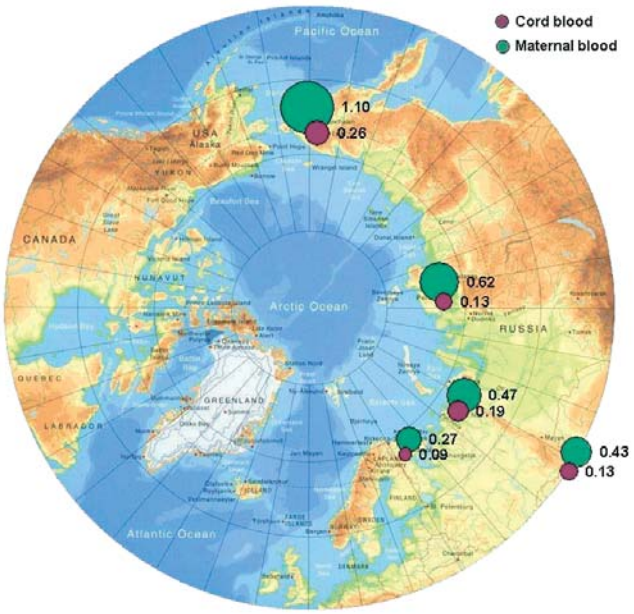

Figure 7.17. Levels of cadmium in maternal and cord blood in the Russian Arctic (geometric means, µg/L plasma).

transfer of pollutants from the mother to fetus through the placenta, although results obtained in this study clearly suggest that the placenta barrier inhibits, to varying extents, the free transport of certain pollutants to the fetus.

It should be noted that in the Chukchi AO, mean concentrations of POPs in the blood of inland indigenous peoples, from the Kanchalan area, are significantly lower than levels in the blood of coastal residents from the Uelen area. This serves as an additional argument that traditional foodstuffs, based on the higher trophic levels of marine food chains, are an important source of PTS intake for indigenous peoples.

7.4.2. Polychlorinated dibenzo-p-dioxins/furans (PCDD/F) in blood of the general adult indigenous population

Because of the small volume of the blood samples taken in the delivery departments of hospitals, and the extremely low concentrations present, it was not feasible to determine chemical compounds such as dioxins/furans (PCDD/Fs) and polybrominated diphnyl ethers (PBDEs) in maternal and cord blood. Studies of these compounds were, however, executed by analysis of pooled samples from the general adult indigenous population (Table 7.5.).

Table 7.5 includes the results of measurements of concentrations of PCDD/F in plasma samples from adults living in the Russian Arctic. Sums for the 17 most toxic dioxin and furan congeners are presented as international toxic equivalent (TEQ) values, in ng/L of plasma and pg/g lipids. The highest TEQ values were detected in the populations of Uelen (Chukchi AO) and Khatanga District (Taymir AO), with levels in the range 0.004-0.03 TEQ ng/L.

Results of PCDD/F analyses in blood samples are more illustrative when normalized to lipid content. Dioxin concentrations (as geometric means) in blood samples from adults of both genders in these regions are within the range 0.3–9.4 pg/g TEQ lipids. The highest concentrations detected in individual samples from the Chukchi and Taymir AOs are as much as 18.7 and 18.1 pg/g TEQ of lipids, respectively. Figure 7.18(a) illustrates the spatial distribution of PCDD/Fs in the areas of Russian Arctic under study.

In earlier studies, workers at facilities producing chlorine-containing pesticides were found to have diox-

Region	Chukchi AO		Kola peninsula		Nenets AO	Taymir AO
Compound	Kanchalan, n=30*	Uelen, n=50*	Krasnoshchelie, n=20*	Lovozero, n=20*	Nelmin-Nos, n=32*	Khatanga area, n=5*
In plasma:						
HCB	0.6 (0.2-2.4)	0.9 (0.1-3.4)	0.8 (0.5-2.0)	0.8 (0.2-1.7)	0.8 (0.3-2.3)	1.0 (0.6-1.9)
β-HCH	0.7 (0.1-4.8)	2.1 (0.2-8.2)	0.7 (0.1-1.6)	1.0 (n.d.-3.8)	0.4 (0.1-2.5)	1.0 (0.5-2.6)
ΣHCH	0.7 (0.1-5.0)	2.1 (0.2-8.2)	0.8 (0.3-1.6)	1.0 (n.d.-3.9)	0.6 (0.2-2.6)	1.0 (0.5-2.6)
Oxychlordane	0.1 (n.d.-1.2)	1.1 (0.1-9.7)	0.01 (n.d.-0.1)	0.02 (n.d.-0.1)	n.a.	0.04 (n.d.-0.3)
p,p`-DDE	1.4 (0.3-3.2)	2.7 (0.5-8.3)	2.6 (1.0-6.3)	7.3 (1.1-45)	1.6 (0.1-12)	2.6 (1.0-4.2)
p,p`-DDT	0.1 (n.d.-0.5)	0.2 (n.d.-0.7)	0.3 (0.1-0.8)	0.7 (0.1-4.1)	0.3 (n.d.-3.3)	0.2 (0.04-0.5)
ΣDDT	1.5 (0.4-3.4)	2.9 (0.5-9.3)	2.9 (1.1-6.7)	8.2 (1.5-50)	2.4 (0.4-16)	2.9 (1.3-4.7)
ΣPCB	1.3 (0.4-5.6)	6.8 (0.9-34)	2.1 (1.1-5.2)	3.0 (0.8-6.5)	1.6 (0.5-29)	2.3 (1.2-4.7)
ΣToxaphenes	0.03 (n.d.-0.2)	0.3 (0.1-1.6)	0.04 (0.01-0.2)	0.06 (0.02-0.5)	0.2 (n.d.-0.9)	0.09 (0.05-0.2)
Lipid, %	0.2 (0.1-0.3)	0.5 (0.3-0.8)	0.3 (0.2-0.5)	0.3 (0.2-0.6)	0.3 (0.2-0.5)	0.3 (0.2-0.8)
In whole blood:						
Cd	1.0 (n.d.-4.6)	n.a.	0.5 (0.1-1.2)	0.5 (n.d.-1.2)	0.8 (0.2-3.0)	1.0 (0.5-1.8)
Pb	62 (16-196)	n.a.	45 (14-165)	33 (12-102)	47 (17-184)	90 (50-140)
Hg	6.1 (n.d.-29)	n.a.	7.1 (n.d.-29)	3.7 (1.0-12)	1.8 (0.5-4.6)	3.1 (1.0-7.5)
In plasma:						
PCDD/F (TEQ, ng/L)	0.003 (n.d.-0.06)	0.004 (n.d.-0.11)	0.002 (n.d.-0.06)	0.01 (n.d.-0.08)	0.001 (n.d.-0.07)	0.03 (0.01-0.1)
PCDD/F (TEQ, pg/g lipid)	0.8 (n.d.-10.6)	1.1 (n.d.-18.7)	0.5 (n.d.-10.2)	1.6 (n.d.-14.9)	0.3 (n.d.-14.6)	9.4 (4.5-18.1)
ΣPBDEs (ng/L)	1.4 (0.2-7.6)	0.8 (0.3-4.1)	5.1 (2.0-10.7)	2.0 (0.3-6.6)	1.4 (0.3-4.2)	0.8 (0.4-2.0)
ΣPBDEs ((pg/g lipid)	307 (25-2800)	231 (70-1047)	934 (375-1747)	441 (45-1155)	408 (70-843)	115 (20-615)
Lipid, %	0.3 (0.2-0.5)	0.3 (0.2-0.6)	0.4 (0.3-0.6)	0.4 (0.3-0.6)	0.3 (0.2-0.5)	0.3 (0.2-0.5)

Table 7.5 Concentrations (geometric mean and range; µg/L unless otherwise indicated) in plasma and whole blood of indigenous adults from the Russian Arctic.
* For analyses of PCDD/Fs and PBDEs in plasma, n = 9, 6, 3, 4, 6, and 10 for Kanchalan, Uelen, Krasnoschel'e, Lovozero, Nelim-Nos, and Khatanga area, respectively.
n. d. – not detected; n. a. – not availiable.

in/furan levels ranging from 128-465 pg/g TEQ of lipids (Neuberger *et al.*, 1999; Amirova and Kruglov, 1998); firemen working in situations where chlorine-containing materials have been burnt were reported to have 12.9 pg/g TEQ of lipids (Schecter *et al.*, 1999a); and incinerator workers, 11.3-831.9 pg/g TEQ of lipids (Watanabe *et al.*, 1999).

For comparative purposes, dioxin levels for populations of various towns in Russia, as well as for some other countries, are provided below. The highest levels of dioxins in blood were observed in women living near to a pesticide plant in Chapaevsk. Here, mean values of dioxins in blood were 27–75 pg/g TEQ (Revich *et al.*, 1996). Recorded dioxin levels in Bashkiria rural areas were 24.8 and 39.8 pg/g TEQ of lipids, respectively (Amirova & Kruglov, 1998). In the Irkutsk Oblast, levels of 14.8–37.3 pg/g TEQ of lipids were found (Schecter *et al.*, 1999a), whilst residents of the Sverdlovsk region were found to have 21.7–64.4 pg/g TEQ of lipids (Amirova and Kruglov, 1998). Mean concentrations of dioxins in blood from residents of other countries have been reported as follows: 16 pg/g TEQ of lipids in Furuoka, Japan (Matsueda *et al.*, 1999), 17-57 pg/g of TEQ of lipids in Vietnam (Schecter *et al.*, 1999b), and 18.2 pg/g of TEQ of lipids in Germany (Papke *et al.*, 1999).

The highest concentrations of PCDD/Fs recorded in human blood in the northern regions of Russia (about 25 pg/g TEQ of lipids) are, therefore, close to the minimum concentrations observed for residents of industrial regions elsewhere. Furthermore, the most toxic dioxins (the tetra- and penta-substituted dioxins) which are typically detected in the blood of workers at hazardous facilities, were not detected in people living in the Russian North. Compounds that were detected include primarily the octa- and hepta-dioxins, which are normally found in background environmental samples. The single exception was one sample which showed the presence of pentachlorofuran, although only at the detection limit level.

In all pooled samples, the sum of dioxins was more than 1 pg/g TEQ of lipids (1.5–15.4 pg/g TEQ of lipids) due to dibenzofurans detected in blood.

7.4.3. Polybrominated diphenyl ethers in blood of the general adult indigenous population

PBDE and PCDD/F were determined using the same pooled blood samples taken from the adult population as those analyzed for dioxins/furans. Results of blood analysis for PBDE (showing the geometric mean and range of concentrations) in adults are presented in Table 7.5.

Maximum mean concentrations of PBDE were found in blood samples from adults from Krasnoshchelie on the Kola Peninsula (with a mean of 934 pg/g lipids and range of 375–1747 pg/g lipids). The lowest concentrations were associated with blood samples from populations within the Taymir AO.

Comparing concentrations of PBDEs and PCDD/F in blood samples of the adult population in the four regions of the Russian North, reveals a significant difference in the distribution of these contaminants. This is especially so when considering the Taymir region, the Nenets AO (Nelmin-Nos), and the Kola Peninsula (Krasnoshchelie). Whereas dioxin concentrations detected in blood samples of populations from Taymir were the highest, ranging from 9.4–5.0 pg/g of lipids in Khatanga district and in coastal settlements of Khatanga, PBDE concentrations in those regions were the lowest. Conversely, where dioxin concentrations were lowest, in blood samples from the adult population of Krasnoshchelie (0.5 pg /g lipids) and the Nenets AO (0.3 pg/g of lipids), PBDE concentrations were greatest.

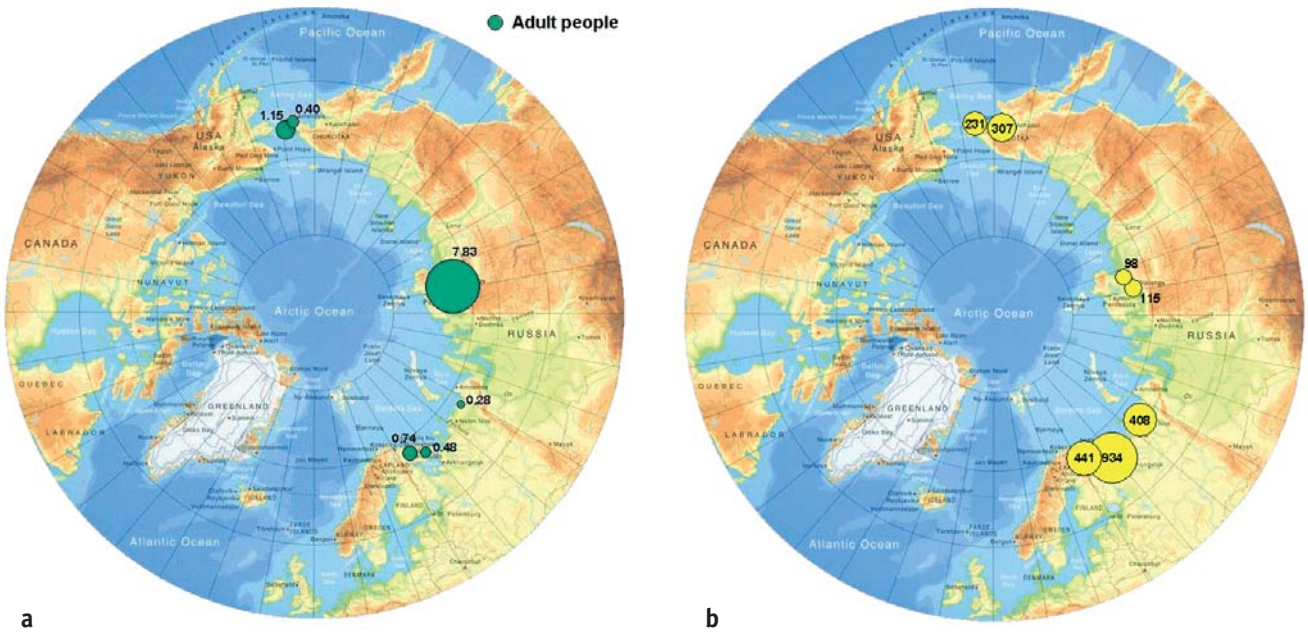

Figure 7.18. Levels of (a) PCDD/F (geometric means; pg/g TEQ of lipids), and (b) PBDE (geometric means; pg/g of lipids) in plasma of adults in Russian Arctic.

Table 7.6.
Concentrations (µg/L) of PCB congeners in breast milk in the Chukchi AO.
n.d. – not detected

PCB Congener (IUPAC)	Chukotsky District n=27	Anadyrsky District n=21	Town of Anadyr n=7	Control n=5
PCB 28/31 [CL3]	0.22 (0.06 – 0.45)	0.11 (0.02 – 0.32)	0.15 (0.09 – 0.37)	0.13 (0.07 – 0.19)
PCB 52 [CL4]	0.10 (0.03 - 0.81)	0.05 (n.d. – 1.24)	0.04 (0.01 – 0.10)	0.04 (0.02 – 0.07)
PCB 99 [CL5]	1.74 (0.22 - 4.83)	0.23 (0.09 – 0.54)	0.40 (0.27 – 0.71)	0.42 (0.28 – 0.66)
PCB 101 [CL5]	0.18 (0.03 - 0.55)	0.04 (n.d. – 0.28)	0.04 (0.003 –0.09)	0.04 (0.03 – 0.08)
PCB 105 [CL5]	0.42 (n.d. – 1.41)	0.06 (n.d. – 0.23)	0.12 (0.08 – 0.21)	0.15 (0.11 – 0.22)
PCB 118 [CL5]	1.89 (0.28 -7.33)	0.25 (n.d. – 0.83)	0.46 (0.35 – 0.67)	0.56 (0.44 – 0.72)
PCB 128 [CL6]	0.02 (n.d. – 0.08)	0.01 (n.d. – 0.05)	0.01 (n.d. – 0.03)	0.01 (n.d. – 0.02)
PCB 138 [CL6]	1.53 (0.25 – 5.63)	0.27 (0.12 – 0.61)	0.47 (0.32 – 0.59)	0.60 (0.28 – 0.89)
PCB 153 [CL6]	6.80 (0.60 – 34.44)	0.69 (n.d. – 2.48)	1.35 (0.75 – 3.72)	1.17 (0.73 – 2.11)
PCB 156 [CL6]	0.33 (n.d. – 3.70)	0.10 (n.d. – 0.34)	0.22 (0.14 – 0.43)	0.11 (n.d. – 0.45)
PCB 170 [CL7]	0.62 (0.08 – 2.26)	0.13 (0.06 – 0.48)	0.17 (0.11 – 0.48)	0.22 (0.15 – 0.31)
PCB 180 [CL7]	1.09 (0.13 – 3.76)	0.21 (0.09 – 0.77)	0.27 (0.17 – 0.86)	0.32 (0.21 – 0.41)
PCB 183 [CL7]	0.18 (n.d. – 0.69)	0.04 (0.02 – 0.12)		

PBDEs have only been identified as an environmental contaminant relatively recently and, therefore, information regarding human contamination by PBDEs, epecially in remote areas, is limited. Concentrations of PBDE in pooled blood samples of people aged 40-50 years from Norway (based on the sum of BDE-28, -47, -100, -99, -153 and -154) (Thomsen *et al.*, 2001) show values of 500 pg/g lipids in 1977, 1000 pg/g lipids in 1981, approximately 2000 pg/g lipids in 1990, and over 3000 pg/g lipids in 1995-1999.

Compared to the PBDE levels provided by Thomsen *et al.* (2001), maximum PBDE concentrations in blood samples of the adult population in Krasnoshchelie, on the Kola Peninsula (934 pg/g lipids), correspond to those found in Norway in 1981. However, levels approaching the PBDE concentrations found in blood samples from populations in Norway from 1990–1999, were detected in individual blood samples. Individual samples from Kanchalan (Chukotka), had levels of 2800 pg/g lipids, from Krasnoshchelie (Kola Peninsula), 1747 pg/g lipids, and from Lovozero (Kola Peninsula),1155 pg/g lipids.

The spatial distribution of PBDEs in the Russian Arctic Figure 7.18(b) suggests that contamination levels are determined by trans-boundary transport. Higher concentrations are observed in the easternmost (Chukchi AO) and westernmost (Kola peninsula) areas of the Russian Arctic, closest to the source areas of North America and Europe, respectively. PBDE levels measured in blood samples in the central regions are either below, or close to the detection limit. Taking into account that PBDEs are relatively recent contaminants

Table 7.7.
Concentrations (µg/L) of chlorinated pesticides in breast milk in the Chukchi AO.
n.d. – not detected

Compound	Chukotsky District n=27	Anadyrsky District n=21	Town of Anadyr n=7	Control n=5
HCB	**7.79** (1.85 – 27.27)	**2.12** (0.48 – 14.14)	**2.62** (1.89 – 5.27)	**1.45** (0.82 – 3.87)
α-HCH	**0.19** (n.d. – 0.64)	**0.05** (n.d. – 0.25)	**0.16** (0.09 – 0.22)	**0.12** (.,06 – 0.21)
β-HCH	**11.59** (2.60 – 59.10)	**2.36** (0.12 – 7.51)	**6.46** (3.64 – 14.28)	**3.33** (2.03 – 11.95)
γ-HCH	**0.02** (n.d. – 0.17)	**0.004** (n.d. – 0.06)	**0.03** (0.02 – 0.05)	**0.005** (n.d. – 0.033)
ΣHCH	**11.88** (2.68 – 59.81)	**2.49** (0.19 – 7.66)	**6.68** (3.89 – 14.48)	**3.49** (2.24 – 12.15)
Heptachlor	**0.01** (n.d. – 0.39)	**n.d.**	**0.002** (n.d. – 0.03)	**n.d.**
Heptachlor epoxide	**0.46** (n.d. – 2.16)	**0.004** (n.d. – 0.14)	**0.05** (n.d. – 0.15)	**0.01** (n.d. – 0.08)
Oxychlordane	**6.35** (0.34 – 43.33)	**0.14** (n.d. – 1.31)	**0.51** (0.18 – 1.65)	**0.09** (0.04 – 0.12)
trans-Chlordane	**0.003** (n.d. – 0.06)	**n.d.**	**0.002** (n.d. – 0.035)	**n.d.**
cis-Chlordane	**0.27** (0.01 – 1.96)	**0.01** (n.d. – 0.10)	**0.02** (n.d. – 0.15)	**0.003** (n.d. – 0.010)
ΣChlordanes	**6.66** (0.35 – 45.36)	**0.14** (n.d. – 1.41)	**0.56** (0.19 – 1.66)	**0.09** (0.04 – 0.13)
Dieldrin	**0.47** (n.d. – 3.62)	**0.01** (n.d. – 0.33)	**0.09** (0.04 – 0.15)	**0.02** (n.d. – 0.09)
o,p`-DDE	**0.01** (n.d. – 0.07)	**0.003** (n.d. – 0.04)	**0.03** (0.01 – 0.05)	**0.01** (n.d. – 0.02)
p,p`-DDE	**7.70** (2.10 – 17.70)	**4.27** (1.64 – 12.71)	**10.90** (7.69 – 17.84)	**10.19** (2.15 – 23.26)
o,p`-DDD	**0.004** (n.d. – 0.21)	**0.003** (n.d. – 0.12)	**0.01** (n.d. – 0.09)	**0.02** (n.d. – 0.20)
p,p`-DDD	**0.19** (0.06 – 0.86)	**0.15** (0.02 – 1.00)	**0.51** (0.21 – 1.62)	**0.25** (0.16 – 0.42)
o,p`-DDT	**0.02** (n.d. – 0.65)	**0.01** (n.d. – 0.45)	**0.14** (0.03 – 0.42)	**0.01** (n.d. – 0.06)
p,p`-DDT	**0.62** (0.11 – 2.67)	**0.58** (0.19 – 1.86)	**1.89** (1.18 – 2.88)	**0.56** (0.36 – 0.81)
ΣDDT	**8.77** (2.40 – 19.85)	**5.12** (1.97 – 15.60)	**13.64** (10.21 – 22.85)	**11.25** (2.67 – 24.42)
Mirex	**0.32** (n.d. – 2.71)	**0.01** (n.d. – 0,20)	**0,01** (n.d. – 0,15)	**n.d.**
trans-Nonachlor	**4,13** (0,52 – 15,08)	**0,26** (0,069 – 0,66)	**0,68** (0,32 – 2,16)	**0,20** (0,03 – 1,78)
cis-Nonachlor	**0,46** (0,08 – 1,75)	**0,04** (n.d. – 0.13)	**0.09** (0.05 – 0.26)	**0.03** (0.02 – 0.10)
Parlar 26	**0.64** (0.06 – 4.83)	**0.04** (0.001 – 0.18)	**0.08** (0.04 – 0.21)	**0.02** (0.004 – 0.06)
Parlar 50	**0.74** (0.07 – 4.01)	**0.07** (0.001 – 0.25)	**0.14** (0.08 – 0.26)	**0.06** (0.01 – 0.27)
Parlar 62	**0.003** (n.d. – 0.10)	**n.d.**	**n.d.**	**n.d.**
ΣToxaphenes	**1.41** (0.14 – 8.84)	**0.11** (0.002 – 0.42)	**0.23** (0.12 – 0.47)	**0.09** (0.01 – 0.33)
Weight, g	**23.0** (11.4 – 33.4)	**22.9** (4.4 – 35.1)	**21.4** (14.9 – 32.6)	**25.7** (23.4 – 33.6)
Lipid, %	**3.14** (0.67 – 5.55)	**2.51** (0.62 – 4.86)	**3.26** (1.86 – 4.78)	**3.38** (2.33 – 6.69)

Table 7.8.
Concentrations (ng/g lipids) of PCB in breast milk in the Chukchi AO.
n.d. – not detected

PCB Congener (IUPAC)	Chukotsky District n=27	Anadyrsky District n=21	Town of Anadyr n=7	Control n=5
PCB 28/31 [CL3]	**7.04** (2.50 – 33.81)	**4.48** (1.24 – 16.43)	**4.46** (2.34 – 9.14)	**3.81** (2.55 – 5.27)
PCB 52 [CL4]	**3.03** (0.87 – 25.48)	**1.93** (0.60 – 50.67)	**1.29** (0.56 – 2.38)	**1.18** (0.52 – 2.75)
PCB 99 [CL5]	**55.35** (12.87 – 158.61)	**9.12** (4.25 – 21.62)	**12.34** (8.28 – 17.44)	**12.30** (4.12 – 28.37)
PCB 101 [CL5]	**4.78** (1.63 – 13.89)	**1.50** (0.18 – 8.78)	**1.15** (0.17 – 2.63)	**1.22** (0.49 – 2.94)
PCB 105 [CL5]	**13.60** (n.d. – 31.26)	**2.66** (n.d. – 32.58)	**3.80** (3.00 – 4.53)	**4.44** (1.94 – 6.16)
PCB 118 [CL5]	**60.25** (18.90 – 159.98)	**9.94** (n.d. – 44.01)	**14.09** (10.78 – 21.35)	**16.65** (8.23 – 20.74)
PCB 128 [CL6]	**0.52** (n.d. – 2.72)	**0.26** (n.d. – 1.34)	**0.32** (n.d. – 0.88)	**0.21** (n.d. – 0.70)
PCB 138 [CL6]	**48.82** (11.59 – 135.06)	**10.95** (4.84 – 38.12)	**14.51** (9.33 – 22.70)	**17.75** (4.26 – 37.99)
PCB 153 [CL6]	**216.76** (34.85 – 1252.46)	**27.39** (15.44 – 95.59)	**41.42** (20.94 – 91.28)	**34.63** (10.91 – 58.84)
PCB 156 [CL6]	**9.96** (n.d. – 66.69)	**4.18** (n.d. – 19.04)	**6.82** (4.08 – 10.50)	**3.03** (n.d. – 12.62)
PCB 170 [CL7]	**19.69** (1.86 – 82.04)	**5.28** (2.08 – 18.72)	**5.19** (2.77 – 11.72)	**6.66** (2.29 – 9.28)
PCB 180 [CL7]	**34.81** (5.23 – 121.58)	**8.25** (4.31 – 33.45)	**8.16** (3.90 – 21.23)	**9.47** (3.10 – 14.07)
PCB 183 [CL7]	**5.39** (n.d. – 17.25)	**1.53** (0.80 – 5.91)	**1.81** (0.97 – 3.73)	**2.01** (0.63 – 3.41)
PCB 187 [CL7]	**16.74** (3.83 – 50.99)	**3.34** (0.14 – 15.73)	**4.48** (2.20 – 11.66)	**3.78** (1.13 – 7.15)
ΣPCB	**521.73** (116.63 – 1702.32)	**97.90** (49.60 – 345.20)	**123.95** (75.62 – 213.79)	**23.34** (43.11 – 169.51)
Weight, g	**23.0** (11.4 – 33.4)	**22.9** (4.4 – 35.1)	**21.4** (14.9 – 32.6)	**25.7** (23.4 – 33.6)
Lipid, %	**3.14** (0.67 – 5.55)	**2.51** (0.62 – 4.86)	**3.26** (1.86 – 4.78)	**3.38** (2.33 – 6.69)

of anthropogenic origin, and that information on their production and use in Russia is not yet available, it has been suggested that PBDEs, used mainly in the industrial developed countries as flame retardants, have the potential to become a new PTS representing a circumpolar hazard, if urgent measures are not taken to limit their production and use.

7.5. POPs in breast milk

7.5.1. POPs levels in breast milk and their correlation with blood levels

A total of 60 samples of breast milk were analyzed for POPs. The samples were collected from different areas of the Chukchi AO: Chukotsky District (27 samples), Anadyrsky District (21 samples), and the town of Anadyr (7 samples). Samples were from the same mothers who participated in the blood study at delivery. 5 control samples from St. Petersburg were also collected and analyzed (Tables 7.6–7.9 and Figure 7.19a-d). Samples in which no POPs were detected were not included in tehdata resened, but represented less than 1% of all cases.

The highest levels of almost all POPs occur in the breast milk of women living in Chukotsky District. Compared to other areas of the Chukchi AO, concentrations were higher in Chukotsky by 3–6 times for HCB; 10–80 times for oxychlordane; up to 10 times for mirex, *trans*- and *cis*-nonachlor, and toxaphene; and 4–5 times for the sum of PCB congeners. Only for the DDT group of compounds were concentrations in breast milk similar in all areas studied within the Chukchi AO. It seems reason-

Table 7.9.
Concentrations (ng/g lipids) of chlorinated pesticides in breast milk in the Chukchi AO.
n.d. – not detected

Compound	Chukotsky District n=27	Anadyrsky District n=21	Town of Anadyr n=7	Control n=5
HCB	**248.5** (73.4 – 934.2)	**84.4** (28.1 – 546.1)	**80.3** (43.3 – 129.4)	**43.1** (31.0 – 108.0)
α-HCH	**5.6** (n.d. – 25.0)	**2.0** (n.d. – 19.3)	**4.9** (3.8 – 9.5)	**3.6** (2.2 – 5.0)
β-HCH	**369.8** (58.1 – 1598.4)	**94.2** (6.1 – 298.1)	**198.4** (100.0 – 505.0)	**98.7** (56.7 – 178.6)
γ-HCH	**0.7** (n.d. – 4.4)	**0.1** (n.d. – 1.6)	**0.9** (0.4 – 2.5)	**0.2** (n.d. – 1.1)
ΣHCH	**378.9** (59.9 – 1627.8)	**99.4** (9.6 – 308.0)	**204.9 (104.3 – 516.9)**	**103.4** (62.5 – 181.6)
Heptachlor	**0.2** (n.d. – 10.4)	**n.d.**	**0.05** (n.d. – 0.66)	**n.d.**
Heptachlor epoxide	**13.9** (n.d. – 99.0)	**0.2** (n.d. – 3.6)	**1.7** (n.d. – 3.8)	**0.2** (n.d. – 2.6)
Oxychlordane	**202.6** (19.4 – 1070.0)	**5.3** (n.d. – 50.6)	**15.6** (6.4 – 36.9)	**2.5** (0.7 – 5.4)
trans-Chlordane	**0.1** (n.d. – 1.6)	**0.0 (n.d. – 0.2)**	**0.1** (n.d. – 1.0)	**n.d.**
cis-Chlordane	**8.6** (0.6 – 73.5)	**0.2** (n.d. – 3.7)	**0.5** (n.d. – 3.8)	**0.1** (n.d. – 0.3)
ΣChlordanes	**212.5** (20.0 – 1099.2)	**5.3** (n.d. – 54.3)	**17.0** (8.1 – 40.7)	**2.6** (0.7 – 5.6)
Dieldrin	**15.1** (n.d. – 106.4)	**0.2** (n.d. – 12.1)	**2.6** (1.3 – 3.8)	**0.7** (n.d. – 3.3)
o,p`-DDE	**0.4** (n.d. – 2.1)	**0.1** (n.d. – 1.7)	**0.8** (0.4 – 1.5)	**0.3** (n.d. – 0.7)
p,p`-DDE	**245.6** (132.6 – 812.1)	**170.0** (53.8 – 768.7)	**334.5** (186.1 – 553.5)	**302.0** (80.7 – 998.5)
o,p`-DDD	**0.1** (n.d. – 7.5)	**0.1** (n.d. – 5.8)	**0.4** (n.d. – 2.2)	**0.6** (n.d. – 5.7)
p,p`-DDD	**6.0** (2.2 – 18.8)	**6.0** (0.9 – 33.4)	**15.6** (8.1 – 35.1)	**7.3** (5.9 – 10.7)
o,p`-DDT	**0.7** (n.d. – 15.5)	**0.4** (n.d. – 9.3)	**4.3** (1.1 – 9.1)	**0.4** (n.d. – 2.5)
p,p`-DDT	**19.7** (2.8 – 74.9)	**23.3** (4.9 – 159.8)	**58.1** (24.8 – 87.1)	**16.5** (5.3 – 34.9)
ΣDDT	**279.7** (150.3 – 910.6)	**204.3** (62.5 – 934.0)	**418.6** (224.4 – 664.6)	**333.2** (100.0–1048.2)
Mirex	**9.9** (n.d. – 61.7)	**0.5** (n.d. – 7.6)	**0.4** (n.d. – 3.7)	**n.d.**
trans-Nonachlor	**131.7** (24.7 – 594.8)	**10.4** (1.8 – 25.5)	**20.8** (10.4 – 53.0)	**6.0** (1.2 – 76.5)
cis-Nonachlor	**14.5** (1.9 – 80.3)	**1.5** (n.d. – 4.7)	**2.9** (1.6 – 6.5)	**1.0** (0.2 – 3.3)
Parlar 26	**20.5** (3.6 – 105.4)	**1.5** (0.03 – 5.2)	**2.5** (1.1 – 5.3)	**0.7** (0.1 – 2.1)
Parlar 50	**23.7** (4.3 – 111.9)	**2.8** (0.04 – 8.7)	**4.4** (3.2 – 6.3)	**1.9** (0.1 – 9.0)
Parlar 62	**0.1** (n.d. – 1.9)	**n.d.**	**n.d.**	**n.d.**
ΣToxaphenes	**45.1** (7.9 – 212.6)	**4.3** (0.1 – 12.2)	**7.0** (4.3 – 11.5)	**2.6** (0.2 – 11.1)
Weight, g	**23.0** (11.4 – 33.4)	**22.9** (4.4 – 35.1)	**21.4** (14.9 – 32.6)	**25.7** (23.4 – 33.6)
Lipid, %	**3.14** (0.67 – 5.55)	**2.51** (0.62 – 4.86)	**3.26** (1.86 – 4.78)	**3.38** (2.33 – 6.69)

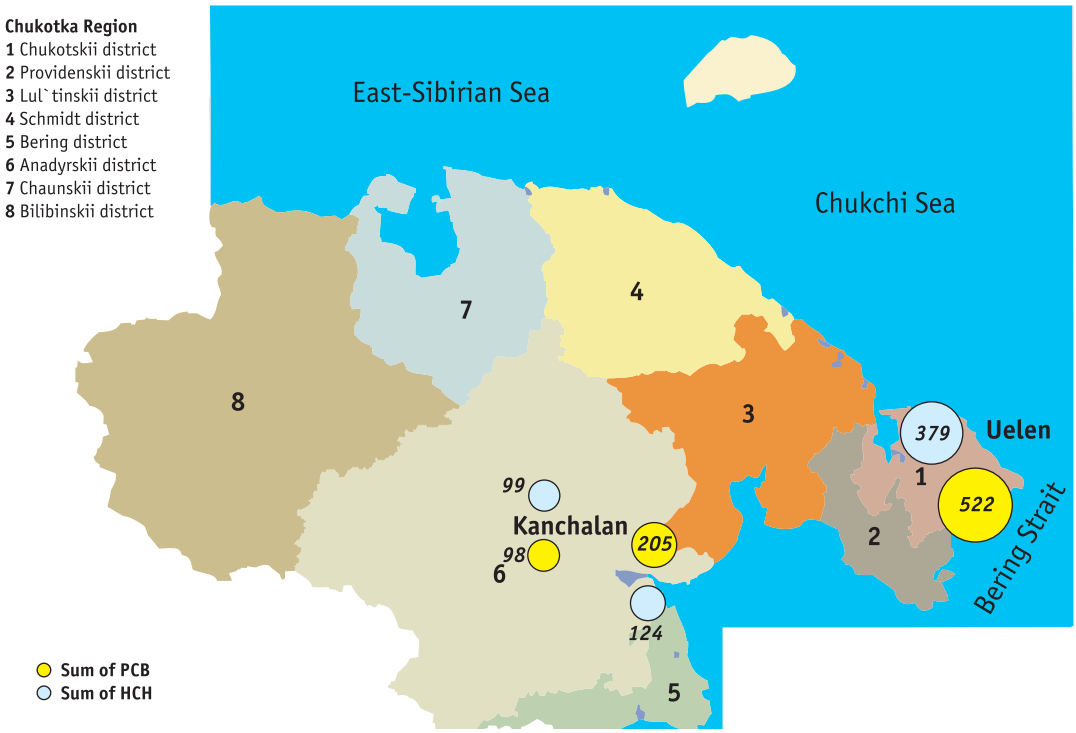

Figure 7.19a.
Levels of PCB and HCH (ng/g lipid) in breast milk of women from various areas of the Chukchi AO.

able to suggest, therefore, that women living in all areas in the Chukchi AO are exposed to a common source of intake for DDT and related compounds.

The results obtained were also compared with levels of breast milk contamination reported for women from Nunavik, Canada (1996–2000), and the Russian Arctic (AMAP, 2002, 2003a; Chashchin *et al.*, 2002).

PCBs

Concentrations of the sum of 14 congeners of PCB in breast milk of women from Chukotsky District are comparable or slightly higher than those in Nunavik, Canada (386 ng/g lipid in Canada compared to 521 ng/g lipid in breast milk from Chukotsky District). The concentrations of individual PCB congeners (118, 138, 153, and 180) detected in breast milk in the towns of Kargopol, Severodvinsk, Arkhangelsk, and Naryan-Mar, occur at levels intermediate to those found in breast milk in Chukotsky District and those reported for other areas of the Chukchi AO.

HCB

Concentrations of hexachlorobenzene (HCB) in breast milk from Chukotsky District, not only exceed those in other areas of the Chukchi AO, but are also 2–5 times

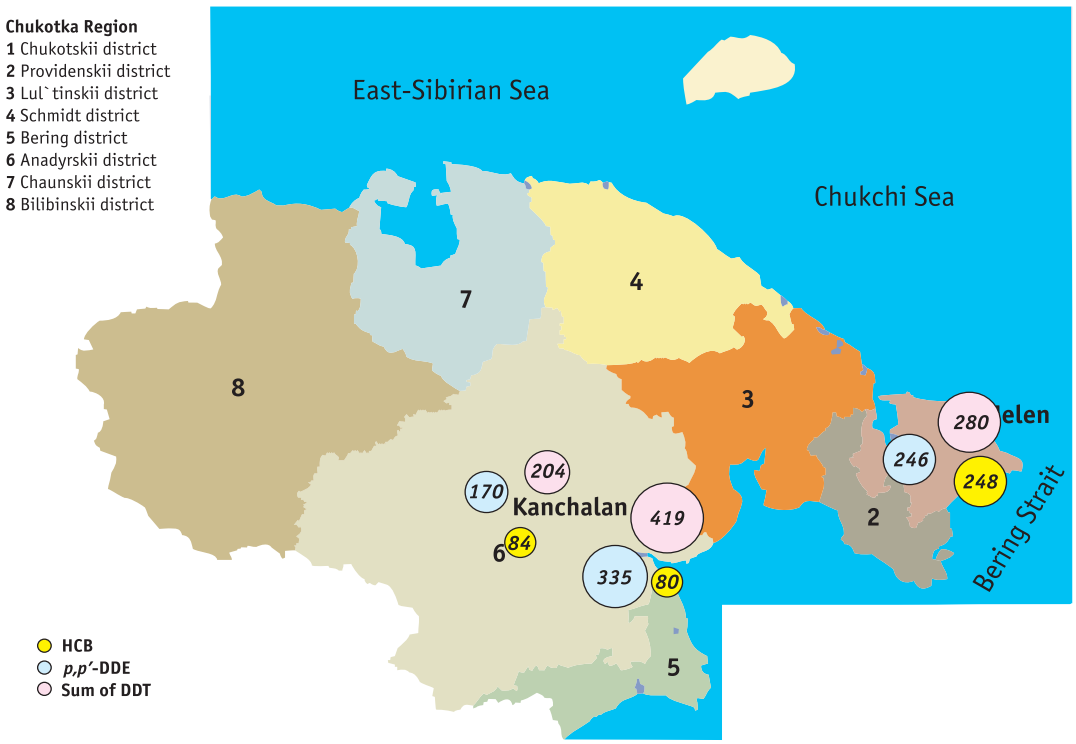

Figure 7.19b.
Levels of HCB and DDT (ng/g lipid) in breast milk of women from various areas of the Chukchi AO.

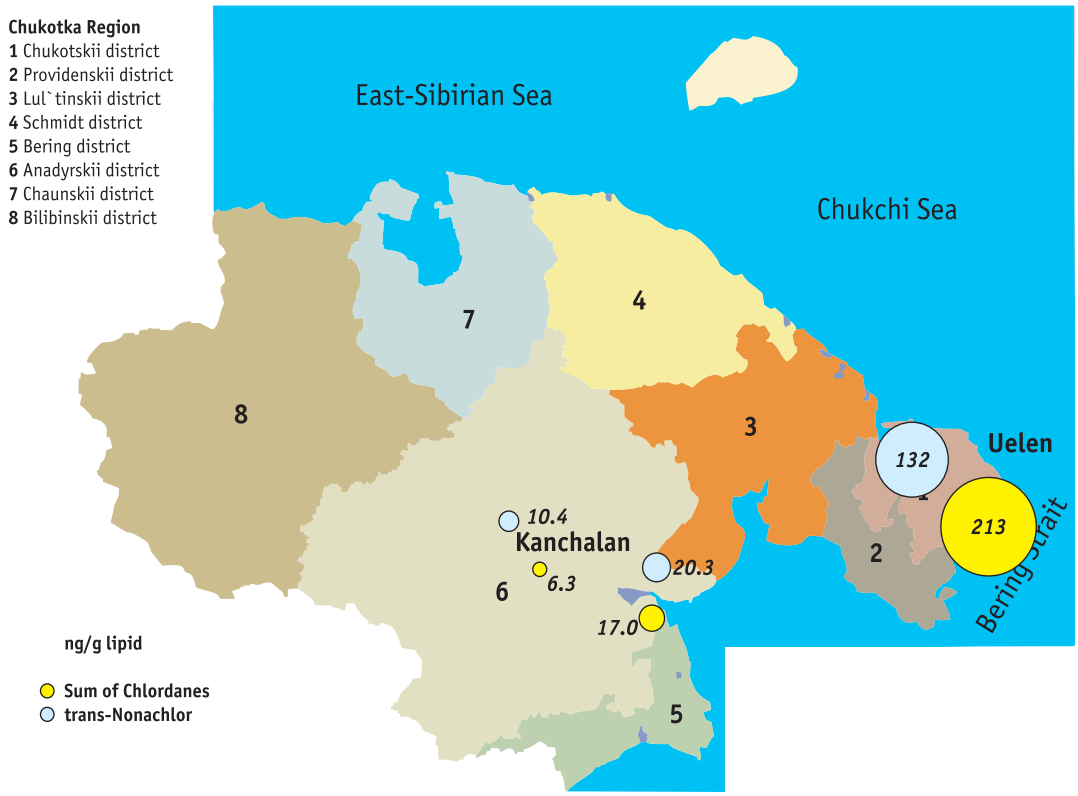

Figure 7.19c.
Levels of Chlordanes (ng/g lipid) in breast milk of women from various areas of the Chukchi AO.

higher than levels reported in Nunavik, Canada, and other northern towns of Russia (AMAP, 2002). Elsewhere in the Russian North, Norilsk (with a geometric mean of 123 ng/g lipids, and range of 29-387 ng/g lipids) shows the closest concentrations of HCB in breast milk to those found in Chukotsky District.

β-HCH

Levels of β-HCH in breast milk of women from the Chukchi AO are distributed in a similar pattern to HCB. Specifically, the highest levels occur in breast milk from Chukotsky rayon (with a mean value of 370 ng/g lipids). Levels are lower, although still relatively high, in the town of Anadyr (198 ng/g lipids). Similar values for β-HCH concentrations in milk are found in Anadyr district (94 ng/g lipids), and also in the control site, St. Petersburg (98 ng/g lipids), however, the range is greater for samples from Anadyrsky District.

Concentrations of β-HCH in breast milk from Chukotsky District exceed levels detected in other areas of the Chukchi AO and other northern towns of

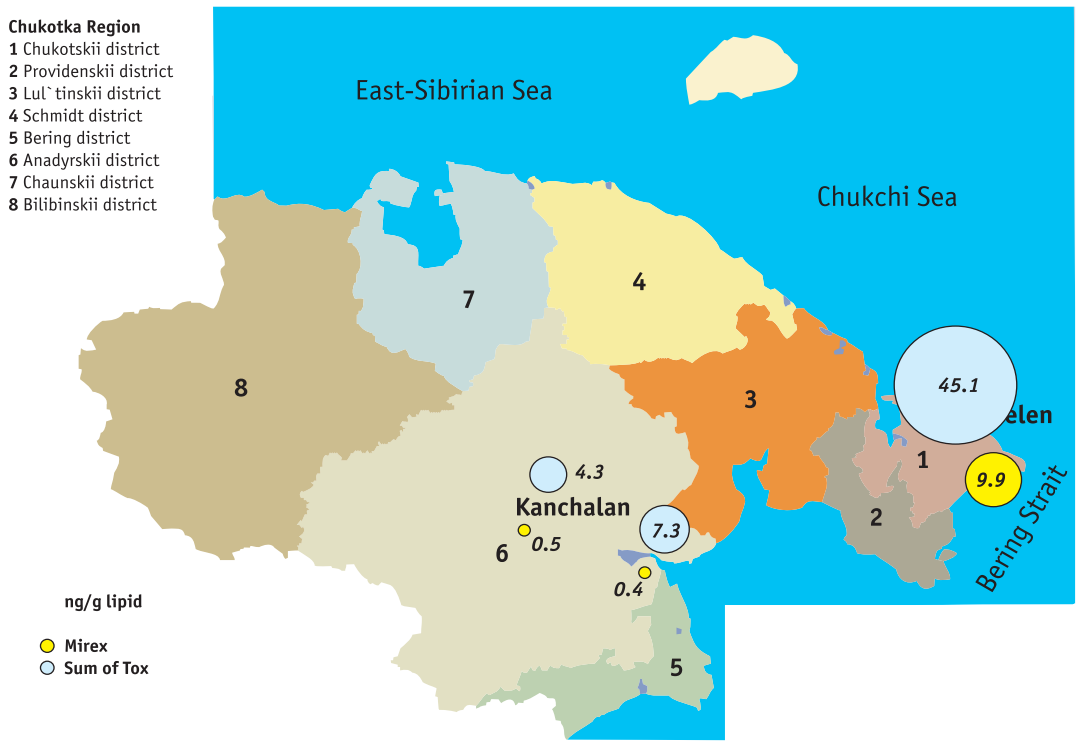

Figure 7.19d.
Levels of Mirex and toxaphene (ng/g lipid) in breast milk of women from various areas of the Chukchi AO.

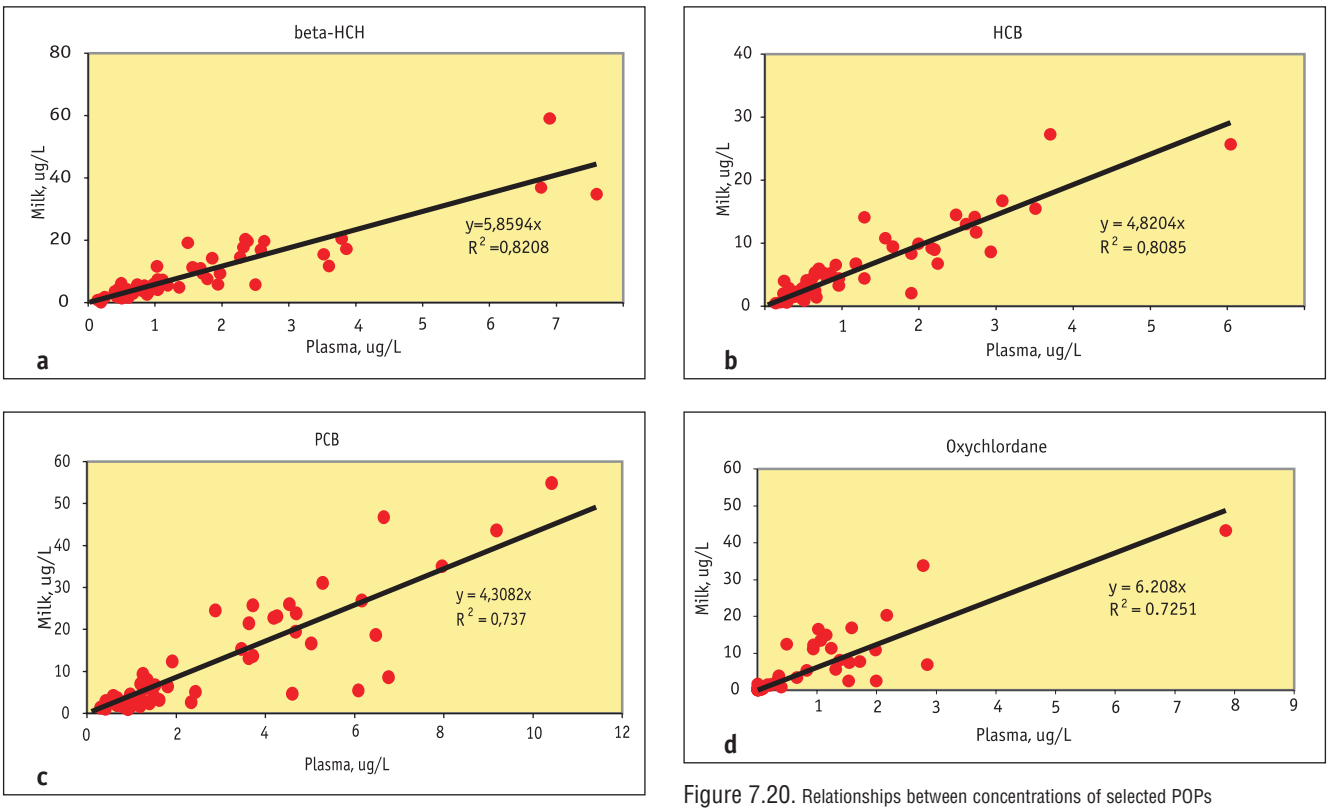

Figure 7.20. Relationships between concentrations of selected POPs in breast milk and plasma of indigenous women of the Chukchi AO.

Russia, as well as levels in Nunavik, Canada (by 30 times). The closest β-HCH breast milk concentrations to those in Chukotsky District, were those found in Arkhangelsk (arithmetic mean of 401 ng/g lipids) and Norilsk (geometric mean of 142 ng/g lipids).

Data from 1984 (Bobovnikova, 1987), include mean levels of total HCH in breast milk samples for various regions of the USSR. For example, total HCH in breast milk was 46 µg/L in Moscow, 66 µg/L in Rostov-on-Don, and 53 µg/L in Baikalsk; mean values were 51 µg/L for Uzbekistan; 136 µg/L for Djambaisky District (an area subject to intense OCP application), and 86 µg/L in 'clean' areas of Uzbekistan. By comparison, total HCH concentrations in breast milk samples from the Chukotka area, found in the current study are much lower, at 2.5–11.8 µg/L (Table 7.7).

Oxychlordane

Oxychlordane is the dominant component in total chlordanes in breast milk. Oxychlordane concentrations in breast milk from Chukotsky District (203 ng/g lipids) are higher than those found in breast milk from northern Canada (Nunavik; 81 ng/g lipids), and exceed concentrations in breast milk from other towns of the Russian North and other districts of the Chukchi AO by 10-100 times.

Distributions of mirex and *trans*- and *cis*-nonachlor are similar. Highest levels of these compounds were also found in breast milk from women in northern Canada (Nunavik) and in Chukotsky District.

DDT

As discussed above, concentrations of DDT and its metabolites in breast milk in different areas of the Chukchi AO are very similar; DDE concentrations range from 245–334 ng/g lipids) and are lower than levels reported in northern Canada (Nunavik; 420 ng/g lipids) (AMAP, 2002). The DDE/DDT ratio ranges from 6 to 18, with the ratio found in samples of breast milk in the town of Anadyr, and in Anadyrsky District of the Chukchi AO, being close to those of industrial cities of the Russian North (e.g., Norilsk, Salekhard, and Dudinka); the ratio found in Chukotsky District, and the control samples are close to those of non-industrial regions of Taymir and Yamal.

The 2003 UNEP/GEF global PTS assessment (UNEP, 2003) presents data on concentrations of DDT and its metabolites in breast milk for different regions of the world. The highest reported levels are those fo China (DDE concentrations of 2850 ng/g lipids, and DDT concentrations of 700 ng/g lipids), which may be explained by continuing use of large amounts of DDT in the region.

The concentrations of total DDT and its metabolites reported previously for various regions of the USSR are as follows: 87 µg/L in Moscow, 128 µg/L in Rostov-on-Don, 45 µg/L in Baikalsk, 191 µg/L in areas of Uzbekistan where pesticides are actively used, and 84 µg/L in the 'clean' areas of Uzbekistan (Bobovnikova,1987). By comparison, total DDT in the areas of the Chukchi AO studied were 5.1 to 13.6 µg/L (Table 7.7).

Table 7.10.
Concentrations (ng/L) of polychlorinated dibenzo-p-dioxins and dibenzofurans in breast milk in the Chukchi AO.
n.d. - not detected

Compound	Chukchi AO		Control (St. Petersburg), n=2
	Chukotsky District, n=10	Anadyrsky District, n=7	
2,3,7,8-TCDD	n.d.	n.d.	n.d.
1,2,3,7,8-PeCDD	**0.13** (n.d. – 0.33)	**0.12** (n.d. – 0.32)	n.d.
1,2,3,4,7,8-HxCDD	n.d.	n.d.	n.d.
1,2,3,6,7,8- HxCDD	**0.16** (0.09 – 0.44)	**0.05** (n.d. – 0.17)	**0.05** (n.d. – 0.10)
1,2,3,7,8,9- HxCDD	n.d.	n.d.	n.d.
1,2,3,4,6,7,8-HpCDD	**0.21** (0.05 – 0.67)	**0.022** (0.09 – 0.38)	**0.18** (0.12 – 0.26)
OCDD	**1.54** (0.33 – 22.10)	**1.45** (0.65 – 5.03)	**1.56** (0.81 – 2.99)
2,3,7,8-TCDF	**0.04** (n.d. – 0.27)	**0.03** (n.d. – 0.17)	n.d.
1,2,3,7,8-PeCDF	**0.03** (n.d. – 0.11)	n.d.	n.d.
2,3,4,7,8-PeCDF	**0.23** (n.d. – 0.65)	**0.08** (n.d. – 0.24)	**0.18** (0.14 – 0.24)
1,2,3,4,7,8-HxCDF	**0.07** (n.d. – 0.26)	**0.04** (n.d. – 0.10)	**0.04** (0.04 – 0.05)
1,2,3,6,7,8- HxCDF	**0.06** (n.d. – 0.23)	**0.02** (n.d. – 0.05)	**0.03** (0.03 – 0.03)
2,3,4,6,7,8-HxCDF	**0.02** (n.d. – 0.31)	n.d.	n.d.
1,2,3,7,8,9-HxCDF	**0.02** (n.d. – 0.12)	n.d.	n.d.
1,2,3,4,6,7,8-HpCDF	**0.13** (n.d. – 1.00)	**0.04** (n.d. – 0.10)	**0.02** (n.d. – 0.03)
1,2,3,4,7,8,9-HpCDF	**0.02** (n.d. – 1.30)	n.d.	n.d.
OCDF	**0.56** (0.13 – 2.04)	**0.42** (0.23 – 0.56)	**0.61** (0.46 – 0.82)
Total Concentration in TEQ	**0.23** (0.14 – 0.71)	**0.07** (n.d. – 0.25)	**0.11** (0.08 – 0.14)
Weight, g	**21.97** (11.42 – 30.67)	**29.25** (24.78 – 32.97)	**28.65** (24.43 – 33.60)
Lipid, %	**2.96** (0.67 – 4.58)	**2.52** (0.62 – 4.86)	**3.09** (2.67 – 3.58)

As breast milk and blood samples were collected from the same women, it was possible to investigate the correlation between POP concentrations in these two body fluids. Figures 7.20 (a)-(d) show the associated relationships for a number of POPs.

As seen from Figure 7.20, statistically significant correlations exist between POP concentrations in breast milk and plasma, which can be used in dose and risk assessment when only one of these characteristics is measured. In general, POP concentrations in breast milk are about 4 to 6 times higher than in plasma. This difference corresponds reasonably well to the difference in lipid content of breast milk and plasma.

7.5.2. PCDD/F and PBDE levels in breast milk of indigenous women from the Chukchi AO

A total of 20 samples of breast milk were analyzed for PCDD/Fs and PBDEs. Samples were collected from Chukotsky District (10 samples), Anadyrsky District (7 samples), and Anadyr town (1 sample), as well as 2 control samples from St. Petersburg (Tables 7.10-7.13). The highest average concentrations of total PCDD/Fs were found in breast milk samples from Chukotsky District (Figure 7.21), up to 7.66 pg/g, using the international toxic equivalent (TEQ) of lipids, i.e, 2–2.5 times higher than in samples from Anadyrsky District (2.70 pg/g) or the control area (3.47 pg/g). Maximum values of PCDD/F concentrations were equal to 21.3 pg/g lipids in Chukotsky District, 9.65 pg/g in Anadyrsky District, and 5.24 pg/g in control samples.

In other studies, low levels of mean PCDD/F concentrations in breast milk were detected in Bulgaria at 6.14 pg/g of lipids (range: 5.08–7.11), and highest levels in the Netherlands, at 18.3 pg/g (range: 17.1–21.3) (UNEP, 2003). In other European countries, reported values were 7.30 pg/g lipids (range: 7.16–7.43) in Norway, and 6.91 pg/g (range: 6.19–8.54) in Ireland.

Mean concentrations of dioxin in breast milk in Russia (2001–2002) were equal to 8.88 pg/g lipids, with a range of 7.46–12.93 pg/g (UNEP, 2003). The highest concentrations were detected in the breast milk of women living in towns involved with the production of organochlorine pesticides. For example, breast milk contamination by dioxins at levels of 43.3 pg/g lipids were determined in Chapaevsk (Revich *et al.*, 1996).

From these figures, mean dioxin and furan concentrations detected in the breast milk of women from the Chukotsky District, and in women from Norway and Ireland appear very similar and are lower than concentrations detected in northern and southern Quebec in Canada (CACAR,1997).

Table 7.11.
Concentrations (ng/L) of polybrominated diphenyl ethers in breast milk in the Chukchi AO.
n.d. – not detected

Compound	Chukchi AO		Control (St. Petersburg), n=2
	Chukotsky District. n=10	Anadyrsky District. n=7	
PBDE #28	**0.49** (n.d. – 1.41)	**0.23** (n.d. – 0.82)	**2.26** (1.07 – 4.77)
PBDE # 47	**7.66** (n.d. – 30.91)	**2.14** (0.85 – 3.85)	**34.28** (12.45 – 94.41)
PBDE # 99	**0.56** (n.d. – 2.32)	**0.62** (n.d. – 1.47)	**2.48** (0.93 – 6.59)
PBDE # 100	**0.60** (n.d. – 2.58)	**0.29** (n.d. – 0.78)	**2.60** (0.65 – 10.38)
PBDE # 153	**0.66** (n.d. – 7.26)	n.d.	**1.29** (n.d. – 4.15)
PBDE # 154	n.d.	n.d.	**0.69** (n.d. – 1.20)
PBDE # 183	n.d.	n.d.	n.d.
Sum	**10.55** (n.d. – 36.54)	**3.06** (0.85 – 6.71)	**42.83** (15.10 – 121.5)
Weight, g	**21.97** (11.42 – 30.67)	**29.25** (24.78 – 32.97)	**28.65** (24.43 – 33.60)
Lipid, %	**2.96** (0.67 – 4.58)	**2.52** (0.62 – 4.86)	**3.09** (2.67 – 3.58)

Compound	Chukchi AO		Control (St. Petersburg), n=2
	Chukotsky District, n=10	Anadyrsky District, n=7	
2,3,7,8-TCDD	n.d.	n.d.	n.d.
1,2,3,7,8-PeCDD	**4.75** (n.d. – 39.40)	**4.36** (n.d. – 12.40)	n.d.
1,2,3,4,7,8-HxCDD	n.d.	n.d.	n.d.
1,2,3,6,7,8- HxCDD	**5.31** (2.18 – 12.99)	**1.49** (n.d. – 6.14)	**1.93** (n.d. – 3.71)
1,2,3,7,8,9- HxCDD	n.d.	n.d.	n.d.
1,2,3,4,6,7,8-HpCDD	**7.18** (1.88 – 18.21)	**8.56** (2.37 – 35.32)	**5.78** (4.53 – 7.37)
OCDD	**51.90** (11.85 – 523.7)	**57.53** (17.34 – 177.4)	**50.40** (30.41 – 83.52)
2,3,7,8-TCDF	**1.19** (n.d. – 6.04)	**0.90** (n.d. – 6.50)	n.d.
1,2,3,7,8-PeCDF	**0.94** (n.d. – 2.70)	n.d.	n.d.
2,3,4,7,8-PeCDF	**6.77** (n.d. – 15.38)	**2.68** (n.d. – 8.63)	**5.87** (3.80 – 9.06)
1,2,3,4,7,8-HxCDF	**2.15** (n.d. – 6.16)	**1.19** (n.d. – 2.92)	**1.44** (1.31 – 1.57)
1,2,3,6,7,8- HxCDF	**1.75** (n.d. – 5.40)	**0.80** (n.d. – 2.09)	**0.92** (0.78 – 1.09)
2,3,4,6,7,8-HxCDF	**0.70** (n.d. – 7.32)	n.d.	n.d.
1,2,3,7,8,9-HxCDF	**0.60** (n.d. – 2.94)	n.d.	n.d.
1,2,3,4,6,7,8-HpCDF	**3.75** (n.d. – 23.70)	**1.16** (n.d. – 3.86)	**0.63** (n.d. – 0.78)
1,2,3,4,7,8,9-HpCDF	**0.75** (n.d. – 30.81)	n.d.	n.d.
OCDF	**18.97** (4.78 – 48.34)	**16.46** (7.74 – 48.71)	**19.70** (17.04 – 22.77)
Total Concentration in TEQ	**7.66** (3.60 – 21.34)	**2.70** (0.65 – 9.65)	**3.47** (2.29 – 5.24)
Weight, g	**21.97** (11.42 – 30.67)	**29.25** (24.78 – 32.97)	**28.65** (24.43 – 33.60)
Lipid, %	**2.96** (0.67 – 4.58)	**2.52** (0.62 – 4.86)	**3.09** (2.67 – 3.58)

Table 7.12.
Concentrations (pg/g lipids) of polychlorinated dibenzo-p-dioxins and dibenzofurans in breast milk in the Chukchi AO.
n.d. – not detected

PBDE levels in breast milk of women from the Chukotsky District are more than 3 times higher than levels detected in Anadyrsky District (307 and 112 pg/g lipid, respectively). However, average concentrations of PBDE in control samples of breast milk from St. Petersburg exceeded those found in both Chukotsky District (by 3 times), and Anadyrsky District (by 10 times).

There are a number of publications in the scientific literature that indicate that PBDE contamination in breast milk has increased by a factor of 2 every 5 years during recent years (e.g. Meironyte *et al.*,1999). The USA is one of main producers of PBDE flame retardants (UNEP, 2002), and there is evidence that PBDE contamination in the breast milk of women in America may exceed that of women in Sweden by 40 times. Average PBDE concentrations of approximately 200 ng/g lipids have been reported for breast milk from the United States (Papke *et al.*, 2001), with 60% of this value accounted for by one congener, BDE-47. Furst (2001) reports average concentration of PBDEs in the breast milk of women from Germany at 1.5 ng/g lipids. Overall, however, there available data on PBDE contamination in breast milk are still very limited.

Given the information above, it can be concluded that PBDE concentrations detected in breast milk samples from the Chukchi AO (0.1–0.3 ng/g lipids) are an order of magnitude lower than values found for breast milk in Germany, whilst control samples of breast milk from St. Petersburg contain PBDE in amounts (1.06 ng/g lipids) comparable with levels found in Germany. In all cases, congener BDE-47 is the main component in breast milk samples.

7.6. Conclusions

1. As the occurrence of PTS in human blood in the Russian North is explained to a large extent by the intake of contaminated fish (marine and freshwater), marine mammals, sea birds, and reindeer meat, it follows that PTS concentrations in the blood of women giving birth, and of their children, are also affected by the traditional diet of indigenous people. The highest concentrations of PTS in maternal and umbilical cord blood were detected in Chukotsky District of the Chukchi AO. These high levels of PTS in blood in this particular area may be associated with high levels of consumption of species occupying the upper trophic levels in marine food webs, as part of the traditional diet. Further work is still needed, however, to confirm and further elucidate this.

2. Concentrations of organochlorine pesticides in cord blood of newborns are normally somewhat lower than in maternal blood, which leads to the conclusion that the placental barrier acts to reduce the transfer of

Compound	Chukchi AO		Control (St-Petersburg), n=2
	Chukotsky district, n=10	Anadyrsky district, n=7	
PBDE # 28	**14,77** (n.d. – 42,28)	**6,97** (n.d. – 16,87)	**53,87** (23,36 – 124,2)
PBDE # 47	**222,6** (n.d. – 696,2)	**82,76** (30,69 – 267,7)	**817,5** (271,83 – 2458)
PBDE # 99	**16,05** (n.d. – 77,85)	**19,25** (n.d. – 41,90)	**77,31** (34,83 – 171,6)
PBDE # 100	**17,18** (n.d. – 86,58)	**8,63** (n.d. – 19,15)	**81,12** (24,34 – 270,3)
PBDE # 153	**22,36** (n.d. – 189,1)	n.d.	**38,90** (n.d. – 108,1)
PBDE # 154	n.d.	n.d.	**20,92** (n.d. – 31,25)
PBDE # 183	n.d.	n.d.	n.d.
Sum	**307,1** (48,50 – 823,0)	**112,6** (30,69 – 267,74)	**1058** (354,4 – 3164)
Weight, g	**21,97** (11,42 – 30,67)	**29,25** (24,78 – 32,97)	**28,65** (24,43 – 33,60)
Lipid, %	**2,96** (0,67 – 4,58)	**2,52** (0,62 – 4,86)	**3,09** (2,67 – 3,58)

Table 7.13.
Concentrations (pg/g lipids) of polybrominated diphenyl ethers in breast milk in the Chukchi AO.
n.d. – not detected

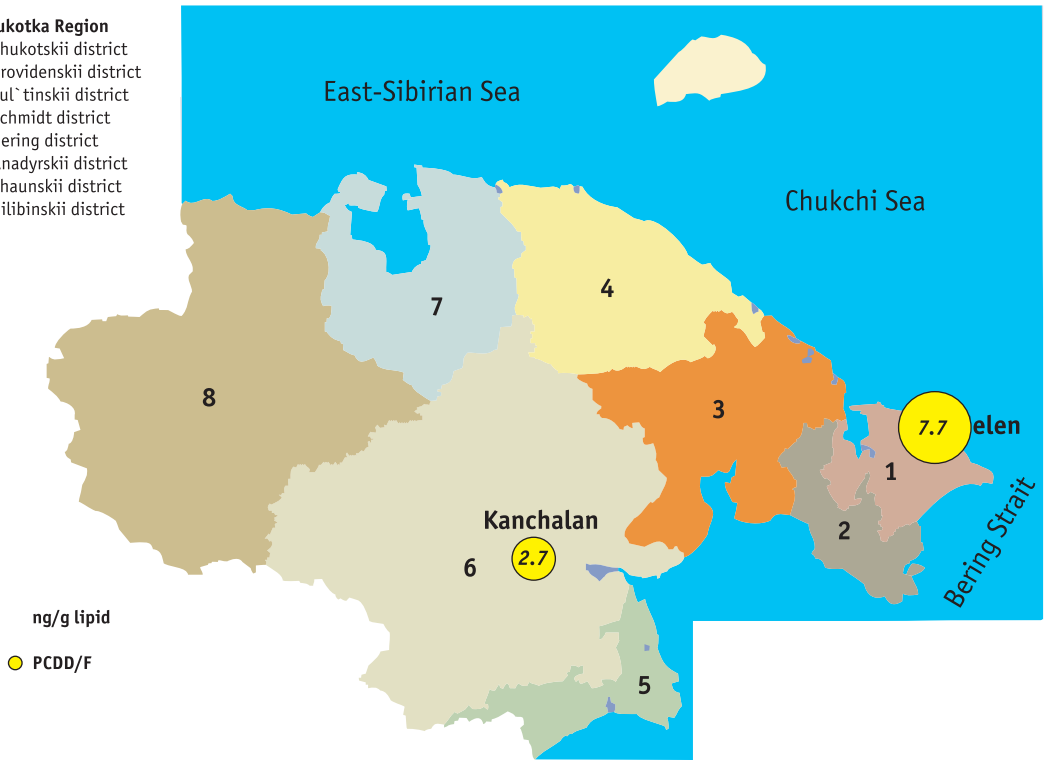

Figure 7.21a.
Levels (ng/g lipid) of PCDD/F in breast milk of women from various areas of the Chukchi AO.

toxic substances from mother to fetus; this is more effective for some contaminants than others. This feature was reflected in blood samples from all regions, except for the Kola Peninsula, and the control area, where the difference between maternal and cord blood concentrations was not statistically significant.

3. Among the DDT group of compounds, DDE is the most prevalent in human blood, the ratio of DDE/DDT concentrations in blood in the various regions ranging from 3-8, although a ratio of 30 was found in the Aral control area.

4. A comparison with results obtained during the 2002 AMAP circumpolar maternal blood survey shows that, on the whole, levels of organochlorine pesticides in human blood samples from the Russian Arctic are similar to those found in coastal areas of Greenland and northern Canada, although for some POPs, such as toxaphene and mirex, the levels found in the Russian Arctic are much lower.

5. Geometric mean concentrations of dioxins in blood samples from adults of both sexes and for all regions, are within the range 0.3–9.4 pg/g TEQ of

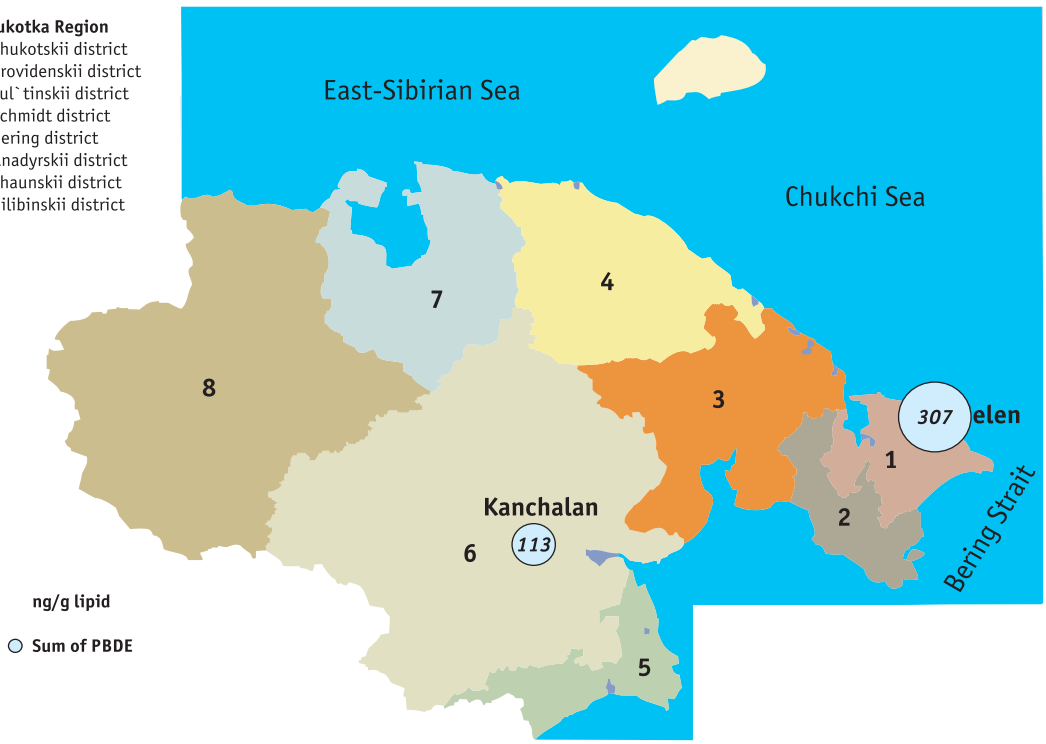

Figure 7.21b.
Levels (ng/g lipid) of PBDE in breast milk of women from various areas of the Chukchi AO.

lipids. The highest concentrations in individual samples were 18.7 and 18.1 pg/g TEQ of lipids (in the Chukchi and Taymir AOs, respectively). The highest concentration of PCDD/PCDFs in human blood from the northern areas of Russia (18.7 pg/g TEQ of lipid) is close to the lowest concentrations found in residents of industrial regions.

6. Among the samples of breast milk from the Chukchi AO, the highest levels of nearly all POPs were found in breast milk from Chukotsky District. Levels here, exceed those found in other areas of the Chukchi AO by 3-6 times for HCB, 10-80 times for oxychlordane, 10 times for mirex, *trans*- and *cis*-nonachlor, and toxaphene, and 4-5 times for the sum of 15 congeners of PCBs. Concentrations of DDT and its metabolites in breast milk did not differ significantly in samples from different areas of the Chukchi AO.

7. With respect to levels of compounds such as PCBs, oxychlordane, DDT, DDE and *trans*-nonachlor, Chukotsky District is similar to Nunavik in northern Canada. However, concentrations of b-HCH and HCB in breast milk from Chukotsky District are 30 and 5 times higher, respectively, than values found in Canada. Concentrations of PCBs, HCBs, b-HCH, and oxychlordane in breast milk from other areas of the Chukchi AO are comparable to those occurring in the breast milk of women from Kargopol, Severodvinsk, Arkhangelsk, and Naryan-Mar.

8. Maximum levels of breast milk contamination, like human blood samples, for all PTS determined, including PCDD/Fs and PBDEs, were found in the Chukotsky District, which is situated in the coastal area of the Chukotka peninsula.

9. Average concentrations of dioxin and furans detected in breast milk of women from Chukotka are the same as levels detected in breast milk of women from Norway and Ireland, and are lower than levels found in Northern Canada (northern and southern Quebec).

10. Comparison of concentrations of PBDE and PCDD/F in blood samples of the adult population reveals a marked difference in the distribution of these PTS in the Russian North, with low levels of PCDD/Fs coinciding with high levels of PBDEs, and vice versa. The difference is most obvious in the Taymir AO, the Nenets AO (Nelmin-Nos), and the Kola Peninsula (Krasnoshchelie). There is not yet sufficient data to ascertain the reasons for the difference in dioxin and PBDE distribution, but it is clear that the sources of pollution and contamination pathways for these groups of substances differ from each other. PBDEs occur at higher levels in areas close to the industrialized source regions of Europe and North America.

11. Maximum PBDE concentrations (of 934 pg/g lipids) in blood samples of populations from the Russian Arctic regions were found on the Kola Peninsula (Krasnoshchelie), and correspond to those observed in sampled populations in Norway in 1981.

12. PBDE concentrations in breast milk samples of women from the Chukchi AO (0.1-0.3 ng/g of lipids) are an order of magnitude lower than concentrations measured in Germany. Control samples of breast milk from St. Petersburg contained PBDE in amounts (1.06 ng/g of lipids) comparable with those from Germany. The predominant congener in all samples is BDE-47.