nated. For dead carbon, all but one of the samples was made by burning lampblack. One was made from tank CO_2, precipitated as $CaCO_3$ and carried through the usual purification process.

The results of the runs on the second batch of CO_2 are shown in the upper part of Fig. 1. Each run is indicated in its proper place on the day-of-the-month scale, and the standard deviation is shown. The gap between 17 and 26 April represents a period when the apparatus was shut down, because I was out of town. Smaller groups represent times when other samples, unrelated to the Sandia material, were run. They are not plotted, since they have no connection with the problem at hand. The line marked ∞ is an estimate of the "infinite age" counting rate, on the basis of the calibration runs shown. Its slope is caused by the gradual drift in the background counting rate over the period of more than a month. Such a drift is usual. Lines are shown that represent the counting rates for other ages, as labeled. Zero age would be 5 counts/min above "infinite" age. The Sandia samples are indicated by circles. The one on 12 April is a 48-hr run. The ones on 29 April and 1 May are two successive 48-hr runs on the same counter filling.

In the lower part of Fig. 1 is shown the result for the tusk material received in 1954. On the basis of all the runs made on the tusk material, we can say that there appears to be no significant difference in counting rate between the Sandia samples and the control samples of dead CO_2, when the statistical limits and the degree of consistency between runs are considered. With regard to the lower limit that can be placed on the age, the diagram speaks for itself. Twenty-five thousand years would certainly be a very conservative lower limit. A lower limit of 30,000 years would be consistent with the usual practice in assessing limits of error.

The great age of the Sandia tusk naturally raises the question whether it is contemporary with the evidences of habitation among which it was found, or whether, instead, we have discovered that among the men who inhabited the cave there were archeologists who collected and brought home tusks belonging to earlier times. Although the probability that such an explanation is correct is small, it nevertheless emphasizes the need for C^{14} measurements on other material from the same level.

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Notes

1. This work was supported by the Michigan Memorial Phoenix Project.

2. The remains from the protein materials, such as blood, as distinguished from the simple, acid-soluble compounds, such as the carbonates and the phosphates.

11 March 1955

Consensual Pupillary Response in Birds

Although the consensual reflex has been reported by Noll (*1*) to occur in birds, the behavior of the two pupils upon the stimulation of one eye with light is so markedly different that the question arises whether the apparent consensual contraction is a true reflex. In the typical consensual reflex of mammals, a beam of light directed into one eye causes the pupils of both eyes to contract simultaneously, and the contractions are equal in amount and duration. In the bird, on the contrary, the pupil of the stimulated eye contracts more promptly and with a greater contraction than does the pupil of the nonstimulated eye. Furthermore, the contraction of the pupil of the nonstimulated eye is capricious. It appears irregularly and varies in intensity and duration, and it is independent of the reaction of the pupil of the stimulated eye. Consequently, it is evident that if this slight, often momentary, reaction of the contralateral eye is a consensual pupillary reflex, it is markedly different from that of man and of other mammals.

The possibility that this small variable contraction of the pupil of the nonstimulated eye of the bird is not a reflex mechanism at all, but is instead a response to direct stimulation of the light, was suggested by some observations on pigeons. If one flashes an ordinary two-cell pencil flashlight into one eye of the pigeon so that the beam of light strikes the eye along the optic axis, the light will pass through the head of the bird and through the opposite eye. The pupil of the opposite eye will be illuminated to an intensity that is clear and unmistakable. A dissection of the head of the pigeon reveals that there is less than 1 millimeter of transparent bone and tissue between the two optic orbits. A beam of light can readily pass through this thin structure that intervenes between the two eyes. (Detailed microscopic drawings of these structures are given in Chard and Gundlach, *2*.)

As a result of this illumination from the rear, the retina is subject to direct stimulation. When this occurs, the pupil of the nonstimulated eye contracts. Since the light is greatly reduced in intensity because of the passage through the head, the contraction is necessarily smaller than that of the pupil of the eye upon which the light directly impinges. If the beam of light enters the first eye at too great an angle to pass through the head and strike the eye on the other side, then there is no consensual contraction. The observed variability in duration of the consensual reaction is then the result of a shift in the direction of the beam of light. In other words, what has appeared to be a consensual pupillary reflex in the bird is, in fact, nothing but the reaction of the pupil to the direct stimulation of light passing through the head.

Additional support for this conclusion has been obtained from observations on the owl. The visual axes of the owl are nearly parallel, and the projection of a beam of light directly upon one eye does not permit the light to pass through the head in the direction of the opposite eye. No consensual pupillary contraction whatsoever can be seen in the owl.

On the basis of these findings some evidence is now available that indicates that there is a functional, as well as an anatomic, difference between the visual systems of the bird and the mammal. As expected, the evidence shows a greater independence of function between the two eyes of the bird than there is between the two eyes of the mammal.

Jacob Levine

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References and Notes

1. A. Noll, *Pflügers Arch. ges. Physiol.* 182, 350 (1915); *ibid.* 196, 629 (1922).
2. R. D. Chard and R. H. Gundlach, The structure of the eye of the homing pigeon. *J. Comp. Psychol.* 25, 249 (1938).

6 June 1955

Our Upper Colorado River Project

Paul B. Sears expresses the opinion that, in regard to the much discussed Upper Colorado Irrigation Development (and evidently the Echo Park Dam) "the remedy is simple . . . such aspects of major problems (should) be referred to competent boards of scientists" [*Science* **121**, 5A (29 Apr. 1955)].

Perhaps too many people—scientists included—have the feeling that the Echo Park Dam is the major point of contention in this controversy. Certainly everyone should know that California has a high-powered, well-financed committee whose main job is to prevent any irrigation development on the Colorado River above Lake Mead. This committee has been successful in persuading the nature lovers of the nation to oppose the Upper Colorado River projects, paying no attention to the promise of federal authorities to the people of that region that a storage project would be permitted when the Dinosaur Monument was extended in area. Thousands who have not seen Dinosaur National Park have responded

to the plea to "Save Our National Parks" by urging their Senators and Congressmen to oppose the Upper Basin Project. The fact that the proposed dam is above the dinosaur "burial ground" and that the reservoir would enable thousands to see the grandeur of the canyon, instead of the few who see it now, seems to have no effect upon the "saviors" of our national parks who give westerners, the people who know our parks and are most eager for their protection and proper use, no credit for not wanting them spoiled.

California does not tell these nature lovers about the Colorado River Compact, which assigns to the Lower Basin States a fixed amount of 7.5 million acre-feet of water annually—not 50 percent of the current flow—and makes the Upper Basin assume the shortage, if any, that, without storage, the Upper Basin must absorb in low water years. Obviously farmers and townspeople in the Upper Basin will look with disfavor and distrust upon any scheme decided by "experts" to appropriate most of the water that *originates* on their lands for the use of those on the farms and in the cities of California. Opposed to such "experts" are some of the best irrigation engineers in the world, U.S. Bureau of Reclamation engineers, and others who have examined and recommended the locations for dams and reservoirs.

There is no doubt of the sincerity of the wildlife conservationists, but the complete conservation picture should be presented to the public, and the water rights of the people of the upper states should be protected. This does not necessarily mean the loss of an area of great importance in a national park.

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13 June 1955

A. D. Moinat renders a service in pointing out the basic conflict of regional interests involved in the Upper Colorado problem—a complication, but by no means the only one, that may be unfamiliar to many whose attention is fixed on the single Dinosaur National Monument issue.

My communication to which he refers was actually concerned with more elementary aspects of this and other problems of policy, namely, the physical and biological facts that are amenable to scientific study. I do not for a moment propose that scientists take over the normal legal and political operations whereby policies are determined. I am trying only to urge that those whose business it is to shape policy do not work blindly or in willful disregard of cold facts. Charge and countercharge, claim and counterclaim are not substitutes for competent studies in field and laboratory.

If the advantage of having the scientific facts in hand when large public issues are being settled is not self-evident, surely the benefits that scientists have conferred upon our civilization entitle them to contribute, within the field of their special competence, toward the solution of such issues.

Incidentally, I have avoided taking either side of the Upper Colorado issue, although quotations from my writings have been used as ammunition and, doubtless, as targets. I do not have sufficient firsthand information to judge the relative merits of the contending parties. What I am insisting on is a more rational approach to costly public enterprises. First get the facts, then hammer out the solution. Such a program can injure no one, except those on shaky ground. Given all the facts possible, policy-makers need not fear that they will ever be faced with technologic unemployment.

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21 July 1955

"Sunglasses" in Two Anoline Lizards from Cuba

In a number of lizards belonging to the families Lacertidae, Teiidae, and Scincidae and in *Cordylosaurus* (Gerrhosauridae) and *Lanthanotus* (Lanthanotidae), there is present in the lower eyelid a transparent or semitransparent "window" that permits some degree of vision when the eye is closed. This condition is thought to be a stage in the evolution of the "spectacle" found in certain genera of the Lacertidae, Teiidae, and Scincidae and in most geckos, all pygopodids, all xantusiids, and all snakes; in these the whole lower eyelid is transparent and fused to the upper lid as a permanent immobile protective cover for the eye.

In the course of study of the West Indian members of the genus *Anolis* (family Iguanidae), it was found that two closely related allopatric forms on Cuba have just such a semitransparent "window" as has been repeatedly described in lacertids, teiids, and so forth. In *Anolis lucius* three black-bordered semitransparent scales form most of the window Fig. 1); in *Anolis argenteolus* only two black-bordered semitransparent scales are involved (Fig. 2). In both forms the area of the lid window is small enough that, in a fully open eye, the window is completely concealed in a fold of the lower lid.

This appears to be the first record of such a condition in the family Iguanidae (although we believe that the phenomenon is commoner in lizards than the present published records indicate); moreover, the occurrence of a lower eyelid window in those anoles is also of interest for an ecological reason.

Barbour and Ramsden (*1*) found *A. lucius* in the vicinity of limestone cliffs, usually crawling about on the rocks at the entrance of caves. They record that although *A. argenteolus* also occurs on limestone it is found much more often than *lucius* on the trunks of trees or on the sides of buildings but usually only near outcroppings of limestone rock. More specific information is provided by Rodolfo Ruibal (University of California, Riverside) who has collected *A. lucius* in Camaguey, Cuba. He writes (*2*): "It is very typical of limestone cliffs and caves. However, like all animals it is sometimes found away from its 'typical' habitat. In caves it certainly is found anywhere in the twilight zone and of course runs out into the sun-lighted zone as well."

Two large recent collections of *A. lucius* have been made in caves; and both E. T. Willis (*3*), collecting in Oriente, and Wilfred T. Neil (*4*), collecting in Matanzas, were very much impressed with the geckolike appearance and actions of the species and their obvious adaptation to the twilight zone. The specimens collected by Willis were found on the cave walls 75 to 100 feet below the surface of the ground. Those collected by Neil were in the twilight zone, clinging upside down to the ceiling.

The Anolinae are typically diurnal, sight hunters in which vision plays a great part also in their sexual display and territoriality. Garth Underwood (*5*) has called attention to the adaptation of *Anolis* for an active diurnal arboreal life by his discovery of two foveae in the retinas of three Jamaican species of the genus. Only two species within this very large genus are suspected of having a partly cave habitat and a partly crepus-

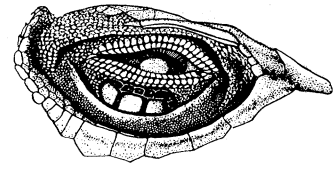

Fig. 1. Eye of *Anolis lucius*.

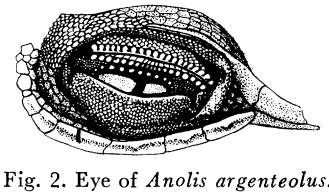

Fig. 2. Eye of *Anolis argenteolus*.