relatively short intervals, mainly those of 12 and 16 hours.

The results of this work indicate that in terms of locomotor activity a premolt crab that retains its eyestalks and one that is eyestalkless are not dissimilar. In level and in rhythmicity, locomotor activity after eyestalk removal appears to follow a pattern characteristic of any crab in darkness making preparations for molting, including one that retains its eyestalks. One may suggest that alterations in locomotor activity during the premolt period may be attributed in an eyestalkless crab to the loss of centers for the synthesis and release of molt-inhibiting hormone and, in a crab possessing its eyestalks, to the withholding of molt-inhibiting hormone from the hemolymph. There is a strong possibility that responsibility for the control of locomotor activity in *G. lateralis* may rest with that portion of the neuroendocrine system concerned with the regulation of molting. The changes noted in darkness concerning the intensity and rhythmicity of locomotor activity prior to molt may, like rapid limb regeneration and precocious uptake and retention of water (see *5*), be part of preparations for molting and therefore a sign that ecdysis is imminent.

In conclusion, it may be suggested that since eyestalk removal appears to weaken but not to destroy the 24-hour rhythm of locomotor activity, it would seem that in the land crab, *G. lateralis*, either the biological clock does not reside in the eyestalks or accessory clocks exist elsewhere (*6*).

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Late Tertiary Microflora from the Basin and Range Province, Arizona

Abstract. Sediments of probable Clarendonian age from central Arizona have furnished the only late Tertiary pollen assemblage known from the Southwest. The associated trees, shrubs, and herbs resemble the chaparral and conifer-oak woodland communities of the semiarid foothills and mountains of central and southeastern Arizona, and suggest a late Tertiary landscape and climate for central Arizona similar to that of today.

A well-preserved microflora from central Arizona provides the first good record of the late Tertiary vegetation of an area remarkable for its scarcity of Tertiary plant mega- and microfossils (*1*). The recently discovered fossil site occurs near 5600 feet altitude in the mountains of the Basin and Range Province, about 4 miles northwest of Prescott and 30 to 40 miles southwest of the Colorado Plateau.

The polliniferous sediments are a rhyolitic tuff, at least in part water-laid, sandwiched between volcanic flows. The sequence is similar in lithology and probably more or less equivalent in age to the Hickey formation (*2*) described from the adjacent Jerome area to the east and tentatively assigned to the Pliocene (*3*). Recently, Lance (*2*) has discovered fragmentary camel bones in tuffs within a few feet below the pollen-yielding sediments; he thinks these remains are like some from the Walnut Grove fauna, found in similar lithologic sequence, about 20 miles south of Prescott. This fauna contains elements indicating a Clarendonian provincial age (*2*). Reference of the polliniferous sediments to the late Miocene or early Pliocene seems in line with the regional geology and paleontology.

Scattered thick deposits of gravel and interbedded volcanics, through much of central Arizona and along the southern margin of the Colorado Plateau, indicate widespread crustal disturbance, uplift, and volcanism in the area during the late Miocene or early Pliocene (*4*). Concurrent deformations in southern Arizona are considered to have been "of mountain-building proportions" (*5*) and there seems to be good evidence that a major disturbance also raised the central Arizona upland locally, as at Prescott, higher than the Plateau blocks (*4*), which were also uplifted about this time (*6*).

Direct geologic evidence for determining the exact Mio-Pliocene altitude of the Prescott area, and of central Arizona in general, is lacking, but the information available strongly suggests at least moderate elevation, and a landscape locally dotted with mountains and volcanic cones possibly of sufficient height to support a montane forest. The Prescott microflora approximates today's foothill and slope vegetation (4000 to 5500 feet) of central and southeastern Arizona, corroborating, in part, the landscape configuration surmised from geologic evidence.

Oak chaparral and ponderosa pine forest are now the main vegetation types near the fossil site; pinyon-juniper woodland and grama grassland are prominent nearby. The relative abundance of components in a pollen rain derived from this vegetation is indicated in Table 1. The sediment analyzed (one of a series studied for this area) is a lake mud from the same elevation as the fossil site. Table 1 also shows the relative abundance of plants identified to date from the fossil pollen assemblage (*7*).

Except for elm, the identified fossils

Table 1. Frequency of components in fossil (Prescott) and modern (Granite Basin Lake) sediments. Plus mark indicates pollen seen on scan. (Some of those listed for the lake sediments were found only at adjacent localities, at elevations, in feet, shown in parentheses.)

Genus or family	Prescott microflora $N = 499$ (%)	Granite Basin Lake (5600 feet) $N = 631$ (%)
	Arborescent pollen	
Quercus	23.8	33.1
Pinus	16.4	33.6
Juniperus-Cupressus	15.8	4.0
Juglans	0.6	2.5
Fraxinus	.4	+
Celtis	.2	+ (5400)
Alnus	+	+ (5500)
Betula	+	+
Ceanothus (*Rhamnus*?)	+	0.3
Ephedra	+	+ (5100)
Ulmus	+	+ (5400)
Agave		0.2
cf. *Garrya*		0.2
Opuntia		0.2
Vitis		0.2
	Nonarborescent pollen	
Gramineae	10.8	2.5
Compositae	8.0	5.8
Artemisia (shrub?)	0.8	0.3
Chenopodiaceae-*Amaranthus*	5.2	1.3
Cyperaceae	1.0	2.5
Eriogonum (shrub?)	0.2	0.2
Malvaceae cf. *Sphaeralcea*	+	+
Polypodiaceae? (trilete spore)	+	+ (5100)
Typha	+	4.6
Plantago		1.7
Polygonum		0.6
Geranium (*Erodium*?)		0.2
Papilionoideae (shrub?)		0.2
	Unknowns	
Tricolporites a	4.6	
Tricolpites a	2.4	
Other	10.4	6.1

(about 80 percent of the flora) are genera and families of the nearby vegetation, and all are represented by pollen in the recent sediments. The similarity between the fossil and living flora is consistent with, and tends to support, a late Tertiary age for the microflora. With regard to the pollen production of genera revealed by the recent pollen rains, pine in inferred to have been less common locally in the Mio-Pliocene vegetation than oak and juniper-cypress; its affinities, based on pollen size-frequency studies, are with the xeric *Pinus cembroides* (pinyon) group rather than the better-watered montane ponderosa pine.

Chaparral plants (other than oak?) are largely missing from the microflora. Most of them, however, are entomophilous, and few have shed pollen that has settled into contemporary sediments (Table 1). The more moisture-loving ash, walnut, and hackberry presumably thrived along washes and canyon bottoms, like their modern counterparts, throughout central and southeastern Arizona; two species of *Ephedra* evidently ranged into the wooded uplands, as do *E. trifurca* and *E. viridis* near Prescott.

Alnus, Betula, and *Ulmus* occur sporadically in the microflora, though it is believed that vegetational facies of the Madro-Tertiary geoflora completely controlled the southern Great Basin in the Mio-Pliocene (*8*). A more comprehensive record of these and other plants of presumed Arcto-Tertiary derivation has been obtained, also, from Mio-Pliocene sediments from coastal southern California (*9*). In all probability, the source of the Prescott pollen was a montane (conifer-deciduous hardwood) forest characteristic of the Arcto-Tertiary geoflora and in particular its West American element, many of whose living equivalents are found in the Rocky Mountain forest and its southern extension into uplands of northern and central Arizona. Single grains of alder and birch pollen in the recent sediments presumably were windborne 60 to 200 miles from the nearest stands of these genera. Elms reach their natural limits in Texas (Pecos River), though they survived in the Far West till at least the late Pliocene (*10*). Elm pollen has been recovered recently from possible Nebraskan pluvial sediments of southeastern Arizona (*11*), which suggests that the genus became extinct in the West only during the Pleistocene. Three species are cultivated at Prescott.

The microflora undoubtedly presents an incomplete spectrum of the herbaceous plants of late-Tertiary central Arizona. Nevertheless, a dimension is added to the vegetation that is scarcely hinted at in megafossil floras. Most of the herbs (Table 1) are seldom found fossil, or lack previous Tertiary records.

The microflora is characterized by the dominant woody genera of brushland and savanna-woodland of central and southeastern Arizona uplands, but lacks the common associated species which today give floristic entity to these communities, and includes some (as unknowns) which apparently do not now occur in these assemblages. Still, the similarity between the microflora and pollen rains from these contemporary communities is marked, although this likeness provides no proof of the stability of these plant associations through time. It is appropriate to question whether chaparral, conifer (juniper-pinyon) woodland, and encinal (oak-juniper-pinyon woodland) were differentiated as they now exist in Arizona (climatic conditions today favor their optimal development in different parts of the State), or whether the Tertiary vegetation was a "generalized" assemblage from which species composing these communities have been segregated because of climatic changes since the Mio-Pliocene, with regard to their varying tolerances and adaptabilities.

The microflora is at an elevation (5600 feet) where pine now largely dominates the vegetation of central Arizona. The relatively low frequency of fossil pine pollen in the flora implies that the basin of deposition was lower, or the climate was drier [average annual rainfall at Prescott (5355 feet) about 18 inches], or both, when the polliniferous sediments were deposited. The presence of birch, alder, and elm might appear to raise rather than lower the moisture requirements of the fossil flora, but their relative scarcity (in fossil and modern pollen rains) indicate distant transport from more mesic uplands (*12*).

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Avian Uptake of Fission Products from an Area Contaminated by Low-Level Atomic Wastes

Abstract. Birds living on the Oak Ridge White Oak Lake bed, an area contaminated by low-level atomic wastes, revealed a striking seasonal difference in uptake of fission products. Because the omnivorous diet of passerine birds is ecologically comparable to the mixed diet of man, uptake of radionuclides by wild birds provides an assay of amounts to be expected at the trophic level of primary interest to man.

The fate of radioactive materials introduced into the environment must be understood before their effects on man and nature can be evaluated. It is particularly important to know what fraction of the total radioactivity entering the environment may be expected to reach successive trophic levels in the major types of ecosystems of the world. At Oak Ridge National Laboratory, the White Oak Lake basin is a waste disposal area in which a slowly fluctuating level of soil contamination occurs (*1*). Avian uptake from a given level of environmental contamination should indicate both the average and the maximum concentration of radionuclides to be expected at the trophic level of particular interest to man, since the seed-fruit-insect diet of a terrestrial bird population is similar, in an ecological sense, to the grain-fruit-meat diet of man. The present paper is concerned with gross beta radioactivity and with concentrations of Sr^{90} and Cs^{137} in birds living on the White Oak Lake bed in 1958–59.

From the ecological standpoint, White Oak Lake bed in 1958, three years after the lake itself had been drained, could be divided conveniently into two zones: an inner "bush" zone of sediments covered by vigorous growths of herbaceous plants, shrubs, and scattered clumps of willows; and an outer "thicket" zone representing the former lake margin, covered with dense growths of alder, pokeweed, and young trees. Summer birds, especially those breeding in the inner zone, were largely replaced by different species or different individuals (that is, "races") of the same species in winter.

Specimens were collected by means of Japanese mist nets, and dissected into several components: feathers, skin, muscle, viscera, eyes, and bone. Bone was separated from muscle by boiling, and the fluid was added to the muscle component. Radioassay of tissues, and of the birds' food, was accomplished by a wet digestion technique previously employed and described by Krumholz and Emmons (*2*). The procedure of Willard and Goodspeed (*3*), was used in the radiochemical analysis for Sr^{90}.