

## Temperature Responses and Distribution of Several Mediterranean Macroalgae Belonging to Different Distribution Groups

S. Orfanidis<sup>1</sup>

*Biologische Anstalt Helgoland (Zentrale), Notkestr. 31, D-2000 Hamburg 52, Fed. Rep. of Germany*

(Accepted 8 June 1993)

### Abstract

The temperature responses of six macroalgae, isolated from the Mediterranean Sea, were experimentally determined and correlated with their geographic boundaries in the North Atlantic Ocean. The algae fall within three phytogeographic groups: (1) the warm-temperate Mediterranean-Atlantic group (*Carpomitra costata*), (2) the Amphiatlantic temperate group (*Colpomenia peregrina* and *Stictyosiphon soriferus*) and (3) the Amphiatlantic tropical to warm-temperate group (*Gigartina teedii*). One species from the genus *Gracilaria* i.e. *G. verrucosa*, has also been investigated. Gametophytes of *Carpomitra costata* survived at 1–23 °C and grew sufficiently (> 20% of maximum rate) at 10–20 °C. The temperature responses of this phase did not explain the distribution boundaries of this species. Sufficient growth, reproduction and formation of macrothalli of *Colpomenia peregrina* proceeded at 10 to 25 °C. Germlings of this species grew better at higher temperatures than the macrothalli, but tolerated a similar temperature range (4–30 °C). Its geographic distribution cannot be entirely explained on the basis of the experimental data. *Stictyosiphon soriferus* survived at –1 to 28 °C and grew sufficiently between 5 and 25 °C. Reproduction occurred at 5 to 20 °C; at 25 °C sporulation was inhibited and the germlings did not form upright thalli. The experimental evidence is in agreement with the distribution in eastern America, the Mediterranean and the Black Sea, but not on the open European Atlantic coasts. Thalli of *Gigartina teedii* pre-incubated at 5 and 30 °C, and at 15 °C grew sufficiently at 15–30 °C and at 10–30 °C, respectively. Thalli cultivated at 15 °C survived at 4–31 °C. The northern geographical boundary of this species in eastern Atlantic is a growth and reproduction limit and the southern boundary a lethal one. *Gracilaria verrucosa* survived a wide temperature range (2–34 °C) and grew sufficiently at 15–30 °C confirming the warm-loving character of the genus.

### Introduction

The present Mediterranean flora has a history of ca. 5 ma. After the isolation of Mediterranean from the Atlantic in the late Miocene (Messinian salinity crisis), some of the late Miocene biota, which had survived the cooling trend at the end of Miocene, re-colonised the vacant basin and established the early Pliocene biota (Raffi and Marasti 1982). At that time the Mediterranean Sea lost its coral reefs and its tropical character in general (Lüning 1990). The dramatic climatic changes (glacial periods) which took place in

this area in the Pleistocene may have forced a number of cold temperate species to invade the area and to form disjunct populations in cooler parts of the Mediterranean after the glaciations (Hoek and Breeman 1990). Empty niche space and the climate changes in the late Pliocene and the Pleistocene may have promoted speciation and origin of endemic species. Nowadays, the Mediterranean coasts are inhabited by a rich seaweed flora including endemic, tropical, warm and cold temperate species.

The temperature responses of four Mediterranean species belonging to the warm-temperate Mediterranean-Atlantic group were tested in a previous paper (Orfanidis 1991). *Choristocarpus tenellus* (Kützting)

<sup>1</sup> Present address: Botanical Institute, Department of Biology, University of Thessaloniki, 54006 Thessaloniki, Greece.