The polar bear (*Ursus maritimus*) and the monitoring of Polychlorinated Biphenyls (PCBs) in the Arctic regions of the world

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OBJECTIVES TO KNOW:

1. THE PROBLEMATIC OF PCBs: WHAT THEY ARE, WHERE THEY COME FROM, HOW THEY REACH THE ARCTIC, INCORPORATION INTO FOOD WEBS AND ADVERSE EFFECTS ON POLAR BEARS.
2. THE STATUS OF THE POLAR BEAR AS MARINE MAMMAL REGARDING TO CLIMATE CHANGE AND THE PRESENCE OF PCBs.
3. THE SITUATION OF MONITORING ON STUDIES ON POLAR BEARS.
4. THE ACTUAL TRENDS AND PCBs MAIN VARIABLES.
5. FUTURE OF POLAR BEARS WITH RESPECT TO PCBs.

POLAR BEAR AS A SENTINEL

Polar bears, like most Arctic fauna, depend upon high fat-content diets, which facilitate that PCBs (highly lipophilic) bioaccumulate and biomagnificate in successive trophic positions in the Arctic marine food web. Therefore, bears are the most affected by the PCBs, arriving to toxic levels. These makes the polar bears a perfect sentinel of PCBs levels.

WHAT ARE PCBs?

PCBs (Polychlorinated Biphenyls) are the dominating Persistent Organic Pollutants (POPs) in Arctic mammals. These are characterized by their high lipophilicity and chemical stability (Fig. 1). Interest in the presence of PCBs arises from the concern that the chronic exposure to these pollutants may put in danger this species.

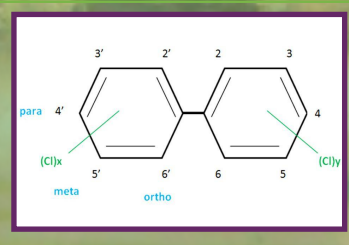

Fig. 1. PCB structure

HOW THEY ARRIVE AT THE ARCTIC?

Transport of contaminants into and within the Arctic occurs via atmospheric pathways, principally from mid-latitudes to the Arctic region. Other ways are north-flowing rivers, ocean currents, migratory animals and re-suspension from ice (Fig. 2).

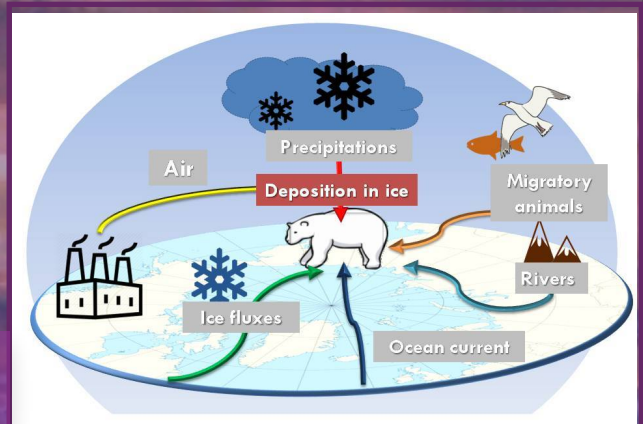

Fig. 2. Pathways of transport of PCBs in Arctic marine ecosystems.

VARIABLES THE MOST RELEVANT ARE:

AGE In cubs pollutants are more bioavailable. The great intake of contaminated milk makes them susceptible of suffer from the negative effects. PCBs came from the mother during gestation and lactation, reason why their concentrations are higher than the mother ones (Fig. 3).

SEX Adult males have the highest levels. On the other hand, adult females have a lower concentration of PCBs as they transfer to offspring as both transplacental and during lactation. Mothers with yearlings have lower levels than mothers with cubs and both have lesser levels than solitary females.

SEASON The variation of body condition throughout the year changes their bioavailability (Fig. 4). The highest amounts occur at the end of winter, during the hyperphagic period previous to the fasting. Those levels come directly from the prey. This seasonal variation is higher in adult females because of pregnancy and lactation, and it is more constant in adult males and subadults.

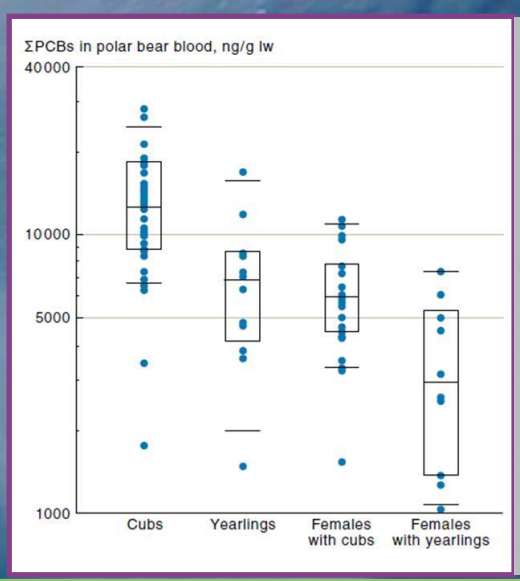

Fig. 3. Mean levels and range of PCBs in cubs, yearlings, females with cubs and females with yearlings. Sum PCBs levels (geometric means (with ranges)) of cubs were significantly higher compared to sum PCBs in females with cubs and yearlings. Females with yearlings had significantly lower PCBs levels. From: Lie et al., (2000).

PHYSIOLOGICAL STATUS/DIET If the animal is in negative energy balance (fasting or lactation), the PCBs detected in blood will be the ones from the animal lipid reserves. If the animal is in positive energy balance, the PCBs will be the ones from the prey.

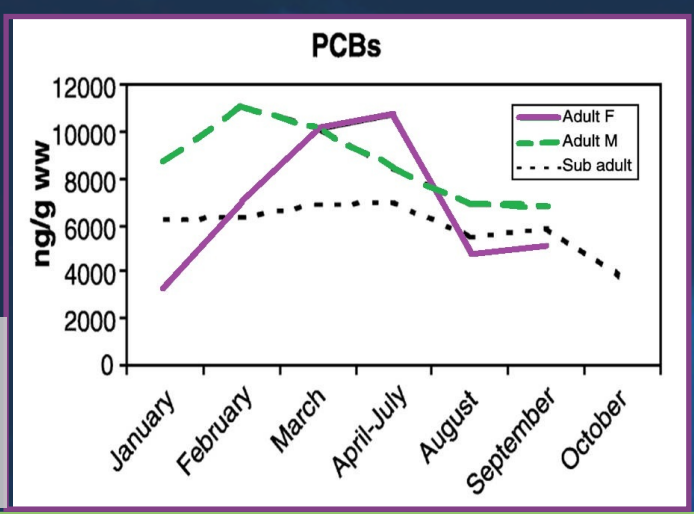

Fig. 4. Seasonal averages of PCBs (ng/g ww (wet weight)) presented for subadult, adult males and adult females polar bears sampled in Scoresby Sund area (1999–2001). Modified from: Dietz et al., (2004).

TRENDS

The levels of PCBs decreased or stabilized in polar bears during the years preceding 2000 (Fig. 5), but these have generally not occurred the following years. Furthermore, new emergent persistent organic pollutants (POPs) have been identified. There is a need for trend information due to a lack of standardized studies, being difficult to compare data. Most of the actual studies evaluate PCBs in subcutaneous fat (ng/g lw) because it is more representative of exposure over time, in contrast with blood, which represents the recent intake.

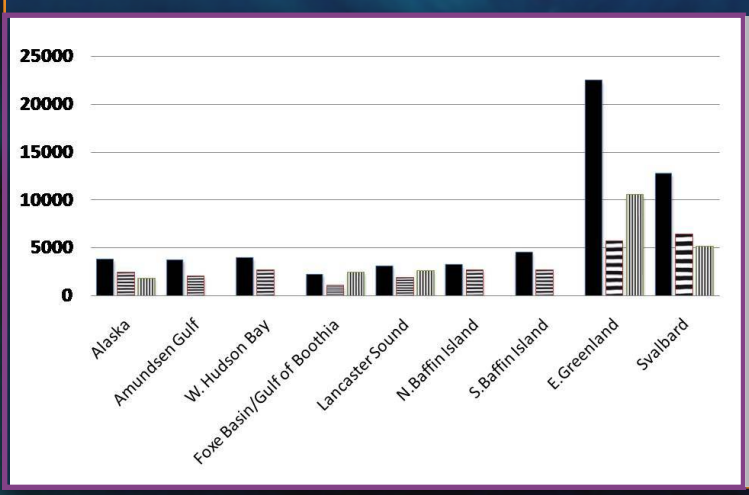

Fig. 5. Temporal comparisons of PCBs in 9 subpopulations collected in 1989–1993 (dark bars; Letcher et al., 1995; Norstrom et al., 1998), 1996–2002 (horizontal stripes; Verreault et al., 2005) and 2005–2008 (vertical stripes; McKinney et al., 2011).
Y = concentration in ng/g lw.

EFFECTS

Most of the controlled studies of effects are difficult to extrapolate to wildlife. It is known that PCBs can cause damage, but also their metabolites. PCBs are suggested causing in polar bears adverse effects on the immune system, the thyroid hormone system and the reproductive system, among others.

CONCLUSIONS

-No constant long-term monitoring in order to make study trends.
-Slower decrease or increase of PCBs, new POPs emerging (PBDE and PFOs).
-Increase of diseases and parasitations in the future due to the climate change.
-Not enough data to associate directly effects with PCBs.

REFERENCES

Dietz R, Rigét F, Sonne C, Letcher R, Born E, Muir D. Seasonal and temporal trends in polychlorinated biphenyls and organochlorine pesticides in East Greenland polar bears (*Ursus maritimus*), 1990-2001. Sci Total Environ. 2004; 331:107-24.

Letcher R, Norstrom R, Bergman A. Geographical distribution and identification of methyl sulfone PCB and DDE metabolites in pooled polar bear (*Ursus Maritimus*) adipose tissue from Western Hemisphere Arctic and Subarctic regions. Sci Total Environ. 1995; 164:409–20.

Lie E, Derocher A, Wiig Ø, Skaare J. Polychlorinated biphenyls in mother/offspring pairs of polar bears (*Ursus maritimus*) at Svalbard. Organohalogen Compd. 2000. 49: 457-60.

McKinney M, Letcher R, Aars J, Born E, Branigan M, Dietz R et al. Flame retardants and legacy contaminants in polar bears from Alaska, Canada, East Greenland and Svalbard, 2005-2008. Environ Int. 2011; 37:365-74.

Norstrom R, Belikov S, Born E, Garner G, Malone B, Olpinski et al. Chlorinated hydrocarbon contaminants in polar bears from eastern Russia, North America, Greenland and Svalbard: biomonitoring of Arctic pollution. Arch Environ Contam Toxicol. 1998; 35:354–67.

Verreault J, Muir D, Norstrom R, Stirling I, Fisk A, Gabrielsen G et al. Chlorinated hydrocarbon contaminants and metabolites in polar bears (*Ursus maritimus*) from Alaska, Canada, East Greenland, and Svalbard: 1996-2002. Sci Total Environ. 2005; 351-352:369-90.