alteration of hemodynamics caused by PPC. CO is distributed so as to maintain coronary blood flow at the expense of splanchnic, skin, muscle and kidney blood flow. Changes of CO and the pattern of its distribution following PPC administration resemble those after endotoxin[11,12]. However, the onset of reaction to PPC is very rapid in comparison with endotoxin. Also there is a more pronounced increase of blood flow values in heart and lungs compared to endotoxic shock. Some dissimilarities, regarding changes of CO distribution, observed in various forms of shock[13] indicate that there may be different mechanisms responsible for the redistribution of blood flow.

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A duration-dependent negative potential in the cichlid electroretinogram

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Summary. A negative potential can be evoked in the local electroretinogram of the cichlid fish *Cichlasoma octofasciatum* by light stimuli of duration longer than 70 msec. This response superficially resembles the proximal negative response, but differs in some waveform components and dependence upon stimulus configuration and duration.

The corneal vertebrate electroretinogram (ERG) represents the activity of several cell types, each component potential change consisting of the summed activity of classes of cells acting in synchrony[1]. Traditionally, the primary components of the vertebrate ERG are a negative a-wave, rapid positive b-wave, slow positive c-wave and a d-wave (off-response) of varying polarity. The a- and b-components appear common to all vertebrate ERG's; however, rod-dominated retinas have conspicuous c-waves and negative d-waves, while cone-dominated retinas have reduced c-waves and positive d-waves[5]. 2 additional components have been subsequently described: a proximal a-wave contribution[4] and a proximal negative response[2]. The latter response (PNR) may dominate the form of the electroretinogram by obscuring or competing with the b-wave component in certain stimulus configurations and intensities. However, in the analysis of the response of the vertebrate retina to light stimuli, the effect of stimulus duration on the form of the ERG has received a lesser degree of attention than the other stimulus variables of wavelength, intensity and configuration.

Electroretinograms recorded from the cornea of the cichlid fish *Cichlasoma octofasciatum* (the Jack Dempsey) show a significant dependence upon stimulus duration. Stimuli longer than approximately 70 msec generate a substantial negative potential whose appearance succeeds the initiation of the b-wave by about 80 msec. Shorter stimuli generate an ERG which assumes the classical waveform (figure 1). This 'cichlid negative response' can be generated from light- and dark-adapted retinas and by a variety of light intensities.

ERG's were recorded with agar, 1.0 M NaCl wick electrodes extruded from 10-cm Pasteur pipettes. Electrodes were apposed to the cornea and trunk of the cichlid, which

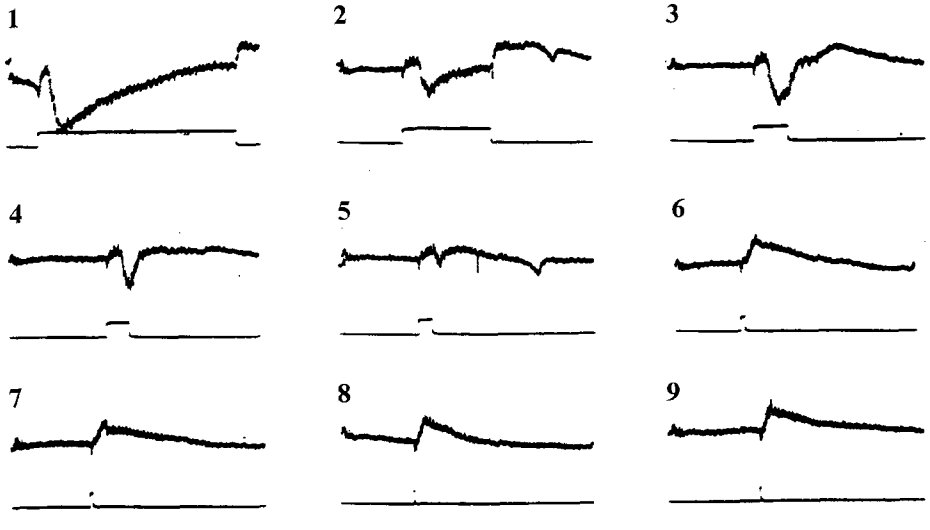

Fig. 1. A stimulus duration series from a light-adapted *C. octofasciatum*. Sweep speed is 2 sec, amplification is 50 μV cm^{-1}, bottom trace is stimulus duration. Durations are 1560, 690, 310, 180, 70, 40, 20, 10 and 5 msec, respectively.

was restrained by a damp gauze wrapping upon a styrofoam board. Bright white light from Ortholux tungsten lamp was focussed within the pupillary area of the eye and regulated by a mechanical shutter. ERG's were displayed upon a Tectronix oscilloscope and filmed on photographic paper. As a test that recording techniques were not generating unusual artifacts, ERG's were recorded from frogs *(Rana pipiens)* in similar fashion immediately before the cichlid recordings. Figure 2 shows 2 consecutive recordings, the first of a frog and the second of a cichlid, with same recording, stimulation and adaptation states. The negative response clearly dominates the cichlid recording.

This negative response of the cichlid retina, dominant in the local ERG elicited by long duration stimuli, does not match readily with known retinal responses. At first approximation, the cichlid negative response might be the teleost version of the PNR; however, the PNR is not considered a dominant contributor to the gross retinal currents recorded externally[2]. In addition, its potential change is positive upon stimulus cessation, while the PNR possesses on- and off-responses of similar polarities. The cichlid response is relatively indifferent to stimulus orientation and configuration, and is apparently quite labile to repeated stimulation. The cichlid negative response must therefore be considered at least a highly modified variant of documented retinal responses, and in view of the high degree of organization of the cichlid retina[3], may reflect an integrative field potential generated within the distal retina. The potential is not exceptionally amenable to investigation, since fish cannot be anesthetized and extremely low (ca. 50–75 μV) potentials are recorded; however, the occurrence of this retinal response in a family of teleosts well-known for their exceptional dependence upon visual stimuli suggests that the visual analysis of these fishes might provide a significant contribution to the interpretation of information processing in the vertebrate retina.

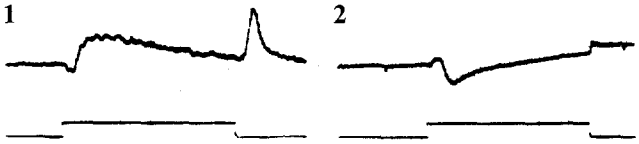

Fig. 2. Responses of frog and cichlid eye to similar stimuli. Sweep speed is 2 sec, vertical scale is 50 μV cm^{-1}, bottom trace is stimulus duration.

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Reduced deformability of erythrocytes exposed to hypercapnia

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Summary. The effect of hypercapnia on the deformability of erythrocytes was studied by means of a nuclepore membrane filter method. A decrement of the deformability by 20–40% was observed when P_{CO_2} was increased from 50 mm Hg to 200 mm Hg, accompanied with an increment of 5% in hematocrit value.

Erythrocytes absorb water and swell, when exposed to hypercapnia[1]. The deformability of the swollen erythrocytes may be lowered, which would act to reduce capillary blood flow. This consideration motivated us to measure the deformability of the erythrocytes which were exposed to carbon dioxide.

The nuclepore membrane filter method of Reid et al.[2, 3] was employed with a slight modification. A 3-way valve and an injection syringe containing saline were connected to the outlet beneath the membrane holder. A small amount of saline was introduced by this syringe through the membrane into the vertical syringe above the filter to push out air bubbles. After closing the saline containing syringe by the valve, a blood sample of 0.6 ml was gently introduced onto the saline on the bottom of the vertical syringe. The time required for 0.5 ml of sample blood to pass through a membrane with 5-μm pores under a pressure difference of 10 cm H_2O was measured. The flow rate (ml/min) thus obtained was considered as a measure of the deformability.

Fresh venous blood (21 ml) obtained from each of 6 healthy subjects was anticoagulated with 1000 units of heparin solution (1 ml) and divided into 3 10-ml injection syringes. Carbon dioxide (2 ml) was introduced into 1 injection syringe. This syringe was slowly rotated in a water bath at 37 °C for 5 min. The blood in the 2nd syringe was not exposed to any external gas and served as a normal control. The blood in the 3rd syringe served to confirm the reliability of the present measurements; the known effect of hyperosmolarity on the deformability of erythrocytes was examined. For this NaCl was added (2.8 mg/1 ml blood), which resulted in an elevation of the osmotic pressure from the normal value of 300 mOsm to about 440 mOsm.

Erythrocyte deformability and other physiological parameters in 6 subjects (mean value ± SD). The differences between normal and experimental measurements were significant by Student's paired t-test ($p < 0.01$)

Condition	Hct (%)	pH	P_{O_2} (mm Hg)	P_{CO_2} (mm Hg)	Deformability (ml/min)	Ratio of deformation
Normal	40.6 ± 2.2	7.356 ± 0.037	62.0 ± 14.3	51.5 ± 5.9	2.72 ± 0.32	1
$+CO_2$	42.4 ± 2.3	6.909 ± 0.049	83.8 ± 18.8	195.7 ± 15.9	1.95 ± 0.37	0.72 ± 0.09
+NaCl	35.0 ± 2.9	7.354 ± 0.025	48.6 ± 7.1	48.8 ± 4.8	0.43 ± 0.16	0.16 ± 0.07