Article

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Taxonomic investigation on *Allium hirtovaginum* group (*Amaryllidaceae*) from East Mediterranean area

Abstract

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Within taxonomic studies on *Allium* sect. *Codonoprasum* from Mediterranean flora, populations belonging to *A. hirtovaginum* Candargy group were examined. Based on field investigation and herbarium surveyes, this group is represented by very critical and not well known taxa, distributed in the East Mediterranean, showing a marked morphological variability. Currently, the species referable to this group in addition to *A. hirtovaginum* are also *A. pilosum* Sibth. & Sm., *A. aeginiense* Brullo, Giusso & Terrasi and *A. nerimaniae* Koçyiğit & Kaya. Besides, other 13 species are here described as new to science, they are *A. pythagoricum, A. pignattii, A. hippocraticum, A. abanticum, A. velutinum, A. carium, A. papillosum, A. adenanthum, A. smyrnaeum, A. pavonianum, A. denticulatum* and *A. compactatum*. A detailed morphological description together with a careful illustration, as well as remarks on their karyology, phenology, ecology, geographic distribution, and taxonomic relationships are provided for each investigated species. An analytical key regarding all the species attributable to this group was processed too.

Key words: *Allium hirtovaginum*, biogeography, East Mediterranean, karyology, sect. *Codonoprasum*, taxonomy.

Introduction

Allium is one of the largest and complex monocotyledonous genera, distributed mainly in the northern hemisphere, with about 1,200 taxa known so far (Govaerts & al. 2020). Within this genus, it is possible to detect a high rate of endemics, which are continuously described from the Mediterranean and Asian territories, representing the main centres of species diversity together with North America (Fritsch & Friesen 2002). Based on literature data, many species and critical groups fall into the subgen. *Allium* and in particular in the sect. *Codonoprasum* Reichenb., which gathers a large number of taxa distributed mainly in the Euro-Mediterranean and Irano-Turanian territories. In fact, previous cytotaxonomic investigations allowed us to describe a significant number of new species belonging to this section and to re-evaluate several critical or little-known species (Brullo & al. 1993, 1994, 1996a, 1996b, 1996c, 1997a, 1997b, 1999, 2001a, 2001b, 2002, 2003a, 2003b, 2004, 2007, 2008a, 2008b, 2009, 2010, 2012, 2013, 2014, 2017, 2019;

Brullo & Tzanoudakis 1994; Salmeri 1998; Bogdanović & al. 2008, 2009, 2011; Giusso & al. 2015; Salmeri & al. 2016; Özhatay & al. 2018). These studies emphasized that in this section the populations referable to the group of *Allium hirtovaginum* Candargy gravitating in the eastern Mediterranean are of particular interest (Halacsy1904: Hayek 1932; Stearn 1978, 1980; Kollmann 1984; Özhatay 1993; Dimopoulos & al. 2013; Govaerts & al. 2020; Flora of Greece Web 2020). This species, described by Candargy (1897) from the island of Lesbos in the eastern Aegean, similarly to all the other species in this section, is characterized by thin leaves distributed on all or part of the scape, spathe with two persistent valves usually longer than the inflorescence, with a well developed appendage, simple staminal filaments, ovary with inconspicuous nectariferous pores and distinctly trilobed more or less obovoid capsule. However, it differs for some very peculiar morphological traits mainly consisting in leaves with a dense hairy indumentum and stamens exserted from the perigon. These features occur constantly in all populations morphologically similar to *Allium hirtovaginum*, which are widespread in many territories of the Aegean area, mainland Greece and Anatolia. Based on literature (Brullo & al. 2008; Koçyiğit & Kaya 2020), *A. aeginiense* Brullo, Giusso & Terrasi and *A. nerimaniae* Koçyiğit & Kaya also close relationships with *A. hirtovaginum*. Besides according to Brullo & al. (2001a), *A. pilosum* Sibth. & Sm. should also be added to this group. Karyological investigations on *A. hirtovaginum* s.l. were carried out by Tanker & Kurucu (1979), Özhatay (1993) and Karavokyrou & Tzanoudakis (1991), which always reported a diploid chromosome count ($2n = 16$). Extensive field investigations carried out in various localities of Greece, especially in the Aegean islands, as well as in western Anatolia (Turkey) allowed us to discover many *Allium* populations all clearly referable to the *Allium hirtovaginum* group. Morphological and karyological investigations performed on living material emphasized that most of them are well differentiated from the known species of this group and therefore they can be treated as species new to science. In order to highlight the most relevant differences among the various examined populations referable to both the already known species and the new ones, the morphological, karyological, phenological, chorological and ecological characteristics of each are provided, together with the taxonomic relationships, a detailed iconography and a list of all examined herbarium specimens.

Materials and Methods

The morphological study was based on living plants collected in Greece and Turkey, which were then cultivated in the Botanical Garden of Catania. Furthermore, herbarium collections from various botanical museums were examined for taxonomic comparison (B, BM, C, CAT, FI, G, HUJ, ISTE, K, M, OXF, P, UPA, W and WU). Qualitative and quantitative morphological traits were examined under a Zeiss Stemi SV11 Apo stereomicroscope at 6–66× magnification from fresh material (about 10 individuals). In particular the vegetative and reproductive features were chosen according to their diagnostic value to discriminate against the populations under investigation. 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 about 10

representative metaphase plates (2 per individual). Metaphase chromosomes were measured using the image analysis systems Zeiss Axiovision 4.8. Karyotyping was performed using Cromolab© 1.1 software (Brullo 2002) for the recognition and ordering of homologues. Chromosome nomenclature and karyotype formulas followed Levan & al. (1964) and Tzanoudakis (1983).

Results

1. *Allium hirtovaginum* Candargy, Bull. Soc, Bot. France 44: 142, 1897 – Fig. 1.

Type. Greece, Lesbos, nelle collline presso Moria, 30.5.1992, *S. Brullo & P. Minissale s.n* . (Neotype: CAT, here designated).

Bulb ovoid, 10-15 × 7-10 mm, with outer tunics coriaceous, striated, blackish brown, often suffused with purple, the innermost membranaceous, whitish-yellow. *Stem* erect or erect-ascending, glabrous, 10-32 cm high, usually covered by the leaf sheaths up to 1/2 of total length. *Leaves* 3-4, subequal or shorter than the inflorescence, totally covered by dense hairs, patent, 0.1-0.2 mm long, longer at throat, blade semicylindrical, ribbed, up to 18 cm long. *Inflorescence* expanded, lax, 4-5 cm in diameter, with 20-40 flowers, on pedicels unequal, glabrous, 15-30 mm long. *Spathe* with 2 valves, unilateral, erect, unequal, longer than the inflorescence, hairy at the top and in the appendage, the largest 5-7-nerved, 6-12 cm long, the smallest 5-nerved, 3.5-7 cm long. *Perigon* campanulate, 4.5-5 mm long, with tepals elliptical, 2-2.5 mm wide, purplish-pink, tinged with green, denticulate and apiculate at the apex. *Stamens* usually only the inners exserted from the perigon, with simple filaments unequal, dark purple above and pale lilac below, the outers 2-2,5 mm long, the inners 4-5 mm long, below connate with tepals into an annulus 0.7-0.8 mm high, without interstaminal teeth; anthers yellow, elliptical, rounded at the apex, 1.5 × 1 mm. *Ovary* subglobose, throttled below, green, papillose above, 1.5-1.6 × 1.8-2 mm; style purplish in the middle, 2 mm long. *Capsule* trivalved, broadly obovoid, 3.8-4 × 4-4.2 mm.

Distribution and habitat. This species described by Candargy (1897) from the Island of Lesbos (East Aegean), was later reported for other Aegean islands, mainland Greece, and several localities in south-western and north-western Anatolia (Tanker & Kurucu 1979; Özhatay 1993; Kollmann 1984; Karavokyrou & Tzanoudakis 1991; Dimopoulos & al. 2013; Koçyiğit & Kaya 2020). In this regard, it should be noted that various populations previously attributed to *A. hirtovaginum* s.l. are treated in this study as new species morphologically very distinct from *A. hirtovaginum* s. str. Therefore, on the real occurrence of *A. hirtovaginum* in other Greek and Anatolian territories, further detailed field and herbarium surveys are needed. Particularly based on data provided by Koçyiğit & Kaya (2020), the Istanbul Herbarium (ISTE) preserves a very conspicuous number of Turkish specimens which these authors attributed to *A. hirtovaginum*. According to our field surveys, this species appears to be confined to the island of Lesbos (Fig. 2A), where it grows in phrygana mainly characterized by *Sarcopoterium spinosum* (L.) Spach, *Cistus* sp. pl. and other sclerophyllous scrubs, occurring at low altitude (100-300 m a.s.l.).

Karyology. According to Brullo & al. (2008a, Fig. 3), the investigated population of *A. hirtovaginum* coming from the type locality is characterized by a chromosome number $2n = 2x = 16$: $12m + 2m^{sat} + 2msm^{sat}$ (Fig. 17A). This karyotype is morphologically quite constant in all examined individuals of this species (Fig. 18A).

Phenology. Flowering from late May to early June.

Etymology. The specific epithet refers to the leaves covered by dense hairs.

Fig. 1. *Allium hirtovaginum* Candargy: **A.** Habit; **B.** flower; **C.** open perigon and stamens; **D.** ovary; **E.** anther; **F.** Capsule; **G.** indumentum of leaf sheaths; **H.** spathe valves. (Drawing by S. Brullo from living plants of type locality).

Taxonomic notes. Morphologically, *Allium hirtovaginum* shows some relationships with the species belonging to *A. stamineum* Boiss. group, mainly in some floral tracts. Both species are in fact characterized by a campanulate perigon with straight stamen filaments usually long exserted, but completely differ in the leaf indumentum, since in *A. hirtovaginum* has leaves totally covered by dense hairs, while *A. stamineum* always shows hairless leaves. Within the Sect. *Codonoprasum*, the leaf hairiness is a feature occurring also in other species of the eastern Mediterranean, such as *A. ionicum* Brullo & Tzanoudakis from Ionian Islands, *A. rhodopaeum* Velen. from Balkans, *A. archeotrichon* Brullo & al. from Rhodos, *A. makrianum* Brullo & al. from Chios, etc. However, all these species, except *A. pilosum*, differ from *A. hirtovaginum* in having the stamen filaments always included into the perigon. As concerns the typification of this species, extensive investigations carried out in the main European herbaria searching for exsiccata collected by Candargy were unsuccessful. This is supported by Flora of Greece Web (2020) claiming that Candargy's (father and son) herbarium appears to have been lost. Therefore, we consider appropriate to designate a neotype, using the material coming from Moria in the Island of Lesbos, which is the "*locus classicus*" mentioned in the protologue by Candargy (1897).

Additional specimens examined. Greece, Lesbos a Karestepas, 30.5.1992, *S. Brullo & P. Minissale s.n* .(CAT); ibid., esemplare coltivato, 8.6.1993, *S. Brullo s.n.* (CAT).

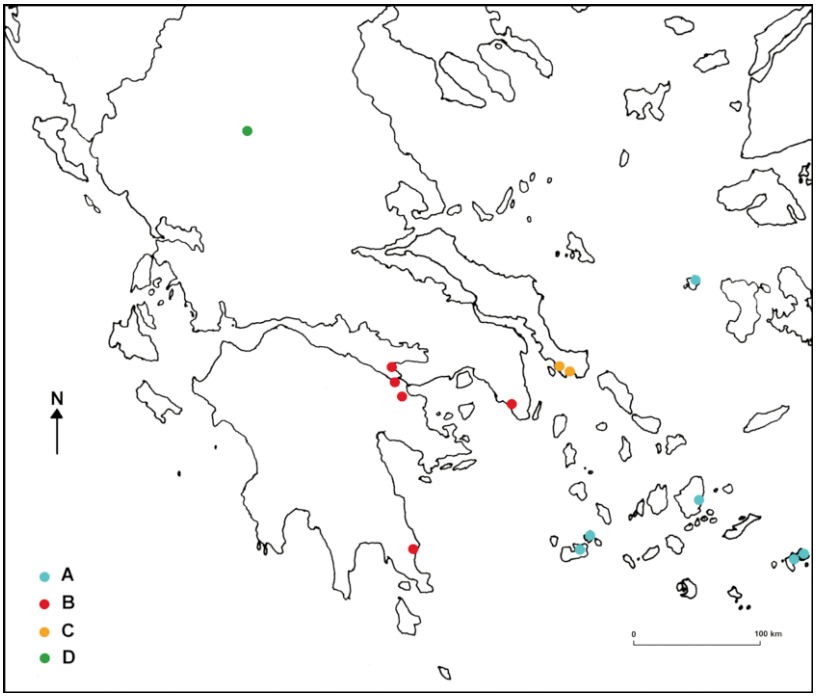

Fig. 2. Geographical distribution of *Allium hirtovaginum* (**A**), *A. smyrnaeum* (**B**), *A. pignattii* (**C**), *A. pythagoricum* (**D**), *A. trichospathum* (**E**), *A. papillosum* (**F**), *A. pavonianum* (**G**), *A. compactatum* (**H**), *A. adenanthum* (**I**), *A. carium* (**J**), *A. denticulatum* (**K**) and *A. hippocraticum* (**L**).

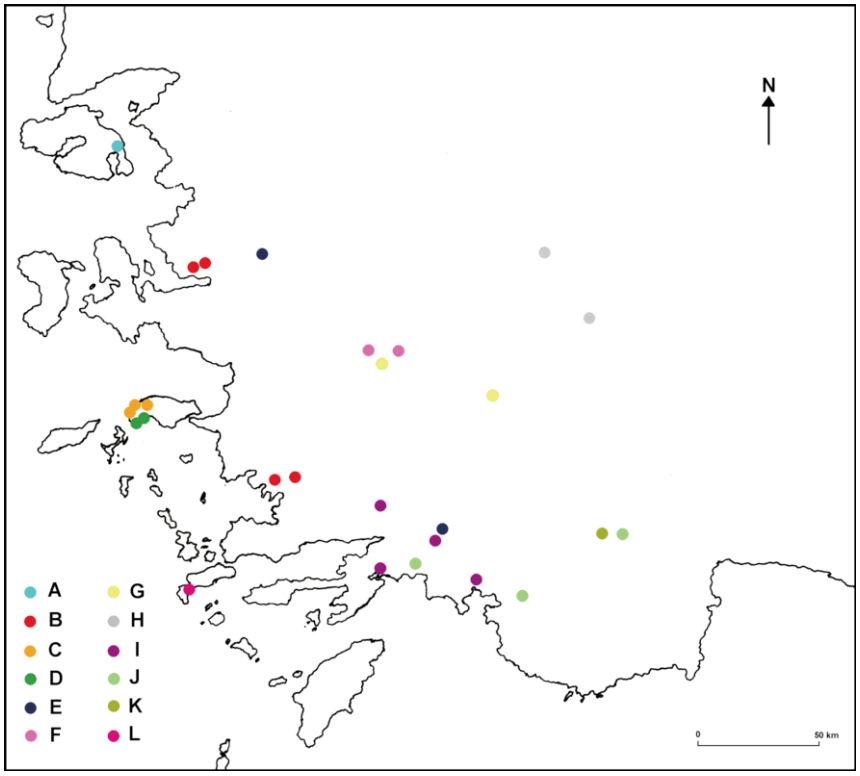

Fig. 3. Geographical distribution of *A. pilosum* (**A**), *A. velutinum* (**B**), *A. abanticum* (**C**) and *A. aegyniense* (**D**).

2. *Allium pilosum* Sm. in Sibth. & Sm., Fl. Graec. Prodr. 1(2): 225, 1809

Iconography. Tav. 321 (Sibthorp & Smith 1823); Fig. 3 (Brullo & al. 2001a)

Type. Greece, In insula Cimolo = Kimolo near Milos, Cycladis, s.d., *Sibthorp* (Holo: OXF), designated by Brullo & al. (2001a); Cimolia, *Sibthorp* (Syn: BM 001066444).

Bulb ovoid-subglobose, 6 × 5 mm, with outer tunics coriaceous, purplish-black, often the innermost membranaceous, whitish. *Stem* erect, glabrous, 2.5-20 cm high, usually covered by the leaf sheaths up to 1/2 of total length. *Leaves* 3, subequal or shorter than the inflorescence, totally covered by dense hairs, patent, 0.8-1.2 mm long, blade semicylindrical, ribbed, up to 13 cm long. *Inflorescence* expanded, lax, with 20-30 flowers, on pedicels unequal, glabrous, 5-15 mm long. *Spathe* with 2 valves, divaricate, unequal, subequal or longer than the inflorescence, with hairy appendage, the largest 5-7-nerved, 1-4 cm long, the smallest 3-5-nerved, 1-1.5 cm long. *Perigon* campanulate, 3.5-4(4.5) mm long, with tepals oblong to elliptical, 1.8-2 mm wide, uniformly purplish-lilac, rounded and apiculate at the apex. *Stamens* usually only the inners exserted from the perigon, at the end all exserted, with simple fila-

ments unequal, almost totally purplish-pink, 2-4 mm long, below connate with tepals into an annulus 0.6-0.8 mm high; anthers yellow, elliptical, slightly apiculate at the apex, 1.2-1.3 × 0.5-0.7 mm. *Ovary* subglobose to subglobose-ovoid, green, papillose above, 1.2-1.8 × 1.5-1.7 mm; style purplish below, 1.4 mm long. *Capsule* trivalved, subglobose, 3.2 × 2.8 mm.

Distribution and habitat. This species was described from Kimolos, a small island near Milos in the Cyclades Archipelago (see Sibthorp & Smith 1809, 1823) and later recorded also from other neighboring islands, such as Astypalea (D'Urville 1822), Milos (Halacsy 1904), and Psara (Kollmann 1984). Its occurrence in the aforesaid islands was further confirmed by Brullo & al. (2001a), with the inclusion of Naxos (Fig. 3A). These authors also emphasized that the record from the island of Samos quoted by Rechinger (1943) was probably to be referred to *A. hirtovaginum*. As far as the ecological requirements are concerned, *A. pilosum* occurs on siliceous substrata, as schists, granites and vulcanites, growing mainly in the ephemeral meadows admidst the phryganas.

Karyology. As reported by Brullo & al. (2001a), *Allium pilosum* has a diploid chromosome number with $2n = 2x = 16$: $14m + 2m^{sat}$. The karyotype is regular and uniform, characterized by metacentric pairs, one of which is microsatellited (see Brullo & al. 2001a, Fig. 7A-C).

Phenology. Flowering from May to early June.

Etymology. The specific epithet refers to the hairy leaves.

Taxonomic notes. According to Brullo & al. (2001a), *Allium pilosum* is a species well distinct from the other ones of this group, showing only some relationships with *A. hirtovaginum*, mainly in having leaves and spathe valves hairy, perigon campanulate, and stamens exserted with filament purplish above. Nevertheless, several diacritical features allow the two species to be well differentiated, such as the occurrence in *A. pilosum* of bulbs smaller, stems much shorter, leaves with longer hairs, spathe valves very smaller, pedicels shorter, perigon smaller, uniformly purplish-lilac, anthers smaller, ovary not throttled below and capsule smaller.

Additional specimens examined. See Brullo & al. (2001a).

3. *Allium aeginiense* Brullo, Giusso & Terrasi, Candollea 63: 199, 2008

Iconography. Fig. 1 (Brullo & al. 2008).

Type. Greece, Thessaly, Meteore (Kalanbaka) substrati conglomeratici presso il Monastero di Megalo Meteoro, 8.VII. 2004, *Brullo, Bacchetta, Giusso & Guarino, s.n.* (Holo: CAT).

Bulb ovoid, 15-22 × 9-11 mm, with outer tunics feeble fibrous, dark brown, the innermost membranaceous, pale brown. *Stem* erect or erect-ascending, rigid, glabrous, 20-30 cm high, usually covered by the leaf sheaths for 1/3 - 1/2 of total length. *Leaves* 3-4, shorter than the inflorescence, totally covered by dense hairs, appressed to patent, 0.2-1.8 mm long, blade flat, ribbed, up to 18 cm long. *Inflorescence* expanded, lax, 4.5-5 cm in diameter, with 20-40 flowers, on pedicels unequal, glabrous, 15-25 mm long. *Spathe* with 2 valves, divaricate to reflexed, unequal, longer than the inflorescence, densely hairy at least in the appendage, both 7-nerved, the largest 6-12 cm long, the smallest 3.5-7 cm long. *Perigon* campanulate, 5-5.5 mm long, with

tepals equal, rectangular, 1.6-2 mm wide, purplish-pink, tinged with purple, midrib purplish-green, smooth and truncate at the apex. *Stamens* all exserted from the perigon, with simple filaments subequal, purplish above and white below, 6-7 mm long, below connate with tepals into an annulus 0.6-0.8 mm high, no interstaminal teeth; anthers yellow, elliptical, rounded at the apex, 1.5-1.6 × 0.8-0.9 mm. *Ovary* ellipsoid, slightly throttled below, green, tuberculate above, 2.1-2.4 × 1.9-2 mm; style white, 0.8-1 mm long. *Capsule* trivalved, subglobose, 3.8-4.2 × 4.2-4.4 mm.

Distribution and habitat. It is a very rare and localized species, currently circumscribed to the top of the rocky pillars occurring in the Meteora area near Kalambaka in Thessaly (central Greece) at about 600-700 m of elevation (Fig. 3D). The substrata are composed by a mixture of sandstone and conglomerate having a lacustrian origin dating back to the Oligo-Miocene. Usually, *A. aeginiense* colonizes the crevices of the bare rock, especially in the flatter stands or anyway slightly sloping, characterized by a very feeble soil accumulation. In these very small places, it grows together with other geophytes and a few small herbaceous species.

Karyology. This species is characterized by a diploid chromosome complement with $2n = 2x = 16$: $14m + 2msm^{sat}$. Its karyotype is regular and uniform in all individuals examined by Brullo & al. (2008a, Fig. 2).

Phenology. Flowering from late June to early July.

Etymology. The specific epithet refers to "Aeginum", latin name of Kalambaka town.

Taxonomic notes. As already highlighted by Brullo & al. (2008), *Allium aeginiense* shows close relationships with *A. hirtovaginum*, mainly in having leaves and spathe valves hairy, perigon pink-purplish, and stamens exserted with filament purplish above. However, relevant features allow them to be clearly distinguished, since *A. aeginiense* is characterized by larger bulbs with outer tunics fibrous, leaves longer, covered by longer hairs, spathe valves both 7-nerved, tepals rectangular, narrower, smooth and truncate al the apex, stamen filaments subequal and longer, ovary ellipsoid, larger, style shorter and totally white, and capsule subglobose. Besides, it differs for its ecological requirement, being a more mesic species linked to rock crevices, as well as also for its phenology, since it flowers about one month later than *A. hirtovaginum*.

4. *Allium nerimaniae* Koçyiğit & E. Kaya, Phytotaxa 435(1): 17, 2020

Iconography. (Fig. 2, Koçyiğit & Kaya 2020)

Type. Turkey, B9 Van, Gürpinar, around Sapakonak village, elevation 2535 m, 7.9.2013, E. *Kaya 4455* (Holo: ISTE; iso: NGBB, AEF).

Bulb ovoid-subglobose, (1)15-20(25) × 16-23(25) mm, with outer tunics fleeble fibrous, light brown, the innermost papyraceous, yellowish to dirty white. *Stem* erect, rigid, velutinous, (30)50-60(70) cm high, usually covered by the leaf sheaths for 1/2 – 2/3 of total length. *Leaves* 4-5(6), shorter than the inflorescence, totally covered by dense velutinous-scabrous tomentum, blade flat, canaliculate, 8-10 cm long. *Inflorescence* dense, subglobose, 6-6.2 cm in diameter, with more than 100 flowers, on pedicels subequal, pruinose, 30-35 mm long. *Spathe* with 2 valves, divaricate, unequal, longer than the inflorescence, 8-11-nerved, slightly villous at the margins,

the largest 8-10 cm long, the smallest 6-7 cm long. *Perigon* globose, with tepals unequal, oblong, truncate at the apex, yellowish-dirty white, striate with purple at the apex, outers 3.5-4 × 1.8-2 mm, with midrib green, inners 4.5-5 × 1-8-2 mm, with midrib dark purplish. *Stamens* all exserted from the perigon, with simple filaments subequal, whitish-yellow, 4.5-5 mm long, below connate with tepals into an annulus 0.5-0.8 mm high; anthers yellow, ovate, rounded at the apex, 0.8-1 × 0.4-0.5 mm. *Ovary* globose-ovoid, slightly throttled below, green, smooth, 1.7-2 × 1.5-1.7 mm; style white, 4.5-5 mm long. *Capsule* trivalved, globose-oblong, 4.5-5 × 4.7-5mm.

Distribution and habitat. Allium nerimaniae is a very rare endemic species, localized in East Turkey with a punctiform distribution. According to Koçyiğit & Kaya (2020, Fig. 3), it is known only from the type locality, where it grows in alpine meadows at 2500-2550 m a,s.l. together with other orophilous geophytes.

Karyology. Unknown.

Phenology. Flowering in July.

Etymology. The species is dedicated to Neriman Özhatay, Turkish botanist, specialist of the genus *Allium*.

Taxonomic notes. For its morphological features *Allium nerimaniae* clearly belongs to the Sect. *Codonoprasum* and can be referred to *A. hirtovaginum* group for the leaves covered by dense hairs and the stamens exserted from the perigon. However, it differs in having scape velutinous, with very appressed and intricate hairiness especially in the outermost leaves, inflorescence dense and subglobose, subequal pedicels, perigon globose with tepals closely appressed and strongly unequal. For such set of characters completely absent in all other populations of the *A. hirtovaginum* group, *A. nerimaniae* can be considered a quite isolated species, showing no direct affinity with any specific taxon. Probably, this must be attributed to its remarkable geographical isolation and its localization in high altitude stands.

5. *Allium pythagoricum* Brullo & Salmeri, spec. nova (Fig. 4)

Allio hirtovagino similis, sed bulbo majore, tunicis fibrosis, scapo 1/2-2/3 vaginis foliorum tecto, pilis foliorum longioribus, spathae valvis glabris, perigonio minore, tepalis viridi-brunneis, porpora suffusis, apice rotundatis, staminum filamentibus brevioribus, purpureis basi, annulo longiore, denticulato inter stamina, antheris ovatis, minoribus, ovario subcylindrico, longiore, stylo albo, breviore, capsula subglobosa, minore.

Type. Greece, Isola di Samos, Votsalaka in garighe costiere a Sud di Marathokampos, 20.6.1993, *S. Brullo & P. Minissale 17* (Holo: CAT).

Bulb ovoid, 15-17 × 13-16 mm, with outer tunics fleeble fibrous, dark brown, the innermost fibrous, pale brown. *Stem* erect, glabrous, 18-25 cm high, usually covered by the leaf sheaths for 1/2 - 2/3 of total length. *Leaves* 4-5, subequal to shorter than the inflorescence, totally covered by dense hairs, sub-appressed to patent, 0.2-1 mm long, blade flat, 10-17 cm long, ribbed. *Inflorescence* expanded, lax, 5-6 cm in diameter, with 20-35 flowers, on pedicels unequal, glabrous, 15-30 mm long. *Spathe* with 2 valves, opposite, divaricate, unequal, longer than the inflorescence, glabrous, the largest 7-nerved, 8-16 cm long, the smallest 5-nerved, 3.5-9 cm long. *Perigon* campanulate, 4-4.5 mm long, with tepals equal, elliptical, 2-2.5 mm wide, green-

brown, tinged with purple, midrib green, smooth and rounded at the apex. *Stamens* with simple filaments unequal, purplish above and white below, usually only the inners exserted from the perigon, 3-3.5 mm long, the outers shorter, 1.8-2 mm long, below connate with tepals into an annulus 1-1.2 mm high, provided with interstaminal teeth; anthers pale yellow, ovate, rounded at the apex, 1-1.1 × 0.8 mm. *Ovary* subcylindrical, green, papillose above, 2.2-2.5 × 1.8 mm; style white, 1 mm long. *Capsule* trivalved, subglobose, 3-3.5 × 3.8 mm.

Distribution and habitat. The species occurs along coastal places in phryganas characterized by low markedly xerophilous shrubs. It was collected in some stands of the south-western side of Samos, a Greek island in the eastern Aegean, near the Turkish coast (Fig. 2D). This area located South of Marathokampos is represented by a very extensive sandy belt, currently subject to an intense anthropic pressure due to beach tourism, which has largely compromised the natural landscape.

Karyology. The two examined populations of *Allium pythagoricum* coming from Votsalaka and Psili Ammos showed the diploid chromosome complement $2n = 2x = 16$: 10m + 4msm + $2msm^{sat}$ (Fig. 17B). The karyotype structure is rather similar in both populations and is characterized by ten metacentric and six metasubmetacentric chromosomes, two of which microsatellited on the short arms (Fig. 18B).

Phenology. Flowering in the second half of June.

Etymology. Pythagoras, philosopher and mathematician born in Samos ca. 569 BC, is commemorated.

Taxonomic note. Allium pythagoricum is closely related to *A. hirtovaginum* sharing several features, such as leaves totally hairy, inflorescence lax and expanded, perigon campanulate, just the inner stamens exserted, and ovary papillose above. However, many other morphological characters well separate the two species, since *A. hirtovaginum* shows bulbs smaller, with outer tunics coriaceous and inner ones membranaceous, stem covered by the leaf sheaths up to 1/2 of total length, leaf hairs shorter, spatha valves glabrous, perigon longer, purplish-pink, denticulate and apiculate at the apex, stamen filaments longer, purplish above, annulus shorter, without interstaminal teeth, anthers elliptical, longer, ovary subglobose, longer, style shorter, purplish in the middle, capsule broadly obovoid, larger. Besides, it has an earlier flowering and karyotype with only one metasubmetacentric pair and two pairs of chromosomes microsatellited on short arms.

Paratype. Greece, Isola di Samos, Psili Ammos in garighe costiere a Sud di Marathokampos, 20.6.1993, *S. Brullo & P. Minissale 26* (CAT).

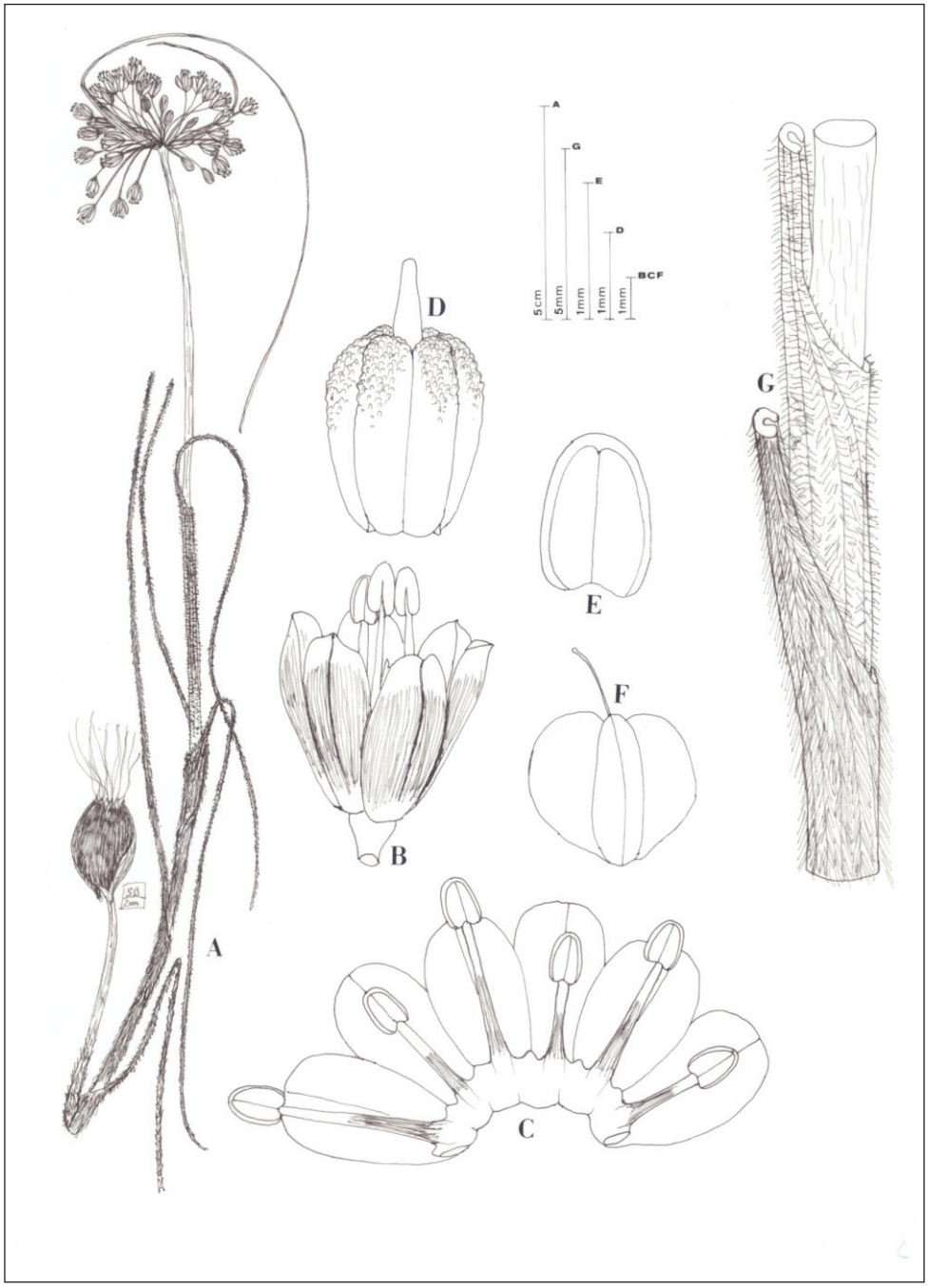

Fig. 4. *Allium pythagoricum* Brullo & Salmeri: **A.** Habit; **B.** flower; **C.** open perigon and stamens; **D.** ovary; **E.** anther; **F.** Capsule; **G.** indumentum of leaf sheaths. (Drawing by S. Brullo from living plants of type locality).

6. *Allium pignattii* Brullo & Salmeri, spec. nova (Fig. 5)

Allio pythagorico similis, sed bulbi tunicis interioribus membranaceis, foliis longioribus, pilis longioribus, spathae valvis appendicibus minute ciliatis margine, perigonio cylindrico-campanulato, longiore, uniformiter colorato, tepalis apiculatis apice, staminum filamentibus albis, leviter violaceo suffusis, dentibus interstaminalibus nullis, ovario longiore, capsula subglobosa, minore.

Type. Greece, Isola di Samos, sulle colline nei dintorni di Marathokampos, 5.6.1993, *S. Brullo & P. Minissale 25.* (Holo: CAT).

Bulb ovoid, 12-18 × 8-15 mm, with outer tunics fibrous, brown, the innermost ones membranaceous, pale brown. *Stem* erect, glabrous, 20-38 cm high, usually covered by the leaf sheaths for 1/2 - 2/3 of total length. *Leaves* 4-5, shorter than the inflorescence, totally covered by dense hairs, sub-appressed to patent, 0.6-1 mm long, blade semicylindrical, ribbed, up to 38 cm long. *Inflorescence* expanded, lax, 5-6 cm in diameter, with 25-40 flowers, on pedicels unequal, glabrous, 10-30 mm long. *Spathe* with 2 valves, divaricate to reflexed, unequal, longer than the inflorescence, with appendage finely ciliate at the margin, the largest 7-nerved, 8-18 cm long, the smallest 5-nerved, 4-8 cm long. *Perigon* cylindrical-campanulate, 4.5-5 mm long, with tepals equal, elliptical, 2-2.2 mm wide, uniformly green-brown, midrib green, smooth and apiculate at the apex. *Stamens* with simple filaments, unequal, white slightly tinged with violet, usually only the inners exserted from the perigon, 3-3.5 mm long, the outers shorter, 1.6-1.8 mm long, below connate with tepals into an annulus 0.8-0.9 mm high, without interstaminal teeth; anthers yellow, elliptical, rounded at the apex, 1.1 × 0.7 mm. *Ovary* cylindrical-obovoid, green, papillose above, 3 × 2 mm; style white, 1.6 mm long. *Capsule* trivalved, subglobose, 3.5 × 4 mm.

Distribution and habitat. This species occurs in some localities of the interior of the island of Samos (Fig. 2C), where it grows in grasslands and phryganas at an elevation not exceeding 700 m a.s.l.

Karyology. The examined population of *Allium pignattii,* coming from the type locality, is characterized by a diploid chromosome complement with $2n = 2x = 16$: $10m + 4m^{sat} + 2msm^{sat}$ (Fig. 17C). The karyotype structure is differentiated by 14 metacentric chromosomes, four of which are microsatellited on the short arms and 2 metasubmetacentric microsatellited chromosomes (Fig. 18C).

Phenology. Flowering from late May to early June.

Etymology. The species is named in honour of Sandro Pignatti, eminent Italian botanist.

Taxonomic notes. For its habit and some morphological features, *Allium pignattii* is closely related to *A. pythagoricum*, also occurring in Samos but in coastal stands. However, the two species differ in some significant diacritical characters, mainly regarding bulb tunics, leaves, spathe, perigon, stamens and ovary. In particular, *A. pignattii* shows innermost bulb tunics membranaceous, leaves longer, covered with longer hairs, appendages of the spathe valves finely ciliate at the margin, longer perigon cylindrical-campanulate, uniformly coloured, stamen filaments slightly tinged with lilac, without interstaminal teeth, ovary longer, while *A. pythagoricum* has bulb tunics totally fibrous, leaves clearly shorter with shorter hairs, spathe valves totally glabrous, perigon shorter, campanulate, tinged with purple, stamen filaments purplish above, with interstaminal teeth, ovary shorter. Other differences concern the karyotype, since that one of *A. pignattii* is characterized by 14 metacentric and 2 submetacentric chromosomes, with 4 microsatellited pairs, while *A. pythagoricum* shows 10 metacentric and 6 metasubmetacentric chromosomes, with one microsatellited pair.

Paratypes. Greece, Isola di Samos, Isidoros nella phrygana, 6.6.1993, *S. Brullo* & *P. Minissale 32* (CAT); Ibid., alla base di monte Kerkis, 6.6.1993, *S. Brullo* & *P. Minissale 31* (CAT).

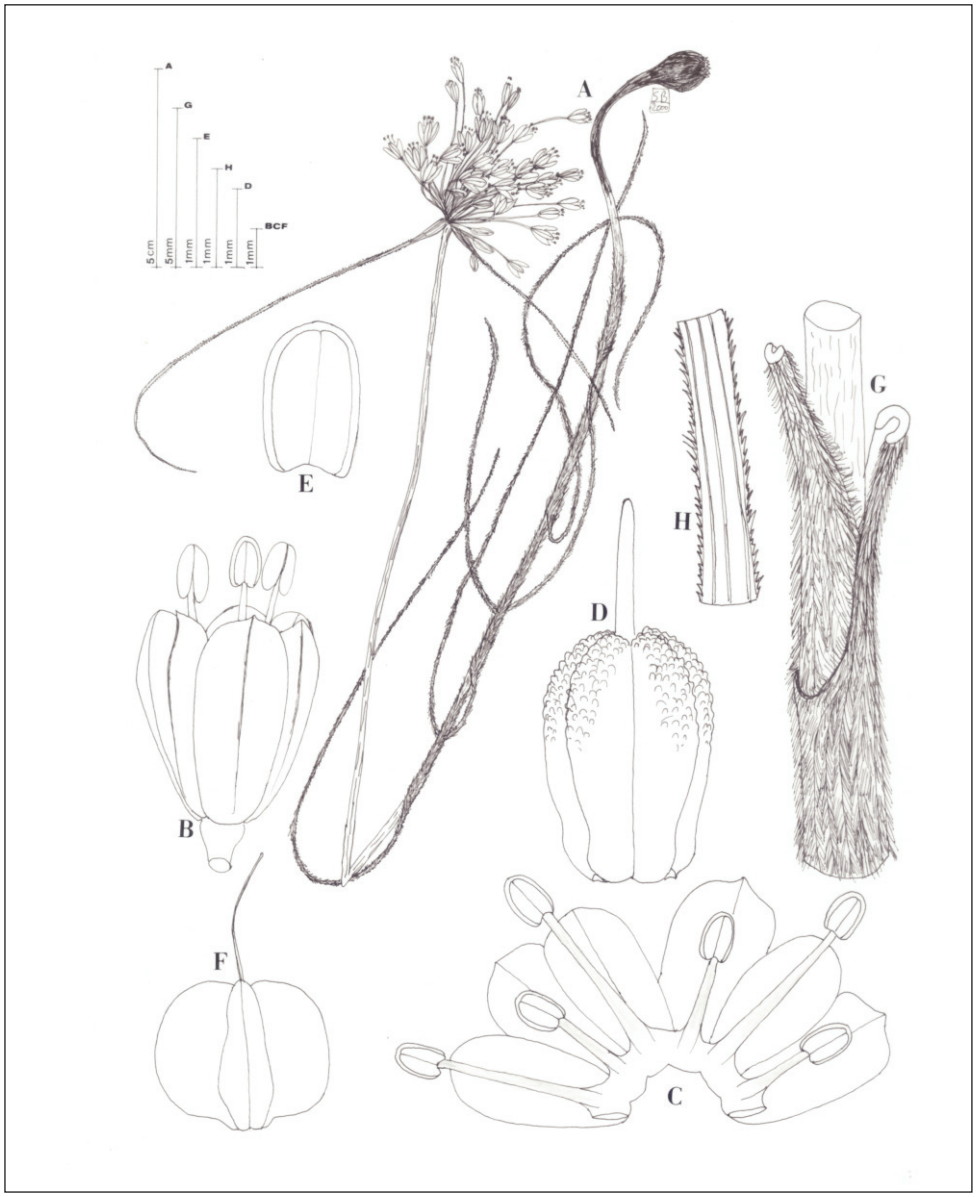

Fig. 5. *Allium pignattii* Brullo & Salmeri: **A.** Habit; **B.** flower; **C.** open perigon and stamens; **D.** ovary; **E.** anther; **F.** Capsule; **G.** indumentum of leaf sheaths; **H.** appendage of the spathe valve. (Drawing by S. Brullo from living plants of type locality).

7. *Allium hippocraticum* Brullo & Salmeri, spec. nova (Fig. 6)

Allio pythagorico similis, sed bulbis ellipsoideis, tunicis esterioribus albo-cinerascentibus, foliis longioribus, inflorescentia longioribus, pilis foliorum brevioribus, spathae valvis appendicibus dense pilosis, perigonio longiore, tepalis atrobrunneo striatis, obtusis apice, staminum filamentibus subaequalibus, longioribus, omnino purpurescentibus, antheris albescentibus, ovario obovoideo, longiore, stylo longiore, capsula globosa-obovoidea, maiore.

Type. Greece, Isola di Kos, nei dintorni di Kefalos, coltivato, 12.7.1994, *S. Brullo & F. Scelsi C30* (Holo: CAT).

Bulb ellipsoid, 13-16 × 9-11 mm, with outer tunics fibrous, greyish-white, the innermost ones membranaceous-fibrous, pale yellow. *Stem* erect, glabrous, 18-25 cm high, usually covered by the leaf sheaths for 1/2 - 2/3 of total length. *Leaves* 4-5, longer than the inflorescence, totally covered by dense hairs, patent, 0.2-0.3 mm long, blade semicylindrical, ribbed, up to 24 cm long. *Inflorescence* expanded, lax, 4-5 cm in diameter, with 25-35 flowers, on pedicels unequal, glabrous, 15-25 mm long. *Spathe* with 2 valves, divaricate, unequal, longer than the inflorescence, with appendage densely hairy, the largest 7-nerved, 10-13 cm long, the smallest 5-nerved, 4.5-6 cm long. *Perigon* campanulate, 5 mm long, with tepals equal, elliptical, 2.2 mm wide, green-brown, striate with dark brown, midrib green, smooth and obtuse at the apex. *Stamens* with simple filaments, subequal, totally purplish, all exserted from the perigon, 4-4.2 mm long, below connate with tepals into an annulus 1-1.2 mm high, provided with interstaminal teeth; anthers whitish, elliptical, slightly apiculate at the apex, 1-1.1 × 0.7-0.8 mm. *Ovary* obovoid, green, slightly papillose above, 2.8-3 × 2 mm; style white, 2.2 mm long. *Capsule* trivalved, globose-obovoid, 4 × 4 mm.

Distribution and habitat. This species was collected in the island of Kos (Dodekanisos archipelago), where it is quite rare (Fig. 2L). A population was surveyed near Kefalos, a small town located in the western of the island, mainly growing in grasslands.

Karyology. The examined population of *Allium hippocraticum* coming from the type locality is characterized by a diploid chromosome complements with $2n = 2x = 16$: 10m + 6msm (Fig. 17D). The karyotype structure is differentiated by 10 metacentric and 6 metasubmetacentric chromosomes; no evident satellites were detected (Fig. 18D).

Phenology. Flowering from late June to early July.

Etymology. Hippocrates, father of medicine born in Kos ca. 460BC, is commemorated.

Taxonomic notes. Allium hippocraticum shows close morphological relations with *A. pythagoricum*, especially for the flowers with tepals green-brown and interstaminal teeth, as well as for the similar karyotype structure, though several diacritic features allow them to be distinguished quite well. In particular, *A. hippocraticum* differs from *A. pythagoricum* in having bulbs ellipsoid, with tunics greyish-white, leaves longer far exceeding the inflorescence, with very shorter hairs, spathe valves with appendages densely hairy, tepals longer, striate with dark brown, obtuse at the apex, stamen filaments subequal and longer, uniformly purplish, anthers whitish, ovary obovoid, longer, style longer, capsule subglobose-ovoid, larger. Converserly, *A. pythagoricum* shows bulbs ovoid, with tunics entirely fibrous, leaves shorter, not exceeding the inflorescence, covered by longer hairs, spathe valves with appendages glabrous, tepals shorter, tinged with purple, rounded at the apex, stamen filaments unequal and shorter, purple above, anthers pale yellow, ovary subcylindrical, shorter, style shorter, capsule subglobose, smaller. The two species also differ in their phenology, since *A. hippocraticum* flowers about one month later.

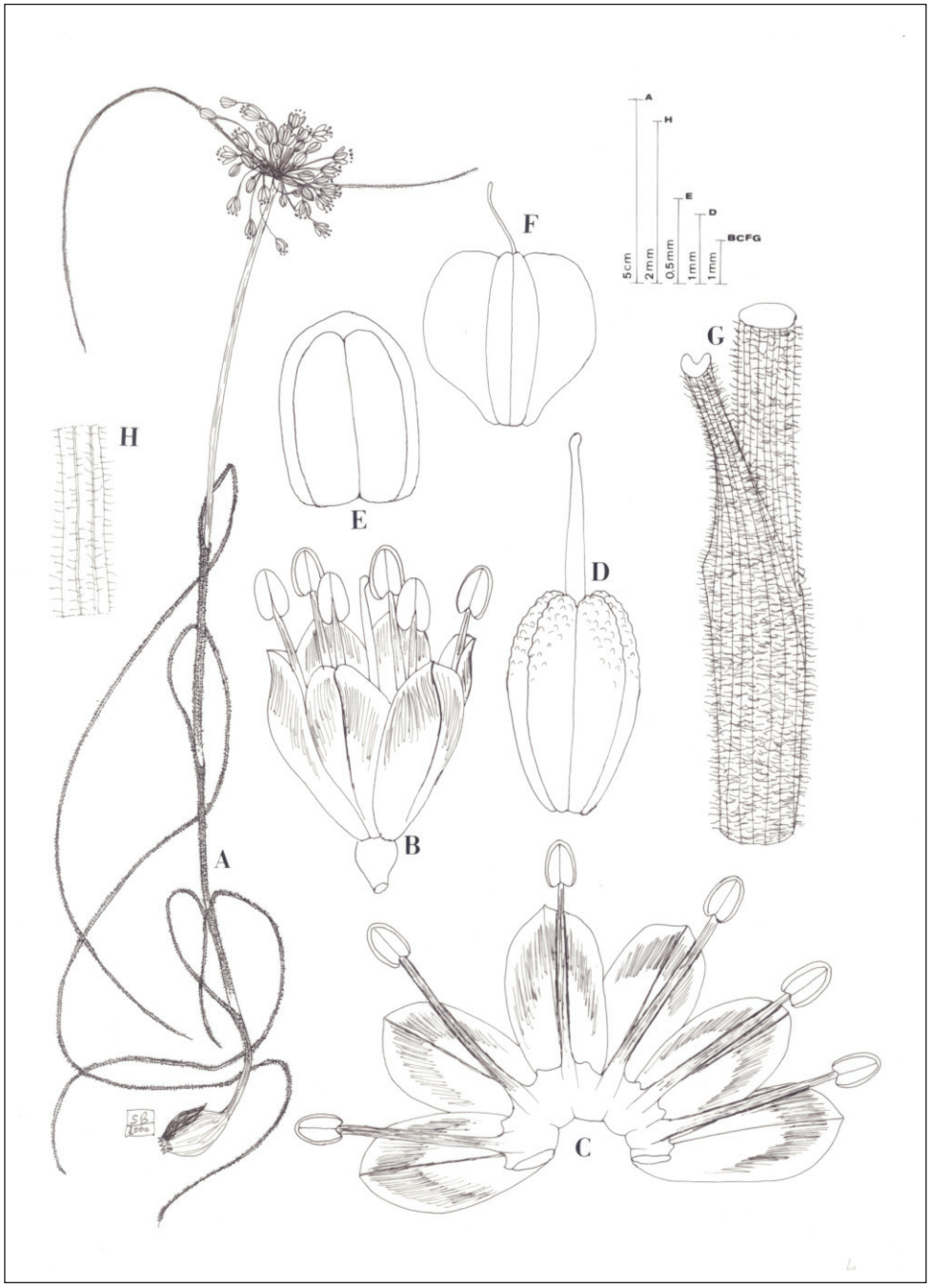

Fig. 6. *Allium hippocraticum* Brullo & Salmeri: **A.** Habit; **B.** flower; **C.** open perigon and stamens; **D.** ovary; **E.** anther; **F.** Capsule; **G.** indumentum of leaf sheaths; **H.** appendage of the spathe valve. (Drawing by S. Brullo from living plants of type locality).

8. *Allium abanticum* Brullo & Salmeri, spec. nova (Fig. 7)

Allio pythagorico similis, sed bulbi tunicis interioribus membranaceis, scapo breviore, foliis brevioribus, pilis valde brevioribus, inflorescentia plus compacta, spathae valvis brevioribus, tepalis angustioribus, viridibus, supra brunneo-purpuram striatis, obtusis apice, staminum filamentibus albis, longioribus, antheris brevioribus, ovario ellipsoideo-obovoideo, longiore, capsula obovoidea, maiore.

Type. Greece, Isola di Eubea, presso Marmaris lungo la costa rocciosa scistosa, 5.6.1992, *S. Brullo & P. Pavone s.n,* (Holo: CAT).

Bulb ovoid, 10-20 × 6-12 mm, with outer tunics fibrous, greyish-brown, the innermost ones membranaceous, pale brown. *Stem* erect, glabrous, 10-18 cm high, usually covered by the leaf sheaths for 1/2 - 2/3 of total length. *Leaves* 4, shorter than the inflorescence, totally covered by dense hairs, patent, 0.2-0.3 mm long, blade semicylindrical, 4-6 cm long, ribbed. *Inflorescence* expanded, more or less compact, 3-4 cm in diameter, with 15-30 flowers, on pedicels unequal, glabrous, 5-20 mm long. *Spathe* with 2 valves, opposite, erect, unequal, longer than the inflorescence, glabrous, the largest 7-nerved, 3-6 cm long, the smallest 5-nerved, 1.5-4 cm long. *Perigon* campanulate, 4-5 mm long, with tepals equal, elliptical, 1.6-2 mm wide, greenish, above striate with purplish-brown, midrib green, smooth and rounded at the apex. *Stamens* with simple filaments unequal, white, inners exserted from the perigon, 4-4.2 mm long, the outers usually shorter, 2-3.5 mm long, below connate with tepals into an annulus 1-1.2 mm high, provided with interstaminal teeth; anthers pale yellow, ovate, rounded at the apex, 0.7-0.8 × 0.7-0.8 mm. *Ovary* ellipsoid-obovoid, green, papillose above, 3-3.5 × 1.3-1.8 mm; style white, 0.8- 1 mm long. *Capsule* trivalved, obovoid, 4.8 × 3.2 mm.

Distribution and habitat. This species occurs along the low rocky south-western coast of the Euboea island between Marmaris and Karistos (Fig.3C). In these stands it grows in the clearings among the pulvinate dwarf shrubs of phryganas, xerophilous community widespread in this territory.

Karyology. The investigated population coming from Karistos shows a diploid chromosome complement with $2n = 2x = 16$: $12m + 2m^{sat} + 2msm$ (Fig. 17E). Its karyotype is characterized by seven metacentric pairs, one of which satellited on short arms, and 2 meta-submetacentric chromosomes (Fig. 18E).

Phenology. Flowering from late May to early June.

Etymology. The epithet comes from "*Abantes*", ancient tribe that inhabited the island of Euboea.

Taxonomic notes. *Allium abanticum* is well differentiated from the other species of the *A. hirtovaginum* group mainly for its small size (19-20 cm tall) and more compact inflorescence with very reduced spathe valves, features clearly also maintained in cultivated plants. For the glabrous spathe valves, unequal stamen filaments and occurrence of interstaminal teeth, it shows some relationships mainly with *A. pythagoricum*, while based on the type of leaf indumentum and the occurrence of interstaminal teeth it is rather similar to *A. hippocraticum*. Several relevant morphological differences separated it from both species.

Paratype. Greece, Isola di Eubea, litorale roccioso calcareo presso Karistos, 6.6.1992, *S. Brullo & P. Pavone s.n.* (CAT).

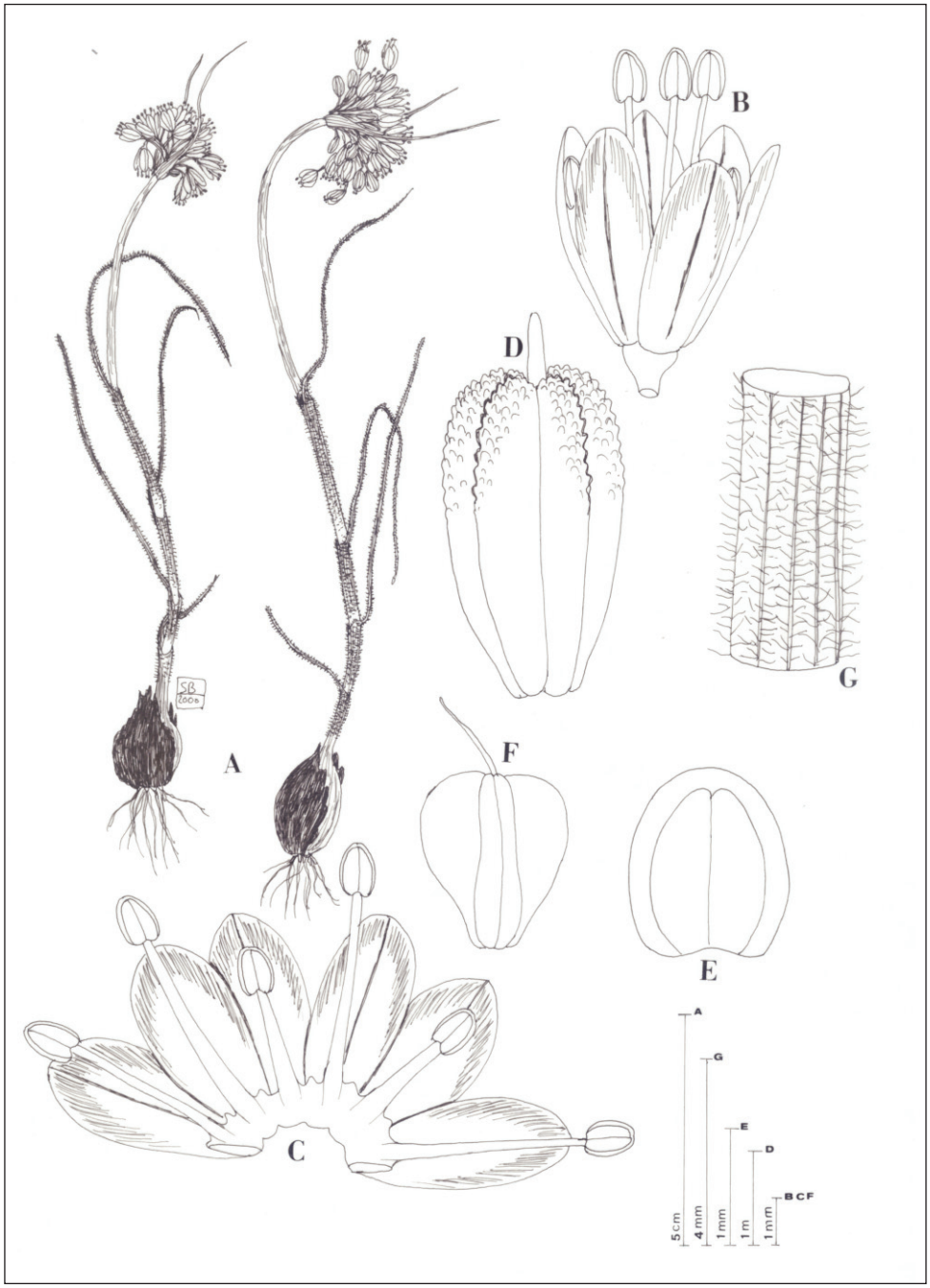

Fig. 7. *Allium abanticum* Brullo & Salmeri: **A.** Habit; **B.** flower; **C.** open perigon and stamens; **D.** ovary; **E.** anther; **F.** Capsule; **G.** indumentum of leaf sheaths. (Drawing by S. Brullo from living plants of type locality).

9. *Allium velutinum* Brullo & Salmeri, spec. nova (Fig. 8)

Allio pythagorico similis, sed bulbis minoribus, tunicis brunneolis, scapo longiore, pilis foliorum velutinis brevioribus, inflorescentia minore, spathae valvis brevioribus, tepalis longioribus, viridi-luteis, obtusis apice, staminum filamentibus subaequalibus, albis, longioribus, antheris luteis, longioribus, ovario ovoideo, laevi, capsula obovoidea, maiore.

Type. Greece, Peloponneso, sulle colline nei dintorni di Monenvasia, 5.6.1992, *S. Brullo & P. Pavone s.n.* (Holo: CAT).

Bulb ovoid, 10-15 × 6-10 mm, with outer tunics fibrous, pale brown, the innermost fibrous, straw-colored. *Stem* erect, glabrous, 30-50 cm high, usually covered by the leaf sheaths for 1/2 - 2/3 of total length. *Leaves* 5-6, shorter than the inflorescence, totally covered by dense velutinous indumentum with hairs patent, 0.05-0.1 mm long, blade flat, canaliculate, 10-18 cm long, ribbed. *Inflorescence* expanded, more or less compact, 2.5-4.5 cm in diameter, with 20-45 flowers, on pedicels unequal, glabrous, 8-25 mm long. *Spathe* with 2 valves, opposite, divaricate, unequal, longer than the inflorescence, glabrous, the largest 6-7-nerved, 7-10 cm long, the smallest 5-nerved, 3-5 cm long. *Perigon* campanulate, 4.5-5 mm long, with tepals equal, elliptical, 2-2.5 mm wide, greenish-yellow, above tinged with purple, midrib green, smooth and rounded at the apex. *Stamens* with simple filaments subequal, white, all exserted from the perigon, 5.5-6.5 mm long, below connate with tepals into an annulus 1-1.3 mm high, provided with short interstaminal teeth; anthers yellow, oblong, rounded at the apex, 1.2-1.3 × 0.8-0.9 mm. *Ovary* ovoid, green, smooth, 2-2.3 × 2; style white, 2-4 mm long. *Capsule* trivalved, obovoid, above tinged with violet, 3.6-3.8 × 4-4.2 mm.

Distribution and habitat. This species was collected in some localities of Peloponnisos and southern Attica, where it shows a fragmentary distribution with small populations (Fig. 3B). It occurs mainly in grasslands and phryganas on limestones.

Karyology. Unknown.

Phenology. Flowering from late May to early June.

Etymology. The epithet refers to the very minute leaf indumentum.

Taxonomic notes. Allium velutinum differs from the other species of the *A. hirtovaginum* group in some quite significant features, such as leaves with very minute and dense hairness, very long stamen filaments, ovary smooth and capsule tinged with violet. For the spathe valves glabrous and the occurrence of interstaminal teeth, it shows some relationships mainly with *A. pythagoricum* and *A. abanticun*, but several relevant morphological differences distinguished it from both species.

Paratypes. Greece, Peloponneso, dintorni di Korynthos nella phrygana, coltivato, 10.6.2003, *S. Brullo & S. Sciandrello s.n,* (CAT); Ibid., Kenkhemeni a Sud di Korinthos, coltivato, 10.6. 2003, *S. Brullo & S. Sciandrello s.n.* (CAT): Ibid., Attica, sito archeologico di Heraion nella peninsula di Perachora (Golfo di Corintho),10.6.2003, coltivato, *S. Brullo & S. Sciandrello s.n.* (CAT); Ibid., Lagonisi a Sud di Atene, lungo la costa rocciosa, 9.6.2003, coltivato, *S. Brullo & S. Sciandrello s.n.* (CAT).

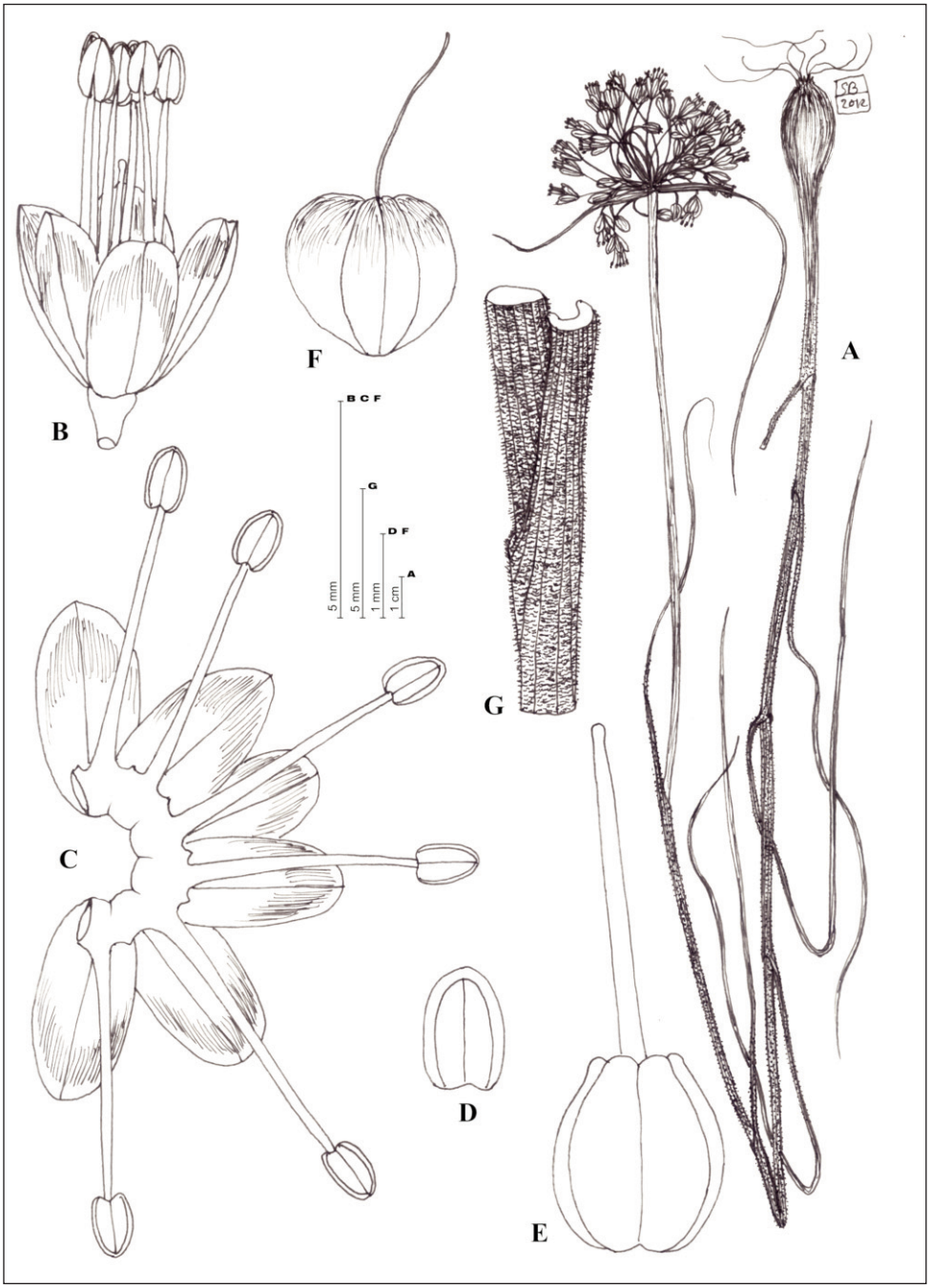

Fig. 8. *Allium velutinum* Brullo & Salmeri: **A.** Habit; **B.** flower; **C.** open perigon and stamens; **D.** ovary; **E.** anther; **F.** Capsule; **G.** indumentum of leaf sheaths. (Drawing by S. Brullo from living plants of type locality).

10. *Allium carium* Brullo & Salmeri, spec. nova (Fig. 9)

Allio abantico similis, sed bulbis ellipsoideis, tunicis exterioribus coriaceis, foliis longioribus, pilis subadpressis, longioribus, inflorescentia laxa, pedicellis longioribus, spathae valvis brevioribus, quam inflorescentia brevioribus vel subaequilongis subaequalibus, tepalis alboviridibus, supra purpuram striatis, exterioribus latioribus, staminum filamentibus longioribus, omnibus perigonio exsertibus, purpureis supra, sine interstaminalibus dentibus, antheris ellipticis, longioribus, ovario subgloboso, complanato, minore, capsula subglobosa, minore.

Type. Turkey, Anatolia sud-occidentale, dintorni di Koyceğiz a Nord di Fethyie, 21.6.1998, *S. Brullo & P. Pavone s.n.* (Holo: CAT).

Bulb ellipsoid, 12-18 × 8-13 mm, with outer tunics coriaceous, brownish, tinged with purple, the inner ones membranaceous, whitish. *Stem* erect, robust, glabrous, 12-18 cm high, usually covered by the leaf sheaths for 1/2 - 2/3 of total length. *Leaves* 4, shorter than the inflorescence, totally covered by dense hairs, subappressed, 0.5-1 mm long, blade flat, canaliculate, up to 10 cm long, ribbed. *Inflorescence* expanded, lax, 4-5 cm in diameter, with 25-35 flowers, on pedicels unequal, glabrous, 15-30 mm long. *Spathe* with 2 valves, opposite, erect, unequal, subequal or shorter than the inflorescence, glabrous, the largest 7-nerved, 2-3 cm long, the smallest 5-nerved, 1.5-2.5 cm long. *Perigon* campanulate, 4.5 mm long, with tepals equal, elliptical, the outers 2.2-2.5 mm wide, the inners 1.7-1.8 mm wide, greenish-white, above striate with purple, midrib green, smooth and rounded at the apex. *Stamens* with simple filaments subequal, all exserted from the perigon, 5.5-6 mm long, white in the lower part and purplish above, below connate with tepals into an annulus 0.9-1 mm high, without interstaminal teeth; anthers yellow, elliptical, rounded at the apex, 1.4 × 0.8 mm. *Ovary* subglobose, flattened, greenish-yellow, slightly papillose above, 1.7 × 2 mm; style white, 4 mm long. *Capsule* trivalved, subglobose, slightly stipitate, 4 × 3.8-4 mm.

Distribution and habitat. Allium carium was found in some localities of south-western Anatolia, as Koyceğiz near Fethyie and Sogut near Korkuteli (Fig. 2J). It is a very rare species growing in the clearings of the maquis.

Karyology. The investigated population coming from the type locality revealed a diploid chromosome complement with $2n = 2x = 16$: 10m + $4m^{sat}$ + 2msm (Fig. 17F). Its karyotype is characterized by seven metacentric pairs, two of which satellited on the short arms (one macrosatellited and the other one microsatellited), and 2 metasubmetacentric chromosomes (Fig. 18F).

Phenology. Flowering from late June to early July.

Etymology. The epithet derives from "Caria", ancient district of south-western Anatolia.

Taxonomic notes. For its small size and leaves shorter than the inflorescence *Allim carium* is morphologically quite similar to *A. abanticum*, but several features allow it to be differentiated from the latter. The most relevant differences are outer tunics coriaceous, leaves longer, covered by hairs subappressed and longer, inflorescence larger with pedicels longer, spathe valves subequal to shorter than inflorescence, tepals greenish-white,wider, stamen filaments longer and all exserted, above purplish, without interstaminal teeth, anthers longer, ovary smaller, subglobose and flattened, capsule smaller. The two species also differ in their phenology, since *A. carium* flowers one month later, and in the karyotype structure as *A.carium* shows an extra macrosatellited chromosome pair.

Paratype. Turkey, Anatolia sud-occidentale, dintorni di Sogut a Ovest di Korkuteli, 21.6.1998, *S. Brullo & P. Pavone s.n.* (Holo: CAT).

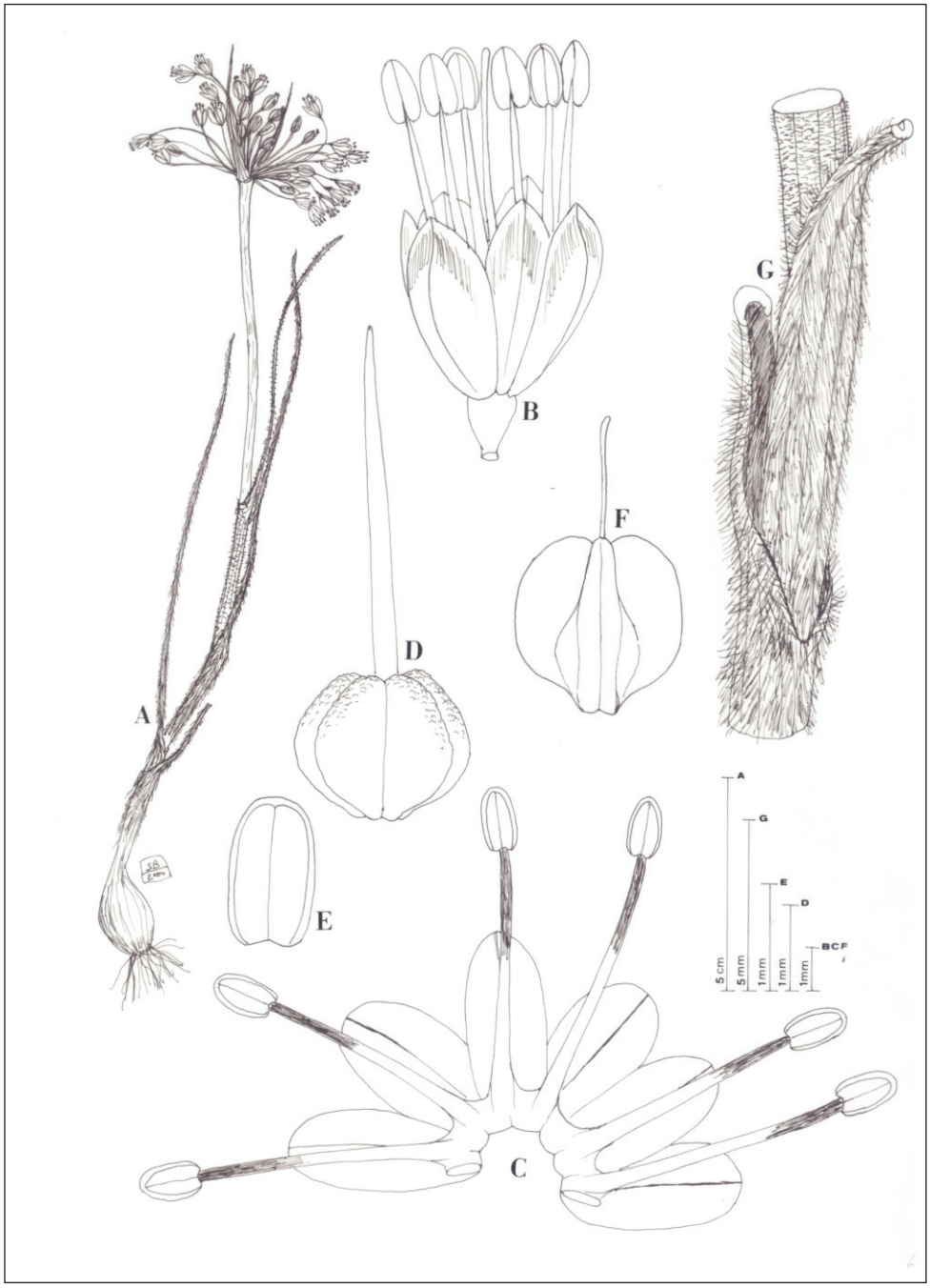

Fig. 9. *Allium carium* Brullo & Salmeri: **A.** Habit; **B.** flower; **C.** open perigon and stamens; **D.** ovary; **E.** anther; **F.** Capsule; **G.** indumentum of leaf sheaths. (Drawing by S. Brullo from living plants of type locality).

11. *Allium papillosum* Brullo & Salmeri, spec. nova (Fig. 10)

Allio cario similis, sed bulbo ovoideo, minore, tunicis exterioribus cinereis, scapo flexuoso, longiore, usque ad 1/2 longitudinem vaginis foliorum tecto, foliis longioribus, pilis patentibus, brevioribus, inflorescentia minore, pedicellis brevioribus, spathae valvis longioribus, quam inflorescentia longioribus, tepalis purpureis, angustoribus, staminum filamentibus brevioribus, antheris luteolis, ovario minore, omnino papilloso, capsula obovoidea.

Type. Turkey, Anatolia sud-occidentale, dintorni di Denizli, 2.7.1987, *S. Brullo*, *P. Pavone* & *P. Signorello s.n.* (Holo: CAT).

Bulb ellipsoid, 10-12 × 6-8 mm, with outer tunics coriaceous, greyish, the innermost ones membranaceous, whitish. *Stem* erect, flexuous, glabrous, 18-28 cm high, usually covered by the leaf sheaths up to 1/2 of total length. *Leaves* 4, shorter than the inflorescence, totally covered by dense hairs, patent, 0.1-0,3 mm long and 0.5-0.8 mm long in the throat, blade flat, canaliculate, up to 15 cm long, ribbed. *Inflorescence* expanded, lax, 4-5 cm in diameter, with 15-25 flowers, on pedicels unequal, glabrous, 12-20 mm long. *Spathe* with 2 valves, erect, opposite, unequal, longer than the inflorescence, glabrous, the largest 7-nerved, 3-7.5 cm long, the smallest 5-nerved, 2.5-3.5 cm long. *Perigon* campanulate, purplish, 4.5 mm long, with tepals equal, elliptical, the outers 2-2.2 mm wide, the inners 1.5-1.6 mm wide, midrib dark purple, smooth and rounded at the apex. *Stamens* with simple filaments subequal, all exserted from the perigon, 5-5.5 mm long, above purplish, below white , below connate with tepals into an annulus 0.7-0.8 mm high, without interstaminal teeth; anthers pale yellow, elliptical, rounded at the apex, 1.3 × 0.8 mm. *Ovary* subglobose, green, entirely papillose, 1.5 × 2 mm; style white, 1-1.2 mm long. *Capsule* trivalved, obovoid, 4 × 4 mm.

Distribution and habitat. Allium papillosum was collected in two stands of south-western Anatolia, such as the hills around Denizli and Kaklik near Nazilli (Fig. 2F). It is a very rare species growing in the clearings of the grasslands.

Karyology: Both investigated populations showed a diploid chromosome complement with $2n = 2x = 16$: $12m + 2m^{sat} + 2msm^{sat}$ (Fig. 17G). Its karyotype is characterized by 14 metacentric chromosomes, one pair provided with macrosatellited on short arms, and 2 metasubmetacentric chromosomes with well developped microsatellites on the short arms (Fig. 18G).

Phenology. Flowering from late June to early July.

Etymology. The epithet refers to ovary entirely covered by papillae.

Taxonomic notes. Allium papillosum shows closest affinity especially with *A. carium*, by sharing bulbs with outer tunic coriaceous, leaves shorter than the inflorescence, spathe valves erect, stamen filaments long exserted from the perigon and purplish above, anthers quite long and lack of interstaminal teeth. However, they differ in numerous morphological traits, since *A. papillosum* is characterized by bulbs ovoid, smaller, with outer tunics greyish, stem longer, flexuous, covered by the leaf sheaths max. 1/2 of total length, leaves longer, with hairs patent and shorter, inflorescence smaller, with shorter pedicels, spathe valves longer, exceeding the inflorescence, tepals purplish, narrower, stamen filaments shorter, anthers pale yellow, ovary smaller, entirely papillose, capsule obovoid. Conversely, *A. carium* is differentiated by a bulb ellipsoid, larger, with outer tunics brown, tinged with purplish, stem much shorter, robust, covered by the leaf sheaths up to 2/3 of total length, leaves shorter, with hairs subappressed and longer, inflorescence larger, with longer pedicels, spathe valves very shorter, not exceeding the inflorescence, tepals greenish-white, wider, stamen filaments longer, anthers yellow, ovary flattened, papillose only at the top, capsule globose.

Paratype. Turkey, Anatolia sud-occidentale, dintorni di Kaklik presso Nazilli, 24.6.1988, *S. Brullo*, *P. Pavone* & *P. Signorello s.n.* (CAT).

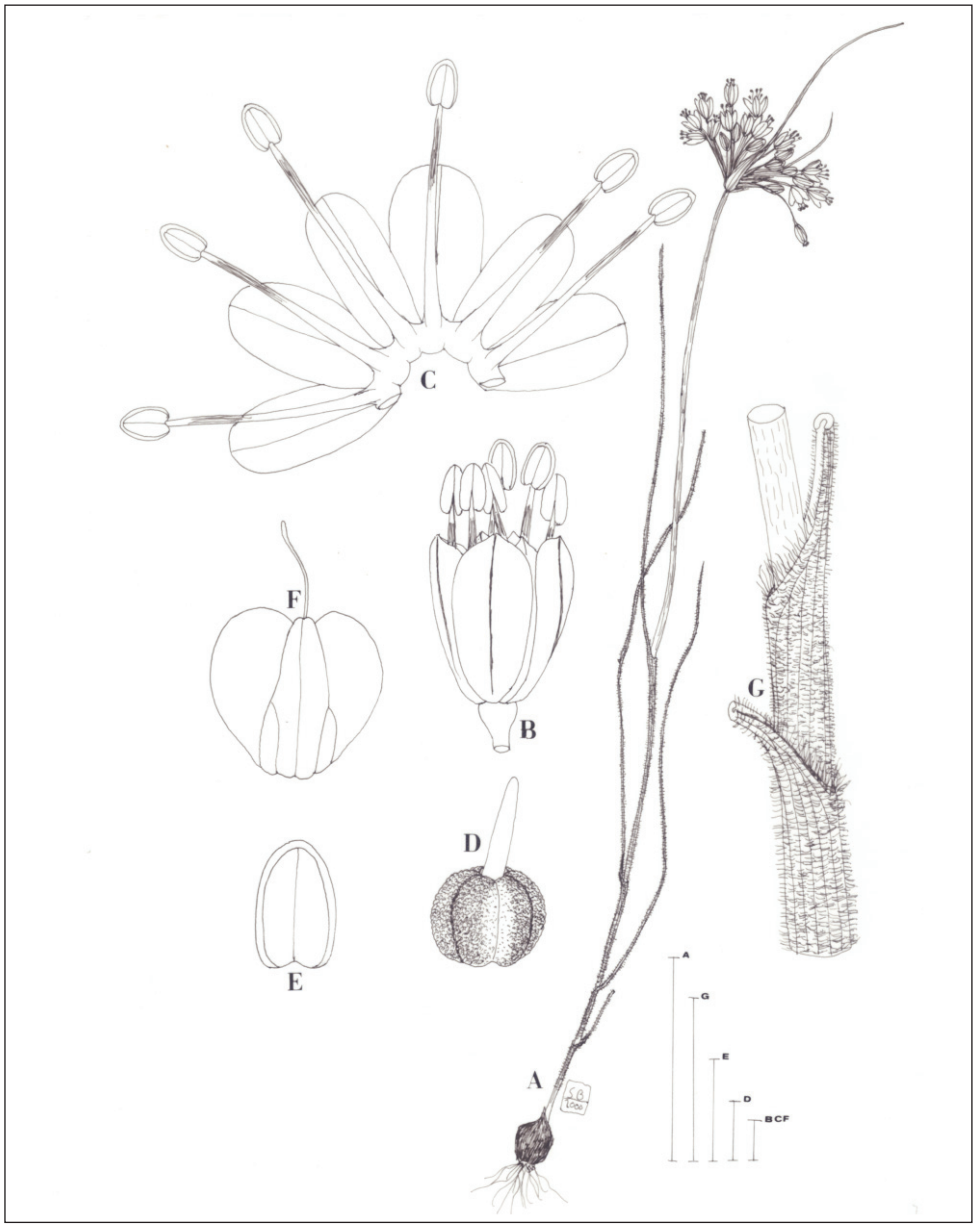

Fig. 10. *Allium papillosum* Brullo & Salmeri: **A.** Habit; **B.** flower; **C.** open perigon and stamens; **D.** ovary; **E.** anther; **F.** Capsule; **G.** indumentum of leaf sheaths. (Drawing by S. Brullo from living plants of type locality).

12. *Allium adenanthum* Brullo & Salmeri, spec. nova (Fig. 11)

Allio hirtovagino similis, sed bulbo ellipsoideo, tunicis exterioribus fibrosis, brunneo-cinereis, scapo flexuoso, longiore, piloso, foliis longioribus, inflorescentia majore, pedicellis longioribus, pilosis, spathae valvis, brevioribus, quam inflorescentia leviter longioribus, tepalis angustoribus, glandulis luteolis conspersis superficiem interiorem, staminum filamentibus omnibus exsertis, ovario majore, subgloboso-ovoideo.

Type. Turkey, Anatolia sud-occidentale, nei pressi di Göcek a Nord di Fethiye, 21.6.1998, *S. Brullo & P. Pavone* s.n. (Holo: CAT).

Bulb ellipsoid, 12-18 × 8-12 mm, with outer tunics fibrous, greyish-brown, the innermost ones membranaceous-fibrous, whitish. *Stem* erect, flexuous, hairy, 16-50 cm high, usually covered by the leaf sheaths for 1/3 - 1/2 of total length. *Leaves* 3-4, shorter than the inflorescence, totally covered by dense hairs, patent, 0.1-0,3 mm long and up to 0.6 mm long in the throat, blade semicylidrical, up to 25 cm long, ribbed. *Inflorescence* expanded, very lax , 6-8 cm in diameter, with 10-25(35) flowers, on pedicels unequal, densely hairy, 10-50 mm long. *Spathe* with 2 valves, unilateral, unequal, slightly longer than the inflorescence (rarely subequal), hairy in the appendages, the largest 6-7-nerved, 2-5 cm long, the smallest 5-nerved, 2.5-4 cm long. *Perigon* campanulate, greenish to purplish-pink. 4-5 mm long, with tepals equal, elliptical, sprinkled with numerous small yellowish glands on the inner surface, the outers 1.8-2 mm wide, the inners 1.5-1.8 mm wide, midrib greenish-purple, smooth and rounded at the apex. *Stamens* with simple filaments subequal, all exserted from the perigon, 4.5-5.5 mm long, above shortly purplish, below white, below connate with tepals into an annulus 0.6-0.8 mm high, without interstaminal teeth; anthers yellow, elliptical, rounded at the apex, 1.4-1.5 × 0.7-0.8 mm. *Ovary* globose-ovoid, green, above and dorsally papillose, 1.7-2 × 2-2.2 mm; style white, 1.5-2.5 mm long. *Capsule* trivalved, obovoid, 4 × 4-4.5 mm.

Distribution and habitat. *Allium adenanthum* was collected in four localities of south-western Anatolia, such as the hills around Göcek near Fethiye, Canalikoy near Mugla, Marmaris and Sandras Dağ (Fig. 2I). In these places it usually grows in the clearings of grasslands and maquis.

Karyology. All investigated populations showed a diploid chromosome complement with $2n = 2x = 16$: $12m + 2m^{sat} + 2msm$ (Fig. 17H). The karyotypes are characterized by more or less metacentric chromosomes, with two pairs actually tending towards the "sms" type (arm ratio around 1.30), one of which always microsatellited on the short arms (Fig. 18H). Differences among populations only regard the evidence of up two extra pairs of microsatellited chromosomes in samples from Sandras Dağ and Mugla.

Phenology. Flowering from June to early July.

Etymology. The epithet refers to the tepals sprinkled with numerous small glands on the inner surface.

Taxonomic notes. Morphologically, *Allium adenanthum* markedly differs from all other species belonging to the group of *A. hirtovaginum* in having stamen filaments densely hairy and tepals with minute glands on the inner surface. Nevertheless, it shows some resemblance mainly to *A. hirtovaginum s.str.* especially in sharing the stem covered by the leaf sheaths up to 1/2 of total length, leaves with minute indumentum, spathe valves unilateral, with appendages hairy, tepals usually purplish-pink and stamen filaments above tinged with purple. Many significant features differentiate effectively the two species. Among these, it is particularly relevant the occurrence in *A. hirtovaginum* of outer bulb tunics coriaceous and dark brown, stem rigid, glabrous, shorter, inflorescence smaller, with pedicels shorter and glabrous, spathe valves longer, tepals eglandular, ovary subglobose.

Paratypes. Turkey, Anatolia sud-occidentale, dintorni di Canalikoy presso Mugla, 20.6.1998, *S. Brullo* & *P. Pavone s.n.* (CAT); Ibid., dintorni di Marmaris, 21.6.1998, *S. Brullo* & *P. Pavone s.n*. (CAT); Ibid. alla base di Sandras Dagi, montagna a Est di Köyceğiz, 2.6.1988, *S. Brullo*, *P. Pavone* & *P. Signorello s.n.* (CAT).

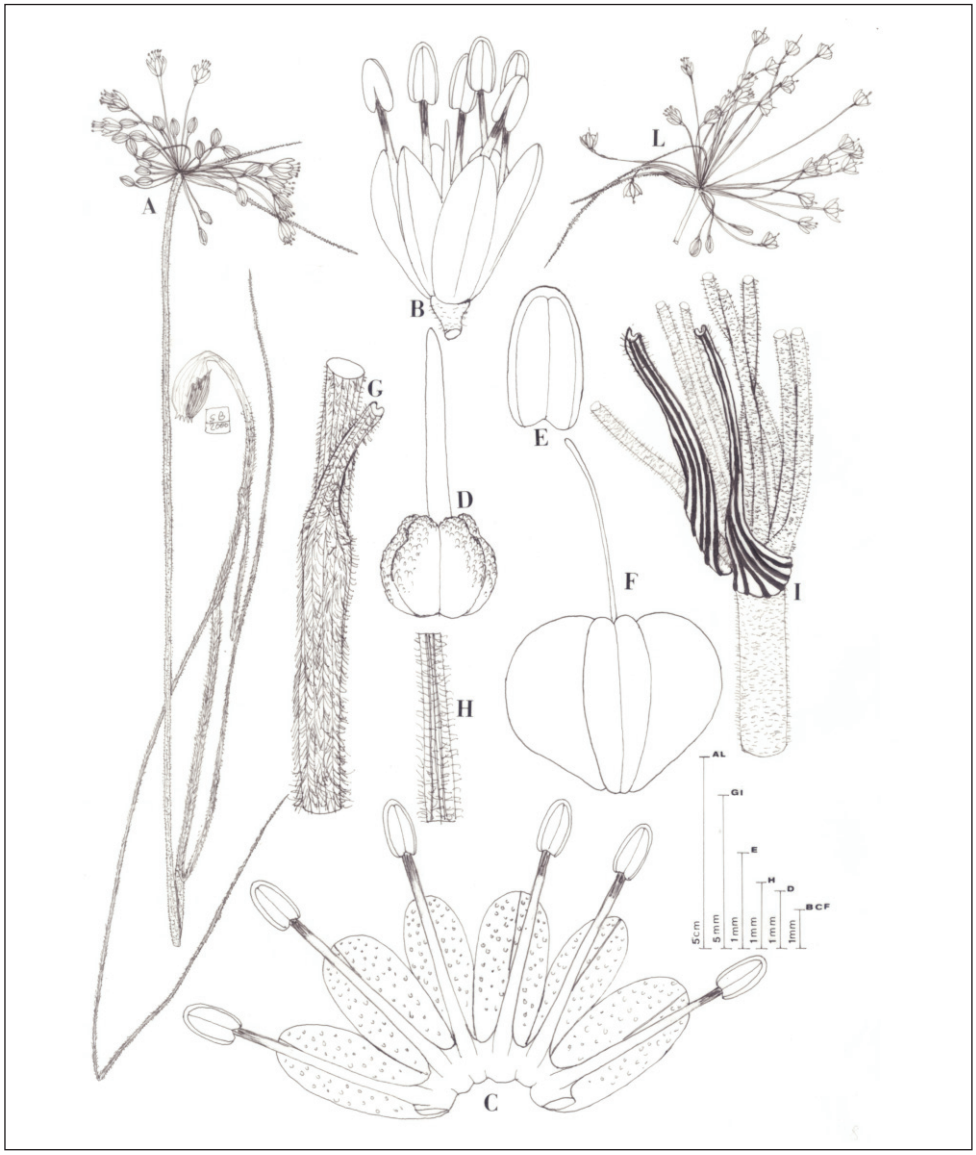

Fig. 11. *Allium adenanthum* Brullo & Salmeri: **A.** Habit; **B.** flower; **C.** open perigon and stamens; **D.** ovary; **E.** anther; **F.** Capsule; **G.** indumentum of leaf sheaths. **H**. appendage of the spathe valve; **I.** base of inflorescence with spate valves and pedicels; **L.** Inflorescence. (Drawing by S. Brullo from living plants of type locality).

13. *Allium smyrnaeum* Brullo & Salmeri, spec. nova (Fig. 12)

Allio hirtovagino similis, sed bulbo majore, tunicis fibrosis, exterioribus brunneis vel brunneo-rubentis, scapo longiore, foliis longioribus, pilis longioribus, inflorescentia fastigiata, compacta, pedicellis longioribus, spathae valvis glabris, tepalis luteo-viridibus, purpuram suffusis, staminum filamentibus omnibus exsertis, albis, annulo dentibus interstaminalibus praedito, antheris luteolis, brevioribus, ovario majore, obovoideo-ellipsoideo, stipitato, supra angulato, capsula majore.

Type. Turkey, Anatolia occidentale, tra Emiralem e Menemer presso Izmir, 19.6.1998, *S. Brullo & P. Pavone s.n.* (Holo: CAT).

Bulb ovoid, 15-22 × 10-16 mm, with outer tunics fibrous, brown to reddish-brown, the innermost ones fibrous, yellowish. *Stem* erect, rigid, glabrous, 20-45 cm high, usually covered by the leaf sheaths up to 1/2 of total length. *Leaves* 3-4, shorter than the inflorescence, totally covered by dense hairs, patent, 0.4-0.6 mm long, blade semicylindrical, up to 20 cm long, ribbed. *Inflorescence* fastigiate, compact, 2-6 cm long and 1.5-4 cm wide, with 20-80 flowers, on pedicels unequal, glabrous, 12-60 mm long. *Spathe* with 2 valves, erect, unilateral, unequal, longer than the inflorescence, glabrous, the largest 7-9-nerved, 6-12 cm long, the smallest 5-7-nerved, 5-7 cm long. *Perigon* campanulate, greenish-yellow, tinged with purplish, 5 mm long, with tepals equal, elliptical, the outers 2-2.5 mm wide, the inners 2 mm wide, midbrib green, smooth and slightly apiculate at the apex. *Stamens* with simple filaments subequal, all exserted from the perigon, 4.5-5.5 mm long, white , below connate with tepals into an annulus 1-1.1 mm high, with interstaminal teeth; anthers pale yellow, elliptical, rounded at the apex, 1 × 0.6 mm. *Ovary* obovoid-ellipsoid, strongly angled at the apex, flattened and dorsally papillose above, green, 3.5-4 × 2 mm; style white, 3-3.5 mm long. *Capsule* trivalved, obovoid, stipitate below, 4.8 × 4.5 mm.

Distribution and habitat. Populations of this species were collected in several stands of western Anatolia, mainly in the Izmir district, such as near Emiralem, Menemer, Selimiye and Labadadağı (Fig. 2B). In this area it showed a very scattered distribution, being especially localized on limestone rocky outcrops and grasslands.

Karyology. The investigated population coming from the type locality shows a diploid chromosome complement with $2n = 2x = 16$: 12m + 4msm (Fig. 17I). The karyotype is characterized by 12 metacentric and 4 metasubmetacentric chromosomes; no evident satellited chromosomes were detected (Fig. 18I).

Phenology. Flowering from late June to early July.

Etymology. The epithet is based on "Smyrna", old name of Izmir, modern Turkish city of western Anatolia.

Taxonomic notes. Allium smyrnaeum is well differentiated from the other species of this group mainly in having inflorescence fastigiate and quite compact, with spathe valves strictly unilateral and almost adherent, whilst in the other ones the inflorescence is generally expanded and loose, with spathe valves opposite and more or less divaricate, or sometimes unilateral but well spaced. Another peculiarity of this species is the ovary strongly angled and flattened at the apex, whereas it is always blunt and rounded in all other species. For the occurrence of spathe valves erect and unilateral, *A. smyrnaeum* shows some relationships with *A. hirtovaginum* s. str., *A. abanticum*, *A. carium*, *A. papillosum* and *A. adenanthum*, from which, however, it differs in several diacritical features.

Paratypes. Turkey, Anatolia occidentale, dintorni di Emiralem presso Izmir, 23.6.1998, *S. Brullo & P. Pavone s.n.* (CAT); Ibid., incolti presso il sito archeologico di Euromus (Selimiye),

20.6.1998, *S. Brullo* & *P. Pavone s.n.* (CAT); Ibid, Labadadağı presso Milas, 20.6.1998, *S. Brullo* & *P. Pavone s.n.* (CAT).

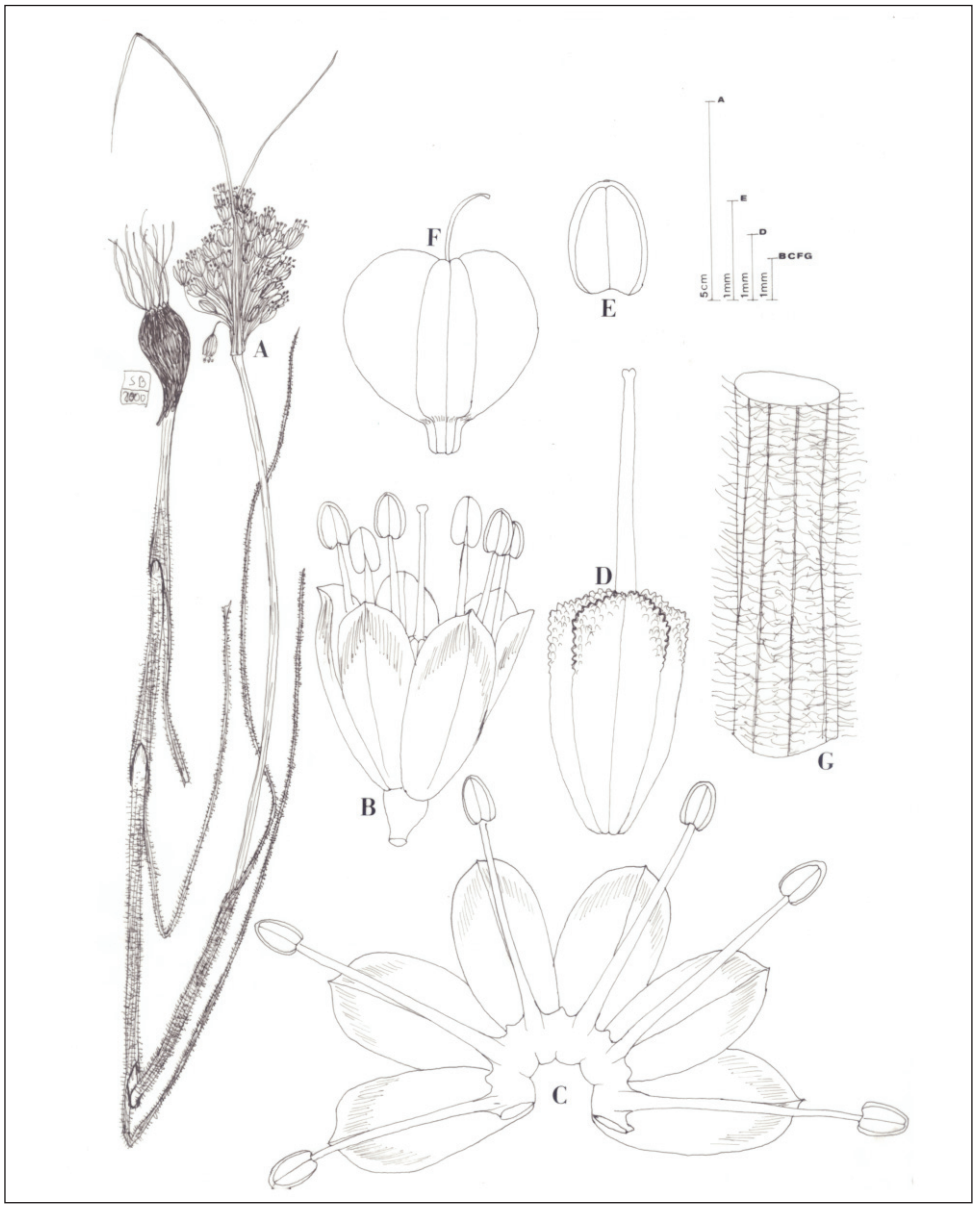

Fig. 12. *Allium smyrnaeum* Brullo & Salmeri: **A.** Habit; **B.** flower; **C.** open perigon and stamens; **D.** ovary; **E.** anther; **F.** Capsule; **G.** indumentum of leaf sheaths. (Drawing by S. Brullo from living plants of type locality).

14. *Allium trichospathum* Brullo & Salmeri, spec. nova (Fig. 13)

Allio hirtovagino similis, sed bulbi tunicis fibrosis, brunneolis, scapo longiore, foliis longioribus, pilis longioribus, subadpressis, inflorescentia majore, cum plures flores, pedicellis plerumque longioribus, spathae valvis oppositis, longioribus, appendicibus longe ciliatis, tepalis luteo-viridibus, brunneum suffusis, staminum filamentibus albis, longioribus, annulo interstaminalibus dentibus praedito, antheris luteolis, brevioribus, ovario majore, obovoideo-ellipsoideo, stipitato, supra leviter angulato, capsula majore.

Type. Turkey, Anatolia occidentale, Manisa Dağ montagna a Nord-Est di Izmir, su depositi sabbiosi, 28.6.1987, *S. Brullo*, *P. Pavone* & *P. Signorello s.n.* (Holo: CAT).

Bulb ovoid, 12-16 × 8-12 mm, with tunics fibrous, pale brown. *Stem* erect, rigid, robust, glabrous, 20-45 cm high, usually covered by the leaf sheaths up to 1/2 of total length. *Leaves* 3-4, shorter than the inflorescence, totally covered by dense hairs, subappressed, 0.5-0,7 mm long, blade semicylindrical, up to 20 cm long, ribbed. *Inflorescence* expanded, lax, 6-7 cm in diameter, with 35-50 flowers, on pedicels unequal, glabrous, 15-45 mm long. *Spathe* with 2 valves, erect, opposite, unequal, longer than the inflorescence, long and densely ciliate in the appendages, the largest 7-nerved, 10-16 cm long, the smallest 5-nerved, 8-12 cm long. *Perigon* campanulate, greenish-yellow, tinged with brown, 5 mm long, with tepals equal, elliptical, 2 mm wide, midrib green, smooth and apiculate at the apex. *Stamens* with simple filaments, white, the outers included, with filaments 1.5-2 mm long, the inners with filaments exserted from the perigon, 3-3.5 mm long , below connate with tepals into an annulus 0.7-0.9 mm high, with interstaminal teeth; anthers pale yellow, elliptical, rounded at the apex, 1.1-1.3 × 0.6-0.8 mm. *Ovary* ovoid-ellipsoid, slightly angled and flattened at the apex, papillose above, green, 3 × 1.8-2 mm; style white, 0.5 mm long. *Capsule* trivalved, obovoid, stipitate below, 5 × 4 mm.

Distribution and habitat. This species was collected in two mountain stands of western Anatolia, on Manisa Dağ and Sandras Dağ (Fig. 2E). In these places it grows exclusively on sandy substrata within grasslands.

Karyology. The two investigated populations coming from Sandras Dağ and Manisa Dağ show a diploid chromosome complement with $2n = 2x = 16$ (Fig. 17J,K). The karyotype is characterized by more or less metacentric, with 2 pairs of metasubmetacentric type (arm ratio exceeding 1.30), one of which satellited on the short arm (Fig. 18J, K). Difference among populations regard the occurrence of macrosatellites in the smallest metacentric pair of samples from Sandras Dağ, which were not detected in the other investigated population.

Phenology. Flowering from late June to early July.

Etymology. The epithet refers to the spathe valves with appendages covered by dense hairs.

Taxonomic notes. *Allium trichospathum* shows a certain similarity with *A. hirtovaginum* s. str. mainly for the habit, leaf indumentum, spathe valves and some flower characters, but markedly differs in having bulb tunics fibrous, stem usually much more developed and robust, leaf hairs longer and appressed, richer inflorescence, with pedicels longer, spathe valves opposite and longer, tepals greenish-yellow, stamen filaments white, occurrence of interstaminal teeth, anthers smaller, ovary much larger, elongated and angulate above, capsule larger. Besides, for its habit and some other features such as the hairiness of leaf and spathe valves, tepal colour and occurrence of interstaminal teeth, this species seems to have some taxonomic relation with *A. rhodopeum* Velen., species distributed in the Balkans (Brullo & al. 1998). This last species, however, is well differentiated from *A. trichospathum* in having the stamens fully included into the perigon, a typical feature of another species group of *Allium* of the Sect. *Codonoprasum*, e.i. *A. paniculatum* L. *s.l.*

Paratype. Turkey, Anatolia sud-occidentale, Sandras Dağ a Est di Mugla, su sabbie scistose, 26.6.1988, *S. Brullo, P. Pavone & P. Signorello s.n.* (CAT).

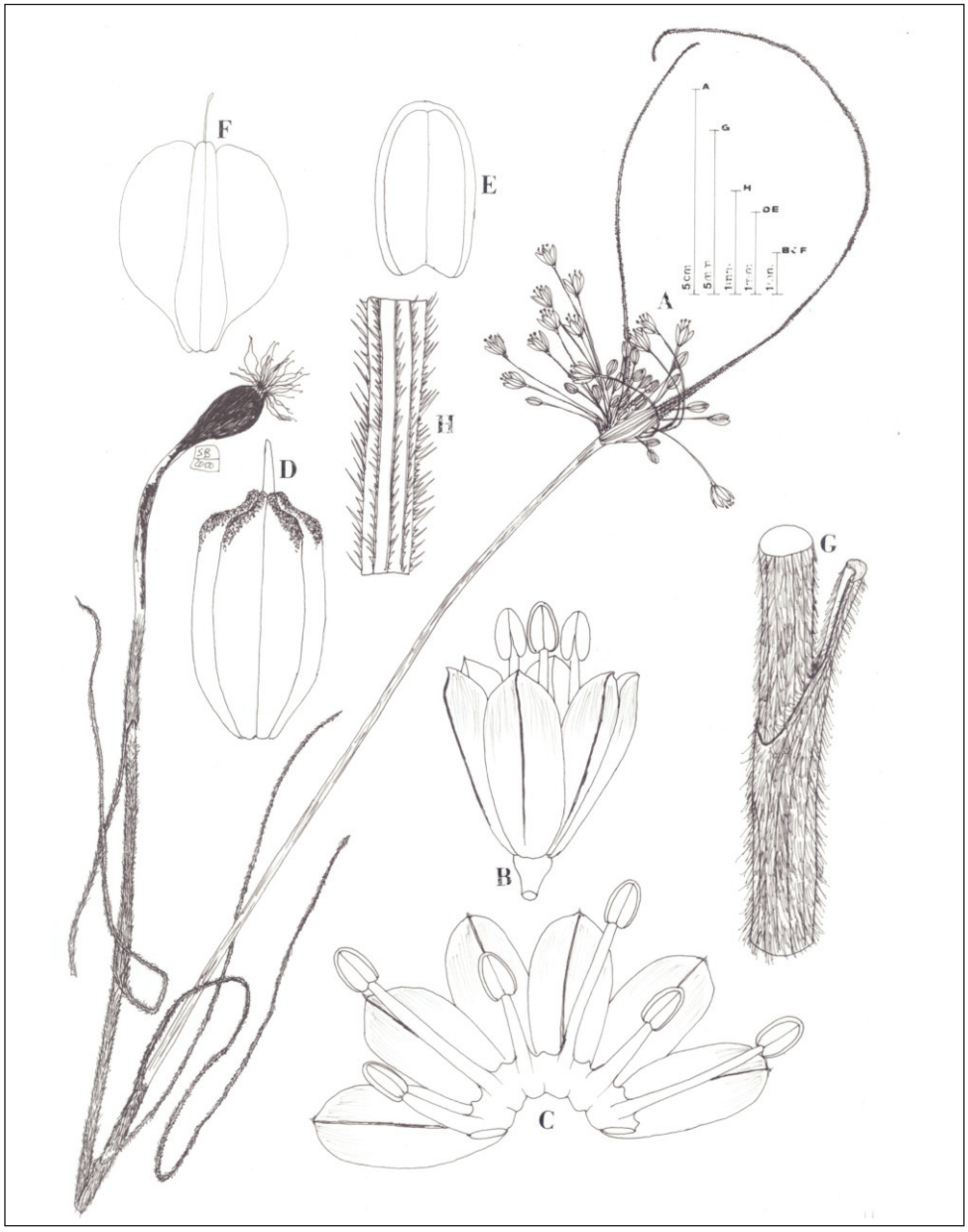

Fig. 13. *Allium trichospathum* Brullo & Salmeri: **A.** Habit; **B.** flower; **C.** open perigon and stamens; **D.** ovary; **E.** anther; **F.** Capsule; **G.** indumentum of leaf sheaths; **H**. appendage of the spathe valve. (Drawing by S. Brullo from living plants of type locality).

15. *Allium pavonianum* Brullo & Salmeri, spec. nova (Fig. 14)

Allio smyrnaeo similis, sed bulbi tunicis exterioribus fibrosis, brunneolis, scapo longiore, foliis pilis foliorum brevioribus, inflorescentia majore, pedicellis plerumque longioribus, spathae valvis oppositis, plerumque longioribus, tepalis brevioribus, brunneum suffusis, rotundatis apice, staminum filamentibus brevioribus, omnino purpureum soffusis, annulo sine interstaminalibus dentibus, ovario minore, non stipitato, supra leviter angulato, capsula minore, subglobosa, complanata.

Type. Turkey, Anatolia occidentale, Beidag presso Nazilli,, 26.6.1987, *S. Brullo*, *P. Pavone* & *P. Signorello s.n.* (Holo: CAT).

Bulb ovoid, 16-20 × 12-15 mm, with outer tunics fibrous, pale brown, the inners membranaceous, whitish. *Stem* erect, rigid, very robust, glabrous, 35-60 cm high, usually covered by the leaf sheaths 1/3-1/2 of total length. *Leaves* 3-4, shorter than the inflorescence, totally covered by dense hairs, patent, 0.1-0.3 mm long, blade semicylindrical, up to 20 cm long, ribbed. *Inflorescence* fastigiate, compact, 3-6 cm long, with 50-100 flowers, on pedicels unequal, glabrous, 10-55 mm long. *Spathe* with 2 valves erect, opposite, unequal, longer than the inflorescence, glabrous, the largest 7-nerved, 6-18 cm long, the smallest 5-nerved, 3-10 cm long. *Perigon* campanulate, greenish-yellow, tinged with brown, 4.3-4.5 mm long, with tepals equal, oblong, 2-2.2 mm wide, midrib green, smooth and rounded at the apex. *Stamens* with simple filaments, completely tinged with purplish, subequal, all exserted from the perigon, 3.7-4 mm long,, below connate with tepals into an annulus 0.5-0.6 mm high, no interstaminal teeth; anthers pale yellow, elliptical, rounded at the apex, 1-1.2 × 0.6-0.7 mm. *Ovary* obovoid-ellipsoid, slightly angled and flattened at the apex, dorsally papillose above, green, 3 × 2 mm; style white, 3 mm long. *Capsule* trivalved, subglobose, flattened, 4 × 3 mm.

Distribution and habitat. This species occurs in some submountain stands near Nazilli in central-western Anatolia (Fig. 2G), where it grows in grasslands and in the clearings of the scrublands.

Karyology. Unknown.

Phenology. Flowering from late June to early July.

Etymology. The species is named in honour of our colleague and friend Pietro Pavone, botanist at Catania University, specialist in the cytotaxonomy of bulbous plants.

Taxonomic notes. Due to its big size, leaf indumentum, inflorescence fastigiate and many-flowered, stamens all exserted from the perigon and ovary well developed, *Allium pavonianum* shows closer relationships mainly with *A. smyrnaeum*, from which it differs in several features regarding mainly the bulb tunics, spathe valves, the flowers and fruit. The most relevant differences are the occurrence in *A. pavonianum* of innermost bulb tunics membranaceous, stem more developed, leaves with shorter hairs, pedicels usually longer, spathe valves opposite, tepals shorter, stamen filaments shorter and tinged with purplish, annulus without interstaminal teeth, ovary shorter, capsule smaller, subglobose and flattened.

Paratype. Turkey, Anatolia occidentale, Kartiz Dag (Nazilli), 26.6.1987, *S. Brullo, P. Pavone & P. Signorello s.n.* (CAT).

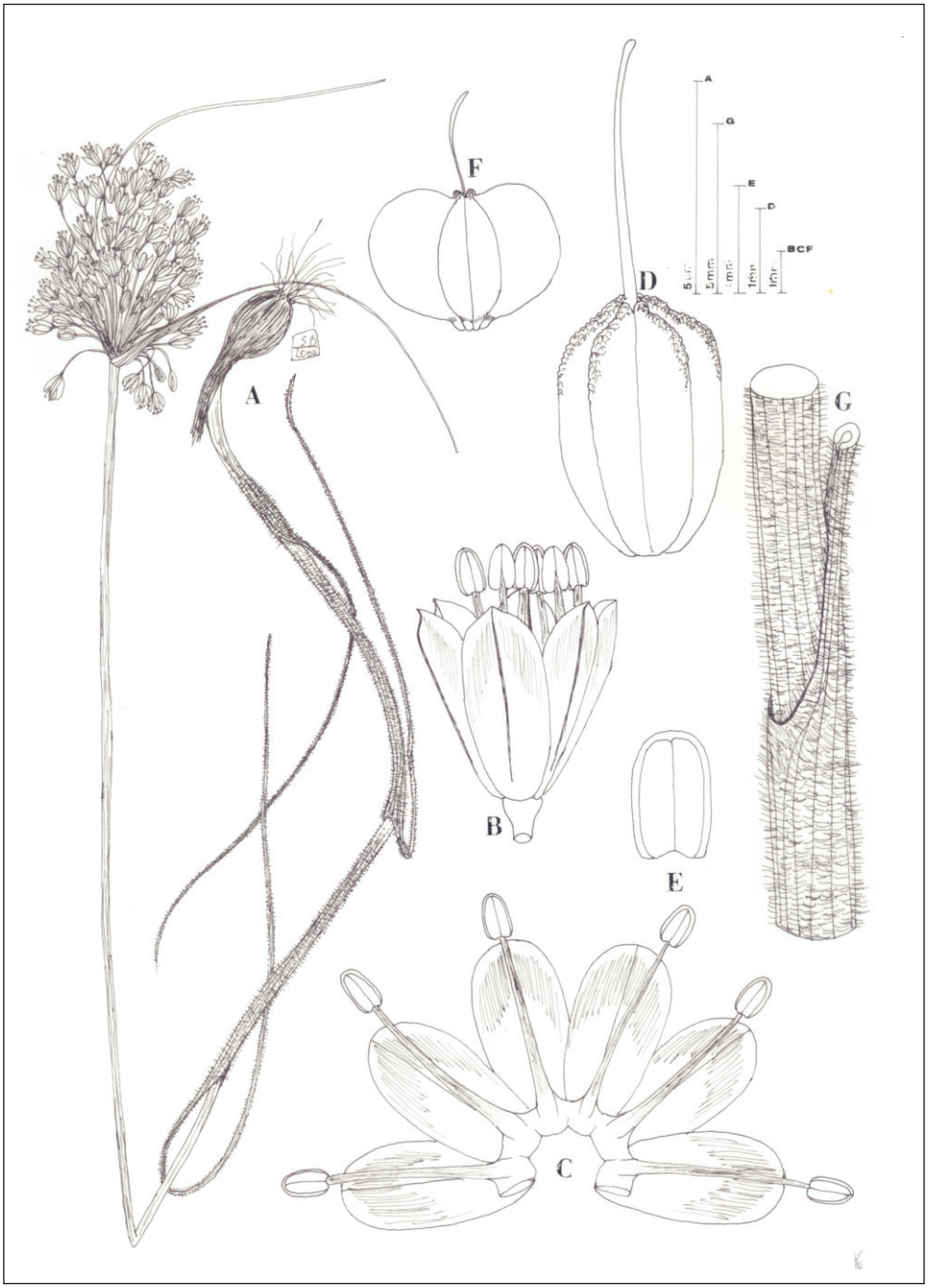

Fig. 14. *Allium pavonianum* Brullo & Salmeri: **A.** Habit; **B.** flower; **C.** open perigon and stamens; **D.** ovary; **E.** anther; **F.** Capsule; **G.** indumentum of leaf sheaths. (Drawing by S. Brullo from living plants of type locality)

16. *Allium denticulatum* Brullo & Salmeri, spec. nova (Fig. 15)

Allio papilloso similis, sed bulbo ovoideo, minore, tunicis fibrosis, scapo breviore, 1/2-2/3 longitudinem vaginis foliorum tecto, foliis 3, brevioribus, secum costas minute denticulatis et pilosis, inflorescentia minore, tepalis longioribus, albo-luteis, interioribus latioribus, staminum filamentibus albidis, antheris longioribus, ovario majore, ovoideo, laevi, stylo longiore, capsula subglobosa, majore.

Type. Turkey, Anatolia occidentale, Kizilkadag (Korkuteli), 21.6.1998, *S. Brullo & P. Pavone s.n.,* (Holo: CAT).

Bulb ovoid, 6-10 × 5-6 mm, with outer tunics fibrous, greyish, the innermost ones fibrous, whitish. *Stem* erect, flexuous, glabrous, 10-20 cm high, usually covered by the leaf sheaths 1/2-2/3 of total length. *Leaves* 3, subequal to shorter than the inflorescence, totally covered along the ribs by minute teeth and hairs, much less than 1 mm long, blade semicylindrical, canaliculate, up to 10 cm long, ribbed. *Inflorescence* expanded, lax, 2.5-4 cm in diameter, with 10-20 flowers, on pedicels unequal, glabrous, 5-20 mm long. *Spathe* with 2 valves, erect, opposite, unequal, longer than the inflorescence, glabrous, the largest 7-nerved, 2.5-6 cm long, the smallest 5-nerved, 2-3 cm long. *Perigon* campanulate, whitish-yellow, 4,8-5 mm long, with tepals subequal, elliptical, smooth and somewhat obtuse at the apex, the outers 2.2 mm wide, the inners 2 mm wide, midrib green. *Stamens* with simple filaments subequal, all exserted from the perigon, 4.5-5.5 mm long, white, below connate with tepals into an annulus 0.8-0.9 mm high, without interstaminal teeth; anthers pale yellow, elliptical, rounded at the apex, 1.7-1.8 × 0.8 mm. *Ovary* ovoid, greenish-yellow, smooth, 1.8-2 × 2-2.2 mm; style white, 2-3 mm long. *Capsule* trivalved, subglobose, 4.5 × 4.5-4.7 mm.

Distribution and habitat. *Allium denticulatum* occurs on Kizilkadag mountain near Korkuteli (western Anatolia), where grows in the clearings of the maquis (Fig. 2K). This species appear to be very rare and localized.

Karyology. Unknown.

Phenology. Flowering from late June to early July.

Etymology. The specific epithet refers to the leaves minutely denticulate.

Taxonomic notes. Allium denticulatum differs markedly from the other species of the *A. hirtovaginum* group for the leaf indumentum, since the leaves are not covered with dense and more or less developed hairs, but they are minutely hairy and denticulate along the ribs. For this peculiarity, it seems to have an intermediate taxonomic position between the typical species of *A. hirtovaginum* group, which have hairy leaves, and those of *A. staminеum* group, which are instead tipically hairless (see Brullo & al. 2007). Currently, due to its hairiness, although quite inconspicuous, and lacking further data supporting a different arrangement, we consider more appropriate to include this species in the *A. hirtovaginum* group. Within this group, *A. denticulatum* shows a certain affinity especially with *A. papillosum*, since both share a stem slender and flexuous, spathe valves erect, opposite and few developed, all stamens exserted from the perigon, no interstaminal teeth and ovary quite small. Nevertheless, in addition to the leaf indumentum, *A. denticulatum* is well differentiated in having a smaller size, bulb ovoid and smaller, with tunics fibrous, stem covered by the leaf sheaths up to 2/3 of its length, leaves 3, inflorescence smaller, tepals whitish-yellow, longer, stamen filaments white, anthers longer, ovary smooth, stile longer, capsule subglobose, larger.

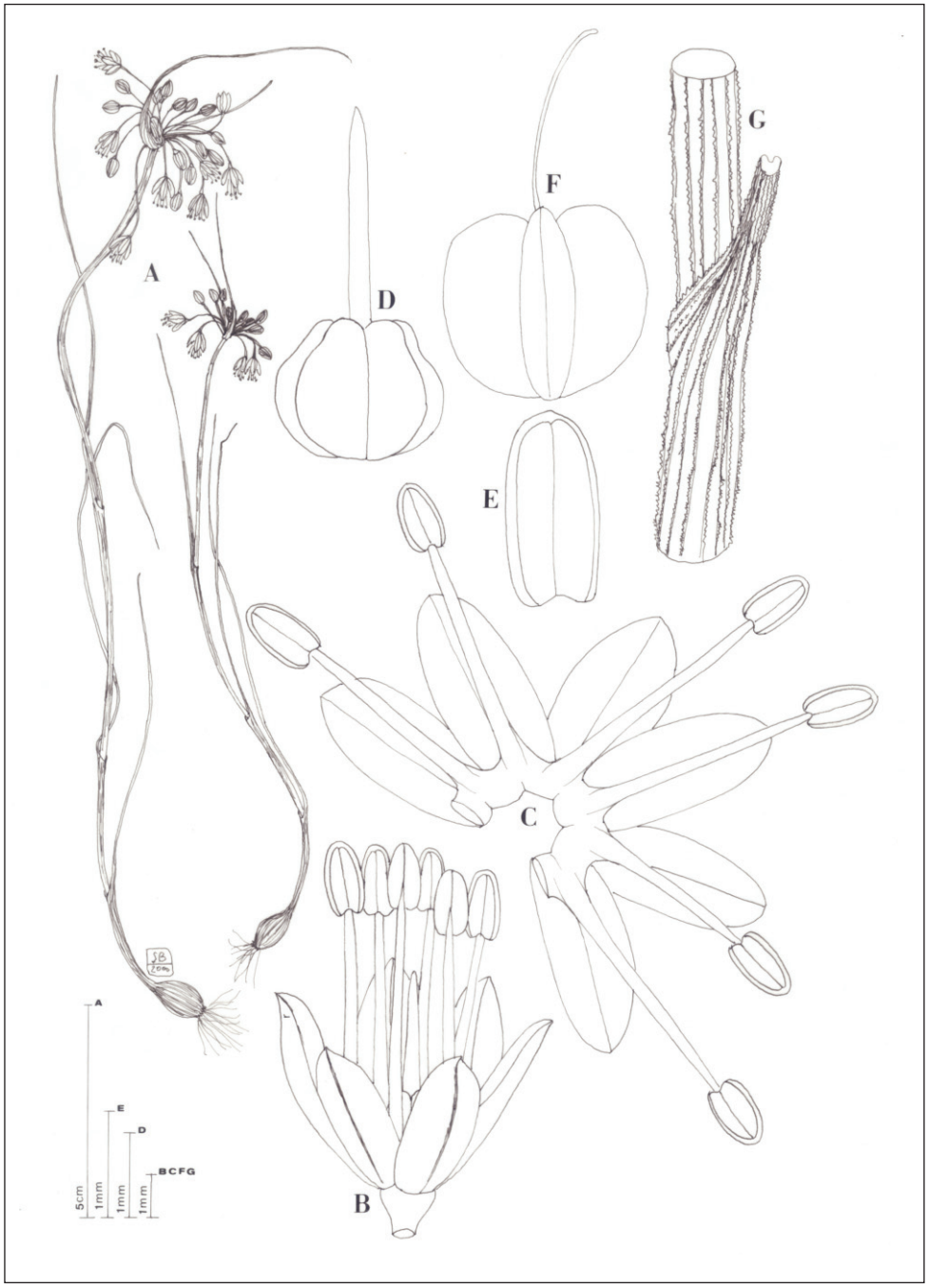

Fig. 15. *Allium denticulatum* Brullo & Salmeri: **A.** Habit; **B.** flower; **C.** open perigon and stamens; **D.** ovary; **E.** anther; **F.** Capsule; **G.** indumentum of leaf sheaths. (Drawing by S. Brullo from living plants of type locality).

17. *Allium compactatum* Brullo & Salmeri, spec. nova (Fig. 16)

Allio denticulato similis, sed bulbis saepe aggregatis, majoribus, scapo robusto, longiore, foliis longioribus, inflorescentia hemispaerica, minore, compactata, spathae valvis longioribus, tepalis longioribus, viriduli-luteis, staminum annulo latiore, interstaminalibus lobulis, antheris brevioribus, luteis, ovario majore, subcylindrico, duabus apicalibus prominentibus gibbis in quoque loculo, capsula obovoidea, minore, colliculata apice.

Type. Turkey, Anatolia occidentale, nello colline presso Civril a Sud di Usak, 27.7.1998, *S. Brullo & P. Pavone s,n,* (Holo: CAT).

Bulbs usually clustered, ovoid, 12-20 × 6-10 mm, with tunics slightly fibrous, the outers greyish, the inners yellowish. *Stem* erect, often curved at the base, robust, glabrous, 20-40 cm high, usually covered by the leaf sheaths 1/2-2/3 of total length. *Leaves* 3, shorter than the inflorescence, totally covered along the ribs by minute teeth and hairs, much less than 1 mm long, blade semicylindrical, canaliculate, up to 13 cm long, ribbed. *Inflorescence* hemispherical, quite compact, 1.5-2.8 cm in diameter, with 10-35 flowers, on pedicels unequal, glabrous, 7-15 mm long. *Spathe* with 2 valves, erect, opposite, unequal, longer than the inflorescence, glabrous, the largest 7-nerved, 6-13 cm long, the smallest 5-nerved, 2.5-9 cm long. *Perigon* campanulate, greenish-yellow, with tepals subequal, elliptical, the outers 5-5.5 × 2.2-2.4 mm, the inners 5.5-5.8 × 1.8-2 mm, midrib green, smooth and somewhat obtuse at the apex. *Stamens* with simple filaments subequal, all exserted from the perigon, 4.5-5 mm long, white, below connate with tepals into an annulus 1.2-1.5 mm high, with interstaminal rounded lobules; anthers yellow, elliptical, rounded at the apex, 1-1.1 × 0.5-0.6 mm. *Ovary* subcylidrical, greenish-yellow, smooth, 2.5-3 × 1.8-2 mm, with 2 apical prominent gibbosities for each loculus; style white, 1.5-3 mm long. *Capsule* trivalved, obovoid, 4 × 4 mm, colliculate at the apex.

Distribution and habitat. Allium compactatum was collected in some localities near Usak, inland of western Anatolia (Fig, 2H). In these stands it is quite rare and sporadic, growing usually in the clearings of the maquis.

Karyology. The investigated populations coming from Civril were diploid with a chromosome complement $2n = 2x = 16$: 10m + 6msm (Fig. 17L). The karyotype is characterized by more or less metacentric chromosomes with 3 metasubmetacentric pairs. No satellited chomosomes were found (Fig. 18L).

Phenology. Flowering from late July to early August.

Etymology. The epithet refers to the inflorescence with very compacted flowers.

Taxonomic notes. Allium denticulatum is well differentiated from the other species of *A. hirtovaginum* group in having the inflorescence hemispherical with quite compacted flowers not expanded and lax or sometimes fastigiate like in all other species. Based on this trait as well as on the occurrence of stamens exserted from the perigon, it shows some relationships with the species belonging to *A. staticiforme* Sm. (Brullo & al. 1995, 2017), which however markedly differ in having mostly hairless leaves, very short spathe valves and much smaller flowers. Among the examined species of the *A. hirtovaginum* group, it seems to have closer affinity only with *A. denticulatum*, since both species share the leaves not densely hairy, but just provided to a minute denticulation mixed with inconspicuous hairs along the ribs. However, the two species show remarkable differences in vegetative and reproductive structures, including the occurrence in *A. denticulatum* of bulbs isolated and smaller, stem slender, flexuous and shorter, inflorescence lax and expanded, larger, spathe valves shorter, tepals shorter, whitish-yellow, annulus larger, without interstaminal lobules, anthers longer, pale yellow, ovary ovoid, smaller, smooth at the

apex, capsule subglobose, larger, smooth.

Paratype. Turkey, colline nei dintorni di Usak, 27.7.1998, *S. Brullo* & *P. Pavone s.n.* (CAT).

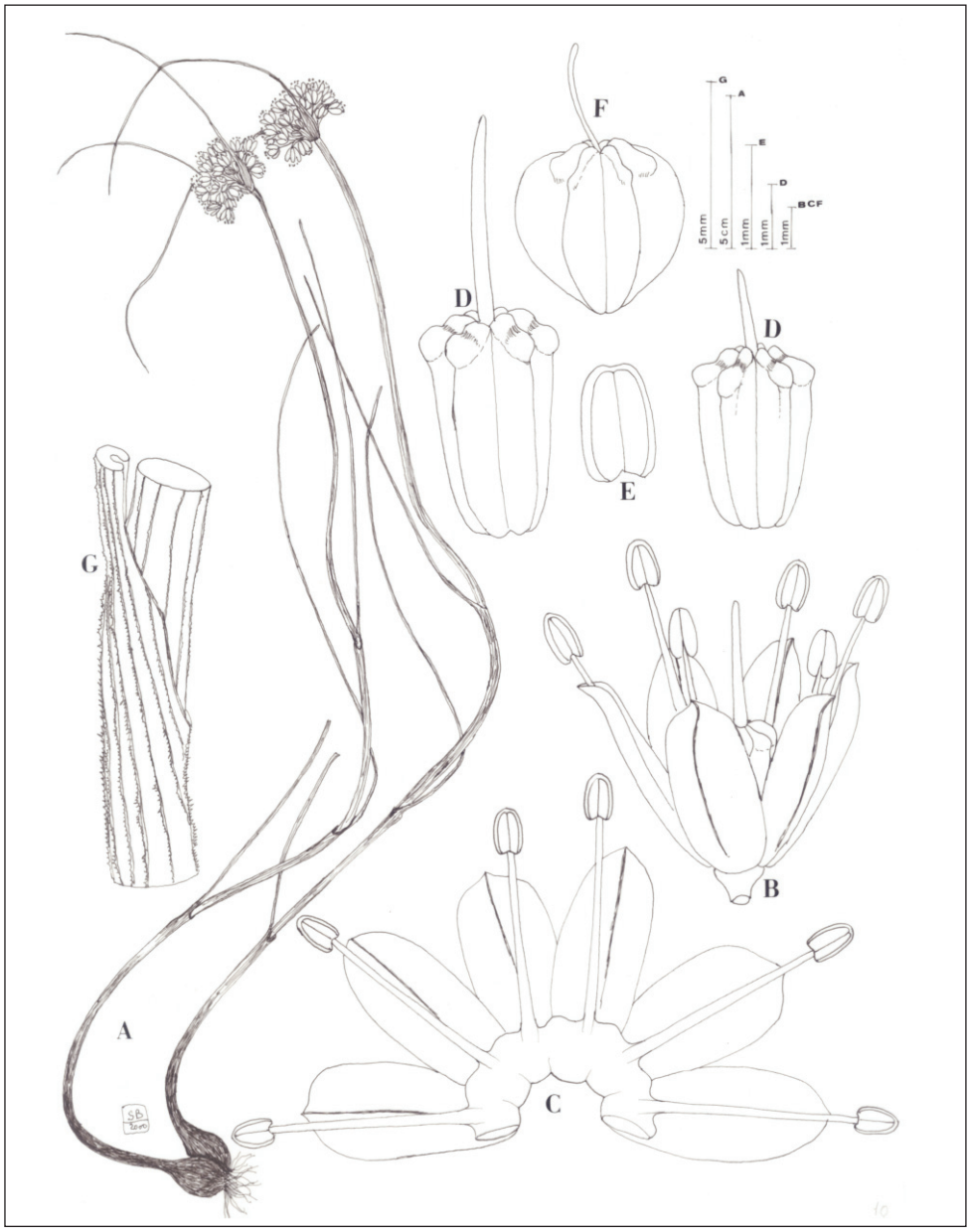

Fig. 16. *Allium compactatum* Brullo & Salmeri: **A.** Habit; **B.** flower; **C.** open perigon and stamens; **D.** ovary; **E.** anther; **F.** Capsule; **G.** indumentum of leaf sheaths. (Drawing by S. Brullo from living plants of type locality).

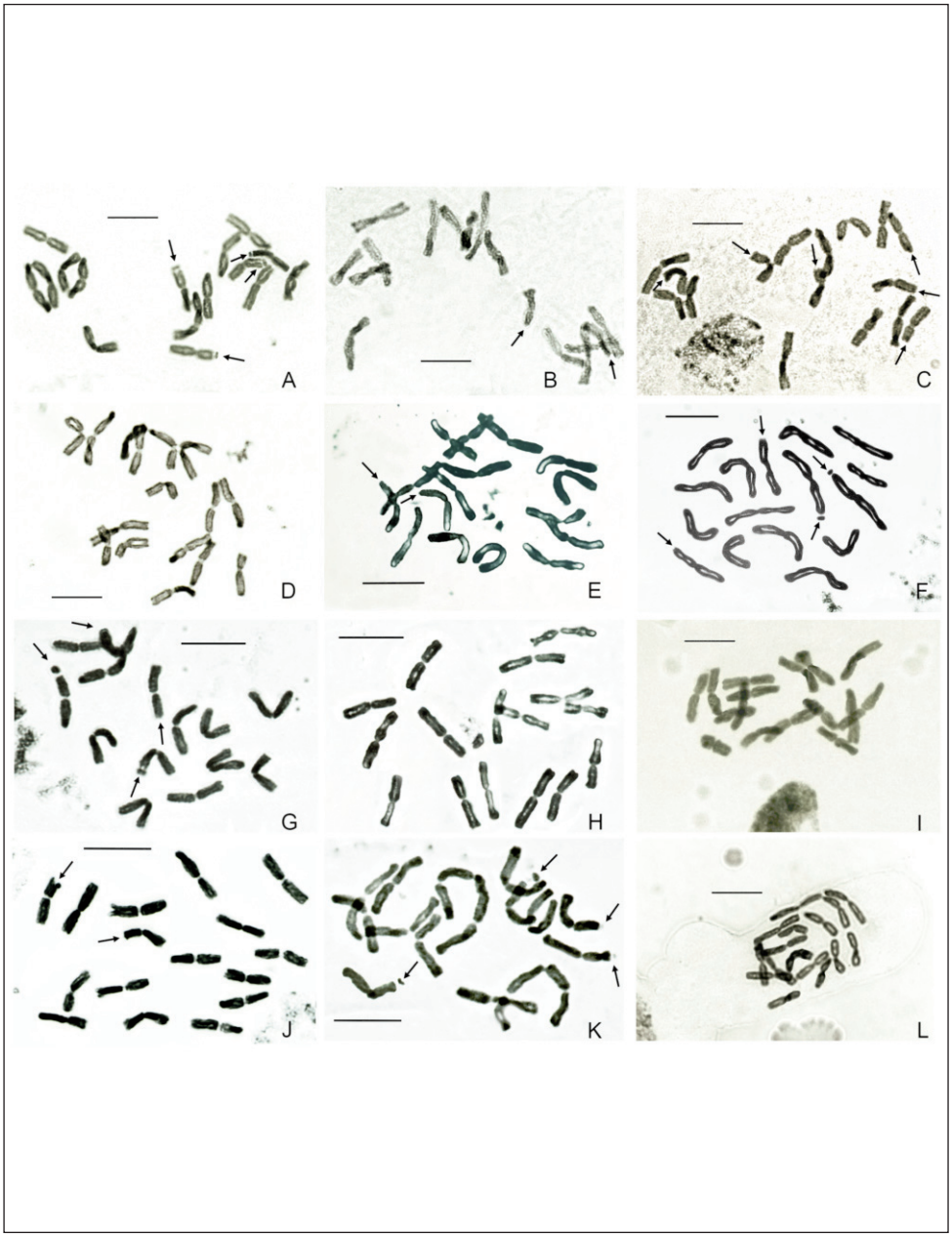

Fig. 17. Mitotic metaphase plates of: **A.** *A. hirtovaginum* (Lesbos, Karestapas); **B.** *A. pythagoricum* (Samos, Psili Amnos); **C.** *A. pignattii* (Samos, Marathokampos); **D.** *A. hippocraticum* (Kos, Kefalos); **E.** *A. abanticum* (Euboea, Karistos); **F.** *A. carium* (Turkey, Fethyie); **G.** *A. papillosum* (Turkey, Denizli); **H.** *A. adenanthum* (Turkey, Gocek); **I.** *A. smyrnaeum* (Turkey, Izmir); **J.** *A. trichosphatum* (Turkey, Manisa Dağ); **K.** *A. trichosphatum* (Turkey, Sandras Dağ); **L.** *A. compactatum* (Turkey, Civril). Bars = 10 μm. Arrows mark satellited chromosomes.

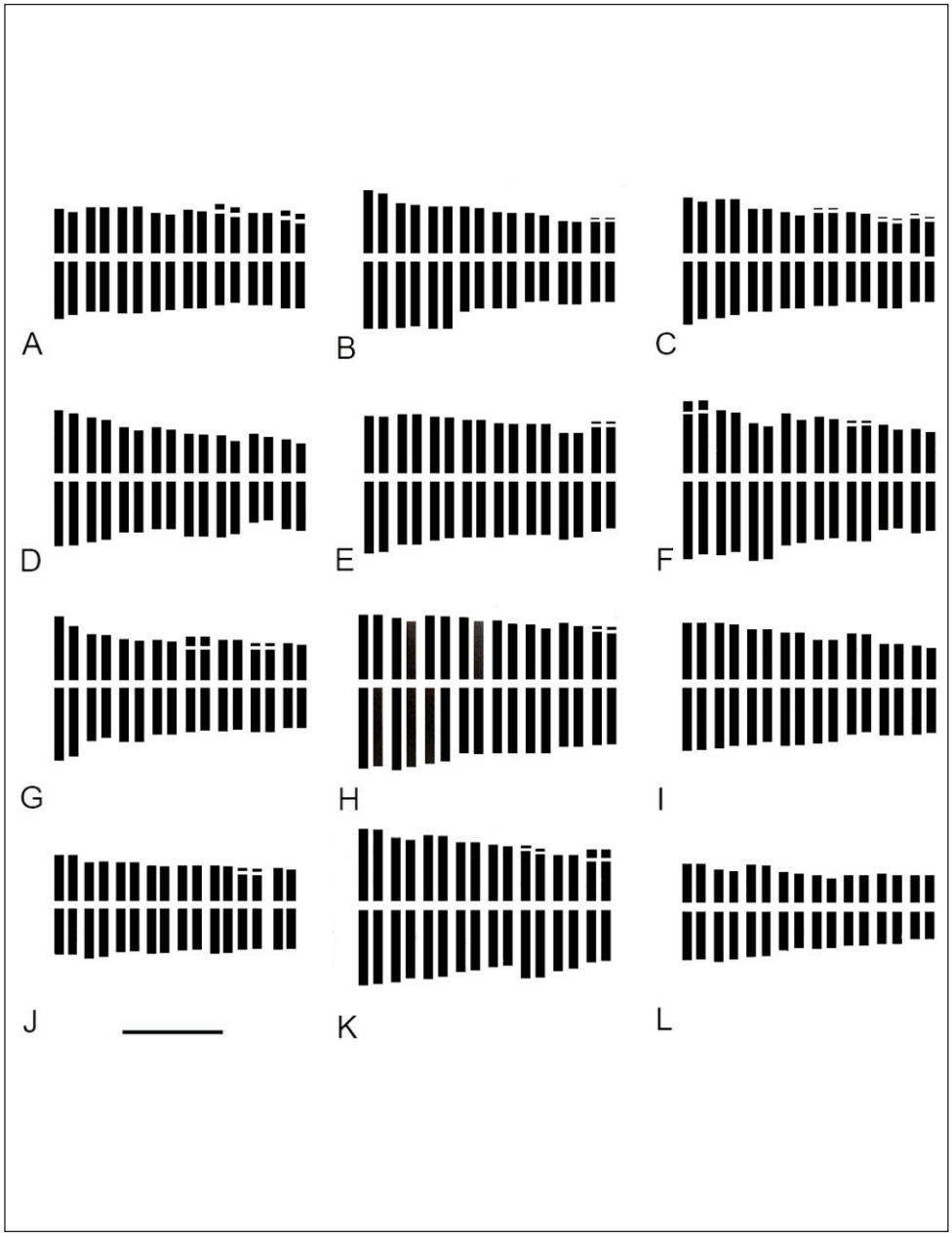

Fig. 18. Karyograms obtained from 10 well spread metaphase plates: **A.** *A. hirtovaginum* (Lesbos, Karestapas); **B.** *A. pythagoricum* (Samos, Psili Amnos); **C.** *A. pignattii* (Samos, Marathokampos); **D.** *A. hippocraticum* (Kos, Kefalos); **E.** *A. abanticum* (Euboea, Karistos); **F.** *A. carium* (Turkey, Fethyie); **G.** *A. papillosum* (Turkey, Denizli); **H.** *A. adenanthum* (Turkey, Gocek); **I.** *A. smyrnaeum* (Turkey, Izmir); **J.** *A. trichosphatum* (Turkey, Manisa Dağ); **K.** *A. trichosphatum* (Turkey, Sandras Dağ); **L.** *A. compactatum* (Turkey, Civril). Bars = 10 μm.).

Key to the investigated *Allium* species belonging to the *A. hirtovaginum* group

1. Stem hairy up to the top **2**
– Stem always hairless **3**
2. Leaves covered by velutinous-scabrous indumentum; inflorescence with more than 100-flowers; pedicels glabrous; spathe valve opposite, glabrous, 8-11-nerved; perigon globose, with tepals unequal, eglandular; stamen filaments entirely white ..... ***A. nerimaniae***
– Leaves covered by dense hairy indumentum; inflorescence with 10-35-flowers; pedicels hairy; spathe valves unilateral, with appendages hairy, 5-7-nerved; perigon campanulate, with tepals equal, sprinkled with glands on inner surface; stamen filaments purplish above..... ***A. adenanthum***
3. Leaves denticulate with inconspicuous hairs along the ribs **4**
– Leaves completely covered by dense hairy indumentum **5**
4. Stem 10-20 cm tall; inflorescence expanded and lax; tepals 4.8-5 mm long; anthers 1.7-1.8 mm long; ovary smooth, 1.8-2 mm long ..... ***A. denticulatum***
– Stem 20-40 cm tall; inflorescence hemispherical and compacted; tepals 5-5.5 mm long; anthers 1-1.1 mm long; ovary with apical prominent gibbosities, 2.5-3 mm long.....***A. compactatum***
5. Spathe valves with appendages hairy **6**
– Spathe valves with appendages glabrous **11**
6. Tepals purplish-pink or purplish-lilac; ovary 1.2-2.4 mm long **7**
– Tepals greenish-brown or greenish-yellow; ovary 2.8-3 mm long **9**
7. Spathe valves subequal or slightly longer than inflorescence; flower pedicels 5-15 mm long; perigon 3.5-4 (4.5) mm long; stamen filaments 2-4 mm long, entirely purple..... ***A. pilosum***
– Spathe valves much longer than the inflorescence; flower pedicels 15-30 mm long; perigon 4.5-5.5 mm long; stamen filaments 4-7 mm long, purplish only above **8**
8. Outer bulb tunic coriaceous; spathe valves unilateral erect; leaves with hairs 0.1-0.2 mm long; perigon 4.5-5 mm long; only inner stamen filaments exserted from perigon, 4-5 mm long; ovary 1.5-1.6 mm long ..... ***A. hirtovaginum***
– Outer bulb tunic fibrous; spathe valves opposite, divaricate-reflexed; leaf with hairs 0.2.1.8 mm long; perigon 5-5.5 mm long; stamen filaments all exserted from the perigon, 6-7 mm long; ovary 2.1-2.4 mm long ..... ***A. aeginiense***
9. Leaves longer than the inflorescence, with hairs patent, 0.2-0.3 mm long; stamen filaments all exserted from the perigon, 4-4.2 mm long ..... ***A. hippocraticum***
– Leaves shorter than the inflorescence, with hairs subappressed 0.5-1 mm long; stamen filaments only the inners exserted from the perigon, 3-3.5 mm long **10**
10. Spathe valves divaricate-reflexed, with appendages hairy at the margin; flower pedicels 10-30 mm long; no interstaminal teeth ..... ***A. pignattii***
– Spathe valves erect, with appendages totally hairy; flower pedicels up to 45 mm long; occurrence of interstaminal teeth ..... ***A. trichospathum***
11. Stem 10-18 cm tall **12**
– Stem 18-50 cm tall **13**
12. Outer bulb tunics fibrous; leaves with hairs patent, 0.2-0.3 mm long; spathe valves longer than the inflorescence, the largest 3-6 cm long; stamen filaments white, only inners

exserted from the perigon, 4-4.2 long, with interstaminal teeth; ovary 3-3.5 mm long..... ***A. abanticum***
– Outer bulb tunics coriaceous; leaves with hairs subappressed, 0.5-1 mm long; spathe valves subequal or shorter than inflorescence, the largest 2-3 cm long; stamen filaments purplish above, all exserted from the perigon, 5.5-6 long, no interstaminal teeth; ovary 1.7 mm long ..... ***A. carium***
13. Inflorescence fastigiate, compact; ovary 3-3.5 mm long **14**
– Inflorescence expanded, lax; ovary 1.5-2.4 mm long **15**
14. Leaf hairs 0.4-0.6 mm long; spathe valves unilateral; perigon 5 mm long; stamen filaments white; annulus with interstaminal teeth; ovary 3.5-4 mm long ..... ***A. smyrnaeum***
– Leaf hairs 0.1-0.3 mm long; spathe valves opposite; perigon 4.3-4.5 mm long; stamen filaments purplish; annulus without interstaminal teeth; ovary 3 mm long...***A. pavonianum***
15. Leaves with hairs up to 1mm long; stamen filaments purplish below, only the inner exserted from the perigon, 3-3.5 mm long; ovary subcylindrical ..... ***A. pythagoricum***
– Leaves with hairs 0.05-0.3 mm long; stamen filaments entirely white or purplish above, all exserted from the perigon, 5-6.5 mm long; ovary subglobose or ovoid **16**
16. Stem 18-28 cm tall; leaves with hairs 0.05-1 mm long; spathe valves erect; perigon purplish, 4-4.5 mm long; stamen filaments above purplish, 5-5.5mm long, no interstaminal teeth; ovary subglobose, 1.5 mm long, totally papillose ..... ***A. papillosum***
– Stem 30-50 cm tall; leaves with hairs 0.1-0.3 mm long; spathe valves divaricate; perigon greenish-yellow, 4.5-5 mm long; stamen filaments white, 5.5-6.5 mm long, with interstaminal teeth; ovary ovoid, 2-2.3 mm long, smooth ..... ***A. velutinum***

Conclusion

This study provides a significant contribution to the knowledge of a group of species of the genus *Allium* sect. *Codonoprasum,* distributed in the eastern Mediterranean territories, in particular Greece and Turkey. On the basis of literature data, this section is still little known from a taxonomic point of view, since it includes numerous critical species and groups, requiring in-depth morphological, karyological, anatomical and molecular investigations. This is confirmed by the high number of species newly described or re-evaluated especially in the Mediterranean area, representing one of the richest diversity centres, especially for this section (Kollmann 1985; Karavokyrou & Tzanoudakis 1994; Brullo & al. 1994, 1995, 1996, 1998, 2002, 2007, 2008b, 2010, 2012; Biel & al. 2006; Peruzzi 2007; Tzanoudakis & Kypriotakis 2008; Trigas & al. 2010; Koçyiğit & al. 2010, 2014, 2016; Koçyiğit & Özhatay 2012; Kalpoutzakis et al 2012; Tzanoudakis & Trigas 2015; Özhatay & al. 2018; Galanos & Tzanoudakis 2019; Trigas & Bareka 2020; Cattaneo 2020). In particular, the species here treated all fall into a quite critical and still taxonomically not well known group, whose populations in the past were usually attributed to *Allium hirtovaginum* (see Tanker & Kurucu 1979; Kollmann 1984; Karavokyrou & Tzanoudakis 1991; Özhatay 1993; Koçyiğit & Kaya 2020). Effectively, *A. hirtovaginum* can be recognized as a species complex, differentiated from the rest of the sect. *Codonoprasum*, especially in having leaves entirely covered by a hairy indumentum, spathe valves often with hairy appendages, and flowers with all or at least the inner stamens exserted from the perigon.

As far as karyology is concerned, all the investigated populations have a diploid chromosome number ($2n = 16$), mostly characterized by metacentric chromosomes and 1 up to 3 metasubmetacentric pairs, with a different number of macro- and/or microsatellited chromosomes. Due to the stamens exserted from perigon, they show some relationships with the species belonging to the *A. stamineum* group, which is also spread in the eastern Mediterranean, where it has a really wide distribution. The latter, anyhow, clearly differs from the *A. hirtovaginum* group in having completely glabrous and smooth leaves. Based on literature data and our extended herbarium investigations carried out in several Botanical Museums (B, BM, C, CAT, FI, G, HUJ, ISTE, K, M, OXF, P, UPA, W and WU), it can be hypothesized that further detailed studies on this group, mainly combined with field surveys, will probably lead to the identification of other new taxa for science.

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