Left pneumonectomy was performed in one cat in order to test the possibility that the receptors being studied were located in the lungs. Discharge patterns in single fibers of the left dorsal roots could not be distinguished in this animal from patterns recorded in animals with intact lungs.

These data show that the expansion and retraction of the chest during breathing produces intermittent activity of receptors in the thoracic wall, just as inflation and deflation of the lungs causes periodic discharge of pulmonary receptors. These thoracic wall receptors are collectively a prolific source of afferent signals rhythmically coursing into the spinal cord and conceivably ascending to higher centers. Boruchow and Nelson (*4*) have identified unitary activity coincident with respiration in the dorsal columns at the level of the third and fourth cervical segments. Yamamoto, Sugihara, and Kuru (*5*) have found fibers in the posterior funiculus of the thoracic region which appeared to discharge in phase with respiratory movements. The activity recorded in ascending tracts by these authors may well have originated in receptors within the thoracic wall. Its physiological effects could be manifest at the segmental level or higher.

The fact that discharge frequency was proportional to chest deformation and that adaptation of these receptors was slow is compatible with their being proprioceptors. The receptors which were specifically localized were in the lateral thoracic wall; they could have been in muscle, fascia, periosteum, or parietal pleura. There is, in addition, the possibility that receptors in the diaphragm, abdominal wall, and costal articulations with vertebrae and sternum are activated by the motions of respiration.

It was concluded that inspiratory and expiratory responses could not necessarily be ascribed to the contraction of an inspiratory or an expiratory muscle. Conceivably, contraction of either type of muscle could produce discharge on inspiration or expiration, depending on whether the receptor being studied was in parallel (muscle spindle) or in series (tendon receptor) with the muscle (*6*).

Literature on the neural regulation of respiration over recent decades has included scant reference to the possibility that thoracic proprioceptors participate in establishing the rhythm of breathing. The older literature, however, contains specific references to this topic. Luciani's textbook, *Human Physiology*, published near the turn of the century, accounts for the respiration after vagotomy as "due to the rhythmical and alternate excitation of the sensory paths of the inspiratory and expiratory muscles" (*7*). In 1917, Coombs and Pike (*8*) demonstrated that sectioning the thoracic and cervical dorsal roots of cats resulted in a diminution or cessation of costal breathing. The afferent streams of rhythmic activity recorded in the present studies are a reasonable basis for these observations (*9*).

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Density of the Lunar Atmosphere

Abstract. The consequences of a model are worked out in which the lunar atmosphere is formed by gravitational accretion of interplanetary gas. Our results differ from those of Firsoff and of Brandt, partly because of the inapplicability of the barometric equation to the case of an exosphere.

The density of the lunar atmosphere has been recently discussed by Firsoff (*1*) and by Brandt (*2*) from the following point of view. It is assumed that no gas is exhaled from the moon itself and that any atmosphere observed in the vicinity of the moon is produced by gravitational accretion from the interplanetary gas.

It may well be true that the amount of gas evolved from the moon is negligible, although this is by no means sure. For example, the careful work of Edwards and Borst (*3*) on the evolution of krypton and xenon must be considered, and the fate of the evolved gas has to be discussed. [We have done this in a separate paper (*4*) and conclude that the loss of krypton and xenon is quite rapid because of photoionization effects, so that its contribution to the atmosphere cannot be important.] Furthermore, the purely gravitational treatment (*1, 2*) may not at all correspond to the real situation. Not only has the existence of a magnetic field been neglected, but we must also take into account the possible existence of a lunar electric charge, and therefore of a surface electric field. When these factors are considered, the picture changes signficantly (*4*).

However, even the purely gravitational treatment is seriously in error. This may be seen as follows. The concept of an isothermal atmosphere in hydrostatic equilibrium is invalid for an exosphere, since the mean free path exceeds the scale height and, in the present case, even the radius of the moon. Hence, the use of the so-called barometric formula, Eq. 1 in Brandt's paper (*2*), cannot be justified. The reasons for this have been discussed in detail (*5*) and are essentially concerned with the negligible effects of collisions among the gas atoms. For example, for the extreme cases considered by Brandt, it can be shown that the mean free path is from 2.5×10^8 cm ($N_e = 10^4$, $T = 10^4$) to 2.5×10^{11} cm ($N_e = 10^3$, $T = 10^5$) for protons in a plasma, and from 5×10^8 cm ($N = 10^6$) to 5×10^{11} cm ($N = 10^3$) for neutral molecules. These figures are in excess of the radius of the moon.

In the absence of magnetic and electric fields, the correct distribution of a gravitationally accreted atmosphere around a center of force, when the mean length of path exceeds the radius of the planet, can be calculated after the theory developed by Öpik (*6*) as follows:

$$\mathrm{N}(r)/N(\infty) = 2\pi^{-1/2}\left[Y^{1/2} + (\exp Y) \cdot \int_{Y}^{\infty} \exp(-x^2) \cdot dx\right] \qquad (1)$$

where

$$Y = G\mathcal{M}M/(rkT) \qquad (2)$$

We use here the notation of Brandt's paper (*2*), with $N(\infty)$ denoting the number density of the unperturbed background (interplanetary gas). When the temperature is high, or when Y is small, the difference between Brandt's Eq. 1 and our Eq. 1 is not significant. For large values of Y, however, Brandt's Eq. 1 yields the spurious high concentrations as actually calculated by Firsoff.

Even within the limited frame considered by Brandt and Firsoff, our Eq. 1 gives only the contribution to the density from interplanetary gas that is elastically scattered by the lunar surface. We may expect, however, that interplanetary protons, after striking the surface of the moon, will be accommodated (*7*). They will lose their charge and, when leaving the surface as neutral 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:

$$[N(r)/N_0]\,(r/R)^2 = \int_0^{\pi/2} \frac{\sin\theta\cos\theta\ \exp(-Ea^2)\ d\theta}{(1-y^2\sin^2\theta)^{\frac{1}{2}}} \cdot [(1+2a^2E)\phi - b\phi'] + \tfrac{1}{2}\int_0^{\pi/2} \frac{\sin\theta\cos\theta\ \exp(-Ea^2)\ d\theta}{(1-y^2\sin^2\theta)^{\frac{1}{2}}} \cdot [(1+2a^2E)(1-\phi) + b\phi'] \qquad (3)$$

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

$$4\pi R^2 N_0 (kT/2\pi M)^{\frac{1}{2}}\,(1+E)\,\exp(-E) \qquad (4)$$

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*).

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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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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