11-2007

Re-occurrence of the tropical green macroalga, Penicillus capitatus (Chlorophyta: Bryopsidales), in Lower Laguna Madre of South Texas.

Joseph L. Kowalski
The University of Texas Rio Grande Valley

Donald L. Hockaday

Gilbert H. Boza Jr.

Hudson R. DeYoe
The University of Texas Rio Grande Valley, hudson.deyoe@utrgv.edu

Recommended Citation

Kowalski, J., Hockaday, D. L., Boza Jr., G. H., & DeYoe, H. R. (2007). Re-occurrence of the tropical green macroalga, Penicillus capitatus (Chlorophyta: Bryopsidales), in Lower Laguna Madre of South Texas. Texas Journal of Science, 59(4), 305–310.

GENERAL NOTES

RE-OCCURRENCE OF THE TROPICAL GREEN MACROALGA, *PENICILLUS CAPITATUS* (CHLOROPHYTA: BRYOPSIDALES), IN THE LOWER LAGUNA MADRE OF SOUTH TEXAS

Joseph L. Kowalski*, Donald L. Hockaday, Gilbert H. Boza, Jr., and Hudson R. DeYoe*
**Department of Biology and the Center for Subtropical Studies*
The University of Texas - Pan American
1201 West University Drive, Edinburg, Texas 78541 and
Coastal Studies Laboratory and the Center for Subtropical Studies
The University of Texas - Pan American
South Padre Island, Texas 78597

The siphonaceous green alga *Penicillus capitatus* Lamarck is a common macroalga of the Carribean and Gulf of Mexico (Littler & Littler 2000). This shaving brush-shaped macroalga was a common inhabitant of the Lower Laguna Madre Texas (LLM) until about 40 years ago when the population was decimated following a salinity decline in the fall of 1959, another salinity reduction due to Hurricane Carla in 1961, and finally a severe freeze in 1962 (Sorensen 1963). Since that time, there have been no reports of *P. capitatus* in the LLM. During a reconnaissance trip in July 2006, a small population was found in the southern portion of the LLM. The species descriptions by Taylor (1960) and Sorensen (1979) were used in the identification of specimens. Herbarium specimens have been deposited in the herbaria of The University of Texas-Pan American Coastal Studies Laboratory (accession number C012), and the University of Texas at Austin Marine Science Institute.

Penicillus thalli were mostly concentrated on unvegetated, unconsolidated sediment, colloquially termed "potholes" or "blowouts", surrounded by the seagrass *Thalassia testudinum* (hereafter *Thalassia*) in the LLM at (26° 08' 48.7" N, 097° 11' 52.0" W), approximately 7.1 km north of the Brazos-Santiago Pass. Other macroalgae found with *Penicillus* were *Caulerpa mexicana* Sonder ex. Kützing and *C. prolifera* F. *obovata* (Forsskal)

Lamouroux. *Halimeda incrassata*, *Caulerpa prolifera*, and *Codium taylorii* were noted as recent additions to the Laguna Madre (Kaldy 1996; DeYoe & Hockaday 2001). *Penicillus*, *C. prolifera*, and *C. mexicana* were found growing in monotypic stands in an area of the LLM characterized by clear, nutrient-poor water 1.2 to 1.3 m deep (Kaldy & Dunton 1997; Kaldy et al. 2004). Salinity during the July 2006 trip was 37 PSU and water temperature was 31° C. The general area was surveyed and many of these potholes were recently vegetated by *Thalassia* deduced from a rugose appearance of the potholes (caused by dead bundle sheaths) and the presence of dead rhizome material in the sediment. Many of these pothole *Penicillus* plants were found with their holdfasts attached to the bundle sheath material. On this trip *Penicillus* biomass samples were collected in three 9 cm diameter cores (0.006 m^2) driven 10 cm into the seabed. Sediment was washed from the samples through a 1 mm mesh sieve immediately upon return to the lab and stored in sealed plastic bags and refrigerated until processed. Processed samples were dried at 80°C to a constant dry weight and weighed to the nearest 0.001 g, then ashed in a muffle furnace at 500°C and weighed to the nearest 0.001 g. Mean biomass (dry weight) for *Penicillus* was 158.03 g m^{-2} (*SE* = 11.53 g m^{-2}) and AFDW 54.47 g m^{-2} (*SE* = 5.78 g m^{-2}). Sorensen (1963) reported a mean dry weight of 5.14 g per 4 inch diameter core which is equivalent to 634 g m^{-2}.

A second trip to the same area was made on 3 August 2006 to characterize the extent and distribution of *Penicillus* at the site. Three 150 m transects, each separated by 50 m and oriented south to north, were selected that intersected at least one bare area. Along each transect, every 10 to 15 m, two quadrats 25 cm x 25 cm (0.0625 m^2) were haphazardly dropped from each side of the boat. Each quadrat was scored for the presence or absence of *Penicillus* or seagrass and thalli or shoots counted. Approximately one-half of the 56 sampling points along all transects were judged to be predominately bare or sparsely covered by seagrass and one-half were judged to be predominately grassy areas. To test the null hypothesis that there was no difference in the occurrence of *Penicillus* as influenced by bottom type (vegetated vs. unvegetated sediments), quadrat counts were examined using a Chi-square test category one 2 x 2 contingency table (Zar 1999). Alpha was set at 0.05. Quadrat counts of thalli and seagrass density were also converted to a per meter square basis for the purpose of discussion.

From the 56 total quadrat counts made from all three transects, *Penicillus* was found within five quadrats, all within potholes with a mean density of 9.14 thalli m^{-2} ($SE = 4.85$, $n = 56$) and occurred independent of vegetated sediments ($X^2 = 9.08$, $n = 56$, 1 *df*). Although no *Penicillus* were recorded among seagrass shoots within given transects, some were noted among *Thalassia* shoots between transects. Mean *Thalassia* shoot density across all transects was 510 shoots m^{-2} ($SE = 45.03$, $n = 28$). This value is low compared to values found by Herzka & Dunton (1997) and Kaldy & Dunton (2000) at nearby sites at similar depth and season. Seagrass shoot densities encountered here may be influenced by the proximity to the adjacent potholes, especially since pothole formation may be directly related to smothering by drift algae, as suspected in the study area. Drift algal mats were observed overlying seagrass shoots followed by seagrass denudation, and resulting short-shoot stubble. If there is a positive relationship between pothole formation and *Penicillus* recruitment, the result may be an increase in sea bottom available for algal colonization. Without directly stating such, Sorensen (1963) implied that greatest thalli densities (several hundred m^{-2}) occurred on unvegetated sediments. Two potholes were selected in the study area where *Penicillus* density appeared uniformly distributed and counted 30 and 33 thalli per quadrat. This is equivalent to 480 and 528 thalli m^{-2}, respectively. Sorensen (1963) also noted that *Penicillus* was less abundant within seagrass beds, similar to observations made during this study. In subsequent trips to other LLM research sites, *Penicillus* was not found.

Penicillus is a common rhizophytic alga, found primarily in shallow tropical embayments associated with coral and seagrass ecosystems. However, it is also found in shallow subtropical regions (Zieman & Zieman 1989). In addition to its role in ecosystem primary productivity, it and its relatives (*Udotea* sp., *Acetabularia* sp., *Halimeda* sp.) can be responsible for much of the calcium carbonate mud deposited in back-reef areas when present in abundance. To the author's knowledge, the LLM is the northernmost extent of the *P. capitatus* range in the western Gulf of Mexico. Its present day occurrence in the LLM likely results from recent introduction from Mexico combined with several years of moderate winter temperatures and moderate salinities. The same conclusion was reached by DeYoe & Hockaday (2001) for the recent records of *Caulerpa prolifera* F. *obovata* and *Codium taylorii*.

Thorhaug et al. (1971) reported vigorous growth in the laboratory between 15 and 31.5°C, but inability of plants to survive more than nine days below 14 and above 34°C. Field studies from Biscayne Bay, Florida have documented a lower thermal tolerance of 12 to 14°C for *Penicillus* (Biber 2002). Long-term daily integrated water column temperature data from two stations in the LLM (Port Isabel and South Padre Island Coast Guard Station) shows that the minimum winter temperatures were 7.10 (January 1997 - Port Isabel) and 6.30°C (December 1998 - Coast Guard Station) (DNR, 2006). Low water column temperature values over the past ten years in the LLM lasted for less than a week and if *P. capitatus* had already re-established itself between 1997 and 1998 it appears that the lowest LLM temperatures were insufficient in either duration or magnitude to vanquish it from the area again. Highest water column temperatures in the LLM over the same period were 34.1 and 34.4°C, appears to be within the upper temperature tolerance of *P. capitatus*. For the period between September 1994 and February 1998 at a mid-bay location, the lowest salinity was 20.2 PSU during December 1995 (DNR, 2006). Sustained low temperatures and salinity could adversely affect this species (Sorensen 1963) but seemed not to have occurred in the past 10 years.

The re-occurrence of *P. capitatus* in the LLM is notable for two reasons. First, experimental work has shown competitive interactions exist between seagrasses and rhizophytic macroalgae. These include interactions between calcareous green plants, such as *Halimeda incrassata* and *Thalassia* (Davis & Fourqurean 2001) and *C. prolifera* and *Halodule wrightii*, shoalgrass (Taplin et al. 2005; Stafford & Bell 2006). Significant increases in the distribution and abundance of rhizophytic macroalgae in the LLM has the potential to lead to edaphic resource competition between newly invading algae and seagrasses. With little to no root/rhizome fraction to support, rhizophytic algae may have a competitive edge in the LLM where sediment porewater nitrogen and phosphorus pools are often half that of seagrass meadows elsewhere along the Texas coast (Kowalski 1999). Second, calcareous macroalgal species, such as *Halimeda* and *Penicillus*, are capable of sufficient lime mud production to influence porewater nutrient levels. Phosphate ions readily and quickly adsorb to calcium carbonate (aragonite and calcite) and become unavailable for plant uptake (Short et al. 1990). Furthermore, *Penicillus* secretes the aragonite form of calcium carbonate which has 20% more surface area than calcite. Davis & Fourqurean (2001) report that 80% of total plant production by *Halimeda* in Florida Bay was from inorganic carbonate at a rate of about 225g^{-1} m^{-2} $year^{-1}$. Phosphorus limits seagrass growth in Florida Bay, ranging from severe (N to P ratio of 96:1) to moderate (N to P ratio of 63:1) (Armitage et al. 2005) possibly due to high levels of aragonite from *Halimeda*.

The Laguna Madre of Texas has not been as well-studied as other Texas bays or estuaries. It is yet unclear how and why recently discovered (and re-discovered) benthic macroalgae have come to occupy the LLM. The species found recently (*H. incrassata, C. prolifera, C. taylorii* and *P. capitatus*) are benthic and distinctive. It is very possible that other more cryptic species have invaded the LLM from the south but have not yet been discovered. The possible impacts of these recent algal discoveries in the LLM ecosystem deserve study.

ACKNOWLEDGEMENTS

We thank David Kowalski, who discovered the first thallus of *Penicillus*, and Chris Pederson for very able field assistance. Comments by Dr. C. O. Patterson improved the manuscript. This is contribution CSS 07-002 of the Center for Subtropical Studies.

LITERATURE CITED

Armitage, A. R., T. A. Frankovich, K. L. Heck, Jr, & J. W. Fourqurean. 2005. Experimental nutrient enrichment causes complex changes in seagrass, microalgae, and macroalgae community structure in Florida Bay. Estuaries, 28(3):422–434.

Biber, P. 2002. The effects of environmental stressors on the dynamics of three functional groups of algae in *Thalassia testudinum* habitats of Biscayne Bay, Florida, A modeling approach. Unpublished Ph.D. Dissertation, Univ. Miami, Coral Gables, Florida, 367 pp.

Davis, B. C. & J. W. Fourqurean. 2001. Competition between the tropical alga, *Halimeda incrassata*, and the seagrass, *Thalassia testudinum*. Aq. Bot., 71(3):217-232.

Division of Nearshore Research. 2006. TCOON data base (http://lighthouse.tamucc.edu/TCOON/HomePage).

DeYoe, H. R. & Donald L. Hockaday. 2001. Range extensions of the seaweeds *Codium taylorii* and *Caulerpa prolifera* into the Lower Laguna Madre of Texas. Tex. J. Sci., 53(2):190-192.

Herzka, S. Z. & K. H. Dunton. 1997. Seasonal photosynthetic patterns of the seagrass *Thalassia testudinum* in the western Gulf of Mexico. Mar. Ecol. Prog. Ser., 152:103-117.

Kaldy, J. E. 1996. Range extension of *Halimeda incrassata* (Chlorophyta, Bryopsidales): occurrence in the Lower Laguna Madre of Texas. Southwest. Nat., 41(4):419-423.

Kaldy, J. E. & K. H. Dunton. 2000. Above- and below-ground production, biomass and reproductive ecology of *Thalassia testudinum* (turtle grass) in a subtropical coastal lagoon. Mar. Ecol. Prog. Ser., 193:271-283.

Kaldy, J. E., K. H. Dunton, J. L. Kowalski & Kun-S. Lee. 2004. Evaluation of environmental factors controlling the success of seagrass revegetation onto dredged material deposits: a case study in the Lower Laguna Madre, Texas. J. Coast.Res., 20(1):292-300.

Kowalski, J. L. 1999. Production of the subtropical seagrass, *Halodule wrightii* Aschers., in Lower Laguna Madre, Texas. Unpublished MS Thesis, Univ. Tex. - Pan American, Edinburg, Texas, 105 pp.

Littler, D. S. & M. M. Littler. 2000. Caribbean Reef Plants. Offshore Graphics, Inc. Washington, D.C., 542 pp.

Short, F. T., W. C. Dennison & D. G. Capone. 1990. Phosphorus-limited growth of the subtropical seagrass *Syringodium filiforme* in carbonate sediments. Mar. Ecol. Prog. Ser., 62:169-174.

Sorensen, L. O. 1963. Growth and decay of *Penicillus capitatus* Lamarck in the Lower Laguna Madre of Texas. Publ. Mar. Sci. Inst., 9:105-111.

Sorensen, L. O.. 1979. A Guide to the Seaweeds of South Padre Island, Texas. Gorsuch Scarisbrick, Publishers, Dubuque, Iowa, 123 pp.

Stafford, N. B. & S. S. Bell. 2006. Space competition between seagrass and *Caulerpa prolifera* (Forskaal) Lamouroux following simulated disturbances in Lassing Park, Fl. J. Exp.Mar. Biol. Ecol., 333(1):49-57.

Taplin, K. A., E. A. Irlandi & R. Raves. 2005. Interference between the macroalga *Caulerpa prolifera* and the seagrass *Halodule wrightii*. Aq. Bot., 83(3):175-186.

Taylor, W. R. 1960. Marine Algae of the Eastern Tropical and Subtropical Coasts of the Americas. University of Michigan Press, Ann Arbor Michigan, 460 pp.

Thorhaug, A., T. Devany, J. C. Bauer & S. Pepper. 1971. The effect of temperature on *Penicillus capitatus* survival in laboratory and field investigations. J. Phycol., 7(5):5-6.

Zar, J. H. 1999. Biostatistical Analysis. Second Edition. Prentice Hall, New Jersey, 663 pp.

Zieman, J. C. & R. T. Zieman. 1989. The Ecology of the Seagrass meadows of the West Coast of Florida: A Community Profile. Volume Biological Report 85(7.25). U. S. Department of the Interior - Fish and Wildlife Service Research and Development, Washington, D. C., ____ pp.

JLK at: kowalski@utpa.edu