

# Egg Wrack (*Ascophyllum nodosum*) morphology



## Genotype / phenotype

Planktonic stage in life cycle, therefore genetically distinct populations may not develop on shores in close geographical proximity, but environmental factors influence variation: selection for form best adapted to minimise effects of wave action

## Temperature

At upper limits of distribution, where algae are exposed to air for long periods, algae will be subjected to a wide variation in temperatures. This will affect rates of enzyme reactions and high temperatures may cause irreversible cellular damage

## Photosynthesis

Rate of photosynthesis depends on light availability which will be affected by - **wave action** :  
-turbulence will decrease light penetration.  
-as wave crests pass over a given point, water depth increases (dependant on the height of the wave) and this will limit light penetration. These may be a factor on wave exposed coasts.

**turbidity / clarity of the water** : increased turbidity will decrease light penetration

Rate of photosynthesis decreases as algae dry out as they are exposed by a falling tide.

As algae at the upper limits of their distribution will be exposed to air for longer than those at the lower limits then maximum rate of photosynthesis will occur for a shorter time period at the upper limits. This may affect growth rate and size.

Exposure to high light intensity for long periods may result in breakdown of some photosynthetic pigments

Algal morphology

## Water balance :

Algae are limited to a particular zone by adaptations which minimise water loss. At upper limits of distribution algae will be subject to desiccation and hence stress. This will limit metabolic processes and may cause irreversible damage.

## Typical investigations

Effect of shore position

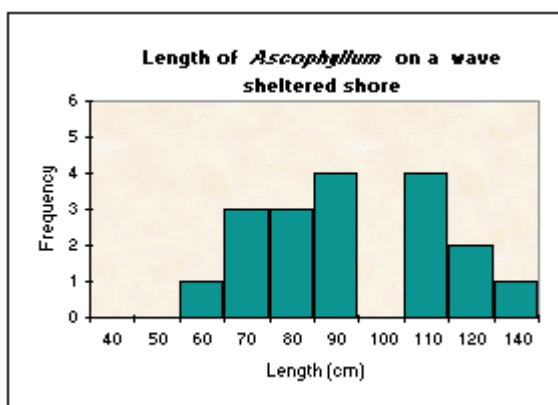
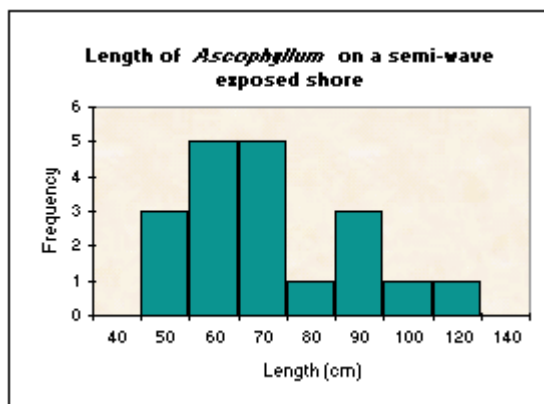
Effect of wave exposure

Distribution	Reproduction and growth	Limiting factors	Adaptations
Widely distributed and abundant. On all coasts in the mid-shore, with greatest abundance on sheltered shores. As wave exposure increases, the plants become more broken, less luxuriant and more scattered.	dioecious - gametes discharged in spring; can reproduce vegetatively from base or after damage; produces approx one air bladder per frond per year after first few years, so the age of undamaged plants can be estimated; lifespan possibly up to 25 years (Dring, 1992).	Light Desiccation Wave action Grazing Salinity	Accessory pigments (fucoxanthin and chlorophyll $c_1$ and $c_2$ ) Cell wall thickness $1.02\mu\text{m}$ (Cremona, 1988) Found from fairly exposed to sheltered shores (Ballantine 1961) Air bladders are larger on sheltered shores (Norton et al 1981) Produces polyphenols as a chemical defence against grazers (Tuomi et al 1989). Unpalatable to grazers. Has softer tissue on the frond apex compared with tough basal tissue Reduced salinity increases the size of air bladders (Norton et al 1981)

## Methods

hypothesis?  
justification of approach?  
what is the independent variable? the dependent variable?  
optimum sample size? calculate by running mean or standard deviation?  
sampling method? random or systematic sampling?  
statistical analysis?  
what to measure?  
accuracy and consistency of measurements?  
how to assess wave exposure?  
how to minimise environmental variables? - e.g. if comparing shores of different wave exposure, sampling needs to be at similar levels and in similar areas on each shore  
How can you control abiotic factors such as temperature, humidity and wind speed?

## Typical results



## Analysis

	Semi-exposed shore		Sheltered shore		t value	probability	Ho
	Mean	s.d.	Mean	s.d.			
Mean length (cm)	67.07	10.95	116.47	26.8	9.35	p<0.001	reject
Mean bladder size (mm)	23.23	5.92	27.5	7.51	2.44	p<0.05	reject
No. of bladders	4.37	0.76	5	0.95	2.85	p<0.01	reject
Mean distance between bladders (mm)	112.3	23	183.7	40.3	8.42	p<0.001	reject

## Discussion

-are plants significantly different in length, bladder number, etc. on exposed or sheltered shores?

-is there greater distance between bladders in the plants from shores of different wave exposure and hence a difference in growth rate?

*A.nodosum* is not tolerant of severe wave action and does not occur on such shores. The bladders are used for buoyancy so that it can float in the water to make most use of the available light.

On wave exposed shores bladders may be a disadvantage as they create drag and so the plant can be broken and as conditions are harsher, growth rate may be affected.

on the sheltered shores there is much more damage to the frond caused by grazing animals, this may have weakened the frond causing breakages. On more wave exposed shores plants support growth of the epiphyte *Polysiphonia* sp. which again may weaken the plant and provide a larger surface area. towards the upper limit for *Ascophyllum* on the shore,

individual plants may be shorter than that growing lower on the shore, they are also reported to have smaller air bladders and broader, thinner internodes (distance between the bladders).

-how does your investigation relate to previous work carried out in this field. Cite some references relevant to your project and compare or contrast your data to previous investigations.