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KARYOMETRIC ANALYSIS ON WILD ITALIAN POPULATIONS OF GENUS VICIA SECTION ERVUM (LEGUMINOSAE) (**)

Riassunto — *Analisi cariometrica in popolazioni spontanee italiane del genere Vicia, sezione Ervum (Leguminosae).* È stata effettuata un'analisi cariometrica dettagliata su 14 popolazioni, individuate in varie località italiane, delle seguenti specie appartenenti alla sezione *Ervum* del genere *Vicia: Vicia hirsuta* (L.) S.F. Gray, *Vicia loiseleurii* (M. Bieb.) Litw. (=*V. meyeri* Boiss.), *Vicia disperma* DC., *Vicia laxiflora* Brot. (=*V. tenuissima* Schinz et Thell.), *Vicia tetrasperma* (L.) Schreb., *Vicia pubescens* (DC.) Link. In tutte le popolazioni indagate il numero cromosomico risultava $2n=14$, e i cromosomi apparivano per lo più submetacentrici (50%) o metacentrici (48%), solo assai raramente subtelocentrici (2%). Tuttavia si poteva evidenziare una notevole variabilità, fra una popolazione e l'altra della stessa entità, nella morfologia dei cromosomi. Questa variabilità, correlata alla grande adattabilità ecologica delle specie appartenenti a questa sezione, farebbe supporre che la simmetria dei loro cariotipi si sia formata durante l'evoluzione e che non sia, come in genere si ritiene, di tipo primitivo.

Abstract — A detailed karyotype analysis was conducted on fourteen wild Italian populations of the following species of the genus *Vicia* section *Ervum: Vicia hirsuta* (L.) S.F. Gray, *Vicia loiseleurii* (M. Bieb.) Litw. (=*V. meyeri* Boiss.), *Vicia disperma* DC., *Vicia laxiflora* Brot. (=*V. tenuissima* Schinz et Thell.), *Vicia tetrasperma* (L.) Schreb., *Vicia pubescens* (DC.) Link. Although the chromosome number was $2n=14$ in all the populations of the taxa investigated, and most chromosomes were submetacentric (50%) or metacentric (48%), only occasionally subtelocentric (2%), a remarkable interpopulational morphological variation of the chromosomes was observed. This variation, correlated with the adaptive ecological characters of the entities belonging to this section, suggests that the symmetry of their karyotypes may be of derived and not, as generally stated, primitive origin.

Key words — *Vicia* - section *Ervum* - karyology - evolutionary trend.

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Introduction

The genus *Vicia* is represented in Italy by about 45 species (Pignatti, 1982) that, according to various authors (Reichenbach and Beck, 1902; Ascherson and Graebner, 1910; Gams, 1924; Ball, 1968; Plitmann, 1970), belong to three to seven sections, one of which is section *Ervum*. This section comprises entities that are considered rather uniform, all plants being annual and showing slender habit, few small flowers on peduncled racemes, showing the same somatic chromosome number ($2n=14$), which is the highest diploid number in *Vicia*, and a prevalently symmetrical karyotype. These last characteristics are regarded as primitive by Lewitzy (1931), Senn (1938) and Stebbins (1971), while the annual life cycle is generally considered advanced in evolution (Hanelt and Mettin, 1970). According to Ball (1968) seven species of this section occur in Italy. Six of them, in contrast to what stated above, resulted very variable in the morphology of the seeds (Roti-Michelozzi and Serrato-Valenti, 1986).

A karyological study has been carried out in this section since 1931 (Heitz, 1931; Senn, 1938 etc.), but mainly on chromosome number determination, or, if more detailed, it was performed on agricultural material or on wild material of only a few species of the section, in Portugal (Fernandes and Santos, 1971), in Poland (Kuta, 1980), and in Bulgaria (Terziiski and Dimitrov, 1983).

To the best of our knowledge wild Italian populations of this group have not yet been studied from a comparative cytological point of view.

The aim of this paper was both to provide more definite information about karyotype morphology on material not investigated up to the present and possibly to enquire into whether these entities could be considered advanced in evolution also from the karyological point of view.

Material and methods

The material consisted of specimens and of seeds collected in natural populations of six species, in the localities listed in Tab. 1. For comparison also one specimen of *Vicia disperma* previously studied by Roti-Michelozzi and Serrato (1980) has been included. When the material consisted of seeds, kindly obtained from several University Botanic Gardens (of Genova, Siena and Palermo), though

TABLE 1. - *Source localities and voucher specimens of the material studied.*

Species	Locality	Voucher specimen	
Vicia hirsuta	Savona Prov., Stella S. Martino	G. Roti-Michelozzi	870702
	Genova Prov., Rocca d'Aveto	S. Gentile	830625
	Genova Prov., Riva Trigoso	G. Roti-Michelozzi	870526
	Catania Prov., S. Agata	G. Roti-Michelozzi	870521
Vicia loiseleurii	Latina Prov., Parco Naz. Circeo	G. Roti-Michelozzi	840531
Vicia disperma	Savona Prov., Capo Noli	G. Roti-Michelozzi	800422
	Genova Prov., Madonna del Gazzo	G. Roti-Michelozzi	810707
	Spezia Prov., Levanto alta	G. Roti-Michelozzi	840611
Vicia laxiflora	Savona Prov., Finale	L. Aita	820713
	Siena Prov., Monteroni d'Arbia	G. Roti-Michelozzi	830620
	Siena Prov., Monselvoli	G. Roti-Michelozzi	850604
Vicia tetrasperma	Spezia Prov., Levanto	G. Roti-Michelozzi	840523
	Palermo Prov., Monte Pellegrino	G. Roti-Michelozzi	830620
Vicia pubescens	Genova Prov., Mexi, Zoagli	G. Roti-Michelozzi	800624

these seeds have also been collected from the wild, some of them were sown in pots in order to produce plants which could account for their correct taxonomic position and nomenclature. From these plants dry voucher specimens were made that are deposited in the Genova herbarium (GE), together with the specimens collected by one of the authors, by S. Gentile and L. Aita of the Genova Botanic Institute. For karyotype analysis root tips from germinated seedlings were pretreated for two-four hours either with a 0.2-0.4% aqueous solution of colchicine, or a saturated aqueous solution of α-bromonaphtalene, fixed in aceto-alcohol (1/3), hydrolised with HCl 1N at 60° for 6-10', stained with 1-1.5% Gomori's hematoxylin (MELANDER and WINGSTRAND, 1953) and squashed on to permanent slides, vouchers of which are kept in the Genova Botanic Institute. About 120 metaphase plates were observed for each population, about 30 of these were suitable for chromosome counts, and about ten of the more uniformly contracted plates were photographed for chromosome study. For karyometric analysis the negatives so obtained were projected using a 35 mm slide projector on a drawing sheet at a given magnification and sketched. The chromosome lengths were recorded in millimeters and converted in micrometers. Idiograms

were drawn from the mean values of the total, long and short arm lengths of at least five metaphase plates of each population investigated, in which the chromosomes were well spread, the length of satellites, when present, being included within the measurements. The r-value, karyotypic formula (according to LEVAN *et alii*, 1964), whole complement length and karyotype index of symmetry (IS according to LADIZINSKY, 1978) were calculated for each population (Tab. 2).

RESULTS

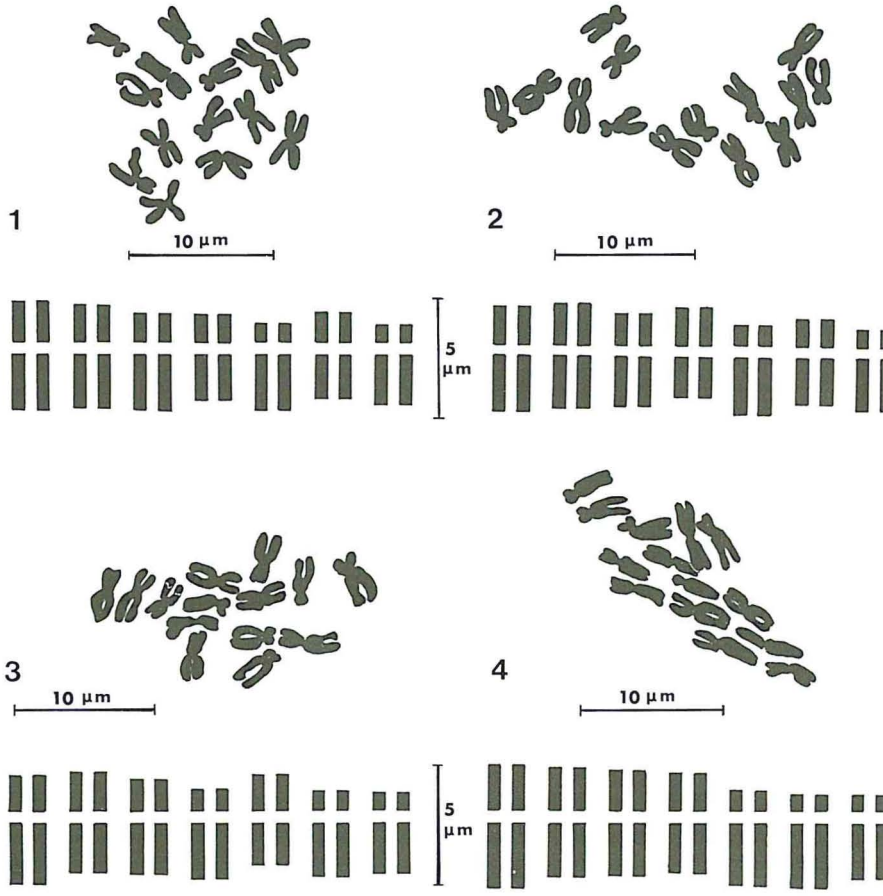
Vicia hirsuta (L.) S.F. Gray

This species is found almost throughout the whole of Europe and has been introduced in North and Central America, where it is now naturalized. Many authors have studied the karyology of this species. Some of them have only determined the chromosome number (ROHWEDER, 1938; SENN, 1938; KOZUHAROV *et alii*, 1972; KIRSCHNER *et alii*, 1982, etc.), while others also exhibited metaphase plates and/or idiograms (HUZIWARA and KONDO, 1963; SRIVASTAVA, 1963; FERNANDES and SANTOS, 1971; CHOOI, 1971; YAMAMOTO, 1973; KUTA, 1980; TERZIISKI and DIMITROV, 1983). The chromosome number found was generally $2n=14$ except for karyotypes from root nodules, where it was $2n=28$ (TATUNO and KODAMA, 1965) and for material from India, where it was $2n=12$ (SAREEN and TREHAN, 1976). The present study confirmed the chromosome number $2n=14$ in all the populations investigated. However, due to the morphological variation observed in some chromosomes, a karyotypic formula (according to LEVAN *et alii*, 1964) common to the four populations investigated could not be given (Tab. 2). It could be generally noticed that the longest three couples of chromosomes were metacentric or weakly submetacentric (r-value $=1.25$-1.73, according to LEVAN *et alii*, 1964) and the shortest pair of chromosomes always strongly submetacentric (r-value$=2.44$-2.93); in the Sicilian population also a subtelocentric pair of chromosomes was visible. In these four populations it could also be noticed that, when the whole complement length was longer, the karyotype was generally more asymmetric, as has been pointed out by BENTZER *et alii*, for *Fritillaria erhardii* (1971). According to these authors, in more contracted plates the long arm of asymmetrical chromosomes tends to shorten more than the short one and the result is, obviously, a

TABLE 2. - *Karyotypic formulae, whole complement lengths and total karyotype indexes of symmetry (IS) of the studied populations.*

Species	Population	Karyotypic formula	Whole complement length (μm)	IS
Vicia hirsuta	Stella S. Martino	4m+2sm+2m+2sm+2m+2sm	48.02	0.59
	Rocca d'Aveto	6m+2M+6sm	46.84	0.61
	Riva Trigoso	2sm+4m+2sm+2M+4sm	48.70	0.57
	S. Agata	8m+2sm+2st+2sm	54.04	0.56
Vicia loiseleurii	Parco Naz. Circeo	6m+2m^s+4sm+2M	55.30	0.63
Vicia disperma	Capo Noli	4m+2sm+2m+4sm+2m	49.72	0.67
	Madonna del Gazzo	4m+2sm+4m+2st+2sm	43.28	0.57
	Levanto alta	2sm+4m+2sm+2m^s+4sm	45.22	0.57
Vicia laxiflora	Finale	2sm+2m+8sm+2m	39.98	0.52
	Monteroni d'Arbia	4m+2sm+4m+4sm	48.82	0.59
	Monselvoli	4m+8sm+2m	46.40	0.56
Vicia tetrasperma	Levanto	2m+8sm+4m	35.72	0.59
	M.te Pellegrino	2sm+2m+6sm+2m+2sm	38.82	0.52
Vicia pubescens	Mexi, Zoagli	2sm+2m+2st^s+6sm+2m	39.74	0.52

more symmetrical karyotype. Another feature present in all the populations studied was the difficulty to identify satellited chromosomes. These were evident only in weakly contracted metaphase plates, in which chromosome morphology could not be studied, and therefore they have not been drawn in the idiograms (Figs. 1, 2, 3, 4). Some former authors also did not notice nucleolar constrictions in this



Figs. 1, 2, 3, 4 - Metaphase plates and idiograms of the specimens of *Vicia hirsuta* (L.) S.F. Gray collected in the following localities: 1) Stella S. Martino (Savona), 2) Rocca d'Aveto (Genova), 3) Riva Trigoso (Genova), 4) S. Agata (Catania).

entity (Huziwara and Kondo, 1963; Chooi, 1971; Fernandes and Santos, 1971). Other authors, on the contrary, have noticed satellited

chromosomes, but in different positions: SRIVASTAVA (1963) located satellited chromosomes in seventh position; YAMAMOTO (1973) in first position, KUTA (1980) in sixth position and TERZIISKI and DIMITROV (1983) in second position.

Vicia loiseleurii (M. Bieb.) Litw.

This species, closely related to *V. hirsuta*, has been called *Vicia meyeri* by BALL (1968) and PLITMANN (1970); this plant was however first described by M. BIEBERSTEIN (1819) as *Ervum Loiseleurii*; its name was subsequently changed to *V. loiseleurii* by LITWINOV (1932). It was formerly reported from a relatively small distribution area: the Crimea, the Caucasus and neighbouring Iranian regions (BALL, 1968). Later its distribution has been gradually enlarged to Anatolia (PLITMANN, 1970) Slovenia (WRABER, 1981) and South Bulgaria (TERZIISKI and DIMITROV, 1983). About 150 years ago specimens of this species were also collected in Italy, near Naples, and were described as *Ervum terronii* by TENORE (1826). We again found it in the Circeo National Park (Lazio), in 1984. Our specimen was well separated from the related species *V. hirsuta* both from the morphological and the karyological points of view. It showed, as all members of section *Ervum*, the diploid chromosome number $2n=14$, confirming former records (METTIN and HANELT, 1968; CHOOI, 1971; TERZIISKI and DIMITROV, 1983). In its karyotype several differential features from those of the Italian populations of *V. hirsuta* were noticed: a) the longest couple of chromosomes was heteromorphic, being constantly provided with one of the short arms longer than the other one; b) the fourth couple of chromosomes bore clearly visible, rather large satellites on the short arm and c) the r-value of the shortest pair of chromosomes was equal to 1 (chromosomes «M» according to LEVAN *et alii*, 1964) (Fig. 5, tab. 2). This last characteristic was also noticed by CHOOI (1971) and TERZIISKI and DIMITROV (1983) in cultivated and wild material respectively, while the position of the nucleolar chromosomes was different. In fact CHOOI (1971) located the satellited chromosomes in first position, and TERZIISKI and DIMITROV (1983) located them in second position. Nevertheless, the finding of a «M» pair of chromosomes in seventh position, in populations situated so far from each other, could account for a fairly stable genome in this entity.

Vicia disperma DC.

This species is not so frequent in Europe as some other members of section *Ervum* and its distribution area is confined to South West Europe (BALL, 1968). In the Liguria region it is rather common and it has been collected in three habitats, in West, Central and East Liguria (Tab. 1). Some differences could be noticed in the karyotypes of these populations (Figs. 9, 10, 11, Tab. 2), with regard to the whole complement length and the number of metacentric pairs of chromosomes: four pairs in West and Central Ligurian populations and three pairs in the East Ligurian population; moreover the presence of satellited chromosomes was detectable only in the East Ligurian population, in the karyotype of which the satellites were attached to the long arm of the fifth pair of chromosomes. The chromosome number $2n=14$, concurrent with our findings, has been previously reported by SENN (1938), FERNANDES and SANTOS (1971) and by VAN LOON (1974). To the best of our knowledge, no idiogram for this species has yet been drawn before ours. FERNANDES and SANTOS (1971) presented the drawings of two metaphase plates, one of which with one satellited chromosome, and the other with two, but while the first one showed a satellite attached to a long arm of a medium sized chromosome, the second metaphase plate exhibited the satellites on the short arm of the smallest chromosomes, thus demonstrating variability in the karyotypes of these plants also in Portuguese wild material.

Vicia laxiflora Brot.

This species, that is a prevalently Mediterranean element, is, as *V. loiseleurii*, critical from the nomenclatural point of view. According to several recent Flora authors (BALL, 1968; ZANGHERI, 1976; PIGNATTI, 1982), in fact, it is called *Vicia tenuissima* (Bieb.) Schinz. and Thell., based on the name *Ervum tenuissimum* Bieb., the type-specimen of which keys down to *Vicia tetrasperma*. This name is therefore incorrect and the later name *V. laxiflora*, given by BROTERUS (1816), is the correct one. With this binominal, in fact, it is quoted by PLITMANN (1970) and ALLKIN *et alii* (1986). Moreover BROTERUS' Tab. n. 52 (1816) illustrates well the entity studied by us, and therefore we accept the name *V. laxiflora*.

The chromosome number $2n=14$ has previously been quoted by

METTIN and HANELT (1968), FERNANDES and SANTOS (1971), YAMAMOTO (1973) and LÖVE and QJELLQVIST (1974), and it has been confirmed by the present study; YAMAMOTO (1973) also provided an idiogram. Several of the foreign authors noticed the presence of nucleolar organizer chromosomes, and Yamamoto placed them in third position. In the three Italian populations, on the contrary, no nucleolar constrictions could be seen (Figs. 6, 7, 8). Moreover the morphology of the chromosomes in these populations varied and therefore three idiograms and three karyotypic formulae were presented (Figs. 6, 7, 8, Tab. 2). Also the whole complement lengths were different (Tab. 2).

Vicia tetrasperma (L.) Schreb.

This species is largely distributed in Europe, North West Africa (BALL, 1968) and South West Asia (PLITMANN, 1970) and therefore it has been extensively studied also from the karyological point of view. The chromosome number $2n=14$, confirmed by our investigation, was reported by the following authors: DAHLGREN *et alii* (1971), KOZUHAROV *et alii* (1972), RAINA and REES (1983). TATUNO and KODAMA (1963) reported $2n=14$ for root tips and $2n=4x$ or $8x$ (28 or 56) for root nodules of this species. Metaphase plates and/or idiograms were presented by SRIVASTAVA (1963), CHOOI (1971) and YAMAMOTO (1973) for material of agricultural origin, by HUZIWARA and KONDO (1963) and KUTA (1980) for material of wild origin. From the comparison of the idiograms drawn by us and those of the above mentioned authors these contrasting results could be achieved: according to SRIVASTAVA (1963) four telocentric chromosomes could be noticed, and the nucleolar organizers were located on the very short arm of the seventh couple of chromosomes; according to YAMAMOTO (1973) instead all the chromosomes were metacentric or hardly submetacentric, and the satellited couple of chromosomes was the first pair. The idiograms obtained from the study of the Italian populations (from East Liguria and Sicily) were similar to each other (Figs. 13, 14), with metacentric or hardly submetacentric chromosomes, as the idiogram drawn by YAMAMOTO (1973), but they did not exhibit satellited chromosomes, as those reported by HUZIWARA and KONDO (1963), CHOOI (1971) or by KUTA (1980).

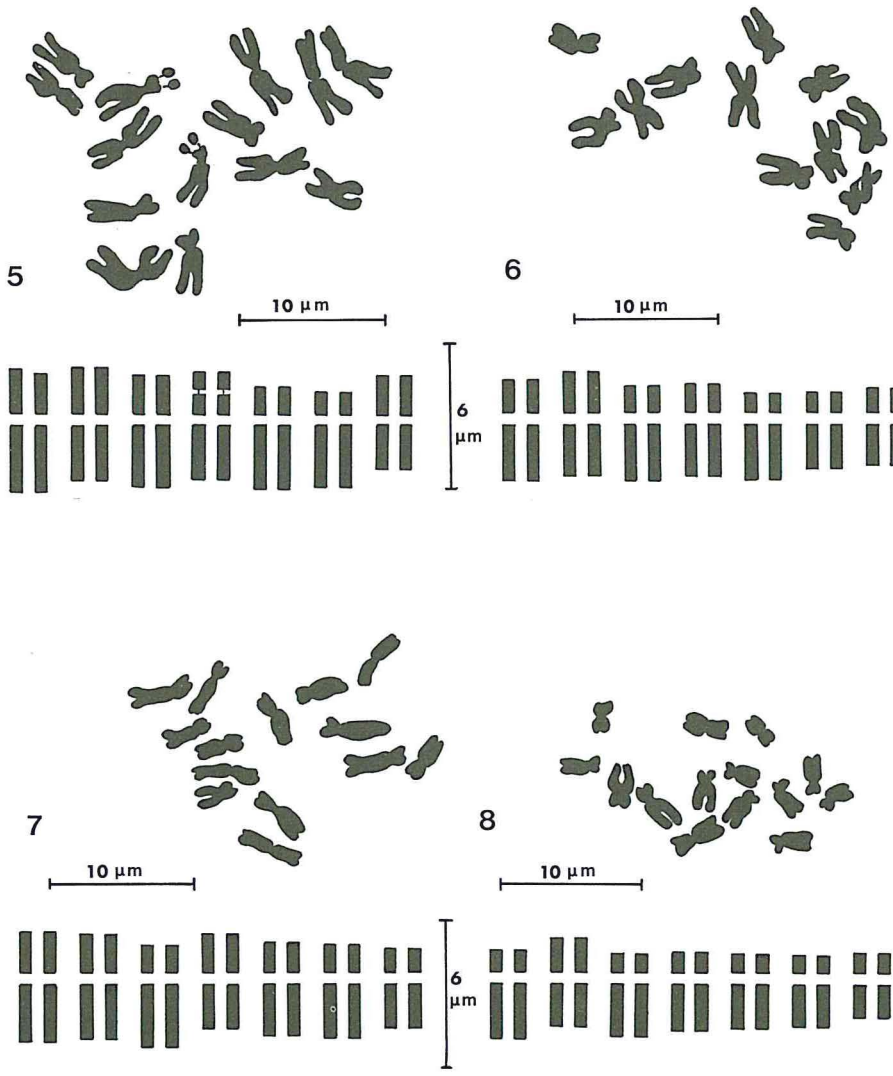


Fig. 5 - Metaphase plate and idiogram of the specimen of *Vicia loiseleurii* (Biel.) Litw. collected in the Circeo Nat. Park (Latina).

Figs. 6, 7, 8 - Metaphase plates and idiograms of the specimens of *Vicia laxiflora* Brot. collected in the following localities: 6) Monselvoli (Siena), 7) Monteroni d'Arbia (Siena), 8) Finale (Savona).

TABLE 3. - *Mean length values and standard deviations (in μm) of each chromosome of the investigated populations, the length of satellites, when present, included.*

Species	Population	Chromosomes I	II	III	IV	V	VI	VII
Vicia hirsuta	Stella S. Martino	4.15±0.22	3.91±0.33	3.67±0.27	3.32±0.18	3.17±0.18	3.04±0.21	2.75±0.25
	Rocca d'Aveto	3.84±0.22	3.77±0.24	3.39±0.17	3.28±0.23	3.23±0.14	3.04±0.18	2.87±0.28
	Riva Trigoso	4.07±0.14	3.77±0.28	3.57±0.16	3.47±0.20	3.32±0.24	3.21±0.22	2.94±0.22
	S. Agata	4.69±0.23	4.25±0.27	4.03±0.35	3.69±0.33	3.60±0.30	3.53±0.29	3.23±0.22
Vicia loiseleurii	Parco Naz. Circeo	4.71±0.30	4.33±0.24	4.05±0.27	3.97±0.29	3.74±0.27	3.44±0.32	3.38±0.37
Vicia disperma	Capo Noli	3.39±0.40	2.98±0.26	2.60±0.27	2.53±0.18	2.33±0.21	2.04±0.24	1.87±0.17
	Madonna del Gazzo	3.92±0.29	3.52±0.43	3.15±0.41	3.07±0.29	2.93±0.44	2.75±0.35	2.30±0.50
	Levanto alta	3.90±0.30	3.70±0.17	3.51±0.14	3.27±0.16	3.00±0.15	2.86±0.25	2.37±0.29
Vicia laxiflora	Finale	3.42±0.27	3.21±0.23	3.06±0.17	2.86±0.23	2.71±0.26	2.51±0.18	2.22±0.17
	Monteroni d'Arbia	4.09±0.33	3.76±0.29	3.63±0.29	3.51±0.25	3.39±0.21	3.36±0.21	2.67±0.70
	Monselvoli	3.91±0.26	3.81±0.25	3.48±0.36	3.34±0.19	3.11±0.39	2.81±0.33	2.74±0.47
Vicia tetrasperma	Levanto	3.22±0.55	2.80±0.42	2.65±0.37	2.55±0.39	2.40±0.37	2.22±0.33	2.02±0.34
	M.te Pellegrino	3.44±0.34	3.11±0.26	2.88±0.29	2.80±0.28	2.71±0.29	2.46±0.27	2.01±0.06
Vicia pubescens	Mexi, Zoagli	3.46±0.45	3.05±0.15	2.93±0.25	2.84±0.21	2.67±0.23	2.57±0.20	2.35±0.16

Vicia pubescens (DC.) Link

This species is found in South Europe (BALL, 1968) and is a Mediterranean element, though it has been found in Crimea (PLITMANN, 1970). It is closely related to *V. tetrasperma*. Previous studies have been made on its chromosome number (DAHLGREN *et alii*, 1971; RAINA and REES, 1983); some authors also added metaphase plates drawings (METTIN and HANELT, 1968; FERNANDES and SANTOS, 1971); but the only author who presented an idiogram, from material of cultivated origin, was CHOOI (1971). Our chromosome study was performed on wild material from Central Liguria and the chromosome number was $2n=14$, concurring with the findings of the former authors. The karyotypes shown by the foreign authors were similar and exhibited rather small, prevalently submetacentric chromosomes, none of which was provided with nucleolar constrictions. In the Italian population, instead, only three couples of chromosomes were submetacentric, and two satellites could be noticed on the long arm of the third couple of chromosomes, a scarsely subtelocentric pair (Fig. 12).

DISCUSSION

Chromosome number and chromosome size

The section *Ervum* of genus *Vicia* has generally been considered rather uniform because of the constance of certain characters in all its members, one of which is the diploid chromosome number $2n=14$. In fact, among the numerous chromosome counts made in this section, only TATUNO and KODAMA (1965) found $2n=4x=28$ in root nodules of *V. hirsuta* and $2n=4x=28$ or $=8x=56$ in root nodules of *V. tetrasperma*, and SAREEN and TREHAN (1976) found $2n=12$ for Indian material of *V. hirsuta*. In the first two cases the tetraploid

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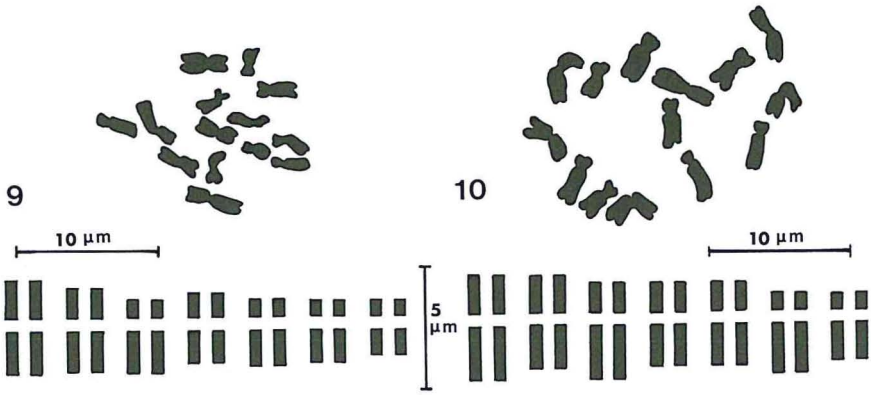
Figs. 9, 10, 11 - Metaphase plates and idiograms of the specimens of *Vicia disperma* DC. collected in the following localities: 9) Capo Noli (Savona), 10) Madonna del Gazzo (Genova), 11) Levanto alta (La Spezia).

Fig. 12 - Metaphase plate and idiogram of the specimen of *Vicia pubescens* (DC.) Link collected at Mexi, Zoagli (Genova).

Figs. 13, 14 - Metaphase plates and idiograms of the specimens of *Vicia tetrasperma* (L.) Schreb. collected in the following localities: 13) M.te Pellegrino (Palermo), 14) Levanto (La Spezia).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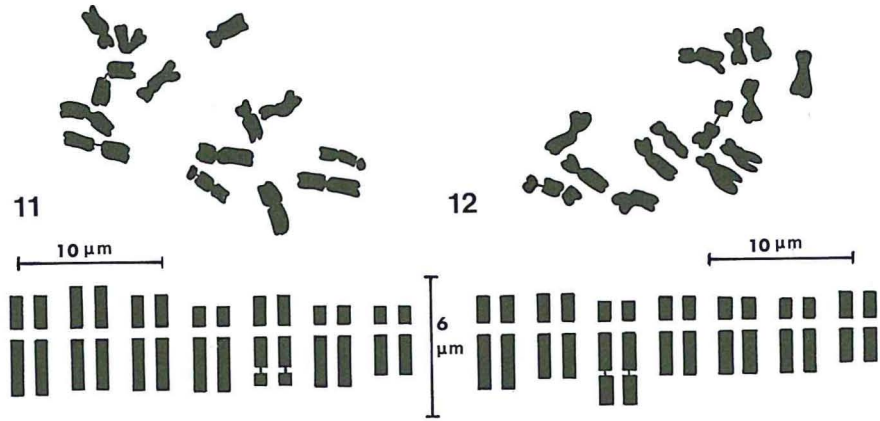
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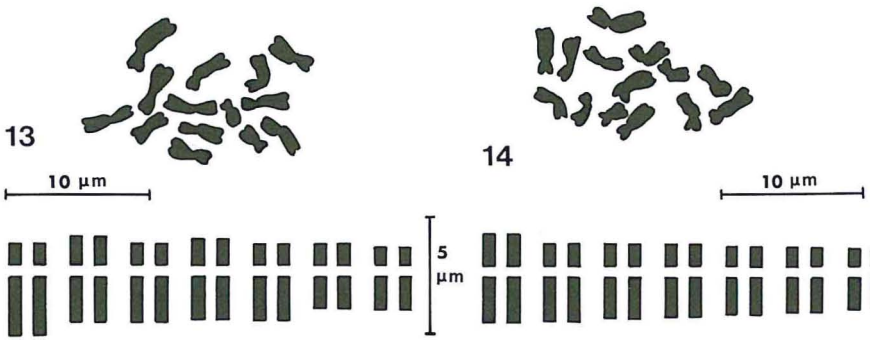
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or octoploid numbers could be due to the symbiotic condition of the root nodules, and therefore the only exception to the general statement would be the finding of SAREEN and TREHAN (1976).

Similarly as in the *Vicia villosa* complex (ROTI-MICHELOZZI, 1986) che complements of the entities of section *Ervum* showed a lack of distinct size differentiation of the chromosomes. The mean chromosome length varied between 2.01 and 4.71 μm and the difference between longest and shortest chromosome of each complement varied between 0.97 and 1.62 μm (Tab. 3). It must be noted, however, that the mean length of the chromosomes was always rather short and therefore these small differences may have some significance. On the whole *V. loiseleurii* seemed to be the species with the longest chromosomes, followed by *V. hirsuta* and *V. laxiflora*. *V. tetrasperma* seemed to be the species with the shortest chromosomes.

Chromosome morphology

Previous reports (METTIN and HANELT, 1968; YAMAMOTO, 1973; KUTA, 1980) state that the karyotypes of *Vicia* species belonging to this section are uniform for the morphology of the chromosomes, and that they are prevalently symmetrical. The populations of this section studied by us also showed rather symmetrical karyotypes (IS=0.52-0.67), but at least two couples of submetacentric chromosomes were always present, very often three couples and sometimes four, even, though rarely, a subtelocentric pair of chromosomes could be noticed.

A morphologic interpopulational variation was very often appreciable (Tab. 2, figs. 1-4, 6-8, 9-11, 13-14). It was not possible, in fact, to draw a single idiogram, even if only two populations of the same entity were studied. In particular the position of the metacentric or submetacentric chromosomes was very often different. This fact could be due to a «reversal of order», as has been noticed in *Larix decidua* by MATÈRN and SIMAK (1968), caused by the possibility that the contraction of the chromosomes in a plate may not always be wholly synchronized. Sometimes, however, there was an extra couple of submetacentrics (as in the Sicilian population of *V. tetrasperma*, or in the Ligurian population of *V. laxiflora* or the East Ligurian population of *V. hirsuta*), or of metacentrics (as in some Ligurian populations of *V. disperma*), in respect to the average number of each entity.

The total indexes of symmetry (Tab. 2) showed that the most asymmetrical karyotypes were found in species with smaller complement lengths and viceversa. There was not, however, a great difference in length between the most asymmetrical and symmetrical karyotypes.

Comparing the karyotypes of Italian members of this section with those of the same entities studied abroad, it was easy to note that, while many foreign authors have recorded in them nucleolar chromosomes, these seemed rare in Italian material. The frequent absence of nucleolar chromosomes has been already pointed out in the karyotypes of *Vicia* species from other sections (ROTI-MICHELOZZI and CAFFARO, 1984; ROTI-MICHELOZZI, 1986). This feature has been variously interpreted. According to DYER (1979) the lack of nucleolar organizers could be due to a greater contraction of the chromosomes, consequent to methods of preparation, contraction which may obscure small organizers, or to hybridity; in certain hybrids, in fact, according to this author, an organizer is inactive in transcription during interphase and does not produce a nucleolus or an undercontracted segment during mitosis. According to BURGER and KNÄLMANN (1979) and HADJOLOV (1985) rRNA gene sites generally coincide with the nucleolar constrictions, but the correlation is not absolute. The first authors in fact found that, in *Vicia sativa*, the rRNA genes are located in two pairs of chromosomes, of which one pair is the satellited pair and the other the longest pair, that does not show satellites.

CONCLUDING REMARKS

The species studied by us are annual, show some uniform but also variable morphological characters, they often occupy different habitats, and sometimes are noxious weeds, thus demonstrating environmental adaptation; they seem therefore ecologically evolute. In contrast they show a prevalently symmetrical karyotype, both for a) median or submedian position of the centromeres, and for b) all their chromosomes being of similar length. This feature is considered (LEWITSKY, 1931; STEBBINS, 1971) primitive. According to these authors, in fact, the predominant trend, in flowering plants, is toward increasing asymmetry of the karyotypes, though, sometimes, there can be a reversal trend toward an increasing symmetry. A reversal trend has been suggested, for instance, in the genus *Ranunculus*, by D'OVIDIO *et alii* (1985). This reversal trend can be attained by

centric fusions (STEBBINS, 1971) or either centric fusions or pericentric inversions (JONES, 1978). Since centric fusions always cause a decrease in chromosome number, and in the section *Ervum*, on the contrary, this number is typically the highest diploid number of genus *Vicia*, the symmetry of section *Ervum* karyotypes could have been reached through pericentric inversions. The karyological variation found in Italian wild material, as well as in material studied by foreign authors of entities of this section, seems to account for the possibility, in these entities, of maintaining chromosomal rearrangements such as pericentric inversions.

On the other hand RAINA and REES (1983) believe that in the genus *Vicia* speciation has been accompanied by massive changes in chromosome size and DNA amount, but that the accretion (or diminution) of chromosomal DNA by the amplification (or deletion) of base sequences within each complement has affected each chromosome to the same degree. These authors also state that, where an increase (or decrease) in total nuclear DNA is achieved by equal increments (or decrements) to all chromosomes, the relative differences in chromosome size within the complements diminish and the complements become more symmetrical. This other hypothesis could explain how the species of section *Ervum*, probably through a gradual loss of chromosomal segments in all the chromosomes, show karyotypes with a lack of different size differentiation.

These entities, therefore, though showing some primitive karyological characters, as a matter of fact, could also be advanced in evolution from the genetical point of view.

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