Osmoregulatory-like Mitochondria-rich Cells in the Developing Pancreatic Ducts of Young Anuran Tadpoles

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ABSTRACT Pancreatic ducts of young posthatching *Rana temporaria* tadpoles are the main component of the developing pancreas. At this stage (free-swimming tadpoles with internal gills), duct cells display a high degree of development of basal and lateral outfoldings of the cell membrane with extensive interdigitation, and numerous mitochondria are present throughout the cytoplasm. Wide intercellular spaces also exist, sometimes forming canaliculi-like structures. Since these traits are characteristic of cells engaged in osmotic regulation, we suggest the possibility that this temporary duct system participates in such control. Duct cells in tadpoles with well-developed hindlegs have diminished interdigitation, and mitochondria are localized apically.

The pancreas is derived from outpocketings of the endodermal lining of the embryonic gut. The original pancreatic diverticula give rise to primitive pancreatic tubules, the tubules of Laguesse (Laguesse, 1893, 1894, 1896), which further differentiate into the diverse pancreatic epithelial components. Primordial ducts therefore have been referred to as sites of cellular differentiation in amphibians as well as other vertebrates (Frye, '58, '62; Ortiz de Zárate et al., '91).

Rana temporaria tadpoles live in fresh water, as is generally the case among anuran larvae. Since the aquatic environment is hypotonic in relation to internal medium, they must have active systems to eliminate water and to retain salts. Osmoregulation in larval amphibians apparently is controlled by several different systems (see Deyrup, '64), whose relative importance has not yet been clearly established.

In adults, the skin is a major organ for salt and water balance. In contrast, several reports suggest that the skin of tadpoles is extremely water-permeable (Swingle, '19; Howland, '21; Rappaport, '55; Bentley and Greenwald, '70) and does not retain salts as does that of adult frogs (Krogh, '37, '39; Taylor and Barker, '65; Alvarado and Johnson, '66; Kawada et al., '69). It is thought that cutaneous active ion transport is probably established around the time of metamorphosis (Adolph, '27b; Taylor and Barker, '65; Frieden and Just, '70). However, the tadpoles can avoid hyperhydration, as was shown early in different species (Adolph, '27a).

We report the existence of a peculiar, well-differentiated structure of pancreatic duct epithelial cells during the early larval life of *Rana temporaria*. Based on their ultrastructural traits, we suggest that, in addition to cellular differentiation, larval pancreatic ducts could play an osmoregulatory role during tadpole development.

MATERIALS AND METHODS

Forty specimens of *Rana temporaria* in various larval (posthatching) stages were used. Eggs were collected in February and March and were reared to the desired stages in the laboratory. Tadpoles were maintained at 18°C in continuously renewed rain water. They were fed ad libitum with boiled spinach and commercial fish food.

There exists a great variability in the terminology used for description of larval development in Anura. In the present study, the animals were staged according to Houillon ('73), who described four phases in *Rana temporaria* larval development. In our studies, we have referred to these stages as phases I, II, III, and IV: early posthatching, nonfeed-

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