Table 1. Three radiocarbon dates from the ancient village site of Chaluka, Umnak Island. The measurements were derived from specimens recovered in 1961 excavations, and were determined by Isotopes, Inc.

Specimen No.	Depth in midden (cm below surface)	Age (yr)
I-494	150	2875 ± 160
I-495	275	3600 ± 180
I-493	300*	3750 ± 180

* 60 cm above native sterile bottom.

long), set on edge and forming an oval outline, suggest house bases.

Verification of the functions of the artifacts and of the ecological base is found in the abundant faunal remains. The bulk of the bones consists of pinnipeds with greatest frequencies of harbor seals, sea lions, and fur seals. The mustelid sea otter (*Enhydra lutris*) is represented by several hundred elements. Remains of whales are present in the lower levels; their bone is the most common fabricational material for harpoon heads and spear heads. Ivory labrets identify the sperm whale; sample limitations do not permit an estimate of their proportional frequency. There is a marked deficiency of sea otter fibulae and an excess of harbor seal and sea lion hyoids. A possible explanation for the paucity of fibulae is their conversion to awls, some of which have been identified. The numerous hyoids may reflect the extensive fabricational use of oesophageal parkas (waterproof kamleikas) and pants, both well known from ethnographic records. More immature specimens of sea otter are found in the lower levels, indicating a possible alteration in hunting habits as the population grew larger.

Of about 20 species of birds represented in the site, two species of cliff-nesting murre, two species of puffin, a cormorant, and the glaucous-winged gull contributed the majority of individual bones. The albatross, including the yellow-billed type, is well represented and suggests the use of kayaks in hunting, although Chamisso (*5*) states that albatross were formerly hunted while they nested in the mountains. Fish bones, incompletely identified, include halibut, cod, salmon, and smaller fishes from the intertidal zone. Large quantities of sea urchin with chitons, limpets, whelks, mussels, and clams indicate extensive use of the intertidal zone.

Comparison of the Chaluka materials with those of an Eskimo site at Rolling Bay (Saataq), Sitkalidak Island, on the south side of Kodiak Island, sharpens the contrast in modes of ecological exploitation and verifies the uses of artifacts. Many more fish bones and fewer pinniped bones characterize this site. This food habit is reflected in large numbers of ground slate ulus (used by women in cleaning salmon and other fish). An absence of compound fishhooks indicates less reliance on the larger, deep-water fish; the absence of fish spears indicates greater reliance on nets or weirs. The scarcity of pinniped and sea otter bones is adumbrated in the dearth of harpoon heads. The absence of bird spear prongs is similarly in functional agreement with the existence of fewer bird bones. Both the earlier Paleo-Konyag (pre-Konyag of Hrdlicka) and the Neo-Konyag skeletons have been found.

A significant fact is the absence of any appreciable change in the composition of the fauna at Chaluka. Four thousands years of exploitation were continuously based on sea mammal hunting, birds, fish, invertebrates, and, by inference, on land plants and marine algae. The absence of sea ice in winter and the presence of easily collected invertebrates have clearly been factors in the continuous development and eventual large population (16,000 at the time of discovery in 1741). These factors favored survival of children, women, and the handicapped in the population. For at least 3000 years the human population appears to have consisted of the Paleo-Aleut variant, persisting through a variety of changes in styles of artifacts. The artifactual changes do not appear to have affected the way of life of these people.

The Paleo-Aleut skeletons are easily distinguishable from their eastern neighbors, the Paleo-Konyags. This suggests that their differentiation precedes 2000 B.C. by a long period. Whether the early Aleuts were replaced by or evolved into the later Neo-Aleuts remains the basic question. More closely spaced samples, in both time and space, are needed to distinguish local evolution from the effects of gene flow or actual migration of people. Ample time is clearly available for evolution of the later, broad-headed population (with higher frequencies of tori and other discrete traits) to have taken place in the Aleutian Islands (*6*).

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Evidence for Direct Stimulation of the Mammalian Nervous System with Ionizing Radiation

Abstract. Exposure to x-rays of low intensity immediately arouses the sleeping rat. Activation of the central nervous system, indicated by behavioral and heart rate responses, depends upon the rate but not the dose of exposure. The arousal reaction is not dependent upon direct visual stimulation. The nervous system is probably directly sensitive to ionizing radiation.

Investigations dependent upon neurophysiological and histological techniques have generally failed to produce evidence of any marked reactivity of the adult mammalian nervous system to ionizing radiation (*1*). Behavioral methods have been used to demonstrate that a low dose of radiation can act as an unconditioned stimulus in the conditioning of avoidance responses (*2*), and it was considered likely that a behavioral criterion might also be utilized to detect the most immediate effects of radiation in the intact mammalian nervous system.

For this purpose, rats were exposed to x-rays while they were asleep in a glass exposure chamber (Fig. 1), and observational measurements of behavioral arousal were made. Heart rate measurements were also made to provide additional evidence of central activation during arousal (*3, 4*).

Young adult male Sprague-Dawley rats served as subjects. Prior to exposure the animals received 40 hours of adaptation (*5*) which included exposure to x-ray-machine and room noises. Heart rate values during the sleep state, obtained in the last 8-hour period of adaptation, were used to equate experimental groups.

Behavioral arousal was measured by a rating scale which identified *any* visible departures from the condition

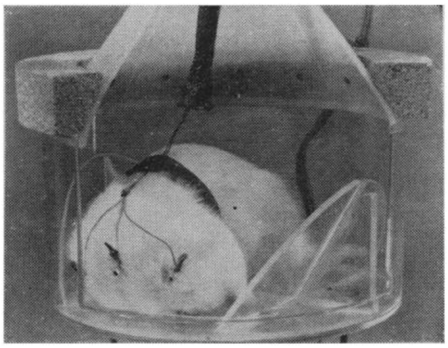

Fig. 1. Cutaway version of observation-exposure chamber with rat in a sleeping position and connected for recording of electrocardiogram.

of sleep or complete inactivity. The viewing distance through a leaded-glass window to the x-ray room ranged from 2 to 5 m. Three trained observers typically showed better than 90 percent agreement on independent ratings made in a series of reliability tests. Heart potentials were recorded on a four-channel oscillograph (Grass). As a precaution to limit systematic observer bias, inspection of all data was delayed until the last experiment was completed.

A Maxitron x-ray unit, operated at 250 kv (peak) and 25 ma (half-value layer, 2.3 mm of Cu), was used for a 1000-r exposure delivered in 9 or 67 minutes. The dose rate for animals in the high-intensity exposure group was nominally 1.9 r/sec (1.5 to 2.5 r/sec, depending upon the animal's position in the chamber), and the rate for the low-intensity exposure group was 0.25 r/sec (0.22 to 0.28 r/sec). Control animals were placed behind lead shields in the x-ray room.

To obtain adequate samples, four to eight animals in each of 12 identical experimental runs were used. No differences among runs were apparent, and data from all were combined in the analysis. From 5 minutes before through 15 minutes after the start of exposure, five sampling intervals per minute were scheduled, each of 12 seconds' duration. Two to three samples per minute were obtained from each animal on each variable during this period. Our report (*6*) presents the data obtained during the first minute of exposure from animals that were rated as asleep and completely inactive over the three intervals just prior to exposure.

Panel A of Fig. 2 shows the relative incidence of behavioral arousal (top) and of mean heart rate (bottom) during the first minute of exposure. Both groups showed evidence of arousal within the first 12 seconds (χ^2 test; $p < 0.02$). The high-intensity exposure group subsequently exhibited a higher incidence of arousal (χ^2 test; $p < 0.001$). Both groups were approaching the level of activity of the control group by the end of the first minute. Analysis of covariance was used on the heart-rate data with the value obtained prior to exposure serving as the concomitant variable in the analysis at each test point (*7*). The intraclass correlations were homogeneous among groups, high, and positive (+ .625 to + .928).

The high-intensity exposure group exhibited a peak in heart rate at about 30 seconds (F test; $p < 0.005$) which corresponded in time to its peak incidence in arousal. These are not responses to a total dose since the low-intensity exposure group, regardless of cumulative exposure time or dose, failed to exhibit any further responses beyond the behavioral response shown in the first measurement interval. It may be concluded that the threshold intensity of radiation exposure required to elicit diffuse neural activation, as indicated by the joint occurrence of the behavioral and heart responses, is between 0.25 and 1.9 r/sec. A threshold intensity for activation limited to behavioral arousal, shown in the first interval of 12 seconds, is probably less than 0.25 r/sec.

A visual sensation of sufficient intensity to arouse an animal sleeping with eyes closed, and, therefore, partially dark-adapted, could presumably be produced by x-rays delivered at the intensities employed (*8*). To test this possibility, additional experimental runs were made with animals that had been subjected to complete, bilateral ophtalmectomy 1 month prior to the exposure test. Panel B of Fig. 2 shows the results. Since the response appeared within the first measurement interval of 12 seconds, it cannot be attributed to direct retinal stimulation with ionizing radiation.

A procedural study was made to test for the presence of an arousing stimulus other than radiation, including residual noise from the sound-shielded shutter. A sham-exposure test was made in each experimental run at least 30 minutes before the radiation-exposure test. The results of these tests indicated that the arousal response cannot be ascribed to stimulation coincident with radiation. This can be shown most readily with the heart-rate data obtained from normal rats that were asleep and inactive before *both* sham-exposure and radiation-exposure tests (panel C, Fig. 2).

It is evident that ionizing radiation acts in a manner analogous to a stimulus in that it evokes a reflex-like

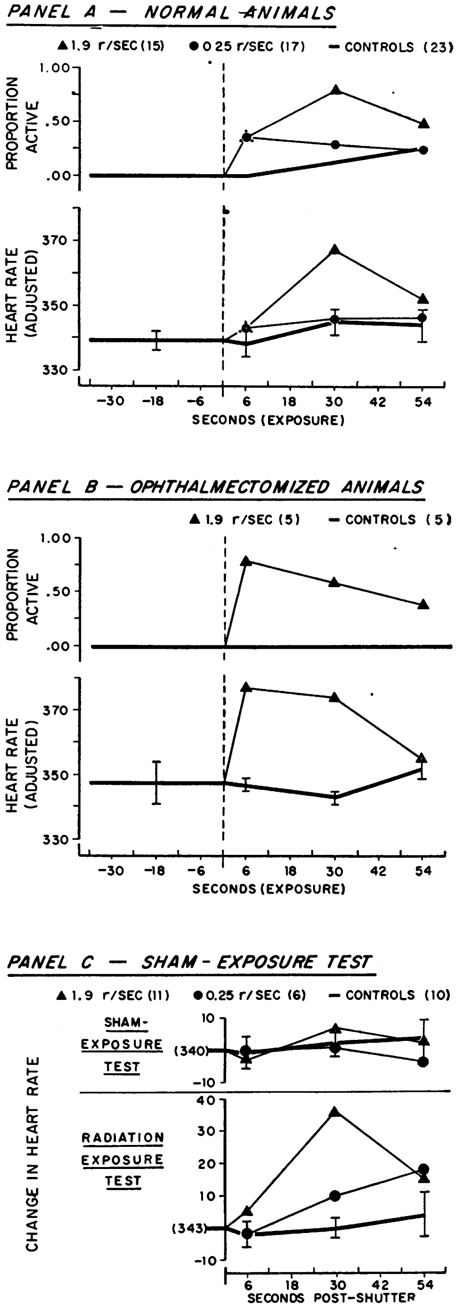

Fig. 2. Incidence of activity and mean heart rates, after covariance adjustment, in normal animals (panel A) and ophthalmectomized animals (panel B). Panel C shows mean changes in heart rates of normal rats that were asleep before both the sham-exposure (top) and radiation-exposure (bottom) tests. Standard error limits are indicated for control group heart rate means.

arousal response in this behavioral preparation. The reaction is initiated in the presence of heightened sensory thresholds normally associated with sleep (*9*). It may be inferred from the behavior data and the heart-rate data that the degree of neural activation underlying the response is related to the intensity of radiation. The arousal response is not dependent upon direct visual stimulation by x-rays. The arousal reactions which arise after or continue beyond the first few seconds very likely involve reflex activation of the adrenal medulla (*4*).

Recent studies with mammals have shown that within the first minute of moderate intensity exposure gastric retention occurs (*10*), oxygen consumption increases (*11*), and electroencephalographic activity is altered (*12*). Although these responses might be related to the arousal response, arising as a consequence of central activation, they might also be primary responses to nervous stimulation with radiation. Reflex-like reactions to ionizing radiations have been described for invertebrates; the most sensitive reaction was found to be tentacle retraction in the snail (*13*). The arousal response in the rat would appear to be of comparable sensitivity.

The nervous mechanisms which are affected by radiation exposure in the production of behavioral arousal and central activation are obscure. Aside from photoreceptors, no sensory receptors have been demonstrated to be directly sensitive to radiation stimulation. Although the visual system is not essential for the reaction, it cannot be ruled out that stimulation through other receptor systems may initiate the central activation. Direct ganglionic sensitivity to ionizing radiation is also possible. This was proposed years ago by Toyama (*14*). More recently, Hug (*13*) suggested that ionizing radiation may act like visible light in activating certain photosensitive processes in ganglionic structures. It is also possible that penetrating ionizing radiation is a particularly efficient means for stimulating large masses of nervous tissue directly since the energy transfer would occur relatively uniformly with minimum spatial or temporal loss.

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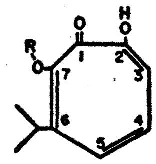
On the Decay Retardant Properties of Some Tropolones

Abstract. The heartwoods of tree species containing tropolone compounds in their extractive components are classed among the more durable woods. Two new tropolones, namely, α-thujaplicinol and pygmaein from the heartwood of *Cupressus pygmaea*, were also found to exhibit strong fungitoxic properties active against a number of wood-destroying fungi. The hydroxyl group appears to be the functional grouping which is largely responsible for the fungicidal action exhibited by this type of compound.

Three tropolones were found to be present in incense cedar heartwood (*Libocedrus decurrens* Torrey), namely, γ-thujaplicin (0.07 percent in wood), β-thujaplicin (trace), and β-thujaplicinol (trace) (*1*). It was previously reported that γ-thujaplicin was among the most potent fungicidal extractive components found in this heartwood (*2*). These three particular tropolones, as well as others, are also present in western red cedar heartwood (*Thuja plicata* Donn) and are largely responsible for the well-known decay resistance of this cedar (*3*).

In recent studies on the occurrence of tropolones in various tree species, two new tropolones were found—α-thujaplicinol (7-hydroxy-6-isopropyl tropolone) (I) (0.4 percent in wood) and its monomethyl ether, pygmaein (7-methoxy-6-isopropyl tropolone) (II) (0.4 percent in wood) in the heartwood of *Cupressus pygmaea* Lemm (*4*). The fungicidal properties of each of these compounds together with γ-thujaplicin (5-isopropyl tropolone) and methylated thujaplicins (laboratory preparation) were determined.



I R = H (α-thujaplicinol)
II R = CH_3 (pygmaein)

The method used, except for minor deviations, was the standard soil-block bioassay procedure (*5*). Test blocks of ponderosa pine sapwood were impregnated with each of the aforementioned compounds and subjected to pure-culture decay. Loss in block weight during the test constituted the measure of decay. The wood-destroying fungi used were: (i) *Lentinus lepideus* (Madison 534), (ii) *Lenzites trabea* (Madison 617), and (iii) *Poria monticola* (Madison 698). The results are summarized in Table 1.

It is quite apparent from these results that α-thujaplicinol is among the most potent of the compounds which we tested. It also will be observed that when one of the hydroxyl groups is replaced by a methoxy group, such as pygmaein, the fungicidal activity decreases. This would suggest that the tropolone hydroxy group is the functional grouping largely responsible for the fungitoxic properties exhibited by this type of compound. This appears to be borne out further by the result with the prepared methylated thujaplicins; these compounds had virtually no decay-inhibiting capacity against the fungi tested, while the naturally occurring γ-thujaplicin was strongly fungicidal. Since each of the two hydroxyl groups in α-thujaplicinol is immediately

Table 1. Decay retardant bioassay. The test blocks contained 1.2 percent (by weight) of chemical; test duration was 6 weeks.

Weight loss caused by decay fungus (%)		
Lentinus lepideus	*Lenzites trabea*	*Poria monticola*
	γ-Thujaplicin	
1	0	18
	α-Thujaplicinol	
1	1	1
	Pygmaein	
4	29	14
	Methylated thujaplicins	
23	51	43
	Control	
33	52	45