

A CONTRIBUTION TO KNOWLEDGE OF THE DISTRIBUTION OF *DALMATOCYTISUS DALMATICUS* (VIS.) TRINAJSTIĆ (FABACEAE)

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The stenoendemic species *Dalmatocytisus dalmaticus* (Vis.) Trinajstić was previously known only from two sites (hills of Medinjak and Šušnjevača) on the outskirts of Sinj. But large populations have been found at over 30 new sites in the surroundings of Sinj, Otok and Trilj. The plant grows on substrate of limestone marls, on rocky grasslands, as well as in the ground layer of planted black pine forests and along the edges of pine forests. The size of the occupied habitat area of *D. dalmaticus* known so far is estimated at approximately 1.5 km². The area has been significantly reduced by the expansion of the settlements of Jasenovo and Poljak, as well as by the building of a macadam road through Greda Hill. The planned construction of a quarry with an access road in the Šušnjevača area will result in an additional reduction of the plant's area. Habitats are exposed to strong anthropogenic pressure and to the changes resulting from the previous and current planting of black pine. According to the methods for threat assessment of the International Union for Conservation of Nature, we propose that *D. dalmaticus* should be included in the national red list in the category of "endangered" taxa (EN; criteria B2ab(ii,iii,iv)).

Keywords: Central Dalmatia, Endangered (EN), *Dalmatocytisus dalmaticus*, stenoendemic taxon, threat assessment.

Milović, M., Karadole, J. & Pandža, M.: Prilog poznavanju rasprostranjenosti vrste *Dalmatocytisus dalmaticus* (Vis.) Trinajstić (Fabaceae). Nat. Croat., Vol. 31., No. 2, 241-250, 2022, Zagreb.

Stenoendemska vrsta *Dalmatocytisus dalmaticus* (Vis.) Trinajstić do sada je bila poznata samo s dva nalazišta (brdo Medinjak i Šušnjevača) na periferiji Sinja. Populacije velike brojnosti pronađene su na više od 30 novih nalazišta u široj okolici naselja Sinj, Otok i Trilj. Biljka raste na podlozi vapnenih lapora, na kamenjarskim travnjacima, kao i u prizemnom sloju sađenih šuma crnog bora i uz rubove borovih šuma. Ukupnu površinu na kojoj dolazi *D. dalmaticus* procjenjujemo na približno 1,5 km². Areal je znatno smanjen širenjem naselja Jasenovo i Poljak, gradnjom makadamskog puta kroz brdo Greda, a planirana izgradnja kamenoloma s pristupnom cestom na području Šušnjevače rezultirat će dodatnim smanjenjem areala. Staništa su izložena jakom antropogenom pritisku i pomjenama koje su rezultat prethodne i sadašnje sadnje crnog bora. Temeljem metoda procjene ugroženosti Međunarodnog saveza za očuvanje prirode, predlažemo uvrštavanje vrste *D. dalmaticus* u Crvenu knjigu vaskularne flore Hrvatske u kategoriji ugrožene svojte (EN; kriteriji, B2ab(ii,iii,iv)).

Ključne riječi: *Dalmatocytisus dalmaticus*, procjena ugroženosti, srednja Dalmacija, stenoendem, ugrožena vrsta (EN).

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INTRODUCTION

The stenoendemic species *Dalmatocytisus dalmaticus* (Vis.) Trinajstić (Fig. 1) was originally described by Visiani in his *Flora Dalmatica*, as the only species of the new genus *Chamaecytisus* (Fig. 2), under the name *Chamaecytisus dalmaticus* (VISIANI, 1852:272). The description of the genus and species was based on the relatively scarce herbarium material collected by Franz Petter on the hill of “Beljak” near the city of Sinj („in saxosis apricis montis Beljak prope Prugovo, ditionis Sign“), and is kept in Visiani’s herbarium of Dalmatian flora in Padua (PAD-HD06392) (TRINAJSTIĆ, 2001; CLEMENTI, 2017:213).



Fig. 1. *Dalmatocytisus dalmaticus* – the plant in bloom on southwestern slopes of Greda Hill (Photo: M. Milović, May 27, 2017).

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DCXXXII. *Chamaecytisus* Vis.

Char. Calyx campanulatus, basi hinc gibbus, tripartitus, laciniis foliaceis, inferiore apice trifida. Corolla vexillo obcordato-subrotundo, ungue complicato exserto carinae alarumque margines excipiente; alis oblongis, margine vexillari rugoso-foveolatis; carinae arcuatae obtusae petalis liberis vel medio connatis. Stamina inferius connata, alternis abbreviatis sterilibus, decimo libero. Pistillum ovario lanceolato-subulato sericeo superne styloque subulato glabris, stigmate transversali oblongo piloso. Legumen ignotum. — Class. Diadelphia, Ord. Decandria Syst. sex.

1784. *Chamaecytisus dalmaticus* Vis.

Icon. Vis. fl. dalm. t. LV. fig. 2.

Hab. in saxosis apricis montis Beljak prope Prugovo, ditionis Signa, unde misit Prof. PETTER. Flores flavi. Floret aestate. †.

Descr. Fruticulus glabrusculus 3—4-pollicaris, radice repente, caule ascendente ramoso, inferne nudo stipularumque reliquiis circumdato, superne dense folioso, striguloso, ramis apice unifloris. Folia petiolata, trifoliolata, petiolo et dorso strigis aliquot adpressis adpersa, stipula oppositifolia amplexicauli rotundata abbreviata indivisa strigosa, foliis petiolulatis oblongo-lanceolatis lanceolatisque, supra glabris. Flores oppositifolii solitarii terminales majusculi, pedunculo calyce subbreviore uni—bibracteolato, bracteolisque linearibus strigulosis. Calyx profunde tripartitus laxus, laciniis acutis, superioribus oblongo-lanceolatis, inferiore obovata acute trifida. Corollae glabrae-vexillum maximum, ungue calycem superante late complicato alarum carinaeque margines in plica excipiente, laminam obcordato-subrotundam obtuse bilobam subaequante; alis breviter unguiculatis, margine vexillari inferius inciso-truncatis incrassatisque, superius ad duas tertias partes transversae rugoso-foveolatis; carina dipetala, petalis semiellipticis brevissime unguiculatis, liberis vel solo dorsi medio in unum connatis. Stamina 9 in vaginam basi connata, filamentis quinque apice antheriferis, quatuor alternis duplo brevioribus lineari-clavatis sterilibus, decimo libero fertili longiora aequante, antheris oblongis. Pistillum ovario lanceolato-subulato, stylo ascendente, stigmate magno malleum referente, apice angustato, undique pilosulo. Legumen non vidi. — Genus habitu *Cytisi*, staminibus heteromorphis et alterne sterilibus in Ordine distinctissimum, et soli *Cytisopsi* Boiss. affine.

Fig. 2. Original description of the new genus *Chamaecytisus* Vis. and new species *C. dalmaticus* Vis. (VISIANI, 1852:272).

No new sites were discovered after the middle of the 19th century, nor was the taxon reconfirmed in its original locality. ASCHERSON & GRAEBNER (1907:234) in their work *Synopsis der Mitteleuropäischen flora* include Visiani's species in the genus *Argyrobium*, as *A. dalmaticus* (Vis.) Asch. et Graebn., and this taxonomic solution has been adopted by the majority of later authors (HAYEK, 1926:894; BALL, 1968:106; LOVAŠEN-EBERHARDT, 1997:61). As the finding in the surroundings of Sinj was not confirmed for a long time, it was not possible to collect herbarium material to complement the holotype in Visiani's herbarium in Padua and to resolve the doubtful taxonomic status of this species. Because of that, some authors have suggested that it is not a separate entity but only an "abnormal form" of the species *Argyrobium zanonii* (Turra) P. W. Ball. (BALL, 1968:106; BOGDANOVIĆ, 2015:210).

The dilemma about the taxonomic status of Visiani's taxon "*Chamaecytisus dalmaticus*" was resolved after more than 150 years by Ivo Trinajstić. At two sites in the far eastern part of the city of Sinj he found populations with a large number of specimens. Based on the analysis of the plants from the locality of Šušnjevača, Trinajstić confirmed Visiani's original opinion that plants found near Sinj should be placed in a separate genus (TRINAJSTIĆ, 2001). Visiani's name *Chamaecytisus* for the new genus was not valid as it had been used already by Link to describe another genus in which some species originally described as belonging to the genus *Cytisus* were placed (HEYWOOD & FRODIN, 1968; TRINAJSTIĆ, 2001; BOGDANOVIĆ, 2015). Consequently, TRINAJSTIĆ (2001) proposed the name *Dalmatocytisus* for the new genus, with only one species: *Dalmatocytisus dalmaticus* (Vis.) Trinajstić. As Visiani's classic finding site "montis Beljak prope Prugovo" was not confirmed, Trinajstić attached herbarium material collected on Šušnjevača Hill (near Sinj), deposited in the herbarium in Zagreb (ZA), to the description of the taxon. In a multidisciplinary analysis of the overall work and herbarium collections of Roberto Visiani, CLEMENTI (2017:345) links the toponym "Beljak" with today's toponym Debeljak. Therefore, the hill of Debeljak near the settlement of Prugovo, southwest of Sinj, can be considered the most probable locus classicus of the species *D. dalmaticus*.

Unfortunately, the status of Visiani's "*Chamaecytisus dalmaticus*" as a separate entity is still unrecognized outside Croatia. In well known databases of vascular flora *The World Checklist of Vascular Plants – WCVP* (2022) and *Euro+Med PlantBase* (2022), Visiani's and Trinajstić's names for this taxon are considered mere synonyms of *Argyrobium zanonii* (Turra) P. W. Ball subsp. *zanonii*.

The aims of this paper were: (i) to investigate the distribution of *D. dalmaticus* in the wider area of the city of Sinj, (ii) to inquire whether the plant still grows on Debeljak Hill near Prugovo (most likely the original locality of this taxon), (iii) to assess the degree of threat for *D. dalmaticus* using IUCN red list criteria.

MATERIALS & METHODS

For the determination of *D. dalmaticus* we used the original description of VISIANI (1852:272, as *Chamaecytisus dalmaticus* Vis.), recently revised by TRINAJSTIĆ (2001). The Gauss-Krüger (GK) coordinates (6th zone) of new finding sites were determined using GPS and were mapped into the topographic map TM 1:25000. We took the coordinates of the site points at a distance of approximately 100 - 150 m from each other in order to be able to see the boundaries and size of the species' range as accurately as possible. The data for the location of the new finding sites, as well as photo material of *D. dal-*

maticus and its habitats, were deposited in the Flora Croatica Database (FCD) (NIKOLIĆ, 2022). The nomenclature of plant taxa follows Flora Croatica Database, FCD (NIKOLIĆ, 2022).

RESULTS & DISCUSSION

Before our investigation, the taxon *Dalmatocytisus dalmaticus* was known only from two localities on the outskirts of the city of Sinj. One of them was the hill called Šušnjevača, and the other is located by TRINAJSTIĆ (2001) "on the very outskirts of the town of Sinj, at the edge of a pine forest". The geocoordinates were not given. In the spring of 2009, Bogdanović, Liber and Nikolić confirmed both of Trinajstić's localities, stated the geocoordinates of the finding sites (NIKOLIĆ, 2022: Id. 4067 and 4068) and collected abundant herbarium material, subsequently deposited in the herbarium in Zagreb (ZA and ZAGR). As an additional finding site they mention Medinjak (Čugurna glavica) along the northeastern edge of the town of Sinj. On several occasions we visited Medinjak Hill (384 m a.s.l.), which is overgrown with planted black pine forest (*Pinus nigra* J. F. Arnold). *Dalmatocytisus dalmaticus* grows in the ground layer of the pine forest, along forest edges and in clearings, in the altitude range from 300 m a.s.l. to the very top of the hill. The habitat is made up of shallow soil formed by the erosion of soft and porous limestone marls, observed also by Bogdanović, Liber and Nikolić (NIKOLIĆ, 2022: Id. 4067). As part of the rocky grassland along the edge of the planted black pine forest, the plant also occurs at a previously recorded site in the area of Šušnjevača hill (464 m a.s.l.).

During our botanical excursions from 2017 to 2021 in the surroundings of Sinj, Otok and Trilj, we found over 30 new sites of *D. dalmaticus*, presented in Tab. 1 and Fig. 3 and 4. The largest number of sites (25) was recorded on the hills along the northeastern part of the town of Sinj: Petrada, Šušnjevača, Greda, Bakračica and Planica. In all habitats the plant grows in cushion heaps on shallow soil formed by the wearing of limestone marls (Fig. 5). It is also present as a part of rocky grasslands (Petrada, Greda), in the ground floor of planted black pine forests (Fig. 6) or along the edges of the forest (Šušnjevača, Greda, Poljak and Planica). We noticed that the plant tolerates moderate shade, so that the growth of the plants in the ground layer of the forest is on average lusher than on open rocky grasslands. However, we assume that further development of the black pine forest and the creation of a dense canopy would significantly reduce the amount of light reaching the ground layer, which could endanger the survival of the species. At the investigated sites, *D. dalmaticus* is most often present in the company of the following species: *Asperula purpurea* (L.) Ehrend., *Anthericum ramosum* L., *Cephalaria leucantha* (L.) Roem. et Schult., *Edraianthus tenuifolius* (Waldst. et Kit.) A. DC., *Frangula rupestris* (Scop.) Schur., *Fraxinus ornus* L., *Fumana procumbens* (Dunal) Gren. et Godr., *Genista sylvestris* Scop., *Globularia cordifolia* L. ssp. *bellidifolia* (Ten.) Wettst., *Hieracium heterogynum* (Froel.) Gutermann, *Juniperus oxycedrus* L. ssp. *oxycedrus*, *Satureja subspicata* Bartl. ex Vis., *Sesleria tenuifolia* Schrad., *Teucrium montanum* L., etc. The recorded sites are in the altitude range of 300–450 m a. s. l.

On the same type of substrate and habitat (rocky grasslands on the substrate of limestone marls), the species was found in the area of Otok and in the vicinity of Trilj. The site of *D. dalmaticus* in the area of Otok was first recorded by Sandro Bogdanović (pers. comm.). During the research in the spring of 2021, we recorded the plant on four sites (Fig. 3) on the slopes of the hill, northwest of the settlement Vuletići. In the sum-

Tab. 1. New finding sites of *D. dalmaticus* in the surroundings of Sinj, Otok and Trilj

No.	Locality	Gauss-Krüger's coordinate (6th zone)	Altitude (m a.s.l.)	Habitat
1	Surroundings of Sinj, Petrada hill	Y=6391644; X=4843916	300 - 350	calcareous rocky grassland on shallow soil
2		Y=6391705; X=4843816		
3		Y=6391759; X=4843721		
4		Y=6391765; X=4843557		
5		Y=6391672; X=4843500		
6		Y=6391699; X=4843272		
7		Y=6391678; X=4843146		
8		Y=6392011; X=4843176		
9		Y=6391660; X=4843022		
10		Y=6391752; X=4842946		
11	Surroundings of Sinj, Šušnjavača hill	Y=6392317; X=4842629	400 - 450	calcareous rocky grassland on shallow soil / planted black pine forest
12		Y=6392175; X=4842543		
13		Y=6392043; X=4842519		
14		Y=6391971; X=4842389		
15	Surroundings of Sinj, Greda hill	Y=6393317; X=4842744	300 - 350	calcareous rocky grassland on shallow soil
16		Y=6393341; X=4842818		
17		Y=6393453; X=4842802		
18		Y=6393564; X=4842924		
19		Y=6393684; X=4842903		
20		Y=6393728; X=4843002		
21		Y=6393876; X=4843073		
22		Y=6394063; X=4843160		
23	Surroundings of Sinj, Bakračica hill	Y=6394711; X=4843547	300 - 350	calcareous rocky grassland on shallow soil / planted black pine forest
24		Y=6394772; X=4843540		
25	Surroundings of Sinj, Planica hill	Y=6395003; X=4843405	330	calcareous rocky grassland on shallow soil / planted black pine forest
26	Otok, Vuletići	Y=6398412; X=4839529	320 - 340	calcareous rocky grassland on shallow soil
27		Y=6398466; X=4839572		
28		Y=6398508; X=4839588		
29		Y=6398562; X=4839604		
30	Surroundings of Trilj, Bila glavica hill	Y=6396767; X=4831857	320 - 365	calcareous rocky grassland on shallow soil
31		Y=6396827; X=4831955		
32		Y=6396917; X=4831953		

mer of 2021, we also discovered the plant on the hill Bila glavica, northwest of Trilj. The plant grows in quite small stands from the base to the top of the hill (366 m a. s. l.). The populations in the area of Otok and Trilj are much smaller than those in the vicinity of Sinj, the two being about 8 km (air distance) from each other. Populations in the vicinity of Trilj are about 11 km from the nearest population in the vicinity of Sinj (on Medinjak Hill), and those in the vicinity of Otok about 5 km from the population in the vicinity of Sinj (on the hill Planica).



Fig. 3. Previously known (red dots) and new sites (numbers 1 - 25) of *D. dalmaticus* in the surroundings of Sinj. The location of the planned quarry is marked with the letter "K".

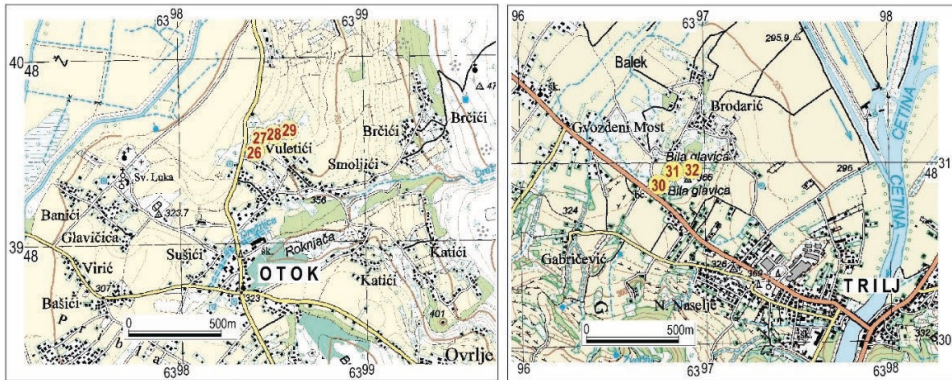


Fig. 4. New finding sites of *D. dalmaticus* in the vicinity of the settlements of Otok (26 - 29) and Trilj (30 - 32).

On two occasions, during the spring of 2018 and 2019, we searched for *D. dalmaticus* in similar habitats on Debeljak Hill, near the village Prugovo, about 13 km (aerial distance) from the nearest site Medinjak near Sinj. Debeljak Hill near Prugovo is most likely the same locality as Visiani's "montis Beljak, prope Prugovo" (VISIANI 1852:272;



Fig. 5. A population of *D. dalmaticus* on rocky dry grassland on Petrada Hill (Photo: M. Milović, June 27, 2021).



Fig. 6. *Dalmatocytisus dalmaticus* in the ground layer in a black pine forest on Šušnjevača Hill (Photo: M. Milović, August 21, 2017).

CLEMENTI 2017:345). Unfortunately, despite a thorough search of the terrain, from the base to the top of the hill (750 m), we have not found the plant so far. We assume that the plant species has disappeared from the locus classicus on Debeljak Hill since Petter's discovery more than 170 years ago.

Based on the points plotted on the topographic map, the size of the occupied habitat area of *D. dalmaticus* in the surroundings of Sinj, Otok and Trilj together is estimated at approximately 1.5 km². Apart from the fact that the area is very small, the habitat is changing significantly in the process of natural succession into shrubs and forests of pubescent oak and black hornbeam. In the whole area, the habitat is changed by the planting of black pine, conducted in order to protect the soil from erosion by the action of torrential waters. Lowland black pine forests (3–5 m high) are present in the habitats of *D. dalmaticus* especially in the area of Medinjak, Šušnjevača and Planica. The planting of black pine is currently taking place in the northern part of Petrada Hill. The planting process itself results in the direct destruction of the habitat, because during mechanization shallow furrows are being made in which pine seedlings are then planted (Fig.

7). Most populations are located in the immediate vicinity of roads and settlements and are exposed to strong anthropogenic influences. The habitat in the area of Petrada and Greda hills has been significantly reduced and fragmented by the expansion of settlements (Jasensko, Poljak) and by the construction of a macadam road. It passes through the habitat of *D. dalmaticus* along the entire length of the ridge of Greda towards Šušnjevača (Fig. 3). The marginal parts of the habitats along the settlements of Jasensko and Poljak have been significantly ruderalized, so the plant is already disappearing from these habitats. The greatest threat for the habitats of *D. dalmaticus* is the planned construction of a quarry for the extraction of architectural and construction stone for which an "Environmental Impact Study" has already been prepared (FRANOLIĆ, 2020). The main exploitation area, 3.25 ha in size, will be located between the hills of Greda and Šušnjevača, and will be less than 100 m away from the habitat of *D. dalmaticus* (Fig. 2). A new significant reduction in habitat area will occur by the widening of the existing macadam road for the purpose of building an access road to the quarry.



Fig. 7. Black pine seedlings recently planted in the habitat of *D. dalmaticus* in the northern part of Petrada hill (Photo: M. Milović, July 16, 2021).

Dalmatocytisus dalmaticus has the status of a strictly protected species (ANONYMOUS, 2016), but so far no IUCN assessment of the threat level has been performed. Based on the results of our research, it can be concluded that the present habitat area occupied by the taxon is extremely small (approximately 1.5 km²), mostly located in the vicinity of Sinj, with two smaller separate patches in the vicinity of the settlements of Otok and Trilj. The area has already experienced a significant reduction and fragmentation, which will be even more pronounced with the planned construction of the Greda quarry with its access roads. The habitat has so far been changed significantly by the planting of black pine (Medinjak, Šušnjevača, Bakračica, Planica) which is still being carried out in the area of Petrada (Fig. 5).

Using IUCN criteria 15.1 (IUCN, 2022) and the guidelines for application at the regional and national levels 4.0 (IUCN, 2012) and related standards, the species *D. dalmaticus* is assessed as a threatened taxon, as follows:

Category: EN

Assessment criteria: B2ab(ii,iii,iv)

B2: area of occupancy (AOO): 20 km² (Sinj 12 km², Otok 4 km² and Trilj 4 km²), according Red list Guidelines 4.10 (IUCN, 2022), estimated from maps presented in Figs. 3 and 4

a: number of locations: 3 (Sinj, Otok, Trilj)

b: continuing decline observed, estimated, inferred and projected:

ii: area of occupancy

iii: quality of habitat

iv: number of locations or subpopulations

Geographic Range: Croatia (Ct), Central Dalmatia, in the surroundings of the town of Sinj (Figs. 3 and 4)

Current population trends: decreasing (observed & inferred)

Habitat (Classification Scheme, Version 3.1): 1. Forest & woodland, 1.4. Temperate forest, 3. Shrubland, 3.8. Mediterranean-type Shrubby Vegetation, 4. Native Grassland, 4.4. Temperate grassland

Threats (Classification Scheme ver. 3.2): 1. Residential & Commercial Development, 1.1. Housing & Urban Areas, 3. Energy production & mining, 3.2. Mining & Quarrying, 4. Transportation & Service Corridors (freight / passenger / mining railways), 7. Natural system modifications, 7.1 Fire & fire suppression.

Conservation Actions needed (Classification Scheme, Version 2.0): 1. Land / water protection, 1.2. Resource & habitat protection, 4. Education & awareness, 4.3. Awareness & communications, 5. Law & policy, 5.1. Legislation, 5.1.2. National level.

Research Needed (Classification Scheme, Version 2.0): 1. Research, 1.2. Population size, distribution & trends, 2. Conservation Planning, 2.2. Area-based Management Plan, 3. Monitoring, 3.1 Population trends, 3.4. Habitat trends.

Estimated by: M. Milović

Date of assessment: November 7, 2022.

We recommend the inclusion of the species *Dalmatocytisus dalmaticus* in the Red Data Book of Croatia.

CONCLUSION

The discovery of a large number of new sites of the species *Dalmatocytisus dalmaticus* during our research has made an important contribution to the knowledge of the total area of this stenoendemic species in Croatian flora. According to the IUCN methods for threat assessment, we propose that *D. dalmaticus* should be included in the national red list in the category of "endangered" taxa (EN), which will further emphasize the need for urgent planning and implementation of protection measures to ensure its survival. The taxonomic solution proposed by TRINAJSTIĆ (2001) has not been accepted by the wider scientific community outside Croatia. Therefore, it is necessary to perform additional morphological and cytogenetic studies of this taxon and to investigate its phylogenetic relationships with related taxa from the genera *Argyrolobium*, *Chamaecytisus* and *Cytisus*.

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