# Calcareous periphyton assemblages of the northern part of Florida Everglades

## Kalcifikovaná nárostová společenstva v severní části floridských Everglades

Jan Vymazal

*Říčanova 40, 169 00 Praha 6*

**Abstrakt**

Kalcifikovaná nárostová společenstva jsou běžnou součástí řasové flóry floridských Everglades. Výskyt kalcifikovaných nárostů je ovlivněn především kvalitou vody (zejména koncentrací fosforu) a hydrologickými poměry. Nejčastěji se vyskytují v oblastech, které nejsou zasaženy přísunem živin z přilehlé zemědělské oblasti, tj. v oblastech s koncentrací celkového fosforu < 10 µg $l^{-1}$ v tzv. „slough", což jsou oblasti, které prakticky nikdy nevysychají. Sušina těchto nárostů dosahuje hodnot >3000 g $m^{-2}$, což je způsobeno vysokou koncentrací vápníku v sušině (až 30%). Tím je ovlivněn i obsah popelovin v sušině, který je většinou > 50%, ale často bývá i > 80%. Bylo prokázáno, že na některých rostlinách je přítomno vždy velké množství nárostů (*Eleocharis* spp., *Utricularia* spp.), zatímco na jiných druzích (např. *Nymphaea odorata*) je nárostů velmi málo. Kalcifikované nárosty jsou velmi důležitou součástí ekosystému, především jako součást potravního řetězce a jako základ pro tvorbu dnových sedimentů, tzv. marl.

Calcareous periphyton is a very characteristic feature of the Everglades ecosystem. Within the Everglades three types of calcareous periphyton are recognized: calcareous blue-green, calcareous diatom-rich, and calcareous green (BROWDER et al. 1994). All are calcareous periphyton because of their high inorganic component, no less than 49% by mass (BROWDER et al. 1981, 1982). Based on statistical comparison by BROWDER et al. (1981), blue-green periphyton is considered to be any calcareous periphyton comprised of greater that 80% blue-green algae, by cell volume, during the latter part of the wet season. The term diatom-rich periphyton is used to label calcareous periphyton communities with a substantial diatom component. Periphyton communities are considered to be diatom-rich if their cell volume consists of less than 80% blue-green algae and diatoms make up a greater proportion of cell volume than greens (BROWDER et al. 1994). Green periphyton contains less than 80% cell volume as blue-green algae and a larger volume of green algae and desmids than diatoms. To conform to the definition given by VAN-METER KASANOF (1973), the green algal component includes desmids, particularly *Pleurotaenium*. The desmids in calcareous green periphyton are not the same acid water species as those described by GLEASON & SPACKMAN (1974) and SWIFT & NICHOLAS (1987). Rather, they are a less speciose group that tolerates hard water (BROWDER et al.1994).

Water quality and hydroperiod are the major factors that appear to influence the species composition and growth rates of Everglades periphyton communities (VAN METER 1965, GLEASON 1972, GLEASON & SPACKMAN 1974, WOOD AND MAYNARD 1974, SWIFT 1981, 1984, SWIFT & NICHOLAS 1987, BROWDER et al. 1981, FLORA et al. 1988, RADER & RICHARDSON 1992, MCCORMICK et al. 1998, PAN et al. 2000, VYMAZAL et al. 2000, 2001).

Calcareous periphyton is abundant in areas of the Everglades that retain the historic oligotrophic conditions of the marsh with total P concentrations < 10 μg $l^{-1}$ while in areas with elevated P concentrations calcareous mat is replaced by filamentous green algae which produce no or little calcification. In oligotrophic areas periphyton biomass on an areal basis can reach values which are comparable or higher than that of macrophytes. GLEASON & SPACKMAN (1974) reported total periphyton biomass (excluding the epipelon) in the Water Conservation Area 1 (WCA-1) in the range of 40 to 225 g AFDM (Ash free dry matter) $m^{-2}$ and up to 447 g DM (Dry matter) $m^{-2}$. VAN METER (1965) reported DM up to 351 g $m^{-2}$ from Taylor and Shark River sloughs in Everglades National park (ENP). Also BROWDER et al. (1982) reported up to 2682 g DM $m^{-2}$ and 526 g AFDM $m^{-2}$ from open water areas of southern ENP. The highest rates of periphyton productivity in the Everglades usually occur in sloughs (sloughs are the deepest natural habitats found in WCAs which may dry out only during most severe drought events; sloughs are dominated by *Eleocharis* spp., *Nymphaea odorata* and *Utricularia* spp.). MCCORMICK et al. (1998) found areal periphyton biomass in the range of 100 to 1600 g AFDM $m^{-2}$ in oligotrophic sloughs and in stands of *Eleocharis*, but periphyton biomass was low in adjacent sawgrass (*Cladium jamaicense*) stands (7-52 g AFDM $m^{-2}$). Also VYMAZAL & RICHARDSON (unpubl. results) found periphyton biomass in southern WCA-2A sloughs up to 3300 g DM $m^{-2}$ and 1340 g AFDM $m^{-2}$. The higher periphyton biomass in open water sloughs as compared to dense stands of *Cladium* is primarily caused by low light availability in dense stands. Numerous results from the Everglades indicate that AFDM values comprise usually < 50% of dry matter and very often < 20% of dry matter values (e.g., WOOD & MAYNARD 1974, BROWDER et al. 1994, VYMAZAL & RICHARDSON 1995). The $CaCO_3$ content of the calcareous periphyton is high and may amount to values as high as 80% of the biomass (VAN METER-KASANOF 1973, WOOD & MAYNARD 1974, VYMAZAL & RICHARDSON 1995).

Calcareous periphyton shows a preference for some plant species over others (VAN METER 1965, GLEASON & SPACKMAN 1974, BROWDER et al.1994, VYMAZAL & RICHARDSON 1995). Among plants which are readily coated by periphyton belong *Eleocharis cellulose, E. elongata* (spikerush), *Utricularia purpurea* (purple-flowered bladderwort), *Bacopa caroliniana* (lemon bacopa) or *Rhynchospora* spp. (beakrush). An example of plants which encrust only very little is represented by *Nymphaea odorata* (white water lily) or *Eriocaulon* *compressum* (pipewort). VYMAZAL & RICHARDSON (1995) reported that periphyton biomass growing on *Eleocharis elongata* was about 20 times higher on stem surface basis as compared to periphyton biomass growing on peduncles of *Nymphaea odorata* in southern WCA-2A. VAN METER-KASANOF (1973) reported that periphyton cylinder on stems in the southern Everglades ranged from 0 to 50 mm in diameter. GLEASON & SPACKMAN (1974) reported periphyton cylinder diameter values up to 63 mm while WOOD & MAYNARD (1974) reported algal mats as thick as 100 mm in parts of the southern Everglades. Periphyton could also be found in the form of floating mats which are not attached to any plants.

The most frequent species in the oligotrophic areas are diatoms *Mastogloia smithii* and *Amphora coffaeformis* and cyanobacteria of the genera *Leptolyngbya, Scytonema* and *Phormidium*. In more eutrophic areas species of the genera *Lyngbya, Spirogyra* and *Oedogonium* are the most abundant

Periphyton communities probably represent a major component of the detrital-based Everglades food web providing organic food matter and habitat for a wide variety of grazing invertebrates and foraging fish (CRAIGHEAD 1971, CARTER et al. 1973, WOOD & MAYNARD 1974, BROWDER et al. 1981). Periphyton photosynthesis and respiration play an important role in controlling diurnal pH, dissolved oxygen, carbon dioxide and calcium concentration within marsh surface waters (GLEASON 1972, GLEASON & SPACKMAN 1974, WILSON 1974). Algal photosynthesis accounts for a large portion of calcium precipitation within the marsh and is responsible for the formation of marl soils within the southern Everglades (GLEASON 1972, GLEASON & SPACKMAN 1974, VYMAZAL & RICHARDSON 1995). The calcareous periphyton deposits marl (calcitic mud), is the second most common soil sediment type (190,000 ha) in the Everglades (GLEASON & SPACKMAN 1974). GLEASON & SPACKMAN (1974) concluded that the aerial extent of calcareous periphyton is impressive, being found abundantly in all of the WCA's, the Everglades National Park (ENP), the Big Cypress National Preserve, and the inland prairies of the southern coast, the largest expanses being found in WCA-3 and the ENP.

## References

BROWDER, J. A., GLEASON,P.J. & SWIFT, D.R. (1994): Periphyton in the Everglades: spatial variation, environmental correlates, and ecological implications. - In: DAVIS, S.M. & OGDEN, J.C. (EDS.), Everglades: the Ecosystem and its Restoration, Delray Beach, Florida: St. Lucie Press, 379-418.

BROWDER, J. A., BLACK, S., SCHROEDER, P., BROWN, M., NEWMAN, M., COTTRELL, D., BLACK, D., POPE, R. & POPE, P.1981. Perspective on the Ecological Causes and Effects of the Variable Algal Composition of Southern Everglades Periphyton, Homestead, Florida: Report T-643, South Florida Research Center.

BROWDER, J.A., COTTRELL, D., BROWN, M., NEWMAN, M., EDWARDS, R., YUSKA, J., BROWDER, M. & KRAKOSKI, J. (1982): Biomass and Primary Production of Microphytes and Macrophytes. In Periphyton Habitats of the Southern Everglades, Homestead, Floruida: Report No. T-662, South Florida Research Center.

CARTER, M. R., BURNS, L.A., CAVINDER,T.R., DUGGER, K.R., FORE, P.L., HICKS, D.B., REVELLS, H.L. & SCHMIDT, T.W. (1973): Ecosystem Analysis of the Big Cypress Swamp and Estuaries. Atlanta, Georgia: U. S. EPA 904/9-74-002, Region IV.

Craighead, F. C. 1971. The Trees of South Florida. University of Miami Press, Coral Gables, Florida.

FLORA, M. D., WALKER, D.R., SCHEIDT, D.J., RICE, R.G. & LANDERS, D.H. (1988): The Response of the Everglades Marsh to Increased Nitrogen and Phosphorus Loading. Part I: Nutrient Dosing, Water Chemistry and Periphyton Productivity. Homestead, Florida: Report to the Superintendent, Everglades National Park.

GLEASON, P. J. (1972): The origin, sedimentation, and stratigraphy of a calcite mud located in the southern freshwater Everglades. Ph.D. Dissertation, Pennsylvania State University, University Park, PA.

GLEASON, P. J. & SPACKMAN,W. JR. (1974): Calcareous periphyton and water chemistry in the Everglades. – In: Gleason, P.J. (ed.), Environments of South Florida, Present and Past, Miami, Florida: Miami Geological Society, 146-181.

MCCORMICK, P.V., SHUFFORD, R.B.E.,III., BACKUS, J.G. & KENNEDY,W.C. (1998): Spatial and seasonal patterns of periphyton biomass and productivity in the northern Everglades, Florida, U.S.A. - Hydrobiologia 362: 185-208.

PAN,Y., STEVENSON, R.J., VAITHIYANATHAN, P., SLATE, J. & RICHARDSON, C.J. (2000): Changes in algal assemblages along observed and experimental phosphorus gradients in a subtropical wetland, U.S.A. - Freshwater Biology 44: 339-353.

RADER, R. B. & RICHARDSON, C.J. (1992): The effects of nutrient enrichment on algae and macroinvertebrates in the Everglades: a review. *Wetlands* 12 :121-135.

SWIFT, D. R. (1981): Preliminary investigations of periphyton and water quality in the Everglades Water Conservation Areas. Technical Publication 81-05. West Palm Beach, Florida: South Florida Water Management District.

SWIFT, D. R. (1984): Periphyton and water quality relationships in Everglades Water Conservation Areas. – In: Gleason, P.J. (ed.), Environments of South Florida, Present and Past II, Miami, Florida: Miami Geological Society, 97-117.

SWIFT, D. R. & NICHOLAS, R.B. (1987): Periphyton and water quality relationships in the Everglades water conservation areas: 1978-1982. Technical Publication 87-2. West Palm Beach, Florida: South Florida Water Management District,

VAN METER, N. 1965. Some quantitative and qualitative aspects of periphyton in the Everglades. M. Sc. Thesis, University of Miami, Coral Gables, Florida.

VAN METER-KASANOF, N.N. (1973): Ecology of the micro-algae of the Florida Everglades. Part 1. Environment and some aspects of freshwater periphyton, 1959-1963. - Nowa Hedwigia 24:619-664.

VYMAZAL, J. & RICHARDSON, C.J. (1995): Species composition, biomass, and nutrient content of periphyton in the Florida Everglades. - J. Phycol. 31:343-354.

VYMAZAL,J., KOMÁRKOVÁ,J., KUBEČKOVÁ,K., KAŠTOVSKÝ,J. & ZNACHOR,P. (2000): Species composition of periphyton growing on natural and artificial substrata along C-transect of the Everglades WCA-2A. Part I: Comparison of species abundance. Final Report to Duke University Nicholas School of the Environment and Earth Sciences Wetland Center, North Carolina, USA.

VYMAZAL, J., KOMÁRKOVÁ, J., KUBEČKOVÁ, K., KAŠTOVSKÝ, J. & BASTL, M. (2001): Species composition of periphyton growing on natural and artificial substrata along C-transect of the Everglades WCA-2A. Part II: Periphyton biovolume and biomass. Final Report to Duke University Nicholas School of the Environment and Earth Sciences Wetland Center, North Carolina, USA.

WILSON, S.U. (1974): Metabolism and biology of a blue-green algal mat. M. S. Thesis, University of Miami, Florida.

WOOD, E. J. F. & MAYNARD,N.G. (1974): Ecology of the micro-algae of the Florida Everglades. – In: GLEASON, P.J. (ed.): Environments of South Florida, Present and Past, Miami, Florida: Miami Geological Society, 123-145.