Zeitschrift: Candollea : journal international de botanique systématique = international journal of systematic botany

Herausgeber: Conservatoire et Jardin botaniques de la Ville de Genève

Band: 60 (2005)

Heft: 1

Artikel: Contribution to the cytotaxonomical knowledge of Gagea Salisb. (Liliaceae) : II. Further karyological studies on Italian populations

Autor: Peruzzi, Lorenzo / Aquaro, Gabriella

DOI: https://doi.org/10.5169/seals-879272

Candollea 60(1): 237-253 (2005)

Contribution to the cytotaxonomical knowledge of Gagea Salisb. (Liliaceae). II. Further karyological studies on Italian populations

LORENZO PERUZZI
&
GABRIELLA AQUARO

ABSTRACT

PERUZZI, L. & G. AQUARO (2005). Contribution to the cytotaxonomical knowledge of Gagea Salisb. (Liliaceae). II. Further karyological studies on Italian populations. *Candollea* 60: 237-253. In English, English and French abstracts.

First chromosome counts for Italian populations of *Gagea lutea* (L.) Ker-Gawl. ($2n = 72$), *G. minima* (L.) Ker-Gawl. ($2n = 24$), *G. pratensis* (Pers.) Dumort. ($2n = 60$) and *G. villosa* (M. Bieb.) Sweet ($2n = 48$) are provided. *Gagea fragifera* (Vill.) Ehr. Bayer & G. López is proved to be in S. Italy an heptaploid species ($2n = 84$). A closely related unit, recently described as a separate species (*G. polidorii* J.-M. Tison), shows instead a caryotype of $2n = 72$ chromosomes. South Italian populations of *G. chrysantha* (Jan) Schult. & Schult. f. s.l. and *G. granatellii* (Parl.) Parl. s.l. are confirmed to be triploid ($2n = 36$). *Gagea foliosa* (J. Presl & C. Presl) Schult. & Schult. f. ($2n = 36$) and *G. mauritanica* Durieu ($2n = 36$), also triploid, are karyologically studied for the first time. Karyotype analysis is carried out for *G. minima*, *G. chrysantha* s.l. and *G. mauritanica*; A_1 and A_2 karyotype asymmetry indexes are calculated for these species, and compared with those of other eleven *Gagea* species, whose idiograms were available in literature.

RÉSUMÉ

PERUZZI, L. & G. AQUARO (2005). Contribution à la connaissance cytotaxonomique de Gagea Salisb. (Liliaceae). II. Etudes caryologiques complémentaires de populations italiennes. *Candollea* 60: 237-253. En anglais, résumés en anglais et français.

Les premiers comptages chromosomiques de populations italiennes sont donnés de *Gagea lutea* (L.) Ker-Gawl. ($2n = 72$), *G. minima* (L.) Ker-Gawl. ($2n = 24$), *G. pratensis* (Pers.) Dumort. ($2n = 60$) et *G. villosa* (M. Bieb.) Sweet ($2n = 48$). Il est prouvé que *Gagea fragifera* (Vill.) Ehr. Bayer & G. López est une espèce heptaploïde ($2n = 84$) en Italie du Sud. Une forme apparentée et récemment décrite comme une espèce séparée (*G. polidorii* J.-M. Tison) présente à la place un caryotype $2n = 72$ chromosomes. Il est confirmé que les populations sud-italiennes de *G. chrysantha* (Jan) Schult. & Schult. f. s.l. and *G. granatellii* (Parl.) Parl. s.l. sont triploïdes ($2n = 36$). *Gagea foliosa* (J. Presl & C. Presl) Schult. & Schult. f. ($2n = 36$) et *G. mauritanica* Durieu ($2n = 36$), aussi triploïdes, sont étudiées sous l'angle caryologique pour la première fois. L'analyse caryotypique de *G. minima*, *G. chrysantha* s.l. et *G. mauritanica* a été faite; les index d'asymétrie caryotypique A_1 and A_2 sont calculés pour ces espèces, et comparés avec and les index existants des autres onze espèces de *Gagea*, dont les idéogrammes sont connus de la littérature.

KEY-WORDS: LILIACEAE – Gagea – Italian flora – chromosome numbers – taxonomy – karyotypes

ISSN: 0373-2967

Introduction

In a previous contribution, one of the authors presented a synthesis of the karyological data of the genus *Gagea* Salisb. (PERUZZI, 2003), summarizing 204 chromosome countings, referring to 95 taxa. To these data, two accounts must be added today: a counting $2n = 6x = 72$ for *G. lutea* (L.) Ker-Gawl. collected near Wien (GREILHUBER & al., 2000) and the first chromosome counting ($2n = 16$) for *G. graeca* (L.) A. Terracc. (KAPASA & al., 2001; plants coming from Greece).

The present contribution is part of a more comprehensive project for the revision of the genus *Gagea* in Italy (PERUZZI & TISON, 2004a) and in the whole Mediterranean area, including studies on nomenclature (TISON, 2001a; TISON & PERRET, 2004; PERUZZI & TISON, 2004b), systematics (REYNAUD & TISON, 1997; TISON, 1996a, 1996b, 1997, 1998a, 1998b, 2004a, 2004c; PERUZZI, 2003), reproductive strategies (GARGANO & al., 2004) and chorology (MOLINA & al., 1998; TISON, 2001b; PERUZZI, 2004, 2005; PERUZZI & GARGANO, 2005).

Materials and methods

Plant material

Living plants of the following taxa were collected:

1. ***Gagea lutea* (L.) Ker-Gawl.**

   ITALY: Calabria, Verbicaro-Orsomarso Range, Campotenese, Masistri, loc. Piano di Mezzo, 1263 m, margins of beech wood, 29.IV.2004, *Peruzzi, Aquaro* et *Gargano* (cult. Hort. Bot. Calabria University, acc. n. 130).

2. ***Gagea pratensis* (Pers.) Dumort.**

   ITALY: Calabria, Verbicaro-Orsomarso Range, Campotenese, Masistro Mountain, 1350 m, 29.IV.2004, *Peruzzi, Aquaro* et *Gargano* (cult. Hort. Bot. Calabria University, acc. n. 516).

3. ***Gagea minima* (L.) Ker-Gawl.**

   ITALY: Calabria, Pollino Massif, southern slope of Mount Manfriana, 1840 m, 20.V.2004, *Peruzzi, Aquaro* et *Passalacqua* (cult. Hort. Bot. Calabria University, acc. n. 233).

4. ***Gagea fragifera* (Vill.) Ehr. Bayer & G. López**

   ITALY: Calabria, Verbicaro-Orsomarso Range, Campotenese, Masistri, loc. Piano di Mezzo, 1263 m, margins of meadows, 29.IV.2004, *Peruzzi, Aquaro* et *Gargano* (cult. Hort. Bot. Calabria University, acc. n. 669).

   SICILY: Madonie, Piano Battaglia, 1650 m, grasslands, 24.IV.2004, *Peruzzi* et *Caparelli* (cult. Hort. Bot. Calabria University, acc. n. 109).

5. ***Gagea polidorii* J.-M. Tison**

   ITALY: Calabria, Verbicaro-Orsomarso Range, Campotenese, Masistri, loc. Piano di Mezzo, 1263 m, margins of meadows, 29.IV.2004, *Peruzzi, Aquaro* et *Gargano* (cult. Hort. Bot. Calabria University, acc. n. 699).

6. ***Gagea chrysantha* (Jan) Schult. & Schult. f. s.l.**

   ITALY: Calabria, Valley of Crati, San Marco Argentano (province of Cosenza), loc. Maiolungo, 9.03.2003, *Peruzzi* et *Caparelli* (cult. Hort. Bot. Calabria University, acc. n. 353).

   SICILY: Iblei, Mount Lauro, III.2004, *Tison* (cult. Hort. Bot. Calabria University, acc. n. 34).

7. ***Gagea foliosa* (J. Presl & C. Presl) Schult. & Schult. f.**

ITALY, SICILY: Madonie, near Piano Battaglia, loc. Rifugio Marini, ca. 1600 m, 24.IV.2004, *Peruzzi* et *Caparelli* (cult. Hort. Bot. Calabria University, acc. n. 312); near the crossroad among Piano Zucchi, Piano Battaglia and Polizzi Generosa, eastern slope of Monte dei Cervi, ca. 1500 m, 24.IV.2004, *Peruzzi* et *Caparelli* (cult. Hort. Bot. Calabria University, acc. n. 329).

8. ***Gagea granatellii* (Parl.) Parl. s.l.**

ITALY, SICILY: Iblei, Mount Lauro, III.2004, *Tison* (cult. Hort. Bot. Calabria University, acc. n. 118).

9. ***Gagea mauritanica* Durieu**

ITALY, APULIA: Lesina (province of Foggia), Bosco Isola, loc. Acquarotta, 6.III.2004, *Peruzzi* et *Caparelli* (cult. Hort. Bot. Calabria University, acc. n. 545).

10. ***Gagea villosa* (M. Bieb.) Sweet**

ITALY, CALABRIA: Pollino Massif, loc. Piano Bellizia, between the "Fagosa" and the Raganello stream, cultivated areas, 19.III.2003, *Peruzzi, Gargano* et *Tison* (cult. Hort. Bot. Calabria University, acc. n. 481).

Voucher specimens of the plants used for karyological analyses are kept in CLU.

Chromosome analysis

Squash preparations were made from young ovules of plants collected *in situ*, according to the following schedule: pretreatment in 0.5% colchicine solution for 4 hours; Carnoy fixing for at least 1 hour; hydrolisis in HCl 1N for 7 minutes at 60° C; staining with leuco-basic fuchsin for 3 hours. Karyotype formulas and terminology are according to LEVAN & al. (1964). At least ten plates were used in order to establish the chromosome numbers, while five plates were measured in order to build the idiograms.

Intrachromosomal (A_1) and interchromosomal (A_2) asimmetry indexes were calculated according to the methodology defined by ROMERO ZARCO (1986).

Results

Sect. *Gagea*

1. ***Gagea lutea***

The chromosome complement of the studied Calabrian population has revealed to be presumably hexaploid, with $2n = 72$ chromosomes (Fig. 1A, B). Because of the average quality of the plates and the high number of chromosomes, we were not able to build the idiogram for this species.

2. ***Gagea pratensis***

The chromosome complement of the studied Calabrian population has revealed to be presumably pentaploid, with $2n = 60$ chromosomes (Fig. 2). Because of the average quality of the plates and the high number of chromosomes, we were not able to build the idiogram for this species.

Sect. Minimae (Pascher) Davlian.

3. *Gagea minima*

The chromosome complement of the studied Calabrian population has revealed to be diploid, with $2n = 24$ chromosomes (Fig. 3A). Karyotype formula can be expressed as follows: $2n = 24 = 2x = 6st + 4m + 2sm + 4m + 6sm + 2m$ (Table 1, Fig. 3B). The mean length of haploid idiogram is 30.7 μm, while chromosome size ranges from 1.26 to 6.19 μm.

Sect. *Fistulosae* (Pascher) Davlian.

4. *Gagea fragifera*

The chromosome complement of both Calabrian and Sicilian populations has revealed to be presumably heptaploid, with $2n = 84$ chromosomes (Fig. 4). Other plants, in the same locality, revealed instead a different chromosome number: $2n = 72$ (Fig. 5). These latter plants are also well morphologically distinguishable from *G. fragifera* s.s. and were recently described as a new species: *G. polidorii* J.-M. Tison (Tison, 2004c). Because of the average quality of the plates and the high number of chromosomes, we were not able to build the idiogram for these species.

Sect. *Didymobulbos* Koch (= Sect. *Foliatae* A. Terracc.)

6. *Gagea chrysantha*

The chromosome complement of both Calabrian and Sicilian populations has revealed to be triploid, with $2n = 36$ chromosomes (Fig. 6A, B). Karyotype formula can be expressed as follows: 9st + 12sm + 3m + 3sm + 3m + 6sm (Table 2, Fig. 6C). The mean length of haploid idiogram is 25 μm, while chromosome size ranges between 1.1 and 4.13 μm. In specimens of both the provenances, we noted often terminal satellites, at least in one of the three chromosomes of the eleventh triplet.

7. *Gagea foliosa*

The chromosome complement of the studied Sicilian populations has revealed to be presumably triploid, with $2n = 36$ chromosomes (Fig. 7A, B). We were not able to build the idiogram for this species, because we observed only one plate showing the centromeres clearly.

8. *Gagea granatellii*

The chromosome complement of the studied Sicilian population has revealed to be presumably triploid, with $2n = 36$ chromosomes.

9. *Gagea mauritanica*

The chromosome complement of the studied Apulian population has revealed to be triploid, with $2n = 36$ chromosomes (Fig. 8A). Karyotype formula can be expressed as follows: $2n = 36 = 3x = 3sm + 6st + 3sm + 3st + 6sm + 3m + 3sm + 3m + 3st + 3sm$ (Table 3, Fig. 8B). The mean length of haploid idiogram is 44.62 μm, while the chromosome size ranges between 1.87 and 6.65 μm.

10. *Gagea villosa*

The chromosome complement of the studied Calabrian population has revealed to be presumably tetraploid, with $2n = 48$ chromosomes.

Karyotype asymmetry

The A_1 and A_2 asymmetry indexes for *G. minima*, *G. chrysantha* and *G. mauritanica* are reported in Table 4 and Fig. 9, together with those calculated for other 11 *Gagea* species from literature, grouped according to their sections.

Discussion

Sect. *Gagea*

1. *Gagea lutea*

Eurasiatic species (PIGNATTI, 1982), whose basionym was typified by Stearn (1983). Our result ($2n = 72$) is the first for Italian plants, and agrees with the majority of countings from many European and Asiatic countries (cf. GREILHUBER & al., 2000; Peruzzi, 2003). For this species are reported also $2n = 24$ chromosomes (MONTSERRAT MARTI, 1981; SOPOVA & al., 1984) and $2n = 48$ chromosomes (MĚSIČEK & HROUDA, 1974; MEHRA & SACHDEVA, 1976), as well as a doubtful counting $2n = 12$ (TISCHLER, 1950: 263).

2. *Gagea pratensis*

European species, occurring also in Morocco (TISON, 2004b). The studied Calabrian plants were described by Terracciano (1896) as a special variety (*G. stenopetala* var. *pollinensis* N. Terracc.), which today is considered fully synonymic to *G. pratensis* (PERUZZI & TISON, 2004b). Also in this case, our result ($2n = 60$) is the first for Italian plants. This counting was already recorded in plants from Slovakia (MĚSIČEK & HROUDA, 1974), while there are at least three more ploidy levels known for this species: $2n = 24$, $2n = 36$ and $2n = 48$ (cf. PERUZZI, 2003).

Sect. *Minimae*

3. *Gagea minima*

Eurosiberian species (PIGNATTI, 1982), whose basionym was typified by STEARN (1983). The studied Calabrian plants were described by TERRACCIANO (1896) as a special variety (*G. minima* var. *calabra* N. Terracc.), which today is considered fully synonymic to *G. minima* (PERUZZI & TISON, 2004b). Our result ($2n = 24$), the first on Italian populations, confirms the diploid nature of this species, already evidenced in plants from Czeck Republic, Denmark, Finland, Macedonia, Norway, Poland and Slovakia (cf. PERUZZI, 2003); for this taxon is known also a "strange" $2n = 32$ cytotype (STENAR, 1927; TISCHLER, 1934).

Sect. *Fistulosae*

4. *Gagea fragifera*

Eurasiatic species, occurring also in Morocco (TISON, 2004b), whose basionym was recently typified by TISON (2001a). Both Calabrian and Sicilian populations evidenced an heptaploid ($2n = 84$) chromosome complement, which is reported for the first time in this species; indeed there is in literature only one approximate counting $2n =$ ca. 80 from Sweden (BIANCHI, 1946). For this species are quoted also $2n = 48$ chromosomes for Macedonia (SOPOVA & al., 1984) and $2n = 60$ chromosomes for India (ZEMSKOVA & LEVICHEV, 1988).

For what concerns *G. polidorii*, here is documented for the first time also its chromosomal distinctiveness from *G. fragifera*. The former species, known until now only for S. France and Calabria, is regarded to be of probable hybridogenous origin between *G. fragifera* and *G. villosa* (TISON, 2004c). Indeed, by considering the chromosome complement of *G. fragifera* and the existence of a pentaploid ($2n = 60$) cytotype in *G. villosa* (see over), our counting supports this hypotesis.

Sect. *Didymobulbos*

6. *Gagea chrysantha*

Central Mediterranean species, whose name is under typification (in preparation). Our results from Calabrian and Sicilian populations confirmed for this species a triploid ($2n = 36$) chromosome complement, already evidenced by PERUZZI (2003) in plants from a different Calabrian locality. It is noteworthy to say that in this species we are merging at present several microtaxa (i.e. *G. longifolia* Lojac., *G. sicula* Lojac. and *G. amblyopetala* var. *calabra* N. Terracc.).

All these names are under study in order to clarify their real taxonomic value. The plants studied in this paper, and those in PERUZZI (2003), seem all identifiable with *G. longifolia* (= *G. amblyopetala* auct. Fl. It.). Triploid plants erroneously called "*G. foliosa*" in PERUZZI (2003) are instead identifiable with *G. sicula* (= *G. amblyopetala* var. *calabra*).

7. *Gagea foliosa*

Central Mediterranean species, whose basionym was typified by PASCHER (1906). This is the first counting for this species ($2n = 36$), although PERUZZI (2003) quoted the same number on Calabrian plants, that in reality fall in the cycle of *G. chrysantha* (see above). Indeed, at our best knowledge, this species seems not to occur in peninsular Italy, but only in Sardinia, Sicily and N. Algerie (TISON, 2004b).

8. *Gagea granatellii*

C.W. Mediterranean species, whose name is under typification (in preparation). Plants from Sicily confirm the same ploidy level ($2n = 36$) evidenced in plants from Calabria (PERUZZI, 2003); for this species is reported also a $2n = 24$ counting from France (TISON, 1998a).

9. *Gagea mauritanica*

Central Mediterranean species (MOLINA & al., 1998), whose name is under typification (in preparation); the studied population was quoted in FORTE & al. (2002). This is the first counting for this species, which revealed to be triploid ($2n = 36$), as many representatives of the sect. *Didymobulbos*. This rare species is particularly interesting, because it is the only *Gagea* of the Italian flora which grows on coastal sandy grasslands.

10. *Gagea villosa*

Eurasiatic species (PIGNATTI, 1982), whose name was typified by RIX (1984). Our result ($2n = 48$) is the first for Italian plants, and agrees with data reported from several countries (cf. PERUZZI, 2003). For this species are reported, from Israel, also cytotypes with $2n = 60$ and 72 chromosomes (HEYN & DAFNI, 1977).

Karyotype asymmetry

The sect. *Gagea* shows the most asymmetrical karyotypes, together with the sect. *Platyspermum* Boiss. The sect. *Fistulosae* (*G. fragifera*) and the sect. *Minimae* (*G. minima*), even if based only on respectively one and two accounts, seem to be somewhat intermediate between the former two sections and the sect. *Didymobulbos*. Moreover, *G. minima* shows the most variable karyotype structure, overlapping to nearly all other considered sections. This occurrence can possibly be related with the primitive status of this species, as supported by its almost constant diploid level and taxonomic isolation. So, *G. minima* shows light chromosomal rearrangements, seemingly avoiding polyploidy events. It is particularly interesting that this matter is in agreement with recent molecular phylogenetic studies (PETERSON & al., 2004): in that paper, resulted a strongly supported monophyletic clade, joining species from sections *Minimae*, *Euspathaceae* (A. Terracc.) Levichev and *Didymobulbos*, sister group of sect. *Gagea* (no representatives of sections *Platyspermum* and *Fistulosae* were investigated). *Gagea minima* occupies the most basal position in the first group (being so the closest species to sect. *Gagea*). Thus, singularly, in the genus *Gagea* a more asymmetrical karyotype has to be considered as a primitive feature, whereas a less asymmetrical karyotype as a derived one. Indeed, representatives of sect. *Didymobulbos* clearly tend to have the least asymmetrical karyotypes. In terms of asimmetry, within this section, *G. mauritanica* shows a karyotype close to that of *G. durieui* Parl. and *G. chrysantha*. Instead, the latter species shows a karyotype somewhat intermediate among those of *G. bohemica* (Zauschn.) Schult. & Schult. f., *G. mauritanica* and *G. villosa*. *Gagea soleirolii* F. W. Schultz, and especially one account of *G. bohemica*, considerably deviate from the core of the section.

Conclusions

This paper evidenced the chromosome complements of 10 *Gagea* representatives, from a total of 13 S. Italian populations, involving three regions: Apulia, Calabria and Sicily. Among them, are noteworthy the first accounts on *G. foliosa*, *G. mauritanica* and *G. polidorii*, a new species related to *G. fragifera*.

Our results on karyotypes structure in the genus *Gagea* show how there is a tendency, for each section, to be marked by a characteristic karyotype asymmetry. However, there are several overlapping; *G. minima* and *G. bohemica* show remarkable variability in karyotype asymmetry. These data, united to the fact that for several *Gagea* species it is often reported more than one ploidy level, lead us to think that this genus is still under active chromosomal evolution.

ACKNOWLEDGEMENTS

This study was financed by the "Giovani Ricercatori" fund "Revisione sistematica e citotassonomica del genere *Gagea* Salisb. (*Liliaceae*) in Italia", University of Calabria (Dr. L. Peruzzi).

REFERENCES

BIANCHI, R. (1946). Untersuchungen über die Fortpflanzungverhältnisse von Gagea fistulosa (Ram.) und Lloydia serotina (Rchb.). *Ber. Schweiz. Bot. Ges.* 56: 523-582.

CORSI, G., F. GARBARI & A. GHELARDI (1996). Reports (684-691). *Fl. Medit.* 6: 249-262.

FORTE, L., V. CAVALLARO, F. PANTALEO, F. S. D'AMICO & F. MACCHIA (2002). The vascular flora of the "Bosco Isola" at Lesina (Foggia - Apulia). *Fl. Medit.* 12: 33-92.

GARGANO, D., L. PERUZZI, K. F. CAPARELLI & G. CESCA (2004). Preliminary observations on reproductive strategies of five early-flowering species of Gagea Salisb. (Liliaceae). *In:* VASIC, O. (ed.), *XI OPTIMA Meeting, 5-11 September 2004, Belgrad; Book of Abstracts*: 124.

GREILHUBER, J., I. EBERT, A. LORENZ & B. VYSKOT (2000). Origin of facultative heterochromatin in the endosperm of Gagea lutea (Liliaceae). *Protoplasma* 212: 217-226.

HEYN, C. C. & A. DAFNI (1977). Studies in the genus Gagea (Liliaceae). II. The non-platyspermous species from the Galilee, the Golan heights and Mt. Hermon. *Israel J. Bot.* 26: 11-22.

HEYN, C. C. & A. DAFNI (1971). Studies in the genus Gagea (Liliaceae). I. The platyspermous species in Israel and neighbouring areas. *Israel J. Bot.* 20: 214-233.

KAPASA, M., T. NIKOLAIDI, E. P. BAREKA & G. KAMARI (2001). Reports (1236-1243). *Fl. Medit.* 11: 448-454.

KOUL, A. K. & A. K. WAKHLU (1985). Studies on the genus Gagea (5). Embryology of Gagea reticulata Schult. *J. Jap. Bot.* 60: 361-369.

LEVAN, A., K. FREDGA & A. A. SANDBERG (1964). Nomenclature for centromeric position of chromosomes. *Hereditas (Lund)* 52: 201-220.

MARTINOLI, G. (1950). Studio cariologico della Gagea soleirolii F. Schulz. *Caryologia* 3: 72-78.

MEHRA, P. N. & S. K. SACHDEVA (1976). Cytological observations on some west Himalayan monocots. II. Smilacaceae, Liliaceae and Trilliaceae. *Cytologia* 41: 5-22.

MĚSIČEK, J. & L. HROUDA (1974). Chromosome numbers in Czechoslovak species of Gagea (Liliaceae). *Folia Geobot. Phytotax.* 9: 359-368.

MOLINA, J., H. MICHAUD, J.-P. ROUX & J.-M. TISON (1998). Gagea mauritanica Durieu (Liliaceae), espèce nouvelle pour la flore française. *Bull. Mens. Soc. Linn. Lyon* 67: 77-78.

MONTSERRAT MARTI, J.-M. (1981). Números cromosomáticos de plantas occidentales, 77-83. *Anales Jard. Bot. Madrid* 38: 249-252.

PASCHER, A. A. (1906). Zur Kenntnis zweier mediterraner Arten der Gattung Gagea (Gagea foliosa R. Sch., Gagea pedunculatis Pasch.). *Beih. Bot. Centralbl.* 20: 76-107.

PERUZZI, L. (2003). Contribution to the cytotaxonomical knowledge of Gagea Salisb. (Liliaceae) sect. Foliatae A. Terracc. and synthesis of karyological data. *Caryologia* 56: 115-128.

PERUZZI, L. (2004). Segnalazioni floristiche Italiane 1100. *Inform. Bot. Ital.* 36: 78-79.

PERUZZI, L. (2005). Gagea pratensis (Pers.) Dumort. *Inform. Bot. Ital.* 37, in press.

PERUZZI, L. & D. GARGANO (2005). Distribuzione del genere Gagea Salisb. (Liliaceae) in Calabria. *Inform. Bot. Ital.* 37, in press.

PERUZZI, L. & J.-M. TISON (2004a). Verso una revisione biosistematica del genere Gagea Salisb. (Liliaceae). Un nuovo tipo di approccio. *Inform. Bot. Ital.* 36: 470-475.

PERUZZI, L. & J.-M. TISON (2004b). Typification and taxonomic status of eleven taxa of Gagea Salisb. (Liliaceae) described by Achille and Nicola Terracciano and conserved at Napoli (NAP). *Candollea* 59: 325-346.

PETERSON, A., H. JOHN, E. KOCH & J. PETERSON (2004). A molecular phylogeny of the genus Gagea (Liliaceae) in Germany inferred from non-coding chloroplast and nuclear DNA sequences. *Pl. Syst. Evol.* 245: 145-162.

PIGNATTI, S. (1982). *Fl. Italia* 3: 352-356.

REYNAUD, C. & J.-M. TISON (1997). Etude phytochimique de quelques échantillons de Gagea (Liliaceae). *Bull. Mens. Soc. Linn. Lyon* 66: 141-144.

REYNAUD, C., R. VERLAQUE & D. FILOSA (1993). Reports (234-239). *Fl. Medit.* 3: 367-373.

RIX, E. M. (1984). Gagea Salisb. *In:* DAVIS, P. A. *Fl. Turkey* 8: 312-327.

ROMERO ZARCO, C. (1986). A new method for estimating karyotype asymmetry. *Taxon* 35: 526-530.

SOPOVA, M., U. STAROVA & Z. SEKOVSKI (1984). Study in the genus Gagea: II. Cytology and distribution of seven Gagea species from Sr. Macedonia. *Acta Mus. Maced. Sci. Nat.* 17: 103-131.

STEARN, W. T. (1983). The Linnaean species of *Ornithogalum* (Liliaceae). *Ann. Mus. Goulandris* 6: 139-170.

STENAR, H. (1927). Entwicklung des siebenkernigen Embryosacks bei Gagea lutea Ker-Gawler. *Svensk Bot. Tidskr.* 21: 344-360.

TERRACCIANO, N. (1896). Intorno alla flora del monte Pollino e delle terre adiacenti. *Atti Reale Accad. Sci. Fis.* ser. 2, 8(9): 6-7.

TISCHLER, G. (1934). Die bedeutung der polyploidie für die Verbreitung der Angiospermen, erläuert an den Arten Schleswig-Holsteins, mit Ausblicken auf andere Florengebiete. *Bot. Jahrb. Syst.* 67: 1-36.

TISCHLER, G. (1950). *Die chromosomenzahlen der Gefässpflanzen Mitteleuropas.* Uitgeverij D.W. Junk.

TISON, J.-M. (1996a). Revision des Gagea du groupe bohemica en France. *Monde Pl.* 455: 11-17.

TISON, J.-M. (1996b). Le Gagea du Petit Luberon. *Monde Pl.* 455: 17.

TISON, J.-M. (1997). Les Gagea du groupe lutea en France. *Monde Pl.* 460: 15-16.

TISON, J.-M. (1998a). Gagea granatellii (Parl.) Parl. en France. *Monde Pl.* 462: 1-6.

TISON, J.-M. (1998b). Notes complementaires sur quelques Gagea francais. *Monde Pl.* 462: 7-8.

TISON, J.-M. (2001a). Typification de Gagea cossoniana Pascher, de Gagea fragifera (Vill.) Ehr. Bayer et G. Lopez et de Gagea maroccana (A. Terracc.) Sennen et Mauricio. *Candollea* 56: 197-202.

TISON, J.-M. (2001b). Gagea villosa (M. Bieb.) Sweet. *Candollea* 56: 153-154.

TISON, J.-M. (2004a). Identité et situation taxonomique de Gagea polymorpha Boiss. *Candollea* 59: 109-117.

TISON, J.-M. (2004b). Contribution à la connaissance du genre Gagea Salisb. (Liliaceae) en Afrique du Nord. *Lagascalia* 24: 67-87.

TISON, J.-M. (2004c). Gagea polidorii J.-M. Tison, espèce méconnue du sud-ouest des Alpes et des Apennins. *Acta Bot. Gallica* 151: 319-326.

TISON, J. M. & P. PERRET (2004). Typification d'Ornithogalum pusillum F. W. Schmidt et relations taxonomiques entre Gagea pusilla (F. W. Schmidt) Sweet, Ornithogalum clusii Tausch et G. clusiana Schult. & Schult. f. *Candollea* 59: 103-108.

ZEMSKOVA, E. A. & I. G. LEVICHEV (1988). Chromosome numbers of the species of the genus Gagea (Liliaceae). *Bot. Zhurn. (Moscow & Leningrad)* 83(9): 136-138.

Submitted on 18 November 2004
Accepted on 10 May 2005

Address of the authors: L. P., G. A.: Museo di Storia Naturale della Calabria ed Orto Botanico, Università della Calabria, 87030 Arcavacata di Rende (CS), Italy. Email (L. P.): peruzzi@unical.it

Table 1. – Measurements made on 5 metaphasic plates, belonging to 5 specimens of *Gagea minima* (2x). Data were obtained from microphotographs, then reported in µm.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Long arms (mean length of the homologue chromosomes, 2x)												
Plant 1	3.40	3.17	2.69	1.74	1.41	1.55	1.47	1.21	1.12	0.95	1.01	0.76
Plant 2	5.14	4.55	3.94	2.22	2.23	1.99	1.80	1.57	1.59	1.34	1.56	1.09
Plant 3	3.59	3.52	3.26	1.84	1.52	1.53	1.32	1.30	1.09	1.16	1.15	0.80
Plant 4	4.11	3.72	3.24	1.94	1.79	1.54	1.29	1.26	1.11	0.92	1.14	0.73
Plant 5	2.27	1.97	1.96	1.47	0.90	0.98	0.79	0.82	1.03	0.77	0.89	0.72
Mean length (L)	3.70	3.39	3.02	1.84	1.57	1.52	1.33	1.23	1.19	1.03	1.15	0.82
Short arms (mean length of the homologue chromosomes, 2x)												
Plant 1	0.78	0.65	0.71	1.24	1.19	0.80	0.85	0.75	0.84	0.58	0.35	0.53
Plant 2	1.05	1.13	0.64	1.27	1.06	0.88	1.01	0.92	0.71	0.77	0.48	0.64
Plant 3	0.75	0.67	0.73	0.99	0.84	0.64	0.72	0.62	0.72	0.54	0.35	0.61
Plant 4	0.77	0.78	0.74	1.43	1.29	0.49	0.95	0.75	0.65	0.41	0.33	0.53
Plant 5	0.60	0.62	0.61	0.73	0.82	0.64	0.74	0.64	0.42	0.60	0.44	0.57
Mean length (S)	0.79	0.77	0.69	1.13	1.04	0.69	0.86	0.74	0.67	0.58	0.39	0.58
Total length (TL)	4.49	4.15	3.70	2.97	2.61	2.21	2.19	1.97	1.85	1.61	1.54	1.39
						30.70						
Ratio Long arm / Short arm (L/S)	4.68	4.41	4.39	1.63	1.51	2.20	1.56	1.67	1.78	1.77	2.96	1.42
Karyotype formula		6st			4m	2sm		4m		6sm		2m

Table 2. – Measurements made on 5 metaphasic plates, belonging to 5 specimens of *Gagea chrysantha* (3x). Data were obtained from microphotographs, then reported in µm. * = Plant from Iblei, Sicily.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Long arms (mean length of the homologue chromosomes, 3x)												
Plant 1	2.53	2.40	2.171.74	1.42	1.15	1.15	0.93	1.04	0.90	0.89	0.80	
Plant 2	3.36	2.84	2.27	1.65	1.52	1.44	1.27	1.14	1.31	1.17	1.07	0.86
Plant 3	2.86	2.71	2.37	1.39	1.46	1.08	1.03	1.13	1.10	0.92	0.88	0.67
Plant 4	2.86	2.71	2.37	1.39	1.46	1.13	1.08	0.97	1.10	0.97	0.88	0.67
Plant 5*	2.52	2.35	1.98	1.31	1.23	1.12	1.00	0.92	1.00	0.84	0.88	0.60
Mean length (L)	2.83	2.60	2.23	1.50	1.42	1.18	1.11	1.02	1.11	0.96	0.92	0.72
Short arms (mean length of the homologue chromosomes, 3x)												
Plant 1	0.95	0.63	0.69	0.81	0.85	0.79	0.62	0.76	0.62	0.68	0.53	0.51
Plant 2	0.77	0.63	0.78	0.95	0.81	0.71	0.74	0.83	0.58	0.64	0.51	0.45
Plant 3	0.60	0.51	0.63	0.90	0.65	0.64	0.64	0.51	0.47	0.59	0.40	0.29
Plant 4	0.60	0.51	0.63	0.90	0.65	0.51	0.64	0.67	0.47	0.56	0.40	0.29
Plant 5*	0.53	0.52	0.77	0.72	0.57	0.45	0.55	0.55	0.39	0.53	0.43	0.50
Mean length (S)	0.69	0.56	0.70	0.86	0.71	0.62	0.64	0.66	0.51	0.60	0.45	0.41
Total length (TL)	3.52	3.16	2.93	2.35	2.12	1.80	1.74	1.68	1.61	1.56	1.38	1.13
							25.00					
Ratio Long arm / Short arm (L/S)	4.12	4.66	3.19	1.74	2.01	1.91	1.74	1.54	2.19	1.60	2.03	1.77
Karyotype formula		9st			12sm			3m	3sm	3m	6sm	

Table 3. – Measurements made on 5 metaphasic plates, belonging to 5 specimens of *Gagea mauritanica* (3x). Data were obtained from microphotographs, then reported in μm.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Long arms (mean length of the homologue chromosomes, 3x)												
Plant 1	5.11	4.88	4.02	2.99	2.40	3.05	2.71	1.65	2.02	1.65	1.77	2.01
Plant 2	4.72	4.43	4.26	2.57	3.73	2.11	2.28	1.76	1.92	1.46	2.08	1.51
Plant 3	4.27	4.01	3.81	2.52	2.68	2.18	2.09	1.97	1.78	1.39	1.73	1.23
Plant 4	3.57	3.95	3.42	2.19	2.75	1.62	2.13	1.43	1.70	1.31	1.83	1.52
Plant 5	4.79	5.11	4.61	3.14	3.58	3.01	2.47	2.01	2.28	2.14	2.09	1.65
Mean length (L)	4.49	4.48	4.02	2.68	3.03	2.39	2.34	1.76	1.94	1.59	1.90	1.58
Short arms (mean length of the homologue chromosomes, 2x)												
Plant 1	1.54	0.94	0.77	1.68	0.77	1.20	1.23	1.60	1.30	1.18	0.50	0.81
Plant 2	1.57	1.12	0.75	1.56	0.71	1.56	1.05	1.46	1.09	1.03	0.55	0.52
Plant 3	0.93	0.89	0.67	0.89	1.06	1.11	0.99	0.91	0.81	1.16	0.52	0.64
Plant 4	1.46	0.72	0.69	1.25	1.11	1.04	0.81	1.20	0.81	1.07	0.52	0.49
Plant 5	2.15	0.90	0.90	1.74	0.95	1.40	1.13	1.56	0.75	1.27	0.50	0.48
Mean length (S)	1.53	0.91	0.76	1.42	0.92	1.26	1.04	1.35	0.95	1.14	0.52	0.59
Total length (TL)	6.02	5.39	4.78	4.10	3.95	3.66	3.38	3.11	2.89	2.73	2.42	2.17
							44.62					
Ratio Long arm / Short arm (L/S)	2.94	4.89	5.30	1.89	3.28	1.90	2.23	1.31	2.04	1.39	3.66	2.69
Karyotype formula	3sm	6st		3sm	3st	6sm		3m	3sm	3m	3st	3sm

Table 4. – Asymmetry indexes calculated for 14 representatives of five *Gagea* sections.

Taxa	Ploidy level	A1	A2	Data derived from
Sectio ***Gagea***				
G. lutea (L.) Ker-Gawl.	2x	0.72	0.42	Sopova & al., 1984
	6x	0.69	0.49	Sopova & al., 1984
G. pratensis (Pers.) Dumort.	2x	0.58	0.40	Sopova & al., 1984
G. pusilla (F. W. Schmidt) Sweet	2x	0.62	0.46	Sopova & al., 1984
	4x	0.62	0.47	Sopova & al., 1984
	5x	0.65	0.38	Sopova & al., 1984
Sectio ***Minimae*** (Pascher) Davlian.				
G. minima (L.) Ker-Gawl.	2x	0.67	0.44	Sopova & al., 1984
	2x	0.50	0.41	present study
Sectio ***Fistulosae*** (Pascher) Davlian.				
G. fragifera (Vill.) Ehr. Bayer & G. López	4x	0.57	0.41	Sopova & al., 1984
Sectio ***Didymobulbos*** Koch				
G. bohemica (Zauschn.) Schult. & Schult. f.	4x	0.67	0.52	Sopova & al., 1984
	4x	0.39	0.33	Peruzzi, 2003
G. chrysantha (Jan) Schult. & Schult. f. (sub "G. foliosa")	3x	0.45	0.37	Peruzzi, 2003
	3x	0.40	0.36	Peruzzi, 2003
	3x	0.52	0.36	present study
G. durieui Parl.	3x	0.60	0.29	Corsi & al., 1996
G. mauritanica Durieu	3x	0.56	0.33	present study
G. soleirolii F. W. Schultz	3x	0.58	0.43	Martinoli, 1950
G. villosa (M. Bieb.) Sweet	4x	0.43	0.37	Reynaud & al., 1993
Sectio ***Platyspermum*** Boiss.				
G. commutata K. Koch	2x	0.67	0.51	Heyn & Dafni, 1971
G. procera Mouterde	3x	0.58	0.46	Heyn & Dafni, 1971
G. reticulata (Pall.) Schult. & Schult. f.	2x	0.54	0.42	Koul & Wakhlu, 1985

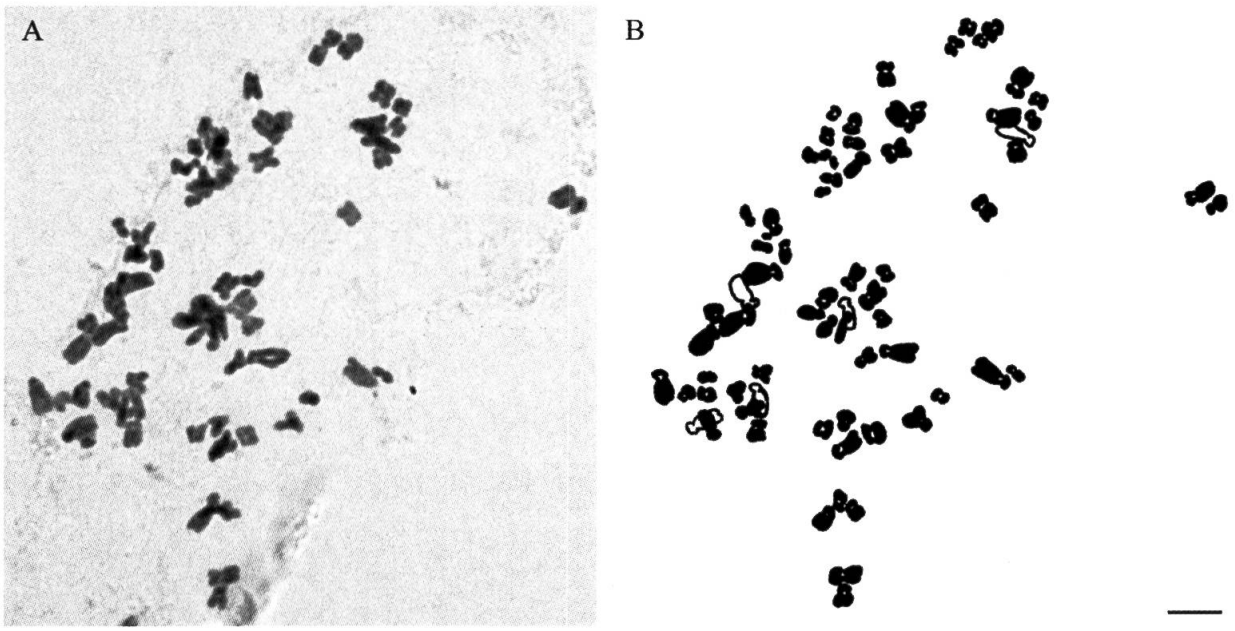

Fig. 1. – *Gagea lutea* (L.) Ker-Gawl. **A.** metaphasic plate; **B.** drawing of metaphasic plate showing $2n = 72$ chromosomes. Scale bar = 5 μm.

Fig. 2. – *Gagea pratensis* (Pers.) Dumort.: drawing of a metaphasic plate showing $2n = 60$ chromosomes. Scale bar = 5 μm.

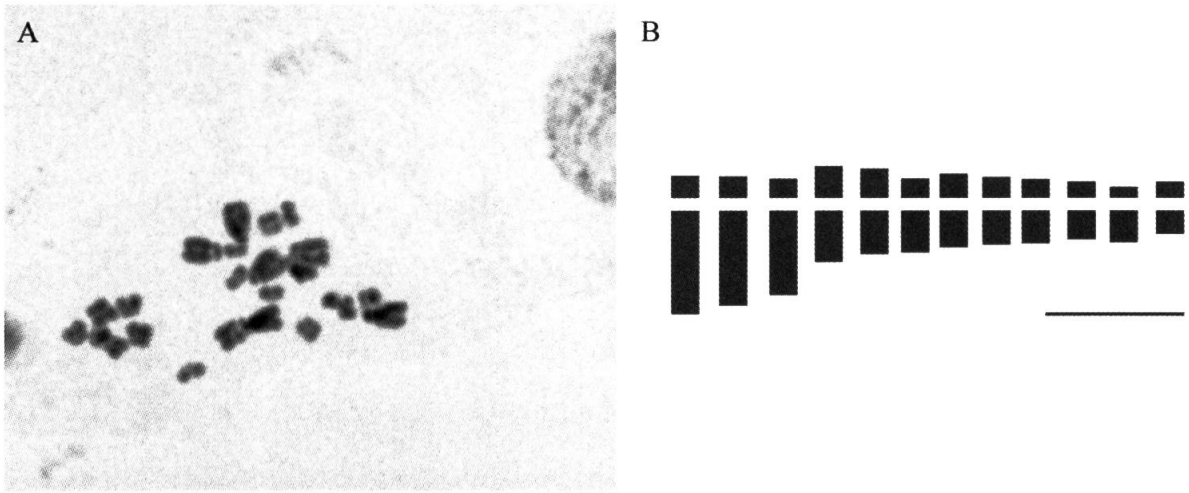

Fig. 3. – *Gagea minima* (L.) Ker-Gawl. **A.** metaphasic plate, showing $2n = 24$ chromosomes; **B.** haploid idiogram. Scale bar = 5 µm.

Fig. 4. – *Gagea fragifera* (Vill.) Ehr. Bayer & G. López: drawing of a metaphasic plate showing $2n = 84$ chromosomes. Scale bar = 5 µm.

Fig. 5. – *Gagea polidorii* J.-M. Tison: drawing of a metaphasic plate showing $2n = 72$ chromosomes. Scale bar = 5 µm.

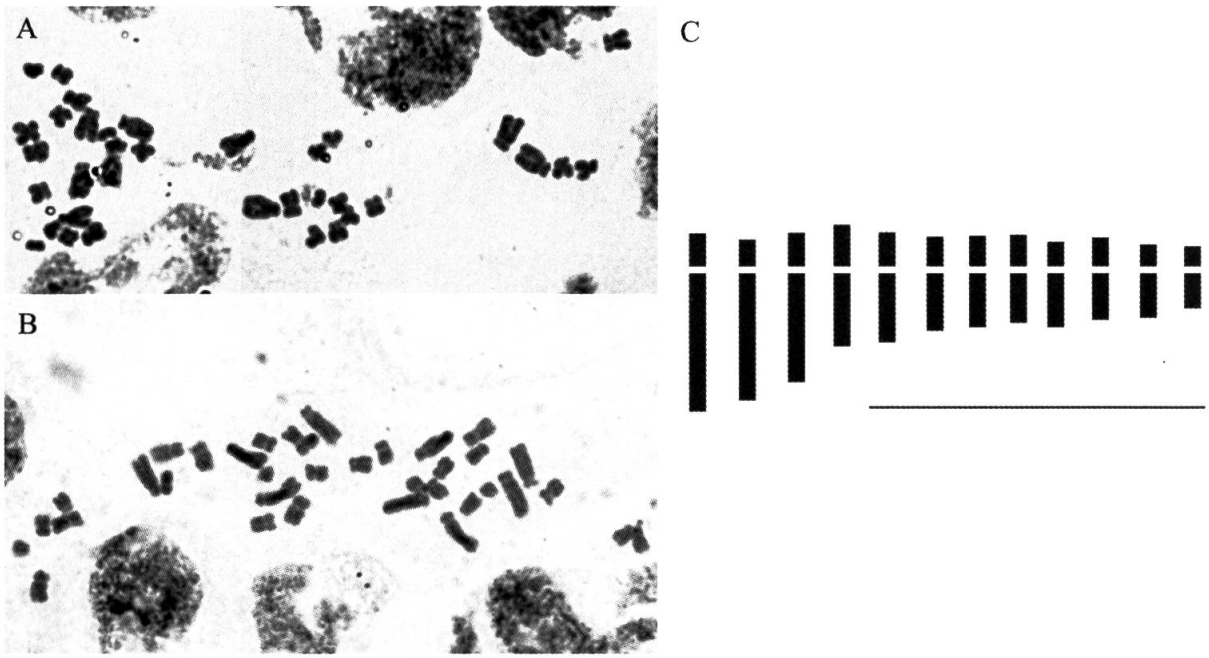

Fig. 6. – *Gagea chrysantha* (Jan) Schult. & Schult. f. **A.** metaphasic plate, showing $2n = 36$ chromosomes from Calabrian plants, **B.** metaphasic plate, showing $2n = 36$ chromosomes from Sicilian plants; **C.** haploid idiogram. Scale bar = 5 μm.

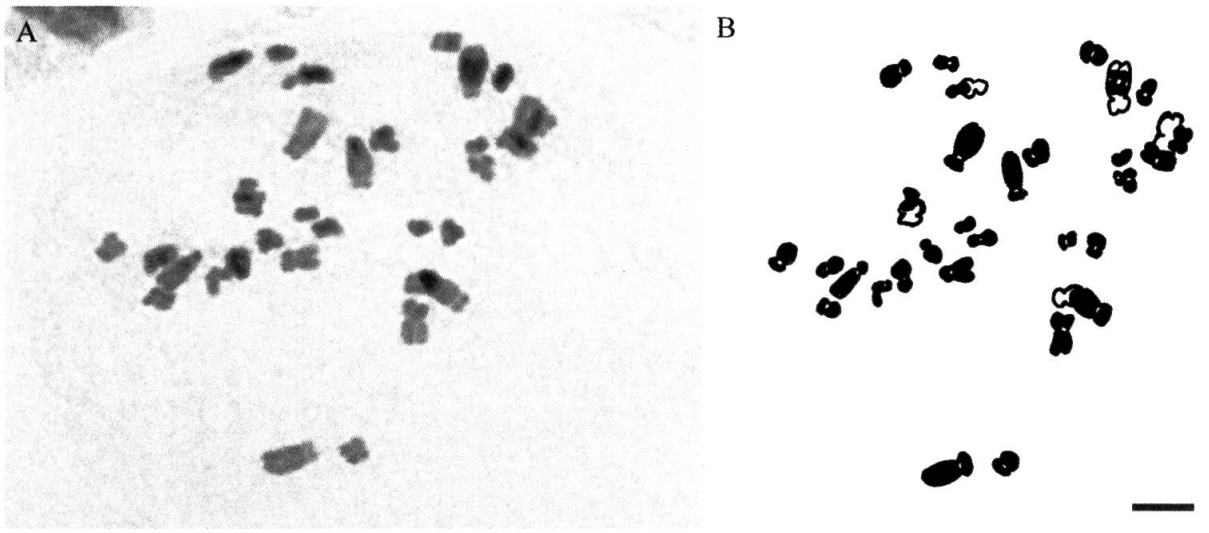

Fig. 7. – *Gagea foliosa* (J. Presl & C. Presl) Schult. & Schult. f. **A.** metaphasic plate; **B.** drawing of the metaphasic plate showing $2n = 36$ chromosomes. Scale bar = 5 μm.

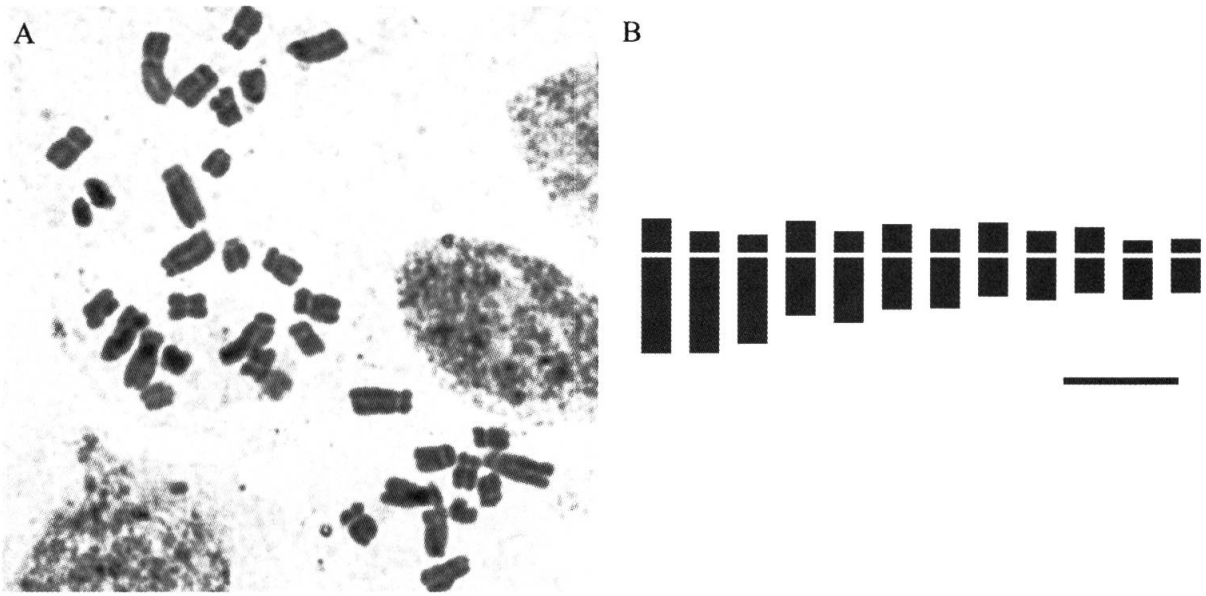

Fig. 8. – *Gagea mauritanica* Durieu. **A.** metaphasic plate showing $2n = 36$ chromosomes; **B.** haploid idiogram. Scale bar = 5 μm.

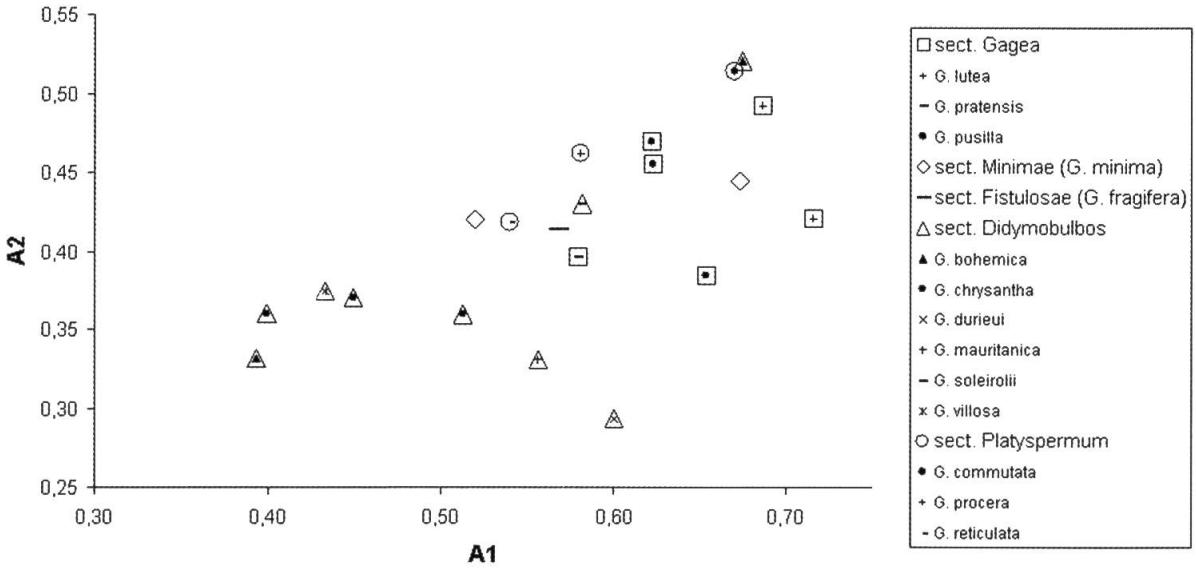

Fig. 9. – Scatter plot of the karyotype asymmetry indexes reported in Table 4. Fourteen species are represented, grouped in 4 sections.