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The Euro+Med treatment of *Boraginaceae* in Willdenowia 34 – a response

Abstracts

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The classification of B. Valdés proposed in Willdenowia 34 in 2004 is shown to be for practical purposes incomplete, incorrect, inconsistent and out of date. A revised list of genera and tribes of *Boraginales* (*Boraginaceae* s.l.) occurring in the region based on recent data is presented.

"The Euro+Med PlantBase provides an on-line database and information system for the vascular plants of Europe and the Mediterranean region, against an up-to-date and critically evaluated consensus taxonomic core of the species concerned." (http://www.euromed.org.uk, accessed 22 October 2004).

In a Euro+Med Notula (No. 10) in Willdenowia 34: 59-61. 2004, B. Valdés presented his view of *Boraginaceae* classification. The most recent literature citation in his article dates from 1992, thus ignoring completely the morpho-anatomical and molecular work published during the last decade. This is unfortunate, because this research has brought a massive improvement of our understanding of taxon limits and phylogenies in *Boraginales* (e.g. Al-Shebaz 1991, Böhle & al. 1996, Diane & al. 2002, Ferguson 1998, Gottschling & al. 2001, Gottschling & Hilger 2001, Hilger & Böhle 2000, Hilger & Diane 2003, Hilger & al. 2004, Långström & Chase 2002, Långström & Oxelman 2003, Lönn 1999, Smith & al. 2000). A "consensus taxonomic core" should try to evaluate all serious attempts at clarifying relationships and should certainly include recent views on the taxonomy and phylogeny as well as a discussion of the traditional publications. While molecular data represent only one window on reality, they do provide deep new insights

into traditional groupings based on morphology, some of which have to be called tentative at best. Ignoring recent molecular data in morphologically ambiguous cases is likely not a helpful approach. Monophyly is much debated as the sole guideline for taxon delimitation, but provided the evidence for it is sound it is generally the most objective basis for taxonomic grouping (although in some cases a judgement may be made that paraphyletic taxa are in practical terms more acceptable).

On the basis of recent studies on *Boraginales,* we here want to challenge various judgements and taxonomic decisions provided by Valdés (2004).

1. *Delimitation of the family*. – *Boraginaceae* s.l. in his sense are paraphyletic. They either have to include *Hydrophyllaceae* and *Lennoaceae* at subfamily rank or the subfamilies *(Cordioideae, Ehretioideae, Heliotropioideae, Boraginoideae)* have to be elevated to family rank. Irrespective of this subjective decision on rank, the arbitrary exclusion of taxa belonging to the monophyletic *Boraginales* (= *Boraginaceae* s.l.) is not justified. *Hydrophyllaceae* (*Nemophila* and *Phacelia* as introduced taxa in Europe!) and *Lennoaceae* are clearly nested in *Boraginales,* and have to be accommodated in some way, most probably in or near *Ehretiaceae* (Ferguson 1998, Smith & Pamphelis 1998, Smith & al. 2000, Gottschling & al. 2001).

Valdés (2004) accepts the segregation of *Cordioideae* and *Ehretioideae,* allegedly following I. M. Johnston, but this was never proposed by this outstanding expert of the taxonomy of *Boraginaceae* in the traditional sense. In the two publications cited in this respect (Johnston 1953, 1954), neither the name *Cordioideae* nor *Ehretioideae* are even mentioned. Valdés unites both taxa into one family (which is open to discussion) and uses *Ehretiaceae* as the proper name. This is, furthermore, formally incorrect, since the name *Cordiaceae* R. Br. ex Dumort. (1829) has priority over *Ehretiaceae* Mart. ex Lindl. (1830, see Taxon 49: 292. 2000).

Considering *Heliotropioideae* (= *Heliotropiaceae*) as the more "primitive" sister of *Boraginaceae* s.str. is very heterodoxical, since recent molecular data clearly place it as sister to *Cordiaceae* and *Ehretiaceae* (Gottschling & al. 2001), with *Boraginaceae* as sister group to these three woody clades plus *Hydrophyllaceae*. It is particularly difficult to understand how Valdés's interpretation and his taxonomic conclusions contribute towards a more comprehensible taxonomic consensus. The term "primitive" as such is also more than ambiguous or confusing, since the floral morphology in *Heliotropiaceae* is probably the most derived morphology anywhere in *Boraginales* (style stigma complex, Gürke 1894, Al-Shebaz 1991), so the statement is both taxonomically irrelevant and morphologically incorrect. *Heliotropiaceae* may retain some plesiomorphic character states in vegetative morphology, but to consider them as some boraginalean "Ursuppe" is grossly wrong.

2. *Delimitation of the tribes*. – The statement that the tribes *Boragineae, Lithospermeae, Echieae* and *Eritrichieae* can be sorted into "primitive" and "derived" groups is bold, and the implicit statement that they represent natural groups as here defined is in our view incorrect. The judgement that the long, yellow, tubular corollas of, e.g., *Onosma (Lithospermeae)* are less derived than the zygomorphic corollas of *Echium,* justifying tribal rank of the latter, is very subjective, and the statement as such is unsubstantiated. Molecular data also strongly indicate that the traditionally defined tribes need some serious re-adjustments, and Table 1 summarizes the current consensus on tribal classification. Salient points are that *Echieae* is firmly nested in *Lithospermeae* (Böhle & al. 1996, Hilger & Böhle 2000, Långström & Chase 2002) and has to be reduced under that tribe. Furthermore, *Ogastemma* does not belong to *Eritrichieae* and *Echiochilon* does not belong to *Lithospermeae,* both instead form part of the *Echiochileae* (Lönn 1999, Långström & Chase 2002, Långström & Oxelmann 2003).

3. *Delimitation of the genera*. – We are not sure what to make of the ambiguous statement "*Boragineae, Eritrichieae* and *Echieae* include well characterised genera" (Valdés 2004: 60).

Table 1. Accepted genera and tribes of Euro+Med area *Boraginales* (compiled from Flora Europaea, Med-Checklist, Flora of Turkey, Flora Palaestina plus additional sources) based on: (1) Hilger & al. 2004: DNA investigation of tribe, (2) Hilger & Diane 2003: DNA investigation of family, (3) Ferguson 1998, 2003: DNA investigation of family, (4) Gottschling & al. in press: position of *Coldenia,* (5) Seibert 1978, (6) Långström & Chase 2002.

***Cordiaceae*[4]**
- ***Coldenia***
- ***Cordia***

***Heliotropiaceae*[2]**
- ***Euploca***
- ***Heliotropium***

***Hydrophyllaceae*[3]**
- ***Nemophila***
- ***Phacelia***
- ***Wigandia***

Boraginaceae s.str.

***Boragineae*[1]**
- ***Anchusa***
- ***Anchusella***
- ***Borago***
- ***Brunnera***
- ***Cynoglottis***
- ***Elizaldia***
- ***Gastrocotyle***
- ***Hormuzakia***
- ***Lycopsis***
- ***Nonea***
- ***Paraskevia***
- ***Pentaglottis***
- ***Phyllocara***
- ***Pulmonaria***
- ***Symphytum***
- ***Trachystemon***

Cynoglosseae
- ***Cynoglossum***
- ***Gyrocaryum***
- ***Mattiastrum***
- ***Microparacaryum***
- ***Omphalodes***
- ***Paracaryum***
- ***Paracynoglossum***
- ***Pardoglossum***
- ***Rindera***
- ***Solenanthus***
- ***Suchtelenia***
- ***Trachelanthus***

"Trichodesmeae"
- ***Caccinia***
- ***Trichodesma***

Eritrichieae
- ***Amsinckia***
- ***Asperugo***
- ***Eritrichium***
- ***Hackelia***
- ***Heterocaryum***
- ***Lappula***
- ***Myosotis***
- ***Rochelia***
- ***Sclerocaryopsis***
- ***Trigonotis***

***Echiochileae*[6]**
- ***Echiochilon***
- ***Ogastemma***

incertae sedis
- ***Mertensia***
- ***Trigonocaryum***

***Lithospermeae*[5]**
- ***Alkanna***
- ***Arnebia***
- ***Buglossoides***
- ***Cerinthe***
- ***Echium***
- ***Halacsya***
- ***Huynhia***
- ***Lithodora***
- ***Lithospermum***
- ***Macrotomia***
- ***Mairetis***
- ***Moltkia***
- ***Moltkiopsis***
- ***Neatostema***
- ***Onosma***
- ***Paramoltkia***
- ***Podonosma***
- ***Pontechium***

Strictly speaking, the statement is true since there are some well characterised genera in each of these groups. If the sentence is, however, supposed to mean that all genera of these tribes are well characterized, then we have to disagree (see, e.g., *Anchusa,* Hilger & al. 2004).

3.1. *Heliotropioideae*. – Neither *Ceballosia* nor *Argusia* can be retained as genera, since both are firmly nested in Old World *Heliotropium,* a finding that is supported by both molecular and morphological data (Hilger & Diane 2003), and *Argusia* itself even might be polyphyletic. *Heliotropium* is thus the only genus of the subfamily that deserves recognition in Europe (and *Euploca* in northern Africa). The affinity between *Tournefortia* and *Argusia* is not borne out by closer study, and *Tournefortia* is a largely tropical genus that is found nowhere near Europe (Hilger & Diane 2003, Verdcourt 1991).

3.2. *Lithospermeae*. – The genera as listed are ill-defined and the list of names is incomplete or taxonomically inconsistent. *Podonosma* is completely omitted, *Halacsya* is erroneously placed

in *Cynoglosseae* instead of *Lithospermeae* (compare Seibert 1978 for nutlet morphology and anatomy), *Pontechium* as segregate of *Echium* is not mentioned at all, neither as valid name nor as synonym (Hilger & Böhle 2000). *Aegonychon* S. F. Gray (1821) is a later synonym of *Buglossoides* Moench (1794). If *Aegonychon* (type: *A. purpureocaeruleum,* Holub 1973) was to be kept separate from *Buglossoides* (type: *B. tenuiflorum,* Johnston 1954) and *Lithospermum,* then it would have to be shown that *A. goulandriorum* is actually more closely related to *B. purpureocaeruleum* than either is to *Buglossoides arvensis,* but we are not aware of such a study. For the justification of a genus *Buglossoides* see Clermont & al. (2003). *Echiochilon* belongs to tribe *Echiochileae* (as does *Ogastemma,* see above, Lönn 1999, Långström & Chase 2002).

3.3. *Boragineae*. – *Boragineae* is at present the best investigated tribe of *Boraginaceae* s.str. (contributions of the Selvi group, Florence). The list of genera by Valdés is incomplete and omits several established generic names, such as *Hormuzakia, Anchusella, Paraskevia, Gastrocotyle* and *Phyllocara* (Hilger & al. 2004). If such names are not accepted, then they should at least be cited as synonyms and with an indication where they supposedly belong. Genus delimitation in *Boragineae* is indeed anything but straightforward and the recent literature is full of taxonomic re-evaluations and transfers of individual species from one genus to the other, especially in paraphyletic *Anchusa* s.l. (see the comprehensive treatment by Hilger & al. 2004 and references therein). There is no consensus at all about the affinities of *Mertensia,* and it would be more honest to leave this genus with "incertae sedis", than arbitrarily "tidying up" and placing it into *Boragineae* (Hilger & al. 2004). Neither *Caccinia* nor *Trichodesma* are generally accepted as belonging to *Boragineae* (see Hilger & al. 2004) and may best be placed in a separate tribe *Trichodesmeae* (Riedl 1967).

3.4. *Eritrichieae and Cynoglosseae*. – The taxon delimitations in these two tribes are very wide and *Cynoglossum* and *Lappula* are defined by Valdés in an extremely broad sense. This is a perfectly legitimate approach, but is highly inconsistent with the recognition of tiny segregate genera in *Boragineae* (e.g., *Elizaldia, Cynoglottis*) and *Lithospermeae* (e.g., *Huynhia, Aegonychon, Macrotomia*) and thus represents a distinct disadvantage for the aim of a "consensus classification".

In summary, the classification proposed by B. Valdés (2004) is incomplete, incorrect, inconsistent and out of date. Making new formal combinations, as he does, on such a weak scientific basis runs counter to all attempts at providing a stable consensus classification and stable names with a minimum of synonyms and is bound to generate longer and longer lists of useless names.

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