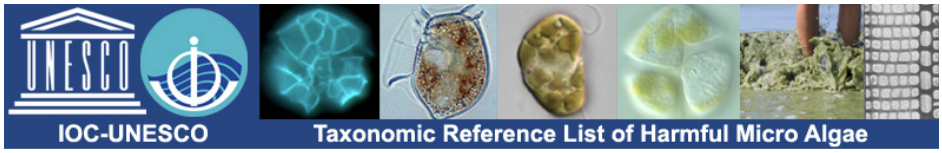
Harmful Algae News

An IOC Newsletter on Toxic Algae and Algal Blooms

No. 77 – December 2024 · https://hab.ioc-unesco.org/



New toxic species – and what about their names?

News from the IOC-UNESCO Task Team on Algal Taxonomy

The IOC-UNESCO Taxonomic Reference List of Harmful Micro Algae (available via the *HAB Index*) is an actively maintained and comprehensive list of all microalgae known to produce toxins.

- It may serve as a starting point for assessing toxigenic microalgae.
- It provides up-to-date and accurate nomenclature.

The list presently includes 116 dinoflagellates, 43 cyanobacteria, 31 diatoms, eight haptophytes, seven raphidophytes, and three dictyochophytes, and the number is steadily increasing.

A group of editors (listed below) continuously updates the list and welcomes suggestions for modifications.

Before reviewing the changes to the list over the past few years, the editorial team would like to extend a heartfelt thank you to Santi Fraga for his invaluable contributions as the editor of the *Alexandrium* group!

We also welcome new editors: Shauna Murray (responsible for the Amphidiniales), Urban Tillman (responsible for the Amphidomataceae, Peridiniales) and Rafael Salas (responsible for the Thoracosphaerales) – thank you for joining the team!!

Recently, we have begun updating information on each species by adding details on morphology, particularly features important for accurate identification, including micrographs. Information on resting stages (cysts, akinetes, etc.) has been included, as well as references to selected GenBank sequences, preferably from or near the type locality. Furthermore, we are working on including more cyanobacteria, this section of the list remains incomplete, particularly concerning freshwater species. Additionally, the list has been updated to reflect that several species have been confirmed to be toxigenic (Table 1).

Additions to the list

(in red: recently described species, in black: species not recently described but newly identified as toxic):

Dinoflagellates

- *Alexandrium fragae*, *A. limii*, *A. ogatae*, *A. taylorii*
- *Centrodinium punctatum*
- *Gambierdiscus caribaeus* and *G. silvae* (new algal CTX-toxin: CTX5), *G. cheloniae*, *G. holmesii*, *G. honu*, *G. lewisii*
- *Gonyaulax bohaiensis*, *G. taylorii*
- *Prorocentrum caipirignum*, *P. fukuyoi*, *P. porosum*, *P. steidingerae*
- *Coolia malayensis*
- *Amphidinium magnum*, *A. pseudomassartii*, *A. tomasii*

Diatoms

- *Pseudo-nitzschia bipertita*, *P. punctionis*, *P. simulans*, *P. subcurvata*

Raphidophytes

- *Chattonella malayana*

Additional modifications to the list are outlined below:

Some species have been renamed

- *Karenia digitata* has been transferred to *Karlodinium digitatum*.
- *Karenia umbella* is a junior synonym of *Karenia longicanalis*.
- *Lingulodinium polyedra* is now renamed as *Lingulaulax polyedra*. *Lingulaulax polyedra* is a new name for *Lingulodinium polyedra*; as such, the genus *Lingulodinium* Wall 1967 is retained in its exclusively fossil status [1].

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Content

Table 1. Newly described or known species, which have recently been shown to produce toxins with indications of toxin types as well as reference.

Species name (new species in bold)	Identified toxins	References
Alexandrium fragae	GTX2, GTX3, and STX	Branco et al. 2020 10.1016/j.hal.2020.101793
A. limii	GDs, with GDA as major variants or demethyl variant	Abdullah et al. 2023 10.1016/j.hal.2023.102475
A. ogatae	GDs, with GDA as major variants	Abdullah et al. 2023 10.1016/j.hal.2023.102475
A. taylorii	GDA and lytic compounds but no PSTs	Tillmann et al. 2020 10.3390/toxins12090564
Centrodinium punctatum	STX, GTX1-4, neoSTX, deoxy-STX	Shin et al. 2020 10.1016/j.hal.2020.101923
Gambierdiscus caribaeus	44-Methylgambierone; C-CTX5 in the Caribbean	Murray et al. 2019 10.1016/j.tetlet.2019.01.043 Murray et al. 2021 10.3390/toxins13050333 Mudge et al. 2023 10.1016/j.jchromb.2021.123014
G. chelonii	MTX-3, MTX-3 analogue,	Smith et al. 2016 10.1016/j.hal.2016.10.006
G. holmesii	MTX-(44-Methylgambierone)	Kretzschmar et al. 2019 10.1016/j.protis.2019.125699
G. honu	MTX	Munday et al. 2017 10.3390/md15070208
G. lewisii	MTX-(44-Methylgambierone)	Kretzschmar et al. 2019 10.1016/j.protis.2019.125699
G. silvae	44-Methylgambierone and gambierone; C-CTX-5 in the Caribbean	Mudge et al. 2022 10.1016/j.jchromb.2021.123014. Mudge et al. 2023 10.1016/j.chemosphere.2023.138659
Gonyaulax bohaiensis	YTXs	Gu et al. 2022 10.1111/jpy.13245
G. taylorii	YTX and homoYTX	Álvarez et al. 2016 10.1016/j.hal.2016.07.006
Prorocentrum caipirignum	OA and prorocentrolide	Nishimura et al. 2020 10.1016/j.hal.2019.101687
P. cf. *fukuyoi*	A strain belonging to the *P. fukuyoi* complex produces OA	Nishimura et al. 2020 10.1016/j.hal.2019.101687
P. porosum	OA	Arteaga-Sogamoso et al. 2023 10.1016/j.hal.2022.102356
P. steidingerae	OA	Steidinger KA & ME Meave del Castillo (Eds) 2018. Free download at [2].
Coolia malayensis	YTX analogue $C_{56}H_{78}O_{18}S_2$ and other analogues, $C_{57}H_{80}O_{18}S_2$ and $C_{58}H_{86}O_{18}S_2$	Phua et al. 2021 10.1016/j.hal.2021.102120
Amphidinium magnum	Brine shrimp bio-assay – 63% decrease compared to controls, toxin not identified.	Karafas et al. 2017 10.1016/j.hal.2017.08.001
A. pseudomassartii	Brine shrimp bio-assay – 95% decrease compared to controls, toxin not identified.	Karafas et al. 2017 10.1016/j.hal.2017.08.001
A. tomasii	Brine shrimp bio-assay – 90% decrease compared to controls, toxin not identified	Karafas et al. 2017 10.1016/j.hal.2017.08.001
Pseudo-nitzschia bipertita	DA	Dong et al. 2020 10.1016/j.hal.2020.101899
P. punctionis	DA	Niu et al. 2023 10.1111/jse.13016
P. simulans	DA	Li et al. 2017 10.1016/j.hal.2017.06.008
P. subcurvata	DA, DA- isomer C	Olesen et al. 2021 10.3390/toxins13020093
Chattonella malayana	Not known	Lum et al. 2022 10.1016/j.hal.2022.102322

Abbreviations: CTX (Ciguatoxin), deSTX (decarbomoyls), DA (Domoic acid), GDs (Goniodomins), GDA (Goniodomin A), GTX (Gonyautoxin), homoYTX (homoyessotoxin), OA (Okadaic Acid), STX (Saxitoxin), MTX (Maitotoxin), neoSTX (Neosaxitoxin), YTX (Yessotoxin).

Others have been removed from the list and added to the Grey List of species for which toxicity is doubtful, as the presence of toxins has not been demonstrated.

- The two pelagophytes (*Aureococcus anophagefferens* and *Aureoumbra lagunensis*).
- The diatom *Halamphora coffeaeformis.*
- The dinoflagellate *Prorocentrum micans.*

Taxonomic issues concerning *Alexandrium*

A notable taxonomic issue that has been discussed is the fact that the genus *Alexandrium* is not a valid name according to the Botanical Code for Nomenclature because it lacked a Latin description and did not indicate a type when Halim described it in 1960. This issue has been known for some time, but it was generally accepted that *Alexandrium* was valid according to the Zoological Code, as this code requires neither a Latin description nor a reference to a type. However, it is only valid under the zoological code if it was clear that Halim considered *Alexandrium* as an animal. Recent phylogenetic analyses reveal that *Centrodinium punctatum* is nested within *Alexandrium*, and since *Centrodinium* (described in 1907) predates *Alexandrium* (described in 1960), it has priority.

To make a short story long, several solutions were considered to avoid changing the name *Alexandrium*, which has been used in thousands of publications; therefore, preserving its name is essential for nomenclatural stability. A solution has hopefully now been found, as a paper is being published supporting that *Alexandrium* should be treated as an animal according to Halim (1960) and thus agreeing with the Zoological Code. The final acceptance depends on a vote in the Commission of the Zoological Code (Gottschling, M. & Elbrächter, M. (in press) Case 3886 — *Alexandrium* Halim, 1960 (Dinoflagellata, GONYAULACIDAE): confirmation of treatment as an animal taxon. – Bulletin of Zoological Nomenclature 81).

A new list of harmful but non-toxigenic species

The scientific and managerial communities have for a long time requested a list of non-toxigenic harmful microalgal species. These microalgae can be responsible of fish kills or other animal mortalities, seawater discoloration, mucilage, and foam formation, among other issues, thus negatively impacting marine life and human activities such as fisheries, aquaculture, tourism, and recreational use of the marine environment.

Listing non-toxigenic but harmful species may be complex and even misleading, as these species are generally beneficial and should not be the focus of management practices. Negative effects occur only in some cases or specific locations, while any species reaching excessive abundance can be harmful to marine life or the ecosystem. With this in mind, it was decided to consider only cases documented either in the Harmful Algae Event Database (HAEDAT, *https://haedat.iode.org/*) or in the peer-reviewed literature. The compilation is divided in two parts, the first addresses species associated with impacts on the health of marine fish and other animals, causing harm due to e.g. cell barbs and spines, anoxia, or other mechanisms not involving toxins. This first list, now completed, comprises 55 species (23 diatoms, 25 dinoflagellates and seven from other groups), and covers 106 documented events or cases. The second list, currently in preparation, will include species responsible for seawater discoloration, mucilage, foam formation, and other events that impact water quality and human activities.

Challenges we see

In the group, we foresee a challenge in having enough individuals in the next generation of taxonomists. In many countries, the number of phytoplankton taxonomists is declining or is expected to decline soon, as many are nearing retirement.

We need to be aware to encourage and train the next generation of taxonomists!!

References

1. *Head MJ et al 2024 Palynology, DOI: 10.1080/01916122.2023.2290200*
2. *Steidinger KA & ME Meave del Castillo (Eds) (2018). Guide to the identification of harmful microalgae in the Gulf of Mexico https://myfwc.com/research/redtide/research/scientific-products/guide/*

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https://doi.org/10.5281/zenodo.14363545

Ojvind Moestrup (past Chair) and Nina Lundholm, Chair of the Task Team on Taxonomy, enjoying Japanese food during a break at the 20th ICHA, Hiroshima, November 2023.