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Karyological studies in some *Hypochoeris* spp. (*Compositae*) from Sicily

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Abstract: Five *Hypochoeris* spp. from Sicily have been investigated: *H. glabra* L. (2n = 10), *H. radicata* L. (2n = 8), *H. cretensis* L. (2n = 6), *H. laevigata* L. (2n = 12), *H. robertia* Fiori (2n = 8). Basic chromosome numbers are very variable, x = 3, 4, 5, 6. The karyotype of each species is presented. Geographical origin (S. America or Mediterranean region) of the genus *Hypochoeris* and the taxonomic position of *H. robertia* are discussed.

Forty *Hypochoeris* spp. with different chromosome numbers (x = 3, 4, 5, 6) occur in the Mediterranean area and S. America. The primary geographical origin of the genus *Hypochoeris* has been discussed in detail by Stebbins (1971) who suggested that it could be S. America where a large number of well differentiated species of the most primitive subgenus occur. The Mediterranean region, where ten species of four or five sugenera and other related genera are found, is also a probable area of origin. Karyological data then led Stebbins (1971) to propose the Mediterranean area as the centre of origin: basic chromosome numbers are variable (x = 3, 4, 5), karyotypes are symmetrical, while in S. America only one basic number (x = 4) exists and the karyotypes are very asymmetrical.

In a previous comparative karyological study of some populations of the *Hypochoeris maculata* L. complex from Yugoslavia we reported the very few occurrences of polyploids known in the genus (Mugnier & Siljak-Yakovlev 1987).

Materials and methods

Origins of the species investigated and their general geographical distribution are given in Table 1. Voucher specimens are preserved in the personal herbaria of the authors and living specimens are grown in the Experimental Botanical Garden of Paris XI University.

Root-tips meristems were pretreated with 0.002 M 8-hydroxyquinoline during 3 h for *H. laevigata* and 4 h for the other species at room temperature. Fixation was in 3 : 1 ethanol-acetic acid for 24–48 h and then stored in 70° ethanol at 4 °C. Hydrolysis was performed at 60 °C with NHCl (10–12 min) and stained following Feulgen method.

The determination of pairs of homologous chromosomes and their position in the karyograms was obtained with the method of Levan & al. (1964). The idiograms were made from the measurements on ten metaphase plates for each taxon. Statistical analysis

Table 1. Origins of the *Hypochoeris* material investigated and general geographical distribution

Species	2n	Origin	General geographical distribution
H. glabra L.	10	Sicily, Mt Quacella, 1850m SL 8. 6. 1983	Europe, N.W. to S.E.
H. radicata subsp. *neapolitana* (DC.) GUADAGNO	8	Sicily, Mt Quacella, 1850m SL 8. 6. 1983	Italy, Sicily
H. radicata L. s. str.	8	France, Les Ulis, 150m SL 8. 8. 1986	Most of Europe except the north-coast
H. cretensis (L.) BORY & CHAUB.	6	Sicily, Mt Portella Mandarine, 1450m SL 9. 6. 1983	E. and C. Mediterranean region
H. laevigata (L.) CESATI, PASSER & GIBELLI	12	Sicily, Mt Quacella, 1850m SL 8. 6. 1983 Mt Portella Mandarini, 1450m SL 9. 6. 1983	Italy, Sicily, N. Africa
H. robertia FIORI	8	Sicily, Mt Etna, 1900m SL 10. 6. 1983	Paleoendemic of Tyrrhenian Islands, Italy, Sicily N. Tunisia

of numerical data carried out by a computer program (SILJAK-YAKOVLEV & YAKOVLEV 1981) allowed the construction of tables giving the average values (μm) of long and short arm lengths with their respective standard errors, total and relative lengths, average of the ratio long arm/short arm, centromeric index, morphological type of each chromosome pair, and finally the plotting of the corresponding idiogram.

Karyotype asymmetry index (AsI %) was calculated by the formula long arms in chromosome set/chromosome length in its set × 100 (ARANO & SAITO 1980). R represents the ratio longest pair/shortest pair.

Results and discussion

Karyotype data for each taxon are reported in Table 2. We found chromosome numbers that confirm the data reported in the literature (e.g., DE FILIPPS 1976). Great variation in basic chromosome number within the genus *Hypochoeris*, where x = 5 is considered as the most ancient (STEBBINS & al. 1953), is revealed in Sicily.

Hypochoeris glabra (Fig. 1, Table 3), 2n = 10 = 6m + 2sm + 2sm-sat. The same number was reported also by BRULLO & al. (1979) in another Sicilian population of the litoral, where the third pair of chromosomes was not m but sm (4m + 4sm + 2sm-sat). The karyotype is very symmetrical, AsI = 61.7%.

The population of ***H. radicata*** (2n = 8) collected in Sicily (Fig. 2, Table 4) has been compared with a population from Les Ulis, France, near Paris (Fig. 3, Table 5). Chromosome formula is 2m + 2m-sm + 2sm + 2sm-sat for the first population (Monte Quacella), and 4m + 2m-sat + 2sm for the second (Les Ulis). The two karyotypes show a great similarity. However, some slight differences can be ob-

Table 2. Karyotype features of the *Hypochoeris* spp. investigated. *AsI* Asymmetry index, *R* ratio longest pair/shortest pair

Species	2n	Chromosome set	AsI	R
H. glabra	10	6 m + 2 sm + 2 sm-sat	61.7	1.3
H. radicata subsp. *neapolitana*	8	2 m + 2 m-sm + 2 sm + 2 sm-sat	62.4	1.5
H. radicata s. str.	8	4 m + 2m-sat + 2 sm	61.7	1.4
H. cretensis	6	4 m + 2 m-sat	56.1	1.8
H. laevigata	12	4 m + 4 sm + 2 sm-sat + 2 st-sat	63.6	1.7
H. robertia	8	2 m + 4 sm-sat + 2 st-sat	71.9	4.5

Table 3. Morphometric data on chromosomes of *Hypochoeris glabra*

Chromosome pair	Long arm (μm) (S.E.)	Short arm (μm) (S.E.)	Total length (μm)	Relative length (%)	Arm ratio L/S	Centromere index	Chromosome type
I	3.75 (0.068)	1.59 (0.038)	5.34	226.14	2.37	29.76	sm
II	3.18 (0.086)	1.72 (0.034)	4.90	207.39	1.86	35.11	sm-sat
III	2.86 (0.086)	1.95 (0.067)	4.82	204.08	1.48	40.54	m
IV	2.63 (0.067)	1.99 (0.036)	4.62	195.81	1.32	43.10	m
V	2.16 (0.078)	1.77 (0.068)	3.93	166.57	1.22	45.03	m

Table 4. Morphometric data on chromosomes of *Hypochoeris radicata* subsp. *neapolitana*

Chromosome pair	Long arm (μm) (S.E.)	Short arm (μm) (S.E.)	Total length (μm)	Relative length (%)	Arm ratio L/S	Centromere index	Chromosome type
I	2.89 (0.217)	1.63 (0.116)	4.52	296.94	1.77	36.15	sm
II	2.59 (0.173)	1.50 (0.069)	4.09	268.51	1.72	36.75	sm-m
III	2.36 (0.122)	1.26 (0.056)	3.62	237.80	1.88	34.78	sm-sat
IV	1.67 (0.081)	1.32 (0.064)	3.00	196.75	1.26	44.20	m

Table 5. Morphometric data on chromosomes of *Hypochoeris radicata* (Les Ulis)

Chromosome pair	Long arm (µm) (S.E.)	Short arm (µm) (S.E.)	Total length (µm)	Relative length (%)	Arm ratio L/S	Centromere index	Chromosome type
I	2.91 (0.077)	1.63 (0.062)	4.53	287.53	1.80	35.89	sm
II	2.60 (0.066)	1.58 (0.040)	4.17	264.80	1.65	37.82	m
III	2.41 (0.082)	1.47 (0.045)	3.88	246.17	1.65	37.84	m-sat
IV	1.81 (0.114)	1.37 (0.043)	3.18	201.51	1.34	43.02	m

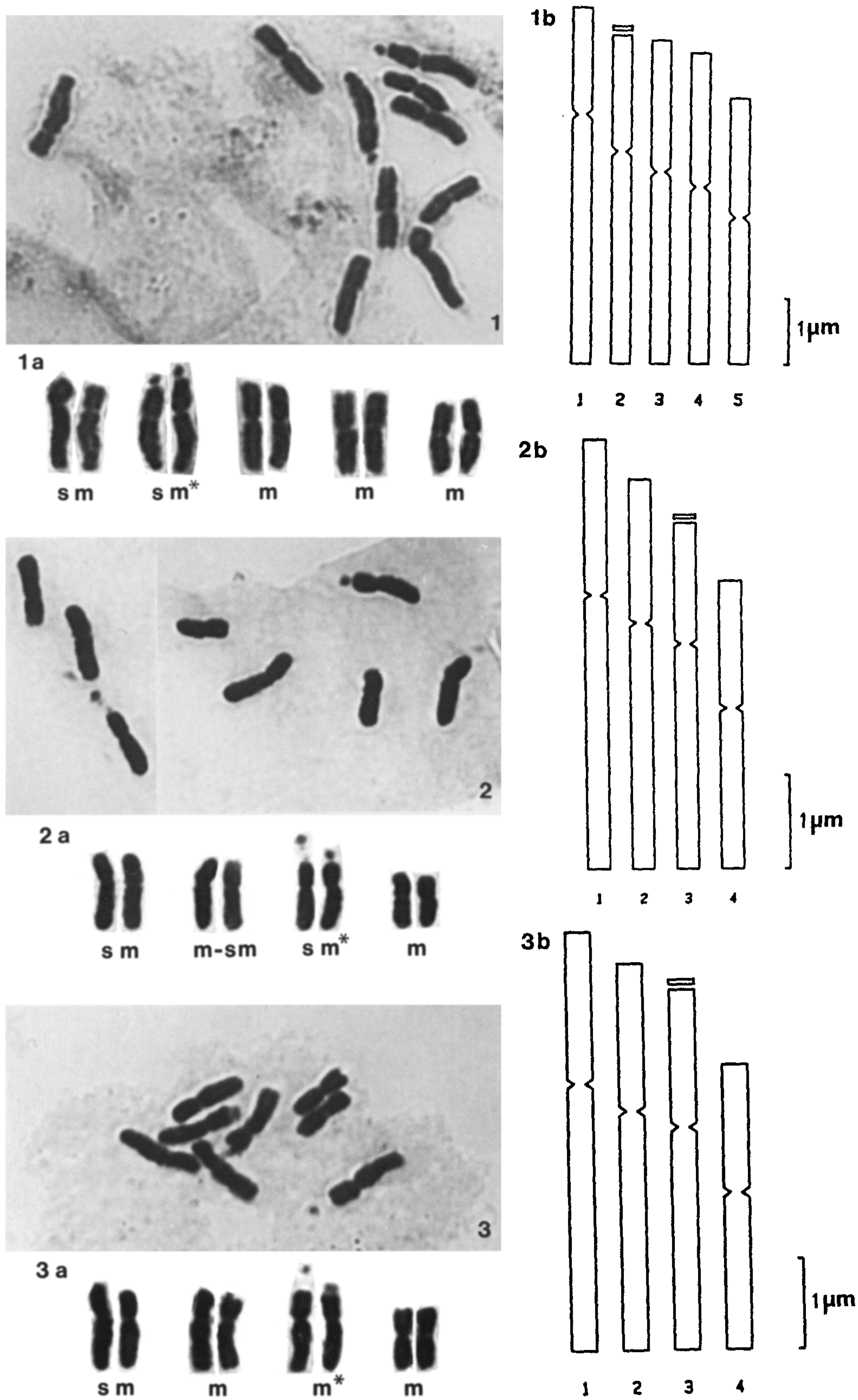
Table 6. Morphomeric data on chromosomes of *Hypochoeris cretensis*

Chromosome pair	Long arm (µm) (S.E.)	Short arm (µm) (S.E.)	Total length (µm)	Relative length (%)	Arm ratio L/S	Centromere index	Chromosome type
I	3.10 (0.100)	2.63 (0.078)	5.73	458.75	1.18	45.87	m
II	2.07 (0.104)	1.55 (0.051)	3.63	290.00	1.34	42.82	m
III	1.84 (0.129)	1.30 (0.052)	3.14	251.25	1.42	41.46	m-sat

served. In the population from Monte Quacella (*H. radicata* subsp. *neapolitana*) the second and third pairs of chromosomes are submetacentric, while they are metacentric in *H. radicata* s. str. from Les Ulis. In the population of Monte Quacella AsI = 62.4% and R = 1.5. In the population of Les Ulis AsI = 61.7% and R = 1.4. Somewhat more asymmetry of karyotype was noticed in the first population.

Our results are different from those of DVORAK & DADAKOVA (1977) in two Little Carpathian populations with $2n = 8 = 8A^m$ (chromosome nomenclature of CHATTERJEE & SHARMA 1969). All the eight chromosomes are metacentric and satellites are observed in the second pair (on the third in our populations). Our results agree with those of BRULLO & al. (1977) in a Sicilian population from

Figs. 1 – 3. *Hypochoeris* spp. * Sat-chromosomes. – Fig. 1. Metaphase chromosomes of *H. glabra* (× 2 400). *a* Corresponding karyogram, and *b* idiogram. – Fig. 2. Metaphase chromosomes of *H. radicata* from Monte Quacella (× 2 400), corresponding karyogram (2 a), and idiogram (2 b). – Fig. 3. Metaphase chromosomes of *H. radicata* from Les Ulis (× 2 400). *a* Corresponding karyogram, and *b* idiogram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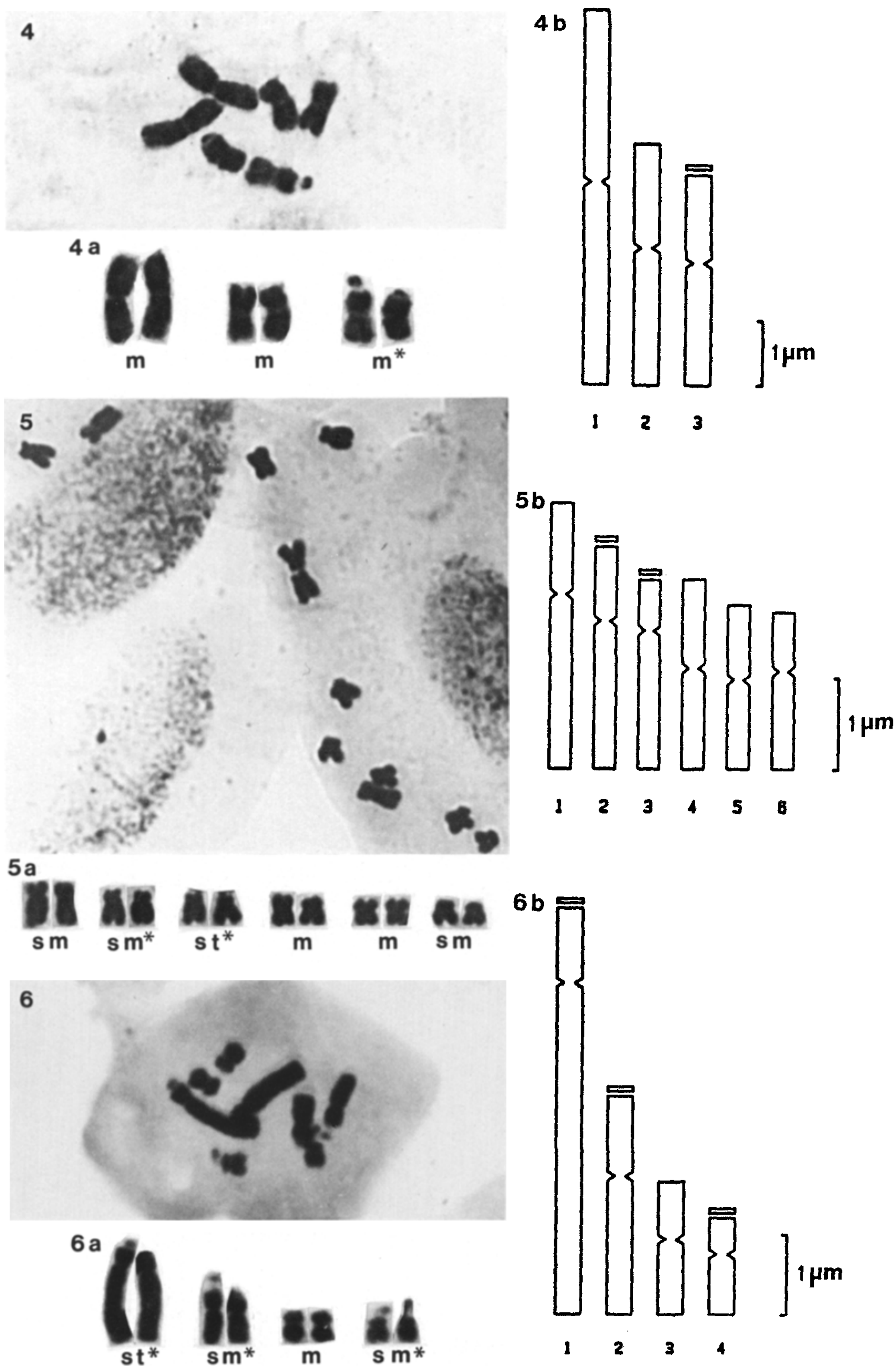
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Table 7. Morphometric data on chromosomes of *Hypochoeris laevigata*

Chromosome pair	Long arm (μm) (S.E.)	Short arm (μm) (S.E.)	Total length (μm)	Relative length (%)	Arm ratio L/S	Centromere index	Chromosome type
I	1.85 (0.123)	0.94 (0.061)	2.80	226.74	1.97	33.78	sm
II	1.56 (0.159)	0.76 (0.039)	2.32	188.11	2.06	32.63	sm-sat
III	1.46 (0.104)	0.50 (0.063)	1.96	158.93	3.01	25.58	st-sat
IV	1.05 (0.066	0.92 (0.063)	1.97	159.50	1.15	46.68	m
V	0.92 (0.088)	0.76 (0.069)	1.68	136.63	1.21	45.34	m
VI	1.01 (0.097)	0.59 (0.035)	1.60	130.10	1.71	36.80	sm

Table 8. Morphometric data on chromosomes of *Hypochoeris robertia*

Chromosome pair	Long arm (μm) (S.E.)	Short arm (μm) (S.E.)	Total length (μm)	Relative length (%)	Arm ratio L/S	Centromere index	Chromosome type
I	4.10 (0.136)	0.89 (0.030)	4.98	487.21	4.65	17.79	st-sat
II	1.67 (0.092)	0.94 (0.041)	2.60	254.58	1.79	36.00	sm-sat
III	0.88 (0.029)	0.66 (0.031)	1.55	151.17	1.34	42.96	m
IV	0.70 (0.034)	0.40 (0.014)	1.09	107.04	1.76	36.36	sm-sat

Messina (Biviere di Cesaro, 1 400 m s.m.). The slight karyotype differences between the two populations of *H. radicata* investigated reflect their geographical and ecological differentiation.

H. cretensis (Fig. 4, Table 6) has the lowest basic chromosome number of the

Figs. 4–6. *Hypochoeris* spp. – Fig. 4. Metaphase chromosomes of *H. cretensis* (× 2 400). *a* Corresponding karyogram, and *b* idiogram. – Fig. 5. Metaphase chromosomes of *H. laevigata* (× 2 400). *a* Corresponding karyogram, and *b* idiogram. – Fig. 6. Metapahase chromosomes of *H. robertia* (× 2 400). *a* Corresponding karyogram, and *b* idiogram. * Sat-chromosomes genus, x = 3. The chromosome morphology, 2n = 6 = 4m + 2m-sat, signifies a high karyotype symmetry morphology (AsI = 56.1%); in respect to chromosome length (one long pair and two short) the karyotype is asymmetrical (R = 1.8). Our results confirm those obtained by Brullo & al. (1977) in another population of Sicily (Monte Nebrodi, 1300 m s.m., near Messina), where the first pair is sub- not metacentric. We think that the largest pair (1) could originate from a fusion of two shorter pairs of chromosomes. The fusion could be the reason of the reducted basic number, and also of the secondary morphologic symmetry of the chromosomes (all 6 metacentric), leading to the high difference in length between the first pair and the others of complement.

H. laevigata (Fig. 5, Table 7) has 2n = 12 = 4m + 4sm + 2sm-sat + 2st-sat. The karyotype is characterized by three pairs of metacentric (4, 5, and 6), two pairs of submetacentric (1 and 2) and one pair of subtelocentric chromosomes (3). The satellites were observed on the second and the third pair of chromosomes. Brullo & al. (1977) had previously observed similar karyotype characteristics in a population from Monte Soro (1600 m s.m., near Messina), but satellites were on the pairs 3 and 4, only the second pair was metacentric, pairs 1, 4, 5, 6 were submetacentric. *H. laevigata* could be a tetraploid with the basic number x = 3.

H. robertia (Fig. 6, Table 8) is a paleoendemic of the Tyrrhenian Islands, the Italian peninsula, Sicily and a small part of the Tunisian litoral, with 2n = 8 = 2m + 4sm-sat + 2st-sat.

Loiseleur-Deslongchamps (1806 – 1807) first described it as *Seriola taraxacoides*. Then De Candolle (1815) considered it as monospecific (*Robertia taraxacoides* DC.). Later, Pampanini (1947), Martinoli (1953), and recently Pignatti (1982) had the same opinion. Other authors, e.g. Bentham & Hooker (1873), followed by Fiori & Beguinot (1910), placed it as a species in the genus *Hypochoeris*. This concept was finally adopted by De Filipps (1976) in "Flora Europaea".

The karyotype is unusual with its great chromosome length asymmetry as previously noted by Contandriopoulos (1962). The ratio longest pair/shortest pair is very high, R = 4.5 and AsI = 71.9%. It is worth-while to note that this species possesses three satellited pairs of chromosomes while the other diploids exhibit only one.

The strongly asymmetrical and bimodal karyotype totally differs from all other karyotypes described for European species. However, it is very similar to those of *Hypochoeris* spp. from S. America (Saez 1949), and especially with *H. brasiliensis* (Stebbins 1953, 1971). Thus, the systematic and evolutionary position of *H. robertia* might be revised, considering Stebbin's hypothesis on evolutionary trends in the genus *Hypochoeris*, and also in relation with other taxonomists who recognize a separate genus. From our karyological investigations, we could consider it as a species belonging to a well defined genus, *Robertia*, which could include S. American species having the same karyotype characteristics. In this context, *Robertia taraxacoides* might be considered as a member of the ancestral stock from which American species could have arisen. Such an hypothesis surely needs more information on S. American species.

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