after the final molt. A drop of paraffin was placed on the cephalothorax near the palps of five members of this group. Paraffin was placed beside the genital pore of the other five. The latter ten males served as controls for the effects of the anesthesia-paraffin treatments.

To determine the approximate onset of courtship, 26 of the experimental and all of the control animals were tested daily, beginning 1 day after the final molt. The remaining nine experimental animals were tested at 2 weeks after the final molt. For each test, the male was introduced to one side of a glass finger bowl, 19 cm in diameter, which was divided in half by a vertical glass partition. A moving female *L. rabida* on the other side of the partition provided a visual stimulus. All 35 experimental males displayed courtship typical for the species. The mean adult age at the onset of courtship (in days after molt) of the 26 experimental males tested daily was 5.9 ± 0.2 S.E. (range, 4 to 8). Onset in the 10 animals of the untreated control group was 5.3 days ± 0.4 S.E. after the final molt (range, 3 to 8); and the mean age at onset for the 10 treated control animals was 5.4 days ± 0.5 S.E. (range, 4 to 8). The differences between the experimental and the control groups, the latter taken either singly or together when compared with the experimental group in *t*-tests, were not significant at the 5-percent level.

These results indicate that the onset of courtship in this species does not depend on proprioceptive feedback from sperm-filled palps, as was suggested by Gerhardt (*4*). Since the experimental groups included spiders which could not perform movements associated with sperm-web construction, or sperm induction, or both, it also appears that the male need not carry out these acts prior to displaying courtship. Thus, there is no "chain-reflex sequence" (*6*) involved in the sexual biology of this spider. The reproductive behavior of the male probably is regulated instead by maturational changes in the gonads, or the central nervous system, or both. Such regulation of sexual behavior has been suggested for other arthropods (*9*).

JEROME S. ROVNER
Department of Zoology, University of Maryland, College Park 20742

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30 November 1965

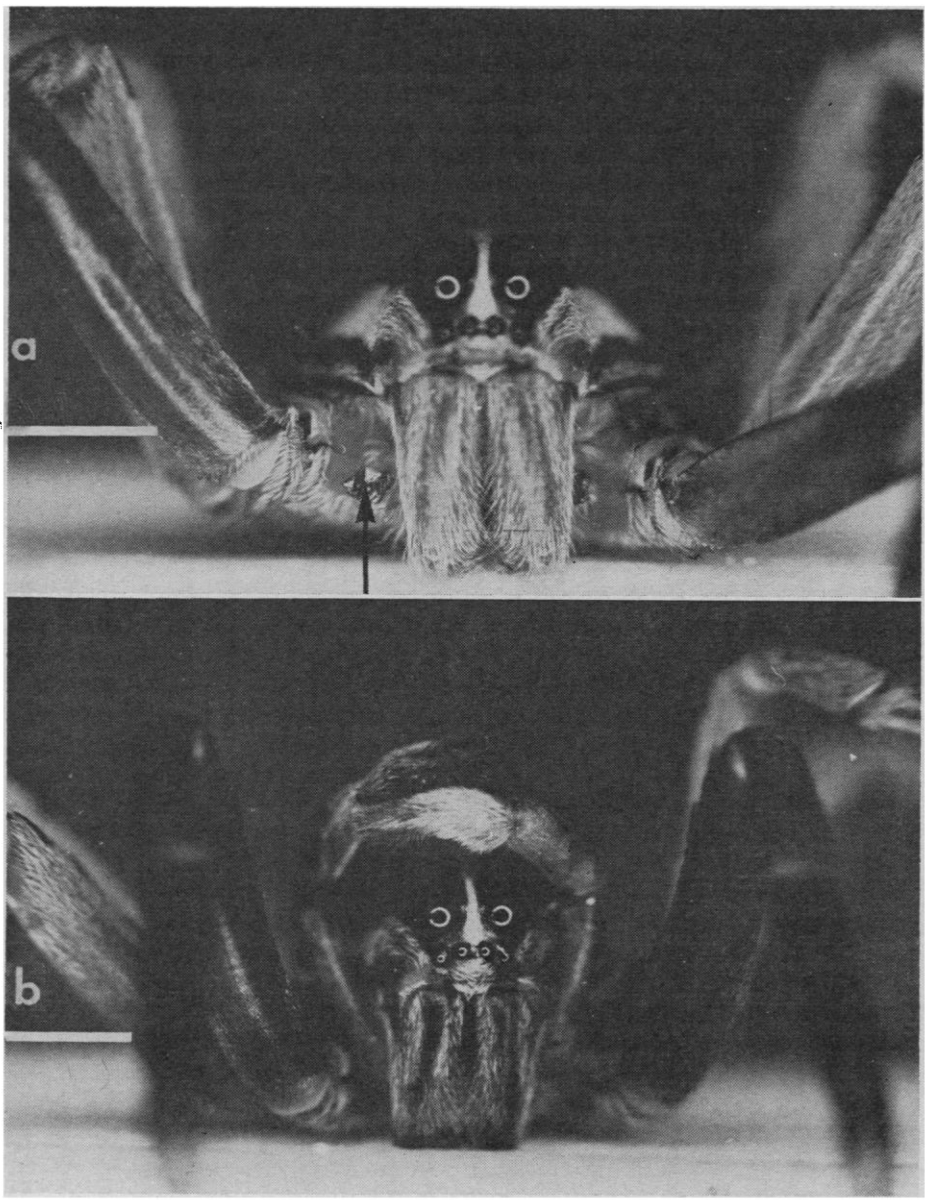

Fig. 1. Adult male *Lycosa rabida* treated immediately after molt to prevent sperm induction. (*a*) Male with autotomized palps. Courtship pattern of palpal movements persists in trochanter (arrow) and coxa of each palp. (*b*) Male with palps fixed dorsal to cephalothorax. Both spiders were photographed while under CO_2 anesthesia. Peculiar appearance of the eyes is due to reflection of the circular flash unit. Scale in both photographs is 2 mm.

Mohole: Preliminary Drilling

Plans are now well advanced for drilling to attain certain scientific objectives during the period of engineering tests of the Mohole drilling platform. The Mohole Advisory Committees of the National Academy of Sciences met with representatives of the National Science Foundation, sponsor of the project, and Brown and Root, the prime contractor, in Houston on 4 and 5 January.

The Mohole Advisory Committees recommended drilling four or more holes within a 160-km radius of lat.

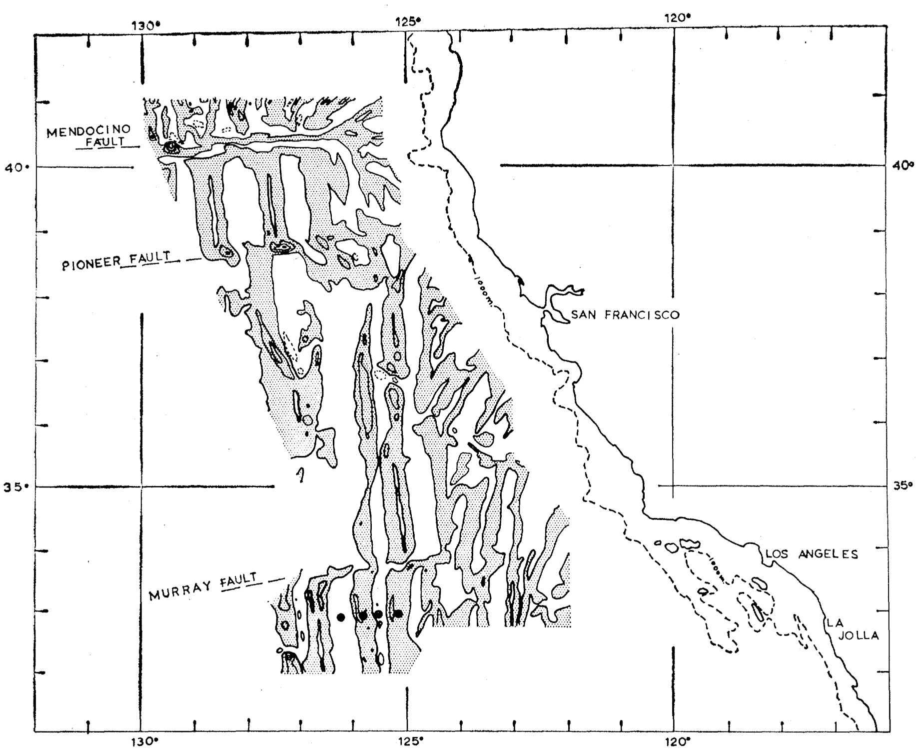

Fig. 1. Tentative sites for drilling the first four holes (solid circles). Stippling indicates areas of positive magnetic anomalies.

33°N, long. 127°W, about 650 km west of Los Angeles. These holes will be drilled to about 300 meters, the depth depending on the maximum which can be attained with one bit because hole reentry will not be feasible.

The drilling will test the hypothesis of ocean floor spreading (*1*) and the generation of long, linear, magnetic anomalies according to the Vine-Matthews hypothesis (*2*), relating them to spreading coupled with reversals of the earth's magnetic field. The main factual information to be sought will be (i) the age of the oldest sediments lying upon the harder rock of layer 2 of the oceanic crust; (ii) the age of the top of layer 2, presumably basalt, by radiometric age determination; and (iii) whether, on magnetic positive and magnetic negative residual anomalies, the remanent magnetization of the rock is normal and reversed, respectively.

The tentative geographic positions of the holes with respect to the magnetic anomalies are shown in Fig. 1. The data used in compiling it come from magnetic surveys (*3*) and from Menard's physiographic diagram of the area (*4*).

H. H. Hess
Department of Geology, Princeton University, Princeton, New Jersey
H. S. Ladd
U.S. Geological Survey, Washington, D.C.

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18 February 1966

Particle Sorting and Stone Migration Due to Frost Heave

Inglis (*1*) has recently discussed a mechanism for particle sorting and stone migration in soils due to freezing. His explanation is based on the expansion accompanying the freezing of soil water. He does not consider the effects of the motion of soil water through the soil during the freezing process, that is, the phenomenon known as frost heave. Stones, fence posts, and other objects can be lifted several inches in one thawing and freezing cycle by frost heave, whereas the normal expansion due to freezing of water could result in motion of only a fraction of an inch. The lifting occurs when the top part of the stone becomes imbedded in the frozen soil as it freezes from the top, as described by Inglis. Subsequent frost heave in the surrounding soil may lift the stone several inches. The stone is unlikely to resettle precisely into the hole where it was, and so net motion of up to several inches is possible. This phenomenon is particularly noticeable in many loamy New England fields, which yield an annual crop of stones.

Soils that heave severely have been called "frost-susceptible" and contain, according to the Casagrande criterion, (*2*) more than 3 percent of particles less than .02 mm in diameter. When these soils freeze, water is drawn to the freezing front, so that the frozen soil contains much more water (in the form of ice) than the unfrozen soil (*3*). Volume changes of 300 percent on freezing are not unusual. The excess water in the frozen soil is in the form of layers of ice, called ice lenses, which are almost free of soil particles. The measured heave of a soil is equal to the total thickness of such ice lenses (*4*).

An essential feature of the frost-heave process is the existence of a layer of water separating the soil particles from the ice in the soil. The frozen soil rides on this thin (~ 10 Å) layer, being fed water from the ground-water table as the ice freezes (*5*). The energy for the process comes from the free energy of the undercooled water in the soil near the ice lens. In the usual case, ice cannot propagate between the soil particles because of capillary action on the ice-water interface (*6*). When some of the water in the water layer between the soil particles and the ice freezes, the thickness of the water layer being thereby decreased, tension is created in the soil water (due to repulsion between the ice and particle), which draws water up from the ground-water table.

The theory of frost heave as developed by Jackson, Uhlmann, and Chalmers (*5*), based on the ideas outlined above, provides quantitative agreement with experiments on frost heave (*4*).

In addition to the migration of stones, there should also be a sorting action on fine soil particles (*7*). Frost action should result in a preferential sifting of the finest particles downwards through the soil, because the smallest particles are more easily