1-2010

The Ratio of Gametophytes to Tetrasporophytes of Intertidal Chondrus Crispus (Gigartinaceae) Across a Salinity Gradient

Michele Guidone
Sacred Heart University, guidonem@sacredheart.edu

Sean Grace
Southern Connecticut State University

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

Author(s): Michele Guidone and Sean Grace
Source: Rhodora, 112(949):80-84. 2010.
Published By: The New England Botanical Club, Inc.
DOI: http://dx.doi.org/10.3119/08-35.1
URL: http://www.bioone.org/doi/full/10.3119/08-35.1

RHODORA, Vol. 112, No. 949, pp. 80–84, 2010

NEW ENGLAND NOTE

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

MICHELE GUIDONE

Department of Biological Sciences, University of Rhode Island, 120 Flagg Road, Kingston, RI 02881
e-mail: mguidone@mail.uri.edu

SEAN GRACE

Department of Biology, Southern Connecticut State University, 501 Crescent Street, New Haven, CT 06515
e-mail: graces2@southernct.edu

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.

ACKNOWLEDGMENTS. We thank A. Mathieson, C. Thornber, and C. Yarish for their valuable comments on earlier drafts of this manuscript.

LITERATURE CITED

Bhattacharya, D. 1985. The demography of fronds of *Chondrus crispus* Stackhouse. J. Exp. Mar. Biol. Ecol. 91: 217–231.

Buschmann, A. H. and B. Santelices. 1987. Micrograzers and spore release in *Iridaea laminarioides* Bory (Rhodophyta: Gigartinales). J. Exp. Mar. Biol. Ecol. 108: 171–179.

Carrington, E., S. P. Grace, and T. Chopin. 2001. Life history phases and the biomechanical properties of the red alga *Chondrus crispus* (Rhodophyta). J. Phycol. 37: 699–704.

Craigie, J. S. and J. D. Pringle. 1978. Spatial distribution of tetrasporophytes and gametophytes in four maritime populations of *Chondrus crispus*. Canad. J. Bot. 56: 2910–2914.

CTDEP. 2006. Water Quality Monitoring Program. Connecticut Dept. Environmental Protection, Bureau of Water Management, Hartford, CT.

De Wreede, R. E. and L. G. Green. 1990. Patterns of gametophyte dominance of *Iridaea splendens* (Rhodophyta) in Vancouver harbour, Vancouver, British Columbia. Canad. J. Appl. Phycol. 2: 27–34.

Dixon, P. S. 1965. Perennation, vegetative propagation, and algal life histories, with special reference to *Asparagopsis* and other Rhodophyta. Bot. Gothob. 3: 67–74.

Dudgeon, S. R. and A. S. Johnson. 1992. Thick versus thin: Thallus morphology and tissue mechanics influence differential drag and dislodgement of two co-dominant seaweeds. J. Exp. Mar. Biol. Ecol. 165: 23–43.

Dyck, L. J. and R. E. De Wreede. 1995. Patterns of seasonal demographic change in the alternate isomorphic stages of *Mazzaella splendens* (Gigartinales, Rhodophyta). Phycologia 34: 390–395.

——— and ———. 2006. Seasonal and spatial patterns of population density in the marine macroalga *Mazzaella splendens* (Gigartinales, Rhodophyta). Phycol. Res. 54: 21–31.

———, ———, and D. Garbary. 1985. Life history phases in *Iridaea cordata* (Gigartinaceae): Relative abundance and distribution from British Colombia to California. Jap. J. Phycol. 33: 225–232.

Garbary, D. J. and R. E. De Wreede. 1988. Life history phases in natural populations of Gigartinaceae (Rhodophyta): Quantification using resorcinol, pp. 174–178. *In*: C. S. Lobban, D. J. Chapman, and B. P. Kremer, eds., Experimental Phycology: A Laboratory Manual. Cambridge Univ. Press, Cambridge, U.K.

Lazo, M. L., M. Greenwell, and J. McLachlan. 1989. Population structure of *Chondrus crispus* Stackhouse (Gigartinaceae, Rhodophyta) along the coast of Prince Edward Island, Canada: Distribution of gametophytic and sporophytic fronds. J. Exp. Mar. Biol. Ecol. 126: 45–58.

Lindgren, A. and P. Åberg. 1996. Proportion of life cycle stages of *Chondrus crispus* and its population structure: A comparison between a marine and an estuarine environment. Bot. Mar. 39: 263–268.

———, H. Pavia, and P. Åberg. 2003. Susceptibility to grazing in different life cycle stages of the red alga *Chondrus crispus*, pp. 349–356. *In*: A. R. O.

Chapman, R. J. Anderson, V. J. Vreeland, and I. R. Davison, eds., Proc. 17th International Seaweed Symposium. Oxford Univ. Press, Oxford, U.K.

Mathieson, A. C. and R. L. Burns. 1975. Ecological studies of economic red algae. V. Growth and reproduction of natural and harvested populations of *Chondrus crispus* Stackhouse in New Hampshire. J. Exp. Mar. Biol. Ecol. 17: 137–156.

Mudge, B. and R. Scrosati. 2003. Effects of wave exposure on the proportion of gametophytes and tetrasporophytes of *Mazzaella oregona* (Rhodophyta: Gigartinales) from Pacific Canada. J. Mar. Biol. Assoc. U.K. 83: 701–704.

Scrosati, R., D. J. Garbary, and J. McLachlan. 1994. Reproductive ecology of *Chondrus crispus* (Rhodophyta, Gigartinales) from Nova Scotia, Canada. Bot. Mar. 37: 293–300.

——— and B. Mudge. 2004a. Persistence of gametophyte predominance in *Chondrus crispus* (Rhodophyta, Gigartinaceae) from Nova Scotia after 12 years. Hydrobiologia 519: 215–218.

——— and ———. 2004b. Effects of elevation, wave exposure, and year on the proportion of gametophytes and tetrasporophytes in *Mazzaella parksii* (Rhodophyta, Gigartinaceae) populations. Hydrobiologia 520: 199–205.

Shonting, D. H. and G. S. Cook. 1970. On the seasonal distribution of temperature and salinity in Rhode Island Sound. Limnol. & Oceanogr. 15: 100–112.

Thornber, C. S., J. J. Stachowicz, and S. Gaines. 2006. Tissue type matters: Selective herbivory on different life history stages of an isomorphic alga. Ecology 87: 2255–2263.