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First record of the invasive green seaweed *Caulerpa taxifolia* (Bryopsidales) on the coast of Turkey

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Abstract – The first record of the invasive green alga *Caulerpa taxifolia* in Yolluca Military Base located near Cesmeaalti port (Izmir, Turkey), far away from the other affected areas, is reported, thus reinforcing the hypothesis of anthropogenic dissemination of this alga in the Mediterranean Sea.

Invasive species / *Caulerpa taxifolia* / dissemination / Mediterranean Sea / Turkey

Résumé – **Première observation de l'algue invasive *Caulerpa taxifolia* (Bryopsidales, Chlorophyta) sur la côte de la Turquie.** L'algue invasive *Caulerpa taxifolia* vient d'être découverte dans la base militaire de Yolluca, située à proximité du port de Cesmealti (Izmir, Turquie). Étant localisée loin des autres zones affectées en Méditerranée, cette nouvelle introduction renforce l'hypothèse d'une dissémination anthropique dans l'expansion de l'algue en Méditerranée.

Espèces invasives / *Caulerpa taxifolia* / dissémination / Mer méditerranée / Turquie

The tropical invasive green alga, *Caulerpa taxifolia* (M. Vahl) C. Agardh 1817, was first introduced into the Mediterranean Sea from the Museum of Monaco in 1984. Shortly after, new introduced *C. taxifolia* populations were reported in other Mediterranean countries, including France in 1990, Italy in 1992, Spain in 1992, Croatia in 1994, and Tunisia in 2000 (Meinesz *et al*., 2001) (Fig. 1). By the end of 2000, 76 areas were colonized along the coasts of Monaco and France, representing a total area of 3,184 ha, all found into two regions (Languedoc-Roussillon region and Provence-Alpes-Côte d'Azur) (Meinesz *et al*., 2001). In Spain, 62.8 ha were colonized in four different areas along the eastern coast of the island of Mallorca between Portocolom and Portopetro by the end of 2000. Today, young *C. taxifolia* colonies also persists in the single zone in Balearic

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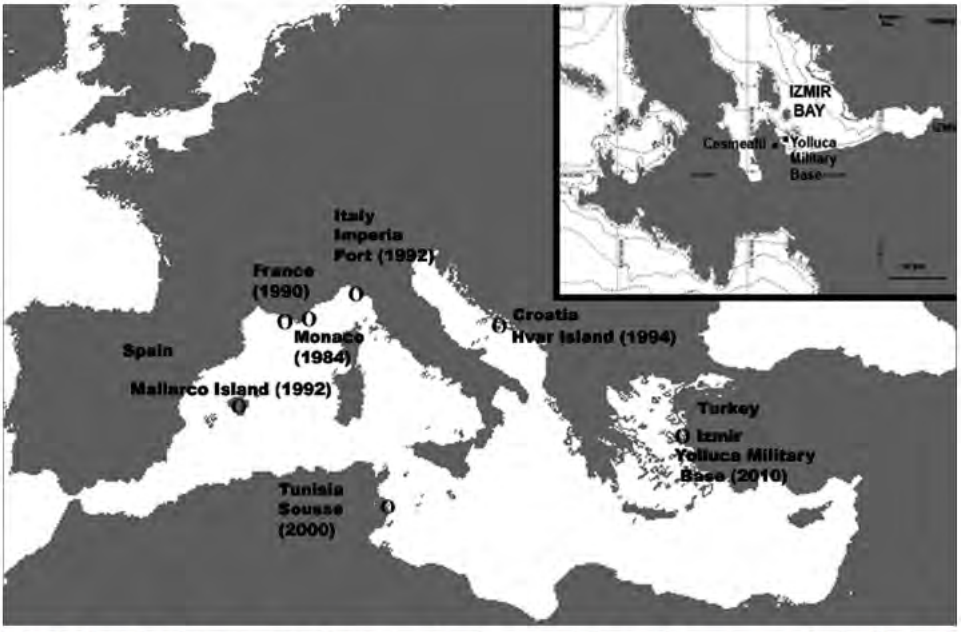

Fig. 1. The distribution area of invasive *Caulerpa taxifolia* in the region of Izmir (Turkey) and in the western Mediterranean basin, including the dates where it was first recorded in each location.

Islands (Meinesz *et al.*, 2010). In Italy, the alga had spread to four regions: Liguria, Toscania, Sicily, and Calabria for a total of 9415 ha of invaded area by the end of 2000 and a new area was discovered in 2009 in the western tip of Sicily (3 hectares in Favignana Island, on Egades Islands) (Meinesz *et al.*, 2001, 2010). In Croatia *C. taxifolia* has been reported at Stari Grad (Hvar Island) and in a port near Malinska (Krk Island) in 1995 (Meinesz *et al.*, 2001), and an isolated colony has been found in 1996 at Barbat Channel near Dolin Island, an area subject to frequent moorings. In Tunisia, the alga has first been recorded in January 2000 at the port of Sousse (Meinesz *et al.*, 2001). The estimated area affected by *C. taxifolia* is 350 ha, at depths of 15-18 m, and more recently it was detected also in the Good Cape in the Bay of Tunisia (Meinesz *et al.*, 2001, 2010) (Fig. 1).

To date, six *Caulerpa* taxa have been reported along the coast of Turkey, including *C. ollivieri* Dostal, *C. prolifera* (Forrskål) J.V. Lamouroux (Guven and Oztig, 1971; Zeybek *et al.*, 1986), *Caulerpa racemosa* (Forrskål) J. Agardh var. *cylindracea* (Sonder) Verlaque, Huisman et Boudouresque, *C. racemosa* var. *lamourouxii* (Turner) Weber-van Bosse f. *requienii* (Montagne) Weber-van Bosse (Cirik and Akcali, 2006, Cirik and Ozturk, 1991), *C. scalpelliformis* (Brown *ex* Turner) C. Agardh (Ertan *et al.*, 1998) and *C. scalpelliformis* var. *denticulata* (Decaisne) (Aysel *et al.*, 2002). More recently, *C. distichophylla* Sonder was found in the Bay of Iskenderun (Levantine coasts of Turkey) by Cevik *et al.* (2007). *Caulerpa distichophylla* closely resembles *C. taxifolia* but its fronds are much finer and narrower, and stolons are terete attached to the substratum by finer rhizoidal branches (Meinesz *et al.*, 2010). Molecular data has corroborated these morphological similarities and suggest that *C. distichophylla* is a brittle form of *C. taxifolia* (Famà *et al.*, 2002; Stam *et al.*, 2006).

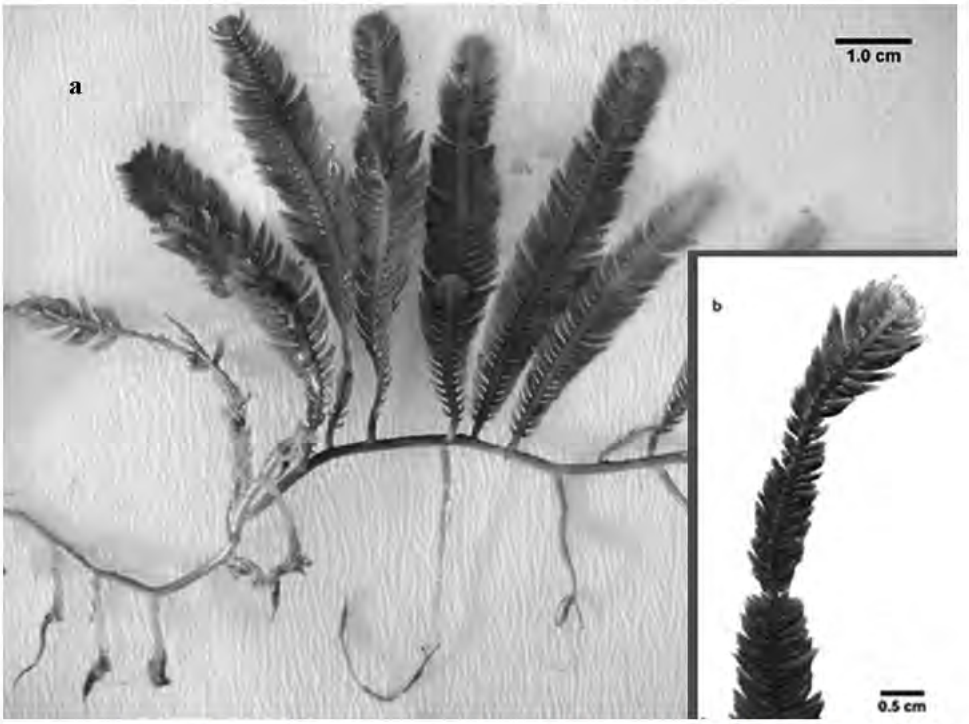

Fig. 2. *Caulerpa taxifolia*, (a) General morphology, (b) detail of the sickle-shaped branchlets, slightly constricted at the base, upwardly curved and gradually tapering into a spine at the apex.

This paper reports on the finding of more typical *C. taxifolia* thalli in the summer of 2010 in Yolluca Social Facility Command belong to Turkish Republic Navy Forces Command located near Cesmeaalti port (38°23'52.88"N and 26°45'16.66"E) located at 70 km west of Izmir's port (Fig. 1). The nearest affected sites to this point are in the Messina Strait of Italy (1,009.88 km SW) and in Stari Grad of Hvar Island in Croatia (1,043.67 km NW) and on the North African coast is found to be in Tunisia (1,488.49 km SW).

Caulerpa taxifolia populations were covering 35 m^2 area on rocky and sandy bottom sheltered from waves, as a dominant species in communities with *Jania rubens*, *Padina pavonica* and *Halimeda tuna*. Seawater temperature of 27.3°C, dissolved oxygen of 10.1 $mg.L^{-1}$, pH of 7.01 and salinity of ‰ 40 were recorded at the sampling time (30 July 2010). The mean stolon diameter, width of fronds, maximal lenght of pinnules and width of pinnules of a total of 50 *C. taxifolia* samples were 1.6 ±0.5 mm, 9.9 ±2.3 mm, 5.4 ±1.3 mm and 1.1 ±0.1 mm, respectively (Fig. 2).

Several experiments with *C. taxifolia* have shown that this alga is able to survive out of water and under humid conditions for up to 10 days (West *et al.*, 2007). It has been assumed that fragments of *Caulerpa* are transported by anchors or fishing nets (Sant *et al.*, 1996, West *et al.*, 2007), or with natural currents (Meinesz *et al.*, 2001). Anthropogenic dissemination seems to be the most possible cause for the spread of *C. taxifolia* in this region which is located on the line of shipping traffic of Izmir port. *C. taxifolia* strains are also available in aquarium shops in Turkey

(Cevik *et al.,* 2007), suggesting aquarium dumping as another possible cause. As far as the intensive maritime activities of the Izmir Port is concerned, further dispersal of *C. taxifolia* in the area are to be expected. Thus, in addition to monitoring and public awareness efforts, biological control and protection against new invasions should be taken as priority solutions for *C. taxifolia* management in Turkey.

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