

Background

- Crude oil theft, known as illegal oil bunkering, is a significant problem in Nigeria, particularly the Niger Delta region.
- Thieves often mix illegally bunkered oil with legitimately sourced oil before selling it to refineries in Nigeria or nearby West African states.
- Oil industry estimates suggest that oil theft in the Niger Delta currently accounts for 150,000-200,000 barrels per day (8-10% of national production).

Methodology

- A simple and reproducible separation methodology utilising solid phase extraction (SPE) technology was developed from pre-existing methods to isolate and collect aliphatic and aromatic fractions from a range of Nigerian export crude oils and binary mixtures of these oils.
- Mixtures of oils in 50:50 ratios and in 90:10 ratios were used to simulate 'stolen oil' samples.

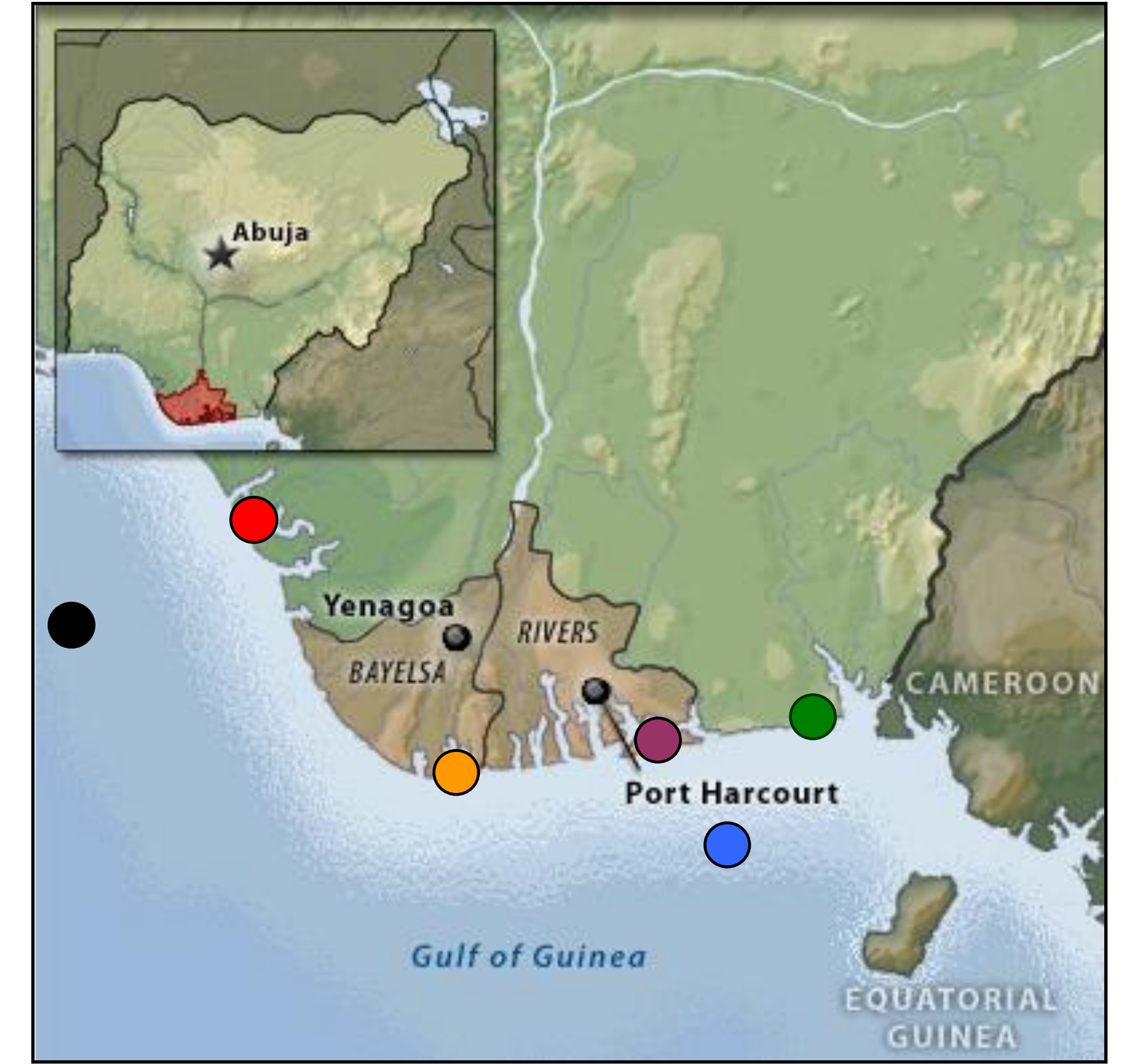


Nigeria

Oil Samples

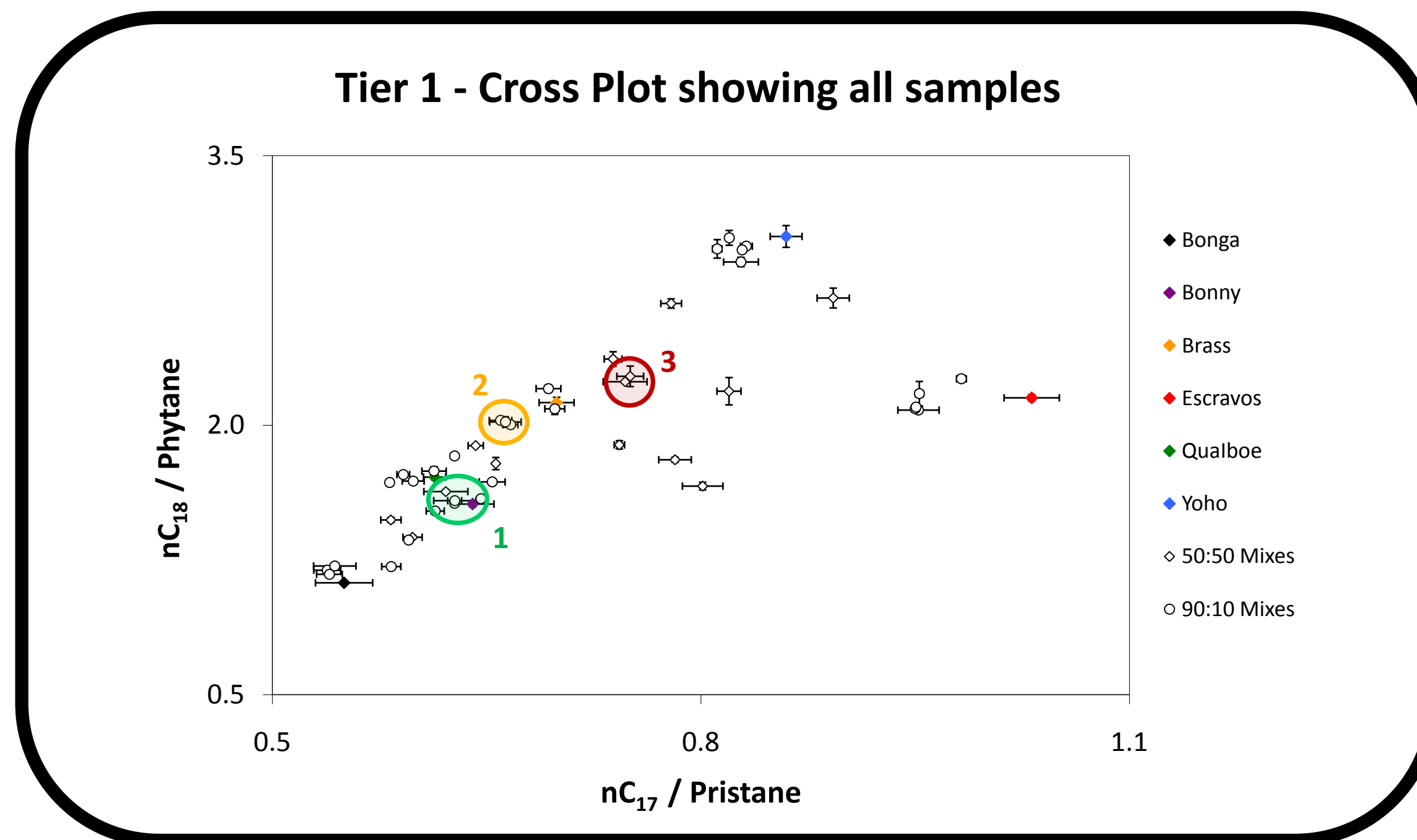
- Bonny (BY) ●
- Brass (BS) ●
- Bonga (BA) ●
- Yoho (YO) ●
- Escravos (ES) ●
- Qua Iboe (QE) ●

Map of Niger Delta Region

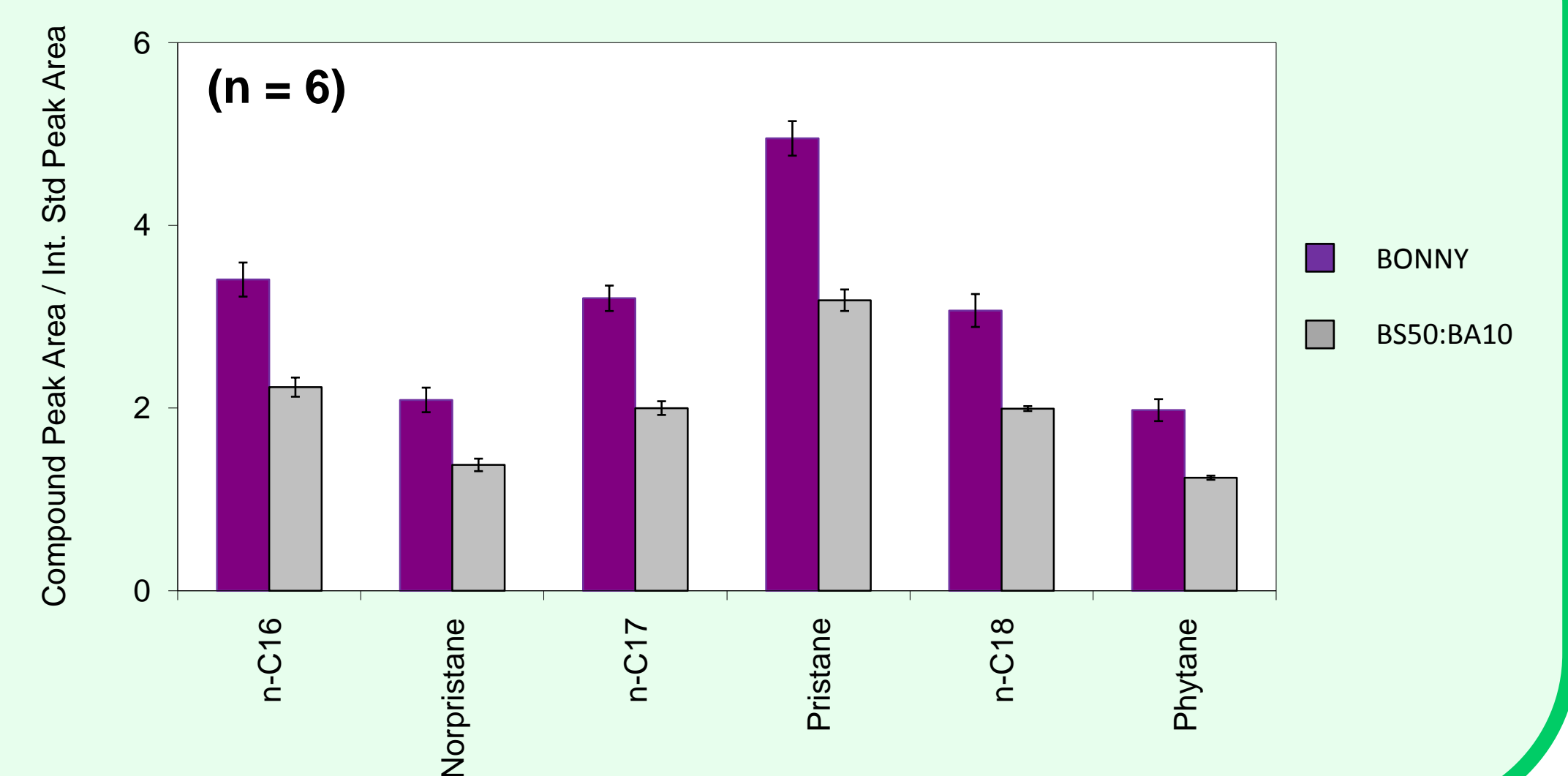


Results

Tier 1 GC-FID

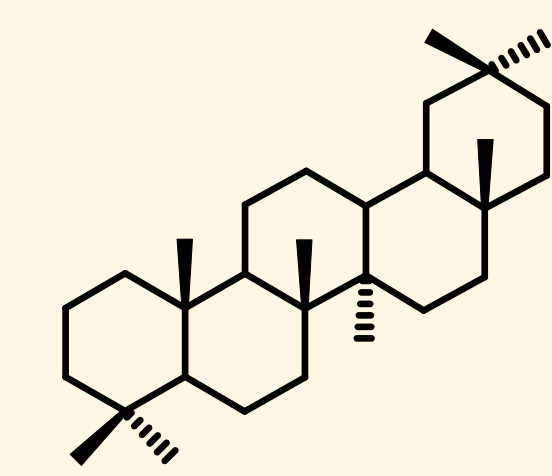
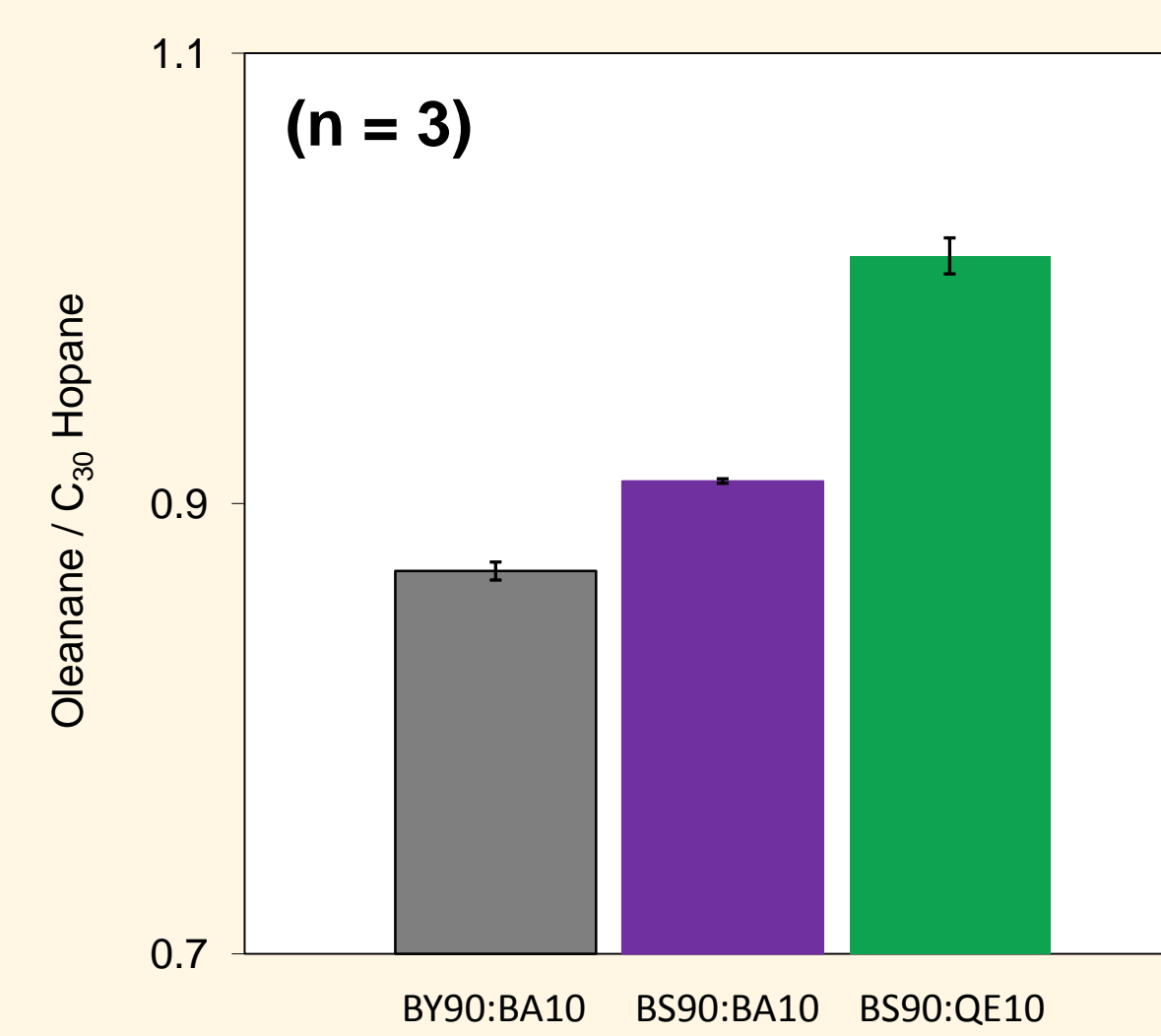


Tier 1 – Differences between Bonny and Brass 50% : Bonga 50%

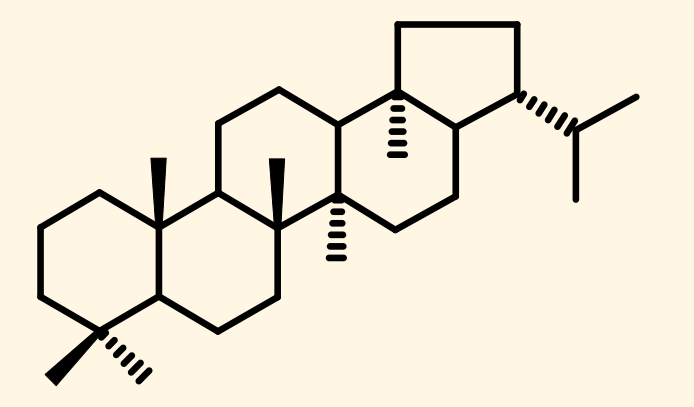


Tier 2 GC-MS

- Oil mixtures Brass 90% : Qua Iboe 10% (BS90:QE10), Brass 90% : Bonny 10% (BS90:BY10) and Brass 90% : Bonga 10% (BS90:BA10) can be distinguished using Tier 2 GC-MS (SIM) analysis.
- Calculation of the oleanane index (oleanane/ C_{30} Hopane) from the m/z 191 mass chromatograms for each sample.
- Distinct differences observed between all three mixtures.



Oleanane

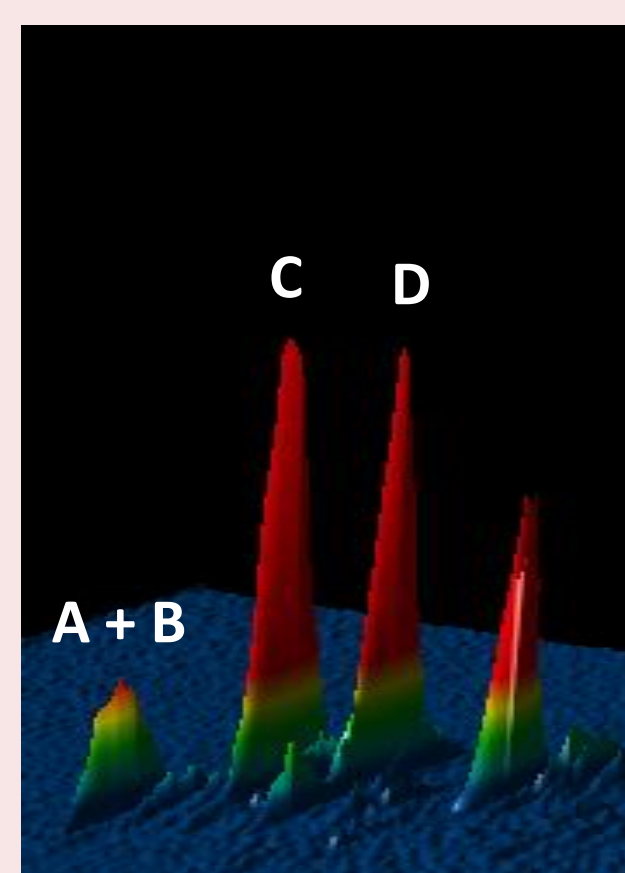


C_{30} Hopane

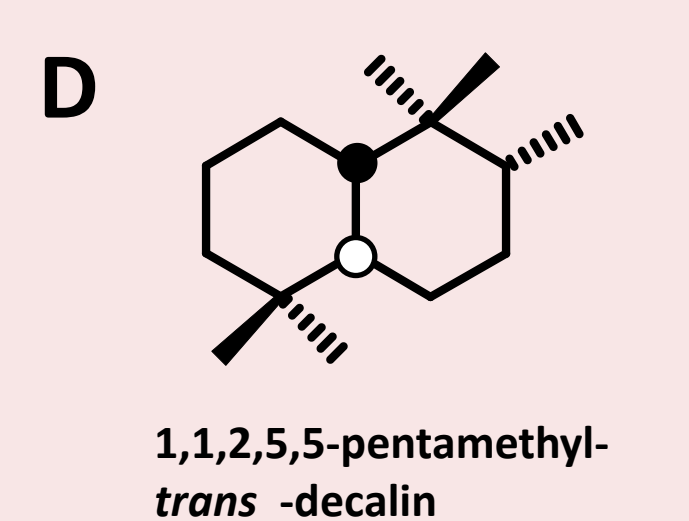
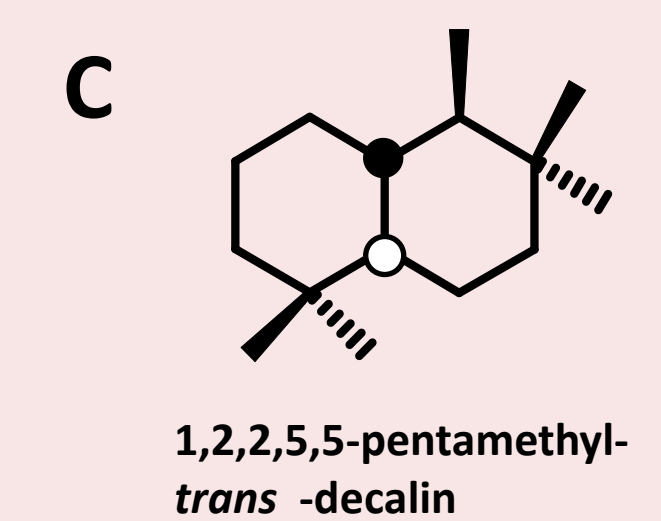
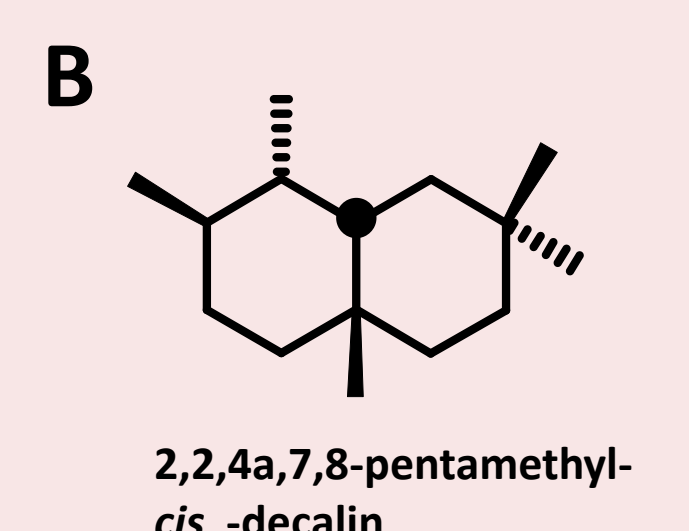
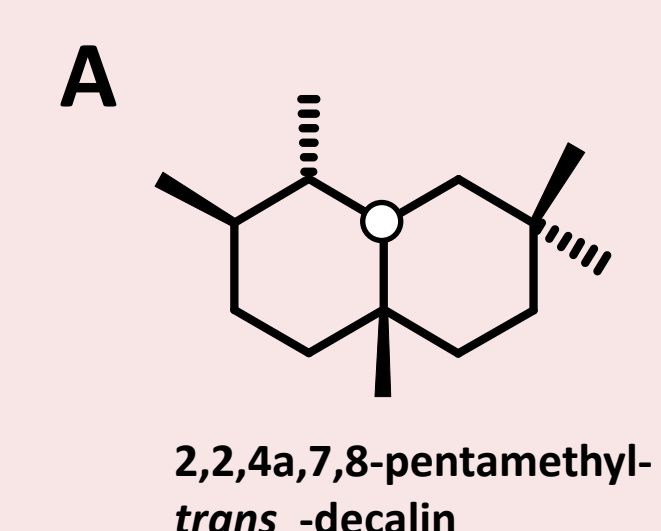
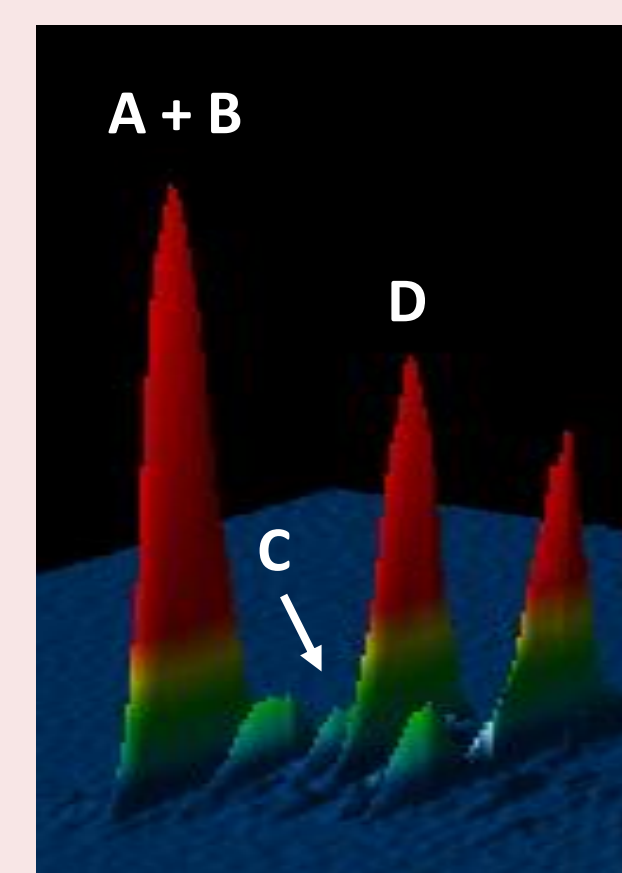
Tier 3 GCxGC-ToF-MS

- Oil mixtures Yoho 50% : Qua Iboe 50% (YO50:QE50) and Yoho 50% : Bonny 50% (YO50:BY50) can be distinguished using Tier 3 analysis.
- Analysis and comparison of m/z 193 mass chromatograms showed distinct variations in the relative abundance of selected C_{15} bicyclic sesquiterpanes (A-D) between the oil mixtures.

YO50:QE50 Mixture



YO50:BY50 Mixture



Acknowledgments

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