Food competition and niche separation between fish and the Red-necked Grebe *Podiceps grisegena* (Boddart, 1783)

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Received 27 March 1997; in revised form 2 February 1998; accepted 2 March 1998

Key words: competition, niche separation, fish, Red-necked grebe, invertebrates

Abstract

During the breeding season, the aquatic bird Red-necked Grebe *Podiceps grisegena* feeds on small aquatic animals, which are also an important food source for many fish species. Because grebes have to provide substantial amounts of invertebrates to their brood, competitive interactions with fish may be expected during the breeding season of grebes. Based on this hypothesis, the distribution of Red-necked Grebes, the abundances of macroinvertebrates, fish, and vegetation, as well as the water depth were determined in a shallow lake during two consecutive breeding seasons. The Red-necked Grebes only utilised the reed bed as breeding site, whereas the adjacent Lagoon, although potentially suitable as breeding site, was not used. Macroinvertebrate biomass was 5–10 times higher in the reed beds than in the Lagoon. The abundance of fish was low in the reed bed but considerably higher in the Lagoon. The results indicate habitat separation between breeding Red-necked Grebe and fish in Lake Tåkern, and that the separation is related to distribution of food resources birds and fish have in common.

Introduction

Adults of the aquatic bird Red-necked Grebe *Podiceps grisegena* feed mainly on fish at non-breeding sites (Madsen, 1957), whereas young grebes are dependent upon aquatic invertebrates during the first weeks after hatching (Palmer, 1962; Ojanen, 1989). Invertebrate food items are also preferred by many fish species (Gilinsky, 1984; Winfield & Townsend, 1988; Giles et al., 1990; Winfield & Winfield, 1994). Competition for food between fish and aquatic birds has been suggested to affect distribution and abundance of aquatic birds in lakes (Eriksson, 1979; Andersson, 1981; 1984; Eadie & Keast, 1982; Giles, 1991). Recently it has been shown that Red-necked Grebes avoid breeding in waters where the fish density is high (Wagner, 1997), suggesting competitive interactions between fish and Red-necked Grebes. In contrast to these observations, Red-necked Grebes have established stable populations in some shallow, densely vegetated south Swedish lakes with high fish densities. Generally, Red-necked Grebes breed in relatively open areas with scattered emergent vegetation (Ahlén, 1970; Curry-Lindahl, 1959; del Hoyo et al., 1992), but in these shallow lakes the grebes do not utilise open areas, but instead choose more densely vegetated reed areas as breeding sites (Bacon, 1974; Jacobsson, 1975). Our hypothesis is that in habitats with dense submerged and emergent macrophytes, invertebrate biomass is higher than in the relatively open areas, offering opportunities for the grebes to feed their brood even though fish density in the lake as a whole is high. We argue that there is an overlap in food preferences between fish and Red-necked Grebes. This leads to the grebes choosing more densely vegetated areas with lower fish and higher invertebrate abundances than in lakes and ponds without fish. We have tested this hypothesis by quantifying fish and invertebrate abundances in two potential breeding sites for Red-necked Grebe: the heterogeneous, densely vegetated habitat ('Reed') and the open littoral zone ('Lagoon'), a habitat type normally preferred as a breeding site by Red-necked Grebe.
The study area

The study was performed in Lake Täkern (58°20' 14'45") during May and July 1991 and June 1992. The lake is large (46 km²) and shallow, with a maximum depth of 1.5 m and a mean depth of 1 m. Of the total lake surface 26%, or 12 km², consists of reed stands (Ekström et al., 1985). The water is calcium-rich and moderately eutrophic, with mean total phosphorus and nitrogen concentrations during summer (June to September) of 31 and 1200 µg L⁻¹, respectively (Blindow et al., 1993).

Materials and methods

The study area in the littoral zone of the lake was divided into two habitats, the 'Lagoon' (open littoral) and the 'Reed' (Figure 1). The Lagoon is an approximately 4 ha opening in the reed, whereas the Reed habitat consists of a mosaic with small openings surrounded by reed Phragmites australis. Both types of habitat are suitable as breeding sites for Red-necked Grebes (Curry-Lindahl, 1959), although only the Reed habitat was used for breeding by the grebes in Lake Täkern (Druid, personal communication). The border between the two habitats was defined to be less than one meter outside the mosaic of dense reeds (Figure 1).

Red-necked Grebes generally use small stands of emergent or floating-leaved vegetation to anchor their nests, indicating that the presence of such stands may be an important feature of breeding sites. To determine whether the Lagoon was a suitable breeding site, we measured the distance between 20 randomly chosen reed stands larger than 1 m². We compared these distances with similar distances in ponds (area 1–4 ha), where Red-necked Grebes breed successfully. Measurements were in both cases made on aerial photographs.

The average water depths were determined at 18–22 randomly chosen sites in each habitat at each sampling occasion. The vegetation depth (the depth of the submerged vegetation) was determined in July 1991 and in June 1992, and mean depths for both years were calculated.

Macroinvertebrates were sampled in May and July 1991 and in June 1992. The sampling was conducted by randomly placing 20 active-fauna traps in each habitat for about 48 h. The active-fauna trap is a modified plastic beaker with a cone-shaped net-funnel (1.0 mm mesh-size) welded onto the opened bottom end (after Pehrsson, 1984). At the top end, the removable lid is furnished with an identical plastic net. The traps were positioned at the sediment surface or on the submerged vegetation, allowing free swimming and climbing animals to enter the traps. The sampled animals were fixed in ethanol. After identification, animals were dried (105 °C; 24 h) and weighed. Because ethanol dissolves fat, macrozoa lose an average of about 25% of their dry weight (Wetzel & Likens, 1979; unpublished data). The data were not compensated for this loss. Macroinvertebrates were combusted at 550 °C during four hours for determination of organic weight.

The invertebrates in each trap were counted and the values normalized by setting the highest number at each sampling occasion to 1. This was done to smooth out the temporal variation prior to comparison between samplings. The difference in invertebrate abundance between the Lagoon and Reed habitats was then tested using Mann-Whitney U-test (n_Reed = 61; n_Lagoon = 59).

Fish were sampled on 7 June 1992 with one survey gill net per habitat (Figure 1). The gill nets had the following mesh-sizes (knot-to-knot): 4, 6, 8, 10, 12.5, 16.5, 22, 30, 40, 55, 75 and 100 mm. Fishing was carried out from 7:00-13:00. To prevent birds from being caught in the nets, the nets were observed during the entire sampling period. The water temperature at the time of sampling was 19–24 °C. The fish caught were identified, measured and weighed. Stomachs were preserved in ethanol for later determination of diet.

The stomach contents from 11 tench, 12 rudd, 2 roach and 11 perch were analysed. Food items in fish stomachs were identified to the lowest possible taxonomic unit. Rare food items, such as Ostracoda, Hymenoptera, Coleoptera, Donica, Araneidae and Lepidoptera, were grouped into the category "other". Although zooplankton were abundant in a few of the stomachs, they are not included in our analysis as they are probably not an important food item for Red-necked Grebes. Binoculars were used to identify nests of Red-necked Grebes and where young birds foraged.

Results

No Red-necked Grebes bred in the Lagoon during 1991 and 1992, whereas approximately 5 pairs bred in the Reed habitat of the investigated area (Figure 1). Similar numbers of breeding pairs have previously been reported from our study area (Druid, 1990).