

RESEARCH ARTICLE

Occurrence of the alien marine red alga *Galaxaura rugosa* in Turkey

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Abstract

In the present paper, the alien marine red alga, *Galaxaura rugosa* (Galaxauraceae, Rhodophyta) is reported for the first time from Turkey. This specimen was collected from Iskenderun Bay on the Mediterranean coast of Turkey. Data and illustrations, concerning the geographical distribution, morphology and ecology of the species are presented.

Key words: Alien algae, *Galaxaura rugosa*, red algae, Turkey

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Introduction

Alien and invasive marine macrophytes have been introduced into the Mediterranean Sea by aquaculture, shipping, via the Suez Canal, fouling, ballast water and accidental escape from aquariums (Cirik and Akçalı 2002). Several studies including or dealing specifically with alien and invasive marine macrophytes of the Mediterranean Sea have been made by Ribera Siguan (2002), Cormaci *et al.* (2004), Zenetos *et al.* (2010), Hoffman (2014) and Verlaque *et al.* (2015). A total of 95 alien and invasive marine macrophyte taxa (63 Rhodophyta, 20 Ochrophyta, 11 Chlorophyta and 1 Magnoliophyta) were reported from the Mediterranean Sea by Ribera Siguan (2002), while Cormaci *et al.* (2004) reported only 81 alien and invasive marine macrophyte taxa (52 Rhodophyta, 15 Ochrophyta, 13 Chlorophyta and 1 Magnoliophyta), since several taxa were accepted as native to the Mediterranean Sea by the latter authors. A list of 133 alien and invasive marine macrophyte taxa at species and infraspecies level (81 Rhodophyta, 28 Ochrophyta, 23 Chlorophyta and 1 Magnoliophyta) was reported in the Mediterranean Sea by Hoffman (2014). More recently, Verlaque *et al.*

(2015) recorded 118 exotic marine macrophyte species (74 Rhodophyta, 23 Ochrophyta, 20 Chlorophyta and 1 Magnoliophyta). In Turkey, 33 alien and invasive marine macrophyte species (13 Rhodophyta, 13 Ochrophyta, 6 Chlorophyta and 1 Magnoliophyta) have been reported (Taşkın *et al.* 2011, 2015; Taşkın and Pedersen 2012).

Members of the red algal family Galaxauraceae are calcified with calcium carbonate in the aragonite form (Norris 2014). This family includes four genera (*Actinotrichia*, *Dichotomaria*, *Galaxaura* and *Tricleocarpa*) and 49 currently accepted taxa (Guiry and Guiry 2017), which are distributed on tropical and subtropical shores around the world (Hoffman *et al.* 2015). Four of these taxa are found in the Mediterranean Sea (Hoffman *et al.* 2015, Guiry and Guiry 2017): *Dichotomaria obtusata* (J.Ellis *et Solander*) Lamarck, *Galaxaura rugosa* (J.Ellis *et Solander*) J.V.Lamour, *Tricleocarpa cylindrica* (J.Ellis *et Solander*) Huisman *et Borowitzka* and *Tricleocarpa fragilis* (L.) Huisman *et R.A.Townsend*. Recently, the calcified *D. obtusata* was reported for the first time from the Mediterranean coast of Israel by Hoffman *et al.* (2015).

In the present paper, the alien marine red alga *Galaxaura rugosa* (Galaxauraceae, Rhodophyta) previously reported in the Mediterranean Sea is recorded for the first time from Turkey.

Materials and Methods

The material was collected from Iskenderun Bay, Mediterranean coast of Turkey, in May 2016 (Figure 1). Sampling was made by SCUBA diving, and specimens were preserved in 4% formalin (Tekkim, Bursa, Turkey) in seawater. A Magellan SporTrak Color GPS device was used to determine the coordinates of the sampling sites. The samples were studied using a light microscope (Nikon SE, Tokyo, Japan), and photographs were taken by digital camera (Nikon P5100, Nikon SE, Tokyo, Japan). Nomenclature has been checked against Guiry and Guiry (2017). The voucher material is deposited in the Department of Biology of the Manisa Celal Bayar University, Turkey.

Results and Discussion

The red alga *G. rugosa* (Galaxauraceae, Rhodophyta) has thalli that are calcareous, erect, 5-6 cm in height, with cylindrical axes (1-2 mm in diameter), subdichotomously branched. Gametophytes are yellowish, sometimes covered with short and long assimilatory filaments at the base (Figure 2a), smooth surface apical (Figure 2b). Tetrasporophyte dark reddish, covered completely with short and long assimilatory filaments (Figures 2c and 2d), the assimilatory filaments pigmented, the cells 30-40 µm long, and 10-16 µm broad, and cut off from basal tumid cells (Figures 2e and 2f). Tetrasporangia were not observed in the present material.

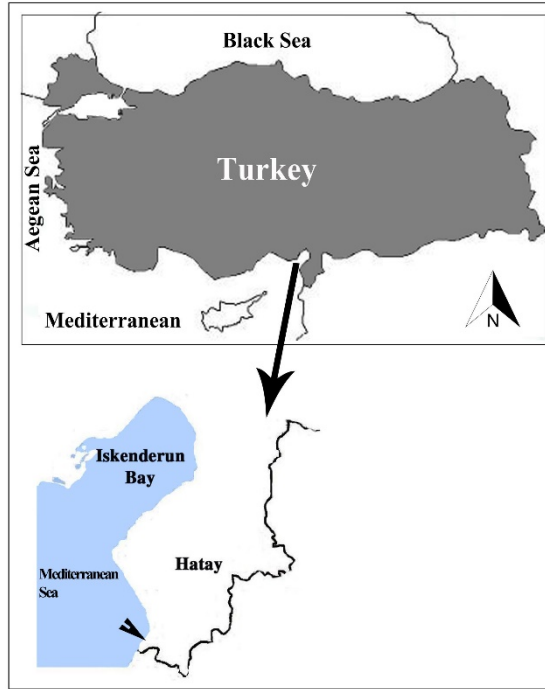


Figure 1. Sampling site of *Galaxaura rugose* (indicated by an arrowhead)

This species was collected from Samandağ in İskenderun Bay (35°57'34"N; 35°55'45"E), the Mediterranean coast of Turkey, in May 2016, at 5 m depth (Figure 2g), at a temperature of 23°C and salinity of 39‰, on a rocky substratum. The identification was made according to the account in Verlaque *et al.* (2015).

Other species present at the sampling site were *Amphiroa rigida* J.V.Lamour., alien green alga *Caulerpa taxifolia* var. *distichophylla* (Sonder) Verlaque, Huisman & Procaccini, *Dictyota spiralis* Mont., alien red alga *Ganonema farinosum* (J.V.Lamour.) K.C. Fan *et* Yung C. Wang, *Mesophyllum expansum* (Philippi) Cabioch & M.L.Mendoza, *Padina pavonica* (L.) Thivy, alien brown alga *Styopodium schimperi* (Buchinger ex Kütz.) Verlaque *et* Boudour., and alien marine angiosperm *Halophila stipulacea* (Forssk.) Ascherson.

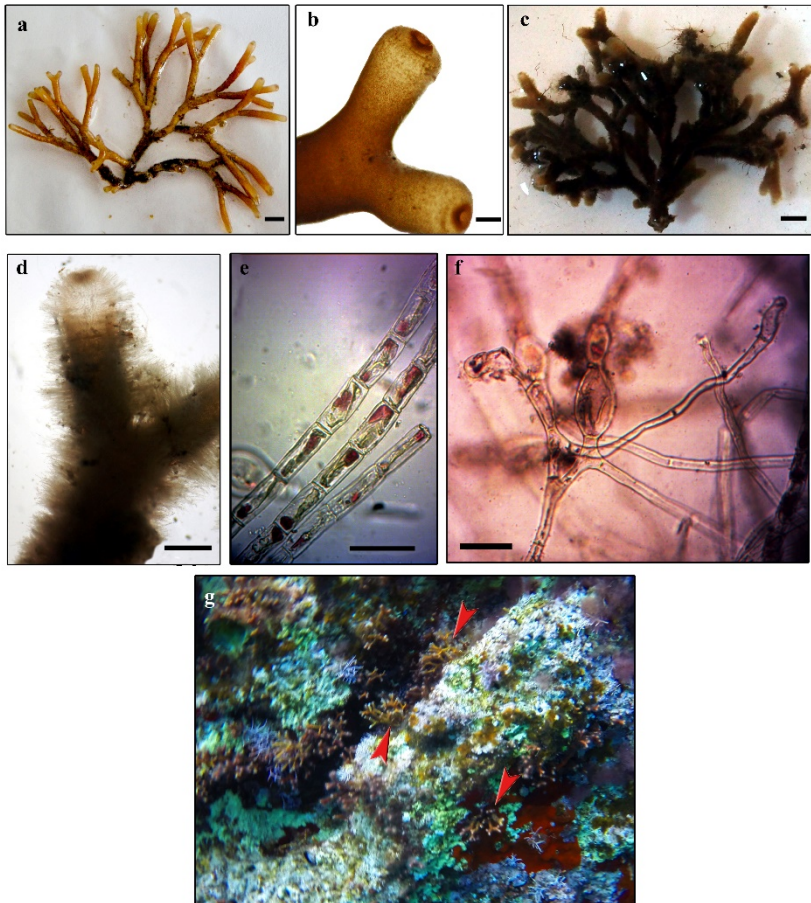


Figure 2. *Galaxaura rugosa*

- a:** gametophyte, covered with short and long assimilatory filaments at the base, scale bar: 3 mm;
- b:** gametophyte, smooth surface apical, scale bar: 250 µm;
- c:** tetrasporophyte, habit, scale bar: 5 mm;
- d:** tetrasporophyte, hirsute assimilatory filaments in upper parts, scale bar: 1 µm;
- e:** the cells of the assimilatory filaments of tetrasporophyte, scale bar: 50 µm;
- f:** the assimilatory filaments cut off from basal tumid cells of tetrasporophyte, scale bar: 50 µm;
- g:** thalli of *G. rugosa* underwater (arrowheads).

The genus *Galaxaura* was established by named by Lamouroux (1812: 185), and *Galaxaura rugosa* was named by Lamouroux (1816: 263), based on *Corallina rugosa* J.Ellis and Solander (1786: 115), the type locality of Jamaica (Wang *et al.* 2005), and it was reported from Atlantic Ocean, Indian Ocean, Pacific Ocean, and Australia (Verlaque *et al.* 2015). *G. rugosa* was introduced into the Mediterranean

via the Suez Canal and it is known on the coasts of Israel, Lebanon, and Syria in the Mediterranean Sea (Verlaque *et al.* 2015).

Life history of *Galaxaura* is triphasic, gametophytic and tetrasporophytic dimorphic (isomorphic in *Dichotomaria*), primary growth and the morphology of spermatangial conceptacles, procarps and cystocarp are similar to *Dichotomaria*, the multinucleate fusion cell in *Galaxaura* incorporates more inner proximal gonimoblast cells (7-10) (3-4 inner gonimoblast cells in *Dichotomaria*), the basal cell produces the involucrel filaments, do not form a pericarp (the basal cell produces involucrel filaments, form the pericarp in *Dichotomaria*) (Wang *et al.* 2005).

Türkiye’de yabancı denizel kırmızı alg *Galaxaura rugosa* varlığı

Öz

Bu çalışmada, yabancı denizel kırmızı alg *Galaxaura rugosa* (Galaxauraceae, Rhodophyta) Türkiye için ilk kez rapor edilmektedir. Bu tür Türkiye’nin Akdeniz kıyılarında olan İskenderun Körfezi’den örneklenmiştir. Türün resimleri, coğrafik dağılışı, morfolojisi ve ekolojisi ile ilgili veriler sunulmaktadır.

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