Soil redox potential as a predictor of benthos species composition in an intertidal zone

Richel Bilderbeek

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Abstract

Soil redox potential measurements can be done without much physical effort in a short amount of time. Measuring benthos species diversity involves more effort and time. This study examines the use of soil redox potential to predict the abundance of benthos species. The measurements are taken at an intertidal zone at Schiermonnikoog, at a transect from salt marsh to muflat. Benthos species and redox values were obtained from two depths, so that the effect of inundation can be estimated. It was found that redox potential alone is a better predictor of species composition than inundation time, allowing these findings to be extended to other ecosystems.

Introduction

Species composition is one of the first and most vital pieces of data a field-based ecological research needs to gather. Any way to reliably conclude the same information with less work will save researchers both time and resources.

Materials and method

Soil samples of 20 cm deep were taken at different distances. The top 5 cm was seperated. Both parts of the soil sample were scored for species.

Redox values were measured by a potentiometer using 4 platinum-tip electrodes and a solution of KCl as a reference. The electrodes were put in at two depths: 2 cm and 10 cm, in this sequence. The potential read is the value that remained constant, when placing or changing the electrodes. The values read were transformed to use earth as a reference point, using the formula $V = 1.8847 \cdot V_{measured} - 53.201$.

Of the 18 species scored, only species with at least 3 individuals (the minimum to test for normality) at both depths were analyzed using niche theory.

For each species, a Shapiro-Wilk normality test was used to determine if abundance is distributed normally around a certain redox potential. This test is chosen, as it has the best power for a given significance [Razali & Wah, 2011].

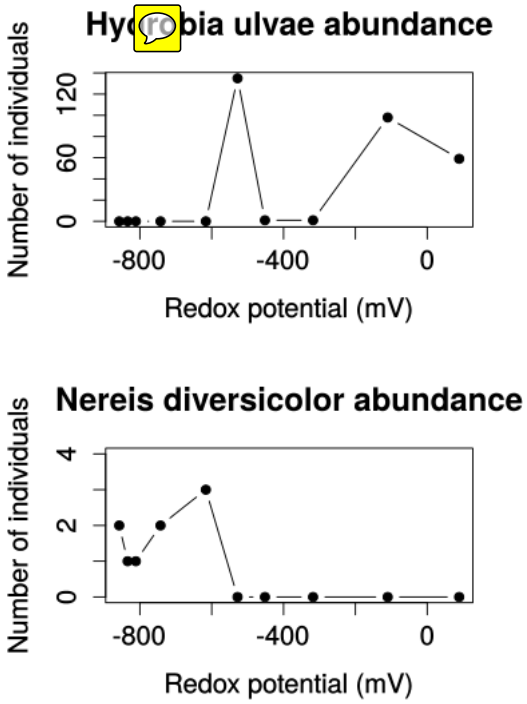

Figure 1: Number of individuals at the different redox potentials

Results

Of the 18 species scored, 8 species had at least 3 individuals at both depths. Out of these 8 species, only 4 could be used, as not all sites had their redox potential measured. From the 4 species left, only the 2 species occurring at multiple redox potentials were analyzed. These two species were *Hydrobia ulvae* and *Nereis diversicolor*. Figure 1 shows the abundance of both species at different redox potentials. A Shapiro-Wilk normality test shows that both species have a significant probability of not following a normal distribution ($p_{Hydrobia} < 0.001$, $p_{Nereis} < 0.05$, see table 1 for exact values).

Name	p	significance
Hydrobia ulvae	< 2.2e-16	***
Nereis diversicolor	0.04965	*

Table 1: Shapiro-Wilk normality test of the species abundances on redox potential. p denotes the chance the values do not follow a normal distribution.

Conclusion

Given a certain redox potential, the abundances of both *Hydrobia ulvae* and *Nereis diversicolor* can not be predicted, when assuming their abundance are distributed normally around a certain redox potential.

Discussion

This study makes a strong case that soil redox potential cannot be used to predict species abundances, for both *Hydrobia ulvae* and *Nereis diversicolor*. As *Hydrobia ulvae* is an epibenthic grazer [Newell, 1965], it seems rather obvious that is not influenced by the oxygen level of the soil underneath it. Less obvious is that individuals were found in benthos 5 cm below the surface. This finding appears not to be an experimental error, as *Hydrobia ulvae* is found in deeper soil samples at multiple distances.

References

[Razali & Wah, 2011] Razali, Nornadiah; Wah, Yap Bee (2011). Power comparisons of Shapiro–Wilk, Kolmogorov–Smirnov, Lilliefors and Anderson–Darling tests. Journal of Statistical Modeling and Analytics 2 (1): 21–33

[Newell, 1965] Newell,R.C. (1965). The role of detritus in the nutrition of two marine deposit-feeders, the prosobranch *Hydrobia ulvae* and the bivalve *Macoma balthica*. Proc. zool. Soc. Lond. 144, 25-45

[Rauschenplat, 1901] Rauschenplat, E (1901). Ueber die Nahrung von Thierer aus der Kielerbucht. Wiss. Meeresunters. 5(2):85-151.

Appendix

Total species count

Number of indiviuals at a certain redox potential

Species name	Depth: 2 cm	Depth: 10 cm
Arenicola marina	12	1
Bathyporeia	2	0
Carcinus maenas	3	14
Cerastoderma edule	5	22
Crassostrea gigas	4	6
Eteone longa	0	5
Gammarus locusta	1	3
Hemigropsus takanoi	4	11
Heteromastus filliformis	1	13
Hydrobia ulvae	131	369
Lanice conchilega	2	31
Littorina littorea	11	51
Macoma balthica	0	31
Mytilus edulis	7	78
Nereis diversicolor	14	10
Nereis virens	3	0
Scoloplas armiger	1	16
Scrobicularia plana	1	0

Table 2: All 18 species and the number of indiduals found per species per depth. Total number of individuals: 863

Redox potential (mV)	*Hydrobia ulvae*	*Nereis diversicolor*
-857	0	2
-834	0	1
-811	0	1
-742	0	2
-616	0	3
-528	135	0
-452	1	0
-318	1	0
-110	98	0
89	59	0

Table 3: Number of individuals at the different redox potentials