

Galegeae (16.01–16.22)

Genus: *Clianthus* D.C. Solander ex J. Lindley

Phylogenetic Number: 16.01.

Tribe: Galegeae.

Subtribe: Coluteinae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; up to 8×0.5 –1 (assumed) \times 0.5–1 (assumed) cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; slightly curved; not plicate; not twisted; asymmetrical; oblong; when asymmetrical with both sutures nearly straight; somewhat inflated; terete; with beak; straight; with solid beak the same color and texture as fruit; long tapered at apex; apex aligned with longitudinal axis of fruit; long tapered at base; base aligned or oblique (slightly) with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit stipitate; with the stipe up to 10 mm long. Fruit with all layers dehiscent; splitting along suture. Dehiscence of valves along 1 suture; apical and down; passive. Replum visible. Epicarp dull; monochrome; dirty dark brown; glabrous; eglandular; without spines; not smooth; with elevated features; transversely veined relative to fruit length and reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown; hairy; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds many; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 3–3.5 mm long; of 1 length only; filiform; more or less straight. Aril faintly present; dry; rim-aril; white.

Seed 3.5 – 4×3 – 3.5×1 – 1.3 mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering or partially adhering to endocarp (seeds often with tufts of endocarp hairs); dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with

frequent streaks; reddish brown or tan (reddish); with black overlay; glabrous; not smooth; with elevated features; reticulate or wrinkled; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible or fully concealed; concealed by radicle lobe; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip; flush; not within corona, halo, or rim. Lens discernible or not discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; up to 0.5 mm long; with margins straight or curved; linear or circular; not in groove of raphe; adjacent to hilum; up to 0.5 mm from hilum; mounded; same color as or dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or tan (reddish); inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle differentiated from cotyledon; bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered or not centered between cotyledons (radicle outside 1 cotyledon and inside other, therefore junctions for each cotyledon different); less than 1/2 or 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

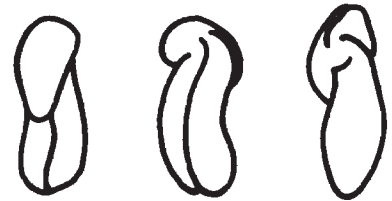
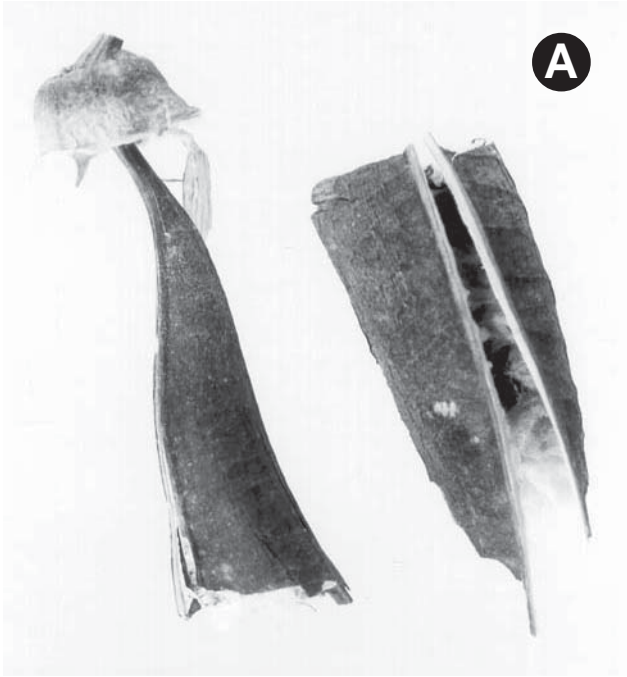
Distribution: Northeastern New Zealand.

Notes: Traditionally this tribe has been called Galegeae.

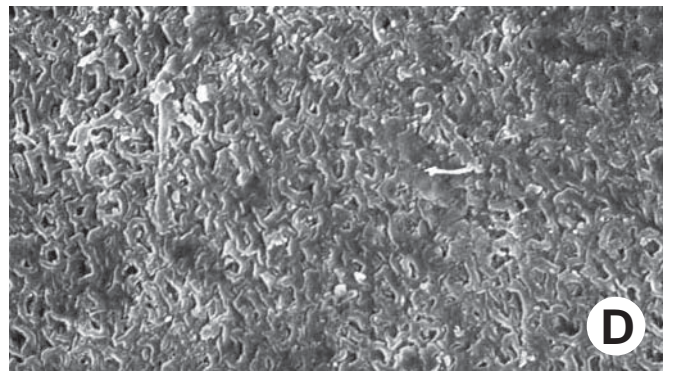
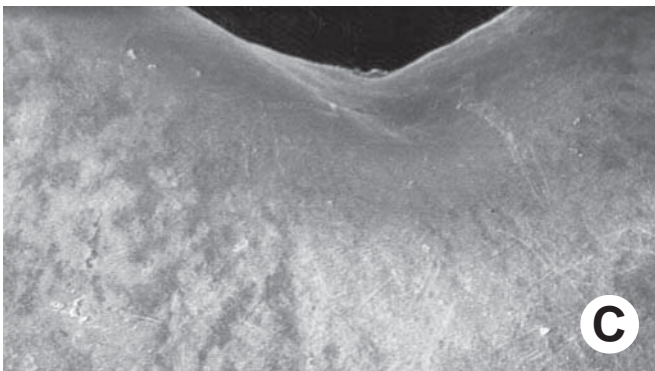
Reveal (1997) reported that the name Astragaleae was published before the name Galegeae. In accordance with the *International Code of Botanical Nomenclature* (Greuter et al. 1994), the oldest name for a taxon must be used, so Reveal suggested that this tribe should be called Astragaleae. In 1999, however, Reveal (1999) reversed himself, so this tribe remains the Galegeae. Welsh (1960) reported on the Galegeae of the North-Central United States. Sanderson and Liston (1995) carried out cladistic analyses of Galegeae genera using molecular data. They concluded that Galegeae is paraphyletic, having given rise to the tribes Cicereae (20), Hedysareae (18), Trifolieae (21), and Fabeae (19), and therefore requiring a re-evaluation of the circumscription of Galegeae. Heenan (1995, 1998c), using

unpublished nuclear ribosomal DNA ITS data, concluded that “*Carmichaelia* (17.05) is nested within [the] ‘Astragalean clade’ of Galegeae” and is the sister group of *Clianthus*. He therefore supported the proposal of Sanderson and Wojciechowski (1996) that Carmichaelieae should not be recognized at the tribal level, but instead should be included in Galegeae. Because the seeds of *Clianthus puniceus* are so unlike those of *C. formsus* (G. Don) N.C. Ford & J.W. Vickery, we are pleased with the transfer of the latter species to *Swainsona* (16.02). Polhill (1981h) noted that *C. puniceus* “is virtually extinct.” We were unable to study an entire fruit of this genus.

Clianthus: *C. puniceus* (G. Don) D.C. Solander ex J.
Lindley (*A-E*). *A*, Broken fruit ($\times 2.2$); *B*, seeds
($\times 10$); *C-D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 6$).



E



Genus: *Swainsona* R.A. Salisbury

Phylogenetic Number: 16.02.

Tribe: Galegeae.

Subtribe: Coluteinae.

Species Studied—Species in Genus: 15 spp.—85 spp.

Fruit a legume; unilocular or bilocular (see also *Astragalus* (16.15)); at least $1-5 \times 0.3-2.5 \times 0.1-0.35$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; linear, oblong, elliptic, or falcate; when asymmetrical with both sutures parallelly curved or nearly straight; not inflated or inflated; flattened; with beak; straight or declined; with solid beak the same color and texture as fruit; short tapered or rounded at apex; apex aligned, oblique, or right-angled with longitudinal axis of fruit; short tapered at base; base right angled or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; membranous, coriaceous, or ligneous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit stipitate, substipitate, or nonstipitate; with the stipe at least up to 10 mm long. Fruit indehiscent or with all layers dehiscent (to tardily dehiscent); splitting along suture. Dehiscence of valves along 1 suture; medial and up and down; passive. Replum invisible. Epicarp dull; monochrome; brown; glabrous or pubescent and indurate; with 1 type of pubescence; villous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined and transversely veined relative to fruit length; not tuberculate or tuberculate (bases of hairs); wrinkled; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds few to numerous; length parallel (assumed) with fruit length; assumed overlapping; in 2 or more series. Funiculus measured; up to at least 2 mm long; of 1 length only; filiform; S-curved. Aril dry; rim-aril; white.

Seed $3.5-4 \times 3-3.5 \times 1$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes;

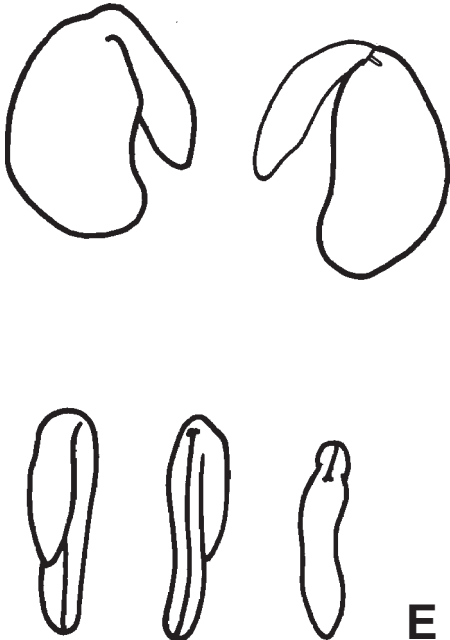
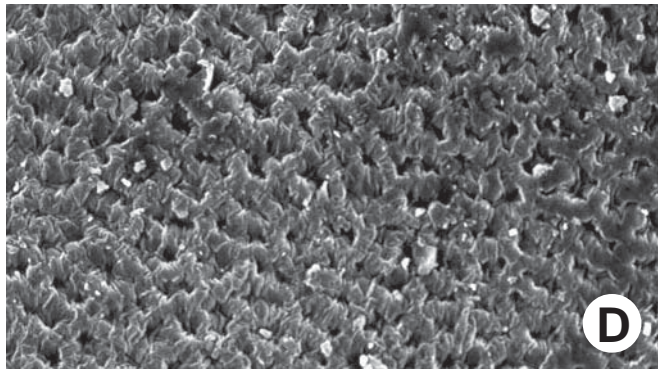
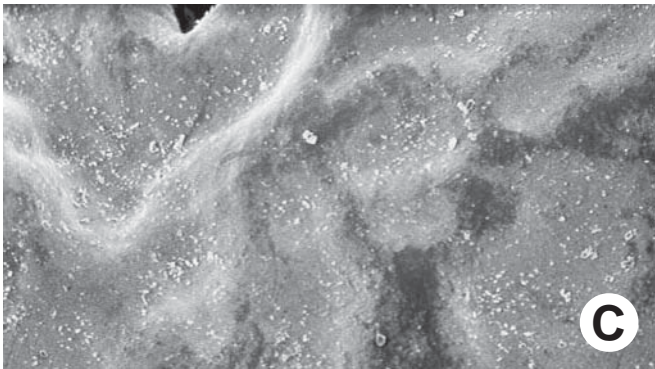
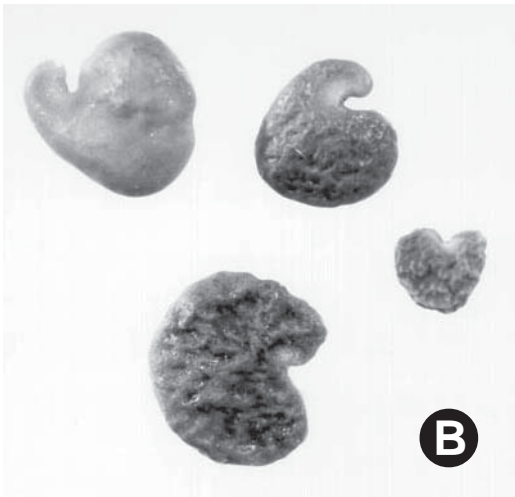
with external groove between radicle and cotyledon lobes same color as testa; without or with deep hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; not smooth or smooth; with elevated features; reticulate; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially or fully concealed; concealed by radicle lobe; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within halo or not within corona, halo, or rim. Hilum halo color lighter than testa. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins straight; linear; not in groove of raphe; confluent with hilum; mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim or within halo. Lens halo color lighter than testa. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; outer face of 1 cotyledon flat and other cotyledon convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight or hooked; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Australia (most species) and southern New Zealand (*S. novae-zelandiae* J.D. Hooker).

Notes: Thompson (1993) monographed *Swainsona* and recognized 85 species, the count that we used. Although fruits are seldom collected for most species, the fruits have great phylogenetic and diagnostic significance for the species. Thompson regarded the primitive and most unmodified fruits to be greatly inflated with seeds that are "erratic in their maturing into viable seeds." She also noted that "seeds have proved difficult to study, few being available in the mature state and those seeming to be somewhat inconsistent in size, shape, surface sculpturing and colour." Species of *Swainsona*, containing swainsonine, are a well known cause of livestock poisoning. *Swainsona* in Australia has many parallels with *Astragalus* (16.15) in North America.

Thompson transferred *Clianthus* (16.01) *formosus* (G. Don) N.C. Ford & J.W. Vickery to *Swainsona*. Heenan (1998c) carried out phylogenetic analyses of the *Carmichaelia* (17.05) complex, *Clianthus*, and 13 species of *Swainsona*, including *S. novae-zelandiae* J.D. Hooker. He concluded that “*Swainsona* is polyphyletic if *S. novae-zelandiae* is included,” and recommended the segregation of *S. novae-zelandiae* as a monotypic genus. The genus *Montigena* P.B. Heenan (Heenan 1998b) was established with the single New Zealand species *M. novae-zelandiae* (J.D. Hooker) P.B. Heenan. We have chosen to include *M. novae-zelandiae* in *Swainsona* pending an expression of a consensus opinion on the status of *Montigena* by the taxonomic community.

Swainsona: *S. maccullochiana* F.H. Mueller (*C-E*), *S. spp.*
(*A-B*). *A*, Fruits and valve ($\times 1.3$); *B*, seeds ($\times 6.4$);
C-D, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 6$).



Genus: *Sutherlandia* R. Brown

Phylogenetic Number: 16.03.

Tribe: Galegeae.

Subtribe: Coluteinae.

Species Studied—Species in Genus: 5 spp.—6 spp.

Fruit a legume; unilocular; $4-6 \times 2-3.5$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong or circular; when asymmetrical with both sutures parallelly curved; inflated; without or with beak; hooked; with solid beak the same color and texture as fruit; short tapered at apex; apex oblique or right-angled with longitudinal axis of fruit; tapered at base; base oblique or right angled with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit indehiscent. Replum invisible. Epicarp dull or glossy; monochrome (and transparent); tan to purplish tan; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp absent. Endocarp absent. Seeds 11–17; length transverse to fruit length; neither overlapping nor touching; in 2 or more series. Funiculus measured; up to 3 mm long; of 1 length only; nearly thick; straight or curved. Aril dry; rim-aril; tan.

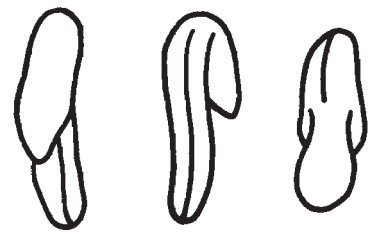
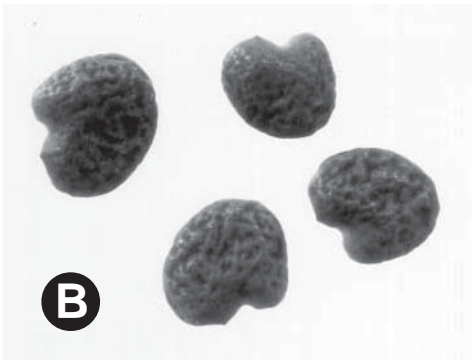
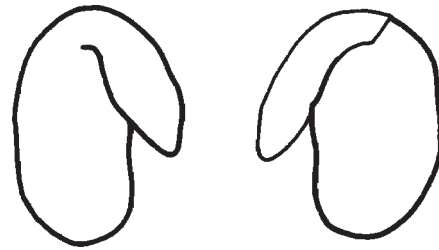
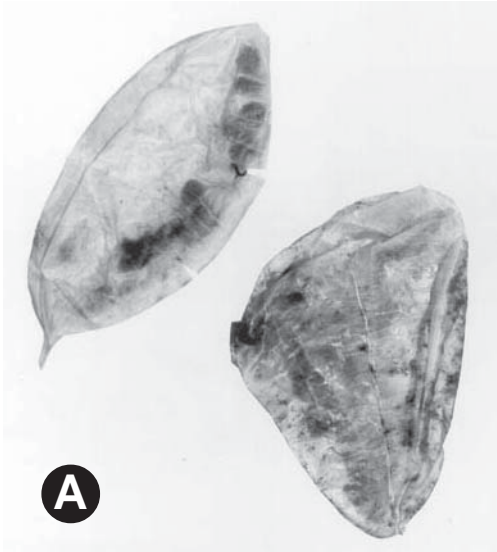
Seed $2-3.7 \times 1.7-3 \times 0.7-1.3$ mm; not overgrown; not angular; asymmetrical; mitaform or reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; with shallow hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; black or brown (blackish to reddish); glabrous; not smooth; with recessed features; pitted with small separate pits; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim or within halo. Hilum halo color lighter than testa. Lens discernible or not discernible; less than 0.5 mm or equal to or greater

than 0.5 mm in length; 0.5 mm long; with margins curved; more or less circular; not in groove of raphe; confluent with hilum; barely mounded; same color as testa; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; $1/2$ to nearly length of cotyledons. Plumule rudimentary; glabrous.

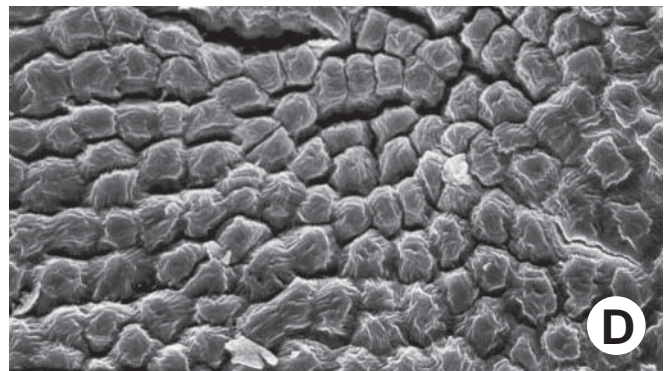
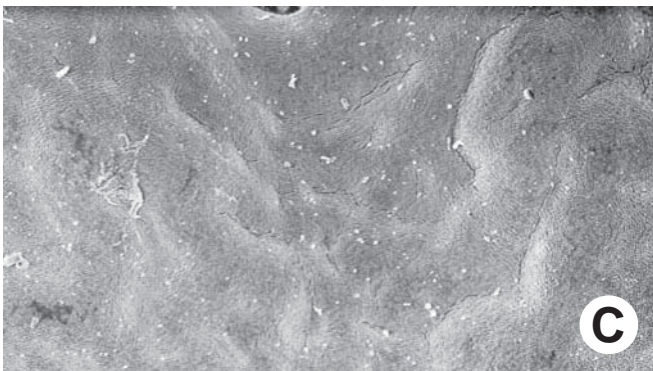
Distribution: South Africa, extending to Namibia and Botswana; naturalized on Mexican, Bolivian, and Argentinian plateaux.

Notes: Schrire and Andrews (1992) briefly reviewed the systematics of the cultivated species, and their species number is used. The fruit wall of *Sutherlandia* is very thin and transparent. Using a dissecting microscope, only a single layer could be discerned, and it was presumed to be the epicarp. It is an unusual condition to have both the mesocarp and endocarp absent.

Sutherlandia: *S. frutescens* (C. Linnaeus) R. Brown (B–E), *S. spp.* (A). A, Fruits ($\times 1.2$); B, seeds ($\times 6.6$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 9$).



E



Genus: *Lessertia* A.-P. de Candolle

Phylogenetic Number: 16.04.

Tribe: Galegeae.

Subtribe: Coluteinae.

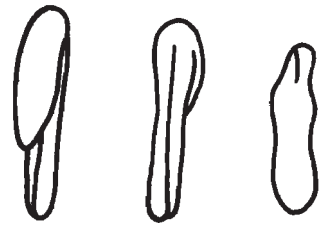
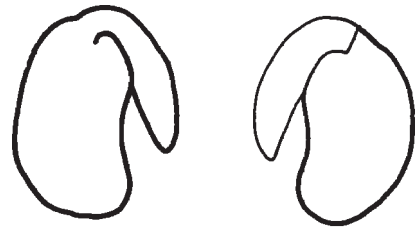
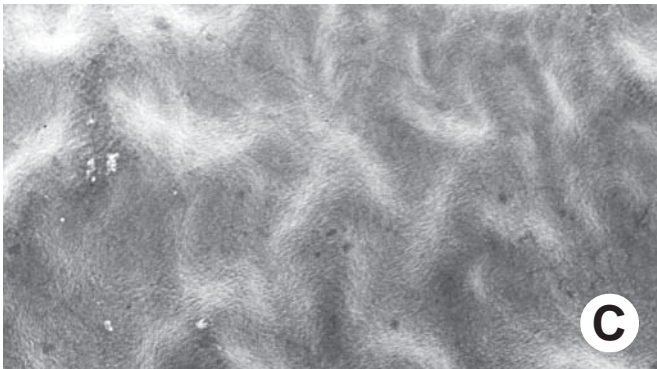
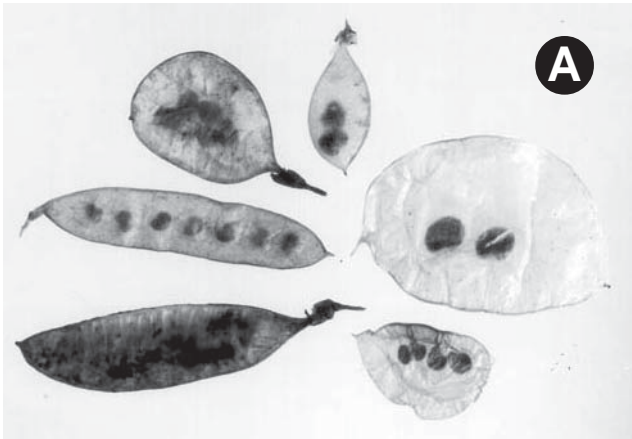
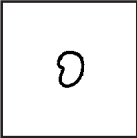
Species Studied—Species in Genus: 10 spp.—ca. 50 spp.

Fruit a legume; unilocular; $0.9-4 \times 0.5-2 \times 0.05-0.12$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical or asymmetrical; oblong, ovate, elliptic, linear (broadly), or circular (somewhat); when asymmetrical with 1 straight and 1 curved suture, both sutures unequally curved, or both sutures parallelly curved; widest near middle or D-shaped; not inflated or inflated; compressed, flattened, or terete; with beak; straight; with solid beak the same color and texture as fruit; short tapered or rounded at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered or rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally visible; with the raised seed chambers torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent (though whole fruit winglike). Fruit substipitate. Fruit indehiscent or with all layers dehiscent (gaping at length at apex or subdehiscent); splitting along suture (at least apex). Dehiscence of valves along 1 suture; apical and down (apex only) or medial and up and down (when gaping); passive. Replum invisible. Epicarp dull (and usually transparent); monochrome or multicolored; mottled and streaked; tan to reddish tan; with black or purple overlay; glabrous or pubescent and indurate; with hairs erect or appressed; with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular; with glandular dots (reddish-brown); without spines; not smooth; with elevated features; reticulately veined; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–9; length oblique or parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; up to 3 mm long; of 1 length only; filiform; straight, curved, or hooked and contorted (somewhat near apex). Aril dry; rim-aril; white.

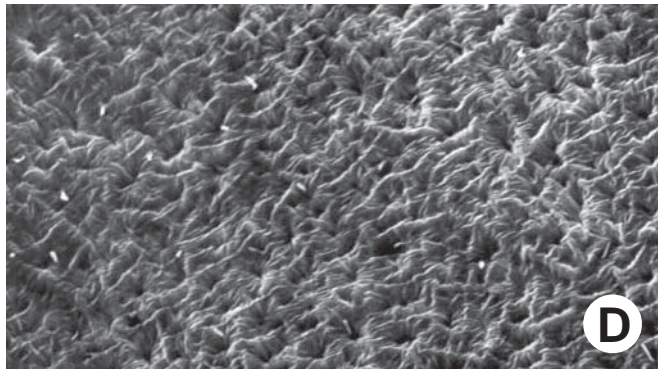
Seed $2.5-4.5 \times 2-3.5 \times 1-1.3$ mm; not overgrown; not angular; asymmetrical; mitaform or reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with or without external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish to greenish brown or black (reddish); glabrous; smooth or not smooth; with elevated features; wrinkled; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible or visible; from hilum to lens; not bifurcating; color of or darker than testa; reddish brown; flush. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; within halo. Hilum halo color lighter than testa. Lens discernible or not discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.3 mm from hilum; mounded; same or similar color as testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; with a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Eastern tropical Africa to South Africa.

Lessertia: *L. benguellensis* J.G. Baker (C–E), *L. spp.* (A–B). A, Fruits and valves ($\times 1.3$); B, seeds ($\times 5.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).



E



D

Genus: *Colutea* C. Linnaeus

Phylogenetic Number: 16.05.

Tribe: Galegeae.

Subtribe: Coluteinae.

Species Studied—Species in Genus: 11 spp.—28 spp.

Fruit a legume; unilocular; 3–7 × 2–3 × 2–3 cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; elliptic; when asymmetrical with both sutures parallelly curved; inflated; terete; without or with beak; straight or declined; with solid beak the same color and texture as fruit; long tapered, tapered, or short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered or rounded at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; membranous or fragile (more or less), thinner than chartaceous like *Trifolium* (21.06); seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit stipitate, substipitate, or nonstipitate; with the stipe up to 10 mm long. Fruit indehiscent or with all layers dehiscent (at apex); splitting along sutures (at apex). Dehiscence of valves passive. Replum invisible. Epicarp dull; monochrome or multicolored; mottled and streaked; tan; with purple overlay; glabrous or pubescent but soon deciduous; with 1 type of pubescence; with pubescence uniformly distributed; with simple hairs; pliable; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; wrinkled (on drying); not exfoliating; without cracks. Mesocarp present or absent; thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp or to epicarp; entire. Seeds 12–15; length transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 2 mm long; of 1 length only; filiform or thick; straight or curved. Aril dry; tongue-aril; tan.

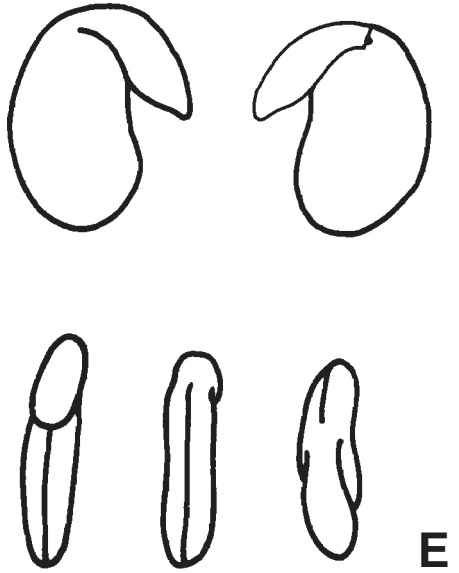
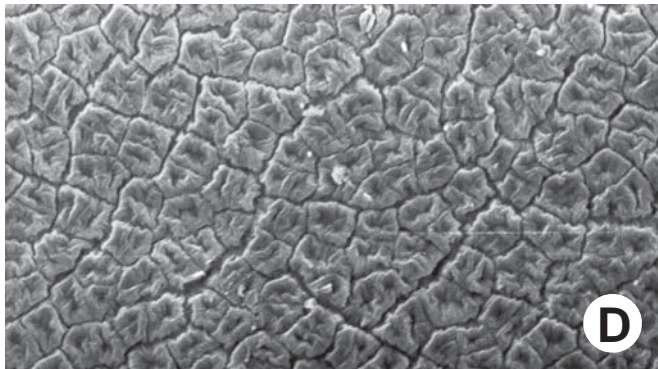
Seed 2–4.5 × 2–4 × 1–1.8 mm; not overgrown; not angular; asymmetrical; oblong or reniform (sub-); compressed; with surface smooth; with or without visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not

adhering to endocarp; dull; not modified by a bloom; colored; monochrome or streaked (faintly and occasionally); with infrequent streaks; dark reddish or blackish brown or black (nearly); with tan (greenish) overlay; glabrous; smooth or not smooth; with recessed features; pitted with small separate pits; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5 mm long; with curved outline; circular; marginal according to radicle tip or between cotyledon and radicle lobe; recessed; within rim. Hilum rim color lighter than testa. Lens not discernible or discernible (faint); equal to or greater than 0.5 mm in length; 1 mm long; with margins straight or curved; elliptic or oblong; not in groove of raphe; adjacent to hilum; 0.2 mm from hilum; mounded; similar color as testa; lighter than testa and darker than testa; reddish brown or tan (reddish); not within corona, halo, or rim. Endosperm present (clear to reddish-tan); thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; light reddish tan or yellow; inner face concave; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 or 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Mediterranean region to eastern and northeastern Africa and China and the Himalayas.

Colutea: *C. orientalis* P. Miller (*C–E*), *C.* spp. (*A–B*). *A*, Fruits (closed and dehiscent) (× 0.9); *B*, seeds (× 3.8); *C–D*, testa (× 50, × 1000); *E*, embryos (× 7).

0



Genus: *Oreophysa* (A.A. von Bunge ex P.E. Boissier) J.F.N. Bornmüeller

Phylogenetic Number: 16.06.

Tribe: Galegeae.

Subtribe: Coluteinae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $2.7-4 \times 2 \times 2$ (assumed) cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; ovate, oblong, or obovate; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; inflated; terete; without beak; rounded at apex; apex aligned or oblique with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous or chartaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscent (apex); splitting along sutures (apical only). Dehiscence of valves along both sutures; passive. Replum invisible. Epicarp glossy; monochrome or multicolored; mottled and streaked; tan; with purple overlay (faintly); glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 3–4 (assumed); length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

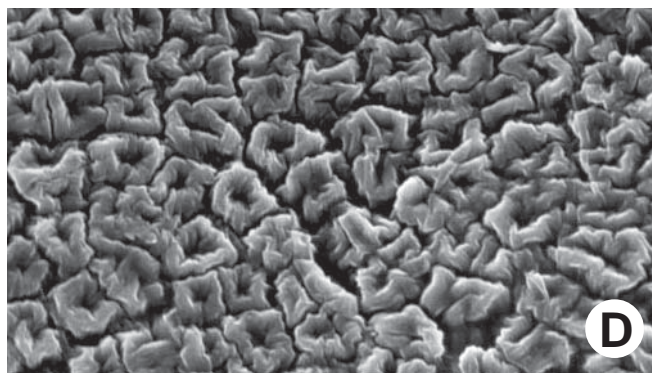
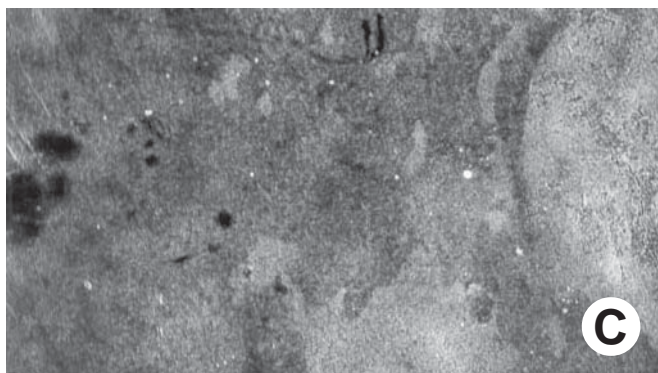
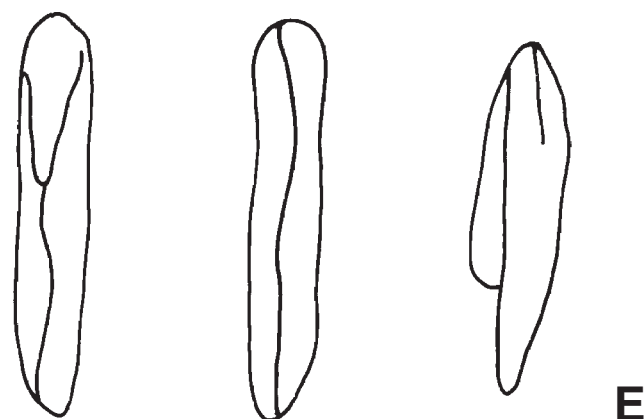
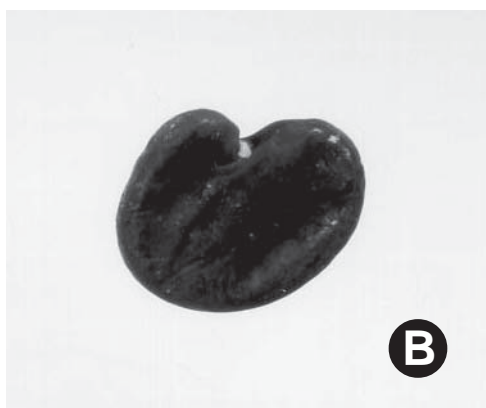
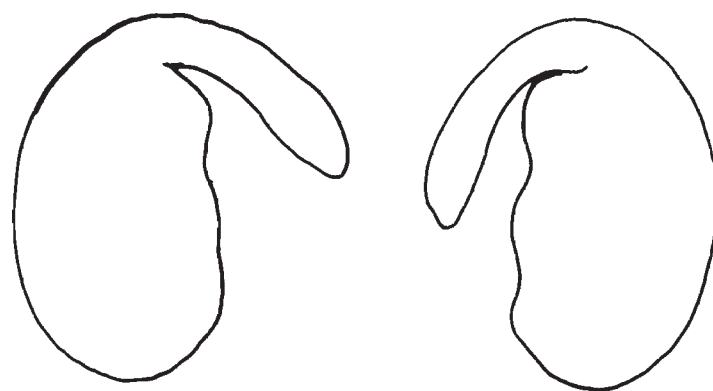
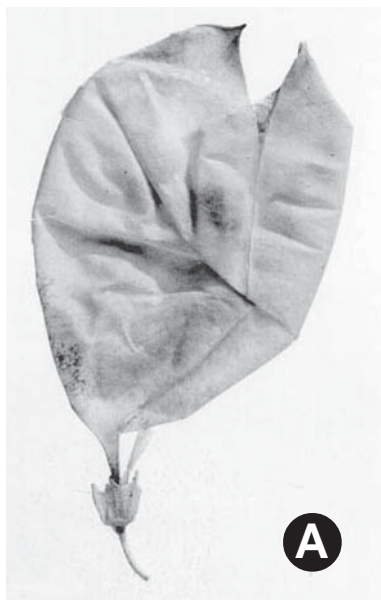
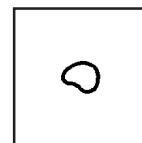
Seed $6 \times 6 \times 2$ mm; not overgrown; not angular; asymmetrical; mitaform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the

faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens discernible; equal to or greater than 0.5 mm in length; 0.7 mm long; with margins straight; linear; not in groove of raphe; adjacent to hilum; 0.3 mm from hilum; flush; dissimilar color from testa; lighter than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; with a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Northern Iran.

Notes: Jaubert and Spach (1843, plate 64) provides excellent fruit and seed drawings.

Oreophysa: *O. microphylla* (H.F. Jaubert & É. Spach) K. Browicz (A–E). A, Fruit ($\times 2.1$); B, seed ($\times 8.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 8$).



Genus: *Sphaerophysa* A.-P. de Candolle

Phylogenetic Number: 16.07.

Tribe: Galegeae.

Subtribe: Coluteinae.

Species Studied—Species in Genus: 1 sp.—2 spp.

Fruit a legume; unilocular; $1.3\text{--}2.4 \times 0.9\text{--}2 \times 0.5\text{--}1.2$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong; when asymmetrical with both sutures nearly straight; inflated; terete; with beak (fragile) or without; straight; with solid beak the same color and texture as fruit; rounded at apex; apex oblique with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous (but firm); seed chambers externally invisible. Fruit margin not constricted; with sulcus; plain. Fruit wings absent. Fruit stipitate or substipitate; with the stipe up to 0.6 mm long. Fruit indehiscent or with all layers dehiscent (scarcely). Dehiscence of valves passive. Replum invisible. Epicarp dull; monochrome; tan; glabrous; without spines; not smooth; with elevated features; reticulately veined and transversely veined relative to fruit length; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; spongy; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds at least 40; length oblique or transverse to fruit length; overlapping or touching; in 2 or more series. Funiculus measured; 1–2 mm long; of 1 length only; filiform (more so than thick); curved, straight, and hooked. Aril dry; rim-aril; white.

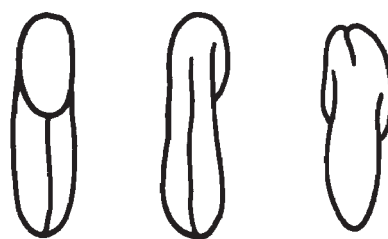
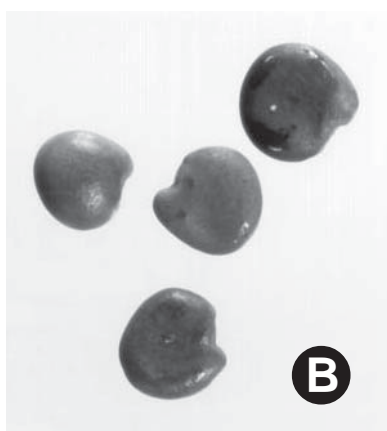
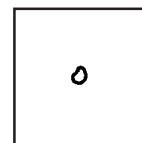
Seed $2\text{--}2.5 \times 2\text{--}2.5 \times 1\text{--}1.5$ mm; not overgrown; not angular; asymmetrical; reniform or mitaform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; brown to greenish or reddish brown, tan (greenish), or green; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as

the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within halo. Hilum halo color lighter than testa. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins curved; elliptic; not in groove of raphe; confluent with hilum; mounded; similar color as testa; darker than testa; greenish brown; within halo. Lens halo color lighter than testa. Endosperm thin; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

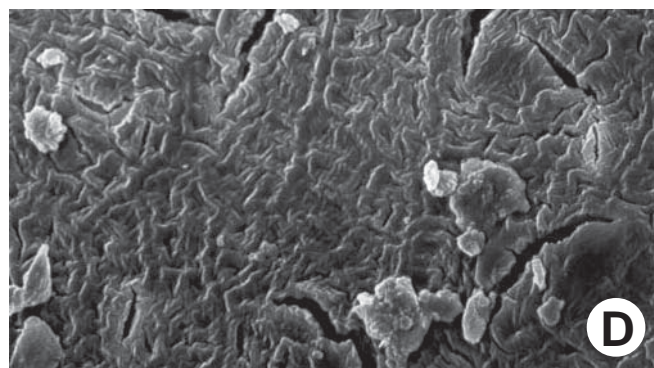
Distribution: Turkey, Syria, Caucasus, Siberia, central Asia, northern Mongolia, and northern China; introduced in United States.

Notes: Polhill (1981h) noted that *Sphaerophysa* is scarcely distinct from *Smirnowia* (16.08). The fruit and seed of *S. kotschyana* P.E. Boissier are unknown.

Sphaerophysa: *S. salsula* (P.S. von Pallas) A.-P. de Candolle (A–E). A, Fruits ($\times 1.2$); B, seeds ($\times 6.5$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 8$).



E



Genus: *Smirnowia* A.A. von Bunge

Phylogenetic Number: 16.08.

Tribe: Galegeae.

Subtribe: Coluteinae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $3.5 \times 2-2.5 \times 2-2.5$ cm (assumed because all fruits were seen from herbarium sheets); with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; circular; when asymmetrical with both sutures parallelly curved or 1 straight and 1 curved suture; widest near middle or D-shaped; inflated; terete; without beak; short tapered at apex; apex aligned or oblique with longitudinal axis of fruit; rounded at base; base aligned, oblique, or right angled with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally invisible. Fruit margin not constricted; with sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; tan to slightly reddish tan; pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined and transversely veined relative to fruit length; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds at least 5; length transverse to fruit length; overlapping or neither overlapping nor touching; in 2 or more series. Funiculus measured; 2 mm long; of 1 length only; thick; curved or hooked. Aril dry; rim-aril; tan.

Seed $4-6 \times 3.5-5 \times 1.5-2.5$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; with umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored;

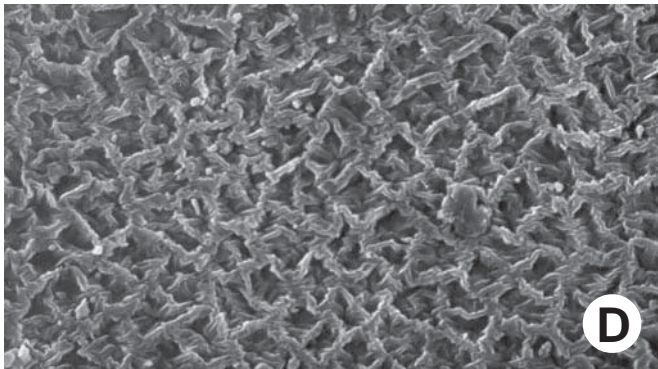
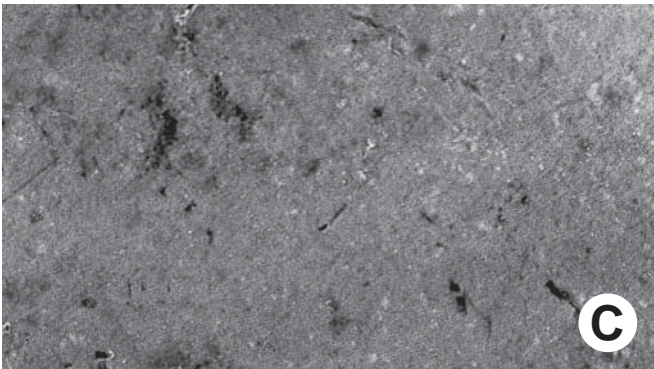
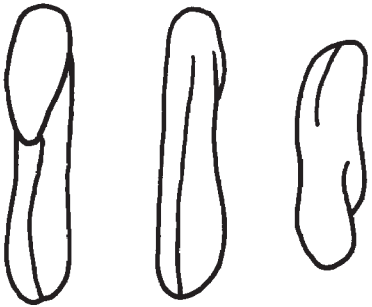
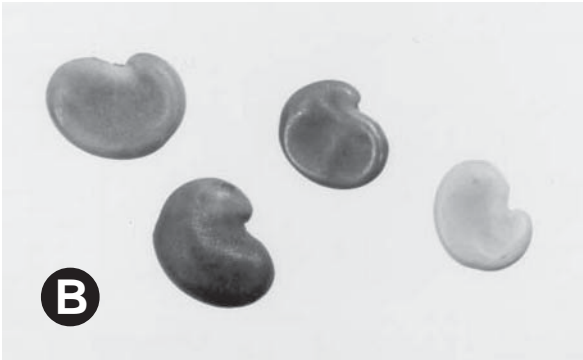
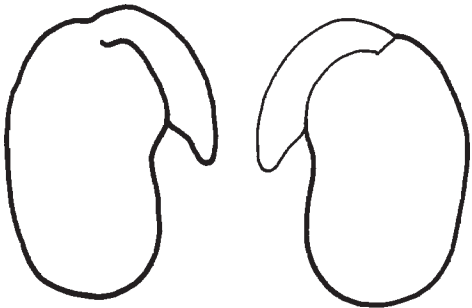
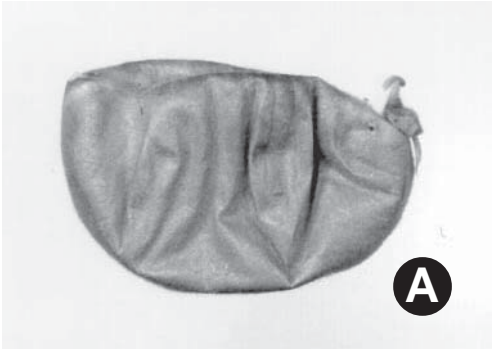
monochrome; reddish brown, tan, or orange; glabrous; smooth; coriaceous. Fracture lines absent. Rim present. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim. Lens discernible; equal to or greater than 0.5 mm in length; 1–1.5 mm long; with margins straight or curved; oblong; not in groove of raphe; confluent with hilum; slightly mounded; similar color as testa; darker than testa; reddish brown or tan (reddish); not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Turkestan.

Notes: Polhill (1981h) noted that *Smirnowia* is “scarcely distinct from *Sphaerophysa*” (16.07).

Smirnowia: *S. turkestanica* A.A. von Bunge (A–E). A, Fruit ($\times 1.3$); B, seeds ($\times 3.2$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).

9



Genus: *Eremosparton* F.E.L. von Fischer & B. Meyer

Phylogenetic Number: 16.09.

Tribe: Galegeae.

Subtribe: Coluteinae.

Species Studied—Species in Genus: 3 spp.—3 spp.

Fruit a legume; unilocular; $1-1.5 \times 0.8-1 \times 0.14-0.26$ cm; with deciduous or persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; ovate or falcate (broadly); when asymmetrical with 1 straight and 1 curved suture, both sutures unequally curved, or both sutures parallelly curved; widest near middle or D-shaped; inflated or not inflated; compressed; with beak; with solid beak the same color and texture as fruit; short tapered at apex; apex oblique with longitudinal axis of fruit; short tapered at base; base right angled with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent (though whole fruit is winglike). Fruit substipitate. Fruit with all layers dehiscing; splitting along suture. Dehiscence of valves along 1 suture; passive. Replum invisible. Epicarp dull; monochrome; tan; pubescent and indurate; with 1 type of pubescence; villous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; nonseptate; coriaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1 or 2; length parallel with fruit length; overlapping or touching; in 1 series. Funiculus measured; up to 1 mm long; of 1 length only; thick; straight or curved. Aril dry; rim-aril; white.

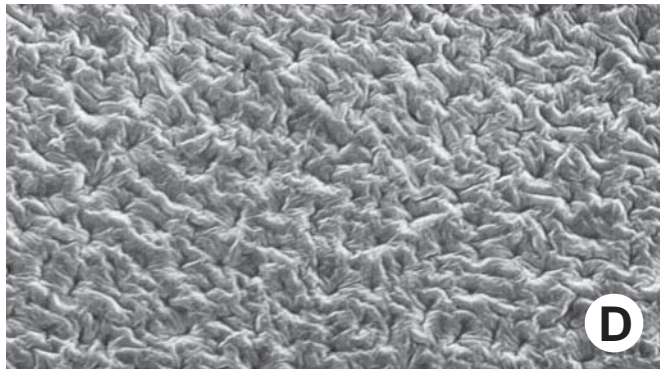
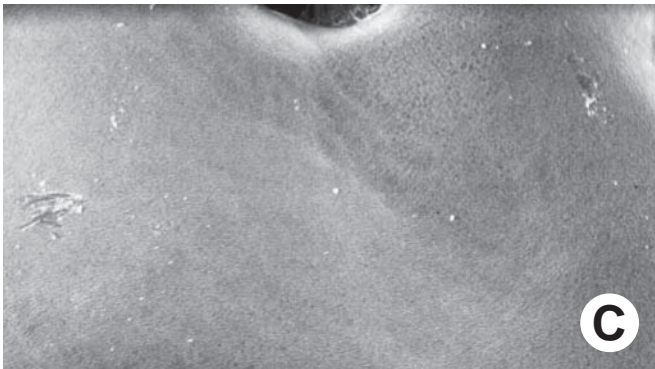
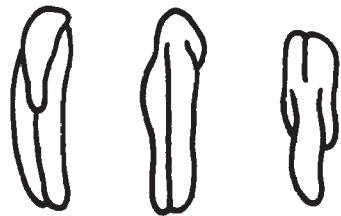
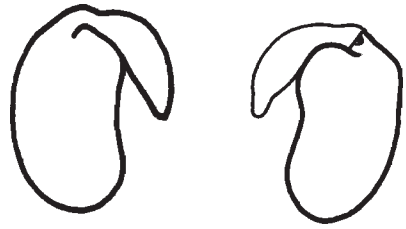
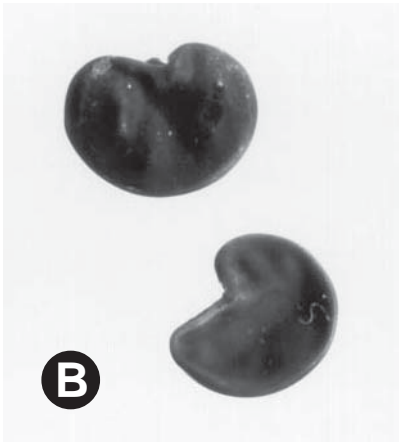
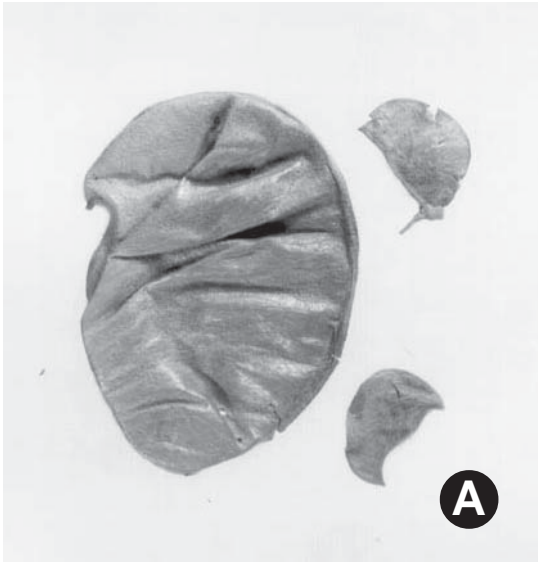
Seed $3.5-4.5 \times 3-3.5 \times 0.7-1$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish to greenish brown; glabrous; smooth; chartaceous. Fracture lines absent. Rim absent.

Wings absent. Raphe not visible. Hilum partially or fully concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; within halo. Hilum halo color lighter than testa. Lens faintly discernible; less than 0.5 mm in length; with margins curved; elliptic; not in groove of raphe; adjacent to or confluent with hilum; 0.5 mm from hilum; mounded; similar color as testa; within halo. Lens halo color lighter than testa. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; greenish brown or green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; with a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; $1/2$ to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Southeastern Russia and central Asia.

Eremosparton: *E. aphyllum* F.E.L. von Fischer & B. Meyer (C-E), *E. spp.* (A-B). A, Fruits ($\times 1.4$); B, seeds ($\times 6.3$); C-D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 6$).

D



Genus: *Halimodendron* F.E.L. von Fischer ex A.-P. de Candolle

Phylogenetic Number: 16.10.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $2-4 \times 1-1.5 \times 0.7-1$ cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; oblong or obovate; inflated; compressed; with beak; straight; with solid beak the same color and texture as fruit; short tapered or rounded at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; with sulcus (on dorsal suture); plain. Fruit wings absent. Fruit substipitate. Fruit indehiscent or with all layers dehiscing (tardily); splitting along suture. Dehiscence of valves along 1 suture; passive. Replum invisible. Epicarp dull; monochrome or multicolored; mottled; dark reddish brown, tan, or black; with black or tan overlay; glabrous; eglandular; without spines; not smooth; with elevated features; veined or not veined; reticulately veined; not tuberculate; faintly wrinkled; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; mottled; tan; with mottling (dark); with brown (reddish) overlay; smooth; nonseptate; coriaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 4–5; length parallel with fruit length; overlapping; in 2 or more series. Funiculus measured; up to 1.3 mm long; of 1 length only; thick; straight. Aril dry; rim-aril; white.

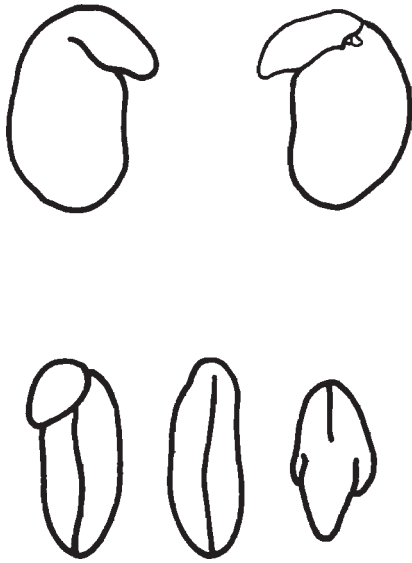
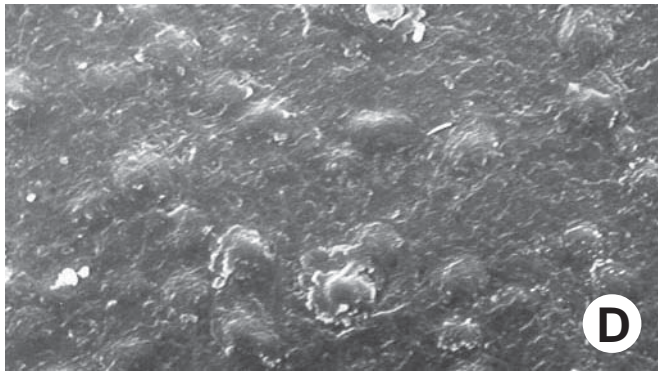
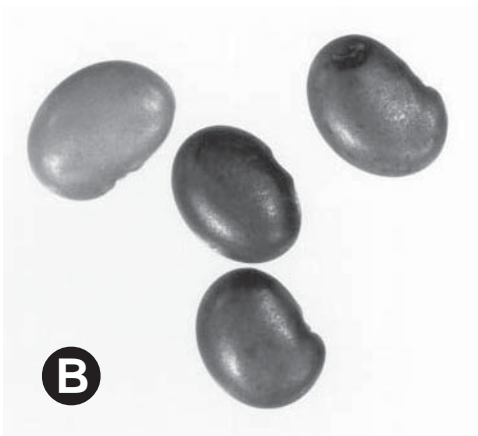
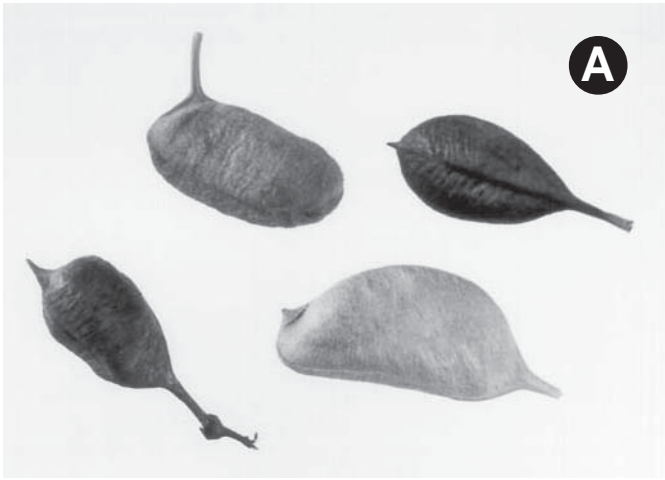
Seed $3-3.5 \times 2.4-2.8 \times 1.4-2.3$ mm; not overgrown; not angular; asymmetrical; oblong or reniform; compressed; with surface smooth; with or without visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome or mottled; with frequent mottles; reddish to greenish brown, orange, tan, or green; with black overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent.

Raphe not visible. Hilum fully concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.4 mm long; with curved outline; circular; marginal according to radicle tip or between cotyledon and radicle lobe; recessed; within rim. Hilum rim color darker than testa. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins straight or curved; triangular or irregular; not in groove of raphe; confluent with hilum; barely mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; white or tan (pale); inner face flat. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

Distribution: Turkey, Iran, Georgia to Siberia, and Afghanistan.

Halimodendron: *H. halodendron* (P.S. von Pallas) A. Voss (A–E). A, Fruits ($\times 1.4$); B, seeds ($\times 5.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 6$).

0



Genus: *Caragana* P.C. Fabricius

Phylogenetic Number: 16.11.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 21 spp.—ca. 80 spp.

Fruit a legume; unilocular; $2-6 \times 0.25-0.6 \times 0.15-0.4$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; linear; when asymmetrical with both sutures nearly straight; not inflated or inflated; compressed; without or with beak; declined; with solid beak the same color and texture as fruit; short tapered at apex; apex oblique with longitudinal axis of fruit; short tapered at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; dark reddish brown; glabrous; glandular or eglandular; with glandular dots; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; somewhat wrinkled; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; reddish tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 2–5; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; up to 1 mm long; of 1 length only; thick; straight. Aril dry; rim-aril; white.

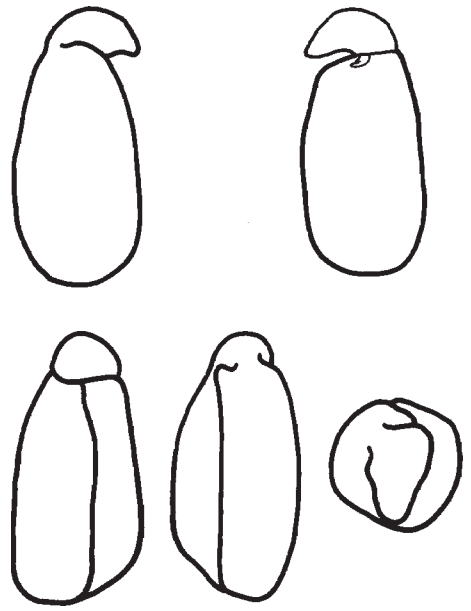
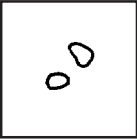
Seed $2.5-10 \times 2-4.5 \times 2-4.5$ mm; not overgrown; not angular or angular (barely); asymmetrical; oblong, linear, circular, or reniform; terete or compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull or glossy; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; dark reddish to orangish brown or orange; with brown (dark reddish) overlay; glabrous; smooth or not smooth; with recessed features; pitted

with small separate pits; chartaceous or coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe visible or not visible; from hilum to lens (at base of seed) or from lens to base of seed and terminating; not bifurcating; color of testa (barely darker); flush. Hilum partially concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform or larger than punctiform; 0.3–0.5 mm long; with curved outline; circular; marginal according to radicle tip or between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens discernible or not discernible; equal to or greater than 0.5 mm or less than 0.5 mm in length; 0.2–1 mm long; with margins straight or curved; wedge-shaped, circular, or elliptic; not in groove of raphe; adjacent to or confluent with hilum; up to 3 mm from hilum; mounded or recessed; similar color as testa; barely darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length or 1 longer than other; not folded (though occasionally 1 cotyledon larger than other); margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; reddish tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

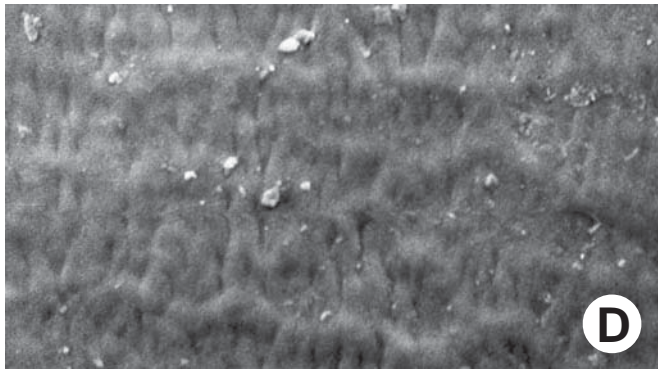
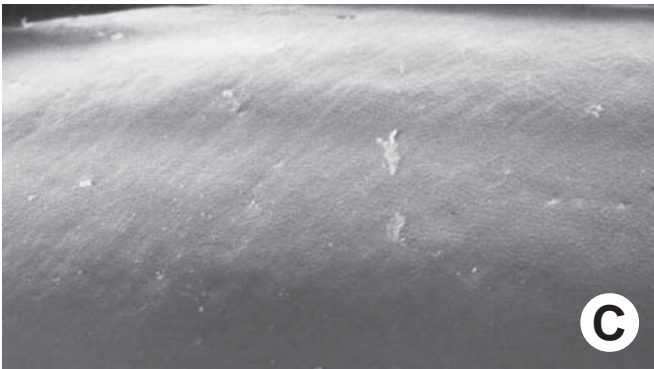
Distribution: Eastern Europe, Asia, and naturalized in North America.

Notes: Yakovlev and Sviazeva (1984, 1985a, 1987) have treated some of the Russian species, and Gorbunova (1984) established a sectional and subsectional sequence for the genus.

Caragana: *C. densa* V.L. Komarov (*C-E*), *C. spp.* (*A-B*). *A*, Valves and dehisced fruits ($\times 2.1$); *B*, seeds ($\times 3.4$); *C-D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 6$).



E



Genus: *Calophaca* F.E.L. von Fischer ex A.-P. de Candolle

Phylogenetic Number: 16.12.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 3 spp.—5 spp.

Fruit a legume; unilocular; $1-3 \times 0.3-0.5 \times 0.4-0.5$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; linear; when asymmetrical with both sutures nearly straight; inflated (when mature); terete (when mature); with beak; straight; with solid beak the same color and texture as fruit; short tapered at apex; apex aligned or oblique with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain or embellished; with fringe (plain and glandular hairs). Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; dark reddish brown; pubescent and indurate; with 1 or 2 types of pubescence; puberulent or villous (restricted to sutures or throughout); with pubescence reddish brown or gray; with long and short gray plain-tipped hairs; with pubescence uniformly distributed; with simple and glandular hairs or glandular hairs; pliable; with hair bases plain; glandular; with glandular hairs (reddish-brown) or dots (reddish-brown); without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thick; surface not veined; 2-layered; without balsamic vesicles; without fibers; with vitreous layer over solid layer; coriaceous. Endocarp dull; monochrome; tan; cobwebby and spongy (but thinly filled); subseptate or nonseptate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–8; length oblique to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 1–2 mm long; of 1 length only; somewhat filiform; straight or curved. Aril absent.

Seed $4-8 \times 0.4-5 \times 0.1-3.3$ mm; not overgrown; not angular; asymmetrical; subreniform or oblong; com-

pressed; with surface smooth; with or without visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; with deep hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth or not smooth; with elevated features; warty or wrinkled; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially or fully concealed; concealed by funicular remnant, radicle lobe, or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform or punctiform; up to 0.7 mm long; with curved outline; elliptic; marginal according to radicle tip or between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens discernible or not discernible; equal to or greater than 0.5 mm in length; 1 mm long; with margins straight; linear; not in groove of raphe; confluent with hilum; flush; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; reddish to dark reddish brown; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip curved or hooked; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 or 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

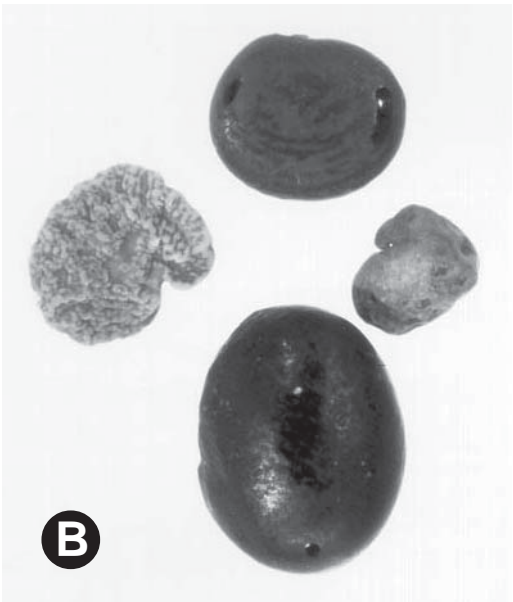
Distribution: Central Asia (4 spp.) and Russia (*C. wolgarica*).

Calophaca: *C. wolgarica* (C. Linnaeus f.) F.E.L. von Fischer ex A.-P. de Candolle (*C-E*), *C. spp.* (*A-B*). *A*, Fruits (dehiscent and closed) ($\times 1.4$); *B*, seeds ($\times 5.8$); *C-D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 6$).

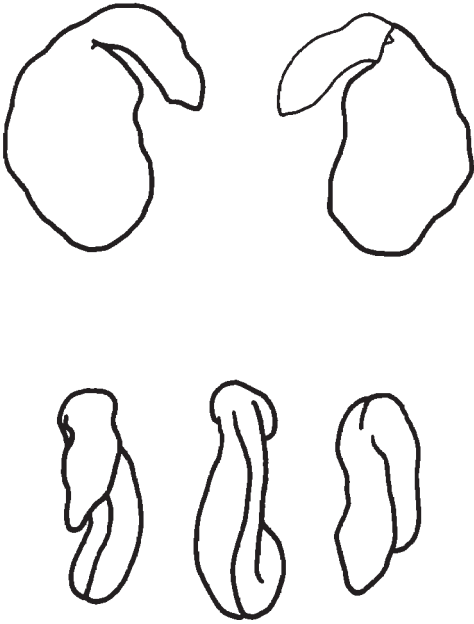
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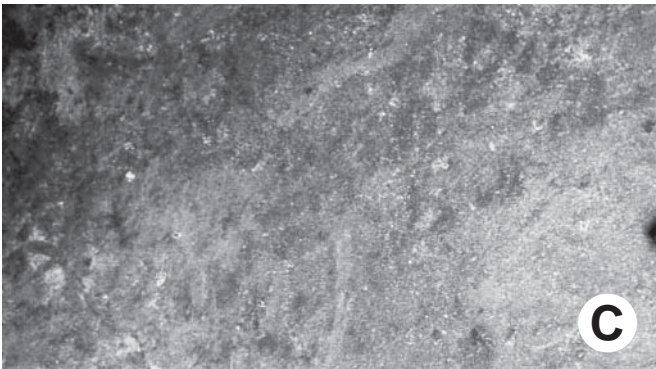
A



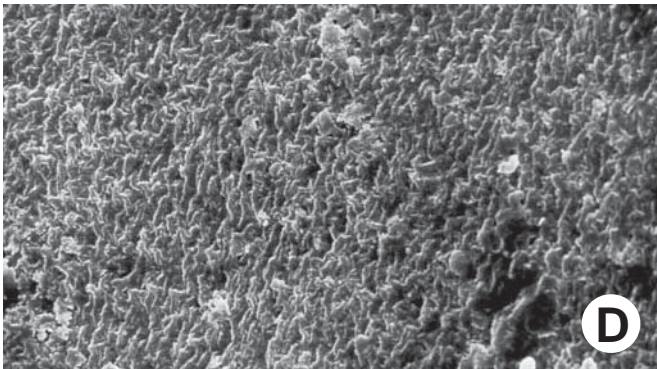
B



E



C



D

Genus: *Chesneya* J. Lindley ex S.F.L. Endlicher

Phylogenetic Number: 16.14.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 9 spp.—20 spp.

Fruit a legume; unilocular; $2.5-8 \times 0.5-1.2 \times 0.2-0.5$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; lanceolate, linear (to lanceolate), or oblong; when asymmetrical with both sutures nearly straight; not inflated or inflated; compressed; with beak; straight; with solid beak the same color and texture as fruit; tapered at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally faintly visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active or passive; with valves twisting. Replum invisible. Epicarp dull; monochrome; reddish brown; pubescent and indurate; with hairs erect or appressed; with 1 type of pubescence; puberulent or villous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown; smooth and scurfy or cobwebby; septate or nonseptate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 8–12; length parallel with fruit length; touching or neither overlapping nor touching; in 1 series. Funiculus measured; 0.5–4 mm long; of 1 length only; filiform (or nearly so); straight or curved (slightly). Aril absent.

Seed $2.5-6 \times 2-4 \times 1-1.2$ mm; not overgrown; not angular or angular; asymmetrical; mitaform (and bent on faces), reniform (and bent on faces), or irregular; compressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on

seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; brown to reddish brown or tan; with black overlay; glabrous; smooth or not smooth; with elevated or recessed features; wrinkled, warty, shagreen, or reticulate; pitted with small separate pits or large depressions on each face (2); chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum to lens; not bifurcating; darker than testa; blackish brown or black; flush. Hilum fully concealed; concealed by radicle lobe or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens barely discernible or not discernible; less than 0.5 mm in length; with margins curved; more or less circular; not in groove of raphe; adjacent to hilum; 1.5 mm from hilum; flush; dissimilar color from testa; darker than testa; blackish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; reddish brown; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip hooked; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 or 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

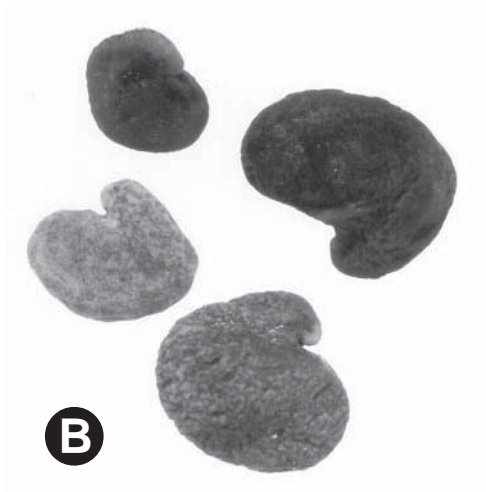
Distribution: Central and southwestern Asia to Mongolia.

Chesneya: *C. rytidosperra* H.F. Jaubert & É. Spach (*C-E*), *C. spp.* (*A-B*). *A*, Fruits (dehiscent) ($\times 1.1$); *B*, seeds ($\times 5.7$); *C-D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 6$).

a



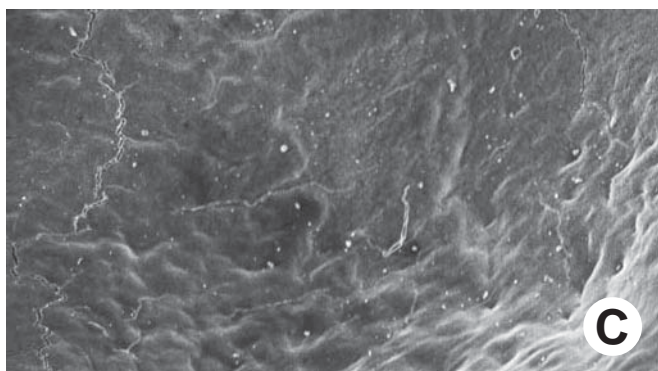
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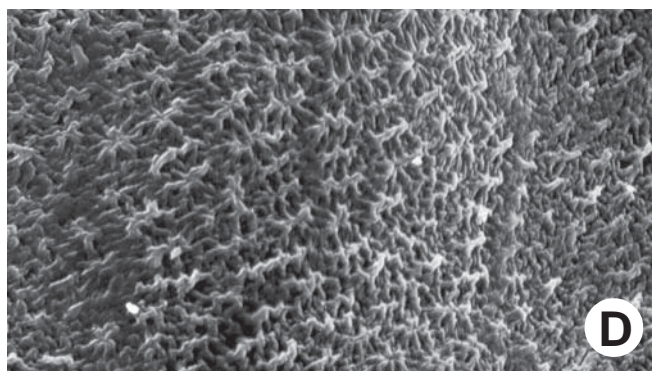
B



E



C



D

Genus: *Astragalus* C. Linnaeus

Phylogenetic Number: 16.15.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 195 spp.—ca. 2,000 spp.

Fruit a legume; unilocular or bilocular (including semibilocular); $0.2\text{--}20 \times 0.15\text{--}6 \times 0.1\text{--}3$ cm; with persistent calyx; with calyx shorter than, equal in length to, or longer than fruit (and calyx inflated or not); without or with orifice formed by curving of fruit or fruit segments; straight, curved (or slightly curved), 0.5-coiled, 1-coiled, or S-curved; not plicate; not twisted; symmetrical or asymmetrical; linear, oblong, elliptic, circular, didymous, ovate, C-shaped, or falcate; when asymmetrical with both sutures parallelly curved, both sutures unequally curved, or 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated or inflated; compressed, terete, subtriangular (to triangular), or quadrangular; without or with beak; straight, declined, coiled, or hooked; with solid beak the same color and texture as fruit; short tapered, tapered, long tapered, or rounded at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered, tapered, long tapered, rounded, or truncate at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous, leathery, membranous, chartaceous, ligneous, drupaceous, or fleshy (when fresh); seed chambers externally invisible or visible; with the raised seed chambers not torulose. Fruit margin not constricted or constricted (one species, *A. shelkovnikovii* A.A. Grossheim); without or with sulcus (intrusion of dorsal or dorsal and ventral sutures); plain or embellished; with fringe (of spines). Fruit wings absent or present (narrow). Fruit nonstipitate (or sessile on stipelike gynophore), substipitate, or stipitate; with the stipe up to 35 mm long. Fruit with all layers dehiscent (valves may completely separate but because of the longitudinal walls which separate the 2 valves in bilocular legume, each half functioning as an “indehiscent fruit”) or indehiscent (fragile and usually inflated and easily fracturing); splitting along sutures. Dehiscence of valves along 1 suture or both sutures; apical and down or basal and up; active or passive; with valves reflexing (inflexed). Replum invisible. Epicarp dull; monochrome or multicolored; mottled; brown to reddish or blackish brown, tan (to purplish tan), black,

green, or purple; with purple, red, brown (purplish), or green overlay; with mottling over seed chambers; pubescent and indurate or glabrous; with hairs erect or appressed; with 1 or 2 types of pubescence; pilose, puberulent, tomentose, velutinous, villous, or sericeous; with pubescence gray or black (to rusty); with gray and black hairs intermixed; with pubescence uniformly distributed; with simple or complex hairs; T-shaped hairs (malpighiaceus); pliable or stiff; with hair bases plain or swollen (somewhat); antrorse; straight or hooked at apex; eglandular or glandular; with glandular dots (reddish); without spines; not smooth or smooth; with elevated features; veined (venation not ribbed to ribbed); reticulately veined or transversely veined relative to fruit length; not tuberculate; rugose (to reticulate), verrucose-rugose, or wrinkled (irregularly to regularly or cross to lengthwise); not exfoliating; without cracks. Mesocarp present or absent (or nearly so); thin or trace; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; ligneous (or subligneous), coriaceous, or chartaceous. Endocarp dull; monochrome; tan; smooth, cobwebby, or fibrous; nonseptate (longitudinal separation between seed chambers making 2 loculi); chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; remaining fused to epicarp; entire. Seeds 1–20; length parallel with or transverse to fruit length; neither overlapping nor touching, touching, or overlapping; in 2 or more or 1 series. Funiculus less than 0.5 mm long or measured; up to 15 mm long; of 1 length only (and with or without hairs); filiform, thick, or triangular; straight, curved, or hooked. Aril dry; rim-aril; greenish brown, tan, white, or green.

Seed $1\text{--}7 \times 0.8\text{--}5 \times 0.1\text{--}0.6$ mm; not overgrown or rarely overgrown, 1 seed filling entire fruit cavity; not angular or angular (dented or not on faces); asymmetrical or symmetrical (except hilum); mitaform, oblong, reniform, rectangular, rhombic, triangular, pyriform, elliptic, D-shaped, cordate, or irregular; compressed; with surface smooth; without or with visible radicle and cotyledon lobes; without or with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; with deep or shallow hilar sinus or without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull or glossy; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent or infrequent mottles; with frequent or infrequent streaks; reddish to yellowish brown to brown, tan (to greenish tan), cream, green (yellowish), olive, orange, yellow, purple, or black; with black,

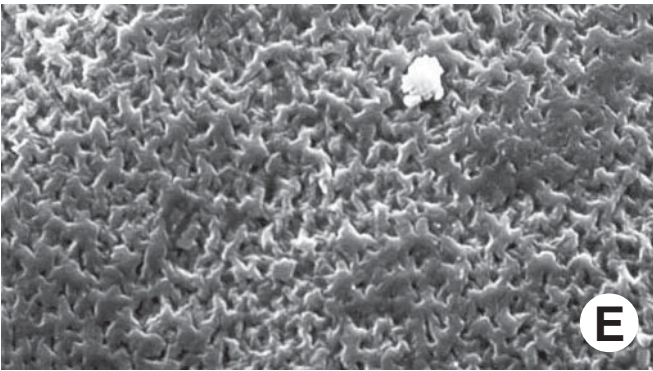
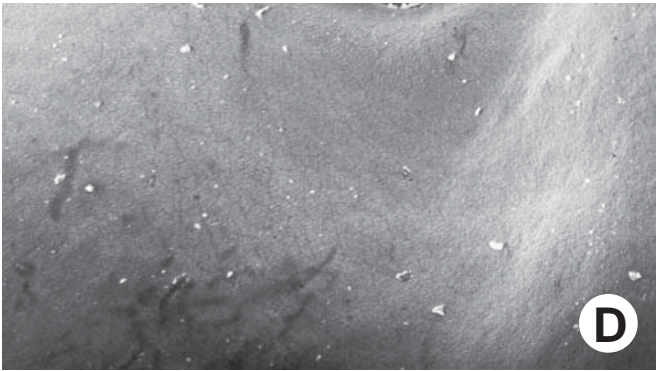
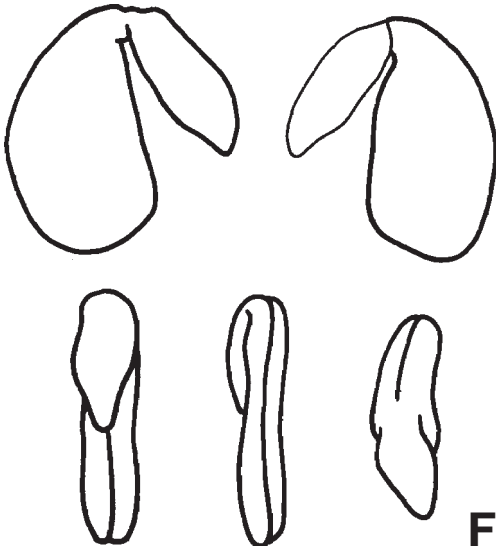
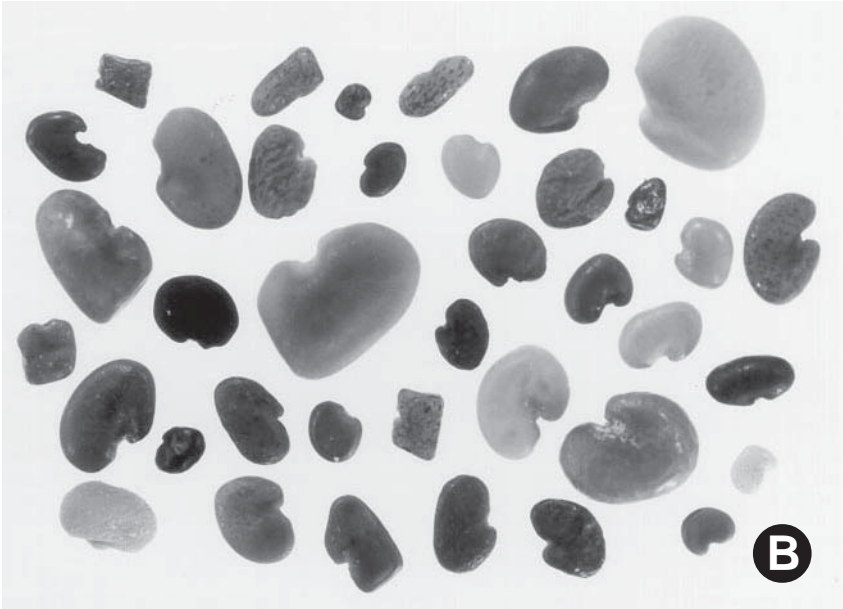
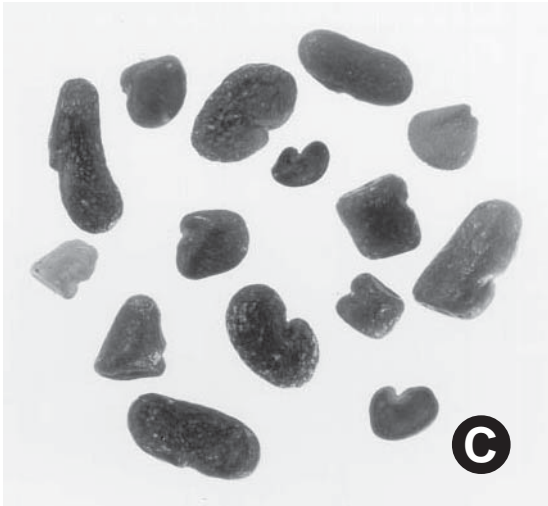
purple, or red overlay; glabrous; smooth (sometimes with a fine reticulate-colored pattern on smooth surface) or not smooth; with elevated or recessed features; rugose or wrinkled; pitted with small separate pits or concaved; coriaceous or chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible or visible; from hilum to lens; not bifurcating; darker than testa; reddish brown to brown; flush. Hilum visible or partially concealed; concealed by wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform or larger than punctiform; up to 0.5 mm long; with curved outline; circular; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim or within halo. Hilum halo color lighter than testa. Lens discernible or not discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; up to 1 mm long; with margins straight or curved; oblong, linear, elliptic, or 2 circular mounds separated by groove; not in groove of raphe; adjacent to or confluent with hilum; 0.2 mm from hilum; mounded or flush; similar or same color as testa; darker than testa; brown or tan (greenish); not within corona, halo, or rim. Endosperm thick or thin; covering entire embryo; adnate to embryo or testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan or brown (reddish); inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous (some almost 1/2 size of cotyledons); lobe tip straight, curved, or hooked; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 or 1/2 to nearly length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

Distribution: North America to South America (Patagonia), Europe, Russia, temperate northern Africa, tropical Africa (mountains), the Iranian Plateau, northern India, China, and Japan.

Notes: *Astragalus* has more species than any other legume genus and more than most other genera, regardless of family. There are a remarkable number of publications dealing with the species in various parts of the world, and a few of the major ones include: North America, Barneby (1964) and Isely (1983, 1984, 1985, 1986); southern temperate South America, Johnston (1938,

1947); highlands of tropical Africa, Gillett (1963a); Iran, Maassoumi (1986, 1989); Russia, Gontscharov and Borisova (1946); Pakistan and Himalayas, Ali (1961). In addition Maassoumi, Podlech, and others have issued a series of more than 30 papers for the Near East. Several sections of *Astragalus* have been monographed: Section *Acanthophaea* A.A. von Bunge and section *Aegacantha* A.A. von Bunge (Deml 1972); section *Alopecuroidei* A.-P. de Candolle (Becht 1978); section *Caprini* A.-P. de Candolle (Podlech 1988); sections *Chlorostachys* A.A. von Bunge, *Phyllobium* A.A. von Bunge, and *Skythropos* N.D. Simpson (Wenninger 1991); section *Chronopus* A.A. von Bunge (Ott 1978); section *Dasyphyllium* A.A. von Bunge (Aytaç 1997); section *Eremophysa* A.A. von Bunge and section *Eremophysopsis* N.F. Gontscharov (Podlech 1993); section *Herpocaulos* A.A. von Bunge (Podlech 1984); section *Laxiflori* C. Agerer-Kirchhoff (Agerer-Kirchhoff and Agerer 1977); section *Megalocystis* A.A. von Bunge (Tietz and Zarre 1994); section *Platyglottis* A.A. von Bunge (Podlech 1990); section *Sesamei* A.-P. de Candolle (Gazer 1993); and section *Theiochrus* A.A. von Bunge (Podlech and Kozik 1983). Sanderson and Liston (1995) cladistically analyzed the Galegeae genera using molecular data. They concluded that *Astragalus* is monophyletic with *Astracantha* (16.16) nested within it and that *Astracantha* should be included in it, possibly as a subgenus. Zarre and Podlech (1997), using morphological and anatomical data, concurred that *Astracantha* should not be maintained as a genus. They concluded that it should be synonymized with *Astragalus* and that it cannot be maintained even at subgeneric level. Polhill (1994b) maintained *Neodielsia* H.A.T. Harms (16.18) as a genus, but Mabblerley (1997) kept it as a synonym of *Astragalus*. We have chosen to follow Mabblerley. Barneby (1964) and others, including Hutchinson (1964), who noted that “an important feature of the *Astragalus* pod is the septum or longitudinal wall produced across the cavity from the dorsal suture.” Because we have restricted the term “septum” to the transverse wall of a legume that separates seeds, we will not use “septum” in the sense used by Barneby and others. We agree with Barneby that legumes endowed with a complete internal longitudinal wall are to be termed bilocular (replacing two-celled fruits of the literature). A partial walled cavity is termed “semibilocular,” and a pod lacking this wall is “unilocular.” Barneby (1964) has a detailed discussion of *Astragalus* fruits.

Astragalus: *A. crassicaarpus* T. Nuttall (*D–F*), *A. spp.* (*A–C*).
A, Fruits ($\times 1$); *B–C*, seeds ($\times 4.1$, $\times 4.5$); *D–E*, testa
($\times 50$, $\times 1000$); *F*, embryos ($\times 10$).



Genus: *Biserrula* C. Linnaeus

Phylogenetic Number: 16.15A.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; bilocular; $1.2-5 \times 0.4-1 \times 0.3-0.7$ cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate (but occasionally irregularly bent); not twisted; symmetrical; linear; not inflated; flattened; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered and truncate at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; seed chambers externally invisible. Fruit margin constricted along both margins; without sulcus; embellished or plain (*B. pelecinus* subsp. *leiocarpa* (A. Richard) J.B. Gillett); with fringe (sinuate dentate with denticulate lobes). Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; brown to reddish brown; glabrous or pubescent but soon deciduous; with 1 type of pubescence; pilose; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; transversely veined relative to fruit length and reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; reddish brown; smooth and cobwebby (near sutures and funiculi); nonseptate (longitudinal separation between seed chambers making 2 locules); chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 5–21; length parallel with or transverse to fruit length; neither overlapping nor touching; in 2 or more series. Funiculus measured; 0.5–0.8 mm long; of 1 length only; filiform; straight. Aril dry; rim-aril; reddish brown.

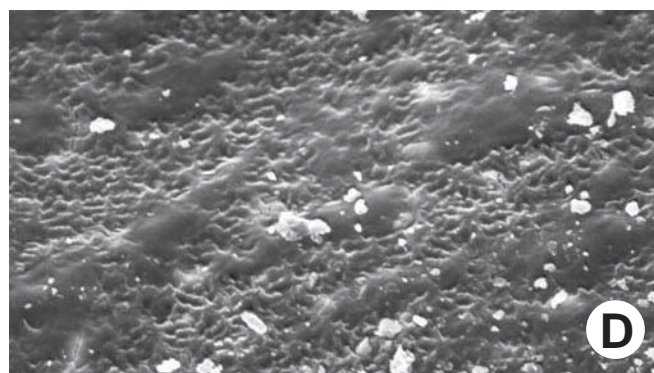
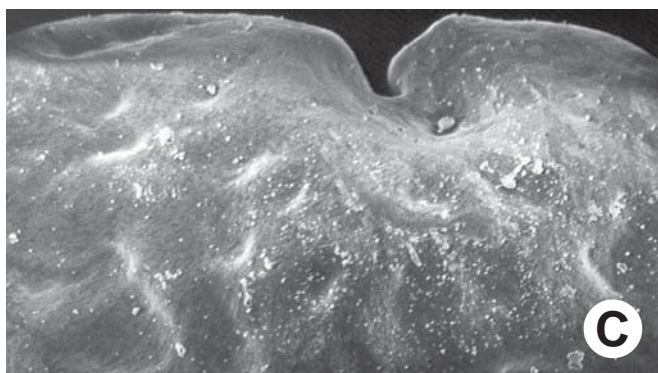
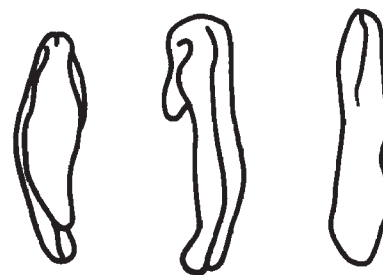
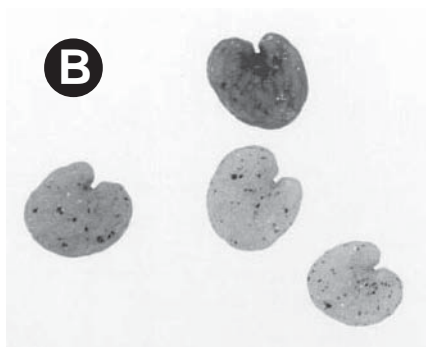
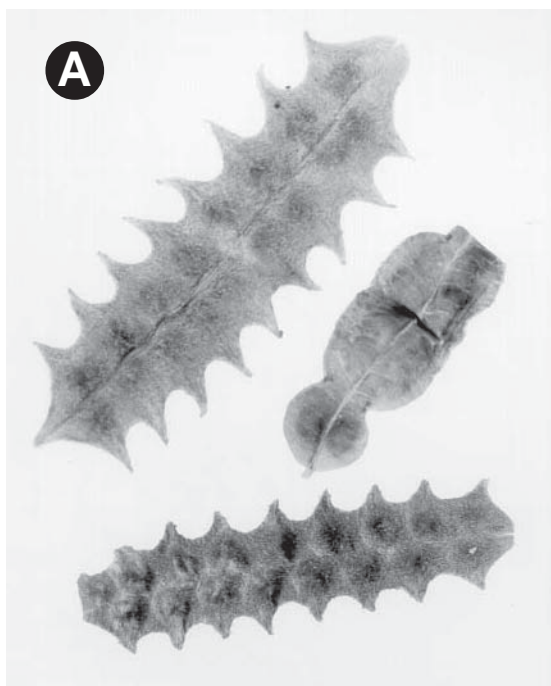
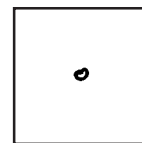
Seed $1.5-2 \times 1.5-2 \times 0.7-0.8$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; with deep hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; clear (except for mottles) or

colored; monochrome or mottled; with frequent mottles; reddish brown, tan, white, or yellow; with black or purple overlay; glabrous; not smooth; with elevated or recessed features; reticulately wrinkled; punctate; chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially or fully concealed; concealed by radicle lobe or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within rim. Hilum rim color of testa. Lens discernible; less than 0.5 mm in length; with margins straight; diamond-shaped; not in groove of raphe; confluent with hilum; mounded; dissimilar color from testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; reddish brown, tan, yellow, or white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight or curved (slightly); deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Mediterranean region and northeastern and eastern tropical Africa.

Notes: Barneby (1964) included this taxon in *Astragalus* (16.15) as *A. pelecinus* (C. Linnaeus) R.C. Barneby.

Biserrula: *B. pelecinus* C. Linnaeus (A–E). A, Fruits ($\times 2.3$); B, seeds ($\times 8$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 15$).



Genus: *Astracantha* D. Podlech

Phylogenetic Number: 16.16.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 5 spp.—215 spp.

Fruit a legume; unilocular; $0.3\text{--}0.6 \times 0.15\text{--}0.35 \times 0.15\text{--}0.35$ cm; with persistent calyx; with calyx longer or shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; circular; when asymmetrical with both sutures unequally or parallelly curved; inflated; terete; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome; black; pubescent and indurate; with 1 type of pubescence; somewhat villous; with pubescence dull and dark golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases swollen; eglandular; without spines; smooth or not smooth; with elevated features; not veined; not tuberculate; somewhat wrinkled; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; brownish black; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1(–2); length parallel with or transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; assumed straight. Aril absent or present; dry; rim-aril; tan.

Seed $2\text{--}7 \times 2\text{--}4.5 \times 1\text{--}2$ mm; not overgrown; angular or not angular; asymmetrical; mitaform, oblong, rectangular (more or less), or D-shaped; compressed; with surface smooth; with visible radicle and cotyledon lobes; with or without external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as or lighter in color than testa; without hilar sinus; without umbo on

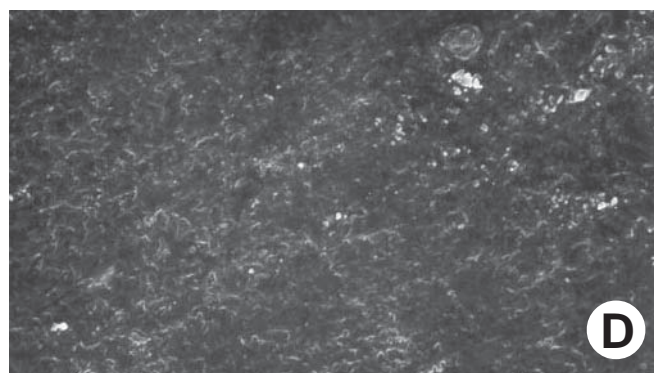
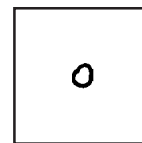
seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled; reddish brown or tan (reddish to greenish); glabrous; smooth or not smooth; with elevated or recessed features; rugose or wrinkled; pitted with small separate pits; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe visible or not visible; from hilum to lens; not bifurcating; darker than testa; reddish brown; raised. Hilum visible or fully concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform or larger than punctiform; $0.3\text{--}0.4$ mm long; with curved outline; more or less circular; between cotyledon and radicle lobe; slightly recessed; within rim. Hilum rim color of testa. Lens discernible; less than 0.5 mm in length; with margins straight or curved; triangular or circular; not in groove of raphe; adjacent to or confluent with hilum; up to 0.3 mm from hilum; mounded; similar color as testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; parallel to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than $1/2$ or $1/2$ to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Europe and Russia.

Notes: Podlech (1983) founded the genus, a segregate of *Astragalus* (16.15), and the species count is based on his work. Reer and Podlech (1986) expanded on the original paper, and this was followed by a seed morphology study with testa micrographs by Engel (1990). Sanderson and Liston (1995) performed cladistic analyses for the Galegeae genera using molecular data. They concluded that *Astragalus* (16.15) is monophyletic with *Astracantha* nested within it and that *Astracantha* should be returned to it, possibly as a subgenus. Zarre and Podlech (1997), using morphological and anatomical data, concurred that *Astracantha*

should not be maintained as a genus. They concluded that it should be synonymized with *Astragalus* and that it cannot be maintained even at the subgeneric level. Our number of seed and fruit samples is inadequate, but our morphological data were enhanced by the cited literature.

Astracantha: *A. echinus* (A.-P. de Candolle) D. Podlech (*A*),
A. gossypina (F.E.L. von Fischer) D. Podlech (*C–E*), *A.*
spp. (*B*). *A*, Fruit ($\times 2.8$); *B*, seeds ($\times 6.5$); *C–D*, testa
($\times 50$, $\times 1000$); *E*, embryos ($\times 1$).



Genus: *Oxytropis* A.-P. de Candolle

Phylogenetic Number: 16.17.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 31 spp.—ca. 300 spp.

Fruit a legume; unilocular; $0.8-4 \times 0.3-0.8 \times 0.3$ cm; with persistent calyx; with calyx shorter or longer than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (or slightly curved); not plicate; not twisted; symmetrical or asymmetrical; oblong, linear, circular, falcate, or C-shaped; when asymmetrical with both sutures parallelly curved; not inflated or inflated; compressed or terete; with beak; straight or declined; with solid beak the same color and texture as fruit; short tapered, tapered, or long tapered at apex; apex aligned, oblique, or right-angled with longitudinal axis of fruit; long tapered or short tapered at base; base aligned or right angled with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous, membranous, coriaceous, or ligneous; seed chambers externally invisible. Fruit margin not constricted; with sulcus (seed bearing suture more or less intruded but legume undivided); plain. Fruit wings absent. Fruit nonstipitate, substipitate, or stipitate; with the stipe up to 15 mm long. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along 1 suture or both sutures; apical and down; passive or active; with valves twisting (loosely). Replum invisible. Epicarp dull; monochrome or multicolored; mottled; brown; with purple overlay; pubescent and indurate or pubescent but soon deciduous; with hairs appressed or erect; with 1 or 2 types of pubescence; puberulent, villous, or velutinous; with pubescence golden or gray and black; with gray and black hairs intermixed; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular or eglandular; without spines; not smooth; with elevated features; reticulately veined or transversely veined relative to fruit length; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp present or absent; thin or thick; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous or chartaceous. Endocarp dull or glossy; monochrome; tan; smooth or cowebby; nonseptate; chartaceous or coriaceous; not exfoliating; remaining fused to mesocarp and epicarp; remaining fused to epicarp; separating into 1-seeded winged

segments. Seeds (3–)5–11; length parallel with fruit length; neither overlapping nor touching; in 2 or more or 1 series. Funiculus measured; 1 mm long; of 1 length only; filiform; S-curved or curved. Aril dry; rim-aril; reddish brown.

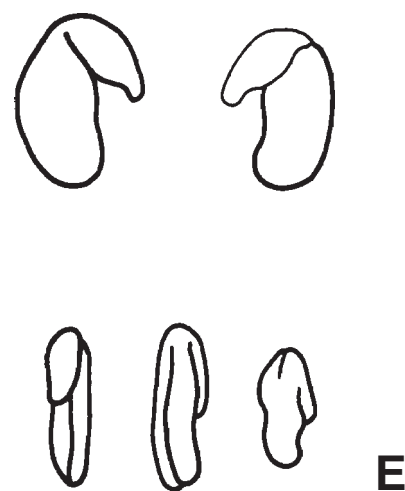
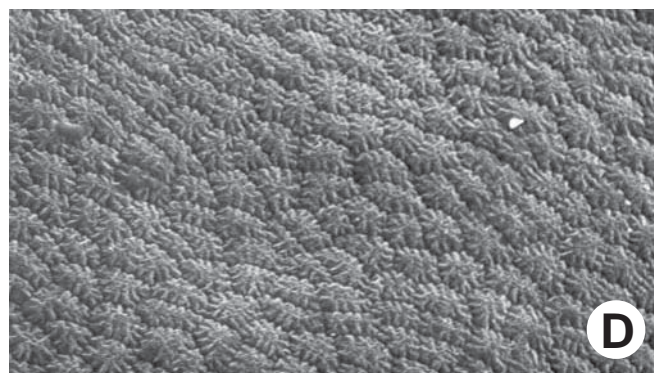
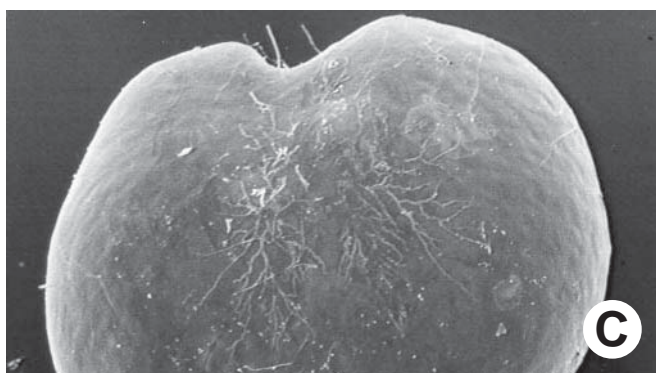
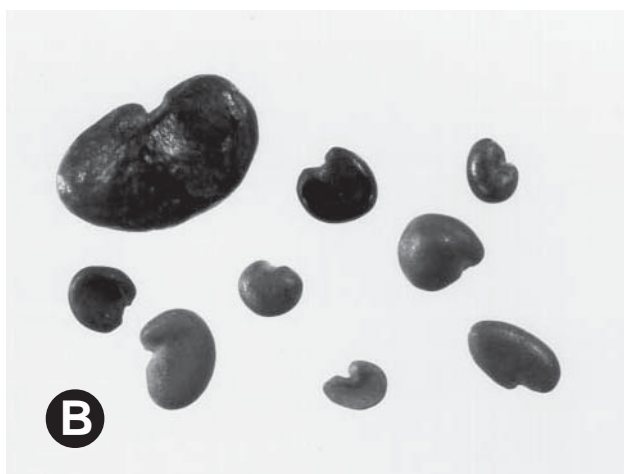
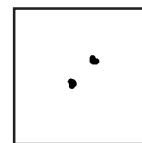
Seed $0.75-3.5 \times 1-1.5 \times 0.5-1$ mm; not overgrown; not angular; asymmetrical; mitaform, reniform, circular, or quadrangular; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; brown to reddish to greenish or pinkish brown, tan, yellow (greenish), orange, olive, green, or black; with black or purple overlay; glabrous; smooth or not smooth; with elevated features; rugose or shagreen; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; not within corona, halo, or rim or within halo. Hilum halo color lighter than testa. Lens discernible; less than 0.5 mm in length; with margins curved; elliptic; not in groove of raphe; adjacent to or confluent with hilum; 0.2 mm from hilum; mounded; similar color as testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: North America (22 spp.) and Eurasia.

Notes: Barneby (1952) monographed the North American species and noted that only two species were found between 1802 and 1951 that challenged the original circumscription of *Oxytropis*. *Oxytropis* has an “intro-

flexion of the pod's ventral suture, as opposed to the muticous keel of *Phaca* and *Astragalus*, with their pods unilocular or bilocular (from the dorsal suture) respectively." *Phaca* C. Linnaeus is subsumed into *Astragalus* (16.15). Fedchenko et al. (1948) reported on the species in Russia, and Ulziykhutag (1979) summarized the 78 Mongolian species in 17 sections. The testa surfaces and transverse sections of *O. riparia* D.I. Litvinov and *O. campestris* (C. Linnaeus) A.-P. de Candolle were studied using SEM (Solum and Lockerman 1991). Pandey and Jha (1988) also reported on testa micrographs of three species of *Oxytropis*, including *O. campestris*.

Oxytropis: *O. pilosa* (C. Linnaeus) A.-P. de Candolle (*C–E*),
O. spp. (*A–B*). *A*, Fruits ($\times 1.5$); *B*, seeds ($\times 5.6$); *C–D*,
testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 10$).



Genus: *Gueldenstaedtia* F.E.L. von Fischer

Phylogenetic Number: 16.19.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 9 spp.—14 spp.

Fruit a legume; unilocular; $1.2-3 \times 0.25-0.4 \times 0.13-0.15$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; linear or ovate (rarely); when asymmetrical with both sutures nearly straight; not inflated; terete; with beak; coiled (to almost so); with solid beak the same color and texture as fruit; short tapered at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome or multicolored; streaked; reddish brown; with black overlay; pubescent and indurate or pubescent but soon deciduous; with 1 type of pubescence; puberulent, villous, or tomentose; with pubescence golden or gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; not veined; not tuberculate; shagreen (bases of deciduous hairs); not exfoliating; without cracks. Mesocarp trace; surface not veined; 1-layered; without balsamic vesicles; without fibers; vitreous (tiny separate dots); chartaceous. Endocarp dull; monochrome; tan; smooth or fibrous (somewhat between seeds); nonseptate (though thinly hairy between seeds) or subseptate; with septa thin (tissue paper-like), flexible; with septa eglandular; coriaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 3–17; length transverse to or parallel with fruit length; touching; in 2 or more series. Funiculus measured; 0.5–1 mm long; of 1 length only; filiform; straight or hooked. Aril absent.

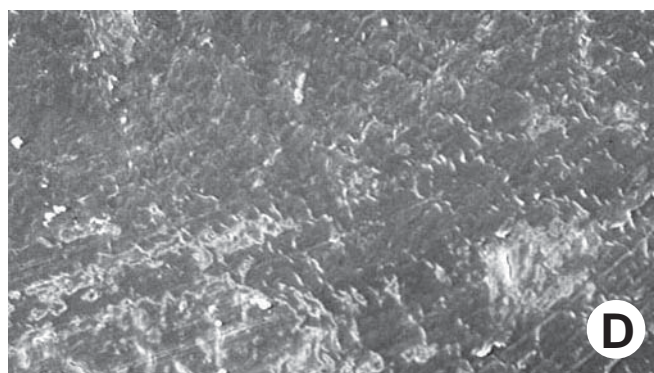
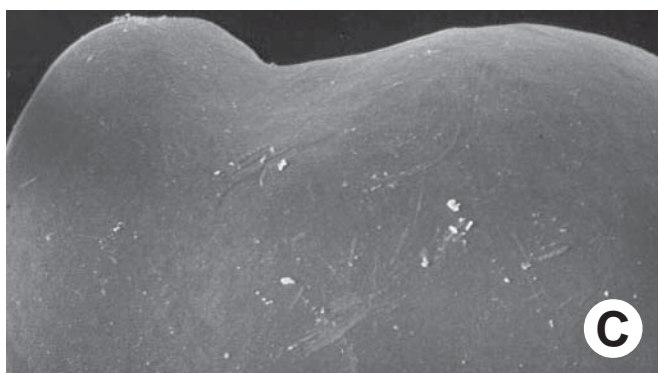
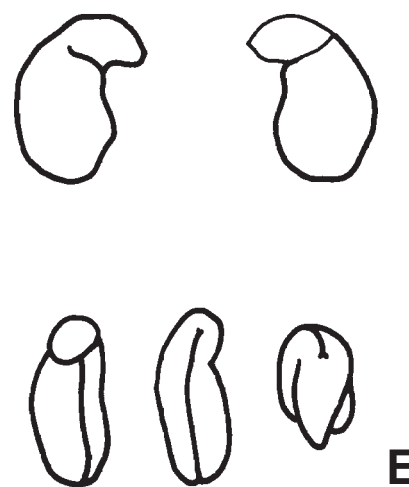
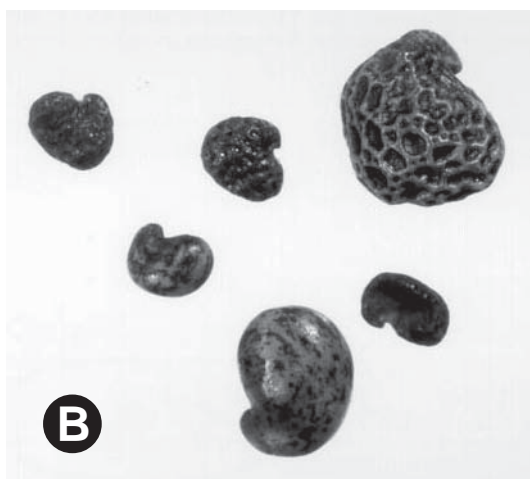
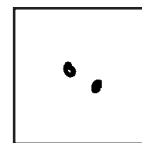
Seed $1-1.5 \times 1-1.5 \times 0.4-0.7$ mm; not overgrown; not angular or angular; asymmetrical; mitaform, reniform, oblong, or quadrangular (somewhat); compressed; with surface smooth; with visible radicle and cotyledon

lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome or mottled and streaked; greenish brown; with black overlay; glabrous; smooth or not smooth; with elevated or recessed features; reticulate; pitted with small separate pits; chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by radicle lobe or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within halo. Hilum halo color darker than testa. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins straight or curved; oblong; not in groove of raphe; confluent with hilum; mounded; dissimilar color from testa; darker than testa; reddish brown; within halo. Lens halo color darker than testa. Endosperm thin; covering entire embryo; adnate to embryo or testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan or white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight or curved; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Sino-Himalayan region to Siberia.

Notes: Yakovlev (1980) reported on the two species in the former U.S.S.R. Mabberley (1997) cited 14 species in the genus, which is the number used here.

Gueldenstaedtia: *G. himalaica* J.G. Baker (C–E), *G.* spp. (A–B). A, Fruits ($\times 2.2$); B, seeds ($\times 7.7$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genus: *Galega* C. Linnaeus

Phylogenetic Number: 16.20.

Tribe: Galegeae.

Subtribe: Galeginae.

Species Studied—Species in Genus: 5 spp.—6 spp.

Fruit a legume; unilocular; $3\text{--}3.5 \times 0.2\text{--}0.9 \times 0.12\text{--}0.13$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; symmetrical; linear; not inflated; compressed; with beak; straight; with solid beak the same color and texture as fruit; tapered at apex; apex aligned with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible or visible; with the raised seed chambers not torulose. Fruit margin not constricted or constricted; constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; dark reddish brown; glabrous or pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; with glandular hairs; pliable; with hair bases plain; glandular; with glandular hairs; without spines; not smooth; with elevated features; longitudinally veined relative to fruit length; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; nonseptate; coriaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–6; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 1 mm long; of 1 length only; filiform; curved. Aril dry; rim-aril; reddish brown.

Seed $3.5\text{--}4.5 \times 1.8\text{--}2 \times 1\text{--}1.5$ mm; not overgrown; not angular; asymmetrical; reniform or linear; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; orange or yellow; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings

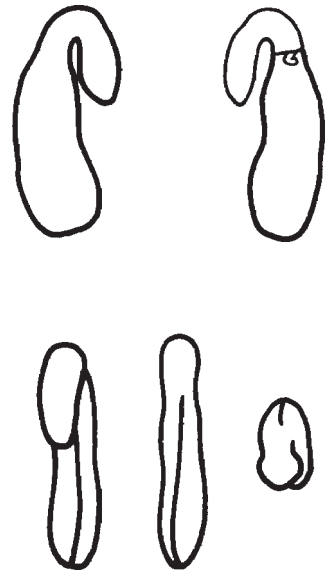
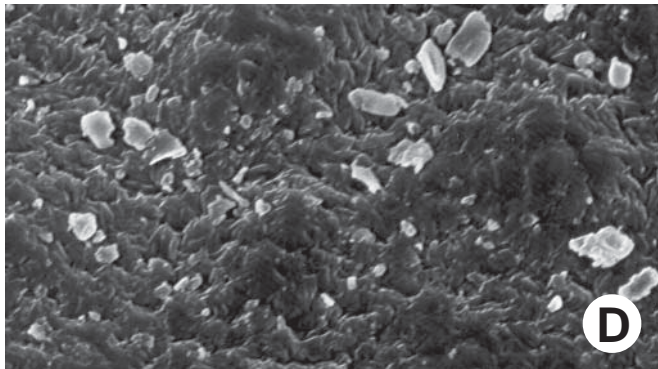
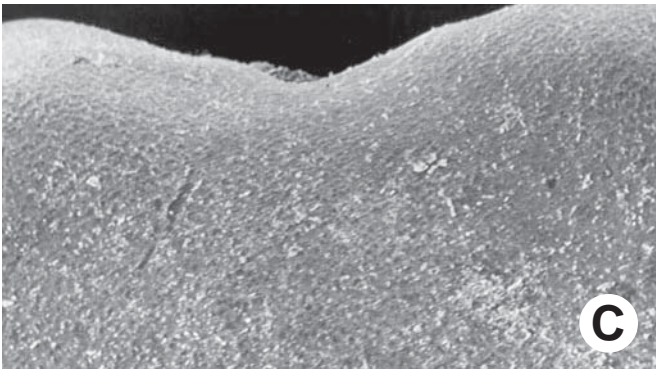
absent. Raphe not visible. Hilum visible or partially concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.4–0.5 mm long; with curved outline; circular; marginal according to radicle tip; recessed; within halo. Hilum halo color lighter than testa. Lens discernible; equal to or greater than 0.5 mm in length; up to 1 mm long; with margins straight or curved; oblong or triangular; not in groove of raphe; confluent with or adjacent to hilum; 0.3 mm from hilum; mounded; dissimilar color from testa; darker than testa; reddish brown or orange; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or brown (reddish); inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; with a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed or rudimentary; glabrous.

Distribution: Eastern Africa and Eurasia.

Notes: Gillett (1963b) studied the *Galega* species in the mountains of eastern tropical Africa. Pandey and Jha (1988) described the testa of *G. officinalis* using the SEM.

Galega: *G. officinalis* C. Linnaeus (C–E), *G. spp.* (A–B). A, Fruits ($\times 1.7$); B, seeds ($\times 7.6$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 6$).

6



Genus: *Alhagi* F. Gagnepain

Phylogenetic Number: 16.21.

Tribe: Galegeae.

Subtribe: Alhagiinae.

Species Studied—Species in Genus: 3 spp.—3 spp.

Fruit a legume or loment (or loment segment, only tardily separating: see Notes); unilocular; $0.8\text{--}2 \times 0.2\text{--}0.4 \times 0.2\text{--}0.4$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (or slightly curved); not plicate; not twisted; asymmetrical; linear or moniliform; when asymmetrical with both sutures unequally curved, 1 straight and 1 curved suture, or both sutures nearly straight; narrowing in several places, resembling *Desmodium* (9.09) fruit; not inflated; terete; with beak; straight or declined; with solid beak the same color and texture as fruit; rounded at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous or coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted (some constrictions may be well developed) or not constricted; constricted along both margins or constricted only on 1 margin; without sulcus; plain. Fruit wings absent. Fruit substipitate or stipitate (because of aborting of lowest seed chamber); with the stipe up to 5 mm long. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments widest across seed area; oblong. Epicarp dull; monochrome; reddish to blackish brown or tan; glabrous, pubescent and indurate (especially between seed chamber), or pubescent but soon deciduous; with hairs appressed or erect; with 1 type of pubescence; sericeous (to sparingly); with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular or eglandular; with glandular dots (reddish-brown); without spines; smooth or not smooth; with elevated features; not veined; not tuberculate; warty or wrinkled; not exfoliating; without cracks. Mesocarp thick; surface not veined; 2-layered; without balsamic vesicles; without fibers; with solid layer over vitreous layer; coriaceous. Endocarp dull; monochrome or mottled; white; with mottling (dark); with brown (reddish-brown (vitreous layer of mesocarp)) overlay; smooth; septate; with septa

thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–9; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril dry; rim-aril; blackish brown or black.

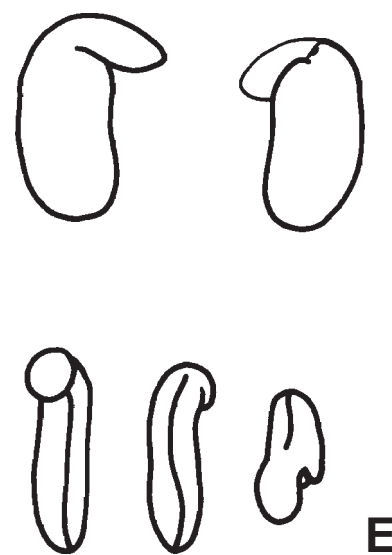
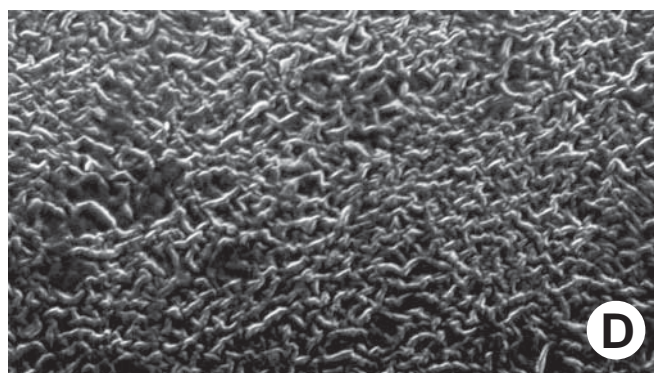
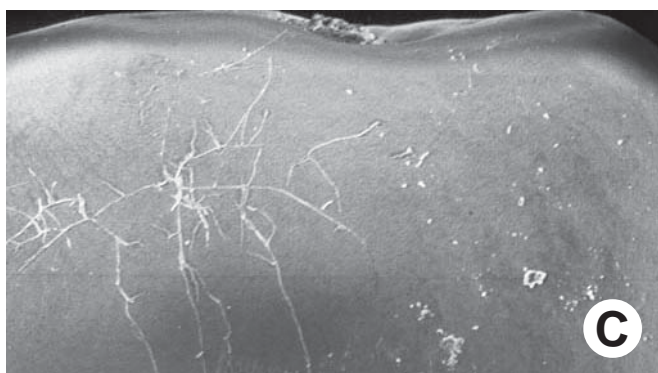
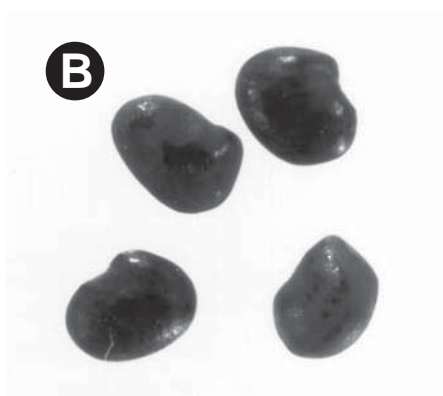
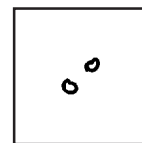
Seed $2\text{--}3 \times 0.8\text{--}2.3 \times 1.3$ mm; overgrown, 1 seed filling entire fruit cavity; angular; asymmetrical; reniform or quadrangular; compressed; with surface smooth; with visible radicle and cotyledon lobes; with or without external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled; with frequent mottles; brown to blackish brown, tan, yellow, green, or black; with black (to purplish black) overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins straight; diamond-shaped or irregular; not in groove of raphe; confluent with or adjacent to hilum; 0.1 mm from hilum; mounded; dissimilar color from testa; darker than testa; blackish brown or black; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Mediterranean region to Nepal.

Notes: Polhill (1981h) noted that *Alhagi* is usually placed in the *Hedysareae*, “but as discovered there the flowers and fruits do not agree well with the current narrow

circumscription of that tribe.” Yakovlev (1979) discussed the species *A. maurorum* as occurring in the former U.S.S.R. Hutchinson (1964) reported “embryo covered by a fleshy membrane,” which is the endosperm adnate to the embryo. The fruit of *Alhagi* is technically and functionally an indehiscent legume and not a loment, notwithstanding the fact that the fruits may tardily and irregularly fracture at the isthmuses, which occur between seed chambers. The fruit has been described accurately as lomentoid or lomentaceous, and, recognizing this situation, we have scored it both ways. Pandey and Jha (1988) described the testa of *A. maurorum* using the SEM.

Alhagi: *A. maurorum* F.C. Medikus (C–E), *A. spp.* (A–B). A,
Fruits and fruit segment ($\times 3.9$); B, seeds ($\times 7.6$);
C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 12$).



Genus: *Glycyrrhiza* C. Linnaeus

Phylogenetic Number: 16.22.

Tribe: Galegeae.

Subtribe: Glycyrrhizinae.

Species Studied—Species in Genus: 9 spp.—ca. 20 spp.

Fruit a legume; unilocular; $1.2\text{--}3.5 \times 0.5\text{--}1.2 \times 0.2\text{--}1$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; slightly curved, curved, or 0.5-coiled; not plicate or plicate (somewhat folded: wavy); not twisted or twisted; symmetrical; elliptic, linear, or moniliform; not inflated; compressed or terete; with beak; straight; with solid beak the same color and texture as fruit; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers torulose or not torulose. Fruit margin constricted along both margins; without sulcus; plain or embellished; with spines (with straight or hooked apices). Fruit wings absent. Fruit stipitate or nonstipitate; with the stipe up to 30 mm long. Fruit with all layers dehiscent; splitting along suture. Dehiscence of valves along 1 suture; apical and down (or just apical); passive. Replum invisible. Epicarp dull; monochrome; reddish brown; glabrous or pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence golden (and gland tipped); with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular; with glandular hairs or dots; with spines (with straight or hooked or plain or glandular tips) or without spines; with spines persistent or broken off and their bases evident; with spines same color as the rest of the fruit; not smooth; with elevated or recessed features; veined or not veined; reticulately veined or longitudinally veined relative to fruit length; not tuberculate; tuberculate (bases of spines); pitted (centers of spine bases); not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; vitreous; coriaceous. Endocarp dull; monochrome or mottled; tan; with brown (reddish) overlay; smooth; septate, subseptate, or nonseptate; with septa thin (tissue paper-like), flexible or thicker than paper, firm; with septa eglandular; coriaceous; not

exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–8; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; up to 1 mm long; of 1 length only; thick; straight or curved. Aril absent.

Seed $2.5\text{--}7.5 \times 2\text{--}6 \times 1.8\text{--}3.3$ mm; not overgrown; not angular; asymmetrical; reniform, oblong, D-shaped, or circular; compressed; with surface smooth; with visible radicle and cotyledon lobes; with or without external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; yellowish, reddish, or greenish brown or green (yellowish or brownish); with black overlay; glabrous; smooth; coriaceous. Fracture lines reticulate. Rim absent. Wings absent. Raphe visible or not visible; from hilum through lens to base of seed and terminating; not bifurcating; darker than testa; black; flush. Hilum visible or partially concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.8 mm long; with curved outline; circular; between cotyledon and radicle lobe; recessed; within rim or within halo. Hilum halo color of or darker (slightly) than testa. Hilum rim color of or darker (slightly) than testa. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.2–1 mm long; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.5–1.5 mm from hilum; mounded; same color as testa; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: North America, temperate South America, Eurasia to Australia.

Glycyrrhiza: *G. lepidota* F.T. Pursh (C–E), *G. spp.* (A–B).
A, Fruits (× 1.4); B, seeds (× 3.1); C–D, testa (× 50,
× 1000); E, embryos (× 6).

