discriminative stimulus. Under one condition the response key was transilluminated and reinforcement was contingent upon the completion of ten pecks. Under a second condition the key was darkened and reinforcement was contingent on at least 1 minute of no response. These conditions were alternated, and each condition was terminated by a reinforcement. After 4 hours of training on this multiple schedule of reinforcement (*3*, p. 729) the duck responded during presentation of the stimulus that accompanied reinforcement for responding and did not respond during the presentation of the stimulus that accompanied reinforcement for not responding.

A response was conditioned that was incompatible with the response of following the imprinted stimulus. A transparent key that enabled the duck to see the imprinted stimulus while responding was mounted midway along the Plexiglas wall. The imprinted stimulus was presented for 1 second after each response. Although this brief presentation was too short to permit the following response, a high rate of pecking was sustained. This finding suggests that the following response is not necessary for presentation of the imprinted stimulus to function as a reinforcer.

To show that the pecking response was not maintained solely by the change in illumination concurrent with presentation of the imprinted stimulus, an attempt was made to sustain responding when the reinforcement consisted only of a change in illumination. First, a stable rate of pecking was obtained by presenting the imprinted stimulus after every tenth response (Fig. 3). At point *a*, the moving stimulus was removed from the apparatus compartment and only the change in illumination was contingent upon responding. The rate of responding declined rapidly, and no responses were emitted for several sessions. At point *b* the schedule of reinforcement was adjusted so that each response, rather than every tenth response, produced the change in illumination. The lights in the apparatus compartment were then turned on for 1 minute. Figure 3 shows that this operation did not initiate responding. The moving stimulus was replaced in the box and, at point *c*, the lights in the apparatus compartment were again turned on for 1 minute. After the reintroduction of the imprinted stimulus, the duck began to peck. The rate of responding continued to rise during the next hour.

The reinforcer in these experiments comprised a complex of events including a change in illumination, presentation of the moving stimulus, and following by the duck. The findings reported above suggest that following is not a necessary component of the reinforcement but that the imprinted stimulus is.

Another experiment showed that the imprinted stimulus must be moving in order to control the rate of responding. A stable rate of pecking was obtained by presenting the imprinted stimulus after every tenth response. When the apparatus was adjusted so that the imprinted stimulus no longer moved during presentation, the rate of responding fell rapidly to zero. The pecking response was obtained again on the following day by reintroduction of the moving stimulus.

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2. The assistance of Dr. H. L. Lane is gratefully acknowledged. This research was supported in part by a grant from the National Science Foundation.
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14 June 1960

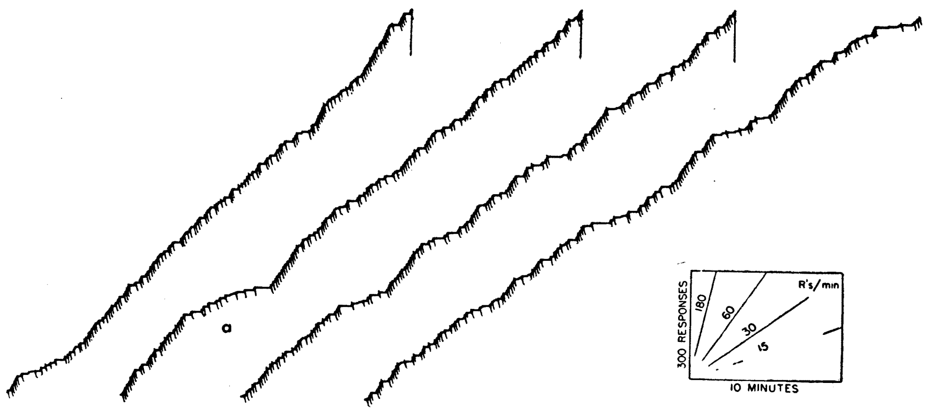

Fig. 2. Rate of pecking by a 3-day-old duck. Each diagonal mark represents a 40-second presentation of the imprinted stimulus after every eighth response (time was not recorded on the abscissa during the presentation of the stimulus). The duck received 750 reinforcements in 12 hours.

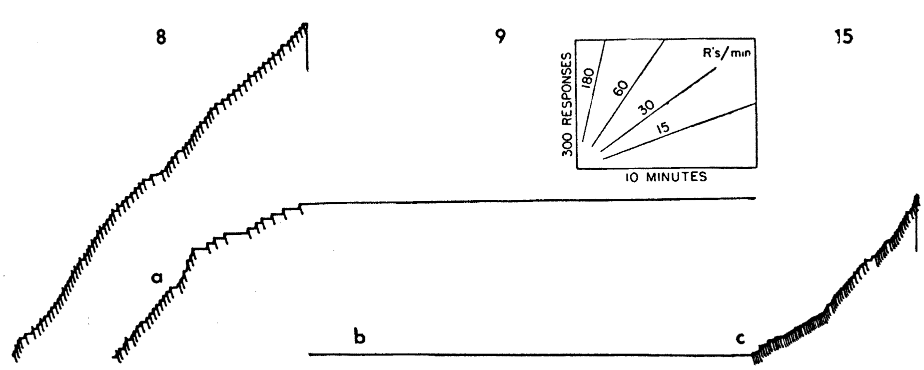

Fig. 3. Records of pecking by a 3-day-old duck. The first record (session 8) shows the rate of responding when the imprinted stimulus was presented after every tenth response. In session 9 the moving stimulus was removed at *a*, and every eighth response produced only a change in illumination. In session 15 illumination was contingent on each response; at *b* the apparatus compartment was lit for 1 minute. At *c* the imprinted stimulus was presented for 1 minute, and reinforcement was then contingent on each response.

Color Phenomena

Abstract. A procedure is described which leads to reports of hues for two black figures, one of which is shadowed. Typically, the shadowed figure is seen as blue, the other as black.

If two properly spaced circles drawn in India ink on a white card are placed in a stereoscope so that on fusion two concentric circles are seen, then the circle presented to a red-filtered eye typically appears blue or blue-green and the circle presented to the nonfiltered eye typically appears dark red (*1*). While I was looking through the stereoscope, with the red filter accidentally removed, it appeared to me that one circle was blue and the other green.

The relative imbalance of the amount of light to the two sides of the card appeared to be the critical variable.

In order to investigate this variable further, an index-card partition was affixed perpendicularly at the midpoint of the line joining the centers of the two circles. In an otherwise dimly illuminated room, the light from a 100-watt bulb in a gooseneck lamp was directed to one side of the card, the partition casting a shadow on the other side. No red filter was in the instrument.

With individual regulation of the distance of the bulb from the card, 16 or 35 subjects reported a blue circle on the shadowed side and a black circle on the bright side, 5 reported purple on the shadowed side and black on the bright side, 3 reported blue on the shadowed side and gray-green on the bright side and, finally, only 4 reported both circles as black. The remaining 7 of the 35 subjects reported other hue combinations for the two circles. The blueness disappeared immediately for some subjects, gradually for others, when the shadowed circle was viewed monocularly. The hue returned immediately with binocular inspection. The results were not affected either by changing the position of the bulb so that the formerly bright side was now shadowed, by initial monocular inspection followed by binocular inspection, or when neutral filters of unlike densities were used to produce one-sided lighting.

It is possible that the yellowish incandescent light was the responsible factor since blue is complementary to yellow. However, the gray-green reported on the bright side by a few subjects offers some difficulty to such an interpretation since this circle is also in yellowish light. Nevertheless, viewing the circles in different illumination may be of value. In white fluorescent light 5 or 12 additional subjects reported blue for the circle on the shadowed side and black for the circle on the bright side, 1 subject reported blue for the shadowed circle and green-gray for the other, and 6 reported black for both circles. For 7 other subjects in daylight, 3 reported the typical blue-black combination, 3 a black-green combination, and one black only. Continuation of this line of experimentation seems desirable because it might provide evidence for an interocular color effect (*2*).

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1. N. Pastore, *Science* **131**, 1400 (1960).
2. I wish to thank Professor B. Hoffmann of the Department of Mathematics of Queens College, who served as a subject, for his stimulating comments on the procedure and the results.

27 July 1960

Discovery of Eocene Sediments in Subsurface of Cape Cod

Abstract. Spores, pollen, and charcoal taken from two wells drilled near the tip of Cape Cod have been identified as Eocene. These are the first Eocene rocks to be identified in Massachusetts. Interpretation of seismic records taken in the Gulf of Maine and Cape Cod Bay will be influenced by this discovery.

Two wells drilled near Provincetown, Mass., on the hook of Cape Cod (Fig. 1) penetrated fluvioglacial material and entered lignitic silts and sand identified as Eocene on the basis of spores, pollen, and foraminifera. Well No. 1 entered Eocene at 86 feet and was still in it at 264 feet. Well No. 2 entered Eocene at 193 feet and was drilled to a total of 203 feet.

The spores and pollen processed by W. S. Hoffmeister from the coal samples at 86 feet 3 inches and at 186 feet from Well No. 1 (Holden's Pond) and at 192 feet 10 inches from Well No. 2 (Stark's Well) have a definite Eocene aspect. Although Upper Cretaceous elements are also present, the evidence points to an Eocene age (probably Lower Eocene). There is a marked similarity between the spores and pollen of these coals and those of a Wilcox (Eocene) sample from Tennessee. Encountering the foraminiferal genus *Elphidium* at 230 feet in the No. 1 well helps to confirm the Eocene age for these sediments, for this genus is not found in material older than Eocene.

No Eocene, in place, had been previously identified from Massachusetts. Coastal plain sediments of Cretaceous and Miocene age crop out at Gay Head on the island of Martha's Vineyard 45 miles southwest of Provincetown. Miocene material resting on granite is known from the subsurface near Duxbury, Mass. (*1*).

In addition to extending the known range of Eocene deposits, discovery of Tertiary sediments beneath the fluvioglacial deposits of Cape Cod is important to marine geophysicists who wish to identify sub-bottom reflections more precisely as to composition and age.

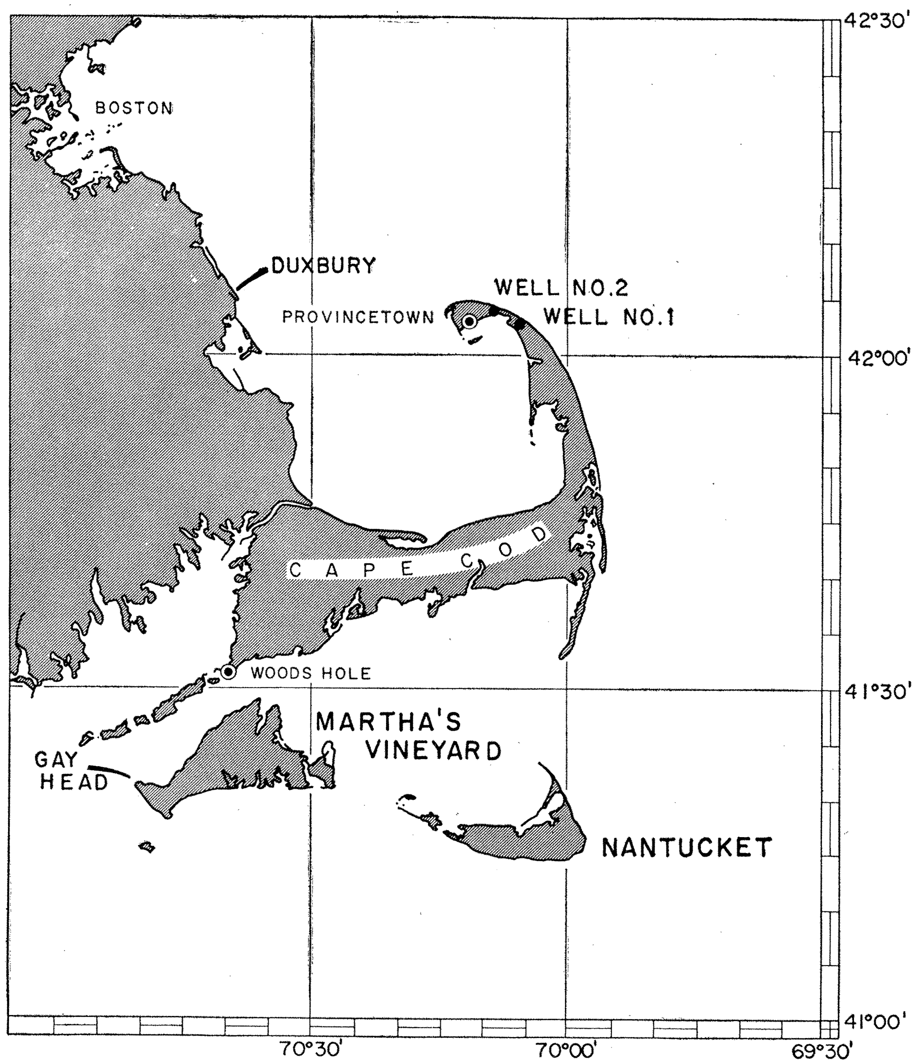

Fig. 1. Cape Cod and surrounding area.