

A COMPARATIVE STUDY OF THE COMPOSITION OF HEPATIC AND GALLBLADDER BILE IN *Squalus acanthias*

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Little is known about the composition of bile in Elasmobranchs (Smith, H.W. J. Biol. Chem. 81:407-419, 1929) and no comparative studies have been made of hepatic and gallbladder bile to assess gallbladder function. Presumably this is because of the technical difficulty in separating hepatic and gallbladder bile due to the anatomical location of the gallbladder within the substance of the liver.

In the present study, a technique was devised to collect bile directly as it entered the proximal portion of the gallbladder from the hepatic ducts, thereby preventing prolonged contact with gallbladder epithelium. Male fish weighing 1.3-2.8 Kg were restrained for up to 15 minutes on a shark board while their gills were perfused with oxygenated sea water. After performing a small ventral abdominal incision, the common duct was identified and ligated, and the gallbladder was drained completely of bile through its distal tip. A large bore polyethylene cannula (PE 200) was introduced through this hole into the proximal gallbladder lumen and sutured in place. The cannula was then externalized through the sutured ventral incision, and bile was collected in small balloons attached to the cannula while the fish swam freely in large pools. No bile was observed within the gallbladder lumen when reexamined at post mortem.

The composition of bile collected through the cannula (hepatic bile) was compared with that of 10 paired collections of gallbladder bile and plasma (Table 1). The results indicate that the concentrations of Na^+ , K^+ and Ca^{++} in gallbladder bile were significantly increased above their respective values in cannula bile but that a much greater increment (15 fold) was observed in the concentration of gallbladder bile acids. In contrast, the concentrations of HCO_3^- and Cl^- in gallbladder bile were strikingly diminished. Despite these gross changes in electrolytes and bile acids, the osmolalities of cannula and gallbladder bile were identical. Cannula bile composition was similar to that of plasma with respect to Na^+ , Cl^- , and HCO_3^- , however slightly increased concentrations of K^+ , Mg^{++} and Ca^{++} were observed.

These findings suggest that the composition of cannula bile was not substantially altered by transport of water or electrolytes across gallbladder epithelium and that cannulation through the gallbladder is an effective technique for obtaining hepatic bile in the dog fish shark. Furthermore, the altered composition of gallbladder bile implies that gallbladder epithelium functions in a comparable fashion to higher vertebrates and mammals by transporting water, cations, chloride, and HCO_3^- and concentrating bile acids in micelles without altering osmolality (Diamond, J.M. J. Physiol. London, 161:442-527, 1962).

TABLE 1
COMPOSITION OF PLASMA AND HEPATIC & GALLBLADDER BILE

	<u>Osmolarity</u> (mosmoles/L)	<u>Bile Acids*</u> (mmoles/L)	<u>Na⁺</u> (mmoles/L)	<u>K⁺</u> (mmoles/L)	<u>Cl⁻</u> (mmoles/L)	<u>HCO₃⁻ **</u> (mmoles/L)	<u>Mg^{**}</u> (mg%)	<u>Ca^{**}</u> (mg%)
<u>Plasma</u>	984±36 (13)†		258±15 (15)	3.8±0.7 (15)†	204±14 (13)	3.3±0.6 (5)	4.6±1.6 (13)†	15.4±0.5 (13)†
<u>Cannula (hepatic)</u>								
<u>bile</u>	922±54 (6)	21±12 (5)	271±14 (8)	5.0±0.9 (8)	224±21 (5)	5.8±3.5 (5)	9.0±2.0 (5)	18.0±0.0 (5)
<u>Gallbladder ***</u>	923							
<u>bile</u>	923±69 (13)	353±77 (10)†	366±40 (15)†	6.5±0.7 (15)†	79±49 (13)†	0.8±0.3 (7)†	10.5±1.5 (7)†	58.7±9.6 (13)†

* Analyzed by hydroxysteroid dehydrogenase method.

** Determinations kindly provided by Dr. T.H. Maren.

† Plasma or gallbladder constituents were significantly different from hepatic bile.

*** All gallbladder constituents were significantly different from plasma.

Numbers in parenthesis = # of fish sampled.