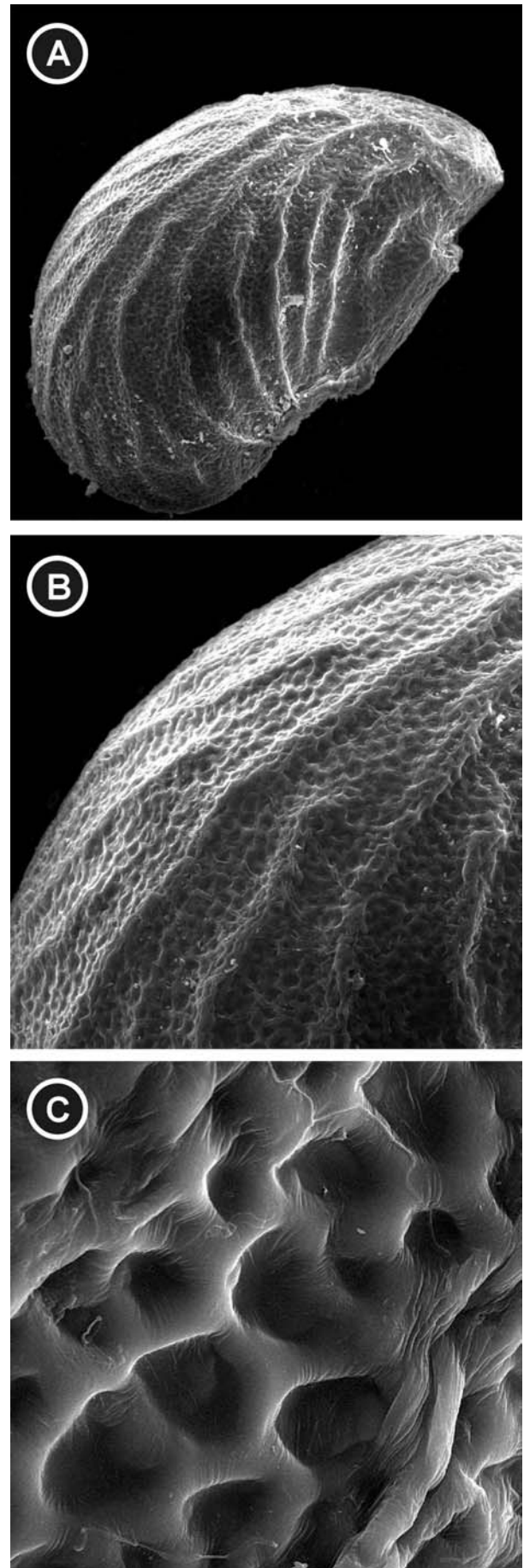


Fig. 4. *P. silesiaca* – Dolny Śląsk prov., Ostra Góra, between Miękinia and Mrozów (Breslau: Spitzberg, zwischen Nimkau und Nippem) loc. class., 28.06.1863, R. Uechtritz, (PRA).

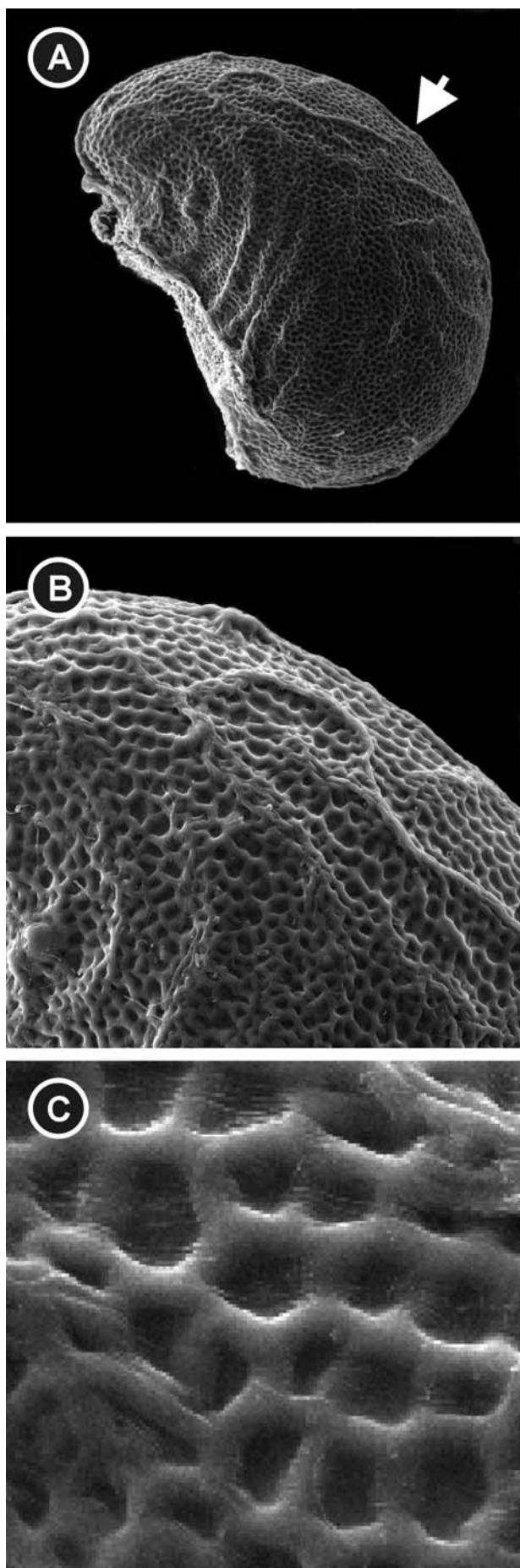


Fig. 5. *P. collina* s.s. – Śląsk prov., Kłobuck near Częstochowa 50°57'N/19°59'E, xerothermic grassland, 29.05.2004, J. Kołodziejek.

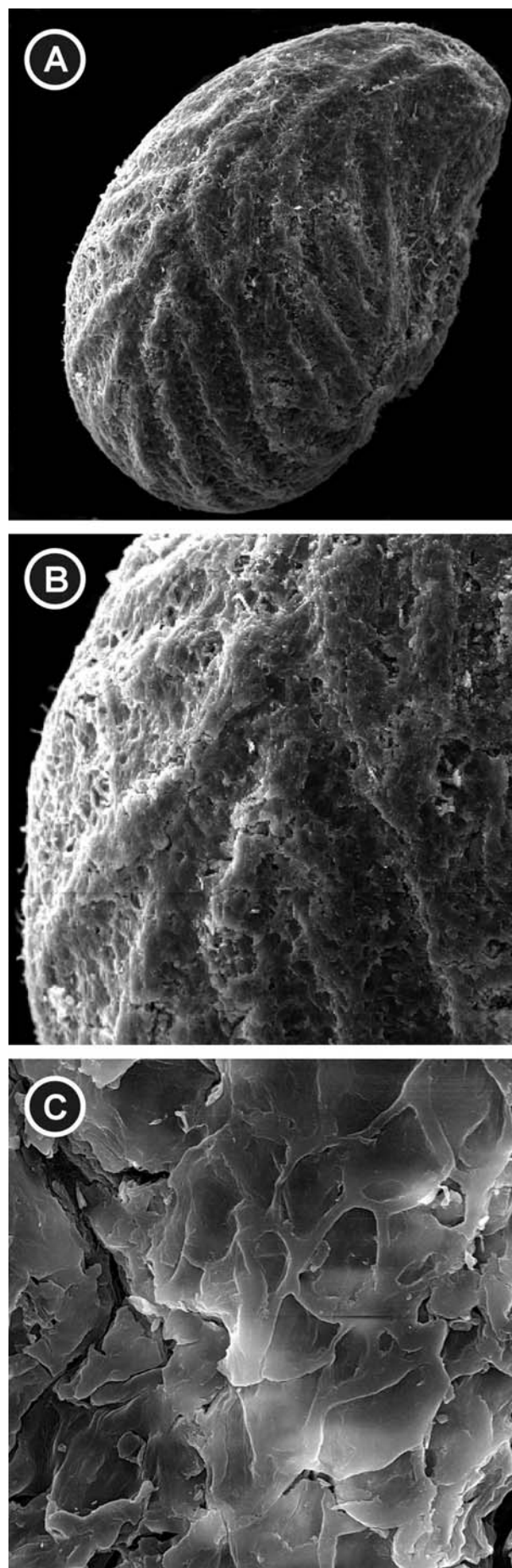


Fig. 6. *P. thyrsiflora* – Śląsk prov., Cisowa near Pilica 50°28'N/19°43'E, xerothermic grassland, 3.06.2004, J. Kołodziejek.

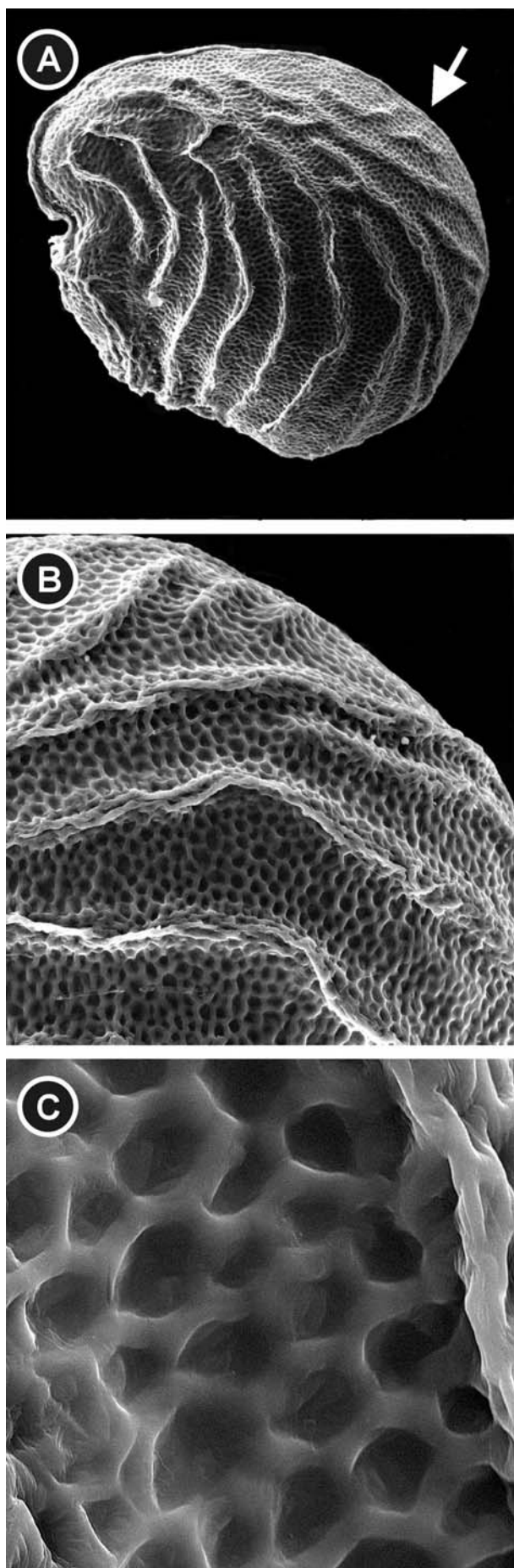


Fig. 7. *P. thyrsoflora* var. *isosepala* – Lwów prov. (Ukraine) – Kortumówka in collibus arenosis loc. class., 6.1896, B. Błocki, (BP 167343).

The results of the present paper indicate significant differences between *P. thyrsoflora* i *P. thyrsoflora* var. *isosepala*. Differences in colour, surface sculpture of achenes and in dorsal ridge dimensions do not support Wolf's (1908) classification of *P. thyrsoflora* as variety, on the contrary they indicate that this taxon should be identified as a species similar to Błocki's (1896) idea and termed *P. isosepala*.

Key to the species of genus *Potentilla collina* s.l. based on morphological characteristics of fruits.

1. Surface of achenes between ribs
 - with ruminated sculpture 2
- 1*. Surface of achenes
 - with ruminated-reticulate sculpture 4
2. Colour light brown *P. leucopolitana*
- 2*. Colour nut-brown 3
3. Dorsal ridge clear, c. 80 μ m wide *P. wimanniana*
- 3*. Dorsal ridge unclear, c. 40 μ m wide *P. thyrsoflora*
4. Colour orange-brown *P. thyrsoflora* var. *isosepala*
- 4*. Colour nut-brown 5
5. Dorsal ridge clear, ribs c. 40 μ m wide *P. collina*
- 5*. Dorsal ridge unclear, ribs c. 10-20 μ m wide *P. silesiaca*

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TABLE 1. Dimensions (in mm) and colour of achenes from taxa of *Potentilla collina* group.

Taxon	Length	Width	Thickness	Colour	
				Achenes	Ribs
<i>P. leucopolitana</i>	1.16±0.02	0.85±0.02	0.64±0.01	Light brown	Yellow
<i>P. collina</i>	1.25±0.01	0.96±0.01	0.69±0.01	Nut-brown	Brown
<i>P. silesiaca</i>	1.30±0.01	0.96±0.02	0.72±0.01	Nut-brown	Brown
<i>P. thyrsoflora</i>	1.28±0.01	0.96±0.02	0.70±0.01	Nut-brown	Yellow
<i>P. thyrsoflora</i> var. <i>isosepala</i>	1.33±0.02	0.99±0.02	0.77±0.01	Orange-brown	Yellow
<i>P. wimanniana</i>	1.23±0.01	0.89±0.01	0.62±0.01	Nut-brown	Yellow

TABLE 2. Characteristic of achenes sculpture in taxa of *Potentilla collina* group.

Taxon	Arl		Dorsal ridge			Surface sculpture	Ribs (µm)	
		Width (µm)		Width	Thickness		Width	Highth
				(µm)				
<i>P. leucopolitana</i>	Clear	40	Clear	80	20-40	Ruminate covered with waxes?	80	40-60
<i>P. collina</i>	Unclear	10	Clear	40	20	Ruminate reticulate	40	20
<i>P. silesiaca</i>	Unclear	10	Unclear	40	20	Ruminate reticulate	10-20	10
<i>P. thyrsoflora</i>	Clear	40	Unclear	40	20	Ruminate covered with waxes?	80	40-60
<i>P. thyrsoflora</i> var. <i>isosepala</i>	Clear	40	Clear	80	20-40	Ruminate reticulate	80	40-60
<i>P. wimanniana</i>	Clear	40	Clear	80	20-40	Ruminate covered with waxes?	80	40-60

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