Table 2. Standard deviations of the average ratios of Sr^{90} to Cs^{137} for five representative stations in North America.

Station	Annual rainfall (in.)	Av. ratio, Sr^{90}/Cs^{137}	Standard deviation (%)
Burlington, Wash.	40–60	0.11	23
Tipton, Calif.	irrigation	0.115	42
St. Albans, Vt.	40–60	0.13	30
Aberdeen, Miss.	40–60	0.27	18
Springfield, Mo.	20–40	0.22	30
			Av. 29

entirely adequate for large-scale monitoring purposes. Presumably the same value would hold for the rest of the Western world and might hold for the whole world. Limited data from a world-wide network of about 15 stations are concordant with this assumption.

A further question, however, is whether the accuracy of the estimate can be improved if the sampling is restricted in some way. First, the standard deviation was calculated for five representative stations for the entire 4-yr period. The results are shown in Table 2.

The combination of the analytical errors probably yields a standard deviation of the ratio of about 15 percent. The average deviation of 29 percent for these five representative stations therefore seems to show a real variation in this ratio in the samples, but it is clear that the estimate of the Sr^{90} concentration from a Cs^{137} assay can be improved if some history is available on the particular station. It can also be observed from these data that the average Sr^{90}/Cs^{137} ratio for a given station remained within the standard deviation from year to year. This suggests that over this period there was no marked difference in the character of the fallout or the relative routes of entry of Cs^{137} and Sr^{90} into grass.

There are significant and reproducible differences in the average Sr^{90}/Cs^{137} ratio between the stations in each group. Thus in the eastern sector, where rainfall is 40 to 60 in. annually, Aberdeen, Miss., has an average ratio of 0.27, whereas St. Albans, Vt., has about 0.15. In the Midwest 20 to 40 in. area, the highest consistent station is Springfield, Mo., with 0.22, and the lowest is LaGrange, Tex., with 0.13. There is no systematic difference with latitude or, within the station variation, with rainfall. Thus the average values for the different groups, each with their standard error of the mean, are: East (40–60 in.), 0.19 ± 0.02; northwest coast (40–60 in.), 0.14 ± 0.02; Midwest (20–40 in.), 0.19 ± 0.02; High Plains states (10–20 in.), 0.19 ± 0.03; West and Southwest (irrigation), 0.14 ± 0.03.

The differences in the average ratio of Sr^{90} to Cs^{137} between individual stations (as much as a factor of 2) appear to be real, but the reason for these differences is as yet obscure.

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References and Notes

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Transport of Oxygen through Hemoglobin Solutions

Abstract. An expression is derived for the steady-state diffusion rate of oxygen through a solution or suspension of oxygen-carrying particles. Several special cases of interest are discussed and compared with the data of Hemmingsen and Scholander. Their observed dependence of the rate of specific oxygen transport on pressure and *p*H is consistent with the present expression.

The discovery by Scholander (*1*) that oxygen diffuses through hemoglobin solution many times faster than nitrogen has stimulated considerable interest (*2*). More recently, Hemmingsen and Scholander (*3*) showed that this specific transport of oxygen is abolished when the liquid film is opposed by a slight back pressure of oxygen. These investigators also pointed out the need for a unified theory to explain all of their data. In the present report, a simple general expression is derived which not only accounts for their results but which may also be useful as a quantitative guide for further experimental work in this direction.

Consider the portion of liquid enclosed in an imaginary cylinder in the diffusion layer as depicted by the broken line in Fig. 1. Let the axis of the cylinder be parallel to the x-axis, which represents the direction of diffusion, and let A and $x_1 - x_2$ represent, respectively, the cross-sectional area and length of this imaginary cylinder. We have, for the concentration C_i of bound O_2 inside the oxygen-carrying particles:

$$C_i \equiv f(p) = cpL'/L \qquad (1)$$

where c is the concentration of total hemoglobin or myoglobin inside the oxygen-carrying particles; p is the partial pressure of O_2; $L' = dL/dp$; and for myoglobin, $L = 1 + Kp$, and for hemoglobin, $L = 1 + K_1p + K_1K_2p^2 + K_1K_2K_3p^3 + K_1K_2K_3K_4p^4$; and K, K_1, K_2, K_3, and K_4 are equilibrium constants for oxygenation reactions (*4*).

Also, for the concentration C_o of dissolved O_2 in water outside the particles, we have

$$C_o = kp \qquad (2)$$

and for the concentration C_p of dissolved O_2 in the particles, we have

$$C_p = k'p \qquad (3)$$

where k and k' are the Henry's law constants.

Differentiating Eq. 1 with respect to p gives

$$f'(p) \equiv df(p)/dp = c(pLL'' + LL' - pL'^2)/L^2 \qquad (4)$$

where $L'' \equiv dL'/dp$.

The steady-state diffusion rate of oxygen molecules in the x-direction, averaged over the entire volume of the imaginary cylinder, is

$$q = \frac{-1}{A(x_2 - x_1)}\left[\int_{v_o} D_o k \frac{\partial p}{\partial x} dv + \int_{v_i} (D_i + D_p)\left\{f'(p) + k'\right\}\frac{\partial p}{\partial x} dv\right] \qquad (5)$$

where D_o, D_i, and D_p represent, respectively, the diffusion coefficient of dissolved O_2 outside the oxygen-carrying particles, that inside the particles, and the diffusion coefficient of the particles themselves. The integration of the first term in Eq. 5 is to be carried out over the total volume, v_o, of the imaginary cylinder outside the particles, and the integration of the second term is over the total volume, v_i, inside the particles.

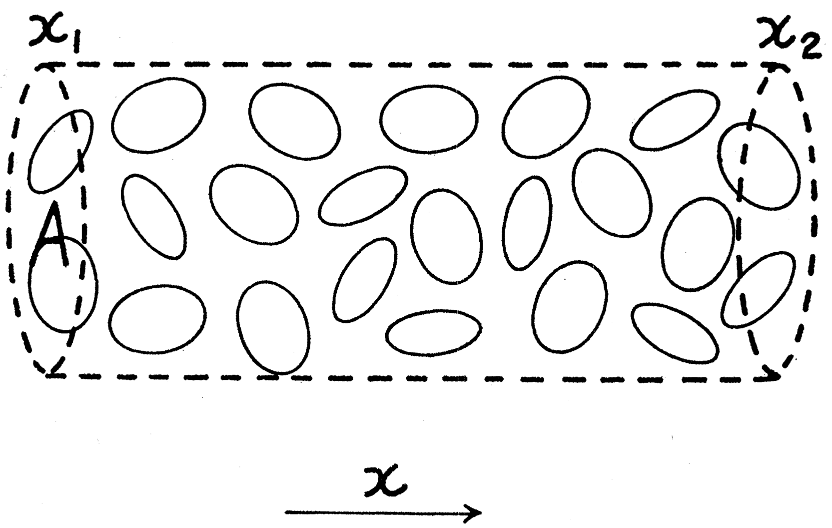

Fig. 1. Diagrammatical representation of a volume element in the diffusion layer containing oxygen-carrying particles represented by the ellipsoids.

The following three particular cases are of special interest:

1) For the diffusion of nitrogen or any other nonreacting gas, $f'(p) = 0$. Consequently, we can make the approximation that $D_o k \simeq D_i k'$ and that

$$\partial p/\partial x = (p_2 - p_1)/(x_2 - x_1) \equiv \triangle p/\triangle x = dp/dx$$

where p_1 and p_2 are the partial pressures of the diffusing gas at x_1 and x_2 respectively. Equation 5 then simplifies to the familiar form

$$q = - D_o\ (\triangle p/\triangle x)k \qquad (6)$$

2) For the diffusion of oxygen at low partial pressures, $f'(p) > k'$ or k. Hence the second integral in Eq. 5 gives rise to an increased rate of diffusion as observed by Scholander (*1*).

3) For the diffusion of oxygen under high partial pressure, $f'(p) \rightarrow 0$. Hence the diffusion rate drops back to normal, as was found experimentally.

The dependence of steady-state diffusion rate on the partial pressure of oxygen can be conveniently illustrated by considering the special case of a very concentrated layer of immobilized myoglobin or hemoglobin solution or gel or a layer of packed erythrocytes. For such a special case we have

$$v_o << v_i \qquad (7)$$

$$Dp \rightarrow 0 \qquad (8)$$

$$\partial p/\partial x = \triangle p/\triangle x = dp/dx \qquad (9)$$

Substituting Eqs. 7, 8, and 9 in Eq. 5 gives

$$q = \frac{-D_i}{x_2 - x_1}\int_{p_1}^{p_2}[f'(p) + k']dp \qquad (10)$$

For simplicity let us consider the case of myoglobin, for which $L = 1 + Kp$, $L' = K$, and $L'' = 0$; hence we have the equation

$$f(p) = cKp/(1 + Kp),$$
$$f'(p) = cK/(1 + Kp)^2 \qquad (11)$$

Substituting Eq. 11 in Eq. 10 and integrating gives

$$q = - D_i\left(\frac{\triangle p}{\triangle x}\right)\left[k' + \frac{ck}{(1 + Kp_1)\ (1 + Kp_2)}\right] \qquad (12)$$

Therefore, at constant pressure gradient, $\triangle p/\triangle x$, the diffusion rate at low partial pressures decreases as p_1 and p_2 are raised. At sufficiently high partial pressures, the second term in Eq. 12 becomes negligible; consequently, the oxygen molecules diffuse as a nonreacting gas. Similarly, the integral in Eq. 10 can be evaluated for hemoglobin, but in this case graphical and numerical methods are probably more expedient. It may also be noted that, although $f(p)$ and $f'(p)$ for hemoglobin are *p*H-dependent, the effect of *p*H on diffusion is noticeable only at low oxygen pressure when $f'(p)$ is not negligible as compared to k', which is in agreement with the observations of Hemmingsen and Scholander (*3*).

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Response Latencies of Female Rats during Sexual Intercourse

Abstract. A female rat, by operating a lever, causes the presentation of a potent male rat and subsequent sexual contact. The female shows contact-response latencies that vary according to the nature of the contact. Latencies after ejaculations are longer than those after intromissions, which in turn exceed those after mounts.

In recent years our knowledge of the sexual behavior of the rat has increased considerably, largely because of the work of Beach and of Larsson (*1*, *2*). The great majority of the studies that these and other workers have carried out focuses primary importance on the male's behavior; the female has come in for scant attention. The experiment reported here measures the effects of single copulations on the behavior of estrus female rats, in the context of an ongoing series of copulations.

The major difficulty encountered in a detailed study of the female's behavior stems from the male's apparent dominance in the control of the intercopulatory intervals during ad libitum intercourse. In order to investigate in detail the behavioral effects of single copulations on the female, therefore, it is necessary to provide a method by which she can control the timing of the copulations. One such method is to make each copulation contingent upon some measurable *arbitrary response* by the female.

Eight albino and seven hooded female rats, ranging in age from 6 to 20 mo, were used as subjects. None of the females had been spayed; four were sexually experienced. Sexually vigorous hooded males between 3 and 6 mo old serviced the females during experimental sessions. Between sessions the animals were segregated, kept in a constant 12-hour light cycle, and fed freely.

A wooden box, 1 ft square and 15 in. high, served as the experimental space. A lever of the sort commonly used in operant conditioning studies protruded from one wall of the box. Operation of the lever activated timing and counting equipment. A buzzer on the outside of the box sounded for 1 sec after a lever-press.

The females were trained to press the lever by making presentation of the male contingent upon successively closer approximations to the desired response. The time required to train each female ranged from 15 to 90 min. At least 2 wk separated final training and the first testing session. Behavioral heat was induced by subcutaneous injections of 0.1 mg of estradiol benzoate (Progynon, Schering) 72 hr before