while the control retina responds to each flash (Figure 1D). With the possible exception of the eel data, the results of this study and previous studies (Ubels and Hoffert, Exp. Eye Res. 32:77, 1981; Ubels et al., Bull MDIBL 21:53, 1981) support the hypothesis that resistance to retinal oxygen toxicity is not a general characteristic of all fishes but is directly related to the degree of rete mirabile development and the P_{O_2} to which the retina is chronically exposed. The teleost retina is therefore a good model for the study of the mechanism of oxygen toxicity and such studies may lead to a better understanding of the effects of high P_{O_2} on the retinas of premature infants. This research was supported in part by NIH grants EY-00933, EY-05450, EY-04069 and ES-01985.

CONTRACTILE ACTIONS OF ISOLATED RENAL TUBULES OF THE WINTER FLOUNDER (Pseudopleuronectes americanus)

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INTRODUCTION--Radial constrictions of flounder renal tubules have been observed in kidney explants maintained in culture (Townsley and Scott, J. Fish. Res. Bd. Canada 20(1) :243, 1963) and in isolated tubular segments (Trump and Bulger, Lab. Invest. 16:453-482, 1967; Beyenbach, Nature 299:54-55, 1982). These systaltic actions are presumably the result of contractions of smooth muscle investments that surround the nephron of flounder species, the English sole (Parophrys vetulus) and the plaice (Pleuronectes platessa), for which detailed renal ultrastructure has been reported (Bulger and Trump, Am. J. Anat. 123:195-226, 1968; Olsen, Acta Pathol. Microbiol. Scand. 212:81s-96s, 1970). This report provides 1) observations on the constrictive actions of isolated renal tubules of the winter flounder (Pseudopleuronectes americanus); 2) confirmation of the presence of smooth muscle cells surrounding the basement membrane of the nephron, and 3) a discussion of the possible role of tubular constrictions to flounder renal function.

METHODS--Renal tubules were isolated by microdissection from freshly excised kidney tissue and bathed in flounder Ringer's solution (MDIBL Bull. 21:40-42, 1981). Individual tubular segments were transferred to depression slides and observed under inverted compound light microscopy (400 x). Kidney tissue for transmission electron microscopy (TEM) was prepared as previously described (MDIBL Bull. 21:35-37, 1981).

RESULTS--Approximately one fourth of isolated tubular segments examined under light microscopy showed slow, undulatory movements associated in nearly every instance with the presence of sharp radial constrictions as previously described (Beyenbach, 1982). Radial constrictions were observed at one or several (up to 5) sites along a given 200 μm portion of the tubular segments and could be sustained or periodic with a frequency of approximately 3-5 constrictions per minute. The constrictions, which in some cases completely occluded the tubular lumen, forced flow of luminal fluid away from the constriction site. Subsequent relaxation allowed luminal fluid to flow back. In one segment a series of constrictions were seen to proceed in a wave-like manner along the tubule. However, multiple constrictions usually appeared independently of each other and true peristalsis was not observed.

Examination of the winter flounder kidney under transmission electron microscopy showed smooth muscle cells attached to the peritubular side of the basement membrane of the nephron (Figure 1). Longitudinal sections of the smooth muscle cells revealed myofilaments and an occasional centrally located nucleus. Single smooth muscle cells imaged in our laboratory to date were associated with proximal tubular segments of the flounder nephron.

DISCUSSION--Previously it was not clear if constrictions of renal tubules of the winter flounder were due to the presence of myoepithelial cells or smooth muscle cells (Beyenbach, 1982). Transmission electron microscopy observations confirm the presence of smooth muscle cells adjacent to the proximal segment of the nephron similar in appearance to those described for the English sole (Parophrys vetulus) by Bulger and Trump (1968). The presence of individual smooth muscle cells rather than a muscular layer is consistent with the observation of radial constrictions at distinct sites along the tubule.

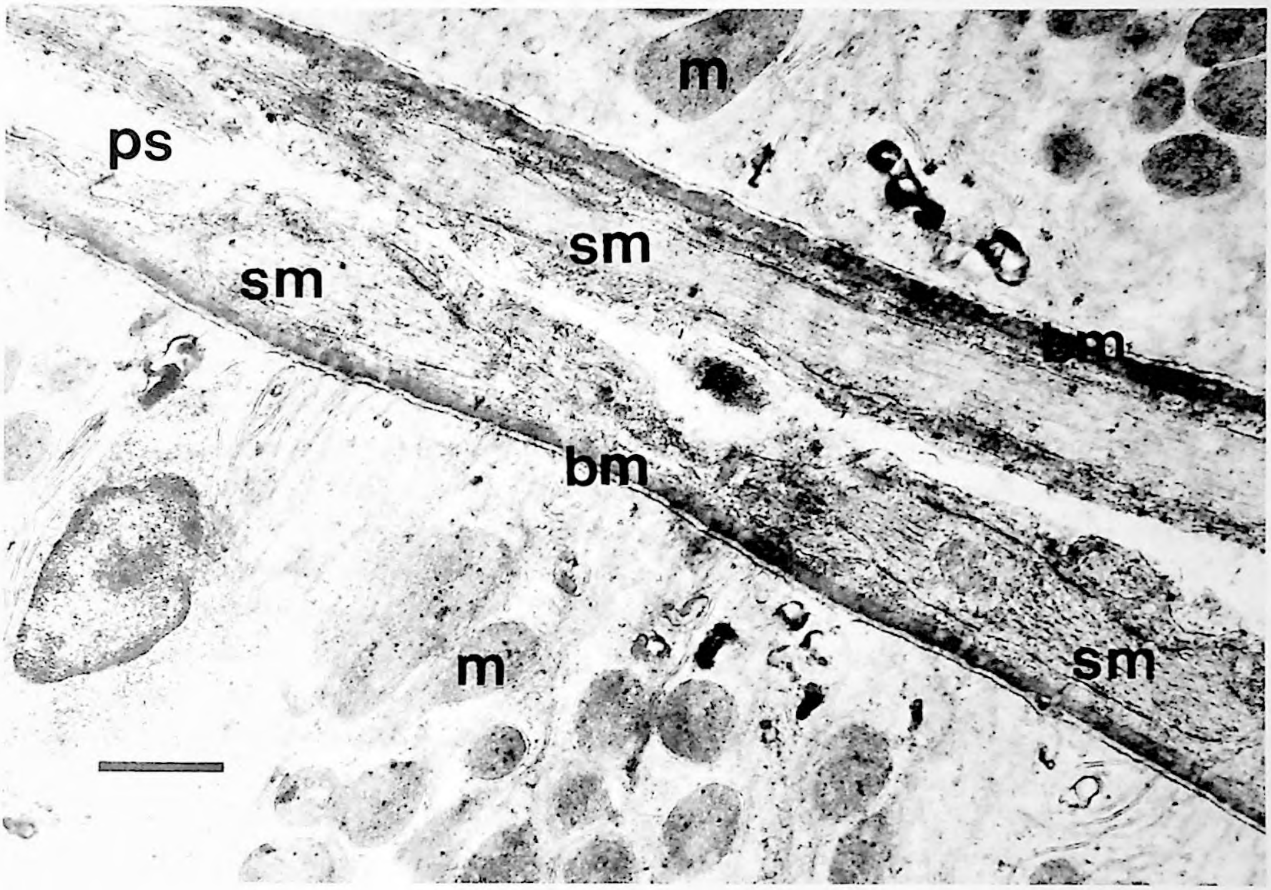

Figure 1.--Electron micrograph of adjacent proximal segments of flounder renal nephrons with numerous mitochondria (m). Smooth muscle cells (sm) are situated between the peritubular space (ps) and the basement membrane (bm) of the tubules. Mag. = 16,600 x, scale bar = 1.0 μm.

The function of tubular constrictions in the glomerular kidney of the winter flounder is not known. Trump and Bulger (1967) speculated that tubular constrictions may contribute to fluid propulsion along the flounder nephron. On the basis of single nephron glomerular filtration rates (gfr) of 350-650 pl min^{-1} (Beyenbach, 1982) and Poiseuilles equation, the pressure needed to drive fluid along the lumen of the renal tubule is negligible (less than .1 mm Hg) when compared to the arterial perfusion pressure of the kidney, 24 mm Hg (Cech et al., In: Respiration of Marine Organisms. Ed., Cech et al., TRIGOM, 155-162, 1975). Thus under normal glomerular filtration rates, filtration pressure should provide sufficient force to drive fluid flow along the nephron without the assitance of tubular constrictions. However, previous studies in our laboratory have shown that proximal tubules of the winter flounder secrete fluid at rates that may exceed the single nephron glomerular filtration rate if gfr is low or zero (glomerular intermittency). This leads us to speculate that in the absence of glomerular filtration (Hickman, Can. J. Zool. 46:427-437, 1968) and in the presence of tubular fluid secretion (Beyenbach, 1982), tubular constrictions may play an important role in the propulsion of luminal fluid along the proximal tubule and more distal segments of the nephron. Supported by Wiegand Fellowship (to WHC) and in part by NIH AM 26633 (to KWB).

CATION SELECTIVITY OF FLOUNDER PROXIMAL TUBLES

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Proximal tubules of the winter flounder *Pseudopleuronectes americanus* secrete fluid into the tubule lumen