Trophic relationships of some prey species off Namibia: Stable isotopes approach

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OUTLINE

- Introduction
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- Methodology
- Data analysis
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- Recommendation
INTRODUCTION AND BACKGROUND

Study area = Namibia

BCE = rich marine ecosystem (high abundances of fish species)?

Small fishes (*E. whiteheadi*, *Mystophids* & *Sepia sp*) occupy different trophic level in the food web

*E. whiteheadi*, *Mystophids* & *Sepia sp* are preyed on by commercial species...... & other predators......
SIGNIFICANCY OF THIS ECOLOGICAL STUDY

- MFMR has been trying to implement a knowledge-based ecosystem approach to FM.
- It is important to study the trophic relationships these species model ie trophic dynamic.
- This study is very important....

- It improves understanding of the ecology of their predators
- Considers multi-species interactions in FM
- It improves ecologists’ understanding (sustainability & stability of the food web)
- Insufficient monitoring & indirect human impact on these prey species could result in several problems
Tropic studies

- Stomach content analysis has been used in most studies >>>shortcomings.

- WHAT? Isotope atoms = proton & electron but neutrons
- SI energetically stable & do not decay radioactive.

$\delta^{15}N$

Determines the TL of an organism

$\delta^{13}C$

reveal the primary producers at the base of a food web

Thus are useful in trophic studies
PREYS SPECIES

- *E. whiteheadi* > round herring.
  - fished, used as bait, & prey for commercial species.

- *Myctophids* > lantern fishes (midwaters species)
  - taken as prey by commercial species
  - used for the production of fish meal

- Sepia sp. > Cuttle-fishes (squids, choquito sin punta)
  - fished, used as bait & prey for commercial species.
OBJECTIVES

● To assess the trophic levels of Sepia sp., E. whiteheadi & Mycotophidae.

● To determine the trophic relationships among Sepia sp., Etrumeus whiteheadi & Mycotophidae.

● To identify the potential trophic roles of Sepia sp., Etrumeus whiteheadi and Mycotophidae in the marine ecosystem.

● To determine the likely contributions of these prey species to the diet of 4 selected predators.
Figure 1: Map indication of geographical positions where samples for *E. whiteheadi* (red triangle), *Myctophids* (black triangle) and *Sepia* species (blue triangle).
METHODOLOGY (in the field)

- Sampling was done on board the RV Blue Sea I & RV Welwitchia during the routine hake, Horse mackerel & Monk annual biomass surveys of the MFMR.

- A total of 334 Tissues from individuals of *E. whiteheadi* (n=117), *Mycophidae* (n=146) and *Sepia sp* (n=71) were collected between September 2012 and March 2014 from 51 stations.

- A total of 156 samples of predators (*M. capensis* = 25, *M. paradoxus* = 47, *L. vomerinus* = 23 and *T. capensis* = 61) for this study.

- These tissues were analyzed for stable isotopes of carbon (\(^{13}\text{C}/^{12}\text{C}\)) and nitrogen (\(^{15}\text{N}/^{14}\text{N}\)).
METHODOLOGY: (LABORATORY)

- A small piece of muscle was cut from the anterior-dorsal region of each fish.
- The tissues were dried in an oven for 48h, at 60 °C.
- A mortar & pestle were used to grind the dried tissues into a fine powder.
- The powder was combusted in an EMS. Isotopic values were expressed on δ notation as ‰ in the ratio of the heavier to the lighter isotope.
DATA ANALYSIS

☐ Normality & homogeneity of variance: Shapiro–Wilks & Levene tests
• P values were all (N,C,CN & L) less than 0.05, thus the null hypothesis for normality was rejected.
• Violations of normality & homogeneity was addressed using log10 transformation of the data.

☐ Trophic level calculations:
• Trophic level = [(δ15Nconsumer - δ15Nbase)/Δδ15N] + 2.0

☐ TR of the prey species looking at δ15N & δ13C
• Variation in SI of δ15N & δ13C values were compared and tested with ANOVA.
• Followed by post-hoc comparisons with a Tukey HSD test.
• All statistical tests were performed using.

☐ Trophic niche calculations
• Calculation of isotope-based metrics such as (a) 15N range (b) δ13C range and (c) total area (TA) were done.

☐ Dietary contributions of different prey species to the diets of the commercial species
• A Bayesian stable-isotope mixing model, termed SIAR, was used to obtain the feasible contributions of the different species to the isotopic signatures of the 4 commercial species.
## Results & conclusion

<table>
<thead>
<tr>
<th>Species</th>
<th>N</th>
<th>Length (cm)</th>
<th>$\delta^{15}$N</th>
<th>$\delta^{13}$C</th>
<th>C:N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myctophids</td>
<td>146</td>
<td>7.78</td>
<td>11.46(±1.14)</td>
<td>-18.45(±1.13)</td>
<td>4.50</td>
</tr>
<tr>
<td>Symbolophorus boops</td>
<td>66</td>
<td>8.61</td>
<td>10.94(±0.97)</td>
<td>-18.92(±1.08)</td>
<td>4.13</td>
</tr>
<tr>
<td>Lampanyctus australis</td>
<td>28</td>
<td>7.62</td>
<td>11.8(±1.16)</td>
<td>-18.24(±1.21)</td>
<td>4.61</td>
</tr>
<tr>
<td>Lampanyctodes hectoris</td>
<td>20</td>
<td>6.4</td>
<td>12.61(±0.73)</td>
<td>-18.49(±0.58)</td>
<td>4.61</td>
</tr>
<tr>
<td>Diaphus meadi</td>
<td>21</td>
<td>6.91</td>
<td>11.73(±1.19)</td>
<td>-19.44(±1.31)</td>
<td>4.93</td>
</tr>
<tr>
<td>Diaphus hudsoni</td>
<td>11</td>
<td>7.28</td>
<td>11.12(±0.25)</td>
<td>-19.68(±0.65)</td>
<td>5.33</td>
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<tr>
<td>Sepia species</td>
<td>71</td>
<td>7.89</td>
<td>11.74(±0.70)</td>
<td>-17.57(±0.59)</td>
<td>3.58</td>
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<tr>
<td>Sepia australis</td>
<td>64</td>
<td>7.85</td>
<td>11.74(±0.64)</td>
<td>-17.59(±0.35)</td>
<td>3.58</td>
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<tr>
<td>Sepia elegans</td>
<td>7</td>
<td>8.28</td>
<td>11.75(±1.18)</td>
<td>-17.4(±1.66)</td>
<td>3.59</td>
</tr>
<tr>
<td>Etrumeus whiteheadi</td>
<td>117</td>
<td>17.45</td>
<td>11.09(±1.77)</td>
<td>-17.0(±1.17)</td>
<td>3.49</td>
</tr>
</tbody>
</table>
### Results & conclusion

#### Table 2: Trophic levels of prey species

<table>
<thead>
<tr>
<th>Species</th>
<th>TL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myctophids</td>
<td>2.67</td>
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<tr>
<td>Symbolophorus boops</td>
<td>2.51</td>
</tr>
<tr>
<td>Lampanyctus australis</td>
<td>2.77</td>
</tr>
<tr>
<td>Lampanyctodes hectoris</td>
<td>3</td>
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<tr>
<td>Diaphus meadi</td>
<td>2.75</td>
</tr>
<tr>
<td>Diaphus hudsoni</td>
<td>2.57</td>
</tr>
<tr>
<td>Sepia species</td>
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<td>Sepia australis</td>
<td>2.75</td>
</tr>
<tr>
<td>sepia elegans</td>
<td>2.75</td>
</tr>
<tr>
<td>Etrumeus whiteheadi</td>
<td>2.67</td>
</tr>
</tbody>
</table>
Results & conclusion

Trophic relationship of the prey species

- An analysis of variance (ANOVA) test results indicated significant variations in $\delta^{13}C$ ($P=0.00312$, $F=1.99$) and $\delta^{15}N$ ($P=0.000108$, $F=2.74$) isotope ratio among prey species analysed.

- However, the pairwise Tukey HSD post hoc test indicated that some species were not significantly different from each other, in terms of $\delta^{15}N$ (Table 4) and $\delta^{13}C$ (Table 5).
Results & conclusion: Tukey multiple comparisons of means of $\delta^{15}N$ among

95% family-wise confidence level

Differences in mean levels of as.factor(species)
Results & conclusion: Tukey multiple comparisons of means of $\delta^{13}C$ among prey species
Results & conclusion

Trophic niche of prey species

Trophic niches of the predators
Results & conclusion

contributions of these prey species to the diet of selected predators,

- **M. capensis**
- **M. paradoxus**
- **T. capensis**
- **L. vomerina**

Diagrams show the dietary proportion of different prey species for each predator.
conclusions

• Same TL except for *L. hectoris* that fed at a slightly higher trophic level (mean $\delta^{15}$N = 12.61 %, trophic level 3.00)

• Isotope analyses revealed that $\delta^{15}$N values of prey species $\delta^{15}$N values were similar among all prey species with few pairwise significant differences. *S. boops* had the most depleted $\delta^{15}$N, while *L. hectoris* most enriched $\delta^{15}$N values.

• Significant differences were noted in $\delta^{13}$C, with *D. hudsoni* ($\delta^{13}$C = -19.69‰) having the most depleted and *E. whiteheadi* (-17.0‰) the most enriched.

• Isotope-based population metrics indicated over lapping of trophic niches of all species, with *E. whiteheadi* having a significantly wider niche.
conclusions

- All prey species analyzed are important in the ecosystem since they all contributed to the diet of the four predators, although their contribution varied.
- Isotope mixing model showed no SD in relative contribution of prey and an indication that prey availability is possibly a greater determining factor of prey dietary contribution than prey preference.

- *E. whiteheadi* was a dominant prey in the diets of these predators with an exception of that of *M. paradoxus*.
- This study is the first that have looked at trophic relationships of prey using SIA in Namibia.
- The study contributes towards understanding of prey trophic interactions, which can aid the implementation of an ecosystem approach to fisheries management in Namibia.
RECOMMENDATION

- Since fish diet is highly linked to fish size which can in turn have an influence on prey preference, prey diversity, feeding behavior or feeding rate, it is strongly recommended that further work should consider these factors.

- There is therefore a need for more long term studies to fill the gaps in the knowledge of these predators and their prey which integrate small as well as large-scale temporal and spatial sampling within the Northern Benguela ecosystem.

- Studies such as this should be coupled with those that provide full details of dietary preferences.
THANK YOU!