was done by noosing each animal from its position on the surface of the sand substratum. If other lizards in the runway changed their position on the surface during a capture, no further capture of surface-dwelling animals was attempted for at least 1 hour. Before another runway was sampled, the sand substratum was searched for lizards, and a second set of cloacal temperatures were recorded. In this manner, preferred body temperatures were recorded for groups of adult fence lizards of approximately equal sex ratio captured during the four seasons of the year.

Seasonal mean body temperatures of lizards captured above ground in the field exhibit a wide range (30.4° to 35.9°C); the most striking deviation occurs in the winter (Table 1). In winter over half the cloacal temperatures taken in the field fell below 28.0°C, whereas during the other three seasons no cloacal temperatures were below this point. Furthermore, the mean cloacal temperature of lizards captured above ground in winter is significantly lower ($P = .001$) than an average of cloacal temperatures taken in the field during the other three seasons. This datum taken by itself might warrant support for Mayhew's hypothesis that there is a lowering of the preferred body temperature in winter which is then followed by an acclimation to higher temperatures in spring. However, in the light of the normal (35.0°C) preferred mean body temperature recorded for the same lizards tested in runways 3 days after capture, the lower body temperatures obtained in the field must be viewed solely as a product of generally lower available ambient temperatures. Furthermore, there has been no report to date of acclimation of lizards to higher preferred body temperatures as a result of higher ambient temperatures. Indeed, the opposite is true (*5*).

Table 1. Seasonal mean preferred body temperatures of lizards in laboratory thermal gradients and in the field. Dates: Spring sample, 29 April–2 May 1963; summer sample, 3–8 June 1963; fall sample, 21 Aug.–28 Sept. 1963 and 18–20 Oct. 1964; winter sample, 2 Feb. 1963 and 31 Jan. 1964.

Season	Lizards (No.)*	Temperature (°C)	
		Seasonal mean	Range
	Field, surface-active		
Spring	52	34.3	28.2–37.9
Summer	50	35.1	31.2–38.9
Fall	40	35.9	32.6–38.6
Winter	29	30.4	19.0–35.8
	Laboratory, surface-active		
Spring	47	34.9	31.1–38.4
Summer	41	34.1	28.6–38.7
Fall	56	34.6	30.7–38.8
Winter	28	35.0	31.7–37.3
	Laboratory, buried		
Spring	38	33.0	25.8–38.7
Summer	43	33.1	26.4–38.6
Fall	72	30.9	20.3–37.9
Winter	27	33.1	20.2–39.7

* One temperature per lizard.

Thus it appears that, in winter, western fence lizards will emerge if temperatures in the hibernacula rise above the threshold for coordinate neuromuscular activity above ground. However, ambient temperatures in winter rarely permit a lizard to obtain or rise above its mean preferred body temperature for surface activity, and only with the advent of warmer spring temperatures may the preferred body temperature range be readily attained and maintained.

The only significant deviation in preferred mean body temperature under laboratory conditions occurred in lizards buried in the sand substratum in the fall sample. This group exhibited a mean 2.2°C ($P = .001$) lower than the means for animals retrieved from buried positions during the other three seasons. One-third of the animals in this group had temperatures below 30.0°C, whereas only a few in the other groups did. It is possible that some sort of prehibernatory behavior is reflected here in which lizards tend to seek out cooler retreats in the fall than in spring and summer. Stebbins demonstrated a significant decrease in preferred mean body temperature of buried striped plateau lizards under laboratory conditions during the fall months (*3*). In addition, he found that the coolest burial sites in the runways were selected about twice as often in fall as in spring. Selection of lower temperatures in fall animals may possibly be of high adaptive significance. A lizard which seeks out a cool retreat in mid or late fall may not experience ambient temperatures high enough to elicit emergence until favorable spring conditions are present. Mayhew suggests that lizards which emerge at the first sign of warm weather are ones which are unable to find a suitable retreat when a sudden cold period occurs (*4*). Furthermore, a cool retreat in fall when ground surface temperatures are still high might be at a sufficient depth or sufficiently well insulated to remain above freezing temperatures in winter. An animal lacking such behavior may run a far greater risk of being caught in a shallow or poorly insulated retreat and freezing to death.

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Pleistocene Age Determinations from California and Oregon

Abstract. *Mollusks have been collected from Pleistocene marine deposits at Tomales Bay, California, and Cape Blanco, Oregon. Dating by the carbon-14 and thorium-230–uranium-234 methods suggests that the shells are at least 33,000 years old. The more probable age of the Tomales Bay locality is ≧ 50,000 years.*

The Millerton formation was named by Dickerson (*1*) from a section exposed on the north shore of Millerton Head on the east side of Tomales Bay, California, about 3 miles (5 km) northwest of Point Reyes Station, and about 40 miles north of San Francisco. Dickerson defined this formation as the fossiliferous deposits unconformably underlying the Tomales formation, which he also named. The fauna consists mainly of marine mollusks which have been studied by Weaver (*2*) and Johnson (*3*). A fossil flora has been studied by Mason (*4*).

All the molluscan species found are known to be living in the waters of San Francisco Bay, with the exception of *Tagelus californicus*, which lives south of Monterey Bay. The Millerton formation has been regarded as of Pleistocene age, but it has not been correlated with any particular phase of that epoch. Its outcrops lie

Table 1. Radiometric age data for shells from Tomales Bay, California, and Cape Blanco, Oregon.

Sample	Apparent age (10^3 yr)		Probable age (10^3 yr)
	C^{14}	Th^{230}/U^{234}	
	Tomales Bay		
L–768C	> 37	55 ± 5	≧ 50
L–720A	34.5 ± 3	55 ± 3	≧ 50
	Cape Blanco		
L–720C	35 ± 2.5	35 ± 2	≧ 33

immediately east of the San Andreas fault, the axis of which extends along Tomales Bay; hence there may have been displacement, as indicated by Weaver (*2*, p. 133).

A collection of mollusks was made by one of us (H.G.R.) in March 1962. The best material came from a point near the north end of the bay (locality 1 of Johnson, at an elevation of 3 meters). The shells were exceedingly fresh in appearance and consisted mainly of the species reported by previous investigators. The most abundant were *Macoma nasuta* Conrad, *Lucina nuttalli* Conrad, *Nassarius fossatus* Gould, *N. mendicus* Forbes, *Olivella biplicata* Sowerby, *Polinices reclusianus* Deshayes, and *Mitrella carinata* Hinds.

Shell beds from the vicinity of Cape Blanco, Oregon, have been studied by Diller, Martin, Baldwin, Addicott, and others (*5*). The shells occur in a deposit of terrace sand and gravel resting on a wave-cut platform south of the cape. The fossils were regarded by Martin as "recent forms deposited under cold water conditions." Baldwin regarded the shells as belonging to the Elk River beds, while Addicott retained the term Elk River for the underlying, gently deformed beds of Late Pliocene (?) age and assigned the shells to overlying terrace deposits of late Pleistocene age. The shell beds are locally horizontal and in other places slightly tilted. Baldwin believes that they date from late to post-Pleistocene, and Addicott regards them as late Pleistocene.

The locality was visited in March 1962 by one of us (H.G.R.), and material was submitted to Lamont Geological Observatory for age determination. The following species were the most common: *Saxidomus nuttali* Conrad, *Schizothaerus nuttali* Conrad, *Cardium* sp., and *Olivella baetica* Carpenter.

Several samples were dated by both C^{14} and Th^{230}/U^{234} methods (Table 1). Sample L-720A consisted of the pelecypod *Lucina nuttalli* (Conrad) from Tomales Bay; L-768C consisted of shell fragments from the same locality; L-720C consisted primarily of fragments of *Cardium* from Cape Blanco.

As pointed out by several workers (*6*), finite ages greater than about 25,000 years old obtained from carbonate materials should be considered minimum ages. The same is likely to be true of Th^{230}/U^{234} ages of mollusks (*7*) unless these ages can be otherwise verified. In the case of the material from Cape Blanco, the apparent agreement of two minimum ages does not necessarily provide proof for the validity of the 35,000 year age. We can only conclude that the samples are at least 33,000 years old.

More information is available for the Tomales Bay locality. One sample is greater than 37,000 years old, by the C^{14} method. Both yield apparent ages of 55,000 years by the Th^{230}/U^{234} method. The most probable age is greater than 50,000 years and these two samples could easily have been deposited during the last interglacial stage or earlier. Neither locality is very late Pleistocene or postglacial.

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Receptive Fields of Directionally Selective Units in the Optic Nerve of the Ground Squirrel

Abstract. *These units responded vigorously to stimuli moving entirely across their receptive field centers in one direction (preferred) and not at all when the direction of motion was reversed (null). The directional selectivity was the result of an inhibitory mechanism which prevented responses to null movements. Surrounding each field center was a concentric antagonistic region produced by a second inhibitory mechanism.*

The purpose of the experiments reported here was to determine the nature and organization of the receptive fields of single optic nerve fibers in a mammal with an all-cone retina. The methods were similar to those used by others (*1*). The ground squirrel (*Citellus mexicanus*) was anesthetized with sodium pentobarbital, fitted with a tracheal cannula, and positioned in a stereotaxic head holder. The right pupil was dilated and accomodation relaxed with 1 percent atropine; a contact lens covered the cornea. The right eye of the animal faced a large screen upon which stimuli were projected from two tungsten-filament slide projectors. (See figure captions for luminances of stimuli and background.) A refracting lens brought the reflected stimuli into focus on the retina.

Gold-plated tungsten microelectrodes (*2*) were used to record from single fibers. The "pencil point" recording area widened from less than 0.5 μm in diameter to 10 to 15 μm over a length of about 25 μm. All of the optic nerve fibers are myelinated and of nearly the same diameter, so it is very unlikely that the electrodes were selectively recording from certain fibers and not from others. The discharges of a single fiber could be influenced by light stimulation over only a restricted area of the visual field. This area, defined as the receptive field, was mapped on sheets of paper attached to the screen (*3*).

The majority of the optic nerve fibers in the ground squirrel (78 of 124 studied; 63 percent) had concentric receptive fields like those of the cat's retinal ganglion cells. However, a second class of fibers (22; 18 percent) exhibited a selective sensitivity to the direction of