populations. North-Holland Publishers, Amsterdam.

PERRINS, C. M. 1970. The timing of birds' breeding seasons. Ibis 112:242–255.

YOM-TOV, Y. 1974. The effect of food and predation on breeding density and success, clutch size and laying date of the crow (*Corvus corone* L.). J. Anim. Ecol. 43:479–498.

*The Condor* 90:958–959


# COLD TOLERANCE OF EUROPEAN BLACKBIRD EMBRYOS AND NESTLINGS[1]

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*Key words: Thermal tolerance; incubation;* Turdus merula; *embryos; nestlings.*

In a review of the thermal tolerance of avian embryos, Webb (Condor 89:879–898, 1987) found few published data on the effects on embryos of limited duration exposure to low temperatures. In particular, Webb commented on the lack of studies on common birds, nesting in relatively benign thermal environments, and suggested that the American Robin, *Turdus migratorius,* would be a suitable species on which to collect baseline data on avian thermal tolerance. I report here some field observations of the cold tolerance of embryos and nestlings of the congeneric and ecologically similar European Blackbird, *Turdus merula.* The observations were made in the University Botanic Garden, Cambridge, England (52°12′N, 0°7′E), during 1987. Air temperature records were taken from the Botanic Garden weather station; the times given are GMT.

A reproductively experienced female blackbird laid a clutch of four eggs that were expected to hatch on 20 May, assuming a typical incubation pattern and incubation period of 13–14 days. At 07:30 on 20 May three eggs were present; by 17:35 only two remained. They were not then examined, but the following day at 07:25 they were both pipped yet cold to the touch. When checked at 09:20, 13:20, and 15:10 that day they were still cold and no nearer hatching. The female had apparently deserted the eggs after the loss of the other two, so that they had been at temperatures between 5.8 and 12.4°C for at least 8 hr, assuming that they were completely shaded (the nest was in an evergreen hedge and it was a mostly cloudy day). At 15:10 I removed and marked the eggs, rewarmed them under an infrared lamp, and placed them in the nest of another blackbird pair whose nestlings were due to hatch. Next morning both eggs had hatched. One nestling was left in this new nest where it grew well for 4 days, but disappeared before I banded the remaining nestlings at 8 days. The second nestling (which was marked at hatching and color-banded when 8 days old) was raised by other host parents. It grew well, fledged at a normal age, and was last seen 14 days after fledging, shortly before young become independent. Snow (Ibis 100:1–30, 1958) records a mean period of dependence of 20 days; range 15–25.

Blackbird nestlings may also be able to tolerate short periods of hypothermia. At one poorly constructed nest I found a nestling, that had hatched that day, lying on the ground at 17:50 on 18 May, completely cold to the touch. The maximum temperature that day was 12.0°C; it had been a wet and completely cloudy day. The nestling was quite still, so it appeared dead, but it revived when rewarmed. I replaced it in the nest, where it grew well for 2 days but had disappeared, along with another nestling, when the brood was measured at 4 days. The remaining two nestlings were deserted, suggesting that the nestling's disappearance may have been due to a poor breeding attempt by this first-year pair, not to irreversible damage when the nestling was cold.

In both cases reported the young would have died if I had not intervened, but I have recorded cold, pipped eggs and cool nestlings which have been rewarmed by their parents. Such records constituted less than 1% of my visits to nests (of the 322 nests which survived at least until the end of hatching; each nest was visited one to 12 times).

Thus the blackbird, which does not seem to nest in an unusually difficult thermal environment in Cambridge, has embryos and apparently nestlings that are tolerant of chilling below 12°C for several hours. Perhaps any species nesting in a temperate climate needs to have embryos tolerant of cooling for at least short periods, although the nominate race of the blackbird breeds as far north as 63° in Finland (Cramp, *Handbook of birds of Europe, the Middle East and North Africa.* Vol. 5. Oxford Univ. Press, Oxford, 1988), so may be especially tolerant for a passerine breeding in England. In the blackbird both sexes feed the nestlings but only the female incubates and broods, and the male

[1] Received 13 April 1988. Final acceptance 24 June 1988.

rarely feeds the female at the nest (pers. observ.). Perhaps if both sexes incubated or the male fed the female on the nest there would be less selective advantage to having thermally tolerant embryos; conversely, intolerant embryos may necessitate biparental incubation or male incubation feeding.

I thank C. D. Piggott and P. Orriss for permission to study blackbirds in the University Botanic Garden, and J.N.M. Smith and an anonymous reviewer for comments on the manuscript. The study was funded by an Australia-U.K. Commonwealth Scholarship.

*The Condor* 90:959–962


# FORAGING BEHAVIOR AND FOODS OF THE LIGHT-FOOTED CLAPPER RAIL[1]

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*Key words: Clapper Rail; foods; foraging;* Rallus longirostris levipes; *salt marsh.*

Several reports are available on the foods and foraging of subspecies of Clapper Rails, *Rallus longirostris* (Bent 1926, Orr 1939, Moffitt 1941, Sibley 1955, Ohmart and Tomlinson 1977, Heard 1982), but nothing has been published for the Light-footed Clapper Rail (*Rallus longirostris levipes*). Because, the Light-footed Clapper Rail is considered endangered, such information could be critical for effective management of the habitat and this bird's recovery (U.S. Fish and Wildlife Service 1985).

The Light-footed Clapper Rail occurs in California's coastal marshes from Santa Barbara County south to the Mexican border and in northwestern Baja California, Mexico (Bent 1926, AOU 1957). Annual censusing of the rails in California since 1980 revealed a high count of 277 pairs distributed in 19 marshes in 1984 (Zembal and Massey 1981, 1985a), followed by a crash to 142 pairs in 14 marshes in 1985. As of the spring of 1987, the state population had only poorly recovered.

We have been investigating the habits of this endangered race since 1979 (see Zembal and Massey 1983a, 1983b, 1985b, 1987; Massey et al. 1984; Zembal et al. 1985; Massey and Zembal 1987). Herein are presented our observations on the known foods and foraging strategies.

## STUDY AREA AND METHODS

Foraging Clapper Rails were observed at Upper Newport Bay, an ecological reserve of the California Department of Fish and Game in Orange County. Upper Newport Bay is a largely unmodified embayment, subject to unconstrained tidal influence (tidal range of 2.6 m) and winter freshwater storm flows. The total area of the reserve is about 304 ha, including a 111-ha salt marsh (California Department of Fish and Game 1984).

Descriptions of foraging behavior, presented here, summarize approximately 180 hr of visual contact with feeding Clapper Rails during the period March 1979–August 1987. In addition, several hours of foraging were captured on video tape, mostly in January and February 1983. The tape of 11 foraging bouts by four rails, totaling 46.3 min of feeding, was detailed enough to allow excellent monitoring of all their activities. The motions and foraging success (swallowings) of these birds were quantified.

A total of 49.85 g of materials regurgitated by Light-footed Clapper Rails was collected in the spring of 1979 and of 1986. Of the total, 77% was collected at Upper Newport Bay, 15.2% from the Seal Beach National Wildlife Refuge in Orange County, 4% from the Kendall-Frost Reserve in Mission Bay, San Diego County, and 3.8% from the Tijuana Estuary National Wildlife Refuge on the Mexican border. The pellets and fragments were separated under a dissecting microscope and recognizable remains were identified.

## RESULTS AND DISCUSSION

Over 90% of the time that Clapper Rails were observed foraging, they hunted in the marsh vegetation, executing numerous surface gleans and usually shallow probes. They appeared to be hunting by sight and erratically changed their direction of travel in response to cues, presumably movements by potential prey items. Consequently, this general foraging behavior involved a lot of abrupt turns and direction reversals, and the foraging birds often covered only very small areas.

The movements involved in 11 bouts of foraging revealed rates of foraging that varied nearly eightfold (Table 1). Higher intensity foraging was regularly observed during peak foraging hours in the late evening. Rates of 1,000–2,000 gleans and probes per hour appeared to be commonly sustained. Lower frequency of feeding motions with more travel by a rail was typical of "crabbing," or the exploration of burrows, particularly along creek banks, for crabs and other larger prey

[1] Received 18 April 1988. Final acceptance 7 July 1988.