Herald

Plant Biology
SC/BIOL 2010

GO Green

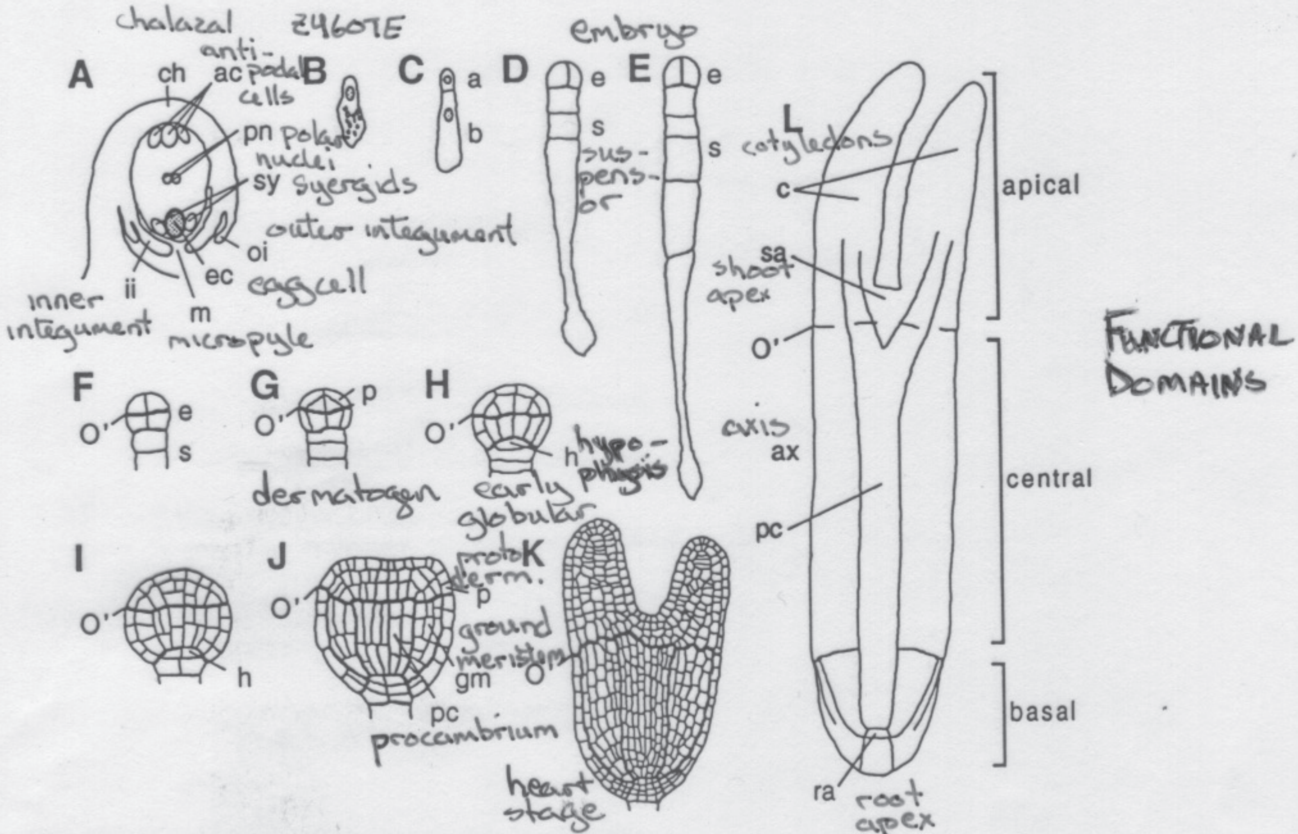

Figure 1. Embryonic Development in a Representative Dicotyledonous Plant.

(A) Ovule. The egg cell (ec) and synergids (sy) are located at the micropylar end (m) of the ovule, and the antipodal cells (ac) are at the chalazal end (ch). ii, inner integuments; oi, outer integuments; pn, polar nuclei.
(B) Zygote.
(C) One-celled embryo proper. The zygote has undergone a transverse cell division, producing a smaller apical cell (a) and a larger basal cell (b). The apical cell produces the embryo proper, and the basal cell develops into the suspensor and hypophysis.
(D) Two-celled embryo proper. The first division of the embryo proper (e) is longitudinal. The suspensor (s) has divided by transverse divisions.
(E) Quadrant stage embryo. The two-celled embryo proper divides by another longitudinal division, perpendicular to the plane of the previous division in the embryo, to produce a four-celled embryo proper. The suspensor has undergone additional transverse divisions.
(F) Octant stage embryo. The four quadrants have divided by transverse divisions to produce an eight-celled embryo proper. The transverse cell walls produced in this division form the indicated O′ line. The basal portion of the suspensor is not shown.
(G) Dermatogen stage. The cells of the octant stage embryo have divided by cleavages parallel to the surface to form a sixteen-celled embryo proper, setting apart the protoderm (p).
(H) Early globular stage. The cells of the protoderm have undergone divisions perpendicular to the surface. The interior cells of the embryo proper have undergone additional longitudinal divisions. The topmost cell of the suspensor has divided transversely to produce the hypophysis (h).
(I) Mid-globular stage. The cells of the hypophysis have divided longitudinally. The cells in the interior of the embryo proper have divided both longitudinally and transversely, while the protodermal cell divisions have continued.
(J) Transition stage. Cell divisions parallel to the surface indicate the emergence of the cotyledon buttresses as the apical pole of the embryo becomes broader. The developing procambium (pc) becomes visible as elongated cells at the center of the embryo. gm, ground meristem.
(K) Heart stage. Cotyledonary lobes continue to enlarge, making the change to bilateral symmetry more obvious. The O′ line is still recognizable.
(L) Linear cotyledon stage. The morphological organization of the embryo is shown. The apical domain comprises the cotyledons (c), the shoot apex (sa), and the upper axis; the central domain consists of the bulk of the axis (ax); and the basal domain includes the root apex (ra). The developing vascular tissue forks just below the O′ boundary.
(B) through **(L)** depict oilseed rape embryos and are adapted from Tykarska (1976, 1979). Drawings are not to scale.

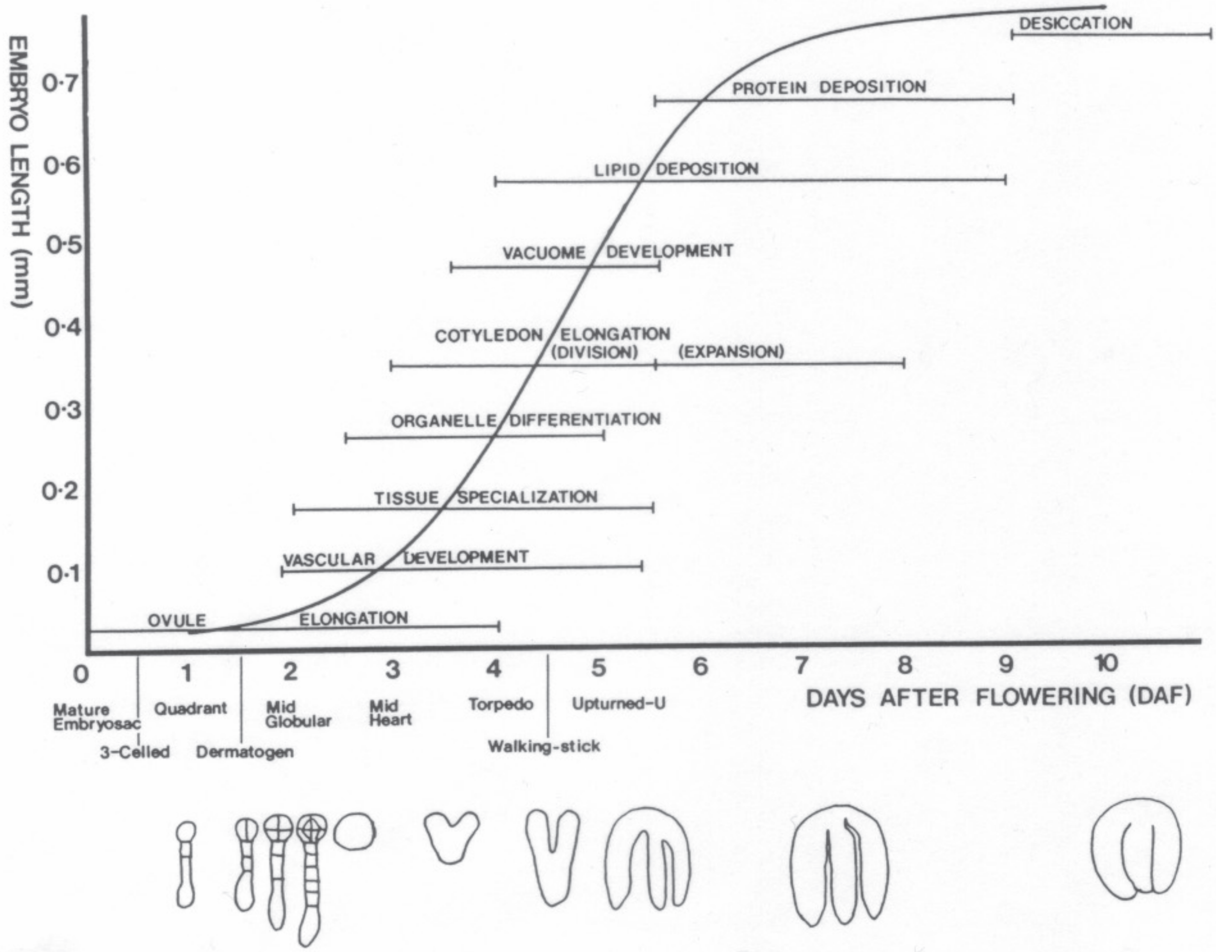

Figure 1. Summary of embryogenesis of *Arabidopsis*. Stages of embryo development and cellular differentiation within the developing embryo related to days after flowering. Flowering is defined as the time the length of the medial (long) stamens exceeds that of the gynoecium. It is essentially the time of pollination [stage 14, as defined by Müller (1961) and Smyth et al. (1990)]. Plants were grown under continuous lighting at 25°C and 70% humidity, and embryos examined were taken from the middle of the silique of the third to seventh flowers on the main flowering stem (Mansfield et al., 1991).

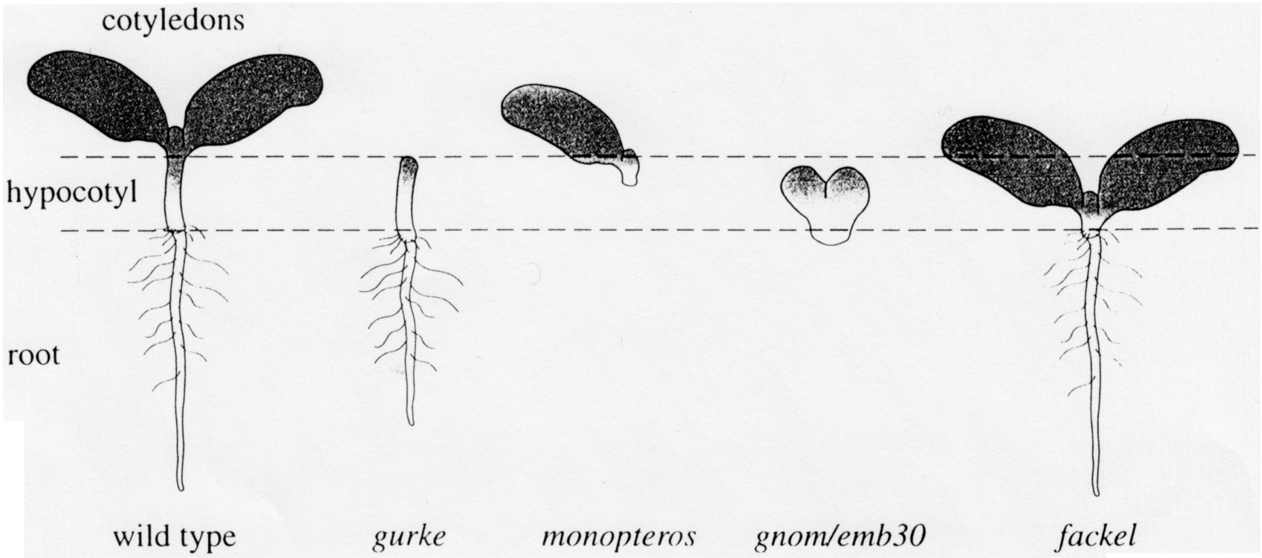

Figure 5.4 Seedling phenotypes of some *Arabidopsis* embryonic pattern mutants. With the exception of *gnom/emb30*, mutants are interpreted to have deletions of various segments along the apical–basal axis of the embryo. The mutant *gnom/emb30* is thought to have defects in establishing an apical–basal axis.

Fruit Key[1]

1A. Fruits fleshy:
- 2A. Fruit simple (true, derived from a flower with 1 pistil
  - 3A. 1 seed enclosed in bony endocarp (pit) —**drupe**— peach, cherry, plum, olive, coconut
  - 3B. more than 1 seed:
    - 4A. no bony, leathery or papery endocarp (berries):
      - 13A. ovary superior:
        - 14A. thin skin —**true berries**— tomato, grape, coffee
        - 14B. leathery skin with oils (Citrus family) —**hesperidium**— all citrus fruits
      - 13B. ovary inferior, fruit with rind (Gourd family) —**pepo**— cucmber, watermelon, pumpkin, squash
    - 4B. leathery or papery endocarp, inferior ovary —**pome**— apple, pear
- 2B. Fruit compound (false), derived from more than 1 pistil:
  - 5A. fruit derived from 1 flower with more than 1 pistil —**aggregates**— strawberry, rose hip, raspberry
  - 5B. fruit drived from more than 1 flower —**multiple fruits**— pineapple, sweetgum, fig, mulberry

1B. Fruits dry:
- 6A. indehiscent:
  - 7A. fruits with a wing —**samara with a wing**— ash, maple, tulip tree
  - 7B. fruits without a wing:
    - 8A. with a hard shell —**nut**— acorn, macadamia
    - 8B. without a hard shell:
      - 9A. pericarp fused entirely to seedcoat (Grass Familty) —**caryopsis (grain)**— all cereals
      - 9B. pericarp not fused entirely to seedcoat —**achene**— sunflower
- 6B. dehiscent::
  - 10A. derived from several fused carpels, opening by slits, pores or a cap —**capsule**— cotton, poppy
  - 10B. derived from 1 or 2 fused carpels, dehiscing lengthwise
    - 11A. fruit with persistent septum (replum) (Mustard Family):
      - 15A. long and thin —**silique**— mustard
      - 15B. short and fat —**silicle**— shepherd's purse
    - 11B. no persistent sptum:
      - 12A. dehiscent along 1 edge —**follicle**— milkweed, magnolia
      - 12B. dehiscent along 2 edges (Legume Family) —**legume**— peanuts, all beans

[1] (source: http://arnica.csustan.edu/key/key2.html) (Dr. Steven J. Wolf, Professor of Botany, California State University, Stanislaus)

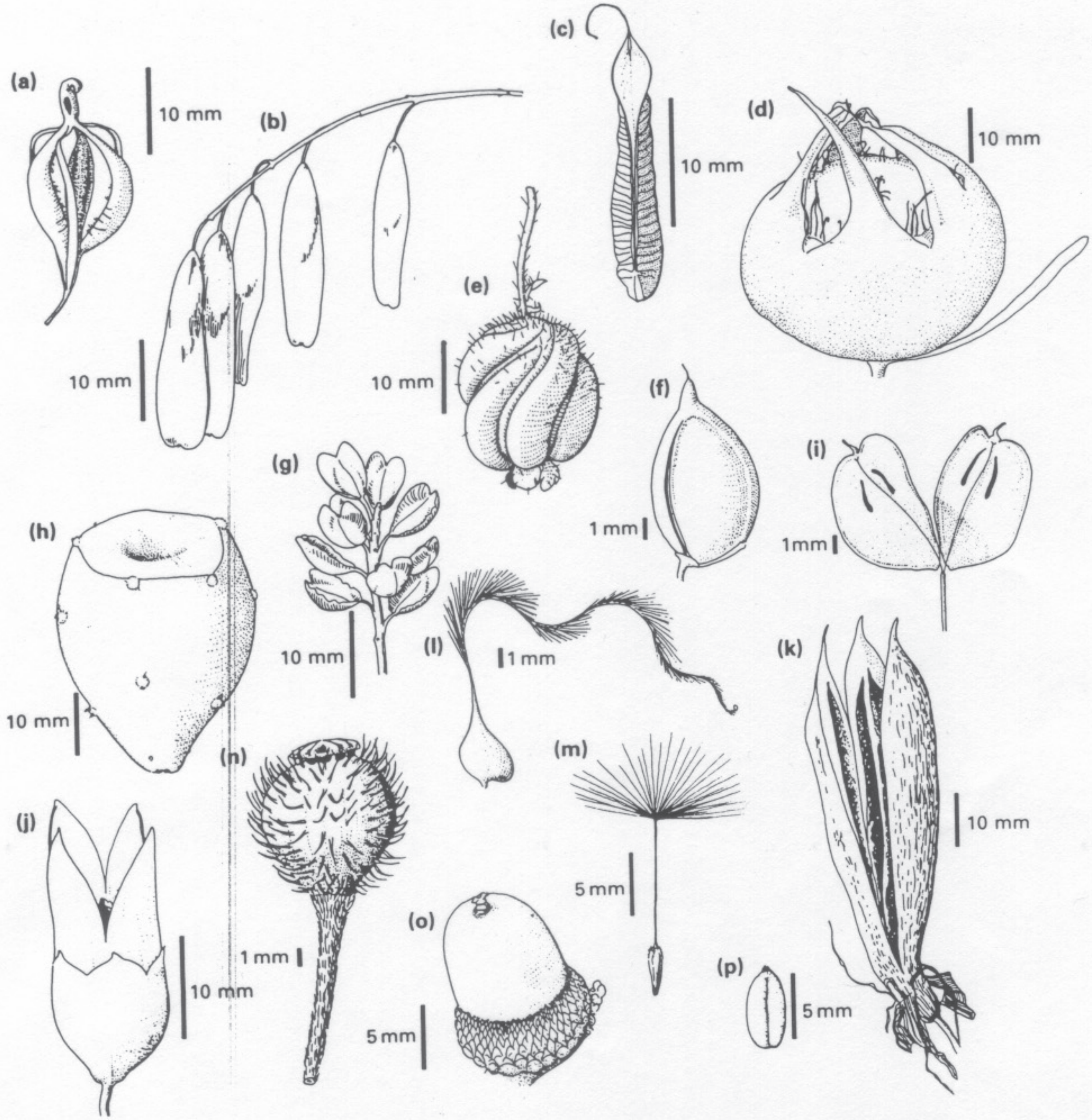

Fig. 155. a) *Epidendrum* sp., septifragal capsule; b) *Fraxinus excelsior,* samara; c) *Aquilegia vulgaris,* follicle; d) *Mespilus germanica*, pome; e) *Blumenbachia insignis*, septicidal capsule; f) *Carmichaelia australis*, legume; g) *Phlox* sp., silicle; h) *Opuntia* sp., berry; i) *Heracleum sphondylium*, schizocarp; j) *Vestia lycioides*, capsule; k) *Phormium tenax*, loculicidal capsule; l) *Clematis montana*, achene; m) *Taraxacum officinale*, achene, inferior ovary; n) *Papaver hybridum*, poricidal capsule;, o) *Quercus petraea*, nut; p) *Triticum aestivum*, caryopsis.

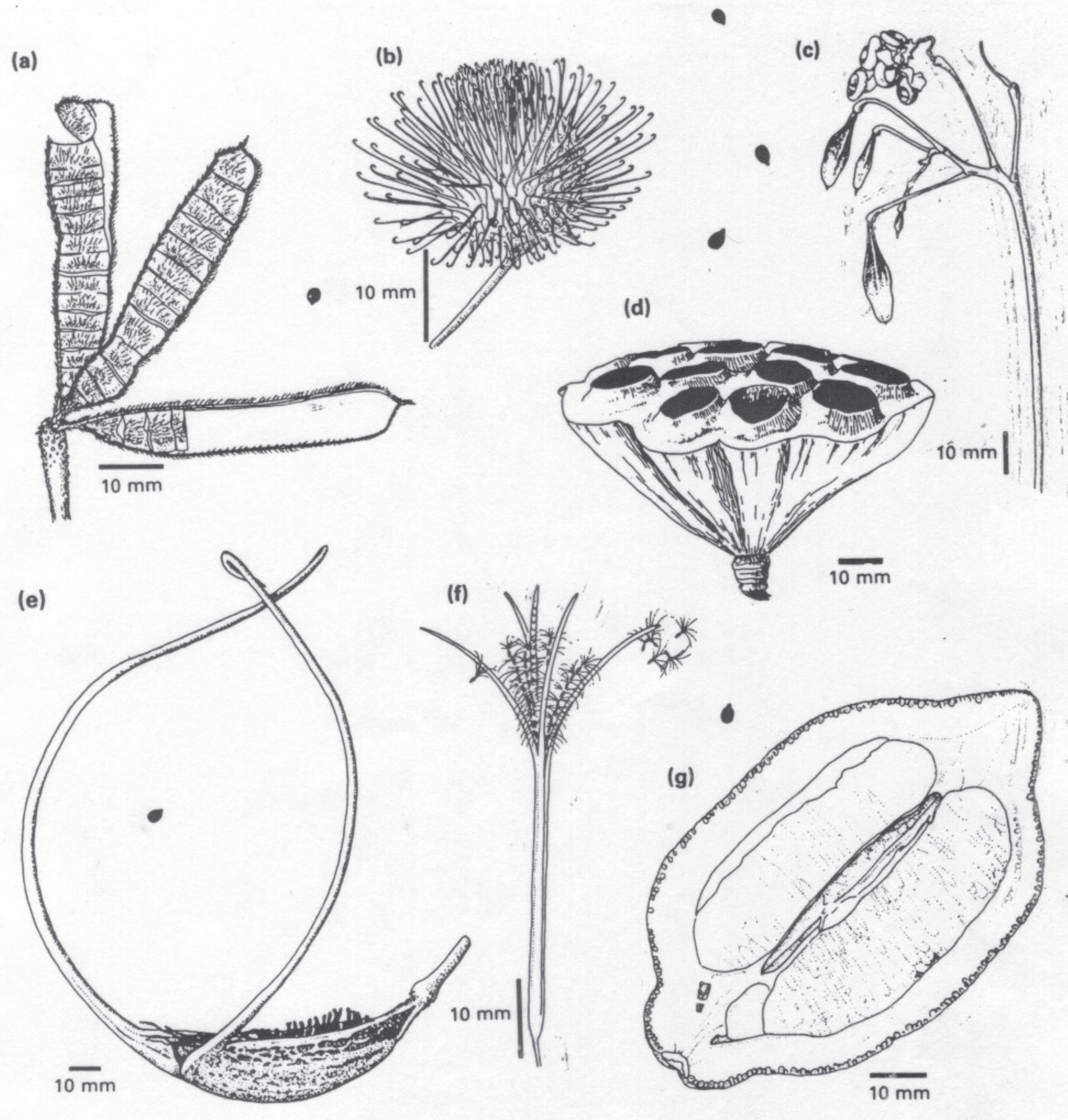

Fig. 161. a) *Mimosa berlandieri*, passive ballistics; b) *Arctium minus*, animal, hooked bracts; c) *Impatiens glandulifera*, active ballistics; d) *Nelumbo nucifera*, passive ballistics plus water; e) *Proboscidea louisianica*, animal, hooked fruit; f) *Epilobium montanum*, wind, seeds plumed; g) *Citrus limon*, animal, active, fleshy endocarp.

SOME MORE "BEAUTIFUL" EXAMPLES OF SEED STRUCTURES - - - -

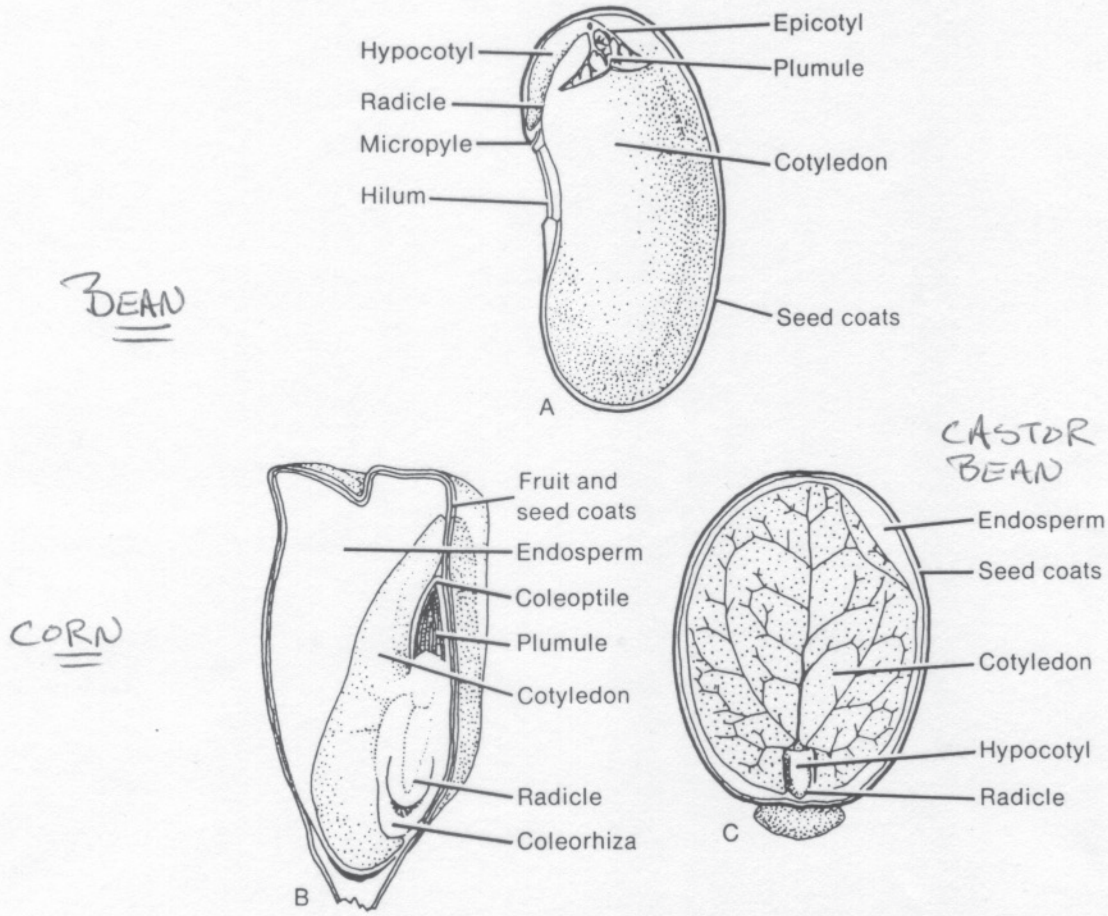

Figure 14-45. Sections through seeds of three types. **(A)** Bean seed, showing one of the two cotyledons. Endosperm is lacking in mature bean seeds. **(B)** A corn grain (caryopsis), characteristic of the grasses. The pericarp (matured ovulary wall) is fused with the seed coats, so a grain is both fruit and seed. The single cotyledon is also called the scutellum. **(C)** A castor bean seed, showing one of the two leafy cotyledons. Most of the accumulated food is in the endosperm. [After V. A. Greulach and J. E. Adams, *Plants: An Introduction to Modern Botany,* John Wiley & Sons, Inc., New York, 1967]

SOURCE: GREULACH, VA 1973 PLANT FUNCTION AND STRUCTURE. MACMILLAN.

Table 4-4. Viable Buried Seeds in Northern Hardwood Stands of Various Ages[a]

Bormann and Likens (1979) Pattern and Process in a Forested Ecosystem.

Species	Estimated Longevity of Dormant Seeds (yr)[b]	Number of Seeds (millions/ha)					
		Age of Stand in Years					
		5	15	20	30	60	>100
Red maple	3–15	—	—	—	0.1	0.2	—
Yellow or white birch	3–15	0.6	0.6	1.2	2.4	1.5	0.8
Erigeron sp.	< 3	9.3	0.1	—	—	—	—
Pin cherry	>15	0.2	—	0.2	—	0.2	0.1
Raspberry or blackberry	>15	0.1	4.9	1.2	1.3	2.6	3.5
Elderberry spp.	>15	1.1	0.2	1.0	—	0.2	0.8
Goldenrod spp.	< 3	—	0.3	0.1	—	—	—
Violet spp.	>15	—	0.3	—	0.1	—	—
Grasses spp.	>15	—	0.3	—	0.4	0.1	—
Sedges spp.	>15	3.8	6.4	0.1	2.0	0.1	—

[a] *Determined by germination of seeds contained in twenty 10×10-cm blocks cut out of the forest floor. Germination per block was very variable, ranging from zero to several orders of magnitude greater than the mean (S. Bicknell, unpublished data).*

[b] *Adapted from Harrington (1972).*

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Elderberry

Elderberry

Birch (*Betula*)

Birch (*Betula*)

sedge

sedge

goldenrod (*Solidago*)

goldenrod (*Solidago*)

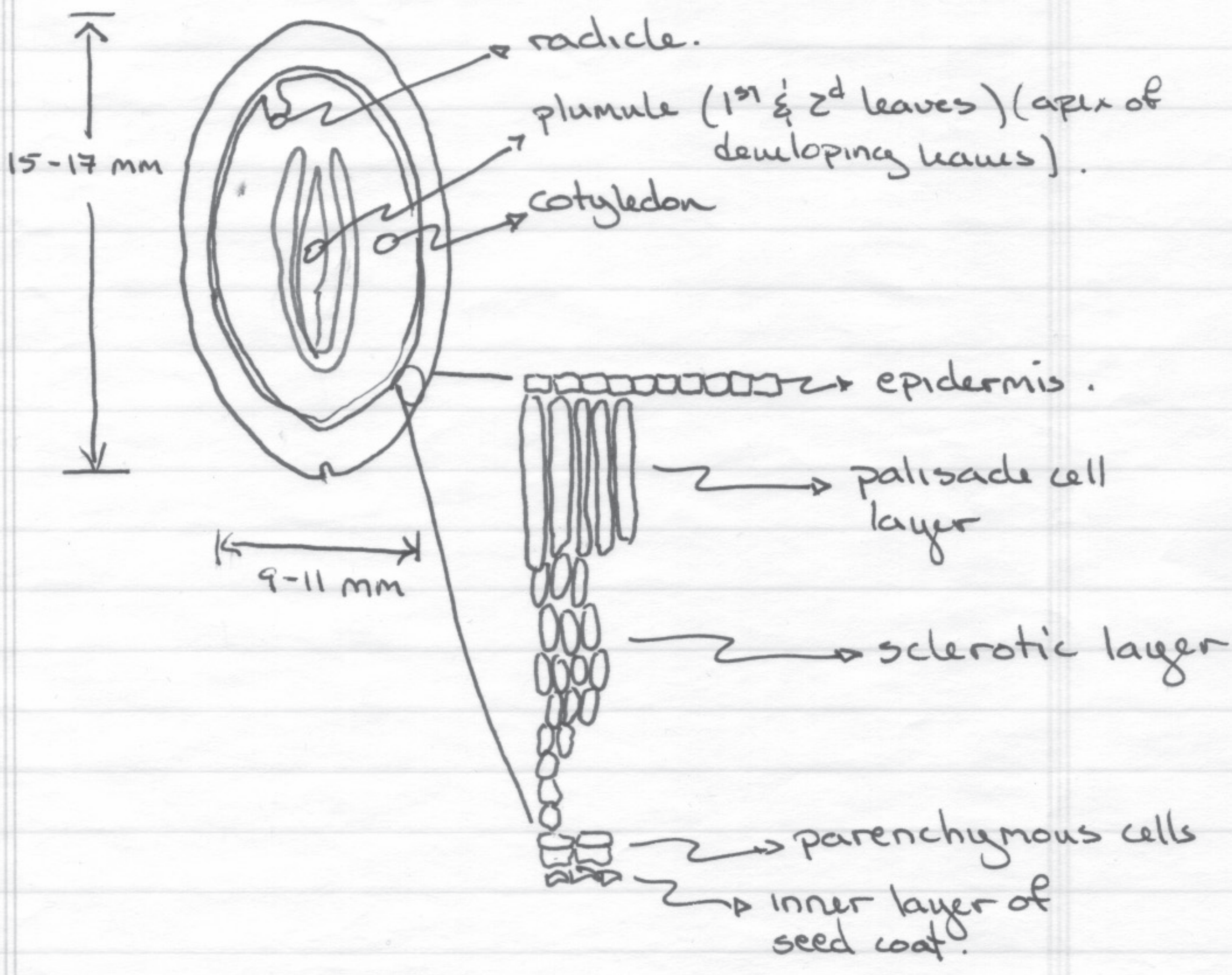
red maple (*Acer rubrum*)

red maple (*Acer rubrum*)

Impermeable seed coat: case study:
Indian Lotus (*Nelumbo nucifera*).

Lotus seeds, extracted from a dry lake bed, with estimated ages of 200 - 500 years,

Structure:



Is the seed coat tough? very. concentrated sulfuric acid treatment for 24 hours does not kill the embryo.

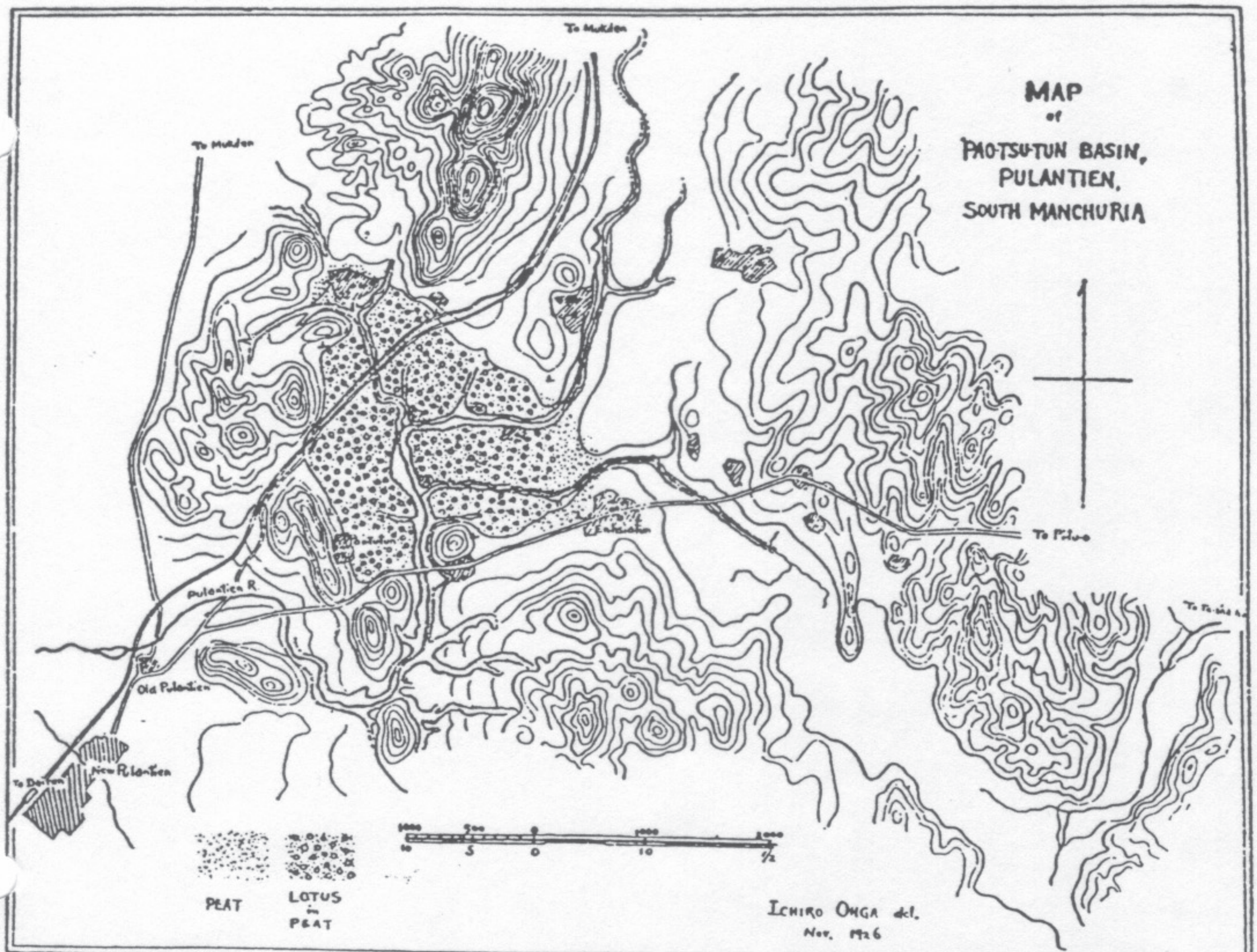
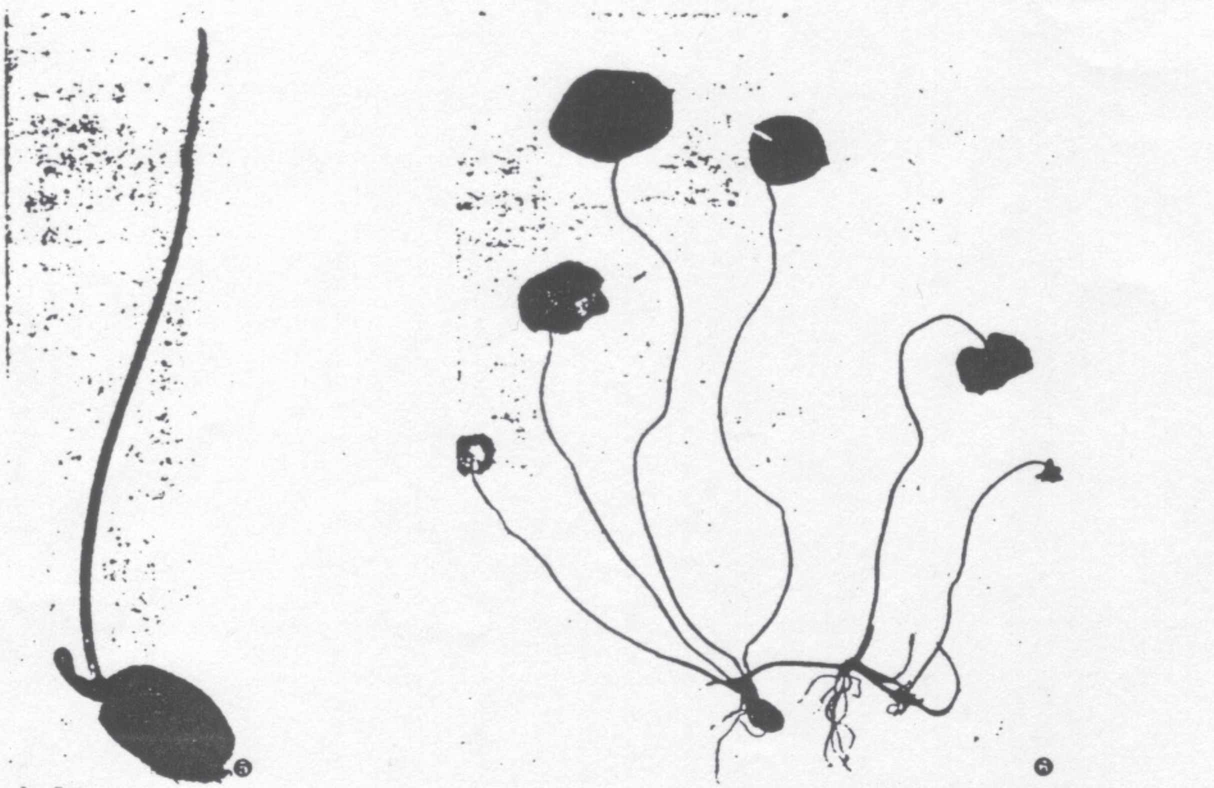
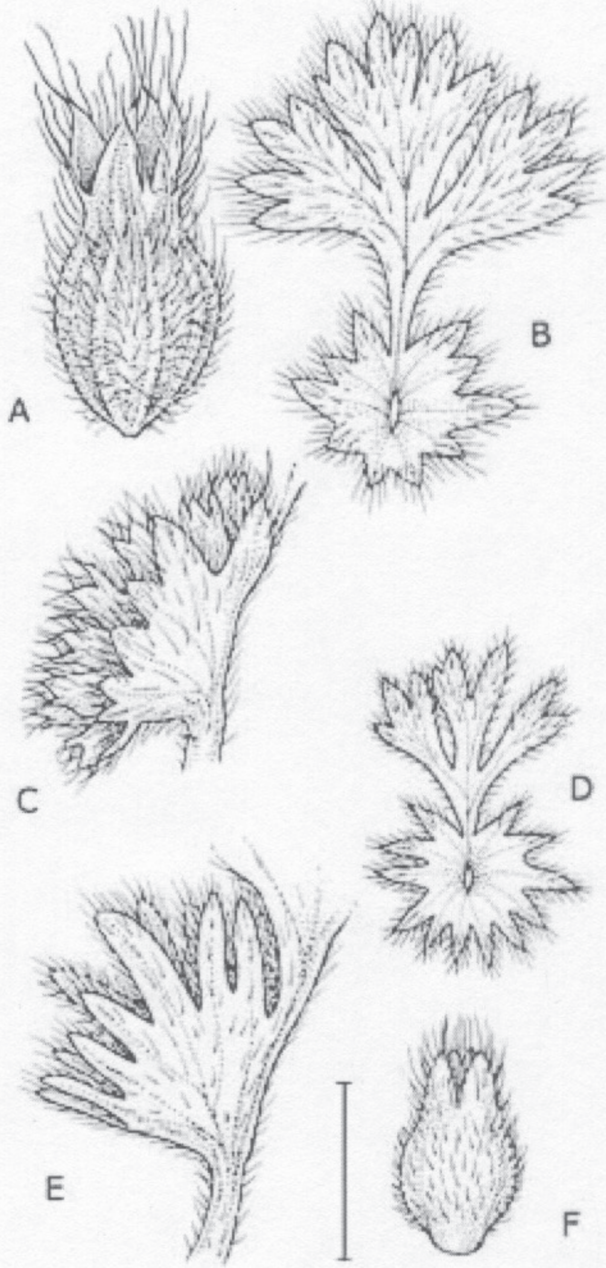


図 2. 満洲普蘭店の附近



大　賀——古い蓮の実の発芽



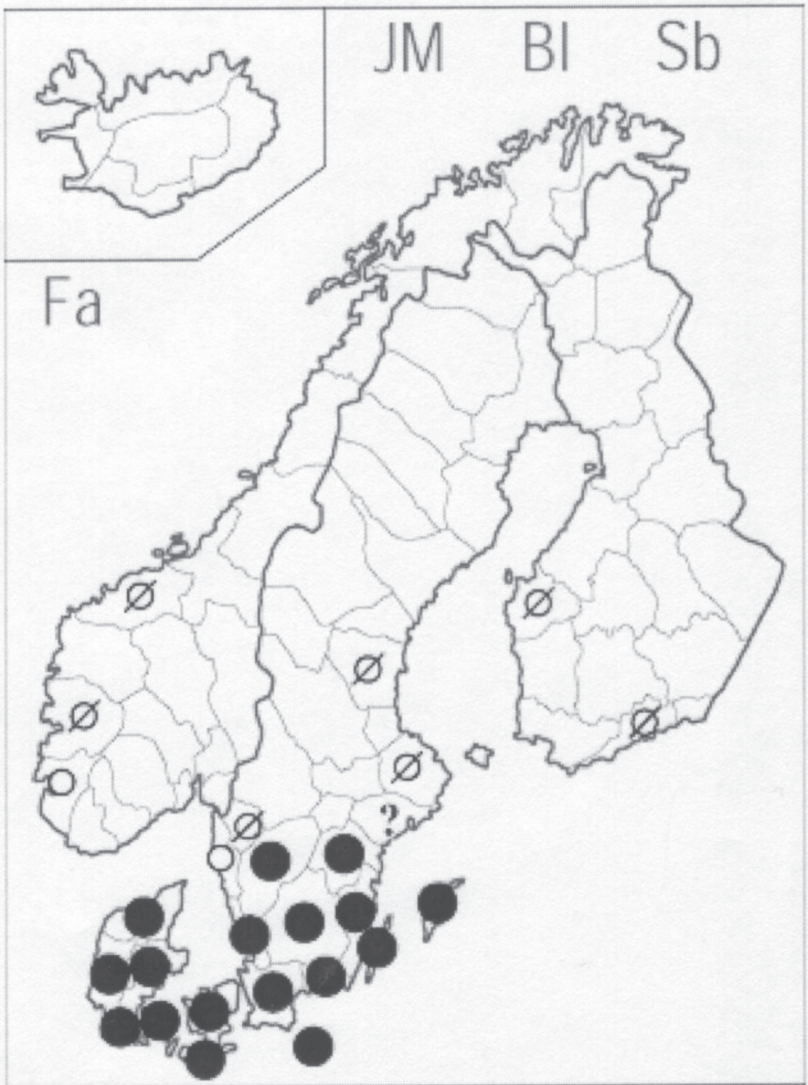
1. Aphanes L.

Linnaeus, Sp. pl.: 123 (1753).

Therophytes (winter- or summer-annuals) with thin taproot. Shoots not rooting, mainly consisting of an elongated, sympodial inflorescence; lateral shoots mainly from the base and then ± as long as the main shoot; sometimes also shorter branches from inflorescence nodes. Leaves spirally arranged. Stipules persistent, herbaceous, divided into 5–7 obtuse lobes (those of the basalmost leaves thin, pale and entire), connate to the petiole and (at the opposite side of the stem) with each other, thus forming a cup-like structure around the stem. Petiole short. Leaf blade deeply cleft into 3 main lobes, each divided at the apex into 3–7 obtuse lobes.

Aphanes. Flowers in fruit, leaves with stipules seen from above (main shoot removed) and flower clusters covered with stipules (lateral view). A–C: *A. arvensis* (Sk). – D–F: *A. australis* (Klm). – Scale in A, F 1 mm, in B, D 6 mm, in C, E 2 mm. ILL. POLLYANNA VON KNORRING

SOURCE: Flora Nordica taxa. By Thomas Karlsson http://www.bergianska.se/stift/floran/aphanesnbexp.html.



Distrubution of *Aphanes arvensis* in Nordic countries

SOURCE: Flora Nordica taxa. By Thomas Karlsson
http://www.bergianska.se/stift/floran/aphanesnbexp.html.

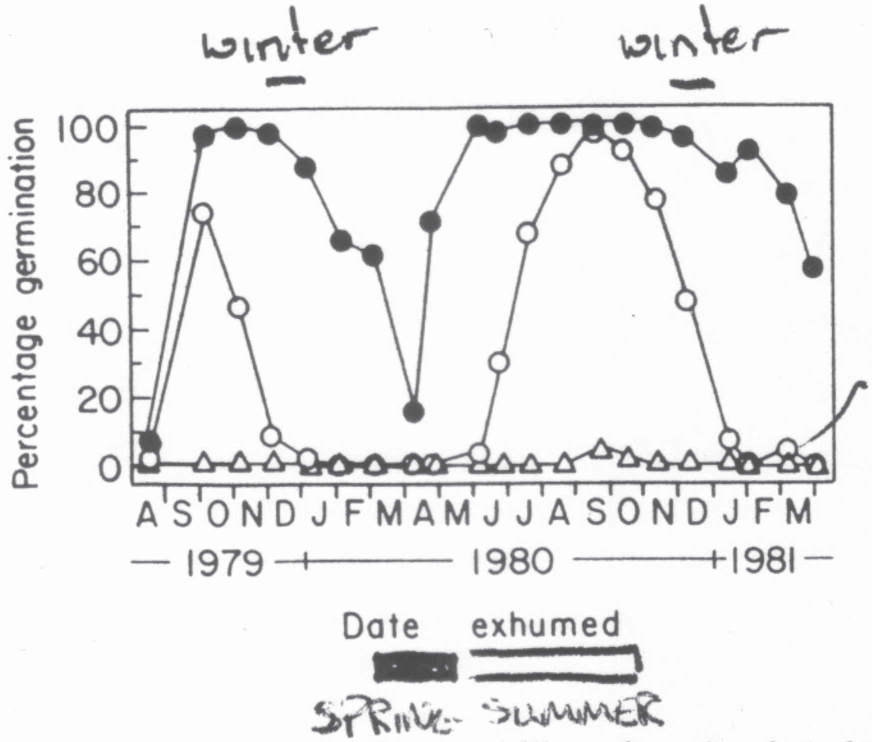
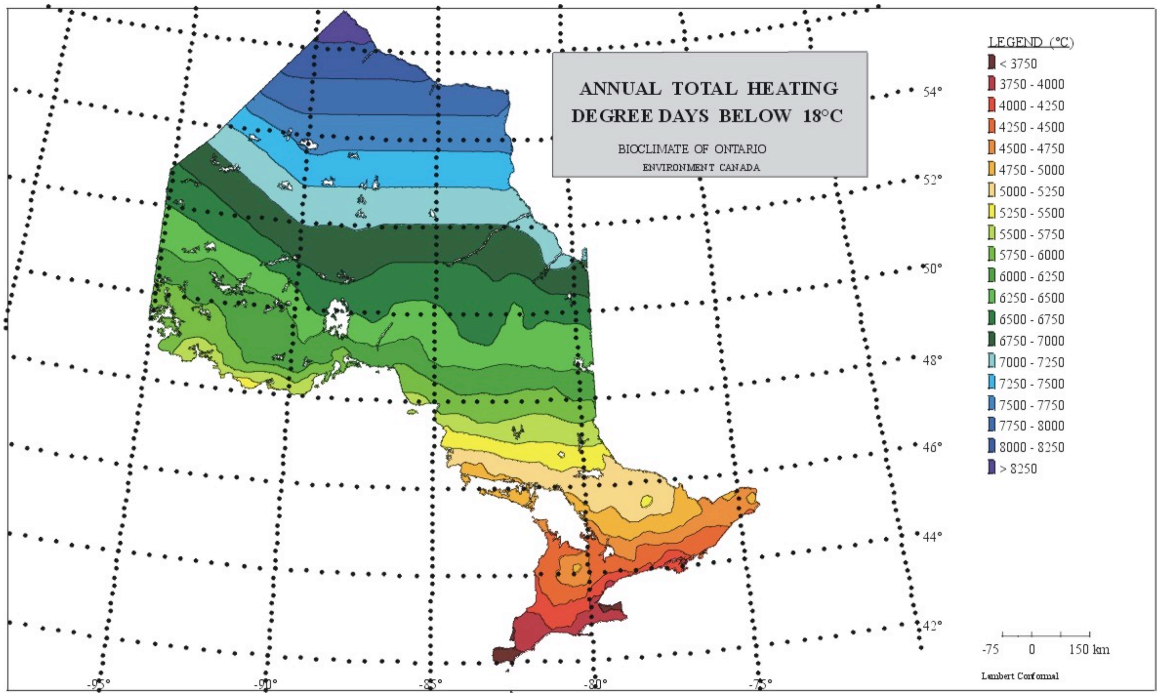


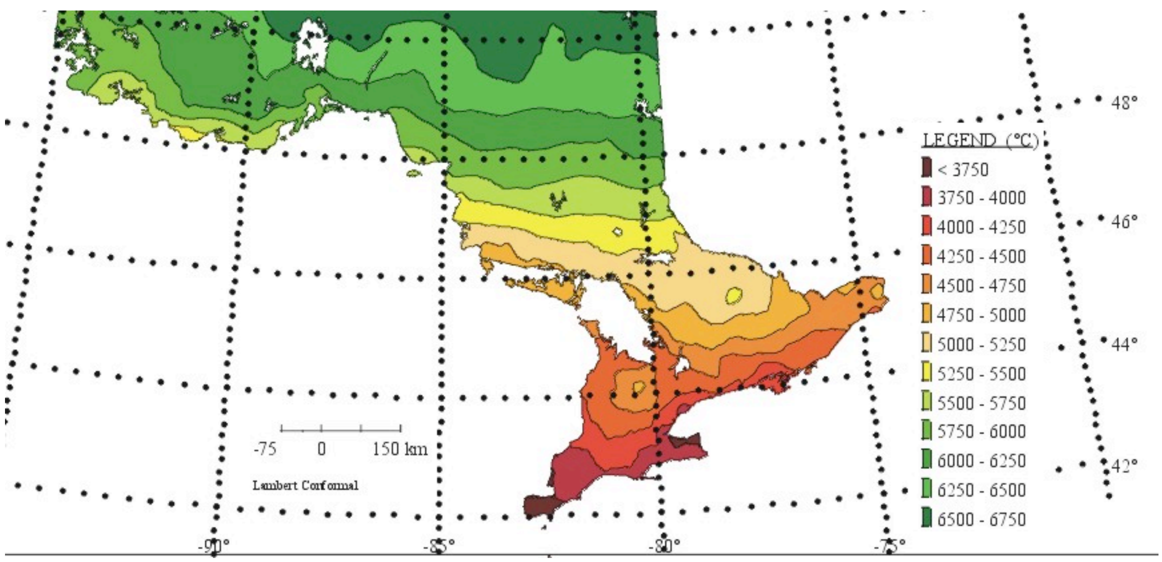
FIG. 4.2. Seasonal changes in the germinability of seeds of *Aphanes arvensis* (from data of Roberts and Neilson, 1982). Freshly collected seeds were buried outdoors in the soil (1977) and samples periodically removed and tested for germination at different temperatures. ●——● germination at 4°C, ○——○ germination at 15°C, △——△ germination at 25°C.

Table 2. *Effect of light on the germination* (%) *of buried seeds of* Aphanes arvensis

		Test temperature (°C)										
Date of test		4	10	15	20	25	30	4/10*	4/20*	10/20*	10/30*	15/30*
July	Light	100	100	92	5	3	0	100	100	88	89	34
	Dark	16	10	0	0	2	1	37	31	3	9	1
September	Light	100	100	100	99	23	0	100	100	100	100	99
	Dark	93	73	17	6	0	4	97	70	49	58	14

* As in Table 1.

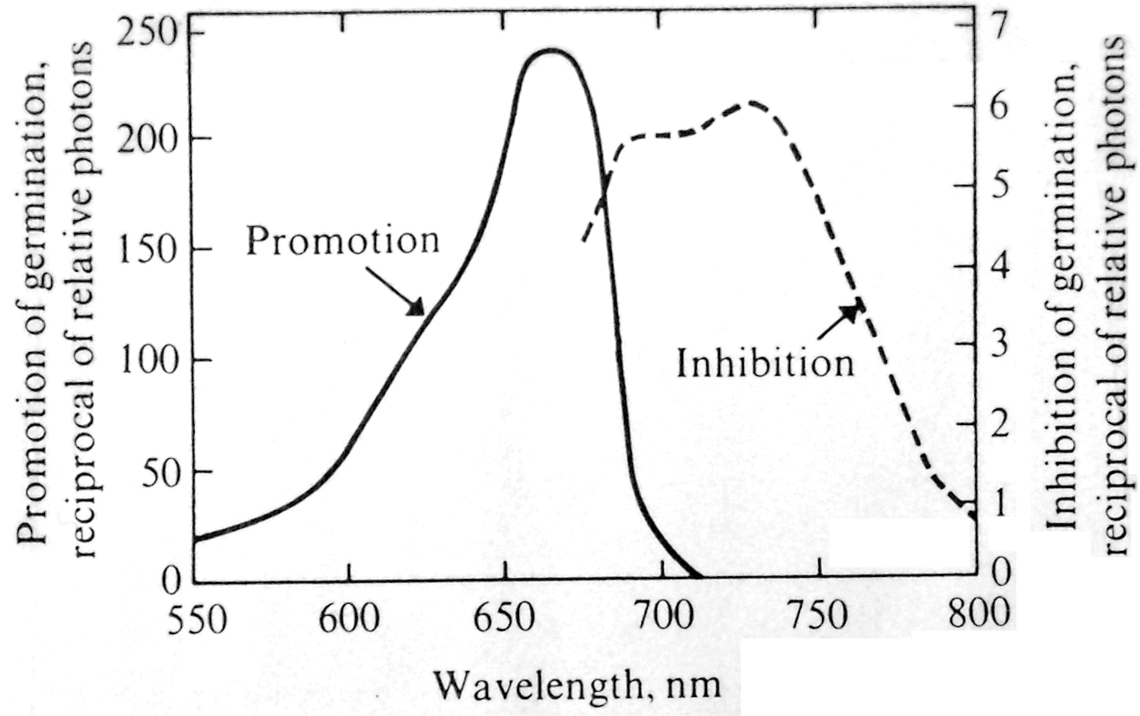




Annual Total Heating Days below 18˚C (degree-days)

Source: With few exceptions the set of maps presented here were developed by Barry G. Watson and Don C. MacIver of the Meteorological Service of Canada - Environment Canada.

http://www.utoronto.ca/imap/collections/climate_and_biota/ontario_bioclimate2.htm



Action spectra for the promotion of lettuce seed germination and it reversal, or “inhibition”.

Source: Nobel, PS (1991) Physicochemical and Environmental Plant Physiology. Academic Press (figure 4.12)

Absorption spectrum:

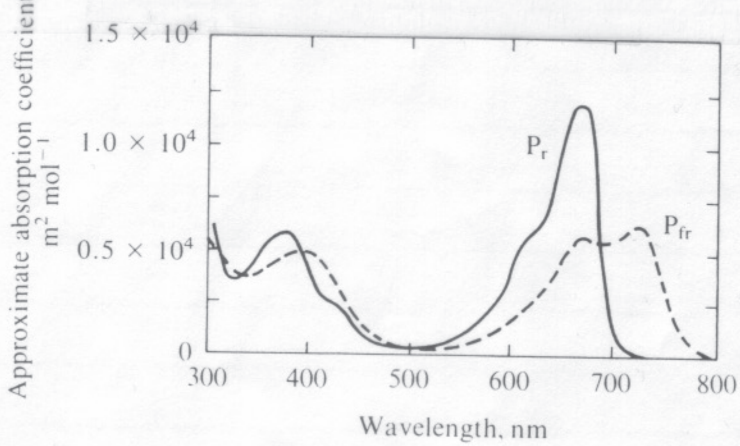
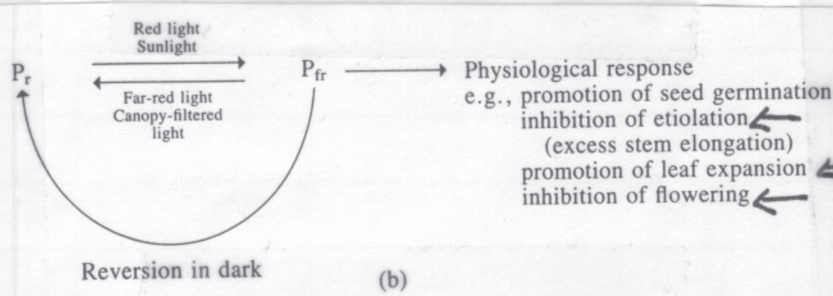


Figure 4.11

Absorption spectra for the red (P_r) and the far-red (P_{fr}) absorbing forms of phytochrome. (Data are replotted from W. L. Butler, S. B. Hendricks, and H. W. Siegelman, in *Chemistry and Biochemistry of Plant Pigments*, T. W. Goodwin, ed., Academic Press, London, 1965, pp. 197–210. Used by permission.) Note that the absorption spectra presented in this text were obtained at or near room temperature.

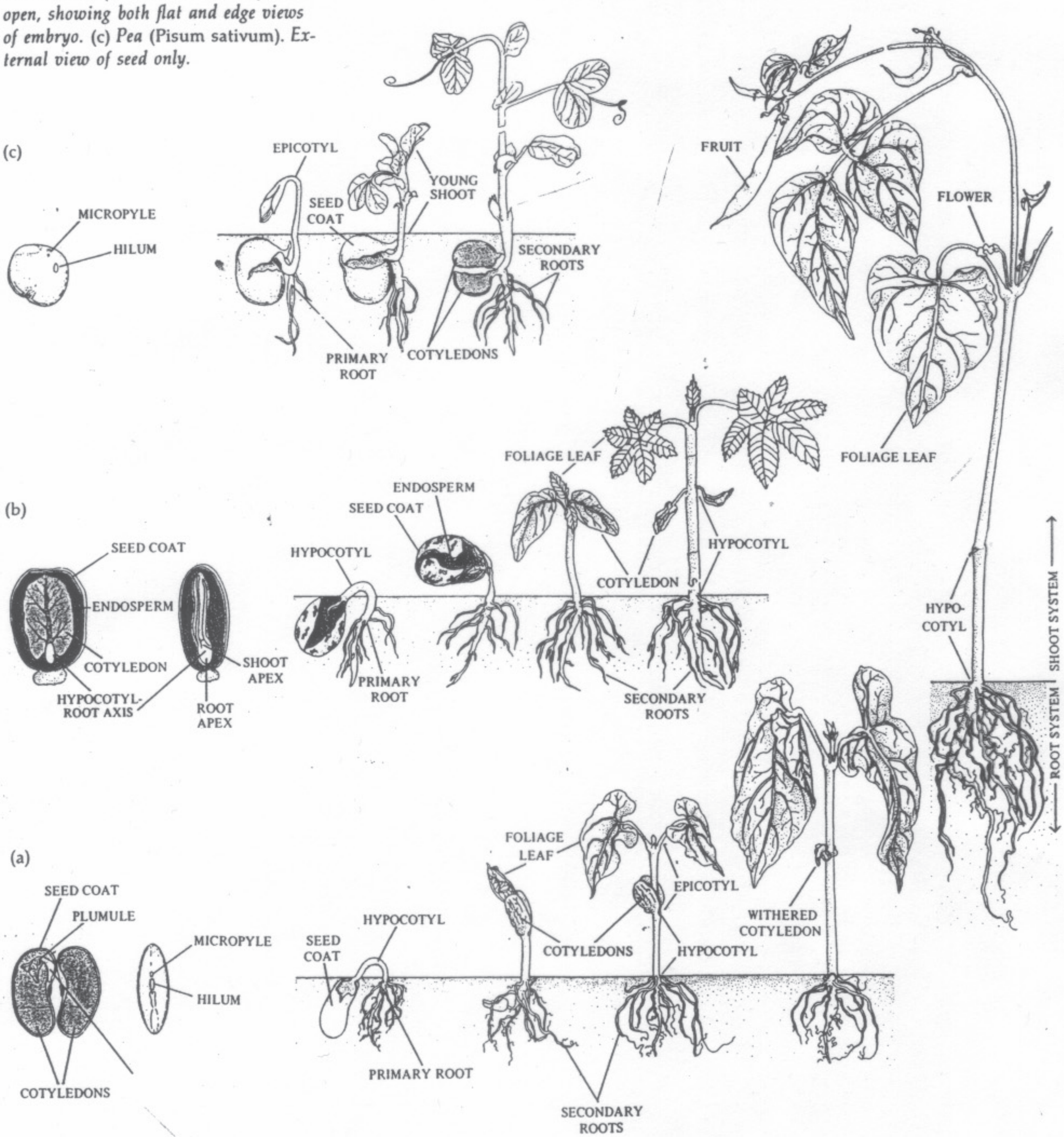
P_R : red (~660 nm) absorbing form
P_{FR} : far-red (~730 nm) absorbing form
red-light causes photoconversion to P_{FR}, the physiologically active form:



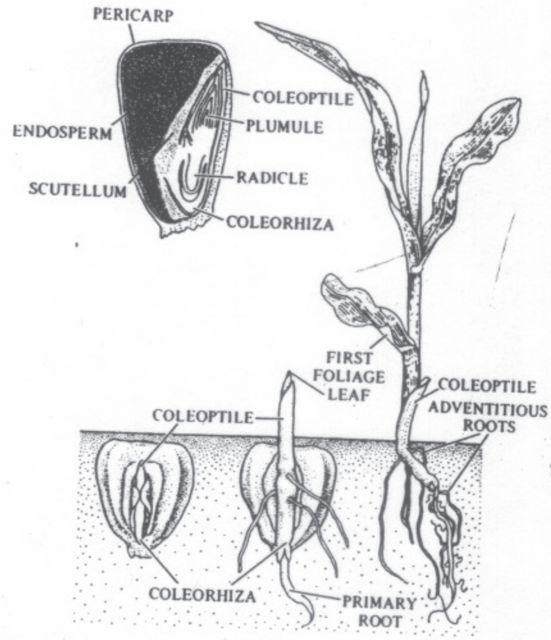
numerous responses.

... (b) Light and dark interconversions of phytochrome, indicating some of the reactions promoted by the physiologically active form, P_{fr}.

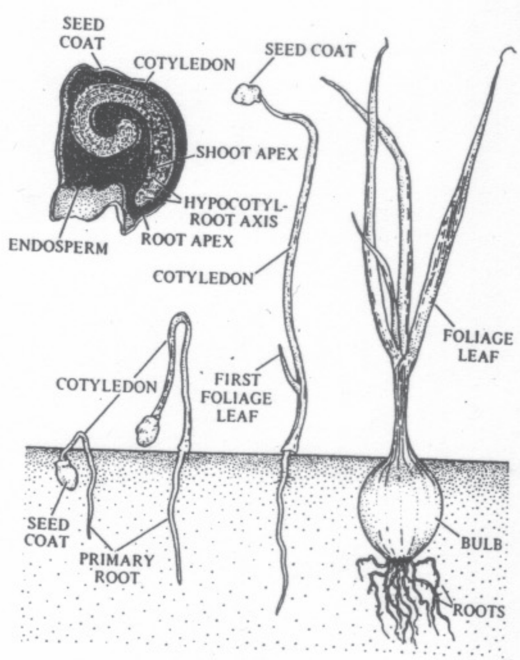
18–2
Seeds and stages in germination of some common dicotyledons. (a) *The garden bean* (Phaseolus vulgaris). *Seed shown open and from external edge view.* (b) *Castor bean* (Ricinus communis). *Seed open, showing both flat and edge views of embryo.* (c) *Pea* (Pisum sativum). *External view of seed only.*



18–3
Seeds and stages in germination of some common monocotyledons (a) corn (Zea mays) and (b) onion (Allium cepa). Both seeds shown in longitudinal section.



(a)



(b)