atoms or molecules, will have a much lower temperature, greater molecular weight (*8*), and hence a larger value of Y than the incoming gas. In this respect at least, Brandt's more recent criticism (*9*) of Firsoff's work is unjustified. As has been pointed out by Gold (*10*), it is the component accommodated to the lunar surface temperature which contributes chiefly to the atmospheric density near the surface.

To calculate then the complete density distribution near the moon, one-half of Eq. 1, referring to the *incoming* component of the interplanetary gas, must be added to the density contributions from the usual components of a planetary exosphere, namely, the ballistic re-entry component and the escaping component (*5*). For these we have derived the following expression:

$$[N(r)/N_o]\,(r/R)^2 = \int_0^{\pi/2} \frac{\sin\theta\cos\theta\ \exp(-Ea^2)\ d\theta}{(1-y^2\sin^2\theta)^{\frac{1}{2}}} \cdot [(1+2a^2E)\phi - b\phi']$$
$$+ \tfrac{1}{2}\int_0^{\pi/2} \frac{\sin\theta\cos\theta\ \exp(-Ea^2)\ d\theta}{(1-y^2\sin^2\theta)^{\frac{1}{2}}} \cdot [(1+2a^2E)(1-\phi) + b\phi'] \qquad (3)$$

where $y = R/r$, $E = G\mathcal{M}M/(RkT)$, $a = [(1-y)/(1-y^2\sin^2\theta)]^{\frac{1}{2}}$, $b = E^{\frac{1}{2}}(1-a^2)^{\frac{1}{2}}$, and $\phi = \phi(b)$ is the error integral, $\phi'(b)$ its derivative, θ the zenith angle of the particle as it leaves the reference level R. The first integral gives the ballistic re-entry component (which contributes twice, on the way up and on the way down); the second integral gives the contribution of the escaping component. It should be noted that in this formula T refers to lunar surface temperature (*11*). The normalization for N_0 must be such that the incoming flux of interplanetary gas equals the escaping flux; it must be applied separately to each atomic species contained in the interplanetary gas. This escaping flux is given by

$$4\pi R^2 N_o (kT/2\pi M)^{\frac{1}{2}}\,(1+E)\exp(-E) \qquad (4)$$

and must equal the accreted flux

$$\pi R^2 N(\infty)(8kT/\pi M)^{\frac{1}{2}}\,(1+E) \qquad (5)$$

On account of the higher Y value of the outgoing component, the density concentration will be much greater than that calculated by Brandt. This increase will be especially pronounced for a gas component of high atomic weight, as has already been surmised by Firsoff (*12*). (Unfortunately, no quantitative statements can be made as to its abundance.) In general, however, the density will be smaller than that found by Firsoff because of the invalidity of the hydrostatic equilibrium formula which he uses. Furthermore, the density of interplanetary gas turns out to be very much lower than 10^3 cm^{-3}, as follows from recent spectral studies of the zodiacal light by the Cambridge, England, group (*13*).

Further, it may be quite unrealistic to consider a quiescent interplanetary gas cloud with respect to the moon. Because of the relative orbital motion, the effective "temperature" to be used in Eq. 1 for the incoming component must be very high, and the resulting *concentration*, accordingly, small. The accommodated component given in Eq. 3 will not be much affected, however, since it depends on the accreted *flux* and the temperature of the lunar surface (*14*).

E. J. ÖPIK
S. F. SINGER

Department of Physics, University of Maryland, College Park

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7. The accommodation coefficient κ depends upon the kinetic energy of the protons, relative to the moving lunar surface. κ will be close to unity for the very high temperatures quoted for the interplanetary gas (*2*). Because of the presumed porosity of the lunar surface, κ will be large even at much lower temperatures.
8. Actually, it is not molecular weight, as used by Brandt (*2*), but "effective gravitational constant" which is halved for the ions of a plasma. Hence, in Eq. 2 we use $\frac{1}{2}G$ for protons and the full value of G for hydrogen atoms.
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17 June 1960

Rare Tumor in Coast Redwood, Sequoia sempervirens

Abstract. A rare tumor on a conifer, *Sequoia sempervirens*, is described as it appears *in situ* and in section. Evidence is given which indicates, but does not prove, that the tumor had a developmental origin.

The infrequent occurrence of idiopathic tumors in gymnosperms makes the discovery of such abnormal growths in these ancient plants a matter of interest and significance. The significance of such a neoplasm to cancer research will be enhanced, of course, provided that the tumor possesses a primordial state of differentiation arising from aberrant embryological and genetic mechanisms. Examples of this type were reported in two species of spruce (*Picea*) (*1*). These cases were characterized by massive, subglobose growths upon the trunks, branches, and roots; a causal organism was not isolable.

Only two reports concerning tumors in *Sequoia* are known to me. The first account (*2*) described a tumor in *S. sempervirens* growing in Eastbourne, England. This tumor, of unknown etiology, caused severe galling at the base of the tree and resulted in extensive defoliation. In the second instance, Martin described tumors upon *S. giganteum* (growing in Germany) which occurred characteristically at the ground level of the young trees (*3*). He assigned the cause to bacterial infection. [A third instance of tumors in *S. sempervirens* is described by Dufrénoy (*4*).]

The present report describes the occurrence of multiple, tumorous growths upon a single specimen of the coast redwood. This tree, shown in Fig. 1*a*, is growing upon the campus of the University of California in Berkeley. Its trunk is about 35 cm in diameter and 30 m in height. The foliage is of normal appearance during the growing season, but unlike the normal sequoia tree, the needles become yellowish and even chlorotic during the late summer and winter (August to March). As in most redwoods, burls [mycorhizal? (*5*)] occur beneath the ground level.

The limbs of this tree are heavily laden with tumors which are as large as 15 cm in diameter. Curiously, these tumors are found only upon the upper parts of the limbs, and, therefore, the growths do not become pendulous. The youngest tumors are asymmetrical and smooth, but with slight swellings of light-green color; buds or shoots are never found upon the tumor surfaces. Older tumors have erupted, scaly surfaces as shown in Fig. 1*b*.

The point of attachment of the tumor is always obscured by the soft mass of tissue forming its main bulk. Nevertheless, careful removal of this soft tissue reveals that the tumor would be entirely separate from its "host" but for a slim peduncle of woody tissue (Fig. 1*c* and *e*). Thus, the latter serves as the sole physiological connection with the tree itself, and this constriction probably accounts for the fact that almost all tumors in excess of 5 cm are dead or partially necrotic. Most tumors (if not all) seem to originate immediately adjacent to a bud or a tiny branch, and, although no tumor occurred upon the trunk itself, tumors were common upon the surfaces of all the branches from their tips to their points of insertion.

Freehand sections of these neoplasms

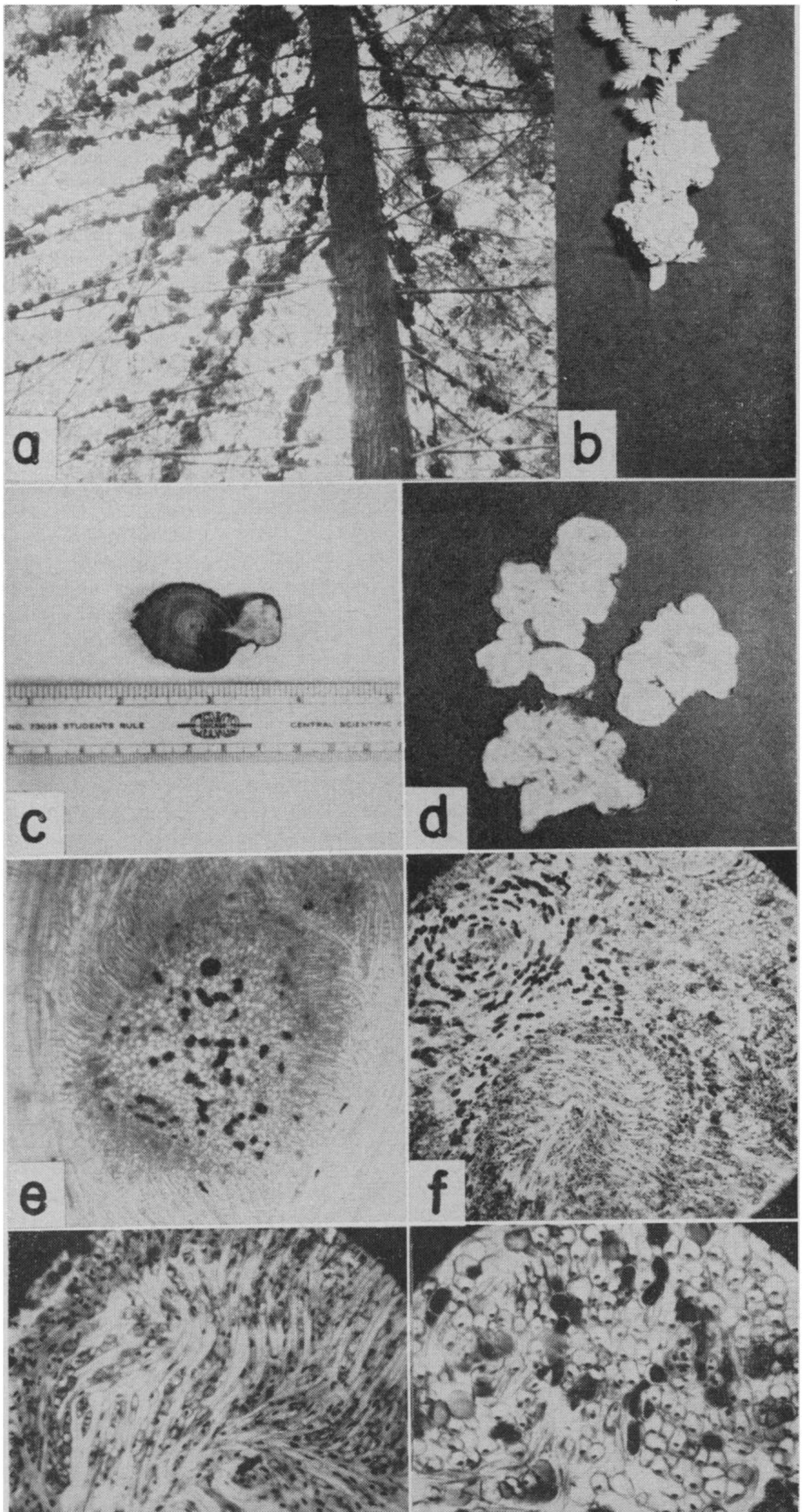

Fig. 1. *Sequoia* tumors *in situ* and in section. (*a*) Growth habit of tumors. (*b*) Typical erupted surfaces of the older tumors. (*c*) Unstained cross section of young tumor and limb showing tracheid bundle emerging from pith. (*d*) Unstained freehand sections of growing tumors. Note disorganized tissue. (*e*) Unstained, transverse section of tracheid bundle leading to tumor. Section was made just beneath cambium layer tangential to limb surface (about × 100). (*f*) Typical appearance of whole tumor after fixation in Craf III and staining with iron hematoxylin (× 50). (*g*) Immature tracheids typical of woody parts of tumor, fixed and stained as in (*f*) (× 128). (*h*) Typical disorganized, soft parenchyma fixed and stained as in (*f*) (× 128).

revealed the extensive disorganization of the tissues both in their soft and woody parts (Fig. 1*d*). Histological examination presented areas (whorls) of immature tracheids (Fig. 1*f* and *g*) surrounded by thick masses of spongy tissue and overlain by scattered areas of collenchyma. The bordered pits characteristic of sequoia tracheids were occasionally to be found. Wood rays were never observed. Figure 1*h* demonstrates the typical disorganized state of the soft tissue. In these sections empty lacunae were very common (often easily visible without magnification). Cells containing pigment (tannin?) were abundant, whereas cells with mitotic figures were very rare (*6*).

The freshly sawn surfaces of tumors dried from the living state have a very pleasant fragrance unlike that of normal wood. The latter, as is well known, is nearly odorless.

The sequoia tumors were observed by me for several years and have been noticed by campus gardeners for much longer periods. Despite the fact that several mature sequoia trees grow in such close proximity to the afflicted tree that their limbs intermingle, not one instance of abnormal growth was found upon the surrounding trees. In my opinion, these facts constitute presumptive evidence that the tumors do not have a fungal or bacterial origin—a conjecture that requires experimental confirmation. However, further support for this opinion is provided when the relationship between the tumor and its supporting tissue is examined (see Fig. 1*c*). Clearly, the tracheid bundle emanating from the pith and the narrow point of attachment of the tumor to the limb surface indicate that this abnormal growth had an early origin from a bud (Fig. 1*e* presents a cross section of the peduncle just beneath its point of insertion into the limb surface). Pertinent to this argument was the fact that freehand sections of dozens of small, growing tumors failed to disclose one instance of an insect parasite —a frequent cause of galling in many plants. Several preliminary attempts to transplant this tumor to the cambium layer of normal sequoia trees have not resulted in growth of the transplant.

It is tentatively indicated that this excrescent neoplasm does not have a parasitic origin, that it is not invasive or naturally transmissible, and that the demands upon its "host" are fastidious. The conclusion that it has a developmental origin (or genetic one) seems inescapable. In any case, one must question whether such a tumor can be considered as an entity separate from the "normal" tree upon which it grows.

C. F. Emanuel*

Department of Physiology,
University of California, Berkeley

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6. Tissues used in this study were collected during the summer months and may not be representative of the growth phase. It is probable that the growth rate is severely restricted because of the narrow peduncle described above. Therefore, the tumor is self-limiting and nonlethal.

* Present address: San Juan Research Laboratory, Bellevue, Wash.

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Alternation as Function of Preliminary Training and Type of Deprivation

Abstract. Laboratory rats trained upon a table top with randomly positioned reinforcement containers showed significantly a greater tendency to alternate in a Y-maze than animals trained on a straight runway. The type of deprivation, either food or water, did not have an effect. The differences in alternation disappeared with repeated trials on the Y-maze.

Alternation has attracted interest among behavioral scientists because of the observed tendency of many organisms to make a different choice on one trial of a series than that made on the preceding trial even though the two choices appeared to require the same degree of effort and to be equally rewarding. Previous studies (*1*) have shown that alternation appears in a variety of similar experimental situations —for example, human beings guessing the outcomes of coin tossing (*2*)—and that there is a persistent tendency to alternate even though one of the choices may be continuously reinforced (*3*).

Explanations of alternation have tended to consist of postulating that the organism has an attribute with properties necessary to account for the observed results. For example, reactive inhibition (*4*) has been a favorite explanation because it has been postulated that reactive inhibition is generated as a positive function of effort and dissipates with time. Presumably responses requiring a greater degree of effort would generate more reactive inhibition with a consequent greater tendency to avoid response repetition temporarily. However, experiments which have separated the degree of effort required to make a response from the time required to make the response have not supported the hypothesis that effort is a variable determining alternation.

Another type of construct links the process producing alternation to perception rather than to responses by postulating a perception-produced decrement in the perceptual process, for example, "stimulus satiation" (*1*). Such response-inferred constructs, however, tend to be circular unless the variables which control them are delineated, in which case they are redundant. An alternative approach, which has not been seriously attempted (*3*), is to examine the extent to which alternation is an effect dependent upon transfer of training. For example, rats in their laboratory living quarters may have to move around to find food; consequently, when a piece of food is consumed in one place, the animals learn to look elsewhere for other pieces.

Conceivably, similar but more complex explanations can be invoked to account for the avoidance by human beings of recently made responses. In fact, a learning explanation of the human tendency to avoid repeating guesses seems to be more plausible than an explanation involving perceptual decrement.

To test the hypothesis that alternation behavior is learned, 38 experimentally naive hooded rats, from the colony maintained at Indiana University by the psychology department, were run in a two-variable factorial design. At the start of each experimental and training session each animal was under 18-hour food or water deprivation. The animals all received 13 days of preliminary training. For 20 of the animals the preliminary training consisted of six reinforced—that is, rewarded with food or water—runs a day on a 4-foot straight runway. Each of the other 18 animals was placed for 3 minutes a day upon a 2½- by 4-foot table top on which were six randomly positioned reinforcement containers with either food or water. No animal failed to find and consume the reinforcements within the 3-minute period. The food reward was a pellet of commercial rat food weighing 45 mg. The water reward was two drops of water from a standard medicine dropper. The reinforcements were presented in small depressions drilled in 1½-inch-square aluminum pieces cut from 3/16-inch stock.

After preliminary training the animals were tested for 15 consecutive days on a Y-maze with 2-foot legs. Each animal was given two pairs of reinforced runs a day. Each pair of runs was separated by the time required to run the other animals in the group receiving the same treatment conditions. An alternation was counted if, on the second run of a pair, an animal chose the side opposite to the side chosen on the first run of the pair.

Because there is less tendency to alternate with longer time between trials (*1*), a time score based on running time in the second run of each pair of runs was computed for each animal. It might be expected that the faster animals would alternate more because they would have a shorter interval between the first and second runs of each pair. Analysis indicates that the running time for the animals trained on the straight runway was significantly shorter ($p < .01$) than that for the animals trained on the table top. The average times were, respectively, 9.99 and 15.05 seconds. If alternation depended only on the time between choices, the animals trained on the straight runway would be expected to alternate more than the others. It was found, however, that the animals trained on the table top alternated significantly more than those trained on the straight runway ($p < .05$). The type

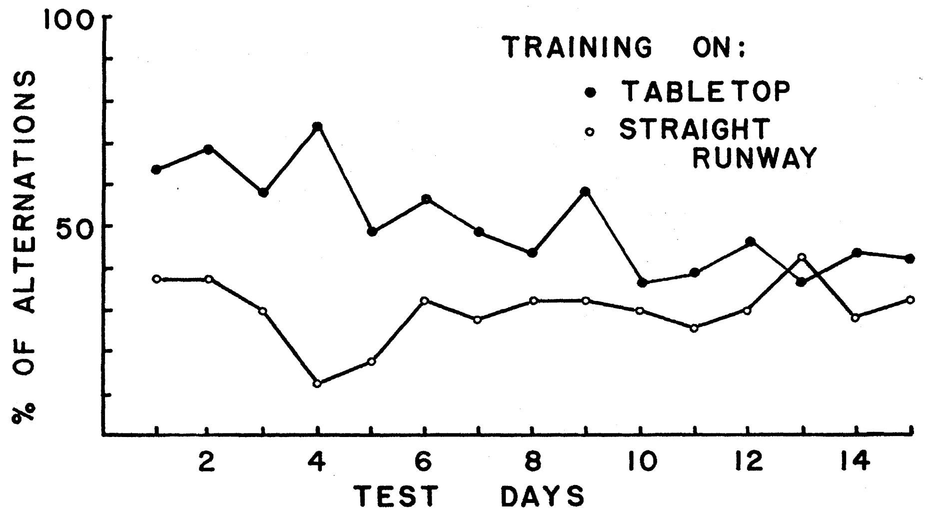

Fig. 1. Percentage of trials on which alternation occurred as a function of days with two pairs of test trials per day. Note the initially greater percentage of alternation of the animals trained on the table top.