

OXYGEN CONSUMPTION AND HEART RATE RESPONSES TO LOWERED AMBIENT TEMPERATURES IN CHICK EMBRYOS AND HATCHLINGS

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The domestic fowl (*Gallus gallus domesticus*, referred to as chick) is precocial species and embryos hatch after about 21 days of incubation at 38°C. Gas exchange is made by molecular diffusion through the chorioallantoic membrane (CAM) and porous eggshell prior to internal pipping (i.e., pipping internally the CAM; IP). With initiation of lung breathing, both the diffusive and convective gas exchanges by the CAM and lungs are made in the egg with subsequent increase in the latter during external pipping (i.e., pipping externally the eggshell). The incubation period prior to initiation of IP on days 19-20 is referred to as prenatal period and the embryo, the prenatal embryo. The period beginning with IP and ending up hatching is referred to as perinatal period of incubation and the embryo, the perinatal embryo. The perinatal period after hatching may be designated as postnatal period and the chick, hatchling or newly hatched chick. In order to investigate the development of thermoregulatory capacity in the prenatal and perinatal chick embryos, we previously developed two cooling tests which examined oxygen consumption responses of the embryo to lowered ambient temperature exposures. One was a gradual cooling test and another was a prolonged cooling test. Both tests were made by keeping the imbalance between heat loss from the egg and heat production of the embryo as small as possible while the egg was cooling and oxygen consumption was measured. The incipient compensatory increases in oxygen consumption were found in perinatal chick embryos. The perinatal embryos needed not emerge from the egg for the compensation to occur. We suggested general model of the development of homeothermy in precocial and also altricial birds (Tazawa *et al.*, 1988; Whitow & Tazawa, 1991). In addition to these reviews, in the present report we investigated the heart rate responses of perinatal chick embryos and postnatal hatchlings to lowered ambient temperature exposures. The instantaneous heart rate (IHR) was determined from ECG measured by specially designed silver wire electrodes in perinatal embryos inside the eggshell and by flexible disk electrodes in hatchlings. Some externally pipped (EP) embryos failed to hatch on day 22 of incubation and stayed inside the eggshell for more than 1-2 days. These EP embryos responded to low temperature exposures by raising the IHR baseline and in addition the raised baseline HR began to oscillate with a period of 10-20 s. These trends were more dominant in hatchlings. Particularly, in hatchlings, the HR oscillations which appeared in a low temperature environment disappeared when they were warmed. Thus, the HR oscillations with a period of 10-20 s which often occur in developing hatchlings are distinctive evidence related to thermoregulation of hatchlings.

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