Harmful Algae 71 (2018) 57–77

Contents lists available at ScienceDirect

Harmful Algae

journal homepage: www.elsevier.com/locate/hal

# *Pentaplacodinium saltonense* gen. et sp. nov. (Dinophyceae) and its relationship to the cyst-defined genus *Operculodinium* and yessotoxin-producing *Protoceratium reticulatum*

Kenneth Neil Mertens[a,*], M. Consuelo Carbonell-Moore[b], Vera Pospelova[c], Martin J. Head[d], Andrea Highfield[e], Declan Schroeder[e,f], Haifeng Gu[g], Karl B. Andree[h], Margarita Fernandez[h], Aika Yamaguchi[i], Yoshihito Takano[j], Kazumi Matsuoka[j], Elisabeth Nézan[k], Gwenael Bilien[k], Yuri Okolodkov[l], Kazuhiko Koike[m], Mona Hoppenrath[n], Maya Pfaff[o], Grant Pitcher[p], Abdulrahman Al-Muftah[q], André Rochon[r], Po Teen Lim[s], Chui Pin Leaw[s], Zhen Fei Lim[s], Marianne Ellegaard[t]

[a] *Research Unit for Palaeontology, Ghent University, Krijgslaan 281 s8, 9000 Ghent, Belgium*
[b] *Oregon State University, Department of Botany and Plant Pathology, College of Agricultural Sciences, 2082 Cordley Hall, Corvallis, OR 97331-2902, USA*
[c] *School of Earth and Ocean Sciences, University of Victoria, OEASB A405, P.O. Box 1700 Box 1700 STN CSC, Victoria, BC, V8W 2Y2, Canada*
[d] *Department of Earth Sciences, Brock University, 1812 Sir Isaac Brock Way, St. Catharines, Ontario, L2S 3A1, Canada*
[e] *The Marine Biological Association of the United Kingdom, Citadel Hill, Plymouth PL1 2PB, United Kingdom*
[f] *School of Biological Sciences, University of Reading, Reading RG6 6AJ, United Kingdom*
[g] *Third Institute of Oceanography, SOA, Xiamen 361005, China*
[h] *IRTA, Crta. Poble Nou, Km 5.5, 43540 Sant Carles de la Rápita, Spain*
[i] *Kobe University Research Center for Inland Seas, Kobe 657-8501, Japan*
[j] *Institute for East China Sea Research (ECSER), Nagasaki University, 1551-7, Taira-machi, Nagasaki, 851-2213, Japan*
[k] *Ifremer, LER BO, Station de Biologie Marine, Place de la Croix, BP40537, F-29185 Concarneau Cedex, France*
[l] *Universidad Veracruzana, Instituto de Ciencias Marinas y Pesquerías, Calle Hidalgo núm. 617, Colonia Río Jamapa, Boca del Río, 94290 Veracruz, Mexico*
[m] *Graduate School of Biosphere Science, Hiroshima University, Kagamiyama 1-4-4, Higashi-Hiroshima, Hiroshima 739-8528, Japan*
[n] *Senckenberg am Meer, Deutsches Zentrum für Marine Biodiversitätsforschung (DZMB), Südstrand 44, D-26382 Wilhelmshaven, Germany*
[o] *Marine Biology Research Center, Ma-RE Institute, Zoology Department, University of Cape Town, Rondebosch 7701, South Africa*
[p] *Marine and Coastal Management, Private Bag X2, Rogge Bay 8012, Cape Town, South Africa*
[q] *Department of Biological and Environmental Sciences, Qatar University, Doha, Qatar*
[r] *Institut des sciences de la mer de Rimouski (ISMER), Université du Québec à Rimouski, 310 allée des Ursulines, Rimouski, QC, G5L 3A1, Canada*
[s] *Institute of Ocean and Earth Sciences, University of Malaya, 16310 Bachok, Kelantan, Malaysia*
[t] *Department of Plant and Environmental Sciences, University of Copenhagen, Thorvaldsensvej 40, DK-1871, Frederiksberg, Denmark*

ARTICLE INFO

*Article history:*
Received 12 September 2017
Received in revised form 8 December 2017
Accepted 8 December 2017
Available online xxx

*Keywords:*
*Pentaplacodinium*
*Protoceratium*
Precingular plates
Salton Sea
*Ceratocorys*
*Operculodinium*
Cribroperidinioideae

ABSTRACT

Strains of a dinoflagellate from the Salton Sea, previously identified as *Protoceratium reticulatum* and yessotoxin producing, have been reexamined morphologically and genetically and *Pentaplacodinium saltonense* n. gen. et sp. is erected to accommodate this species. *Pentaplacodinium saltonense* differs from *Protoceratium reticulatum* (Claparède et Lachmann 1859) Bütschli 1885 in the number of precingular plates (five vs. six), cingular displacement (two widths vs. one), and distinct cyst morphology. Incubation experiments (excystment and encystment) show that the resting cyst of *Pentaplacodinium saltonense* is morphologically most similar to the cyst-defined species *Operculodinium israelianum* (Rossignol, 1962) Wall (1967) and *O. psilatum* Wall (1967). Collections of comparative material from around the globe (including *Protoceratium reticulatum* and the genus *Ceratocorys*) and single cell PCR were used to clarify molecular phylogenies. Variable regions in the LSU (three new sequences), SSU (12 new sequences) and intergenic ITS 1–2 (14 new sequences) were obtained. These show that *Pentaplacodinium saltonense* and *Protoceratium reticulatum* form two distinct clades. *Pentaplacodinium saltonense* forms a monophyletic clade with several unidentified strains from Malaysia. LSU and SSU rDNA sequences of three species of *Ceratocorys* (*C. armata, C. gourreti, C. horrida*) from the Mediterranean and several other unidentified

* Corresponding author. Present address: Ifremer, LER BO, Station de Biologie Marine, Place de la Croix, BP40537, F-29185 Concarneau Cedex, France.
*E-mail address:* kenneth.mertens29@gmail.com (K.N. Mertens).

https://doi.org/10.1016/j.hal.2017.12.003
1568-9883/