References

1. K. M. Glover, K. R. Hardy, T. G. Konrad, W. N. Sullivan, A. S. Michaels, *Science* **154**, 967 (1966).
2. R. C. Rainey, *Nature* **175**, 77 (1955).
3. B. V. Ramana Murty, A. K. Roy, K. R. Biswas, L. T. Khemani, *J. Sci. Ind. Res. India* **23**, 289 (1964).
4. R. C. Rainey, *Food Agr. Organ. U.N., Rome, Progr. Rep. No. UNSF/DL/RFS/3* (1965), p. 9.
5. S. Mazumdar, N. S. Bhaskara Rao, G. R. Gupta, *Tech. Notes World Meteorol. Organ. No. 69* (1965), p. 162.
6. A. B. Crawford, *Proc. I.R.E. (Inst. Radio Engrs.)* **37**, No. 4 (1949).

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Seal Ears

Graham (*1*) expresses the need for a physiological investigation of the middle ear of true seals (Phocidae), similar to that on sea lions (Otariidae) (*2*). Odend'hal and Poulter (*2*) describe cavernous tissue covering the linings of the middle-ear cavity in two species of sea lions and put forward the hypothesis that these tissues serve to equilibrate the air pressure of the middle ear with the external pressure of the water, which varies with depth of diving. Graham accepts this hypothesis, and, on the basis of comparisons of the bulla region of phocids and otariids, proposes that, if true seals do have similar cavernous tissues, they should be able to dive deeper than eared seals, because the volume of air available for compression in the bulla is larger in true seals.

In the course of some studies for a cochlear microphonic experiment, I have opened the bulla of several freshly killed harbor seals (*Phoca vitulina*) and can state that the middle-ear cavities in this species of Phocidae are covered with cavernous tissue, much in the same way those of sea lions are (*2*). However, this appears not to be a new observation, as Tandler has already described this tissue (*3*). Tandler suggests the same function of equilibration as proposed by Odend'hal and Poulter for the sea lion, but he states that importance should be attached only to the morphological findings, not to the speculation about function.

The assumption of Graham, concerning the existence of cavernous tissue in the tympanic cavity of true seals, is thus substantiated, but it should be noted that the hypotheses offered are both based on the supposition that the Eustachian tubes in diving seals are blocked, and the evidence in support of this is not very conclusive.

Another aspect is that the essential point of equilibration is that of keeping the same pressure on each side of the tympanic membrane, while in the first approximation the pressure of the tympanic cavity relative to the external pressure is of minor importance. As a seal closes the orifice of its auditory meatus when diving, the air in the long, cartilage- and bone-supported meatus is trapped, and, consequently, hypotheses on equilibration of the middle ear in these animals should take into account equilibration of the meatus as well. I have made some transverse sections of the auditory meatus of a grey seal (*Halichoerus grypus*) and have found that the space between the lumen and the cartilage actually is occupied with cavernous tissue (Fig. 1). Distention of the cavernous tissue will cause a decrease in the size of the lumen of the meatus; assuming a regulation mechanism for the meatus similar to that proposed for the middle ear by Tandler and Odend'hal and Poulter, we can imagine how the pressure of the two cavities separated by the tympanic membrane may be equilibrated, but other possibilities cannot be excluded, and experiments seem necessary to establish the role of the cavernous tissue in pinniped hearing.

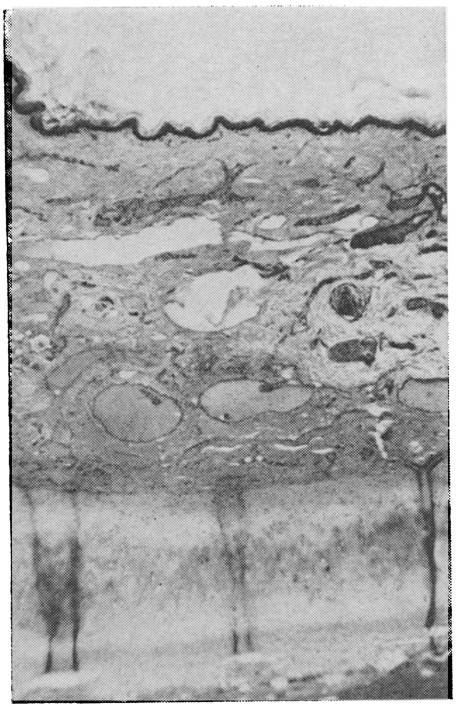

Fig. 1. Transverse section of the auditory meatus of a grey seal, showing cavernous tissue, partly filled with blood, between the lumen (top) and the cartilage (bottom). Black lines in cartilage represent artifacts (× 31).

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References

1. S. F. Graham, *Science* **154**, 489 (1967).
2. S. Odend'hal and T. C. Poulter, *ibid.* **153**, 768 (1966).
3. J. Tandler, *Monatsschr. Ohrenheilk.* **33**, 437 (1899).

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Pollution in the Great Lakes

In the report on pollution in the Great Lakes by R. H. Rainey [*Science* **155**, 1242 (1967)] a plus sign has been omitted from Eq. 1, which should read:

$$C_2 = C_2^0 \exp(-RT/V) + [C_1 + (Q/R)][1 - \exp(-RT/V)]. \quad (1)$$

The neglected effects of the natural forces of purification may be significant when the equation is applied to organic matter, particularly the effects of sedimentation and attendant anaerobic decomposition of organic matter in the deposited sludge and also the decomposition of organic matter by oxidation—the oxygen coming from photosynthesis and from surface aeration as in an "oxidation pond." By introducing a term for these effects, $-K_1VC_2dT$, into the differential equation on which Eq. 1 is based, one obtains the equation:

$$C_2 = C_2^0 \exp[-(R/V + K_1)T] + \{(C_1 + Q/R)/(1 + VK_1/R)\}\{1 - \exp[-(R/V + K_1)T]\} \quad (2)$$

However, it must be admitted that the estimation of the value of K_1 in this equation would be difficult, particularly because of the seasonal growth of algae and the attendant creation of organic matter which at night or in cloudy weather has the same kind of effect on depletion of oxygen in the lake as does decomposing sewage.

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