Gill filaments collected bimonthly during smoltification in 1983 were examined by scanning electron microscopy (SEM), and to a lesser extent by transmission electron microscopy (TEM); filaments were also studied monthly by light microscopy (LM). SEM and TEM observations of secondary lamellae from presmolts showed degenerating mitochondria-rich (MR) cells, the putative chloride cells, protruding from the surface. In April, this epithelium appeared smoother in SEM and, in some cases, the lamellae appeared thinner. The secondary lamellae from smolts (May) were enlarged with a rough surface. In late May, some animals displayed extensively infolded secondary lamellar surfaces. Initially, the MR cells were low in electron density with circular mitochondria, whereas those in April were more electron-dense with elongate mitochondria. These may represent different stages of the same cell type, although intermediate stages were not observed. Gill Na^+/K^+-ATPase levels (analyzed by W. Zaugg) rose in late April coincident with the enlargement of secondary lamellae. Secondary lamellar and interlamellar MR cell density did not vary significantly during the study, although interlamellar MR cell density tended to be increased in May. The inability to distinguish between early and late MR cells at the LM level prevents their individual quantification.

In March (presmolts) and June (postsmolts), coho (n = 16) were implanted intraperitoneally with silastic capsules, either empty (sham-implanted controls) or containing cortisol. Because of its low permeability to cortisol the capsule was sealed only at one end. Eight animals from each group were transferred for 24 h to SW on the 7th (1983) or 12th (1984) day after implantation. Cortisol in presmolts failed to improve SW adaptability; plasma Na^+ levels were similar and higher for both groups in SW compared with levels in the FW controls. However, cortisol-treated FW and SW animals in March, but not in June (1983), had significantly higher ($P<0.05$) gill Na^+/K^+-ATPase activity than FW controls. The SW sham-implanted group showed elevated activity which, however, was not significantly different from the FW group.

SEM studies on the gill epithelium, still in progress, have been completed for March (1984). Gross morphological differences were not observed between control and cortisol-treated FW animals. The apical cavities of chloride cells on the interlamellar surface of control fish were deep, shallow, or absent. Deep apical cavities were absent from two of the four cortisol-treated fish.

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Changes in the lipid composition of juvenile salmonids associated with smoltification and premature transfer to sea water

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ABSTRACT

Smoltification of salmonid fish is accompanied by depletion of total body lipid (Vanstone and Markert, 1968, J. Fish. Res. Board Can., 25: 2403; Fessler and Wagner, 1969, J. Fish. Res. Board Can., 26: 2823; Komourdjian et al., 1976, Can. J. Zool., 54: 544) and glycogen (Fontaine and Hatey, 1950, C.R. Soc. Biol. Paris, 144: 953). Recent work has shown that there are significant changes in the total lipid content, lipid class composition and fatty acid composition of various tissues in juvenile salmonid fish undergoing parr–smolt transformation, as well as alterations in total lipid content brought about by premature transfer to sea water.

Developmental changes in total lipid and lipid class content

The total lipid content of dark muscle, liver, light muscle and serum is depleted during smoltification of steelhead trout (*Salmo gairdneri*); however, mesenteric fat total lipid concentration fluctuates little. Although cholesterol and other lipid classes (depending on tissue) are reduced, lipid depletion is primarily due to decreases in triacylglycerol content (Sheridan et al., 1983, J. Fish Biol., 23: 125). Wax esters have been detected in the serum and liver (Sheridan and Allen, 1982, Comp. Biochem. Physiol., 74B: 251) and become depleted during smoltification.

Developmental changes in tissue fatty acid composition

Fatty acids from the several lipid classes of selected steelhead trout parr and smolt tissues, previously separated by thin-layer chromatography, have been analyzed by gas chromatography. The fatty acid composition of the parr was markedly different from that of the smolt, the former being characterized by relatively low amounts of polyunsaturated fatty acids (such as $20:5\omega6$ and $22:6\omega3$) and relatively high amounts of linoleic acid ($18:2\omega6$), much like the typical freshwater lipid pattern. The fatty acid composition of the smolt was characterized by large proportions of long-chain polyunsaturated fatty acids. Generally, the fatty acid composition of the smolt resembled the typical seawater lipid pattern. The change in fatty acid composition of the smolt is anticipatory to seawater entry and is independent of diet and water temperature (Sheridan et al., 1985, Comp. Biochem. Physiol., in press).

Effects of premature transfer to seawater

Preliminary data indicate that coho salmon (*Oncorhynchus kisutch*) prematurely transferred to sea water in February have significantly lower liver and dark muscle total lipid content, both 30 and 60 days after transfer, than freshwater controls. Mesenteric fat total lipid content appeared to increase following transfer to sea water (Sheridan, Friedlander and Rosenberg, unpublished). These data are consistent with those obtained by Woo et al. (1978, J. Fish Biol., 13: 421) and further suggest that metabolic dysfunction is associated with stunting.

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Biochemical basis of smoltification-associated lipid and carbohydrate depletion

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ABSTRACT

Recent work in our laboratory has shown that increases in lipolytic/glycogenolytic enzyme activity and decreases in the rates of lipid/glycogen synthesis are among the factors responsible for lipid and carbohydrate depletion during salmonid parr—smolt transformation. Alterations in lipolytic rate also occur as a result of premature transfer to sea water.