

Pyrus L.

pear

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Growth habit, occurrence, and use. The pear genus—*Pyrus*—probably originated in the mountain regions of what is now western and southwestern China and evolved and spread eastward and westward. Throughout the world, 24 primary species are presently recognized (Table 1). Pear species are not native to North or South America (Rehder 1986), although some species have naturalized here.

The common pear (*P. communis*), which is cultivated for its fruit, probably originated from complex hybridization of wild progenitors, the wild European pear, *P. korschinskyi* (synonym = *P. pyraster*), and *P. communis* var. *caucasica* in the region of the Caucasus Mountains (Westwood 2002). Fruits of the common pear are pyriform, although the fruits of its progenitors tend to be round. The astringent fruits of the snow pear and hybrids between the common pear and the snow pear have been used in Western Europe to produce the fermented cider-like beverage called “perry.”

Pears have been cultivated in Asia for at least 3,000 years (Kikuchi 1946). The fruits of many pears cultivated in Asia tend to be round. Lombard and Westwood (1987) consider that the (Japanese or Chinese) sand pear was the first pear species domesticated for its edible fruit. The Ussuri pear, the other predominant Asian species, has small, round astringent fruits. Natural hybridization between these 2 wild species occurred in central China and selection for large fruited, edible types has been occurring for several thousand years.

Most modern Japanese and Korean pear cultivars are derived from the sand pear. The principle commercial pears in China are derived from 3 species—sand and Ussuri pears and the hybrid species *P. Hbretschneideri*, which is also known as the “Chinese white pear” (Lombard and Westwood 1987; Teng and others 2002). Recent analysis of pear species using DNA markers such as simple sequence repeats (SSR) suggest that the Chinese white pear is closely related to both sand and Ussuri pears (Yamamoto and others 2002) and might be considered as a subspecies of sand pear (Teng and others 2002).

Several Asian species have fruits with the size and shape of a pea. The Japanese and Korean pea pears and the evergreen pear are considered by some to be varieties or subspecies of Callery pear (Rehder 1986; Yu 1979). The birch-leaf pear has the smallest sized fruit of the pea pears.

The common pear has naturalized in the United States (Gill and Pogge 1974). The Ussuri pear, introduced from Asia about 1855, has been grown on the northern Great Plains in

shelterbelt and environmental plantings and in New England. It has contributed genes for cold-hardiness and resistance to fire blight in pear breeding programs (Stushnoff and Garley 1982). Other traits inherent in this species include vigor, dense growth, attractive glossy foliage, and scarlet autumn leaf color. Pear cultivars adapted to warm winter areas have been derived from the Pashia pear of central Asia. The pendulous form of the willow-leaf pear makes it a unique ornamental landscape plant. Flowering ornamental selections of the Callery pear and the evergreen pear are widely planted as street trees in the United States. The use of the evergreen pear is limited to warm-winter areas such as California and the more southerly states. These species are often referred to as “flowering pears” in the urban landscape. The Callery pear has become naturalized in the eastern United States and is now considered a weed in some areas such as the Maryland suburbs of Washington, DC.

Pears are deciduous, rarely evergreen, sometimes thorny trees or shrubs. Their leaves are serrate, crenate, or entire; rarely lobed. The petioles are stipulate and the buds are involute, with imbricate scales.

Flowering and fruiting. Pear species are cross-compatible sexual diploids ($x = 17$). Individual genotypes are generally self-incompatible. The perfect flowers bloom on 2-year or older spurs, between March and April in the Northern Hemisphere and appear before or with the new leaves (table 2). The inflorescence consists of 6 to 8 flowers occurring in umbel-like racemes. Petals are white, or rarely pinkish with reflexed or spreading sepals, 20 to 30 pink, red, or purple anthers, 2 to 5 free styles that are closely constricted at the base, and 2 ovules per locule.

The fruit is a globose or pyriform pome with persistent or deciduous calyx. Most Asian species, with the exception of the Ussuri pear, have deciduous calyxes. The fruit of different species ranges from about 0.5 to 20 cm in length and are quite diverse (figure 1). The extracarpellary tissue, which comprises the bulk of the fruit flesh, may contain sclerenchyma, that is, stone cells. The ground-color of the fruit skin may change from green to yellow or red during maturation, and russeted lenticels may be prominent on some species. Environmental conditions, such as humidity, may cause russetting or browning of the maturing skin. The ripening season for cultivated pears in the Northern Hemisphere ranges from June through December (table 2). Fruit from some species can be eaten directly from the tree, whereas others may require a period of cold storage to ripen or soften the fruit before it can be eaten. Common pears growing wild in Russia are reported to be biennial producers (Al'benskii and Nikitin 1956).

Collection of fruits; extraction and storage of seeds. The mature fruits can be picked from trees or some can be shaken to the ground. Seeds (figure 2) can be recovered by macerating the fruit, drying the pulp, and using a screen to extract the seeds. Small quantities of seeds can also be effectively removed by carefully transversely cutting fruit to expose the locules. Water can also be used to float immature seeds, flesh, and skin away from viable seeds, which sink. Each ripe fruit contains up to 10 smooth black (or nearly black) seeds, each with a thin layer of endosperm (Gill and Pogge 1974). The seeds can then be air-dried. Pear seed characteristics differ greatly by species (figure 3). The small-seeded species—*P. gharbiana*, from N. Africa, and the birch-leaf pear, contain more than 88,000 seeds/kg (40,000/lb). The largest seeded species—Regel, Syrian, and Mamor Mountain pears—contain 11,000 or fewer seeds/kg (5,000 or fewer/lb). The domesticated species contain about 22,000 to 26,000 seeds/kg (10,000 to 12,000/lb) (table 3). Pears are outcrossing species, so seedlings will not be identical to parental

genotypes.

Germination. Seeds of pears extracted from fresh mature fruit in the fall or winter have dormant embryos that require stratification. Species differ in their stratification requirements (table 3). Seed preparation for germination includes a thorough washing and 1 day of water soaking prior to stratification. Seeds must be stratified for 60 to 100 days at about 4 °C. Germination is epigeal (figure 4) and may require from 5 to 30 days at 20 °C (Ellis and others 1985; Macdonald 1986). Because of the long stratification periods required for germination, official seed testing rules (AOSA 1993; ISTA 1993) recommend tetrazolium staining or the excised embryo test. For the excised embryo test, embryos should be germinated for 10 to 14 days at alternating temperatures of 18/22 °C (AOSA 1993).

Nursery practice. Seeds are planted thickly, about 13 mm (½ in) deep in a seedbed, and allowed to grow for 1 season. The following spring, plants are dug, their roots and top are cut back, and they are transplanted to nursery rows. After a second season, the rootstock are of correct size for budding in the fall (Hartmann and others 1990). Seedlings of 1+0 nursery stock can be either field-planted or root-pruned at a depth of 15 to 20 cm (6 to 8 in) and transplanted for 1 year (Gill and Pogge 1974). Common pear seedlings may be subject to powdery mildew, which is caused by *Podosphaera leucotricha* (Ellis & Everh.) E.S. Salmon, and by root rots. Cultivars are propagated by budding or grafting onto rootstocks. Bench-grafting dormant scions onto bareroot rootstocks is no longer common in large-scale nursery production. Nursery trees can be produced more efficiently by T-budding onto field-grown rootstocks in late summer when the bark is “slipping.” Chip-budding is an alternative technique for seasons when the rootstock bark is not slipping (Frecon 1982). A whip-and-tongue graft or cleft-graft is commonly used when top-working growing trees in early spring. Scions can be grafted a few centimeters off the ground on a young rootstock, as in side-grafting, or multiple grafts can be placed higher up onto scaffold branches to convert an older tree over to a different cultivar, that is, top-working.

Seedlings of wild native species are used as rootstocks throughout the world (Lombard and Westwood 1987). In North America, seedlings of commercial cultivars of common pear such as ‘Bartlett’ or ‘Winter Nelis’ are grown for rootstocks. Seedlings of the Callery pear and birch-leaf pear are often used as rootstocks for Asian cultivars. Seedlings of the Ussuri pear may be used as rootstocks where extreme cold hardiness is needed. Pears are potentially graft-compatible with a number of other genera in the Maloideae sub-family, including serviceberry (*Amelanchier*), cotoneaster (*Cotoneaster*), hawthorn (*Crataegus*), apple (*Malus*), medlar (*Mespilus*), squaw-apple (*Peraphyllum*), mountain-ash (*Sorbus*), and others (Lombard and Westwood 1987; Postman 1992). The common quince (*Cydonia oblonga* Mill.) has traditionally been used as a dwarfing rootstock for edible European pears.

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Figure 1—*Pyrus*: diversity in fruits of pear species. [Color photograph]

Figure 2—*Pyrus communis* L.: longitudinal section. [in original manuscript, Fig. 2]

Figure 3—*Pyrus*: seeds of pear species.

Negative #	Species
0	<i>P. mamorensis</i> Trab.
1	<i>P. cossonii</i> Rehd.
4	<i>P. amygdaliformis</i> Vill.
5	<i>P. betulifolia</i> Bunge
6	<i>P. calleryana</i> Decne.
7	<i>P. communis</i> L.
8	<i>P. cordata</i> Desv.
9	<i>P. dimorphophylla</i> Mak.
10	<i>P. elaeagrifolia</i> Pall.
11	<i>P. fauriei</i> Schneid.
12	<i>P. gharbiana</i> Traub.
13	<i>P. koehnii</i> Schneid
14	<i>P. korshinskyi</i> Litv.
15	<i>P. nivalis</i> Jacq.
16	<i>P. pashia</i> D.Don
17	<i>P. pseudopashia</i> Yu
18	<i>P. pyrifolia</i> (Burm.) Nak.
19	<i>P. regelii</i> Rehd.
20	<i>P. salicifolia</i> Poll.
21	<i>P. syriaca</i> Boiss.
22	<i>P. ussuriensis</i> Maxim
23	<i>P. xerophylla</i> Yu

Figure 4—*Pyrus communis*, common pear: seedling development at 1, 2, 3, 6, and 12 days after germination. [in original manuscript, Fig. 3]

Table 1 has been updated in a separate file: pyrus.tbl.wpd

Table 1— *Pyrus*, pear: nomenclature, growth habit, and occurrence

Scientific name	Common name	Growth habit	Range & extensions
<i>amygdaliformis</i> Vill. <i>P. sinaica</i> Dom.-Cours.	almond-leaf pear	Shrub to small tree, 1–2 m	Mediterranean Europe & Asia Minor
<i>P. betulifolia</i> Bunge	birch-leaf pear	Large tree, 5–6 m	Central & N China
<i>P. calleryana</i> Decne.	Callery pear, pea pear, Chinese pea pear	Medium tree, 3–5 m	Central & S China
<i>P. communis</i> L. <i>P. asiae-medicae</i> Popov <i>P. balansae</i> Decne <i>P. boissieriana</i> Buhse <i>P. elata</i> Rubtzov <i>P. medvendevii</i> Rubtzov	common pear, European pear, cultivated pear	Large broad pyramidal tree, 5–6 m	W to SE Europe, Turkey; in world-wide cultivation
<i>P. communis</i> ssp. <i>caucasica</i> (Fed.) Browicz <i>P. caucasica</i> Fed.	Caucasus pear	Large tree, 5–6 m	SE Europe, Greece
<i>P. cordata</i> Desv.	heart-leaf pear,	Shrub to small tree,	SW England, W France, Plymouth pear
<i>P. cossonii</i> Rehder <i>P. longipes</i> Coss, S. Dur.	Algerian pear	Medium tree, 3–4 m	Algeria
<i>P. dimorphophylla</i> Makino <i>P. calleryana</i> var. <i>dimorphophylla</i> (Makino) Koidz	Japanese pea pear	Medium tree, 3–4 m	Japan
<i>P. elaeagnifolia</i> Pall. <i>P. kotschyana</i> Boiss ex Deone	elaegnus-leaf pear	Medium tree, 3–4 m	SE Europe, Russia, & Turkey
<i>P. fauriei</i> C.K. Schneid. <i>P. calleryana</i> var. <i>fauriei</i> (Schneid.) Rehd.	Korean pea pear	Shrub to small tree, 1–2 m	Korea
<i>P. gharbiana</i> Trab.	—	Small tree, 1–2 m	Morocco & W Algeria
<i>P. glabra</i> Boiss.	—	Medium tree, 3–4 m	Iran
<i>P. koehni</i> C.K. Schneid	evergreen pear	Small to medium tree, 1–3 m	Taiwan & SE China
<i>P. korshinskyi</i> Litv. <i>P. pyra</i> ster Burgsd. <i>P. communis</i> var. <i>pyra</i> ster	wild European pear	Tree to 15 m	Afghanistan; W Russia; Central Asia
<i>P. mamorensis</i> Trab.	Mamor Mountain pear	Small tree	Morocco
<i>P. nivalis</i> Jacq.	snow pear, perry pear	Thornless medium tree, 3–4 m	W Central & S Europe

<i>P. pashia</i> Buch.-Ham. ex D.Don <i>P. kumaoni</i> Decne <i>P. varoillosa</i> Wall ex G. Don. <i>P. wilhelmii</i> C. Schneid.	Pashia pear India wild pear	Medium tree, 3–4 m	Pakistan, India, & Nepal
<i>P. pseudopashia</i> T.T. Yu	Kansu pear	Tree	NW China (Yunnan & Guizhou)
<i>P. pyrifolia</i> (Burm.f.) Nakai <i>P. scrotina</i> Rehd.	sand pear, Japanese pear, Chinese pear	Medium to large tree, 3–5 m	China, Japan, Korea, & Taiwan
<i>P. regelii</i> Rehder <i>P. heterophylla</i> Regel G. Schmalh.	Regel pear	Shrub or tree to 1–2 m	S central Asia & Afghanistan
<i>P. salicifolia</i> Poll.	willow-leaf pear	Small tree, 1–2 m	NW Iran, Armenia, Turkey, & S Russia
<i>P. syriaca</i> Boiss.	Syrian pear	Small tree, 1–2 m	Middle East, SW Russia
<i>P. ussuriensis</i> Maxim. <i>P. lindleyi</i> Rehd. <i>P. ovoidea</i> Rehd. <i>P. sinensis</i> Lindley	Ussuri pear Harbin pear Manchurian pear	Small to medium tree, 1–3 m	Siberia, N China, Korea, Mongolia
<i>P. xerophylla</i> T.T. Yu	—	Tree	N China

Sources: LHBH (1976), Bell (1991), Hedrick (1921), Lombard and Westwood (1987), Rehder (1986).

Table 2—*Pyrus*, pear: flowering and fruiting dates*

Species	Bloom season†	Ripening season‡
<i>P. amygdaliformis</i>	M-ML	L
<i>P. betulifolia</i>	M-ML-L	L
<i>P. calleryana</i>	E-EM-M	L
<i>P. communis</i> (wild types)	EM-M-ML	EM-M-ML-L
<i>P. communis</i> (cultivars)	E-EM-M-ML-L	E-EM-M-ML-L
<i>P. cordata</i>	M-ML-L	ML-L
<i>P. cossonii</i>	M-ML-L	M-ML-L
<i>P. dimorphophylla</i>	E-M-ML	L
<i>P. elaeagnifolia</i>	EM-M-ML	ML
<i>P. lauriei</i>	EM-M-ML	ML-L
<i>P. gharbiana</i>	ML	ML
<i>P. glabra</i>	EM	M-ML
<i>P. hondoensis</i>	EM-M-ML	M-ML-L
<i>P. koehnei</i>	E-EM-M-ML	L
<i>P. korshinskyi</i>	EM-M-ML	EM-M-ML-L
<i>P. mamorensis</i>	ML	L
<i>P. nivalis</i>	ML	ML-L
<i>P. pashia</i>	E-EM-M-ML-L	L
<i>P. pyrifolia</i> (wild types)	EM-M	M-ML-L
<i>P. pyrifolia</i> (cultivars)	EM-M-ML	EM-M-ML-L
<i>P. regelii</i>	M-ML	ML
<i>P. salicifolia</i>	EM-M-ML	ML-L
<i>P. syriaca</i>	EM-M	ML-L
<i>P. ussuriensis</i> (wild types)	E-EM	EM-M-M- L
<i>P. ussuriensis</i> (cultivars)	E-EM-M	M-ML-L

* Observations made at the USDA ARS National Clonal Germplasm Repository in Corvallis, OR, 1988 through 1994.

† Average full bloom: E = March 13–March 23, EM = March 24–April 2, M = April 3–April 7, ML = April 8–April 17, L = April 18–April 26.

‡ Average fruit ripening: E = before July 6, EM = July 6–August 8, M = August 9–August 25, ML = August 26–September 28, L = after September 28.

Table 3—*Pyrus*, pear: seed properties

Species	Chilling requirement (days)	Best chilling temp (_C)	Seed size		L/W ratio	Approx. # of seeds	
			Length (mm)	Width (mm)		/kg	/lb
<i>P. amygdaliformis</i>	25–27	7	6.7	4.2	1.60	24,000	11,000
<i>P. betulifolia</i>	55–86	4	4.0	2.3	1.74	90,000	41,000
<i>P. calleryana</i>	30–87	7	5.2	2.6	2.00	55,000	25,000
<i>P. communis</i> spp. <i>caucasica</i>	130	4	7.7	4.2	1.83	40,000	18,000
<i>P. communis</i> (domestic)	90	4	8.4	4.8	1.77	22,000	10,000
<i>P. cordata</i>	—	4	4.6	2.6	1.77	86,000	39,000
<i>P. cossonii</i>	—	—	—	—	—	—	—
<i>P. dimorphophylla</i>	65–88	7	5.2	2.8	1.86	77,000	35,000
<i>P. elaeagnifolia</i>	90–127	4	6.7	4.2	1.6	22,000	10,000
<i>P. fauriei</i>	38–88	7	4.7	2.9	1.62	57,000	26,000
<i>P. gharbiana</i>	60–78	7	4.6	2.4	1.92	99,000	45,000
<i>P. glabra</i>	—	—	—	—	—	—	—
<i>P. koehnii</i>	—	7	4.4	2.4	1.83	79,000	36,000
<i>P. korshinskyi</i>	—	—	—	—	—	—	—
<i>P. mamorensis</i>	50–58	7	8.9	5.9	1.51	11,000	5,000
<i>P. nivalis</i>	110	4	10.0	4.3	2.32	18,000	8,000
<i>P. pashia</i>	15–43	10	6.5	3.1	2.10	55,000	25,000
<i>P. pseudopashia</i>	—	—	—	—	—	—	—
<i>P. pyrifolia</i>	120–170	4	8.7	4.4	1.98	26,000	12,000
<i>P. regelii</i>	—	—	11.3	7.6	1.49	7,000	3,000
<i>P. salicifolia</i>	—	4	7.2	4.6	1.59	24,000	11,000
<i>P. syriaca</i>	—	7	9.3	6.2	1.50	9,000	4,000
<i>P. ussuriensis</i>	100	7	7.4	4.5	1.64	20,000	9,000
<i>P. xerophylla</i>	—	—	—	—	—	—	—

Sources: Gill and Pogge (1974), Lombard and Westwood (1987), Rudolph (1949), Swingle (1939), Westwood and Bjornstad (1968), Yerkes (1930), Young and Young (1992).

— indicates that no data were available.

Table 2—*Pyrus*, pear: flowering and fruiting dates*

	Bloom season†	Ripening season‡	Species
	M-ML	L	<i>P. amygdaliformis</i>
	M-ML-L	L	<i>P. betulifolia</i>
	E-EM-M	L	<i>P. calleryana</i>
	EM-M-ML	EM-M-ML-L	<i>P. communis</i> wild types
	E-EM-M-ML-L	E-EM-M-ML-L	<i>P. communis</i> cultivars
	M-ML-L	ML-L	<i>P. cordata</i>
	M-ML-L	M-ML-L	<i>P. cossonii</i>
	E-M-ML	L	<i>P. dimorphophylla</i>
	EM-M-ML	ML	<i>P. elaeagnifolia</i>
	EM-M-ML	ML-L	<i>P. lauriei</i>
	ML	ML	<i>P. gharbiana</i>
	EM	M-ML	<i>P. glabra</i>
	EM-M-ML	M-ML-L	<i>P. hondoensis</i>
	E-EM-M-ML	L	<i>P. koehnei</i>
	EM-M-ML	EM-M-ML-L	<i>P. korshinskyi</i>
	ML	L	<i>P. mamorensis</i>
	ML	ML-L	<i>P. nivalis</i>
	E-EM-M-ML-L	L	<i>P. pashia</i>
	EM-M	M-ML-L	<i>P. pyrifolia</i> wild types
	EM-M-ML	EM-M-ML-L	<i>P. pyrifolia</i> cultivars
	M-ML	ML	<i>P. regelii</i>
	EM-M-ML	ML-L	<i>P. salicifolia</i>
	EM-M	ML-L	<i>P. syriaca</i>
	E-EM	EM-M-M-L	<i>P. ussuriensis</i> wild types
	E-EM-M	M-ML-L	<i>P. ussuriensis</i> cultivars

* Observations made at the USDA ARS National Clonal Germplasm Repository in Corvallis, OR, 1988 through 1994.

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<i>P. cordata</i>	ND	4	4.6	2.6	1.77	86,000	39,000
<i>P. dimorphophylla</i>	65–88	7	5.2	2.8	1.86	77,000	35,000
<i>P. elaeagnifolia</i>	90–127	4	6.7	4.2	1.6	22,000	10,000
<i>P. lauriei</i>	38–88	7	4.7	2.9	1.62	57,000	26,000
<i>P. gharbiana</i>	60–78	7	4.6	2.4	1.92	99,000	45,000
<i>P. koehni</i>	ND	7	4.4	2.4	1.83	79,000	36,000
<i>P. mamorensis</i>	50–58	7	8.9	5.9	1.51	11,000	5,000
<i>P. nivalis</i>	110	4	10.0	4.3	2.32	18,000	8,000
<i>P. pashia</i>	15–43	10	6.5	3.1	2.10	55,000	25,000
<i>P. pyrifolia</i>	120–170	4	8.7	4.4	1.98	26,000	12,000
<i>P. regelii</i>	ND	ND	11.3	7.6	1.49	7,000	3,000
<i>P. salicifolia</i>	ND	4	7.2	4.6	1.59	24,000	11,000
<i>P. syriaca</i>	ND	7	9.3	6.2	1.50	9,000	4,000
<i>P. ussuriensis</i>	100	7	7.4	4.5	1.64	20,000	9,000

Sources:

Gill and Pogge (1974), Lombard and Westwood (1987), Rudolph (1949), Swingle (1939), Westwood and Bjornstad (1968), Yerkes (1930), Young and Young (1992).

ND = no data available.