

1-1-2004

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### Recommended Citation

WORZ, ARNO (2004) "On the Distribution and Relationships of the South-West Asian Species of *Eryngium* L. (Apiaceae-Saniculoideae)," *Turkish Journal of Botany*. Vol. 28: No. 1, Article 8. Available at: <https://journals.tubitak.gov.tr/botany/vol28/iss1/8>

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## On the Distribution and Relationships of the South-West Asian Species of *Eryngium* L. (*Apiaceae-Saniculoideae*)

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Received: 23.09.2002

Accepted: 29.01.2003

**Abstract:** This paper deals with the Old World species of *Eryngium* L. which grow mostly in regions with a Mediterranean type climate. Two centres of diversity are visible: one in the Western Mediterranean (Iberian Peninsula, Morocco), and the other one in South-West Asia. Distribution maps are presented for several species from South-West Asia, which is probably the genus' most important centre of diversity. A preliminary new classification of the genus *Eryngium* is presented, including a new combination (*Eryngium* subgenus *Fruticosum* (Wolff) Wörz stat. nov.). Both the species and the sectional diversity are conspicuously present in Turkey, where 9 of 14 sections occur. This sectional diversity decreases in an easterly direction towards Central Asia. Five Mediterranean species are much more closely related to some North American *Eryngiums* than to the other Old World ones. Not related to the American sections is Sect. Palmito H. Wolff, although its species bear grass-like leaves similar to some *Eryngiums* from South America.

**Key Words:** *Eryngium*, *Apiaceae*, *Saniculoideae*, South-West Asia, phytogeography, infrageneric classification

### Introduction

The genus *Eryngium* L. (*Apiaceae* - subfamily *Saniculoideae*) consists of about 250 species in Eurasia, North Africa, North and South America and Australia. It is the most species-rich genus of the *Apiaceae* (Pimenov & Leonov, 1993: 3). The last monograph on *Eryngium* was presented nearly 90 years ago by Wolff (1913). Later, many regional treatments in Floras have been published, such as Davis (1972) for Turkey, Pimenov & Tamamschan (1987) for the Flora Iranica area, or Mathias & Constance (1941) for North America. This was the reason for starting a new attempt at a revision of the whole genus, including modern biosystematic data such as chromosome numbers, ecology, chorology, and - in cooperation with J. Kadereit at Mainz - molecular data.

This *Eryngium* project is now in a condition where the classical taxonomic work, such as nomenclature, types and citation, is nearly finished and published in a taxonomic index (Wörz, 1999). Herbarium evaluations are also nearly completed and their data are the main basis for distribution maps. One very important aim of the revision is the creation of a new classification of the genus, which is still mostly classified by Wolff's system. This consists of many sections, which can in part still be

accepted today. However, his formalistic grouping in Eurasian and North African sections on one side, and American and Australian on the other prevented him realising the close relationship between a few European and some North American species.

### Methods

The distribution maps are based on data from the herbaria B, BM, E, G, K, LE, M, MA, P, STU, W and WU. Further, reliable floristic data have been included from Pimenov & Tamamschan (1987) and H. Duman (pers. comm).

As the molecular study is as yet incomplete, the preliminary classification in Table 1 is mostly based on morphological data.

### Results

Table 1 shows the preliminary new classification. It includes 5 subgenera, 4 of which consist mostly of New World and Australian species. This paper deals predominantly with *Eryngium* subgenus *Eryngium*, which includes all South-West Asian and most Eurasian and North African species.

Table 1. Preliminary new infrageneric classification of the genus *Eryngium* L. All underlined species occur in South-West Asia. The New World subgenera are stated in a short form. The nomenclature of the taxa is provisional and, in some cases, informal, e.g. "Sect. 3".

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Subgenus *Eryngium*

Mostly perennials with palmately or pinnately structured leaves; bracts always much shorter than involucre leaves.  
Exclusively Old World species.

Sect. 1

Sect. *Campestris* H. Wolff in Engler, Pflanzenr. 4/228: 140 (1913) subsect. *Eucampestris* H. Wolff in Engler, Pflanzenr. 4/228: 146 (1913).  
Perennials; basal leaves pinnate to tripartite, always pinnately veined; involucre leaves lanceolate, various in length; bracts entire, rarely the outermost tricuspidate; chromosome base number  $x = 7$ .  
*amethystinum* (Central Mediterranean), *amorginum* (Aegean Islands), *billardierei*, *campestre*, *desertorum*, *glomeratum*, *hainesii*, *polycephalum*.

Sect. 2

Sect. *Dryophylla* Calestani, Webbia 1: 121 (1905) p.p.  
Perennials; basal leaves undivided, spiny, pinnately to reticulately veined; involucre leaves at least twice as long as capitula, linear to lanceolate; bracts about as long as flowers incl. fruits, mostly entire.  
*aquifolium* (S Spain, N Morocco), *bungei*, *carlinoides*, *duriaei* (NW Iberian Peninsula), *huteri* (S Spain), *ilex*, *karatavicum*, *macrocalyx*, *mirandum*, *rechingeri*.

Sect. *Gigantophylla* H. Wolff in Engler, Pflanzenr. 4/228: 136 (1913).

Perennial, basal leaves 3-5 partite, rarely undivided, conspicuously large, pinnately veined; involucre leaves 1- to parallel veined, with broad midrib; bracts entire or tricuspidate.  
*isauricum*, *pyramidale*, *thyrsoides*.

Sect. *Thorifolia* H. Wolff in Engler, Pflanzenr. 4/228: 121 (1913).

Perennials; basal leaves undivided, suborbicular-reniform with retuse apex, thickly coriaceous, stiff; involucre leaves tricuspidate; bracts all tricuspidate or only the innermost entire.  
*pseudothorifolium*, *thorifolium*

Sect. 3

Annuals; basal leaves undivided, obtuse, spiny, pinnately veined; involucre leaves broadly lanceolate to long obovate; bracts tricuspidate; fruits with small obtuse appendages in 1-2 rows.  
*argyreum* (Morocco), *ilicifolium* (S Spain, NW Africa).

Sect. *Chamaeryngium* Calestani, Webbia 1 : 121 (1905).

Annual; basal leaves withered in flowering time, ovate to lanceolate; bracts 4-cuspidate.  
*tenue* (Iberian Peninsula, Morocco)

Sect. *Palmito* H. Wolff in Engler, Pflanzenr. 4/228: 137 (1913).

Perennials; basal leaves long-petiolate, palmatipartite with grass-like segments, not spiny; involucre leaves lanceolate, up to twice as long as umbel.  
*palmito*, *serbicum* (Balkans), *ternatum* (Aegean Islands), *wanaturi*

Sect. *Alpina* H. Wolff in Engler, Pflanzenr. 4/228: 123 (1913).

Perennials; basal leaves undivided, cordate, spineless, large; involucre leaves broadly lanceolate to ovate with pinnate or reticulate venation.  
*alpinum* (Alps, N Balkans), *bornmuelleri*, *giganteum*

Sect. 4

Perennials; basal leaves with palmipartite or tripartite blades, circular to ovoid in outline, palmately veined, very spiny; involucre leaves lanceolate, spiny; bracts entire or tricuspidate; fruits large, obovate to long conical, appendages long filiform at apex, often withering and small or missing.  
*bourgatii* (Iberian Peninsula, Morocco), *davisii*, *dilatatum* (Iberian Peninsula, N Morocco), *glaciale* (Sierra Nevada/Spain, Rif/Morocco), *grossii* (S Spain), *heldreichii*, *kotschyi*.

Table 1. (Continued).

## Sect. 5

Sect. *Plana* H. Wolff in Engler, Pflanzenr. 4/228: 126 (1913) p.p.

Perennials; basal leaves undivided or trifid, not divided to the base, palmately to reticulately, rarely in the upper part pinnately veined, mostly without spines; involucral leaves lanceolate to linear, spiny, rarely entire; bracts mostly tricuspidate.

*antiatlanticum* (S Morocco), *bithynicum*, *caeruleum*, *creticum*, *dichotomum* (NW Africa), *falcatum*, *planum* (Central and E Europe, W Asia), *tricuspidatum* (S Iberian Peninsula, N Africa, Sardinia), *triquetrum* (N Africa, Sicily), *variifolium* (Morocco).

## Sect. 6

Perennial; basal leaves ovate, undivided, with cordate base, without spines, smooth; cauline leaves ovate to lanceolate, undivided; synflorescence paniculate or racemose; involucral leaves linear-lanceolate, entire; bracts not tricuspidate.

*marocanum* (Morocco)

## Sect. 7

Perennial; basal leaves tripartite, spiny, palmately veined; capitula club-shaped; involucral leaves pinnate, spiny, broadly lanceolate, parallel veined; bracts tricuspidate, pungent.

*spinalba* (SW Alps)

Sect. *Astrantiifolia* H. Wolff in Engler, Pflanzenr. 4/228: 139 (1913).

Perennials; basal leaves palmatisect or trisect, long-petiolate, segments not monocotyloid, palmately veined; involucral leaves linear, spiny, bracts tricuspidate.

*palmatum* (N Balkans), *wiegandii* (S Balkans).

Sect. *Eryngium*

Sect. *Halobia* Calestani, Webbia 1: 126 (1905) p.p.

Perennial with long slender cylindrical roots; basal leaves trifid with cordate base; involucral leaves 5-6, broad, reticulately veined; bracts tricuspidate. Sand dune species.

*maritimum*

## Subgenus B

Mostly perennials; basal leaves with monocotyloid structure: parallel venation and grass- or bromelia-like habit.

Includes 4 sections with at least 63 species (1/4 of the genus), from South America north to Mexico.

## Subgenus C

Annuals or biennials; basal leaves lanceolate, long-petiolate, often articulated and inflated, with undivided, parallel veined blades, not spiny; bracts mostly tricuspidate, shorter or equalling the involucral leaves; plants growing in wet conditions.

This subgenus consists of 4 sections with 39 species. One section includes 5 species (*E. atlanticum* Battandier & Pitard, *E. corniculatum* Lam., *E. galioides* Lam., *E. pusillum* L., *E. viviparum* Gay) occurring in the Mediterranean, Western Europe and Morocco. They are the only Eurasian and North African species which do not belong to *Eryngium* subgenus *Eryngium*.

## Subgenus D

Annuals or perennials, basal leaves pinnate or if undivided at least with pinnate venation, never inflated, spiny or at least pungent; bracts shorter or equalling the involucral leaves, sometimes umbels with a coma at the apex; plants growing on dry sites.

Sect. *Diffusa* H. Wolff in Engler, Pflanzenr. 4/228: 156 (1913).p.p.

Sect. *Rostrata* H. Wolff in Engler, Pflanzenr. 4/228: 167 (1913) p.p.

This subgenus comprises 4 sections (incl. Sect. *Foetida* H. Wolff) with 36 species (N and S America, Australia).

Subgenus *Fruticosum* (H. Wolff) Wörz stat. nov.

Sect. *Fruticosa* H. Wolff in Engler, Pflanzenr. 4/228: 268 (1913) (basionym).

Woody species with undivided, parallel veined leaves and orbicular capitula. Four species in one section, all species are endemic to the Juan Fernandez Islands in the Pacific Ocean off South America.

Figure 1 shows a map from Meusel et al. (1978: 305) with the worldwide distribution of the genus. Although the species numbers are mostly outdated, it still reflects the important centres of diversity of *Eryngium*. These are in Mexico and South-East Brazil, and within the Old World in the Western Mediterranean (Morocco, Iberian Peninsula) and South-West Asia, especially Turkey.

A closer look at the Western Mediterranean centre of diversity reveals that 4 of the species occurring in this region do not belong to the subgenus *Eryngium* at all. They are much more closely related to North American species. One example is *Eryngium corniculatum* Lam.: this is a biennial with inflated and articulated leaf petioles and conspicuous comas at the apices of the capitula. These characteristics are common in the New World but absent elsewhere in Eurasia and North Africa. The closest relative is probably *E. fluitans* Jones from Mexico. Other species (*E. atlanticum* Battandier & Pitard, *E. galioides* Lam., *E. viviparum* Gay, and, further east in the Mediterranean basin, *E. pusillum* L.) are annuals with

bracts equalling the involucral leaves. This is also common in many American species and absent from Eurasia and the Mediterranean. Their closest relative may be *E. armatum* (Watson) Coulter & Rose from California. All these species grow in lakes which dry out in summer, a typical habitat for American *Eryngiums*.

Subtracting these species from the species numbers of the Western Mediterranean, the South-West Asian centre of diversity even grows a little in its importance for *Eryngium* subgenus *Eryngium*. A closer look at the classification of the subgenus shows (Table 1) that most, i.e. 9 of 14, sections are extant in South-West Asia, and especially in Turkey. Three monotypic and 2 species-poor sections are the only missing ones. This indicates a great diversity, not only in species, but also at section level. Some distribution maps illustrate this diversity:

Southern Turkey and Aegean endemics (Figure 2):  
 - *E. amorginum* Rech.: endemic to the Aegean Islands, belongs to a section including *E. campestre*, *E. billardierei*, etc.

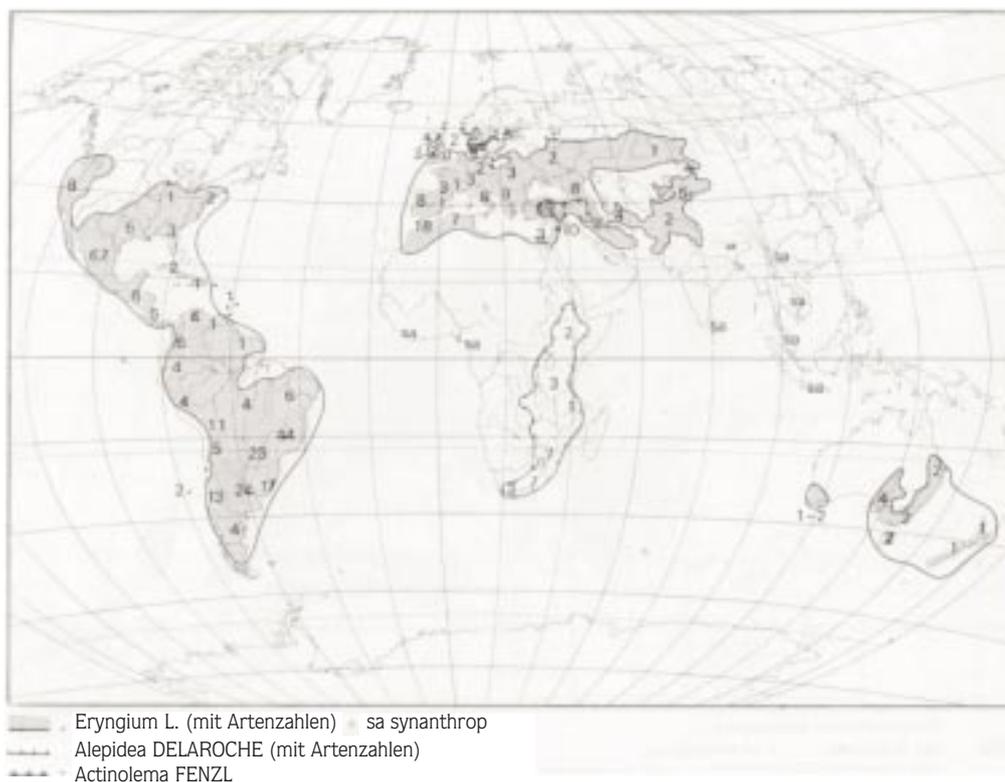


Figure 1. The worldwide distribution of the genus *Eryngium* L. The numbers indicate the species numbers in the region concerned (From: Meusel, H., Jäger, E., Rauschert, S. & Weinert, E.: *Vergleichende Chorologie der Zentraleuropäischen Flora* Bd 2, Gustav Fischer Verlag, 1978, page 305 © Spektrum Akademischer Verlag, Heidelberg, Berlin).

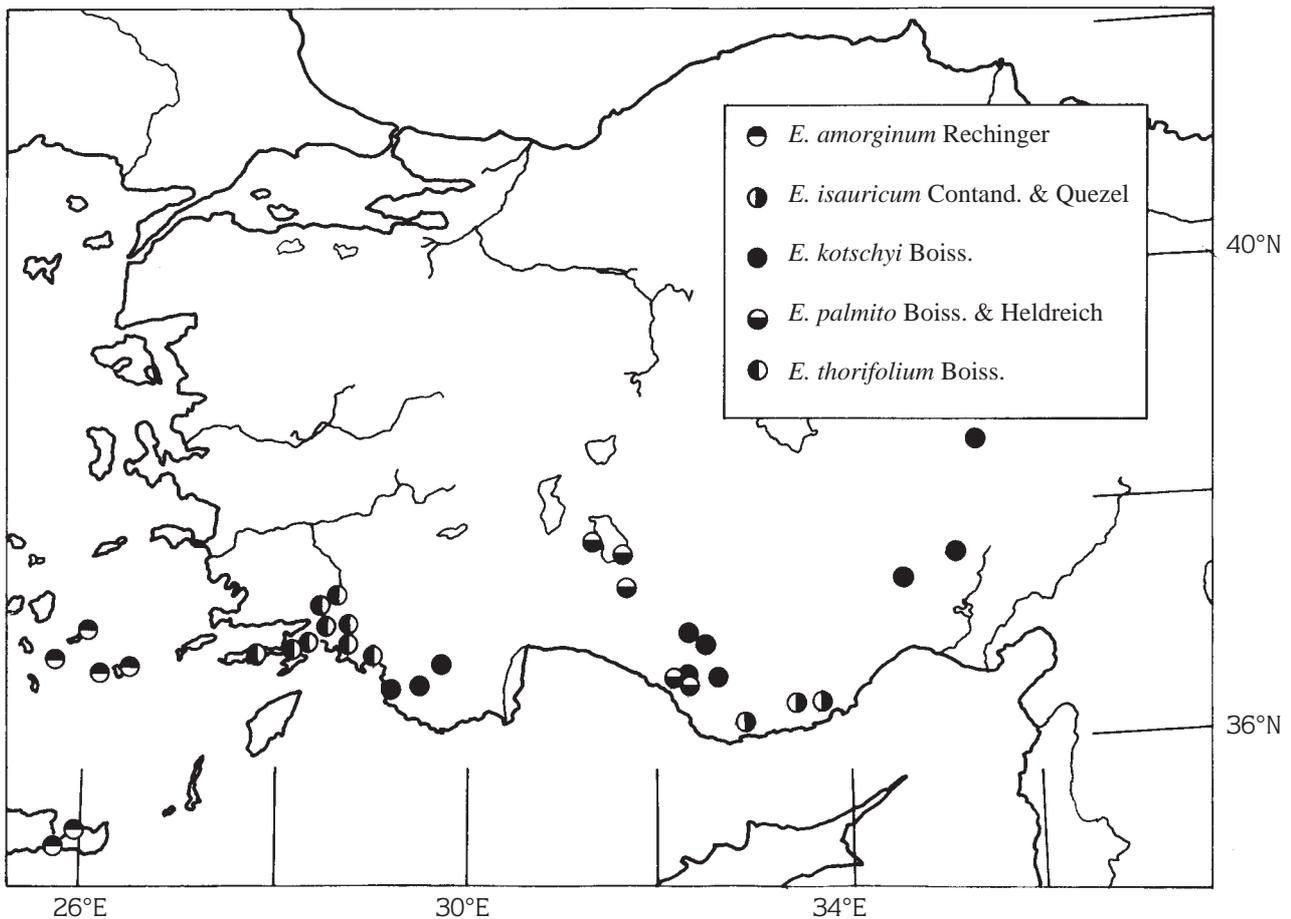


Figure 2. Southern Turkey and Aegean endemics.

- *E. thorifolium* Boiss. is a serpentine endemic of South-West Turkey. It forms, together with the closely related *E. pseudothorifolium* Contandriopoulos & Quezel, a taxonomically fairly isolated section.

- *E. kotschy* Boiss. belongs to a group of species widespread around the Mediterranean.

- *E. palmito* Boiss. & Heldr.: Sect. Palmito H. Wolff, a group of remarkable species, see below.

- *E. isauricum* Contand. & Quezel belongs to Sect. *Gigantophylla* H. Wolff, which is endemic to South-West Asia.

Therefore, in this region grow 5 endemics from 5 different sections.

Southern Turkey and Lebanon disjunctions (Figure 3):

*E. glomeratum* Lam. belongs to the „*campestre*-group“, although it is fairly isolated within this section.

*E. falcatum* Delaroché, a forest species, is part of a widespread section with tricuspidate bracts.

Similar in distribution is *E. heldreichii* Boiss. (not included in the map) from a widespread Mediterranean section.

The similarity of the distribution patterns of these unrelated species is remarkable.

Central and North Anatolian species (Figure 4):

*E. giganteum* M. Bieb. is a Euxine species belonging to a group of broad-leaved forms.

*E. bithynicum* Boiss. is nearly the only Central Anatolian species. However, it seems to be of Euxine origin. It is a biennial with tricuspidate bracts.

Irano-Turanian species (Figure 5):

In this vast eastern region, the pattern of high section diversity gradually changes. In the western part, Sect.

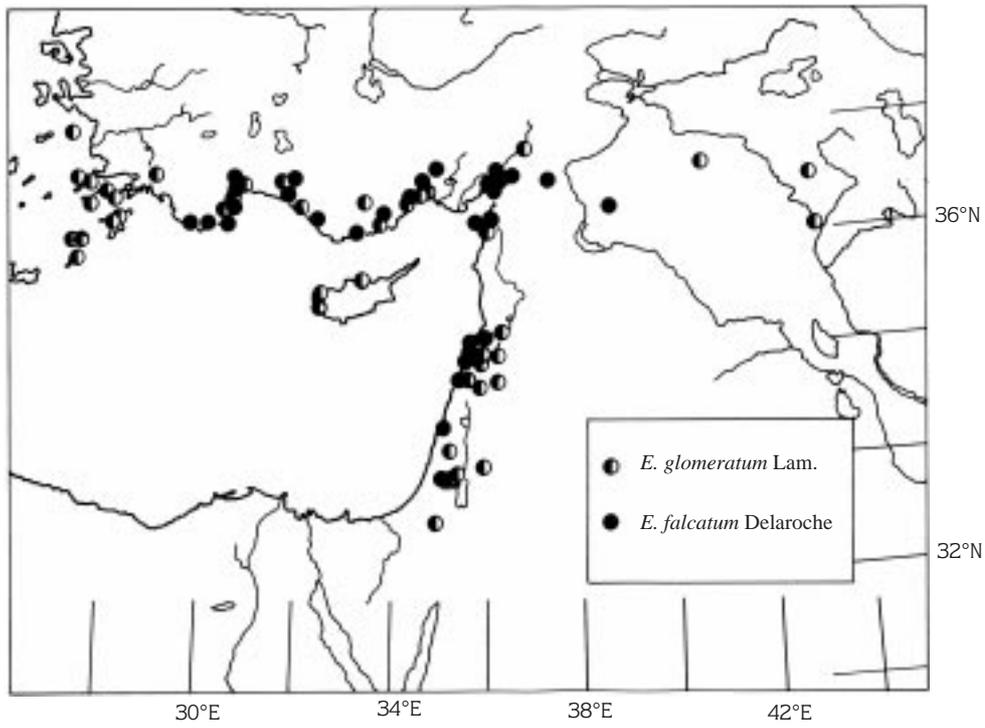


Figure 3. Southern Turkey and Lebanon disjunctions.

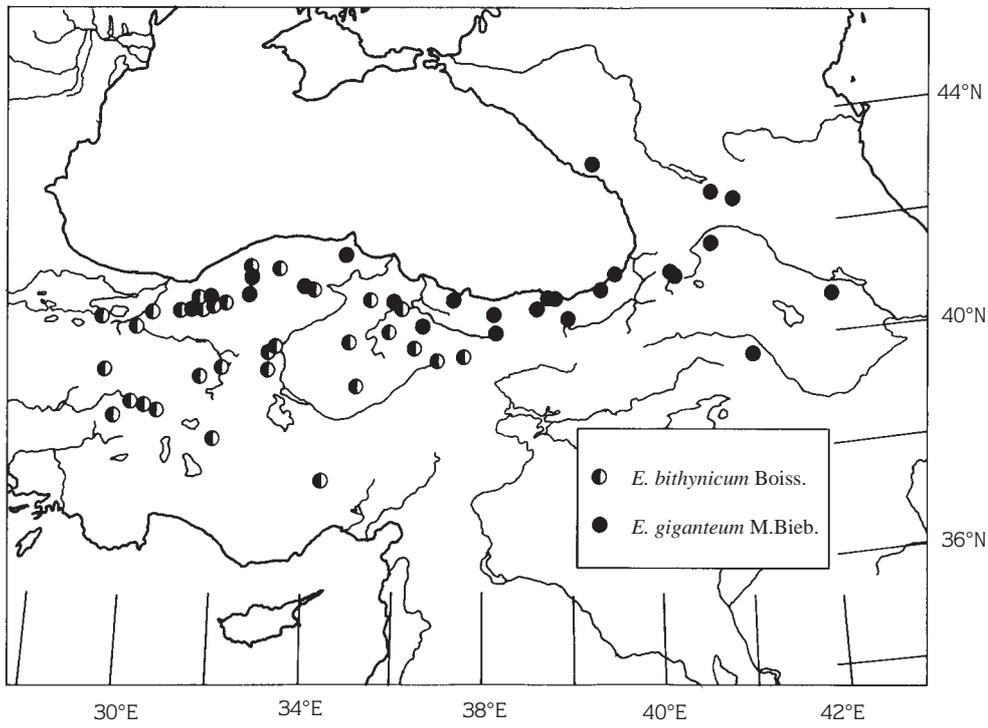


Figure 4. Central and North Anatolian species.

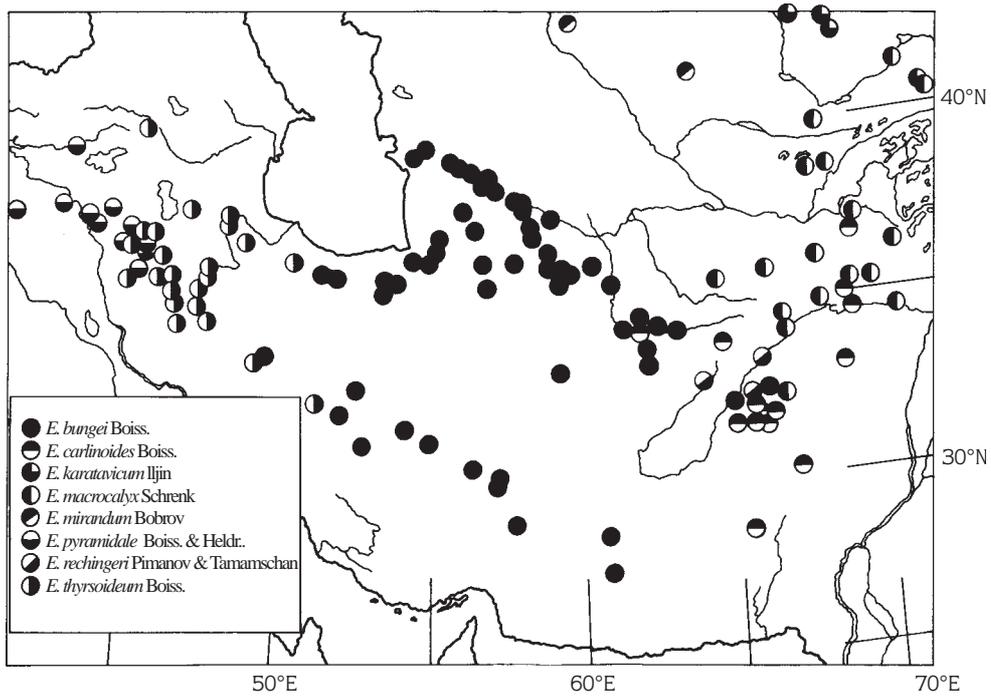


Figure 5. Irano-Turanian species.

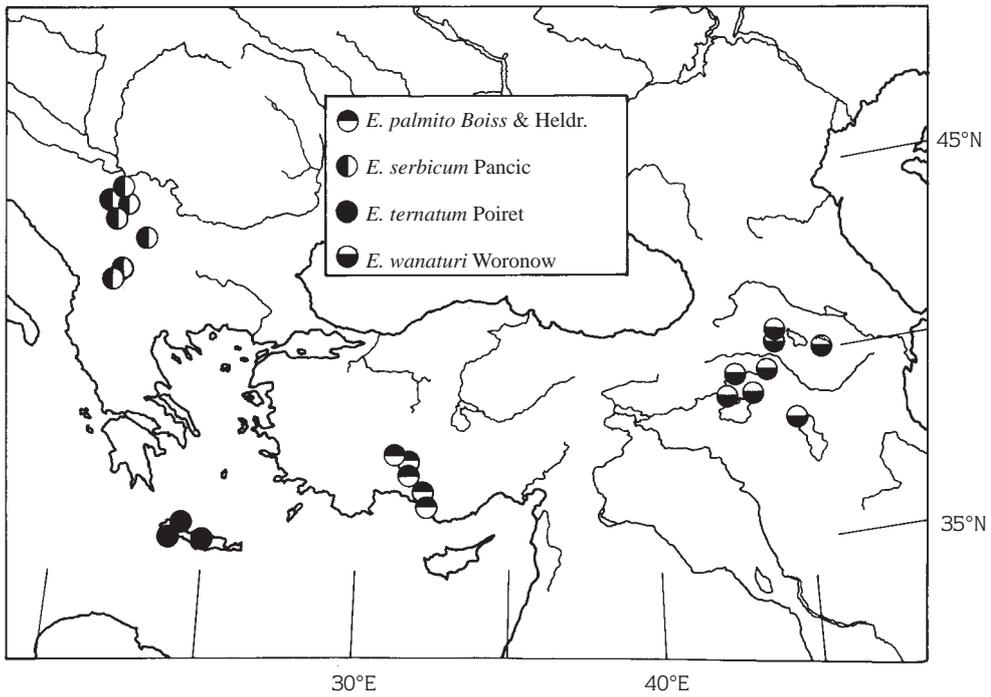


Figure 6. Distribution of the species of Sect. Palmito H. Wolff.

Gigantophylla H. Wolff is represented by 2 species, *E. pyramidale* Boiss. & Heldr. and *E. thyrsoideum* Boiss., and the endemic *E. bornmuelleri* Nábelek (not included in the map) belongs to the broad-leaved section. Further east a group of at least 5 species extend from Iran to Afghanistan and Central Asia (*E. bungei* Boiss., *E. carlinoides* Boiss., *E. karatavicum* Iljin, *E. macrocalyx* Schrenk, *E. mirandum* Bobrov [maybe synonymous with *E. macrocalyx* Schrenk] and *E. rechingeri* Pimenov & Tamamschian). They all belong to the same section and only one other species, the widespread *E. caeruleum*, is in this region. Therefore, in an easterly direction the sectional diversity decreases much more than the species diversity. This is a nice example of the radiation of a species group.

## Discussion

*Eryngium* subgenus *Eryngium* is obviously centred in the Mediterranean and many species do prefer the Mediterranean type climate, even in Afghanistan (see map in Walter, 1968: 10). Within South-West Asia, Turkey is by far the most important region for the genus. It is tempting to speculate about a primary centre of the subgenus *Eryngium*, but the data are still too scarce for a statement. Furthermore, the endemics seem to be of very different ages: the isolated and highly adapted *E. thurifolium* is probably fairly old and may be a Tertiary relict like the sympatric *Liquidambar orientalis* Mill. On the other hand, typical neoendemics such as *E. isauricum* and *E. heldreichii* occur in Turkey, too. This indicates

several waves of immigration and radiation rather than a single event of unfolding and spreading of the species in an old primary diversity centre. On the other hand, related genera such as *Astrantia* and *Actinolema* do occur sympatrically with *Eryngium* in Turkey.

One last exciting group of relictual endemics is Sect. Palmito H. Wolff (Figure 6). It occurs in the Balkans (*E. serbicum* Pancic), Crete (*E. ternatum* Poirlet), Southern Turkey (*E. palmito* Boiss. & Heldr.) and Eastern Turkey/Transcaucasus/Eastern Iran (*E. wanaturi* Woronow). These 4 species are remarkable for their grass-like leaf segments emerging from a palmate structured leaf. In some cases, as in *E. wanaturi*, the number of segments may be reduced to only one. Grass-like leaves are very common in the New World. However, the leaves of the New World species are arranged like rosettes and are in no way palmately structured. Therefore, despite this striking similarity, Sect. Palmito is probably not related to any New World species, and the long sought missing link between the subgenus *Eryngium* and the New World species is still missing.

## Acknowledgements

The author is grateful to the SYSRESOURCE-Programme for sponsoring a stay at the Natural History Museum at London, and to B. Felten for the distribution maps. Furthermore, I thank the curators of the herbaria B, BM, E, G, K, LE, M, MA, P, W and WU for their support during my stays at their institutions, and for the loan of specimens.

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