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Chromosome numbers and karyotypes in Arum (Araceae)

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Chromosome numbers and karyotypes in *Arum* (Araceae)

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SUMMARY — Chromosome morphology was studied in five species of the genus *Arum* (Araceae). The karyotypes of *Arum orientale* ($2n = 28$), *A. alpinum* ($2n = 28$) and *A. nigrum* ($2n = 28$) were very similar. *A. pictum* ($2n = 28$) is composed of a higher number of asymmetric chromosomes. The karyotype of *A. maculatum* ($2n = 56$) shows great similarities to the karyotypes of *A. orientale* and *A. alpinum*.

INTRODUCTION

The genus *Arum* is composed of about fifteen taxa in Europe (PRIME 1982) and includes diploid and polyploid types.

Recently BOYCE (1989) divided the genus *Arum* into two subgenera (*Arum* and *Gymnomesium*) based on the different flowering of *A. pictum* which is the only species of the subgenus *Gymnomesium*. Moreover, sectional separation is on the basis of tuber structure with horizontal-rhizomatous tubers in polyploid species ($2n = 56$, $2n = 84$) and vertical-discoid tubers in diploid species ($2n = 28$) (BEDALOV 1973*b*, 1975*a*, 1975*b*, 1981).

In the present paper karyotypes of *A. orientale, A. alpinum, A. nigrum, A. pictum* and *A. maculatum* are investigated and compared.

MATERIAL AND METHODS

The plants were either collected from nature or from material kept in the Botanical Garden of the University of Zagreb. Plants, chromosome numbers and karyotypes observed are reported in Table 1. Root tips were pretreated with 0.3% colchicine at room temperature for 2 h, then fixed for 5 min in ethyl alcohol 100%, chloroform, glacial acetic acid, formalin mixture (5,1,1,1 v/v) (BATTAGLIA 1957*a*). Hydrolysis was made at cold in concentrated HCl diluted 1:1 with distilled water (approx. 18%) for 20 min (BATTAGLIA 1957*b*), followed by staining with Feulgen. The karyotype was constructed from well-spread metaphase plates. Nomenclature adopted by LEVAN *et al.* (1964) was followed for recognizing chromosome types.

RESULTS

Arum orientale. — Somatic analysis at root tip mitosis revealed $2n = 28$ chromosomes (Fig. 1). The karyotype consists of $6m + 4m_{sc} + 2m^s_s + 8sm + 6sm^s + 2sm_{sc}$ (Figs. 3 and 12a). The lengths of the chromosomes range from 5.40 to 3.10 µm. Pairs 1, 4 and 8 have secondary constrictions on the long arm; pairs 3, 11 and 12 have a satellite on the short arm; pairs 14 has a satellite on the short arm and a microsatellite on the long arm.

Arum alpinum. — At metaphase 28 chromosomes are seen (Fig. 2). Size varies from 4.80 to 2.95 µm. The karyotype of this species consists of $12m + 2m_{sc} + 2m^s_s + 8sm + 2sm^s + 2st_{sc}$ chromosomes (Figs. 4 and 12b). Pairs 1 and 9 have a secondary constriction on the long arm; pair 12 has a satellite on the short arm and pair 14 has a satellite on the short arm and microsatellite on the long arm.

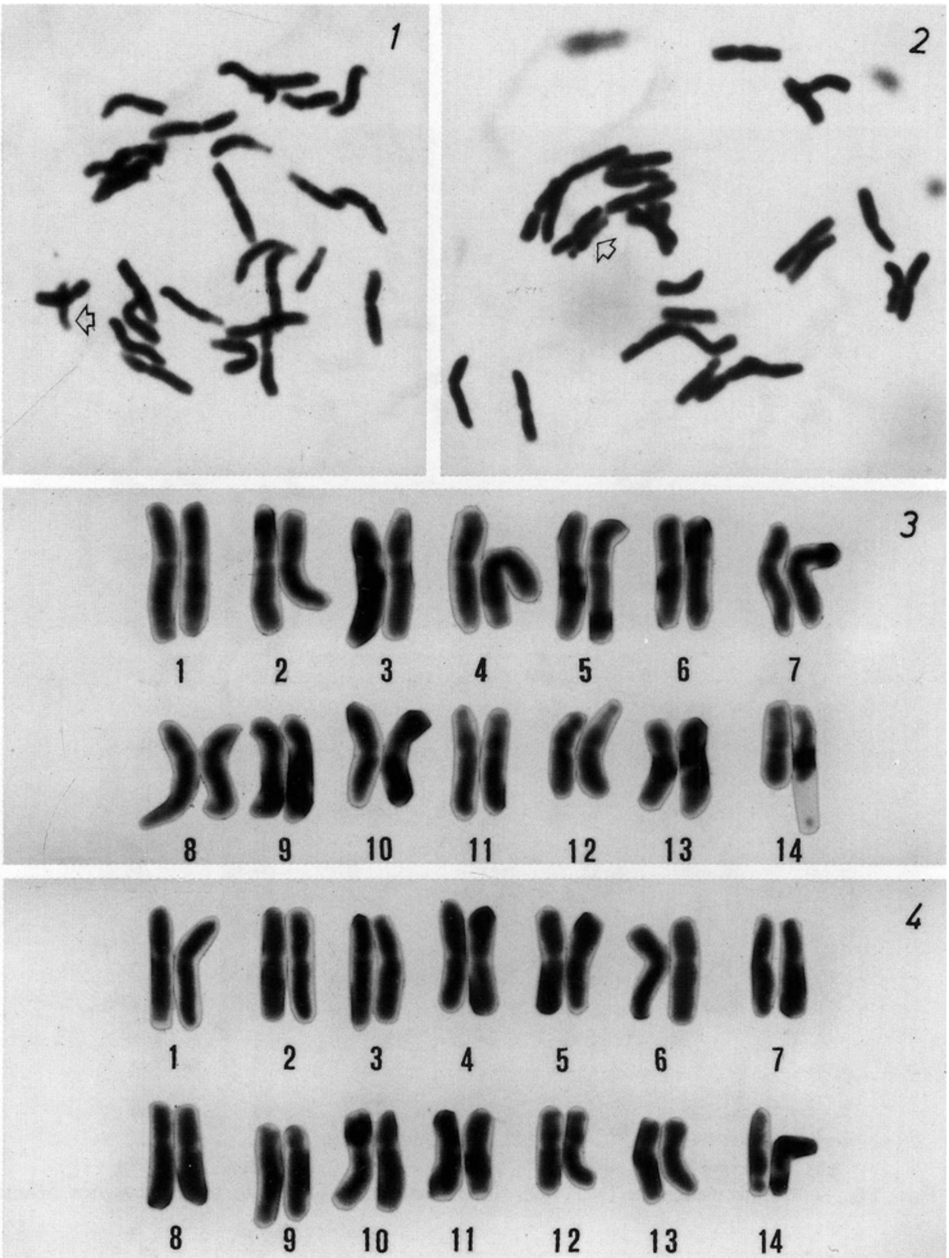
Arum nigrum. — The chromosome number observed was $2n \doteq 28$ (Fig. 5). Size varies from 6.40 to 3.42 µm. The karyotype consists of $14m + 2m^s + 2m_{sc} + 2sm + 4sm^s + 2sm_{sc} + 2sm^s_s$ chromosomes (Figs. 6 and 12c). Pairs 7 and 11 have a secondary constrictions on the long arm; pairs 1, 5, 12 and probably pair 7 have satellite on the short arm; pairs 14 has secondary constriction on the long arm and microsatellite on the short arm.

Arum pictum. — The analysis showed $2n = 28$ chromosomes at metaphase (Figs. 7-8). Size varies from 5.00 to 2.65 µm. The karyotype of the species consists of $8m + 2m^{sc} + 2m^s_s + 6sm + 2sm^s + 6st + 2st_{sc}$ chromosomes (Figs. 9 and 12d). Pair 1 has a secondary constriction on the short arm; pair 5 has a secondary constriction on the long arm; pair 9 has a microsatellite on the short arm and pair 14 has a satellite on the short arm and a microsatellite on the long arm.

TABLE 1 - List of plants, chromosome numbers and karyotypes of the *Arum* examined.

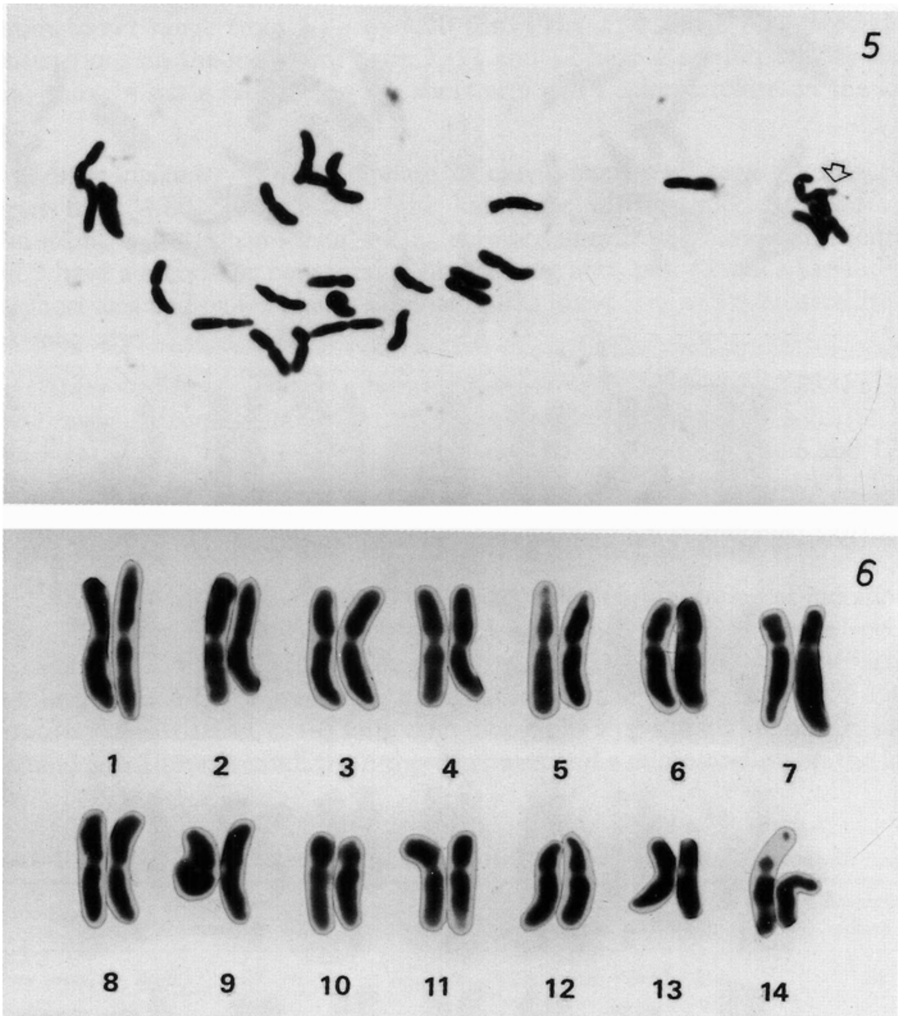
Species	Chromosome numbers ($2n$)	Karyotypic formula	Asymmetry indices %
Arum orientale Bieb.	28	$6m + 4m_{sc} + 2m^s_s + 8sm + 6sm^s + 2sm_{sc}$	61
A. alpinum Schott et Kotschy	28	$12m + 2m_{sc} + 2m^s_s + 8sm + 2sm^s + 2st_{sc}$	61
A. nigrum Schott	28	$14m + 2m^s + 2m_{sc} + 2sm + 4sm^s + 2sm_{sc} + 2sm^s_s$	60
A. pictum L.f.	28	$8m + 2m^{sc} + 2m^s_s + 6sm + 2sm^s + 6st + 2st_{sc}$	65
A. maculatum L.	56	$22m + 6m_{sc} + 12sm + 6sm^s + 2sm_{sc} + 2sm^s_s + 4st + 2st_{sc}$	63

s = satellite
sc = secondary constriction.

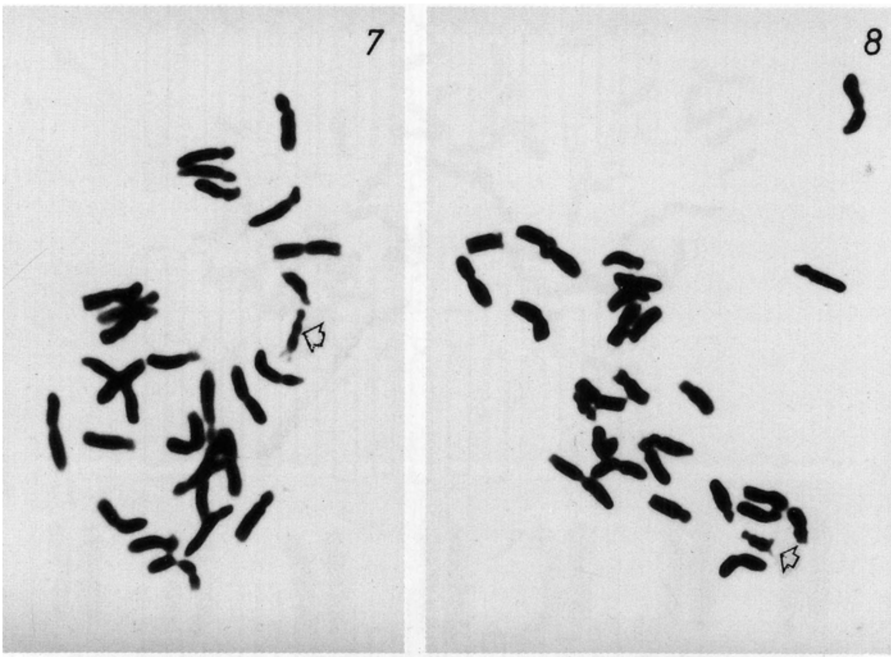


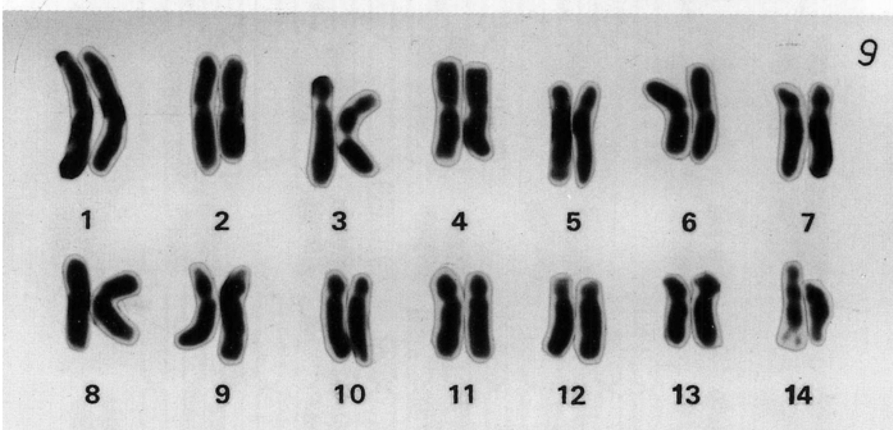
Figs. 1 and 3. — Mitotic metaphase (× 2000); diploid karyotype (× 3000) of *Arum orientale* Bieb.

Figs. 2 and 4. — Mitotic metaphase (× 2000); diploid karyotype (× 3000) of *Arum alpinum* Schott et Kotschy.



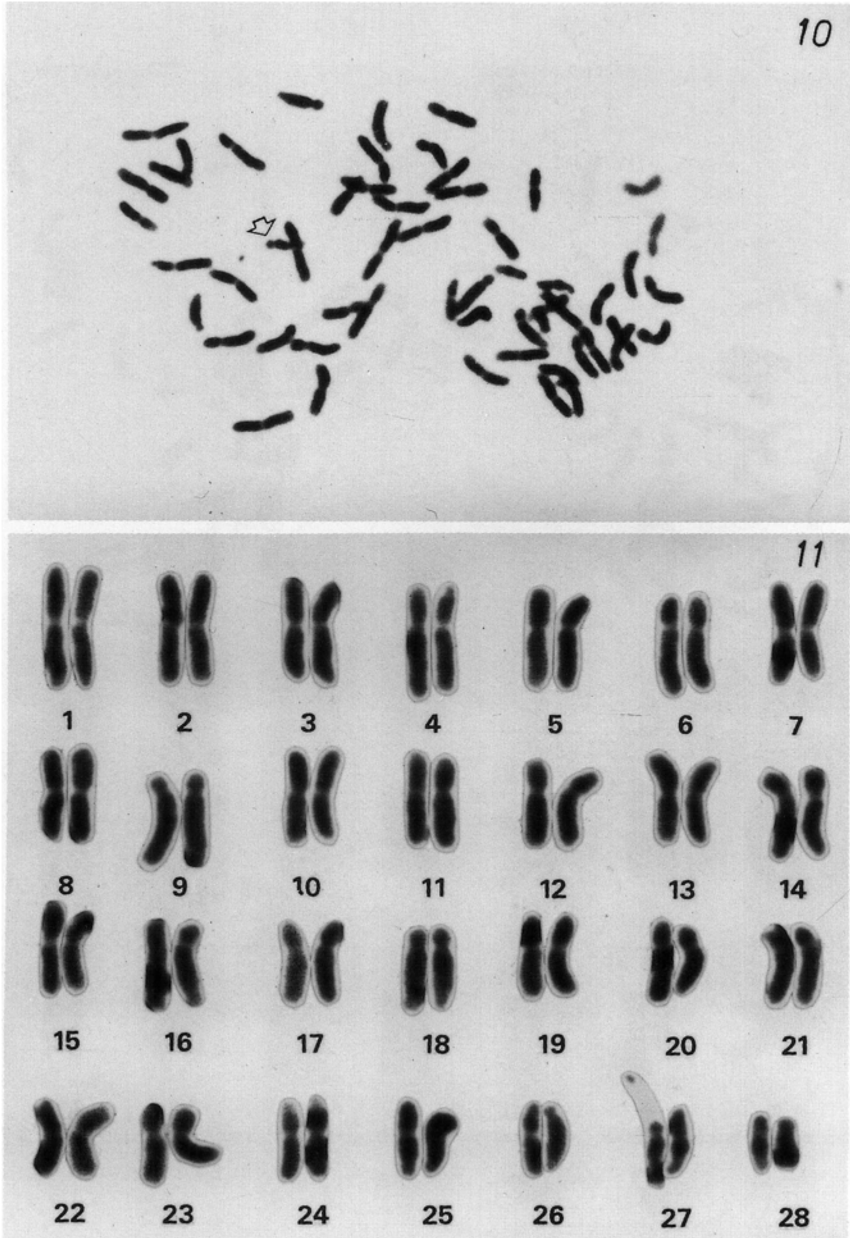
Figs. 5-6. — Mitotic metaphase (× 1400); diploid karyotype (× 3000) of *Arum nigrum* Schott.





Figs. 7-8. — Mitotic metaphase (× 2000).

Fig. 9. — Diploid karyotype (× 3000) of *Arum pictum* L. f.



Figs. 10-11. — Mitotic metaphase (× 1700); diploid karyotype (× 3000) of *Arum maculatum* L.

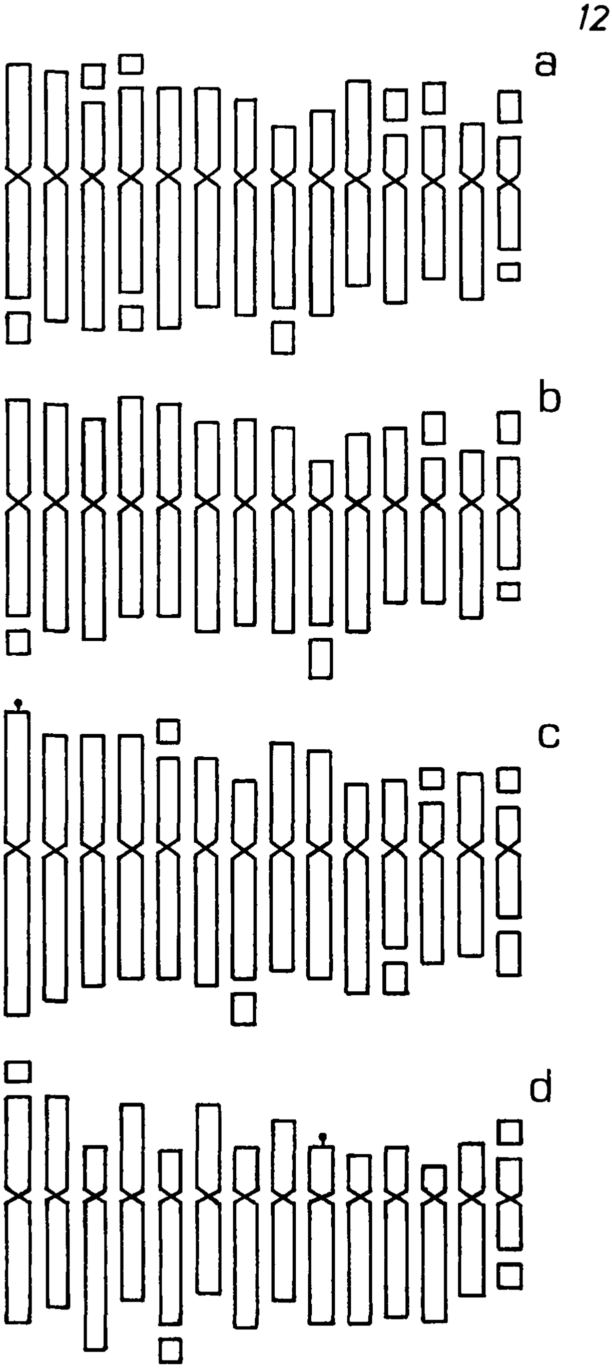


Fig. 12. — Idiograms of a) *Arum orientale* Bieb., b) *A. alpinum* Schott et Kotschy, c) *A. nigrum* Schott, d) *A. pictum* L. f.

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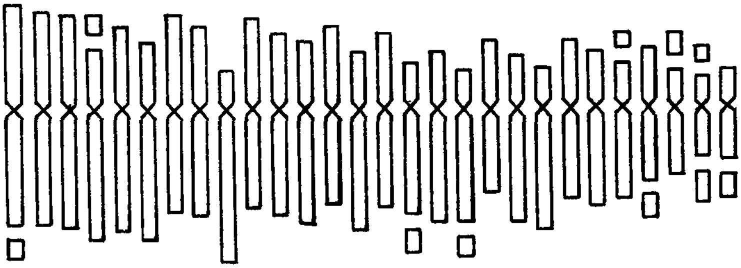

Fig. 13. — Idiogram of *Arum maculatum* L.

Arum maculatum. — The species showed $2n = 56$ chromosomes (Fig. 10). Size varies from 4.80 to 2.00 μm. The karyotype consists of $22m + 6m_{sc} + 12sm + 6sm^{s} + 2sm_{sc} + 2sm^{s}_{s} + 4st + 2st_{sc}$ (Figs. 11 and 13). Pairs 1, 16, 18, 25 and 28 have a secondary constrictions on the long arm; pairs 4, 24, 26 have a satellite on the short arm and pair 27 has a microsatellite on the short arm and a secondary constriction on the long arm.

DISCUSSION AND CONCLUSIONS

Our analyses revealed $2n = 28$ chromosomes in *Arum orientale, A. alpinum, A. nigrum, A. pictum* and $2n = 56$ in *A. maculatum* according to literature (PRIME 1961; LOVE *et al.* 1961, 1973; CONTANDRIOPOULOS 1962; ERBRICH 1965; BOLKHOVSKIKH *et al.* 1969; ZAHARIYEVA *et al.* 1969; TARNAVSCHI *et al.* 1970; WEISLO 1970; BEURET 1971, 1972, 1977; LOVKA *et al.* 1971; MARCHI 1971; NILSSON *et al.* 1971; TERPÒ 1971, 1973; MARCHANT 1972; BEDALOV 1973*a*, 1973*b*, 1975*a*, 1975*b*, 1976, 1977, 1978, 1980, 1981, 1982, 1983; KONONOV *et al.* 1974). In the above mentioned works only chromosome numbers have been reported, while the first paper on *Arum* species karyotypes was published by MONTI *et al.* (1978).

The analyzed diploid karyotypes of *A. orientale*, *A. alpinum* and *A. nigrum* are morphologically very similar; moreover they are characterized by the presence of lightly Feulgen-stained segments in some chromosomes. It is necessary to note a considerable similarity of the asymmetry indices in *A. orientale* and *A. alpinum* (Table 1), while *A. nigrum* differs from the other two diploids for a more symmetric karyotype.

The karyotype of *A. pictum*, compared to the other investigated species, is composed of a higher number of asymmetric chromosomes. This is in agreement with the results obtained from analysis made on similar materials by MONTI *et al.* (1978). The asymmetric karyotype of *A. pictum* suggests a recent origin of the species (STEBBINS 1971), and probably its structure has been derived, during evolution, from an ancestral parent by chromosome rearrangements without alteration of the basic number (FAVARGER and SILJAK-YAKOVLEV 1986).

The karyotypes of these four diploid species and the ones of the other species we are investigating (unpublished data) show some marker-chromosomes. In particular, in every species, pair 14 is constituted by chromosomes with a satellite on the short arm and another satellite on the long arm.

The chromosomes morphology in *A. maculatum*, $2n=56$, is very much similar to those reported for *A. orientale* and *A. alpinum*. The chromosomes of the tetraploid can be divided into sets of two supporting an allopolyploid origin. In this polyploid, too, a chromosome pair with a satellite on the short arm and a satellite on the long arm has been found.

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