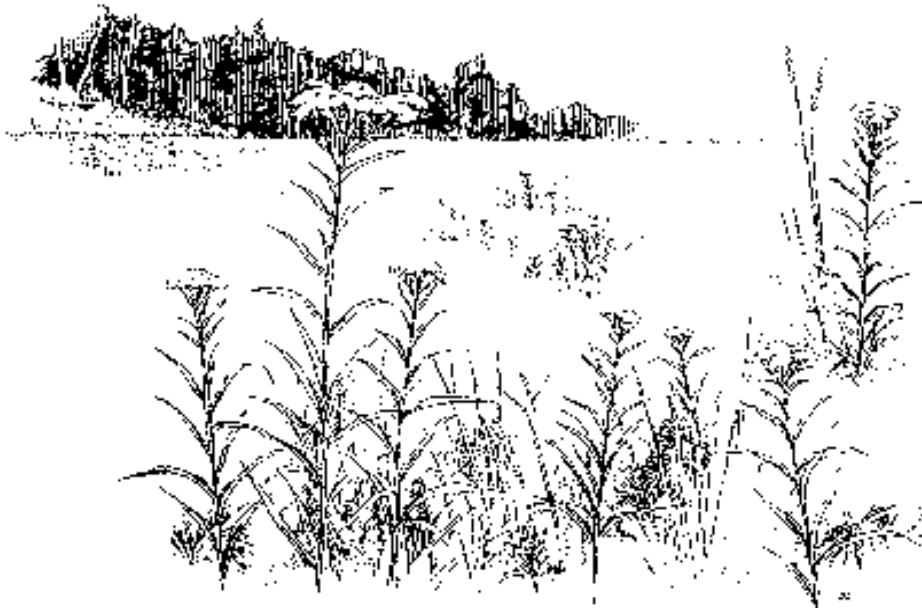


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Five years of following the western prairie fringed orchid (*Platanthera praeclara*) on the Sheyenne National Grassland, North Dakota

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Abstract:

The western prairie fringed orchid (*Platanthera praeclara*) is a federally listed threatened plant species in the United States that is now restricted to isolated tallgrass prairie tracts. In 1987, 160 orchids were permanently marked on 5 sites subjected to variety of burning and grazing regimes on the Sheyenne National Grassland, in southeastern North Dakota. The number of orchids displaying aboveground growth declined each year from 1988 through 1991. By 1991, only 11% of the original plants were visible, the remainder were assumed to be dormant or dead. Recruitment data collected beginning in 1990 indicated that new orchids were present in the swales in spite of droughty conditions. There were no consistent trends in orchid numbers or densities among sites. Vegetative composition in the swales was dominated by Kentucky bluegrass (*Poa pretensis*) and the invasion of these sandy soils by a noxious weed, leafy spurge (*Euphorbia esula*). Future management efforts will likely focus on the task of reducing leafy spurge without harming the orchid. Until these efforts are successful, concern about the effect of burning and grazing on orchid populations diminishes in importance.

Introduction

The western prairie fringed orchid (*Platanthera praeclara*) is a federally listed threatened plant species in the United States (U.S. Fish and Wildlife Service 1989). Once distributed throughout much of the tallgrass prairie west of the Mississippi River in the central United States and southern Canada, its current populations are restricted to isolated prairie tracts. The three largest known populations of the western prairie fringed orchid occur in Minnesota and North Dakota in the United States (Sheviak and Bowles 1986) and in southern Manitoba in Canada (Catling and Brownell 1987).

The prairie-fringed orchid is a perennial, herbaceous plant arising from a fusiform tuber. Inflorescences are large and showy, with up to 20 or more cream-colored flowers arranged on a spike; plants may reach up to 75 cm in height (Sheviak and Bowles 1986). The western prairie fringed orchid usually occurs in mesic swales or draws in tallgrass

prairie. Soils are generally Mollisols. Associated plant species include big and little bluestem (*Andropogon gerardii* and *A. scoparius*), several species of sedges (*Carex* spp.), switchgrass (*Panicum virgatum*), and prairie sandreed, (*Calamovilfa longifolia*) (Bowles and Duxbury 1986).

Historically, the tallgrass prairie evolved with periodic fires and bison grazing. Current management activities in orchid habitat include prescribed burning and cattle grazing. On the Sheyenne National Grassland, in addition to burning and cattle grazing, some swales where orchids occur are mowed to enhance cattle use of the vegetation. This research was initiated to provide preliminary data on the life history and habitat of the western prairie fringed orchid in a variety of pastures on the Sheyenne National Grassland.

Study area

The study was conducted in the Sheyenne National Grassland, in southeastern North Dakota. The National Grassland encompasses approximately 27,244 ha, and is managed by the United States Forest Service. Between 1984-1985, approximately 2,000 western prairie fringed orchids were observed on the National Grassland (Bowles and Duxbury 1986). The plants occur both as isolated individuals and as indistinct subpopulations in lowland depressions. A layer of nearly impervious lake sediments is responsible for the relatively high water table in the swales.

Plant species characteristic of the tallgrass prairie, including big bluestem and little bluestem, occur throughout the study area. Woolly sedge (*Carex lanuginosa*), baltic rush (*Juncus balticus*) and northern reed grass (*Calamagrostis inexpansa*) are common in lowland depressions (Manske 1980). Mixed-grass prairie species such as blue grama (*Bouteloua gracilis*), needle-and-thread grass (*Stipa comata*), sun sedge (*C. heliophila*), and prairie sandreed grow on uplands.

The Sheyenne National Grassland receives an average precipitation of 49.7 cm, 80% of which occurs between April and September (U.S. Dept. Commerce 1973). Precipitation on the study area was above average in 1986, below average in 1987, 1989, and 1990, and slightly above average in 1988 and 1991 (Fig. 1). Sediments deposited in glacial Lake Agassiz constitute the largest portion of the parent materials in the area. Mollisols are the most prevalent soils; Entisols occur in some swales (U.S. Soil Conservation Service 1975).

Methods

In 1987, 16 belt transects were established on 5 separate study sites in areas of orchid concentrations (Bjugstad and Fortune 1989). The 5 study sites included: 1) Olerude; 2) A-Annex; 3) Railroad; 4) Penberthy enclosure; and 5) Penberthy. These sites occur in a core area of the orchid metapopulation on the Sheyenne National Grassland (Fig. 2). Olerude is part of a four-pasture allotment that is grazed by cattle two times during the growing season; some of the swales are mowed. A-Annex is grazed by cattle throughout the growing season. Transects on the Railroad site are not grazed. Both the Penberthy

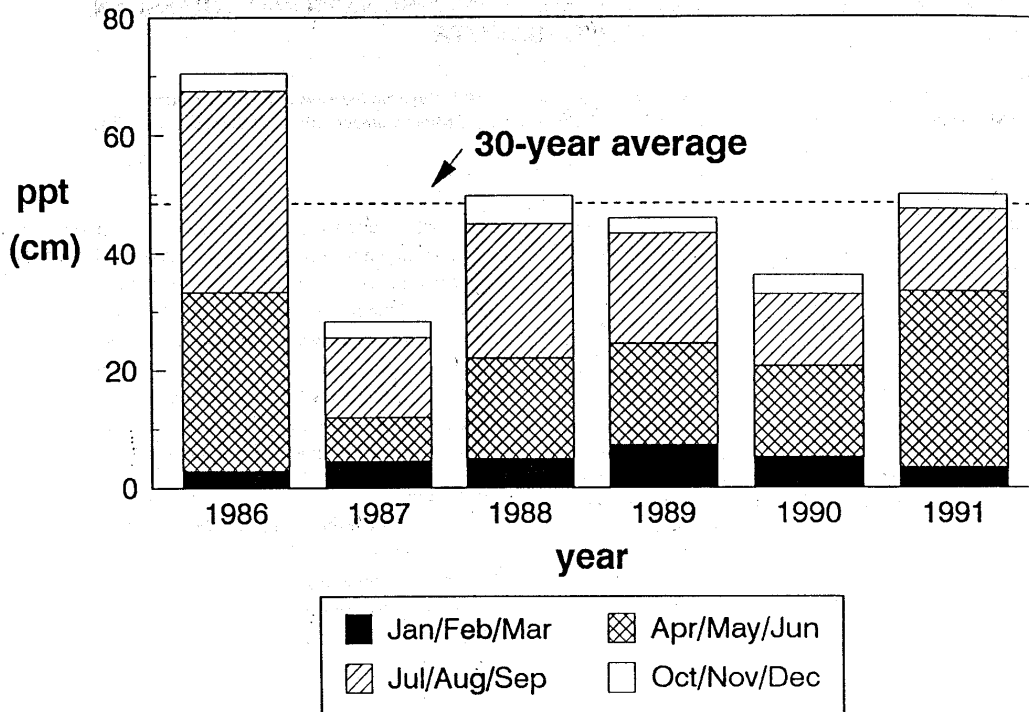


Figure 1. Annual precipitation 1986-1991, showing seasonal distribution, and 30-year average annual precipitation for McLeod, North Dakota, 8 km south of the Sheyenne National Grassland.

sites were prescribed burned in the spring of 1989; the exclosure transects are not grazed, and the other Penberthy transects are part of a three-pasture allotment that are grazed twice by cattle during the growing season. The belt transects were 30 to 80 m long and 10 m wide. Locations of 10 orchids on each transect were permanently marked in 1987 with plastic-coated steel pins 5 dm from the plant. The 160 orchids were resurveyed each year during flowering (last week in June through the middle of July) from 1988 through 1991. Beginning in 1990, new orchids were marked in addition to the ten orchids originally marked on each transect in 1987.

Plant canopy cover was estimated in 1991 following Daubenmire (1959) in 20- by 50-cm quadrats on each site by 6 cover classes (1 = <5 %, 2 = 6 - 25%, 3 = 26-50%, 4 = 51 - 75%, 5 = 76 - 95%, and 6 = 96 - 100%). A total of 30 to 50 quadrats were examined along the centerline of each belt transect. Variables estimated included total plant canopy cover, litter, bare ground, total shrub cover, forb cover, grass cover, and cover by individual plant species.

Soil chemical analyses were conducted in 1988. One soil sample was taken within 15 cm of each permanently marked orchid to a depth of approximately 20 cm. The 10 samples on each swale were composited into 5 samples. Analyses included particle size distribution (Day 1965), percentage organic matter (Prince 1955), pH (McLean 1982), and calcium (Lanyon and Heald 1982).

Statistical analyses

Differences in numbers of marked orchids among sites over the five years and in total orchid densities among sites in 1990 and 1991 were analyzed by repeated measures analysis of variance (Norusis 1990). Normality was tested by plotting residuals, and homogeneity of variances was tested using Mauchly's test of sphericity; variances were homogeneous ($P > 0.1$).

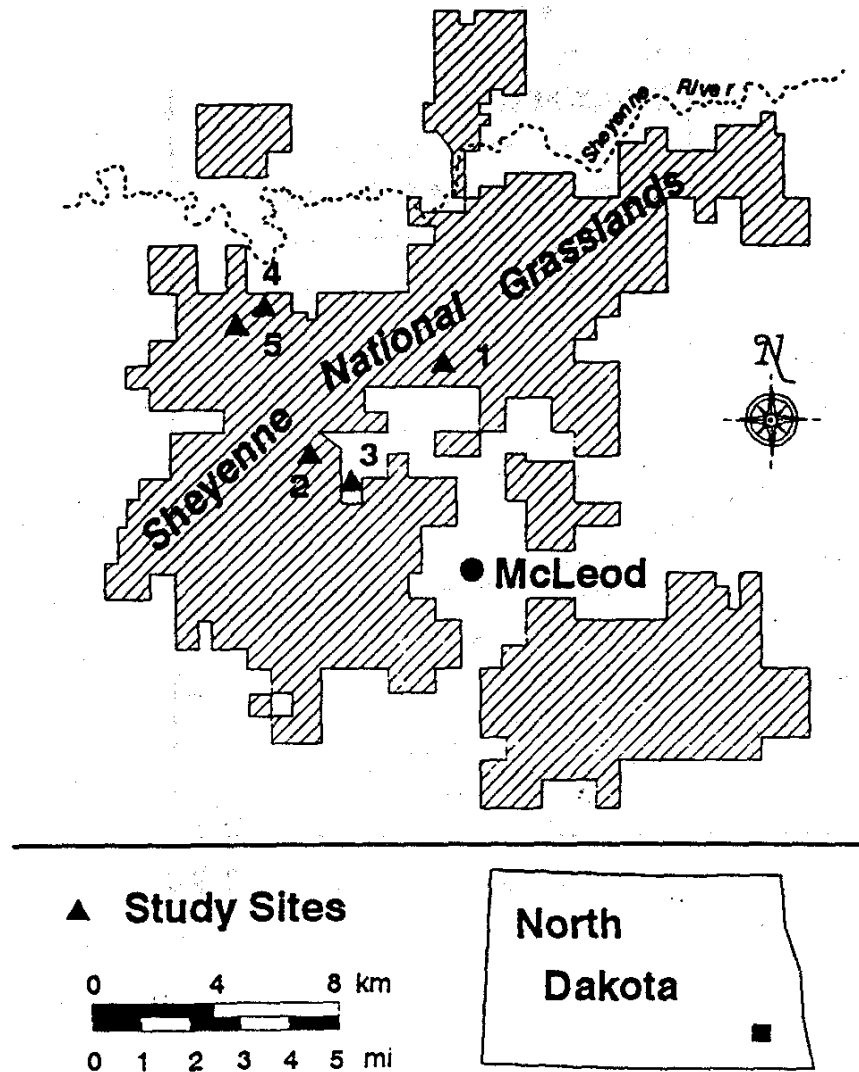


Figure 2. Map of the study area on the Sheyenne National Grassland, in southeastern North Dakota, showing the five study sites: 1) Olerude, 2) A-Annex, 3) Railroad, 4) Penberthy enclosure, and 5) Penberthy.

Results

The number of orchids originally marked in 1987 that reappeared in subsequent years declined significantly ($F = 149.14$, $df = 4$, $P = 0.0001$). By 1991, only 18 of the original plants were observed (Fig. 3). On seven of the transects, none of the original orchids reappeared in 1991. However, the number of orchids reappearing each year did not differ ($P = 0.27$) among sites, and the significant ($P = 0.01$) site X year interaction indicated that none of the sites had consistently higher or lower numbers of marked orchids compared to other sites. For example, in 1988, 75% of the marked orchids were relocated on A-Annex; on the Railroad site 65% were observed (Fig. 2). Yet, in 1990, only 5% of the original orchids were observed on A-Annex and Railroad sites, compared to 27% and 25% that were observed on the Penberthy enclosure and on Olerude site, respectively.

The data collected on new orchids beginning in 1990 indicated that most transects had at least one orchid. Up to nine new orchids per transect were observed in 1990; up to 14 new orchids were observed on one transect in 1991. Average orchid density on the 16 transects was 1.1 and 1.2 plants/100m² in 1990 and 1992, respectively. The highest density observed in 1990 was 2.4 plants/100m²; in 1991, the maximum density was .40-plants/100 m². Densities differed ($P = 0.02$) among sites over the two years, but the significant ($P = 0.003$) treatment by year interaction indicated that orchid densities were not consistently higher or lower on one site relative to the others during the two years (Table 1).

Total plant canopy cover averaged 96% on the 16 transects; litter cover averaged 96%, and bare ground averaged 1% (Table 2). Total graminoid cover averaged 70%, total forb cover 36%, and total shrub cover 16%. Kentucky bluegrass (*Poa pratensis*) was the dominant species on the 16 transect, followed by a variety of sedges; of which woolly sedge was the most common. Other common, graminoids in the swales included baltic rush, switchgrass, northern reedgrass, and Wilcox dichanthelium (*Dicanthelium wilcoxinum*). Strawberry (*Fragaria virginiana*), leafy spurge (*Euphorbia esula*), and Canada anemone (*Anemone canadensis*) were dominant forbs, followed by Canada goldenrod (*Solidago canadensis*) and other species of *Solidago* and perennial ragweed (*Ambrosia psilostachya*). Willows (including *Salix exigua* and *S. bebbiana*) were the most prevalent shrub species.

The majority (59%) of the soils on the 16 swales were sandy loams; 29% of the surface soils were loamy sands and 12% were sandy clay loams. Sand content on the sixteen swales averaged 76.8% (± 5.5 SD), and ranged from 62-86%. Silt content averaged 8.6% (± 2.2 SD), and ranged from 3 to 15%. Clay content averaged 14.6% (± 3.9 SD); the range in clay content was 9-14%. Organic matter averaged 3.8% and ranged from 0.9 to 5.8%. Soil pH averaged 7.9 (± 0.4 SD), with a range from 6.5 to 8.4. Calcium content averaged 3385.6 ppm (± 768.2 SD) and ranged from 1818 to 4545 ppm.

Discussion

The dramatic decline in the number of original marked orchids since 1987 might be due to dormancy or death. Many species of temperate orchids are characterized by irregu-

larly spaced periods of dormancy (e.g., Hutchings 1989). The prairie fringed orchids (*Platanthera* spp.) are reported to be long-lived perennial plants, and other researchers have noted episodic aboveground growth followed by years when orchids seem to have disappeared, and have speculated that the plants are in a stage of dormancy induced by drought. In Illinois, Bowles *et al.* (1992) observed 100 flowering eastern prairie fringed orchids (*P. leucophaea*); the 1988 drought reduced the number of flowering plants to almost none for two years. Lower than average precipitation on our study area for three of five years since this study began may have induced dormancy of many orchids.

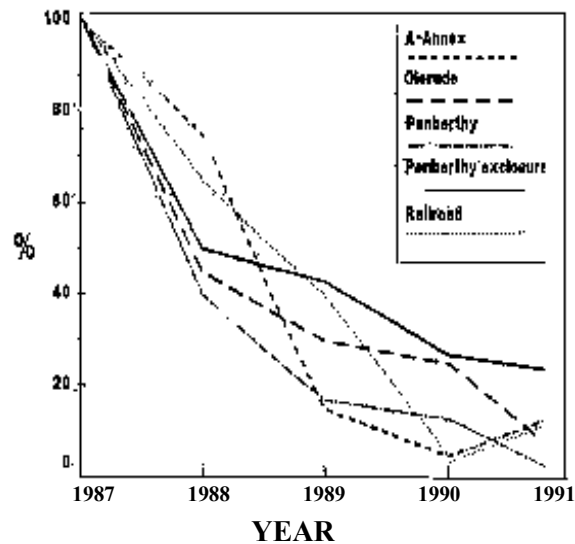


Figure 3. Percentages of permanently marked orchids observed on five burning/grazing regimes in 1987-1991, on the Sheyenne National Grassland, North Dakota.

It is possible that the marked orchids have died. For many orchid species, a dormancy period of 3 to 4 years is the upper limit, beyond which the probability of survival is significantly reduced (Falb and Leopold 1993). However, the presence of other new orchids on the Sheyenne National Grassland is indicative that recruitment is occurring on these sites. Whether the original plants will again reappear remains to be seen. Numbers of eastern prairie fringed orchids were higher in lowlands and in years of high rainfall in Illinois (Bowles *et al.* 1992). Until the Sheyenne population is observed in high precipitation years, conclusions about the longevity of this orchid are purely speculative.

The absence of any clear trends among sites in numbers of original marked orchids reappearing or in orchid densities should not be interpreted as unequivocal evidence that the orchids are not responding to the various management practices. Rather, it is likely that highly variable orchid densities and droughty conditions are masking effects of management regimes. Further, variations in degree of cattle use of the swales, site quality, depth to water table, soils, and original orchid densities before management was applied are variables to consider in the design of future studies on these orchids. It is very likely that several years of data will be required to sort out effects of management regimes from

the behavior of this orchid; and specific studies, designed to measure the impacts of clearly defined management techniques, are required.

Table 1. Average ($\bar{x} \pm SE$) orchid density (no./100m²) swale on five sites on the Sheyenne National Grassland, 1990-1991.

Site	1990	1991
Olerude	1.00 ± 0.10	0.30 ± 0.13
A-Annex	1.24 ± 0.36	3.07 ± 0.39
Railroad	0.48 ± 0.19	1.35 ± 0.81
Penberthy exclosure	1.53 ± 0.51	1.00 ± 0.30
Penberthy	1.07 ± 0.45	0.13 ± 0.12
Average	1.11 ± 0.16	1.22 ± 0.33

Table 2. Plant canopy cover ($\bar{x} \pm SE$) of major plant species on five study sites on the Sheyenne National Grassland, 1991. Plant nomenclature follows Great Plains Flora Association (1986).

Category	Average cover
Species	($\bar{x} \pm SE$)
Total cover	96.4 ± 1.1
Utter cover	96.2 ± 1.3
Bare ground	0.5 ± 0.7
Total forb cover	35.8 ± 13.7
<i>Ambrosia psilostachya</i>	4.1 ± 3.6
<i>Anemone canadensis</i>	4.9 ± 5.5
<i>Euphorbia esula</i>	5.2 ± 8.7
<i>Fragaria virginiana</i>	6.1 ± 9.0
<i>Solidago canadensis</i>	4.5 ± 4.3
<i>Solidago</i> spp.	1.9 ± 2.4
Total graminoid cover	69.8 ± 17.4
<i>Calamagrostis stricta</i>	6.6 ± 7.5
<i>Carex</i> spp. ¹	14.2 ± 11.1
<i>Dicanthelium wilcoxianum</i>	5.3 ± 7.5
<i>Juncus balticus</i>	12.6 ± 9.7
<i>Panicum virgatum</i>	9.7 ± 8.4
<i>Poa pratensis</i>	27.6 ± 27.3
<i>Spartina pectinata</i>	3.6 ± 5.4
Total shrub cover	16.5 ± 13.4
<i>Salix</i> spp. ²	12.7 ± 11.5

¹Includes *Carex lanuginosa*, *C. granularis*, and *C. brevior*.

²Includes *Salix exigua* and *S. bebbiana*.

Plant composition on the 16 swales was quite variable and reflected the problem of introduced species and noxious weeds. Species previously reported to be dominant in these swales, such as northern reedgrass, baltic rush, and woolly sedge (Manske 1980) were less common than Kentucky bluegrass. The domination by Kentucky bluegrass in several swales is a reflection of this species' ability to invade native grasslands; this ability may be further enhanced by cattle grazing and/or mowing (Daubenmire 1978). Swales have also been impacted by the invasion of leafy spurge, a noxious weed. The presence of spurge on all sites except Penberthy indicates the severity of this problem, and highlights the challenge of combating noxious weeds in areas where rare plants occur.

Current efforts to control leafy spurge on the Sheyenne National Grassland include spraying herbicides (usually a mixture of picloram and 2,4-D), biological control, and goats. Three species of flea beetles (*Aphthona nigricutis*, *A. cyparissiae*, and *A. flava*) have been released in the area. Adult flea beetles consume spurge leaves and bracts; the larvae feed on roots (Rees and Spencer 1991). Angora goats have also been introduced on the Sheyenne National Grassland on pastures not included in this study. When used with herders, they show some promise for reducing the spread of leafy spurge. Currently, swales supporting orchid populations are avoided in spraying programs, and goats are either not allowed in orchid-supporting swales during the growing season, or the orchids are covered with wire cages to protect them from goat herbivory.

The sandy, alkaline soils that supported orchid populations on the Sheyenne National Grassland differed from those previously reported for other regions. Soil pH in Iowa, Kansas, and Oklahoma were generally acidic (pH 5.4 to 6.4); pH values in Nebraska, North Dakota and Minnesota ranged from 7.4 to 7.5 (Bowles and Duxbury 1986). Soil pH on the Sheyenne study site averaged 7.9, but ranged from 6.5 to 8.4. Calcium content of these soils (1818 - 4545 ppm) tended to be on the lower end of the values previously reported (1730 - 6456 ppm) (Bowles and Duxbury 1986). Organic matter percentages (<1 - 5.8%) were also lower on all sites than those previously reported (6.1 to 23%).

Conclusion

It is impossible at this time to draw any conclusions on the effects of various management regimes on orchid populations on the Sheyenne National Grassland. Whether marked orchids will reappear following above normal precipitation remains to be seen. However, the fairly consistent recruitment in 1990 and 1991 is encouraging evidence that the orchid persists. It is likely that a combination of the sporadic growth behavior of the orchid and drought is masking the effects of grazing and burning. What is obvious at this point is the problem of leafy spurge invasion on the National Grassland. In spite of efforts to subdue this noxious weed, it continues to expand in these sandy soils. Future management efforts will likely focus on the task of reducing leafy spurge without harming the orchid. Until these efforts are successful, concern about the effect of burning and grazing on orchid populations diminishes in importance.

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