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Science of the Total Environment 366 (2006) 682 – 687
Science of the Total Environment
An International Journal for Scientific Research into the Environment and its Relationship with Humankind
www.elsevier.com/locate/scitotenv

Reproductive effects of heavy metal accumulation on breeding feral pigeons (*Columba livia*)

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Received 7 September 2005; received in revised form 1 February 2006; accepted 7 February 2006
Available online 20 March 2006

Abstract

To investigate the effects of heavy metal accumulations on breeding birds, we compared the egg size, eggshell thickness and some reproductive parameters in feral pigeon populations collected from Seoul and Ansan colonies. The results showed that concentrations of Pb in bone and Cd in kidney of adult pigeons in Seoul were three times higher than in Ansan colony. Significant positive correlation was also observed between Pb and Zn in bone and Cd and Zn in kidney of adult pigeons from Seoul, but not Ansan. This indicates that pigeons at Seoul may be affected more by the toxic Pb and Cd exposure in the environment rather than those at Ansan because of the antagonistic action of Zn against Pb and Cd toxicity. No significant difference was observed in egg characteristics (egg length, width and shell thickness), clutch size (number of eggs per clutch), incubation periods and hatchability of squabs between the two study sites. Although no significant difference was observed, body weight, and primary wing, bill and tarsus lengths of nestlings from Seoul which is more polluted were rather smaller than those from Ansan. Nestlings at Seoul fledged significantly later than at the less polluted site (Ansan). We also observed significantly lower fledging success at Seoul than Ansan colony. Elevated metal exposure may thus result in decreasing growth rate in pigeon nestlings resulting in fledging length and fledging success. Our results suggest a possible effect of heavy metal bioaccumulation on breeding of feral pigeons.

Keywords: Reproductive effect; Heavy metal; Feral pigeons; Seoul; Ansan

1. Introduction

Toxic metals such as lead (Pb) and cadmium (Cd) can have adverse effects on various physiological systems, including endocrine systems at the environmentally relevant concentrations (Martin et al., 2002, 2003; Stoica et al., 2000a,b,c). Studies have shown that heavy metals can also have an influence on the reproduction and general health of some birds (Janssens et al., 2003; Dauwe et al., 2004). Egg characteristics such as egg size and eggshell thickness were the early signs of detrimental effects of pollution on reproduction, growth and nestling survival of birds (Ratcliffe, 1967; Bize et al., 2002). In addition, nestlings can be useful bioindicators for monitoring local pollution in the foraging area during their development (Janssens et al., 2002). However, impact of heavy metals has been

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doi:10.1016/j.scitotenv.2006.02.004

rarely evaluated on the avian species (Œwiergosz et al., 1998; Janssens et al., 2003; Dauwe et al., 2004). In this regard, feral pigeons may be pertinent indicators to examine the possible effects of heavy metal exposure in the environment because of their physiological and biological characteristics such as limited movement, a high metabolic rate and a high respiration rate than man, and the habit of taking up food and grit (Antonio Garćia et al., 1988; Nam et al., 2004; Nam and Lee, 2006).

Our previous studies have shown that Pb in bone and Cd in kidney of adult feral pigeons in Seoul were on average 29.5 ppm (on a wet weight basis) and 1.05 ppm, respectively, three times higher compared to the other site (Ansan). Concentrations in nestlings (22–24 days) also showed similar gradients between the two colonies. The Pb concentration, but not Cd, in embryos at Seoul was significantly higher than Ansan (Nam et al., 2004). Assuming heavy metal residues affect reproductive success in feral pigeons, feral pigeons nesting in Seoul which are relatively contaminated more with heavy metals should have lower reproductive success than pigeons in Ansan which are less contaminated.

In order to examine the possible reproductive effects of heavy metal accumulations on breeding birds, we compared the egg size, eggshell thickness, growth rates and reproductive success of feral pigeons between the two study sites.

2. Materials and methods

2.1. Study sites and sampling

The present study was performed at Seoul and Ansan colonies, having similar colony size (approximately 250 nests) but different traffic density (43,000–113,000 v/d at Seoul and 19,000–35,000 v/d at Ansan) during November 2000 to May 2001. Fig. 1 represents the schematic representation of the breeding ecology and sampling protocol of feral pigeons.

All nests (38 nests from Seoul and 28 nests from Ansan) were marked during the study period of which 14 nests with two-egg clutches in each colony were used for egg and nestling collection in metal analysis. Only the first egg of nine nests in each colony was collected on the day of laying and was used within 72 h to investigate metal concentrations. All eggs were candled so that the air sac could be traced and the shells checked for cracks (cracked eggs were not used). Nestlings after hatching were tagged and eight nestlings aged 22 to 24 days from the two sites were also randomly sampled for quantifying metals.

Twenty four nests from Seoul and 14 nests from Ansan were monitored daily prior and after laying to determine the start of laying and the date of hatching. Each egg was given a unique identification number and a colour. Nests containing eggs were considered active and the weights and air sac tracings were all marked. Because most incubation in pigeons started before laying of the second egg, the incubation period for the eggs were measured individually (both eggs almost hatched at the same day). All eggs (46 eggs from Seoul and 28 eggs from Ansan) were carefully weighed (0.1 mg using OHAUS balance) and measured for their length and width (0.01 mm using Mitutuyo callipers) at the first day of egg-laying. To investigate the eggshell thickness, the hatched and non-hatched eggs from the nests were collected. The non-hatched eggs were cut open at a distal end and the egg content was removed. All eggshells after washing were dried and six sections around equator were cut open and the thickness was determined to the nearest 0.01 mm using Mitutuyo callipers. All measurements of egg size and eggshell thickness were performed in triplicate and the mean value was used in the statistical analysis.

Nestlings immediately after hatching were tagged with numbered rings. The fledging length (interval between hatching and fledging) and growth rates (body weight, and wing, bill and tarsus lengths) of the squabs, which survived until fledging were measured once every 2 or 3 days. Each nestling was weighed using OHAUS balance (to the nearest 0.01 g) and measured with a Mitutuyo callipers (to the nearest 0.01 mm).

An estimate of the hatchability and fledging success for each colony was defined as follows: hatchability

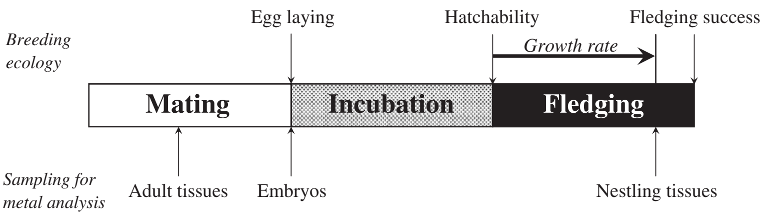

Fig. 1. Schematic representation of the breeding ecology and sampling protocol.