gen produced by submerged aquatic plants during photosynthesis. The actual mechanism by which this stonefly secures and utilizes oxygen is not known. There are no external gills in either nymph or adult.

Specimens were taken during the spring of 1962 in bottom dredge samples at three localities in the lake ranging in depth between 197 and 264 feet (*4*). Most of the specimens, nymphs and adults, were clinging to pieces of *Chara* and aquatic moss.

While the recent discovery of stonefly nymphs in a moist, terrestial habitat in New Zealand and in Argentina is a matter of much interest (*5, 6*), the discovery of this strictly aquatic species is even more noteworthy. The small order Plecoptera shows a remarkable ability to adapt to a very wide range of environmental conditions.

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13 November 1962

Callosal Section: Its Effect on Performance of a Bimanual Skill

Abstract. *Four out of five monkeys showed no lessening of the ability to perform a motor habit requiring concurrent movement of the two hands in opposite directions when the callosum was cut after training. However, in only one animal was there significant transfer, between the hands, of a shape-discrimination habit learned postoperatively.*

A monkey trained to make visual discriminations through one-half visual field is able to make them also through the other. Similarly, a monkey that has learned tactile discriminations with one hand can perform them also with the second hand. However, such visual and tactile transfer generally does not occur if the corpus callosum is cut prior to the initial training. The relevant findings have been reviewed by Sperry (*1*). Myers (*2, 3*) has shown that the posterior body of the corpus callosum is predominantly involved in both visual and tactile transfer.

It is not yet known with what kind of behavioral function or functions the anterior body, and the genu, of the corpus callosum are concerned. Likewise, the pathways by which the motor systems of the left and right hemisphere are connected in the performance of a bimanual skill are not known. This report describes an experiment undertaken to ascertain whether lessening of the ability to perform a bimanual skill would result from section of the corpus callosum.

Five rhesus monkeys were used. Four of the animals (Nos. 1, 3, 6, and 8) had been used in earlier experiments (*4*); the fifth (No. 10) had had no previous training. These five animals were trained to manipulate simultaneously, with the two hands, the two sliding lids of an electrical device. This was placed upon the horizontal shelf of a modified Wisconsin General Testing Apparatus. The two lids, each fitted with a stout handle, were separated by a space 25 cm wide. Each lid was held immovable initially by a pair of solenoids. When the animal pulled the left-hand lid a distance of 2 mm horizontally toward itself and at the same time pushed the right-hand lid an equal distance horizontally away from itself, one solenoid of each pair was released. The animal could then slide the right-hand lid an additional distance of 5 cm away from itself and so expose a food well. The force required to make the initial 2-mm movement and so unlock the lids was 227 g; that required to hold the right-hand lid pushed open while securing a peanut from the food well was 708 g.

Forty trials were given each day. For each trial, performance was scored as correct when the animal, in its initial handling of the lids, took hold of both handles (in either order) and then made the required movements for unlocking the lids and exposing the food. Performance was scored as incorrect when the animal made any other initial response (for example, took hold of, and manipulated, only one handle; took hold of both handles but made the wrong movements, so that the lids remained locked; took hold of both handles, then released one), irrespective of subsequent movements on that trial. After training, three of the animals (Nos. 3, 6, and 10) were given 4 months' rest, retrained, given a week's rest, and then subjected to callosal section. Animals 1 and 8 were given a week's rest after the initial training, then subjected to callosal section. For all five animals, postoperative retraining was started 10 days after surgery.

The results are shown in Table 1 (*5*). Only animal 6 failed to relearn after surgery in fewer trials than it required before surgery.

Table 1. Effect of section of corpus callosum on a preoperatively learned bimanual skill.

Animal	Trials (*N*)		
	To learn bimanual skill	Pre-operative relearning	Post-operative relearning
1	700		10
3	930	0	0
6	260	110	440*
8	1030		30
10	610	120	50

*Criterion not attained.

Postoperatively, and after the animals had been retrained to perform the bimanual skill, they were trained to discriminate, in the dark, between two objects (cylinder and cube) with one hand, the other hand being restrained by attachment of a weight to the wrist. Standard apparatus and noncorrection procedure were used; correct choice of object was rewarded. Forty trials were given each day. The animals were observed through an infrared inspection device. After each animal had reached a level of performance of 90 correct responses in 100 trials, training was

Table 2. Effect of section of corpus callosum on transfer of tactile shape discrimination, learned postoperatively, between the hands.

Animal	Trials required to learn tactile shape discrimination (*N*)	Hand used for learning	Percentage of correct responses in 40 trials with other hand
1	210	Left	58
3	270	Left	70*
6	210	Right	55
8	210	Right	58
10	610	Right	55

*$p = .008$ (one-tailed binomial test).

continued for 300 additional trials. Forty transfer trials were then given; in these the monkey was made to use the untrained hand. Choice of the positive object was still rewarded.

Table 2 shows the results (*6*). Only animal 3 performed at a level significantly better than chance with the previously untrained hand.

Macroscopic examination of the brains of the five animals indicates that in two of the animals the corpus callosum (including genu and splenium) was cut completely; that some few fibers may possibly have remained intact at the posterior end of the splenium in animal 8; that one bundle (approximately 3 mm front to back and less than 1 mm top to bottom) in the genu and another (approximately 3 by 1.5 mm) at the level of the red nucleus remained intact in animal 1; and that a small portion of the ventral genu was not cut in animal 3. There was also variable unilateral destruction of the cingulate gyrus, the septal cortex, the caudate nucleus, and the fornix, with occasional minor degeneration elsewhere (for example, in the dorsomedial nucleus, the orbital cortex, and the anterior commissure).

Myers (*3*) has reported that transfer between the hands persists in the monkey (at least in the case of roughness discriminations) if training with the first hand is carried out before, not after, the callosum is cut. Therefore, it is possible that performance of the bimanual skill would have been more consistently impaired by surgery if all five animals had been trained only after callosal section and appropriate animals from outside the experimental group had been used as controls. However, the available evidence suggests that the callosum is not involved in the learned coordinations required in the performance of bimanual skills. The results reported here indicate, as has previously been reported by others, that the callosum is involved in the transmission of tactile learning between the hemispheres. Nevertheless, the good performance of animal 3 (unless it be supposed that this is not a transfer effect but merely a spontaneous preference of the "correct" object) supports the view of Glickstein and Sperry (*7*) that alternative pathways exist for such transmission (*8*).

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6. In 45 of the 200 trials on transfer testing there was evidence of position habits (defined as ten or more consecutive responses to the same side).
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10 December 1962

Thermal Properties of Meteoritic Iron from —150° to 300° Celsius

Abstract. *Thermal diffusivity and specific heat have been measured by the flash method on a small specimen of meteoritic iron from the Canyon Diablo fall. Measurements have been made over the temperature range —150° to 300°C from which thermal conductivity values have been calculated.*

Meteorites enter the earth's atmosphere from many different angles and velocities which produce very different rates of aerodynamic heating, extending from complete combustion as seen in meteors to meteorites which fell so slowly that they were barely warm when they reached the surface of the earth. These objects offer a novel field for examining different reentry effects.

To evaluate the effect of aerodynamic heating and the subsequent ablation process upon the bulk of the meteorite, it is necessary to determine the thermal diffusivity of the material as a function of temperature. There are few published data in this area (*1*), largely because meteorites are rare objects, and are especially difficult to cut in the usual forms required for thermal measurements.

A flash technique, developed in this laboratory (*2*), makes it possible to measure thermal properties as a function of temperature on small samples which can be readily cut from meteorites as small as a few inches across. One side of the specimen is rapidly heated with a pulse of thermal radiation from a high intensity xenon flash lamp and the resultant temperature history of the opposite side is determined by fine thermocouple wires pressed against the surface. The thermal diffusivity (α) is then

$$\alpha = 0.139\, L^2/t_{\frac{1}{2}}$$

where L is the thickness of the specimen and $t\frac{1}{2}$ the time for the temperature rise to reach one-half of its maximum value. If the side of the sample exposed to the lamp is blackened with carbon deposited from burning camphor or any other black material, and the radiant energy falling on the surface is known, then the product of the density of the material and the heat capacity can be measured from the maximum temperature rise. This follows from the relationship

$$Q = mc/\Delta T$$

where Q is the number of calories absorbed by the specimen, m its mass in grams, c its heat capacity in calories per gram, and ΔT the maximum change in temperature due to the flash. Energy calibrations are made by exposing thin specimens of pure silver, blackened in the same manner, and noting the maximum temperature rise.

The thermal conductivity is calculated from the preceding values by the relationship

$$K = \alpha \rho c$$

where K is the thermal conductivity and ρ is the density. Values for different temperatures are found by heating the specimen above ambient with a resistance heater and cooling below ambient by surrounding the vacuum chamber with liquid nitrogen.

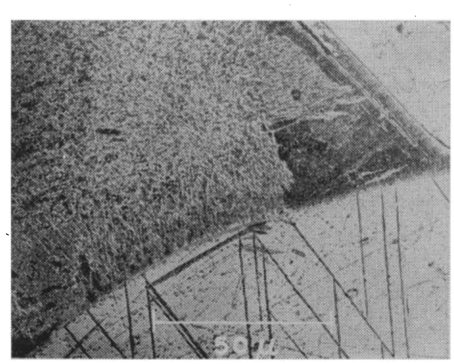

Fig. 1. Photomicrograph of granulated plessite field after temperature cycles from —180° to 300°C. Neumann lines in the lower part retain their original sharpness.