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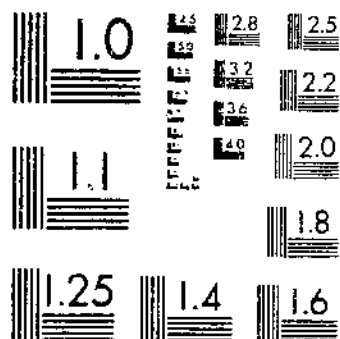
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GUNN, C. R. SELDIN, M.

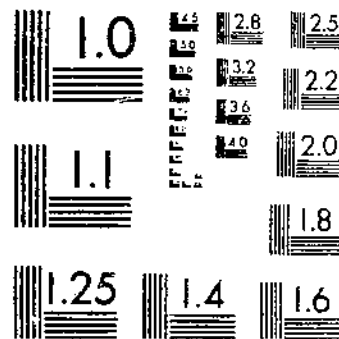
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SEEDS AND FRUITS OF NORTH AMERICAN PAPAVERACEAE

By Charles R. Gunn and Margaret J. Seldin

Technical Bulletin No. 1517

**Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE**

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SEEDS AND FRUITS OF NORTH AMERICAN PAPAVERACEAE

By CHARLES R. GUNN, *curator, BARC Seed Collection, and botanist, Plant Taxonomy Laboratory*, and MARGARET J. SELDIN,¹ *technician, Seed Quality Laboratory, Northeastern Region, Agricultural Research Service*

This study constitutes an investigation of external and internal seed characters and external fruit characters of native and naturalized papaveraceous species found in North America.

As we define this family, it has 24 genera and an estimated 268 species (table 1). Because we recognize the family Fumariaceae, the fumariaceous genera were excluded from this study.

DISTRIBUTION

The centers of diversification for this family have traditionally been defined as western North America and eastern Asia (42);² or southwestern United States especially California, eastern Mediterranean and Asia Minor, and Tibet and western China (33). While contributing to the studies of Duke (13) and Duke et al. (14), we had an opportunity to collect and analyze data on the worldwide distribution of papaveraceous genera and species. Our results are given in table 1.

Fifteen of the twenty-four genera have endemic species in North America. Of these 15, 11 are endemic genera in North America. Two other New World genera have a large number of their species in North America. More than three-fourths of the *Argemone* species and almost half of the *Bocconia* species are native to North America.

Within North America the center of the family's diversification is in southern California and its environs. In figure 1 the compound numbers on the concentric arcs represent the decreasing number of genera and species as one moves away from the epicenter. In southern California the 10 genera and 22 endemic species are the highest concentration of genera

and possibly the highest concentration of endemic species in the world. The outermost northern arc in Alaska has five native *Papaver* spp. The only native member of the family in the Gaspé Peninsula and New England is *Sanguinaria canadensis* (69, 70). When the arc reaches the West Indies, the number represents *Bocconia frutescens*. The arc through southern South America has five *Argemone* spp., which are native to central and southern Chile and Argentina. The island of Hawaii has one endemic species, *Argemone glauca* L. ex Pope.

Although Canada and the United States have recent regional, Province, or State floristic surveys, the only major Mexican floristic survey that includes papaveraceous species was published in 1922, and only the woody species and their near relatives were included (73). To compensate for this inequity, we have prepared table 2. We believe this is the first time the Mexican papaveraceous species have been listed with their distribution. The table was prepared with the cooperation of Efraim Hernandez X. and Stephen D. Koch, Herbario-Hortorio de la Rama de Botanica, Escuela Nacional de Agricultura, Chapingo, Mexico (CHAPA); Ramon Riba, Herbario Nacional, Instituto de Biología, Mexico City, Mexico (MEXU); J. Rzedowski, Escuela Nacional de Ciencias Biológicas, Laboratorio de Botanica Fanerogámica, Mexico City, Mexico (ENCB); Field Museum

¹ Now computer technician, Data Systems Application Division, Northeastern Region, Agricultural Research Service.

² Italic numbers in parentheses refer to Literature Cited, p. 93.

TABLE 1.—Distribution of endemic papaveraceous species by genera

Genus	North America	Central America	South America	West Indies	Europe	North Africa	South Africa	Asia Minor, Soviet Union	Far East	Australia, Hawaiian Islands	Total species ¹
<i>Arctomecon</i> Torrey and Frémont	3	---	---	---	---	---	---	---	---	---	3
<i>Argemone</i> L.	23	---	5	---	---	---	---	---	---	1	29
<i>Bocconia</i> L.	5	5	4	2	---	---	---	---	---	---	11
<i>Canbya</i> Parry ex A. Gray	2	---	---	---	---	---	---	---	---	---	2
<i>Chelidonium</i> L.	---	---	---	---	1	---	---	1	---	---	1
<i>Dendromecon</i> Bentham	1	---	---	---	---	---	---	---	---	---	1
<i>Dicranostigma</i> Hooker f. and Thompson	---	---	---	---	---	---	---	---	3	---	3
<i>Eomecon</i> Hance	---	---	---	---	---	---	---	---	1	---	1
<i>Eschscholzia</i> Chamisso	12	---	---	---	---	---	---	---	---	---	12
<i>Glaucium</i> Adanson	---	---	---	---	2	² (2)	---	(13)	---	---	(17)
<i>Hesperomecon</i> Greene	1	---	---	---	---	---	---	---	---	---	1
<i>Hunnemannia</i> Sweet	1	---	---	---	---	---	---	---	---	---	1
<i>Hypocoum</i> L.	---	---	---	---	4	(1)	---	(13)	(15)	---	(17)
<i>Macleaya</i> R. Brown	---	---	---	---	---	---	---	---	2	---	2
<i>Meconella</i> Nuttall	3	---	---	---	---	---	---	---	---	---	3
<i>Meconopsis</i> Viguiér	---	---	---	---	1	---	---	---	43	---	44
<i>Papaver</i> L.	5	---	---	---	(22)	(1)	1	(75)	---	1	(100)
<i>Platystemon</i> Bentham	1	---	---	---	---	---	---	---	---	---	1
<i>Pteridophyllum</i> Siebold and Zuccarini	---	---	---	---	---	---	---	---	1	---	1
<i>Roeperia</i> Medikus	---	---	---	---	(1)	(5)	---	(5)	---	---	(9)
<i>Romneya</i> Harvey	2	---	---	---	---	---	---	---	---	---	2
<i>Sanguinaria</i> L.	1	---	---	---	---	---	---	---	---	---	1
<i>Stylomecon</i> G. Taylor	1	---	---	---	---	---	---	---	---	---	1
<i>Stylophorum</i> Nuttall	1	---	---	---	---	---	---	---	4	---	5
Total species	62	5	9	2	(31)	(9)	1	(107)	(69)	2	(268)

¹ Sum of components may exceed total, because some species are native to more than one of the defined regions.² Numbers in parentheses are estimates; others are actual count.



FIGURE 1.—Distribution of endemic New World and Hawaiian papaveraceous genera and species. First digit represents number of genera, second the number of species. Distance between arcs is about 1,300 km.

TABLE 2.—Distribution of native and

Scientific name	Aguascalientes	Baja California	Campeche	Chiapas	Chihuahua	Coahuila	Colima	Distrito Federal	Durango	Estado de Mexico	Guanajuato	Guerrero
<i>Argemone acnea</i> G. B. Ownbey						M, U						
<i>Argemone albiflora</i> Hornemann (<i>A. alba</i> Lestib.)					M							
<i>Argemone arida</i> Rose					M, U, M, C				C, M, U			
<i>Argemone brevicornuta</i> G. B. Ownbey					C, U							
<i>Argemone chisosensis</i> G. B. Ownbey					C, U	C, E, F						
<i>Argemone echinata</i> G. B. Ownbey						C, F, U						
<i>Argemone fruticosa</i> Thurber ex A. Gray						C, U						
<i>Argemone gracilentia</i> Greene		C, F, M, U										
<i>Argemone gracilentia</i> Greene X <i>A.</i> <i>pleiacantha</i> Greene ssp. <i>pleiacantha</i>												
<i>Argemone grandiflora</i> Sweet						M						
<i>Argemone mexicana</i> L.		M	U	E, F, M, U	F			M		M		M, U
<i>Argemone munita</i> Durand and Hilgard		U										
<i>Argemone ochroleuca</i> Sweet	M, U	E, F, U		F	E, F, M	F, U	U	E, F, M, U	F, M	E, U	E, F, U	U
<i>Argemone ochroleuca</i> Sweet ssp. <i>ochroleuca</i> X <i>A. pleiacantha</i> Greene ssp. <i>pleiacantha</i>												
<i>Argemone platyceras</i> Link and Otto		M						E, F, M, U	E, M, U			
<i>Argemone pleiacantha</i> Greene					F, M, U							
<i>Argemone polyanthemus</i> (Fedde) G. B. Ownbey												
(<i>Argemone intermedia</i> Sweet)		M			E	M						
<i>Argemone sanguinea</i> Greene						E, F, M, U			M, U			
<i>Argemone subintegrifolia</i> G. B. Ownbey		E, U										
<i>Argemone superba</i> G. B. Ownbey												
<i>Bocconia arborea</i> S. Watson				E, F, M, U		F			C, F, U	F, M		E, M, U
<i>Bocconia frutescens</i> L.				E, M, U	F					C, F, M		
<i>Bocconia gracilis</i> Hutchinson				F								
<i>Bocconia integrifolia</i> Humboldt and Bonpland												
<i>Bocconia latispala</i> S. Watson												

See footnote at end of table.

*naturalized papaveraceous species in Mexico*¹[illegible]

TABLE 2.—Distribution of native and naturalized

Scientific name	Aguascalientes	Baja California	Campeche	Chiapas	Chihuahua	Coahuila	Colima	Distrito Federal	Durango	Estado de Mexico	Guana juato	Guerrero
<i>Bocconia vulcanica</i> Donnell Smith (<i>B. oblanceolata</i> Lundell)				M								
<i>Chelidonium majus</i> L.												
<i>Dendromecon rigida</i> Benth		E,F, M,U										
<i>Eschscholzia caespitosa</i> Benth		F										
<i>Eschscholzia californica</i> Chamisso (<i>E. douglassii</i> Benth)		C,E, F,M, U		F		F,M		M				
<i>Eschscholzia elegans</i> Greene (<i>E. crassula</i> and <i>E. ramosa</i> Greene)		F,M, U										
<i>Eschscholzia frutescens</i> (Greene) J. T. Howell (<i>E. palmeri</i> Rose)		U										
<i>Eschscholzia glyptosperma</i> Greene												
<i>Eschscholzia mexicana</i> L.		F,M, U			U	M						
		C,E, F,M, U										
<i>Eschscholzia minutiflora</i> S. Watson		F,M, U										
<i>Eschscholzia parishii</i> Greene		M,U										
<i>Hunnemannia fumariifolia</i> Sweet		C				E,F, M,U						
<i>Papaver rhoeas</i> L.				C,F								
<i>Papaver somniferum</i> L.								E				
<i>Platystemon californicus</i> Benth		F,M, U										
<i>Romneya coulteri</i> Harvey		F,U										
<i>Romneya trichocalyx</i> Eastwood		E,U										
<i>Romneya</i> sp.		M										
<i>Stylomecon heterophylla</i> G. Taylor		C,F, U										

¹ See preceding text for explanation of following: C = (CHAPA), E = (ENCB), F = (F), M = (MEXU),

*papaveraceous species in Mexico*²—Continued

Hidalgo	Jalisco	Michoacán	Morelos	Nayarit	Nuevo León	Oaxaca	Puebla	Querétaro	Quintana Roo	San Luis Potosí	Sinaloa	Sonora	Tabasco	Tamaulipas	Tlaxcala	Veracruz	Yucatán	Zacatecas
							U											
					F					U		C						
												C						
												C, U						
										M		C, E						
												C						
C, E, M		E			C, E, F, M, U U	C, E, U	F U			C, E, F, M, U								F, U
												U						
												C						

M = (MIN), U = (US).

of Natural History, Chicago, Ill. (F); University of Minnesota Herbarium, St. Paul (MIN);

and U.S. National Herbarium, Smithsonian Institution, Washington, D.C. (US).

TAXONOMY

Even though the taxonomy and nomenclature of most North American papaveraceous taxa are stable in recent North American floristic surveys and monographs, we followed some treatments more closely than others. The monograph by Ownbey (56) was adopted as the authority for *Argemone*. Munz (53) and Munz and Keck (54) were used for the California taxa. In the other regions of North America the most recent floristic surveys were consulted. One major exception to the stability of the North American papaveraceous taxonomy and nomenclature involves the endemic arctic-alpine species of *Papaver*. These poppies (*Papaver* section *Lasiotrachyphylla* Bernhadi) (38) are primarily Alaskan though plants may be found in the alpine niche as far south as Utah and Colorado.

Because of diverse taxonomic opinions as to the definition of a species, we have followed one treatment that we believe is the best thus far produced (79). Even this treatment has problems that can only be solved with more research. In accepting Welsh (79), we do not accept all or part of the arctic-alpine poppy species concepts of Hultén (31), Kiger (39), and Löve (47).

The genus *Hesperomecon* is recognized in Munz (53) but not in Munz and Keck (54), where it is placed in synonymy under *Meconella*.

We agree with Munz that there is sufficient taxonomic evidence to recognize *Hesperomecon*. We also found while reviewing the notes of Ernst³ that he thought *Hesperomecon* should be recognized as a genus (16).

Seed characteristics of the family have been summarized by Fedde (18), Gunn (27), LeMaout and Decaisne (43), Lubbock (48), McClure (49), and Martin (51). Isolated seed identification at the species level generally has been restricted to a few weedy or commercial species or to species of pharmacognostical interest (4, 6, 12, 17, 34, 36, 41, 55, 64, 65, 67, 68, 74, 76). Usually seed characteristics have been omitted or only mentioned superficially in State, Province, or regional floras, or floristic surveys.

Fruit characteristics of the family have been summarized by Fedde (19) and LeMaout and Decaisne (43). Although fruit characters have been used for species identification of *Papaver* (9) and *Argemone* (56), they have not been used in the same manner in which isolated seeds have been used for making identifications. Most of the floras contain at least a partial description of the fruit. A fruit key was prepared to assist in identifying the seeds, because entire fruits or fruit fragments may be found with the seeds.

PROCEDURES

Seed and fruit data in this bulletin have been data banked in a 370-168 IBM computer at the Washington Computer Center. The data bank of native and naturalized North American species is supplemented with information from species not found in North America.

Data banking procedures and programs were modeled after Gunn and Seldin (29) and Morse (52). Five of the six major program routines described in detail in these publications were used in this study, viz, CMPARE, DSCRB2, IDENT1, KEY2, and MXCHEK. They may be summarized as follows: CMPARE has three

parameters for comparing different species:

- (1) The characters of one species are compared with those of the other species in the matrix,
- (2) each species is compared with the other species in the matrix and the comparison given is the minimum number of differences, and (3)

³ Wallace R. Ernst's untimely death terminated the career of the only modern North American plant taxonomist who was spending most of his time in taxonomic research on the family Papaveraceae. We appreciate the cooperation of Edward S. Ayensu, chairman, Botany Department, Smithsonian Institution, who gave us access to unpublished notes and seed samples that Dr. Ernst had collected or accumulated.

the actual differences between species are enumerated. DSCRB2 generates an English language description of each species in one of three ways, viz, by sequence, by decreasing importance values, and by selected characters. IDENT4 enables the user to select specific characters for identification. KEY2 enables the user to select the type of diagnostic key needed to solve a specific problem. MXCHEK is a matrix checking program designed to locate format errors.

With this study it is possible to identify all seeds and fruits to genus and most seeds and fruits to species by using the keys or by comparing unknowns to the photographs and drawings. Both external and internal seed characters were used in preparing the seed keys, descriptions, and illustrations, because external seed topography was not always sufficiently discrete to identify the seeds.

Collateral data presented with the seed and fruit descriptions include notes about origin, distribution, and uses of the plant. Major synonyms are noted when they have been used as legitimate epithets in recent floras or monographs. One or more references to plant illustrations in North American floras are recorded.

The authenticated seed and fruit samples were used to prepare the illustrations and keys. Most of the illustrated *Argemone* seeds and fruits came from specimens identified by G. B. Ownbey. Additional seed and fruit samples, many identified by comparison, were used to complete the survey for each species.

External seed topography was observed at 10 to 60 magnifications with a dissecting stereoscopic microscope equipped with an ocular micrometer. Observations were made at 10 X, except as noted. At least 25 seeds from 1 to 50 samples were examined for each studied species.

The large seed photographs were taken at 10 X on 10 by 15 cm Ektapan film using a Polaroid MP-4 Land Camera equipped with one macroextension and a 4.5 f lens. These photographs are supplemented by a small photograph showing the actual size of the seeds, a 1:1 ratio. The macroextension was not used in making the smaller photographs. A white, gray, or black background was used depending on the color of the seed sample. The seeds were hand selected

and mature, except where noted, and arranged so that various aspects could be seen.

Embryo drawings within the longitudinal outline of the endosperm were made with a camera lucida fitted on a stereoscopic microscope. Illumination was provided by an above-stage microscope floodlamp. In preparing seeds for dissection, mature specimens of representative size and shape were placed in a softening solution of 74 percent distilled water, 25 percent methyl alcohol, and 1 percent dioctyl sodium sulfosuccinate (aerosol OT). Seeds of *Argemone chisosensis*, *Bocconia* spp., *Dendromecon rigida*, *Eschscholzia caespitosa*, *E. californica*, *Hunnemannia fumariifolia*, *Sanguinaria canadensis*, and *Stylophorum diphyllum* turned the softening solution a pale to dark yellow after soaking in it for 2 hours. Seeds of the other species did not affect its color. The seeds were kept in solution for one-half to 3 days depending on permeability and consistency of the seedcoat. The embryo-endosperm drawings are shown at 10 X.

The length of the soaked seeds was determined and the outer seedcoat peeled or chipped off leaving the intact endosperm encased in the inner seedcoat. The length of the endosperm was determined, the embryo was excised, and its length and cotyledon-embryo ratio were determined.

The fluorescence observation was made in a darkroom with crushed dry seeds using a Raytech LS-7, 35 amperes, longwave ultraviolet lamp. When seeds capable of fluorescing were soaked in softening solution and crushed, they fluoresced. However, we found these results more difficult to interpret than the results of the dry crushed-seed tests.

The capsule illustrations were prepared by Regina O. Hughes of the Smithsonian Institution from vouchered fruiting material. Most of the illustrations depict a representative capsule. Two capsules are used for some species to illustrate natural capsule variation. All capsules are shown at their natural size, and some capsules or capsule parts are shown at a higher magnification to illustrate clearly certain details.

In the legends for the illustrations the number after the collector's name refers to the voucher herbarium specimen.

At least one seed and one fruit sample of each studied species are documented by a voucher herbarium specimen. The depository of these specimens is indicated in the figure legends by these symbols:

(BRY) Brigham Young University Herbarium, Provo, Utah

(COLO) University of Colorado Museum Herbarium, Boulder

(DAO) Phanerogamic Herbarium, Plant Research Institute, Canada Department of Agriculture, Ottawa

(DHL) Davies Herbarium of the University of Louisville, Louisville, Ky.

(F) Field Museum of Natural History Herbarium, Chicago, Ill.

(GH) Gray Herbarium of Harvard University, Cambridge, Mass.

(ISC) Iowa State University Herbarium, Ames

(JEPS) Jepson Herbarium of the University of California, Berkeley

(MIN) University of Minnesota Herbarium, St. Paul

(NA) U.S. National Arboretum Herbarium, Washington, D.C.

(NY) New York Botanical Garden Herbarium, Bronx

(SFSC) California State University Herbarium, San Francisco

(SMU) Southern Methodist University Herbarium, Dallas, Tex.

(UC) University of California Herbarium, Berkeley

(US) U.S. National Herbarium, Smithsonian Institution, Washington, D.C.

(UT) University of Utah Herbarium, Salt Lake City

(UVIC) University of Victoria Herbarium, Victoria, British Columbia

SEED MORPHOLOGY

Papaveraceous seed characters have not been used as a primary character to organize the genera as they have been used in the Solanaceae (28). We have been able to group the external seed characters of the North American species into several alliances, viz, arillate versus non-arillate, straight versus curved seed, lignified versus coriaceous outer seedcoat, or dot present versus dot absent on inner seedcoat. If these alliances have phylogenetic significance, it can only be determined by studying all the genera and most of the species.

Papaveraceous seeds arise from amphitropous or anatropous ovules. The ovules are usually numerous on each placenta. The placentas vary from 2 to 18. The ovule is solitary and basal in *Bocconia*.

The seed characters discussed here are in the order given in the section on Synopses of Seed and Fruit Characters. The terminology illustrated in figure 2 is used in these descriptions.

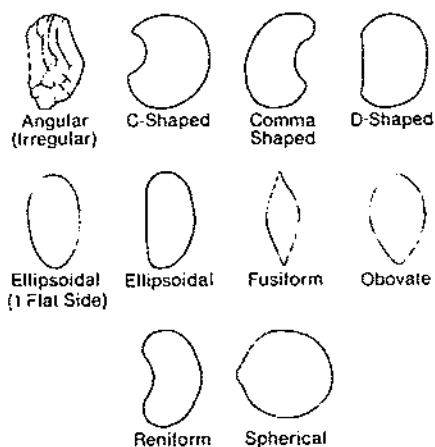
Dimensions of seeds are length (long axis of seed without regard to hilum position), width (at right angles to length and in same plane), and thickness (short axis of seed). The seed length of *Bocconia* spp. and *Dendromecon rigida* is difficult to determine, because their

bases are covered by well-developed arils. The length of these seeds was determined from the apex of the seed to the base of the aril.

Seed outlines are categorized as angular (irregular), C-shaped, comma shaped, D-shaped, ellipsoidal, ellipsoidal with one flattened side, fusiform, obovate, reniform, spherical (or nearly so), or combinations of these outlines (fig. 2). Seeds borne at the ends of linear capsules tend to be more angular because of capsule wall or adjacent seed pressure. An apical or subapical depression is visible on the surface of seeds of *Bocconia*, *Sanguinaria*, and *Stylophorum diphyllum* (fig. 2). A depression or colored dot is present on the outer seedcoat of *Arctomecon* and *Hunnemannia*. The cuticle often obscures this area. The outline may be modified by the presence of a basal or subbasal nipple. All the species in this survey usually bear a nipple, except *Roemeria refracta*. The nipple may be absent on seeds of *Chelidonium majus* and on some seeds of *Papaver rhoeas*. The nipple may be emergent, prominent, or elongate (fig. 2). In *Eschscholzia* the nipple appears to be a remnant of the funiculus. On *Argemone* seeds there may be one or two points that slightly modify their spherical shape.

SEED TERMS

Outlines (Profile View)



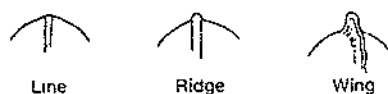
Depressions



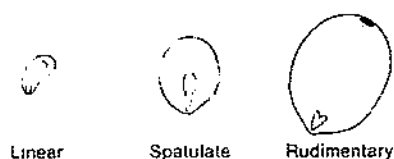
Nipples



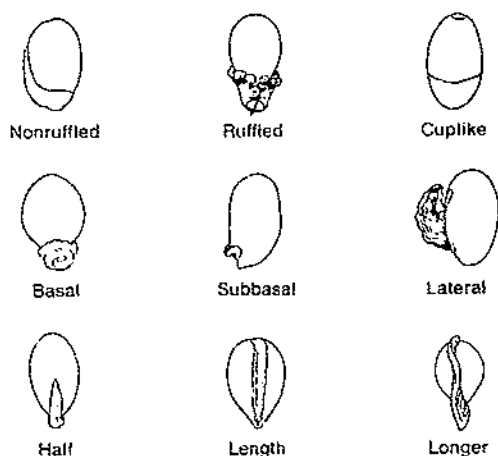
Raphes



Embryos



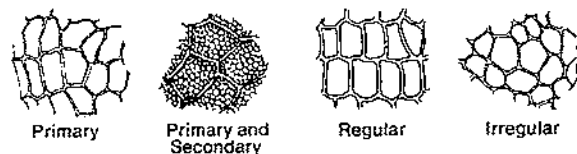
Arls



Reticulation

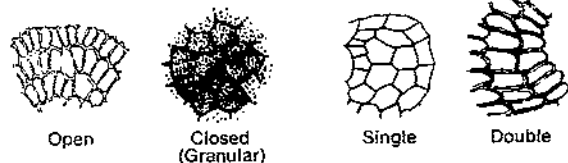
Types

Patterns



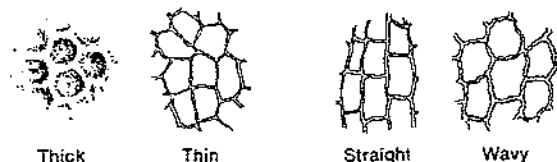
Fields

Wall Types



Wall Thickness

Wall Shapes



Wall Heights

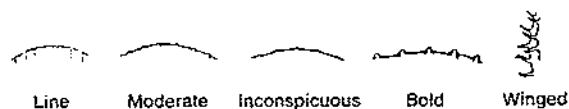


FIGURE 2.—Papaveraceous seed terms.

The seeds are usually terete or nearly so in cross section. *Romneya coulteri* and *R. trichocalyx* may be either terete or sectorial in cross section, and *Hesperomecon lineare* is flattened in cross section (0.5:1).

Mature papaveraceous seeds are usually uniform in color (except *Papaver somniferum*) and monochrome. The seedcoat may be dull or shiny. Regina O. Hughes classified basic seedcoat colors in natural light as amber, black, brown, gray, green, ocher, purple, and white. They are often modified by descriptive adjectives such as bright, dark, dull, light, pale, or one of the listed colors. These as well as honey colored apply to aril and raphe colors.

Seedcoat reticulation (best seen at 10 or 30 \times , except where noted) is a reliable feature in identifying papaveraceous seeds. Usually only one reticulation, a primary one, is present on the studied seedcoats. *Eschscholzia* spp., *Papaver somniferum*, and *Romneya* spp. have both a primary and secondary reticulation. Epidermal cells of the seedcoat are often broken down during maturation so that only the lateral cell walls persist. Thus mature seedcoats often resemble a coarse or fine meshwork, composed of regular or irregular fields. Length of field sizes was categorized as minute (less than 0.1 mm), small (0.1–0.2 mm), moderate (to 0.3 mm), and large (more than 0.3 mm). Basic field shapes were categorized as regular or irregular. A regular field may be circular, oblong, rectangular, or square. An irregular field has an irregular or an unpredictable shape. Occasionally lateral cell walls are eroded during seed maturation to such an extent that the seedcoat is smooth or nearly so. When this occurs, the reticulum is inconspicuous at 10 \times , or it is composed of a meshwork of colored lines that may be conspicuous or inconspicuous depending on the color contrast between the lines and the fields. Occasionally the outer and lateral cell walls persist and give the seeds like those of *Romneya* spp. a granular rather than a meshwork appearance. The walls of the reticulum are single except for *Rorneria refracta*, where they appear to be doubled. The height of the walls may be inconspicuous, moderate, bold, or wing-like. These walls vary in thickness from thin to thick, and their shape varies from straight to wavy. The reticulation of some *Papaver* spp. is

two parted, with a broad regular pattern of rectangular fields on the dorsal side and irregular pattern of fields on the two lateral sides. The irregularity increases near the hilum. Seedcoat reticulation terms are illustrated in figure 2.

An aril is present on seeds of 8 of the 24 papaveraceous genera. The presence or absence of the aril is a generic character. The aril is usually firmly attached to the seed, though occasionally an aril may separate from a *Bocconia* seed. Some *Bocconia* spp. and *Stylophorum diphyllum* have a ruffled aril, whereas other arils are not ruffled. In some *Bocconia* spp. the aril may be lobed. It may be longer than the seed, the length of the seed, one-half the seed length, or shorter than one-half the seed length. If in the last category, the aril may be a basal, sub-basal, cuplike, or lateral (winglike) patch (fig. 2). Arils may be beige, honey colored, or darker. The papaveraceous aril is generally believed to represent a dispersal mechanism, whereby ants attracted to the succulent aril will transport seeds away from the parent plant. The presence or absence of the aril has not been assigned phylogenetic importance, indicating that phylogenists believe the aril has evolved independently in this family.

A raphe is frequently present on seeds in the Euphorbiaceae, Geraniaceae, Papaveraceae, and Sarracenaceae. It represents a part of the funiculus, which is adnate to the outer seedcoat. A raphe may be a ridge, wing, or a colored line (fig. 2). Papaveraceous raphes exhibit all three forms; the ridge is most common. A poorly developed raphe occurs on some *Papaver* spp.

The hilum of the studied seeds is often difficult to locate. Generally it is not large, specially colored, or ornamented. Seeds of *Argemone* spp. may bear a rather conspicuous craterlike hilum, whereas seeds of *Hunnemannia fumariifolia* often have a conspicuous light-colored ovate hilum. The hilum on *Papaver somniferum* seeds is inconspicuous, but the hilar area is often discolored. The hilum is located in the notch of C-shaped, comma-shaped, and reniform seeds and is basal or subbasal on seeds with other shapes.

A cuticle envelops the outer seedcoat of the studied seeds. During seed dissection the cuticle may be separated from the outer seedcoat by scraping or peeling (*Argemone* spp.) or it may

be inseparable (some *Papaver* spp.). The cuticle usually bears only a primary reticulation. However, the cuticle of *Eschscholzia* spp. and *Romneya* spp. bears both a primary and secondary reticulation. In *Eschscholzia lobbi* the walls of the primary reticulation are winglike, and in *E. glyptosperma* the walls are thicker than in the other species. When the cuticle is peeled or scraped from the seedcoat, it is usually amber to dark brown. While in softening solution, the reticulum when viewed from below usually appears as dark brown lines. The cuticle over the fields is usually translucent and is the lighter color. It is separable from the outer part of the outer seedcoat in *Dendromecon* and *Hunnemannia*, but it is apparently inseparable from the outer part of the outer seedcoat in *Bocconia* spp.

The outer seedcoat, excluding the cuticle, may contain as many as four distinct layers (17, 64, 68, 80), which are visible when viewed in cross section with a compound microscope or instrument of similar magnification. These layers are not discernible when using a 30 \times stereoscopic microscope. We identified two types of outer seedcoats, simple and compound, using a stereoscopic microscope. A simple seedcoat peels as one layer exclusive of the cuticle, which may or may not be separable. A simple seedcoat may be coriaceous or lignified. Because there is no clear separation between coriaceous and lignified, we have arbitrarily defined a coriaceous seedcoat as being pliable and less than 0.1 mm in thickness, whereas a lignified seedcoat is brittle and 0.1 mm thick or thicker. A compound seedcoat is composed of two distinct layers, usually a soft layer over a lignified layer. The cuticle of seeds of *Bocconia* spp. is adnate to the soft outer layer of the outer seedcoat.

The inner seedcoat is always membranaceous, one cell thick, and usually amber, seldom green, yellow, or white. This seedcoat may bear a conspicuous dark dot or the dot may be absent. The location of the dot on the endosperm-embryo drawing is not significant on a left-to-right basis. However, its location is significant in relationship to the apex and base. If present, the dot is beneath the apical end of the raphe and represents the point of attachment of the vascular bundle to the inner seedcoat. The outer and inner seedcoats are united at this point. The inner side of the outer seedcoat always bears a

scar of this union, though very faint in some species. During dissection the inner and outer seedcoats may readily separate at this point of attachment, or they may be inseparable. If inseparable, the inner seedcoat tears at the point of attachment. Thus any dot that may be present would be missing from the incomplete inner seedcoat (*Glaucium flurum* and *Stylophorum diphyllum*). The dot is conspicuous and usually present in seeds of *Arctomecon*, *Argemone*, *Dendromecon*, and *Macleaya*. It may be present or absent in *Hunnemannia* and *Sanguinaria*, depending on the dissection technique or the condition of the union. The dot may not be discolored on inner seedcoats of some *Bocconia* spp. This area may be nearly the color of the inner seedcoat and slightly depressed. A smaller discolored area may occur on the apical point of curved or reniform seeds. This area is not a dot. Rather it is a patch, usually inconspicuous because of its size, that covers the apical point (*Canbya*, *Papaver*, *Platystemon*, *Rocmeria*, *Romneya*, and *Stylomecon*). This patch may be morphologically similar to the dot, but the patch is not as conspicuous as the dot and is essentially the same color as the inner seedcoat.

The endosperm is fleshy or granular in the studied species, and it is usually white, seldom amber, green, orange, or yellow. Oil droplets are the color of the endosperm. The endosperm usually fluoresces bluish white, seldom yellowish white or reddish orange, or it is nonfluorescent. Except for a few species, the endosperm is oily and emits oil droplets when teased wet. These may be well-defined droplets or minute droplets that resemble smoke at 10 \times . Endosperms of *Canbya aurea*, *Meconella denticulata*, *Papaver alaskanum*, *P. macounii*, and *P. pygmaeum* are granular, separating into granules when teased wet. These endosperms do not emit oil droplets.

The embryo is usually linear. A linear embryo is several times longer than broad, straight or curved, and the cotyledons are not generally expanded or flattened in cross section. A spatulate embryo, the second embryo type, seen in *Eschscholzia caespitosa* and some seeds of *Bocconia*, is similar to a linear embryo except for expanded cotyledons, which are wider than the radicle. All studied *Eschscholzia* spp. seeds, except *E. californica*, possess an embryo with spatulatelike cotyledons, viz, flattened and

curved in cross section, except that the width of the cotyledons is about equal to the width of the radicle. The third embryo type is rudimentary and is found in *Bocconia*, *Dendromecon*, and *Sanguinaria*. A rudimentary embryo is globular to oval-oblong and small (one-fifth or less length of seed). *Bocconia* embryos vary in length and thus their ratios vary. Although most of these embryos are rudimentary, an occasional embryo may be linear or spatulate. Embryo lengths in the other studied genera are not as variable as

in *Bocconia*. Martin (51) was consulted in defining these embryo terms, and they are illustrated in figure 2. The color of the embryo is the same or nearly the same as the endosperm. The embryo-seed ratio was rounded to the nearest fraction.

The cotyledons may be parallel or divergent. The cotyledon-embryo ratios are rounded to the nearest fraction. The only studied North American species that has cleft cotyledons is *Eschscholzia californica*.

FRUIT MORPHOLOGY

The papaveraceous gynoecium is generally composed of a single pistil. However, in *Platystemon* the pistils are several and coherent. The ovary is superior and one loculed, rarely several loculed by union of intruding placentas or two loculed by a spurious septum in *Glaucium*. The ovary matures into a one- to many-seeded capsule, which usually dehisces by valves, valvelike carpels, or pores. The fruit is indehiscent in *Hypecoum* (a Eurasian genus), *Platystemon*, and cultivars of *Papaver somniferum*, which were selected and perpetuated for their seed retention characteristic. These indehiscent fruits are technically not true capsules, because they lack a regular dehiscence mechanism. In the following discussion, *Platystemon* fruits and nonpore-bearing *Papaver somniferum* fruits will be called capsules to avoid using the general term fruit. A style may be absent or present. Stigmatic characters have some diagnostic value especially in the genus *Papaver*. Excellent capsule illustrations may be found in Fedde (19).

In general, capsules have been studied more than seeds and also have been used as evidence in constructing evolutionary hypotheses (5). Two major hypotheses summarized by Hutchinson (33) involve unique fruits of *Platystemon* and *Glaucium*. *Platystemon* is thought to be a primitive genus because of its multiple pistils. It is more closely related to the Helleboraceae (Ranunculaceae) than are other papaveraceous genera. In Hutchinson's phylogenetic scheme, the Papaveraceae is intermediate between Helleboraceae and Podophyllaceae.

Although the *Platystemon* aggregate fruit appears to be primitive and resembles a ranal-

ian aggregate fruit, Arber (2) concluded from anatomical evidence that this fruit is basically similar to the capsule of *Papaver* spp., though topographically dissimilar. The spurious septum found only in capsules of *Glaucium* has been used at the other end of the evolutionary scale to show a transition between the Papaveraceae and the "climax family" Cruciferae (33). Research revealing this transition is found in Lesiboudois (44, 45). Although their fruits may be similar, their seeds are not.

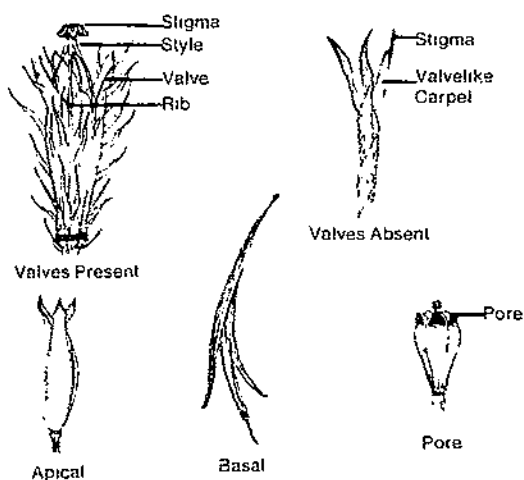
Ernst (15) enumerated these fruit characters, among others, for the four subfamilies he founded: Chelidonioideae, two-valved capsule (three to five valved in *Stylophorum diphyllum*); Papaveroideae, usually more than three-valved capsule with valves dehiscent apically; Eschscholzioideae, two-valved conspicuously ribbed capsule with valves dehiscent basally and violently; and Platystemonoideae, capsule splitting through the placentas, without formation of valves. Although the seed characters do not correlate with these subfamilies, capsule characters fit the subfamilies somewhat better.

The capsule characters discussed here are in the order given in the section on Synopses of Seed and Fruit Characters. The terminology illustrated in figure 3 is used in the capsule descriptions.

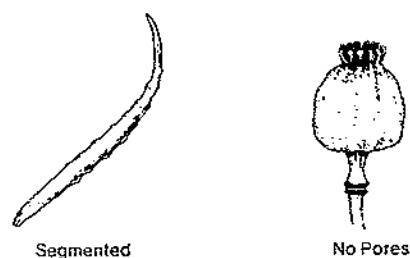
A capsule may be glabrous or armed with hairs, bristles, prickles, or spines. There are two types of hair bases, plain and tuberculate. The type of base has diagnostic value in identifying *Papaver* capsules. As we define bristles, they occur on capsules of *Papaver argemone*, *P. hybridum*, *Roemeria refracta* (occasionally and only on lips), and *Romneya* spp. Prickles

FRUIT TERMS

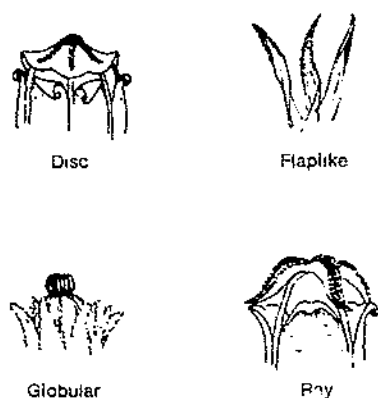
Dehiscence Types



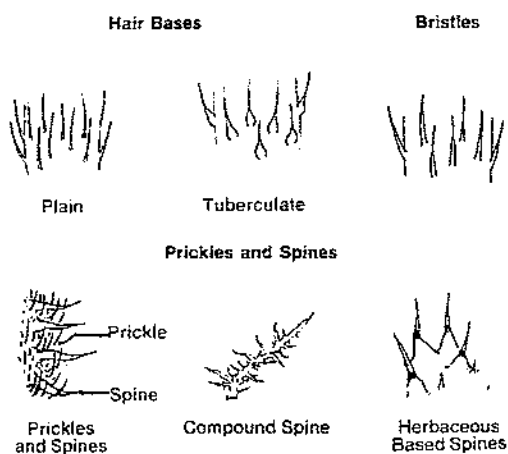
Indehiscence Types



Stigmas



Armature



Outlines

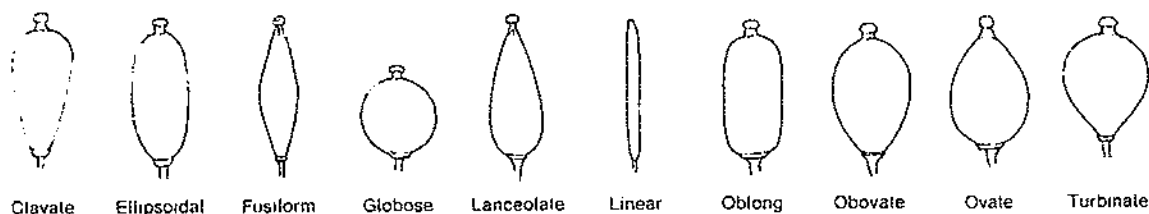


FIGURE 3.—Papaveraceous fruit terms.

and spines are found only on capsules of *Argemone* spp. and are arbitrarily differentiated by length and thickness. Prickles are miniature spines. Spines are usually simple, though compound spines occur on capsules of *Argemone aurantiaca*, *A. cchinata*, and *A. squarrosa* ssp. *squarrosa*. The base of spines may be herbaceous or nonherbaceous. These characters are illustrated in figure 3.

The surface of the capsule may be smooth, wrinkled, or nerved. The nerves may be conspicuous (thickened or discolored) or inconspicuous (impressed or essentially the color of the capsule).

Basic shapes of mature capsules prior to dehiscence were categorized as clavate, ellipsoidal, fusiform, globose, lanceolate, linear, oblong, obovate ovate, and turbinate (fig. 3). Although a linear capsule may be either straight or curved, the other shapes are straight.

The length of the capsule was measured from the apex of the stigma to the base of the capsule. The diameter was determined using nondehiscent capsules.

Papaveraceous capsules vary from one seeded (*Bocconia*) to many seeded.

Capsule colors are usually tan to brown, seldom tinged with black, gray, green, or red.

Capsules may be dehiscent or indehiscent. Dehiscence may be by two to several valves or valvelike carpels or by several apical pores (*Papaver* and *Stylomecon*). The valves may open basipetally (from apex to base) or acropetally (from base to apex). The manner in which the capsule dehisces is consistent for each genus but not for all the subfamilies that Ernst founded. The valves may remain straight, barely opening (*Arctomecon murriamii* and *Romneya* spp.), or they may curve, coil, or twist and open to their base or apex. Valves that open about half way are found in *Argemone* spp., and valves that open fully are represented by *Stylaphorum diphyllum*. Only in *Bocconia* spp. and *Chelidonium majus* are the valves regularly

deciduous. Two studied species have capsules that do not dehisce by valves, valvelike carpels, or pores, viz, *Platystemon californicus* and certain cultivars of *Papaver somniferum*. Although the fruit of *Platystemon* breaks apart at joints or placentas, it has no regular mechanism for dehiscence. As previously noted, capsules of certain cultivars of *P. somniferum* have been selected for their seed retention, viz, lack of functional apical pores. Valvelike carpels, which are not true valves because no ribs are present, are found in *Hesperomecon* and *Mecconella*. Capsule terms are illustrated in figure 3.

Two types of capsule ribs, indurate and fragile, may be present. These ribs are the major vascular bundles of the capsule and represent dehiscence sutures. The ribs unite at the apex, occasionally forming a style.

The valves of *Bocconia* and *Chelidonium majus* are deciduous, whereas the valves of the other studied genera are either not deciduous or not present.

A style may be present or absent. If present, it is persistent and usually single. *Platystemon* has several styles.

The stigma, which also persists, possesses one of these shapes: Disc (*Papaver*), flaplike, globular, or ray (*Canbya*) (fig. 3). The stigmatic surface may be confluent or discrete (lobed). The lobes may be notched. The disc-type stigma possesses several rays, and the number of rays has diagnostic value. A flaplike stigma may have two divergent or appressed segments. The position of the stigma in *Platystemon* is in the primitive position, alternating with the placentas (33). Although Ernst (16) described the position and number of stigmas for the family "as many as and alternate with the placentae," he was apparently considering only the native New World genera. The more advanced genera such as *Glaucium* have stigmas in line with the placentas. This stigmatic position is found in members of the Cruciferae as well as the Saxifragaceae, which are also thought to have a ranalian origin (33).

SEED KEY TO PAPAVERACEOUS SPECIES

1. Seed enclosed snugly in a fruit segment (fruit indehiscent) *Platystemon californicus*
1. Seed falling free of dehiscent capsule.
2. Aril present.
 3. Seed 4 mm or more in length; aril covers base.
 4. Funiculus persistent (dissect aril).
 5. Aril covering up to one-fourth of seed and somewhat ruffled ----- *Bocconia frutescens*
 5. Aril covering up to one-third of seed and ruffled ----- *Bocconia vulcanica*
 4. Funiculus deciduous (dissect aril).
 6. Aril pyramidal, not tapering along raphe.
 7. Apical dot of inner seedcoat, if present, rough and not discolored ----- *Bocconia integrifolia*
 7. Apical dot of inner seedcoat smooth and brown to blackish brown.
 8. Aril two lobed ----- *Bocconia gracilis*
 8. Aril unlobed ----- *Dendromecon rigida*
 6. Aril not pyramidal, tapering along raphe.
 9. Seed with apical depression ----- *Bocconia arborea*
 9. Seed with subapical depression ----- *Bocconia latiseptala*
 3. Seed less than 4 mm in length; aril lateral to subbasal.
 10. Aril one-half length of seed or longer.
 11. Aril longer than seed.
 12. Seed more than 3 mm long ----- *Sanguinaria canadensis*
 12. Seed less than 3 mm long ----- *Stylophorum diphyllum*
 11. Aril shorter than seed.
 13. Aril up to one-half length of seed ----- *Macleaya cordata*
 13. Aril about as long as seed ----- *Arctomecon humilis*
 10. Aril less than one-half length of seed.
 14. Aril winglike, a lateral patch ----- *Chelidonium majus*
 14. Aril not winglike, a subbasal patch.
 15. Seed obovate ----- *Arctomecon merriamii*
 15. Seed ellipsoidal with one flattened side ----- *Arctomecon californica*
2. Aril absent.
 16. Seed appearing minutely granular or tuberculate.
 17. Seed spherical-obovate ----- *Hunnemannia fumariifolia*
 17. Seed angular and irregular to ellipsoidal with one flattened side.
 18. Endosperm nonfluorescent ----- *Romneya coulteri*
 18. Endosperm faintly fluorescing bluish white ----- *Romneya trichocalyx*
 16. Seed smooth except for walls of reticulum.
 19. Reticulation compound (composed of primary and secondary reticulation), conspicuous at 10 X.
 20. Primary reticulation composed of thick walls, discrete lumps, or winglike projections.
 21. Reticulation winglike ----- *Eschscholzia lobbia*
 21. Reticulation not winglike.
 22. Reticulation thick walled ----- *Eschscholzia glyptosperma*
 22. Reticulation lumpy.
 23. Seed ellipsoidal; raphe conspicuous ----- *Eschscholzia elegans*
 23. Seed essentially spherical; raphe often inconspicuous ----- *Eschscholzia frutescens*
 20. Primary reticulation composed of thin walls.
 24. Secondary reticulation a network of colored lines ----- *Papaver somniferum*
 24. Secondary reticulation a network of walls.
 25. Cotyledons either cleft or broader than radicle (thus embryo spatulate).
 26. Cotyledons cleft, not broader than radicle ----- *Eschscholzia californica*
 26. Cotyledons entire, broader than radicle ----- *Eschscholzia caespitosa*

25. Cotyledons neither cleft nor broader than radicle.
27. Seedcoat purplish brown; reticulation tan ----- *Eschscholzia lemmonii*
27. Seedcoat ocher to brown; reticulation tan.
28. Seed spherical to angular, 1.3-1.8 mm long -----
----- *Eschscholzia rhombipetala*
28. Seed spherical to ellipsoidal, seldom up to 1.4 mm long ----
----- *Eschscholzia hyperoides*, *E. mexicana*, *E. minutiflora*, *E. parishii*
19. Reticulation simple, conspicuous or inconspicuous at 10 ×.
29. Seedcoat shiny, reticulation barely visible at 10 × as a network of colored lines.
30. Seedcoat bearing shriveled and frequently dark subbasal patch; seed reniform ----- *Platystemon californicus*
30. Seedcoat without subbasal patch; seed seldom reniform.
31. Fields irregular at 30 ×.
32. Endosperm granular ----- *Canbya eurea*
32. Endosperm oily ----- *Canbya candida*
31. Fields circular at 30 ×.
33. Embryo nearly length of seed ----- *Hesperomecon lineare*
33. Embryo about one-half (not exceeding three-fourths) length of seed.
34. Raphe about one-half length of seed; endosperm granular -----
----- *Meconella denticulata*
34. Raphe about three-fourths length of seed; endosperm oily -----
----- *Meconella californica*, *M. oregana*
29. Seedcoat dull to somewhat shiny, reticulation easily seen at 10 × as a network of walls.
35. Seed spherical or nearly so ----- *Argemone* spp. (p. 25)
35. Seed C-shaped, D-shaped, comma shaped, or reniform.
36. Reticulum complex, either appearing double walled and winged or fields bearing faint to conspicuous network of colored lines.
37. Reticulum simple but appearing double walled and winged -----
----- *Roemeria refracta*
37. Reticulum compound with regular walls and faint to conspicuous network of colored lines in fields ----- *Papaver somniferum*
36. Reticulum simple.
38. Seed D-shaped ----- *Glaucium flavum*
38. Seed C-shaped, comma shaped, or reniform.
39. Seed comma shaped.
40. Endosperm oily.
41. Raphe a line to low ridge about one-half length of seed ----- *Papaver alboroseum*
41. Raphe about three-fourths length of seed.
42. Embryo one-fourth to one-third length of seed ----
----- *Papaver nudicaule*
42. Embryo one-seventh to one-sixth length of seed ----
----- *Papaver radicatum*
40. Endosperm granular.
43. Seed less than 1 mm long ----- *Papaver macounii*, *P. pygmaeum*
43. Seed 1 mm or more in length.
44. Seed 0.8-1 mm long ----- *Papaver macounii*
44. Seed 1-1.4 mm long ----- *Papaver alaskanum*
39. Seed C-shaped to reniform.
45. Embryo less than one-half length of seed.
46. Reticulum pattern on lateral sides different from pattern on dorsal side; seed 0.9 mm or more in length ----
----- *Papaver argemone*
46. Reticulum pattern uniform; seed 0.8 or less in length -----
----- *Papaver californicum*
45. Embryo one-half or more length of seed.

47. Cuticle easily separated from seedcoat (when seed soaked) *Stylomecon heterophylla*
 47. Cuticle barely, if at all, separable from seedcoat (usually just walls of reticulum).
 48. Reticulum walls conspicuously wavy *Papaver rhoeas*
 48. Reticulum walls essentially straight.
 49. Seedcoat purplish gray; seed 0.6-0.8 mm long ..
 *Papaver dubium*
 49. Seedcoat ocher to brown; seed 0.7-1.4 mm long ..
 *Papaver hybridum*

FRUIT KEY TO PAPAVERACEOUS SPECIES

1. Fruit complex, 6-25 aggregated pistils *Platystemon californicus*
1. Fruit simple (one pistil).
2. Fruit linear (at least 10 times longer than wide).
3. Fruit indehiscent, separating into segments *Platystemon californicus*
3. Fruit a dehiscent capsule.
4. Valves or valvelike carpels three to four.
5. Valves separating from three to four ribs *Roemeria refracta*
5. Valvelike carpels not separating from ribs; ribs absent.
6. Capsule 1-1.6 cm long (plant of Pacific NW) *Meconella oregana*
6. Capsule 1.5-3.5 cm long *Meconella californica*, *M. denticulata*
4. Valves two.
7. Valves smooth, nerveless between two sutures.
8. Capsule divided longitudinally by septum; apical dehiscence
 *Glucium flavum*
8. Capsule without septum; basal dehiscence *Chelidonium majus*
7. Valves nerved between two sutures.
9. Ribs indurate *Dendromecon rigida*
9. Ribs fragile.
10. Torus inflated *Eschscholzia* spp.
10. Torus not inflated *Hunnemannia fumariifolia*
2. Fruit not linear (less than 10 times longer than wide).
11. Capsule with zero or two valves; if zero, dehiscence by pores, or indehiscent in some cultivars of *Papaver somniferum*.
12. Valves two.
13. Capsule one seeded, gray to black *Bocconia* spp.
13. Capsule two to many seeded, tan to brown.
14. Capsule flattened (1-2 mm thick), oblanceolate *Macleaya cordata*
14. Capsule terete, linear, ellipsoidal, or fusiform.
15. Capsule ellipsoidal to fusiform, 5-15 mm wide *Sanguinaria canadensis*
15. Capsule linearlike, 1-4 mm wide *Chelidonium majus*
12. Valves zero; capsule apically dehiscent by pores.
16. Capsule glabrous.
17. Style present, 1-3 mm long *Stylomecon heterophylla*
17. Style absent.
18. Capsule subglobose to oblong.
19. Disc rays separate at apex, forming distinct lobes, usually more than 2 cm in diameter *Papaver somniferum*
19. Disc rays notched, not forming distinct lobes, less than 2 cm in diameter *Papaver rhoeas*
18. Capsule clavate, turbinate, or narrowly obovate.
20. Capsule 8-16 mm long, bearing four to seven conspicuous nerves *Papaver californicum*
20. Capsule 15-20 mm long, bearing five to nine inconspicuous nerves *Papaver dubium*
16. Capsule pubescent to bristly.

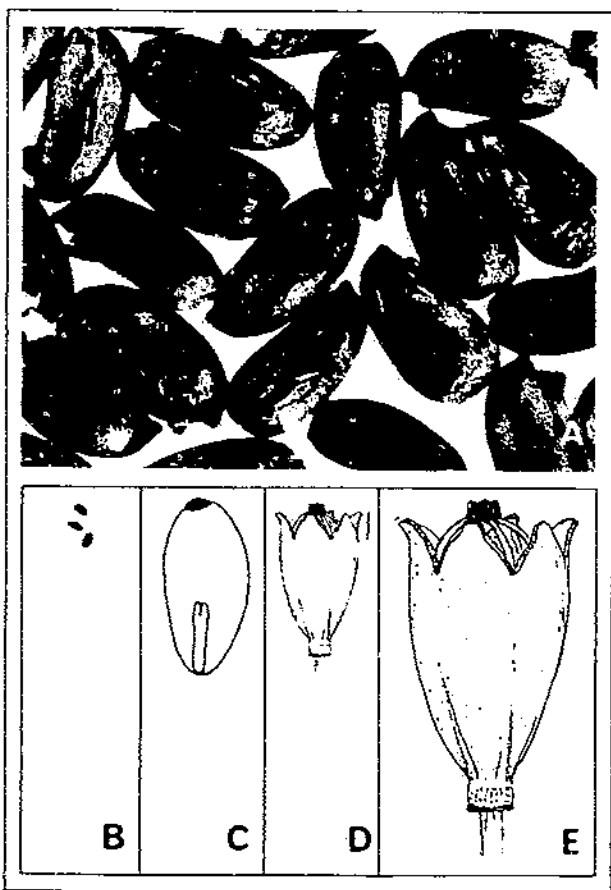
- 21. Capsule bristly.
 - 22. Capsule clavate to oblong-cylindrical, 15-22 mm long *Papaver argemone*
 - 22. Capsule ellipsoidal to ovate, 9-12 mm long *Papaver hybridum*
- 21. Capsule pubescent.
 - 23. Hairs with tuberculate bases.
 - 24. Stigmatic disc as wide as capsule; capsule with four to five conspicuous nerves *Papaver walpolei*
 - 24. Stigmatic disc narrower than broadest portion of capsule; capsule with four to seven inconspicuous nerves.
 - 25. Capsule broad ovate to globose; disc rays five to seven *Papaver albaroseum*
 - 25. Capsule narrowly obovate; disc rays four to five *Papaver pygmaeum*
 - 23. Hairs without tuberculate bases.
 - 26. Capsule nerves conspicuous *Papaver macounii*, *P. nudicaule*
 - 26. Capsule nerves inconspicuous *Papaver alaskanum*, *P. radiculatum*
- 11. Capsule with 3-12 valves.
 - 27. Capsule glabrous.
 - 28. Stigma globular.
 - 29. Capsule tapering to base.
 - 30. Capsule less than 1 cm long *Arctomecon humilis*
 - 30. Capsule 1 cm or more in length.
 - 31. Capsule 1.3-2 cm long *Arctomecon californica*
 - 31. Capsule 2.5 cm or more in length *Arctomecon merriamii*
 - 29. Capsule rounded at base, not tapering.
 - 32. Capsule 2 cm or less in length *Argemone turnerae*
 - 32. Capsule 2.5 cm or more in length *Argemone mexicana* f. *leiocarpa*
 - 28. Stigma not globular.
 - 33. Capsule 8-14 mm long; ribs absent *Hesperomecon lineare*
 - 33. Capsule 1.5-4 mm long; three ribs present *Cantua aurea*, *C. candida*
- 27. Capsule pubescent or spiny.
 - 34. Capsule with soft pubescence, never bristly or spiny. *Stylaphorum diphyllum*
 - 34. Capsule spiny or bristly, hairs may be present or absent.
 - 35. Carpels seven or more.
 - 36. Carpels 7-12; bristles less than 4 mm long *Ranunculus coulteri*, *R. trichocalyx*
 - 36. Carpels 3-7; spines 6 mm or more in length *Argemone albiflora* ssp. *albiflora*
 - 35. Carpels six or less.
 - 37. Spines basally herbaceous.
 - 38. Largest spines compound.
 - 39. Largest spines 15-35 mm *Argemone aurantiaca*
 - 39. Largest spines 8-15 mm.
 - 40. Capsule 20-35 mm long; valves three to four. *Argemone echinata*
 - 40. Capsule 35-45 mm long; valves four to five *Argemone squarrosa* ssp. *squarrosa*
 - 38. Largest spines simple.

41. Spines up to 6 mm long; capsule broadly ovate *Argemone fruticosa*
41. Spines 6 mm or more in length; capsule not ovate.
42. Prickles absent *Argemone albiflora* ssp. *albiflora*
42. Prickles present.
43. Capsule narrowly ellipsoidal, 10-14 mm wide *Argemone albiflora* ssp. *texana*
43. Capsule oblong-ellipsoidal to lanceolate, 14-18 mm wide *Argemone squarrosa* ssp. *glabrata*
37. Spines not basally herbaceous.
44. Spines essentially equal and often scattered.
45. Spines slender, less than 1 mm wide at base.
46. Capsule broadest near base *Argemone subintegrifolia*
46. Capsule broadest above base.
47. Spines 5-6 mm long; capsule 14-16 mm wide *Argemone corymbosa* ssp. *arenicola*
47. Spines 6-8 (-10) mm long; capsule 8-14 mm wide *Argemone gracilentia*
45. Spines stout, 1 mm or more in width at base.
48. Capsule less than 2 cm long *Argemone superba*
48. Capsule 2 cm or more in length.
49. Prickles present *Argemone mexicana* f. *mexicana*
49. Prickles absent *Argemone corymbosa* ssp. *corymbosa*,
A. grandiflora (both subspecies), *A. munita* ssp. *robusta*, *A. ochroleuca* ssp. *ochroleuca*, *A. pleiacantha* ssp. *pinnatisecta*
44. Spines unequal.
50. Prickles absent.
51. Largest spines slender, 1 mm or less in width at base.
52. Spines 6 mm or less in length *Argemone pleiacantha* ssp. *pleiacantha*
52. Spines 7-10 mm long *Argemone arizonica*, *A. chisosensis*
51. Largest spines stout, more than 1 mm wide at base.
53. Capsule rounded to truncate at apex *Argemone platyceras*
53. Capsule tapering to apex *Argemone aenea*, *A. pleiacantha* ssp. *ambigua*, *A. polyanthemus*
50. Prickles present.
54. Largest spines stout, more than 1 mm wide at base *Argemone grandiflora* ssp. *armata*, *A. munita* ssp. *argentea*, *A. ochroleuca* ssp. *stenopetala*, *A. sanguinea*
54. Largest spines slender, 1 mm or less in width at base.
55. Prickles and/or spines spreading *Argemone arida*, *A. brevicornuta*, *A. munita* ssp. *munita*
55. Prickles and/or spines incurved.
56. Largest spines incurved, up to 5 mm long *Argemone munita* ssp. *rotundata*
56. Largest spines spreading, up to 8 mm long *Argemone hispida*

SYNOPSIS OF SEED AND FRUIT CHARACTERS

Arctomecon californica Torrey and Frémont

Yellow-Flowered Desert-Poppy



Arctomecon californica: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, dehiscent capsule $\times 2$. Brandegee, Clark County, Nev. (US).

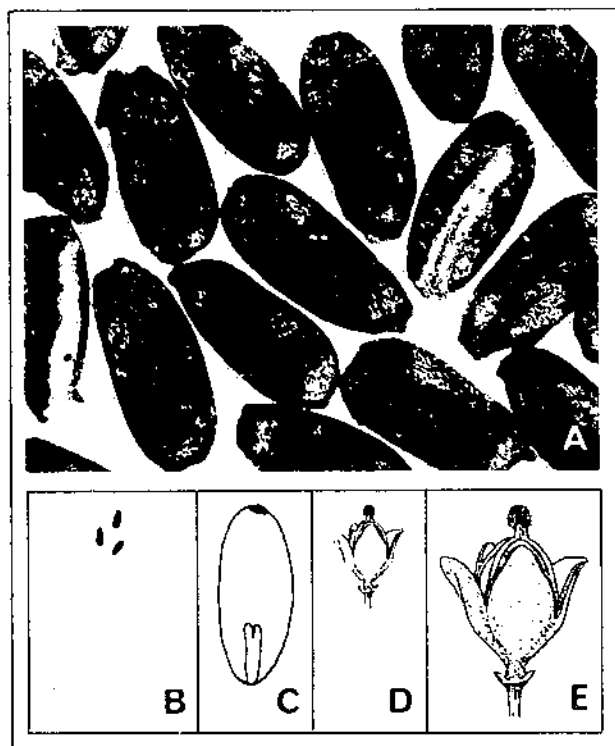
Seed 2-2.5 \times 1-1.3 \times 1-1.2 mm, ellipsoidal with one flattened side, with apical depression concealed by loosely adhering cuticle, bearing prominent basal nipple, terete in cross section. Seedcoat shiny (dull when immature), grayish brown to tobacco brown, wrinkled, appearing nonreticulate. Reticulum inconspicuous, at 30 \times straight walls forming a regular pattern of minute rectangular fields, color of seedcoat. Aril a subbasal patch attached to raphe, honey colored to darker. Raphe a ridge length of seed or nearly so, color of seedcoat. Hilum on nipple, inconspicuous. Cuticle separable from seedcoat, reddish brown. Outer seedcoat weakly lignified, less than 0.1 mm thick, black. Inner seedcoat membranaceous, faint amber, bearing apical brown dot. Endosperm fleshy, whitish, fluorescing yellowish white to bluish white, oily, when teased wet emitting oil droplets. Embryo linear, white, one-fourth to three-fifths length of seed. Cotyledons parallel, up to one-third length of embryo, uncleft.

Capsule glabrous, with three to six inconspicuous nerves, ovate to obovate, 1.3-2 cm long, 9-12 mm in diameter, many seeded, tan to reddish brown, dehiscent apically by three to six valves, which separate from three to six indurate ribs, valves not deciduous. Style, if present, less than 1 mm long. Stigma globular with three to six notched lobes (usually six).

Notes: Yellow-flowered desert-poppy is an endemic perennial of southern Nevada (Clark Co.) to northwestern Arizona (northern Mohave Co.). The specific epithet was applied when the region was Mexican and California covered a much larger territory. The plant is locally used as an ornamental. Gray (22) claimed to have illustrated this species; however, he described and illustrated *A. humilis*.

Arctomecon humilis Coville

White-Flowered Desert-Poppy



Arctomecon humilis: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, dehiscent capsule $\times 2$. Ripley and Barneby 4945, Washington County, Utah (NY).

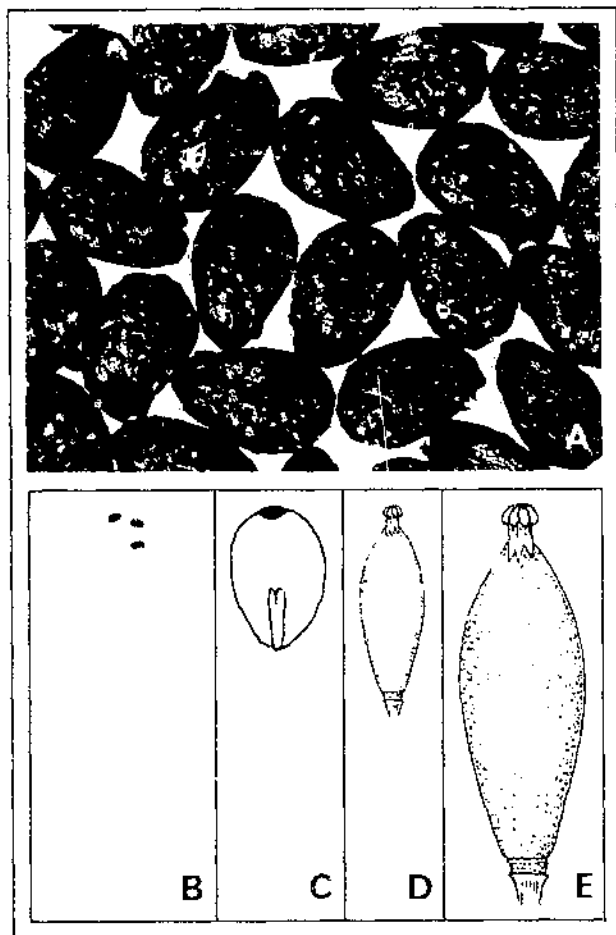
Seed 2.3–2.7 \times 1–1.2 \times 1–1.2 mm, ellipsoidal with one flattened side, frequently with apical depression, bearing prominent basal nipple, terete in cross section. Seedcoat shiny (dull when immature), tobacco brown, somewhat wrinkled, appearing nonreticulate. Reticulum inconspicuous, at 30 \times straight walls forming a regular pattern of minute rectangular to irregular fields (superficially resembling a fingerprint because cross walls are poorly developed), color of seedcoat. Aril linear, up to length of seed, frequently thickest and broadest at basal end, honey colored. Raphe present as a ridge if aril not length of seed, otherwise poorly developed, color of seedcoat. Hilum on nipple, inconspicuous. Cuticle separable from seedcoat, reddish brown. Outer seedcoat weakly lignified, less than 0.1 mm thick, black. Inner seedcoat membranaceous, faint amber, bearing apical brown dot. Endosperm fleshy, whitish, fluorescing bluish white, oily, when teased wet emitting oil droplets. Embryo linear, white, one-fourth to one-third length of seed. Cotyledons parallel, one-fourth to one-third length of embryo, uncleft.

Capsule glabrous, with three to six inconspicuous nerves, ovate to obovate, 7–9 mm long, 5–6 mm in diameter, many seeded, tan to brown, dehiscent apically by three to six valves, which separate from three to six indurate ribs, valves not deciduous. Style, if present, up to 1 mm long. Stigma globular with three to six notched lobes (usually four).

Notes: White-flowered desert-poppy is an endemic perennial of southwestern Utah (Washington Co.) and northwestern Arizona (Mohave Co.). One of the larger populations occurs in the vicinity of St. George, Utah, where in a good season the desert is abloom with this handsome plant. The plant is locally used as an ornamental. This species is illustrated in Gray (22) under the name *A. californica*. The seedcoat reticulation insert in the plate is inaccurately drawn.

Arctomecon merriamii Coville

Bear-Poppy



Arctomecon merriamii: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, indehiscent capsule $\times 1$; E, indehiscent capsule $\times 2$. (A-C) Gilman, Inyo County, Calif. (US); (D-E) Coville and Gilman 406, Inyo County, Calif. (US).

Seed 1.8-2.2 \times 1.2-1.4 \times 1.2-1.4 mm, ob-ovate, with apical or subapical dot concealed by cuticle, bearing emergent to prominent basal nipple, terete in cross section. Seedcoat shiny, dark purplish gray, wrinkled (resembling reticulate pattern), appearing nonreticulate. Reticulum inconspicuous, at 30 \times straight walls forming an irregular pattern of minute irregular fields, color of seedcoat. Aril a subbasal patch attached to raphe, honey colored to darker. Raphe a ridge length of seed or nearly so (resembling a longitudinal wrinkle), color of seedcoat. Hilum on nipple, inconspicuous. Cuticle separable from seedcoat, but not as easily as preceding species, dark reddish brown. (Cuticle when removed wet emits minute oil droplets resembling smoke.) Outer seedcoat weakly lignified, less than 0.1 mm thick, black. Inner seedcoat membranaceous, faint amber, bearing apical or subapical brown dot. Endosperm fleshy, white, fluorescing yellowish white to bluish white, oily, when teased wet emitting oil droplets. Embryo linear, white, one-third to one-half length of seed. Cotyledons parallel, one-third to one-half length of embryo, unleft.

Capsule glabrous, with three to six inconspicuous nerves, narrowly obovate, 2.5-4.5 cm long, 8-11 mm in diameter, many seeded, tan to brown, dehiscing apically by three to six valves, which separate from three to six indurate ribs, valves not deciduous. Style up to 2 mm long. Stigma globular with three to six notched lobes.

Notes: Bear-poppy is an endemic white-flowered perennial of eastern California (Inyo Co.) to western Nevada (Clark and Lincoln Cos.). This species is a member of the Death Valley flora. It is a rare plant and is usually found on loose-rock desert slopes at elevations from 900 to 1,300 m. Like the other two species, this one is locally used as an ornamental. Bear-poppy is illustrated in Abrams (1).

Argemone spp.

Prickly-Poppy

Seed (table 3) 1-3 mm in all dimensions, spherical or nearly so, without depression, bearing emergent to elongate basal nipple, terete in cross section. Seedcoat dull to shiny, shades of brown occasionally with red undertones or with blue sheen, not wrinkled, reticulate. Reticulum moderate to bold straight walls forming a regular pattern of small to large circular, oblong, rectangular, or square fields. Aril absent. Raphe a ridge to wing one-third to nearly length of seed, color of seedcoat. Hilum on side of nipple or between nipple and raphe, conspicuous because of its craterlike appearance. Cuticle separable from seedcoat, amber. Outer seedcoat weakly lignified to lignified, up to 0.3 mm thick, dark brown to blackish. Inner seedcoat membranaceous, amber to white, bearing subapical colored dot. Endosperm fleshy (granular in *A. echinata* and *A. subintegrifolia*), white, fluorescing bluish white, oily to not oily, when teased wet emitting conspicuous, inconspicuous (resembling smoke), or no oil droplets. Embryo linear, white, more or less one-half length of seed. Cotyledons parallel, occasionally uneven, poorly developed to one-half length of embryo, entire.

Capsule (table 3) glabrous or bearing compound and/or simple spines (longest spines 4-35 mm long) occasionally intermixed with prickles, surface visible to obscure (depending on amount of armature), three to six (rarely seven) inconspicuous nerves, ellipsoid, lanceolate, oblong, ovate, or combinations of these shapes, 1.3-5.5 cm long (including stigma), 8-25 mm in diameter (excluding armature), many seeded, tan to brown, dehiscing apically by three to six (rarely seven) valves, which separate from three to six (rarely seven) indurate

ribs, valves not deciduous. Style if present, up to 4 mm long. Stigma globular with three to six (rarely seven) lobes.

Notes: The monograph by Ownbey (56) was used, especially for distributional notes (table 3). Most of the studied seeds and capsules came either from G. B. Ownbey or from herbarium specimens that he annotated. He did not identify these specimens: *A. corymbosa* ssp. *corymbosa* (capsule), *A. hispida* (seed and capsule), *A. platyceras* (capsule), *A. polyanthemus* (seed and capsule), and *A. turnerae* (seed and capsule). *Argemone*, commonly known as prickly-poppy, thistle-poppy, thornapple, chicalote, or cardo, is an American genus except *A. glauca* L. ex Pope, an endemic of the Hawaiian Islands.

These annual and perennial herbs (*A. fruticosa* is a shrub) may be found in "coastal areas of southeastern and southern United States; in the west from southern Montana and western South Dakota southward across the plains to the Gulf of Mexico; southwestward to California, Arizona and New Mexico; throughout the West Indies, Mexico and Central America; in South America in Chile, Argentina, Uruguay, Paraguay, Bolivia and northward along the coasts to the Isthmus of Panama; Hawaii; *A. mexicana* by introduction in tropical and subtropical lands around the world" (56). Some *Argemone* spp. are capable of hybridization. However, the species are usually spatially or ecologically isolated from each other.

In Latin America, seeds of *A. mexicana* and other species of *Argemone* have been used as a purgative or a substitute for ipecacuanha. The juice of many species has been used in treating ophthalmia (56). All species and subspecies except *A. turnerae* are illustrated in Ownbey (56, 57).

TABLE 3.—Selected seed and fruit characters and plant distribution for North American *Argemone* spp.

Argemone spp.	Seed			Capsule							Range ⁷
	Length (mm)	Reticulation		Shape ³	Size (mm)	Valve (number)	Surface ⁴	Spine			
		Type ¹	Size ²					Type ⁵	Base ⁶	Longest length (mm)	
aenea -----	1.5-1.8	b	m	n el-el ob	25-35 × 12-16	4-5	v	s, nev, npr	nh	Up to 8	SW, MEX
albiflora ssp. albiflora -	1.9-2.1	b	m-l	ob-ob el	20-45 × 12-15 (-25)	4-5 (-3-7)	v	s, ev, npr	h	6-8 (-10)	E
albiflora ssp. texana --	1.6-1.8	b	m-l	n el	25-40 × 10-14	4-5 (-3)	po	s, nev, pr	h	7-10 (-12)	SW
arida -----	1.8-2.1	b	m-l	el ob-la	25-45 × 12-15	3-5	po	s, nev, pr	nh	8	MEX
arizonica -----	1.7-2.1	b	m	n el-ob	35-45 × 10-14	3	v	s, nev, npr	nh	8-10	SW
aurantiaca -----	2.4-3	m-b	m	ov	40-50 × 15-25	5-6	po	c, s, nev, pr	h	Up to 35	SW
brevicornuta -----	1.8-2.2	b	m-l	n el-la	25-40 × 8-10	3-4	v	s, nev, pr	nh	5-6	MEX
chisosensis -----	1.8-2.2	m-b	sm-m	n el-la	30-45 × 8-13	3-4	v	s, nev, npr	nh	Up to 10	SW, MEX
corymbosa ssp.											
corymbosa -----	1.6-1.9	m-b	m	ov-la	25-30 × 10-15	4-5	v	s, ev, npr	nh	6-7	SW
corymbosa ssp.											
arenicola -----	2-2.1	m-b	m	la ov	25-35 × 14-16	3-4 (-5)	v	s, ev, npr	nh	5-6	NW, SW
echinata -----	1.9-2.2	b	l	b ob-el	20-35 × 10-14	3-4	po	c, s, nev, pr	h	9-11	MEX
fruticosa -----	1.9-2.2	m	sm-m	b ov	14-22 × 10-15	4-6	po-o	s, ev, pr	h	Up to 6	MEX
gracilenta -----	1.6-2	m-b	m	n el-n el ov	30-50 × 8-14	3-4	v	s, ev, npr	nh	6-8 (-10)	SW, MEX
grandiflora ssp.											
grandiflora -----	1.8-2.3	b	m	b ob-el	20-40 × 10-18	3-5	v	s, ev, npr	nh	5	MEX
grandiflora ssp.											
armata -----	1.9-2.2	b	m	ob, b-n el	20-40 × 12-16	3-5	v	s, ev, npr (nev, pr)	nh	6-8	MEX
hispida -----	2.2-2.7	b	m	ov	30-40 (-50) × 12-18	3-4	po	s, nev, pr	nh	5	NW, SW
mexicana f. mexicana -	1.7-2	b	sm-m	ob-n el	25-45 × 12-20	4-6	v	s, ev, pr	nh	6-10	E, NW, SW, MEX
mexicana f. leiocarpa -	1.7-2	b	sm-m	ob-n el	25-45 × 12-20	4-6	v	smooth	---	---	E
munita ssp. munita ---	2-2.2	b	l	n-b el, el ov	25-45 × 9-14	3-5	v	s, nev, pr	nh	5-8	SW
munita ssp. argentea --	1.8-2.2	b	m-l	el la-la	25-35 × 10-14	3 (-5)	po	s, nev, pr	nh	6-8	SW
munita ssp. robusta --	2.3-2.7	b	l	el-el la	35-50 × 10-18	3-4	v	s, ev, npr	nh	6-8	SW
munita ssp. rotundata -	2-2.5	b	m-l	ov-n el	30-55 × 12-18	3-5	po	s, nev, pr	nh	8	NW, SW
ochroleuca ssp.											
ochroleuca -----	1.6-1.8	b	m-l	la-ov la-ob el	35-50 × 14-18	4-5 (-3-6)	v	s, ev, npr	nh	8-12	MEX
ochroleuca ssp.											
stenopetala -----	1.7-2	b	m	la-ov la-ob el	20-40 × 10-18	3-5	v	s, nev, pr	nh	6-9	MEX
platyceras -----	1.9-2.2	b	m	b el-el ov	25-45 × 14-24	4-5	po-o	s, nev, npr	nh	6-8	MEX
pleiacantha ssp.											
pleiacantha -----	1.8-2.1	b	m	ov-el	(24-) 30-45 × 10-16	3-4	po	s, nev, npr	nh	Up to 6	SW, MEX

<i>pleiacantha</i> ssp.												
<i>ambigua</i> -----	1.8-2.5	b	m	el la-ov	26-36 (-50) × 10-14 (-18)	3-4	v	s, nev, npr	nh	4-6 (-8)	SW	
<i>pleiacantha</i> ssp.												
<i>pinnatisecta</i> -----	2.3-2.6	b	m	el	25-40 × 10-14	3-4	v	s, ev, npr	nh	4-5	SW	
<i>polyanthemos</i> -----	1.8-2.1	b	m-l	n-b el	30-50 × 10-17	3-4	v	s, nev, npr	nh	8-10	NW, SW	
<i>sanguinea</i> -----	1.2-1.6	b	sm	n-b el	25-40 (-50) × 8-15 (-18)	3-5 (-6)	v	s, nev, pr	nh	5-7 (-10)	SW, MEX	
<i>squarrosa</i> ssp.												
<i>squarrosa</i> -----	2.2-2.6	b	m-l	n el-ov	35-45 × 10-18	4-5	po	c, s, nev, pr	h	10-15	NW, SW	
<i>squarrosa</i> ssp.												
<i>glabrata</i> -----	2.4-2.7	b	l	ob el-la ov	25-50 × 14-18	4-5	v	s, nev, pr	h	8-12	SW	
<i>subintegrifolia</i> -----	1.2-1.5	m	sm	ov	25-30 × 13-15	5-6	po	s, ev, npr	nh	5-6	MEX	
<i>superba</i> -----	---	---	---	b el	15-19 × 10-11	4-5	v	s, nev, pr	nh	8-10	MEX	
<i>turnerae</i> -----	1.8-1.9	m	sm	b ov	12-18 × 8-10	4-6	v	smooth	---	---	MEX	

¹ Type of reticulation: *b*=bold; *m*=moderate.

² Size of fields: *l*=large; *m*=moderate; *sm*=small.

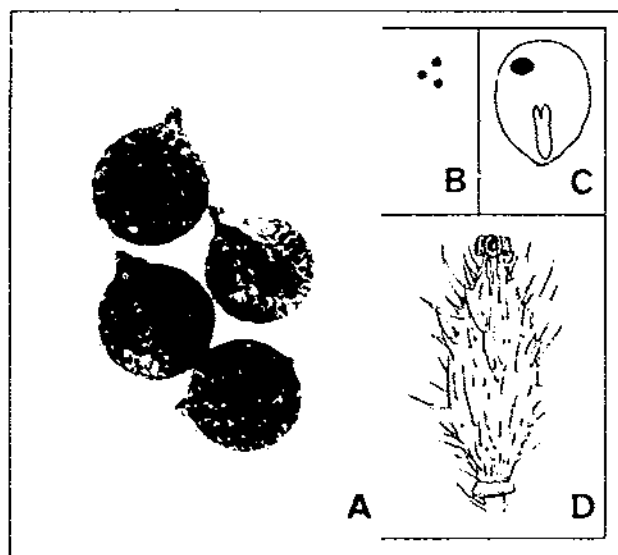
³ Shape of capsule: *b*=broad; *el*=ellipsoid; *la*=lanceolate; *n*=narrow; *ob*=oblong; *ov*=ovate.

⁴ Surface of capsule: *o*=obscured; *po*=partially obscured; *v*=visible.

⁵ Type of spine: *c*=compound; *ev*=even or subequal; *nev*=not even (two distinct sizes); *npr*=no prickles present; *pr*=prickles present; *s*=simple; smooth=no spines or prickles present.

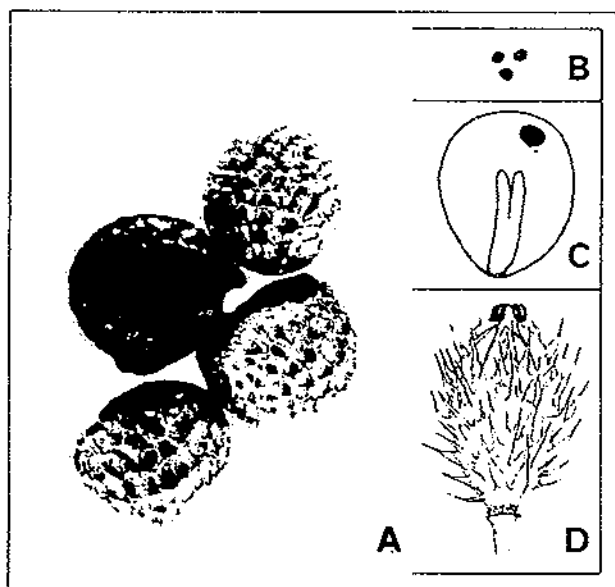
⁶ Base of spine: *h*=herbaceous; *nh*=not herbaceous.

⁷ Range: E=east of Mississippi River; MEX=Mexico; NW=north of 37th parallel; SW=south of 37th parallel.

Argemone aenea G. B. Ownbey

Argemone aenea: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, indehiscent capsule $\times 1$. (A-C) Ownbey and Ownbey 1616, Hidalgo County, Tex. (MIN); (D) Ownbey and Ownbey, Hidalgo County, Tex. (US).

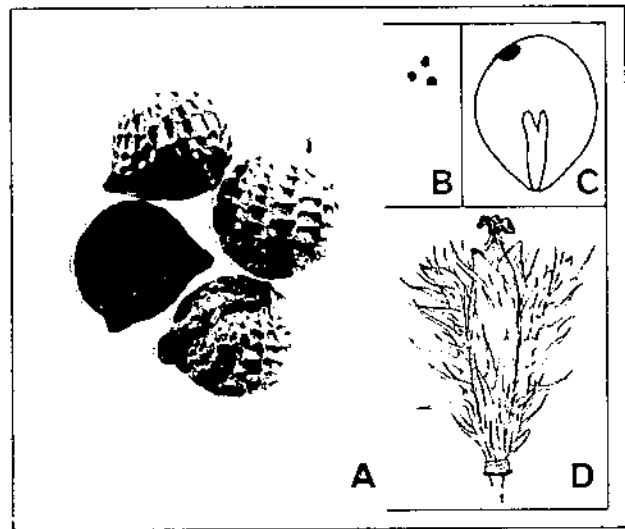
Notes: Bronze-flowered prickly-poppy is an annual, biennial, or short-lived perennial of the dry plains, low hills, and drainage areas below 1,400 m in southwestern Texas and northeast Mexico. It may be a hybrid of *A. mexicana* and *A. sanguinea*.

Argemone albiflora Hornemann ssp. *albiflora*

Argemone albiflora ssp. *albiflora*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. (A-C) Ownbey and Ownbey 1375, Franklin County, Fla. (US); (D) Duke and Hurst 17270, field grown (NA).

Notes: White-flowered prickly-poppy is an annual or biennial of sandy soil of northern Florida. It has become established from southeastern North Carolina to Mississippi, north to Connecticut, and west to Illinois and Missouri. *Argemone alba* Lestiboudois, used in many American floras, or floristic surveys, is a synonym. The plant is also illustrated in Radford et al. (62) and Steyermark (75).

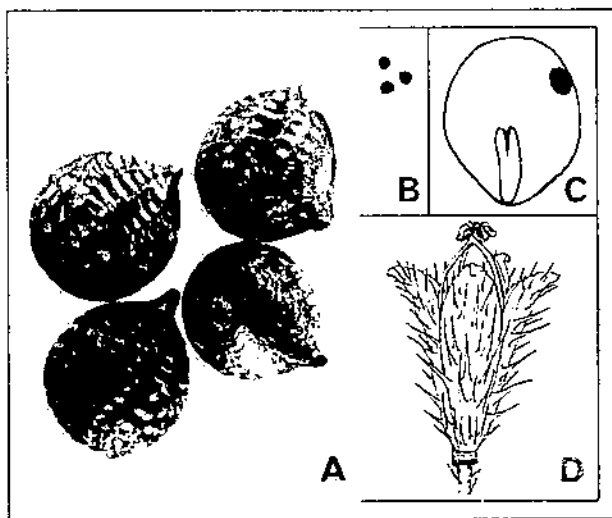
Argemone albiflora Hornemann ssp. *texana*
G. B. Ownbey



Argemone albiflora ssp. *texana*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. (A-C) Ownbey and Ownbey 1387, Waller County, Tex. (MIN); (D) Wurzelow 26, Industry, Tex. (US).

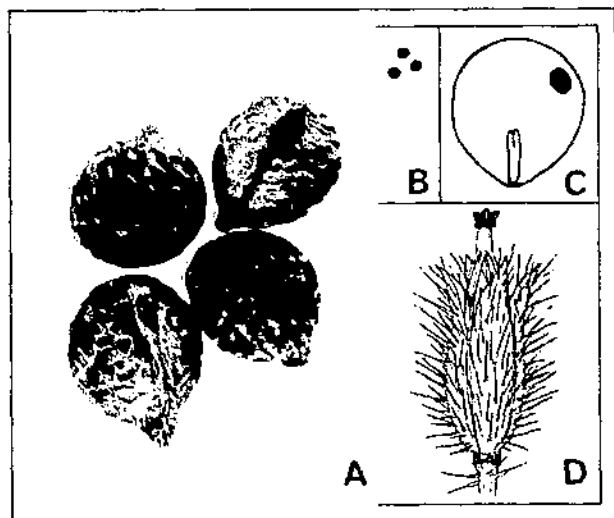
Notes: Texas white-flowered prickly-poppy is an annual or biennial of sandy or gravelly soils. It is found throughout Texas, northern Arkansas, and southern Missouri, and is thought to hybridize with *A. polyanthemus*.

Argemone arida Rose



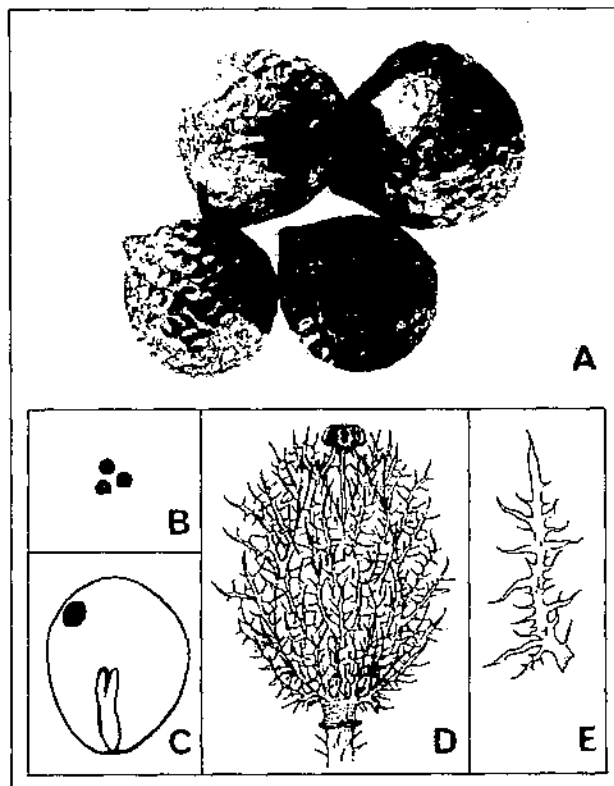
Argemone arida: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. (A-C) Ownbey and Ownbey 2009, Zacatecas, Mexico (MLN); (D) Ownbey and Ownbey 2037, Zacatecas, Mexico (US).

Notes: Desert prickly-poppy, an annual or short-lived perennial, is found in the high prairies and intermountain plains between 1,750 and 2,000 m in southern Chihuahua to San Luis Potosí States, Mexico. Found in disturbed areas and cultivated fields, this plant has weedy tendencies.

Argemone arizonica G. B. Ownbey

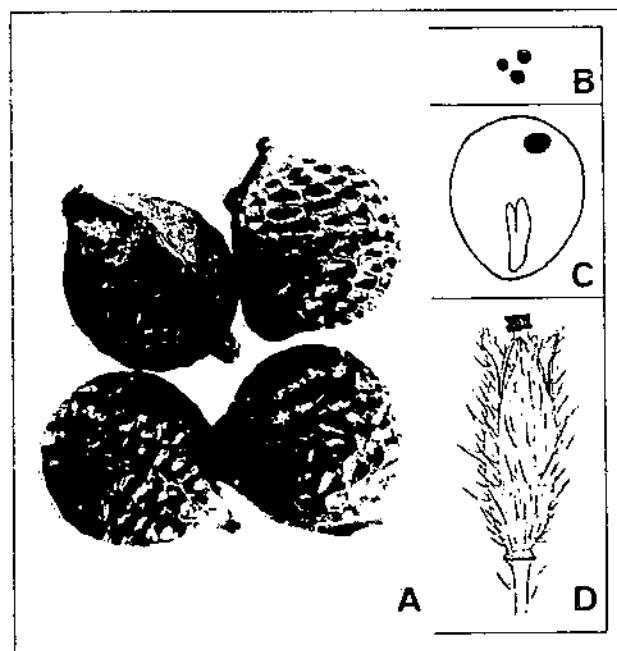
Argemone arizonica: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Ownbey and Ownbey 1817, Coconino County, Ariz. (US).

Notes: Arizona prickly-poppy is a perennial of the precipitous slopes of the Grand Canyon from 900 to 1,500 m. Because many areas of the Grand Canyon are inaccessible, the range may not be completely known.

Argemone aurantiaca G. B. Ownbey

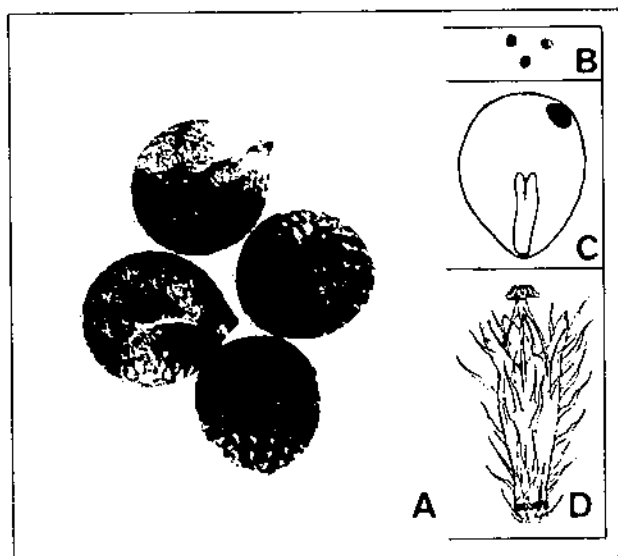
Argemone aurantiaca: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, compound spine $\times 2$. (A-C) Ownbey and Ownbey 1394a, Travis County, Tex. (MIN); (D-E) Kellough 17, Bell County, Tex. (US).

Notes: This prickly-poppy is an annual or biennial from the hilly and rocky terrain of south-central Texas. Its name refers to its unique reddish-orange latex. The capsule spines are often branched, and they are partially covered with prickles.

Argemone brevicornuta G. B. Ownbey

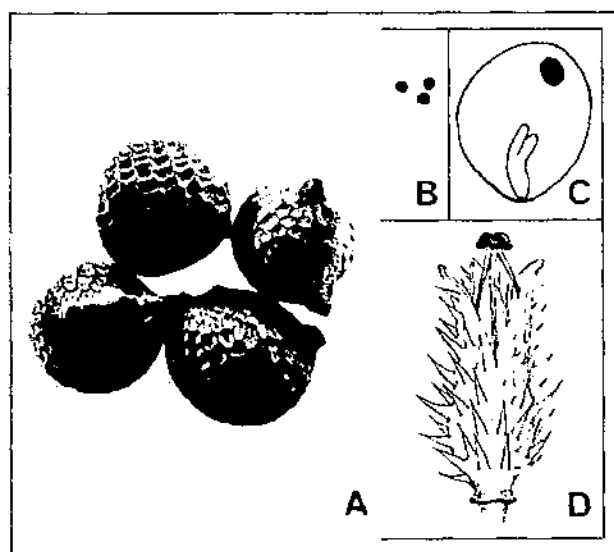
Argemone brevicornuta: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. (A-C) Ownbey and Ownbey 1848, (D, 1845), Chihuahua, Mexico (MIN).

Notes: Short-horned prickly-poppy is a perennial from the gravelly soil of hills and intermountain plains between 1,200 and 1,500 m in southern Chihuahua State, Mexico.

Argemone chisosensis G. B. Ownbey

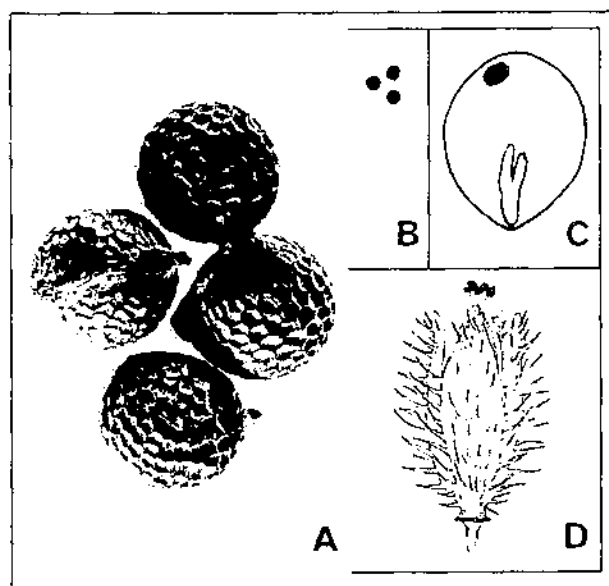
Argemone chisosensis: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Ownbey and Baker 2998, Pecos County, Tex. (MIN).

Notes: The Chisos Mountain prickly-poppy is a biennial or perennial of the arid plains and mountains at 900–2,000 m of western Texas and adjacent Mexico. At higher elevations the plant is very distinctive; however, at lower elevations it is difficult to separate this species from other *Argemone* spp. in the area.

Argemone corymbosa Greene ssp. *corymbosa*

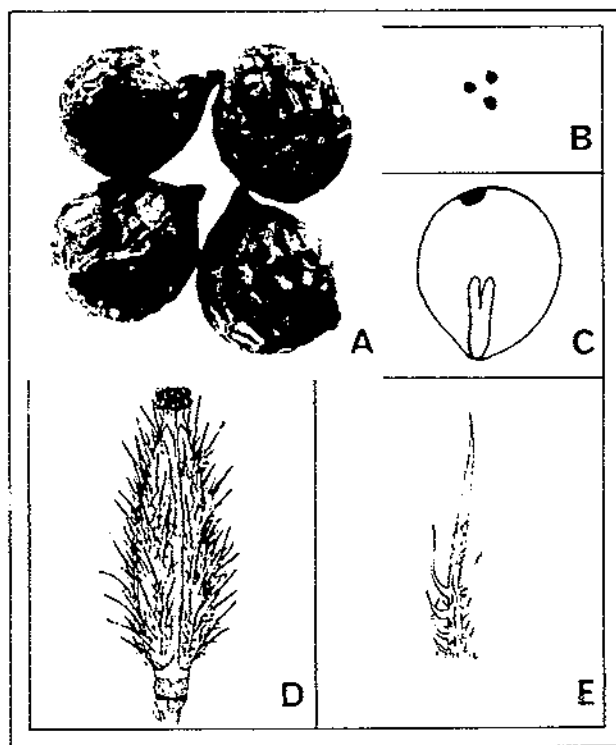
Argemone corymbosa ssp. *corymbosa*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. (A-C) Ownbey and Ownbey 2130, San Bernardino County, Calif. (NY); (D) Welsh and Moore 3620, Emery County, Utah (BRY).

Notes: This perennial prickly-poppy is found in dry open flats, slopes, dunes, and washes from 150 to 900 m in the sand and granitic soils of the Mohave Desert, Calif. The seeds are bluish black and appear to have a grayish bloom. *Argemone intermedia* Greene var. *corymbosa* Eastwood is a synonym of this species. The plant is also illustrated in Abrams (7).

Argemone corymbosa Greene ssp. *arenicola*
G. B. Ownbey

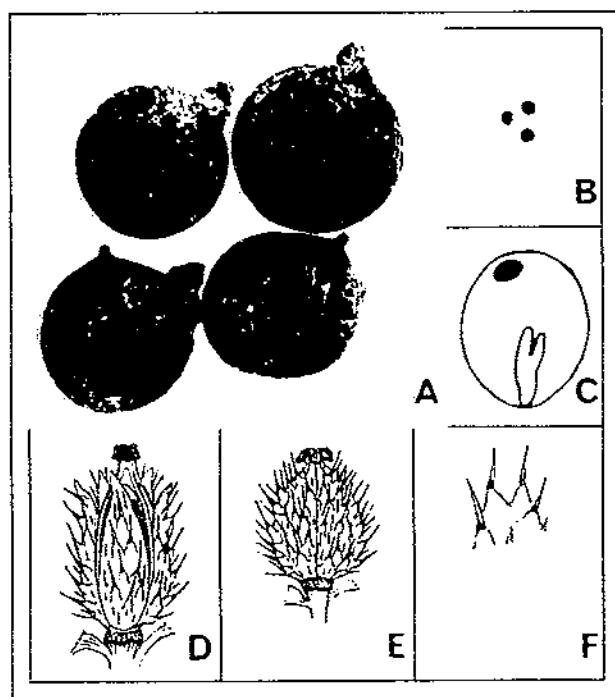
Argemone corymbosa ssp. *arenicola*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Ownbey and Ownbey 2164, San Juan County, Utah (MIN).

Notes: This perennial grows in rust-colored sand areas of dry desert valleys and plains at 900–1,500 m in southeastern Utah and northeastern Arizona. Its seeds are bluish black and often bear a grayish bloom.

Argemone echinata G. B. Ownbey

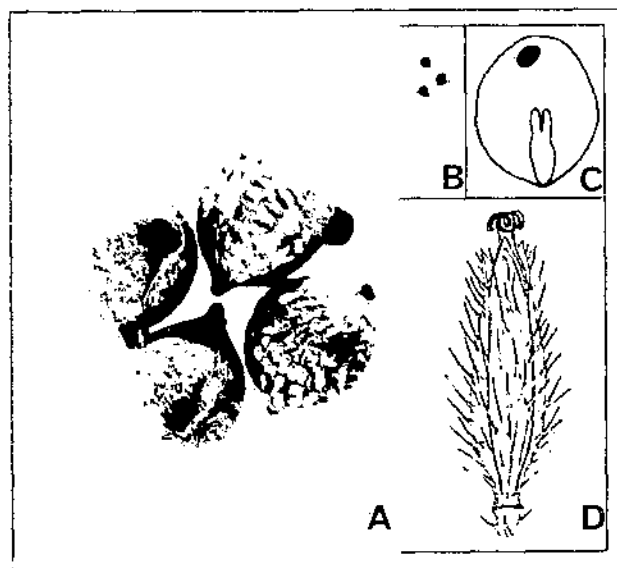
Argemone echinata: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, indehiscent capsule $\times 1$; F, basally herbaceous spines $\times 2$. (A-C, E-F) Palmer 208, Coahuila, Mexico (US); (D-E) Palmer 208, Coahuila, Mexico (US).

Notes: A perennial of Mexico, this prickly-poppy grows on valley floors and playas in deep clay soil in eastern Coahuila, northern San Luis Potosí, and western Nuevo León States at elevations up to 2,000 m. The larger capsule spines are often compound bearing secondary prickles on their herbaceous base.

Argemone fruticosa Thurber ex A. Gray

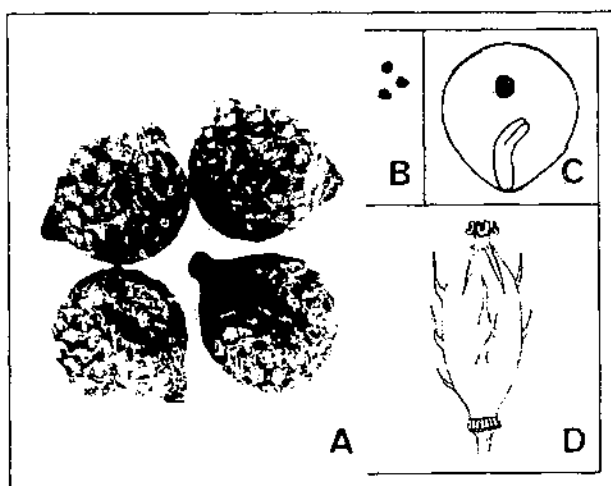
Argemone fruticosa: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, indehiscent capsule $\times 1$; F, basally herbaceous spines $\times 2$. (A-C, E-F) Palmer 21, Coahuila, Mexico (US); (D) Hinton et al. 16582, Coahuila, Mexico (US).

Notes: Shrub prickly-poppy or cardo santo is a perennial of the rocky slopes, hills, and canyons of southern Coahuila State, Mexico, at 1,650–1,830 m. The only woody *Argemone*, this species has a distinctive shrubby habit. Prain described the capsules as dehiscent nearly to the base (56). Other *Argemone* spp. dehisce only one-third the length of the capsule.

Argemone gracilentia Greene

Argemone gracilentia: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Ownbey and Ownbey 2076, Maricopa County, Ariz. (US).

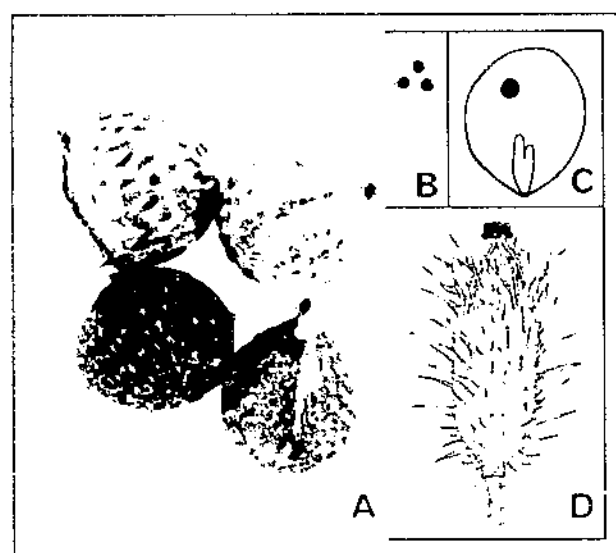
Notes: This slender prickly-poppy is a perennial of sandy and gravelly washes, outwash plains, and dry flat eroded deserts below 900 m in west-central Arizona, south in the Sonoran Desert to southern Baja California, Mexico. This species appears to hybridize with *A. pleiacantha* ssp. *pleiacantha* in southern Arizona and northern Sonora and with *A. pleiacantha* ssp. *umbigua* in central Arizona. The seeds are variable in size, ranging up to 2 mm long.

Argemone grandiflora Sweet ssp. *grandiflora*

Argemone grandiflora ssp. *grandiflora*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, indehiscent capsule $\times 1$. Ownbey and Ownbey 1420, Hidalgo, Mexico (MIN).

Notes: Chacalote or chicalota grande is an annual or short-lived perennial growing at elevations up to 1,800 m in east-central Mexico, from Hidalgo to southern Tamaulipas States. The plant is essentially without spines, except for sparingly spinescent capsules.

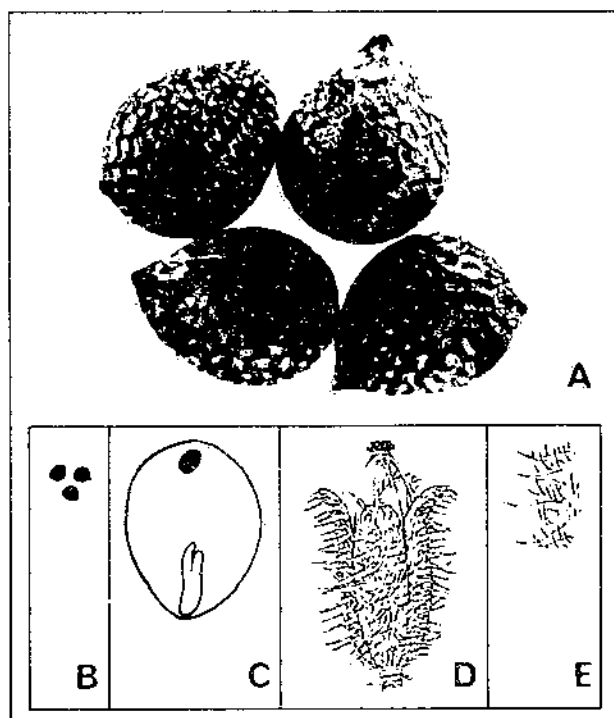
Argemone grandiflora Sweet ssp. *armata*
G. B. Ownbey



Argemone grandiflora ssp. *armata*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. (A-C) Ownbey and Ownbey 1406, Nuevo León, Mexico (MIN); (D) Ownbey and Ownbey 1411, Tamaulipas, Mexico (MIN).

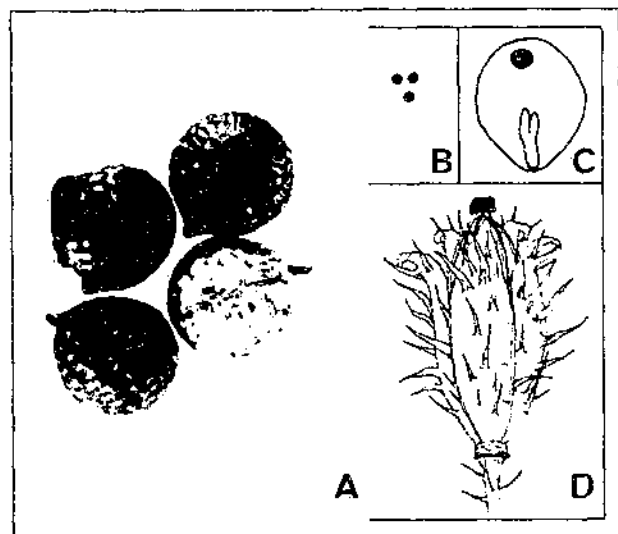
Notes: This prickly-poppy is an annual in fields and waste areas at elevations of 300–1,200 m in Tamaulipas to southern Coahuila States, Mexico.

Argemone hispida A. Gray



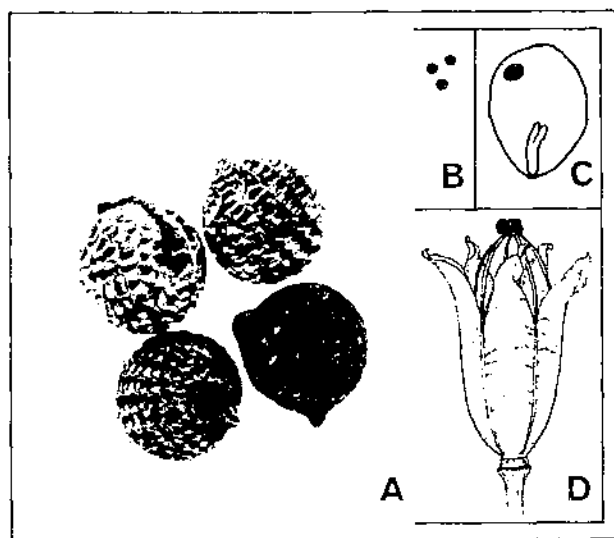
Argemone hispida: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, spines and prickles $\times 2$. Gunn 10065, Fremont County, Colo. (NA).

Notes: A perennial of prairies, slopes, and alluvial valley floors, this prickly-poppy grows in the foothills of the Rocky Mountains at 1,675–2,300 m from southeastern Wyoming south through Colorado to central New Mexico. The species has been given varietal status under *A. platyceras* in Abrams (1), Kearney and Peebles (37), Robbins et al. (63), and Shreve and Wiggins (71).

Argemone mexicana L. f. *mexicana*

Argemone mexicana f. *mexicana*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. (A-C) Ownbey and Ownbey 1366, Dade County, Fla. (MIN); (D) Pollard, Collins, and Morris, Dade County, Fla. (US).

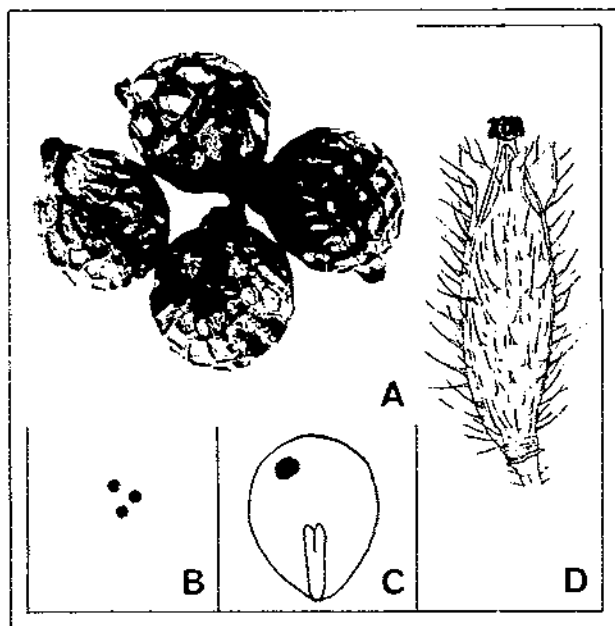
Notes: Devil's-fig, an annual from tropical America, grows in most of the studied area and was probably introduced into Mexico, except for the Yucatan Peninsula. This weedy species is also known as cardo santo, chicalotl, Mexican prickly-poppy, thornapple, and yellow prickly-poppy. It is also illustrated in Gleason (21), Long and Lakela (46), and Small (72). Kingsbury (40) also illustrated this plant and discussed its toxicity.

Argemone mexicana L. f. *leiocarpa* (Greene)
G. B. Ownbey

Argemone mexicana f. *leiocarpa*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Small 7656, Monroe County, Fla. (US).

Notes: Smooth-fruited devil's-fig, an annual with weedy tendencies, occurs in disturbed areas of southern Florida. The plant is totally devoid of spines and was originally considered a separate species by Greene (72).

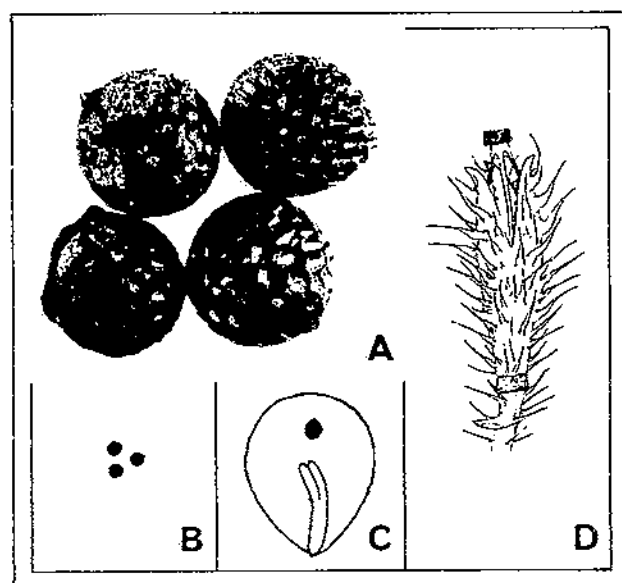
Argemone munita Durand and Hilgard ssp. *munita*



Argemone munita ssp. *munita*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. (A-C) Ownbey and Ownbey 2172, San Diego County, Calif. (MIN); (D) Ownbey and Ownbey 2174, San Diego County, Calif. (US).

Notes: This subspecies is an annual or perennial of the dry foothills and slopes at 450–1,400 m of northern Baja California and north along the Coast Ranges of California to San Luis Obispo County. Natural hybridization occurs with *A. munita* ssp. *rotundata* in southern California.

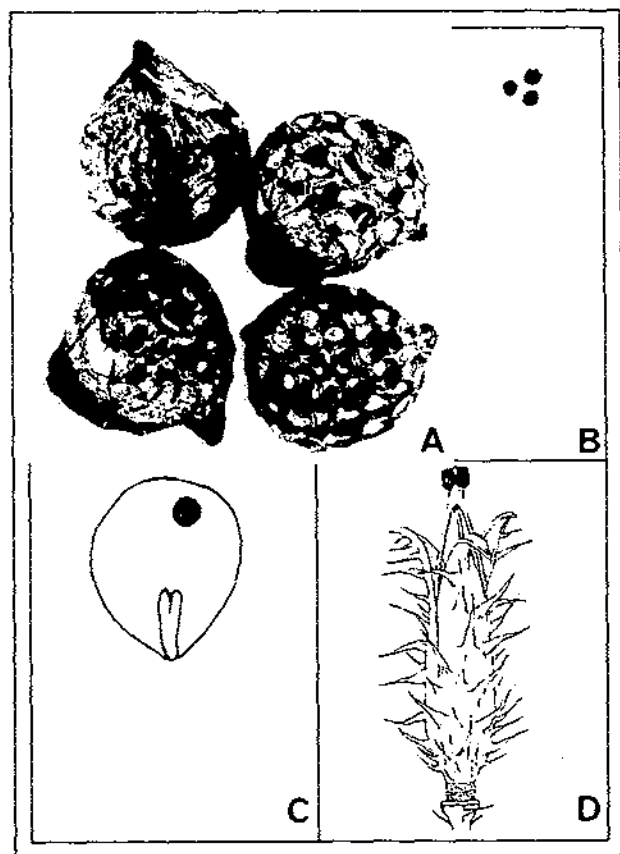
Argemone munita Durand and Hilgard ssp. *argentea* G. B. Ownbey



Argemone munita ssp. *argentea*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. (A-C) Ownbey and Ownbey 2113, Imperial County, Calif. (MIN); (D) Ferris and Ernst 13160, Inyo County, Calif. (US).

Notes: This perennial grows in washes adjacent to dry desert mountain ranges of California (Inyo to San Diego and Imperial Cos.), southern Nevada, and western Arizona at elevations up to 450 m in the south and 900 m or more in the north.

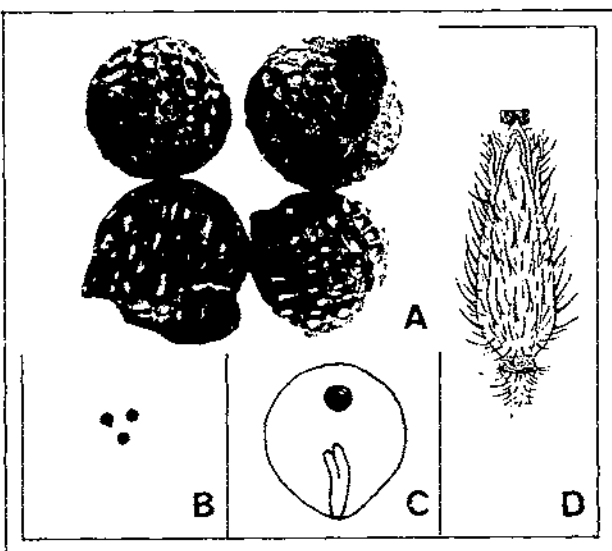
Argemone munita Durand and Hilgard ssp. *robusta* G. B. Ownbey



Argemone munita ssp. *robusta*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Wolf 5403, Orange County, Calif. (US).

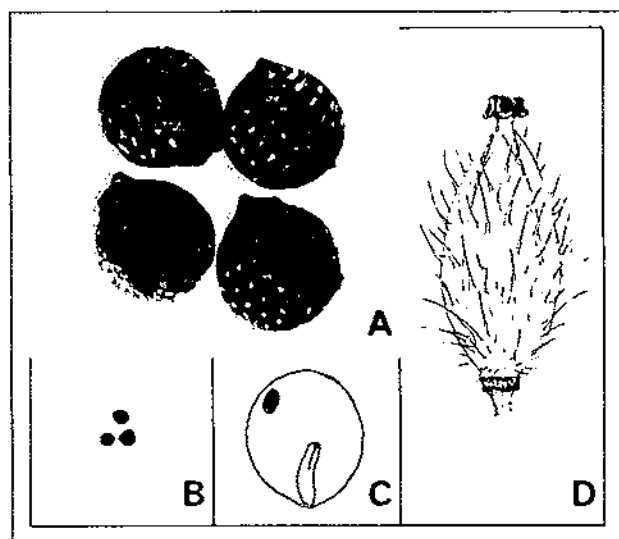
Notes: This annual is a local endemic of the dry slopes of the Santa Ana Mountains at 1,500–1,700 m in Orange County, Calif.

Argemone munita Durand and Hilgard ssp. *rotundata* (Rydberg) G. B. Ownbey



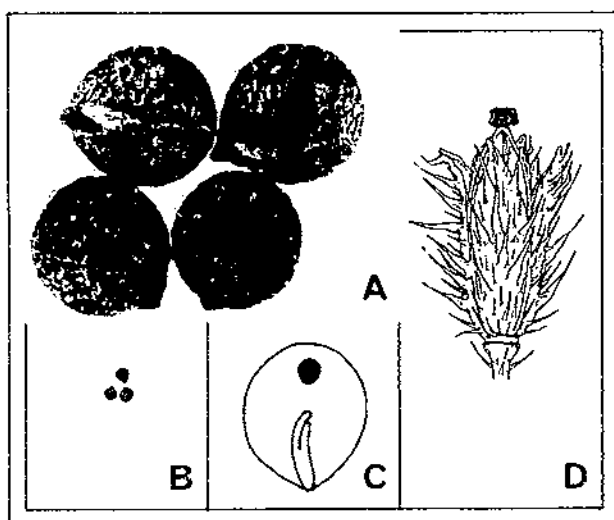
Argemone munita ssp. *rotundata*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. (A–C) Ownbey and Ownbey 1820, Coconino County, Ariz. (MIN); (D) Tidestrom 140, Sanpete County, Utah (US).

Notes: This prickly-poppy is a perennial of the dry open desert slopes and foothills at 1,200–2,600 m in the San Bernardino Mountains north to Shasta County (localized in Lake and Colusa Cos. Calif.), northern Arizona, western Utah, and Nevada. It was originally described as *A. rotundata* Rydberg (56, 66).

Argemone ochroleuca Sweet ssp. *ochroleuca*

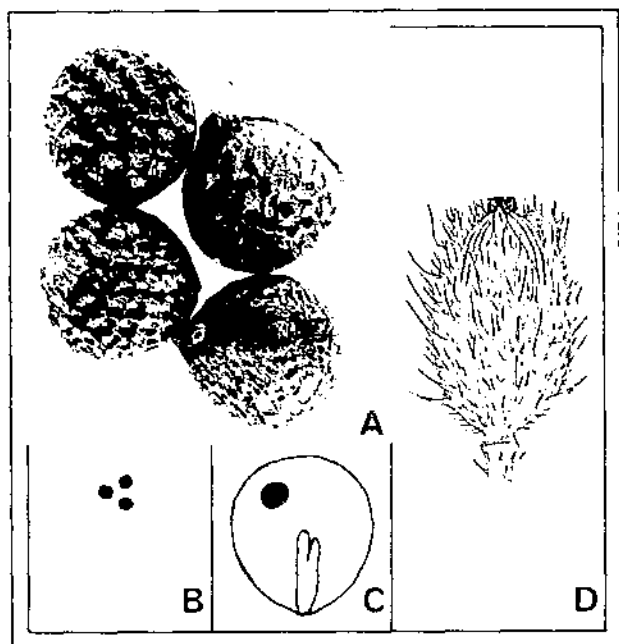
Argemone ochroleuca ssp. *ochroleuca*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, indehiscent capsule $\times 1$. (A–C) Ownbey and Ownbey 2011, Chihuahua, Mexico (MIN); (D) Gentry, Barclay, and Arguelles 19545, Jalisco, Mexico (US).

Notes: Chicalotl is an annual or short-lived perennial growing most commonly in north-western and central Mexico up to 2,300 m. It has become a common weed in disturbed areas. This species will hybridize with *A. pleiacantha* ssp. *pleiacantha*.

Argemone ochroleuca Sweet ssp. *stenopetala* (Prain) G. B. Ownbey

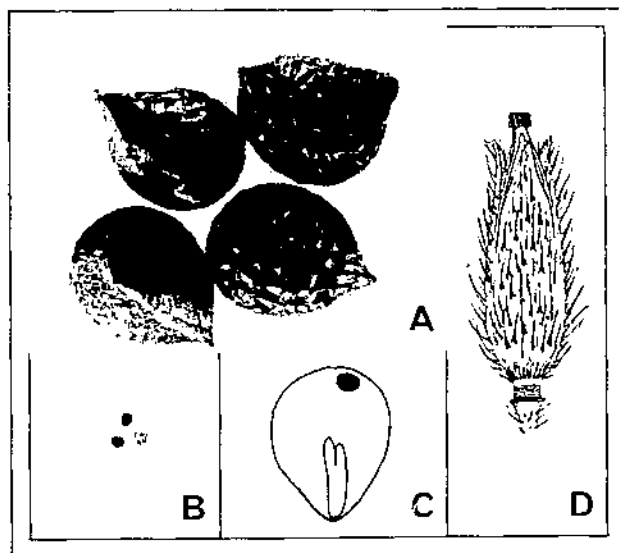
Argemone ochroleuca ssp. *stenopetala*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Ownbey and Ownbey 1850, Chihuahua, Mexico (MIN, US).

Notes: An annual of valleys and high plains at 1,400–2,000 m in northern Durango and southern Chihuahua States, it is also found in the Mexico and Michoacán States (probably by introduction).

Argemone platyceras Link and Otto

Argemone platyceras: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. (A-C) Ownbey and Ownbey 1426, Distrito Federal, Mexico (MIN); (D) Duke and Hurst 17269, field grown (NA).

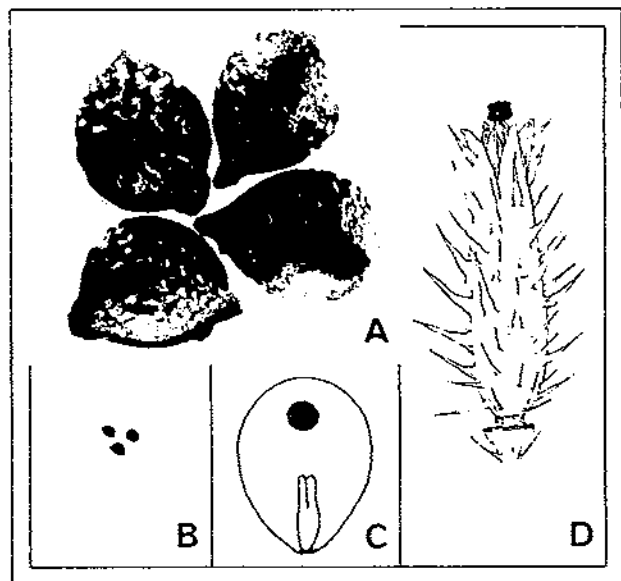
Notes: Crested prickly-poppy is an annual or longer lived weedy plant of open fields at 1,800–3,000 m from Veracruz to northwestern Michoacán and south to northern Oaxaca States. Abrams (1) and Kearney and Peebles (37) incorrectly placed *A. platyceras* in the United States; however, these publications predate Ownbey (56). Shreve and Wiggins (71) who published after Ownbey apparently followed Abrams or Kearney and Peebles.

Argemone pleiacantha Greene ssp. *pleiacantha*

Argemone pleiacantha ssp. *pleiacantha*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. (A-C) Ownbey and Ownbey 1757, Grant County, N. Mex. (MIN); (D) Wootton 2900, Cliz, N. Mex. (US).

Notes: This subspecies is an annual or a perennial of the dry, disturbed areas from 750 to 2,300 m of southwestern New Mexico and southeastern Arizona, south into Sonora and Chihuahua States, Mexico. This subspecies hybridizes with *A. gracilentia* and *A. ochroleuca* ssp. *ochroleuca*.

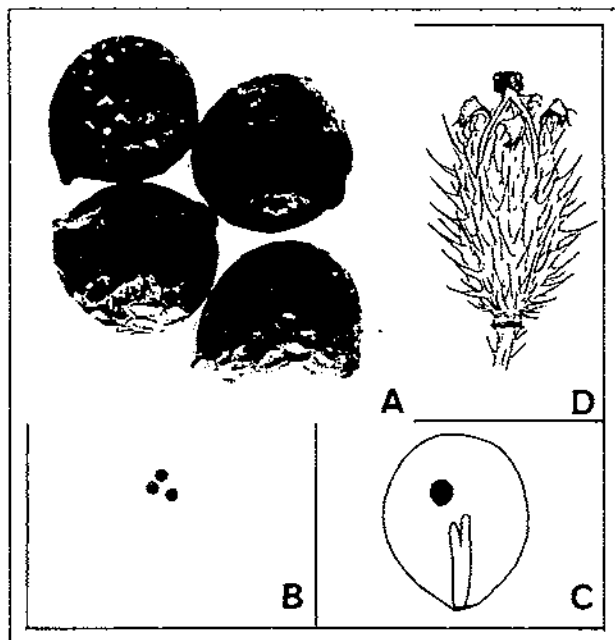
Argemone pleiacantha Greene ssp. *ambigua*
C. B. Ownbey



Argemone pleiacantha ssp. *ambigua*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. (A-C) Ownbey and Ownbey 1799, Gila County, Ariz. (MIN); (D) Peebles, Harrison, and Kearney 4272, Yavapai County, Ariz. (US).

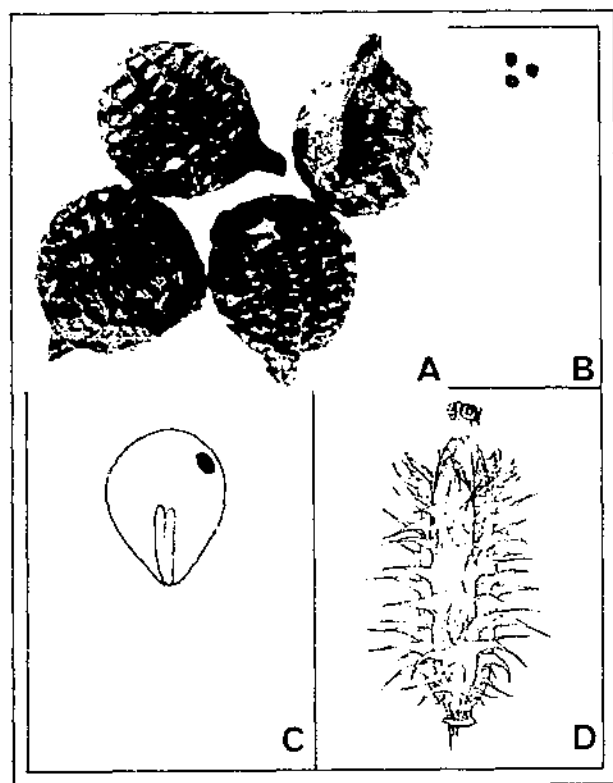
Notes: This annual or perennial prickly-poppy is found in well-drained, gravelly soils of the foothills of central Arizona at elevations of 1,000–1,800 m. It hybridizes with *A. gracilentia* where their distributional areas overlap. Kearney and Peebles (37) probably included this subspecies and *A. gracilentia* in their discussion of *A. intermedia* Sweet.

Argemone pleiacantha Greene ssp. *pinnatisecta*
C. B. Ownbey



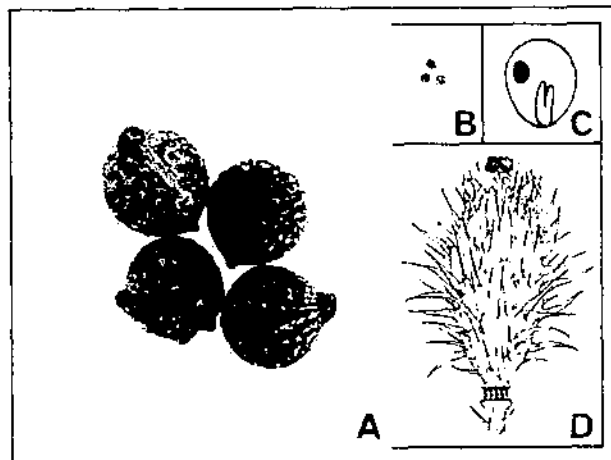
Argemone pleiacantha ssp. *pinnatisecta*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Ownbey and Ownbey 1754, Otero County, N. Mex. (MIN).

Notes: This annual or perennial subspecies grows in the gravelly, limestone soils of the Sacramento Mountains, New Mexico, at 1,900–2,200 m. It is the only *Argemone* found in this area.

Argemone polyanthemus (Fedde) G. B. Ownbey*Argemone sanguinea* Greene

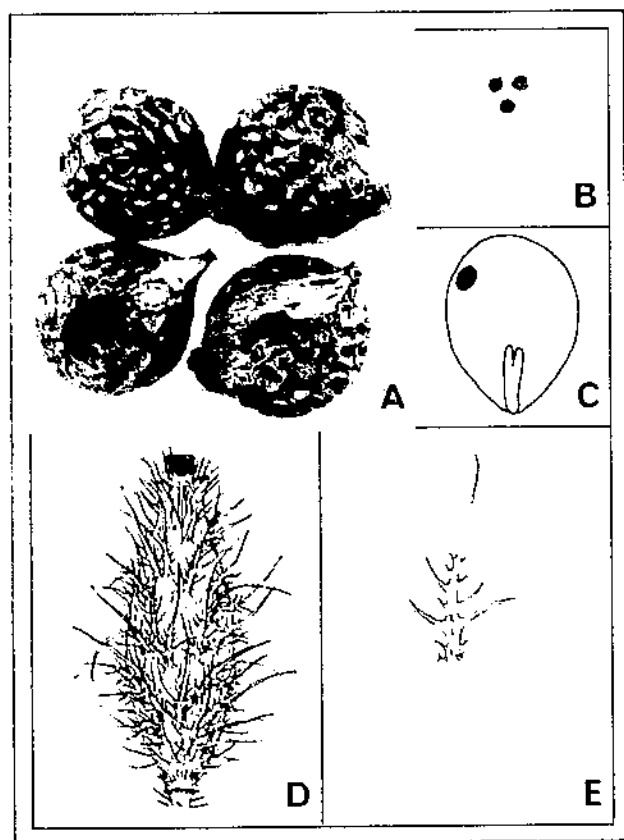
Argemone polyanthemus: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Gunn 10027, Larimer County, Colo. (NA).

Notes: This annual or biennial prickly-poppy is found in prairies, foothills, and mesas from Montana to Texas at elevations up to 2,100 m. The species hybridizes with *A. albiflora* ssp. *texana*. Most of what is called *A. intermedia* Sweet by several American botanists is synonymous with this species.



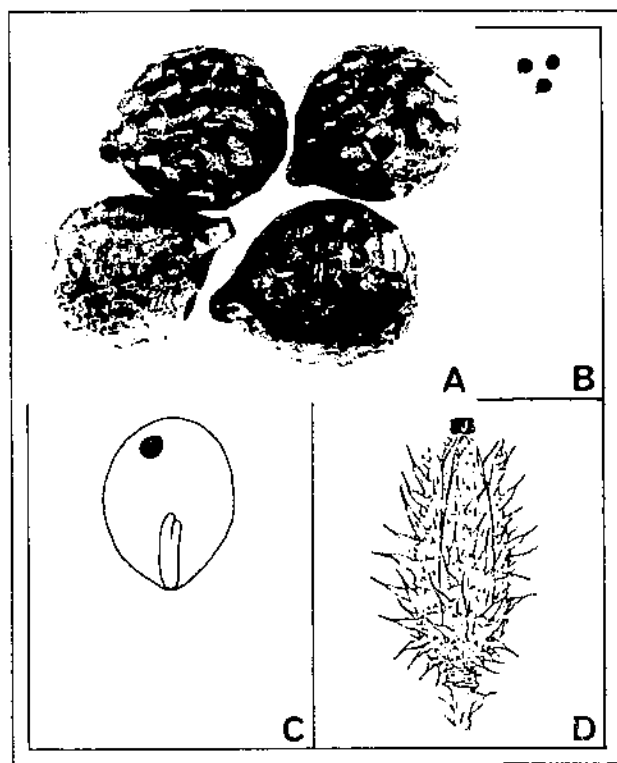
Argemone sanguinea: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. (A-C) Ownbey and Ownbey 16136, Brooks County, Tex. (MIN); (D) Cory 52146, Reeves County, Tex. (NY).

Notes: Red prickly-poppy is an annual, biennial, or short-lived perennial found in disturbed areas with sandy or limestone soils at 1,200–1,500 m in south to southwest Texas and adjacent Mexico from southern Chihuahua and Durango to Nuevo León States. The plant is variable. Shreve and Wiggins (71) placed this species in synonymy under *A. platyceras*.

Argemone squarrosa Greene ssp. *squarrosa*

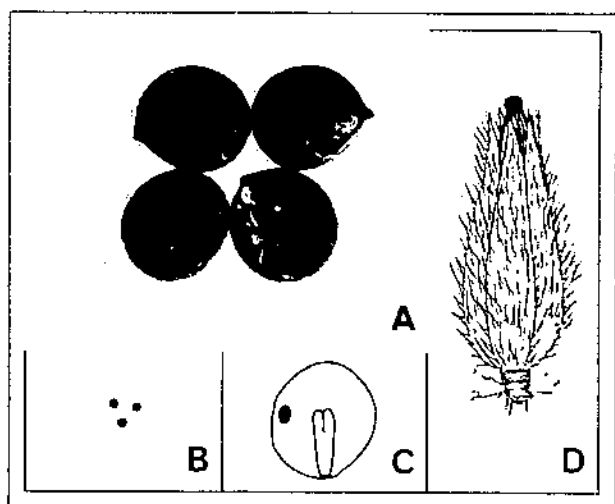
Argemone squarrosa ssp. *squarrosa*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, compound spine $\times 2$. (A-C) Ownbey and Ownbey 1477, Lincoln County, N. Mex. (MIN); (D-E) Rose and Fitch 17022, Hamilton County, Kans. (US).

Notes: This perennial prickly-poppy is found at elevations of 1,000–1,800 m in the sandy soils of prairies and foothills in western Kansas and Oklahoma, southeastern Colorado, and south to southeastern New Mexico. The larger capsule spines are often compound, bearing secondary prickles on their herbaceous bases.

Argemone squarrosa Greene ssp. *glabrata*
G. B. Ownbey

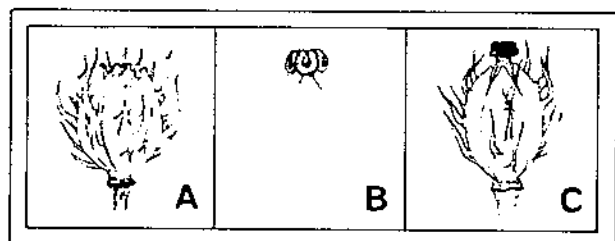
Argemone squarrosa ssp. *glabrata*: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. (A-C) Ownbey and Ownbey 1744, Culberson County, Tex. (MIN); (D) Standley 40467, Eddy County, N. Mex. (US).

Notes: This subspecies is a perennial of the arid lands of western Texas and southeastern New Mexico from 600 to 1,500 m. Most American botanists mistakenly identify this subspecies as *A. platyceras*, which is a native of central and southern Mexico.

Argemone subintegrifolia G. B. Ownbey

Argemone subintegrifolia: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Johnston 3398, Baja California, Mexico (US).

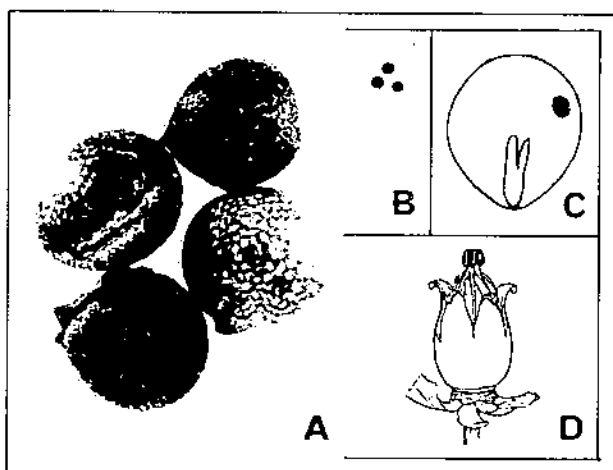
Notes: This prickly-poppy is a little known perennial from the rocky soils of northern Baja California and Angel de la Guarda Island, Mexico.

Argemone superba G. B. Ownbey

Argemone superba: A and C, Dehiscent capsules $\times 1$; B, stigma $\times 2$. (A-B) Ownbey and Ownbey 4170, San Luis Potosí, Mexico (US); (C) Palmer 57, San Luis Potosí, Mexico (US).

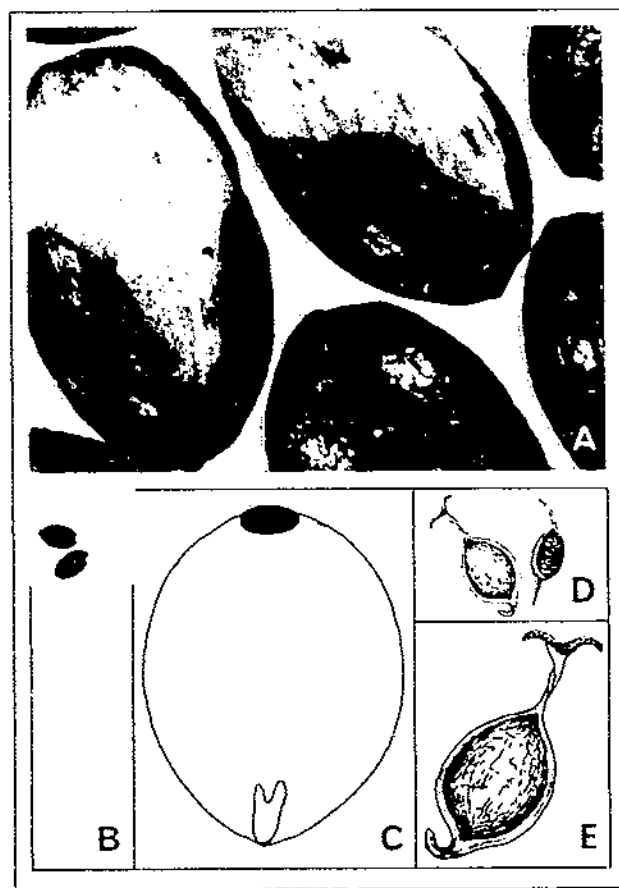
Seed of this species was not available to us during this study of the family.

Notes: This annual species is endemic at 1,400-1,800 m of southern San Luis Potosí State, Mexico. It is closely related to *A. aenea*.

Argemone turnerae A. M. Powell

Argemone turnerae: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Zanoni 2039, Chihuahua, Mexico (COLO).

Notes: Turner's prickly-poppy, a perennial from Chihuahua State, Mexico, is the most recently discovered prickly-poppy (60). It was named after Mrs. B. L. Turner who first noticed this species. The seeds are bluish black and appear to have a grayish bloom, and the capsules are entirely glabrous, a character shared only by *A. mexicana* f. *leiocarpa*.

Bocconia arborea S. WatsonTree *Bocconia*

Bocconia arborea: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, indehiscent capsule $\times 2$. Palmer 1882, Nayarit, Mexico (US).

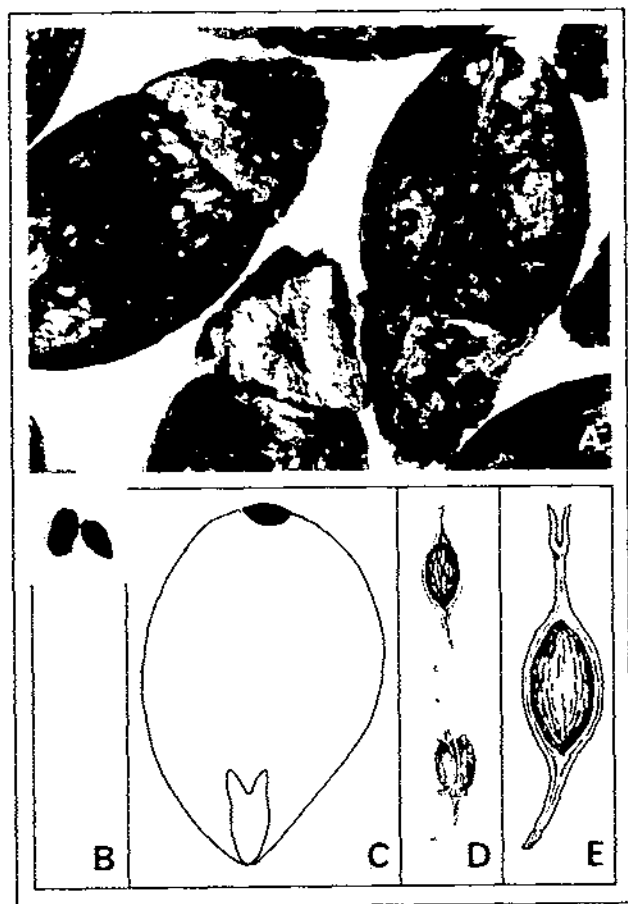
Seed 5–6 \times 2.6–3.8 \times 2.6–3.8 mm, ellipsoidal, bearing apical circular depression and prominent basal nipple (spinelike) covered by aril, terete in cross section. Seedcoat shiny, black (dull and red brown when immature), somewhat wrinkled, appearing nonreticulate. Reticulum inconspicuous, at 30 \times straight walls forming a moderately regular pattern of minute irregular fields. Aril cup shaped, attached basally, not ruffled, covering up to one-third of seed, upper dorsal margin entire, ventral margin tapering to a point along raphe, yellow beige to honey colored (funiculus absent). Raphe a low ridge extending length of seed and through apical depression, color of seedcoat. Hilum on side of nipple, inconspicuous. Cuticle inseparable from outer portion of outer seedcoat. Outer seedcoat two parted: Outer part soft, less than 0.1 mm thick, black on surface, brown below; inner part lignified, 0.2–0.3 mm thick, dark reddish brown. Inner seedcoat membranaceous, yellowish, bearing a faint apical circular depression. Endosperm fleshy, reddish orange to pale yellow (almost white), fluorescing reddish orange or yellowish white to bluish white, oily, when teased wet emitting oil droplets color of endosperm, and minute colored droplets (resembling smoke) from aril. Embryo rudimentary, color of endosperm, up to one-fifth length of seed (variable in size). Cotyledon tips divergent, up to one-half length of embryo, uncleft.

Capsule glabrous, usually wrinkled with two conspicuous nerves, ellipsoidal, 7–10 \times 4.5–5.5 \times 3.5–4 mm, one seeded, grayish black, dehiscent basally by two valves, which separate from two indurate ribs, valves deciduous. Style 4–5 mm long. Stigma two reflexed strap-shaped flaps.

Notes: Tree *Bocconia*, also known as yellow-herb, pigeon-flower, and rod-herb, is a native of central and southern Mexico (Durango and Sinaloa to Puebla and Oaxaca States) and northern Guatemala. Trees may attain a height of 8 m and a trunk diameter of 60 cm. Standley (73) recorded these uses in Mexico: The bark yields a yellow dye, the plant yields several alkaloids used as a local anesthetic, and the wood is occasionally used in tanning. The tree has ornamental value.

Bocconia frutescens L.

Tears of Blood



Bocconia frutescens: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, capsules $\times 1$; E, indehiscent capsule $\times 2$. Palmer 103, Tamaulipas, Mexico (NY).

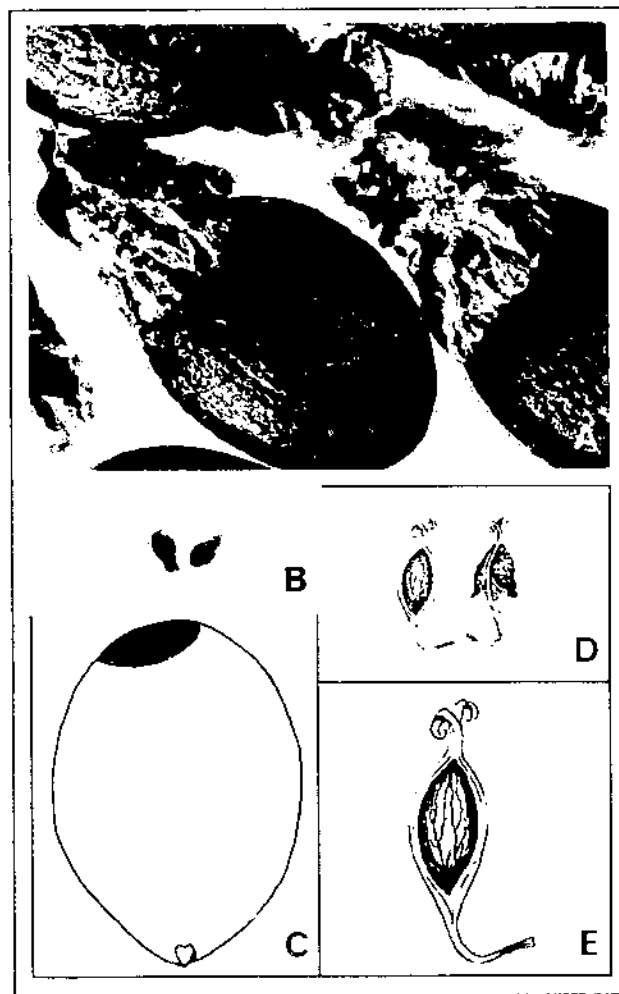
Seed (including aril) 5–6.5 \times 2.5–3.5 \times 2.5–3.5 mm, ellipsoidal, with subapical to apical raised area frequently containing circular depression and bearing emergent basal nipple covered by aril, terete in cross section. Seedcoat shiny, reddish black, somewhat wrinkled to minutely blistered, appearing nonreticulate. Reticulum inconspicuous, at 30 \times straight walls forming an irregular pattern of minute irregular fields. Aril pyramidal, attached subbasally, somewhat ruffled, covering up to one-fourth of seed, upper dorsal margin with notch or cleft, yellow beige to honey colored (occasionally with persistent funiculus concealed by aril, tip may be exposed). Raphe a low ridge extending length of seed through subapical depression and occasionally surrounding entire seed, color of seedcoat. Hilum on side of nipple, inconspicuous. Cuticle inseparable from outer part of outer seedcoat. Outer seedcoat two parted: Outer part soft, less than 0.1 mm thick, reddish black; inner part lignified, 0.3 mm thick, reddish black. Inner seedcoat membranaceous, pale yellowish orange, bearing subapical to apical circular depression. Endosperm fleshy, dark reddish brown, frequently fluorescing bluish white to yellowish white, oily, when teased wet emitting oil droplets color of endosperm. Embryo rudimentary (occasionally spatulate), color of endosperm or lighter, up to one-fifth (up to one-third for spatulate) length of seed. Cotyledons divergent (parallel on spatulate embryos) up to one-half length of embryo, uncleft.

Capsule glabrous, usually wrinkled with two conspicuous nerves, ellipsoidal, 6–9 \times 4–4.5 \times 3–3.5 mm, one seeded, grayish black, dehiscing basally by two valves, which separate from two indurate ribs, valves deciduous. Style 1–2 mm long. Stigma two reflexed strap-shaped flaps.

Notes: Tears of blood is a native shrub or tree in an area from Tamaulipas State, Mexico, south to Peru and east to the West Indies. Standley (73) reported that the plant contains protopine, and that its yellow to orange juice has many local medicinal uses. This species has been introduced into the United States as an ornamental. The plant is illustrated in Presman (61).

Bocconia gracilis Hutchinson

Slender Bocconia

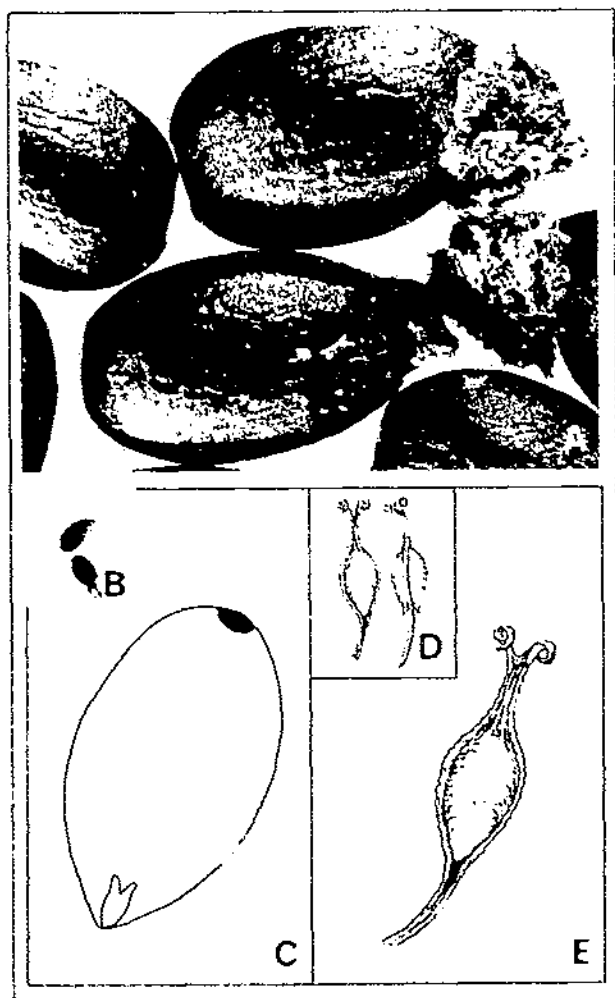


Bocconia gracilis: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, capsules $\times 1$; E, indehiscent capsule $\times 2$. Ton 2090, Chiapas, Mexico (US).

Seed (based on immature seeds and including aril) 5.9–6.5 \times 2.9–3.1 \times 2.9–3.1 mm, ellipsoidal, bearing apical circular depression and prominent to elongate basal nipple, terete in cross section. Seedcoat dull, tobacco brown, minutely blistered, appearing nonreticulate. Reticulum inconspicuous, at 30 \times straight walls forming an irregular pattern of minute irregular fields. Aril pyramidal, attached subbasally, ruffled, covering up to one-fourth of seed, two lobed at base (not united on dorsal side), beige to honey colored (occasionally with persistent funiculus concealed by aril, tip may be exposed). Raphe a low ridge extending length of seed through apical depression, color of seedcoat. Hilum on side of nipple, conspicuous when lighter than seedcoat. Cuticle inseparable from outer part of outer seedcoat. Outer seedcoat two parted: Outer part soft, less than 0.1 mm thick, tobacco brown; inner part lignified, 0.3 mm thick, yellow. Inner seedcoat membranaceous, yellowish, bearing an apical blackish-brown dot (larger than depression on other *Bocconia* spp.). Endosperm fleshy, yellow, fluorescing yellowish white, oily, when teased wet emitting yellow minute oil droplets (resembling smoke). Embryo rudimentary, color of endosperm, less than one-tenth length of seed (small size may be due to immaturity of seeds). Cotyledons poorly developed, uncleft.

Capsule glabrous, usually wrinkled with two conspicuous nerves, ellipsoidal, 9–11 \times 5–5.5 \times 3–4 mm, one seeded, grayish black, dehiscing basally by two valves, which separate from two indurate ribs, valves deciduous. Style 3–4 mm long. Stigma two reflexed strap-shaped flaps.

Notes: Slender Bocconia is an endemic shrub of Chiapas State, Mexico, to Guatemala. This shrub inhabits the dense wet forest from 1,100 to 1 650 m.

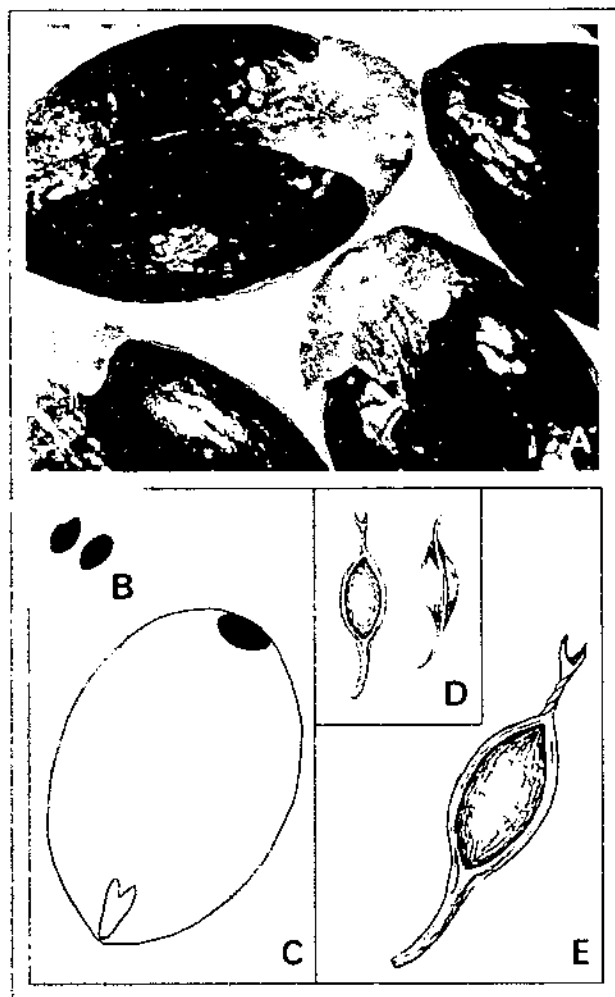
Bocconia integrifolia Humboldt and BonplandShrub *Bocconia*

Bocconia integrifolia: A, Seeds (immature) $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, indehiscent capsules $\times 1$; E, indehiscent capsule $\times 2$. Cuatrecasas and del Llano 27329, Cundinamarca, Colombia (US).

Seed (including aril) 4.5–7 \times 2.5–3.2 \times 2.5–3.2 mm, ellipsoidal, usually bearing apical circular depression and bearing emergent to prominent basal nipple partially covered by aril, terete in cross section. Seedcoat shiny, black (dull and light tobacco brown when immature), somewhat wrinkled to minutely blistered, appearing nonreticulate. Reticulum inconspicuous, at 30 \times straight walls forming an irregular pattern of minute irregular fields. Aril pyramidal, attached subbasally, ruffled, covering up to one-fourth of seed, upper dorsal margin cleft to uncleft, beige to honey colored (occasionally with persistent funiculus concealed by aril, tip may be exposed). Raphe a line to low ridge extending length of seed and midway through apical depression, color of seedcoat. Hilum on side of nipple, inconspicuous. Cuticle inseparable from outer part of outer seedcoat. Outer seedcoat two parted: Outer part soft, less than 0.1 mm thick, black; inner part lignified, 0.1 mm thick, amber. Inner seedcoat membranaceous, color of endosperm, difficult to remove where apical circular area is attached to outer seedcoat, thus this area is rough and may possess part of outer seedcoat. Endosperm fleshy, brick red to yellow or whitish, fluorescing bluish white to yellowish white, oily, when teased wet emitting oil droplets color of endosperm. Embryo rudimentary, color of endosperm, up to one-fifth length of seed. Cotyledons slightly divergent, occasionally uneven, up to one-half length of embryo, uncleft.

Capsule glabrous, usually wrinkled with two conspicuous nerves, ellipsoidal, 8–11 \times 4–5 \times 3–3.5 mm, one seeded, grayish black, dehiscing basally by two valves, which separate from two indurate ribs, valves deciduous. Style 2–3 mm long. Stigma two reflexed strap-shaped flaps.

Notes: Shrub *Bocconia* is a native shrub of an area from Veracruz State, Mexico, south to Peru, and east to the West Indies. We have found no uses recorded for this shrub.

Bocconia latispala S. WatsonHerb *Bocconia*

Bocconia latispala: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscient capsules $\times 1$; E, indehiscent capsule $\times 2$. Pringle 1907, Nuevo León, Mexico (F, NY, US).

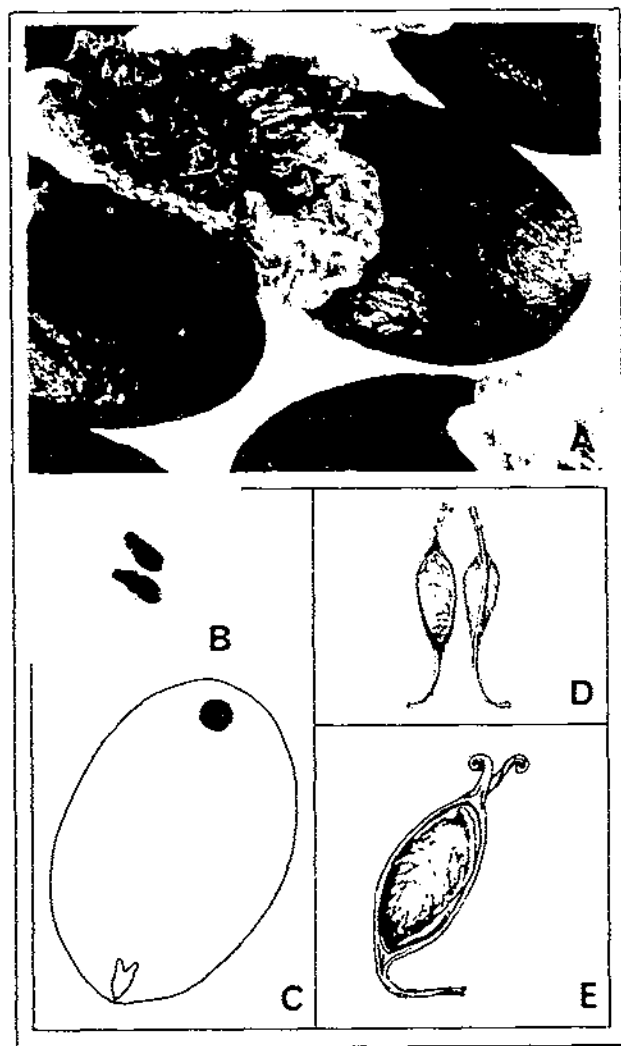
Seed 5.8–6.3 \times 3.3–3.5 \times 3.3–3.5 mm, ellipsoidal, tapering at apical end, bearing subapical raised area containing circular depression and emergent basal nipple partially covered by aril, terete in cross section. Seedcoat shiny, black, somewhat wrinkled, appearing nonreticulate. Reticulum inconspicuous, at 30 \times straight walls forming an irregular pattern of minute irregular fields. Aril cup shaped, attached subbasally, not ruffled, covering up to one-fourth of seed, upper dorsal margin cleft, ventral margin tapering to a darker point along raphe, amber to beige (funiculus absent). Raphe a faint ridge encircling seed, color of seedcoat. Hilum on side of nipple, inconspicuous. Cuticle inseparable from outer part of outer seedcoat. Outer seedcoat two parted: Outer part soft, less than 0.1 mm thick, black; inner part lignified, 0.3 mm thick, reddish black. Inner seedcoat membranaceous, yellow, bearing faint, apical, circular depression or apical orange dot. Endosperm fleshy, dark reddish brown or yellowish to white, frequently fluorescing bluish white to yellowish white, oily, when teased wet endosperm and aril emitting minute oil droplets (resembling smoke) color of endosperm or aril. Embryo rudimentary, color of endosperm, up to one-fifth length of seed. Cotyledons divergent, up to one-half length of embryo, uncleft.

Capsule glabrous, usually wrinkled with two conspicuous nerves, ellipsoidal, 10–13 \times 4.5–6 \times 3.5–4.5 mm, one seeded, gray to grayish black, dehiscing basally by two valves, which separate from two indurate ribs, valves deciduous. Style 2–5 mm long. Stigma two reflexed strap-shaped flaps.

Notes: Herb *Bocconia* is a little known native annual of Nuevo León State, Mexico. Watson (78) described this plant as an herbaceous annual with numerous stems up to 2 m tall. Standley (73) noted the close similarity of this species to the woody species, and he wondered whether it really was herbaceous.

Bocconia vulcanica Donnell Smith

Volcan Bocconia



Bocconia vulcanica: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, indehiscent capsules $\times 1$; E, indehiscent capsule $\times 2$. Breedlove 11445, Sololá, Guatemala (US).

Seed (based on immature seeds and including aril) 7-8 \times 2.8-3.5 \times 2.8-3.5 mm, ellipsoidal, bearing subapical circular depression and prominent basal nipple partially covered by aril, terete in cross section. Seedcoat dull, reddish brown, minutely blistered, appearing nonreticulate. Reticulum inconspicuous, at 30 \times straight walls forming an irregular pattern of minute irregular fields. Aril pyramidal, attached sub-basally, covering up to one-third of seed, two lobed at base (not united on dorsal side), beige to honey colored (occasionally with persistent funiculus concealed by aril, tip may be exposed). Raphe a faint ridge extending length of seed and midway through subapical depression, color of seedcoat. Hilum on side of nipple, inconspicuous. Cuticle inseparable from outer part of outer seedcoat. Outer seedcoat two parted: Outer part soft, less than 0.1 mm thick, reddish black; inner part lignified, 0.2-0.3 mm thick, reddish brown. Inner seedcoat membranaceous, yellow, bearing subapical circular depression. Endosperm fleshy, yellowish, fluorescing bluish white, oily, when teased wet emitting yellowish oil droplets. Embryo rudimentary, yellowish white to yellow, up to one-tenth length of seed. Cotyledons divergent, two-fifths length of embryo, unclotted.

Capsule glabrous, usually wrinkled with two conspicuous nerves, ellipsoidal, 11-13 \times 5-6 \times 3-5 mm, one seeded, grayish black, dehiscing basally by two valves, which separate from two indurate ribs, valves deciduous. Style 1-2 mm long. Stigma two reflexed strap-shaped flaps.

Notes: Volcan Bocconia is an endemic of southern Mexico (Chiapas State) to Guatemala (Departamento Zacatepequez). The species name is derived from the type locality, a slope of the Volcan de Agua.

Canbya aurea S. Watson

Yellow Pygmy-Poppy

Seed 0.6–0.8 × 0.3–0.4 × 0.2–0.4 mm, ellipsoidal with one flattened side, without apical depression, bearing emergent basal nipple, terete to slightly flattened in cross section. Seedcoat shiny, bright amber, not wrinkled, appearing nonreticulate. Reticulum at 60 × straight lines darker than seedcoat forming a moderately regular pattern of minute irregular fields. Aril absent. Raphe a ridge three-fourths length of seed, color of seedcoat. Hilum between nipple and raphe, conspicuous when lighter than seedcoat. Cuticle inseparable from seedcoat. Outer seedcoat coriaceous, less than 0.1 mm thick, bright amber. Inner seedcoat membranaceous, amber, not bearing colored dot. Endosperm granular, white, fluorescing bluish white, not oily, when teased wet emitting no oil droplets. Embryo linear, white, one-half length of seed.

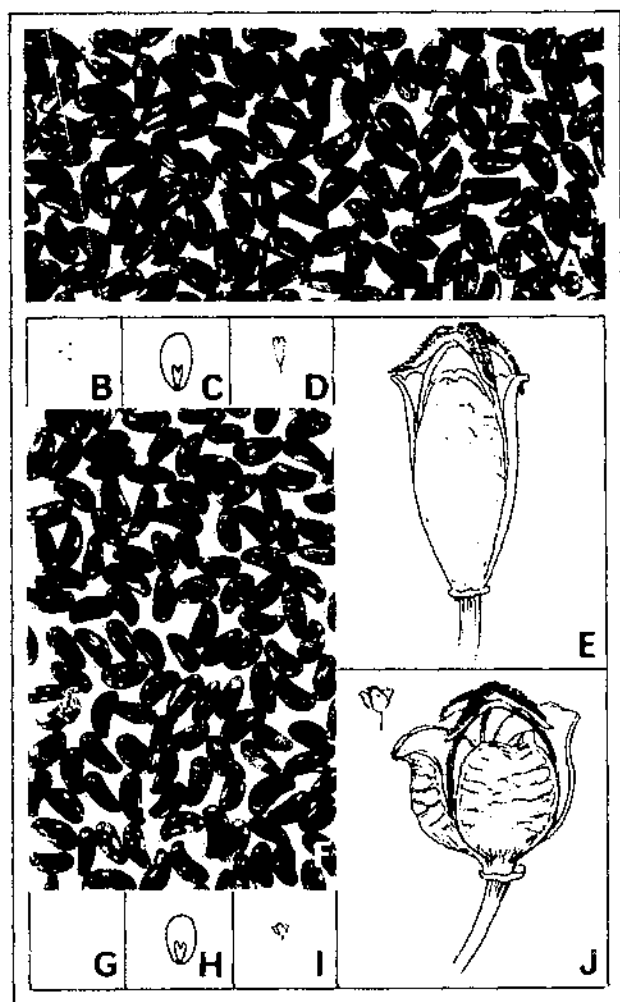
Cotyledons parallel to somewhat divergent, one-fourth to one-third length of embryo, uncleft.

Capsule glabrous, with three inconspicuous nerves, oblong-ovate to ovate, 2–4 mm long, 1.5–2 mm in diameter, many seeded, tan to brown, dehiscing apically by three valves, which separate from three fragile ribs, valves not deciduous. Style absent. Stigma with three rays extending down ribs one-fourth length of capsule.

Notes: Yellow pygmy-poppy is a native of western United States from eastern Oregon (Crook to Lake Cos.) to eastern Nevada (Washoe Co.). This plant, one of the smallest members of the family (5–20 mm tall), is found on dry sandy ground, usually in sagebrush plains. The plant is illustrated in Abrams (1) and Hitchcock et al. (30). The seeds and fruit are shown on page 52.

Canbya candida Parry

White Pygmy-Poppy



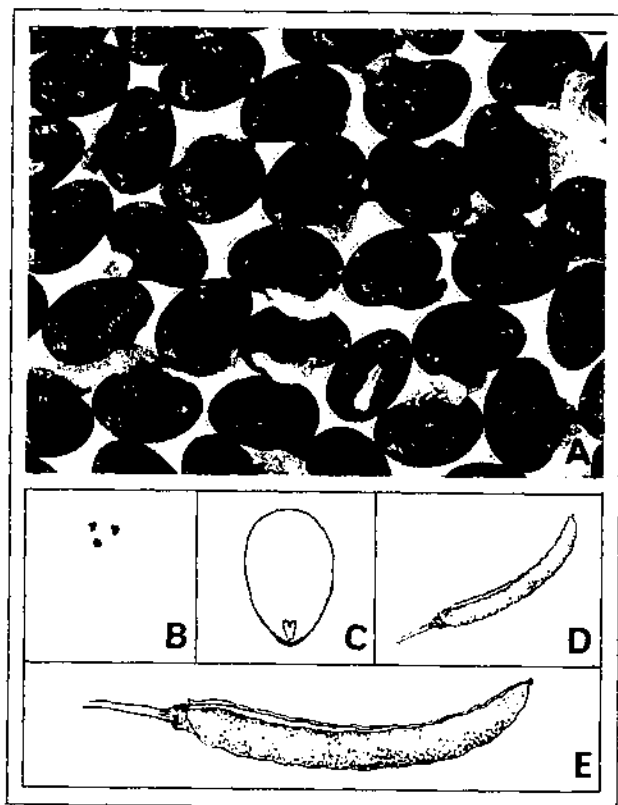
Canbya spp.: A, F, Seeds $\times 10$; B, G, silhouette of seeds $\times 1$; C, H, endosperm-embryo drawing $\times 10$; D, I, capsule $\times 1$; E, J, dehiscent capsule $\times 10$. (A-E) *C. aurea*, Ernst 194, Deschutes County, Oreg. (US); (F-J) *C. candida*, Jones, Kern County, Calif. (US).

This species is similar to the preceding species, varying only in flower color. The flowers are white, whereas those of the preceding species are bright yellow. The seeds and capsules of *C. candida* tend to be slightly smaller; Seed $0.6-0.7 \times 0.2-0.3 \times 0.2-0.3$ mm, capsule 1.5-2.5 mm long, 1-2 mm in diameter. The endosperm of *C. candida* is oily, whereas the endosperm of *C. aurea* is granular.

Notes: White pygmy-poppy is a native of California in the western Mohave Desert from Walker Pass to Victorville. Like *C. aurea*, this plant is one of the smallest members of the family (20-30 mm tall). The plant is illustrated in Abrams (1), Gray (22), and Jepson (35).

Chelidonium majus L.

Celandine



Chelidonium majus: A, Seeds $\times 10$; B, seeds in silhouette $\times 1$; C, endosperm-embryo drawing $\times 10$; D, indehiscent capsule $\times 1$; E, indehiscent capsule $\times 2$. Seldin, Putnam County, N.Y. (NA).

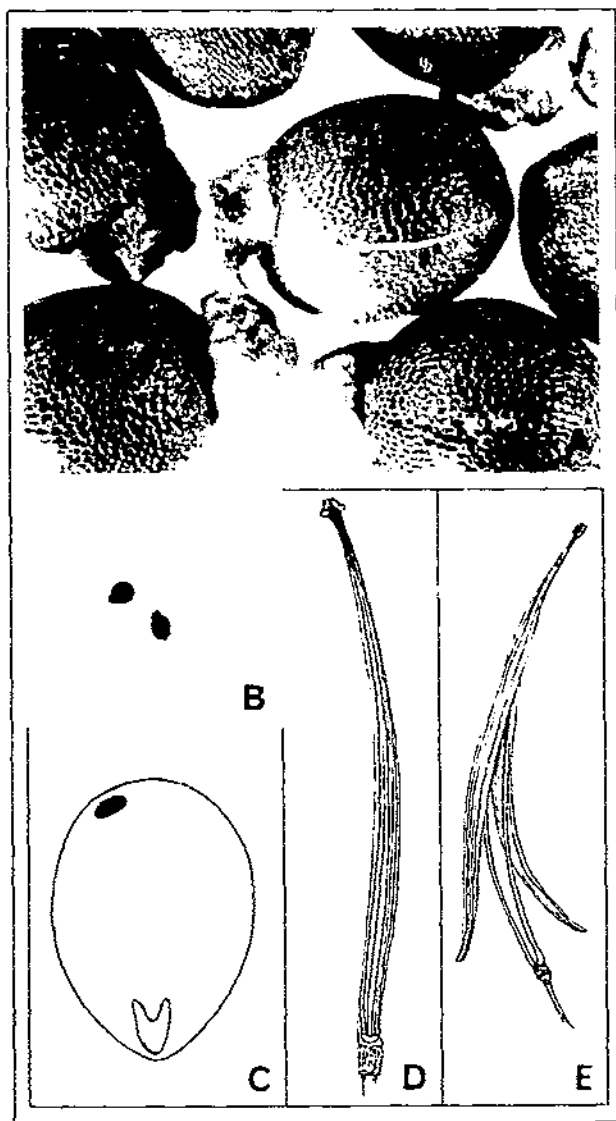
Seed (excluding aril) $1.2-1.7 \times 0.7-1 \times 0.7-1$ mm, ellipsoidal with one flattened side, without apical depression, occasionally bearing emergent basal nipple at maturity, terete in cross section. Seedcoat shiny, reddish brown, not wrinkled, reticulate. Reticulum moderate, at $30 \times$ straight walls forming a more or less regular pattern of small squared fields, color of seedcoat. Aril a winglike lateral patch, honey colored. Raphe absent. Hilum at basal end of aril, conspicuous, frequently lighter than seedcoat. Cuticle separable from seedcoat, translucent, yellowish brown. Outer seedcoat coriaceous, less than 0.1 mm thick, reddish brown. Inner seedcoat membranaceous, faint amber, not bearing colored dot. Endosperm fleshy, white, not fluorescing, oily, when teased wet emitting oil droplets. Embryo rudimentary to almost linear, white, one-seventh to one-fifth length of seed. Cotyledons divergent, one-third to one-half length of embryo, uncleft.

Capsule glabrous, with two conspicuous nerves, linear (torulose), straight, 2-5 cm long, 1-4 mm in diameter, many seeded, tan to brown, dehiscing basally by two valves separating from two fragile ribs, valves deciduous. Style less than 1 mm long. Stigma globular with two discrete lobes.

Notes: Celandine, a biennial to weak perennial native of Eurasia, was introduced into eastern United States and Canada by early European settlers. They brought seeds and planted them, because plants were used in making a popular remedy for various external and internal body disorders. The bright orange juice has been used to remove warts (58). The leaves of celandine strongly resemble those of celandine-poppy (*Stylophorum diphyllum*), a native of eastern United States. Other common names include rock-poppy and swallowwort. The plant is illustrated in Gleason (21), Steyermark (75), and Kingsbury (40), who discusses its toxicity.

Dendromecon rigida Benth

Tree-Poppy



Dendromecon rigida: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, indehiscent capsule $\times 1$; E, dehiscent capsule $\times 1$. (A-C) Balls 19564, Rancho Santa Ana Botanic Garden, Calif. (NY); (D) Clokey 4940, Santa Cruz Island, Santa Barbara County, Calif. (US); (E) Heller 15737, Napa County, Calif. (US).

Seed (including aril) $4-5 \times 2.5-3.3 \times 2.5-3.3$ mm, spherical to ellipsoidal, without apical depression, bearing emergent basal nipple, terete in cross section. Seedcoat dull, brown (green to greenish brown when immature), not wrinkled, reticulate. Reticulum moderate, at $30 \times$ straight walls forming a regular pattern of small to moderate irregular fields, color of seedcoat. Aril pyramidal to flattened, attached basally, honey colored. Raphe a line to low ridge length of seed, lighter than seedcoat. Hilum on side on nipple, inconspicuous. Cuticle separable from seedcoat, translucent, white to amber. Outer seedcoat two parted: Outer part soft, about 0.1 mm thick, brown; inner part lignified, 0.2 mm thick, reddish brown. Inner seedcoat membranaceous, yellow, bearing apical brown dot. Endosperm fleshy, yellow to whitish, fluorescing bluish white, oily, when teased wet emitting conspicuous and minute oil droplets color of endosperm. Embryo rudimentary, color of endosperm, one-seventh to one-fifth length of seed. Cotyledons divergent, more than one-third length of embryo, uncleft.

Capsule glabrous, with 10 conspicuous nerves, linear, straight, 4-10 cm long, 2.5-5 mm in diameter, many seeded, tan to brown, dehiscent basally by 2 valves, which eventually coil and twist, separating almost to apex from 2 indurate ribs, valves not deciduous. Style absent. Stigma globular with two discrete lobes.

Notes: Tree-poppy is a variable woody endemic of California from Shasta County south to northern Baja California. Greene (26) recognized 17 species and Fedde (18) 20 species from this one species complex. Most taxonomists now recognize one species with two subspecies, viz, ssp. *rigida* and ssp. *harfordii* (Kellogg) Raven. The latter is an endemic of the Channel Islands of California. Tree-poppy is illustrated in Abrams (1), Clements (7), and Jepson (35).

Eschscholzia caespitosa Benth

Tufted California-Poppy

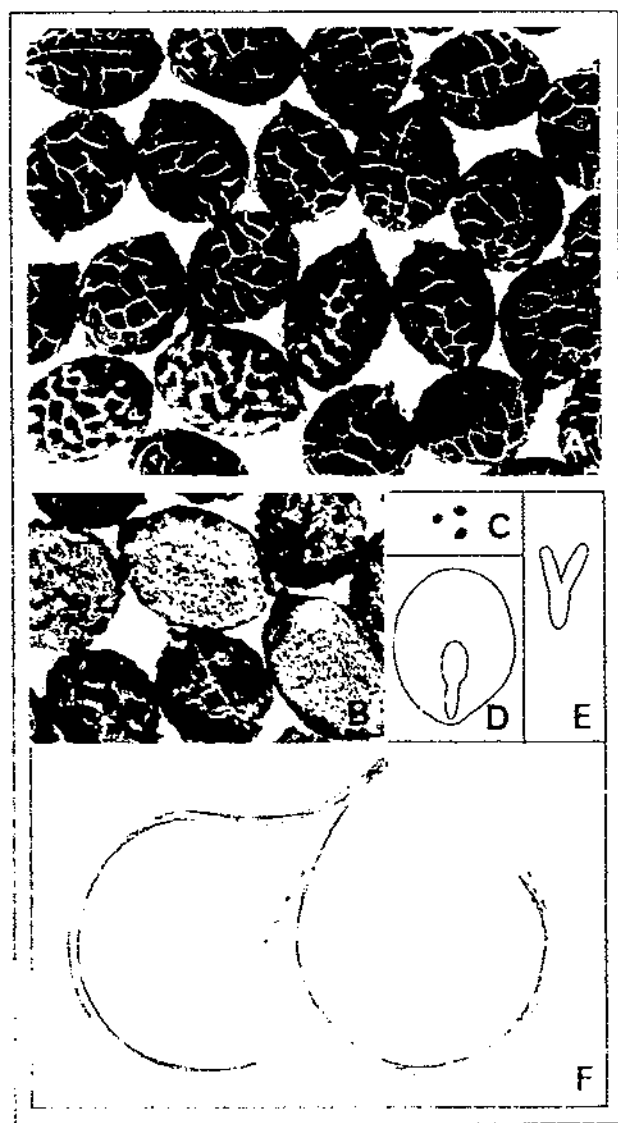


FIG. 1. *Eschscholzia caespitosa* Benth. A, seeds showing compound reticulation; B, magnified view of seeds; C, hilum (three dots); D, seed with embryo; E, cotyledon; F, capsule showing two valves. (A, B, C, D, E, F, from J. R. Howell, *U.S. Nat. Bur. of Entomology and Plant Quarantine*, 1954, p. 100, fig. 100.)

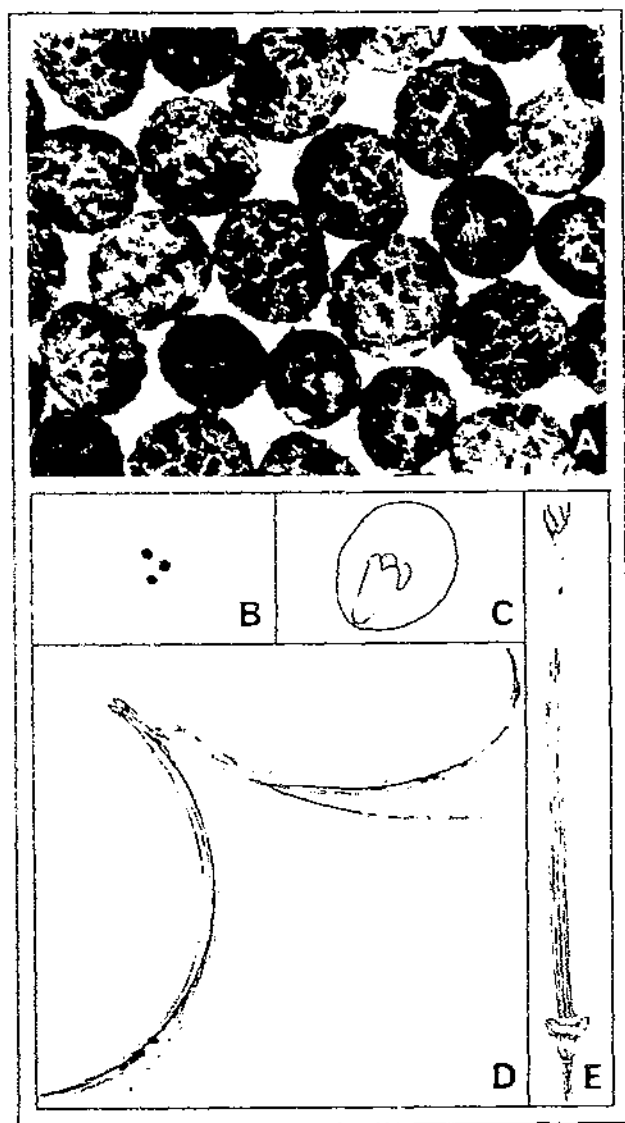
Seed 1.5–2.4 × 1.2–1.6 × 1.2–1.6 mm, ellipsoidal to obovate, without apical depression, bearing prominent basal nipple, terete in cross section. Seedcoat dull, ocher to brown (reticulation tan), not wrinkled, with compound reticulation. Primary reticulation with bold straight to wavy thin walls forming an irregular pattern of irregularly shaped large fields, lighter than to color of seedcoat, at 30 × containing a secondary reticulation of inconspicuous to moderate straight walls forming a more or less regular pattern of minute circular fields. Aril absent. Raphe a line to low ridge length of seed, color of seedcoat to lighter. Hilum on side of nipple, inconspicuous. Cuticle separable from seedcoat, amber. Outer seedcoat coriaceous, less than 0.1 mm thick, ocher to brown. Inner seedcoat membranaceous, dark amber, not bearing colored dot. Endosperm fleshy, white, yellowish or greenish, fluorescing bluish white, oily, when teased wet emitting oil droplets color of endosperm. Embryo spatulate, color of endosperm, up to three-fifths length of seed. Cotyledons divergent, one-half length of embryo, uncleft.

Capsule glabrous, with 10 conspicuous nerves, linear, straight, 5–8 cm long, 1.5–2 mm in diameter (ssp. *kernensis* Munz 2.5–4 mm in diameter), many seeded, tan, dehiscent basally by 2 valves, which curve and separate almost to apex from 2 fragile ribs, which often detach from inflated torus, valves not deciduous. Style absent. Stigma four divergent strap-shaped flaps.

Notes: Tufted California-poppy is an endemic annual of the dry flats and brushy slopes of California from the Great Central Valley south to San Bernardino and Orange Counties. The plant is illustrated in Abrams (1).

Eschscholzia californica Chamisso

California-Poppy



Eschscholzia californica: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, indehiscent capsule $\times 1$. Gunn 10232, Prince Georges County, Md. (NA).

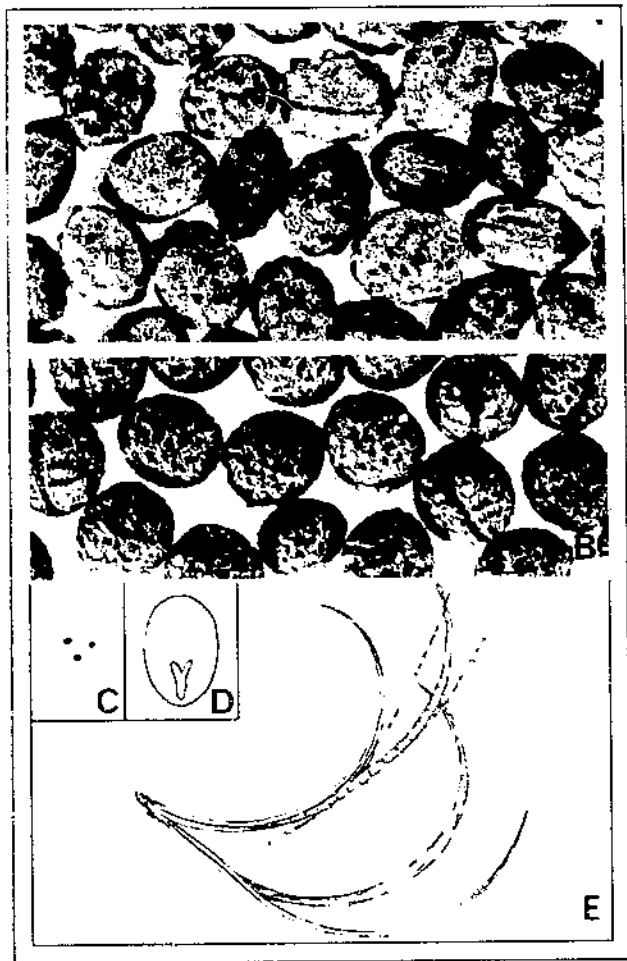
Seed 1.5–1.8 \times 1.2–1.8 \times 1.2–1.8 mm, spherical to ellipsoidal, without apical depression, bearing prominent basal nipple, terete in cross section. Seedcoat dull, dark ocher to blackish (reticulation tan), not wrinkled, with compound reticulation. Primary reticulation with moderate to bold straight to wavy thin walls forming an irregular pattern of irregularly shaped large fields, lighter than to color of seedcoat, at 30 \times containing a secondary reticulation of inconspicuous to moderate straight walls forming a more or less regular pattern of minute circular fields. Aril absent. Raphe, when visible, a line to low ridge length of seed, color of seedcoat or darker to lighter. Hilum on side of nipple, inconspicuous. Cuticle separable from seedcoat, amber. Outer seedcoat coriaceous, less than 0.1 mm thick, dark ocher to blackish. Inner seedcoat membranaceous, dark amber, not bearing colored dot. Endosperm fleshy, whitish, fluorescing bluish white, oily, when teased wet emitting oil droplets. Embryo linear, white, up to one-half length of seed. Cotyledons divergent, about one-half length of embryo, cleft, and each segment may be cleft.

Capsule glabrous, with 10 conspicuous nerves, linear, straight, 3–8 (–10) cm long, 1–3 mm in diameter, many seeded, tan, dehiscent basally by 2 valves, which curve and separate almost to apex from 2 fragile ribs and often detach from inflated torus, valves not deciduous. Style absent. Stigma four divergent strap-shaped flaps.

Notes: California-poppy, an endemic annual or perennial of California and Baja California, possesses a myriad of phenotypes (24 and 54). Seeds of cultivars are sold by the flower seed-packet trade, and the plant is the California State flower. The species is widely planted and may persist after cultivation. California-poppy is illustrated in Abrams (1), Clements (7), Hitchcock et al. (30), Jepson (35), and Radford et al. (62).

Eschscholzia elegans Greene

Island California-Poppy



Eschscholzia elegans: A-B, Seeds $\times 10$; C, silhouette of seeds $\times 1$; D, endosperm-embryo drawing $\times 10$; E, dehiscent capsule $\times 1$. (A, C-E) Ernst 273, Guadalupe Island, Mexico (UC); (B) var. *ramosa*, Raven 17165, San Clemente Island, Los Angeles County, Calif. (UC).

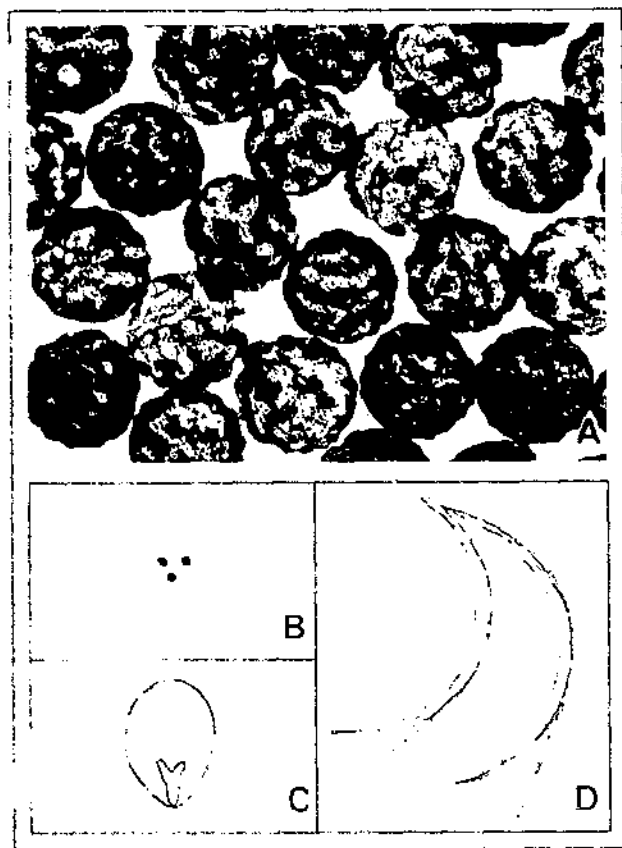
Seed 1.4-1.6 \times 1.1-1.2 \times 1.1-1.2 mm, ellipsoidal, without apical depression, bearing emergent to prominent basal nipple, terete in cross section. Seedcoat dull, light to dark ocher (reticulation tan), not wrinkled, with compound reticulation. Primary reticulation with bold non-continuous lumps, color of seedcoat to lighter, at 30 \times bearing a secondary reticulation of inconspicuous to moderate straight walls forming a more or less regular pattern of minute circular fields. Aril absent. Raphe a line or low ridge length of seed, color of seedcoat or darker to lighter. Hilum on side of nipple, inconspicuous. Cuticle separable from seedcoat, dark amber. Outer seedcoat coriaceous, less than 0.1 mm thick, light to dark ocher. Inner seedcoat membranaceous, amber, not bearing colored dot. Endosperm fleshy, whitish, fluorescing bluish white, oily, when teased wet emitting oil droplets. Embryo linear, white, one-half length of seed. Cotyledons divergent, one-third to one-half length of embryo, unclenched.

Capsule glabrous, with 10 conspicuous nerves, linear, straight, 4-10 cm long, 1-2 mm in diameter, many seeded, tan, dehiscent basally by 2 valves, which curve and separate almost to apex from 2 fragile ribs, which often detach from inflated torus, valves not deciduous. Style absent. Stigma four divergent strap-shaped flaps.

Notes: Island California-poppy is an endemic annual of the California Channel Islands south to Guadalupe and Cedros Islands. Plants are usually found in open fields and chaparral borders. We are including *E. elegans* var. *ramosa* Greene but note that its reticulation is continuous with straight to wavy, bold, thin walls forming an irregular pattern of irregularly shaped moderate fields. The two taxa hybridize. The species is illustrated in Abrams (1).

Eschscholzia frutescens (Greene) J. T. Howell

Guadalupe-Poppy



Eschscholzia frutescens. A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Moran 13797, Guadalupe I., I., Mexico 1958.

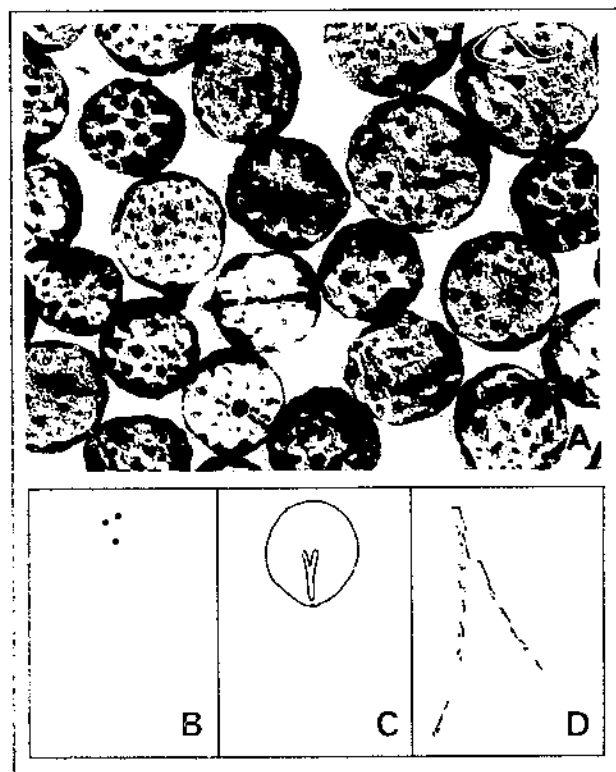
Seed 1.3–1.9 \times 1.3–1.6 1.3–1.6 mm, spherical or nearly so, without apical depression, bearing emergent to prominent basal nipple, terete in cross section. Seedcoat dull, light to dark ocher (reticulation tan), not wrinkled, with compound reticulation. Primary reticulation with bold noncontinuous lumps, lighter than to color of seedcoat, at 30 $^\circ$ bearing a secondary reticulation of inconspicuous to moderate straight walls forming a more or less regular pattern of minute circular fields. Aril absent. Raphe, when visible, a line to low ridge length of seed, color of seedcoat or darker to lighter. Hilum on side of nipple, inconspicuous. Cuticle separable from seedcoat, dark amber. Outer seedcoat coriaceous, less than 0.1 mm thick, light to dark ocher. Inner seedcoat membranaceous, amber, not bearing colored dot. Endosperm fleshy, whitish, fluorescing bluish white, oily, when teased wet emitting oil droplets. Embryo linear, white, up to one-half length of seed. Cotyledons divergent, up to one-half length of embryo, unclift.

Capsule glabrous, with 10 conspicuous nerves, linear, straight, 4–8 cm long, 2–4 mm in diameter, many seeded, tan, dehiscent basally by 2 valves, which curve and separate almost to apex from 2 fragile ribs, which often detach from inflated torus, valves not deciduous. Style absent. Stigma four divergent strap-shaped flaps.

Notes: Guadalupe-poppy is a native perennial of Guadalupe Island. This species was first placed in the segregate genus *Petromeccon* (25).

Eschscholzia glyptosperma Greene

Mojave California-Poppy



Eschscholzia glyptosperma: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Wolf and Johnson 8759, San Bernardino County, Calif. (NY).

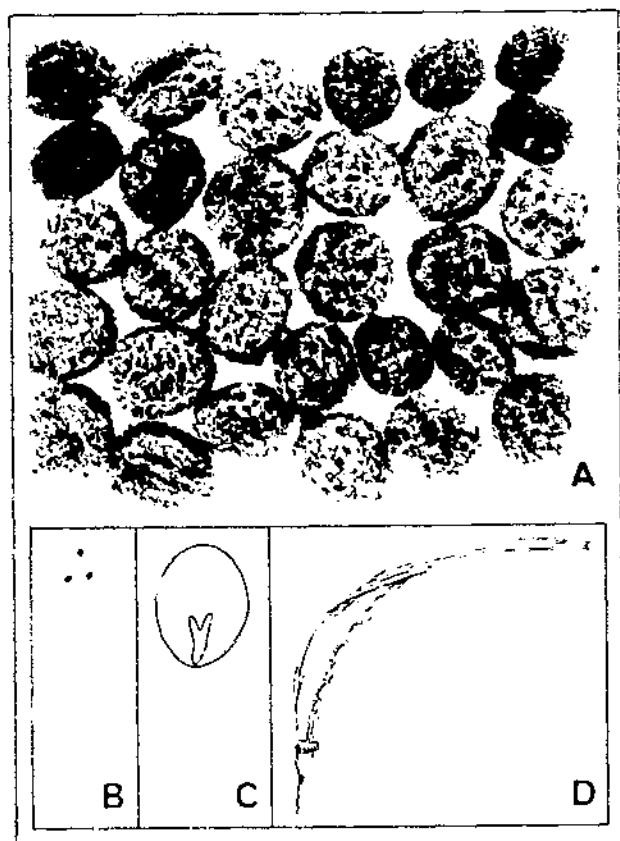
Seed 1.2–1.8 \times 1.1–1.7 \times 1.1–1.7 mm, spherical or nearly so, without apical depression, bearing prominent to elongate basal nipple, terete in cross section. Seedcoat dull, light to dark ocher (reticulation tan), not wrinkled, with compound reticulation. Primary reticulation with bold, straight, thick walls forming an irregular pattern of small to moderate circular fields, lighter than to color of seedcoat, at 30 \times containing a secondary reticulation of inconspicuous to moderate straight walls forming a more or less regular pattern of minute circular fields. Aril absent. Raphe, when visible, a line length of seed, color of seedcoat or darker to lighter. Hilum on side of nipple, inconspicuous. Cuticle thick, separable from seedcoat, dark brown. Outer seedcoat coriaceous, less than 0.1 mm thick, light to dark ocher. Inner seedcoat membranaceous, light amber, not bearing colored dot. Endosperm fleshy, whitish, fluorescing bluish white, oily, when teased wet emitting oil droplets. Embryo linear, white, up to one-half length of seed. Cotyledons divergent, one-fourth to one-half length of embryo, unleft.

Capsule glabrous, with 10 conspicuous nerves, linear, straight, 3.5–6.5 cm long, 1–3 mm in diameter, many seeded, tan, dehiscent basally by 2 valves, which curve and separate almost to apex from 2 fragile ribs, which often detach from inflated torus, valves not deciduous. Style absent. Stigma four divergent strap-shaped flaps.

Notes: Mojave California-poppy, or desert gold-poppy, is an annual endemic of the Mojave Desert from California (Inyo Co. to north Riverside Co.) east to southern Utah and northwestern Arizona (Mojave and Yuma Cos.). The species name, derived from a seedcoat character, is Greek for "carved-seed." The plant is illustrated in Abrams (1).

Eschscholzia hypocoides Benth

Little Lemmon's California-Poppy



Eschscholzia hypocoides: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Twisselmann 13039, Fresno County, Calif. (US).

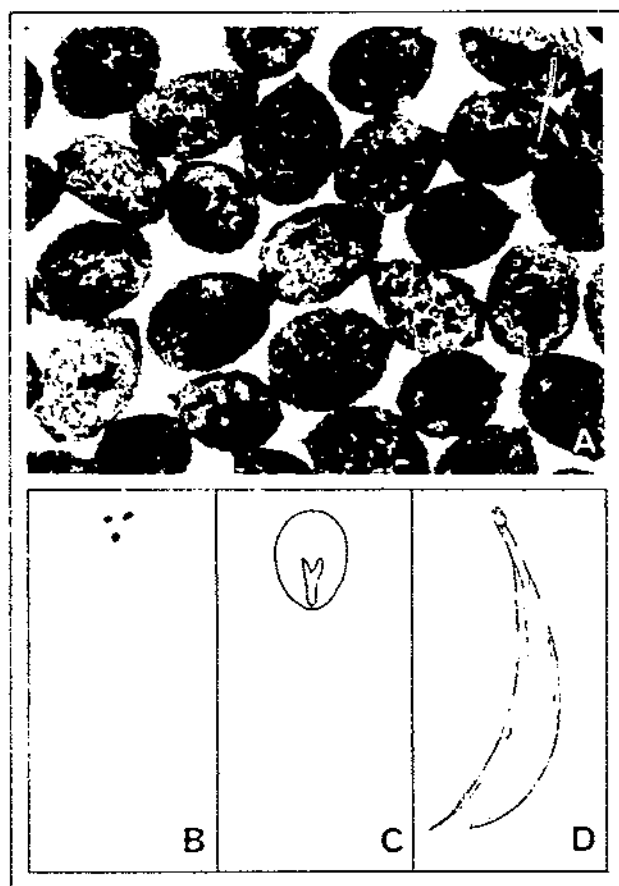
Seed 1-1.3 \times 1-1.2 \times 1-1.2 mm, spherical to ellipsoidal, without apical depression, bearing prominent basal nipple, terete in cross section. Seedcoat dull, light to dark ocher (reticulation tan), not wrinkled, with compound reticulation. Primary reticulation with bold straight to wavy walls forming an irregular pattern of irregularly shaped moderate fields, color of seedcoat to lighter, at 30 \times containing a secondary reticulation of inconspicuous to moderate straight walls forming a more or less regular pattern of minute circular fields. Aril absent. Raphe a line to low ridge length of seed, color of seedcoat or darker to lighter. Hilum on side of nipple, inconspicuous. Cuticle separable from seedcoat, amber. Outer seedcoat coriaceous, less than 0.1 mm thick, ocher to brown. Inner seedcoat membranaceous, amber, not bearing colored dot. Endosperm fleshy, whitish, fluorescing bluish white, oily, when teased wet emitting oil droplets. Embryo linear, white, one-third to one-half length of seed. Cotyledons divergent, up to one-half length of embryo, unclenched.

Capsule glabrous, with 10 conspicuous nerves, linear, straight, 3.5-5.5 cm long, 1-2 mm in diameter, many seeded, tan, dehiscent basally by 2 valves, which curve and separate almost to apex from 2 fragile ribs, which often detach from inflated torus, valves not deciduous. Style absent. Stigma four divergent strap-shaped flaps.

Notes: Little Lemmon's California-poppy is a native annual of the outer southern coast ranges of southern California from San Benito County south to San Luis Obispo County. The plant is similar in many respects to *E. lemmonii*. Although *E. hypocoides* is in synonymy in Munz and Keck (54), Munz (53) recognized it as a species for phenotypic and geographic reasons.

Eschscholzia lemmonii Greene

Lemmon's California-Poppy



Eschscholzia lemmonii: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Ripley and Barney 3276, Kern County, Calif. (NY).

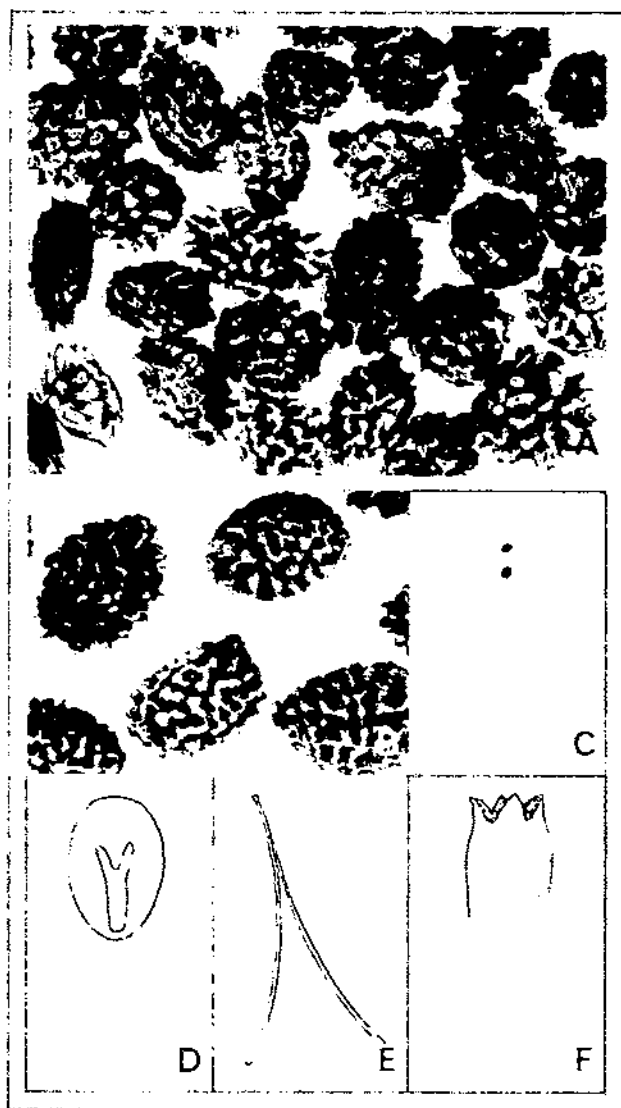
Seed 1.3–1.8 \times 1–1.2 \times 1–1.2 mm, ellipsoidal, without apical depression, bearing prominent to elongate basal nipple, terete in cross section. Seedcoat dull, purplish brown (reticulation tan), not wrinkled, with compound reticulation. Primary reticulation with bold straight to wavy thin walls forming an irregular pattern of irregularly shaped large fields, lighter than to color of seedcoat, at 30 \times containing a secondary reticulation of inconspicuous to moderate straight walls forming a more or less regular pattern of minute circular fields. Aril absent. Raphe a line to low ridge length of seed, color of seedcoat to lighter. Hilum on side of nipple, inconspicuous. Cuticle separable from seedcoat, amber. Outer seedcoat coriaceous, less than 0.1 mm thick, purplish brown. Inner seedcoat membranaceous, amber, not bearing colored dot. Endosperm fleshy, whitish, fluorescing bluish white, oily, when teased wet emitting oil droplets. Embryo linear, white, up to one-half length of seed. Cotyledons divergent, up to one-half length of embryo, unclenched.

Capsule glabrous, with 10 conspicuous nerves, linear, straight, 3–7 cm long, 1–4 mm in diameter, many seeded, tan, dehiscent basally by 2 valves, which curve and separate almost to apex from 2 fragile ribs, which often detach from inflated torus, valves not deciduous. Style absent. Stigma four divergent strap-shaped flaps.

Notes: Lemmon's California-poppy is an annual endemic of the grasslands and slopes below 1,000 m in California from San Benito County south to San Luis Obispo County and east into the foothills of the Sierra Nevada Mountains. The plant is illustrated in Abrams (1).

Eschscholzia lobbi Greene

Rough-Seeded California-Poppy



Eschscholzia lobbi: A-B, Seeds $\times 10$; C, seeds in silhouette $\times 1$; D, endosperm-embryo drawing $\times 10$; E, dehiscent capsule $\times 1$; F, capsule apex $\times 1$. (A, C, F) Balls and Long 1797, Tulare County, Calif. (US); (B) var. *puberula* Brandegee, Calif. (US).

Seed 1.1-2 - 1-1.5 - 1-1.5 mm, spherical to ellipsoidal, without apical depression, bearing prominent basal nipple concealed by winglike reticulations, terete in cross section. Seedcoat dull, ocher to red ocher (reticulation tan), not wrinkled, with compound reticulation. Primary reticulation with bold, winglike, noncontinuous lumps, lighter than to color of seedcoat, at 30

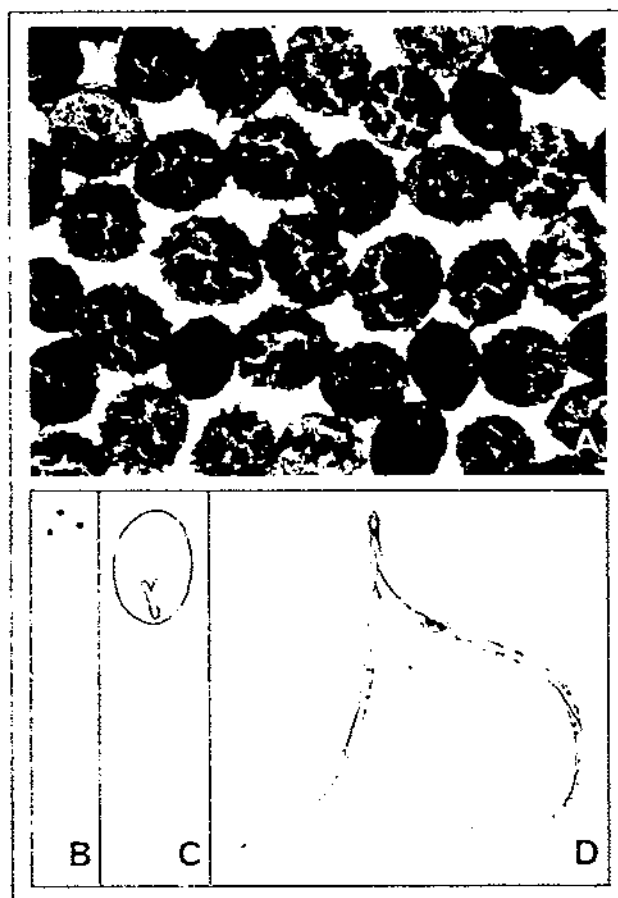
bearing a secondary reticulation of inconspicuous to moderate straight walls forming a more or less regular pattern of minute circular fields. Aril absent. Raphe, when visible, a line to low ridge length of seed, color of seedcoat or darker to lighter. Hilum on side of nipple, inconspicuous. Cuticle forming winglike reticulations, separable from seedcoat, dark brown. Outer seedcoat coriaceous, less than 0.1 mm thick, ocher to red ocher. Inner seedcoat membranaceous, dark amber, not bearing colored dot. Endosperm fleshy, whitish, fluorescing bluish white, oily, when teased wet emitting oil droplets. Embryo linear, white, one-half to two-thirds length of seed. Cotyledons divergent, up to one-half length of embryo, unclenched.

Capsule glabrous, with 10 conspicuous nerves, linear, straight, 3-5 cm long, 1.5-3 mm in diameter, many seeded, tan, dehiscing basally by 2 valves, which curve and separate almost to apex from 2 fragile ribs, which often detach from inflated torus, valves not deciduous. Style absent. Stigma four divergent strap-shaped flaps.

Notes: Rough-seeded California-poppy is an annual endemic of California's Sacramento Valley and environs. Plants usually inhabit grasslands below 600 m. The species is illustrated in Abrams (1) and Jepson (35).

Eschscholzia mexicana L.

Mexican Gold



Eschscholzia mexicana: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Simpson 6012, Pima County, Ariz. (US)

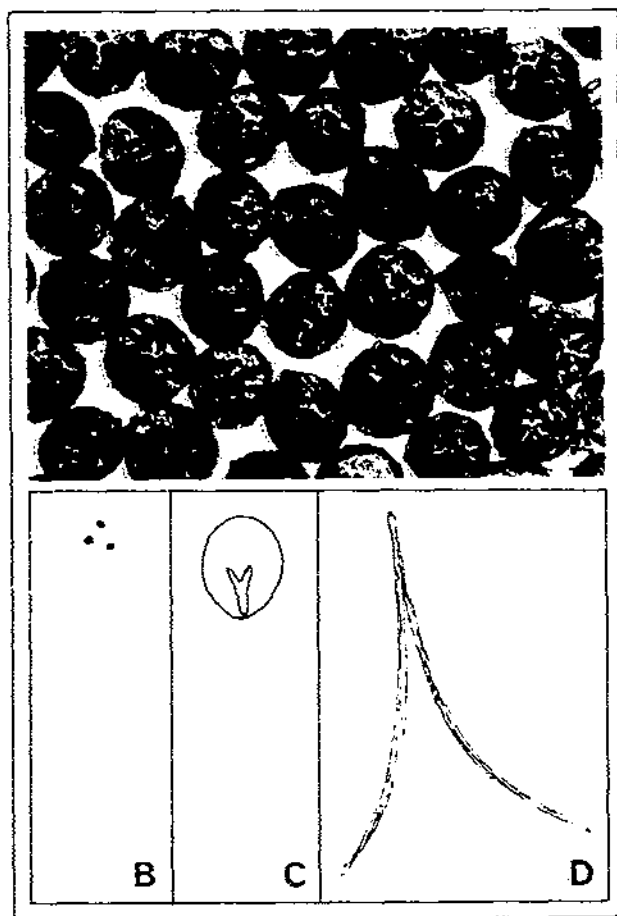
Seed 1–1.3 \times 0.8–1.1 \times 0.8–1.1 mm, spherical to ellipsoidal, with apical depression, bearing prominent to elongate basal nipple, terete in cross section. Seedcoat dull, ocher to dark brown (reticulation tan), not wrinkled, with compound reticulation. Primary reticulation with bold straight to wavy thin walls forming an irregular pattern of irregularly shaped large fields, lighter than to color of seedcoat, at 30 \times containing a secondary reticulation of inconspicuous to moderate straight walls forming a regular pattern of minute circular fields. Aril absent. Raphe a line to low ridge length of seed, color of seedcoat to lighter. Hilum on side of nipple, inconspicuous. Cuticle separable from seedcoat, amber. Outer seedcoat coriaceous, less than 0.1 mm thick, ocher to dark brown. Inner seedcoat membranaceous, light amber, not bearing colored dot. Endosperm fleshy, whitish, fluorescing bluish white, oily, when teased wet emitting oil droplets. Embryo linear, white, one-half length of seed. Cotyledons divergent, one-third length of embryo, uncleft.

Capsule glabrous, with 10 conspicuous nerves, linear, straight, 5–6.5 cm long, 1.5–3 mm in diameter, many seeded, tan, dehiscent basally by 2 valves, which curve and separate almost to apex from 2 fragile ribs, which often detach from inflated torus, valves not deciduous. Style absent. Stigma four divergent strap-shaped flaps.

Notes: Mexican gold is a native annual of the Sonora Desert in southwestern United States and northwestern Mexico. The species may be found as far east as the Franklin Mountains near El Paso, Tex.

Eschscholzia minutiflora S. Watson

Little Gold California-Poppy



Eschscholzia minutiflora: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Gentry 19963, Baja California, Mexico (US).

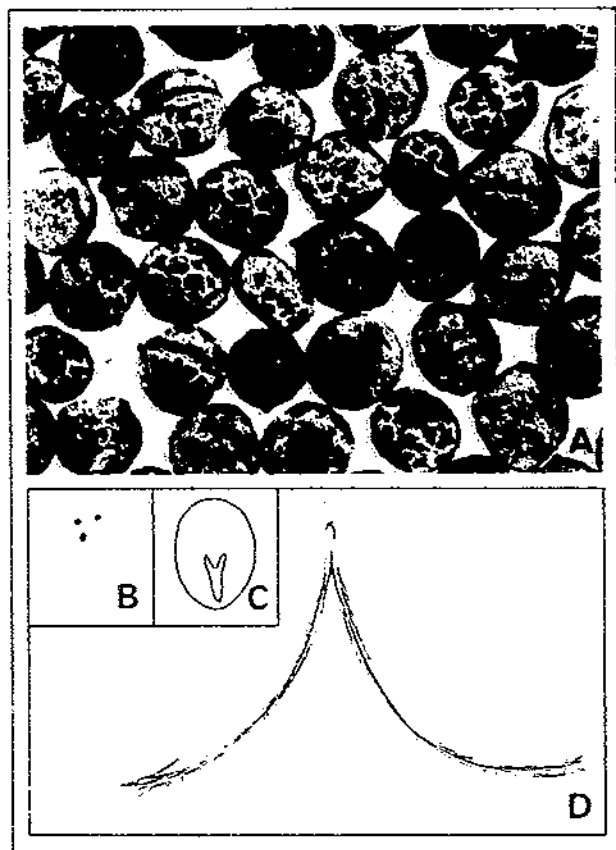
Seed $1-1.4 \times 0.9-1.2 \times 0.9-1.2$ mm, spherical to ellipsoidal, without apical depression, bearing prominent basal nipple, terete in cross section. Seedcoat dull, ocher to red ocher (reticulation tan), not wrinkled, with compound reticulation. Primary reticulation with bold straight to wavy thin walls forming an irregular pattern of irregularly shaped moderate to large fields, lighter than to color of seedcoat, at $30 \times$ containing a secondary reticulation of inconspicuous to moderate straight walls forming a regular pattern of minute circular fields. Aril absent. Raphe a line to low ridge length of seed, color of seedcoat or darker to lighter. Hilum on side of nipple, inconspicuous. Cuticle separable from seedcoat, dark amber. Outer seedcoat coriaceous, less than 0.1 mm thick, ocher to red ocher. Inner seedcoat membranaceous, light amber, not bearing colored dot. Endosperm fleshy, whitish, fluorescing bluish white, oily, when teased wet emitting oil droplets. Embryo linear, white, one-half length of seed. Cotyledons divergent, one-third length of embryo, uncleft.

Capsule glabrous, with 10 conspicuous nerves, linear, straight, 2-4.5 cm long, 0.7-2 mm in diameter, many seeded, tan, dehiscent basally by 2 valves, which curve and separate almost to apex from 2 fragile ribs, which often detach from inflated torus, valves not deciduous. Style absent. Stigma four divergent strap-shaped flaps.

Notes: Little gold California-poppy is an annual endemic of the desert from southern Utah to southeastern California (Mono Co. and southward), Baja California, and western Arizona. The plant is illustrated in Abrams (1).

Eschscholzia parishii Greene

Gold California-Poppy



Eschscholzia parishii: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$. Everett and Balls 23013, Riverside County, Calif. (NY).

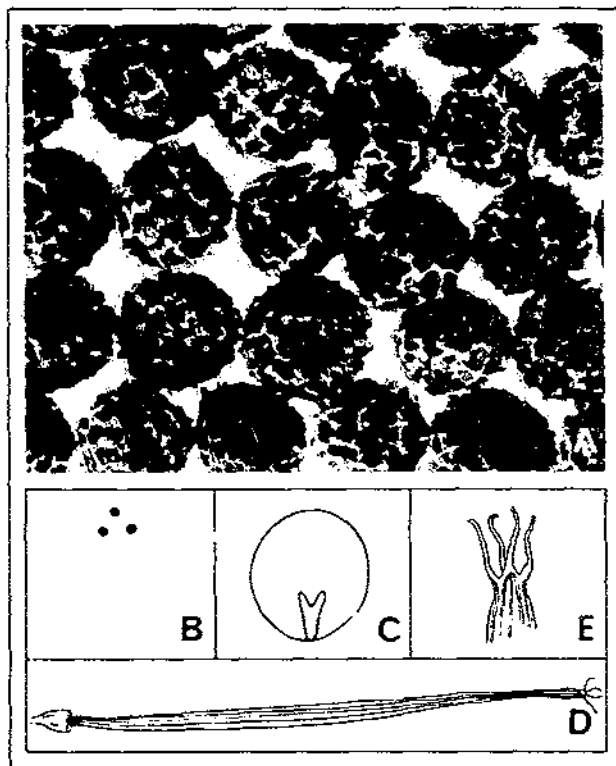
Seed 1–1.4 \times 0.9–1.2 \times 0.9–1.2 mm, spherical to ellipsoidal, without apical depression, bearing emergent to prominent basal nipple, terete in cross section. Seedcoat dull, ocher to brown (reticulation tan), not wrinkled, with compound reticulation. Primary reticulation bold straight walls forming an irregular pattern of irregularly shaped moderate to large fields, lighter than to color of seedcoat, at 30 \times containing a secondary reticulation of inconspicuous to moderate straight walls forming a regular pattern of minute circular fields. Aril absent. Raphe a line to low ridge length of seed, color of seedcoat or darker to lighter. Hilum on side of nipple, inconspicuous. Cuticle separate from seedcoat, amber. Outer seedcoat coriaceous, less than 0.1 mm thick, ocher to brown. Inner seedcoat membranaceous, amber, not bearing colored dot. Endosperm fleshy, whitish, fluorescing bluish white, oily, when teased wet emitting oil droplets. Embryo linear, white, one-fourth to one-half length of seed. Cotyledons divergent, one-third to one-half length of embryo, uncleft.

Capsule glabrous, with 10 conspicuous nerves, linear, straight, 3.5–6 cm long, 1–2 mm in diameter, many seeded, tan, dehiscent basally by 2 valves, which curve and separate almost to apex from 2 fragile ribs, which often detach from inflated torus, valves not deciduous. Style absent. Stigma four divergent strap-shaped flaps.

Notes: Gold California-poppy is a native annual of the dry rocky slopes below 1,200 m in the southern part of the Mojave Desert and Colorado Desert of California and adjacent Mexico (Baja California and Sonora States). This species has been regarded as a variety of *E. minutiflora* (35) and as a synonym of *E. minutiflora* var. *darwinensis* M. E. Jones (1).

Eschscholzia rhombipetala Greene

Little Tufted California-Poppy



Eschscholzia rhombipetala: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, indehiscent capsule $\times 1$; E, capsule apex $\times 4$. (A-C) Hoover 7861, San Luis Obispo County, Calif. (JEPS); (D-E) Hoover 4345, Stanislaus County, Calif. (US).

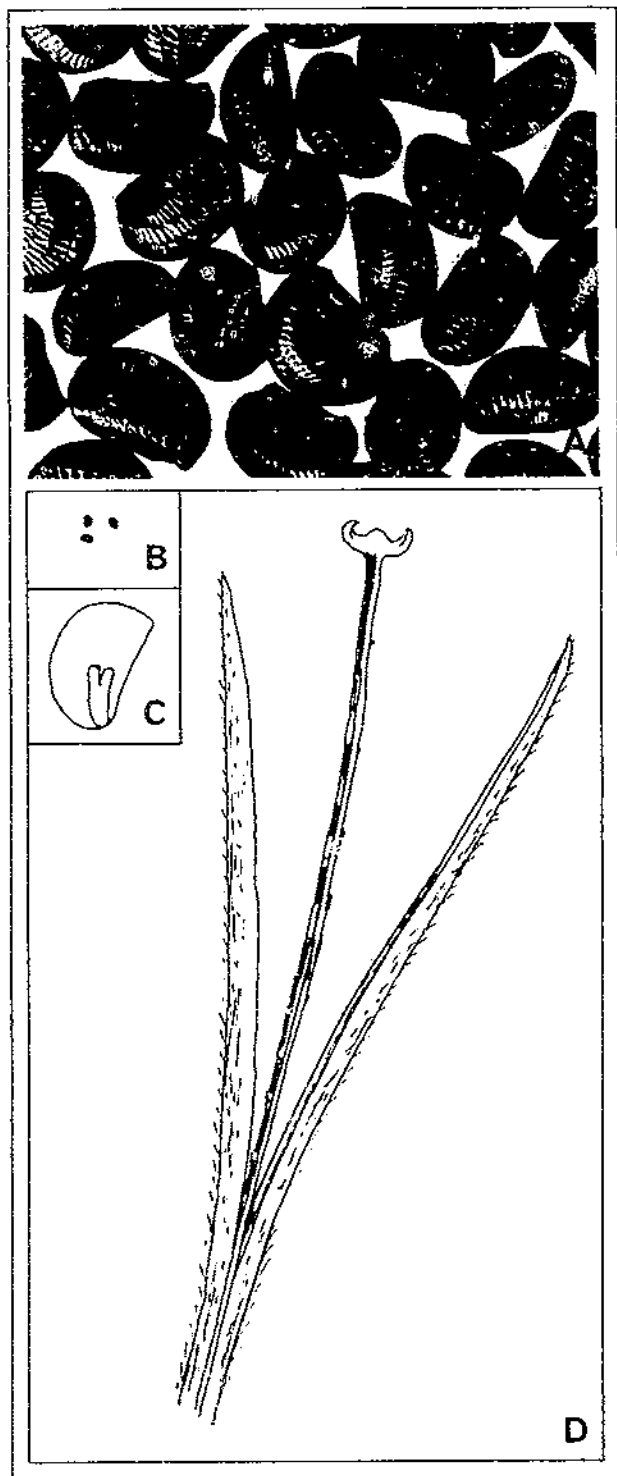
Seed $1.3-1.8 \times 1.3-1.6 \times 1.3-1.6$ mm, spherical to angular, without apical depression, bearing prominent basal nipple, terete in cross section. Seedcoat dull, medium to dark ocher (reticulation tan), not wrinkled, with compound reticulation. Primary reticulation with bold straight to wavy thin walls forming an irregular pattern of moderate to large irregular fields, lighter than to color of seedcoat, at $30\times$ containing a secondary reticulation of inconspicuous to moderate straight walls forming a more or less regular pattern of minute circular fields. Aril absent. Raphe a line length of seed, color of seedcoat to lighter. Hilum on side of nipple, inconspicuous. Cuticle separable from seedcoat, amber. Outer seedcoat coriaceous, less than 0.1 mm thick, medium to dark ocher. Inner seedcoat membranaceous, light amber, not bearing colored dot. Endosperm fleshy, faint amber, fluorescing bluish white, oily, when teased wet emitting oil droplets color of endosperm. Embryo linear, faint amber, up to one-third length of seed. Cotyledons divergent, one-half length of embryo, uncleft.

Capsule glabrous, with 10 conspicuous nerves, linear, straight, 8-10 cm long, 2-4 mm in diameter, many seeded, tan, dehiscent basally by 2 valves, which curve and separate almost to apex from 2 fragile ribs, which often detach from inflated torus, valves not deciduous. Style absent. Stigma four divergent strap-shaped flaps.

Notes: Little tufted California-poppy is a native annual of western California from Contra Costa County to San Luis Obispo County. Only recently has this species been separated from *E. caespitosa* (53).

Glaucium flavum Crantz

Yellow Horn-Poppy



Glaucium flavum: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule apex $\times 1$. Twisselmann 14916, San Luis Obispo County, Calif. (COLO).

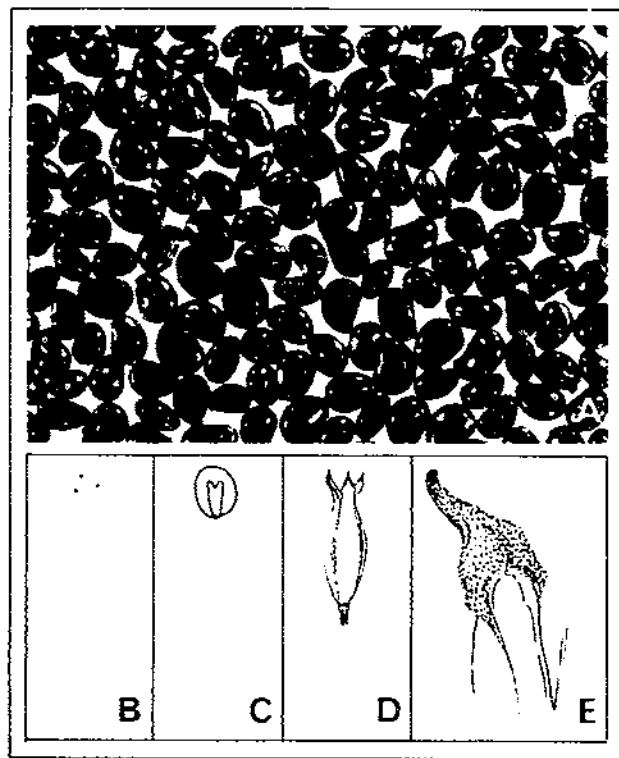
Seed 1.5–2 \times 1–1.2 \times 0.8–1 mm, D-shaped or nearly so, without apical depression, bearing emergent to prominent basal nipple, slightly flattened in cross section. Seedcoat shiny to dull, dark tobacco brown, not wrinkled, reticulate. Reticulum modern to bold straight walls forming a regular pattern of moderate horizontally oblong fields, color of seedcoat. Aril absent. Raphe a ridge or narrow wing three-fourths length of seed, color of seedcoat to lighter. Hilum between nipple and raphe, conspicuous when lighter than seedcoat. Cuticle separable from seedcoat, amber. Outer seedcoat lignified, 0.1 mm thick, dark tobacco brown. Inner seedcoat membranaceous, light amber, not bearing colored dot. Endosperm fleshy, whitish, not fluorescing, oily, when teased wet emitting conspicuous and minute (resembling smoke) oil droplets. Embryo linear, slightly curved, whitish, up to one-half length of seed. Cotyledons parallel, one-third length of embryo, uncleft.

Capsule glabrous, with two conspicuous nerves, linear, straight, 15–24 cm long, 4–5 mm in diameter, many seeded, tan to brown, dehiscent apically by two indurate ribs, valves not deciduous, containing a spurious septum, which divides the pod into two longitudinal chambers. Style absent. Stigma globular with two discrete lobes.

Notes: Yellow horn-poppy, or yellow sea-poppy, is a native biennial or perennial of Europe. The species has become naturalized in eastern and western United States. A few cultivars are available in the ornamental trade. The plant is illustrated in Abrams (1) and Gleason (21).

Hesperomecon lineare (Bentham) Greene

Evening-Poppy



Hesperomecon lineare: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, stigma $\times 6$. Brandegee, Alameda County, Calif. (F).

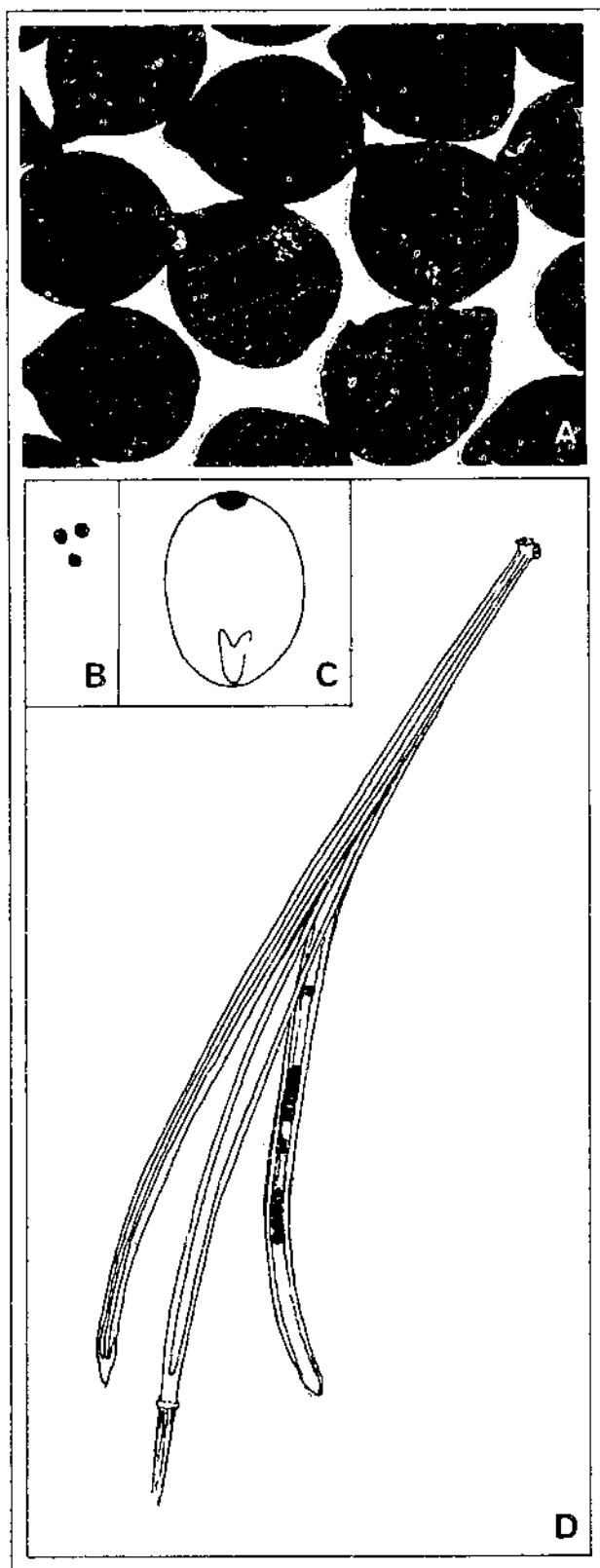
Seed 0.6–0.7 \times 0.5–0.6 \times 0.2–0.3 mm, spherical to ellipsoidal with one flattened side, without apical depression, bearing emergent subbasal to basal nipple, flattened in cross section. Seedcoat shiny, bright amber to blackish, not wrinkled, appearing nonreticulate. Reticulum at 30 \times straight lines lighter in color than seedcoat forming a moderately regular pattern of minute circular fields. Aril absent. Raphe a ridge one-third to one-half length of seed, color of seedcoat. Hilum between raphe and nipple, inconspicuous. Cuticle inseparable from seedcoat. Outer seedcoat coriaceous, less than 0.1 mm thick, bright amber to blackish. Inner seedcoat membranaceous, amber, not bearing colored dot. Endosperm fleshy, white, fluorescing bluish white, oily, when teased wet emitting oil droplets. Embryo linear, white, nearly length of seed. Cotyledons parallel, two-fifths length of embryo, unclleft.

Capsule glabrous, with three to four inconspicuous nerves, obovate, 8–14 mm long, 2–5.5 mm in diameter, many seeded, tan to brown, dehiscent apically by three to four valve-like carpels, which separate, ribs absent, carpels not deciduous. Style absent. Stigma three to four divergent strap-shaped flaps.

Notes: Evening-poppy is an annual endemic ranging throughout the western coastal region from southern Oregon to Santa Barbara County, Calif. The plants are usually found in grasslands, foothill woods, and chaparral. Abrams (1) and Jepson (35) illustrated this plant and like Munz and Keck (54) placed the species in the genus *Meconella*. We are following Ernst, who recognized *Hesperomecon* in his unpublished notes and in his herbarium collections 214, 235, 238, 757, and 760.

Hunnemannia fumariifolia Sweet

Tulip-Poppy



Seed 2-2.7 × 1.8-2.4 × 1.8-2.4 mm, spherical-ovate, frequently with a flush dark circular apex, bearing prominent to elongate basal nipple, terete in cross section. Seedcoat shiny to dull, dark brown with reddish undertones, not wrinkled, reticulate, appearing tuberculate. Reticulum moderate, at 30 × straight thin often winged walls (causing tuberculate appearance) forming a regular pattern of minute circular fields, color of seedcoat. Aril absent. Raphe a line to ridge length of seed, color of seedcoat. Hilum between nipple and raphe, inconspicuous or conspicuous when well developed and tan colored. Cuticle separable from seedcoat, amber. Outer seedcoat two parted: Outer part soft, less than 0.1 mm thick, dark brown, emitting minute oil droplets (resembling smoke) when teased wet; inner part lignified, less than 0.1 mm thick, light amber with apical brown dot. Inner seedcoat membranaceous, pale amber, occasionally bearing apical dark-brown dot (inner seedcoat at dot often remains attached on inner side of outer seedcoat). Endosperm fleshy, whitish, fluorescing bluish white, oily, when teased wet emitting minute oil droplets (resembling smoke). Embryo linear, white, up to one-third length of seed. Cotyledons divergent, one-third to one-half length of embryo, uncleft.

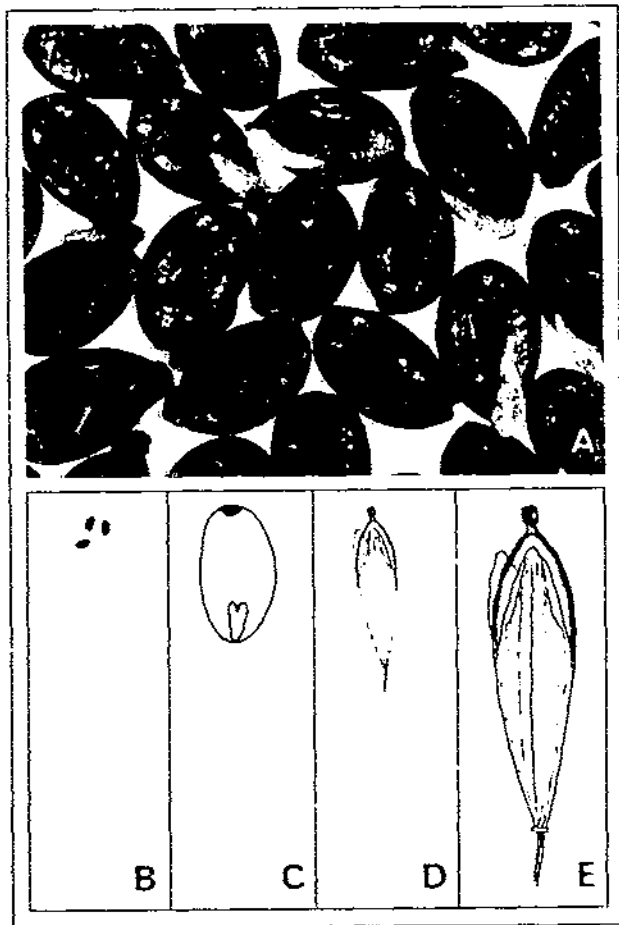
Capsule glabrous, with 10 conspicuous nerves (5 nerves per valve with wide interstices or 3 of 5 nerves centered), linear, straight, 9-13 cm long, 3-5 mm in diameter, many seeded, tan to brown, dehiscent basally by 2 valves, which curve and separate almost to apex from 2 fragile ribs, which often detach from torus, valves not deciduous. Style absent. Stigma globular with two discrete lobes.

Notes: Tulip-poppy, an endemic perennial of Mexico from Coahuila State south to Hidalgo State, has escaped from cultivation in California. As an ornamental, tulip-poppy is handled as an annual. Degener (11), who illustrated the plant, pointed out that it may be harmful to livestock because of its acrid juice.

Hunnemannia fumariifolia: A, Seeds × 10; B, silhouette of seeds × 1; C, endosperm-embryo drawing × 10; D, dehiscent capsule × 1. McVaugh 10496, San Luis Potosí, Mexico (NY).

Macleaya cordata R. Brown

Plume-Poppy



Macleaya cordata: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, dehiscent capsule $\times 2$. Ek, Howard County, Ind. (US).

Seed 1.8–2.1 \times 1–1.3 \times 1–1.3 mm, ellipsoidal, without apical depression, bearing emergent basal nipple, terete in cross section. Seedcoat shiny, dark purplish brown (dull and light to dark tobacco brown when immature), not wrinkled, reticulate. Reticulum moderate, at 30 \times straight walls forming a regular pattern of small to moderate circular to horizontally oblong fields. color of seedcoat (lighter when immature). Aril linear, one-half length of seed, broadest and thickest at basal end, honey colored. Raphe a low ridge one-half length of seed, color of seedcoat. Hilum on nipple or between nipple and aril, occasionally conspicuous. Cuticle separable from seedcoat, dark purplish brown. Outer seedcoat lignified, 0.1 mm thick, light brown. Inner seedcoat membranaceous, faint amber, bearing apical brown dot. Endosperm fleshy, white, not fluorescing, oily, when teased wet emitting oil droplets. Embryo linear, white, up to one-fourth length of seed. Cotyledons parallel, two-fifths length of embryo, uncleft.

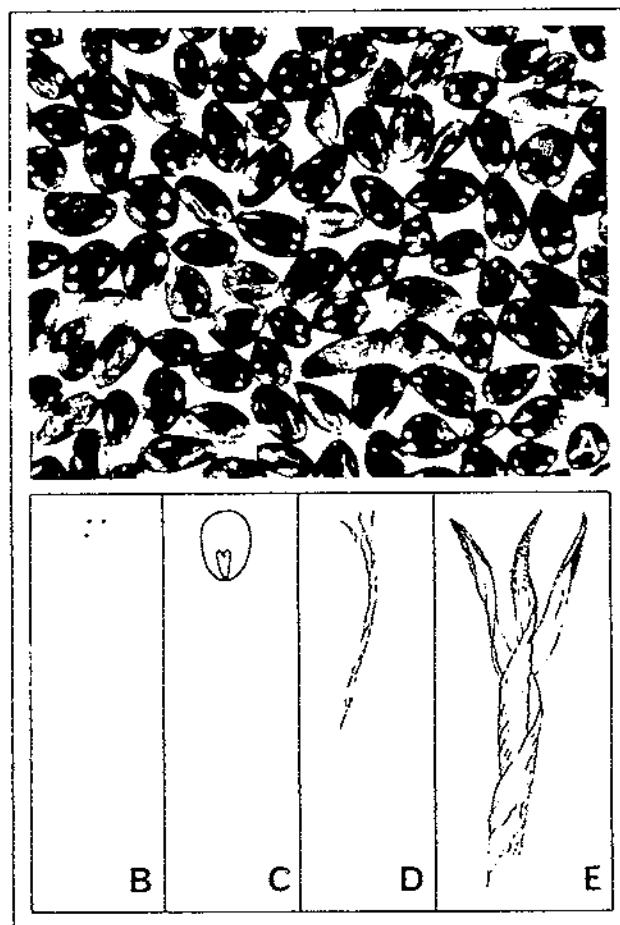
Capsule glabrous, with two conspicuous nerves, oblanceolate, 17–22 \times 4–6 \times 1–2 mm, two to six seeded, tan to reddish brown, dehiscent apically by two valves, which separate from two fragile ribs, valves not deciduous. Style less than 1 mm long. Stigma globular with two parallel lobes.

Notes: Plume-poppy, also known as tree-celandine, is an endemic perennial of China and Japan. It was introduced into North America as an ornamental. Its value as an ornamental is limited because it tends to spread rapidly and to dominate a site. Plume-poppy has spread from cultivation into waste places in eastern United States. The plant is illustrated in Bailey (3) under the name *Bocconia cordata* Willdenow. Prior to Hutchinson (32), plume-poppy was often placed in *Bocconia*. Fernald (20) ⁴ curiously reported this species in separate entries under both generic names.

⁴ In the 1970 corrected edition by Rollins, the *Bocconia* reference was dropped.

Meconella californica Torrey

California Little-Poppy



Meconella californica: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, capsule apex $\times 6$. Eastwood, Sonoma County, Calif. (US).

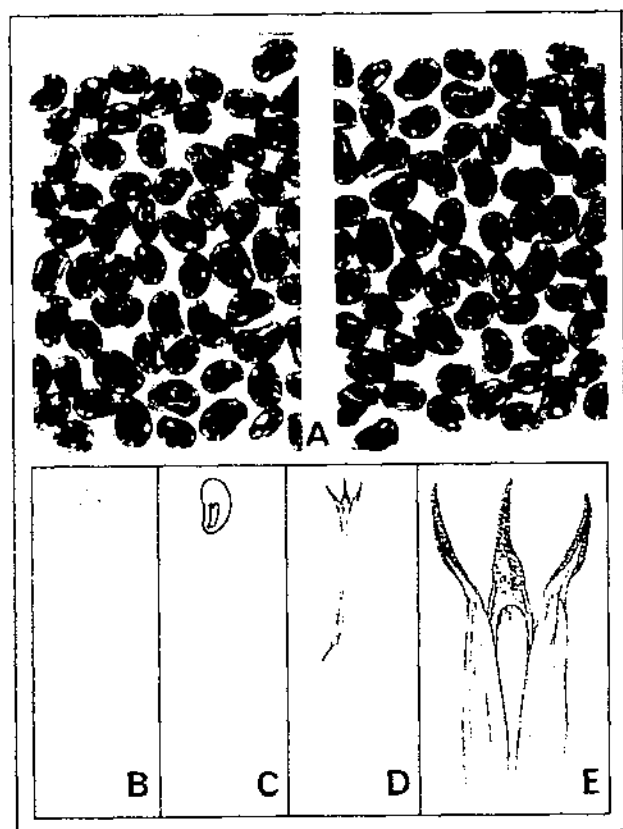
Seed 0.6–1 \times 0.5–0.6 \times 0.4–0.5 mm, ellipsoidal (with one flattened side), obovate to spherical, without apical depression, bearing emergent basal nipple, slightly flattened to terete in cross section. Seedcoat shiny, bright amber to blackish, not wrinkled, appearing nonreticulate. Reticulum at 30 \times straight lines lighter in color than seedcoat forming a moderately regular pattern of minute circular fields. Aril absent. Raphe a ridge three-fourths length of seed, color of seedcoat. Hilum between raphe and nipple, inconspicuous. Cuticle separable from seedcoat, dark amber. Outer seedcoat coriaceous, less than 0.1 mm thick, amber. Inner seedcoat membranaceous, dark amber, not bearing colored dot. Endosperm fleshy, whitish, fluorescing bluish white, oily, when teased wet emitting conspicuous and minute (resembling smoke) oil droplets. Embryo linear, white, more than one-half length of seed. Cotyledons parallel, one-third to one-half length of embryo, uncleft.

Capsule glabrous, with three inconspicuous nerves, linear, straight, 1.5–3.5 cm long, 1–1.5 mm in diameter, many seeded, tan to brown, dehiscent apically by three valvelike carpels, which separate and twist, ribs absent, carpels not deciduous. Style absent. Stigma three divergent strap-shaped flaps.

Notes: California little-poppy is a small annual endemic of California from Shasta County south to Kern County. Plants inhabit open rocky slopes below 900 m in the foothill woods and chaparral vegetation zone. This variable species is illustrated in Abrams (1).

Meconella denticulata Greene

Small-Flowered Little-Poppy



Meconella denticulata: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, capsule apex $\times 6$. Eastwood 74, Santa Barbara County, Calif. (GH, US).

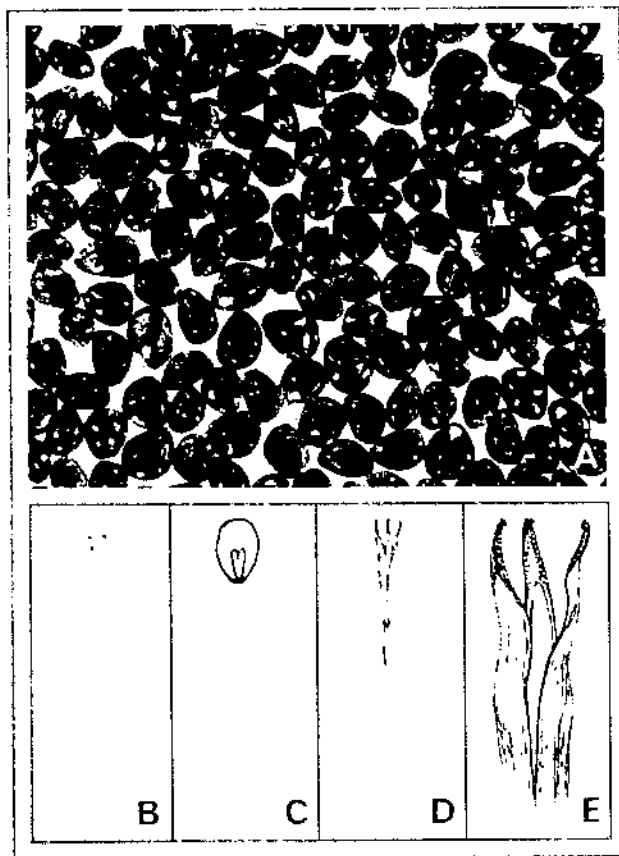
Seed 0.5–0.7 \times 0.4 \times 0.3 mm, ellipsoidal (with one flattened side) obovate to slightly reniform, without apical depression, bearing emergent basal nipple, slightly flattened in cross section. Seedcoat shiny, bright amber to blackish, not wrinkled, appearing nonreticulate. Reticulum at 30 \times straight lines lighter in color than seedcoat forming a moderately regular pattern of minute circular fields. Aril absent. Raphe a ridge one-half length of seed, color of seedcoat. Hilum between raphe and nipple, inconspicuous. Cuticle inseparable (or nearly so) from seedcoat. Outer seedcoat coriaceous, less than 0.1 mm thick, bright amber to blackish. Inner seedcoat membranaceous, amber, not bearing colored dot. Endosperm granular, whitish, fluorescing bluish white, not oily, when teased wet emitting no oil droplets. Embryo linear, white, more than one-half length of seed. Cotyledons parallel, one-third to one-half length of embryo, uncleft.

Capsule glabrous, with three inconspicuous nerves, linear, straight, 1.5–3.5 cm long, 1–1.5 mm in diameter, many seeded, tan to brown, dehiscent apically by three valvelike carpels, which separate and occasionally twist, ribs absent, carpels not deciduous. Style absent. Stigma three strap-shaped flaps.

Notes: Small-flowered little-poppy is an annual endemic of the California Coast Range from Monterey County south into San Diego County and Santa Cruz Island. The plants are frequent but often overlooked (because of their size) members of the shaded canyon flora below 1,000 m. This variable species is illustrated in Abrams (1).

Meconella oregana Nuttall

Oregon Little-Poppy



Meconella oregana: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, capsule apex $\times 6$. Ceska and Ceska, Vancouver Island, British Columbia (UVIC).

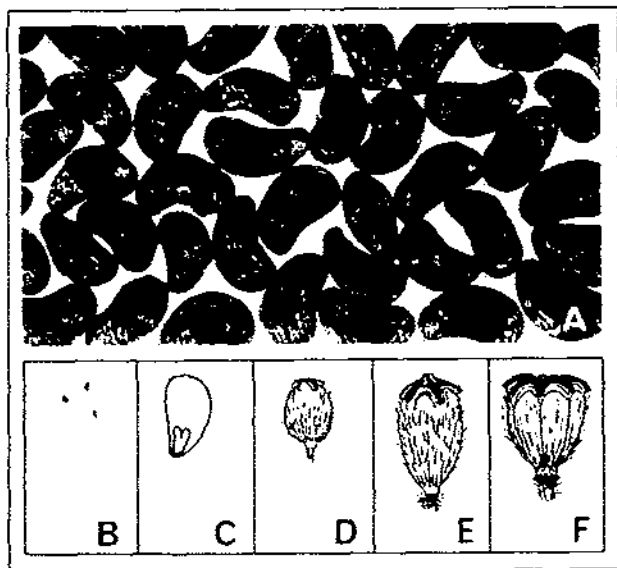
Seed 0.6–0.8 \times 0.4–0.6 \times 0.3–0.4 mm, ellipsoidal (with one flattened side) to obovate, without apical depression, bearing emergent to prominent basal nipple, slightly flattened in cross section. Seedcoat shiny, bright amber to blackish, not wrinkled, appearing nonreticulate. Reticulum at 30 \times straight lines lighter in color than seedcoat forming a moderately regular pattern of minute circular fields. Aril absent. Raphe a ridge three-fourths length of seed, color of seedcoat. Hilum between raphe and nipple, inconspicuous. Cuticle separable from seedcoat, amber. Outer seedcoat coriaceous, less than 0.1 mm thick, amber to blackish. Inner seedcoat membranaceous, amber, not bearing colored dot. Endosperm fleshy, white, fluorescing bluish white, oily, when teased wet emitting conspicuous and minute (resembling smoke) oil droplets. Embryo linear, white, one-half length of seed. Cotyledons parallel, one-third length of embryo, uncleft.

Capsule glabrous, with three inconspicuous nerves, linear, straight, 1–1.6 cm long, 1 mm in diameter, many seeded, tan to brown, dehiscing apically by three valvelike carpels, which separate and occasionally twist, ribs absent, carpels not deciduous. Style absent. Stigma three strap-shaped flaps.

Notes: Oregon little-poppy is a small annual endemic of the Pacific coast from Victoria, British Columbia, south to perhaps northernmost California. Within this area, plants are rare in Washington but frequent in Willamette Valley, Oreg. Plants are usually found in open areas with moist sandy to gravelly soil. The species is illustrated in Abrams (1), Hitchcock et al. (30), and Jepson (35).

Papaver alaskanum Hultén

Alaska Poppy



Papaver alaskanum: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D-F, capsules $\times 1$. (A-C, F) Nelson and Nelson 4119, Mt. McKinley National Park, Alaska (US); (D) Sowl, Amchitka Island, Alaska (COLO); (E) Strutz 1782, St. Paul Island, Alaska (BRY).

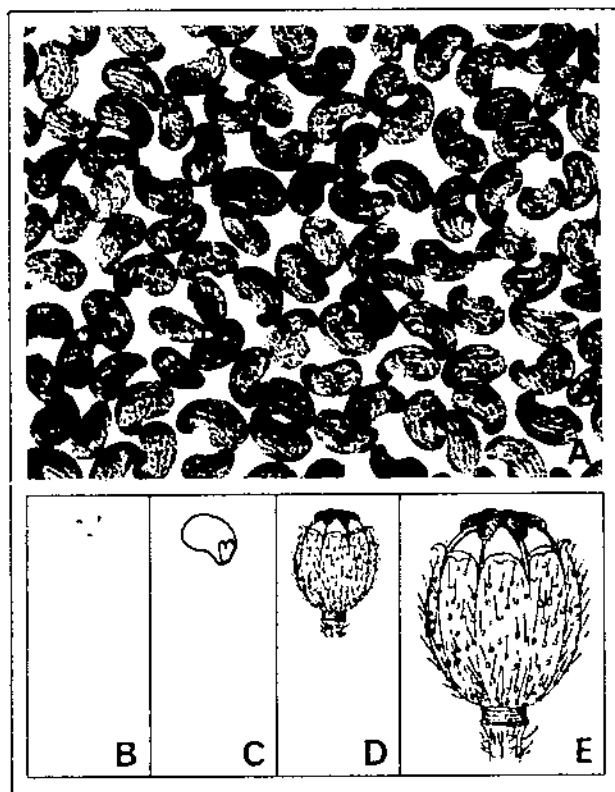
Seed 1-1.4 \times 0.6-0.7 \times 0.5-0.6 mm, comma shaped, without apical depression, occasionally bearing emergent basal nipple, slightly flattened to terete in cross section. Seedcoat dull, light to medium amber, not wrinkled, reticulate. Reticulum moderate, at 30 \times straight to slightly wavy walls forming a regular pattern of small vertically rectangular to square fields on dorsal side becoming irregularly shaped on lateral sides toward hilum, color of seedcoat. Aril absent. Raphe a line to low ridge up to three-fourths length of seed, color of seedcoat. Hilum on raphe, inconspicuous. Cuticle inseparable from seedcoat. Outer seedcoat coriaceous, less than 0.1 mm thick, light to medium amber. Inner seedcoat membranaceous, amber, not bearing colored dot. Endosperm granular, whitish to amber, fluorescing yellowish white, not oily, when teased wet emitting no oil droplets. Embryo linear, white, one-fourth length of seed. Cotyledons parallel, one-third length of embryo, uneleft.

Capsule bearing hispid brown hairs not basally tuberculate, with (rarely four) five to seven inconspicuous nerves, broad obovate to globose, 7-12 mm long, 5-10 mm in diameter, many seeded, tan to brown, dehiscing by (rarely four) five to seven apical pores. Style absent. Stigmatic disc flat to slightly convex with (rarely four) five to seven rays.

Notes: Alaska poppy is an endemic perennial of the arctic and alpine tundra and heathlands of Alaska and southwestern Yukon. Most of the plants are restricted to the Kenai Peninsula, west through the Aleutians, islands of the Bering Sea, and western Alaska. Fewer plants are found in southern Alaska and southwestern Yukon. Welsh (79) noted that "perhaps it should best be treated as *P. radiculatum* ssp. *alaskanum* (Hultén) J. P. Anderson." However, in his flora, Welsh recognized the taxon as *P. alaskanum*. The plant is illustrated in Hultén (31).

Papaver alboroseum Hultén

Pale Poppy



Papaver alboroseum: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, dehiscent capsule $\times 2$. Welsh and Moore 8146, west of Portage Glacier, Alaska (BRY).

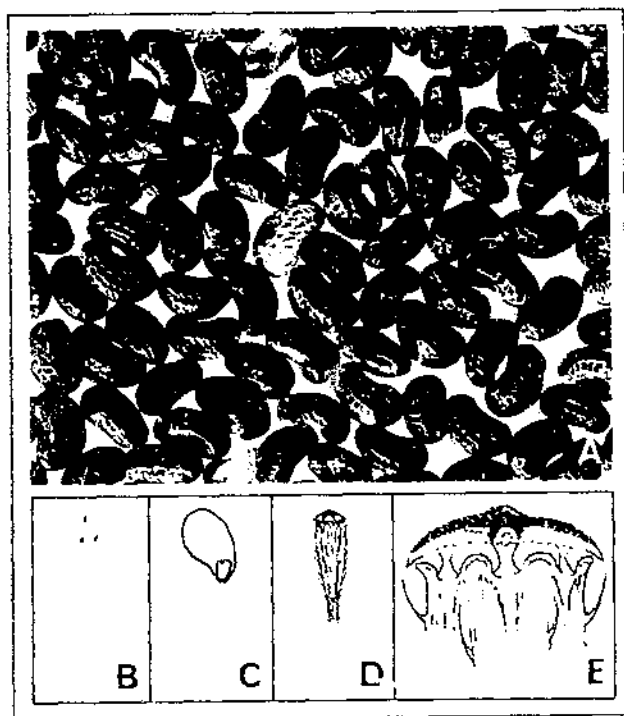
Seed $0.7-0.9 \times 0.4-0.6 \times 0.4-0.6$ mm, comma shaped, without apical depression, bearing emergent basal nipple, terete in cross section. Seedcoat dull, medium to dark amber, not wrinkled, reticulate. Reticulum moderate, at $30 \times$ straight to slightly wavy walls forming a regular pattern of small vertically rectangular to square fields on dorsal side becoming irregularly shaped on lateral sides toward hilum, color of seedcoat. Aril absent. Raphe a line to low ridge one-half length of seed, color of seedcoat. Hilum on raphe, inconspicuous. Cuticle inseparable from seedcoat. Outer seedcoat coriaceous, less than 0.1 mm thick, medium to dark amber. Inner seedcoat membranaceous, amber, not bearing colored dot. Endosperm fleshy, whitish, not fluorescing, oily, when teased wet emitting conspicuous and minute (resembling smoke) oil droplets. Embryo linear, white, up to one-fourth length of seed. Cotyledons parallel, one-half length of embryo, uncleft.

Capsule bearing hispid yellowish to brown basally tuberculate hairs, with five to seven inconspicuous nerves, broadly ovate to globose, 10-15 mm long, 6-11 mm in diameter, many seeded, tan to brown, dehiscent by five to seven apical pores. Style absent. Stigmatic disc flat with five to seven rays.

Notes: Pale poppy, a perennial arctic endemic, grows in gravelly soils and on rock outcrops on Kamchatka Peninsula (U.S.S.R.) and Alaska around Cook Inlet, on Kenai Peninsula, northern British Columbia, and southwest Yukon. This species is closely related to *P. radicum* and perhaps should be regarded at some infraspecific level. According to Welsh (79), all reports of this attractive poppy in northern Alaska are erroneous. This plant is illustrated in Hultén (31).

Papaver argemone L.

Prickly Long-Headed Poppy



Papaver argemone: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, capsule apex $\times 4$. Duke and Hurst 17249, greenhouse grown (NA1).

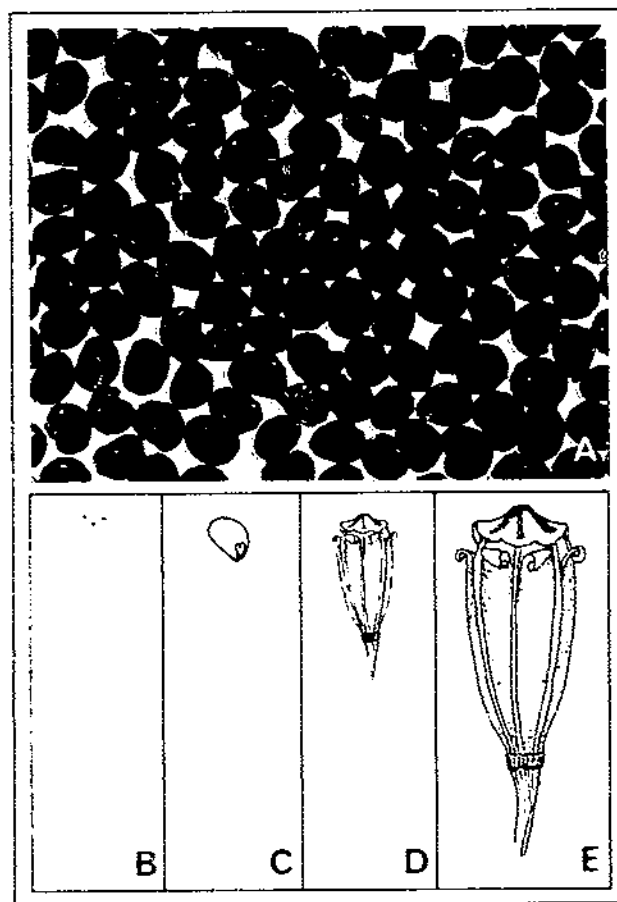
Seed 0.9-1.1 \times 0.5-0.6 \times 0.5-0.6 mm, reniform, without apical depression, bearing emergent basal nipple, terete in cross section. Seedcoat dull, purplish gray to tobacco brown, not wrinkled, reticulate. Reticulum moderate to bold, at 30 \times essentially straight walls (on close examination walls a series of minute curves) forming a regular pattern of small to moderate square to vertically rectangular fields on dorsal side becoming irregularly shaped on lateral sides toward hilum, lighter than seedcoat. Aril absent. Raphe a line to low ridge one-half length of seed, color of seedcoat. Hilum on raphe, inconspicuous. Cuticle barely separable (just walls of reticulum) from seedcoat. Outer seedcoat coriaceous, less than 0.1 mm thick, purplish gray to tobacco brown. Inner seedcoat membranaceous, amber, not bearing colored dot. Endosperm fleshy, whitish, faintly fluorescing yellowish white, oily, when teased wet emitting conspicuous or minute (resembling smoke) oil droplets. Embryo linear, white, more than one-third length of seed. Cotyledons parallel, one-half length of embryo, unclenched.

Capsule bearing scattered hispid spreading or recurved tan bristles, with four to six conspicuous nerves, clavate to oblong, 15-20 mm long, 4-6 mm in diameter, many seeded, tan, dehiscent by four to six apical pores. Style absent. Stigmatic disc convex with four to six rays.

Notes: Prickly long-headed poppy is a native annual of Europe that has escaped from cultivation in both eastern and western United States. Although it does not persist, its occurrence is frequent enough to warrant inclusion in this study. The plant is illustrated in Gleason (21) and Hitchcock et al. (30).

Papaver californicum A. Gray

Western Poppy



Papaver californicum: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, dehiscent capsule $\times 2$. Sweeney, Los Angeles County, Calif. (SFSC).

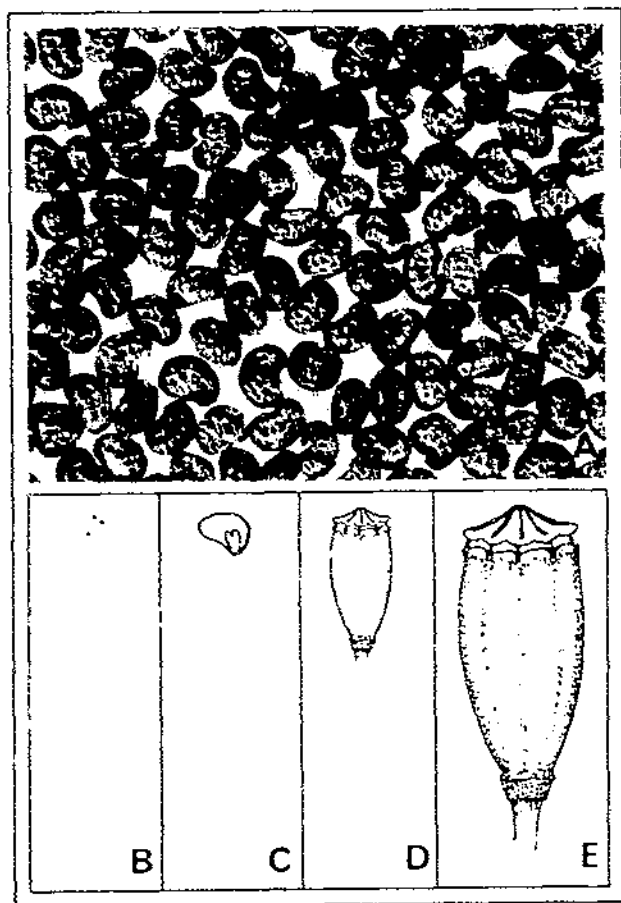
Seed 0.6–0.7 \times 0.4–0.5 \times 0.4–0.5 mm, C-shaped to reniform, without apical depression, bearing emergent basal nipple, terete in cross section. Seedcoat dull, dark purplish gray, not wrinkled, reticulate. Reticulum moderate to bold, at 30 \times straight to slightly wavy walls forming a regular pattern of moderate square to vertically rectangular fields, color of seedcoat. Aril absent. Raphe a ridge to wing one-half length of seed, color of seedcoat. Hilum on raphe, inconspicuous. Cuticle separable from seedcoat, dark purplish gray. Outer seedcoat coriaceous, less than 0.1 mm thick, amber to reddish brown. Inner seedcoat membranaceous, amber, not bearing colored dot. Endosperm fleshy, whitish, not fluorescing, oily, when teased wet emitting conspicuous and minute (resembling smoke) oil droplets. Embryo linear, white, one-fourth length of seed. Cotyledons parallel, one-fourth length of embryo, uncleft.

Capsule glabrous, with four to seven conspicuous nerves, clavate-turbinate, 8–16 mm long, 4–6 mm in diameter, many seeded, tan to brown, dehiscent by four to seven apical pores. Style absent. Stigmatic disc flat to slightly convex with four to seven rays.

Notes: Western poppy is an annual endemic of California in the western chaparral and oak woodlands, below 800 m, in the coastal mountains from Marin County to San Diego County. This species, illustrated in Abrams (1), bears a strong resemblance to *Stylomecon heterophylla* except that the western poppy fruit has no style.

Papaver dubium L.

Blind Eyes



Papaver dubium: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, dehiscent capsule $\times 2$. Commons, Del. (NY).

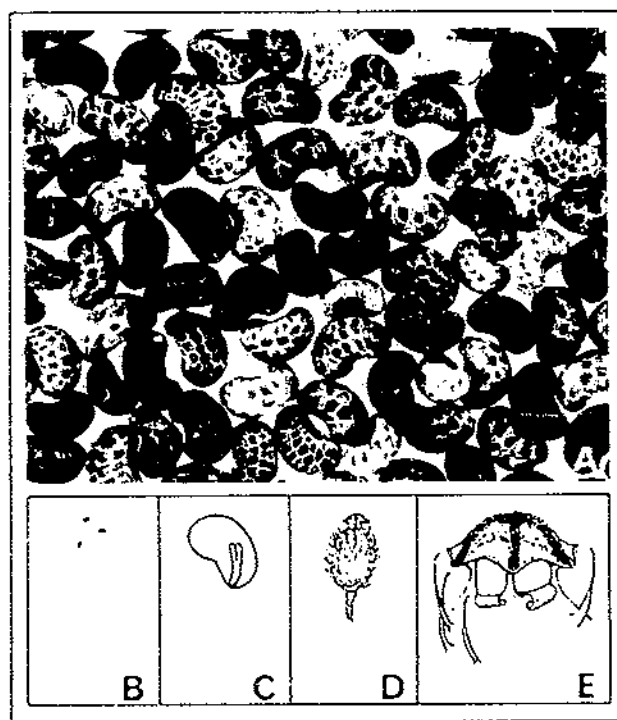
Seed 0.6–0.8 \times 0.3–0.5 \times 0.3–0.4 mm, reniform to C-shaped, without apical depression, occasionally bearing emergent basal nipple, terete in cross section. Seedcoat dull, medium purplish gray, frequently with silver-gray bloom, not wrinkled, reticulate. Reticulum moderate to bold, at 30 \times essentially straight walls (on close examination walls a series of minute curves) forming a regular pattern of small to moderate square to vertically rectangular fields, lighter than seedcoat when only reticulum bears bloom. Aril absent. Raphe a line to low ridge one-fourth length of seed, color of seedcoat. Hilum on raphe, inconspicuous. Cuticle barely separable (just walls of reticulum) from seedcoat. Outer seedcoat coriaceous, less than 0.1 mm thick, medium purplish gray. Inner seedcoat membranaceous, amber, not bearing colored dot. Endosperm fleshy, white to golden, occasionally fluorescing yellowish white, oily, when teased wet emitting conspicuous and minute oil droplets. Embryo linear, slightly curved, white, one-half length of seed. Cotyledons parallel, one-third to one-half length of embryo, unclenched.

Capsule glabrous, with five to nine inconspicuous nerves, narrowly obovate, 15–20 mm long, 5–8 mm in diameter, many seeded, tan to brown, dehiscent by five to nine apical pores. Style absent. Stigmatic disc flat to convex with five to nine rays.

Notes: Blind eyes, an annual, has been introduced into eastern United States from Europe. It has become naturalized in fields, roadsides, thickets, and disturbed sites, especially near habitations. Small (72) listed three common names, smooth-fruited poppy, blind-eye headache poppy, and long-pod poppy. The plant is illustrated in Gleason (21), Radford et al. (62), and Steyermark (75).

Papaver hybridum L.

Rough Poppy



Papaver hybridum: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, capsule apex $\times 4$. Gunn 10231, greenhouse grown (NA).

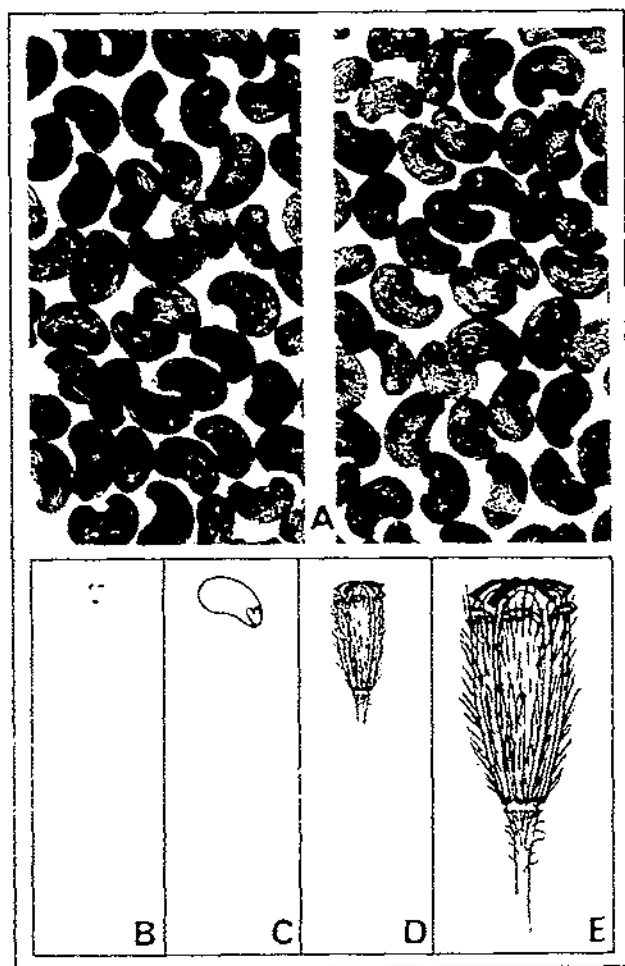
Seed 0.7–1.4 \times 0.4–0.7 \times 0.4–0.7 mm, reniform to C-shaped, without apical depression, occasionally bearing emergent basal nipple, terete in cross section. Seedcoat dull, pale to dark ochre to brown, not wrinkled, reticulate. Reticulum moderate to bold, at 30 \times essentially straight walls (on close examination walls a series of minute curves) forming a regular pattern of moderate square or circular to vertically rectangular fields, frequently lighter than seedcoat. Aril absent. Raphe a line or low ridge one-fourth to one-third length of seed, color of seedcoat. Hilum on raphe, inconspicuous. Cuticle barely separable (just walls of reticulum) from seedcoat. Outer seedcoat coriaceous, less than 0.1 mm thick, pale to dark ochre. Inner seedcoat membranaceous, pale amber, not bearing colored dot. Endosperm fleshy, whitish, rarely fluorescing yellowish white, oily, when teased wet emitting conspicuous and minute (resembling smoke) oil droplets. Embryo linear, white, one-half length of seed. Cotyledons parallel, one-third to one-half length of embryo, uncleft.

Capsule bearing hispid spreading or recurved tan bristles, with four to eight conspicuous nerves, ellipsoidal to ovate, 9–12 mm long, 5–7 mm in diameter, many seeded, tan to brown, dehiscent by four to eight apical pores. Style absent. Stigmatic disc flat to convex with four to eight rays.

Notes: Rough poppy has been introduced into the United States from Eurasia. It has become naturalized in fields, vineyards, and disturbed sites in Modesto and Los Angeles Counties, Calif. Seeds were probably introduced from Australia in wheat shipments (63). It has been reported as an escape from cultivation in Swain County, N.C. (62).

Papaver macounii Greene

Macoun's Poppy



Papaver macounii: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, dehiscent capsule $\times 2$. Spetzman 2103, Umiat, Colville River, Alaska (US).

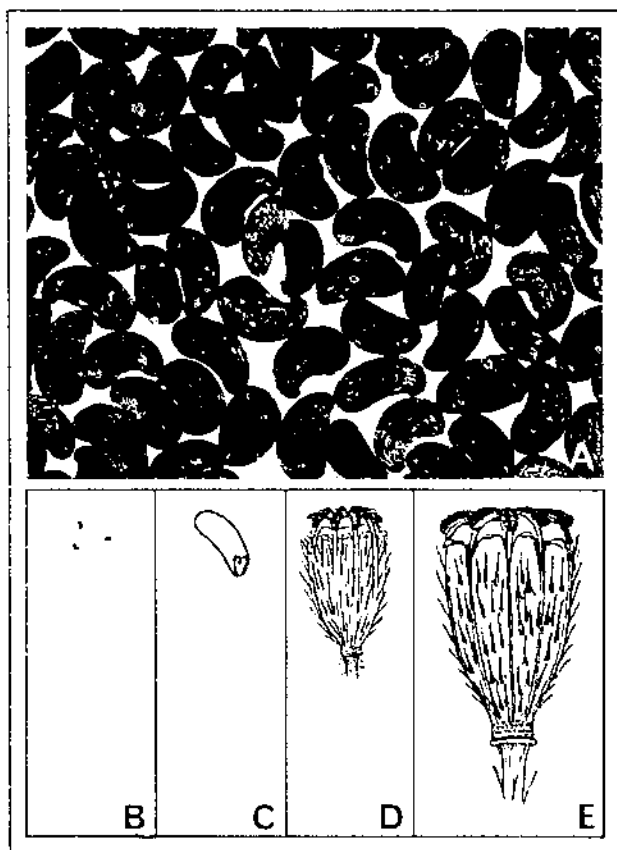
Seed 0.8–1 \times 0.5–0.6 \times 0.5–0.6 mm, comma shaped, without apical depression, frequently bearing emergent basal nipple, terete in cross section. Seedcoat dull, light to dark amber, not wrinkled, reticulate. Reticulum moderate, at 30 \times straight to slightly wavy walls forming a regular pattern of small vertically rectangular to square fields on dorsal side becoming irregularly shaped on lateral sides toward hilum, color of seedcoat. Aril absent. Raphe a ridge, occasionally winglike at midlength, one-half to three-fourths length of seed, color of seedcoat. Hilum on raphe, inconspicuous. Cuticle inseparable from seedcoat. Outer seedcoat coriaceous, less than 0.1 mm thick, light to dark amber. Inner seedcoat membranaceous, amber, not bearing colored dot. Endosperm granular, whitish, fluorescing yellowish white, not oily, when teased wet emitting no oil droplets. Embryo linear, white, up to one-fourth length of seed. Cotyledons parallel, up to one-fourth length of embryo, uncleft.

Capsule bearing hispid brown to whitish hairs not basally tuberculate, with three to five (rarely eight) conspicuous nerves, obovate to clavate, 14–22 mm long, 3–8 mm in diameter, many seeded, tan to brown, dehiscing apically by three to five (rarely eight) pores. Style absent. Stigmatic disc flat to slightly convex with three to five (rarely eight) rays.

Notes: Macoun's poppy is an endemic perennial of the Arctic, viz, Asia, Alaska, and the Yukon east to the Mackenzie Mountains. Collections of this species mainly have been made north of the 62d parallel (79). Plants grow in arctic and alpine tundra and heathlands on sandy to gravelly soils. *P. hulténii* Knaben and *P. keelci* Porsild are synonyms of this species. The plant is illustrated in Hultén (31) and Macoun (50).

Papaver nudicaule L.

Iceland Poppy



Papaver nudicaule: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, dehiscent capsule $\times 2$. Gunn 10230, Prince Georges County, Md. (NA).

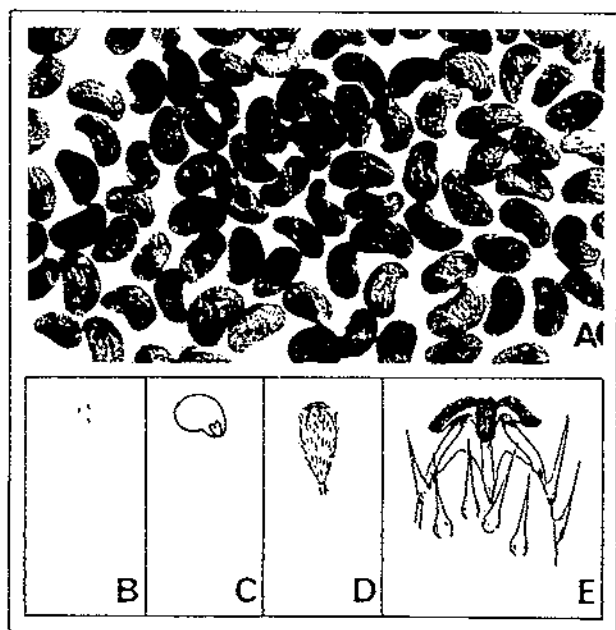
Seed 0.7–1.3 \times 0.4–0.6 \times 0.4–0.6 mm, comma shaped, without apical depression, bearing emergent to prominent basal nipple, terete in cross section. Seedcoat dull, light to dark amber, not wrinkled, reticulate. Reticulum moderate, at 30 \times straight to slightly wavy walls forming a fairly regular pattern of small to moderate vertically rectangular to square fields on dorsal side becoming irregularly shaped on lateral sides toward hilum, color of seedcoat. Aril absent. Raphe a ridge, frequently winglike at mid-length, three-fourths length of seed, color of seedcoat. Hilum on raphe, inconspicuous. Cuticle barely separable (just walls of reticulum) from seedcoat. Outer seedcoat coriaceous, less than 0.1 mm thick, light to dark amber. Inner seedcoat membranaceous, pale amber, not bearing colored dot. Endosperm fleshy, whitish, fluorescing yellowish white, oily, when teased wet emitting conspicuous and minute (resembling smoke) oil droplets. Embryo linear, white, one-fourth to one-third length of seed. Cotyledons parallel, one-eighth to one-sixth length of embryo, unclleft.

Capsule bearing hispid brown (white on old capsules) hairs not basally tuberculate, with (rarely four) seven to eight (rarely nine) conspicuous nerves, obovate to clavate, 9–20 mm long, 6–12 mm in diameter, many seeded, tan to brown, dehiscent by (rarely four) seven to eight (rarely nine) apical pores. Style absent. Stigmatic disc flat with (rarely four) seven to eight (rarely nine) rays.

Notes: A native of Siberia, Iceland poppy is a well-known hardy perennial garden flower, which may persist after planting, especially in northern United States and Canada. Several cultivars are available either as rootstock or from the flower seed-packet trade. These cultivars are attractive and possess various petal colors (white, yellow, orange, or orange scarlet). Single- and double-flowered forms are available, and both make excellent cut flowers. Bailey (J) and Hultén (31) depicted this species.

Papaver pygmaeum Rydberg

Alpine Poppy



Papaver pygmaeum: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, capsule apex $\times 4$. (A-C) Beaman and Stone 1637, Glacier National Park, Mont. (SMU); (D-E) Williams 992, near Stanton Lake, Mont. (US).

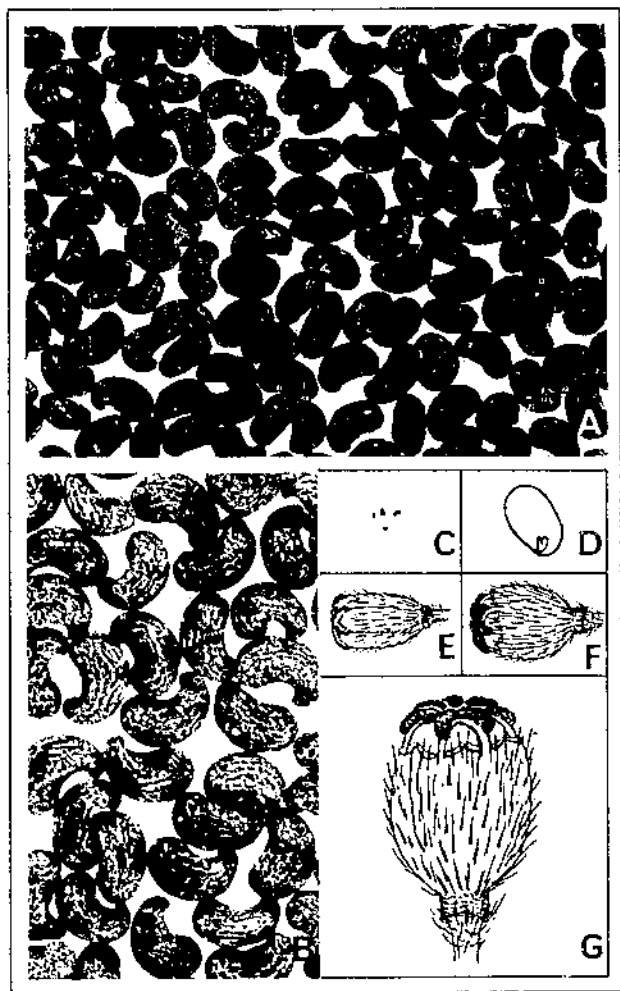
Seed 0.7–0.9 \times 0.3–0.5 \times 0.3–0.5 mm, comma shaped, without apical depression, bearing emergent basal nipple, terete in cross section. Seedcoat dull, light to medium amber, not wrinkled, reticulate. Reticulum moderate, at 30 \times straight to slightly wavy walls forming a regular pattern of small vertically rectangular to square fields on dorsal side becoming irregularly shaped on lateral sides toward hilum, color of seedcoat. Aril absent. Raphe a line to low ridge one-half to three-fourths length of seed, color of seedcoat. Hilum on raphe, inconspicuous. Cuticle inseparable from seedcoat. Outer seedcoat coriaceous, less than 0.1 mm thick, light to medium amber. Inner seedcoat membranaceous, reddish brown, not bearing colored dot. Endosperm granular, whitish, fluorescing bluish white, not oily, when teased wet emitting no oil droplets. Embryo linear, white, one-fourth to one-third length of seed. Cotyledons parallel, less than 0.1 mm, uncleft.

Capsule bearing hispid tan basally tuberculate hairs, with four to five inconspicuous nerves, narrowly obovate, 10–14 mm long, 4–6 mm in diameter, many seeded, tan to brown, dehiscing by four to five apical pores. Style absent. Stigmatic disc flat to convex with four to five rays.

Notes: Alpine poppy is an endemic perennial of the talus slopes of the higher mountains of southeastern Alberta and southwestern British Columbia to northwestern Montana. This distribution essentially follows the axis of the Continental Divide. Löve (47) treated this species in detail and the plant is illustrated in Hitchcock et al. (30).

Papaver radiculatum Rottboell

Arctic Poppy



Papaver radiculatum: A-B, Seeds $\times 10$; C, silhouette of seeds $\times 1$; D, endosperm-embryo drawing $\times 10$; E-F, capsules $\times 1$; G, dehiscent capsule $\times 2$. (A, C) Anderson 4821, Deering, Alaska (ISC); (B, D) Cody 1572, Southhampton Island, Keewatin District, Northwest Territories (DAO); E, Douglass and Douglass 60-199, Grand County, Colo. (COLO); (F-G) Strutz 1838, east of Cantwell, Alaska (BRY).

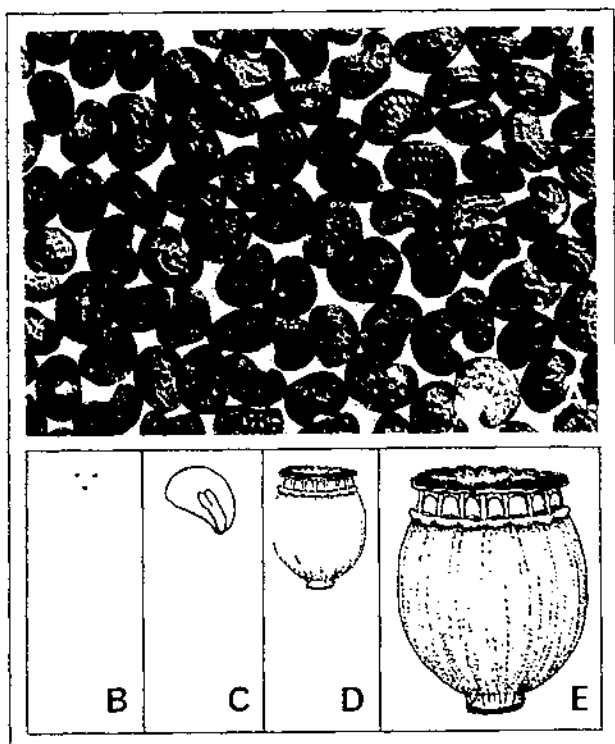
Seed of two sizes, larger $0.9-1.2 \times 0.4-0.6 \times 0.4-0.6$ mm, smaller $0.6-0.7 \times 0.1-0.5 \times 0.4-0.5$ mm, comma shaped, without apical depression, bearing emergent basal nipple, terete in cross section. Seedcoat dull, amber, not wrinkled, reticulate. Reticulum moderate, at $30 \times$ straight to slightly wavy walls forming a regular pattern of small vertically rectangular to square fields on dorsal side becoming irregularly shaped on lateral sides toward hilum, color of seedcoat. Aril absent. Raphe a ridge, occasionally becoming winglike at midlength, three-fourths length of seed, color of seedcoat. Hilum on raphe, inconspicuous. Cuticle inseparable from seedcoat. Outer seedcoat coriaceous, less than 0.1 mm thick, amber. Inner seedcoat membranaceous, amber, not bearing colored dot. Endosperm fleshy, whitish, fluorescing yellowish white, oily, when teased wet emitting conspicuous and minute (resembling smoke) oil droplets. Embryo linear, white, one-seventh to one-sixth length of seed. Cotyledons parallel, less than one-fourth length of embryo, uncleft.

Capsule bearing hispid brown (rarely whitish) hairs not basally tuberculate, with five to eight inconspicuous nerves, obovate, 10-18 mm long, 5-9 mm in diameter, many seeded, tan to brown, dehiscent by five to eight apical pores. Style absent. Stigmatic disc flat to slightly convex with five to eight rays.

Notes: Arctic poppy is an endemic perennial of northern North America, especially along the coast of western and northern Alaska. Plants are less common in interior Alaska, Yukon, and the Rocky Mountains to Alberta. They reoccur in east-central Utah and Colorado in high alpine areas. This species is composed of a series of populations that vary from each other in minor characteristics. Synonyms include *P. kluanensis* D. Löve, *P. lapponicum* (Tolm.) Nordh., and *P. mcconnellii* Hultén. Hultén (31) illustrated this plant under the two subspecies of *P. lapponicum*.

Papaver rhoeas L.

Corn Poppy



Papaver rhoeas: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, dehiscent capsule $\times 2$. Duke and Hurst 17242, greenhouse grown (NA).

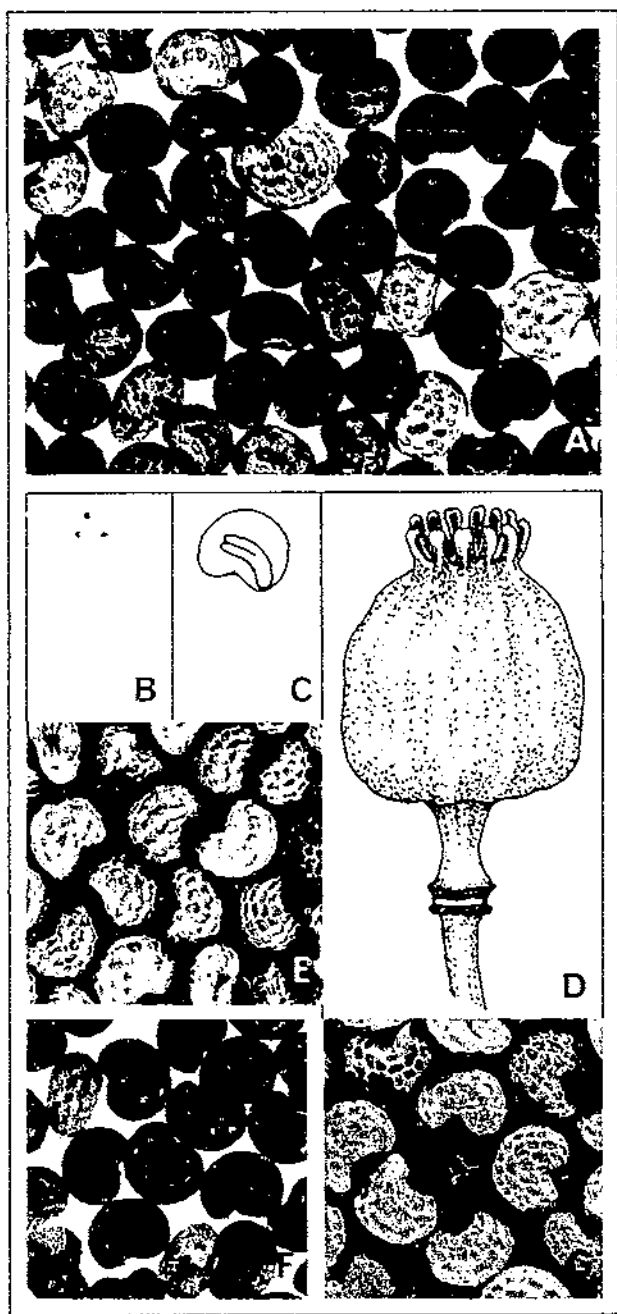
Seed $0.7-1 \times 0.5-0.7 \times 0.5-0.7$ mm, reniform or nearly so, without apical depression, occasionally bearing emergent basal nipple, terete in cross section. Seedcoat dull, amber with purplish sheen, not wrinkled, reticulate. Reticulum moderate to bold, at 30° wavy walls forming a regular pattern of small to moderate square to vertically rectangular fields, color of seedcoat to lighter. Aril absent. Raphe a line to low ridge one-fourth to one-half length of seed, color of seedcoat. Hilum on raphe, inconspicuous. Cuticle barely separable (just walls of reticulum) from seedcoat. Outer seedcoat coriaceous, less than 0.1 mm thick, amber. Inner seedcoat membranaceous, pale amber, not bearing colored dot. Endosperm fleshy, whitish, fluorescing yellowish white, oily, when teased wet emitting conspicuous and minute (resembling smoke) oil droplets. Embryo linear, slightly curved, white, three-fifths length of seed. Cotyledons parallel, one-half length of embryo, unleft.

Capsule glabrous, with 8-18 conspicuous nerves, subglobose to broad-ovate, 10-15 (-20) mm long, 8-15 mm in diameter, many seeded, tan to brown, dehiscent by 8-18 apical pores. Style absent. Stigmatic disc flat to slightly convex with 8-18 rays.

Notes: Corn poppy, a native annual of the Old World, has become naturalized in northern and central United States and Canada. Because of its weedy tendencies, this plant has gained a plethora of common names, including amapola, field poppy, Flanders poppy, red poppy, and Shirley poppy. Cultivars are sold by the flower seed-packet trade under the common name Shirley poppy. Various flower colors and petal numbers and shapes are available. The artificial American Legion poppy is modeled from a red-flowered cultivar. The plant is illustrated in Gleason (21).

Papaver somniferum L.

Common Poppy



Papaver somniferum: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, indehiscent capsule $\times 1$. Duke and Hurst 17143, field grown (NA). Seeds of three cultivars of *P. somniferum* selected to illustrate external topographic variations, viz, size, reticulation, and color variation as shown in black and white photographs ($\times 10$): E, Light-gray seeds, and F, blue-gray seeds from Konarka, Afghanistan; G, beige to white seeds from University of Seattle Drug Plant Garden (no vouchers).

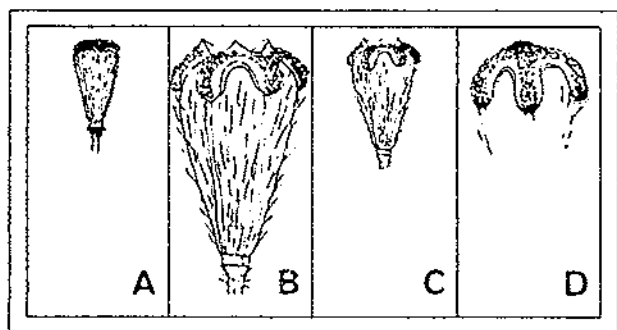
Seed 1–1.5 \times 0.8–1.2 \times 0.7–1 mm, reniform, without apical depression, occasionally bearing emergent basal nipple, slightly flattened to terete in cross section. Seedcoat dull, white through light to dark amber or bluish to blackish, not wrinkled, with compound reticulation. Primary reticulation moderate to bold, at 30 \times straight walls forming a regular pattern of moderate irregular fields, color of seedcoat to lighter, containing a secondary reticulation with straight lines darker than seedcoat forming a regular pattern of minute irregular fields (difficult to see on lightest and darkest seeds). Aril absent. Raphe a ridge to wing one-half length of seed, color of seedcoat. Hilum on raphe, inconspicuous, but frequently surrounded by a dark circle or spot. Cuticle separable or barely so from seedcoat, white to pale amber. Outer seedcoat coriaceous, less than 0.1 mm thick, color of seed. Inner seedcoat membranaceous, dark amber to white (depending on outer seedcoat color), not bearing colored dot. Endosperm fleshy, white, rarely fluorescing faint bluish white (white seeded cultivars fluoresce bluish white internally and externally), oily, when teased wet emitting conspicuous and minute (resembling smoke) oil droplets. Embryo linear, curved, white, three-fourths length of seed. Cotyledons parallel, one-half length of embryo, uncleft.

Capsule glabrous, with 5–15 (–20) inconspicuous nerves, subglobose to oblong, 2–6 cm in all dimensions, many seeded, tan to brown, dehiscent or indehiscent in most cultivars. Style absent. Stigmatic disc concave to convex with 5–15 (–20) rays, separate at apex.

Notes: Common poppy, a native annual of Eurasia, is a multiuse plant that seldom becomes naturalized in the United States and Canada. Live seeds of cultivars were sold in the United States but now may not be offered for sale. In addition to ornamental and narcotic uses of the common poppy, its seeds are used in baking (poppyseed rolls) and to make an edible oil. The plant, also known as opium poppy and garden poppy, is illustrated in Bailey (3), Gleason (21), Small (72), and Steyermark (75).

Papaver walpolei Porsild

Walpole's Poppy



Papaver walpolei: A, C, Capsules $\times 1$; B, capsule $\times 2$; D, capsule apex $\times 2$. (A-B) Porsild and Porsild 1352, Seward Peninsula, Alaska (US); (C-D) Pegau 202, Feather River, Alaska (BRY).

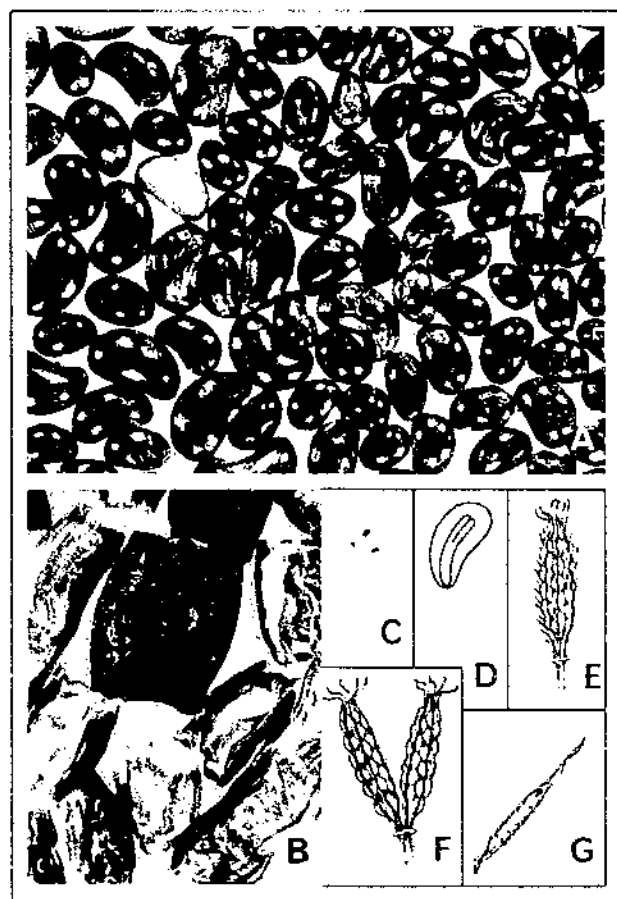
Seed of Walpole's poppy was unavailable to us during our study of this family. In the type description, seeds are described as "1.0 to 1.2 mm long, crescent-shaped and somewhat shiny" (59). From this general description one would expect seeds of this species to be similar to seeds of other native Alaskan species, viz, *P. alaskanum*, *P. alboroscum*, *P. macounii*, *P. pygmaeum*, and *P. radiculatum*. However, this surmise may be falsely drawn.

Capsule bearing hispid whitish to brownish basally tuberculate hairs, with four to five conspicuous nerves, obovate-clavate, 8-15 mm long, 4-9 mm in diameter, many seeded, tan to brown, dehiscent by four to five apical pores. Style absent. Stigmatic disc flat to slightly convex with four to five rays.

Notes: Walpole's poppy is an endemic perennial of the Arctic from easternmost Siberia to Seward Peninsula and southward to the Kuskokwim Delta region (Goodnews Bay). The plants are found in the tundra and heathlands, often in gravel or on rocky outcrops. Unlike other native Alaskan species, this species is distinct and does not appear to be closely related to the other species previously listed. Its leaves are subentire to few lobed, entirely glabrous, almost coriaceous, and dark green. The other Alaskan poppies bear leaves that are once or twice pinnatifid, pubescent, not coriaceous, and not dark green because of the presence and color of the pubescence. The capsule shape is also different. Porsild (59) included a photograph of the type with his original description.

Platystemon californicus Benth

Cream-Cups



Platystemon californicus: A, Seeds $\times 10$; B, fruit segments $\times 10$; C, silhouette of seeds $\times 1$; D, endosperm-embryo drawing $\times 10$; E-F, complete aggregate fruits $\times 1$; G, single pistil $\times 1$. (A-D) Heller 8176, Fresno County, Calif. (US); (E-G) Greene, Contra Costa County, Calif. (US). (Largest seeds in A selected from other samples to show size variation.)

Seed $0.8-1.7 \times 0.5-1.1 \times 0.5-1.1$ mm, reniform to comma shaped to ellipsoidal with one flattened side, at $30\times$ with conspicuous subapical patch or depression, bearing emergent basal to subbasal nipple, terete in cross section. Seedcoat shiny, light amber to dark reddish brown, not wrinkled, appearing nonreticulate. Reticulum inconspicuous, at $30\times$ straight walls forming an irregular pattern of minute irregular fields, color of seedcoat. Aril absent. Raphe a line to ridge one-half to three-fourths length of seed, color of seedcoat. Hilum between nipple and raphe, inconspicuous. Cuticle inseparable from seedcoat. Outer seedcoat coriaceous, less than 0.1 mm thick, light amber to dark reddish brown. Inner seedcoat membranaceous, amber, often bearing subapical brown dot. Endosperm fleshy, whitish, occasionally fluorescing bluish white, oily, when teased wet emitting oil droplets. Embryo linear, white, (rarely one-third) one-half to nearly length of seed, curving with seed. Cotyledons parallel, one-half length of embryo, uncleft.

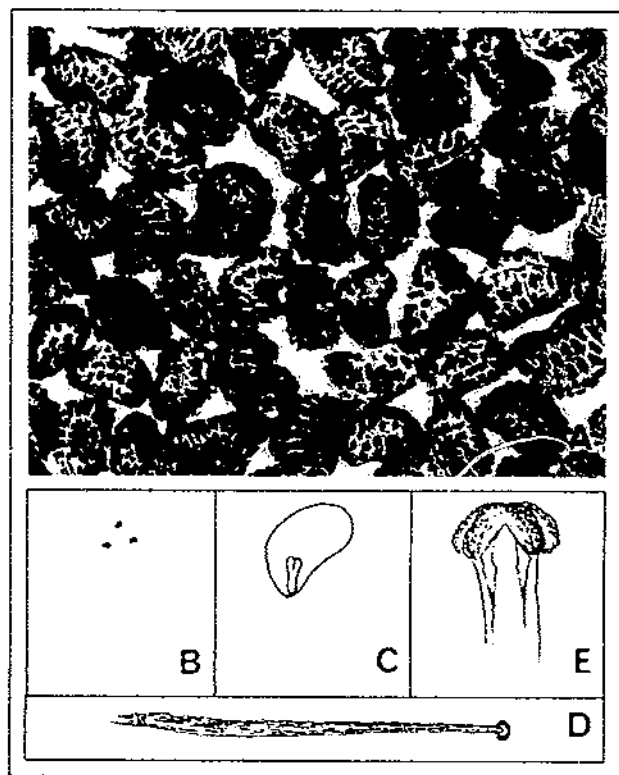
Fruit glabrous or bearing tan to brown hairs, without nerves, composed of 6-25 aggregated linear torulose pistils (forming an oblong aggregate fruit), straight, 2-2.5 cm long, 1 to 2 mm in diameter, with 3-9 seeds per pistil, each pistil breaking transversely along horizontal placentas (between seed chambers) in 3-9 segments (B). An observation by Curran (10) that some races may have some degree of dehiscence has not been suggested by other taxonomists. Style 2-10 mm long. Stigma one strap-shaped flap per pistil.

Notes: Cream-cups is a native annual of the western United States. Plants are found in open grassy clay or sandy places, often in burned areas, below 900 m from Coos County, Oreg., to Baja California and east to Utah and Arizona. Greene (23) recognized 57 species in this 1 species complex. Although plants are highly variable, few taxonomists have recognized this many species. Munz (53) recognized six varieties in California. Abrams (1), Clements (7), and Jepson (35) illustrated this plant.

^aUnit of dispersal is a one-seeded fruit segment; seeds are seldom seen.

Roemeria refracta (Steven) DC.

Field-Poppy



Roemeria refracta: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, indehiscent capsule $\times 1$; E, capsule apex $\times 5$. Garrett and Milner 9407, Box Elder County, Utah (UT).

Seed 1–1.5 \times 0.6–1 \times 0.6–1 mm, reniform and partially angular, without apical depression or basal nipple, terete in cross section. Seedcoat dull, light ocher to slate gray, not wrinkled, reticulate. Reticulum bold, at 30 \times straight winglike walls (which appear double) forming a regular pattern of small to moderate circular fields on dorsal side becoming moderate horizontally oblong fields on lateral sides toward hilum, color of seedcoat or lighter. Aril absent. Raphe a line or low ridge one-third to one-half length of seed, color of seedcoat to darker. Hilum at base of raphe, inconspicuous. Cuticle separable from seedcoat, light amber to gray (forming the winglike reticulation). Outer seedcoat lignified, 0.1 mm thick, amber to dark reddish brown. Inner seedcoat membranaceous, pale amber, not bearing colored dot. Endosperm fleshy, white, fluorescing bluish white, oily, when teased wet emitting conspicuous and minute (resembling smoke) oil droplets. Embryo linear, white, one-third to one-half length of seed. Cotyledons parallel, one-third to one-half length of embryo, unclenched.

Capsule glabrous (tips of valves may bear setae), with three to four conspicuous nerves, linear, straight, 3–10 cm long, 2–4 mm in diameter, many seeded, greenish tan to brown, dehiscing apically by three to four valves separating from three to four fragile ribs, valves not deciduous. Style absent. Stigma globular with three to four confluent lobes.

Notes: Field-poppy is a native annual from Eurasia. Seeds were introduced into the Beaver Dam region of Box Elder County, Utah. The species has now spread and become a noxious-weed seed in Utah. Plants are numerous in some areas, though few have been collected.

Romneya coulteri Harvey

Coulter's Matilija-Poppy

Seed 1.4-2 × 0.8-1.5 × 0.8-1.5 mm, angular and irregular to ellipsoidal with one flattened side, without apical depression, bearing emergent to prominent basal nipple, terete to sectorial in cross section. Seedcoat dull, medium to dark tobacco brown, not wrinkled, compoundly reticulate. Primary reticulation, formed by undulation of cuticle, moderate to bold straight walls forming an irregular pattern of moderate to large irregular fields, color of seedcoat, containing a secondary reticulation appearing minutely granular. Aril absent. Raphe a ridge to wing one-third to three-fourths length of seed, color of seedcoat to lighter. Hilum at base of raphe, conspicuous when lighter than seedcoat. Cuticle separable from seedcoat, brown spotted on tan background. Outer seedcoat weakly lignified, less than 0.1 mm thick, outer surface whitish, inner surface dark amber. Inner seedcoat membranaceous, amber, not bearing a colored dot. Endosperm fleshy, whitish, not fluorescing, oily, when teased wet emitting conspicuous and minute oil droplets. Embryo linear, white, up to one-fourth length of seed. Cotyledons parallel, one-fifth length of embryo, unleft.

Capsule bearing strigose tan bristles, with 7-12 inconspicuous nerves, oblong to ovate, 3-5.5 cm long, 1-2 cm in diameter, many seeded, tan, dehiscent apically by 7-12 valves, which separate from 7-12 indurate ribs, valves not deciduous. Style absent. Stigma globular with 7-12 confluent lobes.

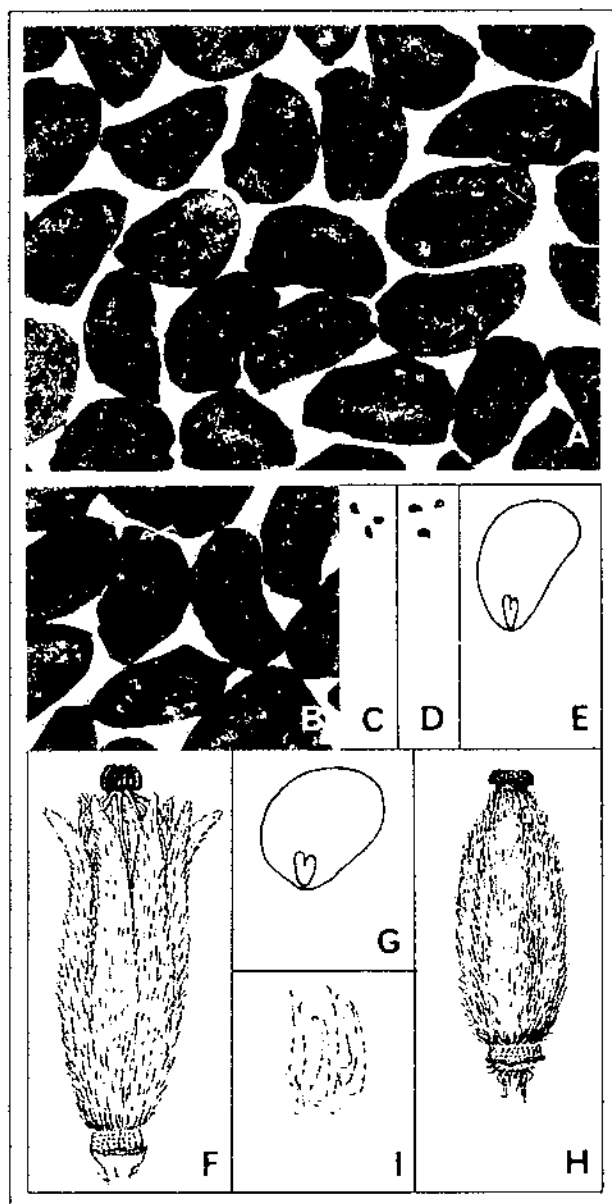
Notes: Coulter's matilija-poppy is an endemic perennial with a nearly woody base, of dry washes and canyons below 1,300 m from Santa Barbara County, Calif., south into Baja California. Growing instructions and illustrations for this excellent ornamental may be found in Bailey (3), Abrams (1) and Jepson (35) also illustrated this plant.

Romneya trichocalyx Eastwood

Matilija-Poppy

Seed similar to preceding except that basal nipple often absent or emergent, endosperm frequently with faint bluish white fluorescence.

Capsule similar to preceding.

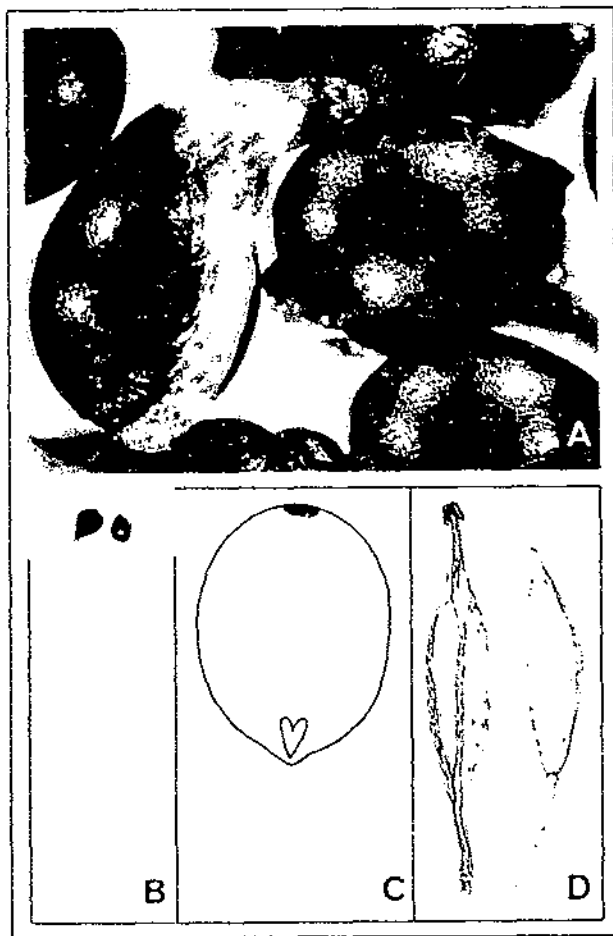


Romneya spp.: A-B. Seeds × 10; C-D, silhouette of seeds × 1; E, G, endosperm-embryo drawings × 10; F, H, capsules × 1; I, bristles × 6. *R. coulteri* (A, C, E) Balls 19761, Rancho Santa Ana Botanic Garden, Calif. (NY); (F) Benson 5885, Ventura County, Calif. (US). *R. trichocalyx* (B, D, G-I) Eastwood, Santa Barbara County, Calif. (US).

Notes: The distribution is similar to the preceding except more coastal. Hybrids between the two species are available from the nursery trade.

Sanguinaria canadensis L.

Bloodroot



Sanguinaria canadensis: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, capsules $\times 1$. (A-B) Rudd 631, North Dakota (US); (C-D) Stump 122, Jefferson County, Ky. (DHL).

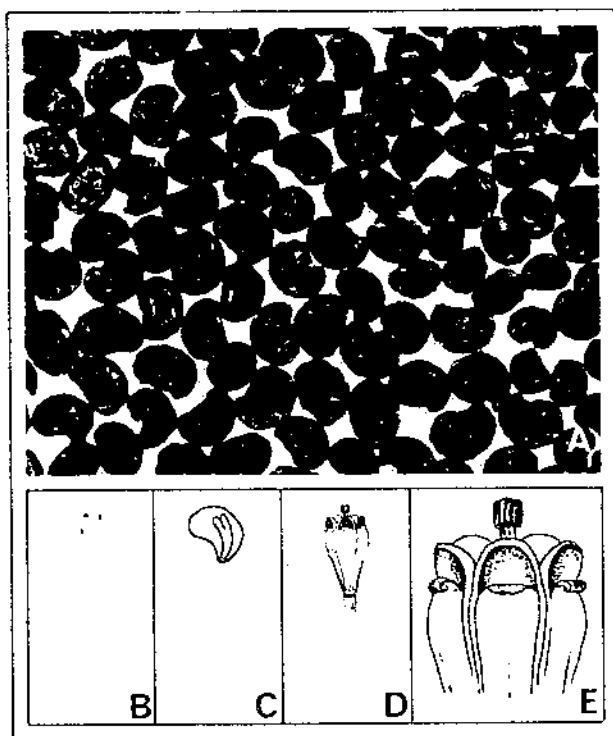
Seed (excluding aril) 3.2-3.7 \times 2.2-2.8 \times 2.2-2.8, obovate, bearing circular apical depression and emergent to elongate basal nipple, terete in cross section. Seedcoat shiny, bright reddish brown (dull and tan when immature), frequently wrinkled, reticulate. Reticulum inconspicuous to moderate, at 30 \times straight walls forming an irregular pattern of minute irregular fields, color of seedcoat. Aril longer than seed, attached from edge of apical depression and extending beyond hilum, pale honey colored. Raphe absent. Hilum on side of nipple, conspicuous when lighter than seedcoat. Cuticle separable from seedcoat, dark amber. Outer seedcoat lignified, 0.1-0.2 mm thick, dark reddish brown. Inner seedcoat membranaceous, yellowish, bearing apical brown dot. Endosperm fleshy, whitish, fluorescing bluish white, oily, when teased wet emitting minute oil droplets (resembling smoke). Embryo rudimentary, white, one-ninth to one-seventh length of seed. Cotyledons divergent, one-fifth length of embryo, unclift.

Capsule glabrous, with two conspicuous nerves, ellipsoidal to fusiform, 3-6 cm long, 5-15 mm in diameter, many seeded, brown, dehiscent longitudinally by two valves, which separate to base and apex from two fragile ribs, valves not deciduous. Style absent. Stigma globular with two confluent lobes.

Notes: Bloodroot, or red puccoon, is an endemic perennial of eastern Canada and the United States, southwest to Oklahoma and eastern Texas (8). A spring wildflower of the mixed deciduous forest, this species has several floral and foliar phenotypes. Rootstocks have been used as medicine, as an emetic, a purgative, and a stimulant. The orange-red acrid juice (hence the common name) was used by American Indians for war paint and for dyeing arrow quills. The plant is illustrated in Gleason (21), Radford et al. (62), Rydberg (66), Steyermark (75), and Kingsbury (40), who discusses the plant's potential toxicity.

Stylomecon heterophylla G. Taylor

Wind-Poppy



Stylomecon heterophylla: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, dehiscent capsule $\times 1$; E, capsule apex $\times 4$. Gunn 10225, greenhouse grown (NA).

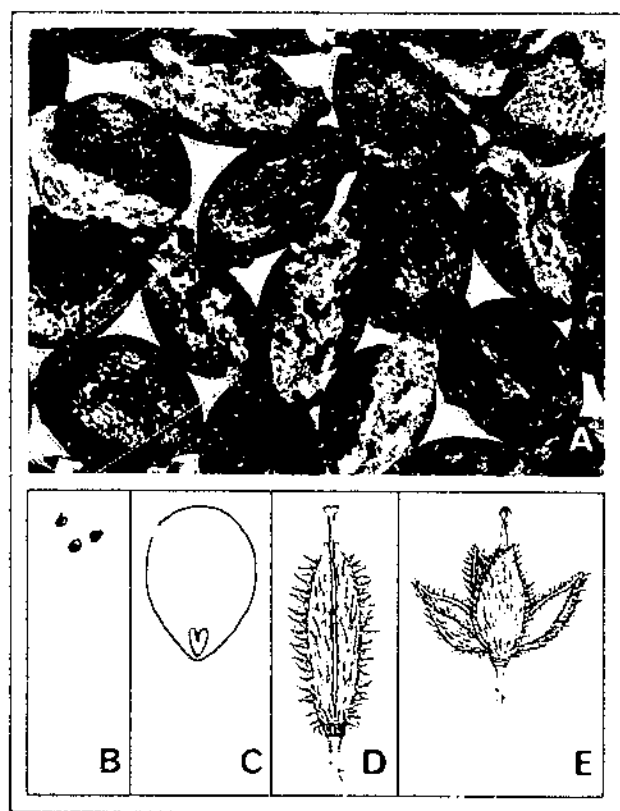
Seed $0.7-0.9 \times 0.4-0.6 \times 0.4-0.6$ mm, C-shaped, without apical depression, bearing emergent to prominent basal nipple, terete in cross section. Seedcoat dull, dark purplish gray, not wrinkled, reticulate. Reticulum moderate to bold, at $30 \times$ wavy walls forming a regular pattern of small to moderate squared fields, color of seedcoat. Aril absent. Raphe winglike, one-half length of seed, color of seedcoat. Hilum on raphe, inconspicuous. Cuticle separable from seedcoat, tan. Outer seedcoat coriaceous, less than 0.1 mm thick, dark brown. Inner seedcoat membranaceous, amber, not bearing colored dot. Endosperm fleshy, whitish, occasionally fluorescing faint bluish white, oily, when teased wet emitting minute oil droplets (resembling smoke). Embryo linear, slightly curved, whitish, two-thirds length of seed. Cotyledons parallel, one-third to one-half length of embryo, unclotted.

Capsule glabrous, with 4-11 conspicuous nerves, obovate to turbinate, 10-22 mm long, 4-7 mm in diameter, many seeded, tan to brown, dehiscent by 4-11 apical pores. Style 1-3 mm long. Stigma globular with 4-11 confluent lobes.

Notes: Wind-poppy is an endemic annual of central California (Lake and Fresno Cos.) south to Baja California (to the south end of Sierra San Pedro Martir), including the Channel Islands. Plants are usually found on shaded to grassy slopes and in canyons below 1,200 m. Originally described as a member of the genus *Meconopsis*, this species was transferred to *Papaver* by Greene and then placed in its own genus by Taylor (77). Wind-poppy resembles *P. californicum* in habit except for the style and fruit, which are unlike those of any other species of *Papaver*. The plant is illustrated in Abrams (1) and Jepson (35).

Stylophorum diphyllum (Michaux) Nuttall

Celandine-Poppy



Stylophorum diphyllum: A, Seeds $\times 10$; B, silhouette of seeds $\times 1$; C, endosperm-embryo drawing $\times 10$; D, indehiscent capsule $\times 1$; E, dehiscent capsule $\times 1$. (A-C, E) Palmer 34909, Stoddard County, Mo. (US); (D) Ruth 229, Knox County, Tenn. (US).

Seed (excluding aril) 1.6-2.1 \times 1.2-1.5 \times 1.2-1.5 mm. obovate, bearing apical to sub-apical circular depression or reddish dot and emergent to prominent basal nipple, terete in cross section. Seedcoat dull, pale brown, not wrinkled, reticulate. Reticulum moderate, at 30 \times straight walls forming a regular pattern of small to moderate irregular fields, color of seedcoat. Aril longer than seed, wide and ruffled, attached at apical depression and extending beyond hilum, honey colored (when teased wet emitting minute oil droplets resembling smoke). Raphe absent. Hilum on side of nipple, conspicuous when whitish. Cuticle separable from seedcoat, translucent, pale amber. Outer seedcoat coriaceous, less than 0.1 mm thick, pale brown. Inner seedcoat membranaceous, light amber, not bearing colored dot (dot permanently attached to inner side of outer seedcoat). Endosperm fleshy, whitish, fluorescing faint bluish white, oily, when teased wet emitting oil droplets. Embryo rudimentary, white, one-seventh to one-sixth length of seed. Cotyledons divergent, one-fourth length of embryo, unclenched.

Capsule bearing hispid brown to black hairs, with four to five inconspicuous nerves, ellipsoidal, 2-3 cm long, 1-1.5 cm in diameter, many seeded, brown to black, dehiscing apically by four to five valves, which eventually separate to base from four to five indurate ribs, valves not deciduous. Style 3-4 cm long. Stigma globular with four to five confluent lobes.

Notes: Celandine-poppy is an endemic perennial of the western United States (Pennsylvania west to Wisconsin and south to Tennessee and Arkansas). An easily grown spring wild flower of the mixed deciduous forest, celandine-poppy possesses little phenotypic variation. Its rootstocks have not been recorded as being used in making home medicine as have the rootstocks of bloodroot (*Sanguinaria canadensis*). The saffron-colored juice of celandine-poppy has no recorded uses. Other common names include mock-poppy, wood-poppy, and yellow-poppy. The plant is illustrated in Bailey (3), Gleason (21), Small (72), and Steyermark (75).

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