MORPHOLOGY, ULTRASTRUCTURE, AND MOLECULAR PHYLOGENY OF WANGODINIUM SINENSE GEN. ET SP. NOV. (GYMNOGINIALES, DINOPHYCEAE) AND REVISITING OF GYMNOGNINUM DORSALISULCUM AND GYMNOGNINUM IMPUDICUM

Zhaohe Luo
Third Institute of Oceanography, SOA, Xiamen 361005, China

Zhangxi Hu, Yingzhong Tang
CAS Key Laboratory of Marine Ecology and Environmental Sciences, Institute of Oceanology, Chinese Academy of Sciences, Qingdao 266071, China

Kenneth Neil Mertens
Ifremer, LER BO, Station de Biologie Marine, Place de la Croix, BP40537, F-29185, Concarneau Cedex, France

Chui Pin Leaw, Po Teen Lim
Bachok Marine Research Station, Institute of Ocean and Earth Sciences, University of Malaya, 16310, Bachok, Kelantan, Malaysia

Sing Tung Teng
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300, Kota Samarahan, Sarawak, Malaysia

Lei Wang, and Haifeng Gu
Third Institute of Oceanography, SOA, Xiamen 361005, China

The genus Gymnodinium includes many morphologically similar species, but molecular phylogenies show that it is polyphyletic. Eight strains of Gymnodinium impudicum, Gymnodinium dorsalisulcum and a novel Gymnodinium-like species from Chinese and Malaysian waters and the Mediterranean Sea were established. All of these strains were examined with light microscopy, scanning electron microscopy and transmission electron microscopy. SSU, LSU and internal transcribed spacers rDNA sequences were obtained. A new genus, Wangodinium, was erected to incorporate strains with a loop-shaped apical structure complex (ASC) comprising two rows of amphiesmal vesicles, here referred to as a new type of ASC. The chloroplasts of Wangodinium sinense are enveloped by two membranes. Pigment analysis shows that peridinin is the main accessory pigment in W. sinense. Wangodinium differs from other genera mainly in its unique ASC, and additionally differs from Gymnodinium in the absence of nuclear chambers, and from Lepidodinium in the absence of Chl b and nuclear chambers. New morphological information was provided for G. dorsalisulcum and G. impudicum, e.g., a short sulcal intrusion in G. dorsalisulcum; nuclear chambers in G. impudicum and G. dorsalisulcum; and a chloroplast enveloped by two membranes in G. impudicum. Molecular phylogeny was inferred using maximum likelihood and Bayesian inference with independent SSU and LSU rDNA sequences. Our results support the classification of Wangodinium within the Gymnodiniales sensu stricto clade and it is close to Lepidodinium. Our results also support the close relationship among G. dorsalisulcum, G. impudicum, and Barrufeta. Further research is needed to assign these Gymnodinium species to Barrufeta or to erect new genera.

Key index words: apical structure complex; cyst; dinoflagellate; Lepidodinium; nuclear chambers; pigment; pyrenoid; ultrastructure

Abbreviations: ASC, apical structure complex; AV, amphiesmal vesicles; BI, Bayesian inference; BPP, Bayesian posterior probabilities; BS, bootstrap support; DAPI, 4',6-diamidino-2-phenylindole dihydrochloride; DMF, N,N-dimethylformamide; GTR, general time-reversible; MCMC, Markov chain Monte Carlo; ML, maximum likelihood; Mv-chl a, monovinyl chlorophyll a; NFC, nuclear fibrous connector; RAxML, Randomized Accelerated Maximum Likelihood; Tchl a, total chlorophyll a

Many athecate dinoflagellates have been classified in the genus Gymnodinium, which originally encompassed gymnodinioid species with a cingulum