

Abstract

During incubation, most birds require the presence of at least one parent to ensure suitable incubation conditions for embryo development. The main factors that affect the development of the embryo are temperature, humidity and egg turning. In this work, incubation conditions were investigated in two biparental Lapwing species (genus *Vanellus*), the Northern Lapwing (*Vanellus vanellus*), which faces the risk of egg cooling in temperate areas, and the Red-wattled Lapwing (*Vanellus indicus*), which faces the risk of egg overheating in the subtropics. A laboratory experiment testing the thermal properties of the Red-wattled Lapwing nest lining showed that it selects lining material that slows down temperature growth during egg heating, thus ensuring suitable thermal conditions during parental absence at high ambient temperatures. Temperature and egg turning during incubation were recorded by an artificial egg with a built-in sensors placed in the nests of both target species; data collected by the sensors were stored by a base-station located nearby. The average egg temperature was 32.5 °C for the Northern Lapwing, and 35.0 °C for the Red-wattled Lapwing. Egg temperature in both species fluctuated significantly, affected by many factors. Egg temperature increased with increasing ambient temperature, it had a diurnal rhythm during the day and was significantly higher during the day than at night. In the Northern Lapwing, a larger volume of nest lining causes the parts of the egg in contact with the lining to maintain a higher temperature. In Red-wattled Lapwing no effect of lining composition on egg temperature was found. The incubation phase did not affect the egg temperature in either of the species. The egg turning is also a key factor influencing the development of the embryo, but it has been little studied in nature. The Northern Lapwing manipulated the egg 1–2 times per hour, the Red-wattled Lapwing less than once in an hour. In both species, egg turning was more frequent during the day than at night. The frequency of rotation and the angle of rotation during manipulation did not differ during the day, nor were they affected by the properties of the nest lining. The Northern Lapwing turned eggs more often at higher ambient temperatures. Red-wattled Lapwing turned eggs through a greater angle when ambient temperatures were high. The results show that although biparental species pay great attention to their clutch, the embryo in the egg is exposed to enormous temperature fluctuations during incubation due to gaps in incubation by the parents and variation in outdoor conditions. The question is how important this phenomenon is for the development of the embryo and whether it is only a necessary physical relationship in the flow of heat or whether these fluctuations can affect things like embryo quality, hatching and survival of nestlings.

Key words: birds; breeding; incubation; thermoregulation; adaptation; behaviour; shorebirds; nest lining; egg turning