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BARIUM SUPPRESSES SLOW PIII IN PERFUSED BULLFROG RETINA

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Under the appropriate conditions a large, slow, negative-going potential change can be recorded from the vertebrate retina in response to a light stimulus. This slow PIII, as it has come to be called, has been reported in the bullfrog (Sillman *et al.*, 1969), rabbit (Faber, 1969; Hanitzsch, 1973), rat (Ernst and Arden, 1972; Arden, 1977), carp (Witkovsky *et al.*, 1975) and mudpuppy (Karwoski and Proenza, 1977). As a result of their detailed spatial analyses of the response Faber (1969) and Arden (1977) concluded that the slow PIII has its origin in the Müller cell. The lengthy time course of the response along with the fact that the potential is not suppressed by treatment of the retina with sodium aspartate, a substance which depolarizes and thereby inactivates retinal neurons proximal to the photoreceptors (Cervetto and MacNichol, 1972; Dowling and Ripps, 1972; Murakami *et al.*, 1972, 1975), led Witkovsky *et al.*, (1975) to the same conclusion. Karwoski and Proenza (1977), who recorded intracellularly from the Müller cells of the mudpuppy retina, also report a prolonged hyperpolarizing response which they suggest might represent the slow PIII. However, this potential was elicited only by light of very long duration and, therefore, its relationship to the slow PIII observed in other studies remains unclear. Nevertheless, it is certainly interesting and of importance that the Müller cell, which is thought to be responsible for the production of the positive going *b*-wave of the electroretinogram (Miller and Dowling, 1970) can, under appropriate conditions, also produce a negative going slow potential. The Müller cell appears to be quite sensitive to alterations in potassium concentration and, therefore, behaves like a potassium electrode (Miller, 1973; Karwoski and Proenza, 1977; Tomita, 1976). It is certainly quite reasonable that the Müller cells could be responsible for the generation of slow PIII. A decrease in potassium concentration in the vicinity of the photoreceptor, for which there is evidence (Oakley and Green, 1976), could indeed cause the Müller cells to hyperpolarize.

Since barium has been shown to decrease potassium conductance (e.g. Sperelakis *et al.*, 1967), it occurred to us that treatment of the retina with barium might provide another test of the suggested relationship between the Müller cell and the slow PIII. Accordingly, dark-adapted bullfrog retinae were removed, separated from pigment epithelium and perfused with an aspartate–Ringer solution as described elsewhere (Sillman *et al.*, 1972). In contrast to previous work the perfusate was buffered with Tris-maleate (pH 7.8) rather than phosphate to avoid precipitation of the barium. Sodium concentration, however, was maintained at 110 mM. Also as described elsewhere (Sillman *et al.*, 1972), recordings were made extracellularly by means of chlorided silver electrodes embedded in the perfusion chamber, one on each side of the retina. All amplification was direct coupled with the 3 dB roll-off point at 40 Hz. A typical series of records is shown in Fig. 1. Traces (A) and (B) represent the response of the retina to a light stimulus (white light, 250 msec, 47 $\mu W/cm^2$) under normal conditions. One can easily distinguish the very rapid negative going potential, known to originate in the photoreceptors (Sillman *et al.*, 1969), and the very

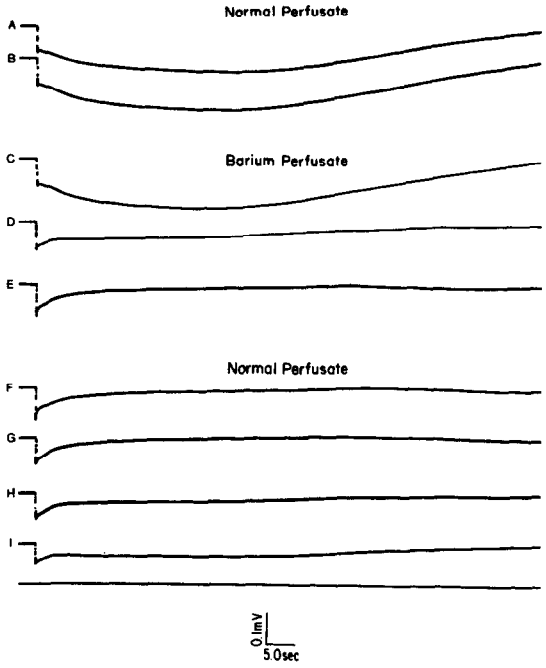

Fig. 1. The effect of barium ions on slow PIII. Traces (A) and (B) represent the response of the retina to a light stimulus under conditions of normal perfusion. Trace (B) was elicited 12 min after trace (A). Trace (C) was elicited 3 min following switchover to a perfusate containing 0.4 mM $BaCl_2$; trace (D) 6 min following switchover; trace (E) 9 min following switchover. Trace (F) was elicited 7.5 min following return to normal perfusate; trace (G) 19.5 min following return; trace (H) 25.5 min following return; trace (I) 115.5 min following return. Stimulus was a flash of white light of 250 msec duration and 47 $\mu W/cm^2$ intensity.