Rosaceae—Rose family

Rosa L.

rose, briar

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Growth habit, occurrence, and uses. The genus *Rosa* is found primarily in the North Temperate Zone and includes about 200 species, with perhaps 20 that are native to the United States (table 1). Another 12 to 15 rose species have been introduced for horticultural purposes and are naturalized to varying degrees. The nomenclature of the genus is in a state of flux, making it difficult to number the species with precision. The roses are erect, clambering, or climbing shrubs with alternate, stipulate, pinnately compound leaves that have serrate leaflets. The plants are usually armed with prickles or thorns. Many species are capable of clonal growth from underground rootstocks and tend to form thickets. Usually found in the more moist but sunny parts of the landscape, wild roses provide valuable cover and food for wildlife, especially the birds and mammals that eat their hips and act as seed dispersers (Gill and Pogge 1974). Wild roses are also utilized as browse by many wild and domestic ungulates. Rose hips are an excellent source of vitamin C and may also be consumed by humans (Densmore and Zasada 1977). Rose oil extracted from the fragrant petals is an important constituent of perfume. The principal use of roses has clearly been in ornamental horticulture, and most of the species treated here have been in cultivation for many years (Gill and Pogge 1974).

Many roses are pioneer species that colonize disturbances naturally. The thicket-forming species especially have potential for watershed stabilization and reclamation of disturbed sites. If roses are to be used for these purposes, it is greatly preferable to utilize species native to the region rather than exotics, which can become serious pests. An

Table 1—*Rosa,* rose: scientific names and geographic distribution for 12 species native or naturalized in the United States

Scientific name	Common name(s)	Geographic distribution
***R. acicularis* Lindl.**	**prickly rose**	Circumboreal, S in North America to Utah, New Mexico, Nebraska, & New York
***R. blanda* Ait.**	**meadow rose,** smooth rose	E North America, S to Missouri & Nebraska
***R. californica* Cham. & Schlecht.**	**California rose**	S Oregon, S to Baja California
***R. canina* L.**	**dog rose**	Introduced from Europe; locally escaping in E North America
***R. eglanteria* L.**	**sweetbriar rose,** eglantine	Introduced from Europe; naturalized in the Pacific NW & in E North America
***R. gymnocarpa* Nutt.**	**baldhip rose,** dwarf rose	Pacific NW S to central California & E to Montana & Idaho
***R. multiflora* Thunb. ex Murr.**	**multiflora rose,** Japanese rose	Introduced from Japan; widely naturalized in E North America
***R. nutkana* K. Presl.**	**Nootka rose**	Alaska S to California, Utah, & Colorado
***R. rugosa* Thunb.**	**rugosa rose,** hedgerow rose	Introduced from E Asia; naturalized in E & mid-W North America
***R. setigera* Michx.**	**prairie rose,** climbing rose	Mid-W United States S to Texas; naturalized in E North America
***R. wichuraiana* Crépin.**	**wichura rose,** memorial rose	Introduced from E Asia; locally escaping in E North America
***R. woodsii* Lindl.**	**Woods rose**	Widely distributed in W & mid-W North America

Source: Gill and Pogge (1974).

example is the multiflora rose, a Japanese species that was widely promoted as a "living fence" in a previous era (Anderson and Edminster 1954). It has invaded thousands of acres of unimproved pastureland in the eastern United States and is now the target of a large and expensive control program (Mays and Kok 1988).

Flowering and fruiting. The large, perfect flowers are usually borne singly or in groups of 2 or 3, though some species (for example, wichura, multiflora, and prairie roses) have flat-topped inflorescences with few to many flowers. The flowers generally appear in late spring or early summer and are insect-pollinated. They are perigynous, with the 5 sepals, 5 to many petals, and many stamens inserted on the edge of the hypanthium and the many pistils borne within its cup. In fruit, the hypanthium enlarges to become the fleshy, berrylike hip (figure 1), and the pistils become single-seeded achenes (figures 2 and 3). The achene wall is usually hard, bony, and resistant to damage.

The fruits may ripen from late summer to fall, but they usually persist on the plants through the winter, presumably as an enticement to dispersers. The hips are often brightly colored in hues of orange, red, and purple that are attractive to birds. Those that have not been taken by spring are pushed off by the newly developing flowers of the next season. Once on the ground, the hips disintegrate quickly.

Figure 1—*Rosa*, rose: fruits (hips) of *R. eglanteria*, sweetbriar rose (**top**); *R. multiflora*, multiflora rose (**bottom left**); *R. nutkana*, Nootka rose (**bottom center**); and *R. setigera*, prairie rose (**bottom right**).

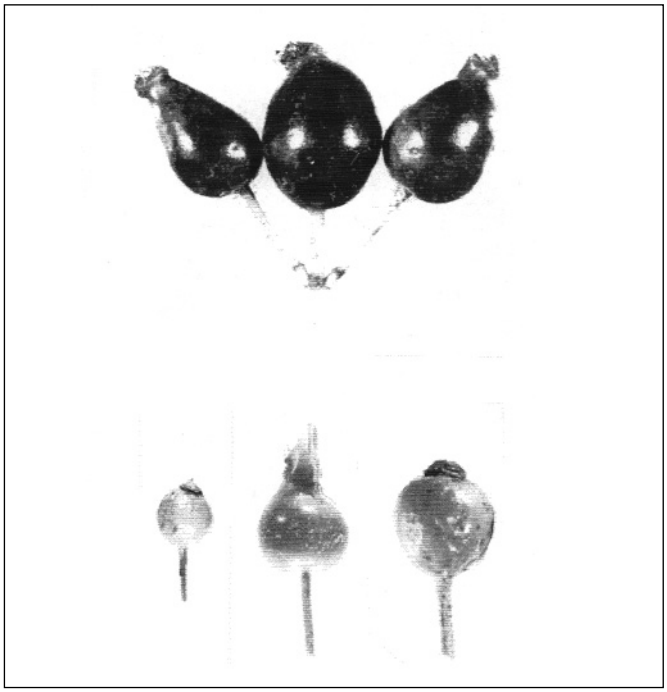
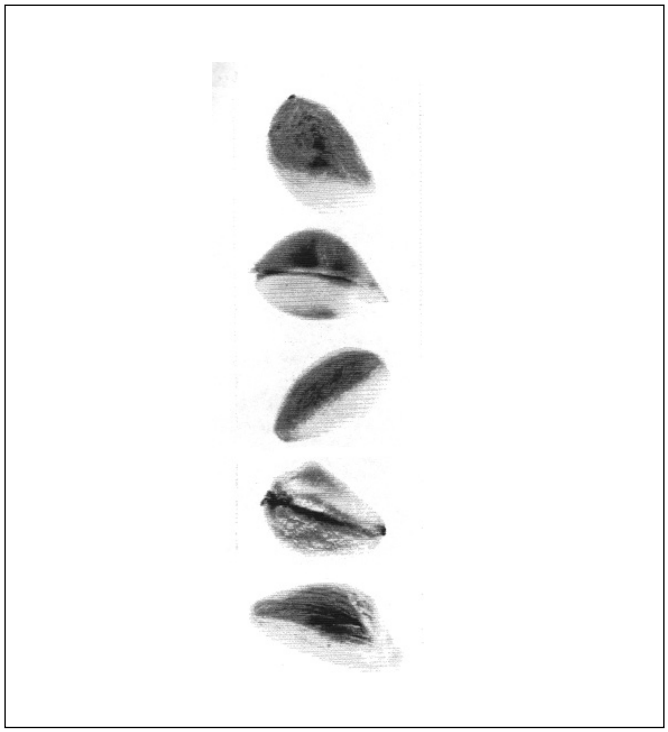


Figure 2—*Rosa*, rose: seeds (achenes) of *R. eglanteria*, sweetbriar rose (**top**); *R. gymnocarpa*, baldhip rose (**second**); *R. multiflora*, multiflora rose (**third**); *R. nutkana*, Nootka rose (**fourth**); and *R. setigera,* prairie rose (**bottom**).



Chalcid wasps of the genus *Megastigmus* (Torymidae) are important predispersal consumers of rose seeds (Mays and Kok 1988; Nalepa 1989). These wasps emerge as adults in spring and oviposit through the hip wall into the ovules of newly developing achenes. Their larvae develop by consuming the seeds over the summer, overwinter as late-instar larvae, pupate in early spring, and emerge as adults in time to repeat the life cycle. Chalcid infestations of 50 to 60% are common (Semeniuk and Stewart 1964; Svejda 1968) and infestations as high as 90% have been reported (Nalepa 1989). Achenes containing chalcid larvae appear normal in size and density and cannot be distinguished by inspection from viable achenes. The native chalcid *M. nigrovariegatus* Ashmead and the light form of the introduced rose seed chalcid *(M. aculeatus* Hoffmeyer) attack most if not all species of rose, whereas the dark form is apparently specific to multiflora rose and is being utilized in biocontrol programs (Mays and Kok 1988; Nalepa 1989).

Seed collection, cleaning, and storage. Rose hips may be collected by hand-stripping or by beating them into containers any time after the seeds are fully ripe. Ripeness is signaled by a change in the color of the hips from green to orange, red, or purple. If not processed right away, the hips

should either be refrigerated or spread out to dry, as otherwise they can overheat and the seeds become damaged. The hips should be soaked in water if they have been allowed to dry prior to processing, then macerated using a macerator or similar device. Small lots can be macerated by rubbing the hips through screens. The achenes may be separated from the pulp by flotation or the material may be dried and the achenes cleaned out using a fanning mill. Achene weights vary from 5 to 17 mg (1.8^{-4} to 6.0^{-4} oz) and they number 59,530 to 185,220/kg (27,000 to 84,000/lb), depending on species and seedlot (table 2). Rose seeds may have a limited storage life, with some loss of viability in laboratory or warehouse dry storage after as little as 2 to 3 years (Crocker and Barton 1931; Gill and Pogge 1974), but they are almost certainly orthodox in storage behavior. Seeds of Woods rose have been reported to retain viability in open warehouse storage for 15 years (Stevens and others 1981). Sealed storage of air-dried seeds at low temperature is recommended (Gill and Pogge 1974).

Germination and seed testing. Rose seeds are normally dormant at maturity and require some form of pretreatment in order to germinate. Release from dormancy is a complex process that may involve changes at the pericarp, testa, and embryo levels. The degree of dormancy and the principal level of dormancy control varies among species, cultivars, seedlots, and even among hips within a single bush. Because the achenes have a thick, hard pericarp and do not swell when placed in water, it is often assumed that they are water-impermeable. Work by Svejda (1972) and others has shown that this is not the case. The achenes do take up water, although the mechanical restriction presented by the pericarp can sometimes prevent full imbibition. Tincker and Wisley (1935) showed, for 10 rose species, that cracking the pericarp alone did not remove dormancy. The importance of including treatments that weaken the pericarp in efforts to remove rose seed dormancy depends on the species and the particular lot. In nursery propagation of the rootstock rose *R. dumetorum* (*R. corymbifera*) 'Laxa', sulfuric acid treatment before warm plus cold stratification improves germination (Roberts and Shardlow 1979). The acid scarification can be eliminated and the warm stratification period shortened if the achenes are warm-stratified with compost activator (Cullum and others 1990). The role of these treatments is apparently to weaken the pericarp along

Figure 3—*Rosa setigera*, prairie rose: longitudinal section through a seed.

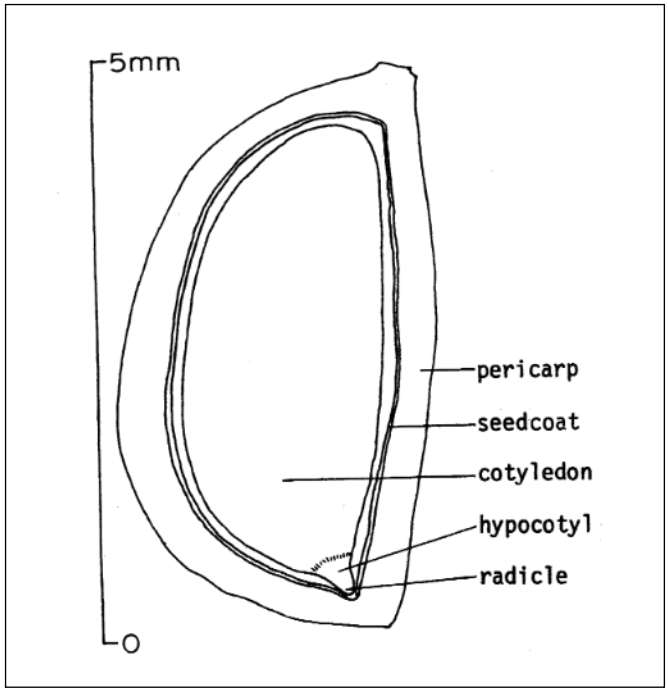


Table 2—*Rosa,* rose: achene weight data

Species	Mean weight		Achenes/weight	
	mg	oz	/kg	/lb
R. acicularis	25–28	0.9–1.0	35,940–40,130	16,300–18,200
R. blanda	9–12	0.3–0.4	81,580–116,860	37,000–53,000
R. californica	4	0.1	224,910	102,000
R. canina	13 (8–17)	0.5 (0.3–0.6)	59,530–119,070	27,000–54,000
R. eglanteria	15	0.5	68,355	31,000
R. gymnocarpa	16	0.6	61,740	28,000
R. multiflora	6–9	0.2–0.3	110,250–180,810	50,000–82,000
R. nutkana	8–15	0.3–0.5	66,150–132,300	30,000–60,000
R. rugosa	6–9	0.2–0.3	114,660–163,170	52,000–74,000
R. setigera	9	0.3	110,250	50,000
R. wichuriana	5	0.2	185,220	84,000
R. woodsii	9 (7–13)	0.3 (0.2–0.5)	77,170–143,320	35,000–65,000

Sources: Belcher (1985), Gill and Pogge (1974), Mirov and Kraebel (1939).

the sutures, whether with acid or through microbial digestion. Responsiveness to warm plus cold stratification can also be increased in *R. dumetorum* 'Laxa' by vacuum-infiltrating the achenes with growth hormones such as gibberellic acid or benzyladenine (Foster and Wright 1983), which suggests that something other than simple mechanical restriction may be involved. Similarly, in the relatively nondormant multiflora rose, the achenes may be induced to germinate without chilling either by treatment with macerating enzymes that weaken pericarp sutures or by leaching with activated charcoal to remove inhibitors from the incubation solution (Yambe and Takeno 1992; Yambe and others 1992). By using macerating enzymes to remove dormancy, these workers were able to demonstrate a phytochrome-mediated light requirement for germination in this species (Yambe and others 1995). Acid scarification (but not mechanical scarification) is reported to substitute for warm pretreatment in the cultivated rose *R. gallica* L. (Svejda 1968).

Chilling is the treatment most often applied to remove rose seed dormancy, and the achenes of most species will germinate eventually if chilled for long enough periods. For some species, periods of cold stratification corresponding to a single winter in the field are sufficient, as in prairie, multiflora, and wichura roses (table 3). Achenes of these species may show increased dormancy if the chilling period is preceded or interrupted by periods of incubation at warmer temperatures (Semeniuk and Stewart 1962; Stewart and Semeniuk 1965). Interruption of chilling with warm incubation resulted in secondary dormancy induction only if the temperature of warm incubation was too high. If the seeds were held below this 'compensating' temperature, no change in dormancy resulted, and the seeds could accumulate the effects of chilling across warm interruptions. Seeds whose chilling requirements had just barely been met germinated best at relatively low incubation temperatures, whereas those that had been in chilling for longer than necessary either eventually germinated in chilling or could germinate at a wide range of temperatures, including those above the compensating temperature. Semeniuk and others (1963) showed that, for prairie rose, the effect of the warm pretreatment

Table 3—*Rosa*, rose: stratification requirements

Species	Warm stratification		Cold stratification		Germination temp (°C)	Incubation (%)
	Days	Temp (°C)	Days	Temp (°C)		
R. acicularis	—	—	365	5	5	57*
	118	25	90	5	20, 10/20	90*
R. blanda	—	—	90	5	13, 18	7†
	—	—	270	5	13, 18	53†
R. californica	—	—	90	5	—	62
R. canina	60	20	60	4	—	47
	90	20	150	4	—	34
R. eglanteria	—	—	570	5	5	24
	—	—	450	5	5	40
R. gymnocarpa	—	—	90	5	—	43
R. multiflora	—	—	90	5	15–18	45
	—	—	180	5	15–18	60
	—	—	120	5	5	72
R. nutkana	—	—	365	4.5	4.5	65
	—	—	128	4.5	18.5	48
	128	18.5	128	4.5	18.5	72
R. rugosa	—	—	90	3	20–29	32
	60	20	90	3	20–29	60
	—	—	210	4	20	85
R. setigera	—	—	120	5	15–18	90
	—	—	90	4.4	18.3	48
R. wichuriana	—	—	60	5	15–18	75
	—	—	45	5	18.3	76
R. woodsii	—	—	120	3	—	0
	60	20	90	3	—	49

Sources: Crocker and Barton (1931), Densmore and Zasada (1977), Gill and Pogge (1974), McTavish (1986), Mirov and Kraebel (1939), Rowley (1956), Semeniuk and Stewart (1962, 1964, 1966), Stewart and Semeniuk (1965), Svejda (1968), Tillberg (1983), Tinker and Wisley (1935).

* Based on total viable seeds.

† Total viability known to be about 55%; all other percentages based on total seeds, viability unknown.

above the compensating temperature was to induce secondary dormancy at the embryo level. Interestingly, this dormancy could be alleviated only by chilling whole achenes; chilling the embryos did not alleviate their dormancy.

Other species, such as prickly, Nootka, and Woods roses, show much increased germination percentages in response to chilling periods corresponding to a single winter if the chilling period is preceded by a period of warm incubation (table 3). This requirement for warm incubation before chilling would effectively postpone seedling emergence in the field until the second spring after seed production (Densmore and Zasada 1977). The temperature and duration of the warm treatment is sometimes important. In rugosa rose, a warm pretreatment of 60 days at 20 °C before 90 days of chilling at 3 °C increased germination over chilling alone, but longer periods resulted in decreased germination (Svejda 1968). The effect of warm pretreatment on chilling response has been formally documented for only a few rose species, but it is likely that high-viability lots of any species that show minimal germination after 6 months of chilling would be benefitted by a warm pretreatment.

Exactly what changes take place in rose seeds during warm pretreatment or chilling is not known. In many cases, the warm pretreatment seems to have effects at the seed level rather than simply providing an opportunity for pericarp weakening (Densmore and Zasada 1977). Hormonal balance has been implicated in the imposition of dormancy in rose seeds by several workers. Substances leached from dormant rose achenes or obtained from them by grinding have been shown to suppress germination of otherwise non-dormant excised rose embryos (Jackson and Blundell 1963, 1965; Svejda and Poapst 1972). Excised seeds with physically disrupted testas showed much lower germination than embryos with testas removed, suggesting that inhibitors leaching from the testa suppressed germination (Jackson and Blundell 1963). Other workers have shown that, although inhibitory substances are present in dormant achenes and may disappear during dormancy loss, their removal alone is not sufficient to induce germination (Julin-Tegelman 1983; Tillberg 1983).

Variation in dormancy-breaking requirements both within and among lots of any rose species make it difficult to predict effective treatments. One of the causes of this variation has been quite well-studied in cultivated tea roses, and the results probably apply to wild species as well. Von Abrams and Hand (1956) were the first to demonstrate that seeds of a given cultivar matured in the field at warmer temperatures were less dormant (that is, had a shorter chilling requirement) than seeds matured at cooler temperatures. This result has been confirmed by De Vries and Dubois (1987), who also found that warmer maturation temperatures were associated with higher hip set and higher numbers of achenes per hip. Gudin and others (1990) examined the relationship of maturation temperature with developmental rate, endocarp thickness, and dormancy status. They also looked at the effect of the pollen parent in controlled crosses. They found that achenes matured at cooler spring temperatures had slower development, thicker endocarps, and higher levels of dormancy than those matured at warmer summer temperatures. Pollen parent also had an effect on both dormancy and endocarp thickness, presumably through its effect on developmental rate. These workers concluded that the higher dormancy associated with lower maturation temperature was mediated through endocarp thickness, but slow development could also have effects at the testa or embryo level. For example, Jackson and Blundell (1963) reported that excised embryos of rugosa rose grown in Wales were non-dormant, whereas Svejda (1972) and Julin-Tegelman (1983), working with lots grown in Canada and Sweden, reported that excised embryos of this species required 3 to 4 weeks of chilling to become germinable.

Another source of variation in dormancy status for rose achenes is a consequence of the post-maturation environment. Semeniuk and Stewart (1960, 1966) showed for several species that achenes from hips that had overwintered on the bush were more dormant than achenes from those same bushes collected and tested in the fall or stored dry and tested along with the field-overwintered achenes. This effect has also been noted by other workers (Jackson and Blundell 1963; Roberts and Shardlow 1979). It is probably best to collect rose hips soon after they reach maturity and to clean the collections immediately if seed dormancy status is an issue.

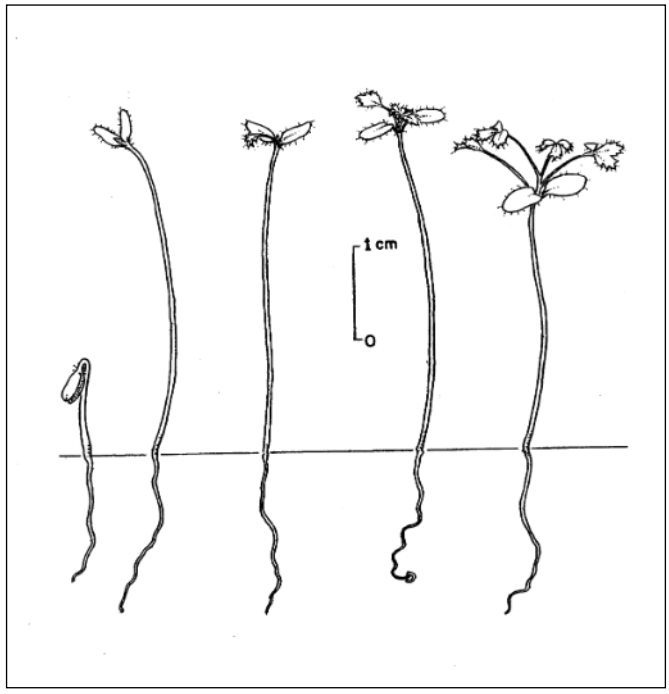
Because of the wide variation in dormancy-breaking requirements within each species, quality evaluations of rose seeds are usually carried out using tetrazolium staining (Gill and Pogge 1974). The achenes are first soaked in water for 24 hours. Firm pressure with a knife on the suture or a tap with a small hammer is used to split open the pericarp. The testa is then scratched or clipped at the cotyledon end and the seed is immersed in 1% tetrazolium chloride for 6 hours at room temperature. The testa is slit along the side and the embryo, which fills the seed cavity, is squeezed or teased out for evaluation (Belcher 1985). The excised embryo method may also be used, although it has little advantage over tetrazolium staining (Gill and Pogge 1974). For purposes of determining fill and chalcid infestation levels, x-radiography is suitable (Belcher 1985).

The preferred method in official testing is also tetrazolium staining (ISTA 1993), although stratification for 28 days at 3 to 5 °C is suggested for multiflora rose (AOSA 1993). For other rose species, the international rules (ISTA 1993) suggest an alternate method of 12 months of stratification, followed by germination in sand at 20 °C for 70 days. Germination is epigeal (figure 4).

Field seeding and nursery practice. Woods rose has been fall-seeded as a part of mixes for revegetation of deer winter ranges in pinyon-juniper and mountain brush communities of the Intermountain West (Plummer and others 1968). It is recommended for areas with more than 300 mm of annual precipitation, and should be broadcast-seeded or drilled with other small-seeded shrubs at rates of 0.5 to 1 kg/ha (0.45 to 0.9 lb/ac). It reportedly is relatively easy to establish from seeds and persists very well after initial establishment. Other native rose species could probably also be direct-seeded successfully in wildland settings.

Planting rose seeds in a nursery setting may be carried out in fall for outdoor cold stratification or in summer for warm followed by cold stratification. Seedlings will emerge the following spring. For spring plantings, the achenes must be appropriately stratified or otherwise pretreated prior to planting. Recommended planting depth is 5 to 10 mm (1/5 to 2/5 in), depending on seed size. Bareroot plants may be produced successfully as 1+0 stock, and container stock can be produced by 3 to 5 months after germination (Landis and Simonich 1984; Shaw 1984). Roses are also readily propagated from cuttings.

Figure 4—*Rosa blanda*, meadow rose: seedling development at 1, 3, 6, 26, and 41 days after germination.



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