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Short Communication

Refractive State of the Rhinoceros

HOWARD C. HOWLAND,*† MONICA HOWLAND,* CHRISTOPHER J. MURPHY‡

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Rhinoceroses have been supposed to be myopic; however, our examination of four specimens by retinoscopy, infrared photorefraction, and telescopic pointspread retinoscopy has shown them to be mildly hyperopic.

Rhinoceros Refraction Retinoscopy Photorefraction

INTRODUCTION

Rhinoceroses are often thought to be myopic. Typical is the view expressed in this quotation from *Jurassic Park* (Creighton, 1990) in describing the visual capabilities of *Triceratops*: "They're nearsighted, like the rhinos of today, and they tend to be surprised by moving objects". This sentiment regarding the refractive state of the rhinoceros is widely held in the popular literature and, as Hughes (1977, p. 666) points out, there is no data to dispel this belief.

We report here the resting refractive state of the rhinoceros to be mildly hyperopic relative to infinity.

MATERIALS AND METHODS

A total of four animals were examined. Three white rhinos (*Ceratotherium simum*) were examined in captivity and one black rhino (*Diceros bicornis*) was examined in the wild. Two 15 yr old, wild-caught rhinos (one male, one female) at the Madison (Wisconsin) Zoo had their resting refractive state determined using streak retinoscopy and neutralizing infrared video retinoscopy (Schaeffel, Farkas & Howland, 1987; Mutti, Zadnik, Johnson, Howland & Murphy, 1992; Murphy, Kern & Howland, 1992). By placing negative and positive ophthalmic lenses a few centimeters in front of their eyes while recording the infrared retinoscopic reflex on video tape, we could estimate the range of accommodation. These animals were examined unrestrained in a darkened enclosure. The number of observations was limited by the excited state of the animals. Cycloplegics were not used. Grain was provided to attract them to the proximity of the refractionist.

A 20 yr old female white rhinoceros was examined by streak retinoscopy at Marine World Africa (Vallejo, Calif.) after sedation with a morphine derivative, M-99. The sedation was induced in order to perform a minor surgical procedure. Topical 1% cyclopentolate was applied 30 min prior to refraction.

A wild black female rhinoceros (age undetermined, but with calf) was observed at night with a spotlight from the balcony of the Ark Hotel in the Aberdare Forest in Kenya. By noting the maximum distance from the spotlight, along a line perpendicular to that from the spotlight to the rhino, at which the eyeshine could be observed through a pair of 8 × 20 Zeiss binoculars, the angular subtense of the pointspread function could be determined. This is a variant of a pointspread retinoscopic technique (Howland, Sayles, Cacciotti & Howland, 1987). From the size of the pupil (estimated to be equal to that measured from captive rhinos) the dioptric defocus could be determined according to the equation:

$$\text{Defocus} = \frac{\text{angular subtense of pointspread radius in radians}}{\text{pupil diameter in meters}}.$$

RESULTS

The optical quality of the eyes was judged to be moderate to poor based upon the lack of crispness in the retinoscopic reflexes. Regular astigmatism was not evident in any of the eyes examined. The resting refractive state of the male and female 15 yr old captive white rhinos was +1.0 to +1.5 D bilaterally (Fig. 1). The 20 yr old sedated female white rhino had a resting cycloplegic refraction of +0.75 D bilaterally. The two 15 yr old white rhinos were found to be able to accommodate through a range of 3–4 D as measured with neutralizing

*W-201 Mudd Hall, Division of Biological Sciences, Cornell University, Ithaca, NY 14853, U.S.A.
†To whom all correspondence should be addressed.
‡Department of Surgical Sciences, School of Veterinary Medicine, University of Wisconsin—Madison, 2015 Linden Drive West, Madison, WI 53706, U.S.A.

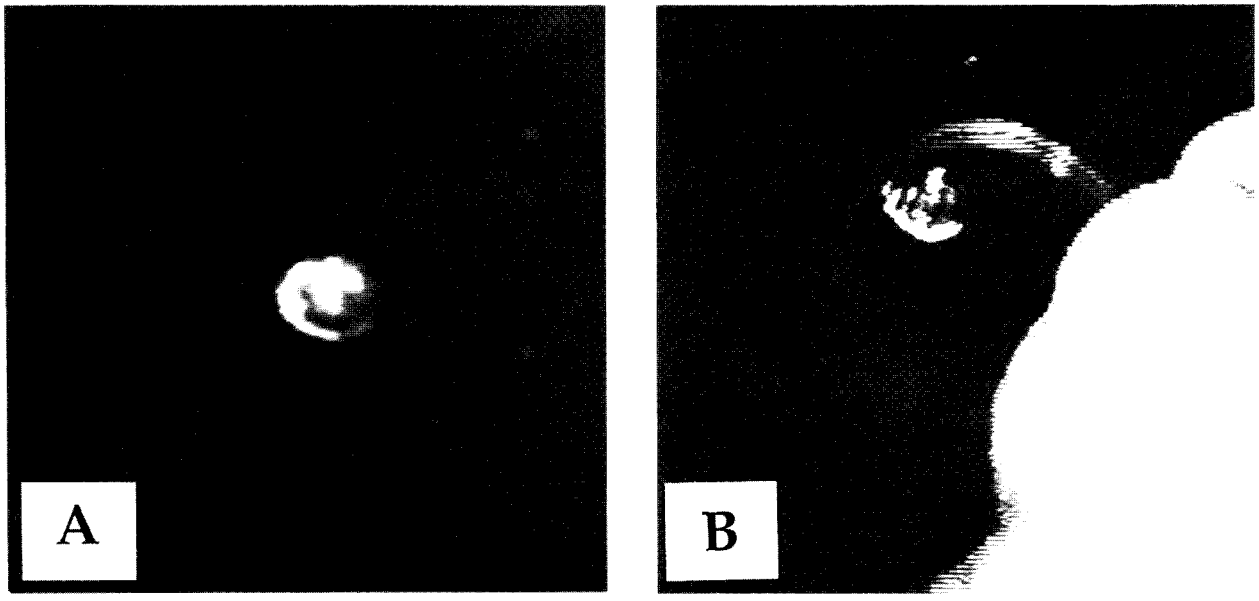

FIGURE 1. Neutralizing videoretinoscopy in a white rhino. The scatter of the light in both pictures (as opposed to forming a crisp reflex at the top or bottom of the pupil) is indicative of the poor optical quality of the eye. (A) The majority of reflected light is located in the superior portion of the pupil indicating the eye to be hyperopically focused. This follows from the fact that the light source of our photoretinoscope was located below the camera aperture. Hence, in a hyperopically focused eye, only the diverging rays originating from the top of the animal's pupil would fall into the camera aperture, while rays from the bottom of the pupil would fall outside of the aperture. (B) A +3.0 D lens placed in front of the eye induces a myopic focus in which the inferior portion of the pupil is illuminated. In this situation of a myopically focused eye, light rays emerging from the rhinoceros' eye are converging; hence, rays from the bottom of the pupil will be directed upward into the camera aperture, while those from the top of the pupil will be directed downward and fall outside of the camera aperture.

infrared photoretinoscopy. The rhino observed telescopically in the wild at a distance of 100 ± 25 ft was found to have a defocus of 2 ± 0.5 D relative to the observer. It was impossible to determine the sign of the defocus. This degree of defocus must be taken as an upper estimate, as the pupil size could well have been larger than those measured in zoos due to the low light level.

DISCUSSION

The eye of the rhinoceros is set well to the side of the head, and its optic axis forms a 60 deg angle with the mid-line of the body (Duke-Elder, 1958). The axial diameter of the globe from a small (500 kg) male black rhinoceros was reported to be 22 mm (Rochon-Duvigneaud, 1943). Duke-Elder (1958) reported the axial diameter of the rhino eye to be 23 mm but did not provide any information on the animal it was obtained from. It is cited as an example that obeys Haller's ratio where the size of the eye is inversely proportional to body size (Duke-Elder, 1958; Rochon-Duvigneaud, 1943). It has a circular pupil and the peripheral aspect of the cornea is pigmented and vascularized (Duke-Elder, 1958). This peripheral corneal pigmentation has been suggested to be an anti-glare device for it is lacking in crepuscular and nocturnal animals (Duke-Elder, 1958).

Thomas (1801) related the generally held view of the day that the rhinoceros "does not enjoy very quick sight and can only distinguish objects placed immediately before him". He also went on to suggest that (as cited by Hughes, 1977, p. 666) "if we should ever become acquainted with the natural habits of this animal, his vision will be found to be as perfect as that of any other animal of the same class". Our data show the rhinoceros to be slightly hyperopic at rest and able to accommodate through a range of 3–4 D. A small portion of that hyperopia (approx. 0.5 D) might be attributable to "the artifact of retinoscopy" (Glickstein & Millodot, 1970) if the retinoscopic reflex of the rhinoceros originated from the retinal vitreal border, rather than from the receptor layer.

In summary, the findings of this paper support Thomas' (1801) view that "it is not probable that nature should have denied to this creature a faculty which has been granted to every other, viz. a power of minutely examining their food before it is taken into the stomach".

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