NOTES

EFFECT OF HEAT ON SEED GERMINATION OF SOUTHWESTERN *YUCCA* SPECIES.—*Yucca* (Agavaceae) has twenty or more species distributed in a variety of environments throughout the southwestern United States, ranging from sea level to 2600 m and occupying various communities, including chaparral, grassland, desert scrub, and woodland.

Reproduction is broadly similar across the genus. The well known *Yucca*-moth pollination symbiosis is applicable to all species though the proportion of seeds consumed by the moth larvae is variable (J. Keeley, et al., 1984). Seed dispersal is however very different among species with a sharp division between dehiscent and indehiscent fruited species. The former group has capsular fruits and light seeds whereas the latter group has baccate fruits with heavy seeds (Table 1). Seed germination has been studied for some southwest species. Webber (Yuccas of the Southwest, USDA Agr. Monogr. No. 17, 1953) noted that of the few specimens examined, all had high viability and germinated readily without any special treatment and he also noted that seed germination was more rapid for capsular-fruited species. Arnott (UC Publ. Bot. 35:1-164, 1962) noted variable levels of viability, even within the same species, as did McCleary and Wagner (Amer. Midl. Nat. 90:503-508, 1973).

We investigated the effect of heat on seed germination in various species of *Yucca*. The experiments were designated to simulate various soil temperatures during wildfires. Since the *Yucca* species being considered represent communities with very different wildfire regimes it was hypothesized that these species would differ in (1) dependence upon heat for stimulating germination as noted for many species of fire prone environments and/or (2) ability to sustain high temperatures without loss of viability.

Four indehiscent baccate-fruited species (*Yucca baccata*, *Y. brevifolia*, *Y. schidigera*, *Y. torreyi*) and six dehiscent capsular-fruited species (*Y. angustissima*, *Y. elata*, *Y. glauca*, *Y. reverchoni*, *Y. thompsoniana*, *Y. whipplei*) were tested. Collectively these species range from California to Texas.

Yucca baccata ranges from southeastern California to southeast Texas (750-2200 m) in grassland and open woodlands. Seed collections were made from southern Utah and central and southern Arizona. *Yucca brevifolia* occupies open desert scrub from southeastern California to western Arizona and Utah (450-1800 m). Collections were made from several populations in the southern Mojave Desert. *Yucca schidigera* occurs along coastal southern California and east to Arizona (0-1800 m) in association with chaparral and other scrub vegetations. Collections were made from several coastal populations in southern California. *Yucca torreyi* is found in New Mexico and Texas (600-1500 m) commonly in open scrub. Collections were made in southeastern Texas.

Yucca angustissima occurs from northcentral Arizona to southern Utah (750-2300 m) in grassland and open scrub. Collections were made in southern Utah and northern Arizona. *Yucca elata* ranges from western Arizona to central Texas (450-1800 m) in desert grasslands and scrub. Collections were made from populations in southeastern Arizona and eastern New Mexico. *Yucca glauca* is widely distributed throughout the plains states (200-2200 m) in grasslands. Collections were made along the Texas-Oklahoma border. *Yucca reverchoni* and *Y. thompsoniana* are endemic to Texas (300-1300 m) in rocky open scrub and grassland. Collections were made from populations in southern and central Texas. *Yucca whipplei* is distributed in widely disjunct populations between southern California, Arizona, and central Baja California (0-2300 m) in chaparral. Collections were made from high elevation populations in southern California.

Seeds were collected in the summer of 1979 and germination experiments were done within 9 mo. Thirty seeds were placed on two layers of Whatman no. 1 filter paper in plastic petri dishes and wetted with deionized H_2O. Heat treatments were selected to represent a range of soil temperatures likely to occur at various soil depths during wildfires. Due to the largely unknown and likely heterogenous nature of seed distribution in the soil profile it is not possible to determine, even in an approximate manner, the temperatures particular species are likely to encounter during a wildfire. In general, species from desert scrub are likely to encounter fewer and less intense fires than ones from chaparral or woodlands. Heating treatments were applied on seeds in open glass petri dishes in a forced convection oven. Seeds were then transferred to the plastic petri dishes. All dishes were covered with plastic bags to reduce evaporation and maintained in the dark (as suggested by McCleary and Wagner 1973) at 5°2 C for 3 wk, followed by two weeks in the light at 23°2 C. After this five week period several species (e.g., *Y. schidigera*

TABLE 1.—*Seed germination of southwest* Yucca *species under various heat treatments. N = 3 or 6 dishes of 30 seeds each. Treatments (within the same species) with the same superscript are not significantly different at P<0.01, NS = P>0.05, LSD = Least Significant Difference at P<0.01. Seed weight is the mean of 100 seeds.*

		Percent Germination						
			2 hours		5 minutes			
	Seed WT (mg)	Control (N=6)	80 C (N=3)	90 C (N=6)	90 C (N=3)	100 C (N=3)	110 C (N=6)	120 C (N=6)
Baccata Species								
Y. Baccata	93	84	9	0	97	49	0	0
Y. brevifolia	99	61[a]	60[a]	0[b]	93	57[a]	26	0[b]
Y. schidigera	139	69[a]	16[b]	0[b]	83	54[a]	11[b]	0[b]
Y. torreyi	117	77	39[a]	0[b]	90	40[a]	20	1[b]
Capsular Species								
Y. angustissima	23	91[a]	86[ab]	6[c]	93[a]	77[b]	7[c]	1[c]
Y. elata	17	94[a]	93[a]	32[b]	90[a]	83[a]	28[b]	0
Y. glauca	16	79	57[a]	42[ab]	41[ab]	59[a]	28[b]	3
Y. reverchoni	8	67[a]	66[a]	34[c]	47[b]	59[b]	34[c]	3
Y. thompsoniana	7	86[a]	87[a]	49[b]	89[a]	82[a]	33[b]	7
Y. whipplei	16	63	34[ab]	44[a]	23[b]	40[a]	24[b]	8
	P<0.01	NS	P<0.01	P<0.01	P<0.01	NS	NS	NS
LSD 0.01	7		49	26	29			

and *Y. angustissima*) showed substantial germination whereas for others (e.g., *Y. glauca*, *Y. reverchoni*, and *Y. thompsoniana*) few or no seeds had germinated. Therefore, this regime of 5 C for 3 wk / 23 C for 2 wk was repeated two more times for all species.

Germination under control conditions was high and not significantly different between species (Table 1). All four of the baccate species had significantly higher germination after 5 min at 90 C. However, increasing temperature treatments produced a nearly linear drop in germination for all species. There was a distinct dichotomy between baccate and capsular species in their tolerance to extended heating. Two hours at 90 C did cause a significant reduction in germination of all species but it was completely fatal for all baccate species.

In general, germination response to heating is more similar among related species than among species sharing similar ecological habitats. Possibly this is a reflection of similarities in seed structure and size shared among species within each group. There is little evidence that fire has been an important selective influence on seed germination behavior. Indeed, *Y. whipplei*, which is a close component of the fire prone California chaparral, has seeds that are more sensitive to high temperatures than any other *Yucca* species. Thus the yuccas studied here appear to have non-refractory seeds and germination occurs when moisture and temperature conditions are adequate.—JON E. KEELEY AND ADRIENE MEYERS, *Dept. of Biology, Occidental College, Los Angeles, CA 90041.*

CARNIVOROUS BEHAVIOR BY A WHITE-TAILED ANTELOPE GROUND SQUIRREL, *AMMOSPERMOPHILUS LEUCURUS*.—Ground squirrels have been observed capturing, killing or consuming young rabbits (Johnson, J. Mamm., 3:187, 1922; Packard, J. Mamm., 39:154, 1958; Bridgwater and Penny, J. Mamm., 47:345-346, 1966), a small chicken (Bailey, J. Mamm., 4:129, 1923), lizards, young birds and mice (Bridgwater and Penny, J. Mamm., 47:345-346, 1966). Also, some individuals have been trapped using flesh as bait (Green, J. Mamm., 6:173-178, 1925), and some readily consume meat in captivity (Hawbecker, J. Mamm., 28:115-125, 1947; Bradley, J. Mamm., 49:14-21, 1968).

Chew and Butterworth (J. Mamm., 45:203-225, 1964) considered the white-tailed antelope ground squirrel to be a diurnal herbivore, but Bradley (J. Mamm., 49:14-21, 1968) and Bradley and Mauer (Southwestern Nat., 17:333-344, 1973) determined the animal to be omnivorous. Although mammalian remains have been found in the antelope ground squirrel diet, it is not known if the prey was killed or consumed as carrion.