Primary producers and production in two West Spitsbergen fjords (Hornsund and Kongsfjorden) a Review

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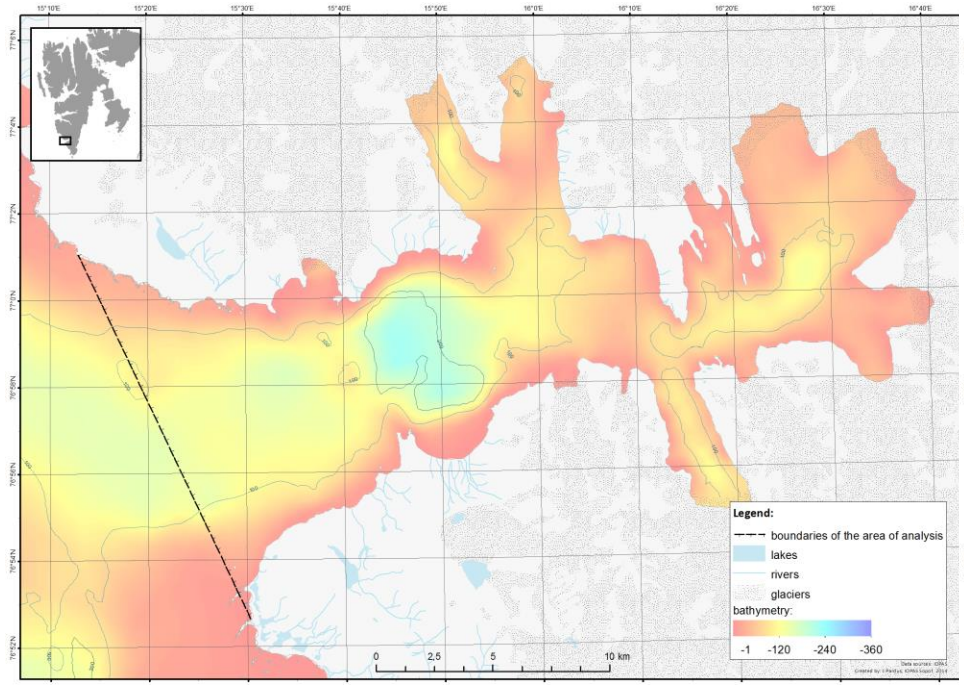
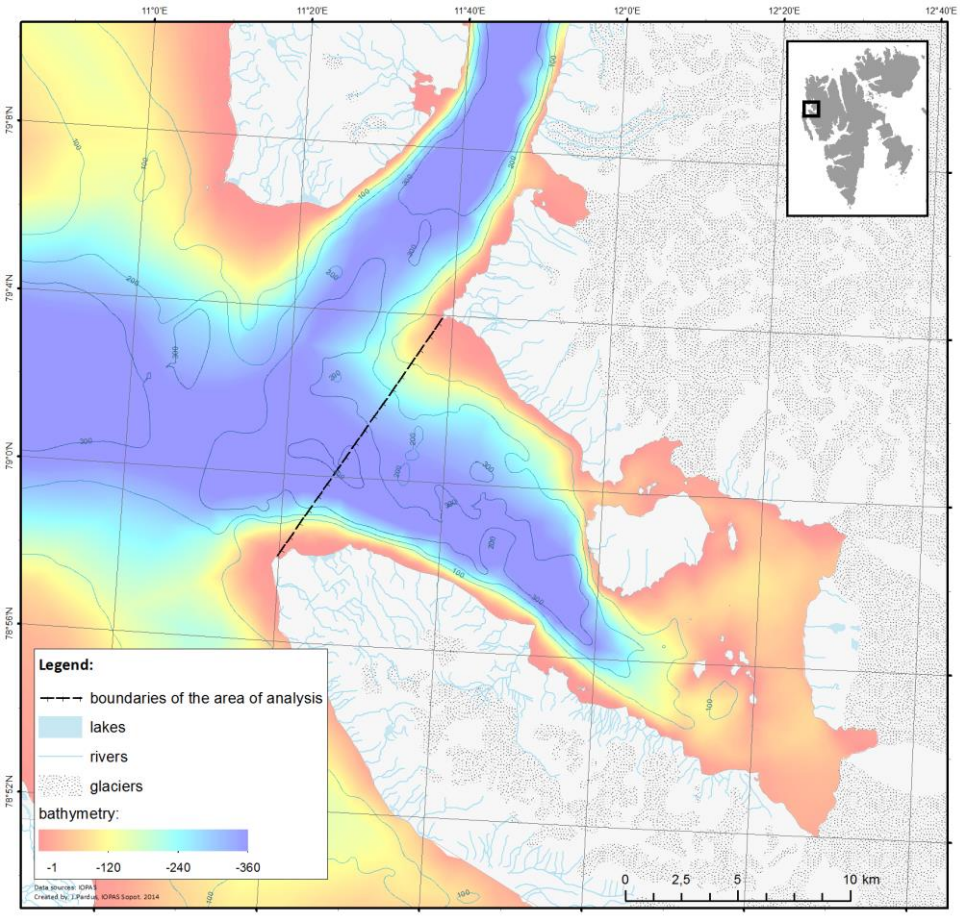
Driver	Hornsund	Kongsfjorden	References
Fast ice	36% of the area (112 km^2)	3% of the area (6km^2)	IO PAN unpublished data
Annual sea surface temperature range [°C]	−1.7 to 6	–1.4 to 12	IO PAN data; Swerpel 1985; Walczowski and Piechura 2011
Salinity [PSU]	34.2 (28 – 34.5)	34.4 (30 – 35)	IO PAN data
Incident PAR- Spring [Einstein·m^{-2}·d^{-1} Mean for 2004–2014]	18.1±17.8 – 30.7±19.0	21.4±14.0 – 29.9±7.0	NASA GES DISC
Incuident PAR Summer [Einstein·m^{-2}·d^{-1} Mean for 2004–2014]	19.3±2.7 – 28.7±3.8	24.7±9.7 – 31.1±11.3	NASA GES DISC
Euphotic zone (1% PAR) [m]	9.56	16.21	IO PAN data; Sagan and Darecki in preparation
Nutrients –Spring [µmol l^{-1}]	Nitrates – no data Phosphates to 0.3 Silicates to 1	Nitrates to 11.3 Phosphates to 0.83 Silicates to 6	Hegseth and Tverberg 2013; Węsławski et al. 1988; Hodal et al 2012
Nutrients – Summer [µmol l^{-1}]	NO_2 to 0.23 NO_3 to 1.96 NH_4 to 2.49 PO_4 to 0.31 Silicates to 6	NO_2 to 0. 29 NO_3 to 0,67 NH_4 to 0,93 PO_4 – no data Silicate to 0.41 to1.9	Eilertsen et al. 1989; Węsławski et al. 1988; Hodal et al 2012; Zaborska et al. in press

Driver	Hornsund	Kongsfjorden	Unit	References
Area of pelagic euphotic zone (0-20m depth)	277	188	km^2	http://www.iopan.gda.pl/projects/Visual/index.html
Volume of euphotic pelagic zone in summer	2,8	3	km^3	http://www.iopan.gda.pl/projects/Visual/index.html , Sagan & Darecki in prep.
Area of seabed within euphotic zone (hard bottom %)	25 (24%)	50 (30%)	km^2	http://www.iopan.gda.pl/projects/Visual/index.html





Group/parameter	Hornsund	Kongsfjorden	References
Mikroplankton taxa number	84	148	Wiktor and Wojciechowska 2005; Okolodkov et al. 2000; Hop et al. 2002
Ice algae species number	28*	23	*Data from nearby Sassenfjord, Spitsbergen; Weslawski et al. 1993; Wiktor 1999
Microphytobenthos taxa number	no data	89	Woelfel et al. 2010
Macroalgae species number	49	76	Wesławski et al. 2010; Latała and Florczyk 1989; Hop et al. 2012; Fredriksen et al. 2014; Wiktor et al. www.

- Hasle and von Quillfeldt (1996) emphasized high contribution of **Atlantic species** in Kongsfjorden phytoplankton assemblages.
- Phytoplankton communities inhabiting West Spitsbergen fjords appears to be more diverse in terms of taxonomy composition than in **open marine waters surrounding the archipelago** (Owrid *et al.* 2000, Hegseth and Sundfjord 2008).
- Fjords associations are also substantially different from the diatom dominated **marginal ice zone blooming** assemblages known in the **Barents Sea** (Olli *et al.* 2002; Ratkova and Wassmann 2002; Olli *et al.* 2007), other Arctic shelves (Sakshaug 2004), polynyas (Lovejoy *et al.* 2002), **Central Arctic Basin** (where assemblages are dominated by relatively small and often unidentified flagellates) or **coastal waters of western Greenland** (Nielsen and Hansen 1999).

Driver	Hornsund	Kongsfjorden	Units	References
Spring Chlorophyll *a* range	45.42	0.001 – 26	mg Chl a m^{-2}	Wiktor, 1999; Węsławski et al. 1988; GAME project – IO PAN data; Hodal et al. 2012; Hop et al. 2002
Summer Chlorophyll *a* range	8.82 – 15.6	1.08 – 158	mg Chl a m^{-2}	Piwosz et al. 2009; GAME project – IO PAN data; IO PAN unpublished data; Hop et al. 2002
Microplankton annual primary production	71,0	42,4	g C m^{-2} y^{-1}	Estimated from the data in table
Macroalgae annual primary production	2.0– 20*	2.0 – 20	g C m^{-2} y^{-1}	Gómez et al. 2009; *adopted from Kongsfjorden
Microphytobenthos annual primary production	No data	2-14	g C m^{-2} y^{-1}	Woelfel et al. 2012

There is a difference in seasonal Chl *a* concentration between fjords (in Hornsund higher in spring and lower in summer compared to Kongsfjorden).

In effect Hornsund have higher microplankton primary production rates per area unit and for the whole year, despite the larger volume of euphotic zone in Kongsfjorden.

This can be caused by one or combinations of the all three reasons: **lower grazing pressure** in Hornsund, higher nutrient supply in Hornsund (**seabird colonies, coastal nutrient rich waters**, **shallower area of easy mixing**), low nutrient amount in Atlantic waters in Kongsfjorden (depleted on the way along West Spitsbergen current, too deep to mix easily).

Fig. 5. Range of biomass (A) and primary production (B) daily values reported across studies during spring and summer in Kongsfjorden and Hornsund (IOPAN data)

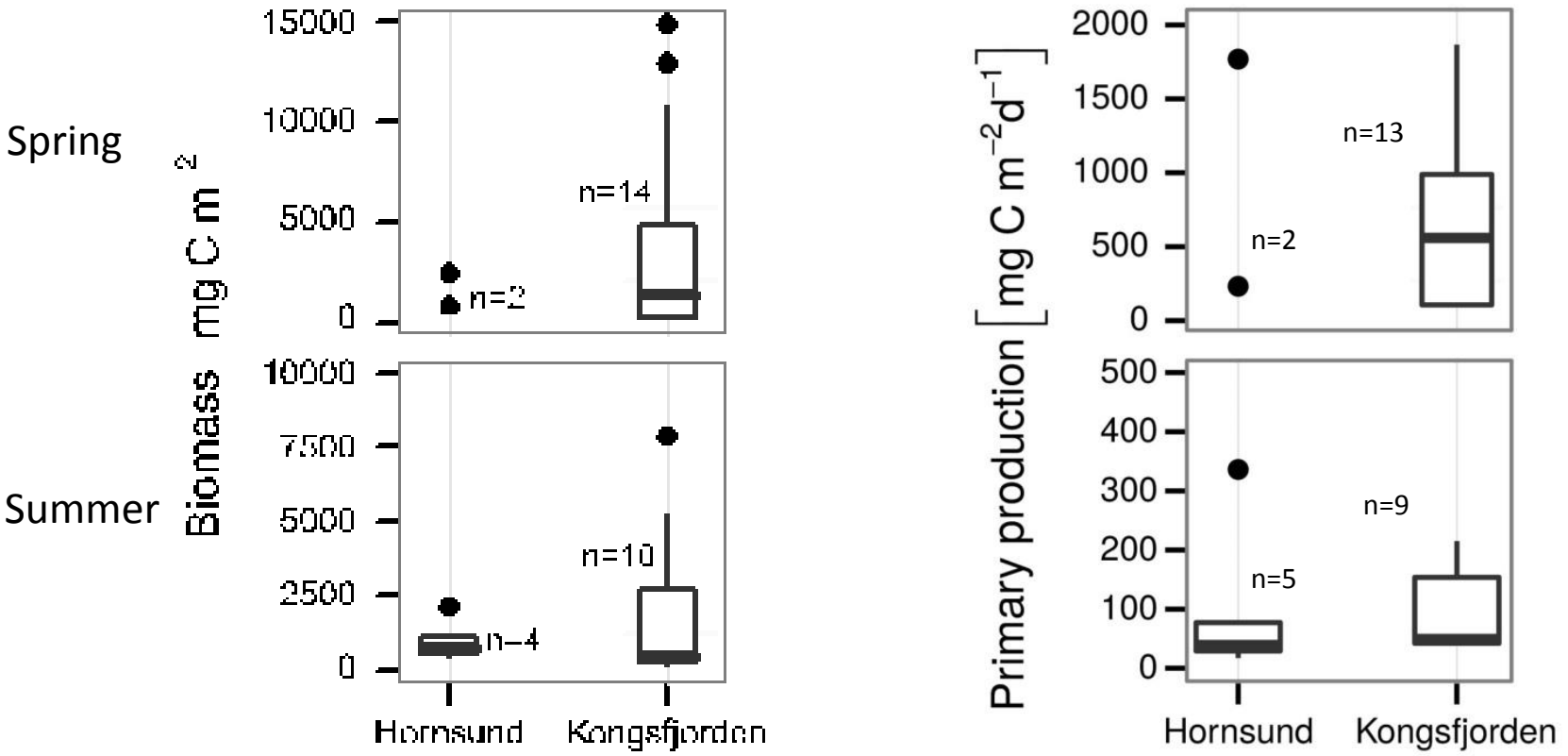
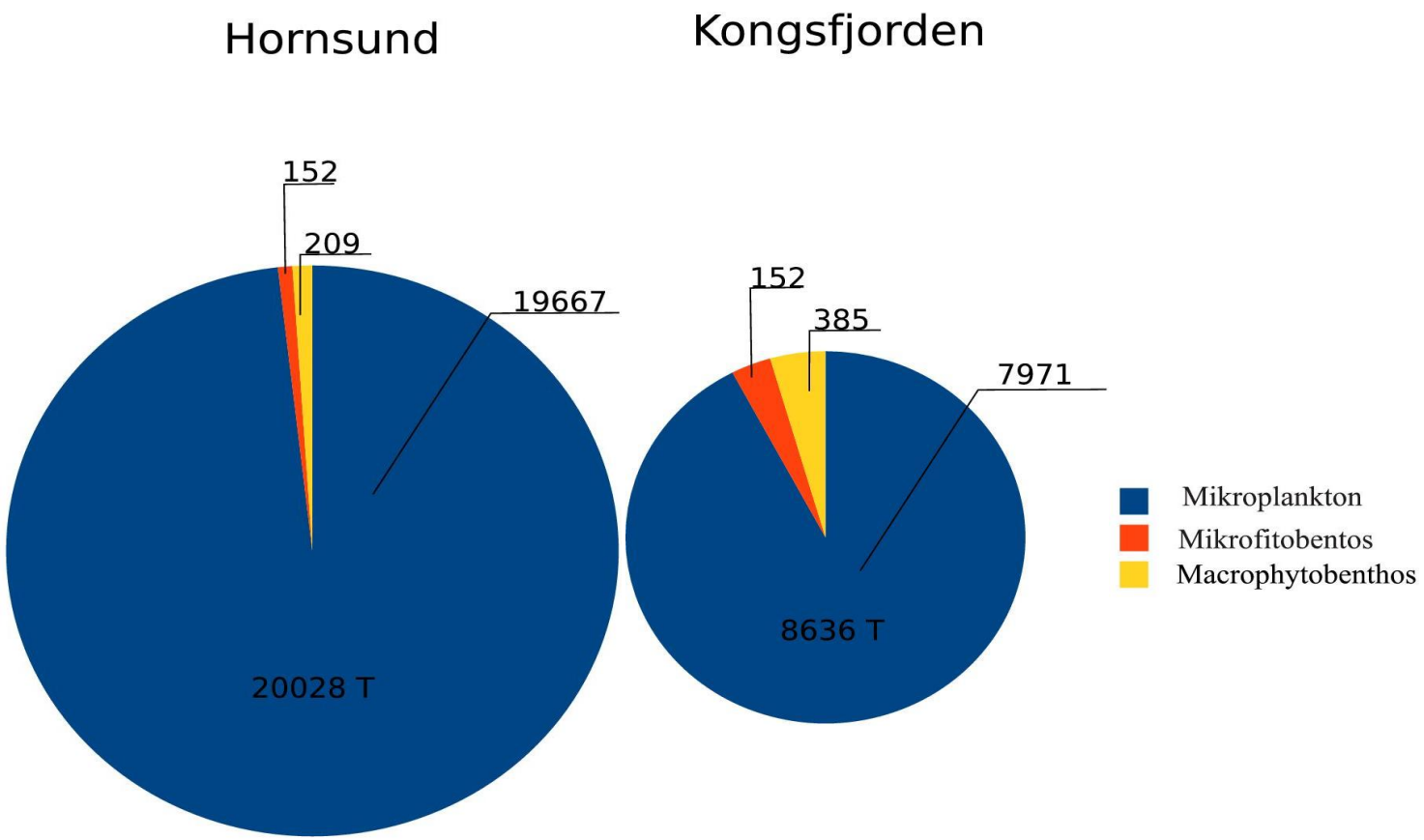


Fig. 6. Organic carbon production in two fjords [T C/euphotic zone/year].



In present situation, the “warmer” fjord shows lower production in compared to colder coastal waters of Hornsund. Share of different autotrophs in the net primary production shows that Kongsfjorden has important contribution from non-pelagic autotrophs, while in Hornsund, the share of benthic species is less visible

Podsumowanie

- Różne wielkości pp we fiordach są poparte **badaniami sedymentologicznymi** Zaborskiej et al (in press) i Grzelak & Głuchowska (in press), które ukazują wyższą ilość węgla organicznego opadającego w Hornsundzie niż w Kongsfiordzie.
- Produkcja pierwotna (72- 44 g C m^2 y^{-1}) i stężenie Chl *a* w Hornsundzie i Kongsfiordzie jest wyższa niż w innych fiordach archipelagu np.: **Rijpfjorden** (Leu *et al.* 2011).
- Wody otaczające archipelag wydają się mniej produktywne niż fiordy zachodniego Spitsbergenu.
- Oszacowana dzienna pp w Hornsundzie i Kongsfiordzie jest podobna do **dziennej pp wzdłuż frontu polarnego morza Barentsa** (Owrid *et al.* 2000).
- Produkcja w **Morzu Beringa i Morzu Czukockim** (230 do >400 g C m^{-2} y^{-1} Sakshaug 2004 albo nawet 576–720 g C m^{-2} y^{-1} Hansell *et al.* 1993) prawdopodobnie najwyższa w rejonie Arktyki, jest znacznie wyższa niż we fiordach zachodniego Spitsbergenu.
- Zmienność ilościowa pp względem regionów Arktyki jest znana i jest związana głównie z różnymi masami wody, obecnością lodu, stężeniem nutrientów (Springer & McRoy 1993; Springer 1988; Hansell & Goering 1990).
- Na różnice produkcji pierwotnej w porównywanych fordach mają przede wszystkim: war. hydrologiczne, powierzchnia pelagicznej strefy eufotycznej i dna w strefie eufotycznej, struktura taksonomiczna, dostępność nutrientów, a także presja konsumentów.

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