tragacanth at 30, 60, and 120 minutes is 1.02, a value which indicates that DMSO may have had no effect on the blood-brain barrier during this time, and that increased brain levels were due only to facilitated entry of radioactivity into the blood. For the time periods prior to 30 minutes no data are cited for the group treated with tragacanth to support the conclusion of a "a partial breakdown of the blood-brain barrier *within* [italics ours] the first 30 minutes."

The action postulated for DMSO in promoting transport across the blood-brain barrier would seem to be most readily demonstrated when DMSO is injected intravenously as a vehicle for drugs acting on the central nervous system. We (*2*) found, however, that when DMSO was administered intravenously as a vehicle for barbital or phenobarbital sodium in various experiments, either there was no difference between the use of DMSO or saline as a vehicle, or it took mice significantly longer to lose their righting reflex with DMSO.

This would indicate that DMSO either had no effect or that it may actually have decreased transport across the blood-brain barrier. Earlier Dixon *et al.* (*3*) had found that the use of DMSO as a vehicle (i) did not affect the penetration of intravenously administered ^{14}C-*p*-aminohippuric acid into the brain or cerebrospinal fluid in dogs, nor (ii) did it affect the time required for intraperitoneally administered phenobarbital to cause a loss of the righting reflex in mice.

Thus, there does not appear to be any substantial evidence showing that DMSO exerts any general action in promoting transport across the blood-brain barrier, and we believe that it remains to be demonstrated that DMSO affects the brain uptake of pemoline specifically.

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Although the comments of Kocsis, Harkaway, and Vogel are valid in the restricted sense that elevated plasma levels of pemoline-C^{14} will increase brain levels of this compound, the authors appear not to consider tissue to plasma ratios as being important to an interpretation of possible changes in transport phenomena. If the ratios at different times in animals injected with pemoline and tragacanth are used as criteria, then averaging the ratios for animals treated with pemoline and dimethyl sulfoxide (DMSO) over time to give a value approximating that of the former group does not necessarily mean that no change in the transport process had occurred within this period, regardless of direction. The authors' proposal that "transport across the blood-brain barrier would seem to be most readily demonstrated when DMSO is injected intravenously as a vehicle for drugs" has recently been used by Thompson and Hart (*1*) to study the effects of DMSO on the transport of sucrose-C^{14} and urea-C^{14} into the brain. Under the conditions employed, DMSO facilitated penetration by urea-C^{14} but had no effect on the uptake of sucrose-C^{14}. It appears that DMSO may have differential effects on the blood-brain barrier, depending on the type of compound used to evaluate the effect of this vehicle on the brain transport process. The citation of Dixon's findings by these authors could represent a case in which DMSO does not affect brain penetration by *p*-aminohippurate, whereas it may well facilitate uptake of pemoline.

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Venus: Ice Sheets

Libby (*1*) suggests that the polar regions of Venus may be covered with ice sheets despite the fact that the Cytherean surface is very hot in the equatorial region. His revival of this old hypothesis stems from the difficulty in accounting for all the water on Venus. It is reasonable to assume that almost as much water has escaped from the interior of Venus as from the interior of Earth.

I point out that if the amount of water on Venus is of the same magnitude as that on Earth (*2*), about 1.5×10^9 km^3, then the Cytherean ice sheets must extend into low latitudes indeed if they are to lock up all the water. Since the equatorial region is very hot it does not appear realistic to postulate that the missing water on Venus is all contained in polar ice sheets.

The profile and thickness of an active ice sheet are almost uniquely determined once its horizontal dimensions are specified (*3, 4*). The profile of a circular ice sheet, centered on a pole of a planet, is given approximately by the equation

$$h^2 = (3\tau R/\rho g)(\theta - \theta_0)$$

where h is the thickness of the ice sheet at latitude θ (measured in radians), θ_0 is the latitude of the edge of the ice sheet, R is the radius of the planet, ρ is the density of ice, g is the gravitational acceleration at the planet's surface, and τ is the average shear stress at the bottom of the ice sheet—

$$\tau \approx -(2\rho gh/3R)dh/d\theta = -\rho gh\alpha$$

where α is the slope of the upper surface. This profile equation is derived under the assumption that an ice sheet sinks isostatically into the crust to the extent of ⅓ the total thickness of ice. (Note that the density of surface rocks is about three times greater than the density of ice.) The curvature of the surface of the planet is taken into account in this equation, but surface relief in the form of mountain chains or "ocean basins" is ignored.

The total volume V of ice in two sheets, one centered at each pole, is

$$V = (4\pi R^2)(3\tau R/\rho g)^{\frac{1}{2}} \int_{\theta_0}^{\pi/2} (\theta - \theta_0)^{\frac{1}{2}} \cos\theta \cdot d\theta$$

The integral in this equation is equal to the series

$$(\pi/2 - \theta_0)^{\frac{3}{2}}\{[2^2(\pi/2 - \theta_0)^2/3 \cdot 5] - [2^4(\pi/2 - \theta_0)^4/3 \cdot 5 \cdot 7 \cdot 9] + [2^6(\pi/2 - \theta_0)^6/3 \cdot 5 \cdot 7 \cdot 9 \cdot 11 \cdot 13] - \ldots\}$$

For the typical value of $\tau \approx 0.5$ bar, we find $\theta_0 \approx 27°$ when V is set equal to the volume of water on Earth. If $\tau \approx 1$ bar, $\theta_0 \approx 36°$. Therefore the Cytherean ice sheets must extend to quite low latitudes if they contain an amount of water comparable to that on Earth. (Stress τ ranges from 0.5 to 1.0 bar for ice sheets on Earth.)

If the ice sheets of Venus were to extend only to 60° latitude, τ would have to be of the order of 19 bars when $V = 1.5 \times 10^9$ km^3. Since the creep rate of ice is proportional to the stress raised to about the third or fourth power, the ice velocity of such ice sheets would be at least 10^4 greater than of those on Earth; it would require a rate of accumulation of snow upon them that is also at least 10^4 greater than the rate of accumulation on either the Greenland or the Antarctic ice sheet. Another unreasonable result for this value of θ_0 is that the maximum ice thickness at $\theta = 90°$ is 47 km.

In addition to the problem of the size of the Cytherean ice sheets, they also present problems of stability. On Earth, ice sheets of this extreme size appear unable to exist in a steady-state condition (*4*).

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5. Supported by the Advanced Research Project Agency of the Department of Defense, through Northwestern University Materials Research Center, under contract SD-67.

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Weertman finds my suggestion (*1*) that water comparable to that on Earth is locked in polar ice caps on Venus unreasonable because the sheets would have to extend too far toward the hot equatorial belt; he suggests that sheets several kilometers in thickness are unstable. Here are my reasons for concluding that ice sheets averaging 10 km in thickness and extending to 45° latitude may be reasonable:

The stability of the sheet depends only on the net rate of precipitation (after correction for vaporization) being great enough to compensate the melting caused by the motion toward the equator and by the hot winds from the equatorial desert; a net precipitation rate of ice of 1 m/year corresponds to a flow rate of 0.3 km/year (if the ice sheet ends at 45° latitude). These seem to me to be reasonable figures, especially in view of the fact that ice formed in the presence of 18 atm of CO_2 may have quite different flow and melting properties.

Takenouchi and Kennedy (*2*) have studied the dissociation pressures of the phase $CO_2 \cdot 5.75\ H_2O$ (*3*). Apparently its mechanical properties have not been measured, but it forms in equilibrium with ice and CO_2-rich water at 10 atm and about −1°C; at 18 atm it forms at about 4°C. At the higher pressures to which the ice caps may be subject, its melting point rises to 19°C at 2000 atm which is the maximum pressure envisaged on Venus (20-km thickness at the poles). This characteristic of melting point rising with pressure is opposite, of course, to that of ordinary ice which at 2000 atm has a melting point of about −20°C (*4*).

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African Agricultural Patterns and the Sickle Cell

The recent paper by Wiesenfeld (*1*) presents most ingenious arguments on the effects of developing agricultural patterns on the evolution and incidence of the sickle-cell trait in Africa. The value of the approach which Wiesenfeld has adopted makes it the more unfortunate that much of his argument is based on Murdock's so-called "Malaysian agricultural complex" (*2*). The concept of the east-to-west spread of this "complex" of root and tree crops across the African continent about 2000 years ago was widely promulgated by Murdock (*2*), but his theory has gained little acceptance by Africanists who have actually worked in the field in Africa, as it ignores botanical, archeological, and agricultural facts, especially insofar as the origin of root crops and their cultivation is concerned. There is, of course, no doubt that Madagascar and the east African littoral have been greatly influenced by peoples and crop complexes of Malaysian origin, but there is little to support the thesis that these peoples and complexes spread to west Africa before the 16th century A.D.

The botanical evidence is clearest in the case of the yam. Although the Malaysian *Dioscorea alata* is a fairly common crop plant in west Africa, *D. cayenensis* and more especially *D. rotundata* (the "Guinea yams") are cultivated on a far larger scale, and these are unquestionably indigenous (*3–5*). In many west African languages the common names of *D. cayenensis* and *D. rotundata* signify "proper yam" (*6*), and it is with the harvesting of these species that the peculiarly west African tradition of the New Yam Festival is associated (*3*). The Asiatic species is grown mainly near the older coastal towns, where European influence is strongest (*7*); furthermore it is certainly no more common to the east of the Dahomey gap than to the west, as Murdock, to support his theory, suggests it is. There exists, also, an area of central Africa more than 1000 miles (1600 kilometers) wide where the Asiatic yam is virtually unknown even today, clearly separating the east and west African areas where this yam is cultivated (*8*). There is, in fact, no reason to suppose otherwise than that *D. alata* was brought by sea to west Africa by Iberian traders of the 16th century (*9*). The introduction of the "Guinea yams" into cultivation is essentially a west African development (*5, 10*), specifically a development peculiar to the Kwa-speaking peoples of the part of west Africa that lies between the central Ivory Coast and the Cameroons (*7, 11*). Reports by the earliest European mariners who visited west Africa, about A.D. 1500, show that cultivation of and trade in yams were already highly organized at that time (*12*). The wealth of myth and legend associated with the cultivation of the "Guinea yams" also points to their great antiquity as crop plants (*3, 11*). Outside the Ivory Coast–Cameroons belt the cultivation of yams is of far less importance; beyond this belt they are grown mainly for use as an occasional vegetable relish or, at best, a secondary staple.

Of the other Asiatic yams mentioned by Wiesenfeld, *Dioscorea esculenta* was