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Onosma kittanae (Boraginaceae-Lithospermeae)

Herwig Teppner[1] and Rainer Karl[2]
With 40 Figures
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Summary: *Onosma kittanae* Strid from NE Greece and *O. pavlovae* Petrova & Tan from S Bulgaria are regarded as conspecific. A detailed description of this asterotrichous species (variability of the indumentum included) is presented. Most peculiar (and unique in S Europaean *Onosma* species) is the calyx with groove-shaped sepals not connected by intermingling hairs in the early bud stages and with precocious development in relation to the corolla. The chromosome number is 2n = 2x = 14. Systematic relationships seem to be possible either to the Greek *O. elegantissima* Rech. f. & Goulimy and *O. stridii* Teppner, or to Anatolian species from the affinity of *O. stenoloba* Hausskn. ex H. Riedl.

Zusammenfassung: ***Onosma kittanae (Boraginaceae-Lithospermeae).*** *Onosma kittanae* Strid von NE-Griechenland und *O. pavlovae* Petrova & Tan von S-Bulgarien werden als konspezifisch angesehen. Eine detaillierte Beschreibung dieser Art (einschließlich der Variabilität des Indumentums) wird gebracht. Besonders auffallend (und einzigartig unter S-europäischen *Onosma*-Arten) ist der Kelch mit rinnigen Sepalen, die in frühen Knospenstadien nicht durch ineinandergreifende Haare verbunden sind und durch im Verhältnis zur Krone vorauseilende Entwicklung des Kelches. Die Chromosomenzahl beträgt 2n = 2x = 14. Verwandtschaftsbeziehungen erscheinen entweder zu den griechischen Arten *O. elegantissima* Rech. f. & Goulimy und *O. stridii* Teppner, oder zu anatolischen Arten aus der Verwandtschaft der *O. stenoloba* Hausskn. ex H. Riedl möglich.

Key words: *Onosma kittanae, Onosma pavlovae, Boraginaceae, Lithospermeae.* – Synonymy, taxonomy. – Description, morphology, indumentum, chromosome number, karyology. – Flora of Greece and Bulgaria.

1. Introduction

The main reasons for considering this species in more detail are:

1) *O. kittanae* Strid was described in 2003 from northeastern Greece (Nomos Evros, Thrakia), as well as 2009 *O. pavlovae* Petrova & Tan from the eastern Rhodope Mts. in Bulgaria. Should it be really true that on both sides of the Greek-Bulgarian border two similar but different species occur?

2) Investigations of an ITS gene (Cecchi & al. 2011) revealed that these species should be close to *O. echioides* and *O. heterophylla*, a finding which is not in accordance with our expectations.

We searched for possible contributions from morphology to address these points.

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2. Material and Methods

Herbarium material from field collections and from cultivated plants, live plants grown in the Botanic Garden in Graz as well as fixations for karyological purposes were available.

Descriptions of the indumentum refer always to the upper side of the leaf blade, if not otherwise indicated. Usually the small glandular hairs on calyx and petiole-like part of the leaves cannot be detected with only the help of stereomicroscopes. Measurements of the fruit length refer to the length of the ventral edge. The size of bracts, calyx and corolla decreases within a cincinnus (cyme) from the base to the top, thus the size of the lowermost flowers is indicated first in the respective descriptive parts. Dry flowers were softened by wetting in hot water and then dissected.

The material for the karyological investigations (flower buds, root tips) was gained from plants cultivated in the Botanic Garden at the Institut fuer Pflanzenwissenschaften der Universitaet Graz. Fixations were made in ethanol : chloroform : glacial acetic acid 5 : 3 : 1 and the material was stained in acetic acid carmine in the usual way for squash preparations; root tips were pre-treated with an 8-hydroxyquinoline solution (e. g., DARLINGTON & LA COUR 1963, SHARMA & SHARMA 1965). Concerning chromosome morphology, the arm ratio is calculated as r = long arm : short arm (in the case of NOR-chromosomes the distal section is not included here.). For Lr, Si, and Gi the satellites are included, compare, e. g. TEPPNER 1974: 62 and 1991: 271–272 [regrettably, in this paper the indicated value of Lr must be doubled].

Photos were taken with a Panasonic Lumix DMC-GF1 and a Leica Dg Macro-Elmarit objective (H. TEPPNER). The images were edited with Adobe Photoshop CS3 (A. DRESCHER and W. OBERMAYER).

LM investigations were made with a Zeiss Photomikroskop III (with a camera lucida) and for live plants and herbarium material a Wild M38 stereomicroscope was used.

For the SEM images of the indumentum, air dried leaf material was mounted on aluminium stubs using C-impregnated double sided tape and sputtered with gold. An SEM XL 30 was used (E. STABENTHEINER). The samples are kept in the collection of the Institute of Plant Sciences in Graz.

3. *Onosma kittanae*

Synonymy

Onosma kittanae STRID in STEVANOVIĆ & al., Plant Syst. Evol. 242(1–4): 157 (2003), STRID & TAN, Phytologia Balc. 9(3): 473 (2004).

Holotype: Greece, Nomos Evrou, Eparchia Soufliou. Pessani forest, Loutra to Dadia. Serpentine outcrop in mixed woodland with deciduous oaks, 400m, 41° 06' N, 26° 06' E, 13 June 2000; …, K. TAN & G. VOLD 23300 (GB). <http://plants.jstor.org/stable/10.5555/al.ap.specimen.gb-0048893>. – Isotype: <http://plants.jstor.org/stable/10.5555/al.ap.specimen.c10005576>.

= *Onosma bulgarica* PAVLOVA, Nord. J. Bot. 27(3): 217 (2009), nom. illegit., non VELENOVSKY, Sitzungsber. königl. böhm. Ges. Wiss. Prag 1(3): 54 (1890); Fl. Bulg. p. 389 (1891).

Holotype: Bulgaria. Eastern Rhodope Mountains: southwards of Goljamo Kamenjane village, south-facing rocky slope; ultramafic rocks; 414 m a.s.l., 41° 24.068' N, 25° 42.231' E, …, 6 June 2005, D. PAVLOVA 105 475 (SO, isotype: SO). <https://

www.researchgate.net/figure/230014210_fig1_Figure-2-Onosma-bulgarica-sp-nov-holotype-SO>.

≡ *Onosma pavlovae* Petrova & Tan, nom. nov., in Tan & Petrova Phytol. Balcan. 15(2): 291 (2009).

Mainly studied Material

Griechenland, Thrakien, Nomos Evros, nahe der Straße von Dadia nach Pessani, ENE der Abzweigung nach Treis Vrysses und Mont Sapka, 330m, (41° 05' 45" N, 26° 06' 00" E); Serpentin, Schuttfluren mit *Juniperus oxycedrus*, *Fumana aciphylla* u. a.; 10. 6. 2007; leg. R. Karl (GZU and herb. Karl); additionally recorded: *Allium stramineum*, *Alyssum sibiricum*, *Apera spica-venti*, *Convolvulus boissieri*, *Genista anatolica*, *Trifolium lappaceum*, *T. strictum*, and *T. tenuifolium*.
Ditto, from nutlets of this collection grown in the Botanic Garden Graz sub Cult No. 1196 (GZU). . . . . n = 7, 2n = 14

Griechenland, Nomos Evros, ca. 35 km NE Alexandroupoli, nahe der Straße von Provatonas über Lefkimi auf den Berg (552 m) mit den Sendern, 475 m, (41° 04' 56" N, 26° 08' 38" E); vulkanisches Silikat, steinig-offene Böschungsflur [mit *Cistus*-Gebüsch] an einer Feuerschneise [nur 7 Pflanzen]; 26. 4. 2014; leg. R. Karl (GZU and herb. Karl); Fig. 8, 9; additionally recorded: *Limodorum abortivum*, *Osyris alba*, and *Quercus pubescens*.

[Bulgaria], Eastern Rhodope Mts., near Dobromirtzi village, on serpentine hil[l]s westward from the village, ca. 342 m a. s. l.; 12. 06. 2009; leg. D. Pavlova (GZU).

Bulgarien, Ostrhodopen, zwischen Krumovgrad und Avren, Goljamo Kamenjane, ehemalige Asbestgewinnung ca. 500 m SW des Ortes, SE-Hang, 400 m, (41° 24' 05" N, 25° 42' 25" E); Serpentin, Fels- und Schuttfluren mit *Cheilanthes marantae*; 1. 5. 2014; leg. R. Karl (GZU and herb. Karl); Fig. 10, 11. . . . . n = 7

Description: A low, more or less dense, often small cushions forming subshrub (suffrutex) with short ramifications in the lignified part and with a number of sterile shoots at flowering time (Fig. 1, 2, 8, 11). Sterile stems short, 0.5–3.0 cm, leaves crowded rosette-like on the top, green at flowering time. One terminal inflorescence shoot from the centre and few forthcoming sterile shoots from leaf axils originating in spring from the previous year's rosettes.

Crowded leaves ("rosette leaves", "basal leaves") very narrow, 20–100 mm long, and (0.7–)1.0–3.0(–3.5) mm wide, very narrowly obovate, subacute, widest in the apical third or half, flat (when young) to strongly revolute, without discernible lateral veins, narrowed very gradually into a petiole-like basal part (c. 1/6 – ⅓ of the total leaf length). Indumentum asterotrichous (= stellate), strongly appressed to the blade surface, long setae on the blade c. 0.5–1.0 mm long, sitting on tubercles with rays c. 0.15–0.3(–0.4) mm long, tubercles somewhat different in size, the larger ones with 5–16 rays, the smaller ones with (1–)3–6 rays (Fig. 19, 20, 26, 27, 28). Even the setae on the margin of the blade appressed. Tubercles reaching the midvein, in the transition zone to the petiole-like part also on the midvein and tubercles with 1–3 rays only. Petiole-like part with marginal setae appressed or to ± antrorsely patent (up to 2.0 × 0.1 mm) on few-rayed to glabrous tubercles (Fig. 21–23); on the upper face with short, appressed, simple hairs of c. 0.1–0.2(–0.3) mm forming a dense indumentum Fig. 24, 25, 29), only the lowermost 0.5–1.0(–2.5) mm glabrous. Indumentum of the blade dense, rays of the tubercles largely intermingling, thus appearance of the leaves greyish.

Flowering shoots (inflorescences) erect, c. (6–)15–20(–30) cm, up to 34 cm in fruit, with an appressed indumentum of setae on few-rayed tubercles and of short simple hairs, sometimes tinged with purple. With c. 9–20 stem leaves, the lowermost ones c. 20–40 × 1–2 mm, ± linear with a petiole-like basal part, middle ones c. 20–40 × 2–3 mm, sessile, ± narrow linear to narrow lanceolate, uppermost ones 18–23 × (2–)3–4.5(–6)

Fig. 1–3: *Onosma kittanae* from Greece, Dadia to Pessani, grown in the Botanic Garden, a c. seven years old plant. – Fig. 1: Habit. – Fig. 2: Inflorescences, detail from Fig. 1. – Fig. 3: Cincinnus, corolla in the open flower whitish in the anterior part, in bud and fading flower light ochre. – Scale bar in Fig. 1 and 2 = 5 cm.

Fig. 4–5: *Onosma kittanae*, Dadia to Pessani, flowers. – Fig. 4: Whitish, first day flower in the centre. – Fig. 5: Corolla split longitudinally, one basal connection between anthers separated artificially. – Scale bar = 1 cm.

Fig. 6–7: *Onosma kittanae*, Dadia to Pessani, cincinni with young flower buds (Fig. 6) and with buds and flowers (Fig. 7), respectively. Bracts and two sepals each removed. – Fig. 6: Smallest corolla bud C = 1.6 mm, K = c. 5 mm, right flower (central flower) C = 6 mm, K= 13 mm. – Fig. 7: Smallest corolla bud C = 3.5 mm, K = 8.0 mm largest C = 23 mm, K = c. 15 mm, open flower = central flower.

Fig. 8–9: *Onosma kittanae*, NE Alexandropouli, habitat and a single plant. – Phot. Leonora KARL.

Fig. 10–12: *Onosma kittanae*, Bulgaria, eastern Rhodope Mts., serpentine. Fig. 10 and 11, habitat and a single plant, phot. Leonora KARL, Fig.12 phot. H. TEPPNER.

Fig. 13–14: *Onosma kittanae,* eastern Rhodope Mts. – Fig. 13: Corolla split longitudinally, one basal connection between anthers separated artificially. – Scale bar = 1 cm. – Fig. 14: Cincinnus in bud stage, one to three sepals removed, bracts bent back. Smallest corolla bud C = 3.5 mm, largest C = 8 mm.

mm, sessile, distinctly widened at the base, narrowly ovate, usually wider than the basal leaves. Rays of the tubercles decreasing in number towards the uppermost stem leaves, these on the upper face often with simple hairs only or dominant. Lower cauline leaves usually alive at flowering time (Fig. 2), often dry or dropped off in fruit.

Two cincinni (a boragoid) on the top of the stems (rarely one), c. (3–)4–12(–15) flowers per cincinnus (Fig. 3, 12), bracts shorter than calyx + pedicel, sometimes the lowermost 1–2(–3) bracts as long or a bit longer, upper face with glabrous tubercles. Pedicels short and thick, 4–2 mm in lower flowers, 2–1 mm in the upper ones.

Calyx (17–)16–12(–9) mm long, sepals 1.5–0.7(–0.5) mm wide, up to 19 × 1.5 mm in fruit, free (only 0.2–0.3 mm grown together), very narrowly triangular to linear, groove-shaped (transversal section a shallow U, Fig. 6, 14), widest at or near the base, not thickened at the base, two lateral veins from the base, margins not touching from early stages on, indumentum appressed, outside with ± sparse setae (on glabrous tubercles) of 0.5–0.8 mm mainly on the midrib and an indumentum of short hairs and minute glands on the face, sepal margin with ± sparse setae in the anterior half and a beard of setae basally, marginal hairs not (or very loosely) intermingling in early bud stages, tips of the sepals with a tuft of ± straight hairs. Inside with a cover of thin, very short hairs, except for the basal (0.5–)1.0–1.5 mm, in the anterior half scattered setae of 0.4–0.5(–0.6) mm. Calyx precocious (e.g. at the time of meiosis, i.e. at a corolla length of c. 2.4–2.8 mm, already 6–9 mm long; corolla equaling the calyx just shortly before anthesis, when c. 13–16 mm long; Fig. 6, 7, 14). Calyces persisting after ripening.

Corolla (27–)25–18(–15) mm long, somewhat clavate, whitish (but not true white such as *O. tenuiflora* Willd., Fig.40, or *Leucanthemum*) in the anterior half at the

Fig. 15–16: *Onosma kittanae*, Dadia to Pessani, fruits harvested in the Botanic Garden. – Fig. 15: Calyx in fruit, two sepals bent back artificially. – Fig. 16: Nutlets in different positions. – Scale bars = 1 cm.

begin of anthesis (Fig. 3, 4, 7, 9, 12), fading very light ochre from the second day on, glabrous except for a few short hairs on the tips, epidermal cells papillose, corolla usually rugose, basal diameter c. 1.2–1.6 mm, ring of basal scales c. 0.2–0.3 mm, shallowly 10-lobed. Corolla-filament-tube (6.2–)7.0–10.0 mm long, yellowish. Free part of the filaments c. (4.5–)5.5–7.0(–7.5) mm (Fig. 5, 13).

Anthers (6.6–)7.0–8.2(–8.5) mm long, included, connected laterally at the very base, part of the anther below the filament insertion c. 2.5–3.0 mm, approximately half as long or a little shorter than the free part of the filaments (Fig. 5, 13). Connective tips c. (0.7–)1.0–1.5 mm long, ± denticulate marginally, the two teeth c. 0.1–0.2 mm long, usually diverging, incision acute. Connective above the filament insertion 0.4–0.55 mm wide, papillose. Stigma exserted for c. 2.0–5.0 mm.

Nutlets (1.7–)1.9–2.5 × (1.5–)1.6–1.9 mm, widest c. 0.7–1.4 mm above the base, trapezoid-rounded or oblong, a bit flattened, bulged on the dorsal side, ventral longitudinal edge straight, blunt, from the rounded, indistinct shoulders gradually narrowed into a c. 0.4–0.8 mm long beak (slightly laterally compressed), greyish, light brown or brown, ± dark brown mottled, shiny, smooth (Fig. 15, 16).

Seedlings: Cotyledons c. 6.5–7.0 × 4.5–5.5 mm, blade roundish, abruptly narrowed into the petiole like part of c. 1.0–1.5 mm (Fig. 17, 18).

Flowering: Second half of April to begin of June.

Fruits: June to July.

Distribution: NE Greece (Nomos Evros) and S Bulgaria (Eastern Rhodope Mts.).

Fig. 17–18: *Onosma kittanae*, Dadia to Pessani, seedlings. – Sown 21.1.2008, germination April 2008, phot. 24.5.2008. – Scale bar = 1 cm.

Habitat: Rocks, screes and embankments on serpentine (Fig. 10, 11) and volcanic siliceous material (Fig. 8, 9). STRID & TAN 2003: 474 mention from serpentine outcrops in the Pessani forest 13 "interesting" accompanying species. In the meantime there is a lot of literature on the Dadia-Lefkimi-Soufli Forest National Park in whose SW part the Pessani forest lies (KORAKIS & al. 2010: 67–68, 73, KORAKIS & GERASIMIDIS 2010 on vegetation, KORAKIS & al. 2006 on floristics, CATSADORAKIS & al. 2010: 272–273 on conservation). PAVLOVA 2009: 218 and 2014: 391 describes the vegetation in the Rhodope Mts. as xerothermic communities of submediterranean type and lists a number of accompanying endemics and rare species.

Karyology

Chromosomes: The interphase nuclei, prophasic transformation (Fig.31a) and condensed chromosomes are in accordance with the conditions usually found in asterotrichous *Onosma* species with x = 7 (see e.g. TEPPNER 1972, 1974, 1991b). *O. kittanae* has 2n = 2x = 14 chromosomes (Fig. 31b, c). Because of loss of some fixations, the idiogram (Fig. 30) has not the same quality as in earlier papers; it is calculated from one plate only and it is not absolutely clear if one or two pairs bear satellites. Nevertheless, the chromosome morphology appears to be in good accordance with other asterotrichous, diploid *Onosma* species (e.g. TEPPNER 1974: 77, Fig. 9c, d).

Meiosis takes place in flower buds with a corolla length of c. (2.1, early pachyten–)2.4–2.8(–3.0, tetrads) mm. Meiosis is completely regular with n = 7 bivalents at metaphase I and 7 chromosomes in the later stages Fig. 31d–f, 32, 33).

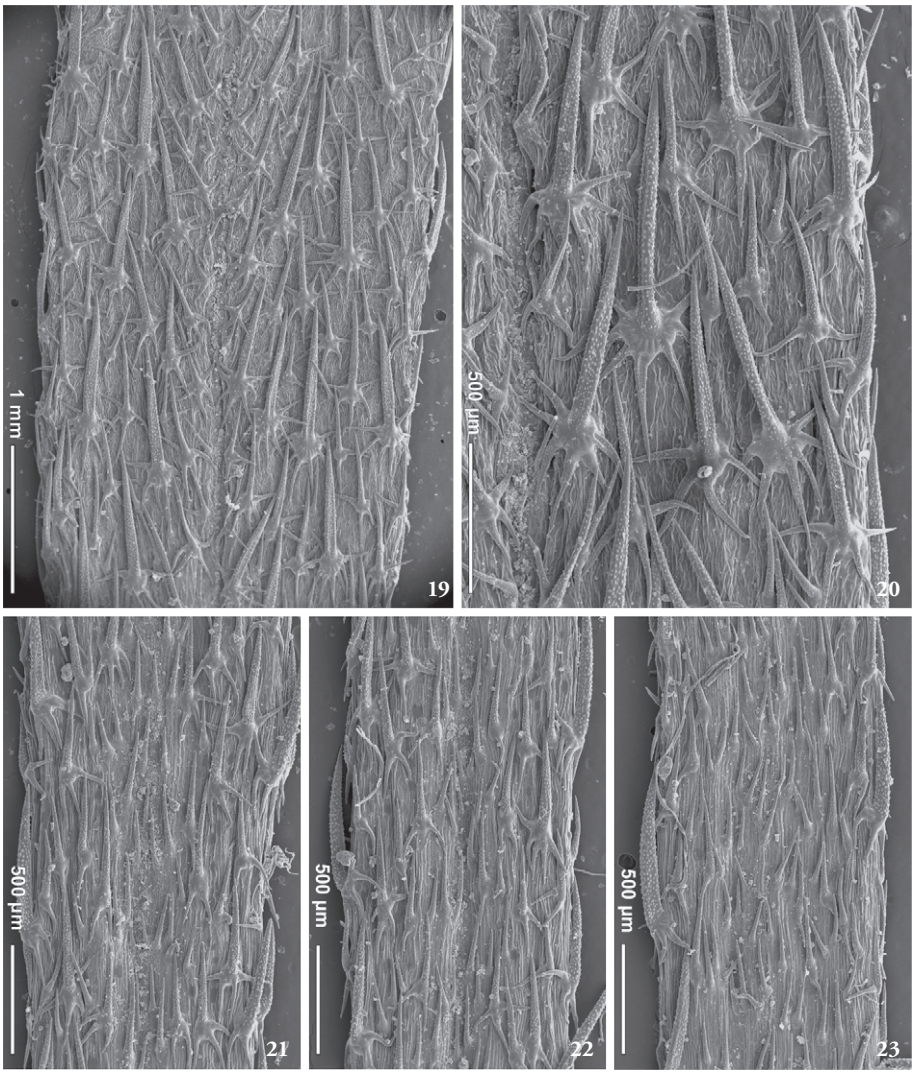

Fig. 19–29: *Onosma kittanae*, NE Alexandropouli, indumentum of the upper face of three basal leaves from one and the same individual. – Fig.19: Near the tip of the leaf. – Fig. 20: Ditto, detail, left the midvein. – Fig. 21–23: Change of the indumentum (especially reduction in the number of rays) in the petiole-like part from above (Fig. 21), the middle (Fig. 22), and near the base (Fig. 23). For the base itself see Fig. 24–25. – Phot. E. STABENTHEINER.

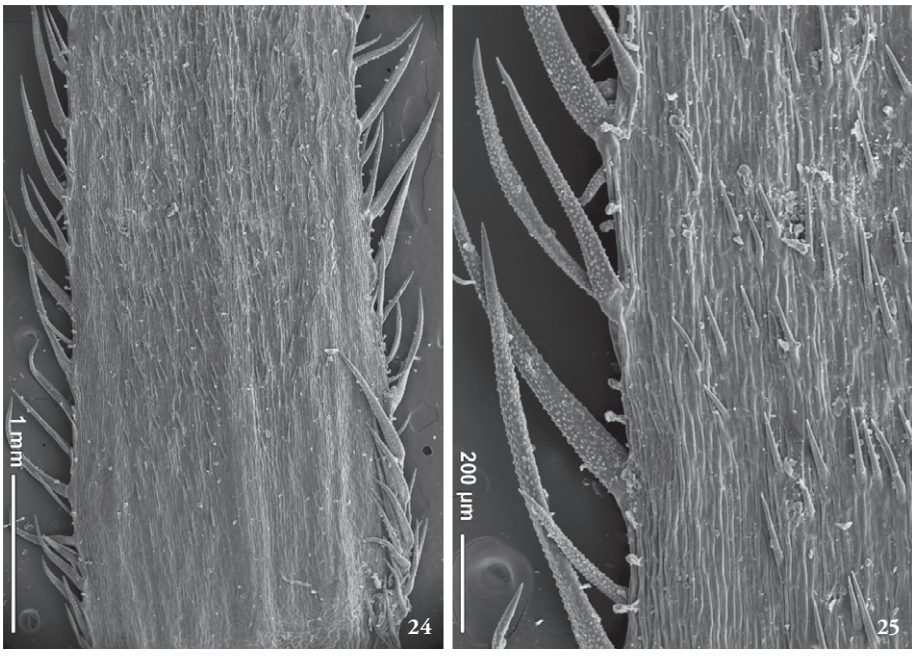

Fig. 24–25: *Onosma kittanae*, NE Alexandropouli, same leaf as in Fig. 19–23, indumentum at the base of the petiole-like part, upper face. – Phot. E. STABENTHEINER.

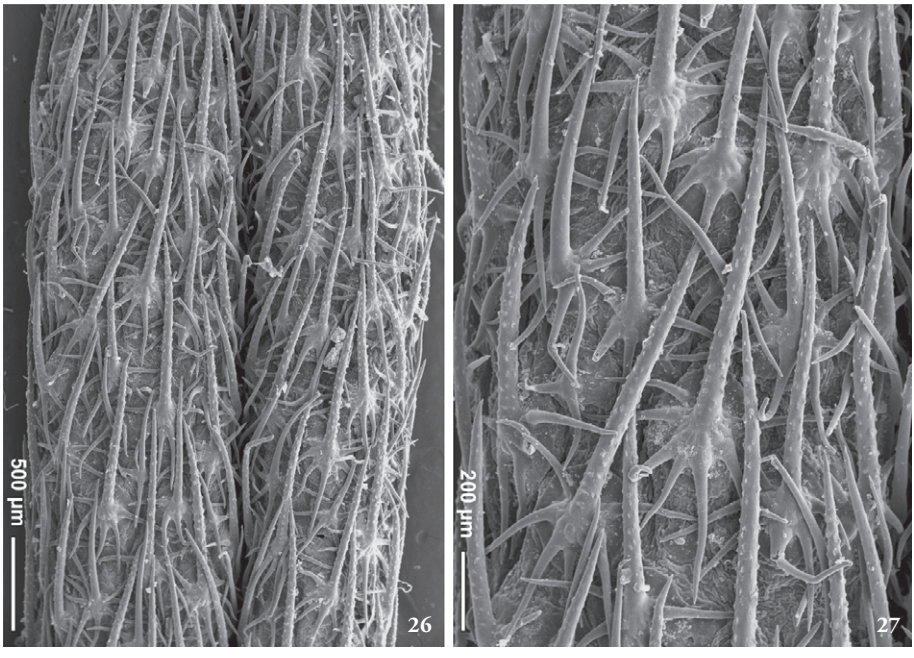

Fig. 26–27: *Onosma kittanae*, NE Alexandropouli, indumentum near the tip of a leaf, up to eight rays per tubercle. In the left figure midvein at the right margin. – Phot. E. STABENTHEINER.

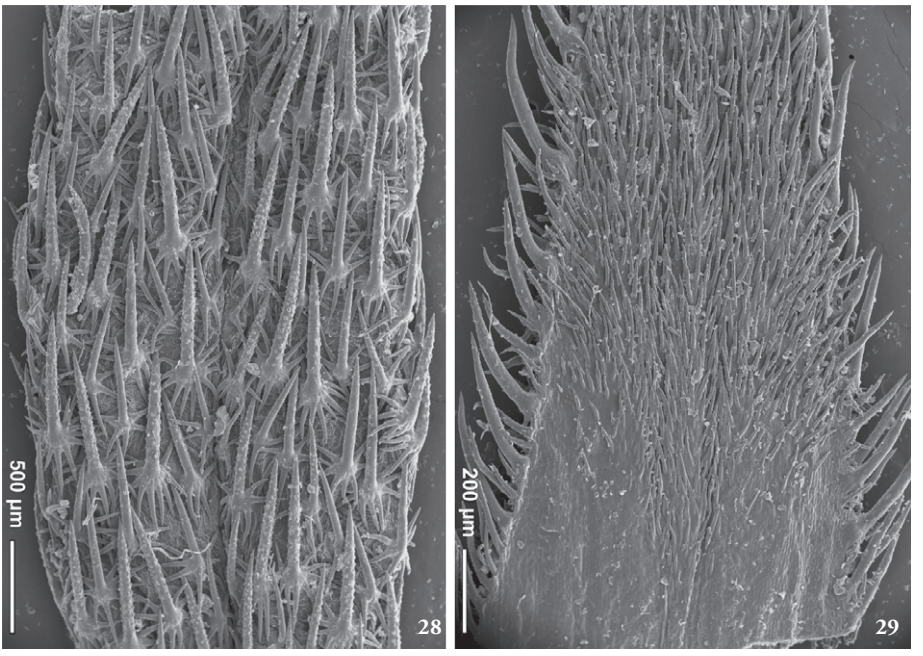

Fig. 28–29: *Onosma kittanae*, NE Alexandropouli, indumentum. – Fig. 28: Near the tip of the leaf, up to 13 rays per tubercle. – Fig. 29: Base of the petiole like part. – Phot. E. STABENTHEINER.

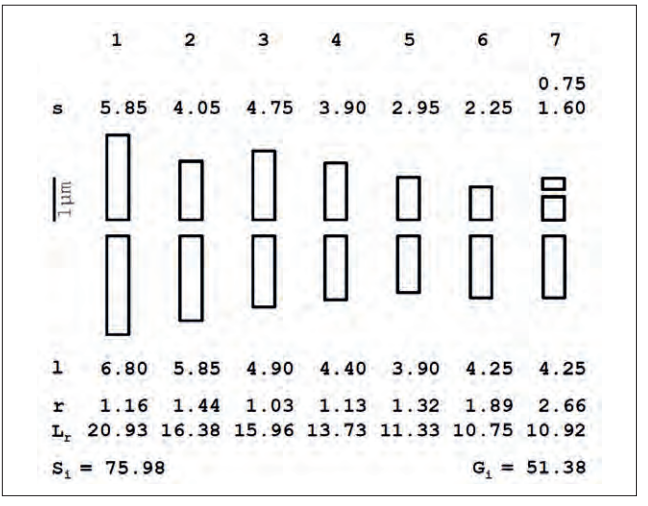

Fig. 30: *Onosma kittanae*, Dadia to Pessani, idiogram of the haploid chromosome set taken from one mitotic metaphase plate. For the idiogram method see, e.g. TEPPNER 1974 or TEPPNER & WETSCHNIG 1980.

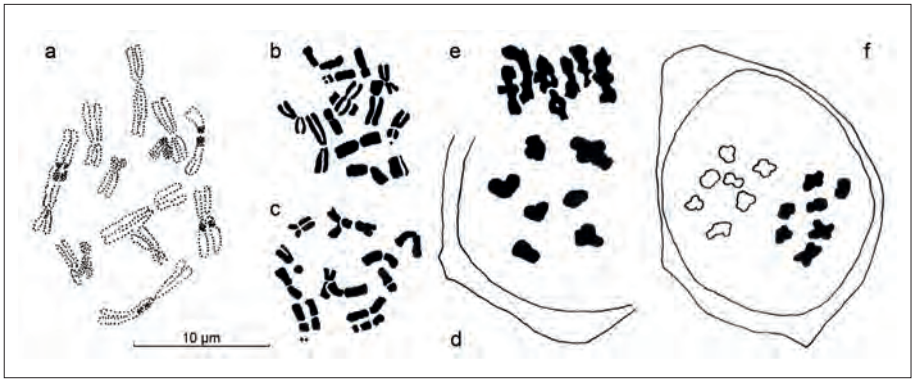

Fig. 31: *Onosma kittanae*, Dadia to Pessani, mitotic and meiotic chromosomes, 2n = 14 and n = 7, respectively. – (a) late mitotic prophase. – (b, c) mitotic metaphase plates. – (d, e) meiotic metaphase I in polar view and side view, 7 bivalents. – (f) meiotic anaphase I, polar view.

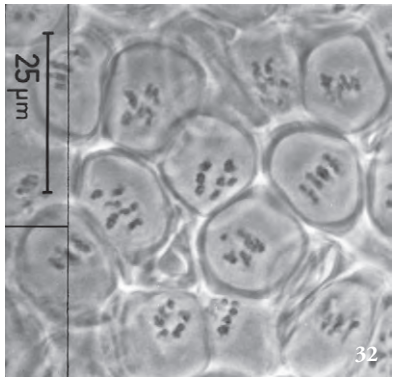

Fig. 32: *Onosma kittanae*, Dadia to Pessani, Pollen mother cells in metaphase I, 7 bivalents.

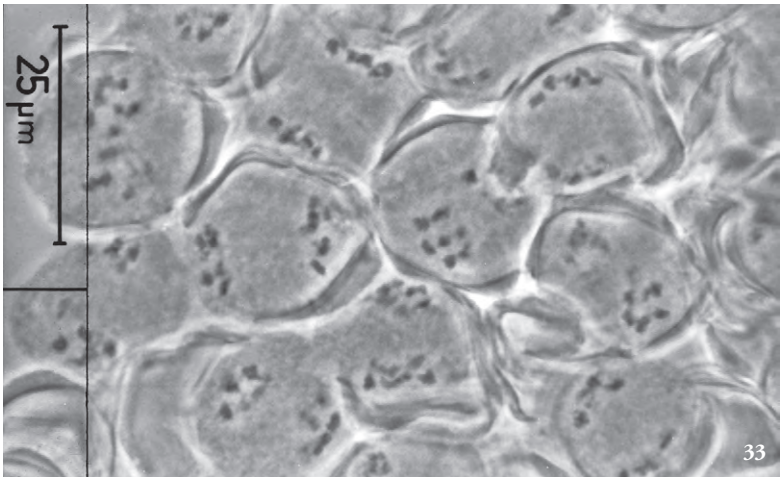

Fig. 33: *Onosma kittanae*, Dadia to Pessani, Pollen mother cells in anaphase I, 7 chromosomes.

4. Discussion

Onosma kittanae and *O. pavlovae* are regarded here as conspecific. The essential characteristics are identical. The differences indicated in PAVLOVA 2009: 217 lie within the usual variability which has to be expected between individuals of a population as well as between populations, especially when populations were isolated for a long time. Even regarding the anther length, there is no caesura in our material (6.6–7.6 mm in Bulgarian, 7.2–8.5 mm in Greek material). Contrary to the wordings in the two original descriptions (white versus pale yellow, respectively) there is no discernible difference in the colour of the corolla between Greek and Bulgarian material (Fig. 2–4, 9 and 11, 12).

The details of the indumentum are usually highly variable within species and within individuals; this was discussed in TEPPNER 2012: 310–314, 316–317 with *O. fruticosa* as an example. Here this variability is demonstrated once more with the help of different leaves of one and the same individual of *O. kittanae* (Fig. 19–29).

O. kittanae is unique among South European *Onosma* species by its peculiar calyx: contrary to all other species its development is highly precocious and the sepals are never strongly connected by intermingling hairs, not laterally, nor on the apex (Fig. 6, 7, 14). On the occasion of the description STRID & TAN 2003: 474 , on one hand, compared it with *O. thracica* VELEN. (a synonym of *O. rigida* LEDEB.), however, we see no affinities with this species. On the other hand, *O. elegantissima* RECH. f. & GOULIMY in RECHINGER 1957 and *O. stridii* TEPPNER 1988, 1991a were presumed to be relatives. From their habit, leaves, indumentum, corolla, nutlets, etc., these two could be related

Fig. 34: *Onosma elegantissima*: Cincinnus with flower buds, in the smallest bud C = c. 2.7 mm, K = c. 3.5–4.0 mm. – Origin: Griechenland, Kozani, Vourinos-Gebirge, Paleokastron, NW- und W-exponierte Hänge (von Felsen durchsetzt, Serpentin) O des Ortes, ca. 900–940 m; *Buxus sempervirens-Quercus pubescens*-Gebüsch, Rasen mit *Chrysopogon gryllus* und Felsfluren; 11.7.1980; leg. H. TEPPNER 80/385 (GZU) . – Grown in the Bot. Garden Graz sub Cult. No. BOR 798/1 (GZU). – Scale bar = 1 cm.

Fig. 35: *Onosma stridii*: boragoid with flower buds, in the smallest bud C = 2.5 mm, K = 4.5 mm. – Origin: [Greece], Nom. Fthiotidos, ep. Lokridos: Mt Kallidromon, along road between the villages of Modion and Kallidromon, 550 m; serpentine gravel on road embankment; 1987-04-13; leg. P. LAULUND & A. STRID no. 26326 (GZU). – Scale bar = 1 cm.

to *O. kittanae*. Only the calyx characters would disagree with this opinion at first sight. A closer look shows that it is also somewhat precocious in these two, less than in *O. kittanae*, but distinctly more than it generally occurs in many other asterotrichous *Onosma* species. In the latter, at the time of meiosis, the calyx is often little longer (less than 1.5 ×) than the corolla (e.g. *O.rigida* Fig. 36, *O. echioides* L., and *O. heterophylla* GRISEB. Fig. 37), whereas it is more than 2–3 times the length of the corolla bud in *O. kittanae* (Fig. 6, 7, 14). The ratio is 1.3–1.5 × in *O. elegantissima* (Fig. 34) and 1.8 × in *O. stridii* (Fig. 35). The corolla equals the calyx at a length of c. 7–10 mm in asterotrichous *Onosma* such as *O.rigida*, *O. echioides* and *O. heterophylla*, and at 13–16 mm in *O. kittanae*; in *O. elegantissima* this is the case at 11–12 mm and in *O. stridii* at 10–12 mm. So the ratios of the length of calyx and corolla seem to be intermediate in *O. elegantissima* and *O. stridii*. Thus, in spite of the intermingling hairs, affinity of the two with *O. kittanae* seems to be possible and cannot be excluded.

Contrary to this point of view, CECCHI & al. 2011 used ITS1 sequence data to show that *O. kittanae* forms a monophyletic clade together with *O.echioides* and *O. heterophylla*. However, due to the very limited sequence data we are not confident that they represent natural relationships among the species. We disagree mainly because of the very different calyx, the same reason as in the case of *O. rigida*.

A distinctly precocious calyx as in *O. kittanae* occurs in several, unrelated parts of the genus *Onosma*, but according to our present knowledge, always combined with sepals connected by intermingling hairs laterally and / or apically. An example is the haplotrichous *O. polyphylla* LEDEB., in which the sepals are twice as long as the corolla at time of meiosis (5.0–6.0 mm versus 2.5–3.0 mm) and both become equal at a length of c. 17–18 mm, and sepals are connected by hairs, especially strong apically (Fig. 38).

Fig. 36: *Onosma rigida*: Cincinnus with flower buds, the first flower opens, in the smallest opened bud C = 2.8 mm, K = 3.5 mm. – Origin: Bulgarien, WSW Varna, Beloslav, 60 m, 43°11'14" N, 27°42'35" E; 23.6.2014; leg. R. KARL (GZU). – Grown in the Bot. Garden Graz sub Cult. Nr. 1323/4 (GZU). – Scale bar = 1 cm.

Fig. 37: *Onosma heterophylla*: Cincinnus with flower buds, in the smallest bud C = 2.3 mm, K = 3.4 mm. – Origin: Bulgarien, Struma-Tal, zwischen Blagoevgrad und Simitli, Felsgruppe an einem NW-exponierten Hang nahe der Straße A1 (= E79), 400 m, 41°56'10" N, 23°06'03" E; quarzreicher Glimmerschiefer, Felsfluren mit *Comandra umbellata*; 9.4.2014; leg. R. KARL (GZU). – Grown in the Bot. Garden Graz sub cult. Nr. 1324/3 (GZU).

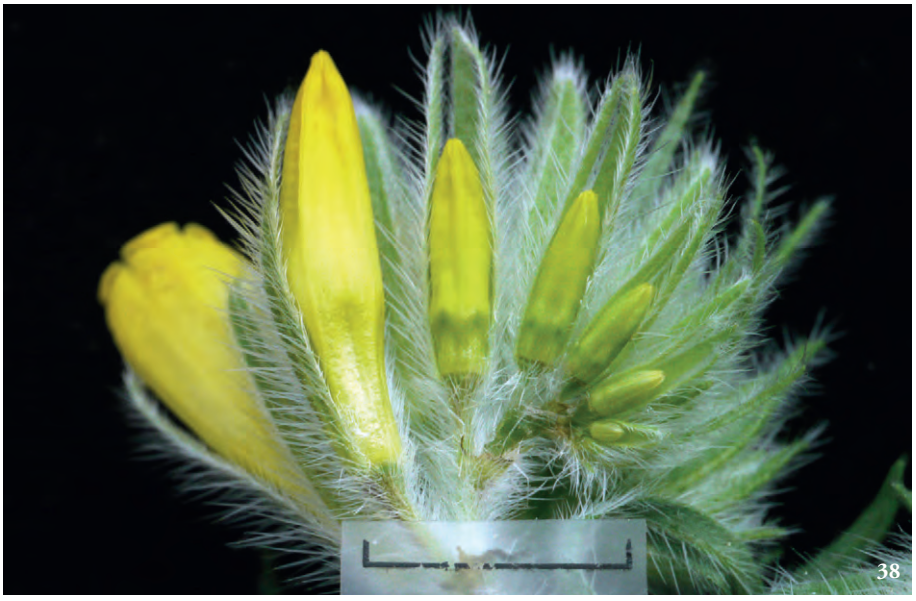

Fig. 38: *Onosma polyphylla*: Cincinnus with flower buds, the central flower open, in the smallest bud C = 1.4 mm, K = c. 3.5 mm. – Origin: Ukraine, Krim, an der Küstenstraße zwischen Alushta und Sudak, ca. 2 km SW Vesele, 210 m, 44° 50' 46'' N, 34° 51' 37'' E; Silikatsedimente, Feinschuttfluren an der Straßenböschung; 6.7.2013; leg. R. KARL (Herb. KARL) – Grown in the Bot. Garden Graz sub Cult. Nr. 1305/4 (GZU). – Scale bar = 1 cm.

Fig. 39: *Onosma stenoloba*: Cincinnus with flower buds, the smallest corolla bud c. 2.3 mm, the others 4.4 and 8.3 mm, respectively. – Origin: Turkey, B6 Sivas, Sivas-Ulaş 12 km. Mescidli around, roadside and slopes, 4250 ft.; 26.05.2006; 39 39N 037 00E; leg. R. BINZET 95 & 96. – Grown in the Bot. Garden Graz sub Cult. Nr. 1256 (GZU).

Fig. 40: *Onosma tenuiflora*, a rare example in *Onosma* with true white corollas. – Origin: Armenia, Aragatsotn province, Talin district, Mt. Arteni, S side; 1433 m, 40° 20' 41'' N, 43° 46' 57'' E; 27.6.2004; leg. E. VITEK & al. 04-1802 (GZU). – Grown in the Bot. Garden Graz sub Cult. Nr. 1217 (GZU). – Length of corolla 10–11 mm.

Sepals most similar to those of *O. kittanae* we have seen in some Anatolian asterotrichous species such as *O. stenoloba* HAUSSKN. ex H. RIEDL and related ones; they are not only strongly precocious, but also soft and U-shaped in transversal section, and connected by crisp, intermingling hairs only apically (Fig. 39). From their morphology, such species are also candidates for an affinity with *O. kittanae*. The occurrence of a genetic shift from crisp hairs at the tip of the sepals to straight hairs may not be too unlikely. The basic chromosome number x = 7 occurs also in this group. Because of our insufficient knowledge of this group, we are not able to discuss this in more detail. Further investigations would be necessary for a decisive conclusion on the affinity of *O. kittanae*.

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6. References

Catsadorakis G., Kati V., Liarikos C., Poirazidis K., Skartsi T., Vasilakis D. & Karavellas D. 2010. Conservation and management issues for the Dadia-Lefkimi-Soufli Forest National Park. – In: Catsadorakis G. & Källander H. (eds.), The Dadia-Lefkimi-Soufli Forest National Park, Greece: biodiversity, management and conservation, p. 265–279. – WWF Greece, Athens. <https://www.researchgate.net/publication/259753746_Conservation_and_management_issues_for_the_Dadia-Lefkimi-Soufli_Forest_National_Park>.

Cecchi L., Coppi A. & Selvi F. 2011. Evolutionary dynamics of serpentine adaption in *Onosma* (*Boraginaceae*) as revealed by ITS sequence data. – Plant Systematics and Evolution 297(3–4):185–199. <https://www.researchgate.net/profile/Federico_Selvi/publication/246610338_Evolutionary_dynamics_of_serpentine_adaptation_in_Onosma_Boraginaceae_as_revealed_by_ITS_sequence_data/links/56e7eaeb08aea51e7f3af0fe/Evolutionary-dynamics-of-serpentine-adaptation-in-Onosma-Boraginaceae-as-revealed-by-ITS-sequence-data.pdf>.

Darlington C. D. & La Cour F. 1963. Methoden der Chromosomenuntersuchung. – Kosmos, Frankh'sche Verlagshandlung. Stuttgart.

Korakis G. & Gerasmidis A. 2010. Vegetation and habitat types. – In: Catsadorakis G. & Källander H. (eds.), The Dadia-Lefkimi-Soufli Forest National Park, Greece: biodiversity, management and conservation, p. 85–93. – WWF Greece, Athens.

Korakis G., Gerasimidis A. & Kati V. 2010. The flora. – In: Catsadorakis G. & Källander H. (eds.), The Dadia-Lefkimi-Soufli Forest National Park, Greece: biodiversity, management and conservation, p. 63–83. – WWF Greece, Athens.

Korakis G., Gerasimidis A., Poirazidis K. & Kati V. 2006. Floristic records from Dadia-Lefkimi-Soufli National Park, NE Greece. – Flora mediterranea 16: 11–32. <http://www.herbmedit.org/flora/16-011.pdf>.

Pavlova D. 2009. *Onosma bulgarica* sp. nov. (*Boraginaceae-Lithospermeae*) found on serpentine in Bulgaria. – Nordic Journal of Botany 27(3): 216–221. <https://www.researchgate.net/profile/Dolja_Pavlova/publication/230014210_Onosma_bulgarica_sp_nov_Boraginaceae-Lithospermeae_found_on_serpentine_in_Bulgaria/links/548087550cf22525dcb5f305/Onosma-bulgarica-sp-nov-Boraginaceae-Lithospermeae-found-on-serpentine-in-Bulgaria.pdf

Pavlova D. K. 2014. *Silene fetlerii* (*Caryophyllaceae*), a new species from Bulgaria. – Annales botanici fennici 51(6): 387–393. <https://www.researchgate.net/profile/Dolja_Pavlova/publication/268216185_Silene_fetlerii_Caryophyllaceae_a_New_Species_from_Bulgaria/links/54be43100cf218d4a16a5714/Silene-fetlerii-Caryophyllaceae-a-New-Species-from-Bulgaria.pdf>.

Rechinger K. H. f. 1957. – Plantae novae graeco-macedonicae, imprimis serpenticolae. – Anzeiger der österreichischen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Klasse 1957(2): 21–27. <http://www.zobodat.at/pdf/AAWW_94_0001-0335.pdf>.

Sharma A. K. & Sharma A. S. 1965. Chromosome techniques. Theory and practice. – Butterworths, London.

Stefanović V., Tan K. & Iatrou G. 2003. Distribution of endemic Balkan flora on serpentine I. – obligate serpentine endemics. – Plant Systematics and Evolution 242(1–4): 149–170. <https://link.springer.com/content/pdf/10.1007%2Fs00606-003-0044-8.pdf>.

Strid A. & Tan K. 2004 ("2003"). New species of *Erodium* (*Geraniaceae*), *Onosma* (*Boraginaceae*) and *Centaurea* (*Asteraceae*) from northern Greece. – Phytologia balcanica 9(3): 471–478.

Tan K. & Petrova A. 2009. Nomenclatural notes. – Phytologia balcanica 15(2): 291–292. <http://www.bio.bas.bg/~phytolbalcan/PDF/15_2/15_2_15_Nomenclatural-notes.pdf>.

Teppner H. 1972. Cytosystematische Studien an *Onosma* (*Boraginaceae*). Die Formenkreise von *O. echioides, O. helveticum* und *O. arenarium*. – Berichte der deutschen botanischen Gesellschaft 84(11): 691–696. <https://static.unigraz.at/fileadmin/_Persoenliche_Webseite/teppner_herwig/Publicationen/Onosma_arenaria_etc._Ber.d.b.Ges._1972.pdf>

TEPPNER H. 1974. Karyosystematik einiger asiatischer *Onosma*-Arten (*Boraginaceae*), inkl. *O. inexspectatum* TEPPNER, spec. nov. – Plant Systematics and Evolution 123(1): 61–82.

<https://static.uni-graz.at/fileadmin/_Persoenliche_Webseite/teppner_herwig/Publicationen/Onosma__asiatische__PSE_1974.pdf>

TEPPNER H. 1988. *Onosma stridii* spec. nova (*Boraginaceae*) aus Griechenland. – Phyton (Horn, Austria) 28(2): 271–275. <http://www.zobodat.at/pdf/PHY_28_2_0271-0275.pdf>.

TEPPNER H. 1991a. 4. *Onosma* L. – In: STRID A. & TAN K. (eds.), Mountain flora of Greece 2: 26–39. – Edinburgh University Press.

<https://static.uni-graz.at/fileadmin/_Persoenliche_Webseite/teppner_herwig/Publicationen/teppner-1991-onosma-greece.pdf>.

TEPPNER H. 1991b. Karyology of some Greek *Onosma* species (*Boraginaceae*). – In: Proceedings of the VI OPTIMA-meeting, Delphi, 10–16 Sept. 1989. – Botanika Chronika 10: 271–292. <https://static.uni-graz.at/fileadmin/_Persoenliche_Webseite/teppner_herwig/Publicationen/teppner-1991-onosma-greece-karyology.pdf>.

TEPPNER H. 2012. Notes on the morphology and karyology of *Onosma fruticosa* (*Boraginaceae-Lithospermeae*) from Cyprus. – Phyton (Horn, Austria) 52(2): 301–320.

<https://static.uni-graz.at/fileadmin/_Persoenliche_Webseite/teppner_herwig/Publicationen/teppner-2012-Onosma_fruticosa_Phyton-52-2.pdf>.

TEPPNER H. & WETSCHNIG W. 1980. Zur Karyologie von *Poa hybrida*, *P. chaixii*, *P. sylvicola* und *P. stiriaca* (*Poaceae*) unter besonderer Berücksichtigung von B-Chromosomen. – Phyton (Horn, Austria) 20(1–2): 47–63. <http://www.zobodat.at/pdf/PHY_20_1_2_0047-0063.pdf>.

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