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## **The Ratio of Gametophytes to Tetrasporophytes of Intertidal *Chondrus crispus* (Gigartinales) Across a Salinity Gradient**

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NEW ENGLAND NOTE

THE RATIO OF GAMETOPHYTES TO  
TETRASPOROPHYTES OF INTERTIDAL *CHONDRUS*  
*CRISPUS* (GIGARTINACEAE) ACROSS A  
SALINITY GRADIENT

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Population studies of the Gigartinaceae (Rhodophyta) have often observed that the ratio of gametophytes to tetrasporophytes (the G:T ratio) varies with the location of the population or the time of sampling. For some species, patterns have emerged that correlate G:T ratio to one or a few particular environmental variables, such as elevation (Scrosati and Mudge 2004b), wave exposure (Dyck and De Wreede 2006; Dyck et al. 1985; Mudge and Scrosati 2003), or season (De Wreede and Green 1990; Dyck and De Wreede 1995, 2006). Identifying these distributional patterns is an important step towards understanding what (if any) ecological differences exist between the two free-living life history stages.

*Chondrus crispus* Stackhouse is a relatively well studied species in the Gigartinaceae, yet a distributional pattern remains to be established for its life history stages. Two studies of subtidal *C. crispus* populations reported an increase in relative tetrasporophyte abundance with increasing water depth (Craigie and Pringle 1978; Mathieson and Burns 1975); however, Lazo et al. (1989) found no consistent relationship between tetrasporophyte abundance and depth, indicating this pattern does not hold under all environmental conditions. Studies of intertidal *C. crispus* have reported a wide range of G:T ratios, with populations ranging from 62% to 100% gametophytic (Bhattacharya 1985; Carrington et al. 2001;

Dudgeon and Johnson 1992; Scrosati and Mudge 2004a; Scrosati et al. 1994).

The purpose of this study was to measure the G:T ratio of intertidal populations of *Chondrus crispus* across a decreasing salinity gradient from Rhode Island Sound, Rhode Island to Long Island Sound, Connecticut. Previous work conducted by Lindgren and Åberg (1996) detected a negative relationship between salinity and *C. crispus* G:T ratio at two sites with yearly salinity ranges of 0–10 PSU and 10–35 PSU. Although the east to west change in salinity at our study sites was not as extreme as the one examined by Lindgren and Åberg (1996), we hypothesized that a negative correlation between salinity and G:T ratio would be found.

Our study sites were, from east to west: Bass Rock (Narragansett, Rhode Island, 41°24.273'N, 71°27.448'W), Bluff Point (Groton, Connecticut, 41°18.844'N, 72°2.156'W), Meigs Point (Madison, Connecticut, 41°14.998'N, 72°32.515'W), and Lighthouse Point (New Haven, Connecticut, 41°14.972'N, 72°54.242'W). Salinity for the four study sites, from east to west, decreases from an average of 32 PSU to 26 PSU (CTDEP 2006; Shonting and Cook 1970). The four study sites also represent an east to west decrease in wave exposure (pers. obs.), however, this was not expected to impact *Chondrus crispus* G:T ratio, as both *C. crispus* phases are equally vulnerable to removal by wave action (Carrington et al. 2001) and high G:T ratios have been observed at both exposed (Bhattacharya 1985; Dudgeon and Johnson 1992) and protected (Carrington et al. 2001) sites.

Fifty *Chondrus crispus* fronds were haphazardly collected on 15 October 2006 from Bluff Point and on 3–4 November from Bass Rock, Meigs Point, and Lighthouse Point. All fronds were collected at mean low water, each at least 10 cm away from the others, to increase the likelihood that each frond represented a different genet (Scrosati and Mudge 2004b). Life history stages were determined using a resorcinol-acetal chemical test (Garbary and De Wreede 1988). A Chi-Square test was conducted using SIGMA-STAT® 2.0 (SPSS Inc., Chicago, IL).

The three Long Island Sound populations were found to be gametophyte dominated with an east to west decrease in the relative proportions of gametophytes. The Bluff Point, Meigs Point, and Lighthouse Point populations were 90%, 78%, and 62% gametophytic, respectively. In contrast, the Bass Rock population showed slight tetrasporophyte dominance, at 48% gametophytic. Results of

the Chi-Square analysis showed that the proportion of life history stages differed significantly among sites ( $df = 3$ ,  $\chi^2 = 23.487$ ,  $p < 0.05$ ).

While an east to west decrease in relative gametophyte abundance was positively correlated to salinity decreases within Long Island Sound, this pattern was inconsistent when the Bass Rock population was considered. Bass Rock had a higher salinity and a greater relative abundance of tetrasporophytes than the sampled Long Island Sound populations. As such, our results failed to confirm the negative relationship between salinity and *Chondrus crispus* G:T ratio observed by Lindgren and Åberg (1996). However, our results may not be directly comparable to those of Lindgren and Åberg (1996), as our sites spanned a smaller salinity gradient and the *C. crispus* populations we sampled were intertidal while those in the Lindgren and Åberg (1996) study were shallow subtidal. In addition, the high percentage of intertidal tetrasporophytes observed at the Bass Rock site might have been due to an “uplifting” of the subtidal population, where tetrasporophytes are thought to be more abundant (Mathieson and Burns 1975). This uplift of the subtidal population would obscure any G:T ratio pattern due solely to salinity. Another factor to consider is that our study populations were located at the southern edge of the *C. crispus* distribution in the western Atlantic. Previous studies have shown the reproductive potential of several Rhodophyta species to be restricted at the edges of their distributional ranges, resulting in abnormal life history ratios (Dixon 1965). However, we do not believe this to be the case for our study populations, as many thalli were reproductive at the time of sampling.

One factor not considered in our study was the impact of herbivores that may preferentially consume one of the two life history stages. Within the Gigartinaceae, selective grazing has been observed to impact *Chondrus crispus* (Lindgren et al. 2003), *Mazzaella laminarioides* (Buschmann and Santelices 1987), and *M. flaccida* (Thornber et al. 2006). Herbivores were not quantified in this study, so it is not known if herbivore composition differs between the study sites or how it might affect *C. crispus* G:T ratio at these sites.

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