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# Chromosome Counts in *Cardaminopsis arenosa* Agg. (*Cruciferae*)

**Chromozómové počty v komplexu *Cardaminopsis arenosa* (*Cruciferae*)**

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Abstract — The following chromosome numbers (from 106, mainly Czechoslovak localities) have been found in *C. arenosa* agg.: diploid 2n = 16 or 2n = 16+0—4B (in all 34 localities in the West Carpathian region), triploid 2n = 24 and ca 24, tetraploid 2n = 32 or 2n = 32+0—1B, pentaploid 2n = 39—40 and aneuploid 2n = 18, 19, ca 28, 30, 31, 34; n = 17. A meiotic anomaly probably resulting in the production of microspores with n = 8 was discovered in one tetraploid individual (2n = 32). The number 2n = 16 found in the tetraploid progeny of one hybrid plant (from nature) is interpreted as a probable result of the sporic apozygoty or apogamety. Furthermore, the chromosome numbers 2n = 16 and 2n = 32 for *Cardaminopsis neglecta* (Schult.) Hayek and 2n = 32 for *Cardaminopsis petraea* (L.) Hiit. have been preliminarily reported. — — The author has divided the Czechoslovak plants of the *C. arenosa* complex into 4 fundamental units: 1 diploid (*C. nitida* nom. provis.), 2 including both a diploid and a tetraploid cytotype [*C. carpatica* nom. provis., *C. petrogena* (Kern.) Měsíček] and 1 tetraploid [*C. arenosa* (L.) Hayek]; short characteristics of this taxa are added. The total variation of the complex has not been exhausted by this list. Some natural or artificial interspecific (intergeneric) hybrids [between diverse units of the *C. arenosa* complex and the other species aggregates of the genus, viz. *C. neglecta* (Schult.) Hayek, *C. halleri* (L.) Hayek and *C. petraea* (L.) Hiit.; between *Arabidopsis thaliana* (L.) Heynh. and *C. arenosa* (L.) Hayek] are also mentioned in the present paper. — A new nomenclatural combination *Cardaminopsis petrogena* (Kern.) Měsíček has been proposed.

In the present paper some results of cytogeographical investigation of natural, mostly Czechoslovak populations of C. *arenosa* agg. are reported. The preliminary treatment of the complex used is, however, also supported by an account of further concrete, above all experimental findings which will be published later. As the taxonomic-nomenclatural study of the units distinguished by the present author within the complex has not yet been finished (owing to the territorial limitation of the present investigation and to difficulties in identifying some taxa described formerly), nomina provisoria have been used in naming some of these units. In most cases the question of their taxonomic rank has also been left open.

## Material and methods

The chromosome numbers were counted mostly in plants from natural localities, i.e. in wild individuals in nature or after their transplantation into a experimental garden, or in their progeny arisen by autogamy. With respect to its size and variability, 2—50 mature individuals were studied karyologically in one population; the plants were chosen with aim of including the total range its morphological variation. In some populations (ca 20%) it was only possible to study one plant. In most cases (even when seeds were obtained from European botanical gardens), a repre-

sentative sample of the given population was cultivated simultaneously (often in several or repeated series) and analysed using some other biosystematic methods (the numbers of experimental strains are given in the list of localities). All vouchers are deposited in the author's collection or in the herbarium of the National Museum in Prague (PR).

Root tip (young seedlings), flower bud, leaf or shoot apex meristems were studied in order to determine the somatic numbers; the gametic ones were counted in PMCs. Pre-treatment: p-dichloro-benzene, but often not used; fixation: AAA (alcohol-acetic acid) 3 : 1, CRAF; staining: lacto-orceine, lacto-resorcin blue, lacto-nigrosine, diverse carmine dyes and gentian violet. The squash method was used as a standard procedure. Drawings were made using a camera lucida; the photos by MF-camera.

### The list of localities

The localities are numbered consecutively, but some numbers have been skipped, because in the present paper only the karyologically analysed populations have been included from the complete list. The localities are ordered primarily in respect to the taxonomic identification of the given population and, in the second place, according to the countries (states) and within this framework according to longitude with an arrangement from East to West. In most cases the localities are taken up as occupied by one population, i.e. both the locality and the respective population are designated by the same number. Under some numbers several independent single populations (2—5) are subjoined (popul. a, b, c, etc.). On the contrary, the localities of sympatric populations (sympatric taxa) are listed under diverse (at most two) current numbers in respect firstly to the main criterion of the arrangement (= taxonomy) and, on the other hand, owing to the fact that such populations can usually be considered to be really occupied by two populations. Besides current numbers (with the symbol P = population), even a strain number (symbol M) is added in the experimentally analysed populations. In addition, every locality is also designated by a topographical reference given at the end of respective text: this reference is quoted in Tab. 1 for the better orientation. — Geological data have been gathered from the atlas "Geologická mapa ČSSR 1 : 200 000" (1964), and they are exact according to the accuracy of this maps and to reading possibility of a datum.

## A. The definitively classified populations

1. *Cardaminopsis nitida* nom. provis.

**P 1:** N. Slovakia, distr. Poprad, deposits of river Bielá near village Slovenská Ves (N. of township Spišská Belá); 49°13′ N., 20°25′30″ E; 630 m a.s.l.; primary substrate: C. - Carpathian flysh (or sandstone); sporadically; coll. B. Slavík 17. 8. 1967. — Geographical reference: Slovenská Ves.

**P 2:** N. Slovakia, distr. Poprad, Belanské Tatry Mts., S. slope of ridge Skalná vrata above chalet Hviezdoň (Plesnivec); 49°13′45″ N., 20°16′50″ E.; 1300—1400 m; limestone; copiously; coll. J. Soják 28. 6. 1969. — "Hviezdoň".

**P 4:** M 42, N. Slovakia, distr. Poprad, Belanské Tatry Mts., rocky ridge Dlouhá stěna Javorinky above NE. border of plateau Stará Polana (immediately above the forest zone); 49°15′45″ N., 20°12′30″ E.; 1400—1460 m; limestone; rather copiously; coll. J. Měsíček 26. 5. 1964, 25. 6. 1965, V. Javůrková 12. 8. 1965 and plants cultivated 1965—1969. — Javorinka I.

**P 5:** N. Slovakia, distr. Poprad, Belanské Tatry Mts., along a trail below rocky ridge Dlouhá stěna Javorinky (immediately below the forest zone); 49°16′ N., 20°12′ E., 1300—1350 m; limestone; dispersed occurence, along with *C. carpatica* 4x (cf. P 47); coll. J. Měsíček 25. 6. 1965, V. Javůrková 9. 8. 1965. — Javorinka II.

**P 7:** M 72, N. Slovakia, distr. Poprad, N. foot of Belanské Tatry Mts.; village Podspády, gravel deposits along confluence of streams Havran and Javorinka; 49°17′ N., 20°11′30″ E.; 900 m; primary substrate: C.-Carpathian flysh; sporadically; coll. V. Javůrková 9. 8. 1965 and pl. cult. 1966—1968. — Podspády.

**P 8:** M 106, N. Slovakia, distr. Liptovský Mikuláš, High Tatra, Červené vrchy Mts., Mt. "Štrky"; 49°13′30″ N., 19°56′35″ E., ca 1450 m; limestone screes; copiously; coll. J. Měsíček and J. Holub 21. 7. 1967 and pl. cult. 1967, 1968. — Štrky.

**P 9:** M 108, M 109, popul. a, b; N. Slovakia, distr. Liptovský Mikuláš, High Tatra, Tichá dolina valley, gravel deposits of torrent Tichý potok; 49°12′ N., 19°55′30″ E.; ca 1100 m; primary substrate: biotite siliceous diorite and granodiorite; very copiously; coll. J. Měsíček and J. Holub 21. 7. 1967 and pl. cult. 1967—1969. —Tichý potok.

**P 10:** popul. a—d; N. Slovakia, distr. Liptovský Mikuláš, High Tatra, Tichá dolina valley, along a road; 49°11′ N., 19°54′ E. — 49°13′ N., 19°55′ E.; 1050—1150 m; primary substrate: see P 9; rather copiously; coll. J. Měsíček 21. 7. 1967. — Tichá dolina.

**P 11:** M 107, N. Slovakia, distr. Liptovský Mikuláš, High Tatra, Červené vrchy Mts., SW. slope of Mt. Małołaczniak, nacked places; 49°14′ N., 19°55′ E.; 1850—1900 m; limestone; an isolated small population; coll. J. Měsíček 21. 7. 1967 and pl. cult. 1967, 1968. — Małołaczniak.

**P 12:** N. Slovakia, distr. Dolný Kubín, High Tatra, bank of river Oravice at a bridge in the near end of Tichá dolina valley; 49°17′25″ N., 19°46′ E.; ca 800 m; primary substrate: C.-Carpathian flysh; coll. V. Javůrková 6. 1969. — Oravice.

**P 13:** N. Slovakia, distr. Dolný Kubín, Liptovské Hole Mts., SW. slope of Mt. Osobitá; 49°15′40″ N., 19°43′45″ E.; 1600—1650 m; limestone; dispersed occurrence; coll. V. Javůrková 6. 1969. — Osobitá.

**P 14:** M 162, S. Poland, gravel deposits of river Białka not far from village Nová Biala (ES. by E. of town Nowy Targ); 49°26′ N., 20°08′ E.; ca 600 m; coll. K. Kopecký 24. 8. 1967 and pl. cult. 1968, 1969. — Białka.

2. *Cardaminopsis carpatica* nom. provis.

diploid cytotype

**P 18:** C. Slovakia, distr. Rožňava, Slovenské Rudohorie Mts., an old quarry at the road between market-towns Stratená and Dobšinná, ca 1,5 km S. of Stratená; 48°51′30″ N., 20°21′15″ E.; ca 850 m; limestone; sparsely; coll. J. Měsíček 18. 7. 1968. — Stratená.

**P 19:** M 93, C. Slovakia, distr. Rožňava, edges of rivulet Hnilec (Gelnický potok) — especially gravel banks (a building site of a new canalization) — ca 2 km E. of cave Dobšinská ľadová jaskyňa; 48°52′45″ N., 20°19′15″ E.; ca 850 m; limestone and dolomite; very copiously on a pronouncedly secondary habitat; coll. J. Měsíček 18. 7. 1968 and pl. cult. 1968, 1969. — Hnilec.

**P 20:** C. Slovakia, distr. Poprad, banks of brook Vernárský potok ca 400 m S. of village Vernár; 48°55′55″ N., 20°15′45″ E.; 780 m; dolomite; sparsely, along with *C. carpatica* 4x (cf. P 131); coll. J. Měsíček 19. 7. 1968. — Vernár.

**P 21:** C. Slovakia, distr. Rožňava, Slovenské Rudohorie Mts., right bank of rivulet Hnilec at S. foot of Mt. Popová ca 2 km E. of railway station Vernár; 48°53′ N., 20°15′15″ E.; 870 m; dolomite and limestone; rather copiously; coll. J. Měsíček 19. 7. 1968. — Popová I.

**P 22:** M 91, C. Slovakia, distr. Poprad, Slovenské Rudohorie Mts., banks of a new road below the top of Mt. Popová; 48°53′45″ N., 20°15′ E.; ca 900 m; dolomite; very copiously on a pronouncedly secondary habitat; coll. J. Měsíček 19. 7. 1968 and pl. cult. 1968, 1969. — Popová II.

**P 23:** M 143, popul. a, b; C. Slovakia, distr. Liptovský Mikuláš, rocks on the right and left banks of river Čierný Váh NE. of village Svarín; 49°00′45″ N., 19°51′15″ E.; 680 m; mainly on dolomite rocks, secondarily even on limestone and slate rocks; sparsely; coll. B. Slavík 17. 8. 1967, J. Měsíček and J. Holub 19. 7. 1968 and pl. cult. 1967, 1968. — Svarín.

**P 28:** N. Slovakia, distr. Liptovský Mikuláš, Chočské pohorie Mts., rocks and stony sites on SW. slope of Mt. Šíp N. of village Stankovany; 49°09′40″ N., 19°10′45″ E.; 800—950 m; dolomite or also limestone; copiously; coll. J. Holub and P. Tomšovic 2. 6. 1969. — Šíp.

**P 29:** M 90, N. Slovakia, distr. Martin, Malá Fatra Mts., foot of rocks along the highway between towns Žilina and Ružomberok at the branch-road to village Šútovo; 49°08′45″ N., 19°05′30″ E.; ca 470 m; dolomite; rather sparsely; coll. J. Měsíček 24. 7. 1967, 20. 7. 1968 et pl. cult. 1967 — 1969. — Šútovo.

**P 30:** C. Slovakia, distr. Martin, Velká Fatra Mts., summit rocks of Mt. Ostrý vrch or nacked places on S. slopes below the top; 48°55′15″ N., 18°58′ E.; 1200—1264 m; magnesian limestone; dispersed occurrence; coll. J. Měsíček 23. 7. 1968. — Ostrý vrch I.

**P 31:** C. Slovakia, distr. Martin, Velká Fatra Mts., N. and NW. slopes of Mt. Ostrý vrch; 48°55′20″ N., 18°58′ E.; 1200—1250 m; magnesian limestone; rather copiously; coll. J. Měsíček 23. 7. 1968. — Ostrý vrch II.

**P 32:** M 86, C. Slovakia, distr. Martin, Velká Fatra Mts., N. and NE. slopes of Mt. Ostrý vrch; 48°55′30″ N., 18°58′ E.; 800—1000 m; dolomite or limestone; rather copiously; coll. J. Měsíček 23. 7. 1968 and pl. cult. 1968, 1969. — Ostrý vrch III.

**P 34:** M 85, popul. a—d; C. Slovakia, distr. Martin, Velká Fatra Mts., Blatnická dolina valley E. of village Blatnica, gravel deposits of rivulet Blatnický potok and rocks along the road; 48°56′ N., 18°56′10″ E. — 48°54′30″ N., 18°58′ E.; 550—600 m; limestone and dolomite; very copiously; coll. J. Měsíček and J. Holub 23. 7. 1968 and pl. cult. 1968, 1969. — Blatnická dolina.

**P 35:** popul. a—e; C. Slovakia, distr. Martin, Velká Fatra Mts., rocks along the foot of slopes in Konská dolina valley E. of village Blatnica; 48°56′10″ N., 18°56′30″ E. — 48°55′30″ N., 18°57′ E.; 520—780 m; limestone and dolomite; very copiously; coll. J. Měsíček 23. 7. 1968. — Konská dolina.

**P 36:** C. Slovakia, distr. Martin, Velká Fatra Mts., along the road in W. end of Gäderská dolina valley E. of village Blatnica; 48°56′30″ N., 18°56′15″ E.; cca 530 m; limestone and dolomite; in this locality sparsely; coll. J. Měsíček 23. 7. 1968. — Gäderská dolina.

**P 37:** M 87, NW. Slovakia, distr. Žilina, Velká Fatra Mts., hillsides below castle ruin Strečno in the vicinity of village Strečno; 49°10′30″ N., 18°51′50″ E.; 360—440 m; dolomite; very copiously; coll. J. Měsíček 20. 7. 1968 and pl. cult. 1968, 1969. — Strečno I.

**P 38:** NW. Slovakia, distr. Žilina, Velká Fatra Mts., the valley between castle ruin Strečno and elevation point 632 m (S. from village Strečno); 49°10′30″ N., 18°51′45″ E.; 350 m; dolomite; very copiously; coll. J. Měsíček 20. 7. 1968. — Strečno II.

**P 39:** M 155, C. Slovakia, distr. Prievidza, Vtáčnik Mts., SW. slope of hill Krivá skála in the vicinity of village Podhradie (near parish Zemianské Kostolany); 48°41′30″ N., 18°38′30″ E.; ca 630 m; andesites; coll. M. Kovanda 1968 and pl. cult. 1968, 1969. — Vtáčnik.

tetraploid cytotype

**P 40:** E. Slovakia, distr. Michalovce, Vihorlat Mts., Mt. Sninský kameň, N. slope immediately below the top; 48°55′50″ N., 22°11′30″ E.; ca 980 m; andesites; very dispersed occurrence; coll. V. Javůrková 8. 7. 1969. — Sninský kameň.

**P 47:** M 73, N. Slovakia, distr. Poprad, Belanské Tatry Mts., along a trail below rocky ridge Dlouhá stěna Javorinky (immediately below the forest zone); 49°16′ N., 20°12′ E.; 1300 — 1350 m; limestone; small population on a eradicated stump, along with *C. carpatica* 2x (cf. P 5); coll. V. Javůrková 9. 8. 1965 and pl. cult. 1966—1969. — Javorinka II.

**P 49:** N. Slovakia, distr. Dolný Kubín, Liptovské hole Mts., a mountain ridge between ridge Bielá skála and Mt. Sivý vrch; 49°12′50″ N., 19°38′40″ E.; 1500 m; dolomite and limestone; coll. J. Holub 12. 8. 1969. — Sivý vrch.

**P 50:** M 114, N. Slovakia, distr. Liptovský Mikuláš, Nízke Tatry Mts., SW. slope of Mt. Krakova hoľa; 48°59′ N., 19°38′ E.; 1650—1700 m; dolomite; copiously; coll. J. Holub 19. 7. 1967. — Krakova hoľa.

**P 54:** N. Slovakia, distr. Liptovský Mikuláš, Chočské pohorie Mts., the N. end of Kvačanská dolina valley (S. of village Huty), along banks of rivulet Hutianka and on rocks above them; 49°12′ N., 19°33′ E.; ca 650 m; limestone; rather copiously; coll. J. Měsíček 20. 7. 1967. — Kvačanská dolina.

**P 55:** popul. a—c; N. Slovakia, distr. Lipt. Mikuláš, Chočské pohorie Mts., Prosiecká dolina valley N. of village Prosiek; 49°10′—49°10′45″ N., 19°29′30″ E.; ca 780 m; limestone and dolomite, in the S. end of the valley even slates and sandstones; very copiously; coll. J. Měsíček 1961, 20. 7. 1967 and pl. cult. 1965. — Prosiecká dolina.

**P 56:** N. Slovakia, distr. Dolný Kubín, deposits of river Orava N. of village Podbiel; 49°18′45″ N., 19°29′15″ E.; ca 530 m; primary substrate: limestone, sandstone; coll. K. Kopecký 29. 7. 1967. — Orava/Podbiel.

**P 57:** N. Slovakia, distr. Lipt. Mikuláš, Chočské pohorie Mts., the top of Mt. Lomno; 49°10′30″ N., 19°28′30″ E.; 1277 m; dolomite and limestone; rather copiously; coll. J. Měsíček 20. 7. 1967. — Lomno.

**P 58:** N. Slovakia, distr. Lipt. Mikuláš, Chočské pohorie Mts., dolina Sv. Anna valley N. of village Liptovská Anna; 49°09′30″ N., 19°28′ E.; ca 750 m; limestone and dolomite; rather copiously; coll. J. Měsíček 20. 7. 1967. — dolina Sv. Anna.

**P 59:** N. Slovakia, distr. Dolný Kubín, deposits of river Orava not far from parish Ďľhá n. Oravou; 49°16′10″ N., 19°27′45″ E.; 525 m; coll. K. Kopecký 18. 7. 1967. — Ďľhá/Oravou.

**P 61:** N. Slovakia, distr. Lipt. Mikuláš, along brook Turík not far from village Turík (E. of town Ružomberok); 49°07′ N., 19°22′45″ E.; ca 740 m; dolomite and limestone; coll. B. Slavík 22. 8. 1966. — Turík.

**P 62:** M 26, popul. a—c; N. Slovakia, distr. Lipt. Mikuláš, Chočské pohorie Mts., beech forests and screes on SE. slope of Mt. Velký Choč; 49°09′ N., 19°21′ E.; 1150—1250 m; limestone; copiously; coll. I. Kláštersky and J. Měsíček 13. 7. 1958, J. Měsíček 17. 8. 1961 and pl. cult. 1965—1969. — Velký Choč I.

**P 63:** M 26, popul. a—b; N. Slovakia, distr. Lipt. Mikuláš, Chočské pohorie Mts., a scree on SE. slope of Mt. Velký Choč (at the upper limit of the forest zone); 49°09′ N., 19°21′ E.; 1250 — 1300 m; limestone and dolomite; very copiously; coll. J. Měsíček 18. 7. 1967 and pl. cult. 1967—1969. — Velký Choč II.

**P 64:** N. Slovakia, distr. Lipt. Mikuláš, Chočské pohorie Mts., Mt. Malý Choč (1368 m); 49°08′45″ N., 19°21′ E.; ca 1360 m; limestone; copiously; coll. J. Holub 18. 7. 1967. — Malý Choč.

**P 65:** popul. a—c; N. Slovakia, distr. Lipt. Mikuláš, Chočské pohorie Mts., the summit of Mt. Velký Choč; 49°09′ N., 19°20′45″ E.; 1500—1600 m; dolomite and limestone; copiously; coll. J. Měsíček 18. 7. 1967. — Velký Choč III.

**P 66:** W. Slovakia, distr. Považská Bystrica, Strážovská hornatina Mts., at the foot of Mt. Vápeč E. of village **Hor.** Poruba; 48°56′15″ N., 18°19′30″ E.; ca 600 m; magnesian limestone; copiously; coll. J. Měsíček and J. Holub 17. 7. 1967. — Vápeč.

3. *Cardaminopsis petrogena* (Kern.) Měsíček

diploid cytotype

**P 67:** M 160, popul. a—b; S. Slovakia, distr. Rožňava, Slovenské Rudohorie Mts., S. part of Muráňská vysočina Mts., Hrdzava (Erzava) valley WN. by W. of market-town Muráň, along road; a: in the near end of the valley; 48°44′45″ N., 20°01′45″ E.; ca 400 m; b: in the upper part of the valley; 48°45′15″ N., 20° E.; ca 630 m; limestone and dolomite, in the near end of the valley also slates; copiously; coll. J. Měsíček 17. 7. 1968 and pl. cult. 1968, 1969. — Hrdzava.

**P 68:** M 159, popul. a—b; S. Slovakia, distr. Rožňava, Slovenské Rudohorie Mts., S. part of Muráňská vysočina Mts., in lower third of SE. slopes of Mt. Šarkanica (NE. of town Tisovec); a: lapiés communities, b: beech forest; 48°43′ N., 19°59′30″ E.; 650—700 m; magnesian limestone; dispersed occurrence; coll. J. Měsíček 17. 7. 1968 and pl. cult. 1968, 1969. — Šarkanica.

**P 71:** S. Slovakia, distr. Nové Zámky, the hills Kováčovské kopce NE. of town Štúrovo, border of a forest; 47°50′ N., 18°47′ E.; ca 130 m; andesites; coll. A. Chrtková 8. 5. 1969. — Štúrovo.

tetraploid cytotype

**P 72:** S. Slovakia, distr. Košice, Slovenské Rudohorie Mts., Juhoslovenský kras (= Slovakian karst), at the foot of slopes in Hájská dolina valley between villages Hačava and Háj; 48°38′15″ to 48°39′30″ N., 20°51′ E.; 350—450 m; limestone, also with dolomite enclosures; rather copiously; coll. J. Měsíček and J. Holub 16.7.1968. — Hájská dolina.

**P 73:** M 158, S. Slovakia, distr. Košice, Slovenské Rudohorie Mts., Juhoslovenský kras, slopes in the near end of Zadielská rokle valley, N. of village Zadiel; 48°37′ N., 20°50′15″ E.; ca 300 m; limestone; rather copiously; coll. J. Měsíček 16. 7. 1968 and pl. cult. 1968, 1969. — Zadielská dolina I.

**P 75:** S. Slovakia, distr. Košice, Slovenské Rudohorie Mts., Juhoslovenský kras, Zadielská dolina valley, along a path in a beech forest on E. side (way out: from chalet in the valley to Turňanská planina plateau); 48°38′30″ N., 20°49′45″ E.; 550 m; limestone; coll. J. Měsíček 16. 7. 1968. — Zadielská dolina II.

**P 80:** NW. Slovakia, distr. Žilina, the foot of rocks on the left bank of river Rajčianka NE. of spa Rajecké Teplice; 49°08′ N., 18°41′45″ E.; ca 390 m; limestone and dolomite; coll. J. Holub and P. Tomšovic 5. 6. 1969. — Rajecké Teplice.

**P 82:** NW. Slovakia, distr. Považská Bystrica, Strážovská hornatina Mts., rocky sites in the valley of brook Bílý potok at the E. foot of Mt. Sokolie (S. of village Predhorie); 48°59′ N., 18°29′ E.; ca 510 m; limestone; coll. J. Holub and P. Tomšovic 4. 6. 1969. — Predhorie.

**P 83:** M 137, popul. a—c; W. Slovakia, distr. Považská Bystrica, Strážovská hornatina Mts., Mt. Strážov 1214 m; a: along a trail on W. slope, ca 900 m; b: rocky headland on NW. slope ca 100 m below the summit; c: the summit; 48°57′30″ N., 18°28′ E.; limestone; rather sporadically; coll. J. Měsíček and J. Holub 24. 7. 1968 and pl. cult. 1968, 1969. — Strážov.

**P 84:** NW. Slovakia, distr. Považská Bystrica, Strážovská hornatina Mts., S. slope of hill Trudovač NW. of village Pružina; 49°02′ N., 18°28′ E.; 400—450 m; dolomite; coll. J. Holub 4. 6. 1969. — Trudovač.

**P 85:** NW. Slovakia, distr. Považská Bystrica, Bílé Karpaty Mts., limestone rocks Vršatec in the vicinity of village Vršatské Podhradie; 49°04′ N., 18°09′15″ E.; 690—710 m; limestone; coll. J. Holub and P. Tomšovic 31. 5. 1969. — Vršatec.

**P 88:** W. Slovakia, distr. Topoľčany, Strážovská hornatina Mts., grassy hillsides NW. of village Závada at the SE. foot of hill Vinište (528 m); 48°38′30″ N., 18°03′45″ E.; 330—350 m; dolomite; coll. J. Holub and P. Tomšovic 28. 5. 1969. — Závada.

**P 89:** M 110, W. Slovakia, distr. Topoľčany, Strážovská hornatina Mts., grassy hillsides below castle ruin Topoľčanský hrad in the vicinity of village Podhradie (NW. of town Topoľčany); 48°39′30″ N., 18°03′ E.; ca 500 m; limestone; very copiously; coll. J. Měsíček 16. 7. 1967 and pl. cult. 1967—1969. — Topoľčanský hrad.

**P 90:** M 129, W. Slovakia, distr. Trenčín, W. hillside below castle Trenčínský hrad; 48°53′45″ N., 18°02′30″ E.; ca 250 m; dolomite; rather copiously; coll. J. Měsíček 17. 7. 1967 and pl. cult. 1967, 1968. — Trenčín.

**P 91:** M 121, popul. a—b; W. Slovakia, distr. Trenčín, N. part of mountain ridge Považský Inovec; a: border of a beech forest at the W. foot (not far from village Selec), ca 450 m; b: rock Jánošíkova skála on W. slope, ca 650 m; 48°46′45″ N., 18°00′15″ E.; schists, mica-schists and gneiss; copiously; coll. J. Měsíček and J. Holub 22. 7. 1968 and pl. cult. 1968, 1969. — Považský Inovec.

**P 92:** M 117, W. Slovakia, distr. Trenčín, Tematínské kopce hill country, in a beech forest on NW. hillside below castle ruin Tematínský hrad (NE. of village Modrová near spa Piešťany); 48°40′45″ N., 17°55′45″ E.; 520 m; dolomite; rarely; coll. J. Měsíček 16. 7. 1967 and pl. cult. 1967—1969. — Tematínské kopce.

**P 94:** M 79, W. Slovakia, distr. Trenčín, Čachtické kopce hill country, grassy hillsides below castle ruin Čachtický hrad not far from village Višňové SW. of town Nové Mesto n/Váhom; 48°43′30″ N., 17°45′45″ E.; ca 350 m; dolomite; copiously; coll. J. Měsíček 28. 5. 1964 and pl. cult. 1965—1969. — Čachtické kopce.

**P 95:** W. Slovakia, distr. Senica, Malé Karpaty Mts., along a path in the valley of a brook W. from elevation point 424 m (E. of town Brezová p/Bradlom); 48°39′30″ N., 17°33′30″ E.; ca 330 m; dolomite; coll. J. Holub and P. Tomšovic 30. 5. 1969. — Brezová p. Bradlom.

**P 96:** SW. Slovakia, distr. Senica, Malé Karpaty Mts., in the saddle between hills M. Vápenná and V. Vápenná E. of village Sološnica; 48°28′30″ N., 17°16′ E.; 600—700 m; limestone; coll. Holub and P. Tomšovic 27. 5. 1969. — Sološnica.

**P 97:** M 116, popul. a—b; SW. Slovakia, distr. Bratislava, Malé Karpaty Mts., the hill Vysoká, top rockeries (a) and beech forests below them (b); 48°25′ N., 17°13′ E.; 670—750 m; limestone; very copiously; coll. J. Měsíček 24. and 25. 7. 1967 and pl. cult. 1967—1969. — Vysoká.

4. *Cardaminopsis arenosa* (L.) Hayek

**P 101:** N. Bohemia, distr. Jičín, town Stará Paka, railway station; 50°31′ N., 15°29′30″ E.; 420 m; coll. V. Jehlík 1. 9. 1967. — Stará Paka.

**P 102:** M 24, C. Bohemia, distr. Benešov, hillsides above brook Sedlický potok not far from town Dolní Kralovice; 49°42′10″ N., 15°06′ E.; 330 m; serpentine; copiously; coll. M. Deyl 1956 and pl. cult. 1964—1968. — Dolní Kralovice.

**P 103:** C. Bohemia, distr. Benešov, hillsides along the road between town Týnec n/Láb. and village Zbořený Kostelec (the right edge of river Sázava); 49°51′ N., 14°35′20″ E.; ca 280 m; amphibole-biotite granodiorite; very sparsely; coll. J. Měsíček 11. 8. 1968. — Zbořený Kostelec.

**P 104:** C. Bohemia, distr. Praha, hillsides along the left edge of river Sázava at village Hostěradice (settlement Rakousy) S. of town Jílové near Praha; 49°52′ N., 14°28′40″ E.; ca 280 m; metabasites and amphibole-biotite granodiorite; very copiously; coll. J. Měsíček 2. 5. 1968. — Hostěradice.

**P 106:** M 11, C. Bohemia, distr. Praha, market-town Libčice n/Vlt., rockeries along the right edge of river Vltava; 50°12′ N., 14°22′30″ E.; 260 m; phyllitic schists; very copiously; coll. J. Měsíček 4. 5. and 12. 6. 1964 and pl. cult. 1965—1969. — Libčice n/Vlt.

**P 108:** M 149, S. Bohemia, distr. Čes. Krumlov, a scree above a quarry NW. of village Vyšný; 48°50′30″ N.,14°17′45″ E.; ca 650 m; crystalline limestone; copiously; leg. S. Kučera 11. 5. 1968 and pl. cult. 1968, 1969. — Čes. Krumlov.

**P 110:** C. Bohemia, distr. Beroun, at the W. foot of the hill Velká hora WN. by W. of village Srbsko; 49°57′ N., 14°09′35″ E.; ca 300 m; limestone; sporadically; coll. J. Měsíček 19. 6. 1964. — Srbsko.

**P 111:** M 19, S. Bohemia, distr. Písek, the right edge of river Otava ca 3 km N. of town Písek, along path Sedláčkova stezka; 49°19′45″ N., 14°09′30″ E.; ca 380 m; biotite granodiorite with amphibole; copiously; coll. J. Měsíček 1. 7. 1958 and pl. cult. 1964, 1965. — Písek.

**P 112:** C. Bohemia, distr. Beroun, on top of rock Skála in the vicinity of village Sv. Jan p. Skalou; 49°58′15″ N., 14°08′15″ E.; ca 430 m; limestone; copiously; coll. J. Měsíček 2. 5. 1969. — Jan p. Skalou.

**P 113:** M 48, C. Bohemia, distr. Kladno, town Unhošť, hillsides in the valley of brook Černý potok (left side) in the vicinity of the mill Markův mlýn; 50°03′30″ N., 14°06′45″ E.; 340 m; phyllitic schists, tuffs and tuffites; rather copiously; coll. J. Měsíček 28. 4., 15. 6., 19. 6. 1964, 1965, 1966 and pl. cult. 1964—1969. — Unhošť.

**P 115:** M 164, Botanical garden of the University Göttingen; seed list 1968; plants cultivated 1969. — Göttingen.

**P 116:** M 136, Botanical Garden of the University Frankfurt am Main; seed list 1968, No. 788; pl. cult. 1968, 1969. — Frankfurt/Main.

**P 117:** M 52, Botanical garden, Genève; seed list 1967, No. 145; pl. cult. 1968. — Genève.

5. The products of introgressive hybridisation

*C. carpatica* (4x) with introgression of *C. neglecta* (Schult.) Hayek

**P 120:** N. Slovakia, distr. Liptovský Mikuláš, on banks of brook Smrečianka NE. of village Žiar; 49°08′15″ N., 19°41′15″ E.; ca 780 m; C.-Carpathian flysh; coll. B. Slavík 17. 8. 1967. — Žiar.

**P 121:** M 144, N. Slovakia, distr. Lipt. Mikuláš, Nízké Tatry Mts., at the end part of Svatojanská dolina valley (N. of village Lipt. Ján), the bed of rivulet Bystrá; 48°58′30″ N., 19°40′ E.; ca 1000 m; diorite and granodiorite; dispersed occurrence; coll. J. Měsíček and J. Holub 22. 7. 1967 and pl. cult. 1968, 1969. — Bystrá.

**P 122:** N. Slovakia, distr. Dolný Kubín, deposits of rivulet Studený potok near village Zuberec; 49°15′50″ N., 19°37′45″ E.; 730 m; C.-Carpathian flysh; coll. K. Kopecký 7. 1967. — Zuberec.

**P 124:** N. Slovakia, distr. Dolný Kubín, deposits at the confluence of rivulet Studený potok and river Orava; 49°18′ N., 19°30′ E.; 550 m; sandstone and limestone; coll. K. Kopecký 27. 8. 1966. — Studený potok.

*C. carpatica* (4x) with introgression of *C. petrogena* (4x)

**P 126:** N. Slovakia, distr. Žilina, Malá Fatra Mts., deposits of torrent Stohový potok in Vrátná dolina valley S. of village Terchová; 49°14′45″ N., 19°02′45″ E.; 560 m; limestone and dolomite; very copiously; coll. J. Měsíček 25. 7. 1968. — Vrátná dolina.

**P 127:** M 140, N. Slovakia, distr. Martin, Malá Fatra Mts., along a path from the upper rope-way station Chleb to chalet chata p. Chlebom and in alpine communities in the saddle between Mt. Chleb and Mt. Velký Kriváň; 49°11′30″ N., 19°02′45″ E.; 1550—1600 m; limestone; very copiously; coll. J. Měsíček 25. 7. 1968 and pl. cult. 1969. — Chleb.

**P 128:** N. Slovakia, distr. Žilina, Malá Fatra Mts., along a trail on the top of Mt. Sokolie; 49°14′15″ N., 19°01′10″ E.; ca 1100 m; dolomite and limestone; dispersed occurrence; coll. V. Javůrková 6. 1969. — Sokolie.

**P 129:** N. Slovakia, distr. Žilina, Malá Fatra Mts., the top of Mt. Žitné; 49°13′10″ N., 19°01′ E.; 1176 m; limestone; dispersed occurrence; coll. V. Javůrková 6. 1969. — Žitné.

**P 130:** M 123, NW. Slovakia, distr. Žilina, at the foot of rocks Súlovské skály N. of village Súlov, along a road between villages Predmier and Súlov; 49°10′30″ N., 18°34′45″ E.; 360 m; calcareous sandstone and marlslate; rarely; coll. J. Měsíček 21. and 25. 7. 1968 and pl. cult. 1968, 1969. — Súlov.

*C. carpatica* (4x) with introgression of *C. carpatica* (2x) or *C. petrogena*

**P 131:** M 161, C. Slovakia, distr. Poprad, banks of brook Vernárský potok ca 400 m S. of village Vernár; 48°55′55″ N., 20°15′45″ E.; 780 m; dolomite; sparsely, along with *C. carpatica* 2x (cf. P 20); coll. J. Měsíček 19. 7. 1968 and pl. cult. 1969. — Vernár.

*C. petrogena* (4x) with introgression of *C. carpatica* (4x)

**P 132:** M 122, W. Slovakia, distr. Považská Bystrica, loose scree debris and sands along and above a road in Manínská soutěska defile (E. of village Považská Teplá); 49°08′30″ N.; 18°30′ — 30′45″ E.; 400—600 m; limestone; rather copiously; coll. J. Belicová 4. 6. 1968, J. Měsíček 25. 7. 1968 and pl. cult. 1969. — Manín.

## B. The preliminarily or approximately classified populations

1. The *C. nitida*-group

**P 133:** M 166, popul. a—b; Austria, Styria, S. part of Totes Gebirge Mts., plateau Tauplitzalm not far from parish Tauplitz; a: the SW. border of plateau, along a road, 46°36′ N., 13°58′ E., 1600 m; b: the S. foot of Mt. Traweng, 46°37′ N., 14°01′ E.; 1750 m; limestone; coll. J. Soják 6. 1969. — Totes Gebirge.

2. The *C. carpatica*-group

**P 134:** M 23, M 157, Moravia, distr. Blansko, Moravský kras (Moravian karst), Suchý žleb valley not far from chasm Macocha W. of village Vilémovice near Blansko; 49°22′10″ N., 16°44′15″ E.; ca 480 m; limestone; copiously; coll. I. Klášterský and J. Měsíček 2. 7. 1958 and pl. cult. 1964, 1965; V. Javůrková 10. 7. 1968 and pl. cult. 1969. — Suchý žleb.

**P 135:** N. Bohemia, distr. Děčín, parish Fukov, on slaggy bank at the railway bridge; 51°02′30″ N., 14°30′15″ E.; 310 m; coll. V. Jehlík 16. 8. 1964. — Fukov.

**P 136:** M 163, Roumania, S. Carpathians, Piatra Craiului Mts. (2239 m) in the Fogărăsului Mts.; 45°18′ N., 25°15′ E.; coll. F. Lörinczi and V. Bot; — Botanical garden, Cluy; seed list 1968 — 1969, No. 2065. — Mtle Fogărăsului.

Table 1
Results of cytogeographical analysis of *C. arenosa* complex

| No. of locality | Topographical reference | Altitude in m | n | 2n | Fig. | Number of individ. studied | Note |
|---|---|---|---|---|---|---|---|
| A. The definively classified populations | | | | | | | |
| *C. nitida* nom. provis. | | | | | | | |
| P 1 | Slovenská Ves | 630 | | 16, 24—28 | | 1 | progeny of 1 plant |
| P 2 | „Hviezdoň" | 1300—1400 | | 16 | | 2 | |
| P 4 | Javorinka I. | 1400—1460 | $8_{II}$ | 16, 16+4B | Fig. 3—4; Pl. XV : a—c | 50 | 1 inbred ind. |
| P 5 | Javorinka II. | 1300—1350 | | 16 | | 1 | |
| P 7 | Podspády | 900 | 8 | 16, 16+0—1B,24 | | 12 | progeny of 1 plant |
| P 8 | Štrky | 1450 | | 16 | | 2 | |
| P 9 | Tichý potok | 1100 | | 16 | | 2 | |
| P 10 | Tichá dolina | 1050—1150 | | 16 | | 26 | |
| P 11 | Małołaczniak | 1850—1900 | | 16 | | 4 | |
| P 12 | Oravice | 800 | $8_{II}$ | | | 1 | |
| P 13 | Osobitá | 1600—1650 | | 16 | | 1 | |
| P 14 | Białka | 600 | | 16, 16+0—4B | | 2 | progeny of 1 plant |
| *C. carpatica* nom. provis. diploid cytotype | | | | | | | |
| P 18 | Stratená | 850 | | 16 | | 4 | |
| P 19 | Hnilec | 850 | | 16 | | 53 | |
| P 20 | Vernár | 780 | | 16 | | 1 | |
| P 21 | Popová I. | 870 | | 16 | | 4 | |
| P 22 | Popová II. | 900 | | 16 | | 14 | |
| P 23 | Svarín | 680 | | 16 | | 20 | |
| P 28 | Šíp | 800— 950 | | 16 | | 1 | |
| P 29 | Šútovo | 470 | | 16 | | 4 | |
| P 30 | Ostrý vrch I. | 1200—1264 | | 16 | | 6 | |
| P 31 | Ostrý vrch II. | 1200—1250 | | 16 | | 10 | |
| P 32 | Ostrý vrch III. | 800—1000 | | 16 | | 14 | |
| P 34 | Blatnická dolina | 550— 600 | | 16 | | 27 | |
| P 35 | Konská dolina | 520— 780 | | 16 | | 11 | |
| P 36 | Gäderská dolina | 530 | | 16 | | 5 | |
| P 37 | Strečno I. | 360— 440 | | 16 | Pl. XV : d | 5 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| P 38 | Strečno II. | 350 | | 16, 18 | | 9 | 1 individual |
| P 39 | Vtáčník | 630 | | 16 | | 1 | |
| | tetraploid cytotype | | | | | | |
| P 40 | Sninský kameň | 980 | $16_{II}$ | | | 3 | |
| P 47 | Javorinka II. | 1300—1350 | 16 | 32 | | 4 | |
| P 49 | Sivý vrch | 1500 | | 32 | | 1 | |
| P 50 | Krakova hoľa | 1650—1700 | | 32 | | 2 | |
| P 54 | Kvačanská dolina | 650 | | 32 | | 10 | |
| P 55 | Prosiecká dolina | 780 | | 32 | | 12 | |
| P 56 | Orava/Podbiel | 530 | | 32 | | 1 | |
| P 57 | Lomno | 1277 | | 32 | | 5 | |
| P 58 | dolina Sv. Anna | 750 | | 32 | | 3 | |
| P 59 | Dĺhá/Oravou | 525 | | 32 | | 1 | |
| P 61 | Turík | 740 | | <32, 32 | | 1 | progeny of 1 plant |
| P 62 | Velký Choč I. | 1150—1250 | 8, 14—16, 16 | ca 32, 32, 34 | Fig. 5, Fig. 1—2; Pl. XV : e—g | 30 | 1 experimental pl. |
| P 63 | Velký Choč II. | 1250—1300 | | 32 | | 8 | |
| P 64 | Malý Choč | 1370 | | 32 | | 5 | |
| P 65 | Velký Choč III. | 1500—1600 | | 32 | | 4 | |
| P 66 | Vápeč | 600 | | 32 | | 4 | |
| *C. petrogena* (KERN.) MĚSÍČEK | | | | | | | |
| | diploid cytotype | | | | | | |
| P $67^{a}_{b}$ | Hrdzava dolina | 400<br>630 | | 16<br>16 | | 7 | |
| P 68 | Šarkanica | 650— 700 | | 16 | | 5 | |
| P 71 | Štúrovo | 130 | | 16 | | 1 | |
| | tetraploid cytotype | | | | | | |
| P 72 | Hájská dolina | 350— 450 | | 28—30, 32<br>32, 39—40 | | 3 | progeny of 1 plant<br>progeny of 1 plant |
| P 73 | Zadielská dolina I. | 300 | | 32 | | 1 | |
| P 75 | Zadielská dolina II. | 600 | | 32 | | 4 | |
| P 80 | Rajecké Teplice | 390 | | 32 | | 1 | |
| P 82 | Predhorie | 510 | | 31, 32 | | 4 | |
| P 83 | Strážov | 1214 | | 32 | | 13 | |
| P 84 | Trudovač | 400— 500 | | 32 | | 1 | |
| P 85 | Vršatec | 690— 710 | | 32 | | 1 | |

| No. of locality | Topographical reference | Altitude in m | n | 2n | Fig. | Number of individ. studied | Note |
|---|---|---|---|---|---|---|---|
| P 88 | Závada | 330— 350 | | 32 | | 3 | |
| P 89 | Topoľčanský hrad | 500 | | 32 | | 9 | |
| P 90 | Trenčín | 250 | | 32 | | 7 | |
| P 91 $^{a}_{b}$ | Považský Inovec | 450 | | 32 | | 1 | |
| | | 650 | 14—16 | | | 1 | |
| P 92 | Tematínské kopce | 520 | | 32 | | 3 | |
| P 94 | Čachtické kopce | 350 | $16_{II}$ | 32 | Pl. XV : j | 13 | |
| P 95 | Brezová p. Bradlom | 330 | | 32 | | 2 | |
| P 96 | Sološnica | 600— 700 | | 32 | | 1 | |
| P 97 | Vysoká | 670— 750 | | 32 | | 23 | |
| *C. arenosa* (L.) HAYEK | | | | | | | |
| P 101 | Stará Paka | 420 | | 32 | | 1 | |
| P 102 | Dolní Kralovice | 330 | | 32 | | 3 | |
| P 103 | Zbořený Kostelec | 280 | $16_{II}$ | | | 2 | |
| P 104 | Hostěradice | 280 | 16 | 32 | | 2 | |
| P 106 | Libčice n/Vlt. | 260 | 16, 17 | (24)*, 32 | | 35 | |
| P 108 | Český Krumlov | 650 | $16_{II}$, $17_{II}$, $14_{II} + 1_{IV}$ | | Fig. 6: Pl. XV : p—r | 3 | |
| P 110 | Srbsko | 300 | | 32 | | 2 | |
| P 111 | Písek | 380 | | 32 | Pl. XV : o | 5 | |
| P 112 | Jan p. Skalou | 430 | $16_{II}$ | | | 2 | |
| P 113 | Unhošť | 340 | 16 | 32, 24?, 32 | Pl. XV : n | 21 | progeny of 1 plant |
| P 115 | Göttingen | | | 32 | | 2 | |
| P 116 | Frankfurt/Main | | | 32 | | 7 | |
| P 117 | Genève | | | 32 | | 5 | |
| | | | | (24, 31)*, 32 | | | experimental plants |
| The products of introgressive hybridisation | | | | | | | |
| *C. carpatica* (4x) with introgression of *C. neglecta* (SCHULT.) HAYEK | | | | | | | |
| P 120 | Žiar | 780 | | 32 | Pl. XV : m | 3 | |
| P 121 | Bystrá | 1000 | | 32 + 0—1B | | 9 | |
| | | | | verosim. 28, 32 | | | progeny of 1 plant |
| | | | | 16, ca 28,30, 32 | | | progeny of 1 plant |
| P 122 | Zuberec | 730 | | 30 | | 1 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| P 124 | Studený potok | 550 | | 32 | Pl. XV : l | 1 | |
| | *C. carpatica* (4x) with introgression of *C. petrogena* (4x) | | | | | | |
| P 126 | Vrátná dolina | 560 | | 32 | | 9 | |
| P 127 | Chleb | 1560—1600 | | 32 | | 20 | |
| P 128 | Sokolie | 1100 | 16 | 32 | | 1 | |
| P 129 | Žitné | 1176 | 16 | | | 1 | |
| P 130 | Súlov | 360 | | 32 | | 11 | |
| | *C. carpatica* (4x) with introgression of *C. carpatica* (2x) or *C. petrogena* | | | | | | |
| P 131 | Vernár | 780 | 16 | 19, <32, 32 | | 5 | progeny of 1 plant |
| | *C. petrogena* (4x) with introgression of *C. carpatica* (4x) | | | | | | |
| P 132 | Manín | 400— 600 | | 32 | | 17 | |
| B. The preliminarily or approximately classified populations | | | | | | | |
| The *C. nitida*-group | | | | | | | |
| P 133 | Totes Gebirge | 1600—1750 | 16 | | | 4 | |
| The *C. carpatica*-group | | | | | | | |
| P 134 | Suchý žleb | 480 | | 32 | Pl. XV : h | 6 | |
| P 135 | Fukov | 310 | | 32 | | 3 | |
| P 136 | Mtle Fogărăsului | | | 32 | | 2 | |
| The *C. petrogena*-group | | | | | | | |
| P 137 | Rokoš I. | 780—1010 | | 16 | | 24 | |
| P 138 | Rokoš II. | 450— 550 | | 16 | | 3 | |
| The *C. arenosa* "s. str."-group | | | | | | | |
| P 140 | Trutnov | 428 | | 32 | | 1 | |
| P 141 | Jindřichovice p. Smrkem | 380 | | 32 | | 1 | |
| P 142 | Liège | | | 32 | | 1 | |
| P 145 | Siljasnäs | | | 32 | Pl. XV : i | 9 | |
| P 146 | Molesmes | | | 32 | | 6 | |
| C. The not classified populations | | | | | | | |
| P 148 | Chochołowska dol. | 1000 | | ca 32 | | 1 | an *C. neglecta*? |
| P 150 | Kláštor p. Znievom | 560 | | 32 | | 1 | verosim. *C. petrogena* |
| P 151 | Stará Paka | 420 | | 32 | | 1 | |
| P 152 | Rumburk | 380 | | 32 | | 2 | highly sterile *C. carpatica* ? |
| P 153 | Uppsala | | | 32 | | 3 | |
| P 154 | Gent | | | 32 | | 3 | |

* The numbers given in parentheses were found only in offsprings of cultivated and open pollinated plants.

3. The *C. petrogena*-group

**P 137:** M 130, popul. a—b; W. Slovakia, distr. Prievidza, Strážovská hornatina Mts., Mt. Rokoš, rockeries along the ridge between the top of mountain and elevation point 784 m; 48°46′30″ N., 18°26′ E.; 780—1010 m; dolomite; copiously; coll. J. Měsíček and J. Holub 14. 7. 1967 and pl. cult. 1968, 1969. — Rokoš I.

**P 138:** W. Slovakia, distr. Prievidza, Strážovská hornatina Mts., beech forests on NW. slope of Mt. Rokoš; 48°46′45″ N., 18°24′30″ E.; 450—550 m; dolomite; copiously; coll. J. Měsíček 14. 7. 1967. — Rokoš II.

4. The *C. arenosa* "s. str."-group

**P 140:** NE. Bohemia, town Trutnov, railway station; 50°34′ N., 15°54′50″ E.; 428 m; coll. V. Jehlík 11. 6. 1967. — Trutnov.

**P 141:** N. Bohemia, distr. Jablonec n/Nisou, town Jindřichovice p. Smrkem, railway station; 50°57′45″ N., 15°20′ E.; 380 m; coll. V. Jehlík 7. 6. 1967. — Jindřichovice p. Smrkem.

**P 142:** M 62, Botanical garden of the University Liège; seed list 1964—1965; pl. cult. 1967—1969. — Liège.

**P 145:** M 78, M 135, C. Sweden, prov. Dalarna, Siljasnäs; 60°30′ N., 15° E.; Botanical garden (Hort. bot. Bergianus), Stockholm; seed lists 1967 (M 78) and 1968 (M 135); pl. cult. 1968, 1969. — Siljasnäs.

**P 146:** M 77, France, town Molesmes NW. of town Chatillon s. S.; 47°55′ N., 4°20′ E.; Botanical garden, Dijon; seed list 1965; pl. cult. 1966, 1967. — Molesmes.

C. The not classified populations

**P 148:** S. Poland, Tatra Mts., the valley Chochołowska dolina, gravel deposits along a torrent; 49°15′35″ N., 19°49′10″ E.; ca 1000 m; coll. K. Kopecký 17. 8. 1967. — Chochołowska dol.

**P 150:** N. Slovakia, distr. Martin, hills N. of Velká Stráňa hill SW. from village Kláštor pod Znievom; 48°58′ N., 18°47′55″ E.; 540—560 m; dolomite; coll. J. Holub and P. Tomšovic 1. 6. 1969. — Kláštor p. Znievom.

**P 151:** N. Bohemia, distr. Jičín, town Stará Paka, railway station; 50°31′ N., 15°29′30″ E.; 420 m; coll. V. Jehlík 18. 9. 1964. — Stará Paka.

**P 152:** N. Bohemia, distr. Děčín, town Rumburk, railway station; 50°57′30″ N., 14°33′ E.; 380 m; coll. V. Jehlík 13. 8. 1964. — Rumburk.

**P 153:** Botanical garden of the University Uppsala, Sweden; seed list 1968—1969, No 571, with the note: „e Mont. Carpaticis". — Uppsala.

**P 154:** M 145, Botanical garden of the University Ghent, Belgium; seed list 1967, No 131; pl. cult. 1968. — Gent.

## Results

The survey of chromosome numbers in *C. arenosa* agg. found by the present author in ca 730 individuals from 106 localities (= 134 populations) is given in table 1; the table is completed by list of localities and by some annotations.

## Discussion

The annotations to table 1

*C. nitida*

**P 1, P 7, P 12, P 17**: Downstream drifted plants.

**P 1, P 7**: The numbers 2n = 24 and 2n = 24—28 were found (in either case) only in a single seedling grown from a diploid wild mother plant: the hybrid origin of these seedlings (*C. nitida* × *C. carpatica* 4x) is apparently beyond any doubt. — In this connection I wish to emphasize that a triploid number — when occurring among orthoploid offspring (2x or 4x) of a wild plant — mostly indicates the direct hybrid nature (i.e. $F_1$ generation from a heteroploid combination) of such triploid individuals, but the mother individual

itself is usually not of a hybrid origin in this case. On the contrary, if aneuploid numbers (especially 2n >27 and <21) have been found more frequently in a orthoploid progeny of a wild plant, it may be assumed with high probability that the mother individual has arisen from a heteroploid cross.
**P 4, P 5**: These data were already published in a preliminary report (MĚSÍČEK 1967); the localities are given more precisely here.
**P 4**: The number 2n = 16+4B was found in a cultivated, highly sterile inbred plant ($I_1$); it was impossible to distinguish the supernumerary chromosomes by their size and form, so that the interpretation 2n = 20 cannot be excluded.

*C. carpatica*

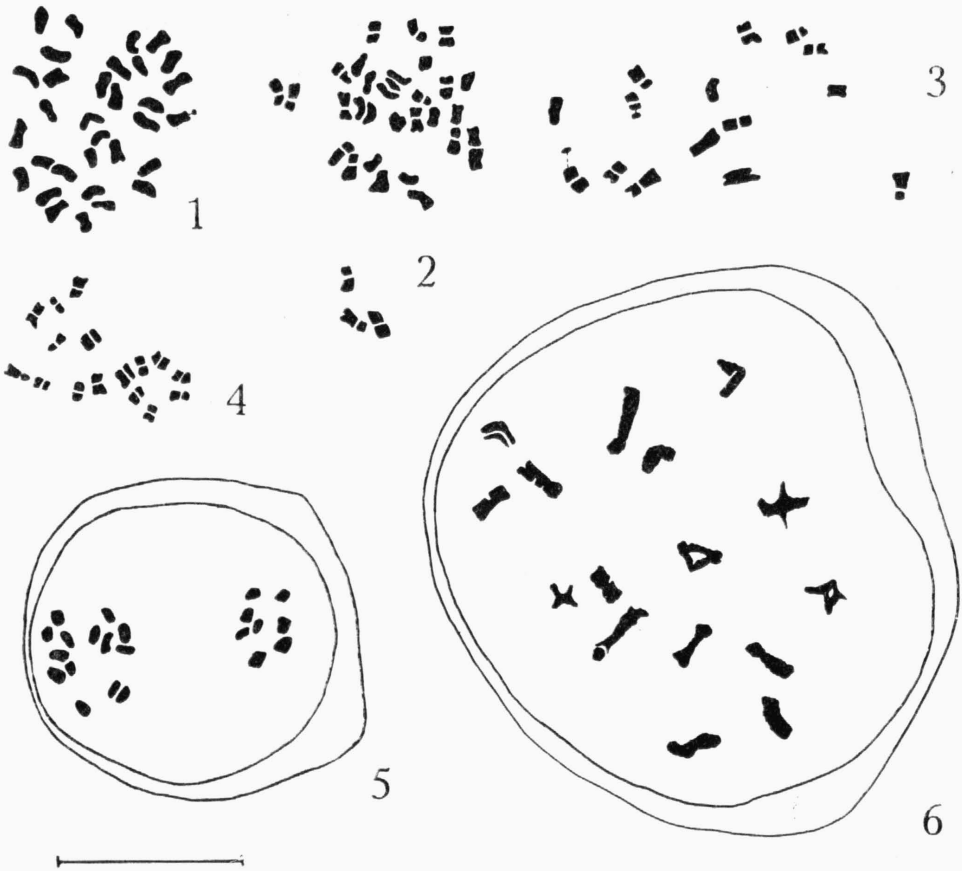
**P 38**: 2n = 18 has been determined as a normal somatic number of one plant resembling a triploid hybrid (a characteristically reduced FF*). The supernumerary chromosomes were not morphologically distinguished. This aneuploidy might also be the consequence of inbreeding.
**P 47:** see the annotation to P 4, P 5.
**P 61:** A downstream drifted plant; the number <32 was found in only one seedling. Owing to the close neighbourhood of populations of the diploid *C. carpatica*, hybridisation between both cytotypes is rather probable on this locality.
**P 62**: To the number n = 8: During the years 1966—1967 I crossed the diploid cytotype *Cardaminopsis neglecta* (SCHULT.) HAYEK (2n = 16) five times with the tetraploid taxa of the *C. arenosa* agg. (neglecta M 36♀ × *arenosa* (L.) HAYEK M 48 ♂ — 4 combinations, *neglecta* M 36 ♀ × *carpatica* M 26 ♂ — 1 crossing). In only one case — from the combination *neglecta* × *carpatica* — did I gain one well developed and really viable seed. In sterilized soil this seed gave rise to a plant which fully conformed — by its cytology (2n = 16), phenotype and fertility — to the $F_1$ hybrids *C. neglecta* (2x) × *C. nitida*.

The explanation of this surprising phenomenon was to be sought in the parents, and two theoretical alternatives came into consideration: a) the seed arose by apomixis: in this case the mother individual itself must have been of a hybrid nature; b) the male parent was in reality diploid. As the parents died out in the meantime, the mentioned alternatives were verified in their offspring acquired by self-fertilisation (*C. neglecta* — 2 plants $I_1$, *C. carpatica* — 6 plants $I_1$). Both *neglecta* individuals implied no indication of contingent hybrid nature (which is in accordance with the records about the mother individual). For the *C. carpatica* ♂, on the contrary, the tetraploid number was verified both directly (in the $I_1$ plants) and indirectly, in the $F_1$ of the reciprocal combination *carpatica* ♀ × *neglecta* ♂ (2n = 24). It is also necessary to add that this reciprocal $F_1$ (on the whole 12 plants) was very heterogeneous, as regards both habitus and fertility: besides matroclinous plants, intermediate phenotype also occurred, two plants even inclined to *C. neglecta*; the fertility of most plants was reduced to a high degree, one individual was quite sterile and another one fully fertile.

In the $I_1$ generation of the *carpatica* plants meiosis was examined simultaneously; special attention was paid to two individuals, the habitus of which

*) The reduced fertility in the genus *Cardaminopsis* (and in a number of other genera belonging to the family *Cruciferae*, too) manifests itself on the one hand by the decrease in the percentage of viable seeds, and on the other hand — beginning with a certain degree — by a change of the length of siliques. It is useful to distinguish these two degrees of fertility (or sterility) in experimental practice; for that reason I speak about the seed or fruit fertility and use the abbreviations SF and FF respectively.

was rather similar to *C. nitida*. One of these individuals was quite normal in the karyological respect (2n = 32, n = 16, reduction division mostly regular). An analogous situation was also found in four inflorescences of the other individual; the frequency of meiotic disturbances (laggards in anaphase I)




Figs. 1—6. — Somatic metaphases: 1: *C. carpatica* (P 62), 2n = 32; 2: *C. carpatica* (P 62), 2n = 34; 3—4: *C. nitida* (P 4), 2n = 16. — PMC's meioses: 5: *C. carpatica* (P 62), metaphase II, irregular distribution of the chromosomes; 6: *C. arenosa* "s. str." (P 108), pro-metaphase I, $16_{II}$. — Scale = 10 μm.

only was distinctly higher in this case. However, in one bud of another inflorescence of the same plant (a chimaera?) about 20 PMCs with a quite uncommon distribution of the chromosomes in the anaphase I (and metaphase II, respectively) were found, viz. 8 chromosomes at one pole, the others at the opposite one (Fig. 5). The chromosomes belonging to the larger group agglomerated to a certain degree, and therefore it was not possible to determine their number exactly; it was certainly not less than 12 and not more than 16 being most probably 14. In the other studied PMCs of the same bud one lagging chromosome often occurred in anaphase I, but the meiosis was otherwise regular (n = 14—16, 2n = ca 32). Thus, the abnormity described here was found in one bud and, without exception, only in the two mentioned

meiotic phases; for that reason I do not know the total course and the end of the homeotypic division in this case. The maturing pollen grains from another anther of the same bud — and the fully ripe microspores from the other buds of this inflorescence as well — were mostly normal, as regards their morphology and size. In a certain number of cases, however, there occurred also giant (2—3 times larger than the normal) or dwarfish (about half size), frequently bi-, tetra- and pentacolpate grains (Pl. XV : k). In analogous cases examined in various artificial hybrids or polyploids it has been confirmed that at least some of these irregular microspores are viable, their size being mostly proportional to the level of their ploidy. That is why I assume that the occurrence of the dwarfish microspores in this case may be connected with the anomalous meiosis described above.

Both the irregularities mentioned, viz. the origin of a diploid hybrid from the combination diploid × tetraploid as well as the supposed occurrence of gametes with n = 8 in an individual with 2n = 32, cannot be explained — if considered separately — quite unambiguously, first of all owing to the incompletness of observations which it was possible to carry out. Taken together — and this coincidence is surely very conspicuous — their argumentation value seems to be more evident. For that reason I do not regard as exaggeration to qualify the occurrence of the number n = 8 with a rather high probability as a case of an accidental "double reduction" of the chromosome number.

To the number 2n = 34: it cannot be interpreted unambiguously as 2n = 32+2B (Fig. 2, Pl. XV : g).

*C. petrogena*

**P 68:** The karyologically investigated plants from the population b (beech forest) are as much as 1 m in height.

**P 71:** The number 2n = 28—30 was found in three seedlings among the tetraploid progeny of one plant, the number 2n = 39—40 in one seedling among the tetraploid offspring of another individual*). The locality is situated in a region where hybridisation between *C. petrogena* (4x) and *C. halleri* (L.) HAYEK (2x) takes place; the specimens of hybrid individuals were found in PR. I regard the origin of the pentaploid number just in this way as highly probable — all the more that in the progeny of triploid hybrids the possibility of a viable fusion of the gamete with a reduced chromosome number of the tetraploid parent (here n = 16) and the gamete with a non-reduced triploid chromosome number (here n = 2n = 24) has actually been demonstrated experimentally. (The number 2n = 40 in $F_2$ from the cross *C. petraea* (L.) HIIT. 2n = 16 × *C. arenosa* (L.) HAYEK 2n = 32, $F_1$ 2n = 24; the number 2n = 37 in $F_2$ (or $B_1$) after open pollination from the cross *Arabidopsis thaliana* (L.) HEYNH. 2n = 10 × *C. arenosa* (L.) HAYEK 2n = 32, $F_1$ 2n = 21). — Of course, the pollination of the tetraploid *petrogena* cytotype by a non-reduced gamete of another individual or, maybe, the cross with a hexaploid cytotype (not found up to the present time) must be considered in this case, too.

**P 82:** The aneuploid number 2n = 31 was found in one plant; some cells with 2n = 30 also occurred in the meristems of this individual.

*) In this cases the mother individuals themselves may have been aneuploid or even triploid.

**P 106:** The number n = 17 (verosim. $16_{II}+1_{I}$) was found in an experimental plant with prevalent n = 16 and with rather frequent meiotic disturbances; in the seeds of another cultivated plant acquired after open pollination, the number 2n = 24 occurred (evidently a spontaneous hybrid).
**P 108:** The number n = $17_{II}$ was found in only one PMC.
**P 113:** The number 2n = 24? relates to only one seedling from the tetraploid progeny of a wild plant. The finding is not fully reliable. In this locality both *C. arenosa* (4x) and *C. petraea* (L.) HIITT. (2x) grow together. The possibility of their hybridisation has been proved experimentally.
**P 117:** The number 2n = 31 occurred once and the number 2n = 24 several times in the seeds of experimental plants after open pollination (spontaneous hybrids).

The products of hybridisation

**P 121:** Some plants from this locality are very problematic from the taxonomic point of view. Seven wild and two cultivated individuals were investigated karyologically; the progenies of the greater part of wild plants were cultivated simultaneously and examined by other methods. The individual with 2n = 32+0—1B is *C. carpatica* (4x) with an obvious introgression of *C. neglecta* (SCHULT.) HAYEK: its progeny has been segregated into parental categories, both FF and SF being almost normal (in some of these hybrid individuals a certain convergence to *C. nitida* has appeared). Three plants with 2n = 32 (in one of them a seed with 2n = 28 was found) bear only very slight indications of the potential influence of *C. neglecta*. The remaining three plants (two with 2n = 32 and one with 2n = 16, ca 30, 32 = numbers found in seedlings) represent from the morphological standpoint more or less the copies of some artificial triploid hybrids between *C. carpatica* (4x) and *C. neglecta* (2x); they differ from these hybrids by the chromosome numbers in the offspring (this fact is a logical consequence of the gametic selection, especially in back-crosses) and by considerably higher fertility. In the last mentioned individual numbers lower than 2n = 32 were found in more seedlings. The seeds of this plant germinated at a very low rate and a high lethality (ca 70%) was found during the first stages of the vegetative phase, too. The reproductive phase was attained only by the individuals with 2n = 32 and with an outstanding — partly strongly vigorous — *carpatica* phenotype; at the same time their fertility was graduated, from the full FF and SF across the reduced SF up to the high sterility. The number 2n = 16, of course, was found only once. In this case it may be supposed that the embryo developed from an unfertilized haploid gamete or even from another haploid cell of the embryo sac (the sporic apozygoty or apogamety, according to the terminology of CHOCHLOV 1967). This process is known in many plants (cf. KIMBER et RILEY 1963, CHOCHLOV 1967), within the family *Cruciferae* in the genera *Brassica*, *Matthiola* and *Sisymbrium*. Of course, owing to the hybrid nature of the mother plant it cannot be excluded that this individual also produced the gametes with n = 8 and that the chromosome number 2n = 16 arose as a result of the fusion of such two gametes. — Up to the present time I have not found the diploid cytotype of *C. neglecta* in the Nízké Tatry Mts.; the occurrence of the numbers 2n = ca 28 and 2n = 30 in this locality is therefore rather unclear.

**P 122:** only one plant (the characters of *C. neglecta*: colour, shape and size of flowers, the mean of branching), probably a direct product of the back-cross triploid × tetraploid, e.g. [*C. carpatica* (4x) × *C. neglecta* (2x)] × *C. neglecta* (4x) or *C. carpatica* (4x). However, an account of other combinations may be considered in this case. Owing to the lack of seeds, a more detailed analysis could not be made.

**P 126—129:** A morphologically clear-cut and very uniform topodeme which inhabits predominantly the supramontane and alpine belts of the central part of Malá Fatra Mts. (N. of the river Váh). In my opinion this topodeme may be a fixed hybridogene from the cross *C. carpatica* (4x) × *C. petrogena* (4x); it seems to be possible that both the putative parents occur together on the locality P 126.

**P 131:** The given numbers were found in the cultivated progeny of one plant [phenotype: a high fertile *C. carpatica* (4x)]; in the locality the mother plant grew along with *C. carpatica* (2x). Several categories occurred in this progeny (from the seeds ripened in the nature), as regards both the morphological features and the fertility; only 26% (i.e. 5 from 19) plants were fully fertile. It may be explained partly by the actual hybridisation in the locality; however, the numbers 2n = 32 even in very sterile plants as well as the finding of one plant with 2n = 19 permit the deduction with a high probability that the mother individual itself was of a hybrid nature. The quantitative characters of *C. petrogena* also appeared in some individuals of the offspring, most likely as a result of heterosis; the possibility of multiple hybridisation (*C. carpatica* 2x—4x—*C. petrogena*), it is true, cannot be excluded.

The preliminarily classified populations

**P 133:** A deme which seems to be very similar to *C. nitida*; the similarity has not been verified by cultivation.

**P 134:** The plants in the region of the Moravian Karst are not uniform, and it is possible that several taxa are represented here.

**P 136:** Not proved sufficiently by cultivation experiments.

**P 142:** A very distinct morphotype perhaps of a higher taxonomic value.

**P 145:** A Scandinavian deme, not quite clear from taxonomic point of view.

**P 154:** With respect to the late date of the cultivation the exact determination of this strain was not possible.

The survey of chromosome numbers known in the *C. arenosa* complex up to the present time is given in table 2; it is arranged from the geographical point of view, not chronologically.

## The annotations to table 2

1. The BURDET's (1967) datum 2n = 16 for *C. petraea* (L.) HIIT. found in the Czechoslovak material from the Tatra Mts. ("TANAP") should most probably be included into the table, too. The occurrence of *C. petraea* in the Tatra, to my knowledge, has not been proved reliably and is quite unlikely also from the ecological point of view. The BURDET's number most probably relates to *C. nitida*.

2. The diploid data published for *C. arenosa* by the Hungarian authors were often accepted as only questionable. POLATSCHEK (1966), for instance, writes: "Bei den von BAKSAY untersuchten Populationen handelt es sich möglicher-

weise um Zählungen an der vielfach diploiden *C. petraea*." BURDET (1967) also gives an similar opinion: he assumes that a confused diploid taxon most likely identical with *C. hispida* (MYG.) HAYEK is distributed in Hungary and Austria [in the latter case he takes POLATSCHEK's (l.c.) datum 2n = 16 for *C. petraea* (L.) HIIT. into consideration*)].

Table 2

The chromosome numbers known in *C. arenosa* complex up to the present time (The papers containing chromosome figures are designated by an asterisk before the author's name)

| Country | Locality | n | 2n | Author |
|---|---|---|---|---|
| Poland | Tatra Mts., rocks in glacial cirque Piekło, SE. slope of Mt. Giewont; zone of *Pinus montana*, ca 1600 m a. s. l. | | 32 | *SKALIŃSKA in SKALIŃSKA, POGAN et al. 1966 |
| | Tatra Mts., border of a wood along the road „Pod Reglami", 920 m | | 32 | l. c. |
| Czechoslovakia | High Tatra, see loc. P 4, P 5 | | 16 | MĚSÍČEK 1967 |
| | High Tatra, see loc. P 47 | | 32 | l. c. |
| Hungary | without further information | 8, 16 | 32 | SOÓ et JÁVORKA 1951 |
| | Kigyósvölgy, Balaton györök; Festuco-Brometum; on rocky places | 8 | | BAKSAY 1956 |
| | Nagykovácsi, Mt. Nagyszénás; Festuco-Brometum; on rocky places | 8 | | l. c. |
| Austria | Tirol, Gschnitz Tal (? — cf. TISCHLER 1950 : 9) | | 28 | MATTICK 1949 in TISCHLER 1950 |
| | Niederösterreich, Lunz, between Mitter-See and Ober-See, ca 900 m; limestone gravel; KRENDL 64/277 | 16 | | *POLATSCHEK 1966 |
| | Steiermark, Gesäuse, along a road from Gstatterboden to Ennstaler Hütte, 1250 to 1400 m; limestone; P 64/267 | 16 | 32 | l. c. |
| | Steiermark, Hieflau, a wall at railway station; P 64/264 | 16 | 32 | l. c. |
| | Steiermark, Pernegg im Murtal, ca 450 m; on bank of a road, silicate; P 64/248 | 16 | | l. c. |
| | Steiermark, Mixnitzbachtal, 500 m; limestone, on bank of a road; P 64/260 | 16 | | l. c. |
| | Steiermark, Weizklamm, 600 m; limestone gravel; coll. EHRENDORFER 64/251 | 16+ 0—3B | | l. c. |
| Germany | without further information | | 32 | LÖVE 1961 |
| | Limburg (LAIBACH) | 16 | 32 | *BERGER 1968 |
| Scandinavia | without further information | | 32 | LÖVE 1961 |
| Sweden | Uppsala, lawn weed in Botanical garden | | 32 | HYLANDER 1957 |
| | Ångermanland | | 32 | l. c. |
| Switzerland | Genève, Botanical garden, ar 1 | | 32 | *BURDET 1967 |
| | Genève, Botanical garden, ar 2 | | 32 | l. c. |
| | Genève, bois de Chancy, ar 4 | | 32 | l. c. |
| | Vaud, Nyon, edge of a road, ar 3 | | 32 | l. c. |
| | Vaud, Hauteville près Vevey, ar 5 | | 32 | l. c. |

*) At the same time BURDET subjoins erroneously the tetraploid cytotype (2n = 32) of *C. petraea* found by POLATSCHEK in Austria and distributed also in Czechoslovakia to *C. arenosa*.

My results verify the data of Hungarian authors almost with certainty; especially the locality from near Budapest (Mt. Nagyszénás, BAKSAY l.c.) seems to be a suitable ecotope (dolomite) for the diploid *C. petrogena* and links up more or less continuously to the southernmost Slovakian locality (P 71). In the environs of Budapest, however, even the tetraploid *C. petrogena* undoubtedly occurs (locus classicus of *Arabis petrogena* KERN.); this finding is based on the morphological analysis of herbarium specimens (Flora exsicc. austro-hungarica, No. 604). As regards the more southern locality of BAKSAY, POLATSCHEK's assumption about the possible confusion — in other respects very justified — seems to be in contradiction with my statement that *C. petraea* in the environment of the lake Balaton is tetraploid (according to its pollen size).

3. BERGER (l.c.) provided valuable information regarding the homology of the chromosome sets in *C. arenosa*; she analysed chromosome pairing and frequency of the multivalents in metaphase I and concluded that *C. arenosa* is to be considered as a amphidiploid rather than a autotetraploid species. She assumes the following configuration of the haploid chromosome set: n = (5a + 3x) + (5a′ + 3x), where the homologous chromosome groups are designated by x. Four chromosomes (a) occur in the single set closely related to those of *Arabidopsis thaliana* (L.) HEYNH.

Even although the problems mentioned are not the subject of the present paper, I wish to suggest that the taxonomic identification of BERGER's material is not quite clear. It is probable that these plants belonged to *C. arenosa* "s. str." [*C. arenosa* (L.) HAYEK in the sense of the present author] which seems to be the most derived taxon of the complex. However, the following datum of LAIBACH (1958) should also be considered in this connection: "eine weissblühende Form findet sich in Limburg am Bahndamm neben der Lahn". The plants from secondary habitats along railway lines are often very confused from the taxonomic point of view and a secondary occurrence of other taxa of the complex cannot be excluded on such sites.

The multivalents occurred also in the Czechoslovak material of *C. arenosa* "s. str." but in a distinctly lower frequency. My results are rather different in this respect from those of BERGER and therefore an analysis of a larger material (i.e. from several natural localities) appears to be necessary.

Considering the origin of *C. arenosa* "s. str.", three speculative hypotheses (see p. 246) have been proposed by the present author: one of them assumes that this taxon arose by means of hybridisation on tetraploid level (from tetraploid putative parents). If the BERGER's results refer really to *C. arenosa* "s. str.", they seem to support this „hybridisation" hypothesis to some extent but, at the same time, they allow *C. arenosa* to be derived both from diploid and autotetraploid or even perhaps from amphidiploid parent forms.

4. Very remarkable are POLATSCHEK's data (l.c.) from the eastern Alps; this is one of the regions where diploid cytotypes of the *C. arenosa* complex were probably distributed and may occur even now.

5. SKALIŃSKA (l.c.) determined her plants from the Tatra Mts. as *C. arenosa* subsp. *borbasii* (ZAP.) PAWŁ.; they are evidently identical with *C. carpatica* (4x).

6. The number 2n = 28 given by MATTICK (l.c.) is by itself possible; however, the karyological data of this author are not correct in rather numerous cases.

## A survey of the main Czechoslovak taxa of the *Cardaminopsis arenosa* agg.

In the end the brief characteristics of the main Czechoslovak taxa of the *C. arenosa* agg. are added; an analysis of their phylogenetic relations and a detailed biosystematic evaluation will be published in an other paper.

*Cardaminopsis nitida* nom. provis.

The most original (to my knowledge) taxon of the complex, a high mountain ecotype with the elementary level of ploidy (2n = 2x = 16) and with comparatively distinct relations to the *C. petraea* agg. According to the specimens from FREYN's herbarium (BRNM) it is identical with *Arabis multijuga* BORB. in FREYN's conception [1889 : 132; = *A. arenosa* subsp. *borbasii* ZAP. a) *tatrensis* ZAP. 1913 : 16]. However, the plants of the isotype specimen of BORBÁS' species (1877 : 604) which I obtained from the same source, are most probably tetraploid. The choice of a correct name for *C. nitida* depends also on the identification of some of SCHUR's taxa described under the generic name *Arabis* L.

In Czechoslovakia, the occurrence of *C. nitida* is confined to the limestone regions of the Tatra Mts. The general distribution cannot be delimited for the time being; at all events it is disjunctive (even in the Tatra Mts. it is not continuous). The tetraploid Austrian individuals from the locality P 133 resemble the diploid plants from the Tatra very much, as regards their habitus, however, they have not yet been confirmed experimentally.

*C. nitida* differs from the most relative *C. carpatica* mainly by its habitus (Pl. XVI : a), by colour, gloss and consistence of leaves, by a high glabrousness, by hairiness of the stem (hairs short or even absent) and by smaller flowers (in average); from the diploid *C. carpatica* it is isolated geographically.

*Cardaminopsis carpatica* nom. provis.

This taxon includes two cytotypes. The Carpathian-colline till montane diploid cytotype is a direct ecodescendant of *C. nitida;* from these two diploid taxa the tetraploid arose in the way of either autoploidy or alloploidy. The ZAPAZOWICZ's taxon *Arabis arenosa* subsp. *borbasii* ZAP. (1913 : 13) seems to include only the tetraploid cytotype (by general description and explicitly by the f. *choczensis* ZAP.); at the same time it is evidently heterogeneous including *C. nitida* and perhaps some other taxa of the complex (or even of the genus), too. This heterogeneity has not been eliminated even by the SCHOLZ's (1962 : 139) conception of the subspecies described by ZAPAŁOWICZ [i.e. *C. arenosa* subsp. *borbasii* (ZAP.) PAWŁ.]; on the contrary, it has been rather amplified. On the basis of the brief and insufficient characteristics given by SCHOLZ both the cytotypes might be ranged in the subspecies mentioned, however, this taxon includes again some other taxa of the complex and certainly also a new, in the literature undescribed tetraploid cytotype of *Cardaminopsis neglecta* (SCHULT.) HAYEK.*) (I deduce this from the distribution data and from the width of siliques given by SCHOLZ.)

The Czechoslovak area of the diploid cytotype seems to be limited in the west approximately by 18°30′ E., in the north by the southern slopes of

*) This cytotype with 2n = 32 is distributed in the High and Low Tatra and occurs also in the East Carpathians.

mountain ridges extending north of the river Váh, in the south it does not spread over the region of the Carpathians; the eastern boundary is not clear (the easternmost locality I know is situated in the Branisko Mts.), but it is possible that the diploid cytotype penetrates beyond the eastern frontier of Czechoslovakia, too. The western, southern and northern boundaries of the Czechoslovak and of the general distribution of the diploid cytotype are probably identical. As regards both the Czechoslovak and the general areas of the tetraploid cytotype, they cannot be exactly delimited at present; the southern boundary of distribution in Czechoslovakia is probably laid down a little more northward than in the diploid cytotype, in the west it runs across Moravia.

The diploid *C. carpatica* (Pl. XVI : b) differs from the tetraploid cytotype not only in karyological and geographical respects but also by some morphological characters (habitus, size of pollen grains etc.). Its populations from the primary habitats may usually be distinguished without any difficulties; on the secondary habitats the vergent types (similar to the tetraploid) occur rather frequently.

*C. carpatica* differs from *C. petrogena* first of all by shorter hairs on the stem, by smaller flowers (in this character only from the tetraploid *C. petrogena*), by lower degree of total pubescence, by habitus and by other features; both taxa are more or less isolated geographically.

The taxonomic delimitation of the tetraploid *C. carpatica* and *C. arenosa* (L.) Hayek appears to be much more difficult. It is caused partly by the fact that the phylogenetic development of *C. arenosa* — owing to the absence of the linking diploid cytotype — is not clear, partly by the secondary and very recent penetration of the Carpathian taxa into the area of *C. arenosa*. Thus, the taxonomic evaluation of the relation between *C. carpatica* and *C. arenosa* is based mainly on their behaviour in nature and on their morphological differences. As the more important diagnostic characters I regard the length of hairs on the stem, the colour of flowers, the size of petals, the general habitus, the total density of the pubescence and partly also the width of siliques as well as the value length × width of seeds. Of course, all these features are of a statistical nature.

In this sense I regard *C. carpatica* (tetraploid cytotype*) as a Carpathian taxon with white flowers, shorter petals, shorter hairs on the stem, in a v e r a g e usually wider siliques and larger seeds. The contradictions characterize the *C. arenosa* (L.) Hayek; within the populations of this taxon the colour of flowers may be combined to a various degree. The features of some populations from northern and eastern Europe are not in full accordance with the delimitation mentioned.

*Cardaminopsis petrogena* (Kern.) Měsíček

A taxon with two cytotypes. The diploid cytotype is an ecodescendant of the diploid *C. carpatica* and includes the typical form very similar to the tetraploid cytotype (differences: size of flowers and of pollen grains, more gracile habitus — see Pl. XVI : c), and a topodeme inhabiting the dolomite rocks of Mt. Rokoš (cf. P 137, P 138). The tetraploid *C. petrogena* is almost

*) The diploid cytotype is not taken into consideration here, because it is separated from *C. arenosa* both karyologically and geographically.

doubtlessly an autoploid derivative of the diploid cytotype. The taxon *C. petrogena* may be evaluated, in my opinion, as a species: its tetraploid cytotype is identical with *Arabis petrogena* KERN. and for that reason I propose the following new combination:

*Cardaminopsis petrogena* (KERNER) MĚSÍČEK comb. n.

Basionym: *Arabis petrogena* KERNER Österr. bot. Z., Wien, 13 : 141, 1863.

The northern limit of the Czechoslovak and the general area of this species is the same: it runs along the southern slopes of the Slovakian Carpathians (here it is contiguous with the area of the diploid *C. carpatica*), and through the valley of the river Váh it penetrates up to the town Žilina (where the tetraploid *C. petrogena* gets into contact with the tetraploid *C. carpatica* and where the mutual introgressive hybridisation takes place). The westernmost Slovakian locality, to my knowledge, is the hill Devínská Kobyla near Bratislava. Its occurrence in southern Moravia seems to be probable. The eastern boundary of the distribution is not clear. *C. petrogena* (including the diploid cytotype) is widespread with certainty also in Hungary and penetrates as far as to Transylvania. The diploid cytotype does not seem to be isolated from the tetraploid *C. petrogena* geographically.

*C. petrogena* [which SCHOLZ (1962) holds to be a component of his subsp. *arenosa*] represents a morphologically rather well defined and little variable taxon. It differs from *C. arenosa* (L.) HAYEK by its habitus, by the higher density of the pubescence (the rosette leaves sometimes almost tomentose), by the consistence and at the same time by the thickness of leaves (they are thick but soft) as well as by other features. The tetraploid cytotype also differs from all the mentioned taxa of the complex by the size of anthers. Of course, some populations occur within the area of *C. arenosa* (L.) HAYEK which may be distinguished from *C. petrogena* with difficulty — especially if the material examined is poor. I know transitional types also from the region where the areas of *C. carpatica* and *C. petrogena* are in contact. — The diploid topodeme P 137, P 138 (Rokoš) appears to be an almost glabrous copy of *C. petrogena*.

*Cardaminopsis arenosa* (L.) HAYEK (*C. arenosa* "s. str.")

The origin of this taxon to which — after the separation of units mentioned above — the name *C. arenosa* (L.) HAYEK belongs, is rather obscure at the present time. Three quite speculative alternatives may be taken into consideration: a) the geographical and ecological differentiation from the tetraploid *C. carpatica* or *C. petrogena*; b) a hybrid origin from the cross *C. carpatica* × *C. petrogena*; c) an origin from another developmental branch independent on the Carpathian centre (according to the results of a statistical evaluation of microspores — which, however, are not quite unambiguous — the diploid plants could be expected in the Estonian SSR). I assume that the natural distribution of *C. arenosa* "s. str." (Central, Western and Northern Europe) does not penetrate into the region of the Carpathians; in Czechoslovakia its eastern boundary runs across Moravia. This taxonomic group split into

several units, the value of which is not clear. The plants from Northwestern Europe, in particular, seem to be well differentiated.

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Souhrn

V této práci shrnuji část výsledků cytogeografického studia rodu *Cardaminopsis* (C. A. Mey.) Hayek, především taxonu, jenž je dnes obecně uváděn pod jménem *C. arenosa* (L.) Hayek. Tento taxon chápu jako komplexní (agregátní) druh, tedy jako soubor jednotek poměrně vysoké klasifikační hodnoty.

V komplexu *C. arenosa* jsem zjistil tyto chromozómové počty (ze 106, převážně československých lokalit): diploidní 2n = 16, resp. 2n = 16+0—4B (celkem 34 lokalit v oblasti západních Karpat); triploidní 2n = 24 a cca 24; tetraploidní 2n = 32, resp. 2n = 32+0—1B; pentaploidní 2n = 39—40; aneuploidní 2n = 18, 19, cca 28, 30, 31, 34 a n = 17 (Tab. 1). U jednoho individua s 2n = 32 byla zaznamenána anomální meiose v PMC s možnou tvorbou mikrospor s n = 8. Protože nález pravděpodobně souvisí se vznikem uměle získaného diploidního hybrida z interspecifické kombinace diploid × tetraploid, považuji výskyt počtu n = 8 za případ náhodného „dvojnásobného snížení" chromozómového počtu. Počet 2n = 16, nalezený v tetraploidním potomstvu jedné rostliny hybridní povahy vykládám jako pravděpodobný důsledek sporické apozygotie resp. apogametie.

Vlastní karyologické výsledky jsou doplněny přehledem počtů pro *C. arenosa* komplex dosud publikovaných (Tab. 2). Z konfrontace vyplývá, že byla definitivně prokázána existence diploidní *C. arenosa*: nápadná aglomerace diploidních cytotypů na území západních Karpat současně naznačuje, že tuto oblast je nutno považovat za vývojové centrum komplexu.

Ve formě předběžného sdělení jsou dále publikovány počty 2n = 16 a 2n = 32 pro *Cardaminopsis neglecta* (Schult.) Hayek (tetraploidní cytotyp nebyl až dosud znám) a je upozorněno na výskyt tetraploidního cytotypu *Cardaminopsis petraea* (L.) Hiit. v Československu.

Na základě uvedených karyologických výsledků — a s použitím zde nepublikovaných závěrů biosystematické analýzy rodu — rozčleňuji československé rostliny komplexu do 4 základních jednotek (z nichž část uvádím pod provizorními jmény, případně bez definitivního určení jejich taxonomické hodnoty): 1 diploidní (*C. nitida* nom. provis.), 2 s di- a tetraploidním cytotypem [*C. carpatica* nom. provis., *C. petrogena* (Kern.) Měsíček] a 1 tetraploidní [*C. arenosa* "s. str." = *C. arenosa* (L.) Hayek]. Vývoj komplexu se přitom realizoval v řadě *C. nitida*—*C. carpatica*—*C. petrogena*; původ *C. arenosa* "s. str." není prozatím jasný. Pro uvedené jednotky (jimiž není celková variabilita komplexu vyčerpána) je připojena jejich stručná morfologická a chorologická charakteristika.

Zcela okrajově se zmiňuji o některých přirozených nebo umělých interspecifických hybridech, mezi různými jednotkami komplexu *C. arenosa* a zástupci ostatních komplexů rodu, t.j. *C. neglecta* (Schult.) Hayek, *C. halleri* (L.) Hayek, *C. petraea* (L.) Hiit. a o umělém intergenerickém hybridu *Arabidopsis thaliana* (L.) Heynh. × *C. arenosa* „s. str."

V práci je navržena nomenklatorická kombinace *Cardaminopsis petrogena* (Kern.) Měsíček comb. n.

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See also plates XV. — XVI. in the appendix.

W. Lötschert:

**Pflanzen an Grenzstandorten**

G. Fischer Verlag, Stuttgart 1969, 167 str., 124 obr., cena váz. 42,— DM. (Kniha je v knihovně ČSBS.)

Kauzální vztahy vegetace a fyzického prostředí jsou nejlépe patrné a zároveň nejlépe prostudované v oboru působení extrémních hodnot anebo mimořádných kombinací činitelů půdy a klimatu. W. Lötschert měl dobrý nápad sestavit knihu z ekologických kapitol týkajících se těchto extrémních a mimořádných biotopů. Výběr látky byl pochopitelně subjektivní a — jak přiznává autor v úvodu — ovlivněn dřívější vědeckou činností autorovou.

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Výše uvedené námitky souvisí patrně s tím, že autor čerpal především z literatury německé. Na jedné straně tak sice dobře vynikl vynikající podíl německé literatury na světové ekologické problematice, na druhé straně však čtenář dostává nesprávnou představu o literárních pramenech z jiných oblastí.

Za dobrý nápad a užitečný přehled o ekologii rostlinstva extrémních stanovišť patří autorovi i vydavateli dík. Kniha je dobrým doplňkem kompendia „Die Vegetation der Erde" vydaného pod redakcí H. Waltera a zaměřeného spíše na vegetaci zonální.

J. Jeník

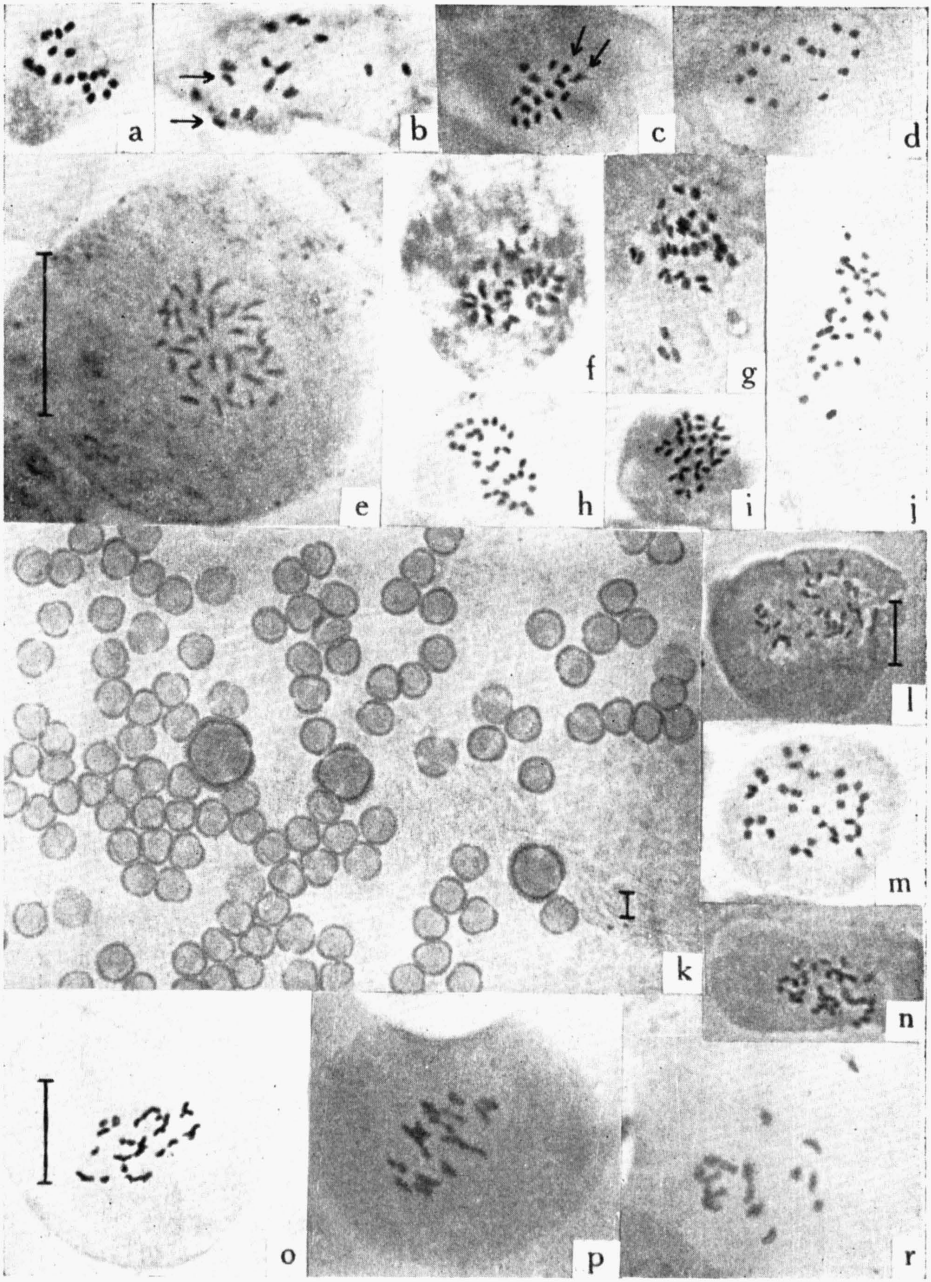


Plate XV. — Somatic metaphases: a—c: P 4, arrows=chromosomes with a satellite; d: P 37; e—g: P 62 (g: 2n=34); h: P 134; i: P 145; j: P 94; l: P 124; m: P 120; n: P 113; o: P 111.—PMC's meioses: p—r: P 108, $16_{II}$. — The regular and giant (tetra-, pentacolpate) pollen grains: k: P 62. — Scale = 10 μm; the scale drawn in fig. o relates to all figures with exception of e, k and l. — Photo J. Měsíček.

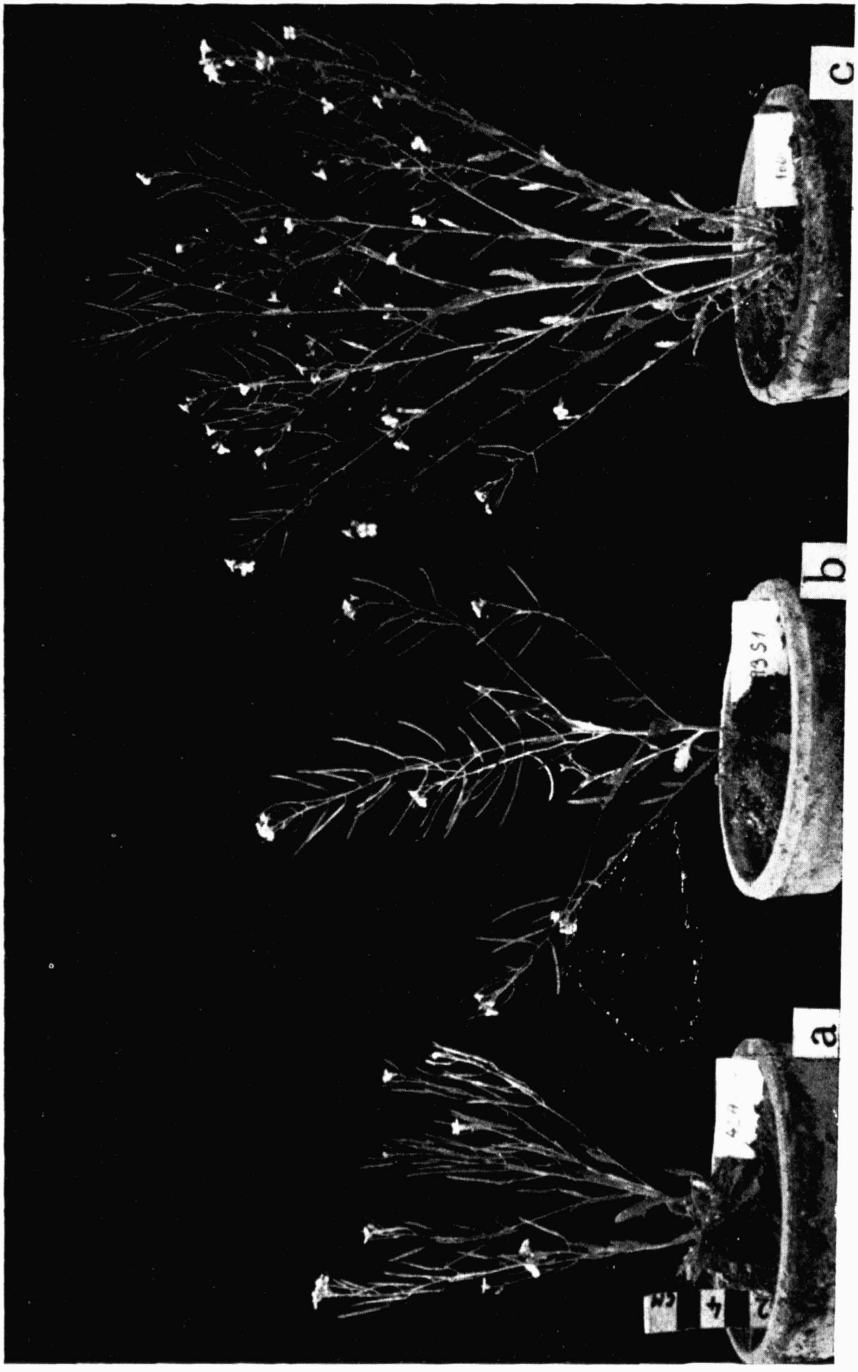


Plate XVI. — The diploid cytotypes of *C. arenosa* agg. (cultivated plants): a: *C. nitida*; b: *C. carpatica*; c: *C. petrogena*. — Photo J. Měsíček.