

Little Yellow Seeds in the Brassicaceae

Presented by:
Deborah J. Lionakis Meyer



A Teaching and Training Webinar




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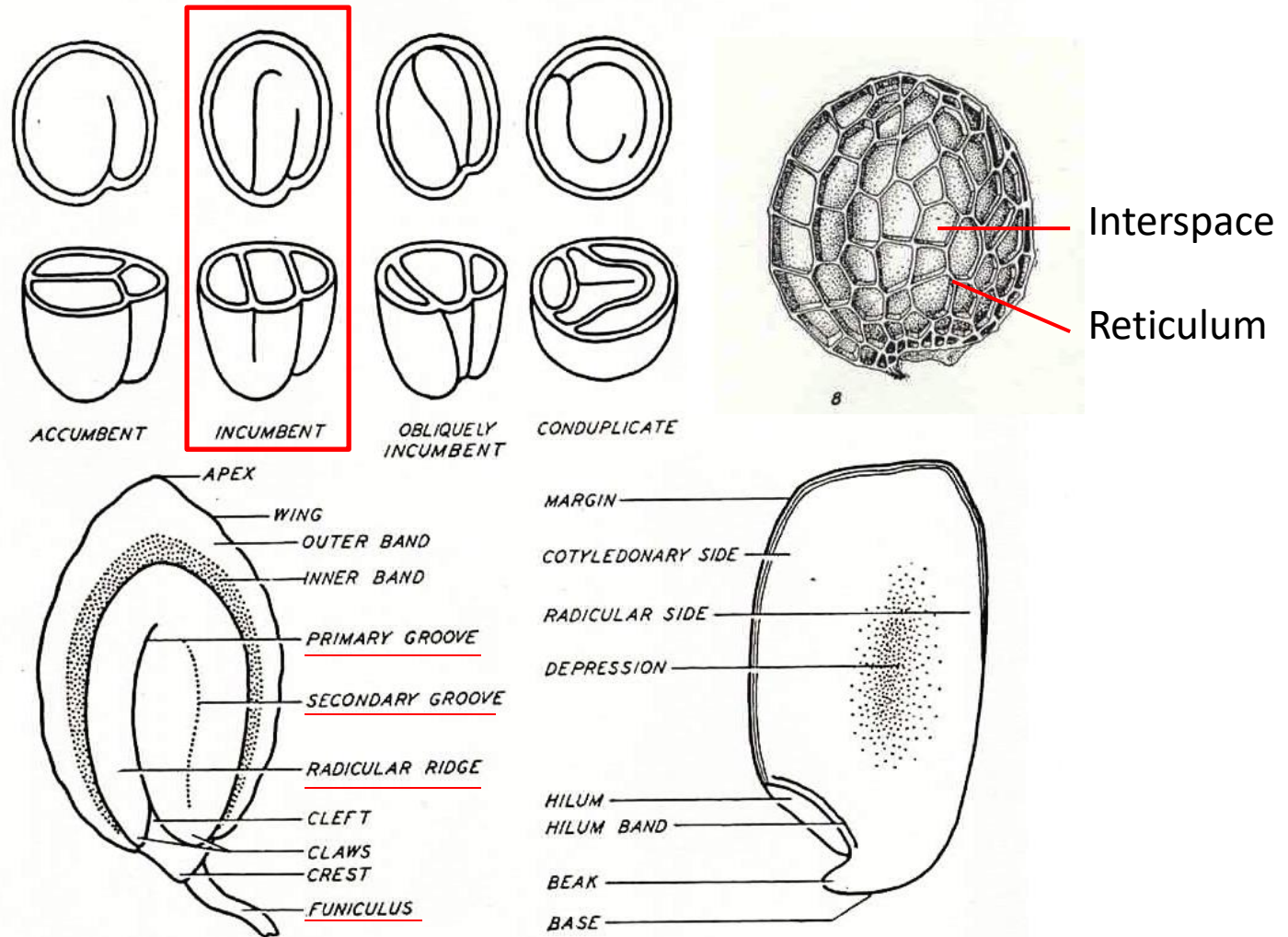
What we will look at today

<i>Camelina*</i>	<i>microcarpa*</i>	Littleseed falseflax	Weed	
<i>Camelina*</i>	<i>sativa*</i>	Bigseed flaseflax	Crop / Weed	
<i>Capsella</i>	<i>bursa-pastoris**</i>	Shepherd's-purse	Weed	
<i>Descurainia</i>	<i>pinnata</i>	Tansymustard	Weed	
<i>Descurainia</i>	<i>sophia*</i>	Flixweed	Weed	
<i>Sisymbrium</i>	<i>altissimum*</i>	Tumble mustard	Weed	
<i>Sisymbrium</i>	<i>irio</i>	London rocket	Weed	
<i>Sisymbrium</i>	<i>loeselii*</i>	Tall hedge mustard	Weed	Noxious Weed Seed: CA
<i>Sisymbrium</i>	<i>officinale</i>	Hedge mustard	Weed	
<i>Lepidium</i>	<i>appelianum*</i>	Globe-podded hoary cress	Weed	Noxious Weed Seed: US & CA
<i>Lepidium</i>	<i>campestre**</i>	Field peppergrass	Weed	Noxious Weed Seed: US & CA
<i>Lepidium</i>	<i>chalepense*</i>	Lens-podded hoary cress	Weed	Noxious Weed Seed: US & CA
<i>Lepidium</i>	<i>coronopus</i>	Swinecress	Weed	Noxious Weed Seed: US
<i>Lepidium</i>	<i>densiflorum*</i>	Prairie pepperweed	Weed	
<i>Lepidium</i>	<i>didymum</i>	Wartgrass	Weed	
<i>Lepidium</i>	<i>draba**</i>	Heart-podded hoarycress	Weed	Noxious Weed Seed: US & CA
<i>Lepidium</i>	<i>latifolium</i>	Perennial peppergrass	Weed	Noxious Weed Seed: US
<i>Lepidium</i>	<i>perfoliatum</i>	Clasping pepperweed	Weed	
<i>Lepidium</i>	<i>sativum**</i>	Gardencress	Crop / Weed	
<i>Lepidium</i>	<i>virginicum</i>	Virginia pepperweed	Weed	

* On Canadian Seed Analyst exam list; ** on RST/CSA exam list

- Specimens are from the California Department of Food and Agriculture Seed Herbarium and Plant Herbarium. Photographs are by D. Lionakis Meyer.
 - Scales shown are in millimeters.
 - Maps shown are from the USDA Plants Database
 - Illustrations are from M. R. Murley, 1951, Seeds of the Cruciferae of Northeastern North America. *The American Midland Naturalist* 46(1):1-81.
 - Noxious weed seed status is based on State Noxious-Weed Seed Requirements Recognized in the Administration of the Federal Seed Act (July 2021) and the Canadian Weed Seeds Order (2016).
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Structures Helpful in Identification



Fruit Types



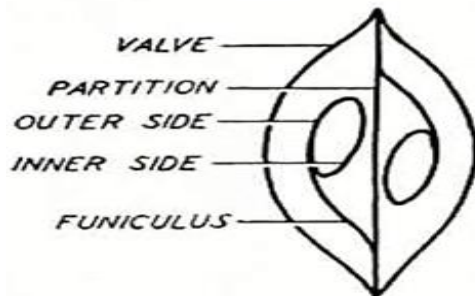
Silicle

not more than twice as long as wide



Silique

usually at least twice as long as wide



Fruit cross-section

*Camelina, Capsella,
Descurainia*

The bottom of the slide features a decorative graphic consisting of two overlapping, wavy horizontal bands. The upper band is a vibrant green, and the lower band is a deep blue. The waves are smooth and flow from left to right across the entire width of the slide.

Camelina microcarpa Andrz. ex DC.

littleseed falseflax

Size: length 0.8-1.6 mm; width 0.5-1.0 mm

Shape: oblong, narrowly oval, egg-shaped; slightly compressed; cotyledon lobe much thicker than radicular ridge; not winged

Radicle: equal to or shorter than cotyledon lobe; radicle ridge is usually straight

Primary groove: visible; secondary groove sometimes visible on one side

Seed coat texture: pitted and tuberculate; copiously mucilaginous when wet

Color: reddish-brown or brown

Funicular tissue: usually remaining attached; white

Cotyledons: incumbent

Fruit: silicle, pear-shaped, dehiscent, 8-25 seeds per fruit

Distribution: native to northern Africa, temperate Asia, and Europe; introduced in North America

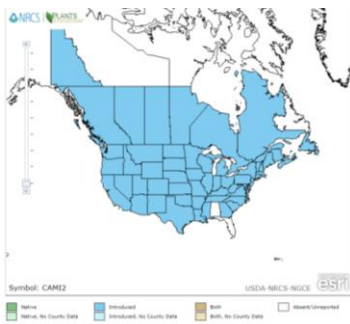


Figure 42 from Murley, 1951.

Camelina sativa (L.) Crantz

bigseed falseflax; camelina

Size: length 1.5-2.6 mm; width 0.7-1.4 mm

Shape: oval or egg-shaped; cotyledon lobe much thicker than radicle ridge; not winged

Radicle: equal to or shorter than cotyledon lobe; radicle ridge +/- twisted

Primary groove: visible; secondary groove +/- visible

Seed coat texture: tuberculate and/or pitted; mucilaginous when wet

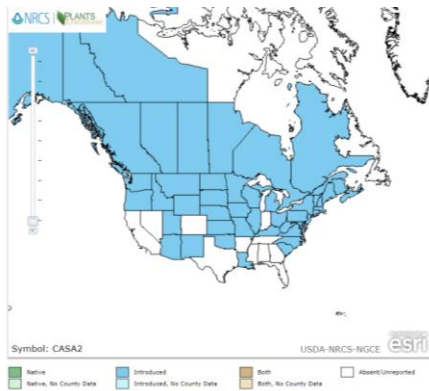
Color: light orange to dark brown

Funicular tissue: usually not remaining attached

Cotyledons: incumbent

Fruit: silicle, pear-shaped, dehiscent, 8-25 seeds per fruit

Distribution: native to temperate and tropical Asia, and Europe; introduced and/or cultivated in North America



USDA, NRCS. 2021.

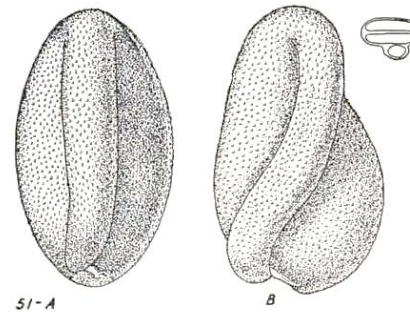


Figure 51 from Murley, 1951



Capsella bursa-pastoris (L.) Medik. shepherd's-purse

Size: length 0.8-1.1 mm; width 0.3-0.7 mm

Shape: oblong, apex rounded, laterally flattened, thickness uniform across entire seed; not winged

Primary & secondary groove: visible, appearing as parallel longitudinal grooves

Radicle: equal to slightly longer than length of cotyledon lobe; radicle ridge straight

Seed coat texture: reticulate with rounded or rectangular interspaces; mucilaginous when wet

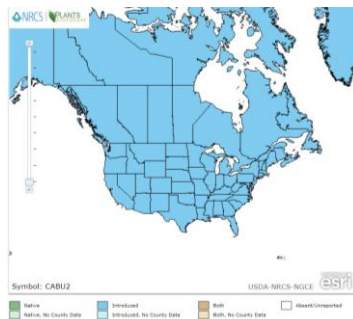
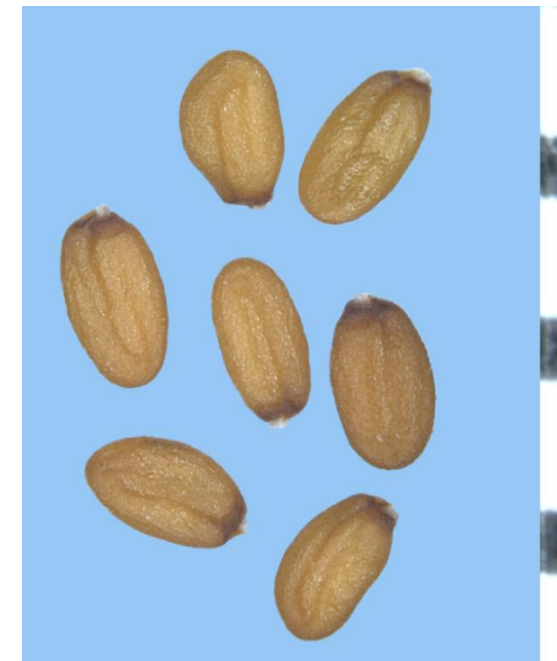
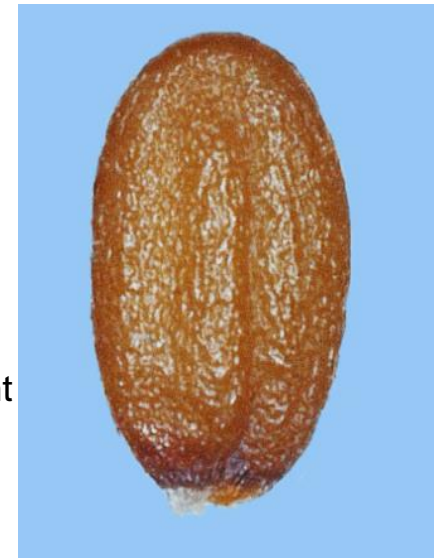
Color: orange-yellow, darker near hilum end; dull to lustrous

Funicular tissue: usually remaining attached; white

Cotyledons: incumbent

Fruit: silicle, flat, triangular-heart-shaped, dehiscent, 20-40 seeds per fruit

Distribution: native to northern Africa, Asia, Europe; introduced in North America



USDA, NRCS, 2021.



Figure 10 from Murley, 1951

Descurainia pinnata (Walter) Britton tansymustard

Size: length 0.5-1.1 mm; width 0.4-0.5 mm

Shape: oblong to oval; not winged

Radicle: equal to or longer than cotyledon lobe; +/- longitudinally twisted

Primary groove: only evident on one side of seed

Seed coat texture: reticulate with thick longitudinal ridges and thin cross ridges (ladder-like), small pit-like interspaces; mucilaginous when wet

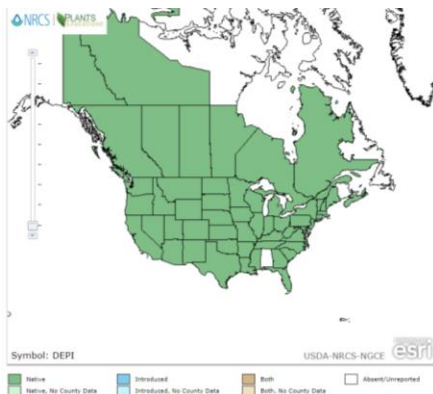
Color: brownish red

Funicular tissue: usually remaining attached; white

Cotyledons: incumbent

Fruit: silique, broadly linear to narrowly club-shaped, with two dehiscent valves, each with a double row of seeds, 16-40 seeds per fruit

Distribution: native to North America



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Figure 7 from Murley, 1951

Descurainia sophia (L.) Webb ex Prantl flixweed

Size: length 0.7-1.5 mm; width 0.3-0.7 mm

Shape: oblong to narrowly oval, apex round or angular; laterally compressed, +/- longitudinally twisted; not winged

Primary groove & secondary groove: visible

Radicle: equal to or longer than cotyledon lobe

Seed coat texture: reticulate with thin longitudinal and cross ridges (ladder-like); mucilaginous when wet

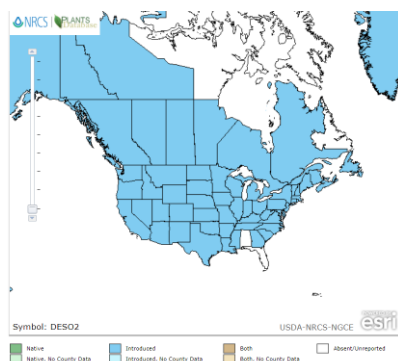
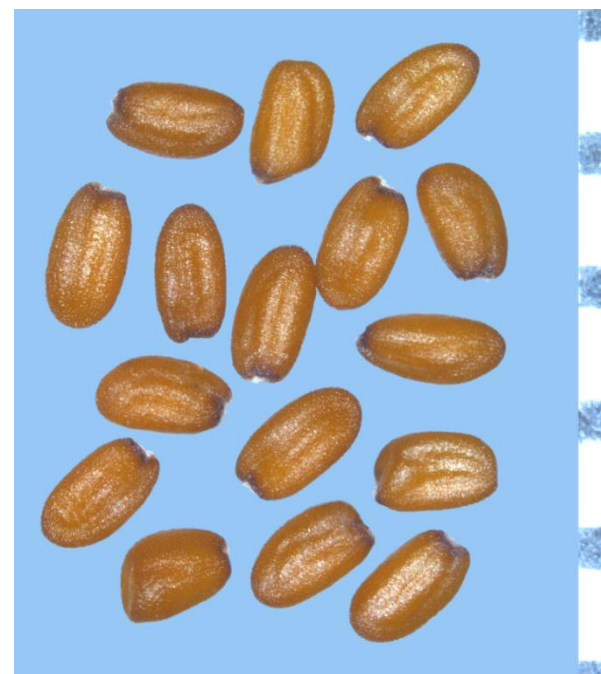
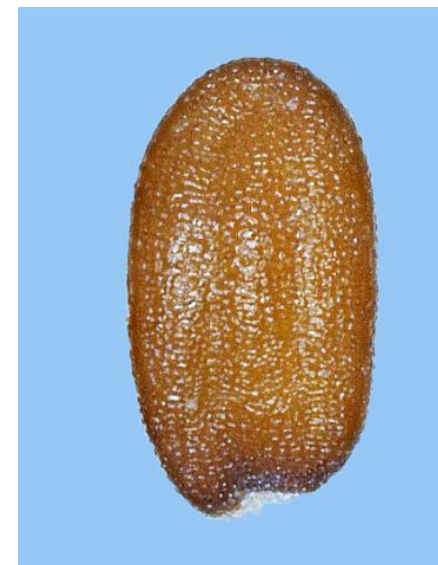
Color: bright orange-brown, darker near hilum end; lustrous to oily

Funicular tissue: may remain attached; white

Cotyledons: incumbent

Fruit: silique, long linear, with two dehiscent valves, each with a single row of seeds, 20-48 seeds per fruit

Distribution: native to northern Africa, temperate and tropical Asia, and Europe; introduced in North America



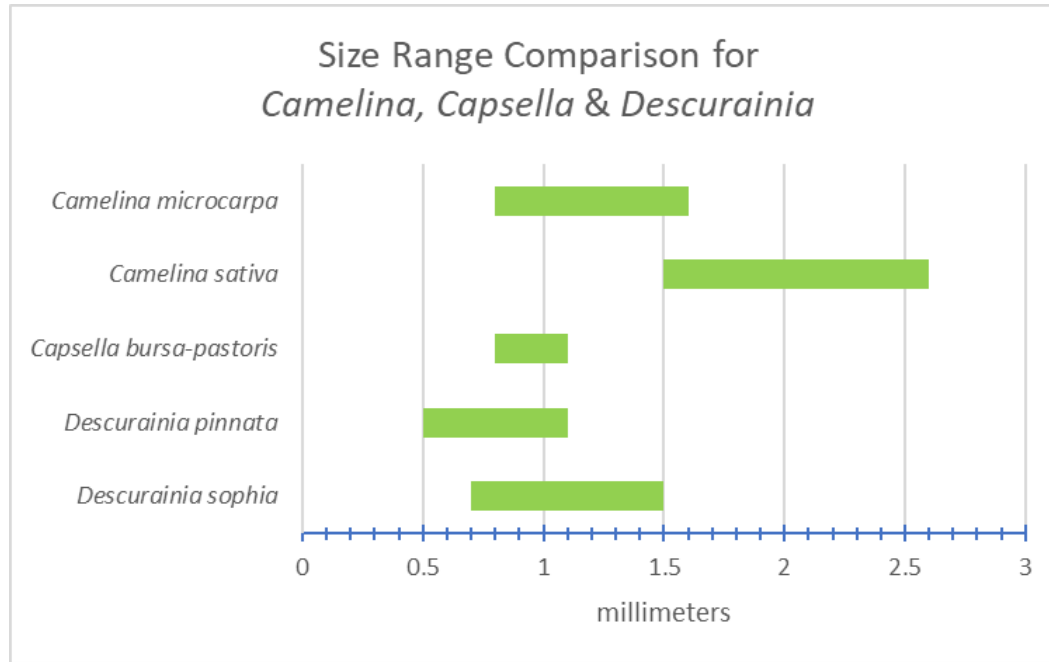
USDA, NRCS. 2021.



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Figure 6 from Murley, 1951

Comparison



Camelina microcarpa
Littleseed falseflax



Camelina sativa
Bigseed falseflax



Capsella bursa-pastoris
shepherd's-purse



Descurainia pinnata
tansymustard



Descurainia sophia
flixweed

Sisymbrium

- 41 species worldwide
- 8 species in the US and Canada



Sisymbrium altissimum L.

tumble mustard

Size: length 0.8-1.3 mm; width 0.5-0.8 mm

Shape: variable based on position in fruit, oblong to rectangular; rounded or flat on one side and rounded or transversely bent on the other side; not winged

Radicle: equal to or longer than cotyledon lobe; radicular ridge usually prominent

Primary & secondary grooves: evident on one side, primary groove only +/- evident on other side

Seed coat texture: shallowly pitted, covered with fine parallel lines or grooves on at least one side, warty on remaining surface; greasy in appearance; mucilaginous when wet

Color: yellow-, green-, or orange-brown; edges of cotyledons darker and visible through seed coat as longitudinal lines

Funicular tissue: may remain attached; white

Cotyledons: incumbent

Fruit: silique, long linear, with two dehiscent valves, each with a single row of seeds, 90-120 seeds per fruit

Distribution: native to temperate and tropical Asia and Europe; introduced in North America

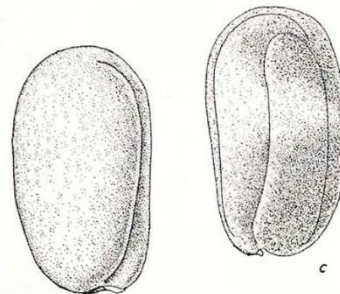


Figure 4 from Murley, 1951

Sisymbrium irio L.

London rocket

Size: length 0.7-1.5 mm; width 0.4-0.7 mm

Shape: oval to oblong; slightly compressed laterally; not winged

Radicle: usually longer than cotyledon lobe, the tip curves toward the cotyledon lobe; +/- slightly twisted, the tip +/- broader than mid-point

Primary groove: visible

Seed coat texture: smooth to wavy, lustrous to glossy, occasionally warty with dried mucilage

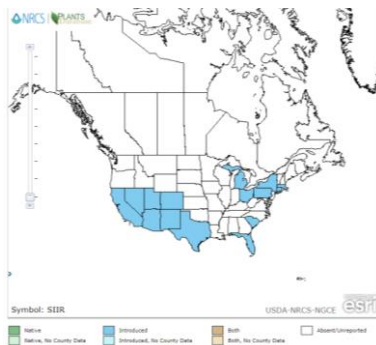
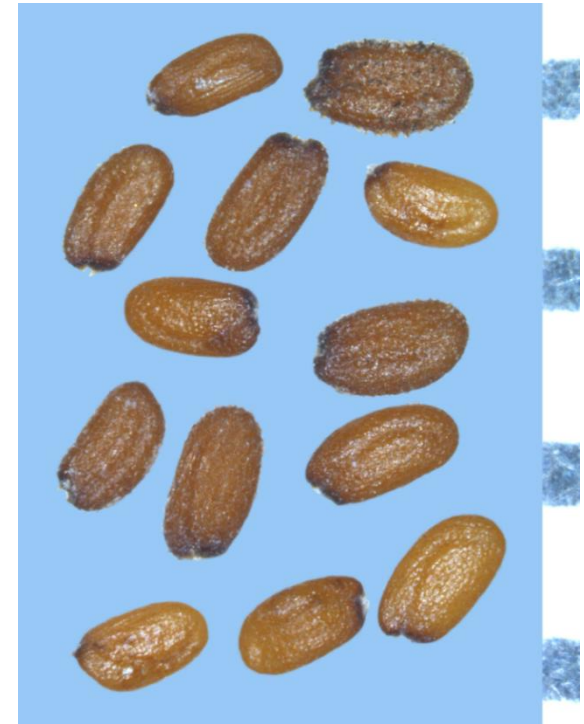
Color: yellow, orange-brown; hilar area red

Funicular tissue: may remain attached; white

Cotyledons: incumbent

Fruit: silique, long linear, with two dehiscent valves, each with a single row of seeds, 40-90 seeds per fruit

Distribution: native to Africa, temperate and tropical Asia, and Europe; introduced in parts of North America



USDA, NRCS. 2021.



Sisymbrium loeselii L.

tall hedge mustard

Size: length 0.6-1.3 mm; width 0.4-0.8 mm

Shape: oval to oblong, apex rounded to obliquely angled; not winged

Radicle: longer than cotyledon lobe; +/- twisted longitudinally

Primary groove: visible; secondary groove +/- visible

Color: yellow, orange, light brown; reddish brown at hilar end

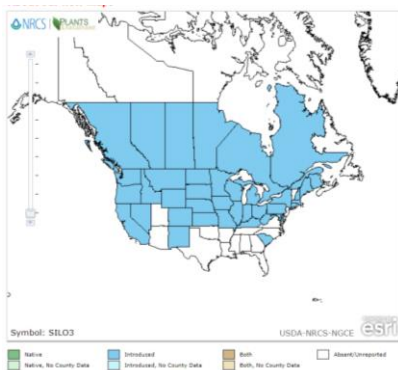
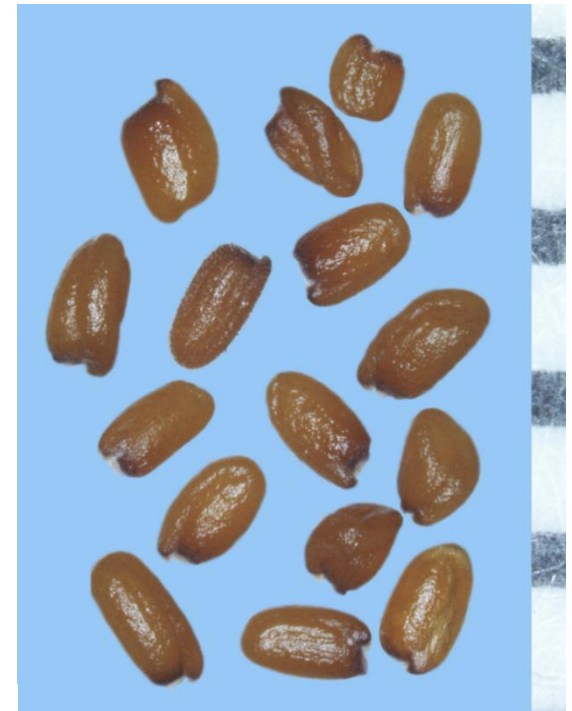
Seed coat texture: minutely pitted, smooth to wavy, glossy; occasionally warty with dried mucilage

Funicular tissue: may remain attached; white

Cotyledons: incumbent

Fruit: silique, long linear, with two dehiscent valves, each with a single row of seeds, 40-60 seeds per fruit

Distribution: native to temperate and tropical Asia and Europe; introduced in North America



USDA, NRCS. 2021.

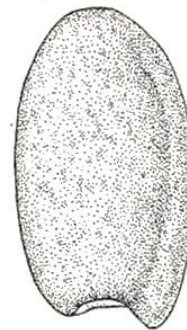


Figure 5 from Murley, 1951

Sisymbrium officinale (L.) Scop. hedge mustard

Size: length 0.8-1.5 mm; width 0.5-0.9 mm

Shape: variable related to position in fruit, generally oblong, but can be transversely ridged, angular, flat, or twisted; apex rounded, squared, or angled; not winged

Radicle: equal to or longer than length of cotyledon lobe; radical ridge +/- prominent

Primary groove: visible; secondary groove usually not visible

Color: yellow, gray-yellow, olive green, gray, greenish-brown, reddish brown; dull to slightly lustrous

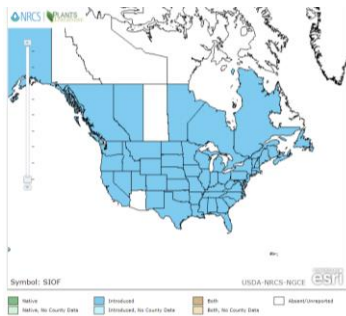
Seed coat texture: minutely pitted, finely ridged or grooved, greasy in appearance; sometimes warty or crusty with dried mucilage

Funicular tissue: may remain attached; white

Cotyledons: obliquely incumbent

Fruit: silique, narrowly triangular, with two dehiscent valves, each with a single row of seeds, 10-20 seeds per fruit

Distribution: native to northern Africa, temperate and tropical Asia, and Europe; introduced in North America



USDA, NRCS. 2021.

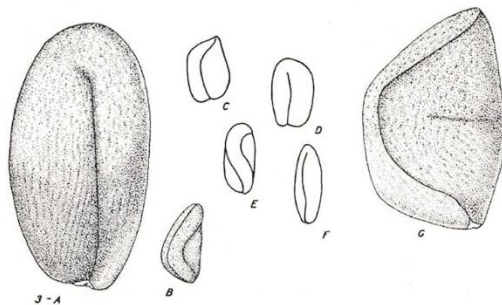
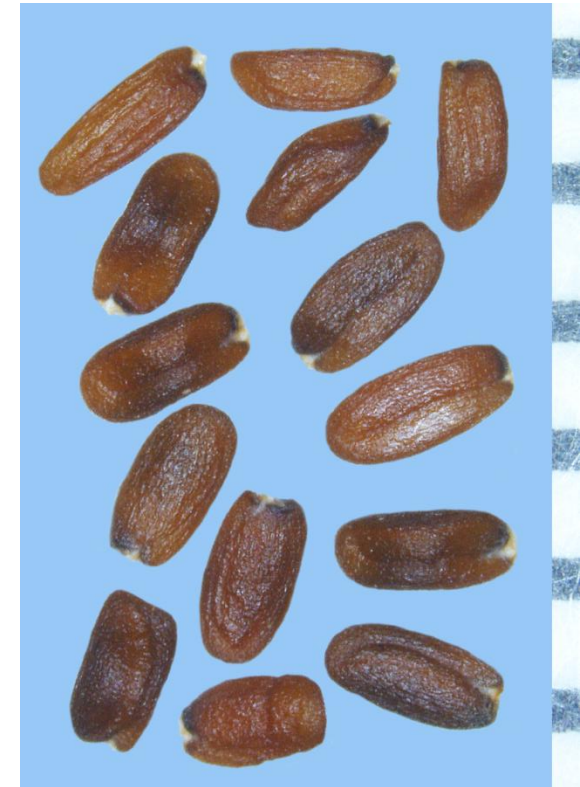
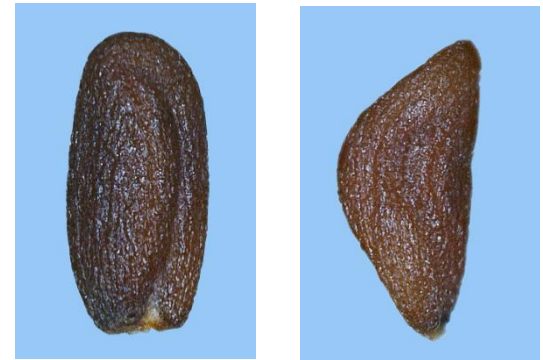
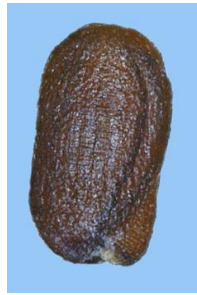


Figure 3 from Murley, 1951



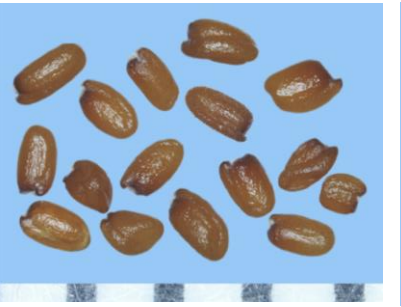
Comparison



Sisymbrium altissimum
Tumble mustard



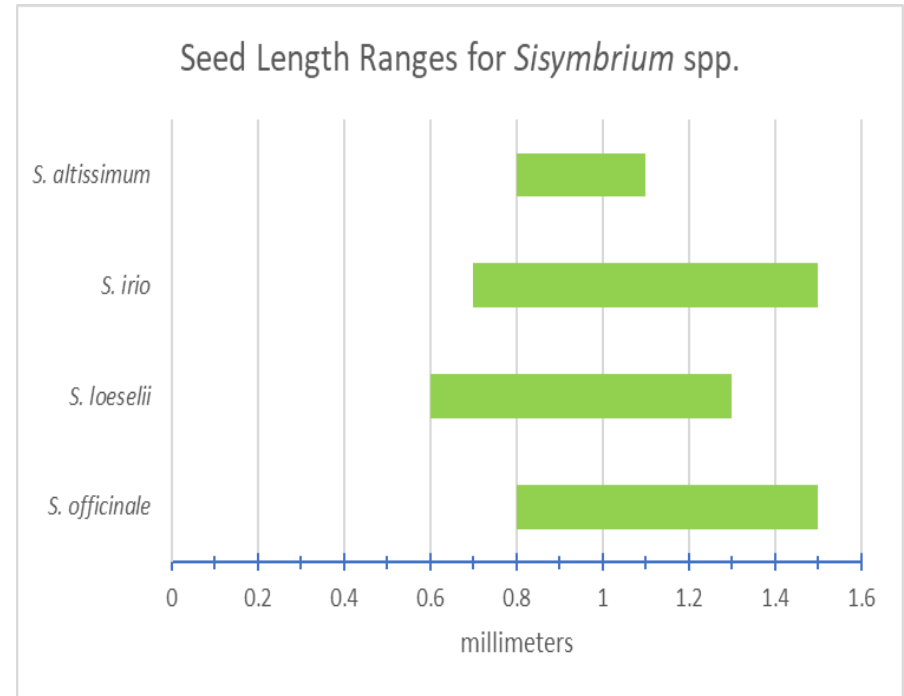
Sisymbrium irio
London rocket



Sisymbrium loeselii
Tall hedge mustard



Sisymbrium officinale
Hedge mustard



Lepidium

- About 220 species of *Lepidium*.
- 42 species occurring in North America.
- *Coronopus* and *Cardaria* now placed under *Lepidium*. [Al-Shehbaz, I., Mummenhoff, K., & Appel, O. (2002). *Cardaria*, *Coronopus*, and *Stroganowia* are United with *Lepidium* (Brassicaceae). *Novon*, 12(1), 5-11. doi:10.2307/3393229]

Lepidium campestre (L.) W. T. Aiton

field peppergrass, field peppergrass, field pepperweed

Size: length 2.0-3.0 mm; width 1.1-2.0 mm

Shape: egg-shaped to oval, pointed at hilum end, not winged

Radicle: forming a wide ridge; equal in length to cotyledon lobe

Primary groove: visible, shallow, marked with a light-colored line

Seed coat texture: tuberculate - covered with rounded or pointed bumps; dull; can be encrusted with dried mucilage; copiously mucilaginous when wet

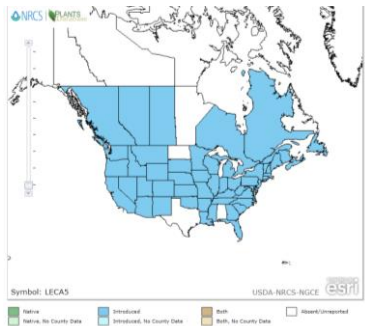
Color: reddish-brown to grayish-black

Funicular tissue: usually remaining attached; yellow

Cotyledons: incumbent

Fruit: silicles, apically winged, valves papillate, dehiscent, 2 seeds per fruit

Distribution: native to temperate Asia and Europe; introduced in North America



USDA, NRCS. 2021.

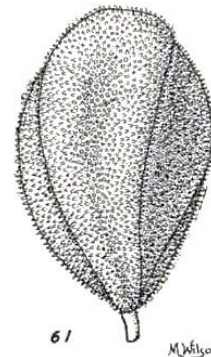


Figure 61 from Murley, 1951



Lepidium densiflorum Schrad.

prairie pepperweed, greenflowered pepperweed

Size: length 1.1-1.6; width 0.7-0.9 mm

Shape: egg-shaped to oval; strongly compressed laterally, wedge-shaped in cross-section; narrowly winged at apex and base and extending down the radicle ridge margin

Radicle: equal in length to cotyledon lobe

Primary groove: visible

Seed coat texture: dull to lustrous, minutely tuberculate; copiously mucilaginous when wet

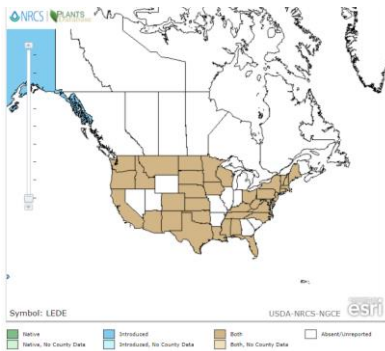
Color: Orange-brown

Funicular tissue: usually remaining attached; yellow

Cotyledons: incumbent

Fruit: silicles, narrowly winged apically, dehiscent, 2 seeds per fruit

Distribution: native to North America; introduced elsewhere.



USDA, NRCS. 2021.



Lepidium latifolium L.

perennial peppergrass, perennial pepperweed, tall whitetop

Size: length 0.8-1.3; width 0.5-1.0 mm

Shape: oval to oblong; not winged; laterally compressed; seed coat extensions at tips of radicle and cotyledon lobes forming a claw shape

Primary groove: visible; secondary groove +/- visible

Radicle: slightly longer than cotyledon lobe

Seed coat texture: grainy to minutely tuberculate; copiously mucilaginous when wet

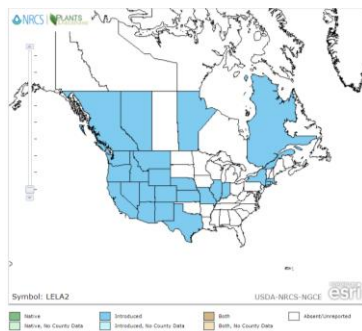
Color: light brownish orange; darkened seed coat extension at tips of radicle and cotyledon lobes

Funicular tissue: remaining attached; yellow

Cotyledons: incumbent

Fruit: silicles, dehiscent, 2 seeds per fruit

Distribution: native to northern Africa, temperate and tropical Asia and Europe; introduced in North America



USDA, NRCS. 2021.



Figure 37 from Murley, 1951



Lepidium perfoliatum L.

clasping pepperweed, perfoliate pepperweed

Size: length 1.6-2.8 mm; width 1.1-2.0 mm

Shape: oval to egg-shaped; laterally compressed; winged along entire margin or reduced to only along the radical ridge

Radicle: shorter than cotyledon lobe

Primary groove: visible, marked by light-colored line; thin dark line follows primary groove and forms a hook near apical end of seed

Color: dark red- or orange-brown with lighter colored wing

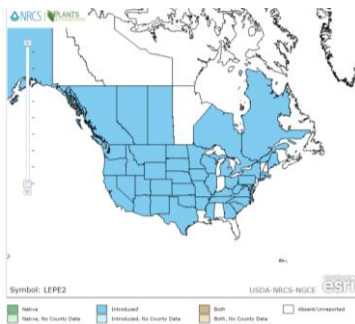
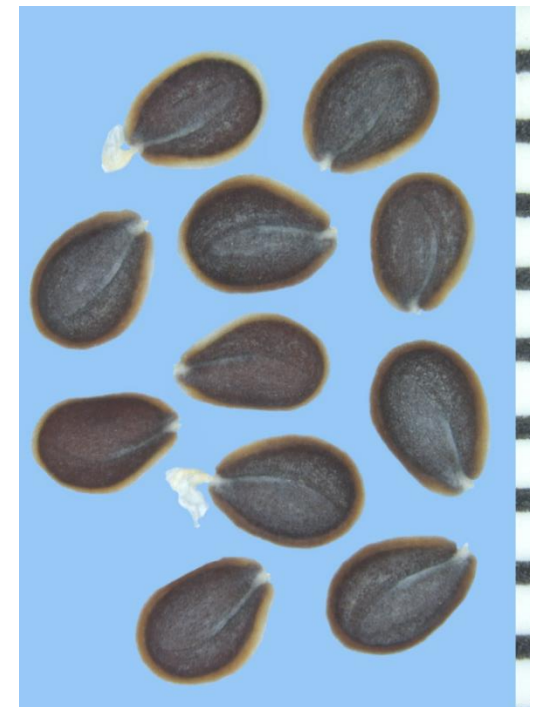
Seed coat texture: sugary granular with delicate light-colored reticulum and dark-colored interspaces or pits; copiously mucilaginous when wet

Funicular tissue: remaining attached; white

Cotyledons: incumbent

Fruit: silicles, dehiscent, 2 seeds per fruit

Distribution: native to temperate and tropical Asia and Europe; introduced in North America



USDA, NRCS. 2021.

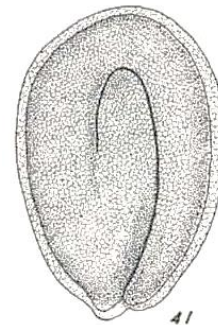


Figure 41 from Murley, 1951

Lepidium sativum L.

gardencress

Size: length 2.0-3.2 mm; width 1.0-1.8 mm

Shape: narrowly oval, oblong, or slightly obovate; slightly compressed, ovate to triangular in cross-section; +/- narrowly winged at apex and along radicle margin

Radicle: equal to or slightly longer than cotyledon lobe

Primary & secondary groove: primary deep; secondary groove indistinct and forked indicating the bifid or trifold cotyledons

Seed coat texture: grainy and with very small uneven ridges; mucilaginous when wet

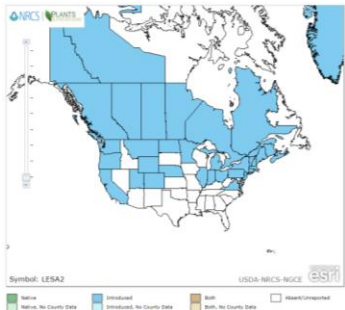
Color: red- or orange-brown

Funicular tissue: remaining attached; yellowish

Cotyledons: incumbent; each with two or three lobes

Fruit: silicles, dehiscent, 2 seeds per fruit

Distribution: native to northern Africa, temperate and tropical Asia; introduced in North America; cultivated as a salad green



USDA, NRCS. 2021.

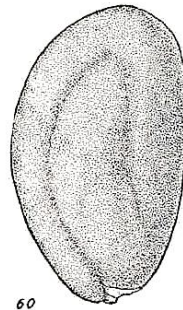
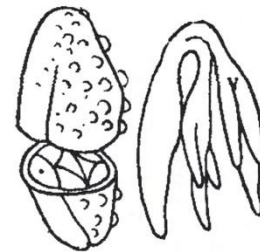


Figure 60 from Murley, 1951



Vaughan & Whitehouse, 1971

Lepidium virginicum L.

Virginia pepperweed

Size: length 1.3-2.1 mm; width 0.7-1.3 mm

Shape: irregularly egg-shaped, cotyledon margin +/- straight and radicle margin curved outward; laterally compressed, narrowly ovate in cross-section; winged at apex and base and narrowly winged along radicle margin

Radicle: equal to or shorter than cotyledon lobe

Primary & secondary groove: primary visible; secondary groove indistinct

Seed coat texture: dull, minutely tuberculate; copiously mucilaginous when wet

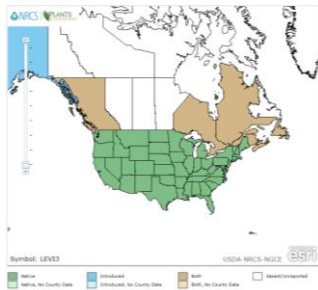
Color: orange to brown with light golden yellow wing and seed coat extensions at tip radicle and cotyledon lobes

Funicular tissue: may remain attached; yellow

Cotyledons: accumbent, incumbent, or oblique

Fruit: silicles, dehiscent, 2 seeds per fruit

Distribution: native to North and Central American and the Caribbean; introduced and naturalized elsewhere



USDA, NRCS. 2021.

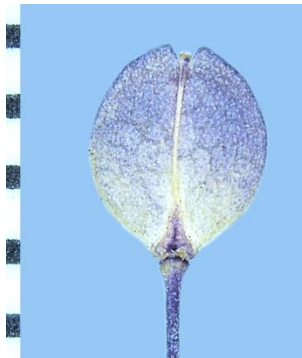
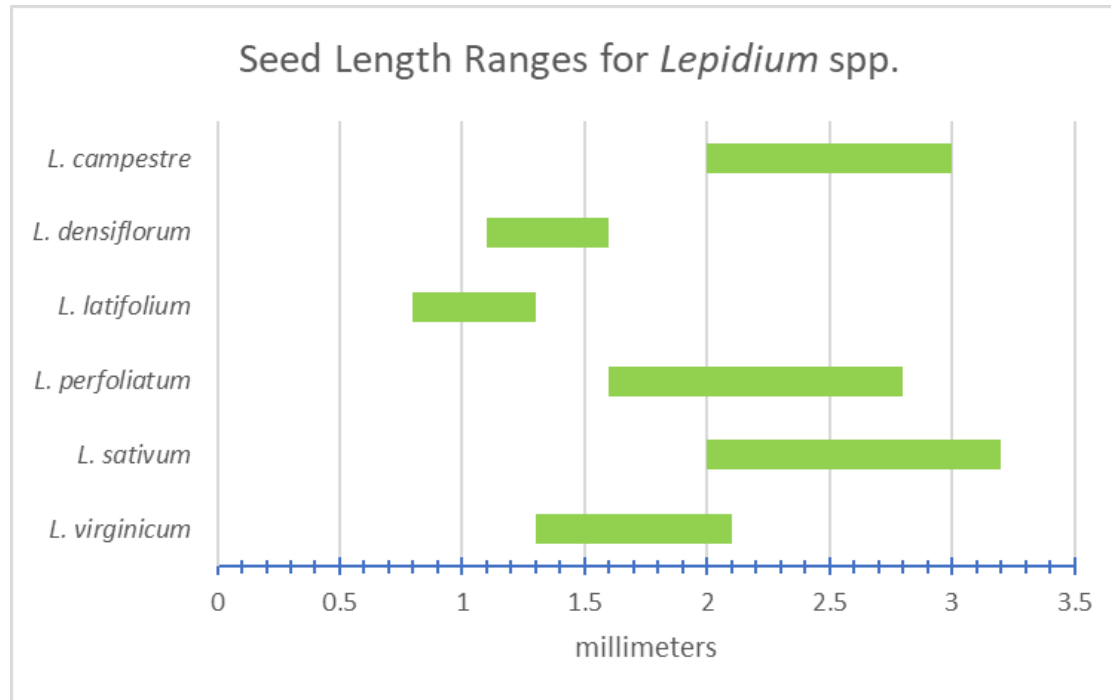


Figure 40 from Murley, 1951

Comparison



Lepidium campestre
Field peppergrass



Lepidium densiflorum
Prairie pepperweed



Lepidium latifolium
Perennial peppergrass



Lepidium perfoliatum
Clasping pepperweed



Lepidium sativum
garden cress



Lepidium virginicum
Virginia pepperweed

Comparison

<i>Capsella bursa-pastoris</i> Shepherd's-purse	0.8-1.1 mm long	0.3-0.7 mm wide	Apex rounded; seed uniformly flattened	Reticulum irregular; interspaces rounded or rectangular	White funicular tissue visible
<i>Descurainia sophia</i> flixweed	0.7-1.5 mm long	0.3-0.7 mm wide	Apex rounded or angular; seed +/- twisted longitudinally	Reticulum ladder-like; interspaces rectangular	White funicular tissue visible
<i>Lepidium latifolium</i> Perennial peppergrass	0.8-1.3 mm long	0.5-1.0 mm wide	Apex rounded	Minutely tuberculate	Seed coat extensions at tips of radicle & cotyledon forming a claw shape; funicular tissue yellow



Coronopus → *Lepidium*

Lepidium coronopus (L.) Al-Shehbaz

[*Coronopus procumbens* Gilibert; *C. squamatus* (Forssk.) Asch.; *L. squamatum* Forssk.]

swinecress (creeping wartcress)

Size: length 1.0-2.1 mm; width 0.7-1.4 mm

Shape: oblong egg-shaped, laterally compressed; curved along radicle side of seed; not winged

Radicle: longer than cotyledon lobe

Primary groove: visible; secondary groove +/- visible

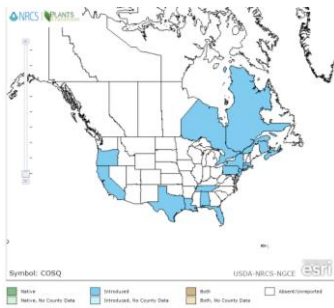
Seed coat texture: irregularly reticulate and warty; not mucilaginous when wet

Color: light yellowish brown

Cotyledons: incumbent and transversely folded at about the first quarter of the cotyledons

Fruit: indehiscent, kidney- to inverted-heart-shaped, 1.9-3.4 × 2-4.4 mm, valves thick with distinct ridges and projections, prominently veined, glabrous; straw-colored, sometimes with greenish tinge; a single seed usually remains in each half of fruit

Distribution: native to northern Africa, temperate Asia, and Europe; introduced in North America



USDA, NRCS. 2021.

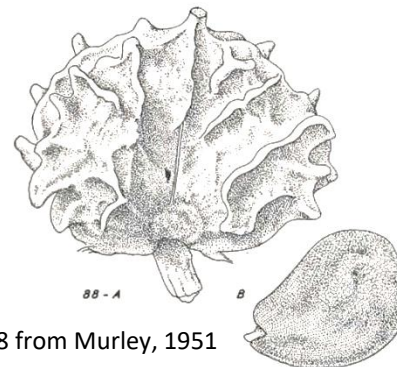


Figure 88 from Murley, 1951



Lepidium didymum L.

[*Coronopus didymus* (L.) Sm.]

wartcress

Size: length 1-1.4 mm; width 0.7-1.0 mm

Shape: ovate to kidney-shaped; laterally compressed; not winged

Radicle: longer than cotyledon lobe

Primary & secondary grooves: visible

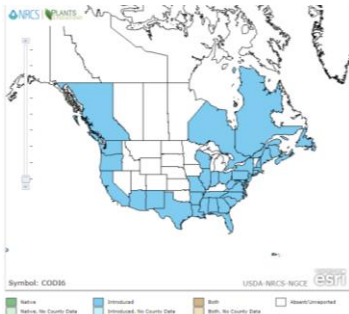
Seed coat texture: reticulate; not mucilaginous when wet

Color: light yellowish brown

Cotyledons: incumbent and transversely folded below the mid-point of the cotyledons

Fruit: indehiscent, bi-lobed, notched at apex, 1.5-2.2 mm × 2-2.75 mm; surface irregularly ridged and strongly veined; dispersal unit is a 1-seeded segment.

Distribution: native to South America; introduced in North America and elsewhere around the world



USDA, NRCS. 2021.

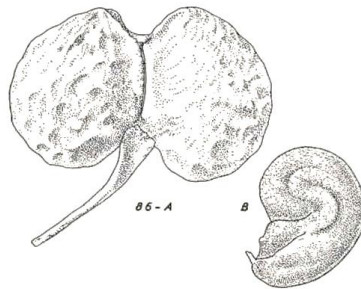
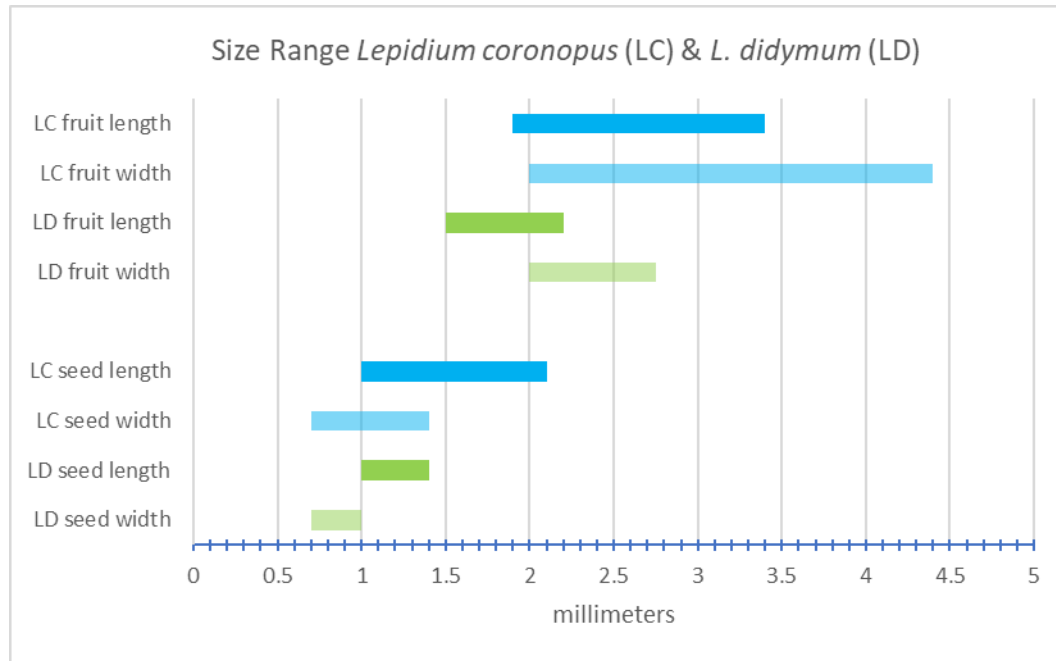


Figure 86 from Murley, 1951



Steve Hurst, ARS Systematic Botany and Mycology Laboratory.
<https://plants.usda.gov/home/plantProfile?symbol=CODI6>

Comparison



Lepidium coronopus, swinecress



Lepidium didymum, wartcress



Cardaria → *Lepidium*

Lepidium appelianum Al-Shehbaz

[*Cardaria pubescens* (C. A. Mey.) Jarm.]

globe-podded hoary cress, ball cress, hairy whitetop

Size: length 1.5-3.0 mm; width 1-2.25 mm

Shape: oval to egg-shaped; slightly laterally compressed, oval in cross-section, cotyledon lobe and radicle ridge similar thickness; not winged

Radicle: equal to or shorter than cotyledon lobe

Primary groove: mostly indistinct, +/- darker in color

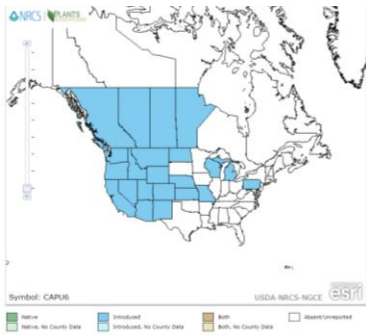
Seed coat texture: granulate, indistinct reticulate; mucilaginous when wet

Color: orange red to dark reddish brown

Funicular tissue: usually remaining attached; yellow

Fruit: indehiscent, globose, densely puberulent, 2 seeds per fruit

Distribution: native to temperate and tropical Asia; introduced in North America



USDA, NRCS. 2021.



Lepidium chalepense L.

[*Cardaria chalepensis* (L.) Hand.-Mazz.; *C. draba* (L.) Desv. var. *repens* (Schrenk ex Fisch. & C. A. Mey.) O. E. Schulz, and others – see GRIN database]

lens-podded hoarycress, perennial peppergrass

Size: length 1.5-3.0 mm; width 1.0-2.0 mm

Shape: oval to egg-shaped; slightly laterally compressed, egg-shaped in cross-section, cotyledon lobe thicker than radicular ridge; not winged

Radicle: equal to or shorter than cotyledon lobe

Primary groove: mostly indistinct, +/- darker in color

Seed coat texture: granulate, indistinct reticulate; mucilaginous when wet

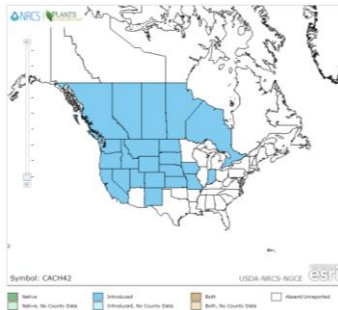
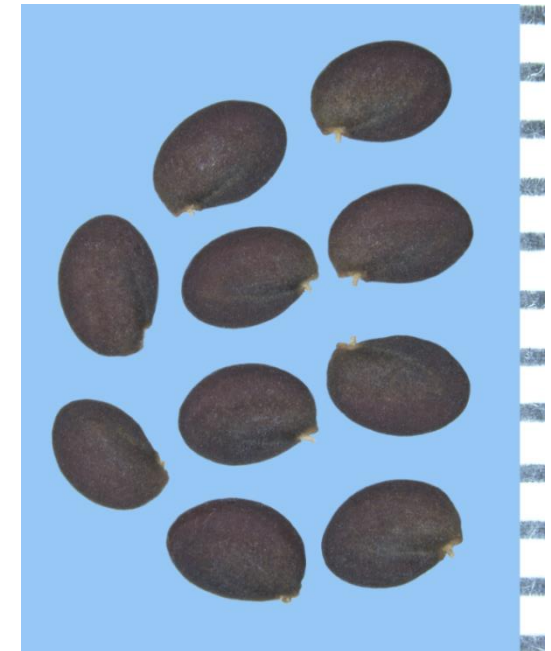
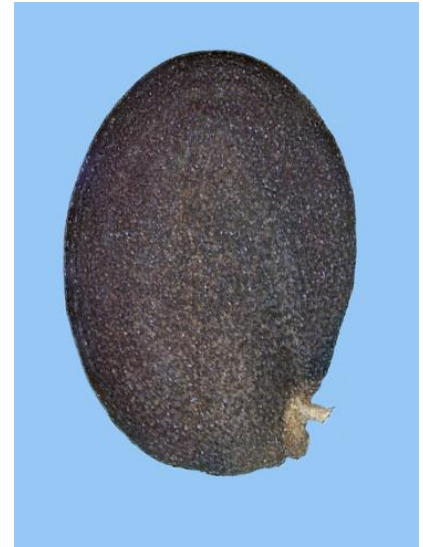
Color: orange red to dark reddish brown

Funicular tissue: usually remaining attached; yellow

Cotyledons: incumbent

Fruit: indehiscent, broadly obovate to nearly round in outline, +/- compressed, glabrous, 2-4 seeds per fruit

Distribution: native to temperate and tropical Asia; introduced in North America



USDA, NRCS. 2021.



Lepidium draba L.

[*Cardaria draba* (L.) Desv.]

heart-podded hoarycress; whitetop

Size: length 1.5-3.0 mm; width 0.8-2.0 mm

Shape: oval to egg-shaped; slightly laterally compressed, egg-shaped in cross-section, cotyledon lobe thicker than radicular ridge; not winged

Radicle: equal to or shorter than cotyledon lobe

Primary groove: mostly indistinct, +/- darker in color

Seed coat texture: granulate, indistinctly reticulate; mucilaginous when wet

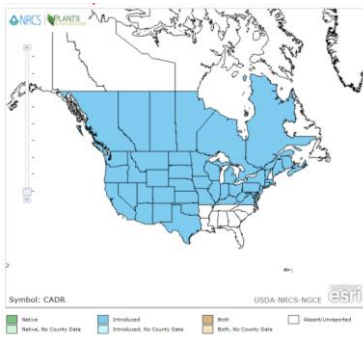
Color: orange red to dark reddish brown

Funicular tissue: usually remaining attached; yellow

Cotyledons: incumbent

Fruit: indehiscent, inverted heart-shaped, veined, glabrous, 2 seeds per fruit

Distribution: native to northern Africa, temperate and tropical Asia and Europe; introduced in North America



USDA, NRCS. 2021.



Figure 57 from Murley, 1951



Comparison of Hoary Cress Species

Lepidium appelianum
Globe-podded hoary cress



1.5-3 mm
long

1-2.25
mm wide

Uniformly thick

Lepidium chalepense
Lens-podded hoary cress



1.5-3 mm
long

1-2 mm
wide

Cotyledon lobe
thicker than
radicular ridge

Lepidium draba
Heart podded hoary cress



1.5-3 mm
long

0.8-2 mm
wide

Cotyledon lobe
thicker than
radicular ridge



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