(wet weight 0.5 g) survived for weeks in running sea-water. The function of the egg-case for the entire 1.5-to-2 year period is protection of the embryo and the external yolk sac from injury; only when the external yolk sac is completely absorbed does the young skate hatch. In contrast to the transient existence of "embryonic hemoglobin" in the oviparous skate, the ovoviviparous shark *Squalus suckleyi* has a distinct fetal hemoglobin throughout its 23-month gestation period (*10*).

The widespread phylogenetic distribution of the ability to synthesize a fetal or embryonic hemoglobin of high oxygen affinity in egg-laying vertebrates (skate, bullfrog, terrapin, and chicken) represents a biochemical "preadaptation" (*11*) which has made possible the development of the oxygen-transfer system involved in the diffusion of oxygen from maternal to fetal blood (*1*) in the polyphyletic evolution of ovoviviparty and viviparity in many vertebrate groups.

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6. I wish to thank J. P. Baumberger and S. Gross for helpful discussion, and C. Hickman, F. L. Hisaw, F. L. Hisaw, Jr., W. S. Hoar, and P. Sund for provision of egg-cases and assistance in catching and bleeding large skates. These studies were made while I was a National Science Foundation fellow. The oxygen equilibrium of skate hemoglobin was evaluated as in a study on hemerythrin [C. Manwell, *Science* 127, 592 (1958)], a model DU Beckman spectrophotometer being used. Erythrocytes were suspended in an isotonic phosphate buffered urea-containing elasmobranch Ringer's solution, modified after the method of C. F. A. Pantin [*Notes on Microscopical Technique for Zoologists* (Cambridge Univ. Press, Cambridge, 1948)].
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11. The term "preadaptation" is being used in the sense of "prospective adaptation" [G. G. Simpson, *The Major Features of Evolution* (Columbia University Press, New York, 1953), especially pp. 188–198].

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Density of the Upper Atmosphere

An atmospheric density at an altitude of about 368 km has been inferred from the orbital behavior and physical characteristics of the American artificial earth satellite Explorer I, also denoted as 1958 Alpha. The orbital data as of 1 February 1958 were (*1, 2*): eccentricity, 0.139; inclination, 33°.2; argument of perigee, 120°.0; anomalistic period, $0^{d}.0798274$; decrease of period 3.9×10^{-7} day per period or about $0^{s}.42$ per day. From these one finds a mean distance of 1.22757 earth radii, corresponding to a perigee height above the international ellipsoid of 368 km.

The satellite is a cylinder 80 in. long and 6 in. in diameter, and it has a mass of about 14 kg (*3*). The area of such an object that is relevant to its air resistance is its area projected on a plane normal to its direction of motion. The average over all possible orientations, for random tumbling, is one fourth of the total superficial area, or 2520 cm^2. The same value is obtained if the cylinder spins about a transverse axis, randomly oriented with respect to the orbit plane. Averaged over a spin period, over orientations of the spin axis with respect to the orbit plane, and over the motion of perigee, the same projected area has been obtained as for random tumbling, and has been employed. The aerodynamic drag coefficient has been taken to be 2. The density has been inferred by a method described elsewhere (*4*) from this value, the mass, the average area, the eccentricity, the mean distance, the rate of decrease of period, and the logarithmic derivative of density near perigee given by the ARDC model atmosphere (*5*).

The density thus found, 1.5×10^{-14} g/cm^3 at a geometric altitude of 368 km (348 geopotential) is about 14 times that predicted by the ARDC model atmosphere. It falls nearly on the middle curve, No. 2, in a study (*6*) that tentatively suggested a modification of the ARDC atmosphere to satisfy a density 4.5×10^{-13} g/cm^3 at 220 km (213 geopotential) that had been inferred (*7*) from observations of the U.S.S.R. satellite 1957 Alpha 2. This value was about 9 times the ARDC density. The values 4.5×10^{-13} and 1.5×10^{-14} g/cm^3 depend somewhat on the gradients of density of the ARDC model employed in the reductions. It seems better to infer the densities at both altitudes from the observations without recourse to model atmospheres, and to proceed by successive approximations until the gradients and densities are consistent. In this way, from the observations of both satellites together, densities have been inferred of about 4.0×10^{-13} g/cm^3 at 220 km and about 1.4×10^{-14} g/cm^3 at 368 km. These values do not agree well with densities predicted by Harris and Jastrow (*8*) as extrapolations from altitudes of about 220 km and below, but they seem to be in surprisingly good agreement with curve No. 2 of reference (*6*).

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References and Notes

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7. T. E. Sterne and G. F. Schilling, *Smithsonian Astrophys. Observatory Spec. Rept. No. 3, IGY Project No. 30.10* (1957).
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Density Determinations Based on the Explorer and Vanguard Satellites

Minitrack observations on the orbits of Explorer I and Vanguard I permit us to make a rough determination of the density of the atmosphere at latitudes between 33°N and 33°S (*1, 2*). Our analysis is based on the orbit elements and rate of change of period obtained from Minitrack data for these satellites by the Vanguard Computing Center. The change in period is the direct result of the drag exerted by the atmosphere, which causes the satellite to lose energy continuously during its lifetime. As the energy of the satellite decreases, it falls towards the center of the earth,

Table 1. Orbital periods for Explorer I, derived by the Vanguard Computing Center from Minitrack data. The third column gives the average value of dP/dt, obtained from the tabular differences in the first and second columns.

Date	P (min)	dP/dt (min/day)
5 Feb.	114.95	
		0.0073
2 Apr.	114.54	
		0.0097
2 May	114.25	
		0.0150
17 May	114.13	
Weighted av. (min/day)		$(9^{+6}_{-2}) \times 10^{-3}$
M/C_dA		(24 ± 8) kg/m²