

## Chromosome Study of the Genus *Rorippa* SCOP. em. REICHENB. in Czechoslovakia

Chromozómové počty československých druhů rodu *Rorippa* SCOP. em. REICHENB.

Vlasta Javůrková-Kratochvílová and Pavel Tomšovic

JAVŮRKOVÁ-KRATOCHVÍLOVÁ V. et P. TOMŠOVIC (1972): Chromosome study of the genus *Rorippa* SCOP. em. REICHENB. in Czechoslovakia. — Preslia, Praha, 44 : 140—156. — A karyological analysis of the genus *Rorippa* from 96 localities in Czechoslovakia was undertaken. *R. austriaca* (CR.) REICHENB. and *R. pyrenaica* (LAM.) REICHENB. were found to be diploid ( $2n = 16$ ), *R. amphibia* (L.) BESS., *R. palustris* (L.) BESS. and *R. silvestris* (L.) BESS. are tetraploid ( $2n = 32$ ). *R. silvestris* is occasionally pentaploid with  $2n = 40$ . The somatic chromosome number of the hybrid from homoploid combination *R. amphibia*  $\times$  *R. silvestris* is  $2n = 32$ . At the heteroploid level of *R. amphibia*  $\times$  *R. austriaca* and *R. austriaca*  $\times$  *R. silvestris* two somatic counts have been found:  $2n = 24$ , which corresponds to the primary hybrid of  $F_1$  generation, and  $2n = 32$ . — Botanical Institute, Czechoslovak Academy of Sciences, Práhonice near Praha, Czechoslovakia.

This is an extension of a taxonomic revision of the genus *Rorippa* SCOP. em. REICHENB. in Czechoslovakia (TOMŠOVIC 1965, 1969) in which five species were recognized: *R. amphibia* (L.) BESS., *R. austriaca* (CR.) REICHENB., *R. islandica* (OEDER ex MURR.) BORB., *R. pyrenaica* (LAM.) REICHENB., *R. silvestris* (L.) BESS. A comparison with the results of JONSELL's (1968) cytotaxonomic study has shown that the Czechoslovak material identified as „*R. islandica*“ belongs to *R. palustris* (L.) BESS. In addition to the species mentioned above, the following hybrids were found by an analysis of morphological characters: *R. amphibia*  $\times$  *R. austriaca*, *R. amphibia*  $\times$  *R. silvestris* and *R. austriaca*  $\times$  *R. silvestris*.

### Material and methods

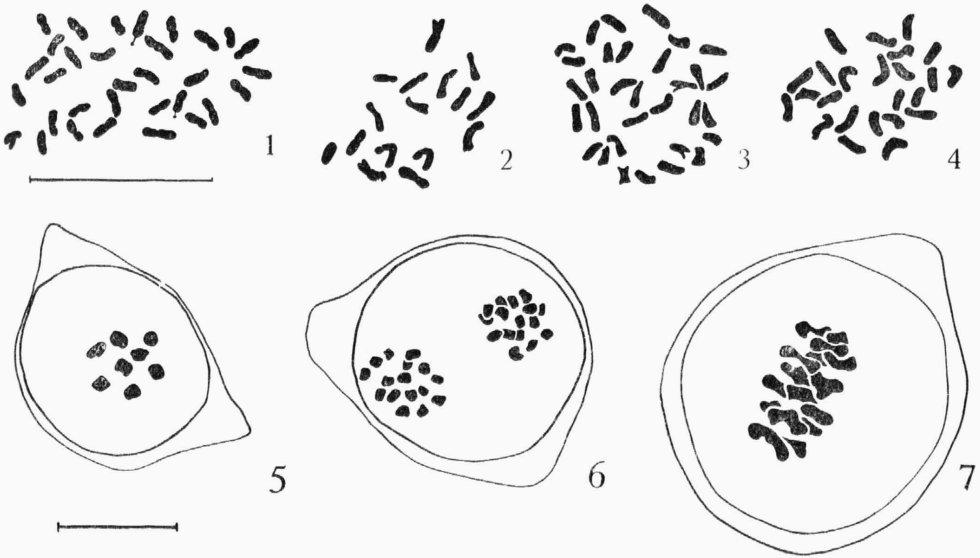
The material for the present chromosome studies was acquired either by collecting in natura habitats and fixing suitable objects (adventitious roots, vegetative cones, flower buds) immediately in the field, or it was taken from plants transferred into experimental plot. The plants examined were mostly kept as voucher specimens. To obtain root-tips, the capacity of yellow-creases (especially of *R. amphibia* and *R. silvestris*) for producing adventitious roots was employed; these are usually produced in the natural habitat if the ground is sufficiently moist. If no adventitious roots were produced, portions of stems were planted in water, whereupon the roots appeared in the leaf axils within 4—5 days. The root-tips of adventitious roots, if compared with those of young seedlings, are more suitable for several reasons. Due to their size, they are easier to handle during the treatment. They also contain extensive zones of dividing meristem, so that convenient mitotic plates are easy to detect. Last but not least, they make it possible to examine the chromosome number of the plant in question, not that of its progeny, as in the case of seedlings. The latter were used in a few cases only, especially in *R. palustris*, which produces adventitious roots rather reluctantly.

The flower buds and root-tips were fixed in acetic alcohol 1 : 3 for several hours to several days and stained with lacto-propionic-orceine. For a portion of the mitotic material, nigrosine was also used as a stain. The chlor-carmin method (SNOW 1963) was used for meiotic material only. The chromosomes were measured using an eyepiece screw micrometer Ok 15  $\times$ . The drawings were made using a camera lucida. All optical equipments used was made by Zeiss Works, Jena.

## Results

### Chromosome morphology

The chromosomes of the genus *Rorippa* are small, rodshaped (this shape is common in some crucifers). Their length in the mitotic metaphase is variable to a certain extent (apparently as a result of the treatment) and keeps bet-



Figs. 1-7. — Somatic metaphases: 1: *R. amphibia* (loc. No. 12),  $2n = 32$ ; *R. austriaca* (loc. No. 8),  $2n = 16$ ; 3: *R. silvestris* (loc. No. 26),  $2n = 32$ ; 4: *R. amphibia*  $\times$  *R. austriaca* (loc. No. 5),  $2n = 24$ . — PMC's meiosis: 5: *R. austriaca* (loc. No. 8), metaphase I, 8<sub>II</sub>; 6: *R. silvestris* (loc. No. 14), metaphase II,  $n = 16$ ; 7: *R. palustris* (loc. No. 7), metaphase I, 16<sub>II</sub>. — Scale = 10  $\mu\text{m}$ . — Del. V. JAVŮRKOVÁ.

ween 1.1  $\mu\text{m}$  and 2.8  $\mu\text{m}$  (KRATOCHVÍLOVÁ 1969); in *R. amphibia* and *R. austriaca* the chromosomes are a little longer (1.4–2.8  $\mu\text{m}$ ) than in *R. palustris* and *R. silvestris* (1.1–2.2  $\mu\text{m}$ ), in *R. pyrenaica* the lengths were not measured. In all five species examined chromosomes with a secondary constriction were found. Their number varies from one unpaired chromosome to four, i.e. two pairs. The satellites are situated terminally, as a spherical body (terminal macro- and microsatellites, see BATTAGLIA 1955).

### Chromosome counts in natural populations

The results of cytogeographical studies from 96 localities are summarized in Tab. 1. Plants supposed to be hybrids on the basis of their morphology are listed separately. Plants cultivated in the experimental plot are designated with strain numbers.

### Discussion

Literature data concerning chromosome numbers in the genus *Rorippa* are relatively plentiful. Both somatic and gametic counts have been made.

Tab. 1. — Chromosome counts in natural populations of the genus *Rorippa*

No. of locality	Strain number	Locality	Altitude in m	n	2n	Number of indiv. studied
<i>R. amphibia</i>						
1		W. Bohemia, distr. Plzeň-jih, left bank of the river Úslava at a road bridge in the town Starý Plzeňec; coll. V. JAVŮRKOVÁ 1970	330	—	32	1
2		W. Bohemia, distr. Plzeň-jih, a dike between fish-ponds S. of the village Sedlec; coll. V. JAVŮRKOVÁ 1970	338	—	32	2
3		W. Bohemia, distr. Plzeň-jih, left bank of the river Úslava at the bridge in NW. part of the village Štáhlavy; coll. V. JAVŮRKOVÁ 1970	343	—	32	1
4	T53	S. Bohemia, distr. Písek, town Písek, left bank of the river Otava at the railway bridge; coll. P. TOMŠOVIC and V. KRATOCHVÍLOVÁ 1967	360	—	32	1
5	T48	C. Bohemia, distr. Beroun, village Srbsko, left bank of the river Berounka near the mouth of the Kačák brook; coll. P. TOMŠOVIC and V. KRATOCHVÍLOVÁ 1967	215	—	32	1
6		C. Bohemia, distr. Beroun, village Srbsko, right bank of the river Berounka, near the lime-kiln; coll. M. JAVŮREK and V. KRATOCHVÍLOVÁ 1968	210	—	32	2
7	T43 T44	C. Bohemia, distr. Praha-západ, left bank of the river Berounka NE. of the village Černošice; coll. P. TOMŠOVIC and V. KRATOCHVÍLOVÁ 1967	195	—	32	3
8	T47	C. Bohemia, distr. Praha-západ, village Mokropsy, left bank of the river Berounka; coll. P. TOMŠOVIC and V. KRATOCHVÍLOVÁ 1967	197	—	32	1
9		C. Bohemia, Praha-Troja, right bank of the river Vltava near the Zoological Park, coll. P. TOMŠOVIC and V. KRATOCHVÍLOVÁ 1968, V. JAVŮRKOVÁ 1970	180	—	32	3
10		C. Bohemia, Praha-Troja, the river Vltava, the N. edge of island Trojský ostrov, near the ferry; coll. P. TOMŠOVIC and V. KRATOCHVÍLOVÁ 1968	180	—	32	1
11	T39	C. Bohemia, distr. Mělník, dead arm of the river Labe 1 km NE. of the town Kostelec n/L.; coll. V. KRATOCHVÍLOVÁ 1967	163	—	32	1

12	T40	C. Bohemia, distr. Mělník, a draining-ditch in fields W. of the village Křenek near the town Stará Boleslav; coll. V. KRATOCHVÍLOVÁ 1967	165	16 <sub>II</sub>	32	2
13		C. Bohemia, distr. Praha-východ, left bank of the river Labe 1.5 km NW. of the town Brandýs n/L., coll. V. KRATOCHVÍLOVÁ 1968	166	—	33	1
14	T62	E. Bohemia, distr. Náchod, town Jaroměř, a drain in meadows near the village Jezbiny; coll. P. TOMŠOVIC and V. KRATOCHVÍLOVÁ 1967	248	—	32	1
15	T65	E. Bohemia, distr. Hradec Králové, deposits along left bank of the river Orlice between the villages Krňovice and Běleč; coll. P. TOMŠOVIC and V. KRATOCHVÍLOVÁ 1967	237	—	32	3
16		S. Moravia, distr. Třebíč, bank of the river Rokytka W. of the town Moravské Budějovice; coll. M. JAVŮREK 1970	445	—	32	1
17		S. Moravia, distr. Břeclav, a dead arm of the river Dyje S. of the village Mušov; coll. P. TOMŠOVIC and I. NOVOTNÁ 1968	165	—	32	2
18		S. Moravia, distr. Břeclav, deposits on right bank of the river Dyje W. of the village Dolní Věstonice; coll. P. TOMŠOVIC, V. KRATOCHVÍLOVÁ and I. NOVOTNÁ 1968	165	—	32	1
19		S. Moravia, distr. Břeclav, a dead arm of the river Dyje in meadows between the villages Dolní Věstonice and Strachotín; coll. P. TOMŠOVIC, V. KRATOCHVÍLOVÁ and I. NOVOTNÁ 1968	165	—	32	2
20		S. Moravia, distr. Břeclav, swampy meadows SE. of the village Strachotín; coll. P. TOMŠOVIC, V. KRATOCHVÍLOVÁ and I. NOVOTNÁ 1968	165	—	32	1
21	T4	S. Moravia, distr. Břeclav, the NW. edge of Nesyt lake not far from the village Sedlec (near the town Mikulov); coll. P. TOMŠOVIC 1962	175	—	32	1
22		S. Moravia, distr. Břeclav, meadows S. of the village Lanžhot; coll. P. TOMŠOVIC, V. KRATOCHVÍLOVÁ and I. NOVOTNÁ 1968	153	—	32	3
23		S. Moravia, distr. Břeclav, a dead arm of the river Morava in the bottomland forest „Lanžhotský prales“; coll. P. TOMŠOVIC, V. KRATOCHVÍLOVÁ and I. NOVOTNÁ 1968	150	—	32	1
24		S. Moravia, distr. Břeclav, village Lanžhot, meadows „Košarské louky“ along left bank of the river Dyje; coll. P. TOMŠOVIC, V. KRATOCHVÍLOVÁ and I. NOVOTNÁ 1968	150	—	32	1
25	T19	S. Moravia, distr. Uherské Hradiště, village Staré Město near the town Uherské Hradiště, right bank of the river Morava; coll. P. TOMŠOVIC 1962	178	16 <sub>II</sub>	32	2
26		E. Moravia, distr. Gottwaldov, town Gottwaldov-Zlín, left bank of the rivulet Dřevnice; coll. M. JAVŮREK 1970	210	—	32	1

No. of locality	Strain number	Locality	Altitude in m	n	2n	Number of indiv. studied
27	T3	SW. Slovakia, distr. Senica, village Moravský Ján, dead arm „Kalifás“ of the river Morava; coll. P. TOMŠOVIC 1962, P. TOMŠOVIC, V. KRATOCHVÍLOVÁ and I. NOVOTNÁ 1968	150	16 <sub>II</sub>	32	3
28		SW. Slovakia, distr. Senica, village Malé Leváre, a dead arm „Morávka“; coll. P. TOMŠOVIC, V. KRATOCHVÍLOVÁ and I. NOVOTNÁ 1968	146	—	32	1
29		SW. Slovakia, distr. Malacky, left bank of the river Morava 1 km W. of the village Gajary; coll. P. TOMŠOVIC, V. KRATOCHVÍLOVÁ and I. NOVOTNÁ 1968	145	16	—	1
30		E. Slovakia, distr. Trebišov, a dead arm Mítkvy Bodrog 2.5 km SW. of the village Somotor; coll. V. JAVŮRKOVÁ 1969	95	—	32	1
31		E. Slovakia, distr. Trebišov, village Strážné, the river Velká Krčava near the farm Bukov; coll. V. JAVŮRKOVÁ 1969	97	—	32	1
32		E. Slovakia, distr. Trebišov, a dead arm of the river Laborec E. of the village Oborín; coll. V. JAVŮRKOVÁ 1969	98	—	32	1
33		E. Slovakia, distr. Trebišov, a dead arm of the river Latorica SW. of the village Lelés; coll. V. JAVŮRKOVÁ 1969	100	—	32	1
34		E. Slovakia, distr. Michalovec, a dead arm of the river Cibavka in meadows 1.5 km S. of the village Senné; coll. V. JAVŮRKOVÁ 1969	99	—	32	1
35		E. Slovakia, distr. Trebišov, pools along left bank of the river Latorica (near the road bridge), 5 km S. of the town Velké Kapušany; coll. V. JAVŮRKOVÁ 1969	96	—	32	1
36		E. Slovakia, distr. Trebišov, dead arm Mítkva Tisa at the E. outskirts of the village Velké Trakany; coll. V. JAVŮRKOVÁ 1969	100	—	32	1
37		E. Slovakia, distr. Michalovec, village Vinné, NW. shore of the lake Vinnianské jezero; coll. V. JAVŮRKOVÁ 1969	206	—	32	1
<i>R. austriaca</i>						
1	T11	C. Bohemia, Praha-Hodkovičky, right bank of the river Vltava near the railway-bridge; coll. P. TOMŠOVIC 1962	190	8 <sub>II</sub>	16	2
2		see <i>R. amphibia</i> , No. 9, (Troja, Zoological Park); coll. V. JAVŮRKOVÁ 1970	180	8	—	1
3	T63	E. Bohemia, distr. Náchod, town Jaroměř, along a barley field near the village Jezbiny; coll. P. TOMŠOVIC and V. KRATOCHVÍLOVÁ 1967	248	—	16	1

4		see <i>R. amphibia</i> No. 19 (Dolní Věstonice-Strachotín)	165	—	16	1
5	VĚ	S. Moravia, distr. Břeclav, town Leďnice, dam of the third little fish-pond, S. of the lake Prostřední rybník; coll. P. Tomšovic 1962	170	8 <sub>II</sub>	16	2
6		S. Moravia, distr. Břeclav, arm „Stará Dyje“ in the W. outskirts of the town Břeclav; coll. P. Tomšovic, V. Kratochvílová and I. Novotná 1968	155	—	16	1
7		see <i>R. amphibia</i> No. 22 (Lanžhot)	153	—	16	1
8	T21	E. Moravia, distr. Vsetín, banks of the river Horní Bečva at the bridge near the village Ústí u Vsetína; coll. P. Tomšovic 1962	355	8 <sub>II</sub>	16	2
9		SW. Slovakia, distr. Senica, village Malé Leváre, a dike of dead arm „Raudolf“ (the river Morava); coll. P. Tomšovic, V. Kratochvílová and I. Novotná 1968	146	8	—	1
10		E. Slovakia, distr. Trebišov, a bank along W. outskirts of the village Klin n. B.; coll. V. Javůrková 1969	95	—	16	1
11		see <i>R. amphibia</i> No. 30 (Somotor)	95	—	16	1
12		E. Slovakia, distr. Trebišov, bank of the river Malá Křčava, 2.5 km SE. of the village Velký Kameneč; coll. V. Javůrková 1969	97	—	16	1
13		E. Slovakia, distr. Trebišov, along a road in S. outskirts of the village Rad; coll. V. Javůrková 1969	101	—	16	1
14		see <i>R. amphibia</i> No. 32 (Oborín)	98	—	16	1
15		E. Slovakia, distr. Trebišov, meadows 2 km SW. of the village Malý Horeš; coll. V. Javůrková 1969	99	—	16	1
16		E. Slovakia, distr. Trebišov, dead arm of the river Latorica 3–4 km NW. of the village Bol; coll. V. Javůrková 1969	97	—	16	1
17		E. Slovakia, distr. Trebišov, along the road 2 km W. of the village Vojany; coll. V. Javůrková 1969	100	—	16	1
18		see <i>R. amphibia</i> No. 34 (Senné)	99	—	16	1
19		see <i>R. amphibia</i> No. 35 (Velké Kapušany)	96	—	16	1
20		see <i>R. amphibia</i> No. 36 (Velké Trakany)	100	—	16	1
21		E. Slovakia, distr. Trebišov, meadows along right bank of the river Tisa, 2 km E. of the village Malé Trakany; coll. V. Javůrková 1969	103	—	16	1

*R. palustris*

1		W. Bohemia, distr. Plzeň-jih, village Koterov, left bank of the river Úslava near the bridge; coll. V. Javůrková 1970	310	16	—	1
2		W. Bohemia, distr. Plzeň-sever, right bank of the river Beřounka near the bridge 2 km E. of the village Chrást; coll. V. Javůrková 1970	290	16	—	2

No. of locality	Strain number	Locality	Altitude in m	n	2n	Number of indiv. studied
3		see <i>R. amphibia</i> No. 3 (Štáhlavy)	343	16	—	1
4		W. Bohemia, distr. Plzeň-jih, along a road in SW. outskirts of the village Klabava; coll. V. JAVŮRKOVÁ 1970	340	—	32	1
5		W. Bohemia, distr. Plzeň-jih, S. shore of a fish-pond near the village Borek (vicinity of the town Rokycany); coll. V. JAVŮRKOVÁ 1970	375	—	32	1
6	T56	S. Bohemia, distr. Strakonice, village Strunkovice n./Vol., deposits along right bank of the river Volyňka near the railway station; coll. P. TOMŠOVIC and V. KRATOCHVÍLOVÁ 1967	420	16 <sub>II</sub>	32	2
7	T55	S. Bohemia, distr. Strakonice, a small fish-pond near the road NE. of the village Drahonice; coll. P. TOMŠOVIC and V. KRATOCHVÍLOVÁ 1967	442	16 <sub>II</sub>	32	1
8	T49	C. Bohemia, distr. Beroun, left bank of the river Berounka SW. of the town Beroun; coll. P. TOMŠOVIC and V. KRATOCHVÍLOVÁ 1967	218	—	32	1
9		C. Bohemia, distr. Beroun, right bank of the river Berounka SW. of the village Karlštejn; coll. M. JAVŮREK and V. KRATOCHVÍLOVÁ 1968	209	—	32	2
10		C. Bohemia, distr. Praha-západ, town Zbraslav-Strnady, left bank of the river Vltava; coll. M. JAVŮREK 1968	190	—	32	2
11	T38	C. Bohemia, Praha-Modřany, along mouth of the brook Modřanský potok, right bank of the river Vltava; coll. V. KRATOCHVÍLOVÁ 1967	190	—	32	1
12		S. Bohemia, distr. České Budějovice, town Hluboká n/Vlt., a clearing 1.5 km N. of the „Stará Obora“ forest house; coll. M. JAVŮREK 1968	470	—	32	1
13		S. Bohemia, distr. Písek, forest nursery in the Hůrky woodland, 4 km S. of the town Písek; coll. L. STRNADOVÁ 1969	440	16	—	1
14		S. Bohemia, distr. Písek, town Milevsko, backyard of Modrá Hvězda hotel; coll. M. JAVŮREK 1969	460	—	32	1
15	T36	C. Bohemia, distr. Praha-západ, the pond Černý rybník, N. of the village Průhonice; coll. V. KRATOCHVÍLOVÁ 1967	280	16 <sub>II</sub>	32	4
16		S. Bohemia, distr. Jindřichův Hradec, lake Holub W. of the village Nová Olešná; coll. Z. PUČELÍKOVÁ 1968	535	—	32	1

17		S. Bohemia, distr. Jindřichův Hradec, lake Mutyněveský rybník N. of the village Mutyněves; coll. Z. PUČELÍKOVÁ 1968	530	16	—
18		S. Bohemia, distr. Jindřichův Hradec, lake Opatovický rybník S. of the town Třeboň; coll. Z. PUČELÍKOVÁ 1968	435	—	32
19		C. Bohemia, distr. Mělník, fields along right bank of the river Labe SW. of the village Křenek; coll. V. JAVŮRKOVÁ 1969	164	—	32
20		C. Bohemia, distr. Praha-východ, inundated bottom of a sandpit „Probošták“ near the town Stará Boleslav; coll. V. KRATOCHVÍLOVÁ 1968	165	—	32
21		see <i>R. amphibia</i> No. 15 (Krnovice)	237	—	32
22		S. Moravia, distr. Jihlava, along the road between the villages Dolní Cerekev and Nový Svět, bank of the river Jihlava; coll. M. JAVŮREK 1970	525	—	32
23		S. Moravia, distr. Břeclav, „Včelínek“ (dead arm of the river Dyje), NW. of the village Poštorná (vicinity of the town Břeclav); coll. P. TOMŠOVIC, V. KRATOCHVÍLOVÁ and I. NOVOTNÁ 1968	165	—	32
24		S. Moravia, distr. Břeclav, along a track in the bottomland forest Lanžhotský prales; coll. P. TOMŠOVIC, V. KRATOCHVÍLOVÁ and I. NOVOTNÁ 1968	150	16	—
25		NE. Moravia, distr. Frýdek-Místek, town Jablunkov, bank of the river Olše near the bridge; coll. M. JAVŮREK and V. JAVŮRKOVÁ 1969	380	16	—
26		see <i>R. amphibia</i> No. 29 (Gajary)	145	16	—
27		N. Slovakia, distr. Dolný Kubín, S. shore of the dam Oravská priehrada; coll. M. JAVŮREK and V. JAVŮRKOVÁ 1969	602	16	—
28		C. Slovakia, distr. Spišská Nová Ves, Slov. Rudohorie Mts., right bank of the river Hornád near the village Čingov; coll. M. JAVŮREK and V. JAVŮRKOVÁ 1970	480	—	32
29		see <i>R. amphibia</i> No. 36 (Velké Trakany)	100	—	32
30		see <i>R. austriaca</i> No. 21 (Malé Trakany)	100	—	32

*R. pyrenaica*

1	V41	E. Slovakia, distr. Humenné, Nízke Poloniny Mts., dry hillsides NE. of the village Dary; coll. J. SOJÁK 1962	600	8	—
2		E. Slovakia, distr. Humenné, Nízke Poloniny Mts. hillsides N. of the village Ruské and 1.5 km S. of the Ruské Pass; coll. D. BLAŽKOVÁ 1969	700	—	16

*R. silvestris*

1		see <i>R. palustris</i> No. 1 (Koterov)	318	—	32
2	T57	see <i>R. palustris</i> No. 6 (Strunkovice n/Vol.)	420	—	32



No. of locality	Strain number	Locality	Altitude in m	n	2n	Number of indiv. studied
3	T52	S. Bohemia, distr. Prachatice, left bank of the river Blanice near the bridge in the village Strunkovice; coll. P. TOMŠOVIC and V. KRATOCHVÍLOVÁ 1967	445	—	32	2
4	T54	S. Bohemia, distr. Písek, village Putim, right bank of the river Otava near the mouth of the river Blanice; coll. P. TOMŠOVIC and V. KRATOCHVÍLOVÁ 1967	365	—	32	1
5		see <i>R. palustris</i> No. 8 (Beroun)	218	—	32	1
6		see <i>R. amphibia</i> No. 6 (Srbsko)	210	—	32	2
7		C. Bohemia, distr. Beroun, right bank of the river Berounka in the village Srbsko; coll. M. JAVŮREK and V. KRATOCHVÍLOVÁ 1968	213	—	32	3
8	T45	see <i>R. amphibia</i> No. 7 (Černošice)	195	—	32	1
9	T46	see <i>R. amphibia</i> No. 8 (Mokropsy)	197	—	32	1
10		see <i>R. palustris</i> No. 10 (Zbraslav-Strnady)	190	—	32	3
11	T37	C. Bohemia, Praha-Modřany, right bank of the river Vltava at the sugar works; coll. V. KRATOCHVÍLOVÁ 1967	190	16 <sub>II</sub>	32	4
12		see <i>R. amphibia</i> No. 9 (Troja, Zoological Park)	180	—	32	2
13	T41	see <i>R. palustris</i> No. 19 (Křenek)	164	16 <sub>II</sub>	32	2
14	T42	C. Bohemia, distr. Mělník, village Křenek near the town Stará Boleslav, as a weed in the garden of the house No. 48; coll. V. KRATOCHVÍLOVÁ 1967	167	16 <sub>II</sub>	32	2
15		see <i>R. palustris</i> No. 20 (Stará Boleslav)	165	—	32	1
16		see <i>R. amphibia</i> No. 13 (Brandýs n/L.)	170	—	32	1
17		C. Bohemia, distr. Praha-západ, fields in the W. outskirts of the village Klánovice; coll. M. JAVŮREK and V. JAVŮRKOVÁ 1969	265	—	32	1
18	T64	see <i>R. austriaca</i> No. 3 (Jaroměř—Jezbiny)	248	—	32	1
19	T67	see <i>R. amphibia</i> No. 15 (Křínovice—Běleč)	237	—	32	1
20		see <i>R. amphibia</i> No. 18 (Dolní Věstonice)	165	—	32	1
21		S. Moravia, distr. Břeclav, meadows S. of the village Podivín; coll. P. TOMŠOVIC, V. KRATOCHVÍLOVÁ and I. NOVOTNÁ 1968	160	16	—	1
22		S. Moravia, distr. Břeclav, a fallow field at W. outskirts of the town Břeclav; coll. P. TOMŠOVIC, V. KRATOCHVÍLOVÁ and I. NOVOTNÁ 1968	155	16	—	1
23		see <i>R. amphibia</i> No. 22 (Lanzhot)	153	16	—	2
24		see <i>R. amphibia</i> No. 24 (Lanzhot)	150	—	40	1

25		S. Moravia, distr. Brno, town Židlochovice, bank of the river Svatka; coll. M. JAVŮREK 1968	180	—	32	1
26	V34	C. Moravia, distr. Přerov, right bank of the river Bečva S. of the village Prosenice near the town Přerov; coll. P. TOMŠOVIC 1962	215	—	32	1
27		see <i>R. palustris</i> No. 25 (Jablunkov)	380	16	—	1
28		SW. Slovakia, distr. Senica, the village Moravský Ján, along a road at dead arm „Čeker“; coll. P. TOMŠOVIC, V. KRATOCHVÍLOVÁ and I. NOVOTNÁ 1968	150	16	—	1
29		SW. Slovakia, distr. Senica, a fallow field at N. outskirts of the village Sekule; coll. P. TOMŠOVIC, V. KRATOCHVÍLOVÁ and I. NOVOTNÁ 1968	160	16	—	1
30		see <i>R. amphibia</i> No. 29 (Gajary)	145	—	32	1
31		W. Slovakia, distr. Žilina, banks of a brook in the village Rašov near the town Povážská Bystrica; coll. J. MĚŠŤEK 1968	310	—	32	3
32		see <i>R. amphibia</i> No. 30 (Somotor)	95	—	32	1
33		see <i>R. amphibia</i> No. 31 (Strážné)	97	16	—	1
34		see <i>R. amphibia</i> No. 32 (Oborín)	98	—	32	1
35		see <i>R. austriaca</i> No. 16 (Boľ)	97	16	—	2
36		see <i>R. amphibia</i> No. 34 (Senné)	99	—	32	2
37		see <i>R. amphibia</i> No. 35 (Veľké Kapušany)	96	—	32	2
38		E. Slovakia, distr. Trebišov, lake Ortov E. of the village Čierné Pole; coll. V. JAVŮRKOVÁ 1969	104	—	32	3
39		see <i>R. amphibia</i> No. 36 (Veľké Trakany)	100	—	32	1
40		see <i>R. amphibia</i> No. 37 (Vinné)	206	—	32	1
41		E. Slovakia, distr. Michalovce, Vihorlat Mts., W. edge of the Morské Oko lake; coll. V. JAVŮRKOVÁ 1969	606	—	32	1
<i>R. amphibia</i> × <i>R. austriaca</i>						
1		see <i>R. amphibia</i> No. 2 (Sedlec)	338	—	32	4
2		see <i>R. amphibia</i> No. 3 (Štáhlavy)	343	—	32	1
3		see <i>R. palustris</i> No. 8 (Beroun)	218	—	32	1
4		C. Bohemia, distr. Beroun, right bank of the river Berounka between the villages Srbsko and Karlštejn; coll. M. JAVŮREK and V. KRATOCHVÍLOVÁ 1968				
5	T13	see <i>R. austriaca</i> No. 1 (Praha-Hodkovičky); coll. V. JAVŮRKOVÁ 1970	190	—	24; 32	1; 1
6		see <i>R. amphibia</i> No. 9 (Troja, Zoological Park)	180	—	24; 32	1; 2
7		see <i>R. amphibia</i> No. 10 (Trojský ostrov)	180	—	32	1
8		see <i>R. amphibia</i> No. 34 (Senné)	99	—	32	1

No. of locality	Strain number	Locality	Altitude in m	n	2n	Number of indiv. studied
<i>R. amphibia</i> × <i>R. silvestris</i>						
1		C. Bohemia, distr. Beroun, village Srbsko, right bank of the river Berounka near the bridge; coll. M. JAVŮREK and V. KRATOCHVÍLOVÁ 1968	213	—	32	1
2		see <i>R. amphibia</i> No. 9 (Troja, Zoological Park)	180	—	32	1
3	T69	see <i>R. amphibia</i> No. 15 (Krňovice, Běleč)	237	—	32	3
4		see <i>R. amphibia</i> No. 17 (Mušov)	165	—	32	1
5		see <i>R. amphibia</i> No. 22 (Lanžhot)	153	—	32	1
6		see <i>R. amphibia</i> No. 34 (Senné)	99	—	32	
7		see <i>R. austriaca</i> No. 21 (Malé Trajany)	100	—	32	1
<i>R. austriaca</i> × <i>R. silvestris</i>						
1	V20	NW. Bohemia, distr. Litoměřice, left bank of the river Labe in the town Lovosice; coll. P. Tomšovic 1961	142	—	32	1
2	V6	see <i>R. austriaca</i> No. 1 (Praha-Hodkovičky)	190	—	24; 32	1; 8
3	V21	C. Bohemia, Praha-Troja, river Vltava, S. part of island Trojský ostrov near the turf; coll. P. Tomšovic 1961	180	—	32	1
4		see <i>R. amphibia</i> No. 9 (Troja, Zoological Park)	180	—	24; 32	2; 14
5		see <i>R. amphibia</i> No. 30 (Somotor)	95	—	32	1
6		see <i>R. amphibia</i> No. 34 (Senné)	99	—	24; 32	1; 1
7		see <i>R. silvestris</i> No. 38 (Čierné Pole)	104	—	32	2
8		see <i>R. austriaca</i> No. 21 (Malé Trakany)	103	—	24; 32	1; 1

A list of previous counts is given in Tab. 2. Counts in *R. palustris* are commonly published under the name *R. islandica*. Previous counts in the genus *Rorippa* are mostly based on material from Northern and Western Europe.

All *Rorippa* species have in common the basic chromosome number of  $x = 8$ . The polyploid series of the genus is not very long, the highest multiple being  $6 \times$ . The chromosome numbers of individual species belong predominantly to the orthoploid series; an exception is the pentaploid *R. silvestris*. Another anorthoploid count — a triploid one — occurs in the  $F_1$  generation of interspecific hybrids the parental species of which were heteroploid. Individual species usually contain one single cytotype. Two of the species examined (*R. austriaca* and *R. pyrenaica*) are diploid (Fig. 2, 5; Pl. VIII: e g, and one (*R. palustris*) is tetraploid (Fig. 7; Pl. VIII: b). The remaining two species include several cytotypes each. In *R. amphibia* two cytotypes are known which do not seem to be separable on the basis of their morphology (JONSELL 1968). In Czechoslovakia only the tetraploid cytotype (Fig. 1; Pl. VIII: c) has been found, the diploid one being limited to Western Europe (HOWARD 1947, 1950, JONSELL 1968). In *R. silvestris* three cytotypes are known: tetraploid, hexaploid and pentaploid, the latter being a result of hybridization of the former (JONSELL 1968). The tetraploid cytotype of *R. silvestris*, widely distributed throughout the geographical range, also occurs frequently in Czechoslovakia (Fig. 3, 6; Pl. VIII: d, f, h); in one locality a pentaploid individual was found. The hybrids *R. amphibia*  $\times$  *R. silvestris* are tetraploid. In the other two hybrid combinations, *R. austriaca*  $\times$  *R. silvestris* and *R. amphibia*  $\times$  *R. austriaca*, the primary hybrid of  $F_1$  generation with  $2n = 24$  (Fig. 4; Pl. VIII: a, i) is rare, while the tetraploid predominates. The evolution within a population obviously proceeds towards the rise and predominance of tetraploids, balanced both cytologically and genetically.

The chromosome counts in the genus *Rorippa* in Czechoslovakia have not yielded any substantially new facts which might elucidate the taxonomic problems of individual species. However, for the interpretation of hybridization processes in natural populations — which are one of the main sources of taxonomic difficulties — the cytological information is indispensable. These problems have also been considered by the present authors and will be dealt with elsewhere.

#### Souhrn

Byla provedena cytogeografická analýza druhů rodu *Rorippa* na území Československa. Studiem 235 rostlin z 96 lokalit bylo zjištěno, že diploidní ( $2n = 16$ ) je *R. austriaca* (CR.) REICHENB. a *R. pyrenaica* (LAM.) REICHENB., tetraploidní ( $2n = 32$ ) *R. amphibia* (L.) BESS., *R. palustris* (L.) BESS. a *R. silvestris* (L.) BESS. V jednom případě byla nalezena pentaploidní *R. silvestris* ( $2n = 40$ ). Hybridní rostliny z homoploidní kombinace *R. amphibia*  $\times$  *R. silvestris* jsou tetraploidní ( $2n = 32$ ) a mají tedy stejný chromozómový počet jako jejich předpokládaní rodiče. U hybridů z heteroploidních kombinací *R. amphibia*  $\times$  *R. austriaca* a *R. austriaca*  $\times$  *R. silvestris* se vyskytuje — vedle naprostě převažujícího tetraploidního počtu  $2n = 32$  — též triploidní počet  $2n = 24$ , který odpovídá primárnímu hybridu  $F_1$  generace. Aneuploidní počet  $2n = 33$  byl zaznamenán jen jednou u *R. amphibia*.

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Tab. 2. — A list of previous counts in five studied species of the genus *Rorippa*

Country	Locality	n	2n	Author
<i>R. amphibia</i>				
Ireland	2 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Great Britain	Thames bank wall, Kew	—	16	HOWARD 1947
	without further particulars	—	16; 32	HOWARD 1950
	6 loc., cf. JONSELL 1968	—	16	JONSELL 1968
Portugal	2 loc., cf. JONSELL 1968	—	32	JONSELL 1968
	1 loc., cf. JONSELL 1968	—	16	JONSELL 1968
France	3 loc., cf. JONSELL 1968	—	16	JONSELL 1968
Belgium	1 loc., cf. JONSELL 1968	—	16	JONSELL 1968
	1 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Netherlands	prov. of Gelderland, near Oud-Zvenaar	—	32	GADELLA et KLIPHUIS 1968
	1 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Germany	Tröndelsee by Kiel	—	32	WULF 1939 <sup>1)</sup>
	1 loc., cf. JONSELL 1968	—	16	JONSELL 1968
	1 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Denmark	12 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Sweden	56 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Finland	6 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Czechoslovakia	26 loc.	—	32	KRATOCHVÍLOVÁ 1969 <sup>6)</sup>
—	without further particulars	—	32	LÖVE Á. et D. 1942
<i>R. austriaca</i>				
Great Britain	Waste ground by Thames (Chiswick)	—	16	HOWARD 1967
France	1 loc., cf. JONSELL 1968	—	16	JONSELL 1968
Denmark	1 loc., cf. JONSELL 1968	—	16	JONSELL 1968
	Copenhagen, Bot. gard.	—	16	MANTON 1932
Czechoslovakia	7 loc.	—	16	KRATOCHVÍLOVÁ 1969 <sup>6)</sup>
<i>R. islandica</i>				
Canada	Graham Island, 2 <sup>1</sup> / <sub>2</sub> mi S of Tlell	8 <sub>II</sub>	—	TAYLOR et MULLIGAN 1968
Greenland	Egaluit, SW Greenland	—	16	JÖRGENSEN et al. 1958
Iceland	without further particulars	—	16	LÖVE Á. et D. 1956
	3 loc., cf. JONSELL 1968	—	16	JONSELL 1968
Ireland	1 loc., cf. JONSELL 1968	—	16	JONSELL 1968
Great Britain	1 loc., cf. JONSELL 1968	—	16	JONSELL 1968

Norway	4 loc., cf. JONSELL 1968	—	16	JONSELL 1968
Germany	Munich (München), Bot. gard.	8	—	JARETZKY 1932
<i>R. palustris</i>				
Alaska	7 miles N. of Carcross, 60°16' N.; 134°44' W., Yukon Territory, occasional along margin of lake in mucky-gravelly area at 3 000 ft	—	32	MULLIGAN 1964 <sup>2</sup> )
	Mile 26 from Alaska Highway on road to Dawson, Yukon Territory, 61°08' N.; 135°21' W., occasional in grassy in open dwarf birch-willow flats at altitude 2 500 ft	—	32	MULLIGAN 1964 <sup>2</sup> )
	Fairbanks Quadrangle, Ballain's Rd., near junction with Yankovitch Rd., 64°53' N.; 147°50' W., Alaska, elevation ca 490 ft, dry roadside	—	ca 32	MULLIGAN 1964 <sup>2</sup> )
Canada	5 loc., cf. JONSELL 1968	—	32	JONSELL 1968
	Plaster Mines, Victoria Country, Nova Scotia, near gypsum outcrop	—	ca 32	MULLIGAN 1964 <sup>2</sup> )
	Val-Jalbert, comté du Lac St. Jean, Quebec	—	32	MULLIGAN 1964 <sup>2</sup> )
	Willow Beach, west of Port Hope, Ontario, sand beach of Lake Ontario	—	32	MULLIGAN 1964 <sup>2</sup> )
	Horton, Souris District, Manitoba, near railway tracks	—	32	MULLIGAN 1964 <sup>2</sup> )
	4 miles N. of Dubuc, Saskatchewan, slough perimeter	—	32	MULLIGAN 1964 <sup>2</sup> )
	Proctor Lake, Flathead, British Columbia, wet edge of slough	—	32	MULLIGAN 1964 <sup>2</sup> )
	8 loc., cf. JONSELL 1968	—	32	JONSELL 1968
U.S.A.	1 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Ireland	2 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Great Britain	Thames bank wall, Kew	—	32	HOWARD 1947 <sup>2</sup> )
	without further particulars	—	32	HOWARD 1950 <sup>2</sup> )
	3 loc., cf. JONSELL 1968	—	32	JONSELL 1968
France	4 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Netherlands	Prov. of Utrecht, near Fort Hoofddijk, de Bilt	—	32	GADELLA et KLIPHUIS 1966 <sup>2</sup> )
	Prov. of Drente, Churchyard Emmen	—	32	GADELLA et KLIPHUIS 1966 <sup>2</sup> )
	1 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Germany	marshy meadows of Einfeldler See	16	—	SCHAEERER 1939 <sup>3</sup> )
	5 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Denmark	without further particulars	—	32	JÖRGENSEN et al. 1958 <sup>2</sup> )
	11 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Sweden	84 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Norway	10 loc., cf. JONSELL 1968	—	32	JONSELL 1968

Country	Locality	n	2n	Author
Finland	41 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Poland	1 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Czechoslovakia	2 loc., cf. JONSELL 1968	—	32	JONSELL 1968
	16 loc.	—	32	KRATOCHVÍLOVÁ 1969 <sup>b</sup> )
Austria	1 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Switzerland	1 loc., cf. JONSELL 1968	—	32	JONSELL 1968
U.S.S.R.	2 loc., cf. JONSELL 1968	—	32	JONSELL 1968
	Primorskiy Kray, Vladivostok region	—	32	JONSELL 1971
Mongolia	Khentey Mts., Gacurt valley, 30 – 50 km NE. of Ulan Bator	—	32	JONSELL 1971
India	Srinagar, Saho	16	—	RAJ 1965
Zealand	without further particulars	—	32	JÖRGENSEN et al. 1958 <sup>2</sup> )
<i>R. pyrenaica</i>				
France	Lyon	—	16	MANTON 1932
	2 loc., cf. JONSELL 1968	—	16	JONSELL 1968
Romania	1 loc., cf. JONSELL 1968	—	16	JONSELL 1968
—	Balkan	—	16	MANTON 1932
Czechoslovakia	1 loc.	8	—	KRATOCHVÍLOVÁ 1969 <sup>b</sup> )
<i>R. silvestris</i>				
U.S.A.	Wood	16	—	EASTERLY 1963
Great Britain	Newry canal at Newry (border of Co. Down and Co. Armagh, N. Ireland)	24	48	HOWARD 1946
	Horton-in-Ribblesdale (Yorkshire)	24	—	HOWARD 1946
	Botanic Gardens at Cambridge and Kew	24	—	HOWARD 1946
	Newry, etc.	24	48	HOWARD 1947
	without further particulars	—	48	HOWARD 1950
	1 loc., cf. JONSELL 1968	—	48	JONSELL 1968
France	3 loc., cf. JONSELL 1968	—	32; 48	JONSELL 1968
Netherlands	Prov. of Utrecht, roadside between Utrecht and Bunnik	—	48	GADELLA et KLIPHUIS 1947
	1 loc., cf. JONSELL 1968	—	48	JONSELL 1968
Germany	Munich	—	32	MANTON 1932
Denmark	7 loc., cf. JONSELL 1968	—	32; 48	JONSELL 1964, 1968
Norway	8 loc., cf. JONSELL 1968	—	32; 40; 48	JONSELL 1964, 1968
Sweden	35 loc., cf. JONSELL 1968	—	32; 40; 48	JONSELL 1964, 1968

Finland	3 loc., cf. JONSELL 1968	—	32; 48	JONSELL 1964, 1968
Hungary	without further particulars	—	32	PÓLYA 1948
	3 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Romania	1 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Yugoslavia	2 loc., cf. JONSELL 1968	—	32	JONSELL 1968
	near Avala, S. of Beograd	—	32	LARSEN 1956 <sup>5)</sup>
Portugal	3 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Czechoslovakia	28 loc.	—	32; 40	KRATOCHVÍLOVÁ 1969 <sup>6)</sup>
<i>R. amphibia</i> × <i>R. austriaca</i>				
Czechoslovakia	5 loc.	—	24; 32	KRATOCHVÍLOVÁ 1969 <sup>6)</sup>
<i>R. amphibia</i> × <i>R. palustris</i>				
Great Britain	Thames bank wall, Kew	8-10 <sub>I</sub> + + 7-8 <sub>II</sub>	24	HOWARD 1947 <sup>4)</sup>
	1 loc., cf. JONSELL 1968	—	32	JONSELL 1968
<i>R. amphibia</i> × <i>R. silvestris</i>				
Great Britain	5 loc., cf. JONSELL 1968	—	32; 40	JONSELL 1968
Sweden	34 loc., cf. JONSELL 1968	—	32; 40	JONSELL 1968
Finland	1 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Czechoslovakia	6 loc.	—	32	KRATOCHVÍLOVÁ 1969 <sup>6)</sup>
<i>R. austriaca</i> × <i>R. silvestris</i>				
Denmark	2 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Norway	2 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Sweden	1 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Finland	1 loc., cf. JONSELL 1968	—	32	JONSELL 1968
Czechoslovakia	5 loc.	—	24; 32	KRATOCHVÍLOVÁ 1969 <sup>6)</sup>

1)–5) published under the name: 1) *Nasturtium amphibium*; 2) *Rorippa islandica*; 3) *Nasturtium palustre*; 4) *Rorippa* × *erythrocaulis*; 5) *Rorippa islandica* (cf. JONSELL 1968).

6) All author's localities have been included in the present paper.



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See also plate VIII. in the appendix.

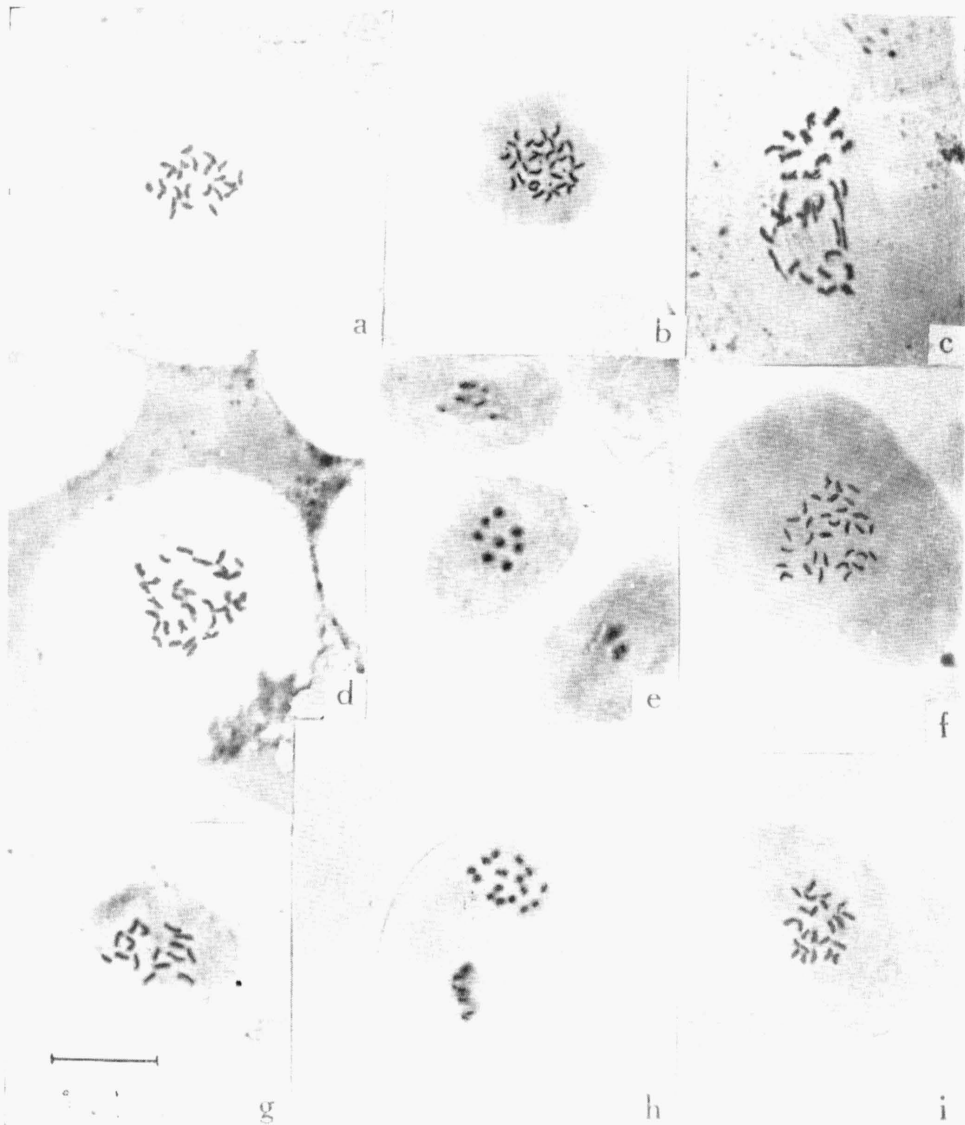


Plate VIII. — Somatic metaphases: a, i; *R. amphibia* × *R. austriaca* (loc. No. 5); b; *R. palustris* (loc. No. 9); c; *R. amphibia* (loc. No. 25); d; *R. silvestris* (loc. No. 26); f; *R. silvestris* (loc. No. 25); g; *R. austriaca* (loc. No. 8); — PMC's meioses: e; *R. pyrenaica* (loc. No. 1), 8<sub>II</sub>; h; *R. silvestris* (loc. No. 14), metaphase II. — Scale = 10 μm. — Photo J. MĚSÍČEK.

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