

## Lectotype Designation for Seven Species Names in the *Daucus guttatus* Complex (Apiaceae) from the Central and Eastern Mediterranean Basin

Fernando Martínez-Flores,<sup>1,4</sup> Carlos I. Arbizu,<sup>2</sup> Kathleen Reitsma,<sup>3</sup> Ana Juan,<sup>1</sup> Philipp W. Simon,<sup>2</sup> David M. Spooner,<sup>2</sup> and Manuel B. Crespo<sup>1</sup>

<sup>1</sup>Departamento de Ciencias Ambientales y Recursos Naturales and Centro Iberoamericano de la Biodiversidad, Universidad de Alicante, P.O. Box 99, ES-03080 Alicante, Spain

<sup>2</sup>U. S. Department of Agriculture, Agricultural Research Service, Vegetable Crops Research Unit; and Department of Horticulture, University of Wisconsin, 1575 Linden Drive, Madison, Wisconsin 53706-1590, U. S. A.

<sup>3</sup>North Central Regional Plant Introduction Station, Iowa State University, Ames, Iowa 50011-1170, U. S. A.

<sup>4</sup>Author for correspondence (f.martinez@ua.es)

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**Abstract**—The *Daucus guttatus* complex includes two to four species growing from central and northern Italy to the Middle East. They are characterized by being typically annuals up to 50 cm high; with primary umbels up to 7 cm in diameter with fewer than 25(35) rays; discolored umbels frequent, bearing one to several dark colored umbellules which form different color patterns; and mericarps relatively small, ca. 2.0–4.5 mm. The taxonomy of this complicated group has not been satisfactorily resolved to date and is the focus of current research. Seven names of species belonging to the *D. guttatus* complex occurring in the central and eastern Mediterranean basin are typified here: *Daucus guttatus*, *Daucus bicolor*, *Daucus involucratus*, *Daucus setulosus*, *Daucus broteri*, *Daucus hirsutus*, and *Daucus speciosus*. Historical data are reported to justify lectotype and/or epitype selection, and selected morphological and distributional data are used to facilitate identification. The resulting typifications will enable proper naming of clades identified in the accompanying integrated molecular and morphological study, clarifying the taxonomy of the *Daucus guttatus* complex.

**Keywords**—Carrot species, Mediterranean flora, nomenclature, typification.

*Daucus* L. (Apiaceae), containing the cultivated carrot, *D. carota* subsp. *sativus* (Hoffm.) Arcang., contains at least 20 (Sáenz 1981) and up to 60 (Zohary 1972) species. They are distributed throughout most of the world, but the major genetic variation is found in the Mediterranean basin, with only one species native to Oceania and three native to the Americas (Sáenz 1981). However, recent morphological and molecular studies (Martínez-Flores et al. 2012) have revealed the existence of still poorly understood or neglected taxa, which will increase the known diversity of the genus.

About 13 species are accepted to occur in the eastern and central Mediterranean areas (Sáenz 1981). Among them, *D. guttatus* Sm., *D. bicolor* Sm., *D. setulosus* Guss. ex DC., and *D. broteri* Ten. form a morphologically similar group, the ‘*D. guttatus* complex.’ They look like dwarf *D. carota*, usually annuals up to 50 cm high, with primary umbels up to seven centimeters in diameter with less than 25(35) rays. Furthermore, discolored umbels are frequent, bearing one to several dark colored umbellules which form different color patterns; mericarps are relatively small, ca. 2.0–4.5 mm, like in *D. carota*. Members of the *D. guttatus* complex are found from central and northern Italy to the Middle East (Okeke 1978a). Although the ‘*D. carota* complex’ is widely accepted to be the most variable group within Apiaceae (Thellung 1926; Heywood 1968), the ‘*D. guttatus* complex’ is also very complex and, in fact, its taxonomy has not been satisfactorily resolved to date (Spalik and Downie 2007; Arbizu et al. 2014b).

At the end of the 18th century, James Edward Smith (1759–1828), in preparing *Flora Graeca*, faced the titanic task of organizing specimens and drawings that John Sibthorp (1758–1796) had disorderedly accumulated during his travels through Greece and the Levant (Middle East). Sibthorp died of tuberculosis upon return from a trip to Greece before being able to complete his work. Smith was faced with a very difficult task, not only because of the huge amount of collected material but also because most of the specimens

were not annotated by Sibthorp (Stearn 1967). As Smith wrote: “There being no names to either specimens or drawings, except a few; which has occasioned me infinite trouble, and required eminent botanical knowledge in order to combine the materials together” (Stearn 1967).

In *Florae Graecae Prodromus*, Smith (1806) briefly described *Daucus guttatus*, *D. bicolor* and *D. involucratus*. He mentioned that *D. guttatus* exhibited a dark sterile flower in the middle of each umbellule, as well as many dark flowers in the central umbellule of the umbel. Contrastingly, *D. bicolor* was said to produce many dark fertile flowers in the central part of the umbel, with no dark flowers in the peripheral umbellules. And *Daucus involucratus* was said to exhibit few subequal flowers. In the protologue, Smith (1806) also referred to three illustrations (plates 269, 270, and 271) of the yet unpublished *Flora Graeca*. Thirteen years later Smith (1819) modified the descriptions of these species and added some additional information on the mericarps, together with the above cited three plates. He further suggested that *D. bicolor* might be a mere variety of *D. guttatus* and affirmed that *D. involucratus* was undoubtedly a different species.

These three species were retained and placed into *Daucus* section *Carota* DC. by de Candolle (1830), who also widened *D. guttatus* to include *D. hirsutus* DC. in synonymy. This is partly congruent with the previous treatment of Sprengel (1820), who accepted *D. guttatus* but included *D. bicolor* among synonyms of *D. carota* L. Furthermore, de Candolle (1830) described *D. setulosus* from southern Italy and placed this new species in *Daucus* section *Platyspermum* (Hoffm.) DC.

Tenore (1830) described *D. broteri* from central Italy. This species honored the Portuguese botanist Felix da Silva de Avellar, Brotero (Latinized as *Broterus*) (1744–1828), because Tenore misinterpreted Brotero’s (1804) concept of *D. muricatus* L. in Portugal. Tenore incorrectly regarded the Italian *D. broteri* as conspecific with the Portuguese plants but different from the original Linnaean definition of *D. muricatus*. He was

most probably misled by Sprengel's (1820) comment about *D. muricatus* being restricted to "Mauritania et Numidia arvis," and therefore not occurring in Europe.

Those four taxa in the *D. guttatus* complex have been interpreted quite differently in the last two centuries. However, two principal trends can be identified (Table 1) in which usually only two species are accepted. On the one hand, *Daucus broteri* has been considered a good species, and all other taxa in the complex have been synonymized or included usually in *D. guttatus* (Fiori and Paoletti 1900; Thellung 1926; Heywood 1968; Meikle 1977; Pignatti 1982; Jafri 1985). On the other hand, *D. broteri* has been included in *D. bicolor*, whereas *D. setulosus* has been included in *D. guttatus* (Boissier 1872; Cullen 1972; Zohary 1972; Okeke 1978a; Sáenz 1981; Reduron 2007).

Some studies of the genus strongly influenced the current treatment of the group and, in part, increased the confusion involving these species. Thellung (1926) considered *D. bicolor*, *D. guttatus* and *D. setulosus* as conspecific and belonging to *Daucus* section *Carota*. Furthermore, he created *Daucus* section *Pseudoplatyspermum* Thell. to accommodate only *D. broteri*. In the revision of the European taxa of *Daucus*, Heywood (1968) only accepted two taxa in the complex (*D. broteri* and *D. guttatus* [including *D. setulosus* and *D. bicolor*]). He mentioned that the base of spines was "markedly confluent and winged" in *D. broteri* (to form a "crest"), whereas it was "dilated but not markedly confluent" in *D. guttatus*. A careful examination of his species descriptions reveals that the mericarp size can also be diagnostic, being 4–6 mm long in *D. broteri* and 2–4 mm in *D. guttatus*. The remaining characters are almost identical in Heywood's concept of both species. Their geographical distributions are widely sympatric, extending through the eastern Mediterranean basin, although *D. guttatus* is found in a wider range than *D. broteri*. Interestingly, Heywood (1968) also included *D. guttatus* Sm. subsp. *zahariadii* Heywood, a new subspecies from Romania which has larger mericarps (3–4 mm) with 9–14 spines that are as long as or slightly longer than the mericarp width (in *D. guttatus* subsp. *guttatus*, mericarps are 2–3 mm long, bearing 7–8 spines which are twice as long as the mericarp width).

Meikle (1977) made interesting comments on the Cypriot species of *Daucus*. As did previous authors, he accepted *Daucus broteri* and *D. guttatus*, and also referred to features of spine base fusion as diagnostic for species differentiation. Furthermore, he argued that both species are usually distinguishable by the longer filiform or setaceous bracts of *D. guttatus*. He also believed that both species, though evidently different enough in some areas, were not always sat-

isfactorily separated. Meikle (1977) considered it correct to include *D. bicolor* in *D. guttatus*, and he also mentioned that the most common "variety" of *D. guttatus* ('*D. setulosus* Guss. '), which he never saw in Cyprus, produced very long and narrow bracts reminiscent of those of *Nigella damascena* L.

In an almost neglected but comprehensive study of the genus *Daucus* worldwide, Okeke (1978a) treated *Daucus bicolor* and *D. broteri* as conspecific (the latter being a synonym). *Daucus bicolor* was placed in *Daucus* section *Pseudoplatyspermum*. He treated *Daucus guttatus* and *D. setulosus* as conspecific (the former name having priority) but placed in *Daucus* section *Daucus*. They were basically distinguished from each other by the morphology of bracts and mericarps (i.e. cross section morphology, spine length and presence of basal crest). Okeke (1978a) argued that there was insufficient evidence to recognize the infraspecific taxa in *D. guttatus* that other authorities had previously accepted based on mericarp characters (e.g. *D. guttatus* var. *setulosus* Boiss., *D. guttatus* var. *brachylaenus* Boiss., or *D. guttatus* subsp. *zahariadii*). Nonetheless, he recognized infraspecific taxa in *D. bicolor*, based on the presence or absence of central purple flowers in umbels.

Sáenz (1981) also studied *Daucus* morphology and anatomy on a world scale. Her treatment was similar to Okeke (1978a), although she transferred *D. bicolor* to *Daucus* section *Platyspermum* together with *D. muricatus* and *D. littoralis* Sm. Among other characters, she focused on morphology of mericarp vittae as a diagnostic character for species identification. Mericarp vittae of oval sections were found in *D. bicolor*, whereas vittae of triangular sections occurred in *D. guttatus*.

Although only two species of the *D. guttatus* complex (*D. bicolor* and *D. guttatus*) were accepted in the most recent comprehensive revisions by Okeke (1978a) and Sáenz (1981), the taxonomy of the '*D. guttatus* complex' is far from resolved and there is no consensus on its component species. Over the last 15 yr, three taxa (*D. guttatus*, *D. bicolor* and *D. broteri*) are usually accepted in most publications that include species of *Daucus* (Lee and Downie 1999; Baranski et al. 2006; Spalik and Downie 2007; Iovene et al. 2008; Spalik et al. 2010; Vandeloos et al. 2012; Spooner et al. 2013; Arbizu et al. 2014a, b). However, those three names are not consistently used, which generates more confusion about this taxonomically difficult complex. For example, the same specimen PI 286611 in the United States Department of Agriculture (USDA), Agricultural Research Service (ARS), National Plant Germplasm System (NPGS) collection has been named *D. bicolor* subsp. *broteri* (Ten.) Okeke (Lee and Downie 1999) or *D. broteri* (Spalik and Downie 2007), without consistent arguments supporting any treatment.

TABLE 1. Principal taxonomic treatments of the '*Daucus guttatus* complex' in the last two centuries.

	<i>D. guttatus</i>	<i>D. bicolor</i>	<i>D. setulosus</i>	<i>D. broteri</i>
	1806	1806	1830	1830
Boissier 1872	<i>D. guttatus</i>	<i>D. bicolor</i>	<i>D. guttatus</i>	<i>D. bicolor</i>
Thellung 1926	<i>D. setulosus</i> section <i>Carota</i>	<i>D. setulosus</i> section <i>Carota</i>	<i>D. setulosus</i> section <i>Carota</i>	<i>D. broteri</i> section <i>Pseudoplatyspermum</i>
Heywood 1968	<i>D. guttatus</i>	<i>D. guttatus</i>	<i>D. guttatus</i>	<i>D. broteri</i>
Okeke 1978a	<i>D. guttatus</i> section <i>Daucus</i>	<i>D. bicolor</i> section <i>Pseudoplatyspermum</i>	<i>D. guttatus</i> section <i>Daucus</i>	<i>D. bicolor</i> section <i>Pseudoplatyspermum</i>
Sáenz 1981	<i>D. guttatus</i> section <i>Daucus</i>	<i>D. bicolor</i> section <i>Platyspermum</i>	<i>D. guttatus</i> section <i>Daucus</i>	<i>D. bicolor</i> section <i>Platyspermum</i>
Pignatti 1982	<i>D. guttatus</i>	<i>D. guttatus</i>	<i>D. guttatus</i>	<i>D. broteri</i>
Reduron 2007	<i>D. guttatus</i>	<i>D. bicolor</i>	<i>D. guttatus</i>	<i>D. bicolor</i>

Recent DNA sequence phylogenies have yielded contrasting results. According to Lee and Downie (1999), nuclear ribosomal ITS sequences show that *Daucus bicolor* subsp. *bicolor* from Israel and *D. bicolor* subsp. *broteri* from Lebanon nest in a single terminal clade, which is sister to *D. pusillus* Michx. However, only eight species of *Daucus* (out of 21 species according to Sáenz 1981) were included in their analyses. More recently, Spalik and Downie (2007) examined another taxon of the complex, identified as *D. guttatus* from Greece. The ITS cladogram included 19 species of the genus, and showed that *D. bicolor* (+ *D. broteri*) and *D. guttatus* belong to two different lineages. Thus the *D. guttatus* complex was found to be non-monophyletic.

Spooner et al. (2013) studied the phylogeny of 22 accessions of *Daucus* with eight nuclear orthologs and one plastid region. In their phylogenetic tree, *Daucus broteri* and *D. littoralis* form a clade sister to *D. involucratu*s, whereas *D. guttatus* and *D. pusillus* form a clade sister to *D. glochidiatus*. A later analysis using 94 nuclear orthologs from 92 accessions of *Daucus* (Arbizu et al. 2014b) placed taxa in the *D. guttatus* complex into three well-supported clades. *Daucus guttatus*-1 nested with *D. littoralis*, *D. guttatus*-2 with *D. pusillus*, and *D. guttatus*-3 with *D. involucratu*s. Arbizu et al. (2016; a companion paper in this volume) expanded this study considerably with the examination of 83 accessions of 15 species and three subspecies of *Daucus*, with a focus on the *D. guttatus* complex, and with a parallel set of accessions for morphological analyses. They supported four species in the *D. guttatus* complex. The main objective of the present study is to designate types for taxa commonly included in the *D. guttatus* complex, namely *Daucus guttatus*, *D. bicolor*, *D. setulosus*, and *D. broteri*, and some of their related taxa. This clarification of the nomenclature is needed as a counterpart to the molecular and morphological study of Arbizu et al. (2016) and to clarify names for future floristic, monographic, and phylogenetic studies of *Daucus*.

#### MATERIALS AND METHODS

Original material conserved at FI, G, NAP, OXF, and RO was consulted for typification. In addition, specimens from ABH, BOLO, C, HG, K, MA, P, RNG, UPA, and W (Appendix 1), and accessions from the United States National Plant Germplasm System used in the study of Arbizu et al. (2016) were analyzed to ensure and clarify the identity of the taxa studied here. These accessions consist of seeds collected in Greece, Syria, and Turkey, as well as plants grown from them; all are maintained at the North Central Regional Plant Introduction Station (NCRPIS) in Ames, Iowa. Original materials of Caruel (FI!), Cesati (RO!), Gussone (G!), Smith (OXF!), and Tenore (NAP!) were regarded as the best choice for lectotypification according to Art. 9.3a of the *Melbourne Code* (ICN; McNeill et al. 2012). The typifications in Okeke's (1978a) PhD thesis were not effective according to Art. 29.1 of the ICN (despite the thesis having been recently published online in a pdf format by the University of Reading, the electronic online publication lacks an ISBN or ISSN number).

#### RESULTS AND DISCUSSION

*DAUCUS GUTTATUS* Sm. in Sibth. & Sm., Fl. Graec. Prodr. 1(1): 184. 1806.—TYPE: Imprecise, including a wide area in the eastern Mediterranean basin: "In insulis Graeciae frequens; etiam in Asiâ minore," specimen not located. (lectotype, designated here: —[Icon in] Smith (1806), Flora Graeca Prodr., Tab. 269; excluding explicitly the drawings of the fruit, Fig. S1). (epitype, designated here:

specimen grown from seed collected in SYRIA. Al Badrusiyah: 35.878 N, 35.884 E, 30 m, 29 Jul 1999, B. Al-Safadi, T. Kotlinska, P. Simon, cultivated in Ames Iowa, Aug 2014, and labeled as PI 652342, Fig. 1; Fig. S2, S3A (ABH-72382!)).

**Observations**—Smith (1806) first described this species with a brief sentence: "643. *D. guttatus*, pilis caulinis patentibus, involucre umbellâ brevioris, involucellis membranaceis, flosculis centralibus abortivis discoloribus. Involucra foliola integra, trifida, vel pinnatifida. Flosculi centrales in umbellulis omnibus, ut et tota umbella centralis, atrosanguinei et abortivi." "643. *D. guttatus*, with patent hairs on stems, involucre [bracts] shorter than the umbel, involucels [bracteoles] membranaceous, with the central flowers aborted, discolor. Bracts entire, trifid or pinnatifid. Central flowers in all umbellules, as well as the whole central umbel [erroneously referred; must read 'central umbellule'], dark-red colored and aborted." The type locality was imprecise and includes a wide area in the eastern Mediterranean basin, "In insulis Graeciae frequens; etiam in Asiâ minore." "[It is] frequent in the islands of Greece; also in Asia Minor."

The morphological description and illustration in the protologue (Icon. Fl. Graec. t. 269) show the special disposition of dark flowers (Fig. S1). According to Smith (1806), all flowers in the 'central umbel' are pigmented, whereas the peripheral umbellules show only one pigmented flower in the center. Most probably this remarkable character led Smith to choose the specific epithet '*guttatus*' (*gutta* = drop, spot-like mark), referring to the dark spotted appearance of the whole flowering inflorescence (Fig. S3B). According to our observations, that color pattern is not present in any other described species of *Daucus*, since when dark flowers are present in other species they occur in only one or a few umbellules in the central part of the umbel (Martínez-Flores et al. in prep.). Smith (1806) also remarked that bracts are entire, trisect or pinnatisect, and do not exceed the umbel perimeter. However, the illustration in the protologue (Fl. Graec. t. 269) only shows bracts entire or trisect. The combination of those morphological characters is extremely infrequent in the genus, and therefore is regarded here as diagnostic for identification of *D. guttatus*.

In the protologue, no data are included on mericarps. Nonetheless, mericarps are depicted in the illustration cited by Smith (1806). Additional data on fruits are mentioned in the amplified description of Smith (1819): "Fructus elliptico-oblongus, undique muricatus. Semina intus plana, commissurâ sulcatâ, lanceolatâ; extus quadricostata, interstitiis pilosis, costis omnibus muricato-setosis, setis patentibus, laevibus, basi complanatis, apice furcato-aduncis". "Fruit elliptic-oblong, muricate. Seeds [mericarps] smooth on the inner side, the commissure sulcate, lanceolate; on the outer side 4-ribbed, pilose on the intercostal surfaces, muricate-setose on all ribs, with patent setae [spines], which are smooth and flattened at the base and furcate-hooked at the apex." Unfortunately, those features are common to mericarps of most species in the genus. More informative is the illustration itself, in which 9–10 spines per secondary rib are evident. The spines are slender and longer than the mericarp width, and they show a narrow basal crest. Smith's (1806) illustration does not depict mature fruiting umbels, and, therefore, the mericarp it includes (marked F and f in the illustration, Fig. S1) could be immature and hence atypical, or even could come from another unidentified specimen. Mericarps of *D. setulosus* are very much like of those in



FIG. 1. Details of epitype of *Daucus guttatus* Sm. (ABH-72382), reproduced with permission (see also Fig. S2 and S3).

the cited illustration, and also some materials labelled as '*D. guttatus*' in the Sibthorpien Herbarium (OXF) indeed correspond to *D. setulosus* (e.g. Sib-0643). Consequently, we prefer to exclude mericarps drawings from the lectotype.

No material apparently exists in the Sibthorpien Herbarium (OXF) explicitly collected 'In insulis Graeciae frequens; etiam in Asiâ minore' ([It is] frequent in the islands of Greece; also in Asia Minor), or in a locality fitting that geographic area. However, the number '643' cited in the protologue allows tracing four specimens labelled '*Daucus guttatus*' (Sib-0643, Sib-0643a, Sib-0643b, and Sib-0643c), of which only two (Sib-0643 and Sib-0643c) are marked '*guttatus*' in Smith's handwriting. The specimen Sib-0643 has immature fruits and flowers, the umbels lacking the typical color pattern characterizing *D. guttatus*. However, the overall traits of the plant on the sheet Sib-0643 match perfectly *D. setulosus* as here circumscribed. The specimens Sib-0643a and Sib-0643c lack well-developed flowering umbels; their fruiting umbels include mature fruits which do not fit the typical fruit pattern of *D. guttatus* (see below). Finally, the specimen Sib-0643b shows characters in serious conflict with the protologue (see *D. bicolor*).

The specimen Sib-0643a was marked as 'holotype' of *Daucus guttatus* Sm. by Pimenov (in sched.; December 2005) In our opinion, this designation is not adequate, given the morphological features conflicting with the protologue, and the lack of any annotation by Smith. Flowers are explicitly cited as diagnostic characters (Smith 1806), and they are absent in that material. Furthermore, when comparing the mericarp depicted in 'Fl. Graec. t. 269' with those in Sib-0643a, they strongly differ in the number of spines per rib. These facts indicate that other materials were likely used for the original description, and Sib-0643a is not the holotype. Furthermore, that specimen is not acceptable as lectotype since it is in serious conflict with the protologue, and hence is to be superseded (Art. 9.19b).

Accordingly, the best choice for lectotype is the color illustration 'Fl. Graec. t. 269', since it is original material and matches the protologue. It is selected here as lectotype of *D. guttatus*. However, the drawing of the mericarp should be excluded since it probably belongs to another taxon. For that reason, an epitype is designated here to support the lectotype (Art. 9.8). The specimen (ABH-72382) associated with accession PI 652342 (USDA, ARS, National Plant Germplasm System) fully matches the concept of *D. guttatus* and is in full accordance with the lectotype and the protologue (Fig. 1; Fig. S2, S3A). Furthermore, seeds from this accession are conserved in the USDA, ARS, NPGS and DNA of this specimen was used for molecular phylogenies (Arbizu et al. 2016).

**Remarks on Morphology and Distribution**—After the study of selected herbarium specimens (Appendix 1), we consider that *D. guttatus* can easily be recognized on the basis of the following: Bracts are mostly trisect (sometimes accompanied by entire and occasionally 5-segmented bracts), with the central segment of bracts narrowly elliptic and usually longer (generally 1.5–2.0) than the lateral ones, and not exceeding (or occasionally equaling) the umbel perimeter. That ratio can vary with fruit ripening, the umbels increasing in diameter and hence the bracts being proportionally shorter. The flowering umbel typically shows 1–4 central umbellules with some (or rarely all) flowers dark pigmented, and all or most surrounding umbellules produce one dark flower in the center (Fig. S3A, B). We have never observed this pattern of umbellules with a central dark 'drop' in any other species of

*Daucus* and it seems to be one of the best discriminating characters to distinguish taxa in the *Daucus guttatus* complex (see additional data in Arbizu et al. 2016). Occasionally, some individuals of natural populations can produce peripheral umbellules without dark flowers. The rays of the umbel mostly bear an indumentum formed with setulose hairs very densely disposed in the apical third, but sparsely arranged in the central part, and very loose to almost absent in the basal third (or half). Mericarps are small, ca. (2.0)2.5–4.5 mm long (excluding the style) and 1.0–1.5 mm wide (excluding the basal crest). Each secondary rib produces 6–8(9) spines, the central one (excluding the crest) 1–3 times longer than the mericarp width. Commonly, the basal crests are very well-developed and very apparent in mature fruits (0.3–1.0 mm wide), this being a morphological feature with high discriminating value (Arbizu et al. 2016). Provided that crests develop mostly in the final stage of ripening, crests of immature fruits can be inconspicuous or very reduced, which can lead to incorrect identifications.

*Daucus guttatus* s. s. is widespread in the eastern Mediterranean basin, usually in coastal environments (up to 100 km inland), in Libya, Lebanon, and Syria, with some scattered localities in northern Italy and Monte Carlo. It is very likely that other populations occur in similar habitats in the neighboring countries.

**Taxonomic clarifications**—The concept of *Daucus guttatus* has been misunderstood in taxonomic revisions of *Daucus* and in Mediterranean floras (e.g. Heywood 1968; Cullen 1972; Okeke 1978a; Sáenz 1981). According to those references, *D. setulosus* was included in *D. guttatus* to constitute a very complicated group with great morphological variability. What is worse, usually the distinguishing features of *D. guttatus* cited by the authors (e.g. aciform segments of bracts) actually correspond with the true *D. setulosus* (see below). It seems that Meikle (1977) suspected the complex to include two taxa at the varietal rank. Therefore, he mentioned that "the more common variety" of *D. guttatus* was "*D. setulosus*," which produced very long and narrow bracts 'remining one of *Nigella damascena*', whereas the specimens collected in Cyprus had 'relatively short involucre bracts' and corresponded with '*D. guttatus* var. *guttatus*'. According to our morphological revision and molecular analyses (Arbizu et al. 2016), *D. guttatus* and *D. setulosus* are clearly two different species, and most citations of *D. guttatus* probably correspond to *D. setulosus* sensu stricto.

**DAUCUS BICOLOR** Sm. in Sibth. & Sm., Fl. Graec. Prodr. 1(1): 184. 1806.—TYPE: Imprecise, Anatolian Peninsula, Turkey, specimen not located. (lectotype, designated here: [Icon in] Smith (1806), Flora Graeca Prodr., Tab. 270, Fig. S4). (epitype, designated here: specimen grown from seed collected in TURKEY. Antalya: 36.82 N, 31.45 E, 18 m, 12 Aug 1999, T. Kotlinska, S. Kucuk, P. W. Simon, cultivated in Ames Iowa, Aug 2014, and labeled as PI 652390, Fig. 2; Figs. S5, S6A (ABH-72383)).

**Observations**—In the protologue, Smith (1806) indicated "644. *D. bicolor*, pilis patentibus, involucro trifido umbellâ longiore, involucellis hinc membranaceis, umbellulâ centrali discolori. Icon. Fl. Graec. t. 270. In Asiâ minore. Involucra foliola omnia trifida. Umbella centralis tota purpurea, fertilis; reliquae albae." "644. *D. bicolor*, with patent hairs, involucre [bracts] trifid, longer than the umbels [exceeding the umbel perimeter], involucre [bracteoles] here membranaceous, with



FIG. 2. Detail of epitype of *Daucus bicolor* Sm. (ABH-72383), reproduced with permission (see also Fig. S5 and S6).

the central umbellule discolored. Icon. Fl. Graec. t. 270. In Asia Minor. All bracts trifid. Central umbel [erroneously referred; must read 'central umbellule'] completely purple-colored, fertile; the rest white." The type locality corresponds to the Anatolian Peninsula in Turkey.

No data on mericarp morphology were mentioned in the protologue, nor were fruits drawn in the illustration ('*Flora Graeca tabula 270*') cited there (Fig. S4). Mericarp features are very useful for taxonomic differentiation in *Daucus* (Okeke 1978a; Sáenz 1981). In a later edition, Smith (1819) added "germen hispidum," "fruit [mericarp] hispidous," to complete his first description. However, this feature is applicable to almost all species of *Daucus*, and hence not useful here as a diagnostic character.

Consequently, other diagnostic characters need to be found in the lectotype and the protologue of *D. bicolor* for an unequivocal identification, a task that is usually difficult in taxa of *Daucus*. Nonetheless, a particular syndrome of characters of the flowers and bracts is found in this species which is not present in any other known taxon of the genus. In both the original description and the illustration of *D. bicolor* (Smith 1819), bracts are trisect and much exceeding the umbel perimeter, and a typically wide central area of the umbel is formed with many dark colored fertile flowers which are accompanied by a single row of umbellules bearing only white flowers (Fig. S4). All these characters together are diagnostic for *D. bicolor*, and the eventual type material should match them.

In Sibthorp's herbarium at OXF, no vouchers were found fitting the sentence 'In Asiâ minore' nor anything similar. The specimen 'Sib-0644' bears two handwritten annotations with question marks in pencil (by Hermia Clokie; Stephen Harris pers. comm.): 'An *Daucus* / *bicolor*?', 'Prodromus Fl. Graecae [printed] Vol I p. 184 n 644? / Flora Graeca [printed] t. 270'. The first one is on a label in Smith's handwriting (Stephen Harris pers. comm.), providing evidence that Smith was doubtful about the full correspondence between the voucher and the described taxon. This is understandable due to the extremely difficult task Smith faced with Sibthorp's collections (Stearn 1967). The second annotation is on the herbarium sheet itself, and is difficult to attribute to any author, although it surely is not Smith's or Sibthorp's handwriting. It perhaps belongs to an assistant responsible for organizing the collection on its return to Oxford (Stephen Harris pers. comm.). The specimen 'Sib-0644' was marked as 'holotype' of *Daucus bicolor* Sm. by Pimenov (in sched. December 2005), a conclusion that apparently was never validly published. Furthermore, Pimenov's selection of 'Sib-0644' as 'holotype' should be corrected to 'lectotype' (Art. 9.9). Nevertheless, such 'lectotypification' cannot be accepted and is to be superseded since the selected specimen shows characters that are in serious conflict with the protologue (Art. 9.19b), i.e. most bracts have 4–6 lateral segments (they are not constantly trisect) and do not exceed the umbel perimeter, and also no purple flowers are found in the central part of the flowering umbels. In summary, these and other morphological features in 'Sib-0644' lead us to treat it as belonging to *D. setulosus*.

Accordingly, the only suitable original material of *D. bicolor* is the 'Icon. Fl. Graec. t. 270', here selected to be the lectotype. However, the lectotype has no fruits, a character extremely important for species identification in *Daucus* (Okeke 1978a; Sáenz 1981), justifying an epitype designation (Art. 9.8).

Provided that no suitable material is extant in Sibthorp's Herbarium, the best choice for an epitype of *D. bicolor* is any fruiting material whose origin is fully traced, fulfilled by accession PI 652390 from the seed collection in the USDA, ARS, NPGS. Seeds in that accession were collected in Antalya Province (SW Turkey) in 1999, this fitting the type locality 'Asiâ minore.' Plants grown from those seeds match perfectly the diagnostic features in the lectotype (Fig. 2; Figs. S5, S6A, B, C), and therefore one of them (here chosen as specimen ABH-72383) is selected here as epitype to support the lectotype (Art. 9.8).

The specimen 'Sib-0643b' from the Sibthorpien Herbarium (OXF) shows morphological characters perfectly fitting the protologue (Smith 1806), though it is labelled '*D. guttatus*' (Fig. S7). It is very likely that the labelling was a mistake; however, that specimen was not cited by Smith and also lacks fruits, and therefore is not a good choice for epitype.

**Remarks on Morphology and Distribution**—Based on our study of herbarium specimens (Appendix 1), we consider that several characters are diagnostic for the identification of *D. bicolor*. Bracts are mostly trisect (sometimes accompanied by entire and occasionally 5-segmented bracts), with the central segment narrowly elliptic and markedly longer (usually twice or more) than the lateral ones, and exceeding the umbel perimeter. These relatively long bracts have been reported as a good discriminating character (see additional information in Arbizu et al. 2016). The umbel usually shows a dark colored central area (up to a half of the umbel diameter), contrasting greatly with the peripheral white-flowered umbellules, a feature that is probably responsible for the specific epithet chosen by Smith (1806). Several central umbellules with all flowers dark colored give the characteristic bicolored aspect to the umbel (Fig. S6B, C). However, some individuals, such as living plants from accession PI 652390, have umbels lacking or with only a few pigmented flowers. Other species such as *D. carota*, *D. conchitae* (Arbizu et al. 2016), *D. gracilis* Steinh., *D. guttatus* and *D. setulosus* also produce pigmented flowers, but the dark area of the umbel is much reduced (pigmented diameter less than 1 cm) when compared with the typical *D. bicolor* (pigmented diameter up to 2.7 cm according to Arbizu et al. 2016) and only comprises 1–4 umbellules. The rays of the umbel mostly bear a distinctive indumentum formed with setulose hairs, densely disposed in the apical third of the ray, but sparsely arranged in the central part, and almost absent in the basal third (or half). Mericarps are small, ca. 2.0–4.0 mm long (excluding the style), and 1.0–1.3 mm wide (excluding the basal crest). Each secondary rib produces (7)8–11 spines, the central one (excluding the crest) 2–3 times longer than the mericarp width. The basal crests are narrow in the mature fruits (0.1–0.2 mm wide), which is a useful discriminating character (see additional data in Arbizu et al. 2016).

Some individuals have a color pattern typical for *D. bicolor* (sensu stricto) but have bracts shorter than the umbel perimeter (P-02400223!, W-03641!, W-04534!). The rest of the characters match the morphological pattern described for the species.

*Daucus bicolor* s. s. is endemic to the western half of Turkey.

**DAUCUS INVOLUCRATUS** Sm. in Sibth. & Sm., Fl. Graec. Prodr. 1(1): 184. 1806.—TYPE: On the coast of the island of Cyprus: "In maritimis insulae Cypri," specimen not located. (lectotype, designated here:—*Daucus involucratus* Sibth. (Smith's handwriting) / Prodromus Fl. Graecae [printed] Vol I p 184 n 645 / Flora Graeca [printed] t271 (specimen



FIG. 3. Specimen Sib-0645 kept at the Sibthorpean Herbarium (OXF), reproduced with permission.



'Sib-0645', Sibthorpien Herbarium, OXF, [digital photograph!], Fig. 3). See Okeke (1978a: 223) for an incorrect (and not effective) 'holotype' (lectotype) selection.

**Observations**—Smith (1806) first described this species with a brief sentence: "645. *D. involucratus*, pilis patentibus, involucro pinnatifido umbellâ longiore, umbellulis paucifloris uniformibus, involucellis angustatis." "645. *D. involucratus*, with patent hairs, involucre [bracts] pinnatifid longer than the umbel, umbellules bearing few uniform flowers; involucels [with] narrow [bracteoles]." Additional data are mentioned in the amplified description of Smith (1819). Both morphological descriptions and the illustration in the protologue ('Icon. Fl. Graec. t. 271', Fig. S8) show a plant with proportionally large involucres, a remarkable character which probably led Smith to choose the specific epithet '*involucratus*'. Smith (1819) indicated that there were some affinities between *D. bicolor* and *D. involucratus*, although the latter is undoubtedly different.

The specimen 'Sib-0645' labelled '*Daucus involucratus*' from the Sibthorpien Herbarium (OXF) includes several incomplete fragments (Fig. 3) showing morphological characters perfectly fitting the protologue (Smith 1806). However, none of these fragments matches perfectly the illustration in table 271 (Fig. S8). Thus we cannot be completely sure that the specimen 'Sib-0645' was the only element used for the description. For this reason, we designate 'Sib-0645' as lectotype of *D. involucratus*. The specimen bears three handwritten annotations. The first one, '*Daucus involucratus* / Sibth.', is on a label presumably in Smith's handwriting. The second annotation is on the herbarium sheet itself, and reads 'Prodromus Fl. Graecae [printed] Vol I p. 184 n 645 / Flora Graeca [printed] t. 271.' Also in this case, it perhaps was written by an assistant who organized the collection on its return to Oxford (Stephen Harris pers. comm.). Finally, the third annotation is on a separate sheet by Pimenov (December 2005), who marked the specimen as 'holotype,' something that apparently was never published. Furthermore, Pimenov's selection of 'Sib-0644' as 'holotype' should be interpreted as 'lectotype' (Art. 9.9), but only if published.

Our morphological data agree with Smith's descriptions: *Daucus involucratus* is a tender plant characterized by long pedunculated umbels, pinnatisect bracts usually exceeding the umbel perimeter, and with very small flowers with subequal petals. In general terms, it is a species with no remarkable taxonomic problems, and the selected lectotype is easily identifiable, so that no further epitype designation is required.

*DAUCUS SETULOSUS* Guss. ex DC., Prodr. 4: 221. 1830.—TYPE: [ITALY]: "in Calabria et ad Neapolium", Gussone, s.d. (lectotype, designated here: ITALY. "*Daucus scabrosus* Bert. Fl. it. in. / *setulosus* Nob. in act. / N. [?] Soc. Borb. / Napoli / Calabria" (Gussone's handwriting) "Mr. Gussone / 1829." (de Candolle's handwriting) (G-00458301 [digital photograph!], the plant on the upper right side, Fig. 4; Fig. S9). See Okeke (1978a: 226) for an incorrect (and not effective) 'holotype' (lectotype) selection.

**Observations**—De Candolle (1830) described *Daucus setulosus* from material collected in Italy by Gussone, to whom he attributed authority of the name. Most of the characters mentioned by de Candolle in the brief description of the protologue are common in many species of *Daucus*. According to our observations, the most reliable diagnostic characters for an identification of this species are: the bracts of

the umbel multifid, divided into many long and narrow segments, the rays shortly and densely hairy almost all over and mericarps with spines longer than the whole mericarp width.

Among de Candolle's Prodromus herbarium at G, G-00458301 matches the protologue. It includes two plants and two different labels (Fig. 4). The fragment on the upper right side (numbered '1') shows flowering and fruiting umbels, and is connected to a larger label which reads "*Daucus scabrosus* Bert. Fl. it. in. / *setulosus* Nob. in act. / N[?] Soc. Borb. / Napoli / Calabria" in Gussone's handwriting and is annotated on the lower left side "Mr. Gussone / 1829" in de Candolle's hand (Fig. S9). The second fragment, on the lower left side of the sheet, only bears flowering umbels and is labelled "*Daucus*" by de Candolle. In the protologue, two localities are cited ("in Calabria et ad Neapolim") and very likely each plant on the sheet belongs to a different gathering from every locality. We have studied other collections by Gussone of *D. setulosus* from Naples (C-10008394!, FI-001466!, P-02461365!, P-02461370!, P-02461392!, P-02461406!; Appendix 1) and the specimens match perfectly with the uppermost individual of G-00458301.

Okeke (1978a) intended to indicate the 'holotype' of *Daucus setulosus* as follows: "In Calabria, et ad Neapolim, Gussone (G-DC holo!)". Since only one voucher labelled *D. setulosus* is conserved in de Candolle's herbarium (G-00458301), we accept that Okeke would have indicated indeed (though not effectively) a 'lectotype' when erroneously referring to a 'holotype' (Art. 9.9). However, G-00458301 includes two gatherings made at two different sites, and certainly it includes two different specimens as defined in the *Melbourne Code* (Art. 8.2). Therefore, we select here as lectotype the individual (specimen) on the upper right side of the sheet, marked '1' in pencil (Fig. S9). It is the best choice because it shows flowers and fruits, as described in the protologue.

In the protologue of *Daucus setulosus*, de Candolle (1830) cited *D. scabrosus* Bert. ex DC. and it therefore has sometimes been included in synonymy of *D. setulosus*. Bertoloni's original material apparently is lost and no vouchers are extant in 'Hortus Siccus Florae Italicae' at BOLO (Annalisa Managlia pers. comm.). Full confirmation of the identity of *D. scabrosus* is hence not possible. Furthermore, *Daucus scabrosus* is a nomen nudum without nomenclatural value, since it apparently was never effectively published, as mentioned by Bertoloni (1837). This latter author however included *D. scabrosus* as synonym of *D. setulosus*.

**Remarks on Morphology and Distribution**—Our herbarium specimen studies (Appendix 1) show *Daucus setulosus* to possess a very stable and distinctive combination of characters allowing easy recognition. These include most bracts divided into 4–8 lateral, very narrow segments (sometimes being partially bipinnatisect); sometimes very few entire or trisect bracts are also present; the apical segment linear-triangular ('aciform' according to Okeke 1978b) or narrowly elliptic, about equaling to much longer than the uppermost lateral ones. Very occasionally, some individuals in populations show umbels with all bracts trisect, a fact that can lead to misidentifications. Usually, those individuals are dwarf plants with very narrow segments, and they co-occur with other typical plants (e.g. MA-89235!). Bracts can vary from about equaling to long exceeding the umbel perimeter. Flowering umbels produce dark flowers in umbellules of the central area, and very commonly only 1–4 umbellules are responsible for the central dark spot, which is

comparatively small when compared with *D. bicolor* (see additional information in Arbizu et al. 2016). Usually, not all flowers in each umbellule become dark colored. In general, the rays of the umbel are very densely hairy throughout, although the indumentum is somewhat denser in the apical third and more loosely disposed to almost absent just at the base (1/4–1/8) of the ray. Mericarps are small, ca. 2.0–3.0 mm long (excluding the style) and 0.5–1.0 mm wide (excluding the basal crest). Each secondary rib produces 5–11 spines, the central one (excluding the crest) 1.5–3.0 times longer than the mericarp width. The basal crests are narrow in mature fruits (0.2–0.3 mm wide). For taxonomic clarifications on *D. setulosus*, see previous comments on *D. guttatus* and Arbizu et al. (2016).

*Daucus setulosus* occurs in coastal areas of the Eastern Mediterranean basin, namely in Italy, Greece, Romania, western Turkey and the western coast of Libya.

DAUCUS BROTERI Ten., Syll. Pl. Fl. Neapol. App. 3. IV. 1830. — TYPE: [ITALY]: Aprutti. (lectotype, designated here: ITALY. “*Daucus setulosus* Guss. *Broteri* Ten. Var. A. *Daucus muricatus* Broter. non L. Turro in Abruzzo” (Erbario Tenoreano campioni 7, fasc. 32, record number 3906 [digital photograph!], the taller plant bearing two fruiting umbels; Fig. 5)).

**Observations**—Tenore (1830) described *Daucus broteri* in a comment following the text of *Daucus muricatus*. The description is brief and the most reliable characters it includes are the bracts mostly trisect (‘subtrifida’ in the Latin sentence) and shorter than the umbel perimeter, and the mericarps with 6–8 spines per secondary rib, which exceed markedly the mericarp width and are fused in a basal crest. Morphological similarities to *D. muricatus* were also mentioned by Fiori (1923), who treated *D. broteri* and *D. bicolor* (including *D. setulosus*) as varieties within *D. muricatus*.

Some authors (i.e. The Plant List: [www.theplantlist.org/tpl1.1/record/kew-2757933](http://www.theplantlist.org/tpl1.1/record/kew-2757933)) have changed the original spelling ‘*broteri*’ with ‘*broteroi*’, based on the Portuguese name ‘Brotero.’ Although both spellings are correct depending on the context in which they are used, in the case of *D. broteri* no changes are acceptable. The Latin form ‘*Broterus*’ is correct as used by Tenore (1830), and therefore the genitive case ‘*Broteri*’ should not be modified for this species, as accepted in IPNI (2015).

We were successful in locating original material of *D. setulosus* as cited by Tenore (1830). In the ‘Erbario tenoreano’ at NAP, the specimen numbered ‘fascicolo 32, campioni 7’ bears a label fitting the protologue, which reads: “*Daucus setulosus* Guss. *Broteri* Ten. Var. A. *Daucus muricatus* Broter. non L. Turro in Abruzzo”. The crossed out name, ‘*Daucus setulosus* Guss.’, coincides with the indication in the protologue about Tenore’s first identification of the plant he collected during some of his travels in Abruzzo, which were published later (Tenore 1832). The sheet includes several fragments and labels, though no clear correspondence exists among them. We designate here as lectotype of *D. broteri* the taller individual, which shows two fruiting umbels.

Caruel (1862) misinterpreted the concept of *D. broteri*, which he considered to be a plant from Portugal conspecific with *D. muricatus*, and proposed to apply the alternative name ‘*Daucus michelii*’ to a plant collected in several localities from the northern half of the province of Tuscany (north-western Italy). Caruel explicitly indicated that his new

binomial honored Pietro A. Micheli (1679–1737), who supposedly had first discovered the plant. However, *D. michelii* is a nomen nudum without nomenclatural value because no Latin description or diagnosis was connected to that name (Art. 38 Ex. 1). In addition, the earlier *D. broteri* was included among synonyms of *D. michelii*, which also made the latter name nomenclaturally superfluous when published and hence illegitimate (Art. 52.1). Thus, *D. michelii* should be excluded from synonymy of *D. broteri*.

**Remarks on Morphology and Distribution**—Based on our study of herbarium specimens (Appendix 1), we consider that *D. broteri* can be recognized by bracts mostly trisect (sometimes accompanied by entire and occasionally 5-segmented bracts), with the apical segment narrowly elliptic and longer (usually 1.5–2.0) than the lateral ones, not exceeding the umbel perimeter (very occasionally some individuals produce bracts slightly exceeding it, as in BOLO-0025500). That ratio can vary with fruit ripening, the umbels increasing diameter and hence the bracts being proportionally shorter, and also among different umbels in the same plant. The flowering umbel is usually concolored, with all flowers white, though we have observed some plants produce umbels with the central umbellule colored (with one or a few dark flowers). This character was not cited in Tenore’s (1830) protologue, and it very likely has led to misidentification as *D. broteri* of plants with concolored umbels belonging to other species of the *D. guttatus* complex in the eastern Mediterranean. The rays of the umbel mostly bear an indumentum formed with setulose hairs very densely disposed in the apical third, but sparsely arranged in the central part, and very loose to almost absent in the basal third (or half). Mericarps are small, ca. (2.0)2.5–4.5 mm long (excluding the style) and 1.0–1.5 mm wide (excluding the basal crest). Each secondary rib produces 5–8(9) spines, the central one (excluding the crest) 2–3 times longer than the mericarp width. Commonly, the basal crests are very well-developed, and very apparent in the mature fruits (0.4–1.0 mm wide). Given that they develop mostly in the final stage of ripening, crests of immature fruits can be inconspicuous or very reduced, which can lead to incorrect identifications.

*Daucus broteri* (s. s.) appears to be restricted to the central and northern parts of Italy.

*Daucus hirsutus* DC., Prodr. 4: 213. 1830.—TYPE: Imprecise, including a wide area in the eastern Mediterranean basin: “frequens in ins. Archipelagi et Asià minore”, specimen not located. (lectotype, designated here: — [Icon in] Smith (1806), Flora Graeca Prodr., Tab. 269; excluding explicitly the drawings of the fruit, Fig. S1).

**Observations**—*Daucus hirsutus* was described by de Candolle (1830) on the basis of Sprengel’s (1818) concept of *D. guttatus*. The protologue includes a short description: “caule pilis patentibus hirsuto, foliis bipinnatisectis, segmentis lanceolatis tenuissimè serrulatis, involucri foliolis integris 3-fidis pinnatifidisve umbellâ brevioribus, aculeis fructûs elongatis glochidiatis coloratis.” “stem hirsute with patent hairs, leaves 2-pinnatisect with lanceolate, slightly serrulate segments, involucre leaves [bracteoles] entire, trifid or pinnatifid, shorter than the umbel, spines of fruit elongated, glochidiate and reddish.”

This description matches well with our concept of *D. guttatus*. Furthermore, in the protologue de Candolle (1830) explicitly cited “tab. 269” from Smith (1819), an illustration

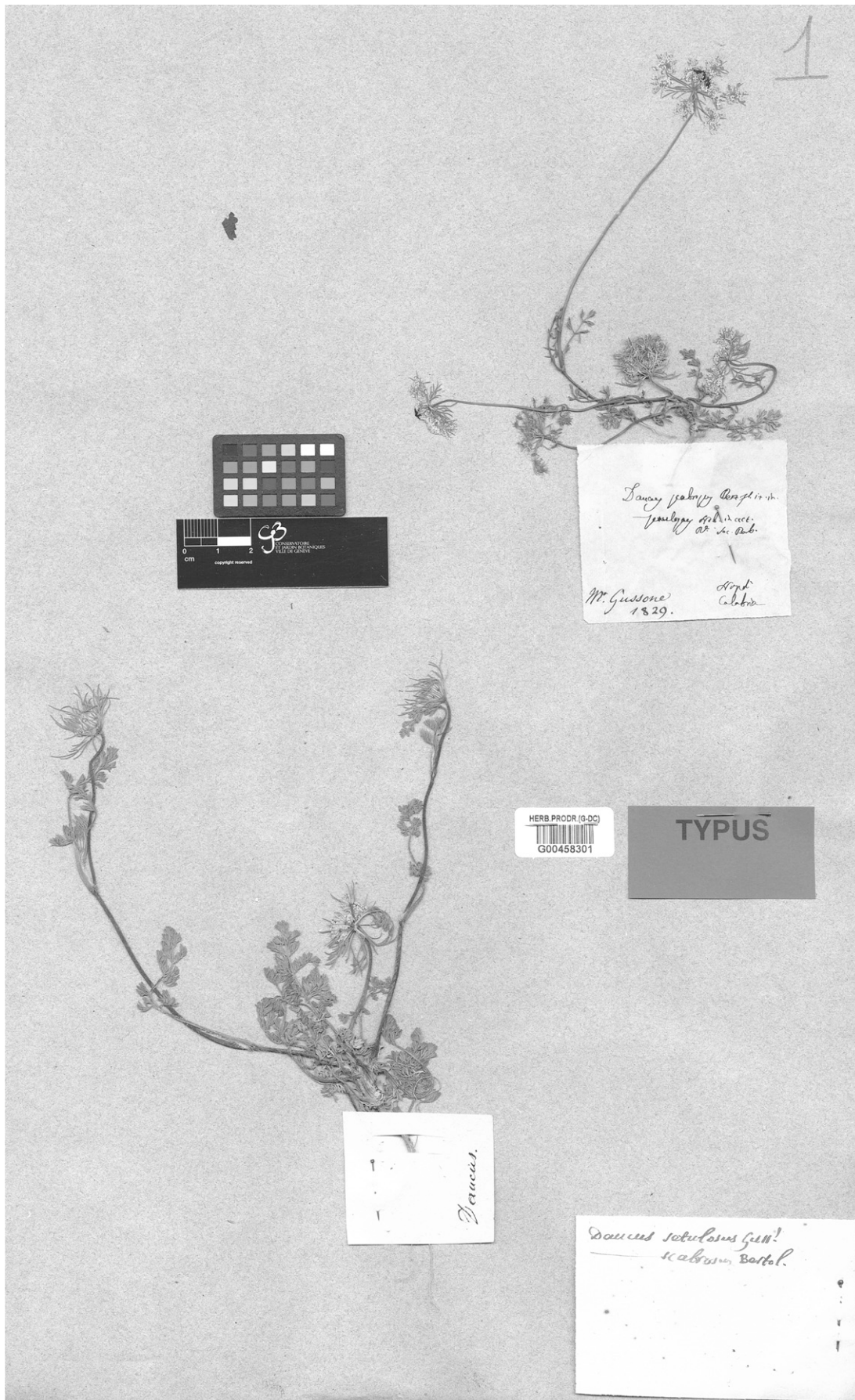


FIG. 4. Lectotype of *Daucus setulosus* (G-00458301): the plant on the upper right side. Reproduced with permission.

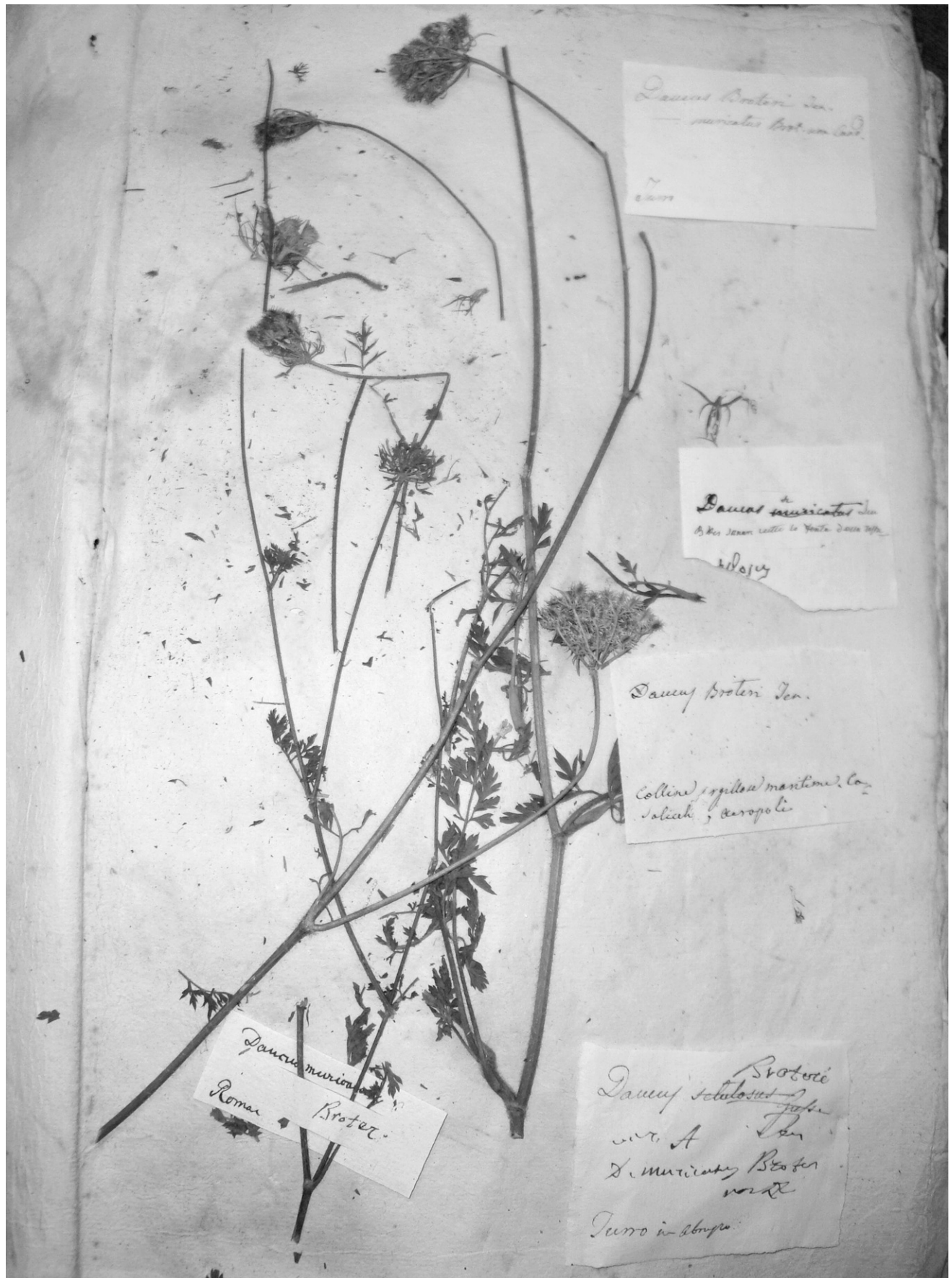


FIG. 5. Lectotype of *Daucus broteri* Ten. (NAP Erbario Tenoreano campioni 7, fasc. 32, record number 3906): the taller plant bearing two fruiting umbels. Reproduced with permission.

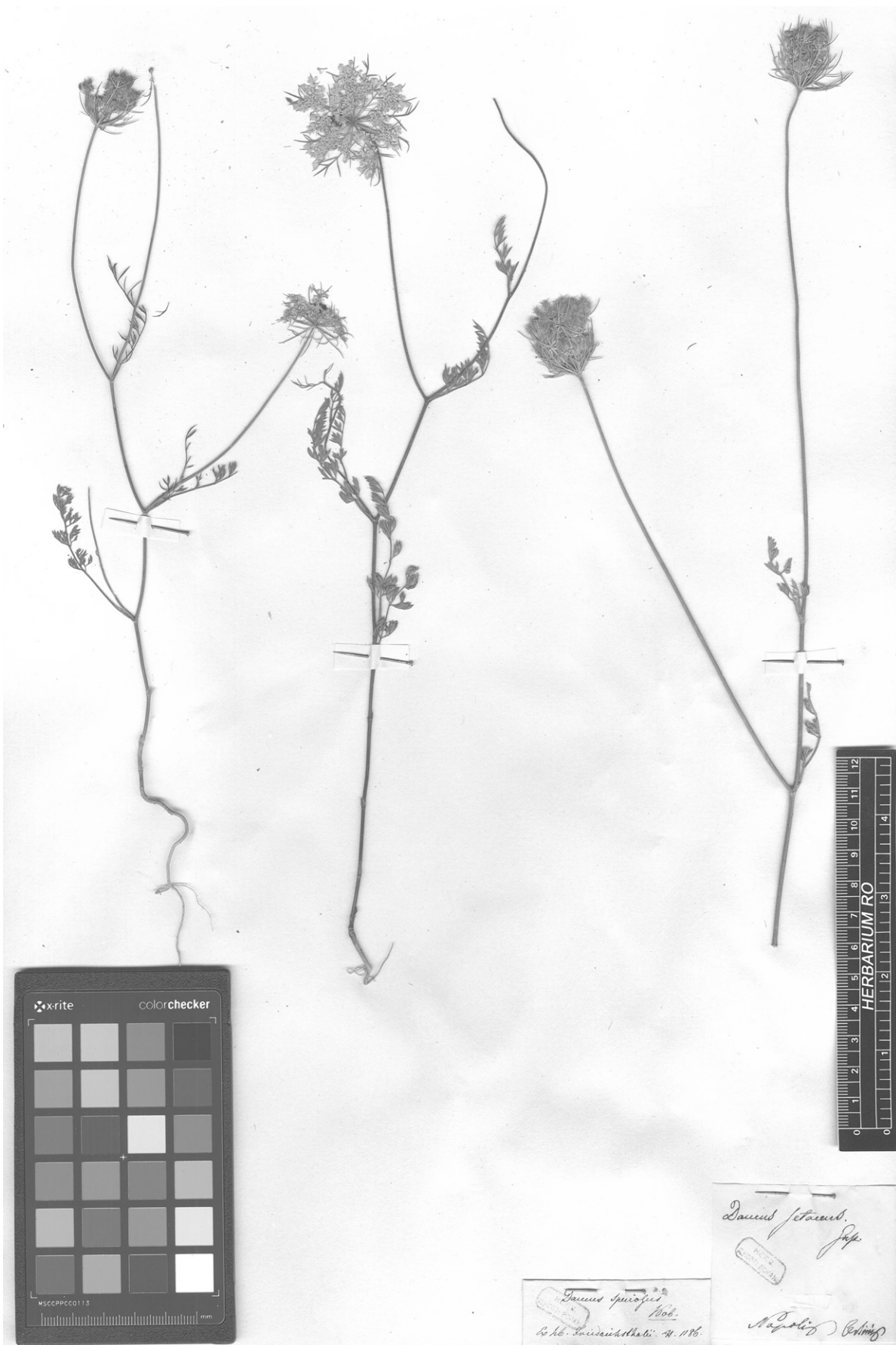


FIG. 6. Lectotype of *Daucus speciosus* Ces. (RO-HC): the fragment on the left side. Reproduced with permission.

designated here as lectotype of *D. guttatus*. No vouchers are currently found in G-DC labelled '*D. hirsutus* DC.' (Laurent Gautier pers. comm.), the cited illustration hence being the available original material for typification purposes. Therefore, we designate here 'Table 269' as the lectotype of that name, which makes it a homotypic synonym of *D. guttatus*.

*Daucus speciosus* Ces. in *Linnaea* 11: 322. 1837.—TYPE: [Greece]: "Aus Griechenland", Cesati. (lectotype, designated here: Greece. "*Daucus speciosus* / Nob. [Nobis] / Ex hb. Friedrichsthali. n. 1186." (Cesati's handwriting) and "*Daucus setaceus* / Guss. / Napoli" (unidentified handwriting). (RO-HC [digital photograph!], the plant on left side, Fig. 6).

**Observations**—According to the protologue (Cesati 1837), *D. speciosus* was described from a single and incomplete sample, lacking lower leaves and showing well-developed fruits. The plant was described by Cesati from among material collected in Greece, and distributed in exsiccata by E. von Friedrichsthal, although no direct mention was made to any collection or particular locality. We have found material at RO-Herbarium Cesatianum that is labelled *D. speciosus* and bears a label marked 'Ex herb. Friedrichsthali. n. 1186', among other data. Two specimens are found which include materials of a *Daucus* species. One of them bears a small fragment of an incomplete plant showing only immature flowering umbels, and it is labelled: "*Daucus* / *speciosus* / Nob. [Nobis] Bibl. Ital. / Ex Hb. Greco Friedrichsth. 1836. / Nauplis lectus [collected in Nafplion] (n. 1186)" (Cesati's handwriting). The other one bears three plants in different maturation stages (two of them with fully ripe fruits, and the third one with flowering umbels), which bear two different labels: "*Daucus speciosus* / Nob. [Nobis] / Ex hb. Friedrichsthali. n. 1186." (Cesati's handwriting) and "*Daucus setaceus* / Guss. / Napoli" (unidentified handwriting). Those labels are not clearly connected to the fragments. Both specimens match the concept of *D. speciosus*, and can be accepted as original material. Provided that the protologue emphasizes the fact that the type specimen lacked lower leaves, showed bracts exceeding the umbel perimeter and borne ripe fruits, we chose the lectotype to fit those characters. Among all those plants in the cited vouchers, only that on the left side of RO-HC matches the protologue, and therefore it is selected here as the lectotype of *D. speciosus*. This species name is regarded here as a synonym of *D. setulosus*.

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#### LITERATURE CITED

- Arbizu, C., K. R. Reitsma, P. W. Simon, and D. M. Spooner. 2014a. Morphometrics of *Daucus* (Umbelliferae): A counterpart to a phylogenomics study. *American Journal of Botany* 101: 2005–2016.
- Arbizu, C., H. Ruess, D. Senalik, P. W. Simon, and D. M. Spooner. 2014b. Phylogenomics of the carrot genus (*Daucus*, Apiaceae). *American Journal of Botany* 101: 1666–1685.
- Arbizu, C. I., P. W. Simon, F. Martínez-Flores, H. Ruess, M. B. Crespo, and D. M. Spooner. 2016. Integrated Molecular and Morphological Studies of the *Daucus guttatus* Complex (Apiaceae). *Systematic Botany* 41: 479–492.
- Baranski, R., M. Baranska, H. Schulz, P. W. Simon, and T. Nothnagel. 2006. Single seed Raman measurements allow taxonomical discrimination of Apiaceae accessions collected in gene banks. *Biopolymers* 81: 497–505.
- Bertoloni, A. 1837. *Flora Italica sistens plantas in Italia et in insulis circumstantibus sponte nascentes*, vol. 3. Bologna: Richardi Masii.
- Boissier, E. 1872. *Flora Orientalis sive enumeratio plantarum in Oriente a Graecia et Aegypto and Indiae fines hucusque observatarum* vol. 2. Geneva and Basel: H. Georg.
- Brotero, F. A. 1804. *Flora Lusitânica, seu plantarum, quae in Lusitania vel sponte crescunt, vel frequentius coluntur, ex florum praesertim sexibus systematice distributarum, synopsis* vol. 1. Lisboa: Regia.
- de Candolle, A. P. 1830. *Prodromus systematis naturalis regni vegetabilis, sive enumeratio contracta ordinum, generum, specierumque plantarum hucusque cognitarum, juxta methodi naturalis normas digesta* vol. 6. Paris: Treuttel et Würtz.
- Caruel, T. 1862. *Prodromo della flora toscana*. Florence: Felice Le Monnier.
- Cesati, V. 1837. Bemerkungen über einige Umbelliferen, in einem Schreiben an den Herausgeber. *Linnaea* 11: 313–325.
- Cullen, J. 1972. *Daucus* L. Pp. 531–536 in *Flora of Turkey and the East Aegean Islands* vol. 4, ed. P. H. Davis. Edinburgh: Edinburgh Univ. Press.
- Fiori, A. 1923. *Nuova flora analitica d'Italia, contenente la descrizione delle piante vascolari indigene inselvatichite e largamente coltivate in Italia* vol. 2. Florence: M. Ricci.
- Fiori, A. and G. Paoletti. 1900. *Flora analitica d'Italia* vol. 2(1). Padova: Tipografia del Seminario.
- Heywood, V. H. 1968. *Daucus* L. Pp. 373–375 in *Flora Europaea, Rosaceae to Umbelliferae* vol. 2, eds. T. G. Tutin, V. H. Heywood, N. A. Burges, D. M. Moore, D. H. Valentine, S. M. Walters, and D. A. Webb. Cambridge: Cambridge University Press.
- Iovene, M., E. Grzebelus, D. Carputo, J. Jiang, and P. W. Simon. 2008. Major cytogenetic landmarks and karyotype analysis in *Daucus carota* and other Apiaceae. *American Journal of Botany* 95: 793–804.
- IPNI. 2015. The International Plant Names Index. Available at: <http://www.ipni.org>. Accessed 1 June 2015.
- Jafri, S. M. H. 1985. *Daucus* L. Pp. 130–144 in *Flora of Libya* vol. 117, eds. S. M. H. Jafri and A. El-Gadi. Tripoli: Al-Faateh University, Faculty of Science, Department of Botany.
- Lee, B.-Y. and S. R. Downie. 1999. A molecular phylogeny of Apiaceae tribe *Caucalideae* and related taxa: Inferences based on ITS sequence data. *Systematic Botany* 24: 461–479.
- Martínez-Flores, F., A. Juan, and M. B. Crespo. 2012. Molecular and morphological evidence supports the resurrection of a neglected species of *Daucus* (Apiaceae) from North Africa. *Botanical Journal of the Linnean Society* 169: 320–337.
- McNeill, J., F. R. Barrie, W. R. Buck, V. Demoulin, W. Greuter, D. L. Hawksworth, P. S. Herendeen, S. Knapp, K. Marhold, J. Prado, W. F. Prud'homme Van Reine, G. F. Smith, J. H. Wiersma, and N. J. Turland. 2012. *International Code of Nomenclature for algae, fungi, and plants (Melbourne Code. Regnum Vegetabile 154)*. Königstein: Koeltz Scientific Books.
- Meikle, R. D. 1977. *Flora of Cyprus* vol. 1. Kew: Royal Botanic Gardens.
- Okeke, S. E. 1978a. *Systematic studies in Daucus L. (Umbelliferae)*. Ph. D. thesis. Reading: University of Reading.
- Okeke, S. E. 1978b. Morphological variation of bracts, bracteoles and fruits in *Daucus* L. Pp. 161–174 in *Les ombellifères "Contributions pluridisciplinaires à la systématique" Actes du deuxième symposium international sur les ombellifères. Monographs in Systematic Botany from the Missouri Botanical Garden* vol. 6, eds. A.-M. Cauwet-Marc and J. Carbonnier. St. Louis: Missouri Botanical Garden.
- Pignatti, S. 1982. *Flora d'Italia* vol. 2. Bologna: Edagricole.
- Reduron, J.-P. 2007. Ombellifères de France vol. 2. *Bulletin de la Société Botanique du Centre-Ouest, Nouvelle Série Numéro spécial* 27: 960–1099.
- Sáenz, C. 1981. Research on *Daucus* L. (Umbelliferae). *Anales del Jardín Botánico de Madrid* 37: 481–534.
- Smith, J. E. 1806. *Daucus*. Pp. 183–185 in *Florae Graecae prodromus: sive Plantarum omnium enumeratio, quas in provinciis aut insulis Graeciae* vol. 1, eds. J. Sibthorp and J. E. Smith. London: A. Taylor.
- Smith, J. E. 1819. *Daucus*. Pp. 63–66 in *Flora Graeca: sive Plantarum rariorum historia, quas in provinciis aut insulis Graeciae* vol. 3, eds. Sibthorp, J. and J. E. Smith. London: R. and A. Taylor.
- Spalik, K. and S. R. Downie. 2007. Intercontinental disjunctions in *Cryptotaenia* (Apiaceae, Oenantheae): an appraisal using molecular data. *Journal of Biogeography* 34: 2039–2057.
- Spalik, K., M. Piwczyński, C. A. Danderson, R. Kurzydina-Młynik, T. S. Bone, and S. R. Downie. 2010. Amphitropic amphiantarctic

- disjunctions in Apiaceae subfamily Apioideae. *Journal of Biogeography* 37: 1977–1994.
- Spooner, D. M., P. Rojas, M. Bonierbale, L. A. Mueller, M. Srivastav, D. Senalik, and P. W. Simon. 2013. Molecular phylogeny of *Daucus* (Apiaceae). *Systematic Botany* 38: 850–857.
- Sprengel, C. 1818. *Species Umbelliferarum minus cognitae*. Halle: officina Rengeriana.
- Sprengel, C. 1820. Umbelliferae Juss. Pp. 473–482 in *Caroli a Linnei equitis Systema vegetabilium secundum classes, ordines, genera, species. Cum characteribus, differentiis et synonymiis* vol. 6, ed. J. A. Schultes. Stuttgart: Sumtibus J. G. Cottae.
- Stearn, W. T. 1967. Sibthorp, Smith, the 'Flora Graeca' and the 'Florae Graecae prodromus'. *Taxon* 16: 168–178.
- Tenore, M. 1830. *Ad Florae Neapolitanae plantarum vascularium Syllogem, Appendix tertia: Emendationes, atque Additamenta novissima complectens*. Napoli: Francese.
- Tenore, M. 1832. *Relazione del viaggio fatto in alcuni luoghi di Abruzzo Citeriore nella State del 1831*. Napoli: Tipografia di P. Tizzano.
- Thellung, A. 1926. *Daucus-Studien. Repertorium Specierum Novarum Regni Vegetabilis* 23: 147–159.
- USDA, ARS, National Plant Germplasm System. *Germplasm Resources Information Network - (GRIN)*. National Germplasm Resources Laboratory, Beltsville, Maryland. Available at: <http://www.ars-grin.gov/npgs/index.html>. Accessed 29 June 2015.
- Vandelook, F., S. B. Janssens, and R. J. Probert. 2012. Relative embryo length as an adaptation to habitat and life cycle in Apiaceae. *The New Phytologist* 195: 479–487.
- Zohary, M. 1972. *Flora Palaestina* vol. 2. Ed. 2. Jerusalem: The Israel Academy of Sciences and Humanities.
- 15 Aug 1856, *T. Caruel* (FI-001477); Lazio: presso Marcellina, Roma, Sep 1895, *E. Chiovenda* (BOLO-0025500); Via Flaminia; Roma, 10 Jul 1891, *E. Chiovenda* (BOLO-25503); Horcatrano, Sep 1985, *H. Groves* (RNG s.n.).
- Daucus guttatus* Sm. in Sibth. & Sm. ITALY. Florence: Florence (circa), 26 Jul 1895, *E. Levier* (P-04199113); Imperia: Bordighera, Jul 1895, *C. Bicknell* (P-02460550); Pescara: circa Caramanico et S. Valentino (Abruzzo), 500–1000 m, 8 Aug 1875, *Porta et Bigo* (P-02460598). LEBANON. Mount Lebanon: Brummana, Iter Syriacum n° 701, 800 m, 12 Jul 1897, *J. Bornmüller* (P-02519011). LIBYA. Tripolitania: Tripoli, May 1865, illegible (P-04199113). MONACO. Monte Carlo: Monte Carlo (prope), Sep 1843, *L. Chiostri* (P-02460604). SYRIA. Al Badrusiyah: 35.878 N, 35.884 E, 30 m, 29 Jul 1999, *B. Al-Safadi, T. Kotlinska, P. Simon*, cultivated in Ames Iowa, Aug 2014, *PI 652342* (ABH-72382); Iter Syriacum n° 701, 1897, *J. Bornmüller* (P-02516597). TURKEY: Hatay: prope Beilan, 2000 m, Jun 1862, *T. Kotschy* 259 (P 02519007, W s.n.).
- Daucus involucratus* Sm. in Sibth. & Sm. CYPRUS. Larnaca: Ayia-Anna, 150 m, 15 Apr 1991, Iter Mediterraneum IV (MA-495558). GREECE. Aetolia-Acarnania: Ep. Vonitsis 4.6 km SW Astakos, 70 m, 16 May 1994, *E. Willing* (B-10 0002857); idem: Monastiri Pavanias 2k südwestl. Olimbos, 154 m, 26 May 1984, *Th. Raus* (B-10 0002855); Chania: Crete, in glareosis calc. faucium prope Guduras, litus australe versus, 10 May 1942, *K.H. Rechinger* (W-15352); Rhodes: collines incultes près Bastida, 26 May 1870, *E. Bourgeau* (P-04101369). UNSPECIFIED. *J. Sibthorp* (OXF-Sib-0645).
- Daucus setulosus* Guss. ex DC. GREECE. Aetolia-Acarnania: Antirrio, 1 Km W. of, 0–2 m, 10 Jun 1997, *Nielsen 12202* (UPA s.n.); Attica: In collibus aridis Atticae, May 1847, *T. Heldreich Herb. Graec. Norm. 1632* (P-04114245); idem: prope Pikrodaphni, 27 May 1901, *T. Heldreich Herb. Graec. Norm. 1632* (WU-0076587); Chania: Kissamos, Crete, 28 May / 8 Jun 1884, *E. Reverchon 210* (P-04198130); Corinthia: Schinos, approx. 0.5–0.8 km before Schinos on the way Kato Alepochori-Schinos, 100–150 m, 27 May 1995, *T. A. Constantinidis 5667* (UPA s.n.); Focida: Amfissa, ca. 3 Km NW, 400–500 m, 3 Jun 1982, *F. Krendl* (W num. 2001-13947); Magnesia: Volos, Ad Volo Thesaliae, *P. E. Boissier 3709* (UPA s.n.); Peloponnese: Nafplion, 1836, *E. von Friedrichsthal Herb. Graec. 1186* (RO-HC); Syros: Gyaros island, Cyclades, 26 May 1977, *D. Tzanoudakis* (UPA num. 3385). ITALY. Campania: Naples, *G. Gussone* (C-10008394, FI-001466, K-000681201, P-02461365, P-02461370, P-02461392); idem, in collibus on campis aridis, *G. Gussone* 1653 (P-02461406); idem, 1829, *G. Gussone* (G-00458301); Grosseto: Promontorio Argentario, Cala Galera, 28 Jun 1911, *S. Sommier* (W num. 16434); Latina: Terracina, 1823, *Fiorini* (BOLO-0025527); Lazio: Civita Lavinia (Lanuvinio), 10 Aug 1899, *E. Chiovenda* (BOLO-0025515); idem: Ariccia, verso la Cecchina, 2 Aug 1899, *E. Chiovenda* (BOLO-0025516). ROMANIA. Oltenia: Fintina Obedeau, prope oppidum Craiova, 110 m, 8 Jul 1960, *C. Malos, M. Olaru and M. Paun* (MA-179150). TURKEY. Izmir: Colles Lydiae, Jun 1842, *P. E. Boissier* (P-02400221, P-02400225). UNSPECIFIED. *J. Sibthorp* 366 (OXF-Sib-0643); au '*Daucus bicolor?*', *J. Sibthorp* (OXF-Sib-0644).

## APPENDIX 1.

*List of representative herbarium specimens examined—Daucus bicolor* Sm. in Sibth. & Sm. TURKEY. Antalya: 36.82 N, 31.45 E, 18 m, 12 Aug 1999, *T. Kotlinska, S. Kucuk, P. W. Simon*, cultivated in Ames Iowa, Aug 2014, *PI 652390* (ABH-72383); idem: Side, 10 m, 29 Jun 1965, *J. Cullen* (W num. 1991-04534); idem: Yarpuz Köyü, 6 Km N. Akseki, c. 1300 m, 10 Jul 1970, *F. Spitzenberger* 35 (W-03641); Izmir: Lydiae colles, Jun 1842, *P. E. Boissier* (P-02400218, P-02400223). UNSPECIFIED. *J. Sibthorp* (OXF-Sib-0643b).

*Daucus broteri* Ten. ITALY. Abruzzo: Caramanico-Abruzzo, Jul 1908, *M. Guadagno* (MA-89104); idem: Turro, *M. Tenore* (NAP Erbario Tenoreano campioni 7, fasc. 32, record number 3906); Toscana: Florence, nei campi a Montici, Aug 1855, *T. Caruel* (FI-001476); idem: Santa Margherita, 15 Aug 1855, *T. Caruel* (HG-02320); idem: prope Chianciano, Aug 1883, *H. Groves* (MA-89102, RNG s.n.); Liguria: Savona, 100 m, Dec 1992, *G. Galasso* (RNG s.n.); Prato: Campi tra Signa e Poggio a Caiano,