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The genus *Allium* in Cyprus: a preliminary cytotaxonomical study

According to the most recent survey of the Flora of Cyprus (Meikle 1985) the genus *Allium* is represented in the island by 19 species. Taking however into consideration further taxonomic studies and revisions dealing with Mediterranean *Allium* (Stearn 1978, Kollmann 1984, Brullo & al. 1991, 1993) the number of *Allium* species known, up to the present, from this island increases to 22.

Having studied the genus *Allium* in Greece for more than 12 years the IV OPTIMA Iter to Cyprus was a good opportunity for me to expand my studies to this neighbouring region.

It is to pointed out however that the results given in the present paper are considered preliminary because (1) the period in which the IV OPTIMA Iter took place (April) is not the best suited for *Allium* collecting since most species come to flower much more later; and (2) no collections have been made from the northern part of the islands which is occupied by the Turkish army since 1974.

Material and methods

The material studied (herbarium specimens and living bulb for cytological studies) was collected: (1) during the IV OPTIMA Iter to Cyprus, 10-30 April 1991 (OPT); (2) by Mr Polyviou (Pol.), a Cypriot PhD student at our Institute in Patras (1987, 1989, 1990); and (3) by staff of the Forest Department of Cyprus (Nikosia) who send it to me: Chatzikyriakou (Chatz.) and Christodoulou (Christ.).

The taxonomic treatment of the material is mainly in accordance with Meikle (1985). In two cases only, *A. pallens* and *A. guttatum*, we follow the nomenclature adopted by Stearn (1978) and Kollmann (1984).

For the study of mitotic chromosomes, root-tips were obtained from potted bulbs and were pre-treated for 6-8 hrs in saturated solution of a-bromonaphthalene. After an overnight fixation in acetic-alcohol (1 : 3) the root tips were stained with the routine Feulgen method.

For chromosome nomenclature (identification of centromeric position) we follow Levan & al. (1965). The classification and the nomenclature of the nucleolar organizer chromosomes are in accordance with Tzanoudakis (1983).

In the karyograms (Fig. 1-5) the chromosomes have been classified in groups by means of their centromeric position (metacentric, submetacentic, subtelocentic), and within each group according to decreasing chromosome length.

Table 1. Chromosome numbers and origin of the *Allium* populations investigated.

TAXON	COLLECTION SITE	2*n*
A. sect. *Molium*		
A. neapolitanum Cirillo	Larnaka: between Xylophagou and Hagia Thekla (OPT)	14
	Larnaka: between Meneou and Cape Kriti (OPT)	32
	Larnaka: Stavrovouni, 450-800 m (OPT)	28
	Limassol: Close to Vouni (OPT)	21
	Limassol: Vouni ca. 700 m. (OPT)	28
	Limassol: Kourion (Chatz.)	35
	Paphos: Forest Station of Agia (OPT)	
A. trifoliatum Cirillo	Larnaka: Cape Creco (OPT)	14
	Larnaka: between Xylophagou and Hagia Thekla (OPT)	14
	Limassol: Kourion (Chatz.)	14
	Troodos: Mitsero (Pol.)	14
	Paphos: between Nata and Axylou (OPT)	14
A. cassium Boiss.	Troodos: Prodromos (Chatz.)	14
A. sect. *Scorodon* s.l.		
A. cupanii Raf. subsp. *cyprium* Meikle	Nikosia: Atthalassa (Christ.)	14
A. autumnale P. H. Davis	Troodos: Saitas (Chatz. & Pol.)	24
A. sect. *Codonoprasum*		
A. pallens L.	Larnaka: between Xylophagou & Hagia Thekla (OPT)	32
	Troodos: Alona (Pol.)	32
	Paphos: Ayias' Valley (OPT)	32
A. sect. *Allium*		
A. scorodoprasum subsp. *rotundum* (L.) Stearn	Larnaka: Stavrovouni (OPT)	32
A. junceum Sm.	Limassol: Vouni (OPT)	16
	Paphos: between Nata and Axylou (OPT)	16
	Paphos: Peyia (OPT)	16
A. curtum Boiss.	Larnaka: Cape Creco (OPT)	16
	Larnaka: Cape Kriti (OPT)	16
A. guttatum subsp. *sardoum* (Moris) Stearn	Troodos: Alona (OPT)	16
A. willeanum Holmboe	Troodos: between Lagoudera and Hagia Marina (Pol.)	16
A. sect. *Melanocromyum*		
A. nigrum L.	Larnaka: Salt lake to Meneou (OPT)	16
	Paphos: Peristeronas (OPT)	16
A. orientale Boiss.	Troodos: Siphylos (Pol.)	32
	Nikosia: Metochi (Christ.)	24

Results

Allium sect. *Molium*

Populations three species of this section have been examined cytologically (Table 1). In *Allium trifoliatum* and *A. cassium* ($2n = 14$), diploid populations only have been found, while in *A. neapolitanum* both diploid ($2n = 14$) and polyploid ($3x = 21$, $4x = 28$ and $5x = 35$) ones have been revealed.

In all the three species studied the haploid chromosome complement belongs to *"neapolitanum"* type, sensu Tzanoudakis (1992), which is characterized by $x = 7$ more or less metacentric chromosomes and SAT-chromosomes with the nucleolar organizer located proximal to the centromere region of the chromosome (Fig. 1).

In all the three species, the haploid complement seems to be characrterized by the presence of one SAT-chromosome. In *Allium neapolitanum* and *A. trifoliatum* the SAT-chromosomes are more or less submetacentric and are characterized by an elongated centromere and a diffuse nucleolar organizer (*"neapolitanum"* type sensu Ved Brat 1965). *A. cassium*, however, seems to possess a differentiated karyotype characterized by 2 metacentric SAT-chromosomes in which the nucleolar organizer is more or less localized and the presence on an intercalary chromosome segment between the centromere and the nucleolar organizer is evident.

From a cytogeographical point of view the diploid chromosome number found in the populations of *Allium trifoliatum* and *A. neapolitanum* is worth noting. Both species are represented in Europe and on other Mediterranean islands by polyploid populations. Diploid populations have been mentioned from the Middle East only (see Tzanoudakis 1986 for reference).

Several authors considered *Allium trifoliatum* as an exclusively triploid species. The discovery of diploid populations in Cyprus not only revealed one more case of intraspecific karyotype variation but also justify Tzanoudakis & Vosa's (1988) opinion regarding the cytogeographical distribution patterns shown by the genus in the Mediterranean area.

Allium sect. *Scorodon*

This section is represented in Cyprus by two rare and endemic taxa, *Allium cupanii* subsp. *cyprium* and *A. autumnale*. *A. cupanii* is now included in *A.* sect. *Brevispatha* Vals. emend Garbari & al., and the same is probably the case of *A. autumnale*, which is considered as a species closely related to *A. callimischon* Link.

Material from both endemic taxa has been investigated caryologically, and their karyotypes are illustrated here (Fig. 2).

Allium cupanii subsp. *cyprium* was found to be diploid ($x = 7$, $2n = 2x = 14$), with a karyotype consisting of 6 metacentric and one subtelocentric chromosome pairs. Nucleolar organizers have been observed in the subtelocentric chromosomes as well as in two different pairs of metacentric ones.

Similar karyotypes have been mentioned in a Cretan population of *Allium cupanii* subsp. *hirtovaginatum* (Garbari & al. 1979), while in other Greek populations of this subspecies, studied by Tzanoudakis (1983) and Tzanoudakis & al. (1991), none or only one metacentric SAT-chromosome has been observed.

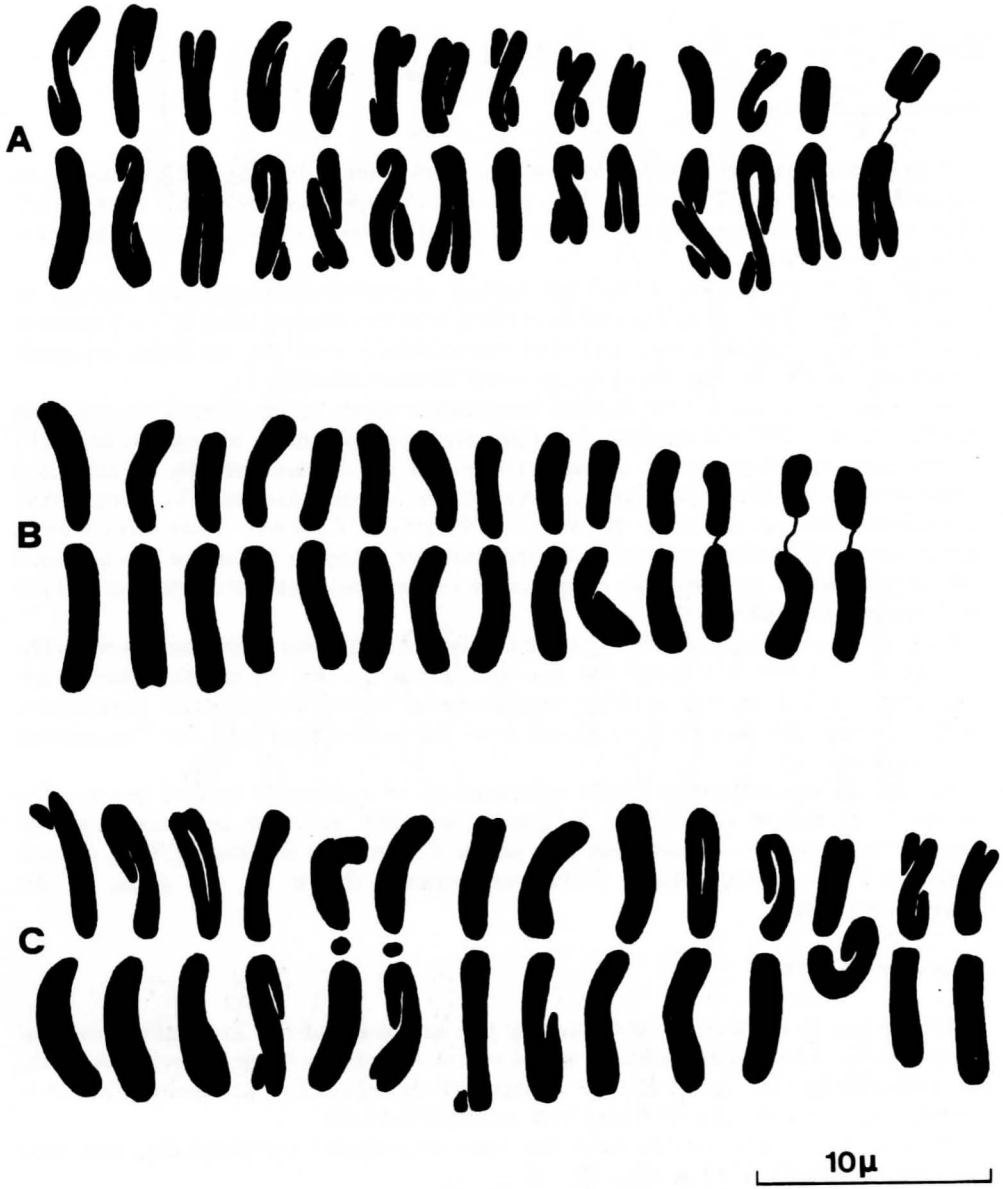

Fig. 1. Karyograms of: **A,** *Allium neapolitanum* (2*x*); **B,** *A. trifoliatum* (2*x*, between Nata and Axylou); **C,** *A. cassium* (2*x*).

In the single population of *Allium autumnale* studied cytologically, the triploid chromosome number ($x = 8$, $2n = 3x = 24$) was found. In the population investigated the haploid complement seems to consist of metacentric chromosomes, two of which possess nucleolar organizers in median (m^B) or proximal to centromere (m^D) region of the chromosome arm.

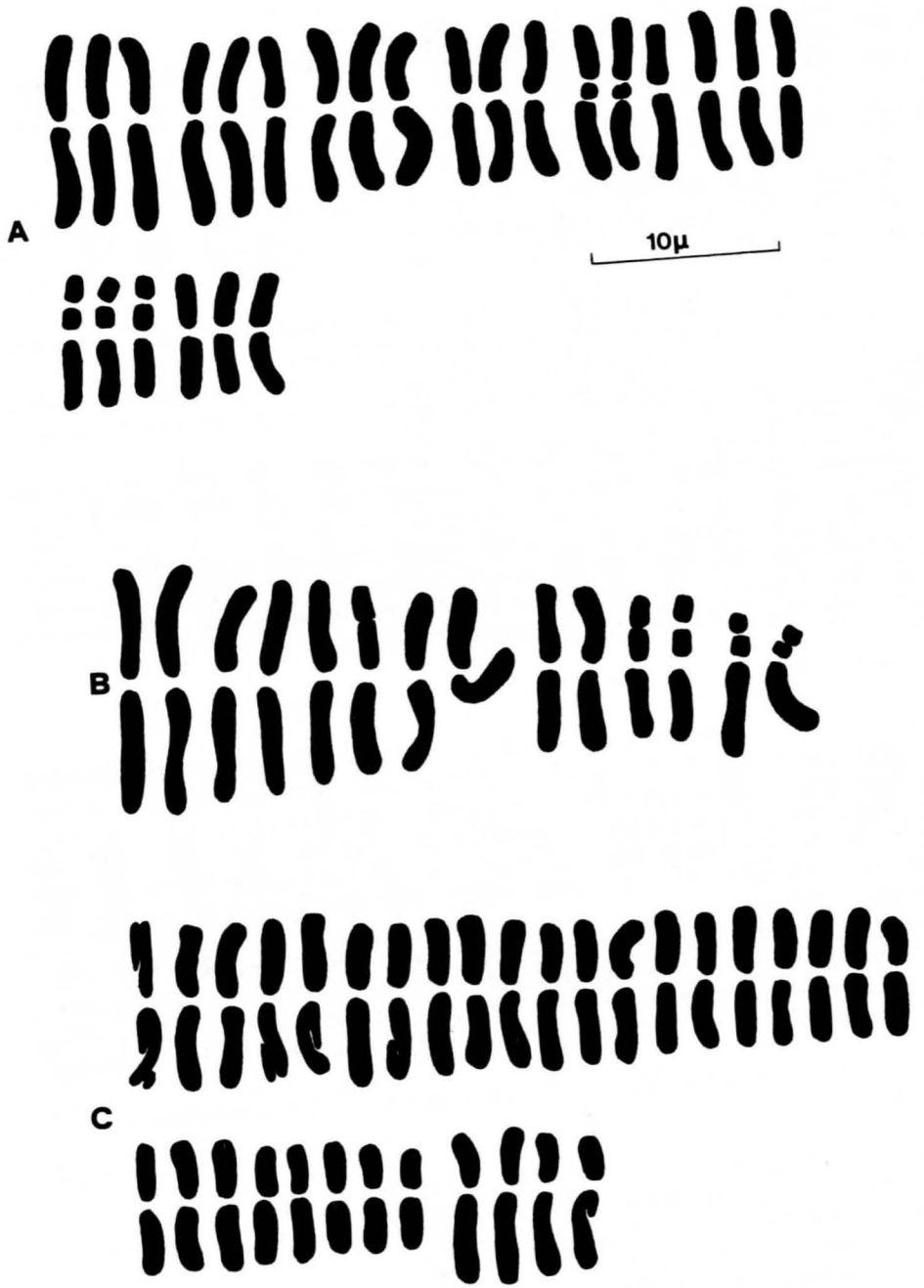

Fig. 2. Karyograms of: **A,** *Allium autumnale* (3*x*); **B,** *A. cupanii* subsp. *cyprium* (2*x*); **C,** *A. pallens* (4*x*, Alona).

The triploid chrosomome number found in *Allium autumnale* is worth noting, because polyploidy is uncommon among species of *A.* sect. *Scorodon* and sect. *Brevispatha* that

are endemic to islands of the East Mediterranean area (Tzanoudakis 1983, Tzanoudakis & Vosa 1988).

Allium sect. *Codonoprasum*

In the present investigation, 3 populations of *Allium pallens* have been examined cytologically. All were found to be tetraploid ($2n = 4x = 32$), a chromosome number known for that species, in which diploids ($2n = 2x = 16$) are also very common (Karavokyroy & Tzanoudakis 1991).

In the karyotype illustrated (Fig. 2) the haploid complement consists of 7 metacentric (m) and one submetacentric (sm) chromosomes. Nucleolar organizers have not been observed but, as *Allium* is well known, in the sect. *Codonoprasum* the nucleolar organizers are located close to the telomers (Type A) and are not always visible in metaphase plates.

Although the existence of tetraploid populations of *Allium pallens* in Cyprus is not surprising, the observation that *A.* sect. *Codonoprasum* is represented in Cyprus by few but mainly polyploid species is of note. *A. dentiferum* is represented by tetraploids (Brullo & al. 1991). *A. marathasicum*, one of the three new species recently described by Brullo & al. (1993), was found to be triploid ($2n = 3x = 24$), and a triploid chromosome number was also found in one (still unidentified) population belonging to the *A. flavum* group collected in Central Cyprus (Tzanoudakis, unpublished data).

Allium sect. *Allium*

In the present study, 5 out of the 8 species of this section reported for Cyprus (Meikle 1985) have been studied cytologically (Table 1). In *Allium junceum*, *A. curtum*, *A. guttatum* and *A. willeanum* the diploid chromosome number $2n = 2x = 16$ was found. The population of *A. scorodopasum* was found tetraploid ($2n = 4x = 32$).

Of the above mentioned species, *Allium junceum* and *A. willeanum* had already been studied cytologically by Miceli & Garbari (1988), who also mention the same diploid chromosome number.

With regard to chromosome morphology, the haploid complement in all the species studied belong to the *"scorodoprasum"* type (sensu Tzanoudakis 1992), being characterized by SAT-chromosomes with the nucleolar organizer located in a more or less median position on the chromosome arm (B or D, depending on the size of the intercalary segment).

Thus, in the 5 species studied the morphology of the haploid complement may be given as follows:

Allium scorodoprasum ($4x = 32$) $x = 8 = 5m + 2m^D + 1Sm$
Allium junceum ($2x = 16$) $x = 3m = 1m^B + 1m + 1Sm^D$
Allium curtum ($2x = 16$) $x = 3m = 1m^D + 3m + 1sm^B$
Allium guttatum ($2x = 16$) $x = 5m + 1m^D + 1m + 1sm^B$
Allium willeanum ($2x = 16$) $x = 5m + 1m^D + 1m^D + 15sm^B$

In the haploid complement of *Allium willeanum* the second m^D chromosome and the sm^B one show mean r-index values close to 1.7 and 3, respectively, and as a consequence could be also characterized as sm^A and st^C, respectively.

In the karyotypes of the same species, the individual chromosomes of the larger m^D pair are characterized by the presence of two secondary constrictions, a type of chromosome observed also in the karyotype of *A. callimischon* subsp. *callimischon* (Tzanoudakis 1983).

In the karyograms of *Allium scorodoprasum* subsp. *rotundum* and *A. guttatum* subsp. *sardoum* illustrated in Fig. 3 and 4, the existence of some inter- or intra-chromosomal exchange in the individuals studied is suggested.

When comparing our results with those of Miceli & Garbari (1988) regarding the chromosome morphology of *Allium willeanum* and *A. junceum*, differences can be noted regarding the number of SAT-chromosomes and the position of the nucleolar organizer on the chromosome arm. However any description, or evaluation of intra- or inter-population karyotype variation should he hased on the study of more material belonging to many more Cyprus populations.

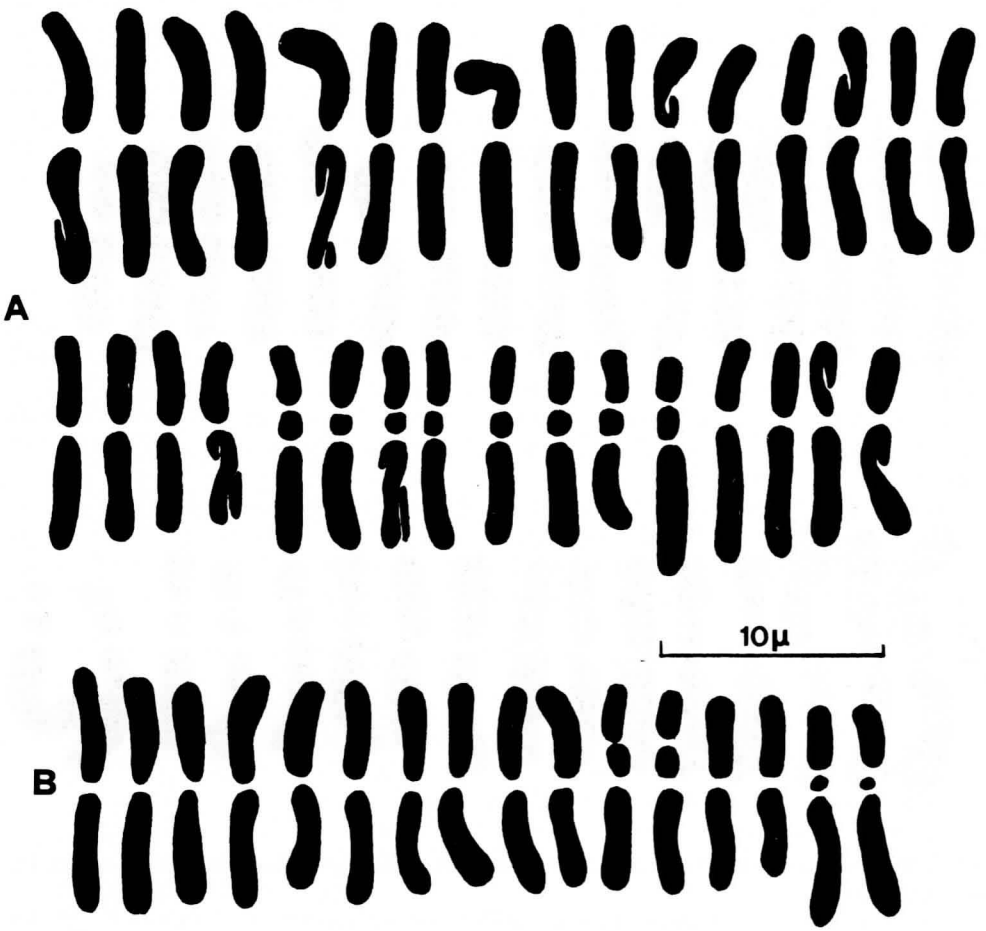

Fig. 3. Karyograms of: **A**, *Allium scorodoprasum* subsp. *rotundum* (4x); **B**, *A. junceum* (2x, Paphos).

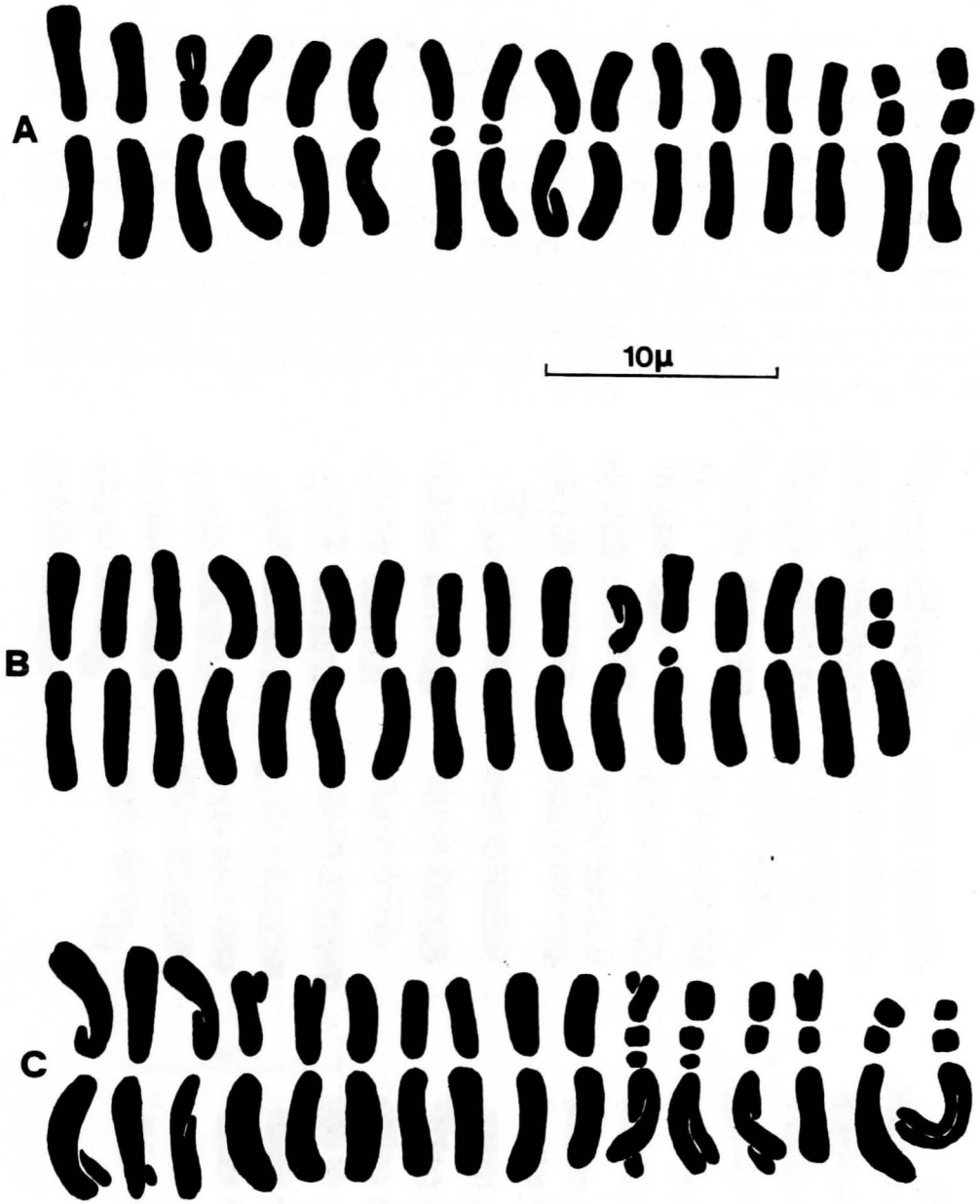

Fig. 4. Karyograms of: **A,** *Allium curtum* (2*x*, Cape Greco); **B,** *A. guttatum* subsp. *sardoum* (2*x*); **C,** *A. willeanum* (2*x*).

Fig. 5. Karyograms of: **A,** *Allium nigrum* (2*x*, Larnaka); **B,** *A. orientale* (3*x*); **C,** *A. orientale* (4*x*).

Allium sect. ***Melanocrommyum***

This section is represented in the Flora of Cyprus by two species, *Allium nigrum* L. and *A. orientale*. Material from both was investigated cytologically. In *A. nigrum* the diploid chromosome number $2n = 2x = 16$ was found in all the population studied, while of the

two studied populations of *A. orientale* studied one was triploid ($2n = 3x = 24$) and the other tetraploid ($2n = 4x = 32$).

In both the species the haploid complement consists of very large chromosomes with a median (m) or submedian (sm) centromeric position. In the diploid karyotype of *Allium nigrum* the chromosomes of the most anisobrachial pair are satellited (sm^{A}). Similar karyotypes have been reported for material from other Mediterranean regions (Scrugli 1982, Tzanoudakis 1992). In *A. orientale* the situation is different. A diploid chromosome number ($2n = 2x = 16$) had been found in material from Israel, and the submetacentric chromosome of the set was also reported as satellited (Kollmann 1970). In the populations of Cyprus not only different levels of ploidy have been found ($3x$ & $4x$) but SAT-chromosomes have not been observed. Such a karyotype variation seems to justify Kollmann's (1984) statement that *A. orientale* is a variable and heterogeneous taxon. In the two populations investigated the haploid complements are not quite similar. From a cytogenetic point of view it is of note that in the karyotype of the tetraploid population (Fig. 5) tetrads of homologous chromosomes are not easily recognized.

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