

A reassessment of the sections of the genus *Cytisus* Desf. (Cytiseae, Leguminosae)

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Recent morphological and molecular research on *Cytisus* and allied genera has produced a great deal of new data relevant to systematics, which have not yet been incorporated into a consistent classification system of the genus. We have compared and evaluated recently published cladograms and phenograms based on morphological and molecular (nuclear and plastid DNA) characters. The genus *Cytisus* sensu lato, including *Calicotome*, *Chamaecytisus*, *Chronanthus*, and *Lembotropis*, appears to be monophyletic. A subdivision of the genus *Cytisus* in 13 sections is presented; one species, *C. tribracteolatus*, remains incertae sedis. A new section (*C. sect. Dendrocytisus*) and two new combinations for taxa in *C. sect. Calicotome* are proposed.

KEYWORDS: *Calicotome*, *Chamaecytisus*, *Chronanthus*, *Lembotropis*, nomenclature, sections, taxonomy.

INTRODUCTION

The tribe Cytiseae Bercht. & J. Presl [= Genisteeae (Adans.) Benth.] and the genus *Cytisus* Desf. have been the subject of several taxonomic studies in recent years. *Cytisus* has been variously circumscribed from very comprehensive (Polhill, 1976; Bisby & al., 2001) to variously restricted (Frodin & Heywood, 1968; Bisby, 1981; Pignatti, 1982; Greuter & al., 1989; Talavera & al., 1999), with recognition of a number of additional smaller genera (e.g., *Chamaecytisus* Link, *Calicotome* Link, *Sarothamnus* Wimm., *Coroanthus* (W.D.J. Koch) C. Presl, *Chronanthus* (DC.) C. Koch, *Spartocytisus* Webb & Berthel., *Lembotropis* Griseb.). Taxonomic treatments based on few characters and/or on few species were often contradictory, due to the complex and reticulate pattern of diversification of Cytiseae (Cristofolini, 1997), possibly connected with the polyploid origin of most Cytiseae (Sañudo, 1973; Troia, 1997; Cubas & al., 2001).

New insights into the phylogeny of *Cytisus* has come from cladistic and phenetic analyses based on molecular data (Cubas & al., 2002; González-Andrés & Ortiz, 1995; Käss & Wink, 1995, 1997; Pardo & al., 2004) and morphology (Cristofolini & Conte, 2002; González-Andrés & Ortiz, 1996). These studies have produced a great deal of new data relevant to systematics, which have not yet been incorporated into a consistent classification system of the genus.

In the present paper we propose a new classification of the genus *Cytisus* based on all relevant taxonomic evidence. Special attention is given to the circumscription of the genus and its division into sections.

METHODS

We compared all recently published phenograms and cladograms of the genus *Cytisus* based on large sets of molecular or morphological data, and covering at least a half of its sections. The following data sources were considered (Table 1): cladograms based on *rbcL* gene sequences (Käss & Wink, 1995, 1997), *trnL-trnF* intergenic spacer (Cubas & al., 2002; Pardo & al., 2004), ITS region (Käss & Wink, 1997; Cubas & al., 2002; Pardo & al., 2004), and morphological characters (Cristofolini & Conte, 2002); phenograms based upon RAPDs (González-Andrés & Ortiz, 1995) and morphological characters (González-Andrés & Ortiz, 1996). Altogether these studies sampled 35 out of about 60 species currently recognised in the genus *Cytisus* s.l., and covered all sections recognised in the present review. Such coverage allows for drawing some general conclusions.

A consensus tree could not be computed by numerical methods since individual authors employed different algorithms, and the set of species sampled overlap only in part. Nevertheless, the topologies of the trees could be compared, in order to ascertain which groups are corroborated and which ones are refuted under different conditions of analysis. In some case differences were observed between analyses based upon the same molecular marker, probably due to the different outgroup chosen. Findings of previous relevant research were taken into account, when cladograms and/or phenograms were incompatible.

Table 1. Synopsis of recent molecular and morphological studies on *Cytisus* and related genera. Morph. = Morphometry (no. of characters in parentheses).

	<i>rbcL</i> ^{1,2}	<i>trnL-trnF</i> IGS ³	<i>trnL-trnF</i> IGS ⁴	ITS nrDNA ²	ITS nrDNA ³	ITS nrDNA ⁴	RAPDs ⁵	Morph. (40) ⁶	Morph. (68) ⁷
Coverage	11 species, 8 sections	14 species, 12 sections	15 species, 11 sections	11 species, 8 sections	14 species, 12 sections	15 species, 11 sections	12 species, 7 sections	11 species, 8 sections	15 species, 14 sections
Methodology	Cladistic	Cladistic	Cladistic	Cladistic	Cladistic	Cladistic	UPGMA	UPGMA	Cladistic
Outgroup	<i>Cercis</i>	<i>Adenocarpus</i>	<i>Crotalaria</i> , <i>Thermopsis</i>	<i>Cercis</i>	<i>Adenocarpus</i>	<i>Melolobium</i> , <i>Crotalaria</i> , <i>Thermopsis</i>	no outgroup	no outgroup	<i>Sophora</i> , <i>Anagyris</i>
<i>Cytisus</i>	sister to <i>Tubocytisus</i>	sister to a clade including most of the genus	in an unresolved clade, with several sections of <i>Cytisus</i>	sister to <i>Calicotome</i>	sister to <i>Verzinum</i> and <i>Calicotome</i>	in a clade with <i>Calicotome</i>	in a cluster with <i>Spartopsis</i> and <i>Verzinum</i>	clusters with <i>Tubocytisus</i>	in the core of <i>Cytisus</i> , sister to <i>C. aeolicus</i>
<i>Dendrocytisus</i>	-	-	-	-	-	-	-	-	in the core of <i>Cytisus</i> , sister to <i>C. villosus</i>
<i>Emeroides</i>	-	-	-	-	-	-	-	-	in the core of <i>Cytisus</i> , sister to <i>Tubocytisus</i>
<i>Tubocytisus</i>	included in <i>Cytisus</i> , polyphy- letic	included in <i>Cytisus</i> , sister to <i>Coroanthus</i> , <i>Spartopsis</i> , <i>Verzinum</i>	included in <i>Cytisus</i> , in an unresolved clade	included in <i>Cytisus</i> , polyphyletic	included in <i>Cytisus</i> , sister to <i>Coroanthus</i> and <i>Alburnoides</i>	included in <i>Cytisus</i> , in a clade with <i>Alburnoides</i>	clusters out of the rest of the genus	clusters with <i>C. villosus</i>	in the core of <i>Cytisus</i> , in a clade with <i>Emeroides</i>
<i>Calicotome</i>	included in <i>Cytisus</i> , sister to <i>Tubocytisus</i> p.p.	included in <i>Cytisus</i> (un- resolved clade including all species)	included in <i>Cytisus</i> , in an unresolved clade	included in <i>C. villosus</i>	included in <i>Cytisus</i> , in a clade with <i>Verzinum</i> and <i>Alburnoides</i>	included in <i>C. villosus</i>	-	-	sister to the core of <i>Cytisus</i>
<i>Coroanthus</i>	-	intermixed with <i>Spartopsis</i> , <i>Verzinum</i> , <i>Alburnoides</i>	in an unresolved clade, with several sections of <i>Cytisus</i>	-	in a clade with <i>Tubocytisus</i> and <i>Alburnoides</i>	sister to <i>Tubocytisus</i> and <i>Alburnoides</i>	-	-	position unstable, depending on the outgroup
<i>Spartopsis</i>	sister to <i>Tubocytisus</i> p.p.	intermixed with <i>Coroanthus</i> , <i>Verzinum</i> , <i>Alburnoides</i>	in an unresolved clade, with several sects. of <i>Cytisus</i>	in a clade with <i>Alburnoides</i>	in a clade with <i>Alburnoides</i>	in a clade with <i>Alburnoides</i>	in a cluster with <i>Verzinum</i>	in a cluster with <i>Verzinum</i>	in a clade with <i>Verzinum</i>
<i>Verzinum</i>	sister to <i>Tubocytisus</i> p.p.	intermixed with <i>Coroanthus</i> , <i>Spartopsis</i> , <i>Alburnoides</i>	sister to <i>Alburnoides</i> and <i>Spartopsis</i> p.p.	in a clade with <i>Tubocytisus</i>	sister to <i>Calicotome</i>	in a clade with <i>Oreosparton</i> and <i>Spartopsis</i> p.p.	in a cluster with <i>Spartopsis</i>	in a cluster with <i>Spartopsis</i>	in a clade with <i>Spartopsis</i>

1Käss & Wink (1995); 2Käss & Wink (1997); 3Cubas & al. (2002); 4Pardo & al. (2004); 5González-Andrés & Ortiz (1995); 6González-Andrés & Ortiz (1996); 7Cristofolini & Conte (2002).

Table 1 (continued)

	<i>rbcL</i>	<i>trnL-trnF</i> IGS	<i>trnL-trnF</i> IGS	<i>ITS nrDNA</i>	<i>ITS nrDNA</i>	<i>ITS nrDNA</i>	RAPDs	Morph. (40)	Morph. (68)
<i>Alburnoides</i>	sister to <i>Verzinum</i> and <i>Tubocytisus</i> p.p.	intermixed with <i>Corothismus</i> , <i>Spartopsis</i> , <i>Verzinum</i>	in a clade with <i>Spartopsis</i> p.p.	polyphyletic, split in two clades	in a clade with <i>Spartopsis</i>	in a clade with <i>Spartopsis</i>	-	clusters with <i>Teline</i>	position unstable, depending on the outgroup
<i>Oreosparton</i>	included in <i>Cytisus</i>	included in <i>Cytisus</i> (unresolved clade including all species)	in an unresolved clade, with several sections of <i>Cytisus</i>	included in <i>Cytisus</i> , in an unresolved clade	sister to <i>Cytisus</i>	included in <i>Cytisus</i> , in a clade with <i>Verzinum</i>	-	-	included in <i>Cytisus</i> , in a clade with <i>Chronanthus</i>
<i>Heterocytisus</i>	-	included in <i>Cytisus</i> , (unresolved clade including all species)	included in <i>Cytisus</i> , sister to <i>Chronanthus</i>	sister to the rest of the genus	-	clusters with <i>Chronanthus</i> , sister to the rest of the genus	-	-	included in <i>Chronanthus</i>
<i>Chronanthus</i>	-	excluded from <i>Cytisus</i> , forms a clade with <i>C. tribracteolatus</i>	included in <i>Cytisus</i> , in an unresolved clade	sister to the rest of the genus	-	clusters with <i>Heterocytisus</i> , sister to the rest of the genus	in a cluster with <i>Teline</i>	in a cluster with <i>Alburnoides</i> and <i>Teline</i>	included in <i>Cytisus</i> , in a clade with <i>Oreosparton</i>
<i>Lembotropis</i>	included in <i>Cytisus</i> , sister to <i>Alburnoides</i> , <i>Tubocytisus</i> , <i>Verzinum</i>	-	-	-	included in <i>Cytisus</i> , in a clade with <i>C. purpureus</i>	-	-	-	sister to <i>Hesperolaburnum</i> and to <i>Podocytisus</i>
<i>Cytisus tribracteolatus</i> incertae sedis	-	excluded from <i>Cytisus</i> , in a clade with <i>Chronanthus</i>	included in <i>Cytisus</i> , in an unresolved clade	included in <i>Cytisus</i> , in an unresolved clade	-	included in <i>Cytisus</i> , in an unresolved clade	-	-	in the core of <i>Cytisus</i> , in an unresolved clade
<i>Cytisophyllum</i>	excluded from <i>Cytisus</i>	excluded from <i>Cytisus</i>	included in <i>Cytisus</i> , in a clade with <i>Chronanthus</i> , <i>Heterocytisus</i> , <i>Telinoides</i>	in an unresolved clade including all <i>Cytisus</i> species	excluded from <i>Cytisus</i>	sister to <i>Laburnum</i> and to <i>Cytisus</i>	clusters with <i>Cytisus</i> p.p. and <i>Teline</i>	excluded from <i>Cytisus</i>	excluded from <i>Cytisus</i>
<i>Argyrocytisus</i>	excluded from <i>Cytisus</i>	excluded from <i>Cytisus</i>	-	included in <i>Cytisus</i>	excluded from <i>Cytisus</i>	-	-	-	excluded from <i>Cytisus</i>
<i>Teline</i>	excluded from <i>Cytisus</i>	excluded from <i>Cytisus</i>	polyphyletic, excluded from <i>Cytisus</i>	excluded from <i>Cytisus</i>	excluded from <i>Cytisus</i>	polyphyletic, excluded from <i>Cytisus</i>	polyphyletic, clusters within <i>Cytisus</i> s.l.	monophyletic, included in <i>Cytisus</i> s.l.	excluded from <i>Cytisus</i>

RESULTS AND DISCUSSION

The number of terminal taxa analysed ranges from ten (Käss & Wink, 1997) to 41 (Cubas & al., 2002), the number of sections from seven (González-Andrés & Ortiz, 1996) to 14 (Cristofolini & Conte, 2002). Four sections (*Cytisus*, *Tubocytisus*, *Spartopsis*, *Verzinum*) were included in all studies and six (*Calicotome*, *Corothamnus*, *Alburnoides*, *Oreosparton*, *Heterocytisus*, *Chronanthus*) in at least five studies (Table 1). Only three studies (Table 1) dealt with *Cytisus* sect. *Lembotropis*. *C.* sect. *Emeroides* and *C.* sect. *Dendrocytisus* were studied only by Cristofolini & Conte (2002).

Circumscription of the genus. — All cladograms based on molecular information (cpDNA as well as ncDNA) present a major clade that includes the following sections: *Cytisus*, *Tubocytisus*, *Calicotome*, *Corothamnus*, *Spartopsis*, *Verzinum*, *Alburnoides*, *Oreosparton*, and *Lembotropis*. This result is consistent with the cladogram based on morphological characters for all sections (Cristofolini & Conte, 2002), with the exception of *C.* sect. *Lembotropis*. In the latter case there is a divergence between molecular and morphological evidence.

Phylogenetic results from molecular data are divergent in the following cases:

a) *Heterocytisus* is included in *Cytisus* (cpDNA: Cubas & al., 2002; Pardo & al., 2004) or is sister to it, in a larger clade that includes, besides *Cytisus*, also *Cytisophyllum* and *Argyrocytismus* (ncDNA: Cubas & al., 2002; Pardo & al., 2004). Since arguments in favour of its inclusion in *Cytisus* are prevailing, this option is here accepted. Nevertheless, the phylogenetic position of section *Heterocytisus* remains unresolved.

b) *Chronanthus* belongs to the clade of the genus *Cytisus* in the morphological analyses (Cristofolini & Conte, 2002) and is sister to *Cytisus* in cladograms based on ncDNA (Cubas & al., 2002; Pardo & al., 2004). Results derived from cpDNA are discordant. Like *Heterocytisus*, inclusion of *Chronanthus* in *Cytisus* must be regarded as provisory.

c) *Tubocytisus*. Contrary to all other evidence, the dendrogram derived from RAPDs diversity (González-Andrés & Ortiz, 1996) places this section outside the genus; other molecular evidence and morphological data support its inclusion in the genus *Cytisus*.

All studies consistently excluded *Cytisophyllum* from the larger *Cytisus* clade; almost all excluded *Argyrocytismus* as well. Only a cladogram based on ncDNA (Cubas & al., 2002) was not consistent with the other evidence. All molecular and morphological trees exclude *Teline* from the larger *Cytisus* clade. However, phenetic analyses based on morphology (González-Andrés & Ortiz, 1995) and on RAPDs (González-Andrés

& Ortiz, 1996) placed *Teline* within *Cytisus* sensu lato. The findings of González-Andrés & Ortiz also conflict with those of Percy & Cronck (2002) who showed *Teline* to be polyphyletic, consisting of two lineages separately nested within *Genista*. The genus *Teline* certainly requires deeper investigation.

Altogether, *Cytisus* sensu lato appears to form a natural group, and deserves to be recognised as a genus. In addition, the sections that we are recognising are supposed to represent monophyletic entities (see below). Whether to split or to lump these in a classification has been a subject of debate for many years, and has been recently discussed in detail by Albach & al. (2005) in a case that presents many analogies with this one. In the case of *Cytisus*, we observe that (a) infrageneric natural aggregates of more sections are not recognisable, and that (b) giving generic rank to all sections would lead to an unpractical fragmentation into about 13 to 14 genera, many of them monotypic. On this ground, we propose to accept the genus *Cytisus* in a broad sense, largely in accordance with Briquet (1894) and Polhill (1976), so as to encompass the previously recognized genera *Chamaecytisus* Link, *Calicotome* Link, *Sarothamnus* Wimm., *Corothamnus* (W.D.J. Koch) C. Presl, *Chronanthus* (DC.) C. Koch, *Spartocytisus* Webb & Berthel., *Lembotropis* Griseb., while excluding *Teline* Medik., *Cytisophyllum* Lang and *Argyrocytismus* (Maire) Raynaud.

Infrageneric taxonomy. — Only groups of species showing robust evidence of monophyly are here accepted as sections. This requirement caused the recognition of a high number of sections (13), several of them monospecific. The main differential morphological characters are synthesised in Table 2.

Cytisus villosus, *C. tribracteolatus*, *C. aeolicus*, *C. emeriflorus* have been included from time to time in *C.* sect. *Cytisus*. Molecular data are available only for the two former species. Neither cpDNA nor ncDNA (Cubas & al., 2002; Pardo & al., 2004) indicate any affinity between them. Morphometric data on the four species (Cristofolini & Conte, 2002), as well as serological data (Feoli-Chiapella & Cristofolini, 1980) of *C. villosus*, *C. aeolicus*, and *C. emeriflorus* did not show mutual similarity within this group, that is only unified by some plesiomorphisms (e.g., the calyx shape). Both *C. aeolicus* and *C. emeriflorus* are relict endemic species (Conte & al., 1998; Conte & Cristofolini, 2000) that are systematically isolated within the genus. Therefore, *C. villosus*, *C. aeolicus*, and *C. emeriflorus* are placed in separate monospecific sections. Data on *C. tribracteolatus* are scanty and contradictory, and its taxonomic position is still unstable (see Talavera & al., 1999). Hence, we must leave this species as *incertae sedis*.

Cytisus sect. *Tubocytisus* is clearly distinct from all

Table 2. The main differential characters of sections in the genus *Cytisus*.

Sections	Habit and twigs	Leaves structure	Hairs	Inflorescence	Calyx shape	Upper lip teeth	Corolla colour	Style after pollen release	Legume
<i>Cytisus</i>	unarmed shrubs; twigs ribbed (5 semicylindric ribs), alternate	trifoliolate, petiolate, persistent	simple (basifixed)	1–3 flowers in axillary fascicles	campanulate, divided to about ¼ of its length	short, acute, divergent	yellow	curved upwards	oblong, multi-seeded
<i>Dendrocytisus</i>	unarmed small trees; twigs terete, alternate	trifoliolate, petiolate, persistent	simple (basifixed)	7–9 flowers on lateral short shoots	campanulate, almost actinomorphic	upper lip short, divided to about 1/3 of its length	yellow	curved upwards	oblong, multi-seeded, not or tardily dehiscent
<i>Emeroides</i>	unarmed shrubs; twigs terete, alternate	trifoliolate, petiolate, deciduous	bifid (medifixed)	axillary fascicles	campanulate, divided to ¼ of its length	obtuse, minute	yellow	curved upwards	oblong, 2- to 7-seeded
<i>Tubocytisus</i>	unarmed or spiny shrubs or herbs woody at the base; twigs terete, alternate	trifoliolate, shortly petiolate, deciduous	simple (basifixed)	axillary fascicles and/or terminal heads	tubular, incise to about 1/3 of its length, ca. 3 × as long as wide	obtuse, broad, divergent	yellow (purple in one species)	almost to slightly curved upwards	oblong, multi-seeded
<i>Calicotome</i>	spiny shrubs; twigs ribbed (10–18 ribs T- or V-shaped), alternate	trifoliolate, shortly petiolate, deciduous	simple (basifixed) or medifixed	axillary fascicles	tubular, circumscissile at anthesis	do not differentiate	yellow	curved upwards	oblong, multi-seeded
<i>Corothenus</i>	unarmed shrubs or herbs woody at the base; twigs ribbed (5 rounded ribs), alternate	unifoliolate, sessile, deciduous	simple (basifixed)	flowers single or in axillary fascicles	campanulate, divided to about ½	acute, inconspicuous, adpressed	yellow	curved upwards	oblong, multi-seeded
<i>Spartopsis</i>	unarmed shrubs; twigs ribbed (5–11 ribs T- or V-shaped), alternate	trifoliolate or unifoliolate, sessile, deciduous	simple (basifixed)	flowers single or in axillary fascicles	campanulate, divided in two lips to about ½ of its length	acute, inconspicuous, adpressed	yellow	revolute	oblong, multi-seeded
<i>Verzinum</i>	unarmed shrubs; twigs ribbed (8–14 ribs T-shaped), alternate	trifoliolate, shortly petiolate, deciduous	simple (basifixed)	flowers single or in axillary fascicles	campanulate, divided in two lips to about ½ of its length	acute, inconspicuous, adpressed	yellow	revolute	oblong, multi-seeded

Table 2 (continued)

Sections	Habit and twigs	Leaves structure	Hairs	Inflorescence	Calyx shape	Upper lip teeth	Corolla colour	Style after pollen release	Legume
<i>Alburnoides</i>	unarmed shrubs; twigs ribbed (8–10 ribs T-shaped), alternate	unifoliolate (sometimes lower leaves trifoliolate), deciduous	simple (basifixed)	flowers single or in axillary fascicles	campanulate, divided in two lips to about 1/3 of its length	acute, inconspicuous, adpressed	yellow or white	slightly curved upwards	linear, multi-seeded
<i>Oreosparton</i>	unarmed shrubs; twigs striped to angled, alternate	trifoliolate, petiole, fugacious	simple (basifixed)	fascicles on lateral short shoots	campanulate, about as long as wide	inconspicuous	pink or white	curved upwards	oblong, 2- to 6-seeded
<i>Heterocytisus</i>	unarmed shrubs; twigs ribbed, alternate	trifoliolate, petiole, deciduous	simple (basifixed)	flowers congested in capitula on lateral long shoots	campanulate, about as long as wide	acute, inconspicuous	yellow	curved upwards	ovoid, 1–2-seeded
<i>Chronanthus</i>	unarmed shrubs; twigs ribbed, alternate	trifoliolate, petiole, deciduous	simple (basifixed)	flowers single or in small fascicles on leafy short shoots	divided to 3/4 of its length	upper lip completely divided into two acute teeth	yellow; petals persistent in fruit	abruptly bended at 90° at half of its length	ovoid, 1–2-seeded
<i>Lembotropis</i>	unarmed shrubs; twigs terete, alternate	trifoliolate, petiole, deciduous	bifid (medifixed)	terminal leafless multiflowered racemes	campanulate, the lower lip twice as long as the upper lip	almost completely fused, minute	yellow	slightly curved upwards	oblong, 3- to 5-seeded
<i>Cytisus tribracteolatus</i> incertae sedis	unarmed shrubs; twigs ribbed, opposite to subopposite	trifoliolate, sessile or subsessile, deciduous	simple (basifixed)	axillary fascicles	campanulate, divided to 2/3 of its length	upper lip divided to about 1/3 of its length into two acute teeth	yellow	bended upwards at right angle	oblong, 2- to 7-seeded

other sections and is very uniform. The conclusion of Käss & Wink (1997) that this section is polyphyletic is not supported by other molecular studies, or by chemotaxonomic (Cristofolini & Feoli-Chiapella, 1977; Feoli-Chiapella & Cristofolini, 1980) and taximetric (Bisby & Nicholls, 1977) work, and deserves further analysis. *Cytisus* sect. *Calicotome* shows different taxonomic affinities, depending on the marker employed. Sections *Corothismus*, *Spartopsis*, *Verzinum* and *Alburnoides* are related both in morphological and molecular analyses. Plastid DNA sequences (Käss & Wink, 1997) failed to discriminate among them. Sect. *Oreosparton* is a member of *Cytisus* in all analyses, but its relationships with the other sections are unresolved. Sect. *Chronanthus* and sect. *Heterocytisus* are either included in *Cytisus* or sister to it. The molecular data available for *Cytisus* sect. *Lembotropis* (Käss & Wink, 1995, 1997) indicate affinity with sections *Verzinum*, *Alburnoides* and *Tubocytisus*. More data are required to define the relationships of this section, which is certainly isolated within the genus.

The available evidence does not allow for aggregation of the sections into more comprehensive, stable units. Additional data sources such as anatomy (see Norverto & al., 1994), seed morphology (see Tahiri & al., 1999), and pollen morphology (see Pardo & al., 2000) may prove more informative when relevant data are acquired for larger sets of sections.

Key to the sections of *Cytisus*

- 1. Leaves evergreen, trifoliolate; shrubs or small trees 2
- 1. Leaves deciduous, trifoliolate or unifoliolate; shrubs 3
- 2. Flowers 1–3, in axillary clusters; shrubs . . . *Cytisus*
- 2. Flowers 5–10, in short racemes on aphyllous short shoots; small trees *Dendrocytisus*
- 3. Calyx breaking away at anthesis; spiny shrubs *Calicotome*
- 3. Calyx not as above; shrubs usually unarmed . . . 4
- 4. Calyx tubular *Tubocytisus*
- 4. Calyx campanulate 5
- 5. Flowers born in terminal leafless racemes or capitules 6
- 5. Flowers single or in fascicles in leafy inflorescences 7
- 6. Flowers born in elongate racemes; hairs on leaves and stem medifixed; legume oblong, 4–6 seeded *Lembotropis*
- 6. Flowers congested in capitules; hairs basifixed; legume ovoid, 1–2 seeded *Heterocytisus*
- 7. Flowers pink or white 8
- 7. Flowers yellow 9
- 8. Twigs with 8–10 ribs T-shaped in transverse section; leaves persistent *Alburnoides*

- 8. Twigs striped to angled, the ribs not T-shaped; leaves fugaceous *Oreosparton*
- 9. Calyx deeply divided in two lips; three linear bracteoles at the calyx base 10
- 9. Calyx divided for less than 1/2 of its length; no bracteoles at its base 11
- 10. Twigs alternate; upper calyx lip completely divided into two teeth; corolla persistent at fructification; legume ovoid *Chronanthus*
- 10. Twigs opposite or subopposite; upper calyx lip divided only in its distal part in two teeth; corolla not persistent; legume oblong [*C. tribracteolatus*]
- 11. Style convolute after pollen release 12
- 11. Style curved upwards, but never convolute 13
- 12. Leaves unifoliolate, at least on young twigs; twigs with 5–11 ribs *Spartopsis*
- 12. All leaves trifoliolate; twigs with 8–14 ribs *Verzinum*
- 13. All leaves unifoliolate *Corothismus*
- 13. Leaves at least in part trifoliolate 14
- 14. Twigs with ribs T-shaped in transverse section; leaves glabrous or with basifixed hairs *Alburnoides*
- 14. Twigs with ribs not T-shaped; leaves with appressed medifixed hairs on the lower side *Emeroides*

TAXONOMY AND NOMENCLATURE

Cytisus Desf., Fl. Atl., 2: 139. 1798, nom. et typ. cons., non L. 1753. – Type (see Polhill & al., 1978): *C. triflorus* L'Hér., Stirp. Nov.: 184. 1791. non Lam., Encycl. Méth. Bot. 2: 250. 1786. – Lectotype of species name (designated here by G. Cristofolini and N. Fumaux): In montibus juxta Algeriam, *Louiche* [René Louiche Desfontaines] s.n. (G-DC). [= *C. villosus* Pourr., Mem. Acad. Toul. 3: 317. 1788].

Shrubs (rarely small trees) or herbs woody at the base; leaves mostly trifoliolate, estipulate, alternate; flowers axillary, in terminal capitules, in fascicles or in leafless racemes; calyx bilabiate, with the upper and the lower lips usually with short teeth; standard about as long as wings and keel; wings and keel with or without auricles; androecium monadelphous; style curved at the base, straight or curved in its distal part; ovary multiovulate; legume polyspermous, usually dehiscent; seeds usually arillate.

The genus *Cytisus* includes about 60 species distributed from northern Africa (Morocco) to southern, western and central Europe, reaching Germany and Poland to the North, and western Russia, the Black Sea and Turkey to the East. The highest species diversity is observed around the Mediterranean Sea.

1. *Cytisus* sect. *Cytisus* ≡ *Trianthocytisus* Griseb., Spicil. Fl. Rumel. 1: 9. 1843.

Unarmed shrubs; twigs angular, alternate; leaves trifoliolate, petiolate, persistent; leaflets obovate; flowers 1–3 in axillary clusters; calyx ebracteate, campanulate, divided in two lips to about ¼ of its length; corolla yellow; style curved upwards after pollen release; legume oblong, 2–5 seeded; Seeds with a small strophiole. 1 species.

The limits of this section have been controversial. *Cytisus villosus*, *C. aeolicus*, *C. tribracteolatus* and *C. emeriflorus* have been included here, in different combinations, by different authors (for a historical overview see Cristofolini & Conte, 2002).

Cytisus villosus appears to be related to sections *Tubocytisus*, *Spartopsis*, or *Calicotome*, depending on the molecular marker, while pollen morphology (Pardo & al., 2000) associate it to *C.* sect. *Alburnoides*. Morphological data (Cristofolini & Conte, 2002) suggest that *C. villosus* is isolated from all other species. *Cytisus villosus* has a wide distribution area around the Mediterranean Sea, especially in the Western and Central regions.

2. *Cytisus* sect. *Dendrocytisus* Cristof. et Troia, **sect. nova.** – Type: *C. aeolicus* Guss., Fl. Sicul. Prodr. Suppl.: 221. 1834. – Lectotype of species name (designated here): In aridis submontosis vulcanicis, Vulcano, 5.VI.1828, *G. Gussone* (NAP - GUSS/Sicilia).

Diagnosis: Arbusculae inermes, ramis foliosis semipervirentibus, apice floriferis; floribus 5–9 in fasciculis aphyllis dispositis; calyce campanulato-tubuloso, labio superiore bidentato, inferiore integro; legumine indehiscente vel tarde dehiscente.

Small trees; twigs terete, alternate; leaves trifoliolate, petiolate, persistent; leaflets obovate; flowers 5–10 in short racemes on aphyllous short shoots; calyx ebracteate, campanulate, divided in two lips to about ¼ of its length; corolla yellow; style curved upwards; legume oblong, 2–5 seeded, not or tardily dehiscent; seeds with a small strophiole.

The systematic isolation of *C. aeolicus* was suggested long ago by serological analyses (Feoli-Chiapella & Cristofolini, 1980; Cristofolini & Feoli-Chiapella, 1984), and has been recently confirmed by Troia (1997), Conte & al. (1998) and Cristofolini & Conte (2002). *Cytisus aeolicus* differs from *C.* sect. *Cytisus* by its arboreal habit, flowers congested in fascicles on leafless brachyblasts, and fruits not (or tardily) dehiscent. The calyx is tubulate-campanulate, intermediate between the campanulate calyx of *C. villosus* and the tubulose calyx peculiar of *C.* sect. *Tubocytisus*. *Cytisus aeolicus* is endemic to the Aeolian Isles (Sicily); its origin and segregation from *Cytisus* is presumably very ancient (Conte & al., 1998).

3. *Cytisus* sect. *Emeroides* Ducommun, Taschenb. Schweiz. Bot.: 160–161. 1869 ≡ *Lembotropis* Griseb. sect. *Emeroides* (Ducommun) Klásk., Acta Univ. Carol., Biol., Suppl. 1964/2: 19. 1964. – Type: *C. emeriflorus* Reichenb., Fl. Germ. Excurs.: 524. 1832. – Type of species name: not designated.

Unarmed shrubs; twigs alternate, ribbed; leaves trifoliolate, petiolate, deciduous, with appressed bifid (medifixed) hairs on the lower side; leaflets obovate; flowers in axillary clusters; calyx campanulate, almost actinomorphic; corolla yellow; style slightly curved upwards; legume oblong, 2–7 seeded, Seeds strophiolate. One species.

This monospecific section contains one species with a chequered taxonomic history (see Cristofolini & Conte, 2002). *Cytisus emeriflorus*, endemic to the Southern Alps, has some morphological affinity with *Lembotropis nigricans* (Gams, 1924); hence, Skálická (1969) placed it in the genus *Lembotropis*. However, an overall morphological analysis showed that *C. emeriflorus* and *C. nigricans* are not closely related. On the contrary, overall morphology places *C. emeriflorus* close to the core of the genus *Cytisus*, in particular to *C.* sect. *Tubocytisus* (Cristofolini & Conte, 2002), corroborating data derived from the serological reaction of seed storage globulins (Feoli-Chiapella & Cristofolini, 1980). The origin of this species seems to be more recent than that of *C. tribracteolatus* and *C. aeolicus* (Conte & Cristofolini, 2000).

4. *Cytisus* sect. *Tubocytisus* DC., Prodr. 2: 153. 1825 ≡ *Chamaecytisus* Link, Handb. 2: 154. 1831. Lectotype (designated by Rothmaler, 1944): *Chamaecytisus hirsutus* (L.) Link, Handb. 2: 155. 1831 [≡ *C. hirsutus* L., Sp. Pl.: 739. 1753]. – Lectotype of species name [designated by Cristofolini & Jarvis, 1991]: Burser Herbarium, vol. XXII: 5 (UPS).

Unarmed or spiny shrubs or subshrubs; twigs alternate, terete or obscurely ribbed; leaves trifoliolate, petiolate, deciduous; leaflets lanceolate to obovate; hairs simple or bifid; flowers in axillary clusters or in terminal heads; calyx ebracteate, tubular, incise to about 1/3 of its length; corolla yellow, white, or purple; style slightly curved upwards; legume oblong, 2–5 seeded; seeds strophiolate. Ca. 30 species (see Appendix).

Two names presently attributed to *C.* sect. *Tubocytisus* were described in the first edition of Species Plantarum, *C. hirsutus* L. and *C. supinus* L. The latter name is now treated as a taxonomic synonym of the former (Cristofolini, 1974, 1976; Cristofolini & Jarvis, 1991). Norverto & al. (1994), based on anatomical observations, argued that the two are different species. Unfortunately, they studied plants grown from seeds provided by botanical gardens, which is unreliable when

dealing with such a critical complex of species, marred by problematical identification (especially Balkanic populations), plasticity, and possible hybridisation.

The taxonomic status of this section, which includes about 30 species from the Canary Islands to Western Asia (Cristofolini, 1991), is critical in view of contrasting systematic evidence. RAPD markers used by González-Andrés & Ortiz (1995) indicate independence of this section from the genus *Cytisus*. Anatomical observations (Norverto & al., 1994) also corroborate the distinction between *Cytisus* and *Chamaecytisus*. In contrast, cladistic analyses based on several plastid and nuclear molecular markers (Käss & Wink, 1995, 1997; Cubas & al., 2002; Pardo & al., 2004) failed to separate the species of *Chamaecytisus* from those of *Cytisus*, corroborating results come from morphometric studies (González-Andrés & Ortiz, 1996; Cristofolini & Conte, 2002) and serological analysis (Cristofolini & Feoli-Chiapella, 1977; Feoli-Chiapella & Cristofolini, 1980). Alkaloid profiles (Käss & Wink, 1995) are identical in species of *C. sect. Tubocytisus*, *C. sect. Cytisus*, and *C. sect. Spartopsis*. Altogether, we observe that the segregation between these two sets of species holds, in numerical analyses, as long as one does not consider such “intermediate” species as *C. aeolicus* and *C. proliferus*. Including these species in cladistic analysis affects the topology of the cladograms and causes sharp distinctions to vanish (Cristofolini & Conte, 2002). Hence, we follow Talavera & al. (1999) in treating *Tubocytisus* as a section of *Cytisus*.

5. *Cytisus sect. Calicotome* (Link) DC., Prodr. 2: 154. (1825) ≡ *Calicotome* Link, in Schrader Neues Jour. Bot. 2, 2: 50 (1807) [basionym]. – Type (designated here): *Cytisus lanigerus* DC., Prodr. 2: 154. 1825 ≡ *Spartium lanigerum* Desf., Fl. Atl. 2: 135. 1798.

We chose *C. lanigerus* as type, since it is the only species mentioned in Link’s protologue of the genus *Calicotome*.

Spiny shrubs; twigs alternate, terete; leaves trifoliate, petiolate, deciduous; leaflets elliptic to obovate; flowers in axillary clusters; calyx with three bracteoles at the base, tubular, circumscissile at anthesis; corolla yellow; style curved upwards; legume oblong, 2–5 seeded; seeds estrophiolate. Four to five species (see Appendix).

Recognition of *Calicotome* as a genus has been a matter of debate for many years. Almost all recent floras (Frodin & Heywood, 1968; Pignatti, 1982; Greuter & al., 1989; Talavera & al., 1999) recognise *Calicotome* as a genus, in spite of the fact that the splitting calyx is its only distinctive feature. On the contrary, *rbcL* gene sequences (Käss & Wink, 1995) and nucleotide sequences of nrDNA and cpDNA (Cubas & al., 2002) support previous serological data (Cristofolini & Feoli-

Chiapella, 1977), indicating that *Calicotome* is a part of the larger *Cytisus* clade. A cladistic analysis of morphological data (Cristofolini & Conte, 2002) leads to the same conclusion.

Four to five species distributed around the Mediterranean Sea are generally recognised within *Calicotome*. We follow here Greuter & al. (1989) and recognise four species and one subspecies:

1) *Cytisus lanigerus* (Desf.) DC. Prodr. 2: 154. 1825 ≡ *Spartium lanigerum* Desf., Fl. Atl. 2: 135. 1798 [basionym]. – Lectotype of species name (designated here): *Spartium lanigerum* / *Spartium foliis ternis*, ramis spinosis / Leguminibus crassis villosis lanuginosis (P-Desf No. P00307207).

= *Spartium villosum* Poir., Voyage Barb., 2, p. 207. 1789.

= *Calicotome villosa* (Poir.) Link in Schrader Neues Jour. Bot. 2, 2: 51. 1807.

A combination in *Cytisus* based on *Spartium villosum* Poiret, the oldest name for this species, is blocked by the name *Cytisus villosus* Pourr., Mem. Acad. Toul. 3: 317. 1788.

2) *Cytisus spinosus* (L.) Lam., Fl. Fr. 2: 625. 1779 ≡ *Spartium spinosum* L., Sp. Pl.: 997. 1753 [basionym] ≡ *Calicotome spinosa* (L.) Link, Enum. Hort. Berol., 2: 225. 1822. – Lectotype (designated by Gibbs in Turland & Jarvis, 1997): Herb. Clifford: 356, *Spartium* 4 (BM).

3) *Cytisus infestus* (C. Presl) Guss., Fl. Sic. Prodr., 2: 372. 1828 ≡ *Spartium infestum* C. Presl, Del. Prag., 1: 33. 1822 [basionym] ≡ *Calicotome infesta* (C. Presl) Guss., Fl. Sic. Syn. 2: 247. 1843 ≡ *Calicotome spinosa* subsp. *infesta* (C. Presl) Burnat ex O. Bolòs & Vigo, Fl. Països Catalans 1: 442. 1984. – Type: not designated.

= *Cytisus spinosus* W.D.J. Koch, Syn. Fl. Germ. ed. II: 169. 1843, non Lam. 1779, nomen illegitimum.

3a) *Cytisus infestus* (C. Presl) Guss. subsp. **intermedius** (C. Presl) Cristof. & Troia, **comb. nova** ≡ *Cytisus intermedius* Salzm. ex C. Presl, Bot. Bemerk.: 51. 1844 [basionym] ≡ *Calicotome intermedia* Boiss. ex Reichb. fil. Ic. Fl. Germ. 22: 33. t. 2094. 1869 ≡ *Calycotome villosa* subsp. *intermedia* (Salzm.) Quézel & Santa, Nouv. Fl. Algérie: 484. 1962 ≡ *Calicotome infesta* subsp. *intermedia* (C. Presl) Greuter in Willdenowia 15: 428. 1986. – Type: not designated.

4) *Cytisus rigidus* (Viv.) Cristof. & Troia, **comb. nova** ≡ *Spartium rigidum* Viv., Fl. Lib. Spec.: 40, tab. 17, fig. 1. 1824 [basionym] ≡ *Calicotome villosa* var. *rigida* (Viv.) Bég. & Vaccari, Contr. Fl. Libia: 47. 1912 ≡ *Calicotome rigida* (Viv.) Maire et Weiller, Bull. Soc. Hist. Nat. Afrique Nord, 30: 271. 1939. – Type: not designated.

6. *Cytisus* sect. *Coroathamnus* (W.D.J. Koch) Nyman, *Consp. Fl. Eur.*: 157. 1878 \equiv *Genista* sect. *Coroathamnus* W.D.J. Koch, *Röhlings. Deutsch. Fl.* 5: 92. 1839 [basionym] \equiv *Coroathamnus* (W.D.J. Koch) C. Presl, *Abh. Königl. Böhm. Ges. Wiss. ser. 5, 3*: 567. 1845. – Type (designated by Skalická, 1967): *C. procumbens* (Waldst. & Kit.) Spreng., *Syst. Veg.* 3: 224. 1826 [= *Genista procumbens* Waldst. & Kit. ex Willd., *Sp. Pl.* 3: 940, 1802]. – Type of species name: not designated.

Unarmed shrubs, erect or procumbent; twigs alternate, with 5 ribs rounded or T-shaped in transverse section; leaves unifoliolate, sessile, deciduous; leaflets elliptic to obovate; flowers 1–3 in axillary clusters; calyx ebracteate, campanulate, divided in two lips up to ½ of its length; corolla yellow; style curved upwards; legume oblong, 2–5 seeded; seeds with a small strophiole. Four to six species (see Appendix).

Cytisus sect. *Coroathamnus* is a small group of species distributed from the Balkan area to the Western Mediterranean. The section is morphologically very homogeneous and systematically isolated, with some affinity to *Genista* (Skalická, 1967) in which it has been included by some authors (e.g., Koch, 1839) because of its simple leaves. However, the floral morphology of sect. *Coroathamnus* is typical of *Cytisus*.

7. *Cytisus* sect. *Spartopsis* Dumort., *Fl. Belg.*: 991. 1827 \equiv *Sarothamnus* Wimm., *Fl. Schles.*: 278. 1832 \equiv *Cytisus* sect. *Sarothamnus* (Wimm.) Benth., *Gen. Pl.* 1: 484. 1865. – Type (designated by Talavera & Salgueiro, 1999): *C. scoparius* (L.) Link, *Enum. Hort. Berol. Alt.* 2: 241. 1822 [= *Spartium scoparium* L., *Sp. Pl.*: 709. 1753]. – Lectotype of species name [designated by Cristofolini in Turland & Jarvis, 1997]: *Herb. Linn. No.* 891.13 (LINN).

Unarmed shrubs; twigs alternate, with 5–11 ribs T- or V-shaped in transverse section; leaves trifoliolate or unifoliolate, sessile, deciduous; leaflets elliptic to obovate; flowers 1–3 in axillary clusters; calyx ebracteate, campanulate, divided in two lips to about ½ of its length; corolla yellow; style revolute upwards after pollen release; legume oblong, 2- to many-seeded; strophiole large. Five species (see Appendix).

The five species that constitute *C.* sect. *Spartopsis* are mainly distributed in the Iberian Peninsula, with the notable exception of *C. scoparius*, which is widely distributed throughout Europe. *Cytisus* sect. *Spartopsis* is related to *C.* sect. *Verzinum*; most monographers and floras united them in a single section (Frodin & Heywood, 1968; Polhill, 1976). The two sections form a monophyletic group when morphological characters are used (Cristofolini & Conte, 2002). Nevertheless, they are discriminated by several morphological characters (see Table 2) and by molecular data (Käss & Wink, 1995;

Cubas & al., 2002).

8. *Cytisus* sect. *Verzinum* (Raf.) Talavera, *Anal. Jard. Bot. Madrid* 57(1): 214. 1999 \equiv *Verzinum* Rafin., *Sylv. Tellur.* 23. 1838 [basionym]. – Type (designated by Talavera & Salgueiro, 1999): *Verzinum arboreum* (Desf.) DC., *Prodr.* 2: 154. 1825 [= *Spartium arboreum* Desf., *Fl. Atl.* 2: 131. 1798]. – Type of species name: not designated.

Unarmed shrubs; twigs alternate, with 8–14 ribs T-shaped in transverse section; leaves alternate, trifoliolate, shortly petiolate, deciduous; leaflets elliptic to obovate; flowers 1–3 in axillary clusters; calyx ebracteate, campanulate, divided in two lips to about ½ of its length; corolla yellow; style revolute upwards after pollen release; legume oblong, 2- many-seeded; strophiole large. Two species (see Appendix).

Two species, distributed in the west-Mediterranean-Atlantic area, constitute this section, which is related to *Cytisus* sect. *Spartopsis* (see above).

9. *Cytisus* sect. *Alburnoides* DC., *Prodr.* 2: 153. 1825. – Type (designated by Talavera & Salgueiro, 1999): *C. multiflorus* (L'Hér.) Sweet, *Hort. Brit.*: 112. 1826. – Type of species name: not designated.

= *Spartocytisus* Webb sect. *Spartothamnus* Webb & Berthel., *Phyt. Canar.* 2, 3: 52. 1836. – Type (designated here): *Spartocytisus albus* Webb & Berthel., *Phyt. Canar.* 2,3:52.1836. – Type of species name: not designated.

Unarmed shrubs; twigs alternate, with 8–10 ribs T-shaped in transverse section; leaves unifoliolate or trifoliolate, sessile or petiolate, deciduous or fugacious; leaflets linear to elliptic; flowers 1–3 in axillary clusters; calyx ebracteate, campanulate, divided in two lips to about 1/3 of its length; corolla yellow or white; style slightly curved upwards after pollen release; legume oblong, 2- to many-seeded; strophiole large. Six to seven species.

Cytisus sect. *Alburnoides* is distributed in the SW-Mediterranean region. The similarity in anatomy and general morphology makes this set of species a natural and well defined-taxon. The main problem concerns its relationship to *C.* sect. *Oreosparton*. Indeed Talavera & al. (1999) merged both sections in one. In spite of their weak morphological differentiation, the long lasting geographic isolation of the two groups seems to have resulted in a marked genetic divergence, as is revealed by molecular markers (Käss & Wink, 1997; Cubas & al., 2002). On this ground, we retain here the original (Webb & Berthelot, 1836) distinction in two sections, also recognised by Polhill (1976) and corroborated by Cristofolini & Conte (2002).

10. *Cytisus* sect. *Oreosparton* (Webb & Berthel.)

Frodin ex Polhill in Bot.Syst. 1: 338. 1976 = *Spartocytisus* sect. *Oreosparton* Webb & Berthel., Phyt. Canar. 2,3: 50. 1836 [basionym]. – Type (designated here): *C. supranubius* (L.f.) Kuntze, Rev. Gen.: 178. 1891 = *Spartium supranubium* L.f., Suppl.: 319. 1781 [basionym] = *Spartocytisus supranubius* (L. f.) Christ ex G. Kunkel, Cuad. Bot. Canar. 2627: 80. 1976. – Type of species name: not designated [= *Spartium nubigenum* Willd., Sp. Pl. 3, 2: 932. 1802 = *C. nubigenus* (Willd.) Link, Enum. Hort. Berol. 2: 240. 1822 = *Spartocytisus nubigenus* (Willd.) Webb & Berthel., Phyt. Canar. 2, 3: 50. 1836 = *Cytisus fragrans* Lam., Encycl. Méth. Bot. 2: 249. 1786].

= *Nubigena* Raf. Sylv. tellur.: 23. 1838. – Type (designated here): *Nubigena tenerifa* Raf. Sylv. tellur.: 23. 1938.

Unarmed shrubs; twigs alternate, striped to angled; leaves trifoliolate, petiolate, fugacious; leaflets elliptic; flowers 1–4 on lateral leafy short shoots; calyx ebracteate, campanulate; corolla pink or white; style curved upwards after pollen release; legume oblong, 2–7 seeded; seeds strophiolate. 2 species.

Two species of the Canary Islands form this small section, which is morphologically related to *C.* sect. *Alburnoides* (see above).

11. *Cytisus* sect. *Heterocytisus* Briq., Et. Cyt. Alp. Marit.: 144. 1894. – Type: *C. fontanesii* Spach in Journ. Linn. Soc. 16: 405. 1878. – Type of species name: not designated. [= *Chronanthus biflorus* (Desf.) Frodin & Heywood in Feddes Repert. 79: 21. 1968]

- “*Cytisus* sect. *Heterocytisus*” Nym., Consp. Fl. Eur.: 157. 1878, nomen nudum.

Unarmed shrubs; twigs alternate, ribbed; leaves trifoliolate, petiolate, deciduous; leaflets linear to lanceolate; flowers congested in capitula on lateral long shoots; calyx ebracteate, campanulate, about as long as wide; corolla yellow; style curved upwards after pollen release; legume ovoid, few-seeded; strophiole large. One species.

This monotypic section was established by Briquet (1894) to accommodate *C. fontanesii*, peculiar for its 5-angled twigs, the stipulate leaves, and campanulate calyx. Rather surprisingly, this species has sometimes been associated with *C. patens* and *C. orientalis* in *C.* sect. *Chronanthus* (Polhill, 1976), a section with which this species at first sight shows very little affinity. In the only molecular study available that included *C. fontanesii* and *C. heterochrous* (Cubas & al., 2002), both species were sister to the main *Cytisus*-clade, but their mutual relationships remained ambiguous.

12. *Cytisus* sect. *Chronanthus* DC., Prodr. 2: 153. 1825 = *Chronanthus* (DC.) C. Koch, Hort. Dendrol.: 248. 1853. – Type (designated by Talavera & Salgueiro,

1999): *C. orientalis* Loisel., Nouv. Duham.: 156. 1812. – Type of species name: not designated.

Unarmed shrubs; twigs alternate, ribbed; leaves trifoliolate, petiolate, deciduous; leaflets obovate; flowers single or in small fascicles on leafy short shoots; calyx campanulate, divided to $\frac{3}{4}$ of its length in two lips, the upper lip deeply divided in two teeth; bracteoles linear, early caducous; corolla yellow, persistent at fructification; style bended upwards at right angle after pollen release; legume elliptic, 1- to 5-seeded; seeds strophiolate. Two species.

This section includes, besides the type, *C. heterochrous* Webb ex Willk. & Lange (Prod. Fl. Hisp. 3: 452. 1877 = *Genista patens* DC., Prodr. 2: 145. 1825).

The status and the position of this section are controversial. The calyx recalls *Genista* and on this ground Talavera & Gibbs (in Talavera & Salgueiro, 1999) ranked this section under *Teline*. However, when a large set of morphological characters is considered (González-Andrés & Ortiz, 1996; Cristofolini & Conte, 2002), *C. heterochrous* is resolved in *Cytisus* rather than *Genista*. González-Andrés & Ortiz (1995) using RAPDs found that *C. heterochrous* takes an intermediate position, without significant links to *Cytisus* and *Genista*. A cpDNA-based tree (Cubas & al., 2002) yielded the same result. In trees generated by nr-DNA (ITS) and in combined trees, however, this species was associated to the *Cytisus* clade. We adhere to the more consistent morphological information and treat *Chronanthus* as a section of *Cytisus*, even though its position is somewhat intermediate between *Cytisus* and *Teline-Genista*.

13. *Cytisus* sect. *Lembotropis* (Griseb.) Benth., Gen. Pl. 1: 484. 1865 = *Lembotropis* Griseb., Spicil. Fl. Rumel. 1: 10. 1843 [basionym] = *Genista* sect. *Lembotropis* (Griseb.) Briq., Et. Cyt. Alp. Marit.: 121 (1894) pro parte. – Type: *Cytisus nigricans* L., Sp. Pl.: 739. 1753 = *Lembotropis nigricans* (L.) Griseb., Spicil. Fl. Rumel. 1: 10. 1843. Lectotype of species name (selected by Cristofolini in Turland & Jarvis, 1997): Herb. Burser XXII: 11, left-hand plant (UPS).

Unarmed shrubs; twigs alternate, ribbed; leaves trifoliolate, petiolate, deciduous; leaflets elliptic, with appressed medifixed hairs; flowers born in many-flowered terminal leafless racemes; calyx ebracteate, campanulate; corolla yellow; style straight to slightly curved upwards; legume oblong, 3- to 5-seeded; strophiole rudimentary. One species.

Taxonomic position of *Cytisus nigricans* is problematical: nucleotide sequences of cpDNA (*rbcL*) and ncDNA (Käss & Wink, 1995, 1997) suggest that this species is associated to the monophyletic clade of *Cytisus* s.l.; homology of seed reserve proteins (Cristofolini & Feoli-Chiapella, 1977) also support this.

However, several morphological characters (inflorescence, calyx shape, naviculate hairs) separate *Cytisus nigricans* from the rest of *Cytisus* (Skálická, 1969; Cristofolini & Conte, 2002). In the absence of convincing evidence to assign generic rank to *Lembotropis*, we follow Polhill (1976) and Greuter & al. (1989) in retaining *Lembotropis* as a section of *Cytisus*.

Species incertae sedis. — *Cytisus tribracteolatus* Webb, Iter Hisp.: 51. 1838 ≡ *Teline tribracteolata* (Webb) Talavera & P.E. Gibbs, An. Jard. Bot. Madrid 57: 210. 1999. — Type [designated by Talavera and Salgueiro, 1999]: “*Cytisus tribracteolatus* Webb! / Otia hisp. n.3! / Baetica ad Pichaco de Alcalá de los Gazules / Herb. Fauches” (G).

Unarmed shrubs; twigs opposite to subopposite, ribbed; leaves trifoliolate, sessile or subsessile, deciduous; leaflets lanceolate; flowers in axillary clusters; calyx with three bracteoles, deeply divided in two lips, the upper lip divided to about 1/3 of its length into two acute teeth; corolla yellow; style curved upwards; legume oblong, 2–7 seeded; seeds strophiolate.

This species, in view of its unique combination of characters, has been assigned to *Genista* (Vicioso, 1953), *Cytisus* sect. *Teline* (Holubová-Klásková, 1964), *C.* sect. *Sarothamnus* (Frodin & Heywood, 1968), *Cytisus* sect. *Trianthocytisus* (Polhill, 1976), and *Teline* sect. *Chronanthus* (Talavera & Gibbs, 1996). Already Briquet (1894) commented to the systematic position of *Cytisus tribracteolatus* Webb with the following “Observatio”: “species mirabilis medium tenet inter sectiones *Telinen* et *Alburnoidem*, ita sectionum cohesionem demonstrans inanitemque generum parvorum propositurum in lucem proferens!”. The species *C. tribracteolatus* is endemic to southern Andalusia. Cristofolini & Conte (2002) suggested that its origin and segregation from the rest of the genus is probably older than that of *C. aeolicus*.

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Appendix: species list.

- Sect. 1. *Cytisus*:** *Cytisus villosus* Pourr.
- Sect. 2. *Dendrocytisus*** Cristof. et Troia: *Cytisus aeolicus* Guss.
- Sect. 3. *Emeroides*** Ducommun: *Cytisus emeriflorus* Rchb.
- Sect. 4. *Tubocytisus*** DC.: *Cytisus hirsutus* L., *C. proliferus* L.f. (incl. *C. palmensis* Hutch.), *C. albidus* DC. [“*C. mollis*” (Cav.) Pau, nomen illegit.], *C. creticus* Boiss. & Heldr. (incl. *C. subidaeus* Gand.), *C. spinescens* C. Presl, *C. pulvinatus* Quézel, *C. purpureus* Scop., *C. leiocarpus* A.Kern., *C. triflorus* Lam. (= *C. elongatus* Waldst. & Kit.), *C. lotoides* Pourr. (= *C. gallicus* A. Kern.), *C. lasiosemius* Boiss., *C. eriocarpus* Boiss. [incl. *C. smirnaeus* Boiss. and *C. absinthioides* (Janka) Kuzm.], *C. austriacus* L. (incl. *C. heuffelii* Wierzb. and *C. pygmaeus* Willd.), *C. tommasinii* Vis., *C. jankae* Velen., *C. albus* Hacq., *C. kovacevii* Velen., *C. neiceffii* Urum., *C. ratisbonensis* Schaeff. (= *C. biflorus* L’Hér.), *C. wulfii* V.I. Krecz., *C. blockianus* Pawł., *C. graniticus* Rehman, *C. podolicus* Błocki, *C. ruthenicus* Fischer ex Woł. (incl. *C. kreczetoviczii* E.D. Wissjul.), *C. paczorskii* V.I. Krecz., *C. borysthenicus* Gruner, *C. cassius* Boiss., *C. drepanolobus* Boiss.
- Sect. 5. *Calicotome*** (Link) DC.: *Cytisus lanigerus* (Desf.) DC, *C. spinosus* (L.) Lam., *C. infestus* (C.Presl) Guss., *C. rigidus* (Viv.) Cristof. & Troia
- Sect. 6. *Corothamnus*** (W.D.J. Koch) Nyman: *Cytisus procumbens* (Waldst. & Kit.) Spreng., *C. decumbens* (Durande) Spach, *C. pseudoprocumbens* Markgr., *C. agnipilus* Velen., *C. commutatus* (Willk.) Briq. (= *C. ingramii* Blakelock), *C. acutangulus* Jaub. & Spach.
- Sect. 7. *Spartopsis*** Dumort.: *Cytisus scoparius* (L.) Link (incl. *C. reverchonii* (Degen & Hervier) Bean and *C. maurus* Humbert & Maire), *C. grandiflorus* (Brot.) DC., *C. megalanthus* (Pau & Font Quer) Font Quer, *C. striatus* (Hill) Rothm., *C. cantabricus* (Willk.) Rchb.f. & Beck in Rchb.
- Sect. 8. *Verzinum*** (Raf.) Talavera: *Cytisus arboreus* (Desf.) DC. [incl. *C. baeticus* (Webb) Steud. [*C. malacitanus* Boiss. (= *C. moloroi* Fern. Casas)], *C. transiens* (Maire) Talavera
- Sect. 9. *Alburnoides*** DC.: *Cytisus multiflorus* (L’Hér.) Sweet, *C. balansae* (Boiss.) Ball, *C. oromediterraneus* Rivas Mart., T.E. Diaz, Fern.Prieto, Loidi & Penas, *C. galianoi* Talavera & P.E. Gibbs, *C. valdesii* Talavera & P. E. Gibbs, *C. ardoini* E. Fourn., *C. sauzeanus* Burnat & Briq.
- Sect. 10. *Oreosparton*** (Webb & Berthel.) Frodin ex Polhill: *Cytisus supranubius* (L.f.) Kuntze, *C. filipes* Webb
- Sect. 11. *Heterocytisus*** Briq.: *Cytisus fontanesii* Spach
- Sect. 12. *Chronanthus*** DC.: *Cytisus orientalis* Loisel., *C. heterochrous* Webb ex Colmeiro
- Sect. 13. *Lembotropis*** (Griseb.) Benth.: *Cytisus nigricans* L.
- Incertae sedis: *Cytisus tribracteolatus* Webb