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Contaminants and Wintering Areas of Peregrine Falcons, *Falco peregrinus*, from the Kola Peninsula, Russia

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ABSTRACT

Eggs collected from the small bog-associated nesting population of migratory Peregrine Falcons, *Falco peregrinus*, along the Ponoy River depression (67°N, 37°E) of the Kola Peninsula contained relatively low concentrations of p,p'-DDE (DDE) in 1991. Polychlorinated biphenyls (PCBs) were higher than DDE, comparable to the contaminant profile shown by peregrine populations from Fennoscandia, and were higher than those in Alaska eggs. Relatively high concentrations of polychlorinated dibenzo-p-dioxins and dibenzofurans also were found in several eggs. The source(s) of these industrial contaminants and the wintering grounds of the population were unknown. In fact, the peregrine subspecies nesting along the Ponoy River was not known for certain. In the summer of 1994, satellite telemetry equipment was attached to four adult nesting females, and standard morphometric measurements were recorded. Knowledge of the wintering grounds of the population could provide useful information for evaluating the source of the industrial contaminants and perhaps, together with measurements, for determining the appropriate subspecies. These peregrines wintered in western Europe (The Netherlands, France and Spain) with *F. p. peregrinus* from Fennoscandia and probably belong to the nominate subspecies. Industrialized western Europe is the probable source of most of the organic contaminants found in their eggs.

INTRODUCTION

Galushin (1977) noted a rapid and continuous decline in numbers of peregrines in the Soviet Union, although chemical residue levels were unavailable for pesticides or other contaminants in eggs or carcasses. Peakall and Kiff (1979) measured eggshells at the Zoological Museum, Moscow, and reported significant shell thinning (25%) in eggs of peregrines taken from Siberia in 1961-66. They also reported the presence of p,p'-DDE (DDE) in shell membranes of eggs measured. With this background and the general understanding that DDE residues in peregrine eggs decreased widely following DDT bans in the early 1970's (Cade *et al.* 1988), peregrine eggs were collected from the Kola Peninsula in 1991 (Henny *et al.* 1994). These eggs contained relatively low concentrations of DDE (geometric mean 3.5 µg/g) and the population had shown a recent increase in numbers. Eggshell thinning (11.4%) was similar to that found in Alaska; however, polychlorinated biphenyls (PCBs), an industrial contaminant that does not thin eggshells, were in higher concentrations than DDE. PCB concentrations were comparable to profiles shown by populations in Fennoscandia, and were higher than those found in the Alaskan eggs (see Henny *et al.* 1994). Two other industrial contaminants, polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs), were found at relatively high concentrations in a few of the eggs. Even though the peregrine population seemed to be released from decades of a DDT problem, exposure to several industrial contaminants continued, and this was cause for concern.

The source(s) of the industrial contaminants and the wintering grounds of the peregrine population from the Kola Peninsula were unknown. In fact, the peregrine subspecies nesting along the Ponoy River remains unknown (see White & Boyce 1988). Therefore, in the summer of 1994 we attached satellite telemetry equipment to four adult nesting females, and we recorded standard morphometric measurements. Knowledge of the wintering grounds of the Kola Peninsula nesting population could provide useful information for evaluating the source of the industrial contaminants and the peregrine subspecies.

STUDY AREA

Ganusevich (1988) reviewed the raptors nesting on the Kola Peninsula of extreme northwestern Russia (near the Finnish border), and began studying this peregrine population of the Ponoy River depression (above the Arctic Circle) in 1977. The 1000 km^2 study area was believed adequately surveyed from 1987 onward, and the peregrine population increased from 4 to 10 pairs between 1987 and 1991, with an average of 1.94 young produced per active nest (Henny *et al.* 1994). The peregrine population is locally distributed in the basin of the upper and middle course of the Ponoy River. The Ponoy depression is characterized by large bogs, many small and large lakes, rivers and hills with parcels of land elevated (above the bogs) with forests, rocks, and cliffs. An abundance of prey (primarily shorebirds associated with the bogs and lakes), suitable nesting sites, and the absence of human activities define optimum conditions for breeding of the peregrine, although easy access to many eyries by predatory animals sometimes causes nest failure.

METHODS

Blood was collected from the brachial vein of 9 nestlings as described by Henny *et al.* (1982). The whole blood (2 ml) was preserved with 0.10 ml formalin. The blood was analyzed for organochlorine pesticides and total polychlorinated biphenyls (PCBs) at the Patuxent Wildlife Research Center, Laurel, MD, following procedures described in Henny *et al.* (1996). DDE was the only pesticide reported and the detection limit was 0.01 µg/g wet weight; PCBs had a detection limit of 0.20 µg/g.

We captured adult peregrines at the nest site using a noose gin. This device is composed of two circular wire loops with nooses attached to ensnare incubating falcons at the scrape or egg location. Four adult female peregrines captured for the study were tracked by satellites via the Argos/Tiros satellite system (Taillade 1992, Fancy *et al.* 1988, Fuller *et al.* 1995). Each peregrine was equipped with a platform transmitter terminal (PTT, Microwave Telemetry Inc., Columbia, MD.) The PTT, model 100, weighed 28 g and was designed for 12 months of operation. The PTTs were attached in a backpack configuration using 6.35 mm teflon ribbon (Snyder *et al.* 1989). The PTT was centrally located on the peregrines back and held in place by a breast loop and a body loop (behind the wings, around the abdomen, Fuller *et al.* 1995). The PTTs were individually fitted to allow for all natural movement. In addition to the PTT each peregrine received a Russian leg band (ring) attached to the tarsus. The processing of each peregrine required about 1 hour and the birds were released in the exact location they were captured.

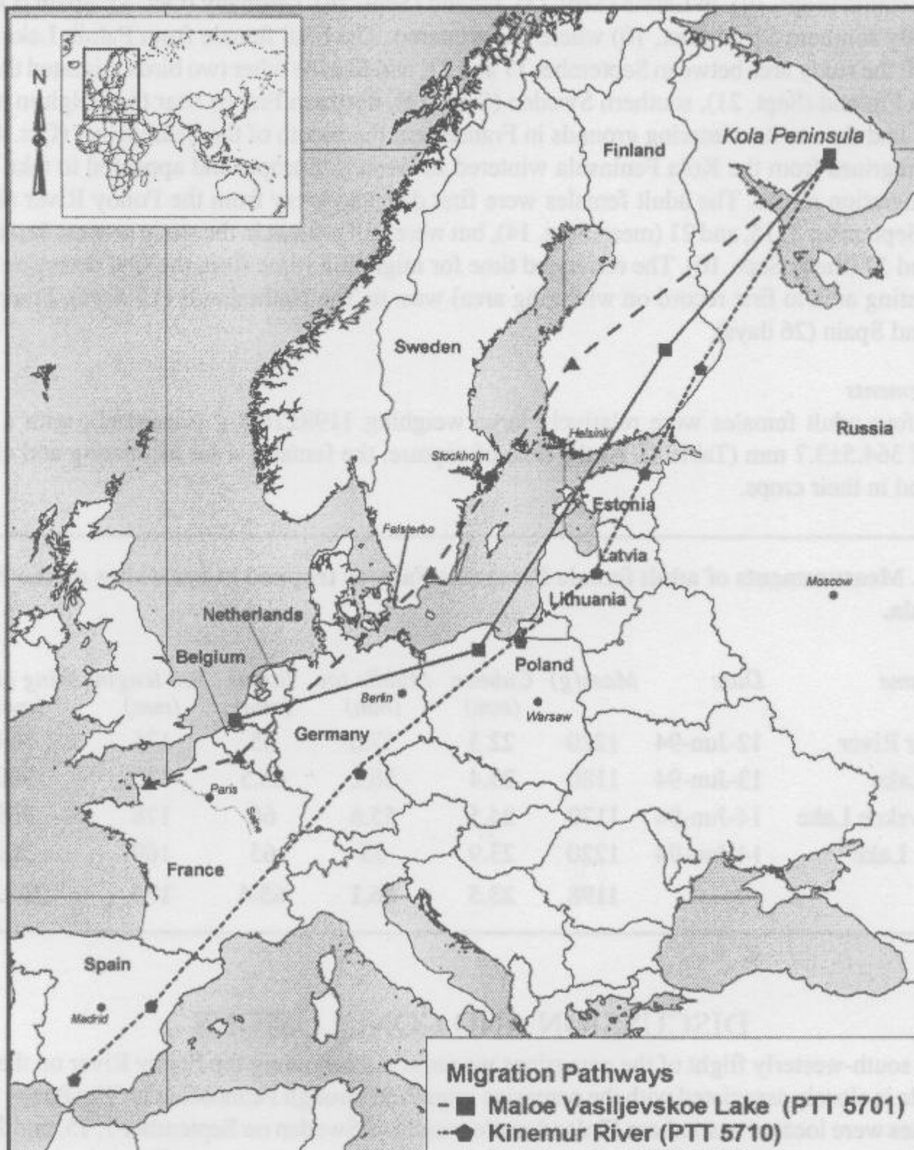
Measurements were taken following procedures of Baldwin *et al.* (1931) for exposed culmen without cere, tarsus, length of tail, middle toe and chord of the closed wing (not flattened wing).

RESULTS

Contaminants in Blood

In 1994 four young from the eyrie at Palnik Lake contained DDE concentrations of 0.01, <0.01, 0.02, and 0.01 μg/g; one young from the Kinemur River 0.01 μg/g; one young from Okunjevy Hill 0.02 μg/g; and two young from Devichy Hill 0.02 and 0.01 μg/g. The detection limit for estimated PCBs was 0.20 μg/g, which was unfortunately high, and all young were below the detection limit.

Figure 1. Autumn migration pathways and wintering localities of adult female Peregrine Falcons nesting on the Kola Peninsula, Russia.



Migration Routes and Wintering Localities

Prior to this study, only one Peregrine Falcon banding record was available from the Kola Peninsula. A nestling banded by Ganusevich on July 31, 1980 (67°N, 39°E) was reported shot on

September 26, 1982 at Loire-Atlantique (near Les Moutiers), France (47°N, 2°W) which is coastal. Its autumn migration may not have been completed when it was shot.

Four adult female peregrines were trapped during incubation at their eyries from June 12-14, 1994, and PTT's attached. The Vuljavr Lake female (PTT 5700) either lost her PTT soon after attachment or died. The Maloe Vasiljevskoe Lake female (PTT 5701) departed the Ponoy River study area between September 2 and 7, was reported in southern Finland (Sept. 7), in Poland (W. Gdansk) (Sept. 12), and in The Netherlands (Sept. 23) where she stayed (Figure 1). Skeletal remains of this bird were found (and reported to Moscow Ringing Centre) in September 1995 on the island of Tholen, village of St. Martensdijk, The Netherlands. The Kinemur River female (PTT 5710) migrated from the study area between September 12 and 15, was reported in southern Finland (Sept. 15), in Estonia (Sept. 19), in Latvia (Sept.23), Poland (Sept. 26), Germany (Oct. 3), Spain (Oct. 7), and finally southern Spain (Oct. 10) where she wintered. The final female from Palnik Lake (PTT 5698) left the study area between September 17 and 21, and like the other two birds migrated through southern Finland (Sept. 21), southern Sweden (Sept. 24), northern France near the Belgium border (Oct. 1), and then to its wintering grounds in France near the mouth of the Seine River (Oct. 4). All three peregrines from the Kola Peninsula wintered in Western Europe, and appeared to take fairly direct migration routes. The adult females were first detected away from the Ponoy River nesting area on September 7, 15, and 21 (mean Sept. 14), but were still present in the study area on September 2, 12, and 17 (mean Sept. 10). The estimated time for migration (time from the first detection away from nesting area to first record on wintering area) was: to The Netherlands (17 days), France (14 days), and Spain (26 days).

Measurements

All four adult females were relatively large weighing 1198±26.3 g (mean±sd), with a wing chord of 364.5±3.7 mm (Table 1). At the time of capture, the females were incubating and did not have food in their crops.

Table 1. Measurements of adult female Peregrine Falcons trapped at eyrie sites on the Kola Peninsula.

Eyrie name	*Date*	*Mass(g)*	*Culmen (mm)*	*Middle toe (mm)*	*Tarsus (mm)*	*Tail length (mm)*	*Wing chord (mm)*
Kinemur River	12-Jun-94	1220	22.3	57.6	65	175	364
Palnik Lake	13-Jun-94	1180	23.4	56.2	65.5	170	360
Vasilijevskoe Lake	14-Jun-94	1170	24.5	55.6	66	178	365
Vulijavr Lake	14-Jun-94	1220	23.9	55	65	169	369
Mean	- -	**1198**	**23.5**	**56.1**	**65.4**	**173**	**364.5**

DISCUSSION AND CONCLUSIONS

The south-westerly flight of the peregrines we radio marked along the Ponoy River on the Kola Peninsula is closely associated with the peregrine migration through Fennoscandia. The Ponoy River peregrines were located in southern Finland and/or southern Sweden on September 7, 15, and 21-24. These dates were within the peak autumn migration of adult peregrines over Falsterbo in southern Sweden (Kjellén 1992).

Peregrines from Norway winter in western Europe (The Netherlands, Belgium, France, England, Scotland, and Wales) with some along the coast of Norway (Schei 1977, T. Nygård, pers. comm.). Lindberg (1977) showed Swedish peregrines also wintering primarily along the western portion of Europe (Denmark, Germany, The Netherlands, Belgium, France, England and Spain). Data from peregrines banded in Finland revealed those birds mostly moved to the southwest into the region occupied by peregrines from Sweden and Norway. A few peregrines from Finland were recovered in central Europe, and the most south easterly in Serbia (Saurola 1977). The general picture of the wintering area of Finnish peregrines has changed during the last two decades: the number of recoveries south of France has increased remarkably (Saurola 1998). Prior to 1970 almost all peregrines were ringed in southern Finland. In contrast, now there are no peregrines in southern Finland where eggshell thinning was more severe in earlier years, and all recent recoveries are from birds breeding in the northern part of the country (Saurola 1998). Thus, it appears that peregrines from Finnish Lapland have their wintering ground south of the area formally used by the peregrines that lived in the south of the country. These findings are in general agreement with Cramp (1980) who reports that *F. p. peregrinus* are non-migratory, except that birds from northern areas in Fennoscandia and Russia vacate their territories in the winter. He states that *F. p. calidus* breeds in the Arctic from east Finnmark to 130° E, and that the entire population migrates, including a transequatorial element. Peregrines from Norway and Sweden were considered *F. p. peregrinus* by White and Boyce (1988), and appeared to broadly winter within the same range as our three adult females from the Ponoy River (The Netherlands, France and Spain).

White and Boyce (l988) were uncertain about the taxonomy of the Ponoy River peregrines. Stepanyan (1995) notes that in the European region, distribution of subspecies is connected with zonal characteristics and *F. p. calidus* resides along the Arctic coast, southwards to forest-tundra zone (in agreeement with Vaurie 1965), down to about 66-67° N., and *F. p. peregrinus* occupies the major part of Europe, south of *calidus* range. The Ponoy River birds at 67° N. are therefore, near the boundary of the two subspecies, although Galushin (1995) referred to them as *calidus*. Vaurie (1961) noted that *calidus* differs only slightly morphologically from nominate *peregrinus* by being generally paler and by averaging slightly larger. Vaurie (1961) further noted that *calidus* is highly migratory, whereas nominate *peregrinus* is sedentary, or its migratory movements are very limited with some individuals spending the winter in the southern part of the breeding range or occasionally the Iberian Peninsula and Sardinia. Curry-Lindahl (1981: 19,52) describes *calidus* as migrating from the north to tropical Africa, "... south to Angola and Natal as well as on Fernando Poo and Mauritius..." Thus, our radio tracking data support the idea that Ponoy River peregrines are *peregrinus*.

Vaurie provides wing measurements (flattened, see Vaurie 1965) for 10 female *calidus* 350-370 mm (mean 361.8), and 21 female *peregrinus* (measured by Dementiev) from Russia and western and southern Siberia 343-375 mm (mean 356.6). Measurements of live adult female peregrines on the Ponoy River were 360-369 mm (mean 364.5) and within the limits for both subspecies. However, it is dangerous to compare live bird measurements with study skin measurements and flattened wing with wing chord. Clayton White (pers. comm) found wing chords of 10 adult females shorter than flattened wings (7.4±1.83 mm, range 5.2-10). It is also recognized that study skin shrinkage occurs and affects wing measurements (see Fjeldså 1980, Henny & Clark 1982). Fjeldså (1980) reported a 3% shrinkage in grebe wing measurements (i.e., about l0.9 and l0.7 mm for *calidus* and *peregrinus*, respectively). Thus, *calidus* adjusts to a mean live adult wing chord of about 361.8 + 10.9 (shrinkage) - 7.4 (flattened to chord) =365.3 mm, and *peregrinus* about 356.6 + 10.7 - 7.4 = 359.9 mm. This exercise with measurements has not clarified the situation much except that the Ponoy River mean wing is between *calidus* and *peregrinus* and with considerable overlap. However, because the Ponoy River peregrines breed near the tundra, but in a region with trees, and show a relatively short migration pattern that is similar to *peregrinus* from Fennoscandia, we believe that they more likely belong to *peregrinus*.

Peregrines from the Kola Peninsula are seemingly distributional extensions from Scandinavia rather than from eastward in Russia as suggested by the migration and winter ground pattern, a pattern shown by many other species (C. M. White, pers. comm). For example, the Arctic Warbler (*Phylloscopus borealis*) has extended out of Siberia into central Alaska, but returns to Asia to winter in southeast Asia rather than south into North America (AOU 1998). Likewise, the Snow Goose (*Chen caerulescens*) and Sandhill Crane (*Grus canadensis*) extend out of the North American arctic into Siberia and Wrangel Island to breed, but return to winter in North America and follow migration routes of North American birds rather than to follow a migration route south in Asia. Blood samples were collected from the four adults for genetic study and remain available for research; this may provide additional insight into the subspecies issue.

The source of the industrial contaminants found in the eggs is the other important issue for the small localized Ponoy River population. The tremendous variation in PCB concentrations among clutches (3.0 to 21.0 µg/g; Henny *et al.* 1994) implies a relatively large wintering area (with many point sources and PCB availability ranging from high to low) is the most likely source of PCBs and is responsible for the variability among clutches. The diet of peregrines on the wintering grounds remains unknown and is probably quite variable, which also can account for differences in exposure to industrial contaminants. No PCB point sources were known along the Ponoy River. While in the remote Ponoy River study area, we saw one village and its associated subsistence fishermen and reindeer herdsmen, one abandoned village, and nobody else and no other structures during the field work on the project.

While on the Ponoy River breeding grounds, peregrines preyed upon at least 30 species of birds (Henny *et al.* 1994). The dominant species included the Ruff (*Philomachus pygnax*), 52.0%; Common Snipe (*Gallinago gallinago*), 8.6%; Jack Snipe (*Lymnocryptes minima*), 4.8%; and Wood Sandpiper (*Tringa glareola*), 4.5%. No other species contributed to more than 3.4% of the diet. Ruffs were collected on the study area, but they did not make it successfully to the United States for chemical analyses; however, 3 of the 4 most important species (65.1% of the Ponoy River diet) had been collected at peregrine territories in northern Sweden in 1976-77 (Lindberg *et al.* 1985). All three species from northern Sweden (Ruff, Common Snipe, Wood Sandpiper) contained extremely low concentrations of PCBs, 0.02, 0.03, and 0.06 µg/g (wet weight), respectively. Likewise, DDT and its metabolites were low, 0.12, 0.02, and 0.12 µg/g, respectively. The young peregrines blood sampled along the Ponoy River during this study contained low DDE concentrations and no detectable PCBs, although the PCB detection limit was high. If (perhaps a big assumption) the principal prey species in the Ponoy River study area contained contaminant concentrations similar to those in northern Sweden two decades earlier (i.e., very low), this further supports the conclusion that wintering grounds of the peregrines were the primary source of the industrial contaminants in the eggs. Henny *et al.* (1982) reported a similar conclusion (based upon strategic blood sampling over time) for Arctic peregrines from North America, and Lindberg *et al.* (1985) reached the same conclusion (based upon breeding ground prey species residues) for peregrines in Sweden. We recognize that PCBs and other contaminants can be transported long distances and be atmospherically deposited thousands of kilometers from the original source (see Bidleman *et al.* 1990, Nakata *et al.* 1998), but the low chemical concentrations in the same prey species at a similar latitude in Sweden, and in the blood of nestlings in this study, argues against atmospheric deposition in the Arctic being critical in the Ponoy River peregrine-contaminant scenario.

In contrast to the relatively low DDE concentrations found in peregrine eggs from the Kola Peninsula in 1991 (Henny *et al.* 1994), one egg from a bog-associated nest site further south in Russia (Novgorod Region, 58°N, 32°E) in 1992 contained high DDE and PCB concentrations (27.3 and 14.3 µg/g wet weight, respectively) (Henny *et al.* 1998). The wintering locality for this more southern nesting peregrine is unknown. For birds from this latter locale, as well as those from the Ponoy River, information gathered by satellite telemetry equipment about wintering areas can be most useful for better understanding environmental contaminant exposure patterns.

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