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P. PANAYOTIDIS

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P. PANAYOTIDIS
Hellenic Center for Marine Research, Institute of Oceanography
P.O. Box 712, 190 13, Anavissos, Attica, Greece

e-mail: ppanag@ath.hcmr.gr

Abstract

The successful sexual reproduction of the Mediterranean invasive species Caulerpa racemosa could explain not only its rapid expansion during the last decade of the 20th century, but also its origin, through hybridation and genetic recombination of preexisting varieties. This paper argues on the cryptogenic origin of the Mediterranean invasive Caulerpa racemosa.

Keywords: Cryptogenic species; Invasive algae; *Caulerpa racemosa*; Mediterranean Sea.

The green alga *Caulerpa racemosa* (Forsskål) J. Agardh was first found on the Tunisian coasts by HAMEL (1926), who has considered it as a Lessepsian migrator. For many decades the species was considered as rare, localized on specific sites of the Southeastern Mediterranean coasts (UNEP, 1990). During the last decade of the 20th century a new invasive variety appeared massively. The first blooms of the invasive variety were reported from the North African coasts (Libya and Egypt), some years later from Turkey, Cyprus and Greece and later on from Italy, France and Spain (PIAZZI *et al*., 2005).

A study of all the Mediterranean varieties of *Caulerpa racemosa* (VERLAQUE *et al.*, 2000) demonstrated the presence of three distinct groups: 1) the *C. racemosa* var. *turbinata-uvifera*, 2) the *C. racemosa* var. *lamourouxii* and 3) the invasive variety, identified (based on morphological data) as the tropic Indo-Pacific *C. racemosa* var. *occidentalis*. A recent study of the invasive variety by molecular analyses (rDNA ITS1 & ITS2) demonstrated that this variety is closer to the warm-temperate Australian *C. racemosa* var. *laetevirens* f. *cylindracea* (Sonder) Weber-van Bosse, than the tropical varieties (VERLAQUE *et al*., 2003). Based on these findings the invasive variety was named *C. racemosa* var. *cylindracea* (Sonder) Verlaque, Huisman & Boudouresque, and was considered as hybrid between the introduced Australian *C. racemosa* var. *laetevirens* f. *cylindracea* and the Mediterranean varieties (DURAND *et al.,* 2004).

The spread of the invasive *Caulerpa racemosa* is supported by succesful sexual production on a massive scale (PANAYOTIDIS & ZULJEVIC, 2001), which is probably the reason for its continuous presence all over the Mediterranean (PIAZZI *et al*., 2005), as opposed to the congeneric alien invasive *Caulerpa taxifolia*, which has only vegetative reproduction (MEINESZ & HESSE, 1991) and whose spread is discontinuous in Spain, France, Italy & Croatia (MEINESZ *et al.*, 2001).

Although there is evidence supporting the genetic relationship between the invasive *Caulerpa racemosa* and the Australian *C. racemosa* var. *laetevirens* f. *cylindracea*, the origin and the vector of the invasive variety remains enigmatic. From our point of view the introduction of an Australian species to the North African coasts without intermediate stations is not a realistic scenario. On the other hand, some authors argue on the hypothesis of an enlargement of biogeographic areas for paleoendemic Mediterranean species, due to climatic changes (GIACCONE, 1997). In other words, using the definition of CARLTON (1996), *Caulerpa racemosa* could be regarded as a cryptogenic species.

In our view, a differentiation of pre-existing Mediterranean varieties of *Caulerpa racemosa* could be considered in the light of its massive, successful sexual reproduction, triggered by the extremely hot summers observed frequently in the Mediterranean since the last decade of the 20th century.

The fact that VERLAQUE *et al*., (2003) demonstrated the genetic relationship between the invasive Mediterranean *Caulerpa racemosa* and the Australian *C. racemosa* var. *laetevirens* f. *cylindracea* does not necessarily imply that the species was introduced from Australia. The biogeographical relationships between the warm-temperate Australia and the Mediterranean are well known and the presence of the seagrass Posidonia, endemic in both areas, is the best evidence of this.

Thus, the origin of the invasive Mediterranean *Caulerpa racemosa* remains enigmatic. Together with the hypothesis of the introduction of an Australian species by unknown means (proposed by DURAND *et al.*, 2004) or the hypothesis of an Indo-Pacific species introduced via the Suez Canal (criticized by Verlaque et al., 2000), a third hypothesis could be considered: the spread of a new variety, an hybrid of paleoendemic Mediterranean *Caulerpa racemosa* varieties. This new hybrid could be produced through recombination of the genome during sexual reproduction, triggered by the climatic change of the Mediterranean.

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