

Trifolieae (21.01–21.06)

Genus: *Ononis* C. Linnaeus

Phylogenetic Number: 21.01.

Tribe: Trifolieae.

Species Studied—Species in Genus: 27 spp.—ca. 75 spp.

Fruit a legume; unilocular; $0.8\text{--}1.6 \times 0.2\text{--}0.4 \times 0.02\text{--}0.04$ cm; with persistent or deciduous calyx; with calyx longer than, equal in length to, or shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; linear, oblong, rhombic, or ovate (rarely); when asymmetrical with 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated; compressed; without beak; 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 invisible. Fruit margin constricted or not constricted; slightly constricted along both margins; 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; tan; pubescent and indurate; with 1 type of pubescence; pilose or puberulent; with pubescence golden or gray; with pubescence uniformly distributed; with glandular and simple hairs; pliable; with hair bases plain or swollen; glandular; with glandular hairs; without spines; not smooth; with elevated features; not veined; not tuberculate; tuberculate (bases of hairs); not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull or glossy; monochrome; tan; smooth; septate or nonseptate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 5–10; 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 absent.

Seed $0.5\text{--}5.5 \times 0.5\text{--}5 \times 1\text{--}4.5$ mm; not overgrown; not angular or angular; asymmetrical; mitaform, ovate, reniform, C-shaped (with cotyledon and radicles more or less of equivalent size and on each side of a deep hilar sinus), or triangular; compressed or terete; with

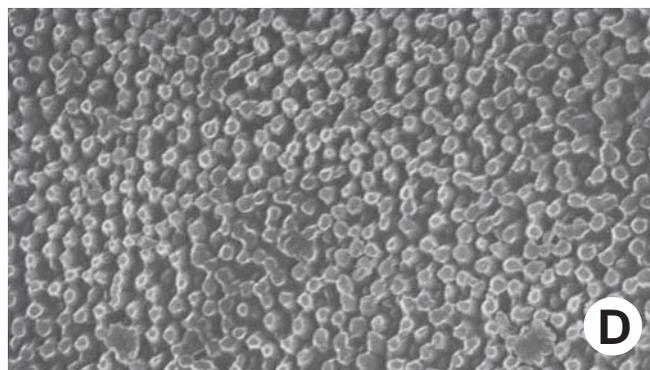
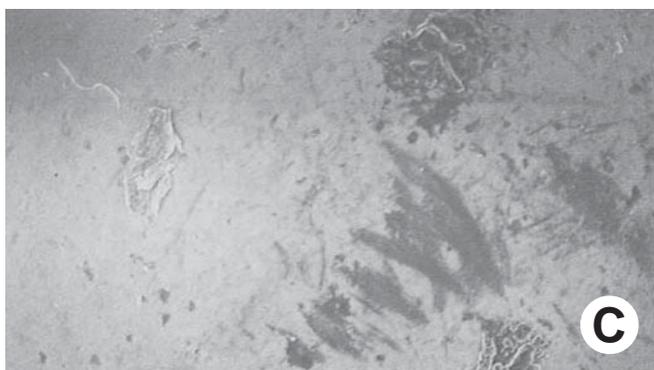
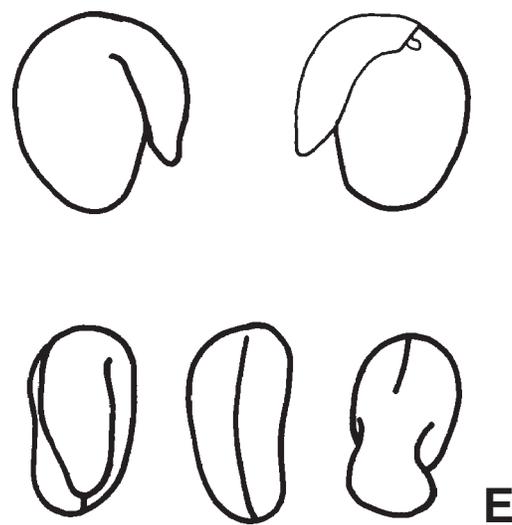
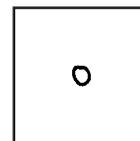
visible radicle and cotyledon lobes; with deep hilar sinus or without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome (occasionally with white tubercles); dark to light reddish brown, tan, or yellow; glabrous; not smooth or smooth; with elevated or recessed features; tuberculate (some quite prominent in size and/or color) or rugose (rarely); punctate; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum to lens; not bifurcating; darker than testa; tan; flush. Hilum visible, fully concealed, or partially concealed; concealed by funiculus 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; recessed; within rim. Hilum rim color of testa. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.5–1 mm long; with margins straight or curved; linear, circular, elliptic, or oblong; not in groove of raphe; adjacent to hilum; 0.1–0.2 mm from hilum; mounded; similar color as testa; darker than testa; reddish brown, tan (reddish), or black (ish); 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; yellow; inner face flat; glabrous around base of radicle. Embryonic axis straight; oblique to length of seed. Radicle linear; lobe tip straight, curved, or hooked; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

Distribution: Northern Europe to Canary Islands, Ethiopia, and Iran.

Notes: After a cladistic analysis using morphological characters, including internal seed morphology, Endo and Ohashi (1997) have proposed that Cicereae (20) and Fabeae (19) formed a monophyletic group whose sister group is Trifolieae. *Ononis* and *Parochetus* (21.02) “are not nearly as closely related to the remaining four genera as the latter are to each other, and indeed ... the two genera are not at all closely related to each other (or so far as I know to anything else)” (E. Small, personal communication, 1997). Butler (1996) presented a table with eight seed characteristics of 14 *Medicago* (21.05) spp., 7 *Melilotus* (21.03) spp., 25

Trifolium (21.06) spp., 11 *Trigonella* (21.04) spp. and 2 *Ononis* spp. as an aid for their identification in archaeological sites. Förther and Podlech (1991) revised the polymorphic *O. natrix* C. Linnaeus group of seven species. La Sota (1978) studied the testa morphology of 10 *Ononis* species.

Ononis: *O. pubescens* C. Linnaeus (*C–E*), *O. spp.* (*A–B*). *A*,
Fruits with and without calyx (intact and dehisced)
($\times 2.5$); *B*, seeds ($\times 6.4$); *C–D*, testa ($\times 50$, $\times 1000$);
E, embryos ($\times 8$).



Genus: *Parochetus* F. Buchanan-Hamilton ex D. Don

Phylogenetic Number: 21.02.

Tribe: Trifolieae.

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

Fruit a legume; unilocular; $1.5\text{--}2.3 \times 0.4\text{--}0.5$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; linear or oblong (narrowly); inflated; without beak; 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 invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscent (to tardily dehiscent); splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; dark brown; glabrous or pubescent but soon deciduous; with 1 type of pubescence; rarely pilose; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; not veined; faintly tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; greenish tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 4–15; length transverse to fruit length; in 2 or more series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril absent.

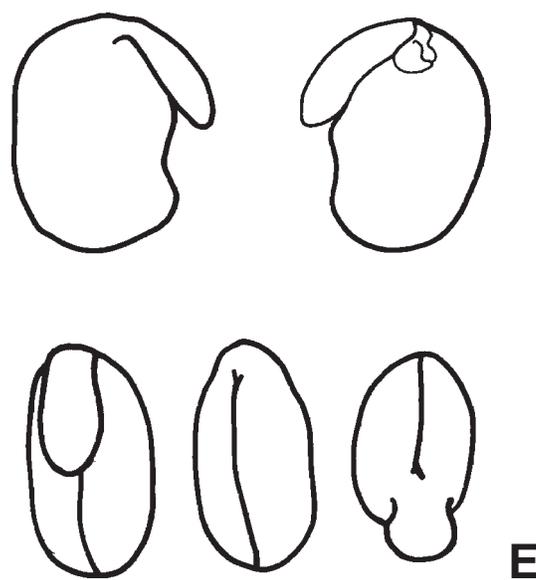
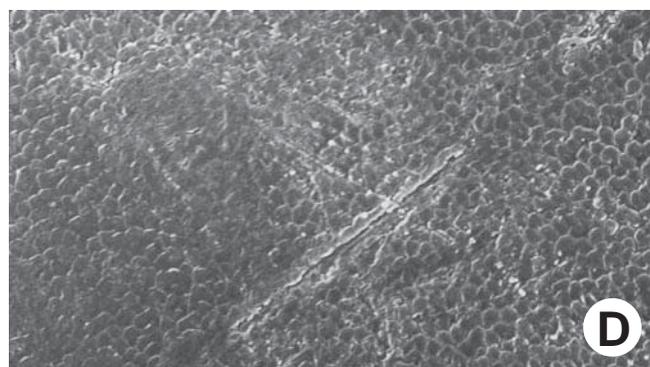
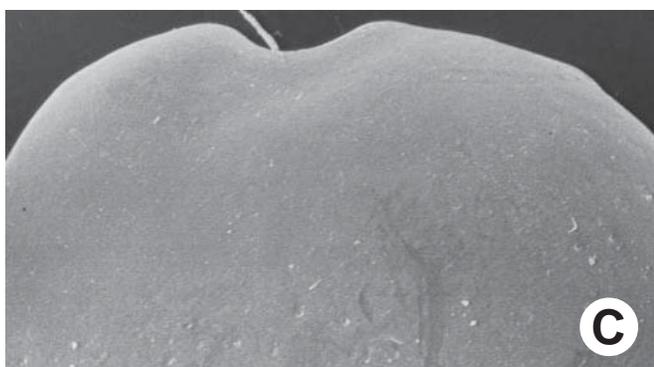
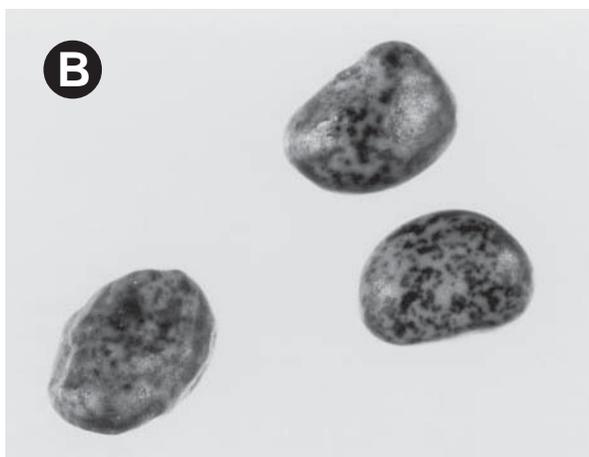
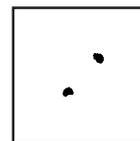
Seed $1.5\text{--}2.5 \times 1.4\text{--}2 \times 1\text{--}1.5$ mm; not overgrown; not angular; asymmetrical; oblong; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; blackish brown; with brown 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; within rim. Hilum rim color slightly darker than testa. Lens not discernible or discernible (barely sometimes); less than 0.5 mm in

length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.5 mm from hilum; flush; similar color as or dissimilar color from testa; darker than testa; reddish brown. Endosperm quite 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; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Tropical Africa, Asia (Himalaya Mountains to Sri Lanka and eastern China) to Indonesia (southeastern Java), and Europe (cultivated).

Notes: For additional information, see the Notes for *Ononis* (21.01). Polhill, in Beckett and Polhill (1991), named a second species, *P. africanus* R.M. Polhill.

Parochetus: *P. communis* F. Buchanan-Hamilton ex D. Don (A–E). A, Fruits (dehiscent) with calyx ($\times 3.7$); B, seeds ($\times 11$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 15$).



Genus: *Melilotus* P. Miller

Phylogenetic Number: 21.03.

Tribe: Trifolieae.

Species Studied—Species in Genus: 16 spp.—19 spp.

Fruit a legume; unilocular; $0.15\text{--}0.8 \times 0.15\text{--}0.45 \times 0.12\text{--}0.4$ 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 or symmetrical; circular, lanceolate, oblong, obovate, or ovate; when asymmetrical with both sutures parallelly curved; not inflated; compressed or terete; without beak; short tapered or rounded at apex; apex aligned or oblique (slightly) 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; membranous, chartaceous, or fragile, thinner than chartaceous like *Trifolium* (21.06); seed chambers externally visible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent or with all layers dehiscing (*M. altissimus* J.L. Thuillier); splitting along suture. Dehiscence of valves along 1 suture; medial and up and down; passive. Replum invisible. Epicarp dull; monochrome; black, brown, or tan; glabrous or pubescent and indurate; with hairs appressed; with 1 type of pubescence; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; veined or not veined; obliquely veined relative to fruit length or reticulately veined; not tuberculate; concentric whorls like a fingerprint, ribbed, or wrinkled; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; brown or tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching or touching; in 1 series. Funiculus less than 0.5 mm long or measured; up to 0.8 mm long; of 1 length only; filiform; straight or curved. Aril absent.

Seed $1.5\text{--}4.5 \times 1\text{--}3 \times 1\text{--}2.2$ mm; not overgrown; not angular or angular (somewhat); asymmetrical; circular, elliptic, mitaform, or reniform; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome, mottled, or streaked; with frequent mottles; with

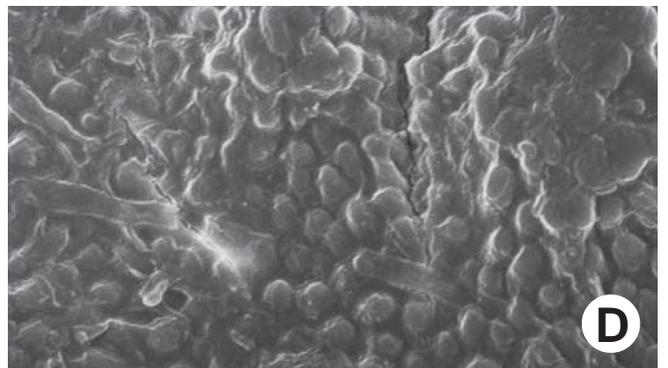
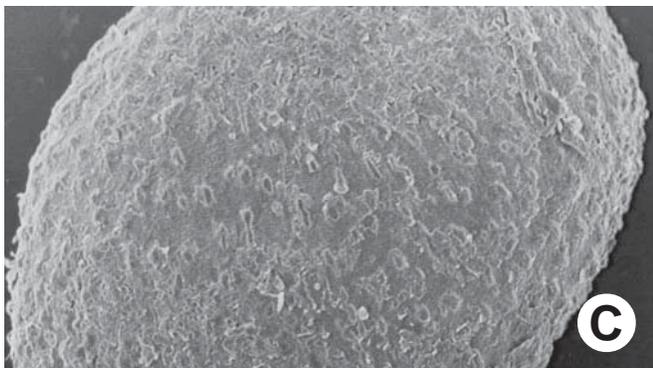
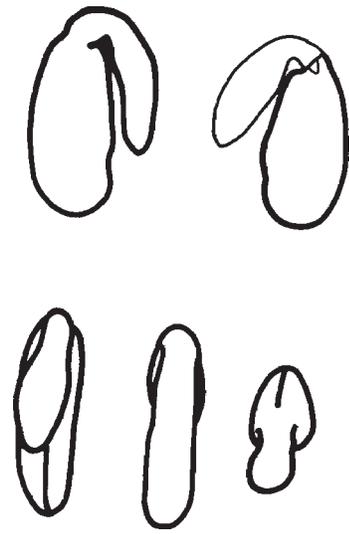
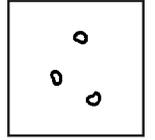
frequent streaks; brown (and yellowish, greenish), green (and yellowish), tan, or yellow; with purple overlay; glabrous; smooth or not smooth; with elevated features; shagreen or warty; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed 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; with curved or angular outline; circular or triangular; between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.6 mm long; with margins straight or curved; oblong; not in groove of raphe; confluent with hilum (at least discolor area); mounded; dissimilar color from testa; darker than testa; 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; not folded or with both folded; not sufficiently folded for inner face to touch itself (essentially cotyledons longer than testa); portions of inner folded face equal; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over or notched at 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. Radicle bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

Distribution: Europe, Asia, and North Africa.

Notes: Stevenson (1969) reviewed *Melilotus*, recognized 18 species, and illustrated its fruits. Jha and Pandey (1989) studied the seeds, especially the testae, of 11 species of *Melilotus*. They concluded that the testa coat ornamentation for a species is characteristic “and of great importance in specific diagnosis of a seed.” Isely (1954) provided flower-fruit keys to the 20 species of *Melilotus*. Voronchikhin and Bazilevskaya (1974) described fruits and seeds of the nine species of *Melilotus* in the former U.S.S.R. Small (1989) noted that *M. bicolor* P.E. Boissier & B. Balansa may perhaps be better placed in *Trigonella* (21.04). Our number of species includes *M. bicolor* and is the same as the count used by Small (1989); we do not agree with the species count of ca. 20 by Heyn (1981). We are not adopting Small’s selection of “*a*” to end species names currently ending in “*us*” in Wiersema et al. (1990). Schulz

(1901:667) noted that the two seeds in a pod may be differently colored: one light yellowish brown and the other dark reddish brown.

Melilotus: *M. indicus* (C. Linnaeus) C. Allioni (C–E), *M.*
spp. (A–B). A, Fruits, most with calyx ($\times 3$); B, seeds
($\times 6$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genus: *Trigonella* C. Linnaeus

Phylogenetic Number: 21.04.

Tribe: Trifolieae.

Species Studied—Species in Genus: 25 spp.—ca. 61 spp.

Fruit a legume; unilocular; $1-11 \times 0.09-1.3 \times 0.07-0.08$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight to curved (slightly), 0.5-coiled, or contorted; loosely plicate; not twisted; asymmetrical or symmetrical; linear, ovate, circular, moniliform, C-shaped, or falcate; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; inflated or not inflated; compressed, flattened, or terete; without or with beak; straight or declined; with solid beak the same color and texture as fruit; long tapered or rounded at apex; apex aligned with longitudinal axis of fruit; tapered or 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 or torulose. Fruit margin not constricted or constricted; slightly constricted along both margins or constricted only on 1 margin; without sulcus; plain or embellished; with prickles. Fruit wing absent or present (rarely); 1; 1–2 mm wide; sutural; on both sutures or 1 suture. Fruit nonstipitate or substipitate. Fruit indehiscent (gaping or not along seed-bearing suture) or with all layers dehiscent (rarely); splitting along sutures. Dehiscence of valves along both sutures or 1 suture; apical and down; passive. Replum invisible. Epicarp dull; monochrome; tan (to white); glabrous or pubescent and indurate; with hairs appressed or erect; 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 or longitudinally veined relative to fruit length (and veins twisted); not tuberculate; warty; not exfoliating; without cracks. Mesocarp present or absent; thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp or to epicarp; entire. Seeds 1–20; length parallel with or transverse to fruit length; neither overlapping nor touching or

touching; in 1 series. Funiculus less than 0.5 mm long or measured; up to 0.6 mm long; of 1 length only; filiform; curved. Aril absent.

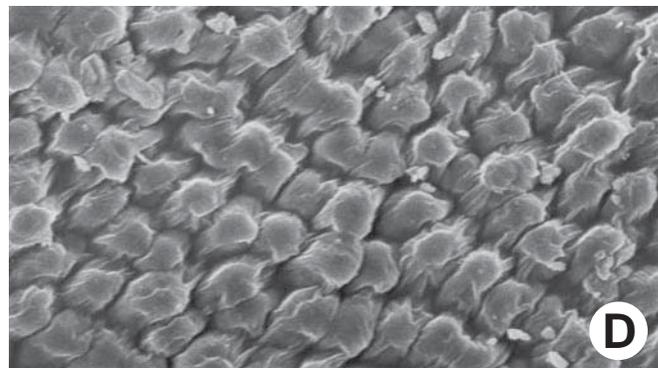
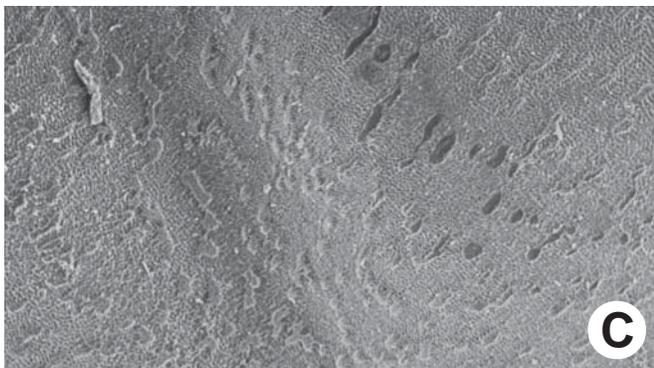
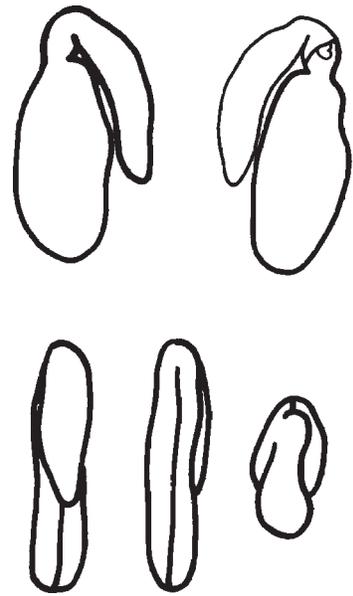
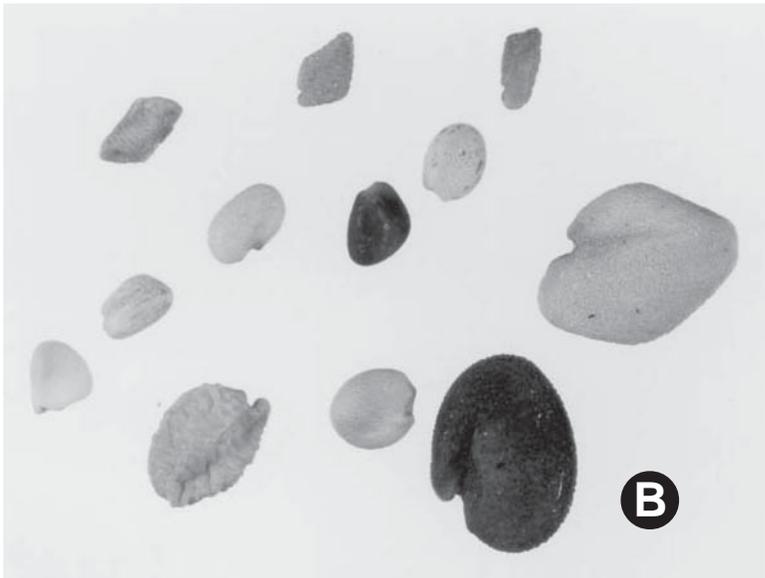
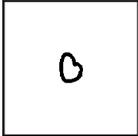
Seed $1.5-5 \times 0.5-3 \times 0.5-1.6$ mm; not overgrown; angular or not angular; asymmetrical; mitaform, oblong, ovate, quadrangular, rectangular, rhombic, elliptic, linear, or circular (sub); compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent or infrequent mottles; with frequent or infrequent streaks; yellowish, greenish, or dark brown, yellow (or pale), orange, or green (grayish); with black or brown overlay; glabrous; not smooth or smooth; with elevated features; tuberculate, wrinkled, or verrucose; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible or partially concealed; concealed by funicular remnant 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; recessed; not within corona, halo, or rim. Lens not discernible or discernible; less than 0.5 mm in length; with margins straight or curved; triangular or irregular; circular or irregular; not in groove of raphe; adjacent to hilum; 0.1–0.3 mm from hilum; mounded; similar color as testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thin or 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; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear or 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 moderately developed; glabrous.

Distribution: Central Europe to South Africa to Canary Islands and Central Asia, and Australia (1 sp.).

Notes: There is a rich history of authors trying to separate *Trigonella* and *Medicago* (21.05), and most of this history was summarized by Baum (1968). The recent publications of Small (1986, 1987a,b) have clarified this separation. Small and Jomphe (1989a) transferred

some species of *Trigonella* to *Medicago*, and our species count reflects these and other transfers. Our species count is based on Small (1989) and not on Heyn (1981), who had ca. 80. The number of perennial Asian species can only be roughly estimated (Small, personal communication, 1997).

Trigonella: *T. foenum-graecum* C. Linnaeus (C–E), *T. spp.*
(A–B). A, Fruits (few with calyx) ($\times 1.2$); B, seeds
($\times 6.7$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 6$).



Genus: *Medicago* C. Linnaeus

Phylogenetic Number: 21.05.

Tribe: Trifolieae.

Species Studied—Species in Genus: 83 spp.—86 spp.

Fruit a legume or nutlet; unilocular; $0.2\text{--}10 \times 0.1\text{--}1 \times 0.2\text{--}1.5$ cm; with persistent calyx; with calyx shorter than fruit; with orifice formed by curving of fruit or fruit segments (with 1 or more than 1 per fruit); straight, curved (slightly), 0.5-coiled, 1-coiled, 1.5-coiled, 2-coiled, 3-coiled, 4-coiled, or 5- to 10-coiled (rarely); not plicate or plicate (*M. plicata* (P.E. Boissier) G.I. Sirjaev); not twisted or twisted; asymmetrical or symmetrical; circular, falcate, or coiled; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; not inflated; compressed, terete, or flattened; without beak; short tapered at base; base right angled with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous, membranous, or lignous; seed chambers externally invisible. Fruit margin not constricted or constricted; constricted along both margins; without sulcus; plain or embellished; with prickles or fringe. Fruit wing absent or present (*M. popovii* (E.I. Korneva) G.I. Sirjaev); 1; sutural; on 1 valve; on 1 suture. Fruit substipitate or nonstipitate. Fruit with all layers dehiscing or indehiscent; splitting along sutures. Dehiscence of valves passive. Replum invisible. Epicarp dull; monochrome; brown or black; glabrous or pubescent and indurate; with 1 or 2 types of pubescence; tomentose (*M. hypogaea* E. Small); with pubescence gray or brown; with simple or glandular hairs; pliable; with hair bases plain; glandular or eglandular; with glandular hairs; without or with spines (spines forked or more often not); smooth or not smooth; with elevated features; reticulately veined; not tuberculate or tuberculate; with solid tubercles on each valve; exfoliating in part; without cracks. Mesocarp absent. Endocarp dull; monochrome; nonseptate, subseptate, or septate; with septa thin (tissue paper-like), flexible or thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–6(–20) (20 or more in *M. scutella* (C. Linnaeus) P. Miller (Small, personal communication, 1997)); length parallel with fruit length; neither overlapping nor touching or touching; in 1 series. Aril absent.

Seed $1.2\text{--}7 \times 1\text{--}4.5 \times 0.7\text{--}1.9$ mm; not overgrown; not angular or angular; asymmetrical; mitaform, oblong, rhombic, or triangular; compressed; with or without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; brown (or yellowish, reddish, or blackish) or yellow; glabrous; smooth or not smooth; with elevated features; rugose, wrinkled, papillate, or transversely ridged; 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; not within corona, halo, or rim. Cotyledons not concealing radicle; entire over radicle; brown to tan; with the interface division terminating at base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle lobe tip straight; deflexed and parallel to cotyledon length; $1/2$ to nearly or equaling length of cotyledons. Plumule rudimentary; glabrous.

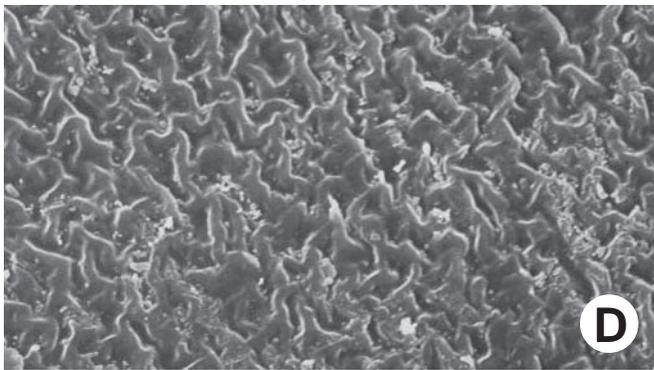
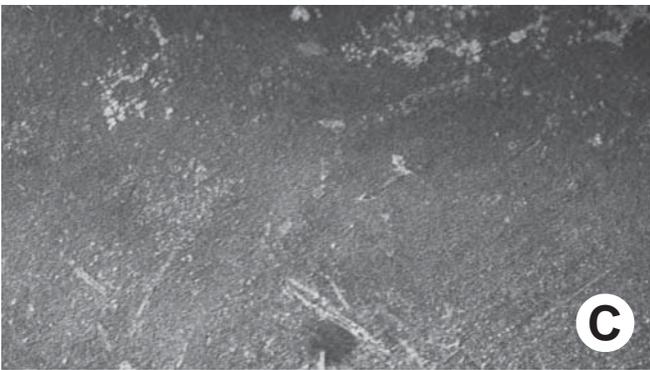
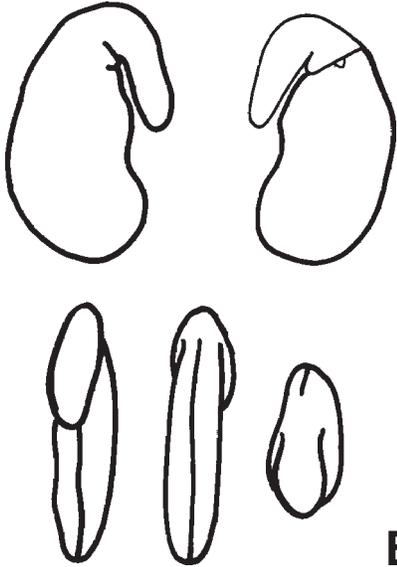
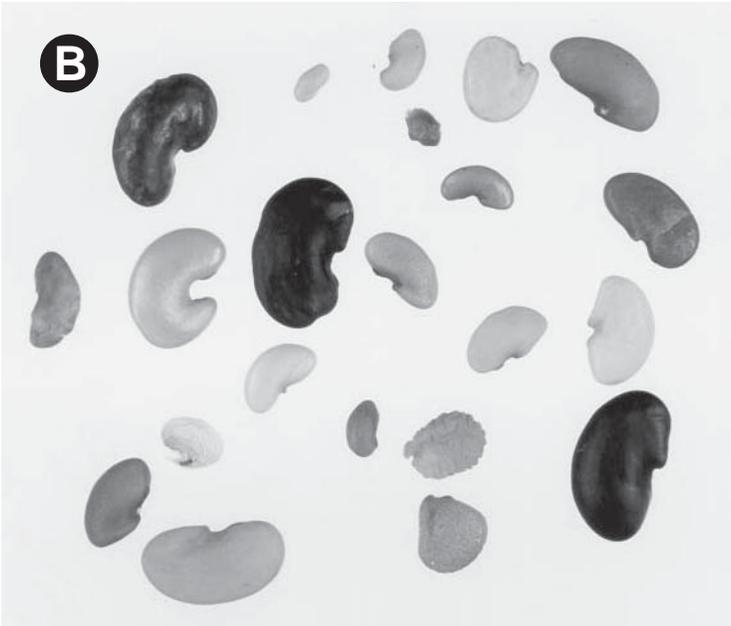
Distribution: Europe to South Africa and western Asia; widely cultivated.

Notes: In an impressive number of papers over the past 20 years dealing with *Medicago* and related genera, Small has resolved many of the problems related to *Medicago*. Our species count follows that of Small et al. (1988), Small and Jomphe (1989a,b), Small (1990a,b), and Small and Brookes (1991), who included in *Medicago* species previously in *Trigonella* (21.04). We did not follow the species count of ca. 50 of Heyn (1981). Small and Jomphe illustrated seeds and fruits in line drawings, and Small et al. (1990) illustrated seeds in photographs and micrographs. *Factorovskya* Eig, a monotypic and geocarpic genus recognized by Heyn, was reduced to *Medicago hypogaea* by Small and Brookes (1984) and is included as such here. The authors used the characteristic coiling of the fruit as one of the main traits supporting the transfer to *M. hypogaea*. Small and Jomphe (1989b) presented a key to the 12 sections and 8 subsections of the genus and a comprehensive illustrated key to the 83 species. The following year he circumscribed the genus based on seed characters (Small et al. 1990). Some species of *Medicago* are important crops throughout the temperate world. The fruits of *Medicago* are as diverse as they are in any faboid genus: Straight, curved, or coiled; terete, compressed, or flat; and sutures spiny, tuberculate,

winged, frimbiate, or plain. Most *Medicago* species have numerous conspicuous veins in the fruit. These veins are located in the epicarp, unlike most other legumes, which have the veins in the mesocarp.

Medicago: *M. ciliaris* (C. Linnaeus) C. Allioni (*C–E*), *M.*
spp. (*A–B*). *A*, Fruits with and without calyx ($\times 1.2$);
B, seeds ($\times 3.9$); *C–D*, testa ($\times 50$, $\times 1000$); *E*,
embryos ($\times 6$).

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Genus: *Trifolium* C. Linnaeus

Phylogenetic Number: 21.06.

Tribe: Trifolieae.

Species Studied—Species in Genus: 121 spp.—ca. 250 spp.

Fruit a legume or nutlet; unilocular; 0.14–1.5 × 0.04–0.5 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; oblong (to linear or ovate), ovate, elliptic, fusiform, lanceolate, linear, dolabriform, or falcate; when asymmetrical with both sutures parallelly curved; inflated or not inflated; compressed; without beak; short tapered or rounded at apex; with the apex and base uniform or differing in texture; fragile, thinner than chartaceous, membranous, chartaceous, coriaceous, or leathery (rarely); seed chambers externally visible or invisible. Fruit margin constricted or not constricted; slightly constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit substipitate or nonstipitate. Fruit indehiscent or with all layers dehiscing (with 2 or 1 prominent sutures); splitting along sutures. Dehiscence of valves along 1 suture or both sutures; passive. Replum invisible. Epicarp dull; monochrome; brown (various shades, yellowish); glabrous or glabrate; with 1 type or 2 types of pubescence; pilose or puberulent (slightly); with pubescence gray; with apical pubescence different from basal pubescence; with apical 1/4 tomentose and basal 3/4 glabrous or apical 3/4 tomentose and basal 1/4 glabrous; with simple hairs; pliable; with hair bases plain; with elevated features; veined or not veined; longitudinally veined relative to fruit length (occasionally) or reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp remaining fused to epicarp. Seeds 1–10. Aril absent.

Seed 0.8–5 × 0.8–3 mm; not overgrown; not angular; symmetrical or asymmetrical; circular, mitaform, oblong, pyriform, quadrangular, reniform, rhombic, or triangular; terete, compressed, or flattened; with or without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome, mottled, or streaked; with frequent mottles; with frequent streaks; black (to reddish, greenish, purplish, yellowish, dark, or reddish), green (yellowish to pale), red, tan, or yellow (to lemon); with black, brown (various shades), or purple overlay;

glabrous; smooth or not smooth; with elevated or recessed features; shagreen, tuberculate (minutely), warty (finely), or wrinkled; 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. Endosperm thin; covering entire 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. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous or linear; lobe tip straight; deflexed and parallel to cotyledon length; 1/2 to nearly or equaling length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Temperate and subtropical regions of the Northern and Southern Hemispheres.

Notes: In discussing the evolution of the legume (their legumen) in the genus *Trifolium*, Zohary and Heller (1984) noted that the section *Lotoidea* has the most primitive legume in the genus. These legumes are often 2–9-seeded and dehiscent by both sutures. From this primitive state, the advanced one-seeded “utricle or nutlet” evolved with a membranous pericarp that may consist of only an epidermal layer. These legumes do not dehisce but instead split transversely (circumscissily) or irregularly and are found in the section *Trifolium* and even in advanced species in section *Lotoidea* H. J. N. von Crantz. Some fruits are operculate. Unlike the fruiting heads of other legume genera, the fruiting heads of a few species of *Trifolium* separate from the plants and serve as the unit of dispersal. In *Trifolium subterraneum* C. Linnaeus, fertile flowers are pushed into the ground, where the fruits and seeds mature. See *Arachis* (14.26) and *Medicago* (21.05).

Trifolium: *T. pannonicum* N. von Jacquin (C–E), *T.* spp. (A–B). A, Fruits (mostly within calyxes) (× 2.1); B, seeds (× 6); C–D, testa (× 50, × 1000); E, embryos (× 10).

