Organic contaminant distributions and transfer in shelf sediments and biota of the Chukchi Sea: Results from the COMIDA Program





H. Rodger Harvey and Karen A. Taylor



University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, Solomons, Maryland 20688 (harvey@umces.edu)

ABSTRACT

To provide baseline data on organic contaminents at potential drilling sites in the Chukchi Sea, the distribution and concentration of polycyclic aromatic hydrocarbons (PAHs) and alkanes were investigated in surface sediments representing 52 sites spanning the study area. PAHs and alkanes were also examined in the foot muscle of northern Neptune whelks (*Neptunea heros*) of varying sizes (<5, 5-8, >8 cm) to investigate the potential for comtaminants to bioaccumulate. Concentrations of PAHs are generally low, but vary across the study area. A varied alkane distribution is seen with major contributions derived from natural sources. PAHs do not appear to bioaccumulate in Neptunea muscle and a shift in distribution between short and long-chain alkanes is observed compared to surface sediment.



Neptunea heros & Surface Sediment



INTRODUCTION

The growing interest for oil exporation and production in the Arctic Ocean has prompted the development of the Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA) Program, supported by the Minerals Management Service, and the beginning of a comprehensive assessment of the Chukchi Sea Lease Sale 126 area to establish baseline data and help identify future impacts from oil and gas production. As part of this continuing program, we are evaluating the current sediment composition for anthropogenic and natural organic products using a suite of chemical compounds including PAHs and aliphatic hydrocarbons.

PAHs are widely distributed in the environment and are released both naturally (i.e. fires, petroleum seeps, diagenesis) and anthropogenically (through the incomplete combustion of fossil fuels) [1]. Their stablity allows PAHs as ideal tracers of ocean and atmospheric transport of contaminents to the Arctic as they are often transported long distances to be detected in remote polar locations [2,3]. The concern for PAHs in the environment stems from their potential to form intermediate compounds that react with DNA and cause adverse effects in biota, which is especially important for a region dependent upon commercial fisheries [4].



Fig. 3. PAH concentrations in surface sediments

- Up to 31 individual PAHs were detected in surface sediment samples.
- Alkyl-substituted PAHs were more abundant than parent species in surface sediments.
- Total PAH concentrations in surface sediments ranged over 20-fold across the study area from 0.13 μ g/g at Station 16 to 2.9 μ g/g at Station 26.

Fig. 4. PAH concentrations in Neptunea and surface sediment from ST 7

A diversity of PAHs were found in Neptunea muscle tissue.

- Neptunea show reduced concentrations of PAHs compared to surface sediment at station 7.
- Total PAH concentrations in Neptunea decrease with size and range from 0.018 μ g/g to 0.039 μ g/g, suggesting that whelks deprivate organic

RESULTS and DISCUSSION: Alkanes

Neptunea heros & Surface Sediment

METHODS

Surface Sediments







Fig. 6. Alkane concentrations in Neptunea and surface sediment from ST 7

- C19-C33 alkanes were measured in Neptunea muscle tissue.
- Adult Neptunea show a greater concentration of alkanes compared to surface sediment with a shift in the distribution of short versus long-chain species.
- Total alkane concentrations in Neptunea increase with size and range from 0.33 μ g/g to 15.7 μ g/g, suggesting the storage of longer-chained aliphatic hydrocarbons in adults.

STUDY ORGANISMS



Fig. 2. Size class distribution of Neptunea heros.

SUMMARY

- PAH concentrations in surface sediments are similar to previous measurements reported for the Western Arctic Ocean [6].
- The distribution of alkanes is variable throughout the study area with major contributions derived from natural sources.
- No evidence for PAH bioaccumulation was observed in Neptunea muscle tissue with a decrease in concentration seen with increasing animal shell size.
- While adult Neptunea (>8cm) have a greater concentration of alkanes compared to the surface sediment, a shift in distribution between short and long-chain species is observed.

BIBLIOGRAPHY

[1] J. M. Daisey, R. J. McCaffrey, R. A. Gallagher. 1981. Atmos Environ 15:1353-1363. [2] M. B. Yunker, R. W. Macdonald. 1995. Arctic 48:118-129. [3] C. J. Halsall, et al. 1997. Environ Sci Technol 31:3593-3599. [4] M. S. Zedeck. 1980. Environ Pathol Toxicol 3:537-567. [5] R. R. Ruminski et al. 2009. Inorg Chim Acta 362:1772-1780. [6] R. W. Macdonald et al. 2000. Sci Total Environ 254:93-234.

ACKNOWLEDGEMENTS

This project was supported by the Bureau of Ocean Energy Management, Regulation and Enforcement. We thank the captains and crews of the R/V Alpha Helix and R/V Moana Wave for sampling and technical support. COMIDA scientists are thanked for assistance with sample collection and identification.