Inventory of macroalgal epiphytes on the seagrass *Thalassia testudinum* (Hydrocharitaceae) in Parque Nacional Cahuita, Caribbean coast of Costa Rica

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Abstract: Seagrass epiphytes play an important role in seagrass habitats; however, available information from Central America is scarce. The present study focuses on macroalgal epiphytes on leaves of the seagrass *Thalassia testudinum* in the seagrass meadows at Punta Cahuita, Caribbean coast of Costa Rica, and it is the first one of its kind in Costa Rica. A representative amount for each algal epiphyte species found was collected, preserved and identified to the lowest possible taxon. Preserved samples of each species were deposited in the Herbarium of the Universidad de Costa Rica. A total of 26 species of macroalgae were found: 15 species belonging to Rhodophyta, four to Chlorophyta, six to the class Phaeophyceae, and one diatom species which could not be identified. The present inventory reports three species that are new for the phycological flora of Costa Rica, four species are reported for the first time for the Caribbean coast of Costa Rica, and 17 are new reports for the Parque Nacional Cahuita area. Epiphyte species number might further rise if sampling efforts and the study area increased. Rev. Biol. Trop. 56 (Suppl. 4): 163-174. Epub 2009 June 30.

Key words: epiphytes, algae, seagrass, *Thalassia testudinum*, Cahuita, Costa Rica.

Seagrass systems serve as a nursery habitat for early life stages of many commercially important species that seek protection from predators. They are also important as a feeding ground for sea turtles, certain fish, sea urchins, and manatees among others (Humm 1964, Hemminga & Duarte 2000). Moreover, these meadows can promote sediment deposition and also avoid resuspension of sediments and suspended particulate matter, which in turn contributes to the stabilization of the coast (Phillips & Meñez 1988, Hemminga & Duarte 2000, Corlett & Jones 2007).

Seagrass leaves provide a suitable substrate for macroalgae found as epiphytes, which are just as important, if not more, as primary producers and basis for a variety of grazers (Humm 1964, Ballantine & Humm 1975, Heijs 1984, van Montfrans *et al.* 1984, Moncreiff *et al.* 1992, Armitage *et al.* 2006). Epiphytes can also serve as a protection layer for seagrasses from excessive UV radiance, and diminish desiccation effects during periods of exposure to air (van Montfrans *et al.* 1984, Littler & Littler 1999). On the other hand, epiphyte load on submersed macrophytes increases as leaf age increases (Humm 1964), and is determined by colonization rate and lifespan of the leaf (Heijs 1984). As epiphyte load increases, it can negatively affect seagrasses mainly by (1) diminishing photosynthesis due to competition for light, (2) competing for nutrients, and by (3) complete or partial leaf loss due to epiphyte related senescence, hervibory, and other biotic factors, and/or increased hydrodynamic drag by waves, currents, storms, and other abiotic

factors (Heijs 1984, van Montfrans *et al.* 1984, Littler & Littler 1999, Drake *et al.* 2003).

The most widely distributed seagrass in the Caribbean is *Thalassia testudinum* Banks ex König, which provides ample substrate for algal epiphytes (Humm 1964, Cho *et al.* 2002, Barrios & Díaz 2005, Corlett & Jones 2007). The seagrasses in Parque Nacional Cahuita have been scarcely studied in recent years, focusing primarily on biomass, productivity, and seasonality of reproduction in *T. testudinum* (Paynter *et al.* 2001, Fonseca *et al.* 2007, Nielsen 2007). Our knowledge regarding seagrass epiphytes from the Caribbean of Costa Rica is extremely limited. The only report of macroalgae as seagrass epiphytes was published by Kemperman (1986), who mentioned the substrate of two macroalgal species from the Caribbean of Costa Rica.

The present study aims to provide an inventory of algal species found as epiphytes on *T. testudinum* leaves in the seagrass meadows at Parque Nacional Cahuita. The results may contribute to a more complete picture of the algal diversity of the Caribbean coast of Costa Rica, and aims to serve as a first step for a better understanding of the ecological processes governing the dynamics of seagrass meadows in the area.

MATERIALS AND METHODS

The study area (Fig. 1) is located in the seagrass meadows dominated by the turtle grass *T. testudinum* (for review of seagrasses in Costa Rica, see Cortés & Salas 2008) at Punta Cahuita (9°44'; 82°48'), Caribbean coast of Costa Rica. This site was selected due to the presence of abundant and highly productive seagrass meadows (Paynter *et al.* 2001). Four 50m transects were positioned parallel to the coast, and among each other, at an increasing distance from the coast line (50, 100, 150 and 200m from the coast, respectively). The depth varied between 0.3 and 2.5m, not necessarily in response to distance to the shore, but related to seagrass patch distribution. Sampling was carried out in March, June and September of 2006.

When examining the above-mentioned transects, a representative amount of *T. testudinum* leaves, which contained different species of algal epiphytes, were collected. Samples were preserved in formaldehyde 3%

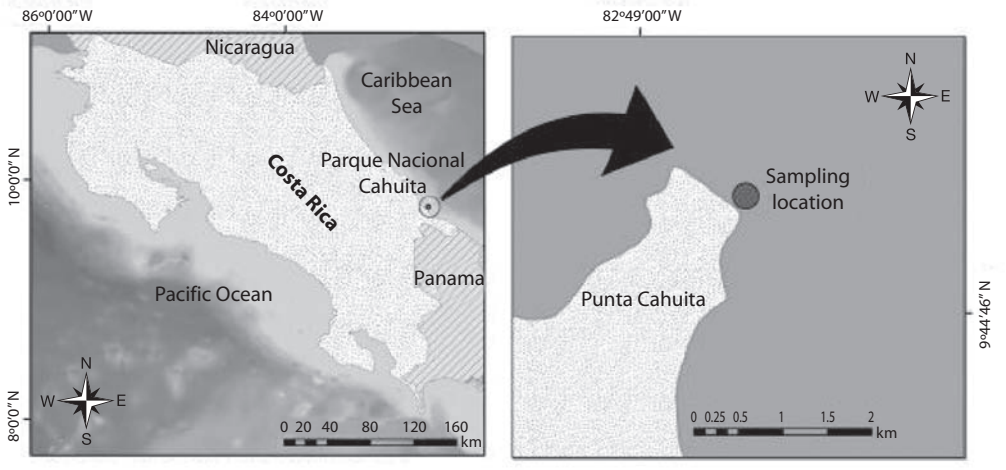

Fig. 1. Location of the study site at Parque Nacional Cahuita, Caribbean coast of Costa Rica.

in sea water, transported to the laboratory at the Universidad de Costa Rica, San José, and identified to the lowest possible taxon. Some of the species could not be identified due to the small amount of material found on the leaves; juvenile forms were excluded from species identification when lacking the necessary structures for identification. The following publications were used for species identification: Taylor (1960), Dawson (1962) and Littler & Littler (2000). Representatives of each algal species found were deposited in the Herbarium (USJ) of the Escuela de Biología, Universidad de Costa Rica.

According to personal observations and unpublished data by the first two authors, the abundance of the species was arbitrarily grouped into the following categories: very abundant (present in all three sample dates and in large quantities), abundant (found only in one-two sample dates and not in large quantities), and rare (found only once during sample period and in small quantities).

RESULTS

A total of 26 species of macroalgae (18 genera) were found as epiphytes on *T. testudinum* leaves (Table 1). Fifteen species belonged to Rhodophyta, four to Chlorophyta, six to Phaeophyceae, and one species of sheathed diatoms which could not be identified. Four species represent new records for the Caribbean coast of Costa Rica, and 17 species are reported for the first time in Parque Nacional Cahuita (Table 1). Furthermore, three species are reported for the first time for the phycological flora of Costa Rica (*Bryopsis pennata*, *Champia salicornioides,* and *Kützingiella elachistaeformis*).

The most frequently encountered species (Table 1) in our study were *Titanoderma pustulatum* and *Pneophyllum fragile* (red coralline encrusting forms), followed by *Dictyota cervicornis* and *D. pulchella* (brown algae), and *Ceramium flaccidum*, *Champia salicornioides*, and *Wrangelia bicuspidata* (red algae).

The following is a list of all epiphyte species found during the study. It includes the collection number for material deposited in the Herbarium of the Escuela de Biología, Universidad de Costa Rica, and information concerning distribution and known habitat for each species.

World Distribution Code: A = Antarctic; AA = Australasia; C = Caribbean; CEP = Central East Pacific; EA= eastern Atlantic; HW = Hawaiian Islands; I = Indian Ocean; M = Mediterranean; NEA / NEP = northeastern Atlantic / Pacific; NWA / NWP = northwestern Atlantic / Pacific; RS = Red Sea; SEA / SEP = southeastern Atlantic / Pacific; SWA /SWP = southwestern Atlantic / Pacific; WA /WP = western Atlantic / Pacific

CHLOROPHYTA
Class Bryopsidophyceae
Family Bryopsidaceae

Bryopsis hypnoides J.V. Lamouroux
USJ - 73886

World distribution: NEA, SEA, NWA, C, SWA, M, RS, I, CEP, HW, SEP, AA (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater Antilles, southern and eastern Caribbean, and Gulf of Mexico (Littler & Littler 2000).

Habitat: Mangrove prop roots or other hard substrates, coral fragments and other hard substrates. Lower intertidal to 1m depth, wave beaten (Littler & Littler 2000, Bernecker 2008).

* *Bryopsis pennata* J.V. Lamouroux
USJ - 73914

World distribution: SWA, C, I, CEP (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).

Habitat: Mangrove prop roots or other solid substrate, rocks. Shallow waters, lower intertidal to 5m depth (Littler & Littler 2000, Bernecker 2008).

*New record for Costa Rica.

TABLE 1

List and frequency of occurrence of macroalgal epiphytes encountered in the present study related to the species lists available for Cahuita, Caribbean coast of Costa Rica, and species previously reported as epiphytes on seagrasses

Taxa	Occurrence	Cahuita	Caribbean coast	Epiphyte on seagrasses
CHLOROPHYTA				
Bryopsis hypnoides	rare	*	Bernecker 2008	na
†*Bryopsis pennata*	rare	*	Kemperman 1986‡, Bernecker 2008‡	na
Chaetomorpha linum	rare	*	Kemperman 1986, Bernecker 2008	na
Cladophora albida	rare	*	*	na
PHAEOPHYTA				
Dictyopteris delicatula	rare	Wellington 1974, Kemperman 1986	Kemperman 1986, Soto & Ballentine 1986, Bernecker 2008	na
Dictyota cervicornis	very abundant	Wellington 1974	Soto & Ballentine 1986, Bernecker 2008	na
Dictyota mertensii	rare	Dawson 1962, Kemperman 1986	Kemperman 1986, Bernecker 2008	Bernecker 2008
Dictyota pulchella	very abundant	*	Bernecker 2008	Littler & Littler 2000, Bernecker 2008
Hincksia mitchelliae	rare	*	Bernecker 2008	na
†*Kuetzingiella elachistaeformis*	rare	*	*	Humm 1964, Littler & Littler 2000
RHODOPHYTA				
Amphiroa fragilissima	rare	Wellington 1974	Kemperman 1986, Soto & Ballentine 1986, Bernecker 2008	Frankovich & Fourqurean 1997
Ceramium brevizonatum	rare	Kemperman 1986	Kemperman 1986, Bernecker 2008	Bernecker 2008
Ceramium brevizonatum var. *caraibicum*	abundant	*	*	na
Ceramium cimbricum	rare	*	Bernecker 2008	na
Ceramium flaccidum	very abundant	*	Bernecker 2008	Littler & Littler 2000, Bernecker 2008
†*Champia salicornioides*	very abundant	*	*	Littler & Littler 2000

TABLE 1 (Continued)

List and frequency of occurrence of macroalgal epiphytes encountered in the present study related to the species lists available for Cahuita, Caribbean coast of Costa Rica, and species previously reported as epiphytes on seagrasses

Taxa	Occurrence	Cahuita	Caribbean coast	Epiphyte on seagrasses
Crouania attenuata	rare	Kemperman 1986	Kemperman 1986, Bernecker 2008	Humm 1964, Bernecker 2008
Herposiphonia secunda	rare	*	Kemperman 1986, Bernecker 2008	Littler &Littler 2000, Barrios & Díaz 2005, Bernecker 2008
Hypnea spinella	abundant	Kemperman 1986, Wellington 1974	Kemperman 1986, Soto & Ballentine 1986, Bernecker 2008	Barrios & Díaz 2005, Bernecker 2008
Jania capillaceae	rare	*	Kemperman 1986, Bernecker 2008	Humm 1964, Littler & Littler 2000, Bernecker 2008
Pneophyllum fragile	very abundant	*	Bernecker 2008	Littler &Littler 2000, Bernecker 2008
Polysiphonia c.f. *howei*	rare	*	Kemperman 1986, Bernecker 2008	Littler & Littler 2000, Bernecker 2008
Titanoderma pustulatum	very abundant	*	Bernecker 2008	Littler & Littler 2000, Bernecker 2008
Wrangelia argus	abundant	Wellington 1974	Kemperman 1986, Soto & Ballentine 1986, Bernecker 2008	Humm 1964, Littler & Littler 2000, Barrios & Díaz 2005, Bernecker 2008
Wrangelia bicuspidata	abundant	*	Bernecker 2008	Bernecker 2008
BACILLARIOPHYCEAE				
Sheathed diatoms	rare	-	-	-

† new report for Costa Rica.
* new report for Cahuita or the Caribbean coast of Costa Rica.
na: no information available.
‡ species reported: *Bryopsis pennata* var. *leprieurii*.

Class Ulvophyceae
Family Cladophoraceae

Chaetomorpha linum (O.F. Müller) Kützing
USJ - 73848

World distribution: NEA, SEA, NWA, C, M, SWA, RS, I, NWP, NEP, SWP, CEP, SEP, AA, A (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).

Habitat: As mats or mounds lying free in high-nutrient areas (near bird islands); up to 3m deep (Littler & Littler 2000).

Cladophora albida (Nees) Kützing
USJ - 73900

World distribution: NEA, NWA, NEP, SWA, C, AA, NWP, M (Guiry & Guiry 2007). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).

Habitat: In protected or wave-exposed areas, on hard substrates. Upper intertidal down to 3m depth (Littler & Littler 2000).

PHAEOPHYTA
Family Acinetosporaceae

Hincksia mitchelliae (Harvey) P.C. Silva
USJ - 73885

World distribution: NEA, EA, NWA, SWA, C, M, RS, I, WP, NEP, SEP, HW, SWP, AA (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).

Habitat: Inconspicuous, on rocks, hard substrates or epiphytic on other algae, often found as brown fuzz on mangrove prop roots. Less than 1m depth (Littler & Littler 2000, Bernecker 2008).

Family Dictyotaceae

Dictyopteris delicatula J.V. Lamouroux
USJ - 73869, 73870, 73879

World distribution: SEA, NEA, SWA, C, I, NEP, NWP, SWP, AA (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).

Habitat: On mangrove prop roots, coral fragments or other hard substrates; from intertidal down to 12m, rarely 30m deep (Littler & Littler 2000, Bernecker 2008).

Dictyota cervicornis Kützing
USJ - 73853, 73857, 73867, 73906, 73920, 73922, 73923, 73924

World distribution: SEA, NEA, SWA, C, I, RS, NWP, SWP (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).

Habitat: Attached to rocks, coral fragments, shell fragments or large plants in sandy shallow areas. Down to 3m depth (Littler & Littler 2000, Bernecker 2008).

Dictyota mertensii (Martius) Kützing
USJ - 73921, 73925

World distribution: SEA, NEA, C, NWP, SWP (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, and southern Caribbean (Littler & Littler 2000).

Habitat: In moderately wave-exposed areas where fish grazing is minimal; epiphytic. Intertidal down to 15m depth (Littler & Littler 2000, Bernecker 2008).

Dictyota pulchella Hörnig and Schnetter
USJ-73845, 73847, 73872, 73905, 73906, 73911, 73916, 73919, 73926

World distribution: SEA, NEA, C (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).

Habitat: On dead coral, shell fragments, other hard substrates, mangrove peat or epiphytic on seagrass and coarse algae; in shallow areas with calm water. Intertidal down to 70m depth (Littler & Littler 2000, Bernecker 2008).

Family Ectocarpaceae

*† *Kuetzingiella elachistaeformis*
(Heydrich) M. Balakrishnan and Kinkar
USJ - 73908
as *Ectocarpus elachistaeformis* Heydrich

World distribution: NWA, SWA, M, AA (Guiry & Guiry 2007). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).

Habitat: Inconspicuous, epiphytic on coarse algae, seagrasses or mangrove prop roots. Intertidal down to 1m depth (Littler & Littler 2000).

*New record for Costa Rica.

† *Ectocarpus elachistaeformis* Heydrich is currently a synonym of *Kuetzingiella elachistaeformis* (Heydrich) M. Balakrishnan and Kinkar (see Balakrishnan & Kinkar 1981).

RHODOPHYTA
Class Florideophyceae
Family Corallinaceae

Amphiroa fragilissima (Linnaeus) J.V. Lamouroux
USJ - 73877, 73878

World distribution: NEA, SEA, NWA, SWA, C, M, RS, I, CEP, SEP, HW, SWP, AA (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).

Habitat: Lightly attached to hard substrate, in crevices, amongst seagrasses or other algae. Down to 60m depth (Littler & Littler 2000, Bernecker 2008).

Jania capillaceae Harvey
USJ- 82580

World distribution: SEA, NEA, NWA, SWA, C, RS, I, CEP, SWP (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).

Habitat: Epiphyte on other marine plants, in calm waters. Down to 15m depth (Littler & Littler 2000, Bernecker 2008).

Pneophyllum fragile Kützing
USJ - 73511, 73517, 73873, 73874, 73875, 73876, 73887, 73896, 73897, 73898, 73901, 73910, 73913

World distribution: NEA, NWA, SWA, C, M, RS, I, NWP, CEP, AA (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).

Habitat: Inconspicuous, epiphytic on macroalgae or seagrasses. Down to 10m depth (Littler & Littler 2000, Bernecker 2008).

Titanoderma pustulatum
(J.V. Lamouroux) Nägeli
USJ - 73510, 73873, 73874, 73875, 73876, 73887, 73896, 73897, 73898, 73901, 73910

World distribution: NEA, SWA, NWA, C, M, I, RS, NEP, SWP, AA, A (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).

Habitat: Epiphytic on seagrasses or coarse algae. Down to 5m depth (Littler & Littler 2000, Bernecker 2008).

Family Ceramiaceae

Ceramium brevizonatum H.E. Petersen
USJ- 82579

World distribution: SWP, I (Bernecker 2008). Caribbean distribution: not available.
Habitat: epiphytic (Bernecker 2008).

Ceramium brevizonatum var. *caraibicum*
H.E. Petersen & Børgesen
USJ-73852, 73889, 73915

World distribution: NWA, C, SWA, I (Guiry & Guiry 2007). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).
Habitat: On dead coral or epiphytic on other algae; down to 1m depth (Littler & Littler 2000).

Ceramium cimbricum
H.E. Petersen
USJ - 73852, 73889, 73915

World distribution: NEA, M, C, NEP, NWP, I, AA, SEP (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).
Habitat: Entangled or epiphytic on coarser algae, on mangrove prop roots or other submerged wood. Down to 40m depth (Littler & Littler 2000, Bernecker 2008).

Ceramium flaccidum
(Harvey ex Kützing) Ardissone
USJ-73854, 73861, 73864, 73865, 73866, 73871, 73890, 73892, 73893, 73917

World distribution: NWA, SWA, M, C, NEA, I, SEA, HW, SWP, SEP, AA, CEP (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and the Gulf of Mexico (Littler & Littler 2000).
Habitat: Epiphytic on seagrasses or coarser or coarser algae, on submerged wood. Down to 22m depth (Littler & Littler 2000, Bernecker 2008).

Crouania attenuata
(C. Agardh) J. Agardh
USJ-73899

World distribution: C, M, NEA, NWP, SWP, I, AA, SEP, CEP, RS (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean (Littler & Littler 2000).
Habitat: Inconspicuous, often tangled among coarser species, epiphytic. Down to 20m depth (Littler & Littler 2000, Bernecker 2008).

Wrangelia argus (Montagne) Montagne
USJ-73858, 73880

World distribution: SEA, NEA, C, SWA, NWA, I, SWP, AA (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).
Habitat: Frequently covering large areas on rocky substrates or epiphytic on coarser plants. Down to 10m depth (Littler & Littler 2000, Bernecker 2008).

Wrangelia bicuspidata Børgesen
USJ-73443, 73854, 73881

World distribution: C, SWP, NWP, I (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).
Habitat: Epiphytic on larger algae. Down to 40m depth (Littler & Littler 2000, Bernecker 2008).

Family Hypneaceae

Hypnea spinella (C. Agardh) Kützing

USJ-73849, 73856, 73882, 73883, 73884, 73909

World distribution: SEA, NEA, SWA, NWA, C, M, RS, I, HW, SWP, SEP, AA (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).

Habitat: On rocks, coral fragments or epiphytic on larger seaweeds. Intertidal down to 30m depth (Littler & Littler 2000, Bernecker 2008).

Family Rhodomelaceae

Herposiphonia secunda (C. Agardh) Ambronn

USJ-73846

World distribution: C, SWA, NWA, SEA, NEA, M, CEP, SWP, NWP, I, HW, AA (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and Gulf of Mexico (Littler & Littler 2000).

Habitat: On hard substrates, or epiphytic on larger plants and animal. High intertidal down to 2m depth (Littler & Littler 2000, Bernecker 2008).

Polysiphonia c.f. *howei* Hollenberg

USJ-73893

World distribution: SWA, NWA, C, SEA, NEA, SWP, I, AA, CEP, HW (Bernecker 2008). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles, southern and western Caribbean, and the Gulf of Mexico (Littler & Littler 2000).

Habitat: On rocks and other hard surfaces, or epiphytic on seagrasses and larger algae. Intertidal to shallow subtidal (Littler & Littler 2000, Bernecker 2008).

Family Champiaceae

**Champia salicornioides* Harvey

USJ-73844, 73859, 73862, 73863, 73888, 73894, 73895, 73903

World distribution: AA, I, SEA, SWA, C, NWA, NWP (Guiry and Guiry 2007). Caribbean distribution: Florida, Bahamas, Greater and Lesser Antilles and southern Caribbean (Littler & Littler 2000).

Habitat: Attached to hard substrates or epiphytic on seagrasses or other algae; down to 27m depth (Littler & Littler 2000).

*New record for Costa Rica.

Phylum HETEROKONTOPHYTA

Class Bacillariophyceae

Sheathed Diatoms

USJ-73901, 73904, 73907, 73912, 73917, 73918

Specimens of sheathed diatoms were found forming groups of algae visible to the unaided eye in the field, but species identification was not possible.

DISCUSSION

The present study represents the first specific contribution on seagrass epiphytes in the Caribbean of Costa Rica. Previously, Kemperman (1986) reported *Sphacelaria tribuloides* Meneghini and *Polysiphonia gorgoniae* Harvey as epiphytic on seagrasses in Puerto Vargas at Cahuita; however, neither species was encountered during this study.

The dominance of red coralline encrusting species in our study (*Titanoderma pustulatum* and *Pneophyllum fragile*) coincides with previous studies in which coralline algae dominated as epiphytes on seagrass leaves (Humm 1964, Corlett & Jones 2007). Humm (1964) found that coralline algae (e.g., *Melobesia* and *Fosliella*) formed a coat covering older *T. testudinum* leaves completely, and assumed that these leaves may die earlier due to the stress for light competition and increased weight. Coralline epiphytes also contribute to sediment supply in seagrass habitats (Humm 1964, Walker & Woelkerling 1988, Corlett & Jones 2007), driven by continuous leaf production and decay, as well as algal growth rate (Walker & Woelkerling 1988). Encrusting forms affect

the leaves they are directly attached to but have no shading effect on subsequent leaves, as opposed to foliose algae (Humm 1964). Thus, differences in epiphyte species composition may have varying physiological and ecological consequences on seagrasses.

Of the species encountered, 16 have been previously reported as seagrass epiphytes for the region; as far as we know, the remaining species have not yet been classified as *T. testudinum* epiphytes (Table 1). Three species (*Bryopsis pennata*, *Champia salicornioides* and *Kützingiella elachistaeformis*) represent new reports for the phycological flora of Costa Rica, four species are new reports for the Caribbean coast of Costa Rica, and 17 species are new reports for the Parque Nacional Cahuita. The high amount of newly reported species reflects the lack of previous studies focusing on seagrass epiphytes and the low number of algal studies in the area (Wellington 1973, 1974, Soto & Ballentine 1986).

In a study focused on the characterization of seagrass epiphyte species and abundance for monitoring purposes in the Gulf of México, Cho *et al.* (2002) found 13 species of algal epiphytes of *T. testudinum*. Our study surpassed that of Cho *et al.* (2002) in species number; however, none of the reported species coincided. Humm (1964) found in Florida a total of 113 species of algal epiphytes on *T. testudinum*. Later on, Ballantine & Humm (1975) reported 66 epiphyte species commonly found on all four seagrass species studied (*T. testudinum, Syringodium filiforme, Diplantera wrightii,* and *Halophila engelmannii*). This reduced number might be related to the considerably smaller study area in the latter, although algal epiphyte species composition is known to vary according to many environmental variables, such as tides, currents, salinity, available light, depth, leaf turnover rate, nutrients and temperature (Humm 1964, Frankovich & Fourqurean 1997, Hemminga & Duarte 2000). Moreover, epiphytes show seasonal variation (Humm 1964, Hemminga & Duarte 2000), which might further explain the variation in the total number of species found in different studies.

A recent study on *T. testudinum* epiphytes in Venezuela (Barrios & Díaz 2005) reported 34 genera and 40 species as epiphytes. The number of both genera and species encountered by Barrios & Díaz (2005) are higher than those encountered in our study (18 genera and 26 species). Both studies share only eight genera (*Chaetomorpha, Cladophora, Ectocarpus, Jania, Ceramium, Wrangelia, Hypnea, Polysiphonia, and Champia*) and two species (*Wrangelia argus* and *Hypnea spinella*). Interestingly, the results obtained by Barrios & Díaz (2005) are based upon a one-year monthly sampling period, covering four different sites, while our results are restricted to a much more limited data set (three sample dates at a single sample location). Therefore, it is reasonable to expect that a more prolonged sampling period with a broader study area should increase the number of seagrass epiphyte species at Cahuita.

The present study provides a preliminary list of *T. testudinum* macroalgae epiphyte species in the Parque Nacional Cahuita meadows, and represents a baseline for future studies on algal epiphytes and seagrass leaf dynamics in the area. The continued study of seagrass epiphytes (biomass, seasonality and species composition) in the area is important, as it has been shown that increases in nutrient levels in coastal areas can alter the balance among marine primary producers, cause changes in water column transparency, and can lead to an increase of seagrass epiphyte biomass (van Montfrans *et al.* 1984, Frankovich & Fourqurean 1997, Hemminga & Duarte 2000, Gil *et al.* 2006) which could have a detrimental effect on seagrass distribution, abundance and productivity (Hemminga & Duarte 2000, Drake *et al*. 2003). Nutrient increases can also promote the presence of faster growing opportunistic species (van Montfrans *et al.* 1984, Armitage *et al.* 2006, Gil *et al.* 2006), and an alteration in primary producers species composition may affect higher trophic levels (Heijs 1984, Armitage *et al.* 2006, Gil *et al.* 2006). The results of the present study may serve as a base for the development of monitoring programs, which

might focus partially on possible variations in species composition of seagrass epiphytes as a consequence of changes in environmental conditions.

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RESUMEN

Los epífitos de pasto marino juegan un papel importante en el hábitat de pastos marinos. Sin embargo, la información disponible sobre este tema en América Central es muy limitada. Este estudio se enfoca en las macroalgas epífitas de hojas del pasto marino *Thalassia testudinum* en las praderas de pasto marino de Punta Cahuita, costa Caribe de Costa Rica y es el primero de su tipo para Costa Rica. Una cantidad representativa para cada especie de epífito algal encontrada se colectó, preservó e identificó al menor taxon posible. Muestras preservadas para cada especie fueron depositadas en el Herbario de la Universidad de Costa Rica (USJ). Se encontró un total de 26 especies de macroalgas: 15 especies de Rhodophyta, cuatro de Chlorophyta, seis pertenecientes a la clase Phaeophyceae y una especie de diatomea que no fue posible identificar. El inventario reporta tres especies por primera vez para la flora ficológica de Costa Rica, cuatro especies son reportadas por primera vez para el Caribe de Costa Rica y 17 especies son nuevos reportes para el Parque Nacional Cahuita. Se comparan nuestros resultados con aquellos obtenidos en estudios similares en la región y se especula que el número de especies de epífitos podría aumentar de ser ampliado el esfuerzo de recolecta y el área de estudio.

Palabras clave: epífitos, algas, pasto marino, *Thalassia testudinum*, Cahuita, Costa Rica.

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