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RESEARCH ARTICLE

Confirmed presence of *Cladophora catenata* in the Marmara Sea, Türkiye

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Abstract

Cladophora catenata (Linnaeus) Kützing is a filamentous green alga with a highly disjunct distribution in tropical seas (Hoek 1982), and its presence in Türkiye has remained unverified until now. In this study, we report the first confirmed occurrence of *C. catenata* in the Marmara Sea, expanding its known distribution beyond tropical and subtropical waters. Specimens were collected from the coast of Üsküdar (41°1′13.68″N, 29°0′25.56″E) (İstanbul, Marmara Sea, Türkiye) in July 2024 at a 0.5 m depth and identified based on morphological characteristics. Our findings contribute to the knowledge of marine algal biodiversity in Türkiye and emphasize the need for further monitoring of *Cladophora* species in the Eastern Mediterranean and adjacent seas, particularly in the context of changing environmental conditions and species dispersal patterns.

Keywords: *Cladophora,* green algae, Marmara Sea, Türkiye

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Introduction

Cladophora Kützing is one of the largest genera of green algae (Chlorophyta), with a worldwide distribution. Within the class Cladophorophyceae, this genus is characterized by its simple thallus structure, consisting of branched, uniseriate filaments composed of multinucleate cells. A total of eleven distinct architectural types (sections) have been identified within the genus (van den Hoek 1963, 1982; van den Hoek and Chihara 2000).

A total of 25 species belonging to the genus *Cladophora* within the order Cladophorales have been recorded along the coasts of Türkiye, including 24 marine species and one freshwater species (*Cladophora rivularis*) (Taşkın *et al.*

2019; Grech *et al.* 2023). *Cladophora catenata* was previously reported from the Marmara Sea, Türkiye, by Taşkın *et al.* (2019); however, the authors noted that the identification was uncertain and required further confirmation. In the present study, the presence of this species is confirmed based on detailed morphological analysis, thereby resolving the earlier uncertainty and providing the first reliable record of *C. catenata* from the Turkish coastline.

Materials and Methods

Cladophora catenata was found from the coast of Üsküdar (41°1′13.68″N 29°0′25.56″E) (İstanbul, Marmara Sea, Türkiye) in July 2024 at a 0.5 m depth (Figure 1). The specimen was preserved in 4-5% formalin in seawater. The identification of the sample was made on the basis of the descriptions by van den Hoek (1982), Leliaert and Coppejans (2003), Gestinari *et al.* (2010).

Figure 1. Sampling site of *Cladophora catenata*

Results and Discussion

***Cladophora catenata* (Linnaeus) Kützing, 1843: 271**
Basionym: *Conferva catenata* Linnaeus
Type locality: Bahamas (van den Hoek 1963: 19, 123)
Description: Thallus dark green to brown, 2-5 cm high, composed of a basal portion consisting of frequently curved, stolon-like filaments bearing erect branches (Figure 2). The branching system is unilateral or irregularly organized, with a maximum of one lateral branch per cell. Newly formed lateral branches generally lack transverse walls at their base. The branching angle varies between 20° and 70°.

Apical cells are long and rounded or tapered gradually to the tip, measuring 70-100 µm in diameter and 290-600 µm in length, with a cell wall thickness of 10-20 µm. Terminal branch cells measure 55-60 µm in diameter and 380-400 µm in length, with a cell wall thickness of 10 µm. Main axis cells are usually curved and almost prostrate, measuring 80-100 µm in width and 610-650 µm in length, with a cell wall thickness of 20 µm. Basal cells measure between 70-110 µm in diameter.

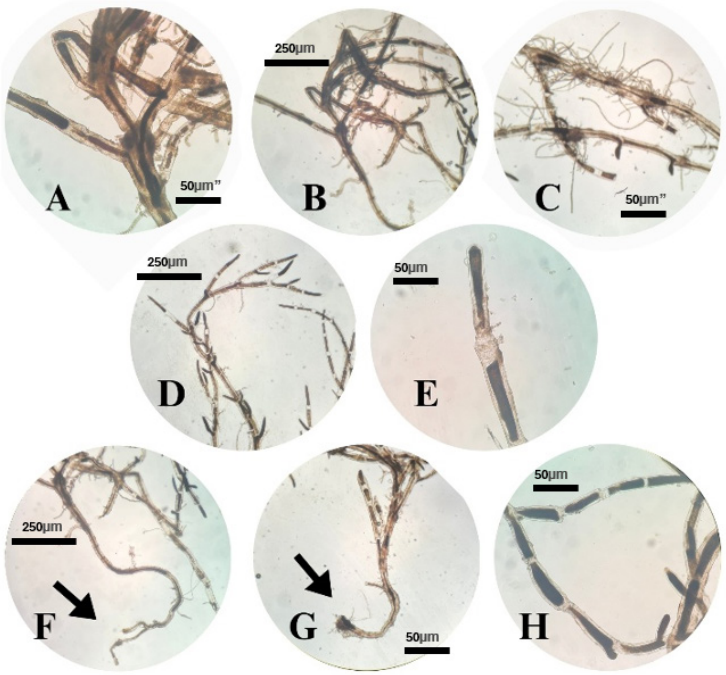

Figure 2. *Cladophora catenata.* A and B- General aspect of the thallus; C and D- detail of the mid-region of a terminal branch of the tuft; E - apical cell; F- branched rhizoid structure; G- branching filaments with decumbent filament with inversion of polarity; H- details of the thallus.

In this study, the morphological characteristics considered for species identification, such as branching pattern, thallus structure, and apical cell shape, are consistent with the descriptions and illustrations provided by van den Hoek (1982), Leliaert and Coppejans (2003), and Gestinari *et al.* (2010). However, in terms of apical cell length, differences were observed compared to the measurements reported by these authors, with the apical cell being observed at smaller sizes (Table 1). The morphology of *Cladophora* has been linked to hydrodynamic factors (van den Hoek 1982).

Rare species in the study area were accompanied by *Lomentaria clavellosa* (Lightfoot *ex* Turner) Gaillon, *Ectocarpus fasciculatus* Harvey, *Ulva* spp., *Ceramium* spp., *Boergeseniella* sp., *Porphyra* sp.

Cladophora catenata has been reported in the literature as a taxon present in the Mediterranean, and the Aegean Sea of Türkiye. However, Taşkın *et al.* (2019) emphasized that its presence in Türkiye needs verification. In this study, the presence of *C. catenata* along the Marmara Sea coast has been confirmed through morphological examinations, thereby definitively documenting its distribution in Türkiye.

Table 1. Variation in cell diameter in *Cladophora catenata*

Reference	Apical cell diameter (µm)	Apical cell length/width	Main cell diameter (µm)
van den Hoek(1982)	(160-275) - (350-450)	(6-26) -(7-30)	(160-350)- (280-420)
van den Hoek and Chihara (2000)	(150-220) - (340-450)	(6-18) -(10-15)	(200-270)- (340-510)
Leliaert and Coppejans (2003)	300-360	7-25	240-470
Gestinari *et al.* (2010)	(195-) 229.3 (-274)	(6-) 11 (-17)	(199-) 241.5 (-292)
This study	70-100	5-7	80-110

Cladophora catenata is a very conspicuous and easily recognized species (van den Hoek 1982). Epilithic in intertidal pools and the infralittoral fringe, forming dark green mats (Leliaert and Coppejans 2003). This species is restricted to the tropical shores of the western Atlantic and Pacific Oceans. It thereby exhibits an outspoken disjunct tropical distribution (van den Hoek 1982). It reaches its northernmost boundary in the Pacific Ocean on the subtropical shores of Japan (van den Hoek and Chihara 2000).

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Author Contributions: O.Y. identified the species and wrote the manuscript. E.T. collected the samples and contributed to the writing process. All authors contributed to the article and approved the submitted version.

Türkiye kıyılarından *Cladophora catenata* türünün varlığının Marmara Denizi'nde doğrulanması

Öz

Cladophora catenata (Linnaeus) Kützing, tropikal denizlerde oldukça parçalı bir dağılım gösteren ipliksi bir yeşil alg türüdür (Hoek, 1982) ve Türkiye kıyılarındaki varlığı bugüne

kadar doğrulanmamıştır. Bu çalışmada, *C. catenata*'nın Marmara Denizi'ndeki ilk kesin kaydı rapor edilmekte ve bilinen coğrafi dağılımının tropikal ve subtropikal bölgelerin ötesine uzandığı ortaya konulmaktadır. Örnekler, Temmuz 2024'te İstanbul'un Üsküdar kıyılarından (41°1′13.68″K, 29°0′25.56″D) 0,5 m derinlikten toplanmış ve morfolojik özelliklere göre tanımlanmıştır. Bulgularımız, Türkiye'nin denizel alg biyoçeşitliliğine katkı sağlamakta ve özellikle değişen çevresel koşullar ve tür yayılım desenleri bağlamında, Doğu Akdeniz ve komşu denizlerde *Cladophora* türlerinin izlenmesinin gerekliliğini vurgulamaktadır.

Anahtar kelimeler: *Cladophora*, yeşil alg, Marmara Denizi, Türkiye

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