Wash once with a little 95 per cent. ethyl alcohol and drain. Add about 2 cc of ethyl alcohol 95 per cent., and stand upright under a hood. Now add about 5 cc of concentrated nitric acid, and place a large test-tube over the open end of the burette to prevent any liquid from spatting out. In a very few minutes the reaction begins and throws the contents repeatedly up the full length of the burette. After the reaction has gone to completion, the burette will be clean and the contents are easily washed out.

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SPECIAL ARTICLES

THE PHOTO-MECHANICAL CHANGES IN THE RETINA OF MAMMALS

At various times attempts have been made to demonstrate the occurrence of pigment migration and positional changes of the visual cells in the retinae of mammals. Conflicting results have been obtained on certain forms, and in only one or two cases, notably that of the ape (Cercopithecus)[1] and that of the dog,[2] have measurable differences in pigment or cone position been observed after light and dark exposures.

The band of retinal pigment is very narrow in most mammals, and in all that I have studied the pigment needles are relatively pale, never having the almost black color observed in fishes and amphibians. In the ape mentioned above, Garten reported a pigment band two or three granules wide in the dark- and three or four granules wide in the light-adapted animal. This slight difference has been accepted by subsequent workers in this field as definitely proving the existence of pigment migration in at least this one member of the mammalian group. The suggestion made by Garten and reaffirmed by Arey[3] that the photomechanical changes occur so quickly in mammalian eyes as to fail to be "caught" by the fixative seems to be invalidated by the work of Detwiler[4] on nocturnal animals, for he was always careful to excise and fix the eyes of dark-adapted animals under faint red light and got negative results.

It has seemed to me that the slight differences found in the pigmentation of the retinae of oppositely-adapted mammals might well have existed before the experiments, and it occurred to me that it would be better to experiment on a single individual, first light-adapting one eye and removing it, then dark-adapting the other eye. Casting about for a form in which it would be easy to remove one eye without much shock or blood loss to the animal, the deer-mouse (Peromyscus maniculatus) was chosen. The eye in this form is very large and protrudes well from the surface of the skull.

My thanks are due to Dr. H. W. Feldman, of this laboratory, who supplied the animals used from his breeding stock and assisted in the operations.

Two animals were used. One was placed in darkness overnight to obtain a standard and for practice in a technical way.

The other, or experimental animal, was placed in diffuse daylight supplemented by the light from a 60-watt lamp and reflector, for five hours. Under ether, one eye was pulled out slightly in its orbit, the optic stalk was ligated with silk thread and the eye snipped off distal to the ligature. The blood loss was negligible, and the animal was allowed to recover in total darkness in which it was kept for twenty hours. At the end of that time the animal was again etherized and the second eye removed under faint red light.

The eyes from both animals were fixed in Perenyi's fluid, embedded in Parlodion and cut $7.5\ \mu$. Sections from both eyes of the experimental animal were mounted on the same slide for convenience, but were not stained. The pigment bands in the two eyes were identical in all respects. They were five or six granules in width, quite uniform in all parts of the eyeball and showed no measurable differences attributable to migration. No attempt was made to measure cone positions, since cones, if present, are indistinguishable from rods in mouse retinae.[4]

I believe this method to be superior to that employing separate animals for the two exposures, and that skilled operators might apply it to other forms in the attempt to settle once and for all this long-standing question as to whether the retinal pigment migrates in mammals and "consequently" in man.

I should like to suggest a more or less philosophical reason why pigment migration should after all not be expected in mammals. If the photo-mechanical changes in the retina be considered from a comparative standpoint, their story is one of degeneration. In the fishes the phenomena are rapid and pronounced; in the amphibians they are less rapid and in general less marked, though still obviously of functional value; in the reptiles only long exposures have resulted in measurable differences in pigment and cone positions in light and darkness. In the mam-

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[1] Garten, S., 1907, "*Graefe-Saemisch Handbuch der ges. Augenheilkunde,*" Leipzig, Aufl. 2, Bd. 3, Kap. 12, Anhang; 130 pp., 5 Taf., 49 Textfig.

[2] Chiarini, P., 1906, *Arch. Ital. de Biol.*, Tom. 45, Fasc. 3, pp. 337–352, 8 fig.

[3] Arey, L. B., 1915, Science, n. s., Vol. 42, pp. 915–916.

[4] Detwiler, S. R., 1924, *J. Comp. Neur.*, Vol. 37.

mals, the phenomena seem to have practically disappeared.

Correlated with this backward orthogenesis is the forward progress in the development of the iris reaction—the familiar dilation in dim light and contraction in strong light of the pupil of the eye. In the fishes the pupil is practically stationary; in the amphibians it expands and contracts within narrow limits; in reptiles the response is about the same as in amphibians, while in the mammals and man the response is very rapid and very extensive. Ophthalmologists are agreed that the chief function of the pupil reaction is to protect the sensitive retina from too strong light and to make available to the retina all the illumination possible in dim light.

Arey[5] has summed up the surmises of previous workers, added his own and evolved an inclusive theory of the adaptive significance of the photomechanical changes based on this very idea—the protection of the sensitive and delicate rods by the pigment and the exposure of the color-perceptive cones in strong light.

It seems to me that we have here one of the not infrequent instances of the replacement of one mechanism by another of similar function through the course of evolution. Certainly the rapid pupil reaction, measured in seconds, is a decided improvement over the sluggish pigment and cell movements whose minimum reaction time at best, in certain fishes, is many minutes.

It must be admitted that the situation in nocturnal animals where both kinds of phenomena are lacking, and in the birds, where both kinds of phenomena are present to a marked degree, is disturbing to this suggestion, but the nocturnal animals have little or no need for either mechanism, and the eyes of birds are so aberrant in many respects that perhaps we are safe in dismissing them in this instance.

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EGG LAYING OF IXODIPHAGUS CAUCURTEI DU BUYSSON IN LARVAL TICKS

IN connection with experiments in rearing and liberating the French tick parasite (*Ixodiphagus caucurtei* du Buysson) at the Hamilton Laboratory of the Montana state board of entomology, the junior author, who is locally in charge of the work, in conducting an incidental and minor experiment uncovered surprising facts.

Both *I. caucurtei* and *Hunterellus hookeri* Howard, so far as is known, develop only in the nymphal stage of their host ticks, and effective egg-laying in certain experiments conducted by Dr. E. Brumpt, of Paris, and H. P. Wood, of Dallas, Texas, was found to occur only in the nymphs of ticks. Following such egg laying, development has always been found to be immediate and continuous.

Having at hand an abundance of fed larvae of *Dermacentor andersoni* Stiles and a plentiful supply of fresh adults of *I. caucurtei,* the junior author placed about 350 of the former with about ninety of the latter (mixed males and females) in a small glass jar at "room temperature" and in the direct sunlight on August 20, 1927. They were left thus for a period of three hours, when the fed larval ticks were placed in a thermal cabinet at 19° C. for incubation, which is our usual method in rearing ticks. By September 22 all the fed larvae had "molted" to the nymphal stage and the resulting "flat" nymphs were placed in a longevity tube out-of-doors in the "tick yard" under conditions simulating nature. On November 11 these nymphs were placed on a rabbit in the laboratory for feeding and seventy-eight fed nymphs were later recovered. These fed nymphs were placed in a thermal cabinet at 19° C., after which they were examined from day to day. On December 5 it was observed that a few showed the usual mottled appearance characteristic of parasitism, and thirty-two nymphs or 41.02 per cent. of the whole number were eventually isolated as parasitized. From these, nine yielded adult parasites in due time. Nine out of thirty-two is an unusually small proportion to come through to the adult condition and there may or may not be special biological meaning in the small number, since a loss of adult parasites is rather common, especially if the conditions of moisture and temperature are not correct, particularly the humidity.

From the foregoing it is shown that (a) under the conditions stated *I. caucurtei* will deposit eggs in fed larvae; (b) that, while in the case of eggs deposited in nymphal ticks, development of the parasites begins promptly and in suitable temperatures will proceed to the maturing of the parasites, in the case of eggs deposited in fed larval ticks development is delayed; (c) that the living parasite is carried through the quiescent period of the fed larva and is alive in the next stage; (d) that the parasite may remain alive through a resting period of the unfed nymphs prolonged for fifty days (September 22 to November 11); and finally (e) that on the nymphs being fed the parasites will develop to maturity.

These findings suggest the possibility of a more or less established adaptation which had not been suspected.

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[5] Arey, L. B., 1919, *J. Comp. Neur.*, Vol. 30.