Reports

Contact Occluders: a Method for Restricting Vision in Animals

Abstract. Preliminary observations show that contact occluders can be used to produce temporary "blindness" in monkeys. This report also describes how such occluders can be made.

Blocking visual input to one or both eyes is involved in experiments on the effects of prolonged visual deprivation (*1*), interocular transfer of visual discrimination habits (*2*), spontaneous recovery of visual function following brain damage (*3*), and also in experiments on senses other than vision where the possibility of the animals' responding to visual cues must be excluded (*4*). For most of these experiments it is essential not only to restrict the animals' vision, but later to restore it. In searching for a simple and reliable way of inducing such temporary "blindness" in monkeys, we have explored the feasibility of occluding vision by inserting plastic cups under the monkeys' eyelids (see Fig. 1). These "contact occluders" are similar to the contact lenses used for correcting vision in man; but for experimental work with animals they must be relatively larger than contact lenses so that the animals cannot remove them, and they must remain in place for considerably longer periods of time without causing injury to the eyes. In our experience, contact occluders have passed both tests surprisingly well.

At first, transparent eyecups of different sizes were tried to determine which would stay in place and whether or not any pathology would develop. The monkeys regularly removed those that were less than about 18 to 20 mm in diameter. The larger cups, however, were not removed, and the only ocular abnormality that could be detected was an occasional collection of cloudy lacrimal secretion which would soon disappear, presumably as a result of sufficient eye-movement.

A pair of large-sized translucent cups was then inserted in the eyes of an adolescent monkey. These cups remained in place for 9 months before the monkey succeeded in removing one of them. The animal is shown in Fig. 1, the picture which was taken after it had been wearing the occluders for 6 months. During the period of induced "blindness," this animal was trained to perform a delayed-alternation task, a tactual roughness discrimination, and an auditory discrimination. Also, shortly before its vision was restricted, it had been trained to make a fairly difficult discrimination between two visual patterns. When the contact occluders were removed 9 months later it showed complete retention of the visual habit. An ophthalmological examination (*5*) made at this time revealed some vascularization of the deeper corneal layers and, also, a few small cloudy patches scattered over the corneas. The corneal epithelium of both eyes was intact, however, and the irises, anterior chambers, and pupils appeared to be normal. (Although the small amount of corneal abnormality in this animal did not interfere with its retention of the visual habit, the presence of other more subtle visual defects could have easily escaped detection. The need for further work along these lines is clearly indicated.)

Most recently, four monkeys were run in an experiment which involved visual discrimination learning with left and right eyes on alternate weeks. At the end of each week the animals were caught and held while the contact occluders were shifted from one eye to the other. Anesthetics were not necessary since removing and reinserting an occluder, which took only about 2 minutes, did not appear to be a traumatic procedure. Each of the animals underwent this procedure a dozen times, and there was no evidence of gross ocular damage in any of them. An ophthalmological examination performed on one of the animals yielded results essentially similar to those described above.

While these preliminary observations have been limited to the use of contact occluders for preventing vision in monkeys, it would seem that the method could be applied to other animals, and to other problems, as well (*6*). For those who may be interested in working with this technique the following description of how occluders can be made may be helpful.

Occluders can be formed from any thermosetting plastic such as Plexiglas or Lucite. We have used sheets ranging in thickness from 1/64 to 1/16 inch with about equal success. Opaque black plastic is available if it is necessary to exclude all light, but milk-white translucent material is useful if it is desired only to prevent pattern vision. Completely transparent plastic serves as an excellent control for the occluders.

While it is not essential that the occluders fit as perfectly as do the contact lenses for ophthalmic use in humans, their curvature should conform reasonably well to the shape of the animal's eyeball. Precise measurements of the corneal and scleral curvature can be made with the ophthalmometer, but it is probably sufficient to approximate these curves from a paraffin or plaster mold made from a freshly enucleated eye. The small variation in the size and shape of eyeballs of monkeys weighing between 6 and 16 pounds has not caused any difficulty.

The form with which the contact occluders are shaped is made of brass or aluminum alloy about 20 mm in diameter, or 1-inch stock if that is the nearest size available. One end is turned in a lathe to fit the eye-mold as closely as possible and then carefully polished. Since any roughness or irregularity of the form will be transmitted to the plastic, the polishing should be thorough. The female part of the form consists simply of a short section of hollow metal tubing, or a hole in a piece of sheet metal, the diameter of the hole depending on the size of the occluder desired. We have found that for monkeys the occluders should be about 18 to 20 mm in diameter, which is about as large as can be inserted under the lids without difficulty.

The plastic material is cut into small squares (about 30 mm on a side) by scoring it heavily with a sharp tool and then breaking it. A piece is grasped at its corner with forceps and waved through a low flame until it becomes soft and pliable. If it is heated too quickly or too much, bubbles may appear, destroying the smooth surface. When it is sufficiently soft for molding the plastic is quickly laid over the hole, and the eye-shaped form is firmly pressed into it and held for a minute or two while the plastic hardens. Excess material is then trimmed off by cutting, grinding, or filing, and the edge is carefully rounded and smoothed. The final

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper. (Since this requirement has only recently gone into effect, not all reports that are now being published as yet observe it.)

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* 125, 16 (1957)].

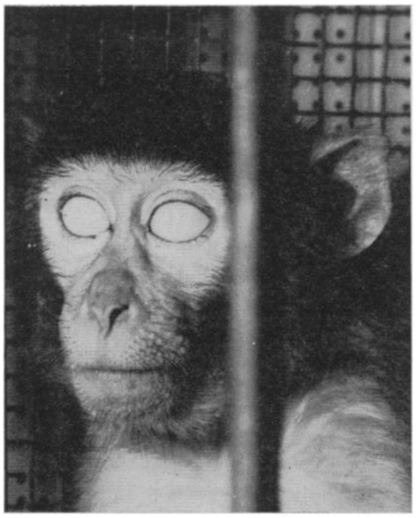

Fig. 1. Monkey with occluders.

operation is polishing, which is done on a soft cotton buffing wheel with tripoli or some other polishing compound. If no sharp edges or roughness are found, the occluders are ready for cleaning and use.

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References and Notes

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2. R. E. Myers, *Brain* 79, 358 (1956).
3. K. L. Chow, *J. Comp. and Physiol. Psychol.* 45, 430 (1952).
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5. We thank Ludwig von Sallmann, of the National Institute of Neurological Diseases and Blindness, for performing the examinations.
6. We have since learned from Austin Riesen that Leo Ganz, in the department of psychology at the University of Chicago, has been independently developing this technique for use with cats to produce, among other things, a colored Ganzfeld (!).

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Spatial Distribution of Phoronopsis viridis Hilton

Abstract. Individuals of the species *Phoronopsis viridis* Hilton exhibit an even distribution within their colonies. The distance between nearest neighbors is probably related to the space required for the operation of the lophophore. Distributions of other marine invertebrates are discussed briefly, together with the paleoecological implications of such knowledge.

The horizontal spatial distribution of *Phoronopsis viridis* Hilton was studied in three intertidal areas on the shores of Tomales Bay, California (*1*). Observations on the nearest-neighbor relationships of *Phoronopsis* were taken and analyzed after the method proposed by Clark (*2*). Individuals of this species occur in clusters of thousands throughout the areas studied. While the clusters or colonies possibly develop as a response to very local environmental features, field examination revealed no obvious differences in the sediment at colonized and noncolonized sites. The first-nearest-neighbor relationships were observed for 384 individuals chosen at random within colonies.

The proportions of first-nearest-neighbor relations that are reflexive in each of the samples are shown in Table 1. The proportions for each locality are not significantly different from one another when tested by chi-square [$Pr(X^2 \geq 1.004) > 0.05$]. The number of reflexives (218) in the pooled data from all three sites was found to be significantly less than that expected for a random distribution (239) [$Pr(X^2 \geq 4.66) < 0.05$]. This result is taken to indicate that individuals of *P. viridis* tend to be distributed evenly within the colonies.

The pattern of dispersion suggested by this analysis probably reflects direct interaction between individuals. After a heavy settlement, the growing animals must compete for space for expansion of the lophophore during feeding. Such competition would be expected to result in an even spacing of individuals in densely populated areas. At the borders of the colonies studied, individuals appear to be less crowded together and likely to be distributed at random. These circumstances are paralleled by the case of the clam *Tellina tenuis* reported by Holme (*3*). In feeding, this small clam sweeps the surface of the substrate with its inhalant siphon. The even spacing of *Tellina* observed by Holme was found to be statistically significant by Connell (*4*). The minimum distance between individuals is thus apparently related to mode of feeding in *Tellina* and *Phoronopsis*.

Connell, using a procedure similar to that employed here, studied the spatial distribution of two species of clams, *Mya arenaria* L. and *Petricola pholadiformis* Lamarck (*4*). He found that the clams were distributed in aggregations in the area of study but at random within the aggregations. He has suggested that this is the most common pattern for sedentary, bottom, filter feeders.

The pattern of spatial distribution of sedentary marine invertebrates can have important implications in marine ecology and paleoecology. Patterns of dispersion are important clues to larval behavior, interactions of individuals, and the nonuniformity of the physical environment. Knowledge of the kinds of patterns characteristic of particular taxonomic groups or modes of life may also be useful in the interpretation of the mode of formation of fossil assemblages. In this regard, such information can aid in recognition of an assemblage that has been buried in place with a minimum of exposure after death. Patterns of spatial distributions of fossils have been determined by techniques similar to those employed here. Miller has used nearest-neighbor relations in an attempt to determine current direction in an ancient, black-shale environment (*5*). For all of these purposes, more modern analogs are needed (*6*).

Table 1. Proportion of nearest-neighbor relations that are reflexive in each of the samples.

Sample	Size	Proportion
1	99	0.53
2	114	0.59
3	171	0.58

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References and Notes

1. Locality 1 was in the small cove immediately north of White Gulch; locality 2 was on the flats east of Lawson's pier; and locality 3 was on the flats near the creek on the south shore of White Gulch (see U.S. Coast and Geodetic Survey Chart 5603, 1957).
2. P. J. Clark, *Science* 123, 373 (1955).
3. N. A. Holme, *J. Marine Biol. Assoc. United Kingdom* 29, 267 (1950).
4. J. H. Connell, *Invest. Shellfisheries Mass. Rept. No. 8* (1956), p. 15.
5. R. L. Miller, *Trans. Am. Geophys. Union* 37, 354 (1956), abstr.
6. This investigation is part of studies supported by a grant from the Louis B. Block Foundation and made possible by the cooperation of the Pacific Marine Station of the College of the Pacific.

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Production of Spherules from Synthetic Proteinoid and Hot Water

Abstract. When hot saturated solutions of thermal copolymers containing the 18 common amino acids are allowed to cool, huge numbers of uniform, microscopic, relatively firm, and elastic spherules separate. The place of this phenomenon in a comprehensive theory of original thermal generation of primordial living units is considered.

A comprehensive theory of the spontaneous origin of life at moderately elevated temperatures from a hypohydrous magma has been developed (*1*). The theory results from experiments which have yielded linked reactions in sequences akin to many in anabolism (*1*), materials which closely resemble protein in qualitative chemical composition and physical properties studied (*2*), and a biointermediate for nucleic acid, ureidosuccinic acid (*3*).

The material with attributes of synthetic protein, *proteinoid,* is easily produced by employing sufficient excess of