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A TAXONOMIC REVISION OF THE UNIFOLIOLATE SPECIES OF LUPINUS (LEGUMINOSEA) IN BRAZIL

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ABSTRACT. A formal taxonomic revision is provided for the 13 unifoliolate species of *Lupinus* which occur in Brazil and also *L. paraguariensis* which has mixed unifoliolate and multifoliolate leaves, together with some observations on the phytogeography of this group, 11 species of which are endemic to upland areas of cent al and SE Brazil.

Lupinus is a large predominantly New World genus with an unknown number of species, perhaps 200–300, and two major centres of diversity, the rocky mountains of W North America and the Andes of South America. There are also some 12 taxonomically heterogeneous species distributed in the Mediterranean and Africa forming a disjunct group in the Old World. The taxa occurring in these three centres are all multifoliolate species with commonly digitate leaves.

The 20 or so unifoliolate (or perhaps simple-leaved) species are quite distinct within *Lupinus*. They have a centre of diversity in the East Central highlands and plateau of Brazil (Map 1) and extend southwards into Paraguay, Uruguay and Argentina, and also have a disjunct cluster of four species (Dunn, 1971) in SE North America. The Brazilian representatives of this unifoliolate group have been rather poorly collected, little studied, and subjected to some confusion with regard to specific limits. We present here a formal taxonomic revision of this group which we hope will provide a framework for the further cytological and experimental studies needed to relate it to the multifoliolate species of the genus.

Dr David Dunn, who has studied the genus *Lupinus* for a number of years, has argued cogently that the leaves of this group are 'simple' rather than 'unifoliolate' (Dunn, 1984; Planchuelo & Dunn, 1984). The grounds for this view are that the abcission layer in the simple-leaved species is at or near the base of the petiole in contrast to the top of the petiole or at the petiolule in the multifoliolate taxa. Furthermore, seedlings of the Argentinian multifoliolate species *L. albescens* Hook. & Arnott, which seems to be allied to the Brazilian unifoliolate group (Planchuelo & Dunn, 1984) present a first true leaf which is 'simple' and only subsequent leaves are, increasingly, 3-, 5- to 12-foliolate. The seedlings of North American multifoliolate species do not produce such a simple leaf. Thus, Dunn considers the Brazilian 'simple-leaved' lupins to be a primitive group within the genus, as is further evinced (Dunn, 1984) by their shrubby habit (or at least stout caudex), large leaves, and large biotically pollinated flowers.

Whilst we find Dunn's views persuasive, we have decided to adopt a conservative approach in the present revision and treat the leaves as unifoliolate. Further evidence needs to be accumulated to establish that these Brazilian

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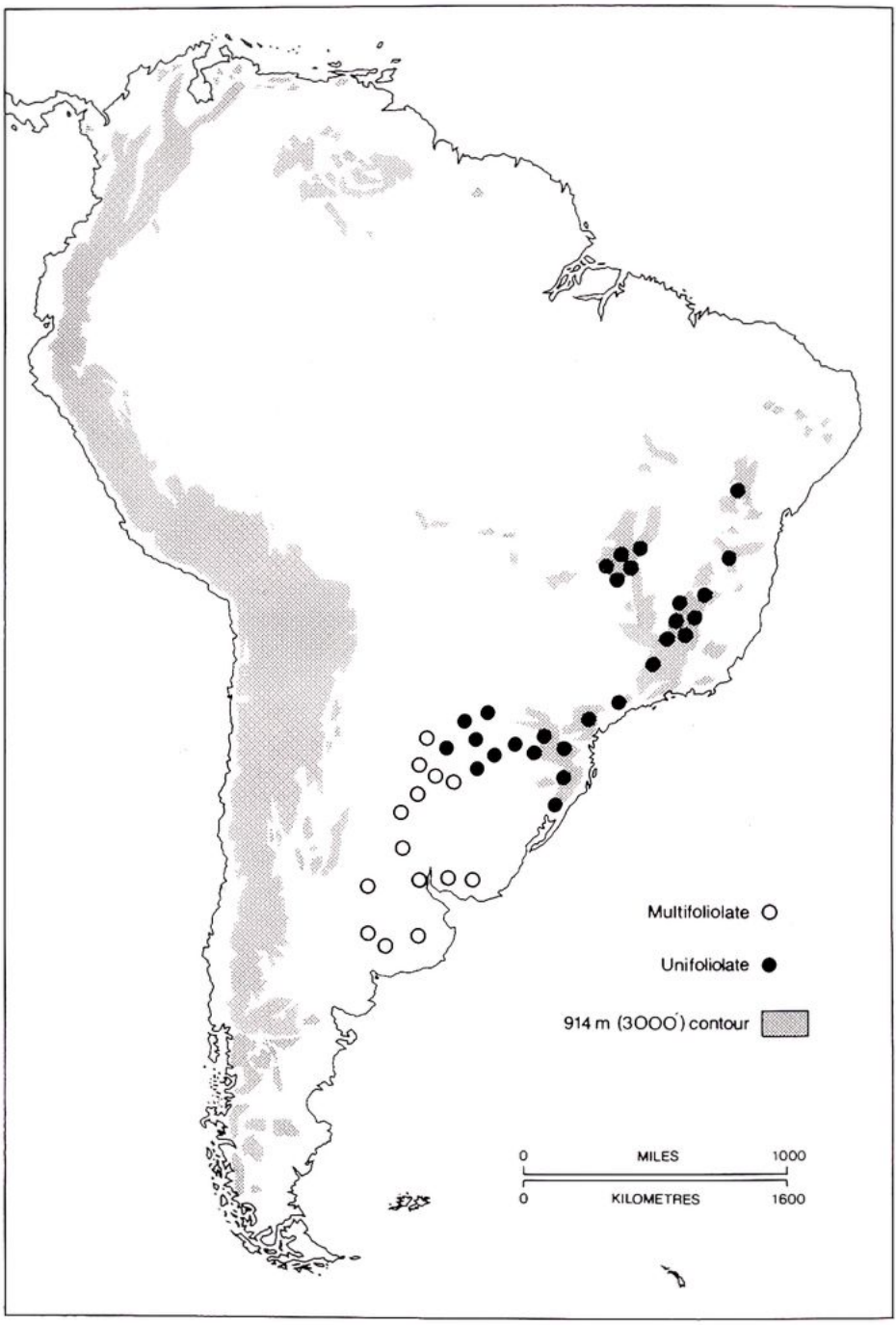


MAP 1. Distribution of unifoliolate and allied multifoliolate lupins in upland areas of EC & SE Brazil and temperate Paraguay, Uruguay and N Argentina. (Selected specimens to show general distribution.)

species are indeed primitive within the genus and do have simple leaves. Whilst there certainly seems to be a gradual transition between 'unifoliolate' lupins and some multifoliolate species such as *L. paraguariensis*, *L. albescens* etc. in N Argentina (Planchuelo & Dunn, 1984), clearly evolutionary trends can be read in both directions and we are influenced by the fact that taxa from diverse families which grow in the mountainous areas of east central Brazil often show striking modifications of their leaf morphology.

Taxonomic history and conspectus

The earliest attempt to classify the unifoliolate species of *Lupinus* as a separate group within the genus was made by Agardh (1835) who distinguished two groups, *'Foliis digitatis'* and *'Foliis integris'*, but without formal taxonomic rank. The digitate-leaved species were further subdivided in 12 'tribes' each of which was named after a constituent species, *Albi*, *Polyphylli*, *Concinni*, etc.

A similar treatment was used by Bentham (1859) who recognized the groupings *'Simplicifolieae'* and *'Digitatae'* in his treatment of the genus *Lupinus* for Martius' *Flora brasiliensis*, again without formal taxonomic rank. Watson (1873), in a monograph of the North American lupins, divided the genus into 'segments' without designating their taxonomic category: *Lupinus* proper (all the perennials and annuals without 'petioled cotyledons'), *Platycarpos* (comprising the annual species with clasping petioles) and *Lupinellus* (a single species with solitary, axillary flowers). Taubert (1894) recognized the genus as divided in three 'sections', *Digitatae gerontogeae*, *Digitatae neogeae* and *Simplicifolieae*, the last as circumscribed by Bentham (1859). In the *Digitatae neogeae*, the segments published by Watson (1837) were included without taxonomic rank.

Several other studies dealing with regional treatments of the genus have presented different infrageneric classifications for *Lupinus*. For example, Piper & Robinson (1906) established Watson's (1837) 'segments' *Lupinus* and *Platycarpos* as subgenera and named as sections the supraspecific groupings as published by Agardh (1835), i.e., *Sericei*, *Saxosi*, etc. Rydberg (1917), in his *Flora of the Rocky Mountains and adjacent Plains* recognized 19 sections, some as new taxa. However, in the most recent attempt to revise the whole group Smith (1938–1952) treated the genus in his *Species Lupinorum* as divided into many informal groupings all of which he left unnamed (see below).

Thus, a disconcerting feature of the genus *Lupinus* is that there is no currently acceptable infrageneric classification available. This is unfortunate since some kind of classificatory structure to give coherence to such a large number of species is needed. However, the taxonomy, particularly of the North American and Andean taxa is complicated by hybridization and polyploidy and a surfeit of names, and the consequent difficulties of establishing specific relationships in these areas have contributed to this situation.

For the present, Dunn's careful assembly of the pieces of this taxonomic jig-saw, whereby species groups and complexes are clustered informally around 'key' species names (Dunn, 1984), represents our best understanding

of the genus. We must await the outcome of studies by Dunn and collaborators on the Central American and Andean taxa which are currently in progress before any more formal overview of the genus can be attempted.

Meantime, the assemblage of unifoliolate (or simple-leaved) species in Brazil, which together with the outlying species in the SE United States and others in temperate South America almost certainly represent a natural, related group, are probably best treated informally as Bentham's *Simplicifolieae*—despite the fact that three of the Argentinian species which also belong here, *L. albescens* Hook. & Arnott, *L. aureonitens* Gilles and *L. multiflorus* Desr., have multifoliolate leaves (Planchuelo & Dunn, 1984).

The earliest citations of unifoliolate species of *Lupinus* refer to the North American taxa *L. villosus* Willd. and *L. diffusus* Nutt. which were listed by Willdenow (1802) and Nuttall (1818) respectively. Subsequently, Bentham (1839) was the first author to describe three species from the uplands of central and eastern Brazil: *L. velutinus*, *L. subsessilis* and *L. coriaceus*. Bunbury (1841) added *L. nitidissimus*, which he considered as distinct from any species previously published by Bentham (1839). However, this taxon is here recognized as a synonym of *L. velutinus*. Gardner (1843) described four species, *L. arenarius*, *L. attenuatus*, *L. parvifolius* and *L. decurrens*, from the uplands of Minas Gerais state in Brazil. All of these species were accepted by Bentham (1859), but in the present work *L. attenuatus* is treated as a synonym of *L. coriaceus*. Casaretto (1843) published *L. chrysomelas* in the same year as Gardner's *L. arenarius* but some three months later, so that *L. chrysomelas* is treated here as a synonym of *L. arenarius*.

Bentham (1859) in his treatment of *Lupinus* for Martius' *Flora brasiliensis* recognized 11 species of unifoliolate *Lupinus*, i.e. the three he had published previously (Bentham, 1839), those treated by Gardner (1843), and four new species: *L. ovalifolius*, *L. crotalarioides*, *L. vaginans* and *L. laevigatus*. A key to distinguish these 11 species was also provided, but it presents some problems in the separation of the taxa because of the weak limits between species which were a reflection of the scarcity of specimens available for study.

After a period of about 40 years since Bentham's treatment of the Brazilian taxa, Glaziou (1906) published, also from central Brazil (Goiás), the name *L. insignis* (*nomem nudum*) as a possible new species of the same group, and Smith (1945) later validated this species. *L. sellowianus*, was described by Harms (1921) and this is an interesting species since in leaf shape and stipules it resembles *L. villosus* Willd. from North America.

The extensive and prolific papers by C. P. Smith published as *Species Lupinorum* brought the Brazilian unifoliolate species under revision only in the 'Signature Thirty, Paper Fourty-six' of this series (Smith, 1945, pp. 481–501). In this paper, 20 species were listed of which six were described as new, but only *L. guaraniticus* C. P. Smith, which is also found in Argentina and Paraguay, has been accepted in the present revision. Another species, *L. spectabilis* (Hassler) C. P. Smith from Paraguay was also considered by Smith (loc. cit.) as likely to occur in neighbouring Brazil. This species, which is regarded as conspecific with *L. amabayensis* C. P. Smith and close to *L. velutinus* by Dunn (pers. com.), has not been found among the exsiccata here studied.

Since the treatment of the unifoliolate *Lupinus* from Brazil provided by Smith (1945) no other modern taxonomic study has dealt with this group of

plants. However, for neighbouring Argentina and extending into Paraguay, Uruguay and southern Brazil, Planchuelo & Dunn (1984) have recently published a revision of two unifoliolate (simple-leaved) species, *L. guaraniticus* and *L. sellowianus*, also *L. paraguariensis* which has a mixture of unifoliolate and multifoliolate leaves, and three multifoliolate allies of this group, *L. albescens*, *L. aureonitens* and *L. multiflorus*.

The present revision recognizes 13 unifoliolate species of *Lupinus* in Brazil which can be arranged into two distinct subgroups.

One subgroup consists of species with either exstipulate leaves or with stipules completely fused to the petioles. The species are:

L. coriaceus
L. decurrens
L. guaraniticus
L. ovalifolius
L. parvifolius
L. prouvensalanus

Except for *L. guaraniticus*, these species are endemic to the uplands of the state of Minas Gerais, and all occur in rocky habitats.

The species of the second subgroup have distinctly stipulate leaves and the stipules, although partially fused with the petioles, have conspicuous free tips, They are:

L. arenarius
L. crotalarioides
L. insignis
L. laevigatus
L. sellowianus
L. subsessilis
L. velutinus

These taxa, as a whole, have wider distribution ranges than the former group and although most of them similarly occur in the same upland rocky habitats some also occur in the cerrado areas of the central Brazilian plateau.

Another species with stipules with free tips is *L. paraguariensis* which represents a rather intermediate condition since the leaves at the base of the plant and at the base of each branch are unifoliolate whilst the remaining leaves are multifoliolate with 3–5 leaflets.

Taxonomic parameters

The following general comments on morphological characters of the Brazilian unifoliolate species of *Lupinus* are based primarily on herbarium material. Because of the remarkably uniform floral morphology, with only slight differences in the size of petals, it is often necessary to resort to vegetative characters to distinguish *Lupinus* species, with some risk that such characters may be subject to phenotypic modification resulting from factors such as altitude. Nevertheless, some confidence in the use of vegetative characters can be gained from the fact that in those species which are represented by fairly extensive collections, the character correlations remain constant to an acceptable extent.

Habit. All species of unifoliolate *Lupinus* are perennials, with the habit varying from decumbent (*L. ovalifolius*) to erect herbs or subshrubs up to 1 m or so tall. The stems sprout from a woody rootstock and may be single or few- to several-branched; they may be of annual duration or persist for more than one year (e.g. *L. guaraniticus*).

Indumentum. Traditionally, trichome characters have been used in species delimitation in *Lupinus* and they are important in the identification of the unifoliolate taxa. In general, the forms of pubescence found in *Lupinus* are: hirsute, sericeous, tomentose, velutinous, villous and lanate.

Stipules. Stipules are an important taxonomic character in the Brazilian unifoliolate species of *Lupinus*. They may be absent, as in *L. ovalifolius*, *L. coriaceus*, *L. parvifolius* and *L. prouvensalanus*. When stipules are present, they are either totally adnate with the petioles and then without free tips (*L. decurrens* and *L. guaraniticus*) or partially adnate with the petiole, that is, the base is adnate to the petiole and usually also extends back along the previous internode, but, with a terminal portion, usually close to the base of the lamina, with the tips free (Fig. 1). In this case, the length and shape of the free tips are useful characters at specific level, i.e. the tips may be short and deltoid to narrowly lanceolate (*L. arenarius*, Fig. 1d), or long, lanceolate and straight (*L. insignis*, *L. laevigatus*, *L. velutinus*, *L. subsessilis*; Fig. 1a, b, e, h) or long, rather setaceous to linear-lanceolate, sometimes curved (*L. sellowianus* and *L. crotalarioides*; Fig. 1c, i). In all cases, the stipules are externally pubescent but always glabrous on the inner face.

Leaves. The leaves may be sessile (*L. coriaceus*, *L. parvifolius* and *L. prouvensalanus*), subsessile (*L. ovalifolius*), shortly petiolate (*L. decurrens*), or distinctly petiolate (*L. arenarius*, *L. guaraniticus*, *L. insignis*, *L. laevigatus*, *L. subsessilis* and *L. velutinus*) and two species are long-petiolate (*L. sellowianus* and *L. crotalarioides*). On the whole, there is considerable variation in the dimensions of the leaf lamina, from 15–17 mm long in *L. ovalifolius* to more than 120 mm in *L. insignis*. The shape is also variable (elliptical, lanceolate, oblong, oblong-lanceolate, ovate or oblong-ovate).

The majority of the species have pubescent leaves and the exceptions to this rule are the subglabrous taxa *L. laevigatus* and *L. coriaceus*. In other species the pubescence varies from hirsute or sericeous, to tomentose or villous. The hairs are always simple. Leaf texture is rather membranaceous in all species except for *L. coriaceus* which is aptly named with coriaceous leaves.

Calyx. The calyx is 2-lipped, with the upper lip deeply divided into two teeth, and the lower lip with three, shorter teeth. Variation in these features, particularly the size of the teeth of the lower lip are of taxonomic value.

Corolla. The corolla is always glabrous, the standard oval to ovate-circular and always strongly reflexed. Size of the standard was the only variation of the corolla found to be of taxonomic value among the unifoliolate species, and this can vary from 8–15 mm.

The wing petals are oblong, oblong-ovate, to oblong-lanceolate with the apex usually curved but sometimes straight. This character shows intra-specific variation and must be used cautiously. The keel petals are usually lanceolate to oblong-lanceolate, with the apex arcuate and beaked.

The corolla shows a large range of colour in the genus, apparently independent of any formal or informal taxonomic groupings (Polhill, 1976; Bisby, 1981). It is important that the colour of young, unpollinated flowers is annotated since it has been shown (Wainwright, 1978; Bisby, 1981) that insect-visited flowers of *Lupinus* species change colour after pollination has

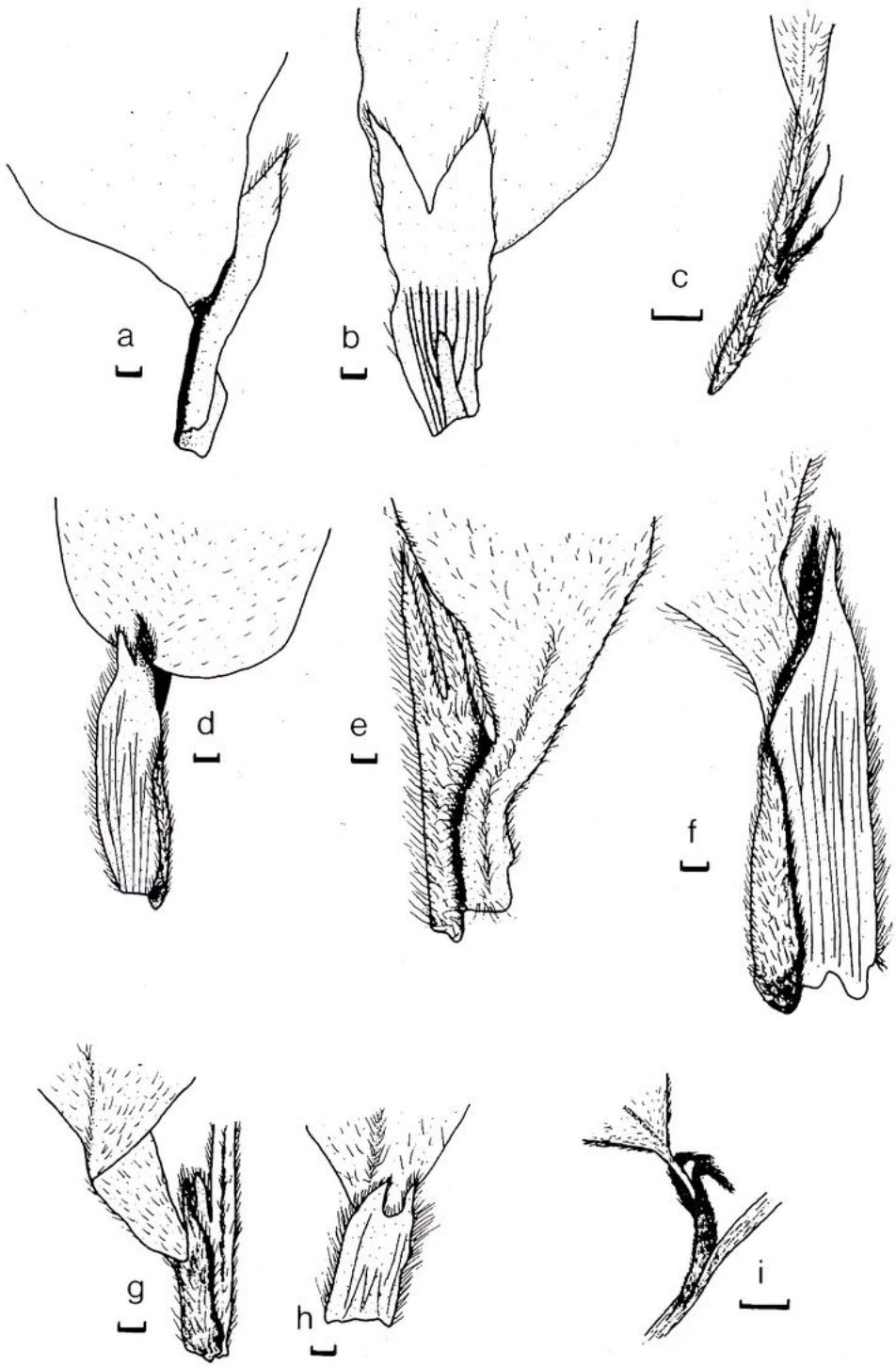


FIG. 1. Examples of stipules in Brazilian unifoliolate lupins. a & b, *L. laevigatus*; c, *L. sellowianus*; d, *L. arenarius*; e & f, *L. velutinus*; g & h, *L. subsessilis*; i, *L. crotalarioides*. Scales: a, b, d–h = 1 mm; c & i = 1 cm.

taken place. Therefore, a blue standard with white spots of an unpollinated flower may change colour to purple with yellow spots (Wainwright, 1978) after being triggered by insects. These colour changes have not been recorded for any unifoliolate species from Brazil, but very often a set of exsiccata for a single species (for example, *L. crotalarioides* and *L. velutinus*) may have the corolla variously described as blue, variegated, or purple. In general terms, the corolla colour of all Brazilian unifoliolate lupins seems to be bluish-violet.

Androecium. The stamens are connate in a closed, glabrous, monadelphous tube; the anthers are alternately long and short, dimorphic, with the shorter ones sagittate ('horse-shoe shaped', *fide* Polhill, 1976) and basifixed, the longer ones lanceolate and dorsifixed.

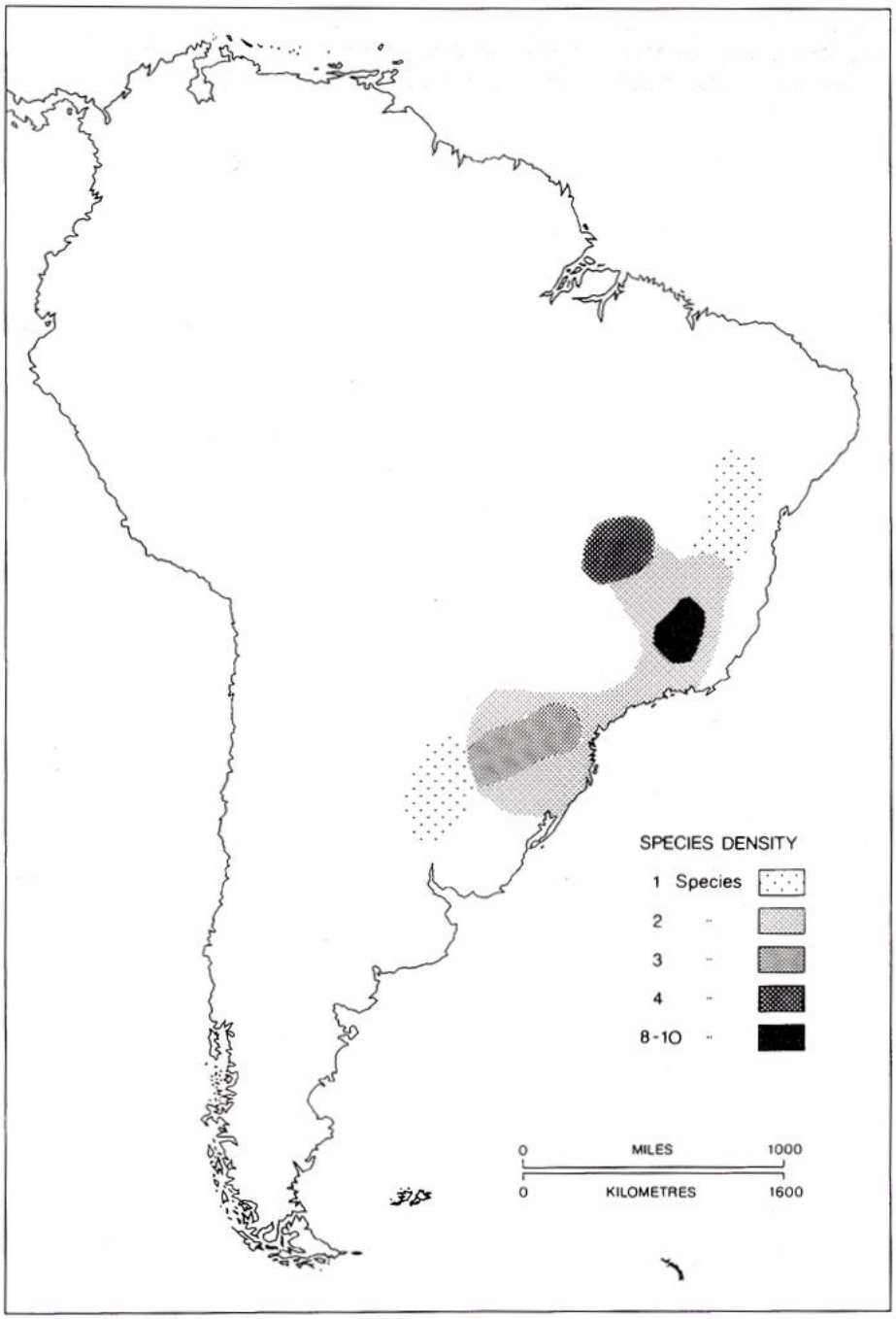
Fruit. It has not been possible to study the legumes of all the unifoliolate species due to the lack of material. However, in the taxa with fruiting specimens available (*L. parvifolius*, *L. decurrens*, *L. laevigatus*, *L. coriaceus*, *L. guaraniticus*, *L. sellowianus*, *L. crotalarioides* and *L. velutinus*) the legumes are generally rectangular, coriaceous to ligneous, beaked, compressed, 2-valved, densely pubescent, varying from 35–50 × 8–10 mm. Seeds 3–8, subcircular-compressed or cylindric-reniform, 3–7·5 mm. No variation of taxonomic value was found in the present work.

Endemism in the unifoliolate lupins in Brazil

The main centre of diversity of the unifoliolate species of *Lupinus* is the uplands of East Central Brazil in the extensive range known in a broad sense as the Serra do Espinhaço. This much dissected mountainous area extends for nearly 800 km in a SW–NE direction from c.20°S, a little to the south of Belo Horizonte, the state capital of Minas Gerais, to near Vitória de la Conquista (c.14°S) in Bahia. The geology of this system is complex, with phyllites and quartzites, some mica-schist and gneiss, and also conglomerates, clays and calcareous rocks (Sendulsky & Burman, 1978). The differential effects of watercourses and erosion on these minerals have produced a strongly accidented region of deep valleys and extensive areas of open, rocky pasture.

This characteristic rocky pasture is called in Portuguese *campo rupestre* and it has a distinctive flora composed particularly of herbaceous Gramineae, Eriocaulaceae, Xyridaceae and Cyperaceae, and shrubby Compositae, Ericaceae, Leguminosae, Melastomataceae, Velloziaceae and Vochysiaceae. On the flanks of the rocky pasture the typical flora of the *campo rupestre* merges with an upland form of *cerrado* vegetation which itself gives way to typical *cerrado* at lower altitudes. The campos rupestres in Brazil are thus isolated 'upland islands' surrounded by cerrado vegetation. The combination of subtly mixed substrates, topography and isolation have combined to produce an extremely rich endemic flora of which the unifoliolate lupins are a component.

Thus, some 10 of the 13 unifoliolate lupins in Brazil have at least part of their distribution in this mountainous region of Minas Gerais (Map 2), and the subunit comprising the Serra de Cipó–Diamantina is particularly rich in endemics with six species possibly restricted to this area (*L. coriaceus*, *L. decurrens*, *L. laevigatus*, *L. parvifolius* and *L. prouvensalanus*).



MAP 2. Species density of unifoliolate lupins in Brazil. Area of highest endemism is the region of the Serra do Espinhaço–Serra do Cipó–Diamantina.

To the north, the Serra do Espinhaço adjoins the highlands of central Goiás and several lupin species either extend here from Minas Gerais or Bahia (*L. arenarius*, *L. crotalarioides*) or are restricted to this region (*L. insignis*, *L. subsessilis*). Also in Goiás, the widespread species *L. velutinus* extends from campo rupestre into typical cerrado vegetation. To the south, a very much modified campo rupestre vegetation occurs on more siliceous substrates in the Serra da Mantiqueira in Rio de Janeiro state and this provides a southerly route for the widely distributed *L. arenarius* which extends from Bahia to this area where it occurs with *L. velutinus*. The uplands of southern São Paulo and Paraná states (Serra de Paranapiacaba) form a link for the most southerly distributed unifoliolates, *L. guaraniticus*, which reaches Argentina and Alto Paraná in Paraguay, and *L. sellowianus* which also extends into the upland corridor of Missiones province in Argentina.

Key to Brazilian unifoliolate species of Lupinus

1. All leaves unifoliolate 2
\+ Only lowermost leaves or those of axillary branches unifoliolate, others multifoliolate ..... **14. L. paraguariensis**
2. Stipules absent or, if present, totally adnate to the petioles and without free tips 3
\+ Stipules present, partially adnate to the petiole and with free tips .. 8
3. Leaves sessile or subsessile, petioles to 1 mm (in *L. coriaceus* the sessile leaves have a long attentuate lamina and may appear deceptively petiolate) 4
\+ Leaves distinctly petiolate, petioles mostly exceeding 3 mm (in some specimens of *L. arenarius* the petioles with adnate stipules may clasp the stem and thus appear to be sessile) 7
4. Leaves ovate; plants decumbent ..... **1. L. ovalifolius**
\+ Leaves linear to oblong-lanceolate; plants erect 5
5. Leaves glabrous to subglabrous with margins ciliate, lamina linear to linear-lanceolate, coriaceous ..... **6. L. coriaceus**
\+ Leaves sericeo-villous to lanate-tomentose, lamina oblong-elliptic to oblong-lanceolate, membranaceous 6
6. Standard 12–15 mm; leaf sericeo-villous, base amplexicaul **2. L. parvifolius**
\+ Standard 8–10 mm; leaf lanate-tomentose, base not amplexicaul **3. L. prouvensalanus**
7. Leaves 20–35(–45) × 7–14 mm, decurrent; stems unbranched; standard 8–10 mm ..... **4. L. decurrens**
\+ Leaves 70–110 × 9–15 mm, not decurrent; stems branched; standard 12–15 mm ..... **7. L. guaraniticus**
8. Leaves and stipules glabrous (margins sparsely ciliate) **5. L. laevigatus**
\+ Leaves and stipules pubescent 9
9. Lower leaves with petioles 20–60 mm; stipules adnate to the petiole below but becoming free well below the leaf lamina, with narrowly lanceolate to rather setaceous tips 10

+ Lower leaves with petioles 8–15 mm; stipules adnate to the petiole for most of their length but with lanceolate free tips which overtop the base of the leaf lamina 11

10. Leaves lanate, apex acute; calyx lanate, 8–10 mm, lower lip with subequal teeth 1·5–3 mm ..... **8. L. sellowianus**

+ Leaves sericeous to villous, apex obtuse; calyx hispid-sericeous, 6·5–8 mm, lower lip with unequal teeth, median tooth 0·8–1·9 mm **9. L. crotalarioides**

11. Wing petals oblong with an obtuse apex; leaf base truncate **10. L. arenarius**

+ Wing petals arcuate-falcate with the apex rather acute; leaf base attenuate-cuneate 12

12. Plants sericeous; stipules 7–11 mm with free tips 3–5 mm **12. L. subsessilis**

+ Plants densely villous to appressed villous; stipules 13–25 mm with free tips 8–13 mm 13

13. Internodes 20–35 mm; lower lip of the calyx distinctly tridentate; leaves lax, less than 120 mm ..... **11. L. velutinus**

+ Internodes 9–13 mm; lower lip of the calyx shortly trifid; leaves congested, more than 120 mm ..... **13. L. insignis**

1. Lupinus ovalifolius Bentham in Martius (ed.), Fl. bras. 15(1):11 (1859). Fig. 2.

Plants perennial with herbaceous, decumbent, long-hirsute to hirsute-sericeous stems, internodes 5–7 mm. Stipules absent. Leaves 12–17 × 9–12 mm, sessile to subsessile with petiole c.1 mm, broadly ovate-elliptic, rounded at the apex, hirsute on both faces and densely so on the margins. Peduncles 6–8 mm, erect, hirsute-sericeous. Racemes 100–120 mm, flowers lax. Bracts lanceolate to oblong-lanceolate, c. 5 × 2 mm, falling late (or persistent?). Pedicels 2–4 mm, densely hirsute. Calyx hirsute-sericeous; lower lip 10–11 mm, lanceolate, tridentate, the median tooth c.1 × 0·06 mm, the two lateral teeth shorter, diverging; upper lip 5·5–6·5 mm, oblong-lanceolate, bifid, the teeth 1–1·5 mm. Bracteoles 0·3–0·7 mm, lanceolate. Standard petal 8–11 mm, oblong-ovate; wing petals 3·5–4 mm, oblong-subarcuate, the claw 1·5–2 mm; keel petals 7 × 2 mm, oblong-lanceolate, arcuate, the claw 1–1·5 mm. Ovules 3–4. Legume and seeds not seen.
Type: Brazil, Minas Gerais, no locality, 1816, *St. Hilaire* 2167 (holo. P).

Bentham (1859) cites the locality 'campis herbidis serra da Tapa' for the type but there is no such indication on the holotype in Paris. It has not been possible to trace this locality in the state of Minas Gerais but it may be a misprint for Lapa which St. Hilaire visited in his 1816–1818 excursion to Minas Gerais. Although *L. ovalifolius* is known only from the type this species is very distinct among the unifoliolate group due to its small, ovate leaves.

2. Lupinus parvifolius Gardner in W. J. Hooker (ed.), Ic. Pl. 6(1):t. 521 (1843). Fig. 3.

Perennial plants with woody stems, 1·5–2 m tall, simple or little-branched, sericeo-villous, internodes 3–4 mm. Stipules absent. Leaves 17–23 × 8–17 mm, sessile, oblong-elliptic to elliptic-ovate, base amplexicaul, apex

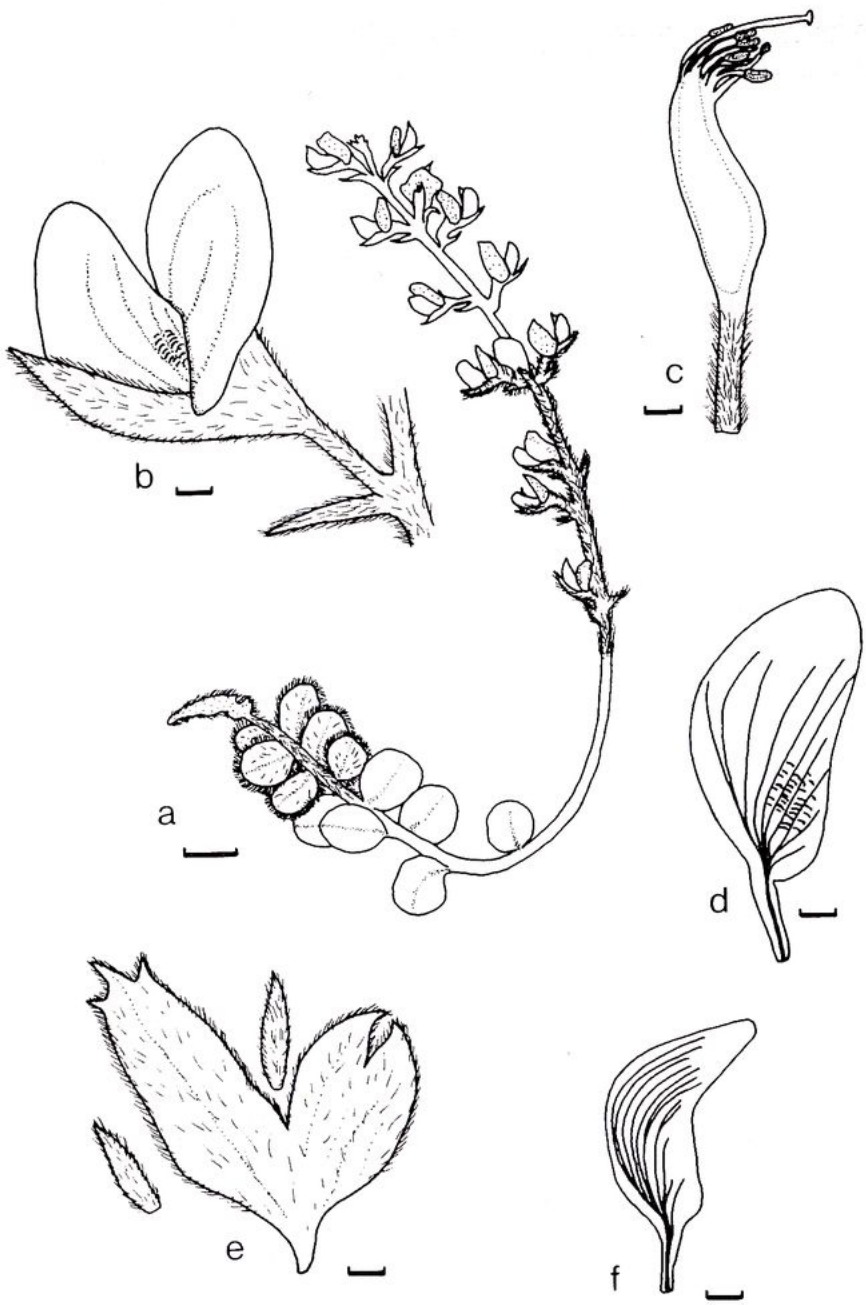


FIG. 2. *Lupinus ovalifolius:* a, habit (pubescence only partly shown); b, flower; c, androecium; d, wing petal; e, calyx; f, keel petal. Scales: a = 1 cm; b–f = 1 mm.

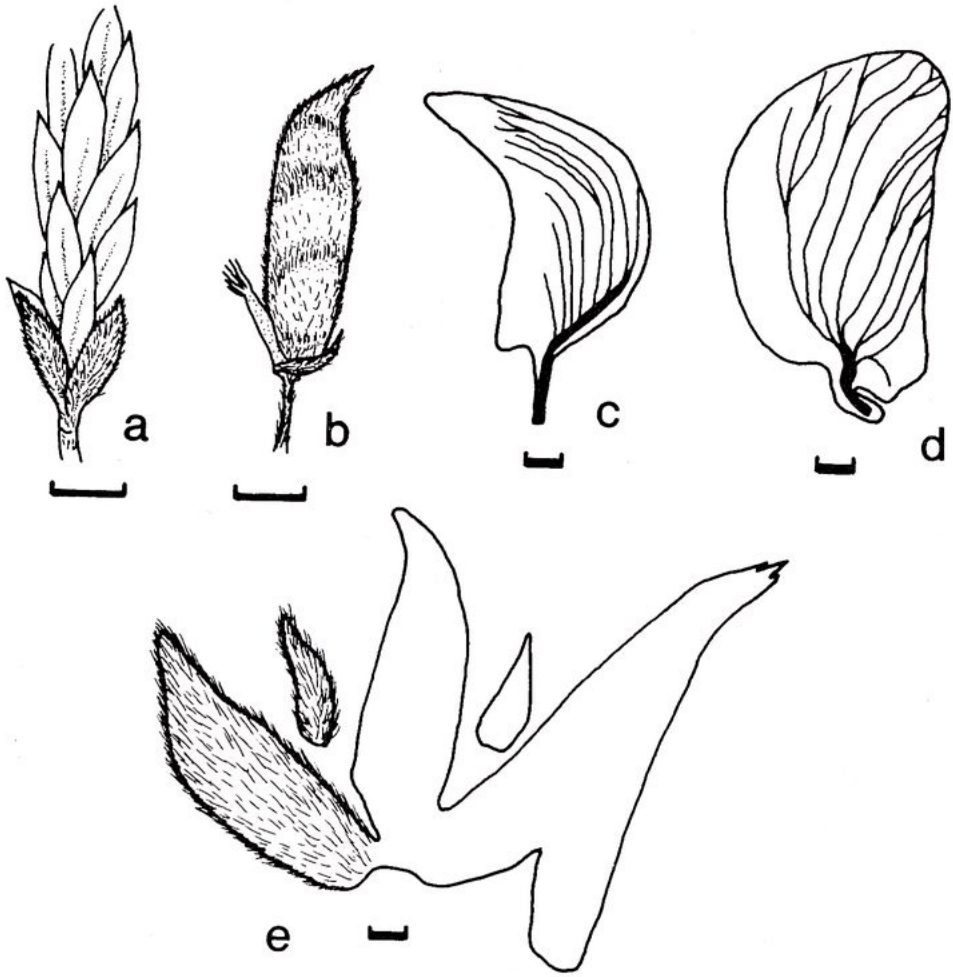


FIG. 3. *Lupinus parvifolius:* a, leaves; b, legume; c, keel petal; d, wing petal; e, calyx (pubescence only partly shown in a & e). Scales: a & b = 1 cm; c–e = 1 mm.

acute, sericeo-villous on both faces. Peduncles 3–10 mm, racemes 30–70 mm, flowers congested. Bracts 5–6 × 3 mm, ovate-lanceolate, caducous. Pedicels 3–6 mm, densely sericeo-villous. Calyx appressed-sericeous; lower lip 10–14 mm, lanceolate, shortly trifid to tridentate, the median tooth c.3 × 0·6 mm, the two lateral teeth shorter; upper lip 10–11 mm, lanceolate, bifid, the teeth 4·5 × 1–1·5 mm. Standard petal 12–15 mm, ovate-circular; wing petals 12–17 × 6–8 mm, oblong-ovate, straight to arcuate at the apex, the claw 2·5 mm; keel petals 8–10 × 3·5–4·5 mm, lanceolate, strongly arcuate at the tip, the claw 3–3·5 mm. Legume 40 × 10 mm, sericeo-villous. Seeds subcircular to cylindric-reniform, 6 × 5 mm, brownish.

Type: Brazil, Minas Gerais, in narrow rocky valleys near Cidade Diamantina, viii 1840, *Gardner* 4502 (holo. K, photo NY; iso. BM, E, G, P, TCD).

BRAZIL: SOUTHEAST. Minas Gerais: Serra do Cipó, mun. of Jabuticatubas, km 131, Palácio, 13 vii 1940, *Foster & Barreto* 10845 (SP, UB); mun. Diamantina, Conselheiro de Mata, 12 viii 1972, *Hatschbach* 30227 (NY); c.26 km SW of Diamantina on road to Gouveia, 1300 m, 22 i 1969, *Irwin et al.* 22413 (NY); road between Diamantina and Gouveia, 12 viii 1960, *Maguire, Magalhães & Maguire* 49175 (K, NY, SP); without precise locality, *Gardner* 4512 (FHO).

This species is easily recognizable by the distinct amplexicaul leaves, congested racemes, and deeply bifid upper lip of the calyx. It seems to be restricted to the Serra da Diamantina and Serra do Cipó areas of the Serra do Espinhaço.

3. Lupinus prouvensalanus C. P. Smith, Species Lupinorum 492 (1945). Fig. 4.

Syn.: *L. subsessilis* Bentham var. *lanata* Bentham in Martius (ed.), Fl. bras. 15(1):13 (1859). Type: *St. Hilaire* 2996 (P).

Perennial plants with erect herbaceous stems up to 0·25 m, lanate-tomentose, interodes c.3·5 mm. Stipules absent. Leaves 50–58 × 12–17 mm, subsessile, oblong to lanceolate, the apex acute to cuspidate, mucronate, lower face sericeo-tomentose with the midvein prominent, the upper face lanate-tomentose. Peduncle c. 55 mm. Raceme c.110 mm, flowers lax. Bracts 5–8 × 0·8–1·2 mm, lanceolate-acuminate, tardily deciduous. Pedicels 2–3 mm. Calyx lanate-tomentose; lower lip 9–11 × 3–4 mm, oblong-lanceolate, tridentate, the median tooth 1 × 0·5 mm, the two lateral teeth shorter; upper lip 6–7 × 2·5–3 mm, oblong-ovate, bifid, the teeth 1–1·5 mm. Bracteoles lanceolate, 2–3 × 0·5–0·8 mm. Standard petal 8–10 mm, ovate-circular; wing petals 7–10 × 3–4 mm, oblong-lanceolate with the apex straight to slightly arcuate, the claw 0·6–0·8 mm; keel petals 5·5–7 × 2·5–3 mm, strongly arcuate, the claw 1·5–2 mm. Ovules 3. Legume and seeds not seen.

Type: Brazil, Minas Gerais, without precise locality, *St. Hilaire* 2996 (holo. P).

The type specimen of this species was identified by Bentham (1859) as *L. subsessilis* var. *lanata*. However, the same author had earlier described *L. subsessilis* as stipulate and petiolate (Bentham, 1839), both features not found in *St. Hilaire* 2996. Because of this Bentham (1859) had to give two entries for *L. subsessilis* in his key. Smith (1945), who studied the types of *L. subsessilis* and *L. subsessilis* var. *lanata* created the new species *L. prouvensalanus* for *St. Hilaire* 2996 but curiously, unlike Bentham, Smith (loc. cit.) failed to match the characters of his description of *L. prouvensalanus* to his key since this species with subsessile leaves was treated as petiolate in the key.

4. Lupinus decurrens Gardner in W. J. Hooker (ed.), Ic. Pl. 6:t. 551 (1843). Fig. 5.

Perennial plants with erect herbaceous to woody stems, 0·3–0·5 m, sericeous, internodes c.10 mm. Stipules totally adnate to the petiole, without free tips. Leaves 20–40 × 7–14 mm, subsessile with petioles 0·5–0·8 mm, decurrent, lanceolate with apex acute, short-mucronate, sericeo-lanate to sericeo-tomentose on both surfaces. Peduncle 20–60 mm. Raceme 60–110 mm, flowers lax. Bracts 6–7 × 1–1·5 mm, lanceolate, sericeo-tomentose, caducous. Pedicles (2·5–)5–8(–10) mm, sericeous. Calyx densely sericeous to sub-tomentose; lower lip 4·5–6 mm, oblong-lanceolate, tridentate, the median tooth 1·5–2 × 0·3–0·5 mm, the two lateral teeth much

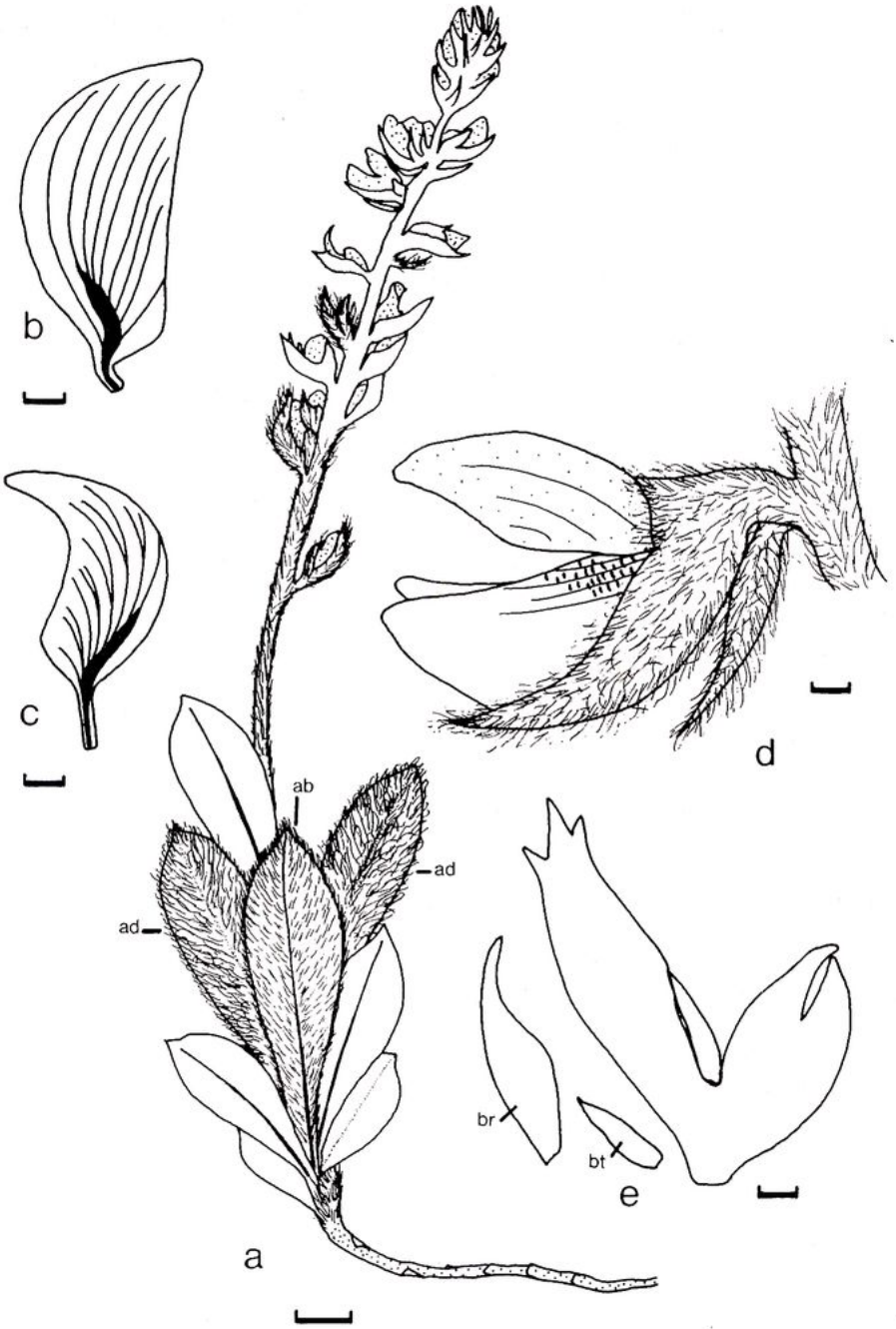


FIG. 4. *Lupinus prouvensalanus:* a, habit (pubescence only partly depicted); b, wing petal; c, keel petal; d, flower; e, calyx (pubescence omitted), bract (br), bracteole (bt). Scales: a = 1 cm; b–e = 1 mm.

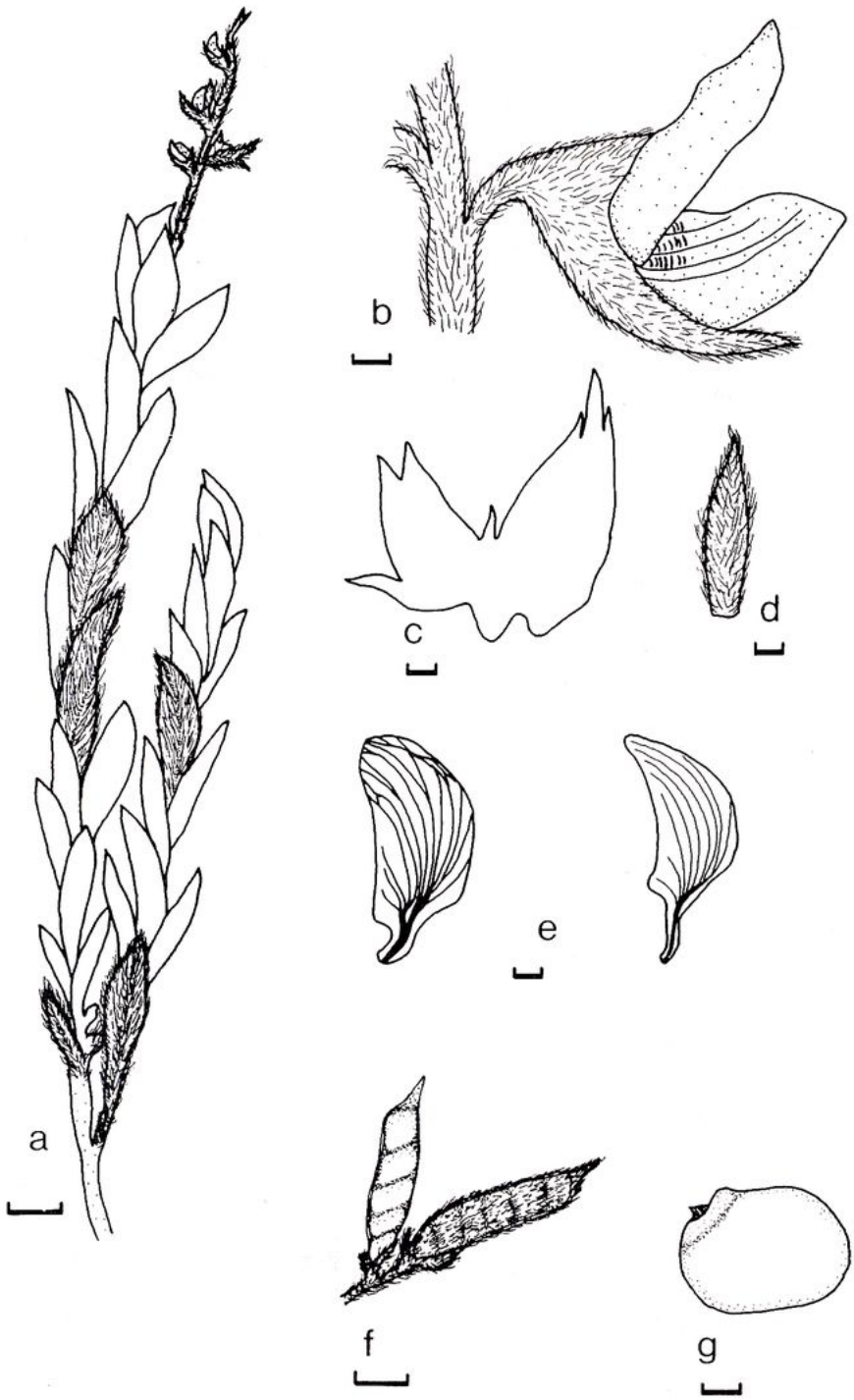


FIG. 5. *Lupinus decurrens:* a, habit; b, flower; c, calyx; d, bract; e, wing and keel petals; f, legume; g, seed—(pubescence only partly or not shown on a, c & f). Scales: a & f = 1 cm; others = 1 mm.

shorter; upper lip 2–3·5 × 1·0–1·5 mm, bifid, the teeth 1·5–2 mm. Bracteoles 1–1·5 × 0·3–0·5 mm, lanceolate, acuminate. Standard petal 8–10 mm, oval-ovate, wing petals 7–9 × 3–4 mm, oblong-ovate, straight, the claw 0·6–1·0 mm; keel petals 7–9 × 2·5–3·5 mm, lanceolate-arcuate, the claw 1·5–2·6 mm. Legume 40–50 × 8–10 mm, sericeo-villous. Seeds subcircular, compressed, 3–4 × 3 mm.

Type: Brazil Minas Gerais, 'in elevated mountain campos, near the capital of the Diamond District' fide Gardner (1843); Diamantina, viii 1840, *Gardner* 4503 (holo. k; iso. BM; photo G, GH, TEX).

BRAZIL: SOUTHEAST. Minas Gerais: Serra do Espinhaço, c.15 km NE of Diamantina, road to Mendanha, 1275 m, 30 i 1969, *Irwin et al* 22891 (K, NY); Estrada Diamantina a Corinto, 10 km, 1 xii 1976, *Shepherd et al* 3866 (UEC); In locis ... montis altis Tijuca, *Riedl* 605 (K); ibid., xii 1827, *Riedl* 1276 (K, P).

L. decurrens was originally described by Gardner (1843) as having sessile leaves and the stipules were not mentioned. However, Bentham (1859) recognized the leaves of this species as subsessile. The presence or absence of stipules in the unifoliolate species of *Lupinus* were considered by Bentham (1859) only with regard to the conspicuous free tips and when the latter were not present the plants were considered to be exstipulate, regardless of the fact that the stipules could be wholly fused with the petiole. Therefore, *L. decurrens* was treated as exstipulate together with *L. parvifolius*, *L. ovalifolius* etc.

Smith (1945) correctly described *L. decurrens* as petiolate and stipulate with the stipules fused to the petioles but these characters are confused in his key where *L. decurrens* is treated as having no stipules ('stipulae nullae') and sessile leaves ('folia sessiles, petioli nulli').

L. decurrens is apparently endemic to the area of the Serra do Espinhaço near Diamantina and its decurrent, sericeo-lanate leaves are distinctive characters.

5. Lupinus laevigatus Bentham in Martius (ed.), Fl. bras. 15(1):13 (1859). Fig. 6.

Erect, shrubby plants to 1 m with branching stems with sericeous, reddish-brown hairs, internodes 5–7 mm. Stipules partially fused to the petiole, 17–26 mm, foliaceous, lanceolate, subglabrous with long-ciliate hairs on the margin, free tips 7–12 × 3–6 mm, apex acuminate. Leaves 37–60 × 16–26 mm, ovate-lanceolate to oblong-ovate, apex obtuse, mucronate, base cordate, glabrous to sparsely ciliate, mid- and secondary veins conspicuous on the upper face. Petioles 6–8 mm. Peduncle 16–25 mm. Racemes 57–85 mm, flowers congested below but becoming lax towards the apex. Bracts 6–8 × 1·5–2 mm, foliaceous, caducous. Pedicels 4–6 mm, sericeo-hirsute. Calyx subglabrous to sparsely sericeous; lower lip 6–9 × 1·5–3 mm, oblong, tridentate, the median tooth 0·5–0·7 × 0·4–0·5 mm, the two lateral teeth much shorter; upper lip 3·5–5 × 2–2·5 mm, bifid, the teeth 1·5–2(–4) mm. Standard petal 9–12 mm, ovate-circular; wing petals 7–8 × 3·5–4·5 mm, oblong, slightly arcuate, the claw 1–1·5 mm; keel petals 5·5–6·5 × 2–3·5 mm, lanceolate-arcuate, the claw 1·5–2 mm. Immature pods 45–55 × 8–10 mm, densely sericeo-tomentose. Seeds not seen.

Type: Brazil, Minas Gerais, without precise locality, 1838, *Claussen* 921 (holo. P).

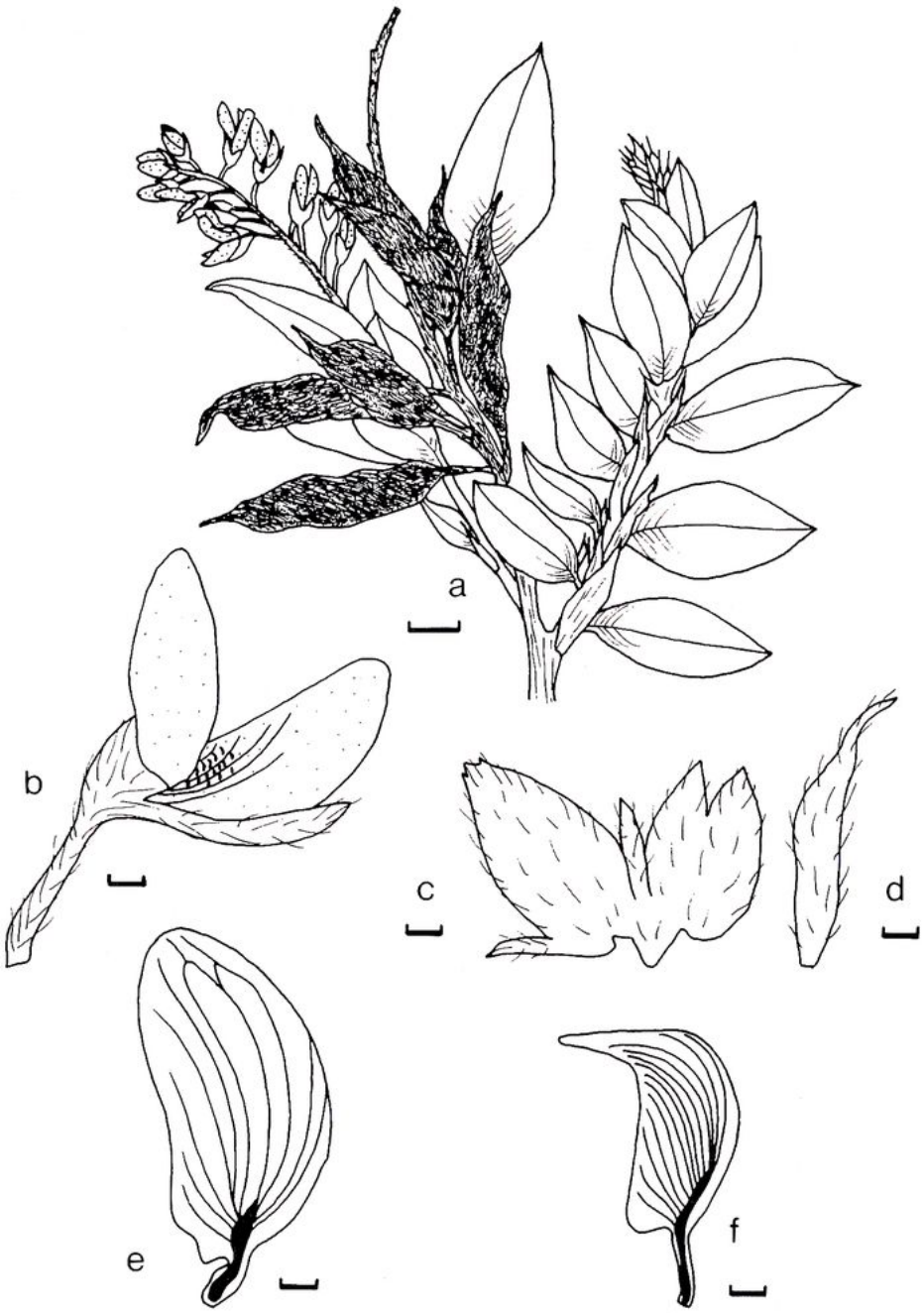


FIG. 6. *Lupinus laevigatus:* a, habbit (pubescence only partly shown); b, flower; c, calyx; d, bract; e, wing petal; f, keel petal. Scales: a = 1 cm; b–f = 1 mm.

BRAZIL: SOUTHEAST. Minas Gerais: Mun. Santa Luzia, Fazenda da Chicaca, alt. 1100 m, 13 xi 1945, *Assis* (GH); mun. Betina, Barreiros, slopes of Serra da Matuca, 1000–2000 m, 3 vi 1945, *Williams & Assis* (GH).

L. laevigatus was regarded by Bentham (1859) as a species close to *L. velutinus* in leaf and stipule morphology but differing in the lack of pubescence. The two taxa are certainly very similar but since *L. laevigatus* is readily distinguished from *L. velutinus* by its sparsely ciliate leaves and longer pedicels we have maintained it as a distinct species.

6. Lupinus coriaceus Bentham, Ann. Nat. Hist. 3:430 (1839). Fig. 7.

Syn.: *L. attenuatus* Gardner in W. J. Hooker (ed.), Icon. Pl. 6: t. 511 (1843). Type: Brazil, Minas Gerais, Serra da Mendanha, vii 1840, *Gardner* 4501 (holo. K).

L. schwackeanus C. P. Smith, Species Lupinorum 492 (1945). Type: Brazil, Minas Gerais, without precise locality, viii 1825, *Schwacke* 11790 (holo. P).

Perennial plants with erect herbaceous to woody stems 0·1–0·3 m, hirsute to lanate, internodes (2–)4–7 mm. Stipules absent. Leaves (20–)35–45(–80) × (2–)3–8(–10) mm, sessile, linear to oblong, coriaceous, apex acute, shortly mucronate, base attenuate, glabrous with ciliate margins or sparsely sericeous with long marginal hairs, veins and veinlets prominent. Peduncle 12–27(–35) mm. Racemes 50–60(–80) mm, flowers lax. Bracts c.2 × 1·5 mm, lanceolate-acuminate, caducous. Pedicels 2·5–5 mm, densely hirsute-sericeous. Calyx sericeous-villous; lower lip oblong-lanceolate, shortly to deeply tridentate, the teeth subequal 1–1·5 × 0·2–0·3 mm; upper lip (5–)7–10 × 3–4·5 mm, oblong-lanceolate, bifid, the teeth 0·5–3·5 mm. Bracteoles lanceolate-acuminate, (1·5–)3–4 × 0·5–1 mm. Standard petal 8–13 mm, oval-ovate; wing petals 8–13 × 4·5–6 mm oblong-ovate, apex straight, claw 1–2 mm; keel petals 8–10 × 3–4 mm, lanceolate, strongly arcuate at the apex, claw 2–2·5 mm. Legume 35–40 × 8 mm, subglabrous to sparsely hirsute. Seeds subcircular, compressed, 3 × 2·5 mm.

Type: Brazil, Minas Gerais, 'near Tejuco and in Serra do Frio', 1833, *Vauthier* 141 & 142 (holo. M, n.v. iso. G, GH, P).

BRAZIL: SOUTHEAST. Minas Gerais: Serra do Cipó, km 128, mun. of Santa Luzia, Palácio, 2 ix 1933, *Barreto* 5444 (UB); ibid., km 139 da estrada do Pilar, 24 viii 1933, *Barreto* 5445 (SP); ibid., km 116, 13 viii 1933, *Barreto* 54549 (SP); ibid., km 132, 1150 m, 4 xii 1949, *Duarte* 2059 (UB); ibid., Conceição do Mato Dentro, 6 × 1980, *Ferreira et al.* 1575 (RB); Serra da Medanha, c. 10 km SW of Diamantina, 1350 m, 22 i 1969, *Irwin et al* 22437 (UB); ibid., mun. of Jaboticatubas, km 140 from Lagoa Santa, 10 ix 1972, *Joly & Muller* s.n. (UEC)., ibid., 'in campis graminosis subhumidis prope Cachoeira do Campo', *Riedl* 604 (K); ibid., Bandeirinhas, xii 1824, *Riedl* 1313 (K); ibid., km 127 from Lagoa Santa, 23 vii 1972, *Semir, Sazima & Cassia*, s.n. (E, UEC); ibid., 7 ix 1974, *Semir, Sazima & Kinoshita* s.n. (UEC); ibid., km 114, 8 ix 1974, *Semir, Sazima & Kinoshita* s.n. (UEC).

In the protologue of *L. attenuatus*, Gardner (1843) mentioned that it was very close to *L. coriaceus* and perhaps 'only a villous variety' of the latter. However, Gardner had not seen the type of *L. coriaceus* and so was unable to compare these taxa in detail. Bentham (1859) maintained *L. attenuatus* as a distinct species but not without reservations since he also considered that it was perhaps a variety of *L. coriaceus*. In his key Bentham (1859) distinguished *L. attenuatus* from *L. coriaceus* by its oblong leaves. However, a detailed analysis of leaf shape in all specimens available for this study has shown that *L. attenuatus* can certainly fit in *L. coriaceus*.

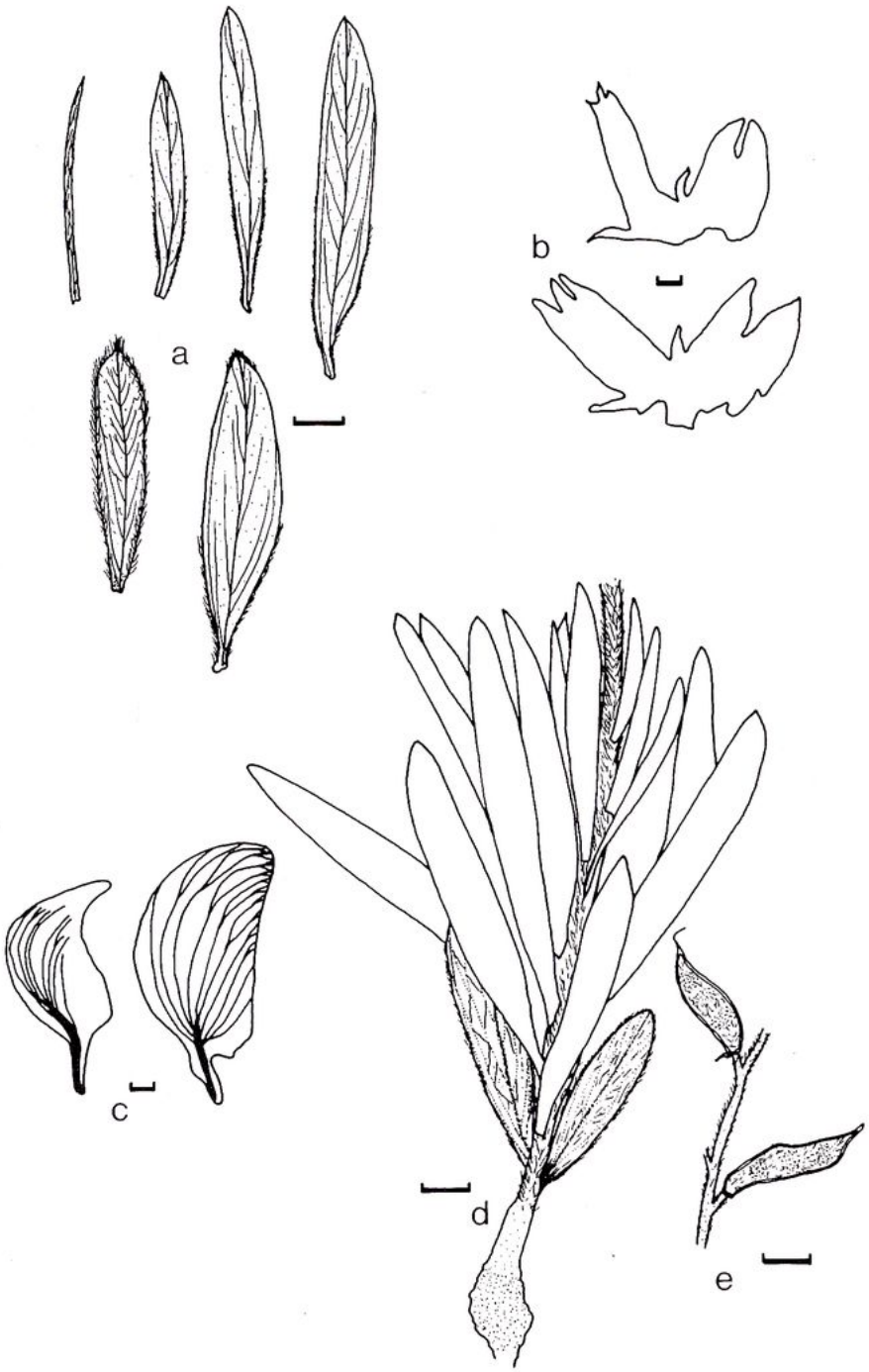


FIG. 7. *Lupinus coriaceus:* a, leaf types; b, calyx types (pubescence omitted); c, keel and wing petals; d, habit (pubescence partly omitted); e, legumes. Scales: a, d, & e = 1 cm; others = 1 mm.

Many specimens received on loan which had been identified as *L. attenuatus* actually belong to *L. guaraniticus* (q.v.), a species which resembles *L. coriaceus* in leaf shape. However, the presence of stipules adnate to the petiole, and the strigose to sericeo-tomentose leaf-indumentum and the several-branched stems of *L. guaraniticus* clearly distinguish it from *L. coriaceus*.

L. aliattenuatus C. P. Smith, a species which according to Smith (1945) is close to *L. attenuatus*, could not be compared with *L. coriaceus* due to lack of material available for study (see addendum).

Smith (1945) recognized *L. schwackeanus* as distinct from *L. coriaceus* on the basis that leaf-shape in the former was 'suboblong-linear' compared with 'linear' in the latter. However, we find the type material of *L. schwackeanus* to fall within the range of *L. coriaceus*.

L. coriaceus has been collected mainly in the Serra do Cipó subunit of the Serra do Espinhaço. It is easily distinguished by the sessile glabrous to subglabrous, thick coriaceous, linear to linear-lanceolate leaves.

7. Lupinus guaraniticus (Hassler) C. P. Smith, Sp. Lup. 325 (1943). Fig. 8.

Syn.: *L. attenuatus* Gardner var. *guaraniticus* Hassler, Repert. Spec. Nov. Regni Veg. 16:158 (1919).

L. succisaefolius [Martius ex] C. P. Smith, Species Lupinorum 493 (1945). Type: Minas Gerais, in campis altis ad Pires et Villa Rica, *Martius* (holo. M).

Perennial plants with herbaceous to woody sericeous stems 0·3–0·7 m, internodes 20–50 mm. Stipules adnate to and partially sheathing the stem, lacking free tips. Leaves 70–110 × 9–15(–20) mm, lanceolate-elliptic to lanceolate-oblong, membranaceous, the adaxial face minutely appressed strigose to tomentose with venation inconspicuous, the abaxial face densely sericeous to sericeo-villous with the mid-vein conspicuous, the base attenuate with the lamina expanding along the petiole to the node; petioles (2–)5–8(–10) mm. Peduncle (25–)30–60(–70) mm, erect, sericeous to hirsute-sericeous. Racemes 70–150 mm, flowers lax, bracts ovate-lanceolate, attenuate at the apex, early deciduous, sericeous, 3–6 × 2·5–3·5 mm; pedicels 2–3·5 mm, densely hirsute-sericeous. Calyx sericeo-tomentose; lower lip 11·5–17 × 2·5–5·5 mm, lanceolate, tridentate, the median tooth 1–1·5 × 0·7–1 mm, the two lateral teeth much shorter; upper lip 7–12 × 3–4 mm, oblong-lanceolate, bifid, the teeth 2–3·5 mm; bracteoles lanceolate, acuminate 1·5–2 × 0·5–0·7 mm. Standard petal 12–16 mm, ovate to ovate-circular; wing petals oblong, straight to arcuate, 13–17 × 5–6·5 mm, the claw 1–1·5 mm; keel petals lanceolate, arcuate to strongly arcuate, 6–8 × 4–5 mm, acute at the tip. Legumes 50–70 mm × 10–12 mm, densely lanate-sericeous. Seeds cylindric-reniform, slightly compressed, 5·5–6·5 × 4 mm, brown.

Type: Paraguay: in fields, Alto Paraná, *Fiebrig* 5681 (holo. G).

BRAZIL: SOUTH. Paraná: mun. de Tibagi, Fazenda Monte Alegre, Miranda de Cima, 16 x 1952, *Hatschbach* (MBM); mun. de Guarapuava, estrada para Laranjeiras do Sul, 15 xi 1957, *Hatschbach* 4238 (MBM); ibid., 15 xi 1957, *Hatschbach* s.n. (MBM); mun. de Arapoti, Fazenda do Tigre, 9 ix 1960, *Hatschbach* 7026 (MBM); mun. de Ipiranga, Faxinal do Tanque, 20 xii 1970, *Hatschbach* 25908 (MBM); mun. de Castro, Carambei, 14 x 1974, *Hatschbach* 35482 (UEC). Rio Grande do Sul: mun. de Santo Angelo, São João Velho, 8 xi 1977, *Pederson* 11949 (A). SOUTHEAST. São Paulo: Jaraguaíba, 1861–2, *Weir* 360 (BM, K); Morungava, prope Itararé campo cerrado, 5 xii 1915, *Dusén* (G).

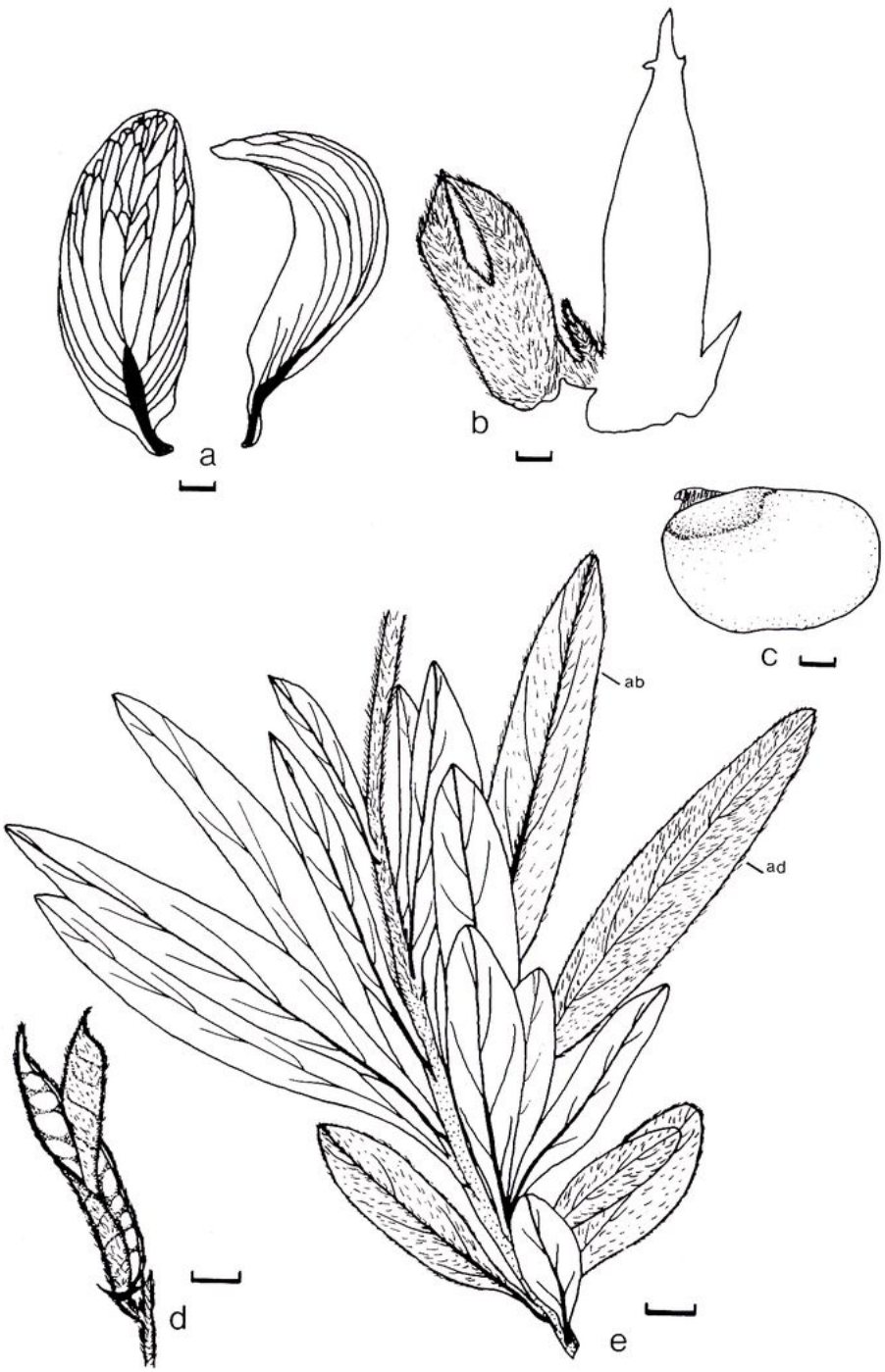


FIG. 8. *Lupinus guaraniticus:* a, wing and keel petals; b, calyx; c, seed; d, legume; e, habit (pubescence only partly shown in b & e). Scales: d & e = 1 cm; others = 1 mm.

The name *L. attenuatus* var. *guaraniticus* was applied to plants formerly recognized as belonging to *L. attenuatus* but having larger, pubescent leaves and calyx (Hassler, 1919). However, Smith (1943) elevated this variety to specific rank and this taxonomic decision is accepted here. The holotype of *L. succisaefolius* [Mart. ex] C. P. Smith (the epithet originally a *nomen nudum* on a herbarium specimen) is an unexceptional specimen of *L. guaraniticus* which was formerly identified by Bentham as *L. attenuatus*.

This species occurs in cerrado and campo rupestre areas of east-central Brazil extending to upland slopes in Paraguay and Argentina. In the latter regions the plants have a much more branched caudex which bears several stems.

8. Lupinus sellowianus Harms, Repert. Spec. Nov. Regni Veg. 17:5 (1921). Fig. 9.

Perennial herbs with erect stems up to 0·4 m, densely lanate, hairs long and whitish; internodes very short at the base of the stem but 15–35 mm in the upper portions. Stipules with the free tips 24–48 mm, caudate to subulate, occasionally sub-foliaceous. Petioles 20–60 mm. Leaves 90–150 × 12–20 mm, oblong-lanceolate to lanceolate, with the apex acute, shortly mucronate, lanate on both faces; peduncle 24–65 mm, lanate. Racemes 100–230 mm, flowers subverticillate or more often lax; bracts lanceolate, with attenuate tips, 7·5–12 × 2–2·9 mm, caducous; pedicels 1·5–2 mm, densely lanate. Calyx densely lanate; lower lip lanceolate, tridentate, 8–10 × 3·5–5 mm, the teeth subequal, 1·5–3 × 1–1·5 mm; upper lip oblong-lanceolate, 5–8 × 3·5–4·5 mm, bifid, the teeth 2·5–5 mm. Standard 10–15 mm, ovate to oval; wing petals 9·5–12 × 3–5 mm, narrowly oblong, apex pointed, claw 1·5–2 mm; keel petals 7–8·5 × 3–4 mm, lanceolate-oblong, shortly arcuate, the claw 2–2·5 mm. Legumes densely lanate, 40–50 × 10–13·5 mm. Seeds reniform-cylindric, slightly compressed, 5 × 3·5 mm.

Type: Harms (1921) did not designate a holotype but cited three specimens; 'Ohne standhort (*Sellow* 4866), Paraná, Villa Velha (*Dusén* 7261, Nov. 1908), and Jaguariahyva (*Dusén* 13173, Sept. 1911)'. The last locality is Jaguariaíva, also in Paraná. Planchuelo & Dunn (1984) single out *Sellow* 4866 as a holotype and they consider *Dusén* 7261 as originating in Espírito Santo. There seems to be no justification for this view since all three collections cited by Harms can be regarded as syntypes and both of the Dusén collections are from localities in the state of Paraná. Although these specimens were seen at Berlin by Smith (Smith, 1945) they are no longer extant. Photos of the syntype *Dusén* 7261 are located at G, NY and TEX. It is possible that duplicates of *Dusén* 7261 & 13173 exist in other herbaria although these have not been traced. However, if this is not the case, *Dusén* 10548, also from Jaguariaíva, could be selected as a neotype.

BRAZIL: SOUTH. Paraná: Jaguariaíva, 26 x 1910, *Dusén* 10548 (G); mun. de Guarapuava, Entre Rios, 21 x 1969, *Hatschbach* 22575 (MBM); ibid., estrada para Laranjeiras do Sul, 15 xi 1957, *Hatschbach* 4239 (MBM).

SOUTHEAST. Minas Gerais: Poços de Caldas, Campo do Saco, 16 x 1980, *Gabrielli et al* 314 (UEC); ibid., 2 xii 1980, *Stubblebine et al* (UEC); no precise locality, *St. Hilaire* 1551 (P). São Paulo: São José dos Campos, 5 ix 1909, *Loefgren* 319 (RB); without precise locality, 1861–2, *Weir* 361 (K).

The shapes of the leaves and stipules of *L. sellowianus* are very close to those of the North American unifoliolate *L. villosus* Willd. and it is possible

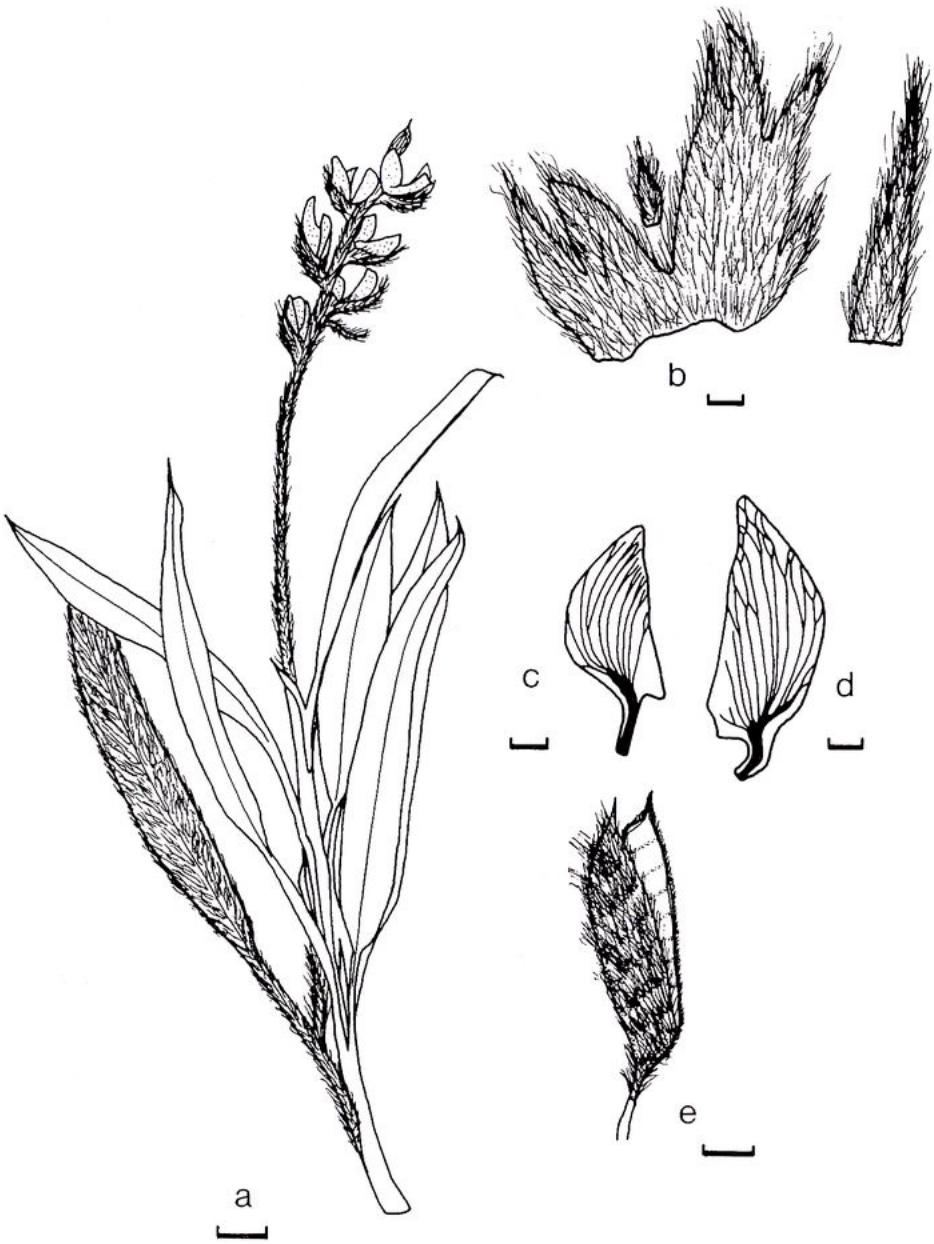


FIG. 9. *Lupinus sellowianus:* a, habit (pubescence partly omitted); b, calyx and bract; c, keel petal; d, wing petal; e, legume. Scales: a & e = 1 cm; others = 1 mm.

that *L. sellowianus* could have provided the 'single, recent source' of unifoliolate lupins introduced into North America through long-distance dispersal (Dunn, 1971). He proposed that such an introduction was subsequently followed by evolution to produce the closely related assemblage of unifoliolate species of *Lupinus* in that area. Interestingly, the pubescence of *L. sellowianus* is also very similar to the North American multifoliolate species *L. lanatus* and *L. multiflorus*.

9. Lupinus crotalarioides [Martius ex] Bentham in Martius (ed.), Fl. bras. 15(1):11 (1859). Fig. 10.

Perennial plants with herbaceous to woody stems with transparent hispid, hairs, internodes 8–30 mm. Stipules subfoliaceous, adnate to the stem, (20–)35–45 mm, the free tips 8–15 mm, linear-lanceolate. Petioles 15–30 mm. Leaves 40–100 × 24–35 mm, ovate to ovate-lanceolate, apex obtuse,

FIG. 10. *Lupinus crotalarioides:* a, habit (pubescence partly omitted); b, legume; c, calyx; d, keel petal; e, wing petal. Scales: a & b = 1 cm; c–e = 1 mm.

mucronate, base truncate, sericeous to sericeo-villous. Peduncle 20–45 mm, hispid. Raceme 100–195 mm, flowers lax to congested. Bracts subulate, 5–6 × 1·5–2·5 mm, tardily caducous. Pedicels 3–4 mm. Calyx hispid-sericeous; lower lip 6·5–8 × 2·3–4 mm, tridentate, the median tooth 0·8–1·9 × 0·2–0·3 mm, the two lateral teeth shorter; upper lip 5–6·5 × 2·3–3·2 mm, bifid, the teeth 0·6–2·0 mm. Standard petal 9–12 mm, ovate; wing petals 10–13 × 4·5–5 mm, oblong, apex straight to slightly arcuate, the claw 1·3–1·8 mm; keel petals 6–7 × 2·5–3 mm lanceolate-acuminate, arcuate, the claw 1·8–2·4 mm. Legume 45–55 × 9–13 mm, hirsute. Seeds cylindric-reniform, compressed, 4–5 × 3–3·5 mm.

Type: Brazil, Bahia, campis ad Sincora, in editis apricis, Bahiensis mediterran, *Martius* 1987 (holo. M; photo. E, GH, NY, TEX).

BRAZIL: SOUTHEAST. Minas Gerais: Lavras, 19 i 1914, *Dorsett, Shamel & Popenoe* 197B (GH); Belo Horizonte, B. Preto, 16 iv 1919, *Gehrt* (SP); Morro das Pedras, c.50 km NE of Patrocínio, 1000 m, 29 i 1970, *Irwin et al* 25708 (K); without precise locality, 1816–21, *St. Hilaire* (P); Lagoa Santa, *Warming* s.n. (GH, P); Serra da Mutuca, c. 8 km beyond Lagoa Santa, 1100 m, 25 iii 1945, *Williams & Assis* 6265 (GH).

WEST CENTRAL. Federal District: Brasília, Cemitário do Plano Piloto, 10 xii 1965, *Belém* 1944 (UB); ibid., Horto do Guará, 7 i 1961, *Heringer* 7852 (UB); ibid., Parque Nacional do Gama, 20 ix 1965, *Heringer* 10796 (UB); ibid., 'en frente do BGP', 4 ii 1966, *Heringer* 10985 (UB); ibid., Cidade Satélite de Gama, 5 v 1976, *Heringer* 15516 (NY, UB, UEC); c.1 km W of Sobradinho, 1100 m, 5 xii 1965, *Irwin, Souza & Santos* 11065 (GH, UB); Chapada da Contagem, c.10 km E of Brasília, 1000 m, 17 xii 1965, *Irwin, Souza & Santos* 11354 (GH, UB); Brasília, i iv 1958, *Lima* 58-2975 (K); Granja Rui Malta, Córrego Sobradinho, 26 iv 1963, *Pires, Silva & Souza* 9436 (UB). Goiás: without precise locality, *Burchell* 736A (K); Chapada dos Veadeiros, 13 ii 1966, *Irwin et al* 12749 (K, UB).

10. Lupinus arenarius Gardner in W. J. Hooker (ed.), Ic. Pl. 6:t. 511 (January 1843). Fig. 11.

Syn.: *L. chrysomelas* Casaretto in Nov. Stirp. Bras. Dec. 6:52 (April 1843). Type: Minas Gerais, Serra da Mutuca, iv 1852, *Casaretto* 2902 (G, photo. TEX).

L. vaginans Bentham in Martius (ed.), Fl. bras. 15(1):12 (1859). Syntypes: Minas Gerais, *Claussen* 1139 (BM, K, G, P, photo. NY, TEX); *in saxosis* Serra do Caraça, *Riedl* 603 (K). Serra de Papagaio, *St. Hilaire* (not located).

L. luetzelburgianus C. P. Smith, Species Lupinorum 490 (1945). Type: Bahia, Itubira, vii 1913, *Lützelburg* 213 (M).

Perennial plants with erect herbaceous to woody stems, 0·5–1·8 m, sericeo-villous, internodes 7–17 mm. Stipules clasping the stem, densely sericeous, 13–23 mm, the free tips lanceolate to deltoid, (1·2–)3–5(–8) × 1–2 mm. Petioles 8–13(–18) mm. Leaves 40–90 × (20–)25–35 mm, elliptic to oblong-elliptic or more usually oblong-ovate, apex acute, shortly mucronate, base truncate, sericeo-villous to villous-tomentose on both faces, veins conspicuous. Peduncle 19–47(–53) mm, erect, sericeo-tomentose. Racemes 95–195 mm, flowers lax to congested. Bracts 4–6 mm, lanceolate, caducous. Pedicels up to 3 mm, sericeous. Calyx densely sericeous-villous; lower lip 7–9(–12) mm, tridentate, the median tooth 1–2 × 0·3–0·6 mm, the two lateral teeth half as long; upper lip 7–9 × 3–4 mm, bifid, the teeth 0·5–4 mm. Bracteoles 1–1·5 × 0·2–0·4 mm, lanceolate. Standard petal 12–18 mm, ovate-circular; wing petals 12–14 × 5–7 mm, oblong-ovate, apex straight, the claw 1·5–2 mm; keel petals 11–13 × 3–4·5 mm, lanceolate-arcuate, the claw

FIG. 11. *Lupinus arenarius:* a, habit; b, legume; c, wing petal; d, keel petal; e, calyx (pubescence only partly shown in a & e). Scales: a & b = 1 cm; c–e = 1 mm.

1·5–2·5 mm. Legumes 45–60 × 15–18 mm, densely sericeo-villous. Seeds subcircular, compressed, 4·5–5·5 × 3·5–4 mm.

Type: Brazil, Minas Gerais, Diamantina, in elevated sandy campos on a mountain track to the north of the diamond district, vii 1840, *Gardner* 4500 (holo. K; iso. BM, E, G, P, TCD).

BRAZIL: NORTHEAST. Bahia: estrada Ituacu–Barra da Estiva, 8 km from Barra da Estiva, Morro do Ouro, campo rupestre, 19 vi 1981, *Giullietti et al* 18199 (E, K).
SOUTHEAST. Minas Gerais: mun. Belo Horizonte, Serra do Taquaril, 18 i 1933, *Barreto* 5450 (SP); ibid., 24 ii 1933, *Barreto* 5433 (SP); ibid., 21 vii 1933, *Barreto* 5454 (SP); ibid., Serra do Curral, 4 i 1934, *Barreto* 5622 (SP); ibid., Serra da Mutuca, 28 vii 1980, *Barreto* 10848 (UB); ibid., vi 1839, *Claussen* (G); ibid., Morro Velho, 15 xii 1918, *Gehrt* 18 (SP); ibid., 15 xii 1918, *Gehrt* 3252 (BM); Morro das Pedras, c.26 km NE of Patrocínio, 29 i 1970, *Irwin et al* 25567 (K); Lagoa Seca, 6 ii 1900, *Schwacke* s.n. (SP); Serra da Mutuca, ii 1945, *Williams* 5075 (GH). Rio de Janeiro: entre Macieira e Agulhas Negras, 2000–2500 m, iii 1981, *Bockerman* 39 (SP); ibid., Campo Feio, 24 i 1873, *Glaziou* 4787 (P); ibid., 2000–2300 m, 17 i 1929, *Smith* 1930 (GH); ibid., 4 vi 1913, *Tamandare & Brade* 6404 (SP). São Paulo: Serra da Bocaina, Morro da Boa Vista, 1800 m, 26 iv 1951, *Brade* 20725 (RB); ibid., 8 iv 1879, *Glaziou* s.n. (G, P); ibid., 1650 m, 20 x 1966, *Hoehne* 6153 (SP).
WEST CENTRAL. Goiás: Serra dos Cristais, 17°S 48°W, rocky hillside, c.33 km E of Cristalina, 1250 m, 4 iii 1966, *Irwin et al* (UB).

This species, together with the taxa which are here included as synonyms, has been the cause of some taxonomic confusion. Gardner (1843) originally described *L. arenarius* as exstipulate, an understandable error since the short stipules of some specimens may be obscured by the indumentum—although Gardner's illustration of this species depicts a plant with stipules. Bentham (1859) correctly recognized *L. arenarius* as having short-stipulate, ovate leaves, and like Gardner (loc. cit.) he regarded this species as close to his own *L. velutinus*. Bentham (loc. cit.) also described a new species, *L. vaginans*, with the same general features as *L. arenarius* but with 'short petioles' in contrast to 'dilatate petiole' in the latter. However, this difference is untenable and the type specimen of *L. vaginans* is easily accommodated within the general variation of *L. arenarius*.

L. luetzelburgianus is one of a number of new species described by C. P. Smith (1945). The measurements given by Smith (1945) for *Lützelburg* 213, the type and only specimen of this taxon are at variance with those of the actual material (Dunn, pers. comm. has reported other instances of discrepancies between Smith's published descriptions and the original material of other species) and we can find no criteria for not treating this species as a synonym of *L. arenarius*. This was also essentially the view of Harms who identified *Lützelburg* 213 as *L. vaginans*.

11. Lupinus velutinus Bentham in Ann. Nat. Hist. 3:430 (1839). Fig. 12.
Syn.: *L. nitidissimus* Bunbury in Proc. Linn. Soc. 1:109 (1841). Type: Minas Gerais, Mountains between Capão and Villa Rica, vi 1834, *Bunbury* (GCE).
L. glaziouanus C. P. Smith, Species Lupinorum 488 (1945). Type: Goiás, entre Brancas et Cocal, 25 i 1895, *Glaziou* 20930 (G, P).

Perennial plants with woody erect stems, 0·4–2 m, internodes (10–)20–35(–40) mm, villous-lanate. Stipules 13–23 mm, free tips 8–13 × 3–4·5 mm lanceolate, villous-lanate. Petioles 12–14 mm. Leaves 60–120 × 25–70 mm, ovate- to oblong-lanceolate, base attenuate, apex acute, sericeo-villous on both faces. Peduncle 15–60 mm, densely villous. Racemes 165–350 mm, flowers usually lax but sometimes congested. Bracts 6–18 mm, lanceolate-triangular, tardily caducous. Pedicels 2–5 mm. Calyx densely villous; lower lip 10–16 mm, lanceolate, tridentate, the median tooth 0·3–0·6 × 0·5–0·8 mm, the lateral teeth shorter; upper lip 6·5–9 × 3–4·5 mm, oblong-lanceolate, bifid, the teeth 1·2–3·5 mm; bracteoles 2·5–3·5 × 1–1·3 mm, lanceolate.

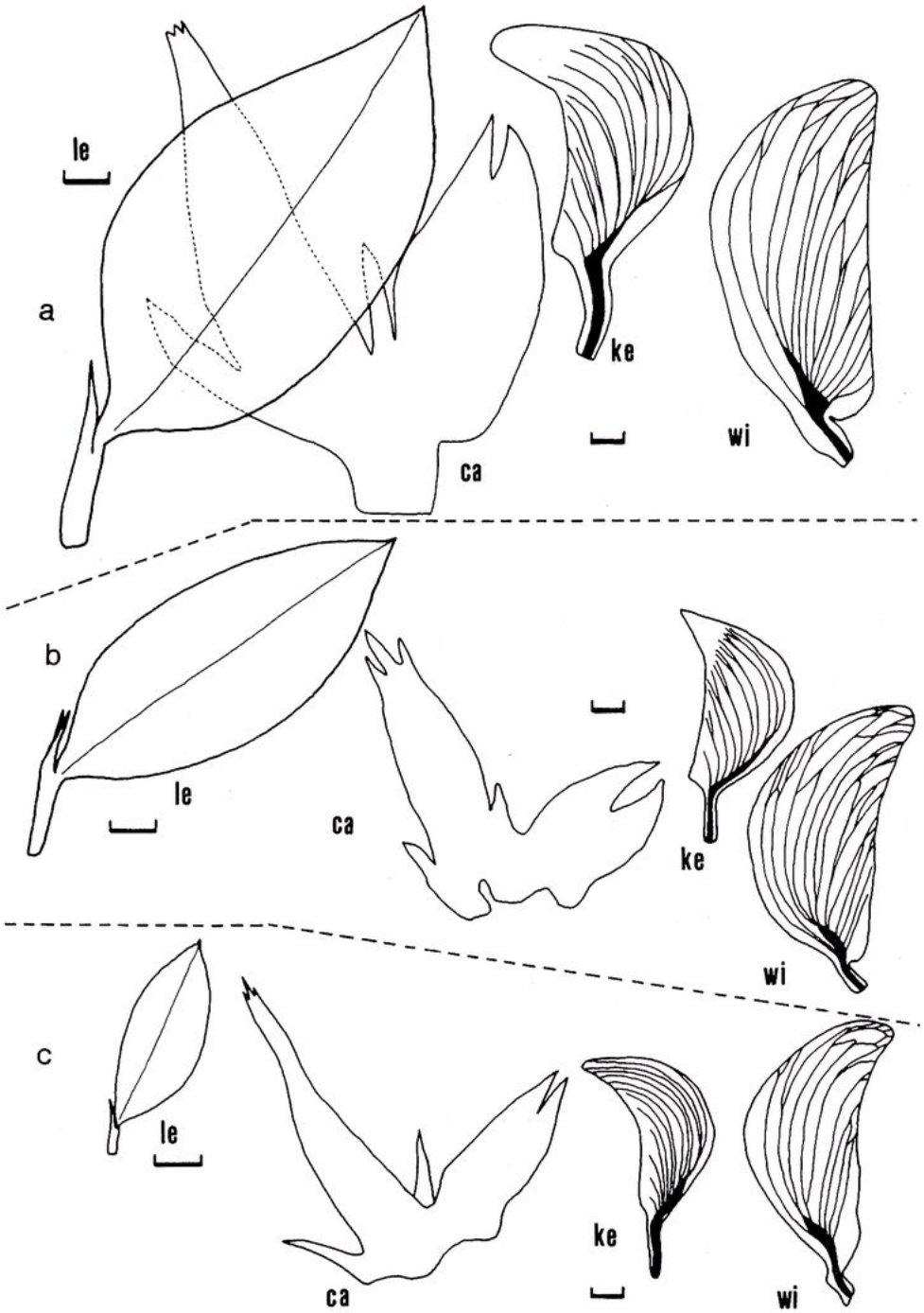


FIG. 12. a, *Lupinus insignis*; b, *L. velutinus*; c, *L. subsessilis*. 1e, average sized leaf; ca, calyx; ke, keel petal; wi, wing petal (pubescence omitted for leaf & calyx). Scales: 1e = 1 cm; others = 1 mm.

Standard petal 12–15 mm, ovate-circular; wing petals 10–15 × 3·8–6·5 mm, oblong-ovate, the claw 0·9–2·3 mm; keel petals 10–12·5 × 3·8–4·5 mm, lanceolate-arcuate, the claw 2–2·5 mm. Legume 35–50 × 8–10 mm, densely villous. Seeds 6·5–7 × 3·6–5 mm, subcircular.

Type: Brazil: on the rio São Franciso, *Pohl* s.n. (not traced).

BRASIL: NORTHEAST. Bahia: Morro do Chapeu, 26 ix 1965, *Duarte* 9197 *& Pereira* 10107 (RB); ibid., 14 x 1981, *Hatschbach* 44253 (K).

SOUTHEAST. Minas Gerais: 'in campis Minas', xi 1834, *Riedl* 616 (NY, TEX, photos). Rio de Janeiro: Itatiaia, Campo Feio, iii 1872, *Glaziou* 8643a (P); without precise locality, *St. Hilaire* 345, 1462 (P).

WEST CENTRAL. Federal District: mun. of Planaltina, near São Gabriel de Goiás on highway GO-12, 1200 m, 19 ii 1975, *Anderson* 11437 (NY); Brasília, Fazenda Água Limpa, 22 i 1980, *César* 47 (UB); ibid., 4 iii 80, *César* 359 (E); ibid., between University and lake, 3 iii 1965, *Clayton* 4923 (NY, UB); ibid., area do Zoobotânico, 10 i 1967, *Duarte* 10123 (RB); ibid., Asa Norte, 15 i 1965, *Handro* 115 (SP); ibid., Horto do Guará, 25 i 1961, *Heringer* 7875 (SP, UB); ibid., W margin of Lago Paranoá, 975 m, 11 iii 1966, *Irwin et al* 13890 (NY, UB); 15 km E of Sobradinho, 1115 m, 7 xi 1965, *Irwin, Souza & Santos* 9029 (UB); Brasília, Catetinho, cerrado, 20 iii 1964, *Pereira* 9018 (NY, RB); ibid., campo cerrado between University and lake Paranoá, 1050 m, 2 v 1963, *Philcox & Onishi* 4863 (K, NY, UB); ibid., Fazenda Água Limpa, near Vargem Bonita, c.18 km SSW of Brasília TV tower, 24 iii 1976, *Ratter & Fonseca* 2819 (E, K, UEC). Goiás: Chico Costa, 1896, *Glaziou* 20932 (G, K, P); Arredores de Formosa, 9 iii 1979, *Hatschbach* 42008 (MBM); 63 km W of Rio Verde on road to Caiapônia, 13 ii 1959, *Irwin* 2564 (K, NY, TEX); c.20 km E of Brasília, summit of Chapada da Contagem, 1100 m, 14 i 1966, *Irwin, Souza & Santos* 11639 (NY, UB); ibid., 13 viii 1964, *Irwin & Soderstrom* 5057 (NY); 20 km E of Corumbá de Goiás, near Pico dos Pirineus, 27 i 1968, *Irwin, Maxwell & Wasshausen* 19324 (G, K, NY, UB); Niquelândia, Jacuba, 24 ii 1956, *Macedo* 4427 (K, NY); mun. Alto Paraíso de Goiás, Chapada dos Veadeiros, 24 i 1978, *Martinelli* 3791 & *Jovin* (RB); Cristalina, road BR-7, km 620, 27 iii 1963, *Pereira* 7343 (NY).

The available collections of *L. velutinus* present a rather disjunct distribution, with the species apparently fairly common in the cerrados of central Goiás and also upland habitats in this region, but also extending from Bahia in the NE to Itatiaia in Rio de Janeiro State in the SE. It is possible that this apparent disjunct distribution is simply due to poor sampling.

The combination, of stipules partially adnate to the petioles and with distinctive lanceolate, free tips, together with leaves ovate- to oblong-lanceolate with the base attenuate, characterizes a group of three species, *L. velutinus*, *L. subsessilis* and *L. insignis*. This trio tend to form a sequence in leaf size and pubescence:

	L. insignis	*L. velutinus*	*L. subsessilis*
leaf size:	large 126–130 mm	medium–large 60–120 mm	small 45–65 mm
leaf indumentum:	densely sericeous-villous	sericeous- villous	sericeous

However, they can be fairly readily distinguished despite occurring sympatrically in southern Goiás and the Federal District and we have therefore retained them as distinct species for the present. Future detailed studies may establish that they comprise a single species complex perhaps also linking with *L. arenarius*.

12. Lupinus subsessilis Bentham in Ann. Nat. Hist. 3:430 (1839). Fig. 12.

Perennial plants with erect herbaceous to woody stems to 1 m, internodes 15–30 mm, hirsute-sericeous. Stipules sericeous, the free tips 3–5 × 1·5–2·3 mm, lanceolate-acuminate. Petioles 6–7 mm. Leaves 45–65 × 9–25 mm,

elliptic-lanceolate to elliptic-ovate, appressed sericeous on both faces. Peduncle 20–35 mm. Racemes 100–150 mm, flowers lax. Bracts 5–6 mm, lanceolate-subulate, caducous. Pedicels c.4 mm, sericeo-villous. Calyx densely sericeous to villous; lower lip 13–16 mm, lanceolate-linear, tridentate, the median tooth 0·6–0·8 × 0·2–0·3 mm, the lateral teeth much shorter; upper lip 10–11 × 3·5–5 mm, oblong-lanceolate, bifid, the teeth 2–4·5 mm. Standard petal 14–16 mm, ovate-circular; wing petals 7–8 × 3–3·8 mm, ovate-oblong, the claw 1–1·5 mm; keel petals 6·5–7·5 × 2·5–3 mm, lanceolate-arcuate, the claw 1·5–2 mm. Legume 50 × 8–10 mm, densely sericeous-villous. Seeds cylindric-reniform, 6–7·5 × 3·5–4·2 mm.
Type. Brazil: Goiás, Serra dos Cristais, 20 xii 1818, *Pohl* (holo. K).

BRAZIL: WEST CENTRAL. Federal District: Brasília, Horto do Guará, 27 ii 1966, *Heringer* (UB). Goiás: Serra dos Cristais, 7 x 1981, *Hatschbach* 44053 (MBM); ibid., c.5 km E of Cristalina, 1175 m, 6 ix 1965, *Irwin et al* 10007 (GH, SP, UB); ibid., 3 km E of Cristalina, 1250 m, 4 iii 1966, *Irwin et al* 13471 (GH, K).

Smith (*Species Lupinorum* 1945) has cited the State of Minas Gerais as the area where the holotype was collected, but the Serra dos Cristais is in the State of Goiás and this is certainly the region visited by Pohl in December 1818 (fide Urban in *Flora brasiliensis* 1 (1):79, 1906).

13. Lupinus insignis [Glaziou ex] C. P. Smith, Species Lupinorum 489 (1945). Fig. 12.

Syn.: *L. insignis* Glaziou in Mém. Soc. Bot. Fr. 1(3):129 (1906) *nomen nudum*.

Perennial plants with erect herbaceous to woody stems, up to 0·75 m, internodes 9–13 mm, densely appressed sericeo-villous. Stipules 23–25 mm, lanate-villous, with the free tips 9–12 × 3–5 mm, lanceolate-acuminate. Petioles 13–15 mm. Leaves 126–130 × 30–56 mm, ovate-lanceolate, densely appressed sericeo-villous on both faces. Peduncle 15–45 mm. Raceme 160–370 mm, flowers congested. Bracts 12–15 × 2·5–3 mm, ovate-lanceolate, acuminate, densely villous, tardily caducous. Pedicels 10–20 mm. Bracteoles 3·5–4·5 × 1–1·5 mm, lanceolate. Calyx densely appressed sericeo-villous; lower lip 12–14(–16) mm, tridentate, the teeth subequal, 0·2–0·4 × 0·3 mm; upper lip 10–12 × 3·5–4 mm, bifid, the teeth 2·5–4 mm. Standard petal 12–17 mm, ovate-circular; wing petals 11–12 × 4–5 mm, oblong, straight to arcuate at the tip, the claw 1–1·5 mm; keel petals 10–11 × 3·5–4·8 mm, lanceolate-arcuate, the claw 1·5 mm. Legume and seeds not seen.
Type: Brazil, Goiás: entre Engenho e Jatobá, 21 i 1891, *Glaziou* 20931 (holo. P; iso. G, K).

BRAZIL: WEST CENTRAL. Goiás: Chapada de Veadeiros, 9 km by road S of Teresina, 1100 m, 19 iii 1973, *Anderson* 7467 (NY, UB); 'entre Rio dos Couros et Rio Picarão', 18 i 1895, *Glaziou* s.n. (P); c.10 km E of Brasília, summit of Chapada da Contagem, 13 ix 1965, *Irwin, Souza & Santos* 8252 (NY, UB).

The typification of this species has a somewhat confusing history because of erroneous citations of collection numbers and specimens by Glaziou. *Lupinus insignis* was published as a *nomen nudum* but the specimen cited, 'Goiás: entre Rio dos Couros e Rio Picarão' was mistakenly cited as collection *Glaziou* 20931. This number actually refers to another collection as the specimen in Paris confirms. Smith (1945), who had seen both

specimens, correctly cited the holotype, although he also cited a basionym for this species '*L. velutinus* var. *insignis* Glaziou', a combination which does not appear to have been published.

14. Lupinus paraguariensis Chodat & Hassler in Bull. Herb. Boiss., sér. 2, 4:836 (1904).

Syn.: *L. paraguariensis* var. *missionum* Hassler in Repert. Spec. Nov. Regni Veg. 16:159 (1919). Type: Argentina, Missiones, fields near San Ignacio, *Hassler* 445 (holo. G).

L. missionum (Hassler) C. P. Smith, Species Lupinorum 325 (1943).

Plants perennial with herbaceous to woody stems 40–50 cm, appressed lanate, internodes 20–80 mm. Stipules 25–40 mm, adnate to the petiole, free tips 10–40 mm, slender. Petioles 30–120 mm. Leaves at the base of the main shoots and branches unifoliolate, all others 3–5 palmate-multifoliolate, leaflets 70–120 × 12–40 mm, elliptic to oblanceolate, mucronate, apex obtuse, lanate on both faces. Peduncles 40–70 mm, lanate. Racemes 100–300 mm, flowers rather lax. Bracts narrowly lanceolate, 8–13 mm, caducous. Pedicels 2–4 mm, lanate. Calyx lanate, lower lip 13–17 mm, rather oblong, tridentate, teeth equal 1–3 × 0·4–0·8 mm; upper lip 9–13 mm, bifid, teeth 4–6 mm; bracteoles lanceolate, 2·5–4 mm. Standard 14–15 mm, ovate; wing petals 13–15 mm, arcuate with obtuse apex, claw 2–3 mm; immature legumes shaggy-lanate, mature legumes and seed not seen.

Type: Paraguay: Capibary, *Hassler* 4430 (G).

BRAZIL: SOUTH. Paraná: Ponta Grossa, Parque Vila Velha, *Hatschbach* 8752 (RB): Ponta Grossa, próxima Rio Papagaio, *Pereira* 6112 (RB).

This species, which extends from southern Brazil into W Argentina (Missiones) and Paraguay, has unifoliolate leaves at the base of the stems with multifoliolate ones higher up. It therefore presents an intermediate condition to the multifoliolate species from NE Argentina which Planchuelo & Dunn (1984) link with the unifoliolate group.

Doubtful species

Lupinus amabayensis C. P. Smith, Species Lupinorum 640 (1948).

Syn.: *L. velutinus* Benth. var. *spectabilis* Hassler in Repert. Spec. Nov. Regni Veg. 16:157 (1919).

L. spectabilis (Hassler) C. P. Smith, Species Lupinorum 502 (1945) non Hoover (1938).

These names are all based on the same type: Paraguay, Sierra de Amambay, near Estrella, *T. Rojas* 10347 (G).

This taxon is known only from the type specimen which was collected at a locality in Paraguay. Since, however, the Sierra de Amambay occurs on the border between Paraguay and Brazil, to the south of Ponta Porã (Mato Grosso Sul) it is likely that *L. amabayensis* also occurs in Brazil.

Hassler's original treatment certainly reflects the general impression of the type specimen which looks like a rather vigorous, densely villous plant of the *L. velutinus* group, somewhat intermediate between *L. velutinus* (calyx lower lip distinctly tridentate) and *L. insignis* (leaves 100–120 mm, internodes c.10 mm). Further collections in this area are clearly desirable to clarify the

status of this taxon, which was not included by Planchuelo & Dunn (1984) in their study of the unifoliolate lupins from Argentina, Paraguay and southern Brazil.

Lupinus aliattenuatus C. P. Smith, Species Lupinorum 485 (1945).

Smith based this species on a single specimen, 'Brasilia meridionalis', 13 vi, *Sellow* 1149', which we have been unable to trace. According to Smith (loc. cit.) the species resembles *L. attenuatus* Gardner (i.e. *L. coriaceus* Benth. in the present revision) in habit and in having linear-oblong leaves with a maximum size of 50 × 10 mm. It differs from *L. coriaceus* in the 3–10 mm petioles, and having only sparsely hairy leaves (*'inconspicue pilosa utrinque'*).

The locality is hopelessly vague but the date of the type collection is also enigmatic. According to Urban (1901) Sellow's travels in Minas Gerais were undertaken during 1818–1820 but with his visits to the upland areas of the Serra do Espinhaço-Ouro Preto region between October 1818 and May 1819. From the beginning of June 1819 to January 1820 Sellow collected mainly in São Paulo State. If this specimen dates from Sellow's earlier travels of 1814–1817 it is likely to have originated in Bahia.

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