Clutch size and breeding success of Tengmalm's Owl *Aegolius funereus* in natural cavities and nest-boxes

Erkki Korpimäki

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Altogether 287 nests of Tengmalm's Owl *Aegolius funereus* were visited in 1966—82 in western Finland. The clutches were significantly larger in nest-boxes than in natural cavities. The hatching percentage and number of fledglings also seemed to be higher in boxes than in natural nesting places, but the difference was not significant. Clutch size in Tengmalm's Owl is positively correlated with the bottom area of the box and this "area effect" is probably responsible for the smaller clutches in natural holes. Poor breeding success in natural holes may be due to poor insulation of the cavity or to ice, water or old nest material at the bottom of the nest. It may also be caused by the hyperthermia occurring among large broods on hot days, increased cannibalism in small holes and a high degree of predation in cavities with large entrances. As the numbers of fledglings are generally smaller in natural cavities than in nest-boxes, studies of box populations may give misleadingly large breeding results for hole-nesting birds.

Erkki Korpimäki, kp. 4, SF-62200 Kauhava, Finland

Introduction

Tengmalm's Owl is the most numerous owl species in Finland (Merikallio 1958). Its natural nesting places are holes of the Black Woodpecker *Dryocopus martius,* but due to modern forestry methods the number of natural cavities has decreased rapidly in the last few decades. Nowadays a considerable part of the Finnish population breeds in nest-boxes, mainly provided by ornithologists (the total number of boxes is at least 6 100, see Forsman et al. 1980, Jokinen et al. 1982).

Many hypotheses and theories concerning bird population dynamics (e.g. clutch size determination and breeding success) have been based on data collected in nest-box studies of small hole-nesting passerines. Some authors (e.g. Nilsson 1975) have shown that clutch size and breeding success are higher in nest-boxes than in natural cavities, which casts some doubt on the general validity of conclusions drawn from such data. Consequently, the aim of this paper is to compare the clutch size and breeding success of Tengmalm's Owl in natural cavities and nest-boxes.

Study area, material and methods

This paper is part of a long-term study on the ecology and biology of Tengmalm's Owl, carried out since 1966 in the Kauhava region (63°N, 23°E), western Finland (Korpimäki 1981a, 1981b, 1982, 1983). The size of the study area is about 1 000 km^2 and it has contained 35 (in 1966) to 450 (in 1982) boxes and holes suitable for Tengmalm's Owl. The boxes were mostly square and made of darkened board. The inner width ranged between 15 and 25 cm (the mean bottom area being 325 cm^2), the height between 45 and 60 cm and the diameter of the opening between 5 and 18 cm. The owl population nested mainly in nest-boxes (90 % of all nests found in 1966—82, the total number of nests being 287).

Data on the breeding biology were collected by checking the boxes and all the known natural cavities in the study area in late March, April and May (the total number of checking visits was about 3 200 in 1966—82). In low vole years, when breeding began late, the visits to the nesting places were continued till June (for additional details of the methods, see Korpimäki 1981a).

Results

In the combined material from 1966—82 Tengmalm's Owl laid significantly larger clutches in nest-boxes than in natural cavities (t-test, $P<0.001$, Fig. 1). The clutch size ranged from 2 to 8 in natural cavities and from 1 to 10 in nest-boxes. This marked difference was not caused by a preference of natural nesting places, since the proportions of pairs breeding in natural cavities represented 6.2 % of the total pairs in the peak owl years (a total of 134 nests from 1966, 1969, 1973, 1977 and 1982) and 6.8 % of the pairs in the low owl years (N = 153 from the other study years).

The clutch size of most, if not all, Finnish passerine birds shows a typical temporal pattern, early clutches being larger than later ones (v. Haartman 1967, 1969). The almost linear decrease in clutch size from the beginning of the breeding season is also apparent in Tengmalm's Owl (Korpimäki 1981a). This progressive decrease in clutch size is not responsible for the small clutch size in natural cavities, because the median date for egg-laying in the data from 1966—82 was 4 April in natural nesting places and 3 April in nest-boxes (the difference is not significant).

The hatching percentage was 86.7 % in nest-boxes (combined material from 1966—82, total number of nests = 167) and a little lower in natural cavities (79.8 %, N = 23), but the difference was not significant. The number of fledglings seemed to be larger in nest-boxes than in natural cavities (Fig. 1). The difference was not significant due to the small sample from holes of the Black Woodpecker (t-test). The percentage of nests that were totally destroyed seemed to be smaller in nest-boxes (22.9 %) than in natural cavities (26.7 %), but the difference was not significant.

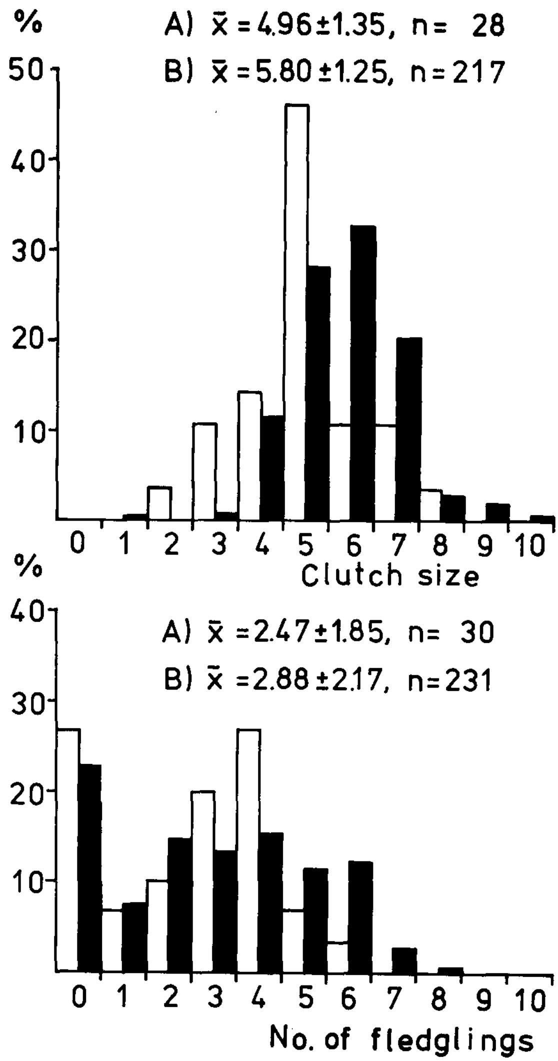

Fig. 1. Clutch size and number of fledglings of Tengmalm's Owl in natural cavities (A and white columns) and nest-boxes (B and black columns) in the Kauhava region, western Finland. Combined material from 1966—82.

Discussion

Clutch size has been shown to be influenced by such factors as the condition of the individual birds and the nesting environment (for a review, see Klomp 1970). In hole-nesting birds it may be regulated by certain qualities of the nest cavity. Significant positive correlations between the bottom area of the nest-box and the clutch size have been obtained in some small passerines, e.g. the Marsh Tit *Parus palustris,* Willow Tit *P. montanus* (Ludescher 1973), Great Tit *P. major* and Pied Flycatcher *Ficedula hypoleuca* (Karlsson & Nilsson 1977). Recently, Korpimäki (1984) found that the clutch size of Tengmalm's Owl also correlated positively with the bottom area of the nest-box in good vole years, but this "area effect" was not observed in the decrease, low and increase phases of the vole populations. The "area effect" will cause smaller clutches in natural cavities than in nest-boxes, because the average diameter of the Black Woodpecker's nest-hole is 20.1 cm (Rudat et al. 1979), which is clearly smaller than that of my nest-boxes for Tengmalm's Owl. Consequently, I can conclude that when nesting in natural cavities the owl suffers from lack of area. In good vole years this is due to the larger clutch size and greater number of prey animals stored in the nest. The size of the incubating females in Northern Europe is also larger than in Central Europe (material from Finland, Korpimäki 1981a, compared with data from Germany, Kuhk 1949, 1950, König 1969 and Schelper 1972).

In East Germany the number of fledglings of Tengmalm's Owl averaged 3.35 (N = 34) in nest-boxes and 4.18 (N = 22) in natural cavities (Ritter et al. 1978), but the material is rather limited and the difference is not significant (t-test); the hatching percentage in natural nesting places was better than in the boxes. Ritter et al. (1978) considered that the good hatching success in natural holes was caused by better insulation against the cold, the walls of the natural cavities being thicker than those of the nest-boxes. The relative air humidity can be as high as 90 % in natural cavities (Sixl 1969) and this may also increase the hatching percentage.

My results contrast with those presented by Ritter et al. (1978), since the hatching percentage and number of fledglings were larger in the boxes than in natural cavities. There are many reasons for this difference. Old holes of the Black Woodpecker may have many openings, which reduces the insulation of the cavity, so that the thermoregulation of the female owl will probably take more energy during breeding. The species is one of the earliest breeders among the birds of Northern Europe (Korpimäki 1984). In rainy weather water may flow into the hole, forming ice or a layer of water on the bottom of the cavity. Rudat et al. (1979) observed in the GDR that 20 % of the nests in natural cavities failed due to water on the bottom, but this was not observed in my study area. The Red Squirrel *Sciurus vulgaris* and Flying Squirrel *Pteromys volans* partly fill up the holes with nest material or food stores. This makes the cavities shallow and therefore energetically unfavourable nesting places for Tengmalm's Owl.

Large broods of the Great Tit (Mertens 1969, Balen & Cavé 1970), Blue Tit *Parus caeruleus* and House Sparrow *Passer montanus* (O'Connor 1975) may suffer from hyperthermia at high temperatures, and in large boxes the nestlings can spread out on hot days to avoid this phenomenon. In the nests of Tengmalm's Owl competition for bottom area is keen in good vole years, when the broods are large. The cramped conditions in small natural cavities may increase cannibalism among the nestlings. Nilsson (1975) pointed out that predation by the Great Spotted Woodpecker *Dendrocopos major* can reduce the breeding success of small passerines in natural cavities as compared with nest-boxes. When the entrance to the hole is too large, greater hole-nesting owls (especially the Ural Owl *Strix uralensis* and Tawny Owl *S. aluco)* may kill Tengmalm's Owls (see also Mikkola 1976, 1982). The main nest robber in the study area is, however, the Pine Marten *Martes martes,* which perhaps cannot find the nest so easily in a box as in a natural cavity.

Many investigators of hole-nesting birds have shown that the numbers of fledglings were smaller in natural cavities than in nest-boxes (in the Great Tit, Nilsson 1975; Marsh Tit, Ludescher 1973, Nilsson 1975; Blue Tit, Nilsson 1975; Nuthatch *Sitta europea,* Löhrl 1957, Nilsson 1975; Starling *Sturnus vulgaris,* Nilsson 1975 and Tengmalm's Owl, present study). Consequently, studies of nest-box populations give relatively high breeding results for hole-nesting birds and can in some cases be misleading. Additional comparative studies of populations breeding in natural cavities and boxes are necessary, before general conclusions can be drawn regarding the factors regulating population dynamics and influencing breeding strategies in hole-nesting birds.

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Selostus: **Helmipöllön munaluku ja poikastuotto luonnonkoloissa ja pöntöissä**

Helmipöllön munalukua ja poikastuottoa tutkittiin luonnonkoloissa ja pöntöissä vuosina 1966—82 Etelä-Pohjanmaalla, Kauhavan seudulla (pesälöytöjen yhteismäärä 287). Pesyekoko oli merkitsevästi suurempi pöntöissä kuin luonnonkoloissa (kuva 1). Kuoriutumisprosentit ja poikastuotot näyttivät myöskin olevan suurempia pöntöissä verrattuna luonnonkoloihin (kuva 1), mutta erot eivät olleet tilastollisesti merkitseviä. Helmipöllön munaluku kasvaa hyvinä myyrävuosina pesäkolon pohjan pinta-alan lisääntyessä ja tämän ansiosta keskimääräiset pesyekoot ovat suurempia suurialaisissa pöntöissä verrattuna ahtaisiin palokärjen koloihin. Luonnonkolojen heikon poikastuoton syinä voisivat olla seuraavat tekijät: useiden lentoaukkojen ja ohuen seinän aiheuttama heikko eristys vanhoissa koloissa, kolon pohjalla oleva jää, vesi tai vanhat pesäainekset, suurten poikueiden hypertermia ahtaissa koloissa kuumina päivinä, ahtauden aiheuttama lisääntynyt kannibalismi poikasten keskuudessa sekä predaation yleistyminen suuriaukkoisissa luonnonkoloissa. Koska poikastuotot ovat yleensä pienempiä luonnonkoloissa kuin pöntöissä, pönttöpopulaatioissa tehdyt tutkimukset antavat suhteellisen korkeita pesimätuloksia koloissa pesiville linnuille.

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9th I.B.C.C. CONFERENCE

The joint 9th International Conference on Bird Census Work and the 7th meeting of the European Ornithological Atlas Committee will be held at the University of Dijon, Côte d'Or, France, 2—6 September 1985.

The IBCC Conference will be mainly devoted to a special theme: "The influence of man on forest bird communities". The European Atlas Committee will be reviewing the progress of fieldwork for the European Atlas, which is due to start in the spring of 1985. For further information contact Dr. B. Frochot, Laboratoire d'Ecologie, Bâtiment Mirande, Université, 21000 Dijon, France.