In my paper on "Human ecology" [*Science* **120**, 962 (1954)] the reference to "the late Otto Glaser" should read "Otto Glasser." Otto Glaser, professor emeritus of biology at Amherst, died in 1951. I am happy to report that Otto Glasser of the Department of Biophysics, Western Reserve Medical School, and editor of the excellent handbook of *Medical Physics* is still very much alive.

To O. S. Gibbs of Jefferson Medical College I am indebted for a vigorous objection to my somewhat unguarded statement that "Nature long ago discarded the nonsense of carrying poisonous wastes and nutrients in the same vessels." This is of course not literally true, except as mass effects are concerned, and they are what I had in mind. In both "pure" rivers and "pure" arterial blood there are materials with a considerable range of physiological properties, their effects being regulated by what amount to homeostatic processes. These processes break down in streams overcharged with human waste, industrial and domestic, and since we often depend on such streams for public water supply, a situation amounting to biological nonsense does exist.

Perhaps I should have used the analogy of upper and lower alimentary canal rather than artery and vein. But since the bulk of correspondence concerning the article has come from medical men, none of whom have raised the issue, I assume that my intent was clear and the analogy was not wholly inappropriate.

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C^{14}-Labeled Ergot Alkaloids

To provide detectable material for *in vivo* studies with the alkaloids and their derivatives and to enable an extension of our investigations on their biosynthesis, we have produced C^{14}-labeled ergot alkaloids (*1*).

Rye was grown in crocks and, prior to flowering, sealed in bell jars of 40-lit capacity. Approximately 160 ml of CO_2, containing 0.1 mc C^{14}, was introduced each day for 9 days. Illumination at an intensity of 300 ft-ca was continuous for 12 days. The plants, after removal, were infected with a culture of *Claviceps purpurea* and maintained in a normal environment until the sclerotia were mature. Fourteen sclerotia, of total weight 192 mg, were obtained.

The defatted sclerotia were extracted and the alkaloids isolated by a column partition chromatographic procedure (*2*). Further purification was effected by converting the alkaloid to the lactate and shaking with ether to remove nonalkaloid contaminants. The base, generated in aqueous solution, was recovered by shaking with ether-chloroform (2 : 1) mixture.

The ether-chloroform solution was evaporated on a planchet, and 20 1-min counts were made with a thin mica end-window G-M tube. The residue was redissolved in ether and again counted. The alkaloid was quantitatively removed, converted to the lactate, and assayed spectrophotometrically using *p*-dimethylaminobenzaldehyde test solution (U.S.P.). The results of analysis are reported in Table 1. Production of a larger quantity of labeled alkaloids is planned.

Table 1. Results of analysis.

Alkaloid	counts/min		Amt. (μg)	count/min mg	
Ergotoxine	144.8 ± 1.9	151.8 ± 3.3	68.5	2115	2216
Ergotamine	334.3 ± 4.5	358.1 ± 3.7	240.4	1390	1489
Ergonovine	42.1 ± 2.0	50.0 ± 1.6	6.0	7016	8333

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References and Notes

1. Aided by grants from the U.S. Atomic Energy Commission, contract No. AT (30-1) 1666.
2. J. E. Carless, *J. Pharm. Pharmacol.* **5**, 883 (1953).

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Diffusion Constant and Diffusion Coefficient

In his treatise, *The Anatomy and Physiology of Capillaries,* Krogh (*1*, p. 268) defines the diffusion constant as

> . . . the number of cc of gas which will in one minute diffuse through an area of 1 cm^2, when the pressure gradient is one atmosphere per μ (0.001 mm).

Krogh uses this definition in his discussion of diffusion within tissues. The term *diffusion constant* has usually been regarded as analogous to the diffusivity (*2*), but Krogh's diffusion constant differs from the diffusivity, or diffusion coefficient, in two ways: in defining the gradient it employs the micron instead of the centimeter, and it employs "tension" units instead of concentration units. ("Tension" is partial pressure of diffusing substance in the gas phase at equilibrium between gas and liquid phases.) The first difference is unimportant because it simply introduces a constant factor of 10^4; but the second is important because it makes the diffusion constant a composite of two variables, the diffusivity and the solubility of diffusing substance in the liquid medium. For example, Krogh lists a value of 0.34 for the diffusion constant of O_2 in water at 20° C. The diffusivity of O_2 in water is 1.607 cm^2/day (Spoehr, *3*), or 1.12×10^{-3} cm^2/min. The solubility of O_2 in water is 0.031 at 20°C. Thus the magnitude of the diffusion constant of Krogh can be computed as $1.12 \times 10^{-3} \times 0.031 \times 10^4 = 0.346$.

Obviously this diffusion constant is not an index of diffusivity because it is so importantly influenced by solubility; yet it appears that physiologists have made the error of assuming that it is such an index.

Prosser *et al.* (*4*) reproduce Krogh's definition and

indicate in parentheses that it differs from the diffusion coefficient by a factor of 10^4; thus they fail to point out the important distinction between them. And they state,

> In spite of its larger molecular size carbon dioxide diffuses through tissues 20 to 30 times faster than oxygen does, owing to the higher solubility of CO_2.

This sentence leaves the impression that solubility somehow imparts a 20 to 30-fold higher diffusivity to the heavy CO_2 molecule. Actually the diffusivity of CO_2 is 1.378 cm^2/day (*3*), which, compared with 1.607 for O_2, is inversely proportional to the square root of molecular weight, in agreement with Graham's Law. Krogh himself implies that the diffusivity of CO_2 is many times higher than that of O_2, for he states (*1*, p. 273),

> . . . the carbon dioxide produced in the tissues can always be eliminated by diffusion into the capillaries, since the diffusion constant for CO_2 in tissues is some thirty times higher than for oxygen. The CO_2 pressure difference between any point in the tissue and the blood must, moreover, in all circumstances, be an absolutely negligible quantity.

Actually, the concentration gradient required to achieve a given CO_2 transport must be higher than for the same O_2 transport; therefore Krogh's use of the words *absolutely negligible* indicates that he failed to distinguish between his diffusion constant and the diffusion coefficient. Furthermore, both Prosser *et al.* and Krogh state that the diffusion constant for oxygen increases about 1 percent/deg C, taking the 20°C rate as unity. This statement is false. It is approximately true for the diffusion coefficient [the temperature coefficient of O_2 diffusivity in water, as is indicated by the dropping Hg electrode, is 1.6 percent/deg C in the neighborhood of 20° C (*5*)], but the influence of solubility, which decreases with rising temperature, will offset the increase in diffusivity. Thus the magnitude of the diffusion constant for O_2 in water at 30°C is about $1.30 \times 10^{-3} \times 0.026 \times 10^4 = 0.338$, which is almost identical to the value at 20°C.

These quotations and computations show that Krogh's diffusion constant has been erroneously regarded as an index of diffusivity, and that many biologists have been led to believe that CO_2 has a higher diffusivity than O_2 in aquatic mediums. The error has resulted from the unfortunate use of tension units (*6*) in Krogh's diffusion constant.

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References

1. A. Krogh, *The Anatomy and Physiology of Capillaries* (Yale Univ. Press, New Haven, 1936).
2. L. P. Hammett, *Introduction to the Study of Physical Chemistry* (McGraw-Hill, New York, 1952), p. 199.
3. H. A. Spoehr, *Photosynthesis* (Chemical Catalog Co., New York, 1926), p. 84.
4. C. L. Prosser *et al.*, *Comparative Animal Physiology* (Saunders, Philadelphia, 1950), p. 211.
5. W. M. Manning, *Ecology* **21**, 509 (1940).
6. J. Verduin, *Science* **118**, 254 (1953).

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Antibiotic Effect on *Ceratostomella fimbriata* of Ipomeamarone, an Abnormal Metabolite in Black Rot of Sweetpotato

It has been reported that the respiratory increase in black-rotten sweetpotato roots infected by *Ceratostomella fimbriata* is caused by the uncoupling action of ipomeamarone (Ip.) (*1–3*)

(130°C, 3 mm-Hg)

that had been accumulated in the infected parts by the sweetpotato. It is important, we suppose, from the phytopathological point of view, to learn whether Ip. disrupts the phosphorus metabolism of the penetrating fungus or not, and to make clear the relationship between the accumulated Ip. and the resisting power of the sweetpotato root. M. Hiura has proved that the germination of *C. fimbriata* is controlled in the Ip.-containing culture medium, and we confirmed that the growth, sporulation, spore formation, and respiration of the fungus were restrained by Ip.

In our experiments with the spore-cell suspension taken from the shaking culture, as well as with the mycelium prepared from surface culture, we observed that Ip., even in a low concentration, prevented the absorption of inorganic phosphate by *C. fimbriata* from the medium and the conversion from inorganic P to acid-soluble-organic P and insoluble P. At the same time Ip. promoted spore respiration in the same concentration. The fact became more evident in an experiment using a medium containing P^{32} in which Ip. prevented the conversion of inorganic P^{32} into acid-soluble P and insoluble P.

S. Spiegelman *et al.* (*4*) proposed from their data on phosphate metabolism of yeast that ATP, generated through glycolysis or respiration, was required when inorganic P in medium was converted into acid-soluble-organic P and insoluble P; thus uncouplers such as DNP, azide repressed considerably the conversion of inorganic P.

The mechanism of antibiotics such as Aureomycin, usnic acid, gramicidin, and dehydroacetic acid (*5*), and others has been known to be based on the uncoupling action of oxidative phosphorylation. Now we suppose that Ip. also takes part in the resistive power of sweetpotato root against *C. fimbriata* as an uncoupler.

In addition, oxidative product of chlorogenic acid was observed to repress the oxidative phosphorylation of sweetpotato particles. The oxidative product of chlorogenic acid by polyphenol oxidase in the infected tissues also might be explained to be a factor contributing to the resistance of sweetpotato root.

A further investigation of ours has been focused upon the relationship of Ip. to the nucleic acid metabolism of *C. fimbriata*, the mutation, and adaptation of the fungus.