Methods: Kelp blade characteristics to support frond turnover calculations

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Author(s): Gabriel Rodridguez (M. O'Brien, ed.)

Overview/Background: The giant kelp, *Macrocystis pyrifera*, is the largest marine alga in the world and supports one of the most productive ecosystems on earth. While the processes governing its growth have been well studied, the processes that drive the loss of foliar biomass are poorly understood. This project investigated traits associated with blade lifespan and frond turnover dynamics in giant kelp in the context of leaf lifespan theory developed for higher plants. These data were generated by a combination of approaches including focused field studies, and mathematical modeling.

Methods: Macrocystis blade lifetime observations

Field Collection. Changes in blade size and blade lifetime were measured from July to November 2012. Two midwater blades and one canopy blade from each of twenty mature plants consisting of 10-50 fronds were haphazardly chosen along a transect running along the offshore edge of the kelp forest (hereafter referred to as the forest edge). Likewise, two midwater blades and one canopy blade each from another 20 mature plants were chosen from a parallel transect 10 m inshore of the edge of the forest in an area with dense kelp cover (hereafter referred to as the forest interior). A single frond from each of the 40 plants measuring ~75 cm in total length was chosen to observe changes in blade area and lifespan. All 120 blades (60 interior and 60 edge) were measured every seven days from this initial observation (or from the time of separation from the apical meristem in the case of canopy blades) until the blades had senesced to less than 10% of the maximum length, until the frond had senesced to less than 50% of maximum length, or until the frond was lost from the holdfast.

I measured the length as the maximum distance along the primary axis of the blade and blade width as the greatest distance perpendicular to the primary axis. Blade area was calculated from length and width assuming the shape was elliptical. The lifespan of the blade was defined as the time from when the blade reached 80% of maximum area to when it senesced to less than 10% of this maximum. If the frond was lost before the blades had senesced to less than 10% of the maximum length, the data for that sample blade were excluded from the analysis. Fifteen of the 120 blades were excluded from the analysis because of frond loss and no group suffered severely disproportional sample loss.

Laboratory Processing. None.

Data Processing. Total blade area was calculated using blade length and width, and assuming that blades are elliptical

Methods: Macrocystis blade photosynthetic characteristics

Field Collection. Fourteen midwater blades of known ages were collected on October 2012 to test the hypothesis that Pmax decreases with blade age. Blades collected for Pmax measurements were obtained from the same plants used to evaluate blade area and lifespan, but from different fronds than those monitored for senescence. Eight blades came from plants on the forest edge, 6 blades were from the forest interior. Upon collection, blades were placed in dark sealed containers until Pmax was measured following the methods of Miller et al. (2012).

Laboratory Processing. Blades were incubated in nitrogen-purged, sealed aquaria and oxygen evolution was measured using a self-contained D-Opto dissolved oxygen logger (Zebra-Tech, Nelson, New Zealand). Blades were exposed to varying levels of photosynthetically active radiation ranging from complete darkness to 700 μE*m-2*s-1, measured using spherical MkV/L Light Intensity Recorders manufactured by Alec Electronics Corporation (Kobe, Japan).

Pigment and dry mass density (a measure of blade thickness) of these blades was measured from samples taken from the blades at the conclusion of the Pmax measurements. Dry mass density and chlorophyll a (Chl a) mass per unit blade area for mature blades were estimated from six 1 cm diameter cores taken from the centerline of the blade, approximately 5 cm from the base of the blade. Chl a and other pigments were extracted using a dimethyl sulfoxide/acetone solvent and analyzed using a Shimadzu UV 2401PC spectrometer (Shimadzu Scientific Instruments, Kyoto, Japan) following the methods of Seely et al. (1972).

Data Processing. Following Miller et al (2012)

Methods: Macrocystis blade content characteristics

Field Collection. I analyzed pigment and dry mass density (a measure of blade thickness) from 46 mature blades, and nitrogen from 46 mature and 61 senescent blades collected from haphazardly chosen plants at the edge and in the interior of the kelp forest. Mature midwater (N=35) blades were collected from young 3-4 m long fronds, senescent midwater blades (N=47) and mature canopy blades (N=11) were collected from fronds 5-7 m in length and senescent canopy blades (N=14) were selected from fronds > 8 m in length that had stopped elongating.

Laboratory Processing. Dry mass density and chlorophyll a (Chl a) mass per unit blade area for mature blades and nitrogen as a percentage of dry mass for mature and senescent blades were estimated from six 1 cm diameter cores taken from the centerline of the blade, approximately 5 cm from the base of the blade. Nitrogen content was estimated using a CE-440 CHN/O/S elemental analyzer (Exeter Analytical, Chelmsford, Massachusetts, USA). Chl a was extracted using a dimethyl sulfoxide/acetone solvent and analyzed using a Shimadzu UV 2401PC spectrometer (Shimadzu Scientific Instruments, Kyoto, Japan) following the methods of Seely et al. (1972).

Data Processing. None.

References:

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