Increased Hemoglobin-Oxygen Affinity at Extremely High Altitudes

Eaton *et al.* (*1*) stated that "increased, rather than decreased, oxygen affinity is an effective mode of short-term adaptation to markedly reduced environmental oxygen pressures" and pointed out the need to reevaluate the idea that "decreased hemoglobin-oxygen affinity is of adaptive value to humans at high altitudes."

We fully agree with these authors and wish to call attention to the fact that human natives of high altitudes are unique in having a right shift of the oxygen dissociation curve in their hypoxic environment. Thus, camelids (alpaca, vicuña, llama), rodents (chinchilla, vizcacha), ruminants (yak), and birds (ostrich, huallata) that are native to high altitudes have a higher oxygen affinity than their relatives at sea level (camel, rabbit, ox, and a variety of sea level birds) (*2, 3*).

We have recently shown that the Peruvian high-altitude native increases his hematocrit as a function of both age and altitude (*4*) and, in collaboration with Sime (*5*), we have found that this is due to a decrease in ventilatory rate with age. Since the changes observed in the ventilatory function and the hemoglobin-oxygen affinity at high altitude do not seem to be of long-term adaptive value, the physiology of human adaptation to very high altitudes needs to be reevaluated.

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Oil Spills in the Arctic Ocean: Extent of Spreading and Possibility of Large-Scale Thermal Effects

Campbell and Martin (*1*) have considered the possibility that a major oil spill might significantly change the heat balance of the Arctic Ocean and trigger widespread melting of the pack ice. Based on assumptions regarding the thickness to which oil will spread on open water and the percentage of open leads in the Arctic ice pack, they estimated the area that would be "affected" by an oil spill of 2×10^6 barrels (3.2×10^5 m^3). Their estimates ranged from 240 km^2 to 8×10^5 km^2. The upper limit is about 8 percent of the total area covered by pack ice (10^7 km^2).

We believe the assumptions leading to the higher values in the quoted range are too pessimistic. Furthermore, the "affected area" calculated by Campbell and Martin, that is, the area of the entire region where oil would be found in open leads, including all the ice not covered by oil between the leads, is not a good indicator of the potential effect on the Arctic heat balance. Open water has a high absorptivity for solar radiation (*2*), which is not increased much by the presence of an oil film. Neither is the albedo of a clean ice floe altered by the presence of an oil film on the surrounding water. Significant thermal effects are expected only from oil on the ice surface where it could cause a drastic change in reflectivity. Therefore, a more relevant indicator of the potential thermal effect of an oil spill would be the ice surface area that is actually covered by oil.

We also believe that the assumed spill volume of 2×10^6 barrels is very unlikely to occur in any single accident. The *Torrey Canyon* spill (7×10^5 barrels) (*3*) is the largest on record, and estimated spill volumes from other major spill accidents have been significantly less (*3, 4*). Current emphasis on safer oil transportation techniques should reduce the chance of large spills occurring in the future. Furthermore, it is unrealistic to assume no cleanup operations for a spill of this size. Most observers (*5–7*) believe that cleanup in the Arctic would be more effective than in open waters because the ice would serve as natural containment booms and work platforms. Nevertheless, like Campbell and Martin, we will base our estimates on a spill of 2×10^6 barrels with a 25 percent evaporation loss (leaving an oil volume of 2.4×10^5 m^3) without cleanup operations.

Oil spreading on water. The equilibrium thicknesses of oil slicks on ice-covered water are much greater than those on open water. In the presence of ice, the spreading forces can be balanced by the wind stress acting on the surface of the oil. Using equations developed by Hoult (*8*), we estimated typical film thicknesses of oil confined by floating ice barriers to range from 0.1 to 1 cm for wind speeds from 1 to 5 knots (1 knot = 1.854 km/hour). This agrees with observations by Glaeser and Ayers, who took part in the U.S. Coast Guard oil spill test in the Chukchi Sea (*5*). For a film thickness of 0.1 cm, the slick area would be 240 km^2. Campbell and Martin suggested that "lead-matrix pumping" could disperse oil over much wider areas. This appears reasonable. However, should extensive dispersion occur by this or any other mechanism, the experience cited above indicates that the oil would form individual patches whose aggregate surface area would still not exceed the estimated maximum of 240 km^2.

Mechanisms of oil spreading over and under ice. As noted above, to cause significant melting, oil must find its way onto the ice surface. Aside from direct over-ice or under-ice spilling, the most obvious mechanism by which oil can be incorporated in or on sea ice is by the freezing of oil-covered leads. Typically, the newly formed ice is subject to compression by adjacent floes, a process that will greatly reduce the surface area of contaminated ice. Another mechanism is lateral transport by wave action from open leads onto or under the adjacent ice, that is, in the form of spray or entrained droplets, respectively. Oil trapped below the ice would eventually reach the surface by alternating processes of summer melting on top and winter freezing at the bottom of the ice sheet. Thus, we must consider spreading at both the ice-water and the ice-air interface.

Gravity provides the main spreading mechanism at both interfaces, with possible contributions from meltwater runoff on top (*9*) and current-induced shear forces below the ice. In addition, spreading below the ice may result from under-ice transport of dispersed oil droplets. Campbell and Martin visualized this mechanism as perhaps the