of the periphery of the gyre, four conditions contribute to its existence. (i) Nutrient-biomass levels are high, sustaining an abundant and diverse flora and fauna (*9*). Because foraminifers are as likely as other zooplankton to have species-specific food sources among the plankton on which they feed, their compositional diversity should mirror both the abundance and variety of food in the peripheral waters of the subtropical gyre (*11*). Locally, cool upwelling waters off coastal Saharan Africa at 20°N furnish very high nutrient and biomass concentrations, and diversity in that area is high. The winter overturn of the Northern Sargasso Central water above 30°N apparently boosts its diversity above the Southern Sargasso Central water minimum (*8*). (ii) Salinities are intermediate, neither so low (as off Guiana) nor so high (as in the southern Sargasso Sea) as to prohibit species from inhabiting those regions. (iii) Currents of sufficient velocity exist to carry equatorial foraminifers northward to northeastward and more northern species southward to southwestward within the general clockwise circulation of the subtropical gyre. These latitudinal displacements occur primarily in the Gulf Stream and the Canaries Current regions, where a mixed fauna with greater diversity results (*12*). (iv) Strong physical oceanographic gradients allow temporal overlap of water masses and create laterally mixed faunas in the sediments below. The particularly abrupt Gulf Stream gradients must encourage temporal mixing within the meander belt. The southernmost portion of the peripheral belt of high diversity may be in part due to seasonal and long-term mixing. Along latitudes 15° to 20°N several typically equatorial and central water species overlap. Because no species is wholly indigenous to those latitudes, the high diversity there seems better attributed to this overlapping effect.

Within compact, well-defined gyres such as that in the North Atlantic, prohibitively severe conditions may override and blur planetary dominance and diversity gradients. The resulting dominance maximums and diversity minimums among planktonic fauna can constitute valid criteria by which to detect paleoecologically significant water masses, along with the major features of ocean circulation.

WILLIAM F. RUDDIMAN*
Lamont-Doherty Geological
Observatory, Palisades,
New York 10968

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* Present address: U.S. Naval Oceanographic Office, Chesapeake Beach, Maryland 20732.

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Lecithin Aerosols Generated Ultrasonically above 25°C

Abstract. DL-*Dipalmitoyl-α-lecithin, suspended in 0.15-molar sodium chloride solution by sonic cavitation at 20 kilohertz, can be aerosolized by an 800-kilohertz ultrasonic generator only at temperatures above 25°C. The aerosol thus produced is exceptionally stable against evaporation even at particle radii of 0.1 to 0.6 micron; this suggests applicability to the therapy of pulmonary disorders.*

Synthetic DL-dipalmitoyl-α-lecithin (DPL) dispersed in 0.15*M* aqueous sodium chloride (saline) by a sonic cavitation generator (Branson Heat Systems sonifier W185D, 20 khz) can be readily aerosolized ultrasonically (Macrosonics Corporation Ultramist III, 800 khz) above a threshold temperature of about 25°C, without the addition of albumin, glycol, or other materials. The aerosol particles ultrasonically generated from 2 percent DPL (by weight) suspended in saline in air saturated with water vapor at 37°C have radii ranging from 0.1 to approximately 0.6 micron, whereas the control saline gives particles larger by a factor of 10, as estimated by Stokesian settling velocity. The aerosolized lecithin particles are exceptionally stable against evaporation.

The Laplace equation

$$P_e = 2\sigma / r$$

relates the excess pressure P_e inside a drop of radius r to its surface tension σ. For a drop of pure water ($\sigma = 72$ dyne/cm) with $r = 0.2$ micron, $P_e = 7.2$ atm.

The Poynting equation for the actual vapor pressure P^* of a liquid of molal volume $\overline{V}$ and standard (*1*) vapor pressure P^0 under an excess pressure P_e at temperature T gives

$$P^* = P^0 \exp (P_e \overline{V} / RT)$$

where R is the gas constant. The solution for $P_e = 7.2$ atm and $T = 310$°K gives $P^* \cong 1.005\ P^0$. With pure water aerosols, approximately 0.2 micron in radius, such a driving force ($P^* - P^0$) in combination with a large surface-to-volume ratio would lead to rapid evaporation and disappearance, even in air at 100 percent relative humidity (*2*). That our lecithin aerosol particles of this size do not rapidly evaporate suggests that $P^* \approx P^0$; thus $P_e \approx 0$, and $\sigma \cong 0$. This implies that, in disruption of the geysers (*3*) in the ultrasonic aerosol generator, the rapidly decreasing surface area of the ejected matter leads to minima in surface tension near zero. This has been observed by Kuenzig *et al.* (*4*) and Fujiwara *et al.* (*5*) for lecithins in albumin by measurement of surface tension on a Wilhelmy balance and by cinephotomicrography on rapidly changing sessile bubbles in pure saline suspensions of DPL at 27°C or above (*6*).

We measured (*6*) the surface tension of DPL suspensions in saline as pendant drops of constant area as a function of time (Laplace equation) and found a discontinuity in this function at a temperature between 22.3° and 25°C, interpretable either as a drastic increase in the diffusion coefficient of DPL through saline or as a greatly increased mobility of DPL at the air interface.

Gershenzon and Eknadiosyants (*7*) report that the rate of ultrasonic generation of aerosols from pure simple liquids at 200 khz (in grams per minute) is proportional to $\sqrt{P^0/\eta\sigma}$, where P^0 is vapor pressure, σ is surface tension, and η is viscosity. Having found that no aerosolization of DPL saline suspension occurs in the ultrasonic generator below 25°C, and that the rate approaches 60 percent of that for plain saline at 37°C, we postulate that, with DPL saline suspension, the effective surface viscosity below 25°C is very high, or that it is highly viscoelastic.

Our observations lead us to suggest the reinvestigation of the therapeutic administration of lecithin aerosols—a question apparently not pursued since Robillard *et al.* (*8*) reported the use of DPL in glycol and water, aerosolized by means of an air-jet (impingement) generator, for hyaline membrane disease (respiratory distress syndrome). Stable aerosol particles 0.1 to 0.6 micron in radius should easily reach the pulmonary alveoli and should act not only to supply DPL, if needed, to alveoli deficient in DPL, but also to convey agents such as penicillin, radioisotopes, and so forth. That the DPL aerosol particles do indeed reach the alveoli and deposit therein, when aerosolized ultrasonically at 30° to 45°C, is strongly supported by experiments on excised dog lung (*9*).

EDWARD W. MERRILL
DAVID J. GRAVES*
KENNETH A. SMITH
Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge 02139
DANIEL C. SHANNON
HOMAYOUN KAZEMI
Pulmonary Unit, Massachusetts General Hospital and *Harvard Medical School, Boston, Massachusetts*

References and Notes

1. Standard in that the pure liquid is in equilibrium with pure vapor and the interface is flat.
2. An order-of-magnitude approximation is as follows: The flux I, (in grams per second) of a molecular species j undergoing steady-state evaporation from the surface of a sphere of radius r, where its concentration is C_{js} (in grams per cubic centimeter), into a quasi-infinite continuum, where its concentration is $C_{j\infty}$, is related to the diffusion coefficient D (in square centimeters per second) by the equation
$$I = 4\pi r D(C_{js} - C_{j\infty})$$
In the case at hand, the perfect gas law gives
$$C_s - C_\infty = (P^* - P^0)M/RT$$
where R is the gas constant. The solution for $P^0 = 47$ mm-Hg water vapor pressure at $T = 310°C$ and molecular weight $M = 18$ gives $I = 1.53 \times 10^{-11}$ g/sec for a sphere of radius 0.2 micron. Since the mass of the sphere at unit density $= 4\pi r^3/3 = 3.35 \times 10^{-14}$ g, this means that the sphere is losing 50 percent of its mass per millisecond at this instant.

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* Present address: U.S. Army Medical Corps, Fort Sam Houston, San Antonio, Texas.

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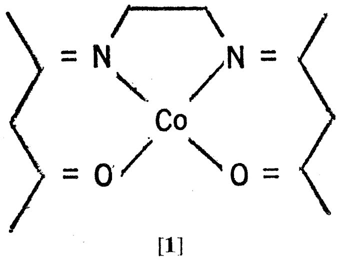
Monomeric Cobalt-Oxygen Complexes

Abstract. *Some Schiff base complexes of cobalt(II) form stable cobalt-oxygen species in solution instead of the usual cobalt-oxygen-cobalt bridged complexes. These one-to-one adducts were isolated as crystalline solids and characterized by means of elemental analysis, magnetic properties, and molecular weight determinations.*

Synthetic oxygen carriers of cobalt (II) complexes have been extensively studied (*1*). Unlike hemoglobin, in which one molecule of oxygen is bound to one iron atom, the oxygen adducts of cobalt(II) complexes generally contain two atoms of cobalt for every molecule of oxygen. The formation of 1 : 1 cobalt-oxygen adducts as active intermediates has been postulated (*2*). We report here on the formation and isolation of some 1 : 1 cobalt-oxygen adducts of the cobalt(II) Schiff base complex **[1]**, bis-(acetylacetone)ethylenediiminecobalt(II) [Co(acac)$_2$en]. Floriana and Calderazzo (*3*) have investigated some corresponding salicylaldehyde (sa) Schiff base systems and found that all of these except one formed the usual peroxo-bridged compounds. The 3-methoxy derivative reacted with oxygen in the presence of pyridine to form the 1 : 1 cobalt-oxygen adduct.



[1]

Reversible oxygen absorption by complex **[1]** requires that it be dissolved in toluene in the presence of an appropriate Lewis base. The bases used were *N,N*-dimethylformamide (DMF), pyridine (py), 4-methylpyridine (CH$_3$-py), 4-cyanopyridine (CN-py), and 4-aminopyridine (NH$_2$-py). Oxygenation took place at approximately −10°C. Absence of the Lewis base or temperatures in solution above 0°C resulted in decomposition of the complexes as evidenced by a nonstoichiometric absorption of oxygen.

Complex **[1]** was prepared by a method similar to that of Everett and Holm (*4*). The five oxygen adducts (Table 1) were prepared by cooling a concentrated toluene solution of **[1]** and one of the five Lewis bases to below −10°C. Oxygen was then bubbled through the solution at this temperature. The crystalline product was isolated by cooling the solution to approximately −50°C and filtering at that temperature.

All of the crystalline oxygen adducts were found to be thermally unstable. The DMF adduct **[2]** decomposes quite dramatically on warming to room temperature. Controlled decomposition of a weighed sample in a vacuum chamber equipped with a Toepler pump results in the quantitative release of one mole of DMF (*5*) and one mole of oxygen (*6*) per mole of cobalt

$$\mathrm{Co(acac)_2en(DMF)O_2} \rightarrow \mathrm{Co(acac)_2en + DMF + O_2}$$

The other crystalline oxygen adducts containing coordinated pyridine and substituted pyridines (**[3]**, **[4]**, **[5]**, **[6]**) did not release molecular oxygen on warming to room temperature in the solid state. However, if these solids are dissolved in an appropriate organic solvent in a vacuum, quantitative measurements (*6*) indicate that between 0.5 and 1.0 mole of oxygen are released per mole of cobalt. The lower than expected values for the release of oxygen by these 1 : 1 adducts is thought