

POLAR BEAR CASE STUDY

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Introduction

At Svalbard, alarmingly high PCB levels have been found in polar bears¹. Recent studies have revealed that the highest levels of PCBs and the pesticides chlordanes and DDE are found in polar bears from Franz Josef Land and the Kara Sea with decreasing trends eastwards and westwards from this region^{2,3}. By comparing the PCB levels found in polar bears with thresholds for biological effects, it is reasonable to assume that polar bears at Svalbard may be at risk⁴.

The Norwegian School of Veterinary Science, the National Veterinary Institute, the Norwegian Polar Institute and the University of Oslo have collaborated since 1987 with the aims to provide comprehensive data for risk assessment of the high PCB exposure in polar bear in the Norwegian Arctic. Collaboration with Canadian Wildlife Service was initiated in the early 1990s. Associations between organochlorines (OCs) and physiological parameters such as retinol, thyroid hormones, sex hormones and IgG have been studied. An experimental study to investigate associations between OCs and several immunological parameters has been performed. Furthermore, ecological studies on reproduction and cub survival have been done. Highlights from these studies will be considered.

Materials and methods

Sampling procedures, analyses of OCs and physiological parameters have been reported in detail are presented elsewhere^{1,5,6,7,8}. Details on the immunological parameters used and the design of the experimental study are presented elsewhere^{9,10,11}.

Results and discussion

At Svalbard, PCB levels ranged from 21-228 ng/g in polar bear plasma (median 67 ng/g)⁵. Higher levels of PCB were found in males as compared to females. Females unload a relatively large proportion of their OC burden to their cubs via milk (20-50% fat). Higher PCB levels have been found in cubs-of-the-year than in their mothers¹². Relatively low cub survival was found at Svalbard and there are indications that the reproduction cycle was less than 3 years^{13,14}. Thus, ecological studies suggest that reproduction and cub survival in polar bears at Svalbard may be impaired.

In polar bears at Svalbard, significant negative relationships were found between PCBs and retinol and thyroid hormones (Figure 1). The OCs explained 12% of the variation of the retinol

concentration and 30 and 7% of the variation of the total T4/free T4 and total T3/free T3 ratio, respectively, after correction for age and sex⁶. Furthermore, the linear combination of sum pesticides and sum PCBs explained 57% of the variation in the testosterone concentration in male polar bears (Figure 2)⁸. In female polar bears, progesterone concentrations were positively correlated with PCB (Figure 3). Sum PCB explained 27% of the variation in the progesterone concentration⁷. These results are indications for modulation of the endocrine system and suggest that perinatal exposure to OCs may affect normal reproductive development and hormone levels. Furthermore, a significant decrease of IgG with increased sum PCB levels was found in a study of 56 polar bears indicating a possible contaminant associated suppression of antibody-mediated immunity in polar bears at Svalbard which indicated a contaminant-associated suppression of their antibody-mediated immunity⁵.

Results from the experimental study (sample of 56 polar bears), designed to assess possible effects of OCs on the formation of specific antibodies and lymphocyte function, demonstrated significantly higher levels of highly chlorinated PCBs in polar bears at Svalbard as compared to Churchill, Canada. Significantly higher serum IgG levels and antibody titres against influenza, reo and herpes virus following immunization were found in the Canadian bears than in the Svalbard bears¹⁰. Furthermore, high levels of sum PCBs contributed to a decrease in serum IgG levels, production of antibodies against influenza- and reo virus following immunization¹⁰. Also, significantly negative relationships between lymphocyte responses and Σ PCBs were found¹¹. These results indicate that PCBs are associated with decreased resistance to infections. In conclusion, the results of the ecological, physiological and immunological studies indicate that the population status and health of polar bears with very high PCB levels may be at risk⁹.

Acknowledgements

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References

1. Bernhoft, A., Skaare, J.U. and Wiig, Ø. (1997) Organochlorines in polar bears (*Ursus maritimus*) at Svalbard. *Environ Pollut.* 95, 159-175
2. Andersen, M., Lie, E., Belikov, S.E., Boltunov, A.N., Derocher, A.E., Garner, G.W., Skaare, J.U. and Wiig, Ø. (2001) *Polar Biol.* 24, 231-238
3. Lie, E., Bernhoft, A., Riget, F., Belikov, S.E., Boltunov, A.N., Derocher, A.E., Garner, G.W., Wiig, Ø., Skaare, J.U. (2003) *Sci Total Environ.* 306:159-170.
4. De March, B.G.E., De Wit, C.A., Muir, D.C.G., Braune, B.M., Gregor, D.J., Norstrom, R.J., Olsson, M., Skaare, J.U. and Stange, K. (1998) in: *AMAP Assessment Report: Arctic Pollution Issues* (Wilson, S.J., Murray, J.L. and Huntington, H.P. Eds) ISBN 82-7655-061-4
5. Bernhoft, A., Skaare, J.U., Wiig, Ø., Derocher, A.E., and Larsen, H.J. (2000) *J Toxicol Environ Health.* 59,101-114
6. Skaare, J.U., Bernhoft, A., Wiig, Ø., Norum, K.R., Haug, E., Eide, D.M. and Derocher, A. (2001) *Toxicol Environ Health* 24, 231-238
7. Oskam, I.C, Ropstad, E., Lie, E., Derocher, A.E., Wiig, Ø., Dahl, E., Larsen, S., Wiger, R., Skaare, J.U. (2003) *J Toxicol Environ Health.* In press.
8. Haave, M., Ropstad, E., Derocher, A.E., Lie, E., Dahl, E., Wiig, Ø., Skaare, J.U., Bjørn Munro Jenssen, B.M. (2003). PCBs and reproductive hormones in female polar bears at Svalbard. *Environ. Health Persp.* In press.

9. Skaare, J.U., Larsen, H.J.S., Lie, E., Bernhoft, A., Derocher, A.E., Norstrom, R, Ropstad, E, Wiig, Ø. (2002) *Toxicology*. 181-182, 193-197
10. Lie, E., Larsen, H. J. S., Larsen, S., Johansen, G. M., Derocher, A. E., Lunn, N. J., Norstrom, R. J., Wiig, Ø., and Skaare, J. U. Submitted
11. Lie, E., Larsen, H. J. S., Larsen, S., Johansen, G. M., Derocher, A. E., Lunn, N. J., Norstrom, R. J., Wiig, Ø., and Skaare, J. U. In prep.
12. Lie, E., Derocher, A.E., Wiig, Ø. and Skaare, J.U. (2000) Polychlorinated biphenyls in mother/offspring pairs of polar bear (*Ursus maritimus*) at Svalbard. *Organohalogen compounds*. 49, 457-46
13. Wiig, Ø. (1998) *Ursus* 10, 25-32.
14. Wiig, Ø., Gjert, I., Hansson, R. and Thomassen, J. (1992) *Polar Rec.* 28, 157-159.

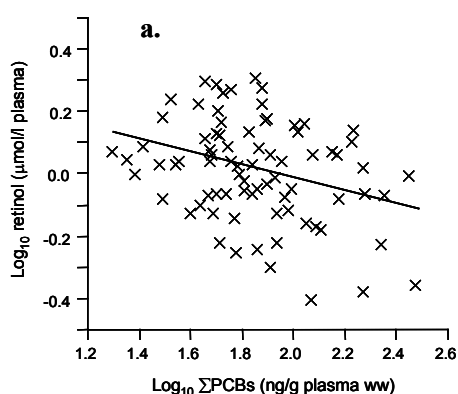


Figure 1a. The association between retinol corrected for age and sex by regression and Σ PCBs in plasma of 79 polar bears at Svalbard. The regression line is shown ($\log \text{residual retinol} = 0.40 - 0.21 \log \Sigma\text{PCBs}$). The Pearson correlation coefficient $r = -0.33$ ($P = 0.003$)⁶.

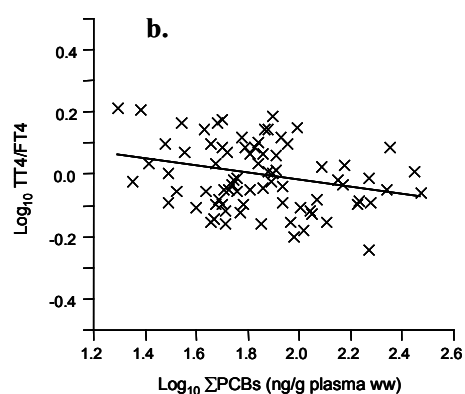


Figure 1b. The association between the ratio of total T4 and free T4 (TT4/FT4) corrected for age and sex by regression and Σ PCBs in plasma of 78 polar bears at Svalbard. The regression line is shown ($\log \text{residual total T4/free T4} = 0.21 - 0.12 \log \Sigma\text{PCBs}$). The Pearson correlation coefficient $r = -0.28$ ($P = 0.013$)⁶.

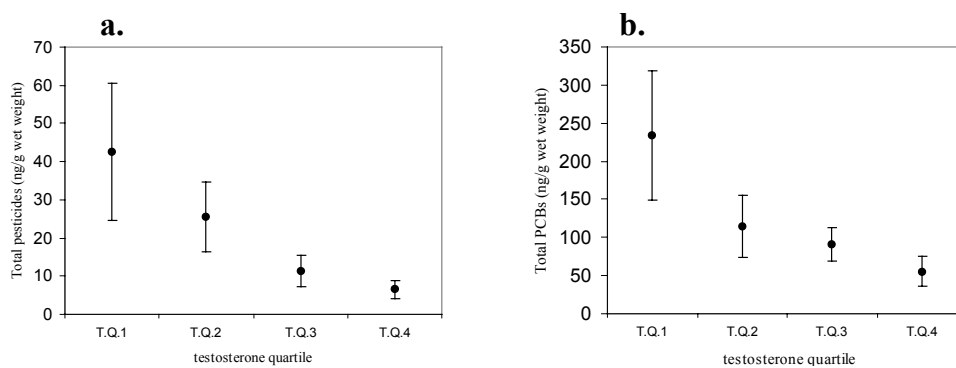


Figure 2. Sum pesticide (a) and sum PCB (b) concentrations (ng/g wet weight) showing the mean and 95% confidence interval for the testosterone quartiles. The testosterone quartiles are based on the empirical distribution of plasma testosterone concentrations of male polar bears from Svalbard, 1995-1998 (n=121, $p < 0.001$). Both sum pesticides (a) and sum PCBs (b) showed a significantly negative contribution to the variation of the testosterone concentration ⁷.

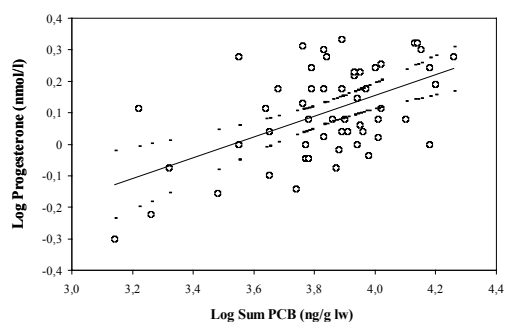


Figure 3. In female polar bears with offspring, the plasma progesterone concentration was positively related to plasma sum PCB concentrations. The regression line and 95% confidence limits are indicated ($r^2 = 0.27$) ⁸.