COLD TOLERANCE IN THE DESERT FAN PALM, *WASHINGTONIA FILIFERA* (ARECACEAE)

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ABSTRACT

Natural populations of *Washingtonia filifera* tolerate temperatures down to −11°C and subfreezing temperatures for at least 22 hours. Nonacclimatized seedlings survive temperatures as low as −21°C for one hour. Seeds are hardy, germinating readily after 36 hours of exposure to a temperature of −21°C. Available climatic data suggests that the absence of *W. filifera* from springs and seeps in the eastern Sonoran Desert and portions of the Mojave Desert is for reasons other than simple intolerance to subfreezing temperatures.

The desert fan palm, *Washingtonia filifera* (Lindl.) Wendl., of the Sonoran Desert is known to tolerate subfreezing temperatures. Muirhead (1961) stated that adults survived temperatures to at least −9°C with small plants showing leaf burn at temperatures below −4°C. Blombery and Rodd (1982) believed that desert fan palms survived winter temperatures down to −5°C. Although these references provide some information on the minimum temperature tolerance of *W. filifera,* no data have been presented on the duration of the subfreezing temperatures. The purpose of this paper is to present 1) new information on the minimum temperatures and the duration of subfreezing temperatures tolerated by natural populations of *W. filifera,* and 2) the results of tests on the cold tolerance of both seeds and seedlings. I use these data to evaluate the effect of temperature on the present distribution of *W. filifera* (Fig. 1).

METHODS

Minimum temperatures that occurred in the vicinity of six palm oases were obtained from seven meteorological shelters within the Sonoran Desert of southeastern California and western Arizona [Agave Hill, Pinyon Crest, and Taylor Site data obtained from the Boyd Deep Canyon Desert Research Center, Palm Desert, CA; Kofa and Castle Creek data from Sellers and Hill (1974); Oasis of Mara data obtained from Joshua Tree National Monument Headquarters; Indio data from U.S. Date and Citrus Station (1981)]. Locations of oases and shelters are given in Table 1. With two exceptions, each palm oasis was situated within 2 km and at approximately the same elevation as one of the weather shelters. Owl Hole was approximately

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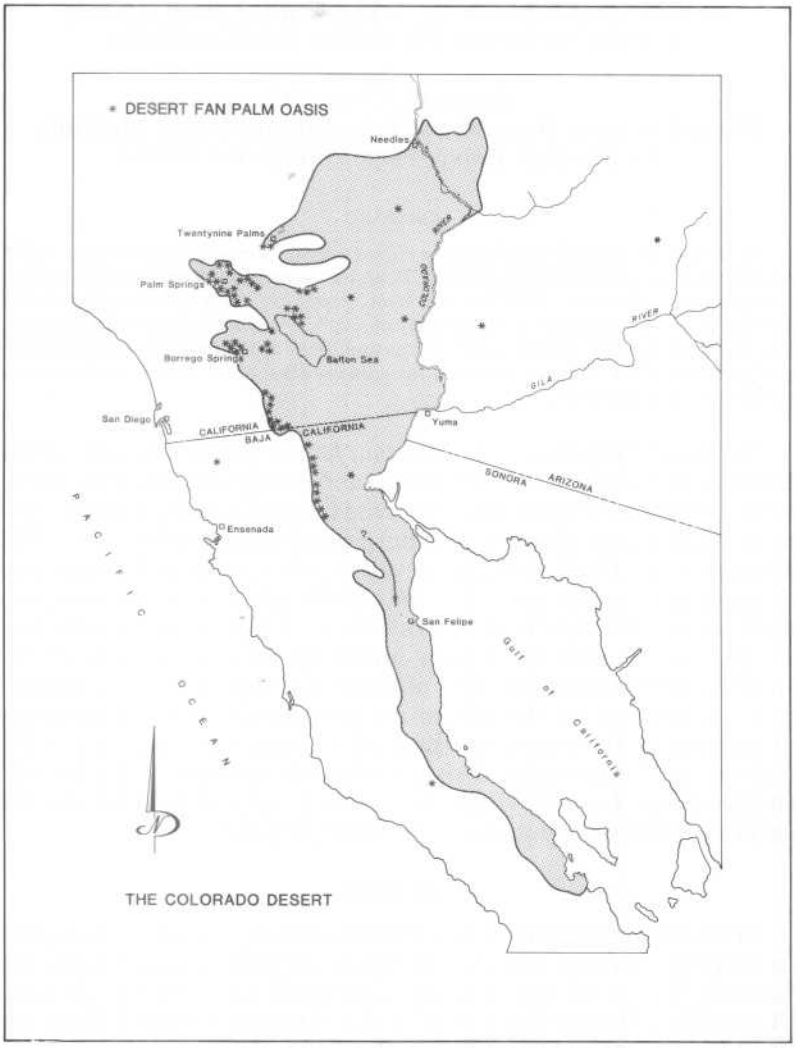

FIG. 1. The Colorado Desert subdivision of the Sonoran Desert (shaded area). * = location of desert fan palm oases.

40 m higher and 7 km north of the weather shelter at Indio, Riverside Co., CA. Kofa Palm Canyon was 144 m higher and 12 km north of the weather shelter located in the settlement of Kofa, Yuma Co., AZ. Three of the shelters (Agave Hill, Taylor Site, and Pinyon Crest) enclosed continuous recording thermographs and, thus, recorded the duration of subfreezing temperatures.

Minimum cold tolerance of *W. filifera* seeds was determined by

TABLE 1. MINIMUM TEMPERATURES AND DURATION OF SUBFREEZING TEMPERATURES EXPERIENCED BY POPULATIONS OF *Washingtonia filifera* IN SIX PALM OASES LOCATED IN THE SONORAN DESERT. D = duration; BDCDRC = Boyd Deep Canyon Desert Research Center, Univ. California, Riverside.

Min. temp. °C	D (h)	Palm oasis location	Elevation (m)	Date of minimum	Shelter location
−03	15	CA, Riverside Co.: Santa Rosa Mountains, Hidden Palms Canyon	938	28 Jan 1979	CA, Riverside Co.: BDCDRC, Agave Hill
−04	14	Hidden Palms Canyon	938	2 Jan 1974	Agave Hill
−04	14	CA, Riverside Co.: Santa Rosa Mountains, Dos Palmas Spring	1066	20 Jan 1983	CA, Riverside Co.: BDCDRC, Pinyon Crest
−05	?	AZ, Yuma Co.: Kofa Palm Canyon	685	?	AZ, Yuma Co.: Kofa
−06	18	Dos Palmas Spring	1066	29 Dec 1982	Pinyon Crest
−08	?	AZ, Yavapai Co.: Castle Creek	621	?	AZ, Yavapai Co.: Castle Hot Springs
−09	22	Dos Palmas Spring	1066	29 Jan 1979	BDCDRC, Taylor Site
−11	?	CA, San Bernardino Co.: Joshua Tree Nat. Mon., Oasis of Mara	600	3 Jan 1974	CA, San Bernardino Co.: Twentynine Palms, Mon. Headquarters
−11	?	CA, Riverside Co.: Indio Hills, Owl Hole	37	22 Jan 1937	CA, Riverside Co.: Indio

placing them in a freezer for the durations and temperatures shown in Table 2. Following cold exposure, the seeds were planted in plastic containers filled with a mixture of compost and vermiculite in equal proportions. The containers were placed on a heating pad that maintained a constant temperature of 32°C. The bedding medium was saturated with water on alternate days. Daily inspections were made

TABLE 2. DURATION OF MINIMUM TEMPERATURE EXPOSURES OF *Washingtonia filifera* SEEDS.

Min. temp. °C	Duration (h)	Germination success #/total	%
−07	24	38/40	95
−07	96	18/20	90
−12	06	38/40	95
−21	36	17/20	85

TABLE 3. DURATION OF MINIMUM TEMPERATURE EXPOSURES OF *Washingtonia filifera* SEEDLINGS.

Min. temp. °C	Duration (h)	Survival rate #/total	%
−12	1.0	6/20	30
−12	3.0	0/19	0
−12	6.0	0/19	0
−18	0.5	20/20	100
−21	1.0	4/19	21

to determine whether sprouting had occurred. Cold tolerance of seedling palms was determined by placing 20–30 day-old sprouts in a freezer for the durations and temperatures shown in Table 3.

RESULTS

Weather records indicate the minimum temperature tolerance of natural populations of *W. filifera* to be at least −11°C, two degrees lower than the known minimum of −9°C (Table 1). In addition, it appears that adult trees can withstand up to 22 h of subfreezing temperatures.

Palm seeds germinated readily after exposure to subfreezing temperatures. In these studies, seeds tolerated exposures as low as −21°C for 36 h (Table 2). Seeds exposed to such low temperatures also tended to germinate earlier ($\bar{x}$ = 21.5 days; s.d. = 2.6) than seeds not exposed to subfreezing temperatures ($\bar{x}$ = 27.5 days; s.d. = 5.1). These means are significantly different (t-test, $p < 0.001$). Seeds also germinated readily following exposure to freezing temperatures for seven days with temperatures dropping to −30°C (A. Stumpf, pers. comm.). Palm seedlings were less tolerant of cold, although four seedlings survived one hour exposure at −21°C (Table 3). Percent survival may have increased had the seedlings been acclimatized prior to exposure to freezing temperatures.

DISCUSSION

At least three populations of *W. filifera* probably experience even colder temperatures and for longer durations than do the palm oases listed in Table 1. Fortynine Palms oasis in Joshua Tree National Monument is located 6 km west of the Oasis of Mara and 206 m higher at 878 m. Because of its higher elevation and decreased exposure to direct sunlight due to its canyon location, temperatures are probably colder for longer periods at Fortynine Palms than at the Oasis of Mara. Mopah Spring, located in the Turtle Mountains of San Bernardino Co., CA, lies 24 km north and 100 m higher than the Oasis of Mara. Some individuals in Munsen Canyon (Joshua

Tree National Monument) occur at approximately 1015 m, which is the second highest elevation recorded for adult *W. filifera*. Although no climatic data exist for this site, the upper end of the Munsen Canyon palm grove may experience colder temperatures than do the high-altitude palms at Dos Palmas Spring in the Santa Rosa Mountains.

Low winter temperature is a probable factor in the exclusion of *W. filifera* from certain regions adjacent to its present range. Desert fan palms line many of the eastward-trending canyons that drain the Peninsular Ranges of southern California and adjacent Baja California Norte. Perennial streams exist in over a dozen of these canyons. Palms occur at the lowest point where water appears on the surface and they grow along the streams up to an elevation of approximately 900 m; they are absent above 1000 m even though the streams continue well above this elevation. Palms also are absent from most of the Mojave Desert where winter temperatures occasionally drop to −13°C or lower (U.S. Weather Bureau 1951, 1980, Sellers and Hill 1974). These observations, combined with the data from Table 3, suggest that the distribution of *W. filifera* is affected by low winter temperatures, but not to the degree that the tropical association of its family might indicate. How cold temperatures affect the palms is not known. Possibly, the seedlings may fail to establish because of a reduction in competitiveness that results from retarded growth or because of frost damage to the apical meristem.

The information presented on low temperature tolerances of *W. filifera* indicates, insofar as temperature is concerned, that the distribution of this species could be broader than it is at present. For example, there are no low temperature records that preclude the widespread occurrence of desert fan palms at springs and streams within the Sonoran Desert of Arizona and northern Mexico (Sellers and Hill 1974, Steinhauser 1979). The presence of two palm oases in Arizona, at the Kofa Mountains and Castle Creek, indicates that climatic conditions are suitable for *W. filifera* in the Sonoran Desert. Potential habitat also exists in the Colorado River drainage region of southern Nevada and the Death Valley area in the Mojave Desert. Geographical and ecological barriers, the lack of efficient dispersal agents, or insufficient time may account for the absence of the desert fan palm in these regions.

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Literature Cited

Blombery, A. and T. Rodd. 1982. Palms. Angus and Robertson Publishers, London.

Muirhead, D. 1961. Palms. Dale Stuart King Publisher, Globe, AZ.

National Climatic Center. 1980. Local climatological data: Las Vegas, NV. U.S. Dept. of Commerce, Asheville, NC.

Sellers, W. D. and R. H. Hill. 1974. Arizona climate 1931–1972. Univ. Arizona Press, Tucson.

Steinhauser, F. 1979. Climatic atlas of North and Central America. World Meteorological Organization, Geneva, Switzerland.

U.S. Date and Citrus Station. 1981. Climatological summary for Indio. U.S. Date and Citrus Station, Indio, CA.

U.S. Weather Bureau. 1951. Climatological summary for Barstow. U.S. Dept. Commerce, Asheville, NC.

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