POPULAR CONCEPTIONS OF WAVE-EXPOSED ALGAE: TESTING THE RELATIONSHIP BETWEEN ALGAL ABUNDANCE AND WAVE EXPOSURE.

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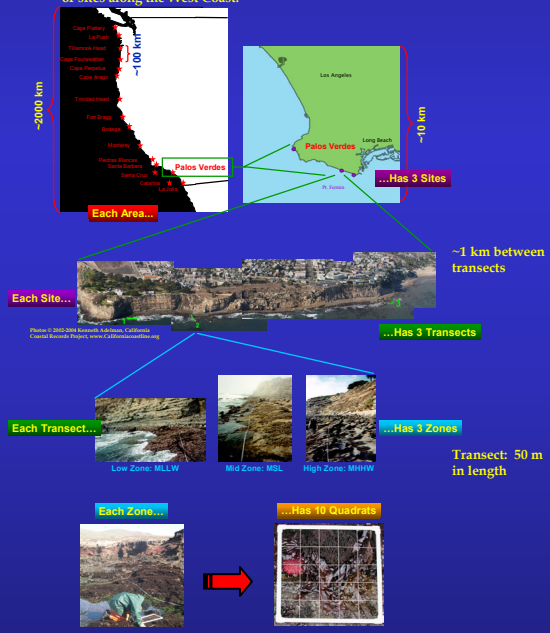
INTRODUCTION:

Enthusiasts of intertidal algae understand that some species grow more favorably at a particular level of wave exposure. Some species, such as *Postelsia palmaeformis*, are widely regarded as "wave-exposed" indicators despite a lack of supporting analyses. Here, we investigate correlations between wave exposure and the presence and abundance of intertidal algal species. Three questions were addressed: Do "wave-exposed" species co-occur at any particular site? Is species presence or absence a product of wave exposure? Are species abundances related to wave exposure? Data about the presence and abundance of species were collected in a rocky intertidal survey along the West Coast of the continental U.S. Our analyses suggest that algal species have patterns of presence, but these are not always aligned with the popular conception. These species-specific responses to wave exposure are characteristic of intertidal communities and essential to our understanding of how they are structured.

SAMPLING SCHEME:

Species data were gathered using quadrats along horizontal transects at selected tidal heights. These data were the result of a spatially nested survey of sites along the West Coast.



Quadrats:

- Percent cover of algae, sessile invertebrates, bare rock, and sand
- Density counts of mobile invertebrates
- Measurements of physical components (slope, roughness)

BIOTA ELEVATION:

Intertidal upper biota data were collected using standard surveying methods. The upper extent of the biota was considered to be the height at which there was ≤ 5% of algae or sessile invertebrates (excluding freshwater-influenced species) if one were counting a quadrat at that location. Data are represented here as elevations in feet above MLLW.

DATA ANALYSIS:

Algal cover was calculated as the mean abundance per transect. Only species with ranges encompassing the sample region from Cape Flattery to Monterey (65 transects; 43 species) were used in the analyses. Wave exposure was calculated as the average height of the upper limit of the biota above MHHW. To account for latitudinal variance in tidal heights, the difference between the average upper biota height per transect and the site-specific MHHW height was calculated. Positive values indicate an average upper biota height above MHHW and negative values indicate an elevation below MHHW.

Particular attention was given to five species that are commonly recognized as wave-exposed species and are stated as growing in wave-exposed habitats by Abbott and Hollenberg.


Lessoniopsis littoralis


Erythrophyllum delesserioides


Mazzaella linearis


Postelsia palmaeformis


Schizymenia pacifica

Species Group Patterns

Comparisons were made between the mean abundances per transect of the five "wave-exposed" species in question to summarize the frequency of co-occurrence of these species. This was only performed for transects at which both species were present, to investigate a relationship between them. A Pielou and Pielou combinations test was also conducted to examine co-occurance of the five focal species at each transect.

Abundance-Wave Exposure

Was there a correlation between algal abundance and wave exposure at the locations where the species were found?
Linear regressions were used to determine if mean transect species abundances were related to the degree of wave exposure.

Presence-Wave Exposure

Was there a correlation between the presence of species and wave exposure?
Species presence-absence data were analyzed with the wave exposure metric in a Runs Test simulation.

RESULTS:

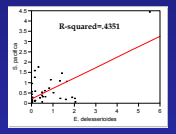
Species Group Patterns

The comparison charts shown below demonstrate the frequency of co-occurrence of the species. As expected, the more common species such as *M. linearis* and *S. pacifica*, frequently occur in the same transects.

Species	Number Transects
Erythrophyllum delesserioides	40
Lessoniopsis littoralis	15
Mazzaella linearis	61
Postelsia palmaeformis	14
Schizymenia pacifica	55

Species Combinations	Number transects 1+ species	Number shared transects
Eryt-Lesson	44	11
Eryt-Malin	63	38
Eryt-Post	42	12
Eryt-Schy	58	37
Lesson-Malin	62	14
Lesson-Post	23	6
Lesson-Schy	58	12
Malin-Post	62	13
Malin-Schy	63	53
Post-Schy	57	12

Of all the combinations of the five species, only the presence of *E. delesserioides* and *S. pacifica* seemed to be correlated.



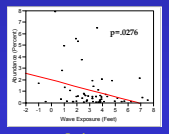
The simulated combinations test suggested that the five focal species may occur together more frequently than one would expect by chance (p = .0428 and .1460 depending on model).

Presence-Wave Exposure

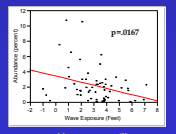
There was no significant relationship between wave exposure and the species presence.

Abundance-Wave Exposure

Only two species, *Porphyra sp.* and *Mastocarpus papillatus*, were significantly related to wave exposure. Both species seemed to be negatively affected by wave exposure with decreased abundances at higher levels of wave exposure.



Porphyra sp.



Mastocarpus papillatus

DISCUSSION:

Some algal species are often considered to be wave exposure indicator species, however, our data do not coincide with this hypothesis. "Wave-exposed" species may tend to coexist, but the results suggest that this co-occurrence is not the product of wave exposure. The analyses indicate that species presence and species abundance are not related to the degree of wave exposure. Apparently, the notion of a "wave exposed" indicator species needs more careful scrutiny.

Many scientists judge wave exposure simply by making observations about the waves, the species present, the pattern of zonation, or the elevation of biota on the rocks. However, wave exposure is complex. Measurements of the extent of the upper level of the intertidal biota may not adequately account for all aspects of wave exposure.

There is likely merit in historical observations that certain species occur in more wave-exposed environments. The wave climate may, however, drive patterns of species presence and abundance differently than it affects the upper extent of the biota and veil relationships between species distributions and wave exposure.

Wave exposure does not appear to structure communities at the 50-meter, transect scale used for these analyses. It is more likely that smaller scale gradients in wave exposure create variable abiotic environments, which may drive patterns of species presence or abundance. A more detailed study, at smaller scales, may resolve the relationship between wave exposure and "indicator" species, but such an analysis will require much finer resolution wave exposure data than is currently available.

It is still noteworthy that the results presented here are not consistent with the general perception that certain algal species are indicators of wave exposure. Nearshore and intertidal environments are complex and it is difficult to discern the processes that determine species distribution.

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