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Biosystematic researches on *Allium cupani* group (*Amaryllidaceae*) in the Mediterranean area

Abstract

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Allium cupani Raf. is a species complex of the subgenus *Allium* L., which is taxonomically quite critical mainly for its marked karyological and morphological variability. In the present study, karyo-taxonomic characterization of some peculiar populations of this group from Italian, N African, Balcan and Aegean territories has been performed, using both living plants collected in the field and herbarium material. As a result, ten new species have been recognized and described within the *A. cupani* complex. They are *A. panormitanum* from N Sicily, *A. samniticum* from C Italy, *A. mauritanicum* from N Morocco and NW Algeria, *A. balcanicum* from mountains of Balkan Peninsula, *A. tzanoudakisanum* from Aegean area, *A. cephalonicum* from Cephalonia island, *A. meikleanum* from Cyprus, *A. pelagicum* from Lampedusa island, *A. maghrebinum* from Tunisia and NE Algeria, and *A. tingitanum* from N Morocco and NW Algeria. A comprehensive description and detailed illustration, together with significant notes on karyology, phenology, ecology, geographic distribution, and taxonomic relationships are provided for each species.

Key words: biogeography, karyology, Mediterranean, *Allium* sect. *Cupanoscordum*, taxonomy.

Introduction

As a result of extended biosystematic studies carried out on the genus *Allium* L. in the Euro-Mediterranean countries over the last thirty years (Brullo & al. 1982, 1993, 1996, 1997a, 1998, 2001, 2003a, 2003b, 2004, 2008a, 2008b, 2009, 2010, 2013, 2014; Bogdanovič & al. 2008, 2009, 2011a, 2011b; Giusso & al. 2015), this contribution on a critical and poorly known group of taxa currently attributed to the *A. cupani* Raf. complex is presented.

Populations belonging to this species complex are distributed in the whole Mediterranean area, spreading eastward to the Irano-Turanian region. They are usually very scattered and geographically quite isolated, often restricted to small surfaces with few individuals. This biogeographical pattern has been interpreted as a consequence of ancient segregation processes, probably dated back to the Miocene (De Wilde-Duyfjes 1976; Garbari & al. 1979; Brullo & al. 1995, 2008c).

Based on literature (Rafinesque 1810; Kunth 1843; Boissier 1882; Vvedenskii 1935; Palau 1953; Stearn 1978; Garbari & al. 1979; Llorens 1979; Brullo & Pavone 1983, 1988; Pastor & Valdes 1983; Kollmann 1984; Miceli & Garbari 1987; Pogosian 1989; Brullo & al. 1989, 1990, 1995, 1997b, 2008c; Andersson 1991; Iatrou & Tzanoudakis 1995) and vast herbarium surveys, several taxa reported for the Mediterranean area and the Middle East should be referred to this group, some of which actually having a doubtful taxonomic status. They are: *A. cupani* Raf., *A. callidictyon* C.A. Meyer ex Kunth, *A. hirtovaginatatum* Kunth, *A. lacerum* Freyn, *A. incisum* Fomin, *A. araxanum* Fomin ex Grossh., *A. fimbriatum* Schischkin, *A. peroninianum* Azn., *A. antonii-bolosii* P. Palau, *Allium cupani* Raf. subsp. *cyprium* Meikle, *A. cupani* subsp. *anatolicum* Stearn, *A. greuteri* Brullo & Pavone, *A. eivissanum* Garbari & Miceli, *A. pentadactyli* Brullo, Pavone & Spamp., *A. karistanum* Brullo, Pavone & Salmeri, *A. ritsii* Iatrou & Tzanoudakis, *A. balcanicum* Brullo, Pavone & Salmeri nom. nud., *A. panormitanum* Brullo, Pavone & Salmeri nom. nud., *A. pelagicum* Brullo, Pavone & Salmeri nom. nud.

A characteristic feature of the taxonomic history of the *Allium cupani* complex is the inclusion in many different sections of the subgen. *Allium*, such as sect. *Schoenoprasum* Dumort. (Regel 1875; Vvedenskii 1935; Martinoli 1955), sect. *Macrospatha* G. Don (Maire 1958), sect. *Codonoprasum* Reichenb. (Garbari & Senatori 1976; De Wilde-Duyfjes 1976), sect. *Scorodon* C. Koch (Wendelbo 1971; Stearn 1978, 1980; Tzanoudakis 1983; Tzanoudakis & Vosa 1988; Özhatay 1990), sect. *Brevispatha* Valsecchi (Garbari & al. 1979; Kollmann 1984; Tzanoudakis 1992; Özhatay 1993; Brullo & al. 1995), and sect. *Cupanoscordum* Ceschm. (Cheschmejiyev 1975; Brullo & al. 2008c; Salmeri & al. 2014, 2015).

Some morphological traits of *Allium cupani*, as for instance spathe often shorter than the inflorescence, simple stamen filaments, included into the perigon, and ovary with well-developed nectariferous pores, indeed characterize various members of sect. *Scorodon* s. l., but many other taxonomically important characters, including outer bulb coats always reticulate-fibrous, sheathing spathe with 1 or 2 valves always connate at base, usually unilateral inflorescence, and 2-4 bostryces clearly distinguish *A. cupani* populations from sect. *Scorodon* s. l. The inclusion within sect. *Codonoprasum* should also be excluded, since all members of this section show membranaceous or coriaceous bulb tunics (the outermost ones sometimes only slightly fibrous), more or less large leaves, never filiform, spathe with 2 very long valves, splitted or slightly welded, ovary with inconspicuous nectariferous pores. These evidences are well supported by many phylogenetic studies, which place *A. cupani* s. l. in a distinct clade sister to the monophyletic sect. *Codonoprasum*, within the subgenus *Allium*, while sect. *Scorodon* s.str., typified by *A. moscatum* L., is included in the subgenus *Polyprason* Radić. (Fritsch & Frisen 2002; Frisen & al. 2006; Nguyen & al. 2008; Li & al. 2010; Hirschegger & al. 2010). Despite some affinities based on sheathing spathe, few-flowered inflorescence and 2 bostryces (Valsecchi 1974; Brullo & al. 1982), *Allium cupani* does not properly fit even within sect. *Brevispatha*, which is typified by *A. parciflorum* Viv., species markedly differing from *A. cupani* in a combination of relevant diagnostic features, such as only slightly fibrous outer bulb coats and coriaceous inner ones, 2-valved spathe always associated with 2 bostryces, and ovary with inconspicuous nectariferous pores.

It must be stressed that taxonomic diacritic characters of *Allium* species can be properly detected only on living plants, because most traits, especially the floral ones, become altered

and not recognizable in dry specimens so as to be unsuitable for a correct identification (Brullo 2009). This is probably one of the main reasons why many critical species and groups of this genus are still poorly investigated or misclassified, as in the case of *A. cupani*.

All populations of the *Allium cupani* complex are morphologically well differentiated from the other *Allium* species by a distinctive combination of diagnostic features, comprising brown outer bulb tunics, fibrous and more or less markedly reticulate, filiform leaves, with cylindrical to semicylindrical outline, subglabrous to densely hairy leaf indumentum, persistent spathe, with 1 or 2 valves basally connate, partially sheathed the flower pedicels, inflorescence few-flowered, fastigiate and usually unilateral (rarely hemispherical), arranged in 2 or 4 bostryces when the spathe is 1-valved or 2-valved respectively, perigon cylindrical to urceolate, white-pinkish to pink-purple, simple stamen filaments included into the perigon, ovary with well-developed nectariferous pores, covered by a membranous plica, capsule included into the perigon.

This combination of morphological features, together with many other anatomical, ultra-structural and biogeographical peculiarities (Garbari & al. 1979, 1991; Tzanoudakis & Vosa 1988; Brullo & al. 1995, 2008c, 2012; Celep & al. 2012), indeed suggests a more appropriate inclusion of the *A. cupani* group in the autonomous sect. *Cupanoscordum* as proposed by Cheschmejiyev (1975). Recent phylogenetic studies supported the monophyletic status of this group, whose species usually form a distinct clade in sister-relationship to other sections of subgenus *Allium*, especially sect. *Codonoprasum* (Friesen & al. 2006; Li & al. 2010; Salmeri & al. 2014, 2015).

In addition, the *Allium cupani* group is characterized by a significant variation both in the chromosome number and karyotype structure amongst different taxa and populations, as clearly highlighted in the current literature (Garbari & al. 1979; Tzanoudakis 1983; Brullo & Pavone 1983; Miceli & Garbari 1987; Tzanoudakis & Vosa 1988; Pogolian 1989; Brullo & al. 1989, 1990, 1995, 1997b; Tzanoudakis & al. 1991; Iatrou & Tzanoudakis 1995). These studies pointed out that the ancestral chromosome complement in the *A. cupani* group was diploid ($2n = 16$), with a basic number $x = 8$, as common in the whole subgenus *Allium* (Garbari & al. 1979; Narayan 1988; Özhatay 1993; Brullo & al. 1995; Hanelt 1996; Ohry & al. 1998). Populations of *A. cupani* s. l. also exhibit a tetraploid chromosome number $2n = 32$, derived by autopolyploidy or allopolyploidy processes. From these euploid chromosome complements, other two hypo-aneuploid counts $2n = 2x = 14$ and $2n = 4x = 30$ directly derived, due to mutational events.

This study aimed to clarify some of the taxonomic and nomenclatural problems within the *A. cupani* complex, using morphological, karyological, phenological, ecological, and chorological data, mostly obtained from living plants collected in various Mediterranean localities. As a result of these investigations, some species have been discovered and here described as new to science.

Materials and Methods

The morphological study was based on living plants collected in many localities of the Mediterranean area (Aegean area, Anatolia, Bulgaria, Crete, Cyprus, European Turkey, Greece, Balears, Italy, Libya, Morocco, Sicily, Tunisia), then cultivated in the Botanical

Garden of Catania. Living plants specifically coming from the type locality were surveyed whenever possible. Furthermore, many herbarium collections from various botanical museums were examined for taxonomic comparison (B, BM, BOLO, C, CAT, FI, FI-W, G, G-BOIS, HUJ, ISTE, K, M, MA, MPU, NAP, OXF, P, PAL, PI, RO, UPA, W, WU). Qualitative and quantitative morphological traits were examined and recorded under a Zeiss Stemi SV11 Apo stereomicroscope at 6–66× magnification from fresh material (about 10 individuals). Both vegetative and reproductive characters, together with some anatomical and ecological features, were chosen according to their diagnostic value for discriminating among the investigated populations. Herbarium specimens and available literature data were also employed to better define the range of intra-specific variability.

Karyological analyses were performed on mitotic plates obtained from root meristematic cells of cultivated bulbs (at least five), pre-treated with 0.3% (w/v) colchicine at room temperature for 3 h, fixed in Farmer's fixative (3:1 v/v, absolute ethanol: glacial acetic acid) for 12 hours, and hydrolyzed with 1N HCl for 7 min at 60°C. Chromosomes were stained using the Feulgen method (Feulgen & Rossenbach 1924). The somatic chromosome number was established and karyotype details were defined from 10 representative metaphase plates (2 per individual). Metaphase chromosomes were measured using the image analysis systems IKAROS 4.6 (Metasystem) and Zeiss Axiovision 4.6. Karyotyping was performed using software Cromolab© 1.1 (Brullo 2002) for the recognition and ordering of homologues. Chromosome classification and karyotype formulas followed Levan & al. (1964) and Tzanoudakis (1983).

Results

1. *Allium cupani* Raf., Caratteri: 86, 1810 – Figs. 1A, 3A, 5A, 6A, 7A, 8A.

Type: Sicily, Nasce sopra il Monte Etna e le Madonie, Rafinesque (types destroyed).

Lectotype: *Moly alpinum minus, capillaceo folio, floribus purpureo-rubris*, vol. 2, T. 201, Cupani (1713), here designated.

Epitype: Sicilia, Madonie, Quacella, 30.7.1991, *S. Brullo s. n. (CAT!)*, here designated.

Bulb ovoid, sometimes bulbiferous, 15–18 × 7–11 mm, with brown tunics, reticulate-fibrous, attached to the base of the bulb, covering the stem up to 2.5 cm. *Stem* erect or erect-ascending, flexuous, 12–18 cm high, covered by the leaf sheaths from 1/2 to almost total length. *Leaves* 4–5, shorter than the inflorescence, filiform, semicylindrical, sometimes canaliculate, 1.5–8 cm long, subglabrous or sparsely hairy with patent hairs 0.15–0.2 mm long. *Inflorescence* fastigiate, unilateral, with 4–10 flowers on pedicels 12–30 mm long. *Spathe* 1-valved, shorter than the inflorescence, 3-nerved, sometimes with 2 additional incomplete nerves, 12–20 mm long, with an appendage 1–3 mm long. *Bostryces* 2. *Perigon* cylindrical-campanulate, 6–7.5(8) mm long; tepals white-pink or pink with a purplish mid-vein, the outers oblong-lanceolate, entire, obtuse, 2–2.2 mm wide, the inners linear-oblong, rounded and gnawed-undulate at the apex, 1.6–1.8 mm wide. *Stamens* with white filaments, unequal, the outers subulate-triangular, 0.7–1.7 mm long and 0.5–0.7 mm wide at the base, the inners subulate above and broadened below, 1.5–2.5 mm long and 1–1.2 mm wide at the base, below connate with tepals into an annulus 1.2–1.5 mm high; anthers white-straw coloured, linear-elliptical, rounded at the apex, 1.6–1.8 × 0.6–0.8 mm.

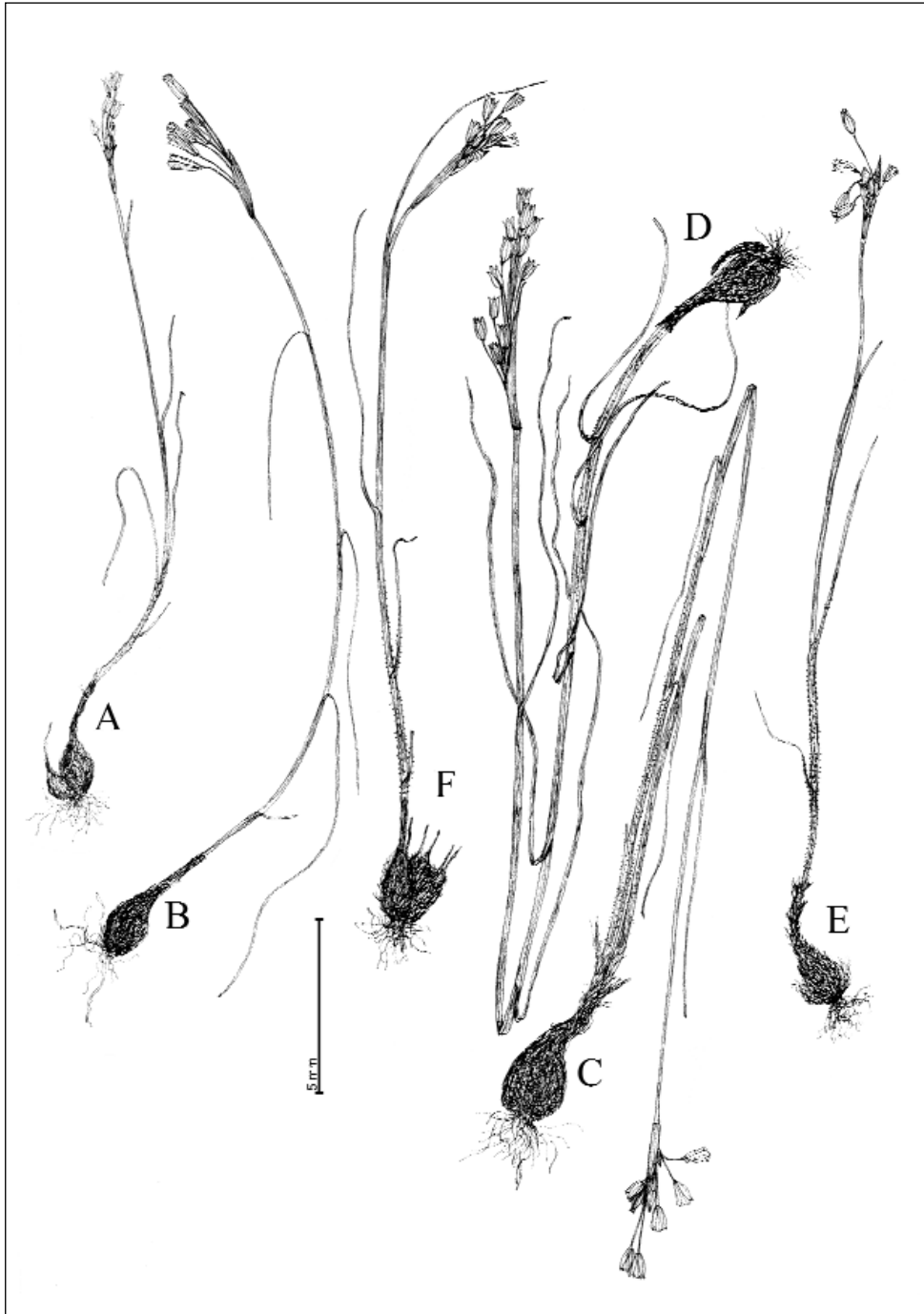


Fig. 1. Habit: **A.** *A. cupani*; **B.** *A. panormitanum*; **C.** *A. samniticum*; **D.** *A. mauritanicum*; **E.** *A. balcanicum*; **F.** *A. tzanoudakisanum* (Drawing by S. Brullo from living plants of type locality).

Ovary, ovoid or ovoid-pyriform, smooth, green, $1.8-2 \times 1.5$ mm; style white, 1-1.3 mm long. *Capsule* trivalved, ovoid to ellipsoid, uniformly coloured, $4.5-5 \times 3.2-3.8$ mm.

Distribution and habitat: Limited to some NW Sicilian mountains, such as Madonie, Mt. Pizzuta, Mt. Kumeta and Rocca Busambra. The species grows within orophilous meadows and dwarf shrub communities, which develop in rocky and semiruprestrian places up to about 2000 m of elevation, on calcareous, dolomitic or quarzarenitic substrata.

Karyology: All investigated populations of *A. cupani* s. str. (Tab. 1) revealed a tetraploid chromosome complement with $2n = 32$ (Fig. 9A), which confirms the count reported by Garbari & al. (1979). The karyotype appeared to be diploidized with homologues arranged in pairs instead of tetraplets, revealing a possible allopolyploid origin. It was mostly characterized by more or less metacentric (*m* to *msm*) chromosomes, two sub-metacentric (*sm*) pairs, one of which microsatellited on the short arm, and 4 subtelo-centric (*st*) pairs. Two to eight of these latter chromosomes, depending on the different analysed populations, showed microsatellites in the short arms. The karyotype formula can be summarized as follows: $2n = 4x = 32: 12m + 8msm + 2sm + 2sm^{sat} + 8st$. Plants from type locality (Madonie Mts.) revealed a haploid chromosome complement $131.68 \mu\text{m}$ in length, varying from $11.61 \mu\text{m}$ of the longest chromosome to $5.74 \mu\text{m}$ of the shortest one, while the relative length ranged from 8.82 to 4.36%.

Phenology: Flowering from mid July to late August.

Etymology: Francesco Cupani, pre-linnean Sicilian naturalist, is commemorated.

Taxonomic notes: In the protologue of *Allium cupani*, Rafinesque (1810) quoted as *locus classicus* "Nasce sopra il Monte Etna e le Madonie". Given the loss of the Sicilian herbarium of Rafinesque due to a shipwreck while he was returning to N America in 1815, we propose as lectotype the iconography published in Cupani (1713), that Rafinesque (1810) quoted in the protologue. Since this illustration is rather unclear and does not show the relevant diacritic features of this species, one specimen from Madonie Mts. is here designated as epitype. To this respect, it must be highlighted that the neotype previously designated by De Wilde-Duyffjes (1976: 109) "in montosis panormitanis a Monte Gallo, *Parlatore* (FI-W)" was not correctly chosen because it does not come from the *locus classicus*. Furthermore, this specimen differs from *A. cupani* in many relevant morphological features and corresponds to another species of the *A. cupani* group occurring at Monte Gallo, named *A. panormitanum*, which has an autumnal flowering period.

A. cupani s.str. belongs to a group of tetraploid taxa with $2n = 32$ only present in Sicily, CS Italy and NW Africa, which share some morphological characters, including bulb coats attached to the base of the bulb, glabrous to subglabrous or sparsely hairy leaves, 1-valved, 3-4-nerved spathe, shorter than the inflorescence and provided with a small appendage, smooth ovary, as well as a merely summer flowering time (July-August). Specifically circumscribed to some mountain localities of NW Sicily, *A. cupani* is characterized by relict populations, geographically isolated and confined to small surfaces with few individuals, which testify the very old origin and segregation of this taxon.

Additional specimens examined: Sicily, Nei Monti di Palermo e alle Madonie, 1822, *G. Gussone s.n.* (BOLO!); Madonie, Quacella, 30.7.1991, *S. Brullo s.n.* (CAT!); *ibid.*, Pizzo Carbonara, 29.7.1991, *S. Brullo s.n.* (CAT!); *ibid.*, Colma Grande, 24.7.1992, *S. Brullo s.n.* (CAT!); *ibid.*, M. S. Salvatore, 21.7.1979, *S. Brullo s.n.* (CAT!); *ibid.*, Piano



Fig. 2. Habit: **G.** *A. cephalonicum*; **H.** *A. maghrebinum*; **I.** *A. hirtovaginatam*; **J.** *A. meikleianum*; **K.** *A. pelagicum*; **L.** *A. tingitanum* (Drawing by S. Brullo from living plants of type locality).

Battaglia, 3.9.1972, *S. Brullo s.n.* (CAT!); *ibid.*, inter Piano Battaglia et Pizzo Carbonara, 04.8.1965, *H. Merxmüller & H. Grau 20391* (M!); Pizzo dell'Antenna, 1850, no collector (PAL!); Madonie, con *Genista cupani*, nelle radure delle Faggete, Mercato di Cixè (Geraci Siculo), 1975, *F. M. Raimondo s.n.* (PI!); Monte Kumeta (Piana degli Albanesi), 25.7.1990, *S. Brullo s.n.* (CAT!); Monte Pizzuta (Piana degli Albanesi), 25.7.1990, *S. Brullo s.n.* (CAT!); Rocca Busambra, 12.7.1981, *S. Brullo s.n.*(CAT!); *ibid.*, 26.7.1990, *S. Brullo s.n.* (CAT!)

2. *Allium panormitanum* Brullo, Pavone & Salmeri, spec. nova – Figs. 1B, 3B, 5B, 6B, 7B, 8B.

Allio cupano similis, sed scapo 20-30 cm longo, foliis glabris, spatha apiculata, 6-9-nervata, perigonio cylindrico-urceolato, 7,5-9 mm longo, tepalis exterioribus rotundatis, 2,3-2,7 mm latis, tepalis interioribus 1,8-2,2 mm latis, filamentibus staminum inferne cum tepalis per 1,7-2 mm in annulum connatis, antheris ellipticis, 1,4-1,5 mm longis, ovario papilloso-rugoso superne, capsula ellipsoidea, 4,2 mm longa.

Type: Sicily, Monte Pellegrino (PA), 10.9.1992, *S. Brullo s.n.* (Holo: CAT!).

Bulb ovoid, sometimes bulbiferous, 12-20 × 7-12 mm, with brown outer tunics, reticulate-fibrous, attached to the base of the bulb, covering the stem up to 3 cm. *Stem* erect, flexuous, 20-30 cm high, covered by the leaf sheaths 1/2-3/4 of its length. *Leaves* 4-5, shorter than the inflorescence, filiform, subcylindrical, 5-15 cm long, glabrous or sometimes provided with hairs 0.2-0.3 mm long on the sheath gorge. *Inflorescence* fastigate, unilateral, with 5-8 flowers on pedicels 10-40 mm long. *Spathes* 1-valved, shorter than the inflorescence, 6-9-nerved, 12-20 mm long, apiculate. *Bostryces* 2. Perigon cylindrical-urceolate, (7.5-)8-9 mm long; tepals subequal white-pink, tinged with purple, with a purplish mid-vein, the outers linear-elliptical, entire, rounded, 2.3-2.7 mm wide, the inners linear-oblong, rounded and gnawed-undulate at the apex, 1.8-2.2 mm wide. *Stamens* with white filaments, triangular, unequal, the outers 1-2 mm long and 0.7-0.8 mm wide at the base, the inners 1.8-3 mm long and 1.2-1.5 mm wide at the base, below connate with tepals into an annulus 1.7-2 mm high; anthers white-straw coloured, elliptical, rounded at the apex, 1.4-1.5 × 0.8 mm. *Ovary* green, ovoid, papillose-rugose in the upper part, 2 × 1.5-1.6 mm. *Style* white, 1 mm long. *Capsule* trivalved, ellipsoid, 4.2 × 3.5 mm.

Distribution and habitat: The species occurs in some mountains near Palermo (NW Sicily), such as Mt. Pellegrino, Mt. Gallo and Mt. Caputo. It preferably grows in crevices and rocky places at 100-500 m of elevation, where it is a member of thermoxerophilous garigues or perennial grasslands, such as *Ampelodesmos mauritanicus* communities, linked to Mesozoic limestones.

Karyology: All analyzed populations of *Allium panormitanum* (Tab. 1) showed the same tetraploid chromosome number $2n = 32$ as *A. cupani* s.str. The karyotype structure (Fig. 9B) was also rather similar with chromosomes arranged in pairs instead of tetraplets and a majority of more or less median chromosomes (*m* or *msm* types) plus 4 subterminal (*st*) pairs. Notwithstanding, the karyotype of *A. panormitanum* differs in the occurrence of one additional submetacentric pair and in various karyomorphometric parameters, including greater chromosome length (THL), higher difference between long and short arms (D-value) and smaller difference in chromosome relative length (DRL). The karyotype formula can be summarized as: $2n = 4x = 32: 12m + 8msm + 4sm + 8st$. Satellites were clearly detected in specimens from Mt. Caputo, where one submetacentric pair

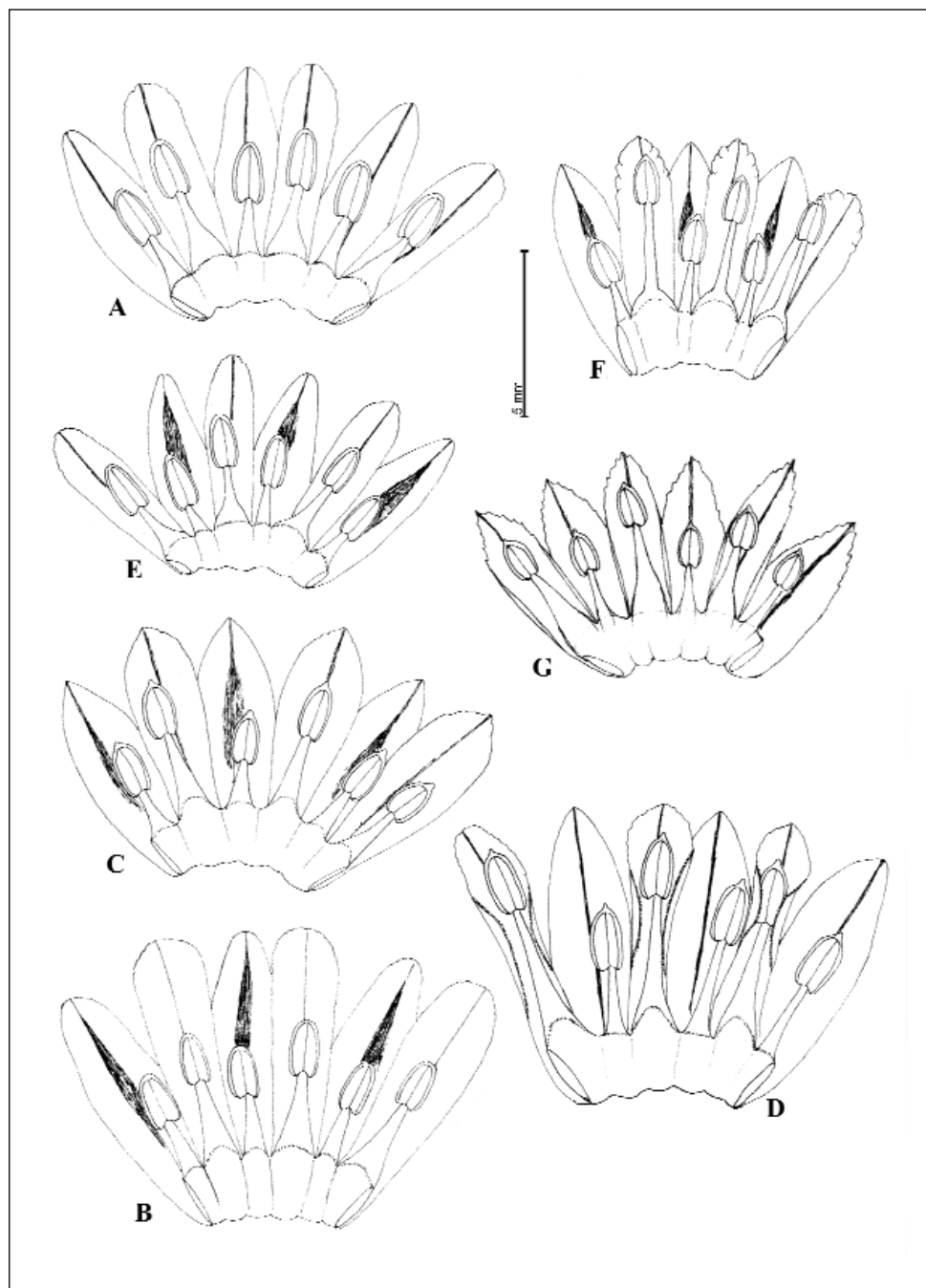


Fig. 3. Open perigon: **A.** *A. cupani*; **B.** *A. panormitanum*; **C.** *A. samniticum*; **D.** *A. mauritanicum*; **E.** *A. balcanicum*; **F.** *A. tzanoudakisanum*; **G.** *A. cephalonicum* (Drawing by S. Brullo from living plants of type locality).

showed macrosatellites on the short arms and 3 subtelocentric pairs were microsatellited. Specimens from type locality showed a haploid chromosome complement $154.35 \pm 12.16 \mu\text{m}$ long, the total chromosome size varying from $12.65 \pm 1.06 \mu\text{m}$ of the longest chromosome to $6.10 \pm 1.7 \mu\text{m}$ of the shortest one, and the relative length ranging from 6.16 to 3.92%.

Phenology: Flowering from September to mid November.

Etymology: From Latin “*Panormus*”, today’s Palermo in NW Sicily.

Taxonomic notes: Based on bulb coats attached to the base of the bulb, 1-valved spathe shorter than the inflorescence, and tetraploid chromosome number ($2n = 32$), *Allium panormitanum* is quite related to *A. cupani*, although the two species significantly differ in several features. Firstly, *A. panormitanum* is a typical autumn-flowering (September–November) geophyte, whereas *A. cupani* flowers from late spring to summer (June–August). Then, *A. panormitanum* shows higher stem (20–30 cm), apiculate spathe with 5–9 complete nerves, bigger perigon (c. 8–9 mm) and papillose-rugose ovary, while *A. cupani* is characterized by a shorter stem (8–20 cm), appendiculate spathe with 3–5 complete plus 2 incomplete lateral nerves, smaller perigon (c. 6–7.5 mm) and entirely smooth ovary.

Paratypes: Sicily, Monte Pellegrino (PA), 10.9.1992, *S. Brullo s.n.* (CAT!); In montosis Siciliae, Monte Gallo, s.d., *F. Parlatore s.n.* (W!); Palermo, a Monte Gallo, 6.1854, *A. Todaro s.n.* (WU!); *ibid.*, 9.1980, *C. Marcenò s.n.* (CAT!); *ibid.*, 8.1880, *M. Lojacono 228* (WU!); *ibid.*, 10. 1880, *M. Lojacono s.n.* (W!); *ibid.*, 10.9.1992, *S. Brullo s.n.* (CAT!); *ibid.*, 3.9.1993, *S. Brullo s.n.* (CAT!); *ibid.*, 10.1868, *F. Parlatore* (FI!); *ibid.*, s.d., *F. Parlatore* (FI-W!, PAL!); *ibid.*, 1846, *A. Todaro s.n.* (PAL!); *ibid.*, 10.1823, s.l. (PAL!); *ibid.*, 10.1881, *M. Lojacono s.n.* (PI!); *ibid.*, s.d., s.l. (PAL!); *ibid.*, in aridis montosis, s.d., *A. Todaro 1454* (MPU!, PAL!); *ibid.*, 9, *A. Todaro s.n.* (PAL!); *ibid.*, s.d., *A. Todaro s.n.* (P!, W!); *ibid.*, in saxosis calcareis, 10.1881, *M. Lojacono 110* (BC!); *ibid.*, 10.1881, *M. Lojacono 20720* (FI!, G!, MA!); In collibus saxosis calcareis al Telegrafo, 10.1880, *M. Lojacono 228* (BM!, FI!, G!, MPU!, P!, WU!); Sopra Monte Gallo, 10.10.1824, s. l. (PAL!); Alla Scala del Guadagno, s.d., *F. Parlatore s.n.* (FI!); Alla Portella Spartivento, in sax. calc. c. 200 m, 30.10.1914, *C. Lacaïta 328/11* (BM!); Monti presso Caputo (PA), 2510.1988, *S. Brullo s.n.* (CAT!); S. Maria di Gesù, s.d., s.l. (PAL!); Scala del Mezzagno, 10.1825, s.l. (PAL!); *ibid.*, 1842, *F. Parlatore s.n.* (FI!); Palermo, 10.841, *F. Parlatore s.n.* (G!); *ibid.*, 1847, *V. Tineo s.n.* (K!); *ibid.*, 1859, *G. Gussone s.n.* (NAP-GUSS!); *ibid.*, s.d., *F. Parlatore s.n.* (K!); *ibid.*, s.d., s.l. (K!); *ibid.*, s.d., *V. Tineo s.n.* (P!); Montagne de Palerme, s.d., *G. Gussone s.n.* (G!); In montosis panormitanis, s.d., *F. Parlatore* (FI-W!); *ibid.*, s.d., *A. Todaro s.n.* (FI!); In montibus Panormi, s.d., *F. Parlatore s.n.* (BM!); In aridis montosis prope Panormum, s.d., s.l. (W!); In pascuis montanis Siciliae, s.d., *F. Parlatore s.n.* (K!).

3. *Allium samniticum* Brullo, Pavone & Salmeri, spec. nova – Figs. 1C, 3C, 5C, 6C, 7C, 8C.

Allio cupano similis, sed bulbo ellipsoideo-ovoideo, tunicis pallido-brunneis, scapo usque ad 28 cm alto, foliis pilosis, pilis 0,2-0,6 mm longis, spatha 5-7-nervata, appendice 2-7 mm longa, tepalis roseis vel roseo-purpureis, exterioribus acutis vel subobtusis, antheris apiculatis, capsula globoso-obovoidea, 4,8-5 × 4,2-4,5 mm.

Type: Italy, L’Aquila, Villavallelonga, 25.8.1990, *P. Minissale s.n.* (Holo: CAT!).

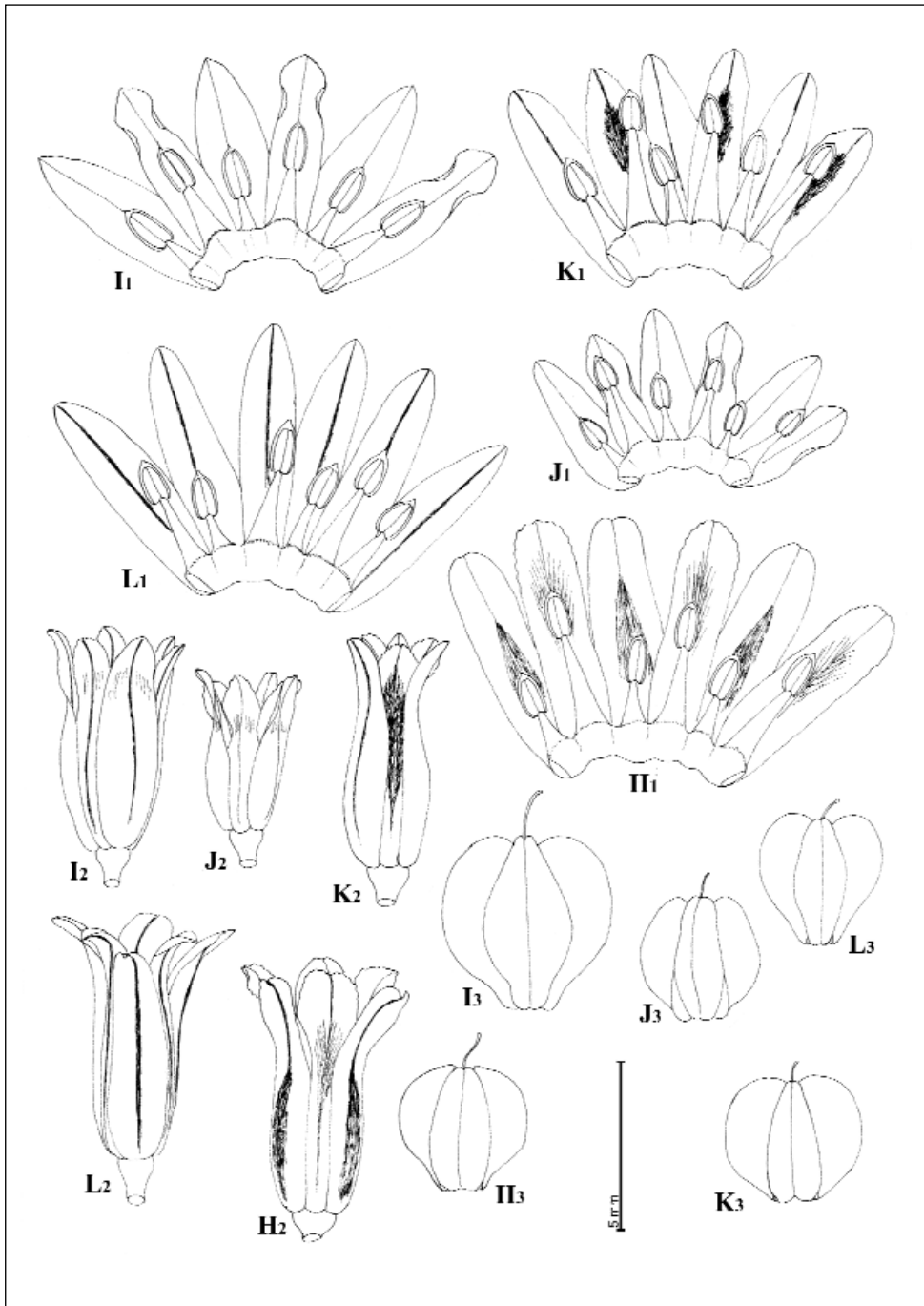


Fig. 4. Open perigon (1), perigon (2), capsule (3): **H.** *A. maghrebinum*; **I.** *A. hirtovaginata*; **J.** *A. meikleianum*; **K.** *A. pelagicum*; **L.** *A. tingitanum* (Drawing by S. Brullo from living plants of type locality).

Bulb ellipsoid-ovoid, 12-20(-25) × 6-9 mm, with pale brown or golden-brown outer tunics, reticulate-fibrous, attached to the base of the bulb, covering the stem up to 4 cm. Stem erect, flexuous, 13-28 cm high, covered by the leaf sheaths 1/2-3/4 of its length. *Leaves* 4, shorter than the inflorescence, filiform, subcylindrical, 4-15 cm long, subglabrous or hairy with scattered subappressed hairs 0.2-0.6 mm long. *Inflorescence* fastigiate, unilateral, with 4-12(-20) flowers on pedicels 12-40 mm long. *Spathe* 1-valved, shorter than the inflorescence, 5-7-nerved, 13-27 mm long, with an appendage 2-7 mm long. *Bostryces* 2. *Perigon* cylindrical-subcampanulate, 6.5-7.5 mm long; tepals pink or pink-purplish with a marked brown-purplish mid-vein, the outers lanceolate-elliptical, entire, acute or subobtuse, 2-2.2 mm wide, the inners linear-oblong, rounded and gnawed-undulate at the apex, 1.5-2 mm wide. *Stamens* with white filaments, subulate-triangular, unequal, the outers 0.9-1.5 mm long and 0.6-0.8 mm wide at the base, the inners 2-2.6 mm long and 1.1-1.3 mm wide at the base, below connate with tepals into an annulus 1.5-1.7 mm high; anthers yellow-straw coloured, linear-elliptical, apiculate, 1.5-1.7 × 0.6-0.8 mm. *Ovary* ovoid, smooth, green, 1.5-2 × 1.5-1.7 mm. *Style* white, 1.3-1.5 mm long. *Capsule* trivalved, globose-obovoid, 4.8-5 × 4.2-4.5 mm.

Distribution and habitat: The species occurs in several mountains of C Italy, where it mainly grows in the rocky meadows on limestone, above 1000 m of elevation.

Karyology: The chromosome number of this species was turned out to be tetraploid with $2n = 32$ in all studied specimens (Tab. 1). The karyotype of *A. samniticum* (Fig. 9C) was similar to those ones of the two allied Sicilian taxa (*A. cupani* and *A. panormitanum*) in the prevalence of more or less metacentric chromosomes (*m* and *msm*), as well as in the occurrence of 4 subtelocentric pairs. Three of the latter pairs always carried microsatellites in the short arm. Main differences from the Sicilian species consisted in a major number of submetacentric (*sm*) pairs (which are 6, instead of 4 and 2 as in the Sicilian species) and in the occurrence of microsatellites in 3 *st* pairs, as well as various karyomorphometric parameters. Variation in the proportion of *m* and *msm* chromosomes (shifting to 10 and 8 respectively) has been recorded in samples from Latium. The karyotype formula of plants from type locality was: $2n = 4x = 32: 14m + 4msm + 6sm + 2st + 6st^{sat}$. Size of haploid complement was 118.55 μm, absolute length of chromosomes varied from 9.84 to 5.65 μm, while the relative one from 8.30 to 4.76 %.

Phenology: Flowering from mid July to late August.

Etymology: From Latin “*Samniticus*”, i.e. coming from “*Samnium*”, an old name of Abruzzo region (C Italy).

Taxonomic notes: *Allium samniticum* is a vicariant of *A. cupani* s. str. in central Apennines. Both species indeed share several features, including general habit, reticulate-fibrous bulb coats attached to the base of the bulb, 1-valved spathe shorter than the inflorescence and provided with an apical appendage, 2 bostryces, perigon 6.5-7.5 mm long, as well as summer flowering and tetraploid chromosome number ($2n = 32$). Nevertheless, *A. samniticum* differs from *A. cupani* in relevant diagnostic morphological characters, such as ellipsoid-ovoid bulbs, hairy leaves with 0.2-0.6 mm long hairs, spathe provided with 5-7 complete nerves and appendage 2-7 mm long, pink to pink-purplish tepals, the outer ones acute or subobtuse at the apex, apiculate anthers, globose-obovoid capsule, 4.8-5 × 4.2-4.5 mm.

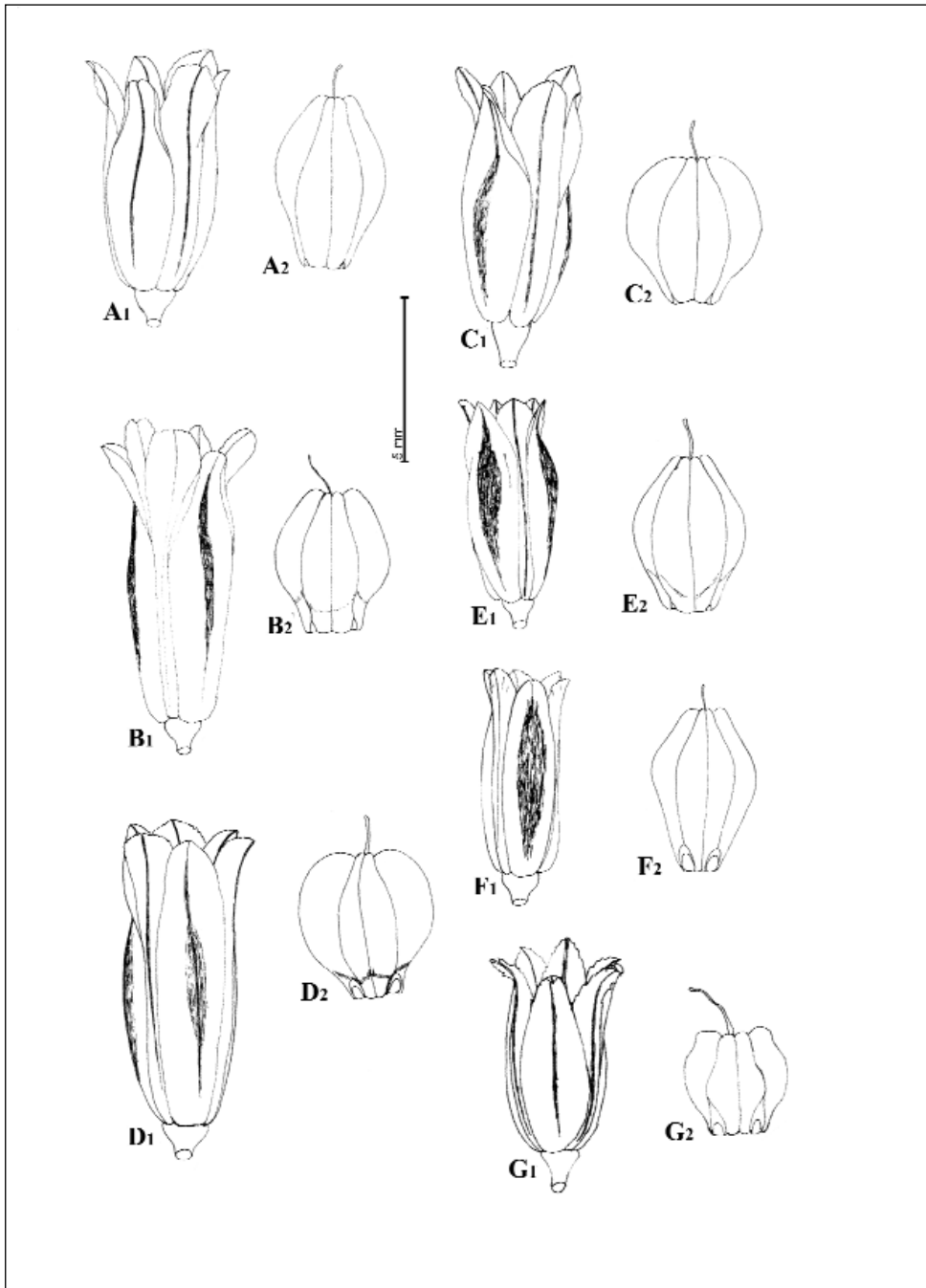


Fig. 5. Perigon (1), capsule (2): **A.** *A. cupani*; **B.** *A. panormitanum*; **C.** *A. samniticum*; **D.** *A. mauritanicum*; **E.** *A. balcanicum*; **F.** *A. tzanoudakisianum*; **G.** *A. cephalonicum* (Drawing by S. Brullo from living plants of type locality).

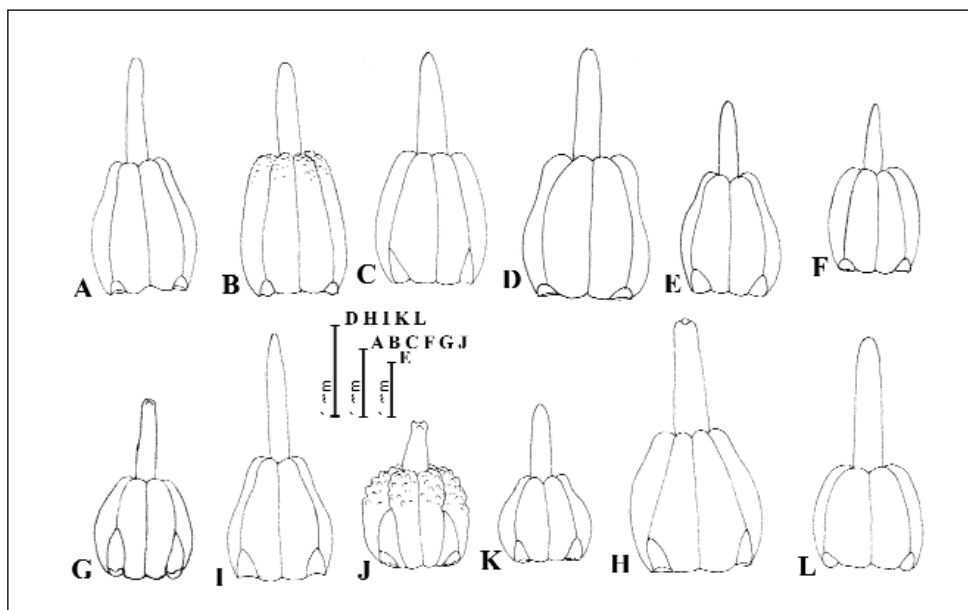


Fig. 6. Ovary: **A.** *A. cupani*; **B.** *A. panormitanum*; **C.** *A. samniticum*; **D.** *A. mauritanicum*; **E.** *A. balcanicum*; **F.** *A. tzanoudakisanum*; **G.** *A. cephalonicum*; **H.** *A. maghrebicum*; **I.** *A. hirtovaginatatum*; **J.** *A. meikleanum*; **K.** *A. pelagicum*; **L.** *A. tingitanum* (Drawing by S. Brullo from living plants of type locality).

Paratypes: Italy, L'Aquila, Monte dei Cerri, 28.7.1903, *L. Grande s.n.* (FI!, RO!); *ibid.*, in herbosis lapidosis alla Liscia, 1050 m circa, solo calcareo, 19.8.1905, *L. Grande 415* (BM!, FI!, K!, RO!); Subiaco, Piani di Arcinazzo, 20.7.1986, *S. Brullo s.n.* (CAT!); *ibid.*, 20.8.1990, *P. Minissale s.n.* (CAT!); *ibid.*, 17.8.1895, *C. Sommier s.n.* (FI!); Monti Simbruini sopra Filetino, 20.8.1990, *P. Minissale s.n.* (CAT!); *ibid.*, Guercino, 8.8.1887, *Marcellino s.n.* (RO!); in Appenninis Filetino, presso la cerreta, 8.8.1860, *E. Rolli s.n.* (RO!); *ibid.*, culta in Horto Botanico, 11.8.1862, *E. Rolli s.n.* (RO!); Campello, a Volta del Corno, luoghi sassosi, m. 850, 10.8.1986, *B. Moraldo s.n.* (RO!); *ibid.*, *Minutillo & Dicroce s.n.* (FI!); San Nicola sopra Colle Amaro, Abruzzo, 16.9.1826, *G. Gussone s.n.* (NAP!); Collina sotto Varattizzi, Vaccariccia (Molise), 26.9.1994, *F. Lucchese s.n.* (CAT!).

4. *Allium mauritanicum* Brullo, Pavone & Salmeri, spec. nova – Figs. 1D, 3D, 5D, 6D, 7D, 8D.

Allio cupano similis, sed bulbo 18-25 × 10-13 mm, scapo usque ad 40 cm longo, pilis foliorum 0,1-0,15 mm longis, spatha apiculata, 12-45 mm longa, 3-5 nervis principalibus et 1-2 secundariis incompletis, perigonio cylindrico vel cylindrico-suburceolato, (7-)-8-9 mm longo, tepalis exterioribus lineari-ellipticis, 2,4-2,6 mm latis, filamentibus staminum exterioribus 2-3 mm longis, interioribus 4-4,3 mm longis, inferne cum tepalis per 1,7-2 mm in anulum connatis, antheris apiculatis, 1,7-2 mm longis, capsula subgloboso-obovoidea, 4-4,2 × 4-4,2 mm.

Type: Morocco, Ifrane, 11.8.1995, *S. Brullo & P. Signorello M16* (Holo: CAT!).

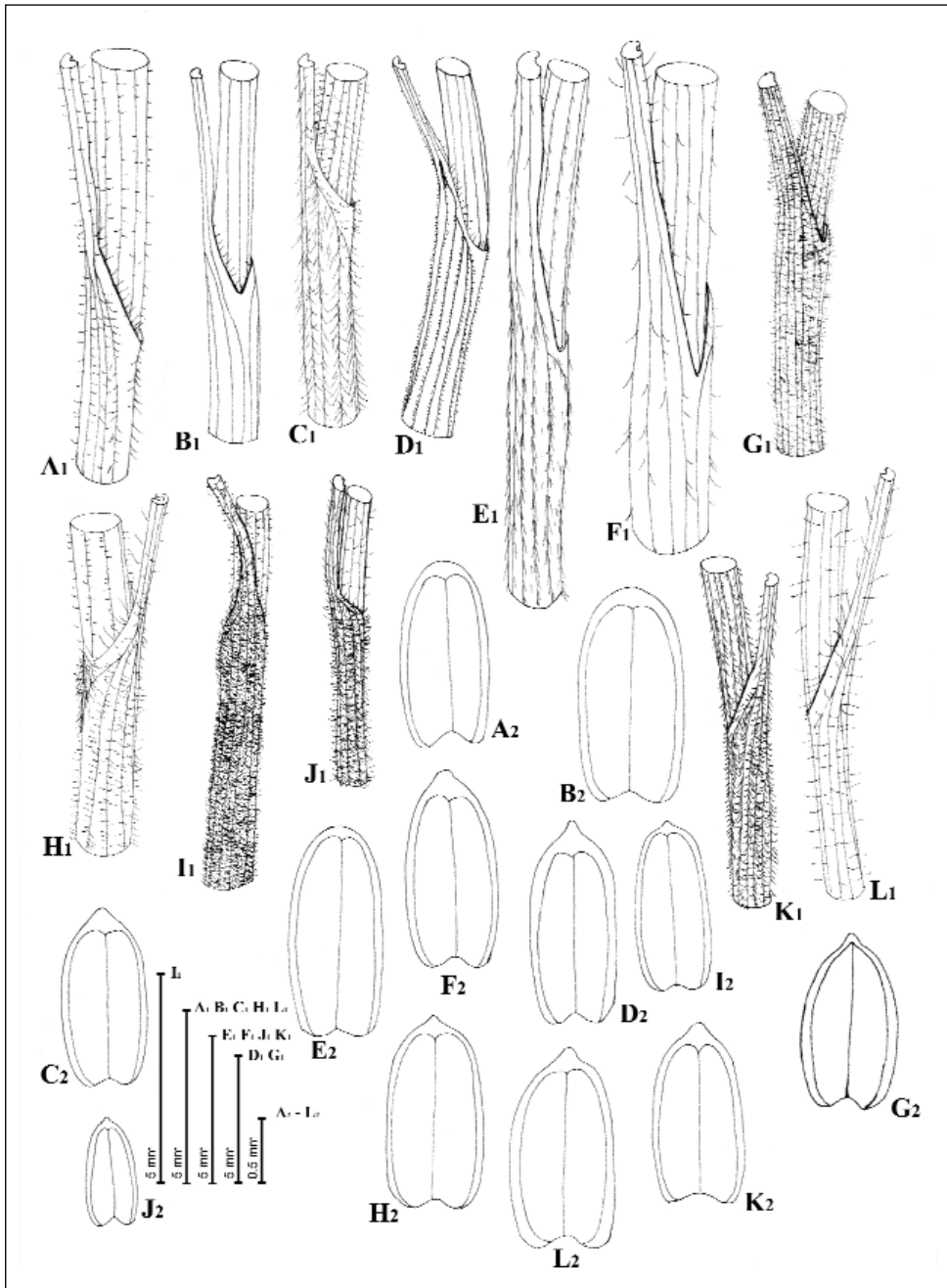


Fig. 7. Stem with leaf sheath (1), Anther (2): **A.** *A. cupani*; **B.** *A. panormitanum*; **C.** *A. samniticum*; **D.** *A. mauritanicum*; **E.** *A. balcanicum*; **F.** *A. tzanoudakisanum*; **G.** *A. cephalonicum*; **H.** *A. maghrebinum*; **I.** *A. hirtovaginatatum*; **J.** *A. meikleianum*; **K.** *A. pelagicum*; **L.** *A. tingitanum* (Drawing by S. Brullo plants of type locality).

Bulbs ovoid, bulbiferous, often clustered, 18-25 × 10-13 mm, with outer tunics brown, reticulate-fibrous, attached to the base of the bulb, covering the stem up to 1 cm. *Stem* erect, rigid, 10-40 cm high, covered by the leaf sheaths 1/2-2/3 of its length. *Leaves* 4-6, shorter than the inflorescence, filiform, subcylindrical, 10-20 cm long, subglabrous or hairy with scattered hairs 0.1-0.15 mm long. *Inflorescence* fastigiate, unilateral, with 3-14 flowers on pedicels 15-70 mm. *Spathe* 1-valved, shorter than the inflorescence, 3-5-nerved with additional 1-2 incomplete nerves, 12-45 mm long, apiculate. *Bostryces* 2. *Perigon* cylindrical or cylindrical-suburceolate, (7-)8-9 mm long; tepals white-pink, with a purplish-green mid-vein, the outers linear-elliptical, entire, obtuse, 2.4-2.6 mm wide, the inners linear-oblong, rounded and gnawed-undulate above, 1.6-1.8 mm wide. *Stamens* with white filaments, subulate-triangular, unequal, the outers 2-3 mm long and 0.6-0.7 mm wide at the base, the inners 4-4.3 mm long and 1-1.3 mm wide at the base, below connate with tepals into an annulus 1.7-2 mm high; anthers straw coloured, linear-elliptical, apiculate, 1.7-2 × 0.7-0.8 mm. *Ovary* yellowish-green, ovoid, smooth, 1.8-2.2 × 1.5-1.8 mm. *Style* white, 1.5 mm long. *Capsule* trivalved, subglobose-obovoid, slightly throttled towards the base, 4-4.2 × 4-4.2 mm.

Distribution and habitat: The species occurs in various coastal and mountain localities of N Morocco and NW Algeria. Usually, it is localized in rocky meadows and dwarf shrub communities, at 100-1600 m of elevation.

Karyology: All studied specimens from Morocco (Tab. 1) revealed a tetraploid chromosome complement $2n = 32$. The karyotype of *A. mauritanicum* (Fig. 9D) showed the same main structure as the other polyploid taxa from Sicily and C Italy, more resembling that one of *A. samniticum* in the number of submetacentric (*sm*) pairs. In particular, it was characterized by 12 metacentric (*m*) and 6 metasubmetacentric (*msm*) chromosomes, 3 submetacentric (*sm*) pairs, one provided with microsatellites in the short arm, and 4 subtelocentric (*st*) microsatellited pairs. The karyotype formula was as follows: $2n = 4x = 32: 12m + 6msm + 4sm + 2sm^{sat} + 8st^{sat}$. Particularly, in the mitotic plates from type locality total haploid chromosome length was $128.68 \pm 14.27 \mu\text{m}$, varying from $10.46 \pm 0.59 \mu\text{m}$ of the longest chromosome to $66.13 \pm 0.15 \mu\text{m}$ of the shortest one, while the relative length ranged from $8.09 \pm 0.42\%$ to $4.76 \pm 0.12\%$.

Phenology: Flowering from late summer to early autumn (August-October).

Etymology: From “*Mauritania*”, old name of NW Africa.

Taxonomic notes: Based on literature and our surveys, at present *Allium mauritanicum* is the only polyploid member of the *A. cupani* group occurring in N Africa, also characterized by bulb coats attached to the base of the bulb, 1-valved spathe shorter than inflorescence and 2 bostryces, likewise the other tetraploid endemics *A. samniticum*, *A. panormitanum* and *A. cupani*, from C Italy and Sicily respectively. In spite of this overall similarity, *A. mauritanicum* is well distinguished by its longer and rigid stem, leaves with shorter hairs and longer spathe. It shows more similarities with *A. panormitanum* due to the apiculate spathe, perigon 8-9 mm long, well developed annulus and late flowering period, but differs in many other relevant morphological characters, including leaf hairs 0.1-0.15 mm long, spathe up to 45 mm long, 3-5-nerved with 1-2 additional incomplete nerves, linear-elliptic and obtuse outer tepals, outer stamen filaments 2-3 mm long, inner ones 4-4.3 mm long, linear-elliptic and apiculate anthers up to 2 mm long, smooth ovary, and subglobose-obovoid capsule 4-4.2 × 4-4.2 mm. *A. mauritanicum* could have

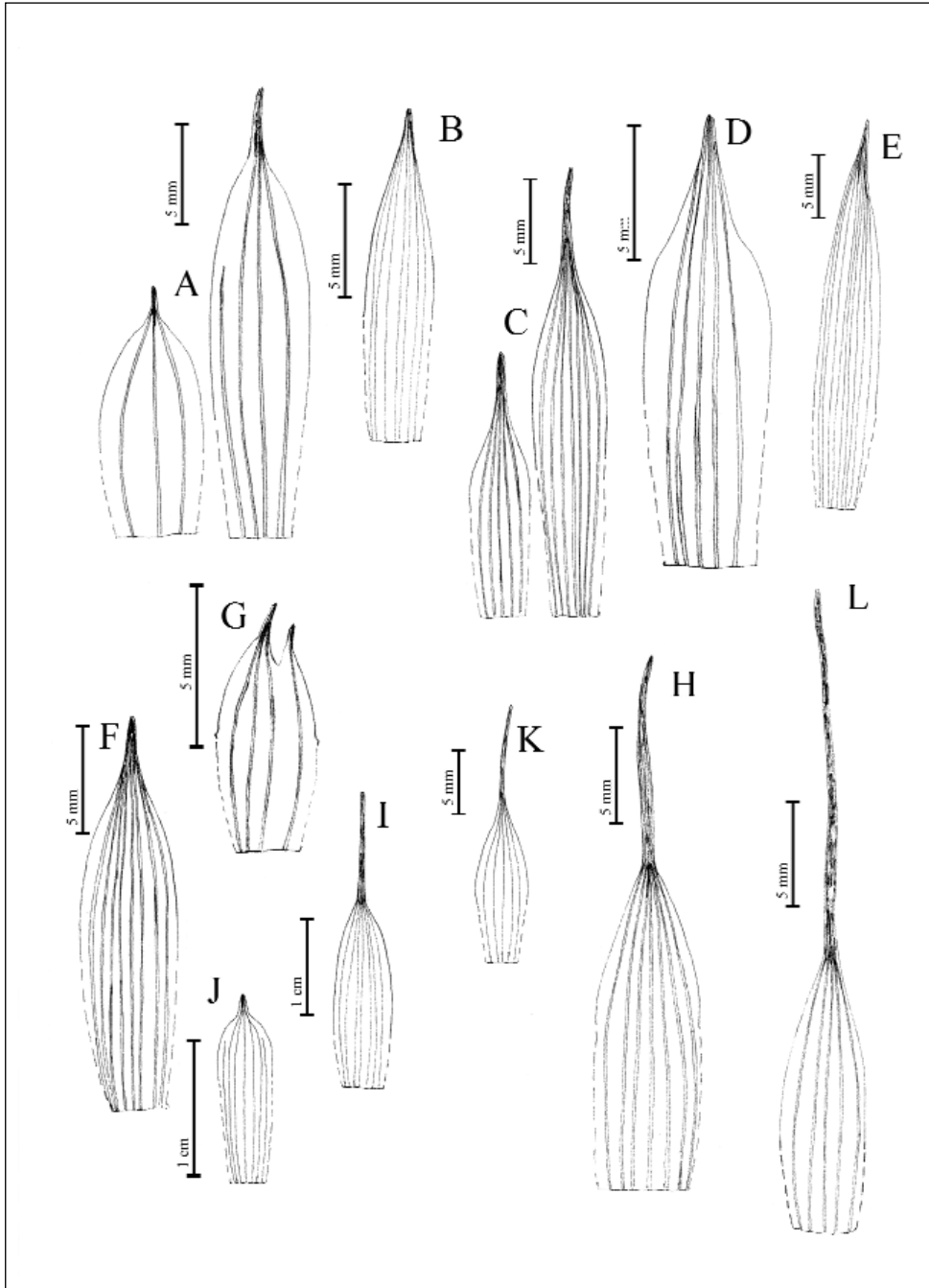


Fig. 8. Spathe: **A.** *A. cupani*; **B.** *A. panormitanum*; **C.** *A. samniticum*; **D.** *A. mauritanicum*; **E.** *A. balcanicum*; **F.** *A. tzanoudakisianum*; **G.** *A. cephalonicum*; **H.** *A. maghrebinum*; **I.** *A. hirtovaginatam*; **J.** *A. meikleianum*; **K.** *A. pelagicum*; **L.** *A. tingitanum* (Drawing by S. Brullo from plants of type locality).

originated from *A. panormitanum* as a consequence of speciation events likely arisen from old geographical isolation.

Paratypes: Morocco, Col Duzad, 22.7.1994, *S. Brullo & P. Signorello M7* (CAT!); Bir Bou Hidir, 22.7.1994, *S. Brullo & P. Signorello M15* (CAT!); Jebel el Alem, Bab Bou Hidir, 1600 m, between boulders in dry sandy soil, 17.8.1968, *W.L. Fry 2* (BM!); Melilla, s.d., *C. Vicioso s.n.* (BCF!); Marineur, Riff oriental (cult!), 23.9.1920, *C. Vicioso s.n.* (MA!); Riff oriental, s.d., *C. Vicioso s.n.* (BM!); Massif de Tichchoukt, above Boulemare, Middle Atlas, province de Meknes, very dry stony north facing hillside, 11.8.1966, *R.M. Harley 910* (BM!); Fez el Sefran, 10.1913, *Mourat 1384* (P!); **Algeria**, Oran, 3.9.1846, *M.C. Durieu* (K!); *ibid.*, lieux secs, 8.1921, *A.C. d'Alleizette s.n.* (M!); Santa Cruz, lieux rocailleux, 16.9.1929, *A. Faure* (K!); Gorge de Santa Cruz, 19.9.1888, *Garrigues* (BM!, P!); Fort S. Gregoire, August, *G. Munby s.n.* (K!); *ibid.*, 1847, s.l. (K!); M. Bou, au Planteur bord du chemin venant de l'Ardoisan pour le Belvedere, 8.1922, *A.C. d'Alleizette s.n.* (P!); Mostaganem, clairees des broussailles, 20.8.1848, *B. Balansa s.n.* (P!); *ibid.*, rocheur nu, 9.1911, *A.C. d'Alleizette s.n.* (P!); Fedy et Ahmeur, a l'ouest du Kef Souma, Djebel Sgao, prov. De Costantine, 8.1888, *V.C. Reboud* (P!).

5. *Allium balcanicum* Brullo, Pavone & Salmeri, spec. nova – Figs. 1E, 3E, 5E, 6E, 7E, 8E.

Syn.: *A. balcanicum* Brullo, Pavone & Salmeri, Giorn. Bot. Ital. 129(1): 118, 1995, nom. nud.

Allio cupano similis, sed scapo rigido, foliis subglabris vel pilosis, pilis adpressis, 0,3-0,6 mm longis, spatha usque ad 28 mm longa, 7-10-nervata, apiculata, tepalis cylindrico-suburceolatis, roseis vel roseo-purpureis, exterioribus 1,7-2 mm latis, interioribus 1,4-1,5 mm latis, antheris albo-roseis vel purpureis, 1,5 mm longis, ovario subgloboso-ovoideo, 1,5-1,8 mm longo.

Type: Greece, M. Timfristòs, presso Karpenision, 12.9.1989, *G. Bartolo, S. Brullo & P. Minissale s.n.* (Holo: CAT!).

Bulb ovoid or ellipsoid-ovoid, sometimes bulbiferous, 10-18 × 5-10 mm, with brown tunics, reticulate-fibrous, attached to the base of the bulb, covering the stem up to 2 cm. *Stem* erect, rigid, 8-20 cm high, covered by the leaf sheaths from 3/4 up to total length. *Leaves* 4, filiform, subcylindrical, shorter than the inflorescence, 4-10 cm long, the upper one often without blade, subglabrous or hairy with scattered, appressed hairs 0.3-0.6 mm long. *Inflorescence* fastigiate, unilateral, with 3-15 flowers on pedicels 5-28 mm long. *Spathe* 1-valved, shorter than the inflorescence, rarely subequal, 7-10-nerved, 15-28 mm long, apiculate. *Bostryces* 2. *Perigon* cylindrical-suburceolate, 6-7 mm long; tepals pink or purplish-pink, tinged with purple, with a purplish-brown mid-vein, the outers ovate-lanceolate, entire, subobtusate, 1.7-2 mm wide, the inners linear-oblong, rounded and gnawed-undulate at the apex, 1.4-1.5 mm wide. *Stamens* with white filaments, subulate-triangular, unequal, the outers 0.8-2 mm long and 0.5-0.7 mm wide at the base, the inners 1.8-2.3 mm long, markedly broadened at the base and 1-1.2 mm wide, below connate with tepals into an annulus 1-1.2 mm high; anthers pinkish-white to purplish, linear-elliptical, rounded, 1.5 × 0.7 mm. *Ovary* greenish, subglobose-ovoid, smooth, 1.5-1.8 × 1.2-1.5 mm. *Style* white, 1-1.2 mm long. *Capsule* trivalved, ellipsoid, 4.5-5 × 3.5-3.8 mm.

Distribution and habitat: This species occurs in several mountains of Balkan Peninsula, particularly in N Greece, W Bulgaria, Macedonia, Serbia and Albania. It grows sparsely in rocky places at elevation over 1000 m, mainly within orophilous pulvinate shrub communities.

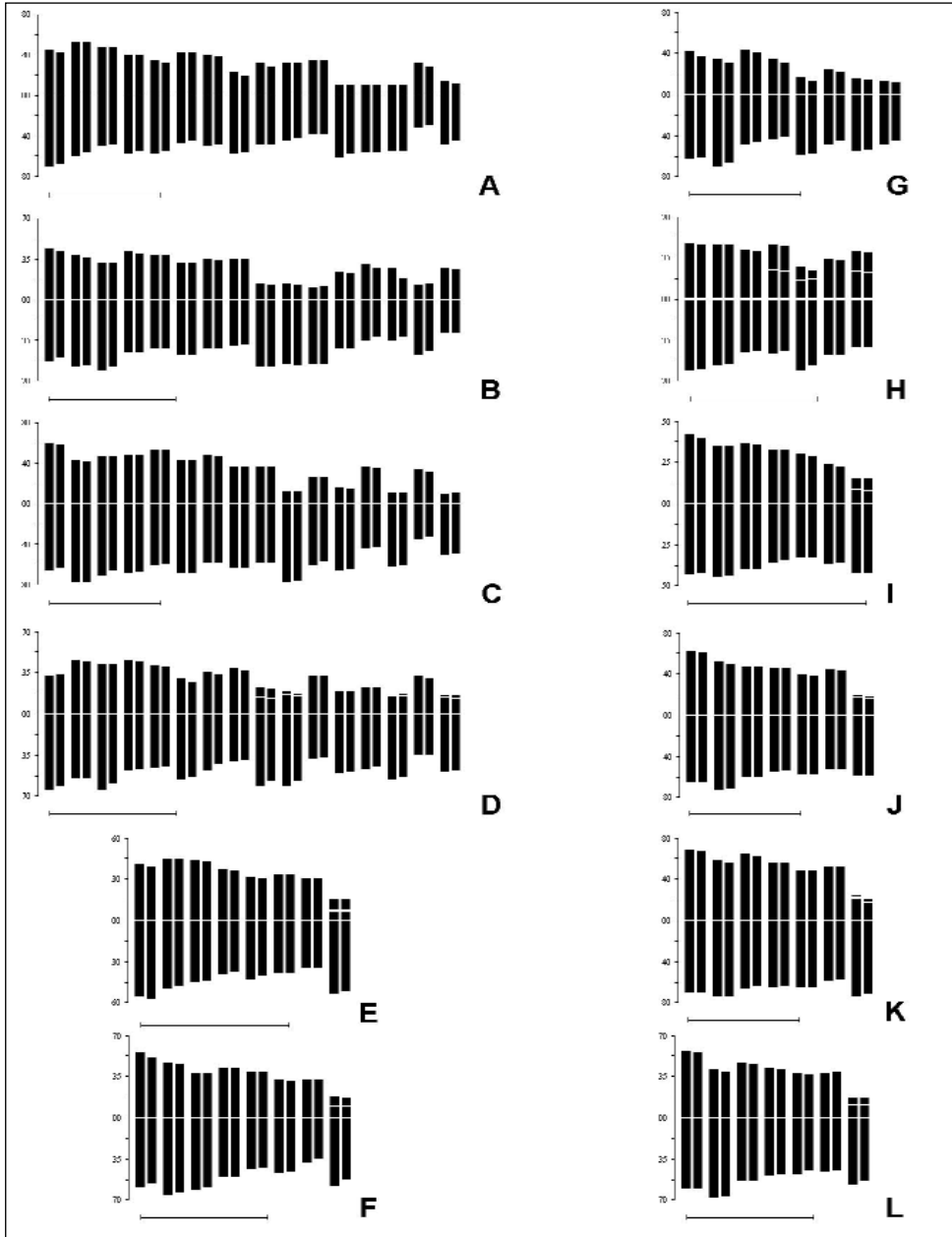


Fig. 9. Karyograms obtained from 10 well spread metaphase plates: **A.** *A. cupani* (Pizzo Carbonara); **B.** *A. panormitanum* (Mt. Pellegrino); **C.** *A. samniticum* (Villavallelonga); **D.** *A. mauritanicum* (Ifrane); **E.** *A. balcanicum* (Mt. Timfristos); **F.** *A. tzanoudakisanum* (Monopetra); **G.** *A. cephalonicum* (Mt. Enos); **H.** *A. hirtovaginatam* (Çeşme); **I.** *A. meikleanum* (Larnaca); **J.** *A. pelagicum* (Vallone Madonna); **K.** *A. maghrebinum* (Cape Bon); **L.** *A. tingitanum* (Taza). Bars = 10 µm. Localities in brackets correspond to the type localities (see Tab. 1).

Karyology: Studied populations from Greece and Bulgaria (Tab. 1) revealed a diploid chromosome complement with $2n = 16$, which confirmed previous reports from various Balkan populations referred to *A. cupani* or seldom to *A. cupani* var. *hirtovaginatium* (Sopova 1972; Cheschmejiyev 1973; Garbari & al. 1979; Strid & Franzen 1981; Tzanoudakis 1983). The karyotype (Fig. 9E) consisted of 5 pairs of metacentric chromosomes, 2 meta-submetacentric pairs, and one pair ranging from microsatellited subtelocentric type (Dancavo population) to macrosatellited telocentric type (type locality). The karyotype formula can be resumed as follows: $2n = 2x = 16: 10m + 4msm + 2st^{sat}/2t^{Msat}$. Particularly, mitotic plates from type locality revealed a haploid chromosome complement $63.31 \pm 4.57 \mu\text{m}$ in length, varying from $9.71 \pm 0.96 \mu\text{m}$ of the longest chromosome to $6.58 \pm 0.87 \mu\text{m}$ of the shortest one, while the relative length ranged from $7.66 \pm 0, 2\%$ to $5.19 \pm 0.31\%$.

Phenology: Flowering from August to November.

Etymology: From latin “*Balcanicus*”, meaning “from Balkans” (SE Europe), where the species can be found.

Taxonomic notes: Based on literature, populations of *Allium balcanicum* were usually ascribed to *A. cupani* or more rarely to *A. hirtovaginatium*. Nevertheless, as already highlighted by Brullo & al. (1995, 2008c), *A. balcanicum* clearly differs from *A. cupani* s.str. in the chromosome complement ($2n=16$), which is diploid instead of tetraploid ($2n=32$), and in the typically autumnal flowering, as well as in many significant morphological characters including rigid stem, subglabrous to hairy leaves with appressed hairs 0.3-0.6 mm long, apiculate 7-10-nerved spathe, up to 28 mm long, pink or purplish-pink cylindrical-suburceolate perigon, outer tepals 1.7-2 mm wide, inner tepals 1.4-1.5 mm wide, pinkish-white to purplish anthers up to 1.5 mm long, and subglobose-ovoid ovary, 1.5-1.8 mm long.

Paratypes: Greece, in latere meridionale montis, supra oppidum Karpenisi, ad 1550 m, In clivis dumetosis herbosis meridiem spectantibus, solo calcareo, 4.8.1977, *W. Greuter 15415* (B!, G!); M. Olympus, in declivis prope Hagios Dionisios, 14.9.1889, *P.E. Sintenisi 1937* (B!, G!, K!, M!, P!, MPU!, W!, WU!); Mt. Vourinos (Saloniki), serpentine rocks 1000 m, 18.8.1981, *D. Babalonas B41* (MA!); Pellis, Mt. Pinovon, S side 1400-1700 m, rocky limestone outcrops in *Fagus* woodland, 16.8.1979, *A. Strid & K. Papanicolaou 16554* (G!); *ibid.*, M. Tzena, E side of the SE summit 1800-2000 m, alpine meadows and rocky outcrops limestone, 19.8.1979, *A. Strid & K. Papanicolaou 16715* (G). **Albania**, Gjergjevice, base stony ground in serpentine gorge, 21.8.1935, *A. Alston & C.I. Sandwith 2583* (BM!, K!); Hasi Pastrik Grajige Hange, in der subalpinen region, ca.1400 m, 2.9.1916, *I. Dörfler 355* (BM!, G!, K!, W!); Trockene steinige Weisen amsudwestabhang des Pashtrik, ca. 1400-1500 m, 9.8.1918, *Zerny s.n.* (W!). **Bulgaria**, Dancavo near Brestovitza, 24.11.1993, *I.V. Ceschmedziev s.n.* (CAT!); *ibid.*, 20.10.1994, esemplare coltivato, *I.V. Ceschmedziev s.n.* (CAT!); In lapidosis calcareis M. Cepan, 28.8.1854, *V.I. Velcev & K. Kocev 379* (G!, MA!, MPU!, W!); Mt. Chepan, roches, 28.8.1854, *Georgioff s.n.* (K!); Prope stationem Dragoman, 28.8.1893, *Georgioff s.n.* (HUJ!, K!). **Macedonia**, Na Varovicen Kamenjar, 1320 m, 7.9.1974, *K. Micevski s.n.* (W!). **Serbia**, In fruticetis collium Mramor non procul ab urbs Nisch, 9.1888, *S. Petrović 2587* (BM!, G!, K!, M!, MPU!, P!, W!); Siccov, 8.1879, *S. Petrović s.n.* (G!); In saxosis calcareis ad Leskovak, s.d., *J. Panić s.n.* (WU!); In herbosis venosis in Leskovak,

Table 1. Populations karyologically investigated of the *Allium cupani* group.
 Bold names indicate type localities

Taxon	Locality	Ploidy	N.chrom.
<i>A. balcanicum</i>	Bulgaria, Dancavo	2x	2n=16
	Greece, Mt. Timfristos	2x	2n=16
<i>A. cephalonicum</i>	Aegean, Is. Kefalonia, Mt. Enos	2x	2n=16
<i>A. cupani</i> s. str.	Sicily, Rocca Busambra		
	Sicily, Madonie Mts, Pizzo Carbonara	4x	2n=32
	Sicily, Piana degli Albanesi, Mt. Kumeta	4x	2n=32
<i>A. hirtovaginatum</i>	Turkey, Çeşme	2x	2n=14
<i>A. maghrebinum</i>	Tunisia, Cape Bon	2x	2n=14
	Tunisia, El Beja	2x	2n=14
	Tunisia, El Fas	2x	2n=14
	Tunisia, Korbous	2x	2n=14
	Tunisia, Sidi Daud	2x	2n=14
<i>A. mauritanicum</i>	Morocco, Bir Bou Hidir	4x	2n=32
	Morocco, Col Duzad	4x	2n=32
	Morocco, Ifrane	4x	2n=32
<i>A. meikleanum</i>	Aegean, Cyprus, Athalassia	2x	2n=14
	Aegean, Cyprus, Larnaca	2x	2n=14
<i>A. panormitanum</i>	Sicily, Palermo, Mt. Caputo	4x	2n=32
	Sicily, Palermo, Mt. Gallo	4x	2n=32
	Sicily, Palermo, Mt. Pellegrino	4x	2n=32
<i>A. pelagicum</i>	Italy, Is. Lampedusa, Vallone Madonna	2x	2n=14
<i>A. samniticum</i>	Italy, Abruzzo, Villavallelonga	4x	2n=32
	Italy, Latium, Piani d'Arcinazzo	4x	2n=32
<i>A. tingitanum</i>	Morocco, Taza	2x	2n=14
<i>A. tzanoudakisanum</i>	Aegean, Is. Evvia, Akro Kimi	2x	2n=16
	Aegean, Is. Lesbos, Vatoussa	2x	2n=16
	Aegean, Is. Naxos, Monopetra	2x	2n=16
	Aegean, Is Paros, Agion Theodoron	2x	2n=16

9.1879, *J. Panić* s.n. (W!); Staro Selo, unter dem Glicar Dagli, 780 m, 20.8.1938, *Houska* s.n. (K!); Just North of Titovales on road to Skopje in gneiss, 16.9.1974, *B.F. Mathew* s.n. (K!); Parmi le boissons sur le collines près de checonas non loin de Niv, 9.1888, *S. Petrović* s.n. (WU!); In subalpinis Pirot, 8.1892, *Favanović* s.n. (W!).

6. *Allium tzanoudakisanum* Brullo, Pavone & Salmeri, spec. nova. – Figs. 1F, 3F, 5F, 6F, 7F, 8F.

Allio balcanico similis, sed bulbis aggregatis, foliis subglabris pilis sparsis, usque ad 0,9 mm longis, folia superiori inflorescentia longiora, spatha usque ad 40 mm longa, appendice 1-3 mm longa, tepalis exterioribus lineari-lanceolatis, interioribus valde undulatis apice, filamentibus staminum subulatis, exterioribus 1,5-2 mm longis, interioribus ex abrupto dilatatis base, 2,8-3,3 mm longis, antheris lineari-ellipticis, luteis, apiculatis 1-1,5 mm longis, capsula 3,5-4,5 mm longa.

Type: Greece, Naxos, Monopetra, su calcare, 27.8.1994, S. Brullo & F. Scelsi s.n. (Holo: CAT!).

Bulbs ovoid-ellipsoid, bulbiferous, clustered, 15-22 × 5-8 mm, with dark brown tunics, reticulate-fibrous, attached to the base of the bulb, covering the stem up to 8 cm. *Stem* erect, rigid, (6-)10-28 cm high, covered by the leaf sheaths from 1/2 up to total length. *Leaves* 4, filiform, subcylindrical, 4-12 cm long, subglabrous with scattered patent hairs 0.4-0.9 mm long, the upper one longer than the inflorescence and often without blade. *Inflorescence* fastigiate, unilateral, with 4-10(-12) flowers on pedicels 10-40 mm long. *Spathes* 1-valved, shorter than the inflorescence, (5-)7-10-nerved, 10-40 mm long, with an appendage 1-3 mm long. *Bostryces* 2. *Perigon* subcylindrical or cylindrical-suburceolate, 6-7 mm long; tepals white-pinkish, the outers tinged with purple, with a purplish-brown mid-vein, linear-lanceolate, entire, subobtusate, 1.6-1.8 mm wide, the inners linear-oblong, rounded and markedly undulate at the apex, 1.2-1.5 mm wide. *Stamens* with white filaments, subulate, unequal, the outers 1.5-2 mm long and 0.5-0.7 mm wide at the base, the inners 2.8-3.3 mm long, abruptly enlarged at the base and 1.2-1.5 mm wide, below connate with tepals into an annulus 1.6-1.8 mm high; anthers yellow, linear-elliptical, apiculate, 1-1.5 × 0.5-0.6 mm. *Ovary* greenish, ovoid or subglobose-ovoid, smooth, 1.3-2 × 1.1-1.5 mm. *Style* white, 1-2.5 mm long. *Capsule* trivalved, ellipsoid, 3.5-4.5 × 3-3.2 mm.

Distribution and habitat: *Allium tzanoudakisanum* is circumscribed to Greece, where it occurs in some Aegean islands (Evia, Lesbos, Naxos, Dounussa, Syros, Sifnos, Amorgos, Paros and Serifos) and in E Peloponnesus too. The species is usually localized in the coastal or hill stands, growing in relatively shady and fresh rocky places on limestone and siliceous substrata.

Karyology: All investigated populations (Tab 1) showed a diploid chromosome number $2n = 16$. The karyotype of *A. tzanoudakisanum* (Fig. 9F) was rather similar to that one of *A. balcanicum*, especially differing in the terminal subtelocentric pair, which was often macrosatellited in the short arms, and in the proportion of *m* and *msm* chromosomes. Variation in numbers of *m* against *msm* pairs was also detected among examined populations, which differently showed from 6 to 4 metacentric pairs. The karyotype formula in plants from type locality was: $2n = 2x = 16: 8m + 6msm + 2st^{Msat}$. The total haploid chromosome length was $71.75 \pm 5.30 \mu\text{m}$, varying from $11.51 \pm 1.69 \mu\text{m}$ of the longest chromosome to $6.83 \pm 0.52 \mu\text{m}$ of the shortest one, while the relative length ranged from $8 \pm 0.8\%$ to $4.76 \pm 0.02\%$.

Phenology: Flowering from August to October.

Etymology: The species is named after Dimitris Tzanoudakis, Greek botanist in Patras and specialist of the genus *Allium*.

Taxonomic notes: *Allium tzanoudakisanum* is closely related to *A. balcanicum* sharing the same chromosome number ($2n = 16$), the autumnal flowering time and some morphological characteristics concerning habit, leaves and flower features. Notwithstanding, it

differs from *A. balcanicum* due to bulbiferous and clustered bulbs, leaves with patent longer hairs, the upper one longer than the inflorescence, longer spathe provided with a short appendage, linear-lanceolate outer tepals, the inner ones markedly undulate at the apex, longer stamen filaments and annulus, yellow, linear-elliptic, and apiculate anthers 1-1,5 mm long, capsule 3,5-4,5 mm long. Moreover the two species have very different ecological requirements, as *A. tzanoudakisanum* always grows at low elevation, whereas *A. balcanicum* is a typical orophyte.

Paratypes: Greece, Peloponnisos, Argos, esemplare coltivato, 27.8.1986, *S. Brullo s.n.* (CAT!); Evvia, Akros Kimi, esemplare coltivato, 9.9.1992, *S. Brullo s.n.* (CAT!); *ibid.*, Pockets of soil in rocky ground limestone, 3500 ft., 8.1959, *K.W. Spicer 105* (K!); Lesbos, Vatoussa (Pineta), 28.8.1992, *S. Brullo & P. Minissale s.n.* (CAT!); Paros, Agion Theodoron (fessure della roccia), no flowered specimens, 9.8.1992, *S. Brullo & P. Minissale s.n.* (CAT!); Naxos, Zeus, esemplare coltivato, 11.8.1995, *S. Brullo s.n.* (CAT!); Amorgos, Profitis Elias, rupi calcaree, 28.8.1994, *S. Brullo & F. Scelsi s.n.* (CAT!); *ibid.*, In garigue between Khore and Potamos, 6.10.1939, *P.H. Davis 943* (K!); Syros, Syringas, esemplare coltivato, 8.9.1994, *S. Brullo & P. Minissale E2* (CAT!); *ibid.*, Mitakas, esemplare coltivato, 8.11.1994, *S. Brullo & P. Minissale E3* (CAT!); Sifnos, Profitis Elias, esemplare coltivato, 8.9.1994, *S. Brullo & P. Minissale E16* (CAT!); Serifos, on the hill called Troutos, 1500 ft., ground through *Poterium spinosum*, 24.9.1939, *P.H. Davis 872* (K!); Donoussa, Kavos Panagias, 29.8.1998, *G. Bartolo & S. Brullo s.n.* (CAT!).

7. *Allium cephalonicum* Brullo, Pavone & Salmeri, spec. nova. – Figs. 2G, 3G, 5G, 6G, 7G, 8G.

Allio karistano similis, sed bulbo 15-20 × 7-10 mm, tunicis leviter reticulato-fibrosis, foliis glabris, raro solitariis inconspicuis pilis, spathae appendicis gradatim acuminatis, valva majore 7,5-10 mm longa, valva minore 1-nervata, 6-9,5 mm longa, perigonio urceolato, 6-6,5 mm longo, tepalis eroso-incisus apice et acutis, exterioribus ovato-lanceolatis, interioribus lineari-ellipticis, filamentibus staminum interioribus 1,8-2,8 mm longis, non dilatatis basi, antheris luteis, ovario ovoideo, 1,3-1,5 × 1,2-1,4 mm, capsula obovoidea, 3-3,2 × 3,2 mm.

Type: Greece, Isola di Cefalonia, Monte Enos, a circa 1000 m, nelle formazioni pulvinari orofile, 18.7.2011, *S. Brullo & G. Giacalone s.n.* (Holo: CAT!).

Bulbs ovoid, densely clustered, 15-20 × 7-10 mm, with brown reticulate-fibrous outer tunics, attached to the base of the bulb. *Stem* solitary, rigid, erect, 8-10 cm high, covered by the leaf sheaths 4/5 of its length, sometimes totally. *Leaves* 4, filiform, cylindrical or subcylindrical, shorter than the inflorescence, 1.5-6 cm long, glabrous or rarely with inconspicuous and isolated hairs. *Inflorescence* fastigate-ellipsoid, with 4-8 flowers on pedicels 1-2.5 mm long. *Spathe* 2-valved, shorter than the inflorescence, valves unequal, on one side almost totally welded, gradually ending in an acuminate appendage 0.5-1.2 mm long, the bigger valve 3-nerved, 7.5-10 mm long, the smaller one 1-nerved, 6-9.5 mm long. *Bostryces* 4. *Perigon* urceolate, 6-6.5 mm long; tepals pinkish, erose-incised at apex, acute, with a purplish mid-vein, the outers ovate-lanceolate, 2.2-2.5 mm wide, the inners linear-elliptical, 1.5-1.8 mm wide. *Stamens* with white unequal filaments, the outers subulate or subulate-triangular, 1.5-1.8 mm long and 0.5-0.6 mm wide at the base, the inners subulate-triangular, 1.8-2.8 mm long and 0.8-1 mm wide at the base, not broadened below, connate

with tepals into an annulus 1.2-1.6 mm high; anthers yellow, oblong, apiculate, 1.2-1.3 × 0.6-0.7 mm. *Ovary* greenish, ovoid, smooth, 1.3-1.5 × 1.2-1.4 mm. *Style* white, 1-1.2 mm long. *Capsule* trivalved, obovoid, 3-3.2 × 3.2 mm.

Distribution and habitat: This species only occurs on Mt. Enos in the Greek island of Kefalonia (Ionian archipelago). It grows on mountain rocky places, about at 1000 m of elevation, within the orophilous dwarf shrubby communities, dominated by *Astragalus cephalonicus* C. Presl.

Karyology: *Allium cephalonicum* is characterized by a diploid chromosome complement of $2n = 16$. The karyotype was rather asymmetrical (Fig. 9G) with a prevalence of anisobrachial chromosomes (*sm* and *st*) and only one typical metacentric pair, as resumed by the following formula: $2n = 2x = 16: 2m + 4msm + 4sm + 6st$. No evident satellites were detected. The total haploid chromosome length was $63.75 \pm 3 \mu\text{m}$, varying from $10.5 \pm 1.89 \mu\text{m}$ of the longest chromosome to $5.63 \pm 1.3 \mu\text{m}$ of the shortest one, while the relative length ranged from $8.2 \pm 1.1\%$ to $4.41 \pm 0.9\%$.

Phenology: Flowering from late July to August.

Etymology: From Latin “*Cephalonia*”, nowadays Cephalonia or Kefalonia, island of the Ionian archipelago (NW Greece), where this plant grows.

Taxonomic notes: Due to bulb coats attached to the base of the bulb, 2-valved spathe, 4 bostryces and eu-diploid chromosome number ($2n = 16$), *Allium cephalonicum* belongs to the cycle of *A. callidictyon*, a species occurring in the Middle East and East Mediterranean (see Brullo & al. 1995). Within this cycle, it shows closest relationships with *A. karistanum*, endemic to Evvia island, in having clustered bulbs, upper leaf and spathe shorter than inflorescence, which is few-flowered, but *A. karistanum* clearly differs in many relevant morphological characters including bigger bulbs, hairy leaves with scattered hairs on the veins, longer spathe valves, which abruptly end in an apically rounded appendage, longer perigon, with tepals gnawed-undulate at apex, longer inner stamens, broadened at the base, anthers straw-coloured, ovary pyriform, bigger ellipsoid capsule. In addition, it has a late summer flowering time and very different karyotype structure (Brullo & al. 1997).

8. *Allium hirtovaginatum* Kunth, Enum. Pl. 4: 412, 1843. – Figs. 2I, 4I, 6I, 7I, 8I.

Syn.: *Allium cupani* var. *hirtovaginatum* (Kunth) Halácsy, Consp. Fl. Graec. 3(1): 253, 1904; *Allium cupani* f. *hirtovaginatum* (Kunth) Hayek, Feddes Repert. (Beih.) 30(3): 49, 1932; *Allium cupani* subsp. *hirtovaginatum* (Kunth) Stearn, Ann. Mus. Goulandris 4: 151, 1978.

Type: Turkey, Asia mineure, Tchesmé, no date, *G.A. Olivier & J.G. Bruguère s.n.* (lectotype P!, designated by Garbari & al. 1979).

Bulb ovoid, solitary, 9-15 × 7-12 mm, with pale brown outer tunics, fibrous, feebly reticulate, detached from the base of the bulb, covering the stem up to 3 cm. *Stem* erect or erect-ascending, flexuous, 12-20 cm high, covered by the leaf sheaths 2/3-3/4 of its length. *Leaves* 3-4, filiform, subcylindrical, shorter than the inflorescence, 5-15 cm long, hairy with dense patent hairs 0.1-0.25 mm long. *Inflorescence* fastigiate, unilateral, with 3-8(-12) flowers on pedicels 7-28 mm long. *Spathe* 1-valved, longer than the inflorescence or subequal, persistent, 7-9-nerved, 12-45 mm long, with an appendage 4-20 mm long. *Bostryces* 2. *Perigon* cylindrical-suburceolate, 6-6.5 mm long; tepals pink, with a purplish-brown mid-vein, the

outers linear-ovate, entire and subacute at the apex, 1.8-2 mm wide, the inners linear-oblong, rounded and gnawed-undulate at the apex, 1.5-1.6 mm wide. *Stamens* with filaments white, triangular, unequal, the outers 1-1.2 mm long and 0.5-0.6 mm wide at the base, the inners 1.5-1.8 mm long and 0.9-1 mm wide at the base, below connate with tepals into an annulus 0.8-1 mm high; anthers yellow, linear-elliptical, apiculate, 1.2-1.3 × 0.5-0.6 mm. *Ovary* greenish, ovoid-subpyriform, smooth, 1.3-1.5 × 1.2-1.4 mm. *Style* white, 1.2-1.5 mm long. *Capsule* trivalved, subglobose, throttled below, 5 × 5 mm.

Distribution and habitat: This species s.str. is circumscribed to some localities of CW Anatolia, near Izmir. It occurs in the hilly and mountain rocky places, within the dwarf shrubby vegetation.

Karyology: Previous reports from many localities of Mediterranean area described *Allium hirtovaginatum* as a diploid species with an aneuploid complement $2n = 14$ (Garbari & al. 1979; Johnson 1982; Tzanoudakis 1983; Tzanoudakis & al. 1991). The population here investigated coming from the type locality (Çeşme, W Turkey) confirmed this count. The karyotype (Fig. 9H) was formed by more or less metacentric chromosomes (*m* and *msm* type), two submetacentric (*sm*) pairs, always provided with very long satellites in the short arms, and one subtelocentric (*st*) pair, also macrosatellited. The chromosome formula was summarized as follows: $2n = 2x = 14: 6m + 2msm + 4sm^{Lsat} + 2st^{Msat}$. The total haploid complement was $63.10 \pm 2.23 \mu\text{m}$ in length; absolute length of chromosomes ranged from $10.91 \pm 0.6 \mu\text{m}$ of the longest one to $8.01 \pm 0.25 \mu\text{m}$ of the shortest one, while the relative length varied from $8.64 \pm 0.2\%$ to $6.36 \pm 0.4\%$.

Phenology: Flowering from mid June to July.

Etymology: The specific epithet refers to the hairy leaf sheaths.

Taxonomic notes: Kunth (1843) in the protologue quoted *Allium hirtovaginatum* from "Persia (Tchesme, Olivier & Bruguere leg.)". As already pointed out by Gay (1847), Stearn (1978) and Garbari & al. (1979), Kunth provided a wrong indication, since Tchesme there is not in Persia but in W Anatolia, corresponding to Çeşme, locality near Izmir. *Allium hirtovaginatum* has been often considered as synonym or a form, variety and subspecies of *A. cupani* simply differentiated by hairy leaves (Halácsy 1904; Hayek 1932; Maire 1958; Stearn 1978, 1980; Kollmann 1984). According to Garbari & al. (1979) and Brullo & al. (1995, 2008c), *A. hirtovaginatum* markedly differs from *A. cupani* and allied species characterized by eudiploid ($2n = 16$) or tetraploid ($2n = 30, 32$) chromosome complements, mainly in having bulb coats detached from the base of the bulbs and aneuploid chromosome number ($2n = 14$). Based on our expanded investigations on living plants and herbarium specimens, these features are shared by many other populations of different localities of E Mediterranean area and N Africa, as also remarked by Garbari & al. (1979). In particular, *A. hirtovaginatum* s. str. is morphologically well distinct from the other aforesaid species in some remarkable diagnostic features, such as bulb coats with subparallel feebly reticulate fibres, densely hairy leaves with short hairs up to 0.25 mm long, spathe always longer than the inflorescence, with 7-11 nerves and appendage up to 2 cm long. The typical populations occur in a limited area of CW Anatolia, while in the remaining Mediterranean territories several populations, which were usually reported sub *A. cupani* subsp. *hirtovaginatum* or sub *A. hirtovaginatum*, indeed represent different geographical vicariants, often with a punctiform or very circumscribed distribution. The taxonomic position and relationships of these

populations are currently being studied.

Additional specimens examined: Turkey, Colline presso Cesme, 25 Juin 1987, *S. Brullo, P. Pavone & P. Signorello s.n.* (CAT!); Manisa Dag, 8 July 1998, *S. Brullo & P. Pavone s.n.* (CAT!); Cima di Manisa Dag (Izmir), 25 Juin 1987, *S. Brullo, P. Pavone & P. Signorello s.n.* (CAT!); Cima di Manisa Dag, coltivato, 23 Juin 1999, *S. Brullo s.n.* (CAT); Manisadag (Sipylos), Steinige Gipfel Region, 12 August 1933, *O. Schwarz 1012* (B!); *ibid.*, ca. 600 m, 24 August 1978, *Seçmen & Lesbecici 1714* (HUJ!).

9. *Allium meikleanum* Brullo, Pavone & Salmeri, spec. nova. – Figs. 2J, 4J, 6J, 7J, 8J

Syn.: *Allium cupani* Raf. subsp. *cypricum* Meikle, Ann. Mus. Goulandris 6: 94, 1983, non *A. cypricum* Brullo, Pavone & Salmeri, Candollea 48: 280, 1993.

Allio hirtovaginato aemulans, differt foliis subglabris vel pilosis cum pilis 0,3-0,5 mm longis, florum pedicellis usque ad 4 cm longis, spatha quam inflorescentia multo brevior, 10-18 mm longa, 5-nervata et cum aliis duobus incompletis nervis, appendice 1-5 mm longa, perigonio 4-5 mm longo, tepalis exterioribus 1,5-1,7 mm latis, interioribus 1,2-1,3 mm latis, filamentibus staminum subulato-triangularibus, exterioribus 0,6-1 mm longis, annulo 0.6-0.7 mm alto, ovario globoso, papilloso-tuberculato superne, 1-1,2 mm longo, capsula 3,5-3,6 mm longa.

Type: Cyprus, In montibus inter Potami et Evriku (Evrykhou), 14.6.1880, *P.E.E. Sintenis & G. Rigo 860* (holotype K!, isotypes G!, MPU!).

Bulb ovoid, solitary, 10-15 × 8-12 mm, with outer tunics brown, reticulate-fibrous, detached from the base of the bulb, covering the stem up to 4 cm. *Stem* flexuous, erect, 8-16 cm high, covered by the leaf sheaths 1/2-2/3 of its length. *Leaves* 3-4, filiform, subcylindrical, shorter than inflorescence or subequal, 5-15 cm long, subglabrous or hairy with patent hairs 0.3-0.5 mm long. *Inflorescence* fastigiate, unilateral, with 4-12 flowers on pedicels 1-4 cm long. *Spathe* 1-valved, shorter than the inflorescence, 5-nerved with 2 additional incomplete nerves, 10-18 mm long, provided with an appendage 1-5 mm long. *Bostryces* 2. *Perigon* campanulate-suburceolate, 4-5 mm long; tepals pinkish-white, with a purplish mid-vein, the outers linear-lanceolate, entire and subobtuse at the apex, 1.5-1.7 mm wide, the inners linear-oblong, rounded and gnawed-undulate above, 1.2-1.3 mm wide. *Stamens* with white filaments, subulate-triangular, unequal, the outers 0.6-1 mm long and 0.4-0.5 mm wide at the base, the inners 1.6-1.8 mm long and 0.6-0.8 mm wide at the base, below connate with tepals into an annulus 0.6-0.7 mm high; anthers white-straw coloured, linear-elliptical, apiculate, 1.2-1.3 × 0.5 mm. *Ovary* greenish, globose, papillose-tuberculate above, 1-1.2 × 1-1.3 mm. *Style* white, 0.5-0.7 mm long. *Capsule* trivalved, subglobose, 3.5-3.6 × 3.5-3.7 mm.

Distribution and habitat: *Allium meikleanum* is a very peculiar taxon limited to some localities of Cyprus, at 0-600 m of elevation. It grows in the ephemeral meadows amidst the phrygana and sub-halophilous shrubby communities alongside salt marshes.

Karyology: The investigated populations (Tab. 1) showed a diploid chromosome number $2n = 14$. This aneuploid complement agrees with that one reported by Tzanoudakis (1999) sub *A. hirtovaginatatum*. The karyotype of *A. meikleanum* (Fig. 9I) was mostly characterized by metacentric chromosome pairs with only two subtolocentric chromosomes, which bear small macrosatellites in the short arms. Karyotype formula was as follows: $2n = 2x = 14: 10m + 2msm + 2st^{Msat}$. Studied specimens from Larnaca showed

a total haploid chromosome of $48.68 \pm 5.17 \mu\text{m}$; the absolute chromosome length ranged from $8.58 \pm 0.59 \mu\text{m}$ of the longest chromosome to $5.58 \pm 1.3 \mu\text{m}$ of the shortest one, while the relative length varied from 8.83 to 5.7%.

Phenology: Flowering from June to July.

Etymology: In honour of R. Desmond Meikle, English botanist and author of the “Flora of Cyprus”.

Taxonomic notes: Meikle (1983) described the Cyprian plants of this group as *Allium cupani* subsp. *cyprium*. Due to the bulb tunics detached from the base of the bulb and the aneuploid chromosome complement ($2n = 14$), these plants are indeed well distinct from *A. cupani*, showing instead closest relationships with *A. hirtovaginatatum*. However, the Cyprian populations differ from *A. hirtovaginatatum* in having a little appendiculate spathe much shorter than the inflorescence, provided with 5 complete nerves plus 2 additional incomplete ones, very small perigon (4-5 mm long) and ovary markedly papillose-tuberculate in the upper part. As a result, the plants of *A. cupani* group from Cyprus have been treated as a distinct new species that could not bear the epithet “*cyprium*” used by Meikle (1983) because another valid species named *A. cyprium* already exists (see Brullo & al. 1993).

Paratypes: Cyprus, Athalassia, 6 October 1988, S. Brullo & P. Pavone s.n. (CAT!); ibid., esemplare coltivato, 15 July 1989, S. Brullo s.n. (CAT!); Larnaca, in prossimità dei pantani salmastri, 14.06.2001, Brullo S., Giusso G., Guarino R. s.n. (CAT!).

10. *Allium pelagicum* Brullo, Pavone & Salmeri, spec. nova. — Figs. 2K, 4K, 6K, 7K, 8K

Allio hirtovaginato aemulans, differt bulbis 15-22 × 8-20 mm, scapo erecto, rigido, usque ad 30 cm alto, vaginis foliorum per 3/4 longitudinis vel omnino tecto, folia superiore inflorescentia longiore, pilis 0,2-0,3 mm longis, pedicellis usque ad 4 cm longis, spatha inflorescentia brevior, 3-5-nervata, max. 3 cm longa, tepalis exterioribus lineari-ellipticis, obtusiusculis apice, filamentibus staminum exterioribus 1,5-2 mm longis, interioribus 2,5-3 mm longis, annulo 1-1,3 mm alto, antheris stramineis, ovario subgloboso, 1,1-1,2 × 1,2-1,3 mm, capsula 4 × 4 mm.

Type: Sicily, Lampedusa, Vallone Madonna, 20.8.1989, S. Brullo s.n. (Holo: CAT!).

Bulb ovoid, solitary or clustered, 15-22 × 8-20 mm, with outer tunics dark brown, fibrous, feebly reticulate, detached from the base of the bulb, covering the stem up to 4 cm. *Stem* rigid, erect, 10-30 cm high, covered by the leaf sheaths from 3/4 of its length up to totally. *Leaves* 4-5, filiform, subcylindrical, the upper one longer than the inflorescence, 6-16 cm long, hairy with patent hairs 0.2-0.3 mm long. *Inflorescence* fastigiate, unilateral, with 4-12 flowers on pedicels 0.5-4 cm long. *Spathe* 1-valved, shorter than the inflorescence or subequal, 3-5-nerved, 15-30 mm long, provided with an appendage 4-20 mm long. *Bostryces* 2. *Perigon* cylindrical-urceolate, 6-7 mm long; tepals white-pinkish or pink, with a brown-purplish mid-vein, the outers linear-elliptical, entire and subobtuse at the apex, 1.8-2 mm wide, the inners suffused with purple near the mid-vein, linear-oblong, rounded and slightly gnawed-undulate above, 1.5-1.6 mm wide. *Stamens* with white filaments, triangular, unequal, the outers 1.5-2 mm long and 0.6-0.8 mm wide at the base, the inners 2.5-3 mm long and 0.9-1.1 mm wide at the base, below connate with tepals into an annulus 1-1.3 mm high; anthers white-straw coloured, linear-elliptical, apiculate, 1.2-1.3 × 0.6-0.7 mm. *Ovary* greenish, subglobose, smooth, 1.1-1.2 × 1.2-1.3 mm. *Style* white, 1-1.5

mm long. *Capsule* trivalved, subglobose, 4×4 mm.

Distribution and habitat: This species is endemic to Lampedusa, island of the Pelagian Archipelago, in the Channel of Sicily. It occurs alongside the calcareous rocky coasts, where is member of ephemeral meadows.

Karyology: *Allium pelagicum* has a diploid chromosome number $2n = 14$, already reported by Brullo & al. (1990) sub *A. hirtovaginatum*. Its karyotype (Fig. 9J) mainly consisted in metacentric chromosomes and only one subtelocentric microsatellited pair, as summarized by the following formula: $2n = 2x = 14: 8m + 4msm + 2st^{sat}$. The total haploid complement was $72.44 \pm \mu\text{m}$ long; absolute chromosome length varied from $12.76 \pm 1.95 \mu\text{m}$ of the longest chromosome to $7.45 \pm 2.54 \mu\text{m}$ of the shortest one, while their relative length ranged from 8.82 to 5.07%.

Phenology: Flowering from late July to August.

Etymology: From Latin “*pelagicus*”, i.e. “of Pelagian archipelago” in the Channel of Sicily.

Taxonomic notes: Populations from Lampedusa belonging to the *Allium cupani* group were previously referred to *A. hirtovaginatum* by Brullo & Pavone (1988) and Brullo & al. (1989). Further and more in-depth investigations indeed showed that these plants were well differentiated from the typical *A. hirtovaginatum* and had to be treated as a distinct species, here named *A. pelagicum*. It can be distinguished by *A. hirtovaginatum* due to its bigger bulbs, stem up to 30 cm long, covered by the leaf sheaths 3/4 of its length to totally, leaves with hairs 0.2-0.3 mm long, the upper one longer than the inflorescence, spathe shorter than the inflorescence or subequal, 3-5-nerved, subglobose shorter ovary, and smaller capsule. Moreover, *A. pelagicum* shows a later flowering time and a different karyotype structure without macrosatellited subtelocentric pairs as occurring in *A. hirtovaginatum*.

Paratypes: Sicily, Lampedusa, Vallone Madonna, 25.7.1985, S. Brullo, P. Minissale & G. Spampinato s.n. (CAT!); ibid., 25.3.1986, S. Brullo, P. Minissale, P. Pavone & G. Spampinato s.n. (CAT!); ibid., Vallone Imbriacole, 24.3.1986, S. Brullo, P. Minissale, P. Pavone & G. Spampinato s.n. (CAT!); ibid., Vallone della Forbice, 25.7.1985, S. Brullo, P. Minissale & G. Spampinato s.n. (CAT!).

11. *Allium maghrebinum* Brullo, Pavone & Salmeri, spec. nova – Figs. 2H, 4H, 6H, 7H, 8H.

Allio hirtovaginato similis, sed bulbis 12-25(-30) × 7-20(-22) mm, solitariis, geminatis vel fasciculatis, tunicis manifeste reticulato-fibrosis, scapo rigido et robusto, vaginis foliorum per 3/4 longitudinis vel omnino tecto, foliis subglabris vel sparsim pilosis, pilis 0,2-0,4(-0,7) mm longis, superiore inflorescentia longiore, pedicellis usque ad 4,5 cm longis, spatha inflorescentia brevior, interdum longiore, usque ad 7 cm longa, appendice usque ad 3,5 cm longa, perigonio cylindrico-campanulato, 7-8 mm longo, tepalis striis purpureis prope venam medianam, omnibus lineari-oblongis, exterioribus rotundatis apice, filamentibus staminum exterioribus 1-2 mm longis, interioribus 2,7-4 mm longis, annulo 0,7-0,8 mm alto, ovario subgloboso vel subgloboso-ovoideo, capsula globosa, 4 × 4 mm.

Type: Tunisia, Capo Bon, presso El Haouaria, 7.9.1990, S. Brullo & P. Minissale s.n. (Holo: CAT!).

Bulb ovoid or long ovoid, solitary, paired or clustered, 12-25(-30) × 7-20(-22) mm, with outer tunics brown or reddish-brown, reticulate-fibrous, detached from the base of the bulb, covering the stem up to 8 cm. *Stem* rigid, stout, erect or erect-ascending, 5-26 cm

high, covered by the leaf sheaths 3/4 of its length up to totally. *Leaves* 3-5, filiform, sub-cylindrical, the upper one longer than the inflorescence, 6-25 cm long, subglabrous or sparsely hairy with patent hairs 0.2-0.4 mm long (0.7 mm long in the sheath gorge). *Inflorescence* fastigiate, unilateral, with 2-12(-18) flowers on pedicels 0.6-4.5 cm long. *Spathe* 1-valved, shorter or sometimes longer than the inflorescence, 1-7 cm long, 7-9(-11)-nerved, provided with an appendage 3-35 mm long. *Bostryces* 2. *Perigon* cylindrical-campanulate, 7-8 mm long; tepals pinkish-white to pink, with purple striae near the mid-vein, linear-oblong, the outers entire and rounded at the apex, 1.8-2 mm wide, the inners subobtusate or rounded and gnawed-undulate above, 1.5-1.7 mm wide. *Stamens* with white filaments, triangular, unequal, the outers 1-2 mm long and 0.7-0.8 mm wide at the base, the inners 2.5-4 mm long and 1.1-1.3 mm wide at the base, below connate with tepals into an annulus 0.7-0.8 mm high; anthers yellowish-white, linear-elliptical, apiculate, 1.2-1.5 × 0.7-0.8 mm. *Ovary* greenish, subglobose or subglobose-ovoid, smooth, 1.2-1.5 × 1-1.5 mm. *Style* white, 1-1.5 mm long. *Capsule* trivalved, globose, throttled below, 4 × 4 mm.

Distribution and habitat: The species is widespread from central and northern Tunisia to north-eastern Algeria. It usually occurs on compact soils of coastal and inland steppe territories, characterized by very dry climate, within thermo-xeric meadows and shrub vegetation.

Karyology: The chromosome arrangement was investigated on specimens from different localities of Tunisia (Tab. 1), all showing a diploid chromosome complement $2n = 14$. The karyotype was quite homogeneous, mostly characterized by chromosomes with a more or less median centromere, frequently with 3 *msm* pairs, and only one subtelocentric pair usually satellited in the short arm (Fig. 9K). Some variation in the satellite size was also found among the studied populations, where the subtelocentric chromosomes exhibited micro- (Cape Bon, El Beja) to macro-satellites (Korbous) or even a heteromorphic combination of both types (Sidi Daud, El Fas). The karyotype formula can be represented as: $2n = 2x = 14: 6m + 6msms + 2st^{sat}$. Mitotic plates from the type specimens revealed a total haploid chromosome complement 83.84 μm in length, with chromosomes ranging from 13.97 to 8.97 μm in absolute length, and from 8.33 to 5.35% in relative length.

Phenology: Flowering from mid August to September.

Etymology: From Maghreb, geographical area corresponding to NW Africa.

Taxonomic notes: Due to the bulb coats detached from the base of the bulb, 7-11-nerved spathe sometimes longer than the inflorescence, and the aneuploid chromosome complement with $2n = 14$, this species is rather related to *A. hirtovaginatum*, which occurs in East Mediterranean territories. It also shows some resemblance to *A. pelagicum*, mainly in the rigid stem, covered by the leaf sheaths from 3/4 to total length, and upper leaf longer than the inflorescence. Notwithstanding, *A. maghrebinum* is well differentiated from these species in the late summer flowering time and many relevant morphological characters, including bulbs up to a 3 cm long, with markedly reticulate-fibrous outer coats, leaves with scattered hairs 0.2-0.4(-0.7) mm long, spathe up to 7 cm long, with an appendage up to 3.5 cm long, cylindrical-campanulate perigon 7-8 mm long, linear-oblong tepals, the outer ones rounded at the apex.

Paratypes: **Tunisia**, Capo Bon, presso El Haouaria, 21.11.1990, *S. Brullo & P. Minissale s.n.* (CAT!); Korbous, 1.9.1984, *S. Brullo s.n.* (CAT!); *ibid.*, 6.9.1990, *S. Brullo & P. Minissale s.n.* (CAT!); Sidi Daud, 1.9.1984, *S. Brullo s.n.* (CAT!); *ibid.*, 6.9.1990, *S. Brullo & P.*

Minissale s.n. (CAT!); El Beja, esemplare coltivato, 26.8.1992, *S. Brullo s.n.* (CAT!); El Fas, esemplare coltivato, 26.8.1992, *S. Brullo s.n.* (CAT!); In collibus dumetosis humilioribus circa Zaghoun, 9.7.1854, *J.-L. Kralik 380* (MPU!, G!, P!, PAL!); *ibid.*, *J.-L. Kralik 385* (FI-W!, G!, PI!); Dj. Zaghouna, 6.8.1884, *J.-L. Kralik s.n.* (FI-W!); Ariana, 22.10.1901, *A. J. Cuenod s.n.* (G!); Nabel, in dumetosis, 16.10.1907, *M. Gandoger 151* (G!); **Algeria**, Batna, sur les collines incultes, 30.7. 1853, *B. Balansa 743* (MPU!, P!).

12. *Allium tingitanum* Brullo, Pavone & Salmeri, spec. nova – Figs. 2L, 4L, 6L, 7L, 8L.

Allio maghrebino aemulans, differt scapo flexuoso, vaginis foliorum ad dimidium tecto, pilis foliorum 0,5-0,8 mm longis, spatha 5-6-nervata, max. 4 cm longa, tepalis aequalibus vel subaequalibus, lineari-oblongis, integris et obtusiusculis apice, ovario 1-1,2 mm longo, capsula obovoidea.

Type: Morocco, Taza, esemplare coltivato, 20.7.1991, *S. Brullo s.n.* (Holo: CAT!).

Bulb ovoid, solitary, 15-20 × 10-12 mm, with outer tunics brown, reticulate-fibrous, detached from the base of the bulb, covering the stem up to 4 cm. *Stem* flexuous, erect, 12-25 cm high, covered by the leaf sheaths 1/2 of its length. *Leaves* 4, filiform, subcylindrical, shorter than the inflorescence, 6-15 cm long, subglabrous or hairy with scattered patent hairs (0.3-)0.5-0.8 mm long. *Inflorescence* fastigiate, unilateral, with 4-11 flowers on pedicels 1.5-4.5 cm long. *Spathe* 1-valved, shorter than the inflorescence or sometimes subequal, 5-6-nerved, 1.5-4.5 cm long, provided with an appendage 14-25 mm long. *Bostryces* 2. *Perigon* cylindrical-campanulate, 7-7.5 mm long; tepals equal or subequal, pinkish-white, with a purplish-brown mid-vein, linear-oblong, entire and subobtuse at the apex, 1.6-1.8 mm wide. *Stamens* with white filaments, unequal, the outers subulate-triangular, 1.1-1.6 mm long and 0.5-0.7 mm wide at the base, the inners triangular, 2.6-3 mm long and 0.8-1 mm wide at the base, below connate with tepals into an annulus 1-1.2 mm high; anthers yellow, oblong, apiculate, 1.4-1.5 × 0.8-0.9 mm. *Ovary* greenish, subglobose, smooth, 1-1.2 × 1-1.2 mm. *Style* white, 1.2-1.4 mm long. *Capsule* trivalved, obovoid, throttled below, 4 × 4 mm.

Distribution and habitat: This species occurs in N Morocco and NW Algeria. It is spread both in coastal and inland steppe territories, within the thermo-xeric meadows and shrub vegetation.

Karyology: Studied specimens from the type locality (Tab. 1) showed a diploid chromosome complement with $2n = 14$. Similarly to the previously investigated aneuploid taxa of this group, the karyotype of *A. tingitanum* (Fig. 9L) was characterized by relatively metacentric (*m*) chromosomes and one subtelocentric (*st*) pair, differing in the presence of one submetacentric (*sm*) pair, which sometimes revealed microsatellited in the short arm, and evident macrosatellites in the *st* pair. The karyotype formula was as follows: $2n = 2x = 14: 8m + 2msm + 2sm + 2st^{Msat}$. The total haploid chromosome complement was $65.47 \pm 6.5 \mu\text{m}$ in length; chromosome absolute length ranged from $11.65 \pm 1.8 \mu\text{m}$ of the longest chromosome to $7.02 \pm 0.8 \mu\text{m}$ of the shortest one, while the relative length varied from 8.87 to 5.36%.

Phenology: Flowering from June to July.

Etymology: From Latin “*tingitanus*“, i.e. “from *Tingitania*“, historical region of N Africa corresponding to N Morocco.

Taxonomic notes: *Allium tingitanum* shows closest relationships with *A. maghrebicum* in having similar leaf indumentum, pedicel length, perigon shape and size, but many relevant mor-

phological features involving both vegetative (stem, spathe) and reproductive (tepals, ovary, capsule) elements allow to distinguish very well the two species. Phenological differences also occur in their flowering and fruiting times, because *A. tingitanum* starts flowering much earlier than *A. maghrebicum* that fully blooms in late summer.

Paratypes: Morocco, Dar Druis, sol argileux très dur, 12.7.1930, *E.M. Sennen 7720* (G!, MPU!); *ibid.*, 25.6.1931, *E.M. Sennen & H. Mauricio 8044* (G!, MA!, MPU!, P!); Berkane, lieux rocaillieux près la Mouloya, 22.6.1932, *A. Faure s.n.* (G!, MA!, MPU!); Fez, a Sefrou, bord de route, 10.1913, *C.-J. M. Pitard 1384* (MPU!, P!); *ibid.*, Dar Maharés, coteaux argilleux, 7.1913, *M. Mouret 2154* (MPU!); Melilla, Hidum, coteaux calcaires, 8.7.1933, *E.M. Sennen & H. Mauricio 8947* (G!, MA!, MPU!); Riff oriental, Monte Uixan, Benibuifruz, 17.9.1920, *B. Vicioso s.n.* (MA!); **Algeria**, Oran, 1851, *E.M. Durand s.n.* (G!, MPU!, P!); *ibid.*, 10.9.1888, *Bouiquet s.n.* (MPU!); *ibid.*, 8.1918, *A.C. d'Alleizette s.n.* (G!); *ibid.*, lieux secs, 8.1921, *A.C. d'Alleizette s.n.* (MA!); *ibid.*, sur les collines, 6.1850, *G.L. Durando 164* (FI-W!, G!, P!); *ibid.*, in collibus siccis, 7.1851, *G. Munby s.n.* (G!, P!); *ibid.*, a Santa Cruz, lieux rocaillieux près du Belvedere, 26.8.1927, *A. Faure s.n.* (M!); *ibid.*, maquis près Sidi-bel-Abbes, 20.8.1873, *E.A. von Regel 99* (P!); *ibid.*, Zelouses, 20.7.1873, *Wariou s.n.* (G!, MPU!); Tlemcen, prov. d'Oran, 26.7.1894, *Vomnerguell s.n.* (P!); Mostaganem, 20.8.1848, *B. Balansa s.n.* (P!); *ibid.*, rocher nu, 9.1911, *A.C. d'Alleizette s.n.* (P!).

Key to the investigated species of *Allium* sect. *Cupanioscordum*

1. Bulb tunics attached to the base of bulb.....2
 - Bulb tunics detached from the base of bulb.....8
2. Stem 8-10 cm high; spathe with 2 valves partially fused; inflorescence arranged in 4 bostryces; capsule 3-3.2 mm long.....*A. cephalonicum*
 - Stem 10-40 cm high; spathe 1-valved; inflorescence arranged in 2 bostryces; capsule 3.5-5 mm long.....3
3. Tepals usually 8-9 mm long.....4
 - Tepals usually 6-7.5 mm long.....5
4. Leaves subglabrous to hairy; spathe 12-45 mm long, usually 3-5-nerved; anthers apiculate at the apex; ovary smooth; capsule subglobose-obovoid.....*A. mauritanicum*
 - Leaves glabrous; spathe max. 20 mm long, 6-9-nerved; anthers rounded at the apex; ovary papillose-rugose on the top; capsule ellipsoid.....*A. panormitanum*
5. Stem flexuous; spathe 3-7-nerved; perigon cylindrical-campanulate.....6
 - Stem rigid; spathe 7-10-nerved; perigon cylindrical-suburceolate.....7
6. Spathe 3-nerved, sometimes with 2 additional incomplete nerves, appendage 1-3 mm long; leaves with patent hairs, 0.15-0.2 mm long; anthers rounded at the apex; capsule ellipsoid.....*A. cupani*
 - Spathe 5-7-nerved, with an appendage 0.2-0.6 mm long; leaves with subappressed hairs, 0.2-0.6 mm long; anthers apiculate at the apex; capsule globose-obovoid.....*A. samniticum*
7. Bulbs solitary (sometimes with few bulbills); leaves with appressed hairs; spathe apiculate; staminal annulus 1-1.2 mm high; anthers pinkish-white to purplish; capsule 4.5-5 × 3.5-3.8 mm.....*A. balcanicum*

- Bulbs bulbiferous; leaves with patent hairs; spathe with appendage 1-3 mm long; staminal annulus 1.6-1.8 mm high; anthers yellow; capsule 3.5-4.5 × 3-3.2... *A. tzanoudakisanum*
- 8. Spathe with appendage 1-5 mm long; perigon 4-5 mm long; ovary papillose-tuberculate above; capsule 3.5-3.6 mm long..... *A. meikleanum*
- Spathe with appendage 4-35 mm long; perigon 6-8 mm long; ovary smooth; capsule 4-5 mm long..... **9**
- 9. Bulbs 9-15 mm long; spathe longer than inflorescence; capsule 5 × 5 mm... *A. hirtovaginatatum*
- Bulbs (12-)15-25(-30) mm long; spathe shorter than inflorescence or subequal; capsule 4 × 4 mm..... **10**
- 10. Stem flexuous, covered by the leaf sheaths 1/2 of its length; all leaves shorter than the inflorescence; capsule obovoid..... *A. tingitanum*
- Stem rigid, covered by the leaf sheaths 3/4 of its length to totally; upper leaves longer than the inflorescence; capsule globose or subglobose..... **11**
- 11. Leaves hairy; spathe 3-5-nerved; perigon cylindrical-urceolate, 6-7 mm long; staminal annulus 1-1.3 mm high; ovary 1.1-1.2 mm long..... *A. pelagicum*
- Leaves glabrous or sparsely hairs; spathe 7-9(-11)-nerved; perigon cylindrical-campanulate, 7-8 mm long; staminal annulus 0.7-0.8 mm high; ovary 1.2-1.5 mm long..... *A. maghrebinum*

Conclusion

This study is a first contribution providing a morpho-karyological characterization and taxonomic revision of some relevant taxa belonging to the *Allium cupani* group. Most of exsiccata specimens in several Herbarium collections have been generally identified sub *A. cupani* Raf. or sub *A. hirtovaginatatum* Kunth. Our investigations revealed that these are two complex species characterized by several highly variable and taxonomically controversial populations whose relationships and systematic position need further investigations. As a consequence, a full revision of the sect. *Cupanoscordum* is currently in progress to be published.

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