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SHORT COMMUNICATION

First report of the epizoic red alga *Polysiphonia carettia* (Hollenberg, 1971) on the loggerhead turtle *Caretta caretta* in the Adriatic Sea

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The authors report the first record of the red alga Polysiphonia carettia *(Hollenberg, 1971) in the Adriatic Sea, collected from two loggerhead sea turtles* Caretta caretta *captured along the coast of the Savudrija peninsula (Croatia, Northern Adriatic Sea). The identification of the samples is based on both vegetative and reproductive tetrasporangial features. The morphological characters of the specimens studied are in agreement with previous reports of this species from other parts of the Mediterranean Sea.*

Key words: *Polysiphonia carettia,* epibionts, sea turtles, *Caretta caretta*, Adriatic Sea

INTRODUCTION

Sea turtles are widely distributed in temperate and tropical seas, and their carapace is often colonized by species of macroalgae. There have been several studies on the epibionts of loggerhead turtles, *Caretta caretta* Linnaeus, from different parts of the world (KITSOS, *et al*., 2005; PFALLER *et al*., 2006, 2008). The carapaces of loggerhead turtles represent an important substratum for a variety of macroalgae (DODD, 1988). SENTÍES *et al*. (1999) reported 37 species of algae growing on loggerhead turtles found off the Caribbean coast of Mexico. Recently, FRICK *et al*. (2000; 2002; 2004), found 12 new records of previously undocumented epibiont species from loggerhead turtles nesting in Georgia, USA, while GARCÍA *et al*. (2003a,b) reported a total of 28 macroalgae on sea turtles from Oman (Arabian Sea). From the western Atlantic Ocean 33 species and 4 taxa were described by SENTÍES *et al*. (1999). To date only 20 species (and 2 taxa identified only at genus level) have been reported as epizoic on Mediterranean loggerheads (BÁEZ *et al*., 2002; KITSOS *et al*., 2005).

The red alga *Polysiphonia carettia* (Rhodomelaceae, Rhodophyta) was described as new species by Hollenberg (HOLLENBERG, 1971). The type material, tetrasporic, was collected from the carapace of a *Caretta caretta* turtle from California. BÁEZ *et al*. (2001) reported the first record of *P. carettia* in the Mediterranean Sea as epizoic on *C. caretta* captured by a Spanish longline vessel south of Ibiza, Balearic Islands. Subsequently, SERIO *et al*. (2011) mentioned the presence of this species on the carapace of

loggerhead turtles at Lampedusa Island, Sicily Channel, without providing any further details. Previous records of this species were as epibiontic alga on loggerhead turtles from California (HOLLENBERG, 1971), Canary Islands (ROJAS-GONZÁLEZ *et al*., 1994; LAWSON *et al*., 1995), North America (California) (ABBOTT & HOLLENBERG, 1976) and the Caribbean Sea (SENTÍES *et al*., 1999). The most recent record is from the Western Atlantic (WYNNE, 2011).

The implication of the presence of *P. carettia* on the biogeography of loggerhead turtles in the Northern Hemisphere has been discussed in BÁEZ *et al*., (2001). These authors investigated the possibility of using *P. carettia* as a biological marker to distinguish the loggerheads that come from the Atlantic Ocean, from those coming from the eastern Mediterranean Sea. Additional studies on *Polysiphonia* distribution are underway to test this hypothesis. In this paper, we report the first record of *P. carettia* Hollenberg in the Adriatic Sea, which was collected from two individuals of *C. caretta* captured along the coast of the Savudrija peninsula (Croatia, Northern Adriatic). Data on the main morphological characters of this alga and a comparison with previous reports are presented.

MATERIAL AND METHODS

Samples were collected from two individuals of loggerhead sea turtle *Caretta caretta*, captured along the coast of the Savudrija peninsula (Croatia) in July 2014, and transferred to the Aquarium of Piran for observations. The two turtles were young individuals, with carapaces 35.3 cm long and 41.4 cm long, respectively (in adult individuals of this species the carapace usually measures around 74 cm in length, according to MÁRQUEZ (1990)). The algal material was removed by scraping the carapace of the turtles with a scraper and preserved in 75% seawater-ethanol solution. Voucher specimens were deposited in the personal herbarium of the first author at the National Education Institute of the Republic of Slovenia of Koper. The samples were then studied in the laboratory. Observations and measurements of relevant morphological characters were made using a motorized inverted microscope Axio Observer Z1 (Zeiss) and a stereomicroscope Olympus, SZX 16. Photographs were taken by an AxioCam MRc5 camera using the program AxioVision.

RESULTS

The identification of the samples of *P. carettia* is based on both vegetative and reproductive features. The morphology of *P. carettia* was in agreement with descriptions previously reported for other parts of the Mediterranean and Atlantic. The samples of *P. carettia* were brown-red to reddish in color, with a very soft and flaccid texture, consisting of a short system of creeping axes, from which poorly ramified erect axes 0.5–1.0 cm high arose (Fig. 1A, 1B). Creeping

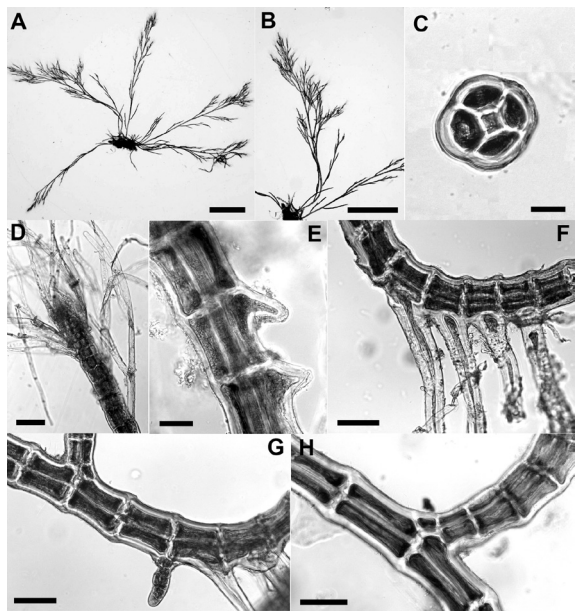

Fig. 1. Polysiphonia carettia *Hollenberg from the Adriatic Sea: A) General habit (scale bar: 2 mm); B) Detail of erect axes (scale bar: 2 mm); C) Transversal section of axis showing central cell and 4 pericentral cells (scale bar: 20 µm); D) Apical portion of an erect axis bearing trichoblasts (scale bar: 50 µm); E) Detail of rhizoids in early stages of development, still in open connection with pericentral cells (scale bar: 20 µm); F) Fully developed rhizoids, cut off from the pericentral cells (scale bar: 80 µm); G) Detail of a creeping axis from which a new erect axis is arising adventitiously (scale bar: 80 µm); H) Detail of a creeping axis supporting a fully-developed erect axis, with associated scar cell (scale bar: 80 µm)*

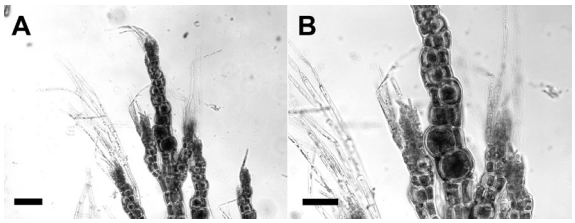

Fig. 2. Polysiphonia carettia *Hollenberg from the Adriatic Sea: A) Upper parts of tetrasporangial axes (scale bar: 120 µm); B) Detail of the apical portion of an erect branch bearing tetrasporangia with spiral arrangement (scale bar: 60 µm)*

and erect axes consisted of small axial cells surrounded by four pericentral cells devoid of cortication (Fig. 1C). Creeping axes were 72-86 µm in diameter, with cells 117-134 µm long. The erect axes were terete, 69-74 µm wide, with cells 60–150 µm long, and borne on basal cells of trichoblasts. Colorless vegetative trichoblasts occurred mainly at the top of the erect axes and were 1–3 (4) times pseudo-dichotomously branched (Fig. 1D). The trichoblasts were deciduous, except the basal cells (scar cells) that were irregularly disposed. The creeping axes were attached to the substratum by short unicellular digitate rhizoids, which initially were in open connection with pericentral cells (Fig. 1E), but when fully developed were cut off by a cross wall as separate cells from the pericentral cells (Fig. 1F). New erect axes were issued adventitiously from the creeping axes (Fig. 1G, 1H). The diameter of the central cells was about 12 µm. The pericentral cells were dorsoventrally compressed, about 29 wide and 15 µm in height (Fig. 1C). Tetrasporangia were the only type of reproductive structures present in the material examined. They were produced with spiral arrangement in the upper parts of the erect axes (Fig. 2A). They were spherical, tetrahedrally divided, 50 to 64 µm in diameter (Fig. 2 B).

DISCUSSION AND CONCLUSIONS

The morphology of the samples of *P. carettia* described in this paper is similar to the samples of *P. carettia* described by HOLLENBERG (1971)

Table 1. Comparison of morphological data between Polysiphonia carettia *from the Adriatic Sea (this study) with the material of the original description (Hollenberg, 1971) and material from the Canary Islands (Rojas-González et al., 1994) and the Balearic Islands (BÀEZ et al., 2001)*

	HOLLENBERG, 1971	ROJAS-GONZÁLEZ *et al*., 1994	BÁEZ *et al*., 2001	This study
Habit	Red-brown, uncorticated, 0.5–1.5 cm long.	Light brown, uncorticated up to 1.5 cm long	Red-brown, uncorticated, 0.5–4.0 cm long.	Red-brown, uncorticated, 0.5–1.0 cm long.
Number of pericentral cells	4	4	4	4
Rhizoids	Unicellular; in open connection with pericentral cell.	Unicellular; initially in open connection with pericentral cell, when developed cut off.	Unicellular; initially in open connection with pericentral cell, when developed cut off.	Unicellular; initially in open connection with pericentral cell, when developed cut off.
Tetrasporangia	Spherical, 30–35 µm in diameter	Spherical, 25-35 µm in diameter	Spherical, over 40–43 µm in diameter	Spherical, 50–64 µm in diameter
Creeping axes	50–70 µm in diameter	35–75 µm in diameter		72–86 µm in diameter
Segments of erect axes	2–4 diameters long; mostly 1 diameter long in upper parts	2-3 diameters long	1.3 diameters long	2 diameters long; mostly 1 diameter long in upper parts.
Axial cell			Smaller in diameter than pericentral cells.	Smaller in diameter than pericentral cells.
Erect axes	Up to 80 µm in diameter	15-40 µm in diameter		69–74 µm in diameter

and BÁEZ *et al*. (2001) in several aspects, namely the number of pericentral cells, the relative length and diameter of segments (ratio length/ width) and the arrangement of tetrasporangia (Table 1). Our material differs from the alga described by HOLLENBERG (1971) in the origin of the rhizoids, because in our samples the unicellular rhizoids are initially in open connection with pericentral cells, but when fully developed are cut off by a cross wall as separate cells. This is in agreement with the observations of ROJAS-GONZÁLEZ *et al*. (1994) for Canary Islands and BÁEZ *et al*. (2001) for Mediterranean samples. On the other hand, our samples are slightly smaller (up to 1 cm tall) than the samples described by BÁEZ *et al*. (2001) (up to 4 cm) and ROJAS-GONZÁLEZ (1997) (up to 2 cm, as referred by BÁEZ *et al*. (2001)). This difference might be merely due to the different developmental stage of our samples, compared to those described in these studies. No sexual reproductive structures were found, as only tetrasporic and vegetative thalli were observed. The tetrasporangia of our samples are bigger (up to 60 μm in diameter) than the samples observed by HOLLENBERG (1971) (up to 35 μm in diameter) and BÁEZ *et al*. (2001) (up to 43 μm in diameter).

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Prvo izvješće o epizoičnoj crvenoj algi *Polysiphonia carettia* (Hollenberg, 1971) na glavatoj želvi *Caretta caretta* u Jadranskom moru

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SAŽETAK

Autori navode prvi zapis o pojavljivanju crvene alge *Polysiphonia carettia* (Hollenberg, 1971) u Jadranskom moru. Podaci su prikupljeni s dvije glavate želve *Caretta caretta* koje su primijećene uz obalu poluotoka Savudrija (Hrvatska, Sjeverni Jadran). Identifikacija uzoraka temeljila se na vegetativnim i na reproduktivnim tetrasporangijalnim značajkama. Morfološke značajke jedinki istraživane su u skladu s prethodnim izvješćima o ovoj vrsti iz drugih dijelova Sredozemnog mora.

Ključne riječi: *Polysiphonia carettia,* epibionti, morske kornjače, *Caretta caretta*, Jadransko more