burst of clicks while approaching the mirror, Sam remained silent and showed no further interest. The results for the other two sea lions (Figs. 2 and 3) indicate that both orientation and clicking: (i) decreased within each test session, (ii) recovered between sessions, and (iii) generally declined over sessions. In addition to clicking, Bibi emitted sharp cracks and whinnies. Both animals frequently swam 3 to 4 m from the mirror before swinging about to make a rapid "run" at it while vocalizing; they either paused a few centimeters in front of it or made a sharp turn away. In many of these excursions the animals moved their heads back and forth spasmodically in front of the mirror as if threatening; they pushed it with their noses, bit it, and occasionally slapped and clasped it with the front flippers.

Our results generally confirm the notion that clicking and other underwater vocalizations by *Zalophus* are associated with its social and investigative response and are therefore related to increased behavioral and presumably physiologic arousal. Furthermore, social facilitation of clicking and other vocalizations, and their frequent association with aggressive behavior patterns, indicate that vocalization does play a role in the underwater-communication system. Since the most vocal animal in the experiments (Cathy) had been the least vocal of the three before it was conditioned to vocalize, the threshold for elicitation of underwater vocalization may decrease as a function of previous learning.

Welker (*5*) lists prominent features that tend to characterize play and investigative behavior: response to novelty, habituation, and recovery; all have been demonstrated in connection with *Zalophus*'s investigative behavior as reflected by measures of visual orientation, and the underwater click vocalizations also conform to these principles. In fact, the curves for underwater clicks (Fig. 3) resemble those of object-contact curves obtained with chimpanzees (*13*). Moreover, the frequency and type of investigative behavior displayed by *Zalophus* appear to resemble those of other modern Carnivora (*14*).

RONALD J. SCHUSTERMAN
ROGER GENTRY
JAMES SCHMOOK
Stanford Research Institute,
Menlo Park, California 94025

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7. The interior of the oval redwood tank (4.6 by 9.1 by 1.8 m deep) was painted white; it was filled with 82 kl of fresh water, and six windows in the walls permitted observation and photography.
8. Underwater vocalizations were continuously monitored by a Channel Industries–275 hydrophone (20 cy/sec to 150 kc/sec) and an Ampex-2044 amplifier-speaker system (65 cy/sec to 13 kc/sec). Vocal signals were periodically recorded with a Uher-4000S tape recorder at 20 cm/sec (40 cy/sec to 20 kc/sec) and were analyzed with a Kay-661 spectrum analyzer.
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Superconductivity of Alpha Uranium

The report (*1*) entitled "Superconductivity of β-uranium" shows that the β-uranium structure, when retained to low temperatures by quenching uranium alloyed with β-stabilizing elements, is a bulk superconductor with a transition temperature of about 0.8°K. However, the authors go on to suggest: "The reported superconducting behavior of α-uranium may be due only to superconducting filaments of retained stabilized α-, β-, and γ-phases, or perhaps even filaments of superconducting compounds."

I would like to point out that in the α-uranium which has been examined for superconductivity there is no metallurgical reason to find retained β- or, still less likely, γ-phases or filaments of superconducting compounds.

Investigations (*2*) based on magnetic measurements of the highest purity uranium yet produced, the Argonne uranium, have suggested that α-uranium is a superconductor. However, investigations of the specific heat (*3*) reveal no anomaly suggesting that the superconductivity is due to a filamentary structure of some sort rather than to the bulk sample.

In order to stabilize the β-phase to room temperature and below, the $\beta \rightarrow \alpha$ transformation, which occurs at 667.7° ± 1.3°C in the Argonne uranium (*4*), has to be suppressed. For a given cooling rate this occurs if the solute content of the alloy exceeds a critical value. This critical value has a lower limit of about 0.1 atom percent for the most effective solutes but is higher for most other elements. For the Argonne uranium all the solute will be in solution in the β-phase and in the high-temperature end of the α-phase, with the exception of the nonmetallic impurities, oxygen, nitrogen, and carbon. These have no stabilizing influence on the β-phase, as is shown by the similar behavior of reactor-grade uranium and Argonne uranium during the $\beta \rightarrow \alpha$ transformation. There is thus no mechanism whereby any significant enrichment of the grain boundaries can take place while the uranium is maintained in the β-phase, or during the transformation from β- $\rightarrow$ α-phase. The same argument also applies to the γ-phase and the $\gamma \rightarrow \beta$ transformation.

Even if β-phase were retained to room temperature, in low-alloy material the rate of $\beta \rightarrow \alpha$ transformation at room temperature is rapid, and only a few hours or a few days are needed to complete the transformation.

Normal metallographic examination with the light microscope of high-purity uranium (*5*, *6*), such as the Argonne uranium, which has been cooled slowly from the γ-phase field, reveals typically a very few isolated particles of U(CNO) (*5*) (the solid solution which forms between UC, UN, and UO) and UO_2 and occasionally U_6Fe and UAl_2 together with a fine eutectoidal network also of U(CNO) all in an α-phase matrix. This network does not coincide with the grain boundaries of the α-phase. It is probably at sites where there once were the grain boundaries of the prior β-structure and results from precipitation from the β-phase. Annealing in the α-phase after slow cooling does not modify the networks appreciably. It is possible to modify these networks by various heat treatments (*5–7*) but it must be pointed out that they are comparatively coarse networks. As quenched from the γ-phase, the particles in the network are virtually undetectable except by transmission electron microscopy and are no more than 25 to 50 Å in diameter, but are still of the order of 0.1 μ apart (*6*). Under conditions of slow-cooling and after α-phase annealing the particles will be larger than this, about 0.1 to 1.0 μ, but are much further apart, about 1.0 μ (*8*).

A reasonable estimate for the coherence length for these particles of U(CNO), if they become superconducting below 1°K, is about 100 Å (*9*). If this is the case, no superconductivity should be observed in the quenched condition, and in that the particles are so far apart in the slow-cooled or annealed conditions, no bulk superconductivity effect should be observed there either. The latter remark also applies to the isolated particles of U(CNO), U_6Fe, UAl_2, and UO_2 not associated with the networks. Of these only U_6Fe has been observed to become superconducting above 1°K (*10*). In addition it should be pointed out that UN becomes antiferromagnetic below 45°K (*11*), so it is most unlikely to become a superconductor.

No investigation by normal metallographic means (*5*), by x-rays, or by transmission electron microscopy (*6*, *8*, *12*) of any nominally pure uranium has ever shown the presence of retained β-phase at room temperature. Phases based on γ-uranium have never been retained in alloys containing less than about 9 atoms percent solute (*13*).

The situation is thus very different from that existing in the rhodium-lanthanum system (*14*) where the addition of 0.5 atoms percent lanthanum is sufficient to develop a grain boundary network of $LaRh_5$ whose thickness varies from 0.1 to 1 μ.

Hence the apparent superconductivity of α-uranium does not seem to be explicable on the basis of networks of U(CNO) or of retained β- or γ-uranium. However the phase U(CNO) should be investigated for superconductivity down to a lower temperature than 1.2°K (*10*), the lowest temperature to which UC and UN have been investigated.

B. W. Howlett
Metallurgy Division, Atomic Energy Research Establishment,
Harwell, England

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Howlett's discussion appears to verify our hypothesis. In our paper we stated the reason for our belief that the superconductivity observed in α-uranium above 0.3°K is not a bulk effect and explained the apparent superconductivity observed as being due to filaments. Howlett says of our hypothesis, "If this is the case, no superconductivity should be observed in the quenched condition, and, in that the particles are so far apart in the slow-cooled or annealed conditions, no bulk superconductivity effect should be observed there either." This is just what we had tried to explain, namely why there is no bulk superconductivity. All caloric measurements, after all, do show the absence of bulk superconductivity (*1*), but Howlett nevertheless assumes bulk superconductivity.

The remaining metallurgy mentioned by Howlett is valid only for thermodynamic equilibrium, which is hard to obtain in uranium. It is not valid to assume the total impurity concentration to be below 100 ppm, the minimum required for our hypothesis (*2*).

In the meantime the two different systems of filaments we suspected have been seen with the help of an electron microscope.

B. T. Matthias
Bell Telephone Laboratories,
Murray Hill, New Jersey

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Dimethyl Sulfoxide and Dogs

In view of the current situation regarding the use of dimethyl sulfoxide (DMSO) for experimental use on humans, I submit that the report by L. F. Rubin and P. A. Mattis [*Science* **153**, 83 (1966)] on oral administration of DMSO to dogs has such broad implications that a request for clarification of certain experimental conditions and of the results is in order.

Having experienced considerable difficulty in obtaining reproducible physical measurements even with recrystallized DMSO, I am concerned that no mention was made of the source of the material used for their experiments, of its purification, or of its analysis for impurities. The doses seem massive; even small percentages of impurities might of themselves account for the effects noted.

A more general question concerns the dosage range and the accuracy of the report. Assuming that the work is intended to have bearing on the use of DMSO as a medicinal agent, I wonder why data were not collected under conditions more closely resembling those usually obtaining in such usage—especially external application in small amounts—or at least more fully in low-dosage regions; even 2.5 g per kilogram of dog seems an unusually high dosage. But, even for the adverse situation created, the reported results of the tests are ambiguous. What does "could (would) not tolerate such dosage" mean?

I presume from "seven survivors" (of the original 12 or of the ten receiving DMSO?) that it means that the others died from the DMSO; but Table 1 says, of results of actual administration, that the dogs were "reported to have vomited drug after dosage." It would have been also relevant to report the cause of death, the general condition of the survivors, and whether other effects were sought or found.

One may argue that this report should be considered apart from the current controversy concerning use of DMSO, but both the timing and nature of the report oppose this argument. Assuming the validity of my earlier premise, I suggest that more relevant and thorough study and a more careful report were warranted.

L. J. Sacks
Department of Chemistry,
State University College,
Buffalo, New York