usual food sources (Ulfstrand 1962). The scarcity of observations of egg predation in Sweden, even during large sawfly outbreaks, indicates that feeding on sawfly eggs requires learning by the birds. Furthermore, due to the small size of the sawfly eggs, this behaviour is likely to be reinforced only at very high egg densities. It is possible that the egg eating behaviour becomes established more easily on lodgepole pine, since the yellowish marks over the egg niches contrast much more with the normal colour of the needles than they do on the native Scots pine.

The overall effects of egg predation by birds on populations of the European pine sawfly can be assumed to be negligible. A high egg density is apparently required before this behaviour is profitable to the birds. Even at high egg densities it seems unlikely that predation can reach high levels, because the time needed to find a new egg cluster will gradually increase as more egg clusters are destroyed. The availability of other food items can also be expected to influence the level of predation on sawfly eggs.

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Selostus: **Ruskean mäntypistiäisen munat talitiaisen ravintona**

Ruskean mäntypistiäisen munia tutkittiin 13 tuhoalueella, mutta lintujen havaittiin syöneen niitä vain kahdella alueella. Itä-Upplannissa havaittiin vain muutamia syötyjä munia, mutta Smålannissa, 55 hehtaarin nuoressa Pinus contorta-männikössä, 5 % munista oli syötyjä. Tällä alueella munatiheys oli erittäin suuri. 1 960 vuosikasvainnäytteestä 47 %:ssa oli munia. Yhdessä vuosikasvainnäytteessä oli keskimäärin 224 munaa. Metsikössä arvioitiin olleen 200 miljoonaa munaa, ja lintujen arvioitiin syöneen niistä 10 miljoonaa. Talitiaisten havaittiin syövän munia.

Munat ovat neulasen sisällä, mutta neulasen pintaan muodostuu vastaavaan paikkaan keltainen piste. Yksi muna painaa vain n. 0.16 mg. Talitiaisen arvioitiin tarvitsevan päivässä vähintään 50 000 munaa. Tähän se ei kuitenkaan pystyisi, mutta esimerkiksi 10 lintua, joista kukin käyttäisi munien syömiseen 20 % päivittäisestä ruokailuajastaan, pystyisi aiheuttamaan havaitun predaation noin 100 päivässä.

Ruskean mäntypistiäisen munien syöminen talvella on luultavasti kannattavaa vain, jos munatiheys on hyvin suuri, jolloin munaryhmät voidaan löytää nopeasti. Munapredaatiohavaintojen harvinaisuus jopa tuhoalueella viittaa siihen, että tämä käyttäytyminen vaatii linnuilta oppimista. Loppupäätelmänä on, että lintujen munapredaatiolla ei ole merkittävää vaikutusta ruskean mäntypistiäisen populaatiodynamiikkaan, mutta munat voivat ajoittain olla talitiaisen ja ehkä muidenkin tiaisten talviruokaa.

References

Galoux, A. 1952: La pullulation du lophyre roux (*Neodiprion sertifer* Geoffr.) dans la région spadoise (1948–1950). — Trav. Sta. Rech. Groendaal (Sér.C) 16:31 pp.

Gibb, J. 1957: Food requirements and other observations on captive tits. – Bird Study 4:207–215.

Gibb, J. 1960: Populations of tits and goldcrests and their food supply in pine plantations. — The Ibis 102:163–208.

Juutinen, P. 1967: Zur Bionomie und zum Vorkommen der roten Kiefernbuschhornblattwespe (*Neodiprion sertifer* Geoffr.) in Finnland in den Jahren 1959–65. — Comm. Inst. For. Fenn. 63(5):1–129.

Lyons, L. A. 1964: The European pine sawfly, *Neodiprion sertifer* (Geoffr.)(Hymenoptera:Diprionidae). — Proc. Entomol. Soc. Ontario 94:5–37.

Pschorn-Walcher, H. 1982: Unterordnung Symphyta, Pflanzenwespen. — *In:* Schwenke, W. Die Forstschädlinge Europas, 4. Band, Hautlfügler und Zweitflügler. Paul Parey. Hamburg und Berlin.

Ulfstrand, S. 1962: On the nonbreeding ecology and migratory movements of the great tit (*Parus major*) and the blue tit (*Parus caeruleus*) in southern Sweden. — Vår Fågelvärld. Suppl. 3.

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Mercury content in eggs of the Great Crested Grebe *Podiceps cristatus* and the Horned Grebe *Podiceps auritus* in the archipelago of Korsnäs, Gulf of Bothnia

Johan Ulfvens

Accumulating in food chains, mercury can become a threat to successful reproduction in birds, especially piscivorous species.

In eggs of migratory species, such as the Goosander in the south-western archipelago of Finland, high mercury contamination has been traced to the overwintering area (Wahlberg et al. 1971). Mercury and other biocides in the eggs of seven aquatic birds breeding in Lake Päijänne have also been assumed to derive mainly from the winter quarters, as the birds lay their eggs soon after arriving in Finland (Paasivirta et al. 1981).

In this study, I measured mercury content in the eggs of two species which feed largely on fish (Fjeldså 1973, von Haartman et al. 1963-72).

The aim was to determine the mercury levels in an area which is supposed to be relatively free from mercury, as the closest known sources of mercury pollution are situated 50 km north and south of the study area (Nuorteva 1971).

I also had in mind to determine whether there is a decrease in the mercury level of grebes' eggs during the breeding season, as this would indicate that the birds can eliminate mercury, a capacity which has been established in the Osprey (Häkkinen & Häsänen 1980) and several other species (Fimreite 1979).

Table 1. Mercury content in eggs of the Great Crested Grebe and the Horned Grebe (mg/kg, wet weight).

	Great Crested Grebe			Horned Grebe		
	N	Range	Mean ± SD	N	Range	Mean ± SD
Fresh eggs						
white	20	0.10–0.33	0.203 ± 0.067	3	0.13–0.22	–0.16 ± 0.052
yolk	13	0.01–0.07	–0.05 ± 0.018	3	0.03–0.05	0.043 ± 0.012
Addled eggs	5	0.13–0.19	0.158 ± 0.022			

Table 2. Mercury content in eggs from the same clutches of the Great Crested Grebe (mg/kg, wet weight). Eggs not in chronological order.

Clutch no.	Mercury content in different eggs (white/yolk)					
1	0.16/0.05	0.17/0.02				
2	0.22/0.06	0.24/0.07	0.25/0.06			
3	0.10/0.04	0.12/0.04	0.11/0.06	0.25/0.06		
4	0.30/–	0.32/–	0.30/–	0.29/–		
5	0.16/0.05	0.18/–	0.24/–	0.20/0.06	0.19/–	0.25/–

The eggs, a total of 44 from the Great Crested Grebe and 4 from the Horned Grebe, were collected between 20 May and 3 August 1981 in Korsnäs (62°49'N and 21°10'E) on the coast of the Gulf of Bothnia. All the eggs were taken from nests which had either been destroyed by rising water and hard wind or otherwise deserted by the grebes.

The mercury contents were measured using a Coleman MAS-50 cold vapour atomic absorption spectrometer.

The mercury level in the eggs was generally low and ranged from 0.01 to 0.33 mg/kg, wet weight (Table 1). In the eggs of both species, the mercury content of the white was approximately 4 times as high as that of the yolk. According to Bäckström (1969), a high level in the white indicates that the mercury mostly occurs in the form of methyl mercury.

Five of the eggs of the Great Crested Grebe were addled, but their mercury content was also low (Table 1).

The mercury content in eggs from the same clutches varied only slightly (Table 2). This result is in accordance with mercury analyses on Heron and Egret eggs (Hoffman 1980).

Unfortunately, a possible change in the mercury level of the eggs during the summer could not be studied more closely, as most of the eggs were collected on one occasion, early in the breeding season.

The level of mercury in eggs of the Great Crested Grebe in Lake Päijänne, $\bar{x}$ = 0.92 mg/kg (Paasivirta et al. 1981), was four to five times as high as the levels measured in this study. In contrast to the present coastal area, Lake Päijänne receives the effluents of several pulp and paper mills.

However, it is not certain that the difference in mercury levels is due to the differences in the contamination level of the breeding areas, as the wintering areas can also play a decisive role.

The mercury levels in the eggs collected for this study probably do not affect the reproductive success of the Great Crested Grebe or the Horned Grebe. Häkkinen & Häsänen (1980) reported that the hatchability of eggs of piscivorous species is impaired when the mercury level reaches 0.5 to 1.0 mg/kg, wet weight. However, the tolerance of mercury, can vary widely between species (Fimreite 1979).

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Sammanfattning: **Kvicksilverinnehåll i ägg av skäggdopping och svarthakedopping i skärgården i Korsnäs**

Sommaren 1981 insamlades 44 ägg av skäggdopping och 4 ägg av svarthakedopping i skärgården i Korsnäs. Kvicksilverhalten i äggen var genomgående låg och varierade mellan 0.01 och 0.33 mg/kg. Högst var halten i vitan hos färska ägg och i rötägg. Halterna torde inte påverka äggens kläckbarhet.

References

Bäckström, J. 1969: Distribution studies of mercuric pesticides in quail and some freshwater fishes. — Acta Pharmacol. Toxicol. 27, suppl. 3:1–103.

Fimreite, N. 1979: Accumulation and effects of mercury on birds. — *In:* Nriagu, J.O. (ed.): The biogeochemistry of mercury in the environment: 601–627. Amsterdam — New York — Oxford.

Fjeldså, J. 1973: Feeding and habitat selection of the horned grebe, Podiceps auritus (Aves), in the breeding season. — Vid. medd. dansk naturhist. for. 136:57–95.

von Haartman, L., Hildén, O., Linkola, P., Suomalainen, P. & Tenovuo, R. 1963-72: Pohjolan linnut värikuvin. — Otava, Helsinki.

Hoffman, R.D. 1980: Total mercury in heron and egret eggs and excreta. — Ohio J. Sci. 80:43–45.

Häkkinen, I. & Häsänen, E. 1980: Mercury in eggs and nestlings of the osprey (Pandion haliaetus) in Finland and its bioaccumulation from fish. – Ann. Zool. Fennici 17:131–139.

Nuorteva, P. 1971: Methylquecksilber in den Nerungsketten der Natur. — Naturwissensch. Rundschau 24:233–243.

Paasivirta, J., Särkkä, J., Pellinen, J. & Humppi, T. 1981: Biocides in eggs of aquatic birds. Completion of a food chain enrichment study for DDT, PCB and HG. — Chemosphere 10:787–794.

Wahlberg, P., Karppanen, E., Henriksson, K. & Nyman, D. 1971: Human exposure to mercury from goosander eggs containing methyl mercury. — Acta Med. Scand. 189:235–239.

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