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POLLEN CARDS OF THE *GENISTA RADIATA* GROUP *(GENISTEAE, FABACEAE)*

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Abstract: Pollen cards of the taxa of the *Genista radiata* group [*G. radiata* (L.) Scop. var. *radiata, G. radiata* var. *sericopetala* Buchegger, *G. holopetala* (Koch) Bald., *G. hassertiana* (Bald.) Buchegger] are presented. The acetolyzed pollen was observed by light and scanning electron microscope.

Introduction

This paper is part of a series of pollen cards of taxa belonging to *Genista*, the most heterogeneous and complex genus of the tribe *Genisteae (Fabaceae)*.

A first group of cards (G1 - G5), describing *G. germanica* L. and the *G. sylvestris* group, was published by Feoli Chiapella & Rizzi Longo (1983).

In the present study the pollen cards of some taxa of *Genista* sect. *Spartocarpus* are presented. Cards G6 - G9 relate to the taxa belonging to the *Genista radiata* group:

- *Genista radiata* (L.) Scop. var. *radiata*, a south-eastern European orophyte;
- *G. radiata* var. *sericopetala* Buchegger, a western Alpine-Apenninic taxon;
- *G. holopetala* (Koch) Bald., a species endemic to south-western Slovenia, north-western Croatia and north-eastern Italy (Trieste Karst);
- *G. hassertiana* (Bald.) Buchegger, a central-southern Balkanic species (southern Serbia, north-western Albania, Macedonia and northern Greece).

Materials and methods

For each taxon, specimens from two distinct populations were examined. Voucher specimens are deposited in the herbarium of the Department of Biology, University of Trieste (TSB) and in the Herbarium of the Department of Botany, Slovenian Academy of Sciences and Arts (LJU). The nomenclature follows Greuter *et al.* (1989) and Gibbs (1966).

The cards were compiled according to the procedure proposed by Della Casa Accorsi & Bertolani Marchetti (1974), subsequently modified by Accorsi & Forlani (1976) and by Accorsi *et al.* (1983). The data, concerning both qualitative and quantitative characters, were obtained by means of light microscopy with the exception of the data on the sculpture of exine which derive from scanning electron microscopy. For the pollen terminology see Faegri & Iversen (1989) and Punt *et al.* (1994).

Pollen from herbarium specimens was acetolysed according to Erdtman (1960), included in glycerol 50% and observed by light microscope (LM).

Measurements were taken using a filar ocular micrometer mounted on a Nikon Labophot within a standard period after preparation (4 hours), in order to avoid alterations in dimensions (Van Campo 1966; Hanks & Fairbrothers 1976; Rizzi Longo 1986). Given that the means appear to stabilise after 20-25 measurements (Rizzi Longo 1986), a minimum of thirty measurements was taken per character per sample.

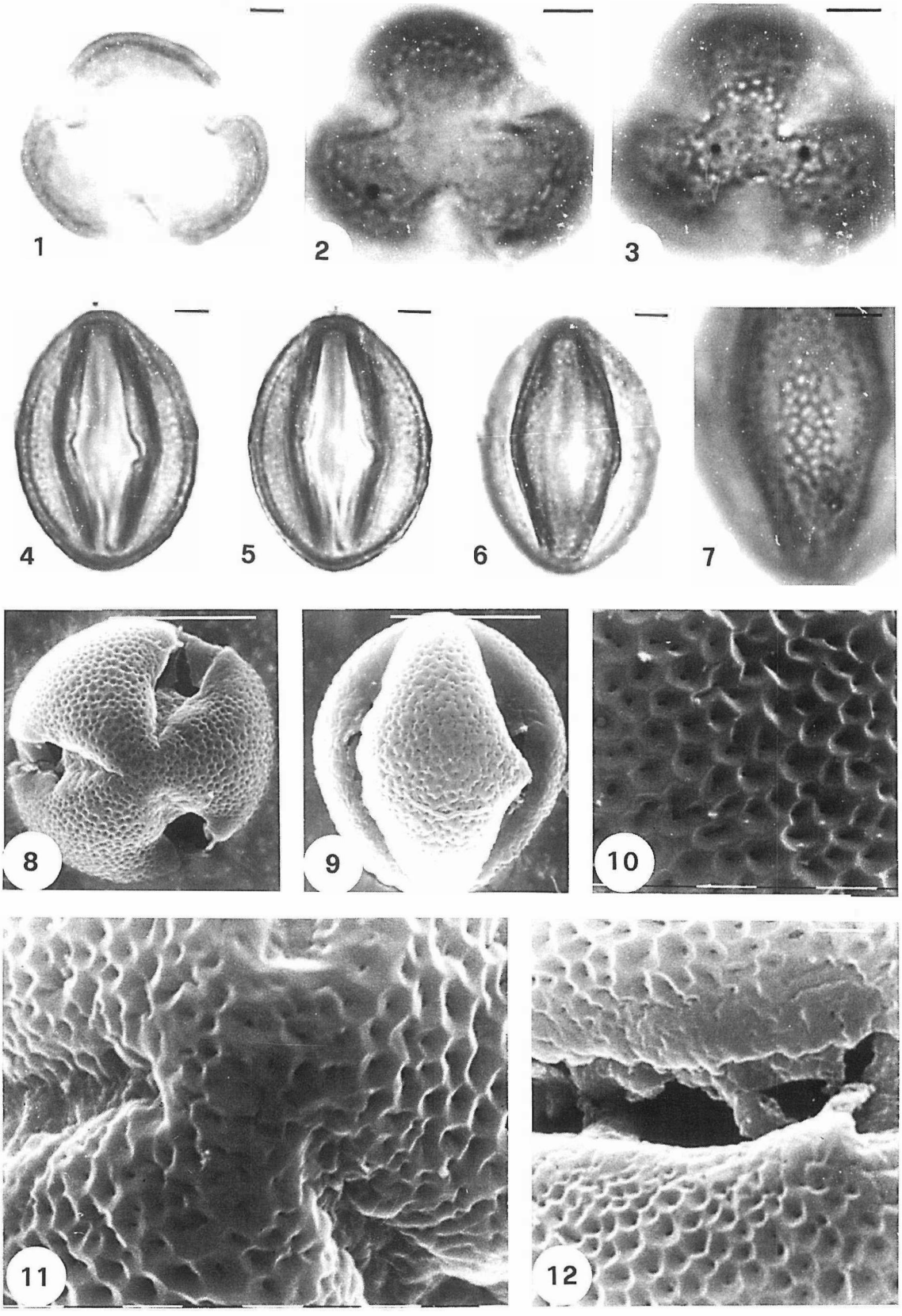
The pollen was acetolysed, dehydrated in acetone, dried according to the critical point technique (Anderson 1951) and coated with gold-palladium for the examination by SEM (Philips Scanning Electron Microscope SEM 500).

Genista radiata (L.) Scop. var. ***radiata*** **G 6**

				sd	mode	median
PRINCIPAL POLLEN CHARACTERS	monads, 3-zonocolpate (3-zonocolporoidate) grains					
POLLEN UNIT	monads					
SYMMETRY	radially symmetric grains					
POLARITY	isopolar grains					
OUTLINE	in polar view (amb): circular flat (26.5%), circular open (27%), circular with invaginations (35%), semi-angular open (10%), angular (1.5%) in equatorial view: subcircular (48%), elliptical (52%)					
SHAPE	subprolate: 44% prolate spheroidal: 54% oblate spheroidal: 2%	P/E ratio	1.15 (0.97 - 1.32)	0.07	1.14	1.14
	3 - zonocolpate: 64% 3 - zonocolporoidate: 36%	NPC 343				
APERTURES	rectangular or with equatorial constrictions, rarely elliptic acuminate colpi; pointed or rounded apices (LM); nanogranulate, sometimes nanoverrucate colpus membrane (SEM)	colpus length	22.1 (18.3 - 26.1) µm	2.0	22.0	22.0
		colpus breadth	1.7 (1.2 - 2.2) µm	0.2	1.7	1.7
		mesocolpium width	14.2 (11.0 - 16.4) µm	1.7	13.7	14.2
		distance between the apices of two ectocolpi (d)	5.6 (3.4 - 7.8) µm	0.9	6.1	5.9
		apocolpium index (d/E ratio)	0.27 (0.15 - 0.36)	0.04	0.29	0.27
EXINE	tectate perforate, supramicro(nano)reticulate, rarely with unperforate areas; trend to reduced reticulum at the margin of apertures (SEM)	exine thickness at mesocolpium (Ex)	1.9 (1.7 - 2.4) µm	0.2	1.7	1.7
		Ex/E ratio	0.09 (0.07 - 0.12)	0.01	0.09	0.09
SIZE	medium sized grains: 35% small grains: 65%	polar axis length (P)	24.0 (20.3 - 27.3) µm	1.8	23.7	23.7
		equatorial diameter (E)	20.9 (19.3 - 23.7) µm	1.3	21.7	21.0
MATERIALS AND METHODS	Examined specimens: 1) Čepovan (Slovenia); 2) Višegrad (Jugoslavia). Technique for preparing pollen: acetolysis (Erdtmann, 1960). Analysis: pollen included in water and glycerine 1:1 (LM); dehydrated, dried and coated with gold - palladium (SEM). Examined grains: 60					

Figs. 1-12 - *Genista radiata* (L.) Scop. var. *radiata*. 1: optical section in polar view; 2: colpi and mesocolpium exine sculpture in polar view; 3: apocolpium exine sculpture in polar view; 4: optical section in equatorial view; 5: colpi in equatorial view; 6: mesocolpium exine sculpture in equatorial view; 7: detail of the mesocolpium exine sculpture in equatorial view; 8: pollen grain in polar view; 9: pollen grain in equatorial view; 10: mesocolpium exine sculpture; 11: apocolpium exine sculpture; 12: exine sculpture at the margin of the aperture in equatorial view. Figs. 1-7: LM; Figs. 8-12: SEM. Scale line: Figs. 1-7 = 3 µm; Figs. 8-9 = 10 µm; Figs. 10-12 = 1 µm.

Genista radiata (L.) Scop. var. ***radiata*** **G 6**

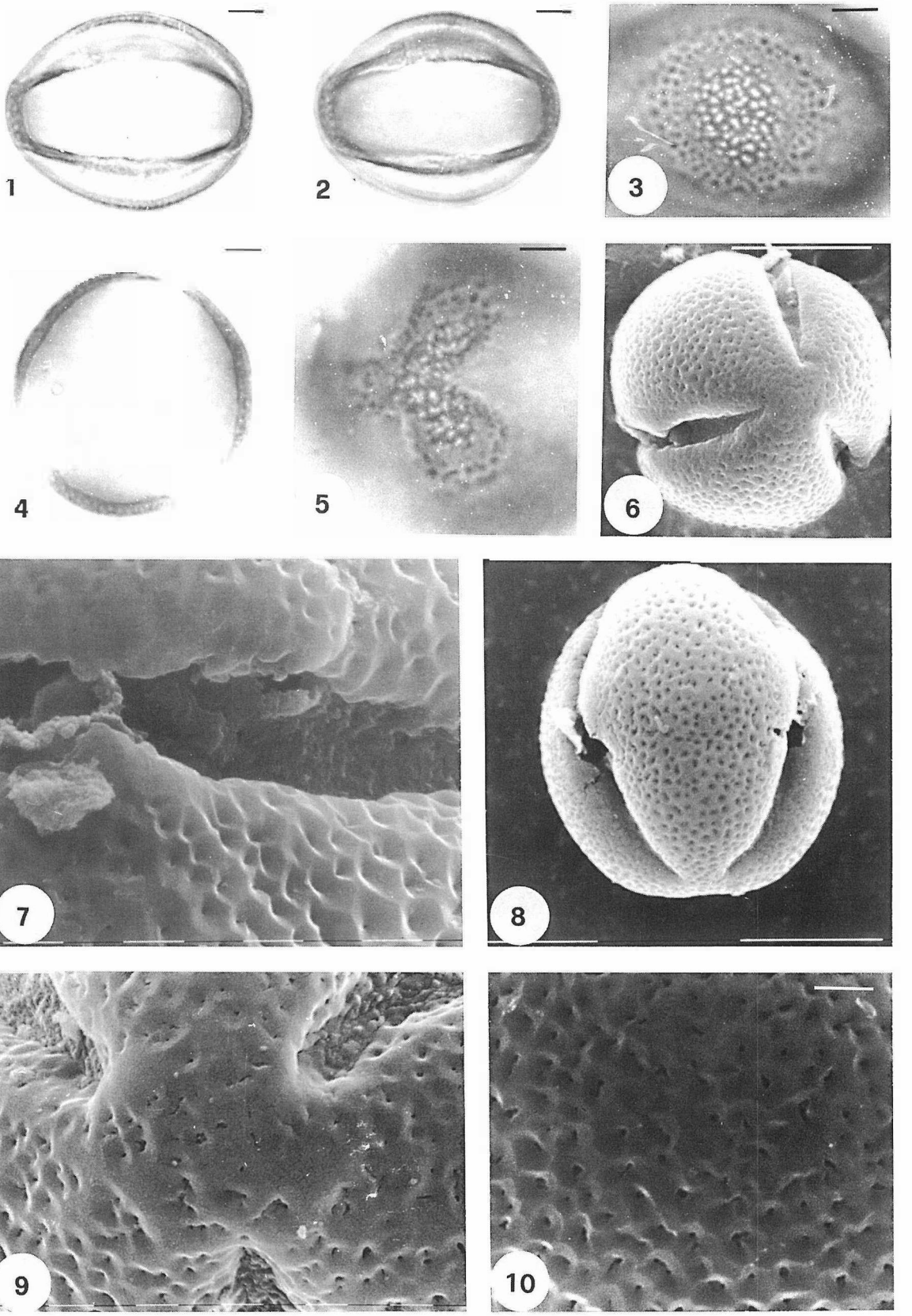


Genista radiata (L.) Scop. var. ***sericopetala*** Buchegger **G 7**

PRINCIPAL POLLEN CHARACTERS	monads, 3-zonocolpate (3-zonocolporoidate) grains					
POLLEN UNIT	monads					
SIMMETRY	radially simmetric grains					
POLARITY	isopolar grains					
OUTLINE	in polar view (amb): circular flat (68%), circular open (5%), circular with invaginations (13%), semi-angular open (11.5%), angular (1.5%) in equatorial view: subcircular (47%), elliptical (53%)					
				sd	mode	median
SHAPE	euprolate: 4% subprolate: 33% prolate spheroidal: 51% oblate spheroidal: 9% suboblate: 3%	P/E ratio	1.13 (0.91 - 1.82)	0.12	1.06	1. 11
	3-zonocolpate: 78% 3-zonocolporoidate: 22%	NPC 343				
APERTURES	rectangular colpi, sometimes with equatorial constrictions colpi; pointed or rounded apices (LM); colpus membrane from psilate to nanogranulate, rarely nanoverrucate (SEM)	colpus length	25.6 (21.7 - 30.3) µm	1.7	25.4	25.6
		colpus breadth	1.5 (1.5 - 2.2) µm	0.3	1.5	1.5
		mesocolpium width	16.8 (10.0 - 21.2) µm	1.9	15.9	16.7
		distance between the apices of two ectocolpi (d)	6.3 (4.1 - 8.8) µm	1.2	6.1	6.1
		apocolpium index (d/E ratio)	0.25 (0.16 - 0.36)	0.05	0.25	0.24
EXINE	tectate perforate, supramicro(nano)reticulate punctate, with some unperforate areas (SEM)	exine thickness at mesocolpium (Ex)	2. 0 (1.5 - 2.2) µm	0. 4	1. 7	2. 0
		Ex/E ratio	0.08 (0.05 - 0.09)	0. 02	0. 07	0. 08
SIZE	medium sized grains: 99% small grains: 1%	polar axis length (P)	28.3 (24.4 - 32.2) µm	1.5	29.3	28.3
		equatorial diameter (E)	25.3 (19.5 - 30.5) µm	2.2	23.9	25.4
MATERIALS AND METHODS	Examined specimens: 1) Gap, Manteyer - Hautes Alpes (France); 2) Pas de la Graille, Montagne de Lure - Alpes de Haute Provence (France). Technique for preparing pollen: acetolysis (Erdtman, 1960). Analysis: pollen included in water and glycerine 1:1 (LM); dehydrated, dried and coated with gold - palladium (SEM). Examined grains: 80					

Figs. 1-10 - *Genista radiata* (L.) Scop. var. *sericopetala* Buchegger. 1: optical section in equatorial view; 2: colpi in equatorial view; 3: mesocolpium exine sculpture in equatorial view; 4: optical section in polar view; 5: apocolpium exine sculpture in polar view; 6: pollen grain in polar view; 7: exine sculpture at the margin of the aperture in equatorial view; 8: pollen grain in equatorial view; 9: apocolpium exine sculpture; 10: mesocolpium exine sculpture. Figs. 1-5: LM; Figs. 6-10: SEM. Scale line: Figs. 1-5 = 3 µm; Figs. 6, 8 = 10 µm; Figs. 7, 9, 10 = 1 µm.

Genista radiata (L.) Scop. var. ***sericopetala*** Buchegger **G 7**



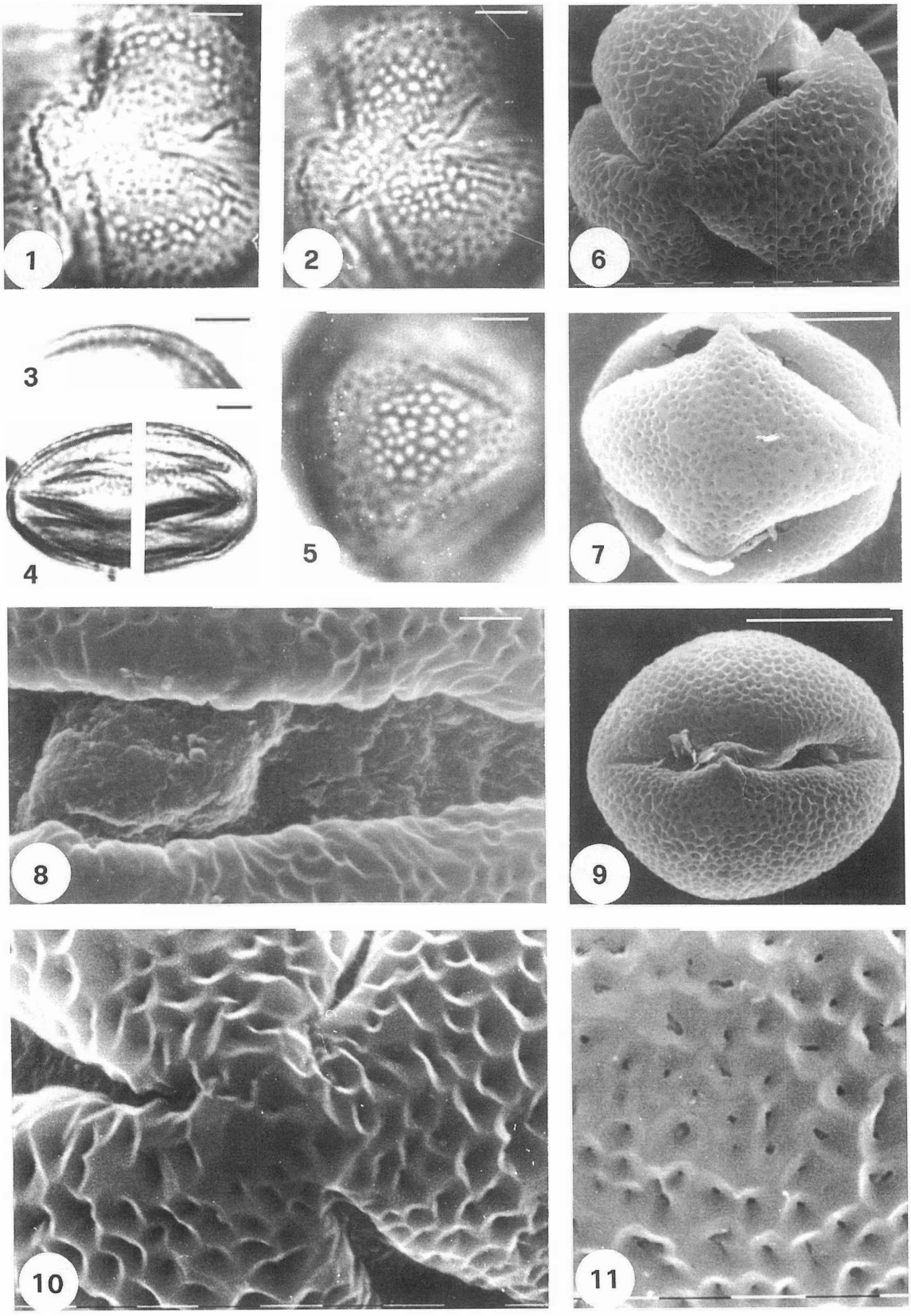
Genista holopetala (Koch) Bald. **G 8**

PRINCIPAL POLLEN CHARACTERS	monads, 3-zonocolpate (3-zonocolporoidate) grains					
POLLEN UNIT	monads					
SYMMETRY	radially symmetric grains					
POLARITY	isopolar grains					
OUTLINE	in polar view (amb): circular flat (10%), circular open (31.5%), circular with invaginations (56.5%), semi-angular open (1.5%), angular (1.5%) in equatorial view: subcircular (68.5%), elliptical (31.5%)					
				sd	mode	median
SHAPE	prolate: 2% subprolate: 28% prolate spheroidal: 70%	P/E ratio	1.11 (1.00 - 1.34)	0.08	1.10	1.10
	3 - zonocolpate: 67% 3 - zonocolporoidate: 33%	NPC 343				
APERTURES	rectangular sometimes with equatorial constrictions colpi; pointed apices (LM); psilate or nanogranulate colpus membrane (SEM)	colpus length	22.8 (18.5 - 25.9) µm	1.7	22.0	22.6
		colpus breadth	1.7 (1.5 - 2.0) µm	0.1	1.7	1.7
		mesocolpium width	15.1 (10.7 - 18.7) µm	1.8	14.9	15.0
		distance between the apices of two ectocolpi (d)	5.2 (3.4 - 6.8) µm	0.9	5.6	5.4
		apocolpium index (d/E ratio)	0.24 (0.15 - 0.30)	0.04	0.24	0.24
EXINE	tectate perforate, supramicroreticulate with unperforate areas; sometimes with reduced reticulum at the margin of apertures (SEM)	exine thickness at mesocolpium (Ex)	1.7 (1.5 - 2.0) µm	0.1	1.7	1.7
		Ex/E ratio	0.08 (0.06 - 0.09)	0.01	0.08	0.08
SIZE	medium sized grains: 35 % small grains: 65 %	polar axis length (P)	24.6 (22.0 - 28.5) µm	1.7	24.4	24.2
		equatorial diameter (E)	22.1 (19.0 - 25.1) µm	1.3	22.2	22.2
MATERIALS AND METHODS	Examined specimens: 1) Obruč - Gorski Kotar (Croatia); 2) Čaven (Slovenia). Technique for preparing pollen: acetolysis (Erdtman, 1960). Analysis: pollen included in water and glycerine 1:1 (LM); dehydrated, dried and coated with gold - palladium (SEM). Examined grains: 60					

Figs. 1-11 - *Genista holopetala* (Koch) Bald. 1: colpi in polar view; 2: apocolpium exine sculpture in polar view; 3: optical section in polar view; 4: optical section in equatorial view; 5: detail of the mesocolpium exine sculpture in equatorial view; 6: pollen grain in polar view; 7: pollen grain in equatorial view; 8: exine sculpture at the margin of the aperture in equatorial view; 9: pollen grain with colpus in equatorial view; 10: apocolpium exine sculpture; 11: mesocolpium exine sculpture. Figs. 1-5: LM; Figs. 6-11: SEM. Scale line: Figs. 1-5 = 3 µm; Figs. 6, 8, 10, 11 = 1 µm; Figs. 7, 9 = 10 µm.

Genista holopetala (Koch) Bald

G 8

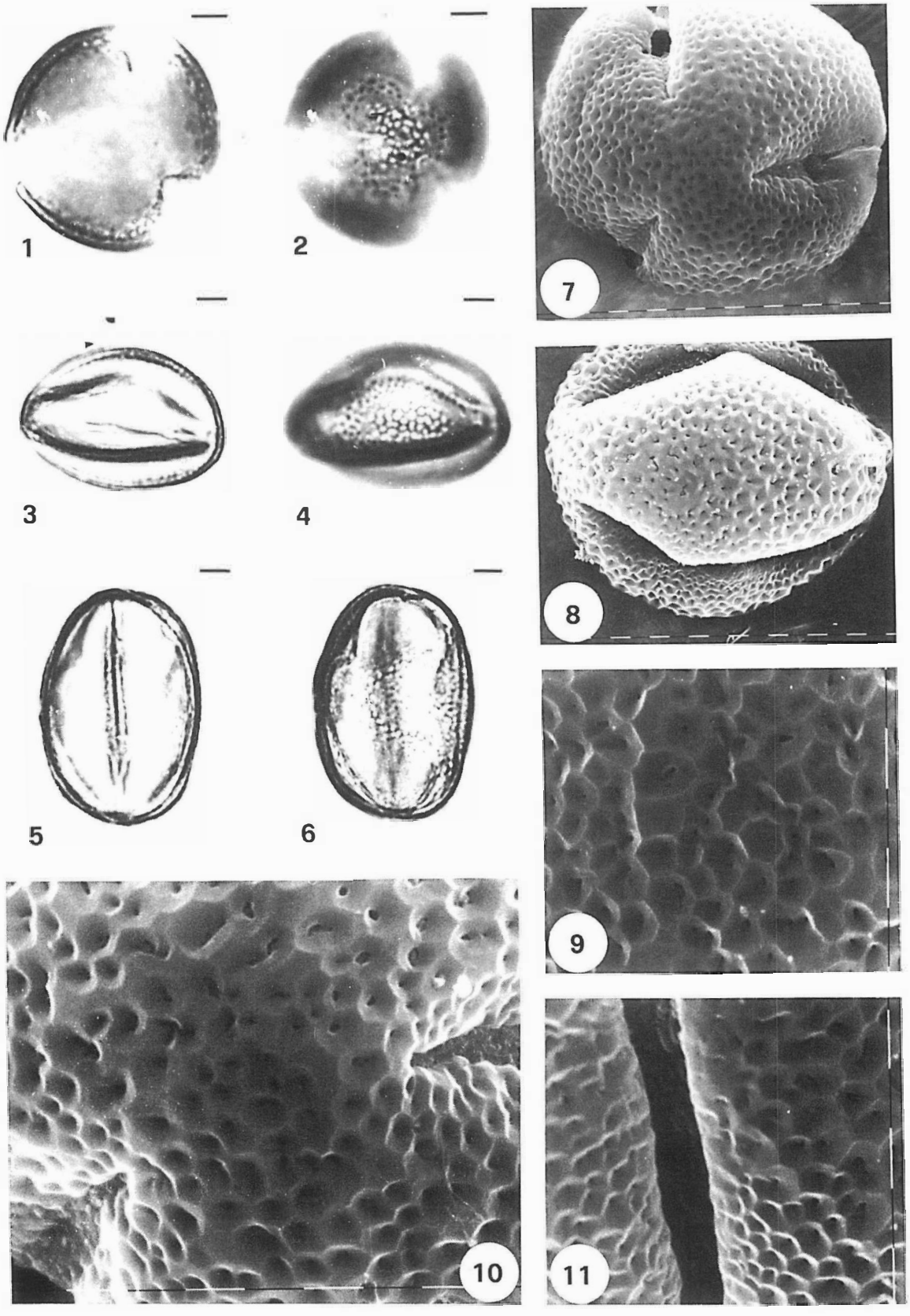


Genista hassertiana Buchegger **G 9**

PRINCIPAL POLLEN CHARACTERS	monads, 3 - zonocolpate (3 - zonocolporoidate) grains					
POLLEN UNIT	monads					
SYMMETRY	radially symmetric grains					
POLARITY	isopolar grains					
OUTLINE	in polar view (amb): circular flat (1.5%), circular open (46.5%), circular with invaginations (43.5%), semi-angular open (8.5%) in equatorial view: subcircular (93%), elliptical (7%)					
				sd	mode	median
SHAPE	subprolate: 6.5% prolate spheroidal: 70 % oblate spheroidal: 23.5%	P/E ratio	1.05 (0.92 - 1.36)	0.07	1.00	1.04
	3 - zonocolpate: 76% 3 - zonocolporoidate: 24%	NPC 343				
APERTURES	rectangular or with equatorial constrictions colpi; pointed or sometimes rounded apices (LM); psilate or nanogranulate colpus membrane (SEM)	colpus length	20.2 (17.6 - 23.9) µm	1.4	18.8	20.3
		colpus breadth	1.7 (1.5 - 2.0) µm	0.1	1.7	1.7
		mesocolpium width	15.0 (9.8 - 17.6) µm	1.4	14.4	15.1
		distance between the apices of two ectocolpi (d)	5.5 (3.4 - 7.8) µm	1.2	5.6	5.6
		apocolpium index (d/E ratio)	0.27 (0.13 - 0.43)	0.05	0.25	0.26
EXINE	tectate perforate, supramicro(nano)reticulate with unperforate areas, rarely with reduced reticulum at the margin of apertures (SEM)	exine thickness at mesocolpium (Ex)	1.9 (1.5 - 2.4) µm	0.2	1.7	2.0
		Ex/E ratio	0.09 (0.07 - 0.12)	0.01	0.09	0.09
SIZE	medium sized grains: 2%	polar axis length (P)	21.8 (18.8 - 25.4) µm	1.4	21.2	21.7
	small grains: 98%	equatorial diameter (E)	20.8 (17.8 - 23.2)µm	1.2	21.2	20.7
MATERIALS AND METHODS	Examined specimens: 1) Kosmet, Miruša, Beli river - Kosovo (Jugoslavia); 2) Tetovsko Rogačevo (Macedonia). Technique for preparing pollen: acetolysis (Erdtmann, 1960). Analysis: pollen included in water and glycerine 1:1 (LM); dehydrated, dried and coated with gold - palladium (SEM). Examined grains: 60					

Figs. 1-11 - *Genista hassertiana* Buchegger. 1: optical section in polar view; 2: apocolpium exine sculpture in polar view; 3: optical section in equatorial view; 4: mesocolpium exine sculpture in equatorial view; 5: colpus in equatorial view; 6: mesocolpium in equatorial view; 7: pollen grain in polar view; 8: pollen grain in equatorial view; 9: mesocolpium exine sculpture; 10: apocolpium exine sculpture; 11: exine sculpture at the margin of the aperture in equatorial view. Figs. 1-6: LM; Figs. 7-11: SEM. Scale line: Figs. 1-6 = 3 µm; Figs. 7-11 = 1 µm.

Genista hassertiana Buchegger **G 9**



Discussion

Genista radiata, *G. holopetala* and *G. hassertiana* display single, isopolar, radiosymmetric, 3-zonocolpate or 3-colporoidate, medium-small sized, spheroidal or subprolate grains, with perforate tectum and supramicro(nano)-reticolate exine.

Slight differences in pollen characters have been found among the examined species. The pollen grains are medium-sized in *Genista radiata* var. *sericopetala*, medium-small sized in *G. radiata* var. *radiata* and in *G. holopetala*, small-sized in *G. hassertiana*. *G. radiata* var. *sericopetala* displays the highest values in quantitative characters, *G. hassertiana* the lowest. The outline in polar view is generally circular in all examined taxa, that in equatorial view is prevalently elliptical in *G. radiata*, both var. *radiata* and var. *sericopetala*, and mostly subcircular in *G. holopetala* and *G. hassertiana*. At the SEM, *G. radiata* var. *radiata* and *G. holopetala*, more rarely *G. hassertiana*, display a trend of reduction of the exine reticulum at the margin of the apertures. In all taxa the colpus membrane appears nanogranulate, sometimes also nanoverrucate in *G. radiata* var. *radiata* and var. *sericopetala*, at times psilate in *G. hassertiana*.

In spite of the slight differences observed in the examined samples, the pollen grains of *Genista radiata, G. holopetala* e *G. hassertiana* are very similar. The results of the pollen analysis confirm the remarkable morphological similarity (Buchegger 1912, Fukarek 1964) and karyological affinity (Cusma Velari & Feoli Chiapella, 1987 a,b) of these taxa. Indeed, several authors have considered it appropriate to group them together, either in the genus *Genista* (Spach 1844, Buchegger 1912, Pignatti 1982, Rizzi Longo & Feoli Chiapella 1994), or in the genus *Cytisanthus* O.F. Lang (Fukarek 1964, Mayer 1970).

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References

Accorsi C.A. & Forlani L., 1976. *Schede per una flora palinologica italiana. Contributo n° 4: schede di nuova impostazione.* Arch. Bot. Biogeogr. Ital., 52: 58-111.

Accorsi C.A., Aiello M., Bandini Mazzanti M., Bertolani Marchetti D., De Leonardis W., Forlani L. & Piccione V., 1983. *Flora palinologica italiana. Schede elaborate tramite computer.* Arch. Bot. Biogeogr. Ital., 59: 55-104.

Anderson T.F., 1951. *Techniques for the preservation of the three-dimensional structure in preparing specimens for the electron microscope.* New York Acad. Sci. Trans., 13: 130-134.

Buchegger J., 1912. *Beitrag zur Systematik von* Genista hassertiana, G. holopetala *und* G. radiata. Österr. Bot. Z., 62 (1): 303-312, 368-376, 416-423, 458-465.

Cusma Velari T. & Feoli Chiapella L., 1987a. *Analisi cariologica e citogeografica di* Genista radiata. Biogeographia, 13: 421-427.

Cusma Velari T. & Feoli Chiapella L., 1987b. *Nota cariologica su* Genista holopetala *(Fleischm. ex Koch) Baldacci.* Inform. Bot. Ital., 19: 267-269.

Della Casa Accorsi C.A. & Bertolani Marchetti D., 1974. *Schede per una Flora Palinologica italiana.* Not. Fitosoc., 8: 97-127.

Erdtman G., 1960. *The acetolysis method, a revised description.* Svensk Bot. Tidskr., 54: 561-564.

Faegri K. & Iversen J., 1989. *Textbook of pollen analysis.* IV ed. John Wiley & Sons, Chichester, 328 pp.

Feoli Chiapella L. & Rizzi Longo L., 1983. *Schede palinologiche delle* Genisteae. *I.* Gortania, 5: 101-114.

Fukarek P., 1964. *Geobotanička i ekološka istraživanja balkanskih omelika. Vrste roda* Cytisanthus *Lang.* Naučno Društvo sr Bosne i Hercegovine, 25, Odjeljenje Privredno-Tehničkih Nauka, Sarajevo, 7: 5-56.

Gibbs P.E., 1966. *A revision of the genus* Genista *L.* Notes Roy. Bot. Gard. Edinburgh, 27 (1): 11-99.

Greuter W., Burdet H.M. & Long G. (eds.), 1989. *Med-checklist. 4.* Conservatoire et Jardin botaniques, Genéve, 458 + CXXIX pp.

Hanks S.L. & Fairbrothers D.E., 1976. *Palynotaxonomic investigations of* Fagus *L. and* Nothofagus *Bl.: light microscopy, scanning electron microscopy and computer analysis.* Bot. Syst., 1: 1-141.

Mayer E., 1970. *Zur Kenntnis der Südosteuropäischen* Cytisanthus *- Sippen.* Glas. Repub. zavoda Zas. Prirode, 3: 37-47.

Pignatti S., 1982. *Flora d'Italia. 1.* Edagricole, Bologna, 790 pp.

Punt W., Blackmore S., Nilsson S. & Le Thomas A., 1994. *Glossary of pollen and spore terminology.* LPP Foundation, Utrecht, 71 pp.

Rizzi Longo L., 1986. *Tassonomia su basi palinologiche.* Boll. Accad. Gioenia Sci. Nat. Catania, 19: 335-342.

Rizzi Longo L. & Feoli Chiapella L., 1994. *Contribution to the systematics of* Genista *L. sect.* Spartocarpus *Spach* (Genisteae, Fabaceae) *with emphasis on palynological data.* Studia Geobot., 14: 41-62.

Spach E., 1844. *Revisio generis* Genista. Ann. Sci. Nat. Bot., sér 3, 2: 237-279.

Van Campo M., 1966. *Variations polliniques intraflorales.* Adansonia (n.s.), 6: 55-64.

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