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Research Article **Araştırma Makalesi**

Extended North Distribution of *Penicillus capitatus* Lamarck 1813 off the Turkish Shores

Penicillus capitatus Lamarck 1813'un Türk Kıyılarında Kuzeye Doğru Yayılımı

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Abstract: Existence of *Penicillus capitatus* Lamarck 1813 has been known along the southern coastline of Turkey since 2010. On the other hand, no record of *P. capitatus* off the northern Aegean coastline of Turkey has so far been reported. The present paper reports the observation of *P. capitatus* in the coastline of Dikili, north of the Aegean shores of Turkey. In conclusion, it seems that the physicochemical parameters of the Aegean Sea are very suitable for *P. capitatus* and therefore, its observation in all locations of the Aegean Sea is most likely to be expected. Regular monitoring is recommended for this newly observed and habitat-forming species in the Turkish Coastline of the Aegean Sea.

Keywords

- extended distribution
- marine seaweed
- new habitats
- *Penicillus capitatus*

Özet: *Penicillus capitatus* Lamarck 1813'un Türkiye'nin güney kıyılarında varlığı 2010 yılından bu yana bilinmektedir. Bununla birlikte, *P. capitatus*'un Türkiye'nin Kuzey Ege kıyılarından kaydı henüz yapılmamıştır. Bu makale, *P. capitatus*'un Türkiye'nin Kuzey Ege kıyılarında yer alan Dikili'den kaydını rapor etmektedir. Sonuç olarak, Ege Denizinin fizikokimyasal parametrelerinin *P. capitatus*'un yayılımı için uygun olduğu ve Ege Denizinin birçok yerinden kaydının kuvvetle mümkün olacağı değerlendirilmektedir. Türkiye'nin Ege Kıyılarında yeni gözlenen ve habitat oluşturan bu tür için düzenli izleme faaliyetleri önerilmektedir.

Anahtar kelimeler

- artan yayılım
- deniz algi
- yeni habitatlar
- *Penicillus capitatus*

1. INTRODUCTION

Penicillus capitatus Lamarck 1813 is a marine seaweed in the Mediterranean Sea. According to Guiry and Guiry (2021), the distribution of this species is reported from Atlantic Islands, North America, Central America, Caribbean Islands, Western Atlantic, South America, Africa, Middle East, Southwest Asia, Australia and New Zealand. When the Mediterranean Sea is considered, Guiry and Guiry (2021) also listed the observation of *P. capitatus* from the Adriatic Sea (Gallardo et al. 1993), Balearic Islands (Ballesteros, 1992; Gallardo et al. 1993; Ribera et al. 1997), Corsica (Gallardo et al., 1993), France (Gallardo et al., 1993; Anon, 2017), Greece (Athanasiadis, 1987; Gallardo et al., 1993; Tsirika and Haritonidis, 2005; Tsiamis et al., 2014), Italy (Gallardo et al., 1993; Furnari et al., 1999; Rindi et al., 2002), Spain (Gallardo et al., 1985; Gallardo et al., 1993; Flores-Moya et al., 1995) and Veneto (Sfriso, 2011).

The first observation of *P. capitatus* in Turkey was reported from the Gulf of Antalya by Turna et al (2010). They reported that their samples were collected between May-June 2006 and June 2007. Sandy and mud substrates in which *Cymodocea nodosa* meadows are mentioned in the habitats of

P.capitatus. The depth of the location of the sampling station was reported between 0.5 – 22 m by the authors.

In 2010, Okudan et al (2010) reported another paper for extended distribution of *P. capitatus* along the southern Mediterranean coastline of Turkey. The localities that the authors observed *P. capitatus* are Muğla (Fethiye) and Antalya (Konyaaltı, Olympus, Gulf of Maden, Beş Adalar, Üç Adalar, Phaselis, Göynük, Sıçan Adası and Side). From the report of Okudan et al (2010), it is understood that *P.capitatus* distributed to the east and west after the first observation of *P. capitatus* by Turna et al (2010). Okudan et al (2010) reported *P. capitatus* as an invasive species and its adaptation to the Turkish waters is also underlined in their paper. However, it has not been considered as an invasive species by other reports (Tsiamis and Gerakaris, 2014). After 2010, no observation from Turkish shores has so far been reported yet. This paper reports the new record of *P. capitatus* from the northern shores of the Aegean Sea, Dikili (Turkey). Dikili is far away from Antalya, and it is most likely that *P. capitatus* must be existed between Antalya and Dikili. The present paper reports the extended distribution of *P. capitatus* along the northern Turkish shores by presenting morphometric parameters of the samples.

2. MATERIALS and METHODS

The first observation of *P.capitatus* in Dikili coastline was observed in the summer of 2020 (August). The google map coordinates of the location (39˚07’27’’ N, 26˚ 51’ 06’’ E) were shown in Figure 1.

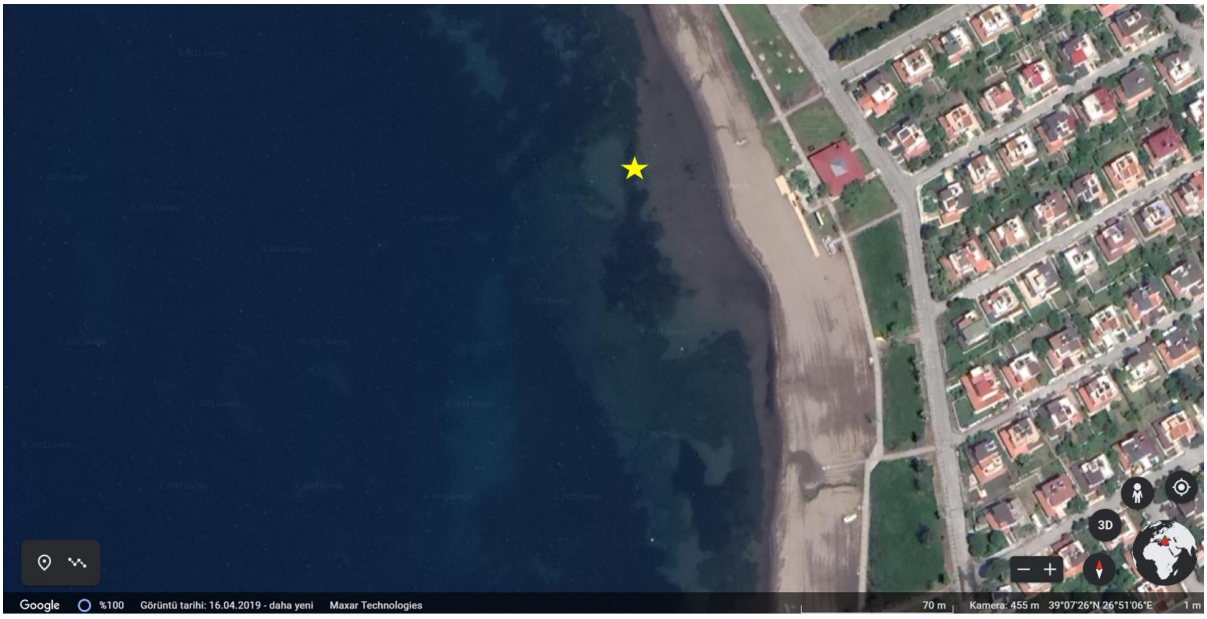

Figure 1. The google earth coordinates and photo of the region. The yellow symbol within the image shows the observed *P.capitatus* samples in the region (Google earth V 9.151.0.1. (December 08, 2021). Dikili, İzmir. 39˚07’27’’ N, 26˚ 51’ 06’’ E, Eye alt 70 m. http://www.earth.google.com [December 12, 2021].

Since we have been working on the invasive *Caulerpa cylindracea* in this station for more than 15 years, *P. capitatus* did not exist before 15 years in this region. In the summer of 2020, *P. capitatus* covered meadows were around 6 m^2. To be sure that this species was adapted to new habitat, and it is observable after one year, a snorkel diving was done in the same region in August-2021. In 2021, extended distribution was observed in the same region, the *P. capitatus* covered meadows were measured more than 20 m^2. The seawater temperature was measured as 24 ℃. The depth in which *P. capitatus* was observed was between 2.5 – 7.0 m. Since the observation was carried out by snorkelling,

deeper areas were not checked. A sample of *P. capitatus* was deposited to the Flora and Fauna Research Center in Dokuz Eylül University. The code of the sample in this centre is FFDEU-CAVAS-009.

3. RESULTS and DISCUSSION

P. capitatus has been known from the southern coastlines of Turkey since 2006 (Turna et al, 2010). Although Turna et al (2010) was published their report in 2010, the observation year was reported as 2006 in their paper. The species is known as Neptune's shaving brush because of its unique morphological characteristics. Since they are very remarkable under the water, their observation is very easy, and this species can be controlled by using citizen science methodology. We have been monitoring invasive *Caulerpa cylindracea* distribution in Dikili since 2002. Therefore, it was very easy for our group to recognize this species under the water. The morphological characteristics are very similar compared to the samples mentioned by Turna et al (2010) and Okudan et al (2010). The main morphological parts of *P. capitatus* are base, stalk and capitulum. The mean length of the individuals and capitulum are 4.4 ± 0.6 cm and 1.5 ± 0.3 cm, respectively. The mean diameter of the rhizoids is found to be 0.9 ± 0.2 cm. From these morphological parameters, it could be said that the *P. capitatus* population in Dikili is homogenous and they must have come to the region at the same time. The underwater view of *P. capitatus* meadows are shown in Figure 2a and b. The photos in Figures 2a and b from the same region were taken in August-2020 and August-2021, respectively.

a)

b)

Figure 2. Underwater view of *Penicillus capitatus* meadows in a) August-2020 and b) August-2021.

As can be seen from these photos, *P. capitatus* meadows formed mixed vegetations with *Cymodocea nodosa* in August 2020. On the other hand, it is extremely important to note that no *Cymodocea nodosa* was observed in the same region in August-2021. After the collection of 20 individuals from one of the dense meadows in the station, morphological photos of the capitulum, stalk, and base of individuals were taken and present in Figure 3-7. The capitulum of the samples is very unique including brush-like branches (Figure 3).

Figure 3. Capitulum of *Penicillus capitatus* collected from Dikili, İzmir-Turkey.

The stalk part of the *P. capitatus* samples is also very well in line with the characteristics that are previously reported by Turna et al (2010) and Okudan et al (2010) from the Antalya vicinity. Branches of the capitulum of *P. capitatus* collected from Dikili are shown in Figure 4.

A close photo of the branches is shown in Figure 5 in which calcification of the branches is clearly seen. The round and randomly distributed pores are also clearly observable on the branches (Figure 6). The rhizoid structure of *P. capitatus* is depicted in Figure 7.

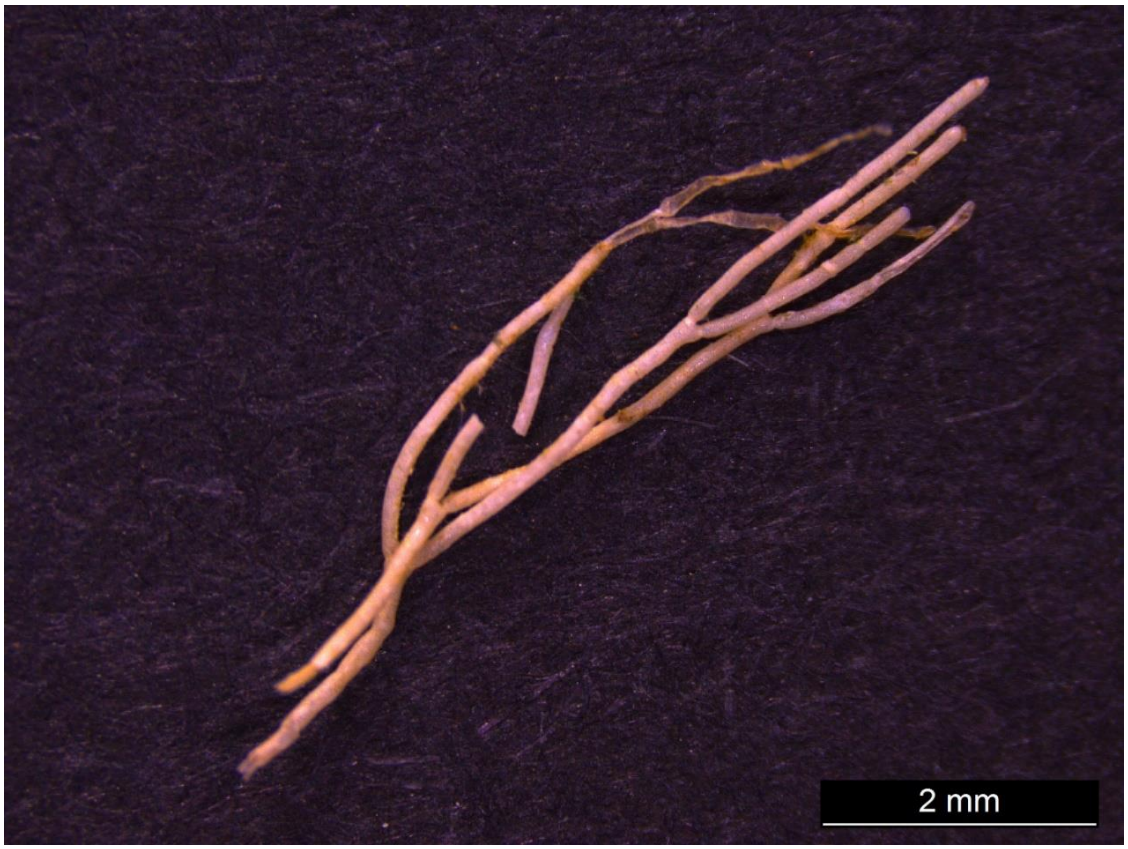

Figure 4. Branches of the capitulum of *Penicillus capitatus* collected from Dikili, İzmir-Turkey.

Figure 5. Calcification on the branches of the capitulum of *Penicillus capitatus* collected from Dikili, İzmir-Turkey.

Figure 6. Round and randomly distributed pores on the branches of Penicillus capitatus collected from Dikili, İzmir-Turkey.

Figure 7. Rhizoid structure of *Penicillus capitatus* collected from Dikili, İzmir-Turkey.

From Figure 7, tangled structures of the fine branched rhizoids are observed. Since the substrate was muddy-sandy, the rhizoids are with muddy structures. Substrate residues were not cleaned not to damage the fine structure of the rhizoids. It is very recommended marine scientists to study fauna within the rhizoids. From the structure and the organisms observed within rhizoids (unpublished data), *P. capitatus* in the region can behave an ecological engineer and it may alter the biodiversity in the region. So far, only an alien dendronotacean nudibranch *Melibe viridis* (Kelaart, 1858) was reported by Ozvarol (2013) from the meadows of *P.capitatus* in Antalya, Turkey. *Caulerpa scallpelliformis* and *Acetabulum acetabularia* were two other seaweeds reported by Ozvarol (2013) in the same region. Identification of two anti-fungal triterpenoid compounds, capisterones A and B, against *Lindra thallasiae* in *P. capitatus* may play role in the ecological engineering of this species (Puglisi et al, 2004). Even if this species was previously observed in Sithonia-Greece (Athanasiadis 1987), this paper reports its existence in the northern shores of the Turkish Aegean Sea for the first time.

Citizen science is nowadays being one of the important tools in scientific projects. Turkey has 8333 km long shores in the Mediterranean Sea. Therefore, observation of this species will be very easy via citizen science from two perspectives: *i)* underwater view of this species exhibits very different structure compared to other species in the same habitat, therefore, all snorkeling people can easily recognize and report this species to the authorities (Figure 2a and b), *ii)* Even if the common name of the species is known as “Neptune's Shaving Brush”, it resembles like micro-pine forest (*Pinus pinea*) under the water. Due to this remarkable difference, snorkeling people will have a curiosity to look at it carefully like we did in the initial phases of this investigation.

In conclusion, observation of *P. capitatus* in Dikili shows that this species is continuing its distribution to the north of the Aegean Sea along the Turkish shores. Since *P. capitatus* has a very characteristic morphological structure, it is very easy to recognize this species under the water. It is highly recommended to check the distribution of this species between Antalya and Dikili and the Greek Islands in the Aegean Sea. Since its habitat-forming characteristics are reported previously (Tsiamis and Gerakaris, 2014), the north of the Aegean Coastline of Turkey should be monitored regularly.

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CONFLICT of INTEREST

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

AUTHOR CONTRIBUTIONS

Levent Cavas is only author in the paper.

DATA AVAILABILITY STATEMENT

Data supporting the findings of the present study are available from the corresponding author upon reasonable request.

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