

**Validation of the phylum name *Heterokontophyta***Michael D. Guiry<sup>1</sup>, Øjvind Moestrup<sup>2</sup> & Robert A. Andersen<sup>3</sup>

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Ruggiero & al. (2014) provided “A higher level classification of all living organisms” for the [Catalogue of Life](#) and [ITIS](#) (Integrated Taxonomic Information System). This classification was adopted by [AlgaeBase](#), but it has become clear in recent years that some names of taxa used there—largely at the insistence of the late Thomas Cavalier-Smith (1942–2021)—are not at all familiar to most phycologists even though they are in use by the protistological community. One such taxon name is *Ochrophyta* Cavalier-Smith (Cavalier-Smith 1998: 252, validated by reference to *Ochrasta* Cavalier-Smith (Cavalier-Smith 1986: 339), a subphylum of *Heterokonta*, a phylum\* of the kingdom *Chromista*). We believe that the phylum name *Heterokontophyta* would be a more suitable and appropriate name for 18 classes of heterokont organisms currently recognised as algae by phycologists (Table 1). We here present a history of this name and validate it under the [International Code of Nomenclature for algae, fungi, and plants](#) (Turland & al. 2018). We have no desire to create dissension between phycologists and protistologists (and protozoologists) but rather to provide a more familiar name for the use of the algal community.

The class name *Heterokontae* was first introduced by Luther (1899: 17, 19, as ‘Klasse *Heterokontæ*’) to include the orders *Chloromonadales* (families *Chloramoebaceae* and *Vacuolariaceae*) and *Confervales* (*Confervaceae*, *Chlorotheciaceae* and *Botrydiaceae*) referring, amongst other things, to the disk-shaped chloroplasts that in addition to chlorophyll contain a yellow pigment, an absence of starch or paramylon, and flagellate cells with flagella of two different lengths. Oltmanns (1904: 18) included the class *Heterocontae* [*sic*] in his *Morphologie und Biologie der Algen* without attribution, and included the *Chloromonadaceae* and *Confervaceae*, essentially the same concept as that of Luther. Luther's two orders were quickly separated, e.g. Pascher (1914) placed his *Heterokontae* (xanthophytes only) with the *Bacillariophyceae* and *Chrysophyceae* (*Chrysophyta*) and placed the *Chloromonadinae* closer to the *Eugleninae*. Today, Luther's class *Heterokontae* is essentially coextensive with the classes *Xanthophyceae* Allorge ex Fritsch 1935 and *Raphidophyceae* Chadeffaud ex P.C.Silva 1980.

Papenfuss (1955) and Silva (1979) provided comprehensive and scholarly accounts of the taxonomic history and nomenclature of the “yellow-green algae”, which it is not necessary to repeat here. The first valid phylum name applied to these algae is *Xanthophyta* Hollerbach & Poljansky (Hollerbach & Poljansky 1951: 7, 14, 188), which was proposed seemingly as a replacement for the *Heterocontae* [*sic*] with a description in Russian but with separate phyla names *Bacillariophyta* and *Chrysophyta*, and as such a different circumscription. Other earlier phyla names applied to the yellow-green algae remain invalid (Silva 1979: 25).

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\* Division (*Divisio*) and phylum are treated as equivalent ranks by the ICN (Art. 3.1, Turland & al. 2018).

In an excellent textbook “*Algen*” first published in 1978, and a reflection on the electron microscopy discoveries of the 1970s, Hoek introduced “*Divisio (Abteilung) Heterokontophyta*” for five classes of algae: *Chrysophyceae*, *Xanthophyceae*, *Bacillariophyceae*, *Phaeophyceae*, and *Chloromonadophyceae*, along with the phyla *Cyanophyta*, *Rhodophyta*, *Haptophyta*, *Eustigmatophyta*, *Cryptophyta*, *Dinophyta*, *Euglenophyta*, and *Chlorophyta*, essentially the core phylum classification for algae in wide use today. Hoek (1978: 79) provided a comprehensive description in German of the *Heterokontophyta*. A similar treatment is found in the second edition of the same work (Hoek 1984), and an enlarged version in English appeared 10 years later (Hoek, Mann & Jahns 1995) including an English description of the *Heterokontophyta*.

Independently, Christensen (1962: 54) had earlier introduced the name *Chromophyta* without attribution or Latin description for nine classes, including the *Xanthophyceae*. He later (Christensen 1989: 9). validated his descriptive name with a Latin diagnosis. However, Christensen’s *Chromophyta* was not co-extensive with Hoek’s *Heterokontophyta* being rather part of an evolutionary concept recognising four divisions of algae: *Cyanophyta*, *Rhodophyta*, *Chlorophyta* and *Chromophyta*. His description of the *Chromophyta* bears this out: “A group comprising all classes of the commonly used systems characterised by the presence of flagella and chlorophyll *a* and the absence of chlorophyll *b*.” That is, Christensen’s *Chromophyta* included the *Cryptophyceae*, *Dinophyceae*, and *Haptophyceae*.

Leedale (1980, the text of a 1974 presentation and article) included the name *Heterokontophyta* in a table (Leedale 1980: 14) as a Division in which he included the classes *Chrysophyceae*, *Xanthophyceae*, *Phaeophyceae*, *Chloromonadophyceae*, *Bacillariophyceae*, and *Oomycota* (Fungi); however, no description for the “division” name or reference to an existing name was provided, rendering it an invalid name.

Several factors have adversely affected the evolution of a consistent name for heterokont algae at the phylum level not least of which are the efforts by authors treating ambiregnal representatives of organisms with heterokont flagella such as Cavalier-Smith (1989), who adopted the subkingdom [*sic*] name *Chromophyta* Cavalier-Smith that included the *Heterokonta* Cavalier-Smith, an act referred to by Christensen (1989: 9) as a “nomenclatural trick”. This was not the last time advantage was taken by Cavalier-Smith of certain provisions of the ICN.

In the same symposium volume, Patterson (1989: 357) stated that “...the concept of chromophytes as a group of algae is restrictive and phylogenetically unsatisfactory” and pointed to the difficulties of organisms repeatedly gaining and losing traits. He introduced the term “stramenopiles”<sup>†</sup> for heterokont algae and related organisms including various non-photosynthetic groups such as the opalinids, labyrinthulids and thraustochytrids and even the foraminifera. The descriptive name *Stramenopiles* D.J.Patterson is not a valid name under the ICN. While it is laudable to recognize a more encompassing grouping (a kingdom?), phycologists need a name specifically for the heterokont algae.

In a major departure from existing schemes of classification, Moestrup (1992) proposed a classification scheme of algae into 11 divisions [phyla] and 22 classes and he included the “*Division Heterokontophyta*” as a “well-defined group, characterised by the presence of tripartite

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<sup>†</sup> Later authors disputed the orthography of this name, and it seems only to have been nomenclaturally validated as “*Stramenipila*, as kingdom: M.W.Dick, *Straminipilous Fungi*: 275, 2001” (see David 2002 for further discussion). The name was derived from *stramen* (a straw) a third declension Latin noun (*straminis*, gen. sing.), a reference to the hollow hairs, and *pilus*, a hair. Later authors adopted the more correct orthography “straminopile”.

hairs of the front flagellum.” And specifying that the “...heterokont algae may be grouped into the phylum *Heterokontophyta*, but in a protistan classification should include also the heterokont water moulds (*Oomycetes*, *Hyphochytriomycetes*), the labyrinthulids and thraustochytrids.”

A factor that has affected the adoption of a common naming scheme for algae at the phylum level has been the permitted use of descriptive names and automatically typified names (ICN Art. 16, Turland & al. 2018) and the absence of a requirement for priority of names above the level of family (ICN Art. 11). Even the requirement for the approved ending “-*phyta*” is only a requirement for automatically typified names. And even Rec. 16A is that in “...choosing among typified names for a taxon above the rank of family, authors should generally follow the principle of priority.” This recommendation does not apply to descriptive names. These difficulties do not arise for most users of the Code who are only dealing with a handful of phylum and class names.

In choosing a name for the heterokont algal classes, which now number 18 (Table 1), we here advocate the use of *Heterokontophyta* as the most widely recognised phylum name by phycologists. The earliest and most well-known phylum name that included many of today’s classes is the *Heterokontophyta* of Hoek (1978, 1984) and Hoek, Mann & Jahns (1995). However, this is an invalid name as Art. 44.1 required a Latin description (or a reference to one) from 1 January 1958 through 31 December 2011 and this was not provided. Moestrup’s (1992) concept of the name *Heterokontophyta* is the closest to today’s concept but that name is also nomenclaturally invalid.

We validate the name herewith:

***Heterokontophyta*** Moestrup, R.A.Andersen & Guiry, *phyl. nov.*

Description: A new descriptive phylum name for heterokont algae with heterodynamic flagella, an immature flagellum (“tinsel”) bearing tripartite hairs and a mature flagellum lacking tripartite hairs. Transitional area of the flagellum generally with a transitional helix. Mostly photosynthetic with plastids derived by endosymbiosis from red algae, usually possessing chlorophylls *a* and *c*, and various accessory pigments such as fucoxanthin. Plastids enclosed by four membranes, outer two continue to the nuclear envelope (plastid endoplasmic reticulum). Thylakoids are stacked in groups of three (lamellae), and a girdle lamella usually surrounds the other thylakoids. Starch absent, reserves laminarin, chrysolaminaran or similar short-chained (degree of polymerisation, ~ 25) carbohydrates formed outside the plastids in special vacuoles. Cells naked or covered by scales, lorica or a cell wall. Unicellular, colonial, multicellular or coenocytic; large multicellular thalli with differentiated tissues in some *Phaeophyceae*. Asexual reproduction by fragmentation, propagules, vegetative cell division, sporogenesis, zoosporogenesis. Sexual reproduction by isogamy, anisogamy or oogamy. Freshwater, marine and terrestrial.

Type: *Fucus* Linnaeus, 1753.

Phycobank Registration: <http://phycobank.org/104049>

Note: While descriptive names do not require types, designating a type for a descriptive name is not excluded by the ICN.

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**Table 1.** Current classes of *Heterokontophyta* in alphabetical order.

1. *Bacillariophyceae* Haeckel
2. *Bolidophyceae* Guillou & Chrétiennot-Dinet
3. *Chrysoparadoxophyceae* Wetherbee
4. *Chrysophyceae* Pascher
5. *Coscinodiscophyceae* Round & R.M.Crawford
6. *Dictyochophyceae* P.C.Silva
7. *Eustigmatophyceae* D.J.Hibberd & Leedale
8. *Mediophyceae* Medlin & Kaczmarska
9. *Olisthodiscophyceae* Barcyte, Eikrem & M.Eliás
10. *Pelagophyceae* R.A.Andersen & G.W.Saunders
11. *Phaeophyceae* Kjellman
12. *Phaeosacciophyceae* R.A.Andersen, L.Graf & H.S.Yoon
13. *Phaeothamniophyceae* R.A.Andersen & J.C.Bailey
14. *Pinguicophyceae* Kawachi, Inouye, Honda, O'Kelly, Bailey, Bidigare & R.A.Andersen
15. *Raphidophyceae* Chadeaud ex P.C.Silva
16. *Schizocladophyceae* E.C.Henry, K.Okuda & H.Kawai
17. *Synchromophyceae* S.Horn & C.Wilhelm
18. *Xanthophyceae* P.Allorge ex F.E.Fritsch