

Mediterranean Marine Science

Vol 7, No 1 (2006)



On the enigmatic origin of the Mediterranean invasive *Caulerpa racemosa* (Caulerpales, Chlorophyta)

P. PANAYOTIDIS

doi: [10.12681/mms.181](https://doi.org/10.12681/mms.181)

To cite this article:

PANAYOTIDIS, P. (2006). On the enigmatic origin of the Mediterranean invasive *Caulerpa racemosa* (Caulerpales, Chlorophyta). *Mediterranean Marine Science*, 7(1), 119–121. <https://doi.org/10.12681/mms.181>

Mediterranean Marine Science

Volume 7/1, 2006, 119-121

**On the enigmatic origin of the Mediterranean invasive
Caulerpa racemosa (Caulerpales, Chlorophyta)**

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 South-eastern 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 successful 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 sex-

ual reproduction, triggered by the climatic change of the Mediterranean.

Acknowledgements

Special thanks are expressed to A. Zuljevic and B. Montesanto, for their contribution to the present paper.

References

- CARLTON, J.T., 1996. Biological invasions and cryptogenic species. *Ecology*, 77: 1653-1655.
- DURAND C., MANUEL M., BOUDOUR-ESQUE C.F., MEINESZ A., VERLAQUE M. & LE PARCO Y., 2004. Molecular data suggest a hybrid origin for the invasive *Caulerpa racemosa* (Caulerpaceae, Chlorophyta) in the Mediterranean Sea. *Journal Evol. Biology* 15: 122-131.
- GIACCONE G., 1997. Phytosociologie et écologie du genre *Caulerpa* en Méditerranée. In «Dynamique d'espèces marines invasives». *Académie des Sciences Paris*: 131-144.
- HAMEL, G., 1926. Quelques algues algues rares ou nouvelles pour la flore méditerranée. *Bulltain Museum Natural Science Paris* 32: 420.
- MEINESZ, A. & HESSE, B., 1991. Introduction et invasion de l'algue tropicale *Caulerpa taxifolia* en Méditerranée nord-occidentale. *Oceanologica Acta* 14: 415-426.
- MEINESZ, A., BELSHER, T., THIBAUT, T., ANTOLIC, B., BEN MUSTAPHA, K., BOUDOURESQUE, C-F, CHIAVERINI, D., CINELLI, F., COTTALORDA, J-M., DJELLOULI, A., EL ABED, A., ORESTANO, C., GRAU, AM., IVESA, L., JAKLIN, L., LANGAR, H., MASSUTI-PASCUAL, E., PEIRANO, A., TUNESI, L., DE VAUGELAS, J., ZAVODNIK, N. & JULJEVIC, A., 2001. The introduced green alga *Caulerpa taxifolia* continues to spread in the Mediterranean. *Biological Invasions*, 3:201-210.

- PANAYOTIDIS P. & ZULJEVIC, A., 2001: Sexual reproduction of the invasive green alga *Caulerpa racemosa* var. *occidentalis* in the Mediterranean. *Oceanologica Acta*, 24 (2): 199-203.
- PIAZZI, L., MEINESZ, A., VERLAQUE, M., AKHALI, B., ANTOLIĆ, B., ARGYROU, M., BALATA, D., BALLESTEROS, E., CALVO, S., CINELLI, F., CIRIK, S., COSSU, A., D'ARCHINO, R., DJELLOULI, A., JAVEL, F., LANFRANCO, E., MIFSUD, C., PALA, D., PANAYOTIDIS, P., PEIRANO, A., PERGENT, G., PETROCELLI, A., RUITTON, S., ŽULJEVIĆ, A. & CECCHERELLI, G., 2005. Invasion of *Caulerpa racemosa* var. *cylindracea* (Caulerpales, Chlorophyta) in the Mediterranean Sea: an assessment of the spread *Cryptogamie, Algologie*. 2005, 26(2): 189-202.
- UNEP, 1990. Livre rouge 'Gerard Vuignier' des végétaux, peuplements et paysages marins menacés de la Méditerranée. MAP Technical Reports Series No 43, Athens 1990, 280 p.
- VERLAQUE, M., BOUDOURESQUE, C.F., MEINESZ, A. & GRAVEZ, V., 2000 - The *Caulerpa racemosa* Complex (Caulerpales, Ulvophyceae) in the Mediterranean Sea. *Botanica Marina* 43: 49-68.
- VERLAQUE, M., DURAND, C., HUISMAN, J.M., BOUDOURESQUE, C.F. & LE PARCO Y., 2003. On the identity and origin of the Mediterranean invasive *Caulerpa racemosa* (Caulerpales, Chlorophyta). *European Journal of Phycology* 38: 325-329.
- VERLAQUE, M., ALFONSO-CARDILLO, J., GIL-RODRIGEZ, CM., DURAND, C., BOUDOURESQUE, C.F. & LE PARCO, Y., 2004. Blitzkrieg in a marine invasion: *Caulerpa racemosa* var. *cylindracea* (Bryopsidales, Chlorophyta) reaches the Canary Islands. *Biological Invasions* 6: 269-281.

Accepted in March 2007

