

Review

# Back to Basics: Revision of Coccolithophore Species List in the Adriatic Sea

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**Abstract:** Coccolithophores are unicellular marine algae belonging to the haptophyte group, characterized by the production of intricate calcium carbonate plates that adorn their cells and exhibit species-specific morphology. The Adriatic Sea has historically been the type locality of numerous phytoplankton species, including coccolithophores. However, since the initial description, many species have not been recorded during the frequent phytoplankton surveys in the Adriatic Sea. This was mainly because these surveys did not use electron microscopy, which is necessary for accurate species identification. In this study, we re-evaluate the coccolithophore species lists using historical records and compare them with recent surveys in the coastal and open waters of the Adriatic Sea. In light of changes in nomenclature resulting from clarification of the species' life cycles, we update the taxonomic list of coccolithophore species occurring in the Adriatic.

**Keywords:** coccolithophores; species diversity; Adriatic Sea; historic survey; checklist



**Citation:** Godrijan, J.; Arapov, J.; Skejić, S.; Bužančić, M. Back to Basics: Revision of Coccolithophore Species List in the Adriatic Sea. *Water* **2023**, *15*, 603. <https://doi.org/10.3390/w15030603>

Academic Editor: Genuario Belmonte

Received: 30 December 2022

Revised: 26 January 2023

Accepted: 29 January 2023

Published: 3 February 2023



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## 1. Introduction

Coccolithophores are single-celled algae characterized by their ability to calcify. They are part of the marine phytoplankton and are among the most important primary producers in the sea. Because of their ability to both calcify and photosynthesize, they fundamentally affect the chemistry of seawater and are one of the most important drivers of the oceanic carbon cycle and thus the Earth's climate [1]. Coccolithophores occur in both open and coastal marine waters and sometimes form large blooms [2] which are detectable in ocean colour satellite imagery [3].

The characteristic feature of coccolithophores is their intricately shaped calcite plates, coccoliths, which adorn their cells in at least one phase of their life cycle [4]. Coccolithophores have a complex haplo-diplontic life cycle in which both haploid (with a single set of chromosomes) and diploid (with two copies of each chromosome) phases can reproduce vegetatively. Coccolith morphology differs between these two phases. In the diploid phase, coccolithophores produce heterococcoliths, plates consisting of a series of intricately shaped calcite crystals that deviate from the typical rhombohedral geometry [5]. In their haploid phase, their cells are covered with holococcoliths, nannoliths, or they do not calcify at all and have only organic scales covering their cells. Holococcoliths consist of single rhombohedral crystals, while nannoliths are calcareous structures that do not have the characteristic features of either heterococcoliths or holococcoliths.

The taxonomy of coccolithophores is based primarily on the characteristic, species-specific morphology of the coccoliths that cover their cells, the coccospheres [6]. Coccospheres bearing different types of coccoliths have been considered to belong to separate taxa because of their morphological differences, so coccolithophores of the same taxa but at different stages of their life cycle have been incorrectly classified as different species. Although the dimorphic life cycle of coccolithophores was first described by Parke and Adams [7], life cycle associations have only been clarified for ~60 coccolithophore species, representing ~20% of the described diversity, with examples distributed throughout the

diversity of coccolithophores [8]. The main tool for clarifying life cycle associations is the detection of “combination cells” (coccospheres, bearing both hetero- and holococcoliths, first defined in Thomsen et al. [9]) in natural samples using scanning electron microscopy (SEM) [8].

The currently known diversity of coccolithophores includes ~280 morphospecies [8], including ~60 holococcolithophores, which should probably be excluded as they likely represent the life cycle stage of heterococcolithophores [10]. Coccolithophores are most diverse in subtropical and tropical waters [11]. In northwestern Mediterranean waters, Cros and Fortuño [12] reported 168 coccolithophores (including various taxonomic and morphotypic units). In the last comprehensive review of phytoplankton species in the Adriatic Sea, Viličić et al. [13] list 95 coccolithophore species in their Table 1. However, the authors note that the species diversity of coccolithophores throughout the Mediterranean is not comparable due to differences in identification methods, suggesting that the use of SEM for coccolithophores was not widespread at the time.

**Table 1.** List of morphospecies published by Erwin Kamptner (1941) (*Die Coccolithineen der Südwestküste von Istrien. Ann. Naturhist. Mus. Wien.* 51: 54–149). HET and HOL indicate the life cycle stage, HET diploid and HOL haploid, and ‘-’ indicates an unidentifiable life cycle stage. Table lists coccolithophore species along the coast of the Istrian peninsula, northern Adriatic Sea, including 16 new species for science. Accepted names were updated following the recommendations on Young, J.R., Bown P.R., Lees J.A. (2022) Nannotax3 website. International Nannoplankton Association. Accessed 14 December 2022. URL: [www.mikrotax.org/Nannotax3](http://www.mikrotax.org/Nannotax3). Comments are indicated with \*.

N	Type	Species Name (Kamptner List)	Accepted Name with Comments (Indicated with *)
1	HET	<i>Acanthoica aculeata</i> nov. spec.	<i>Cyrtosphaera aculeata</i> (Kamptner) Kleijne, 1992
2	HET	<i>Acanthoica ordinata</i> nov. spec.	<i>Alisphaera ordinata</i> (Kamptner) Heimdal, 1973
3	HET	<i>Acanthoica quattrosphina</i> Lohm.	<i>Acanthoica quattrosphina</i> Lohmann, 1903
4	-	<i>Acanthoica rubus</i> nov. spec.	* ? line drawing of coccosphere inadequate to determine species
5	HET	<i>Anthosphaera robusta</i> (Lohm).	<i>Syracosphaera molischii</i> Schiller, 1925 HOL
6	HOL	<i>Anthosphaera fragaria</i> Kampt.	<i>Algirosphaera robusta</i> (Lohmann 1902) Norris, 1984
7	HET	<i>Calciosolenia grani</i> Schill, var. <i>cylindrothecaeformis</i> Schill.	<i>Calciosolenia brasiliensis</i> (Lohmann) Young, in Young et al., 2003
8	HOL	<i>Calyptosphaera gracillima</i> nov. spec.	<i>Syracosphaera mediterranea</i> Lohmann 1902 HOL <i>gracillima</i> type, <i>sensu</i> Geisen et al., 2002
9	HOL	<i>Calyptosphaera pirus</i> Kampt.	<i>Syracosphaera pulchra</i> Lohmann, 1902 HOL <i>pirus</i> type, <i>sensu</i> Young et al., 2003
10	HOL	<i>Calyptosphaera quadridentata</i> Schill.	<i>Sphaerocalyptra quadridentata</i> (Schiller 1913) Deflandre, 1952
11	HOL	<i>Calyptosphaera tholifera</i> nov. spec.	<i>Sphaerocalyptra quadridentata</i> (Schiller 1913) Deflandre, 1952
12	HET	<i>Coccolithus carteri</i> (Wall.)	<i>Helicosphaera carteri</i> (Wallich 1877) Kamptner, 1954
13	HET	<i>Coccolithus leptoporus</i> (Murr. & Blackm.)	<i>Calcidiscus leptoporus</i> (Murray & Blackman 1898) Loeblich & Tappan, 1978
14	HOL	<i>Corisphaera arethusae</i> nov. spec.	<i>Syracosphaera arethusae</i> (Kamptner 1941) Triantaphyllou et al. 2016 HOL
15	HOL	<i>Corisphaera corona</i> nov. spec.	* <i>Syracosphaera</i> Lohmann 1902 HOL ( <i>Anthosphaera</i> type); cf. <i>Syracosphaera periperforata</i> Kleijne 1991 var. <i>periperforata</i> HOL
16	HOL	<i>Corisphaera gracilis</i> Kampt.	<i>Corisphaera gracilis</i> Kamptner, 1937
17	HOL	<i>Corisphaera ponticulifera</i> nov. spec.	* <i>Helicosphaera</i> HOL <i>ponticuliferus</i> type informal
18	HOL	<i>Corisphaera spinosa</i> nov. spec.	<i>Homozygosphaera spinosa</i> (Kamptner 1941) Deflandre, 1952
19	HOL	<i>Helladosphaera aurisinae</i> nov. spec.	<i>Syracosphaera aurisinae</i> HOL (Kamptner 1941) Keuter et al., 2021
20	HOL	<i>Helladosphaera cornifera</i> (Schill.)	<i>Helladosphaera cornifera</i> (Schiller 1913) Kamptner, 1937
21	HOL	<i>Periphylophora mirabilis</i> (Schill.)	<i>Syracosphaera anthos</i> (Lohmann 1912) Janin, 1987 HOL
22	HET	<i>Pontosphaera huxleyi</i> Lohm.	<i>Emiliania huxleyi</i> (Lohmann 1902) Hay & Mohler, in Hay et al. 1967
23	HET	<i>Pontosphaera nana</i> nov. spec.	<i>Syracosphaera nana</i> (Kamptner 1941) Okada & McIntyre, 1977
24	HOL	<i>Pontosphaera pietschmanni</i> Kampt.	* ? clearly a holococcolith but holotype is drawing with too little detail to allow identification

Table 1. Cont.

N	Type	Species Name (Kamptner List)	Accepted Name with Comments (Indicated with *)
25	HET	<i>Pontosphaera steueri</i> Kampt.	* ? cf. <i>Hymenomonas globosa</i> (Magne 1954) Gayral & Fresnel, 1976
26	-	<i>Rhabdosphaera erinaceus</i> Kampt.	* not a coccolithophore: <i>Scrippsiella acuminata</i> (Ehrenberg) Kretschmann, Elbrächter, Zinssmeister, S. Soehner, Kirsch, Kusber & Gottschling 2015
27	-	<i>Rhabdosphaera nigra</i> Schill.	* not a coccolithophore: <i>Scrippsiella acuminata</i> (Ehrenberg) Kretschmann, Elbrächter, Zinssmeister, S. Soehner, Kirsch, Kusber & Gottschling 2015
28	HET	<i>Rhabdosphaera stylifer</i> Lohm.	<i>Rhabdosphaera clavigera</i> Murray & Blackman, 1898
29	HET	<i>Syracosphaera binodata</i> Kampt.	<i>Syracosphaera mediterranea</i> Lohmann 1902
30	HOL	<i>Syracosphaera catillifera</i> Kampt.	<i>Helicosphaera</i> HOL <i>catilliferus</i> type Young & Bown (2014)
31	HET	<i>Syracosphaera corii</i> Schill.	<i>Michaelsarsia adriaticus</i> (Schiller) Manton, Bremer & Oates, 1984
32	HOL	<i>Syracosphaera cornus</i> nov. spec.	<i>Helicosphaera</i> HOL <i>catilliferus</i> type Young & Bown (2014)
33	HOL	<i>Syracosphaera dalmatica</i> Kampt.	<i>Syracosphaera mediterranea</i> Lohmann 1902 HOL <i>wettsteinii</i> type, sensu Geisen et al., 2002
34	HET	<i>Syracosphaera histrica</i> nov. spec.	<i>Syracosphaera histrica</i> Kamptner, 1941
35	HET	<i>Syracosphaera molischi</i> Schill.	<i>Syracosphaera molischii</i> Schiller, 1925
36	HET	<i>Syracosphaera nodosa</i> nov. spec.	<i>Syracosphaera nodosa</i> Kamptner, 1941
37	HET	<i>Syracosphaera pulchra</i> Lohm.	<i>Syracosphaera pulchra</i> Lohmann, 1902
38	HOL	<i>Syracosphaera quadriperforata</i> Kampt.	<i>Calcidiscus leptoporus</i> subsp. <i>quadriperforatus</i> (Kamptner 1937) Geisen et al., 2002 HOL
39	HET	<i>Syracosphaera schilleri</i> Kampt.	<i>Scyphosphaera apsteinii</i> Lohmann, 1902 HOL
40	HET	<i>Syracosphaera tuberculata</i> Kampt.	<i>Syracosphaera mediterranea</i> Lohmann 1902
41	HET	<i>Tergestiella adriatica</i> nov. spec.	<i>Tergestiella adriatica</i> Kamptner, 1941
42	HET	<i>Thalassopapus pellucidus</i> Kampt.	* ? cf. <i>Calciopappus caudatus</i> Gaarder & Ramsfjell, 1954
43	HOL	<i>Zygosphaera debilis</i> nov. spec.	<i>Zygosphaera amoena</i> Kamptner, 1937
44	HOL	<i>Zygosphaera hellenica</i> Kampt.	<i>Syracosphaera mediterranea</i> Lohmann 1902 HOL <i>hellenica</i> type, sensu Cros et al., 2000
45	HOL	<i>Zygosphaera wettsteini</i> Kampt.	<i>Syracosphaera mediterranea</i> Lohmann 1902 HOL <i>wettsteinii</i> type, sensu Geisen et al., 2002

In this study, we aimed to investigate and review the taxonomic work on coccolithophores in the Adriatic Sea from the early 1900s to the early 2000s. We intended to update the taxonomy of these old works with new knowledge from the biology of coccolithophores. We also aimed to provide a comprehensive picture of the current diversity of coccolithophores in the Adriatic Sea by summarising published taxonomic surveys using SEM as a gold standard for coccolithophore identification. We anticipate that our efforts to update the checklist of coccolithophore species in the Adriatic Sea will be considered an important source of information for both research and policy.

## 2. Materials and Methods

In our analysis of historical and modern records of diversity in the Adriatic, we followed the recommendations of the taxonomy of the Nannotax3 website [14]. This online taxonomy project was originally based on the creation of online versions of the well-established syntheses of Bown [15] and Young et al. [6] and was later updated to include data from later publications. It is a useful basis for analysis, both because it is the most up-to-date review and because an attempt has been made to make it comprehensive, including both formally described species and many informally described morphotypes that are very likely to be true species.

For the analysis of the historical record, we used the works of Steuer [16], Brunthaler [17], Schiller [18–20], Kamptner [21,22], Revelante [23], and Viličić et al. [13].

In 1903, Steuer [16] conducted studies in the Gulf of Trieste, while Brunthaler [17] studied coastal waters near Rovinj, Croatia in 1910. Schiller's studies [18–20] were based on material obtained during the seasonal voyages of the research steamer "Najade", which investigated transects in the Adriatic Sea: Venice to Rovinj, Ancona to Dugi Otok Island, Bari to Dubrovnik, Otranto to Cap Linquetta in February, May, August, and November 1912. The investigation of coccolithophores by Kamptner [21,22] was mainly related to the coastal

waters of the town of Rovinj and various other places on the southwestern coast of Istria, Croatia. The investigations of the coastal waters of the town of Rovinj were carried out quantitatively for a whole year, from the beginning of May 1935 to the end of April 1936. Samples of 2 L were completely sedimented and examined by light microscopy (LM) under high magnifications (1750 $\times$ , 3750 $\times$ , and 6000 $\times$ ).

Recent studies on coccolithophores in the northern Adriatic included Cerino et al. [24], Godrijan et al. [25], and Neri et al. [26]. Cerino et al. [24] analyzed data from monthly sampling between May 2011 and February 2013 at the C1-LTER coastal station in the Gulf of Trieste. Coccolithophore composition was determined using a polarized light microscope (PLM) and an SEM. Godrijan et al. [25] analyzed the coccolithophore community on the eastern Adriatic coast from September 2008 to December 2009, sampling fortnightly at 5 m depth. Morphospecies composition was determined using an SEM. Neri et al. [26] presented the entire phytoplankton community in the surface layer using LM (Utermöhl method) for the 1988–2018 data series from offshore station SG05, located 15 nm off the Italian coast, with variable temporal frequency (monthly to quarterly).

For the middle Adriatic, coccolithophores were studied by Šupraha et al. [27–29], Skejić et al. [30,31], and Young et al. [32], and in all taxonomic identification was performed by SEM. The works of Šupraha et al. [27–29] deal with the coccolithophore community in the coastal region of the Krka estuary in February and July 2013, and quantitative and qualitative analyses were performed for the vertical profile of the coccolithophore community. In their 2018 work, Skejić et al. [30] focused on data collected in December 2015 and April 2016. The study area includes the Jabuka Pit depressions (depth 260 m) and an Italy–Croatia transect (maximum depth 160 m). In their 2021 study, Skejić et al. [31] investigated the sampling site in the highly stratified Krka River estuary on the eastern Adriatic coast. Samples were collected from August to October 2017. Sampling occurred every two weeks at the surface (0 m), in the halocline (mainly 1.5 m), and at 7 m depth. Finally, Young et al. [32] report a single event from a surface water sample collected at an offshore station in March 2018.

Studies on coccolithophores in the southern Adriatic were scarce and, in the last 15 years, have included only the investigation by Balestra et al. [33]. The samples for this study were collected in October 2000 in a grid along four transects in the Gulf of Manfredonia, in the western part of the southern Adriatic. The data presented in this article are from quantitative analyses performed on the vertical water profile using the PLM and SEM.

Images were processed using the Adobe Lightroom 6.1. (Adobe, Mountain View, California, United States). Some of the images in figures have been published elsewhere, e.g., in Godrijan et al. [25], Skejić et al. [30], and Young et al. [32].

### 3. Results and Discussion

#### 3.1. History of Coccolithophore Research in the Adriatic Sea

In 1903, Steuer [16] conducted the first survey of coccolithophores in the Adriatic Sea, in the Gulf of Trieste and found *Syracosphaera pulchra*, *Rhabdosphaera stylifer*, and *Syracosphaera robusta*. In 1910, Brunnthaler [17] found a much larger number of coccolithophores in the coastal waters near Rovinj. Overall, the Adriatic Sea is the type locality of many phytoplankton species, including coccolithophores. New species of coccolithophores in the Adriatic Sea were described by (i) Brunnthaler [17], who listed one new species of coccolithophores, *Syracosphaera lohmanni* Brunnthaler 1911; (ii) Schiller, who listed 23 new species in 1913 [18] and another 23 new species in 1925 [19]; and (iii) Kamptner, who listed 4 new species in his 1927 article [22] and 16 new species in 1941 [21].

The list of morphospecies in Table 1 was published by Erwin Kamptner in 1941 [21] as an overview of his efforts in the study of coccolithophores along the coast of the Istrian Peninsula in the northern Adriatic. The list includes 45 taxa. However, due to sparse information in the descriptions of some species and limited details in some line drawings of coccospheres, some of the listed species cannot be identified to species level. Moreover, some of the species listed are duplicates resulting from taxonomic revisions [14]. We note,

then, that the Kamptner species list contains 35 morphotypes of coccolithophores from the northern Adriatic, for which we trust ourselves to give a currently accepted name. Furthermore, two of the listed species later turned out not to be coccolithophores but calcified dinoflagellate cysts of the species *Scrippsiella acuminata* (Ehrenberg) Kretschmann, Elbrächter, Zinssmeister, S. Soehner, Kirsch, Kusber, & Gottschling 2015. Kamptner also described *Acanthoica rubus*, but the line drawing of the coccosphere is rather insufficient to identify the species, and subsequently this morphospecies was never recorded again. Here, we propose that *Corisphaera corona* shares similarities with *Syracosphaera periperforata* Kleijne 1991 var. *periperforata* HOL in the highly arched circum-flagellar coccoliths, while *Pontosphaera steueri* resembles *Hymenomonas globosa* (Magne 1954) Gayral & Fresnel 1976, due to the organisation of its coccoliths and elliptical muraliths, and finally that *Thalassopapus pellucidus* Kampt has similarities to *Calciopappus caudatus* Gaarder & Ramsfjell, 1954 in the shape of its coccosphere and its circum-flagellar coccoliths modified into elongate spines.

Table 2 consists of a list of morphospecies compiled by Noelia Revelante in 1985 [23]. This work mentions a total of 81 morphospecies that have been recorded in the northern Adriatic. However, this list was compiled from data from the literature and lists species reported for the northern Adriatic by Brunthaler, Schiller, and Kamptner. Going back to the original descriptions, some of the species cannot be recognized to the species level due to the lack of details in species descriptions and some line drawings of the coccospheres. Additionally, some of the listed species are duplicates as a consequence of taxonomic revisions [14]. We have marked all morphospecies that are not identifiable. We therefore conclude that the Revelante species list contains 41 morphotypes of coccolithophores from the northern Adriatic, for which we can give the currently accepted names.

**Table 2.** List of morphospecies compiled by Noelia Revelante (1985) (A catalogue of phytoplankton reported for the Rovinj area of the northern Adriatic. *Thalass. Jugoslav.* 21/22, 139–169). HET and HOL indicate the life cycle stage, HET diploid and HOL haploid, and ‘-’ indicates an unidentifiable life cycle stage. This paper reports morphospecies recorded in the northern Adriatic Sea. Accepted names were updated following the recommendations of Young, J.R., Bown P.R., Lees J.A. (2022) Nannotax3 website. International Nannoplankton Association. Accessed 14 December 2022. URL: [www.mikrotax.org/Nannotax3](http://www.mikrotax.org/Nannotax3). Comments are indicated with \*.

N	Type	Species Name (Revelante List)	Accepted Name with Comments (Indicated with *)
1	HET	<i>Acanthoica acanthos</i> Schiller, 1925	<i>Acanthoica acanthos</i> Schiller, 1925
2	HET	<i>Acanthoica aculeata</i> Kamptner 1941	<i>Cyrtosphaera aculeata</i> (Kamptner) Kleijne, 1992
3	HET	<i>Acanthoica monospina</i> Schiller, 1925	<i>Acanthoica acanthifera</i> Lohmann 1912 ex Lohmann, 1913
4	HET	<i>Acanthoica ordinata</i> Kamptner, 1941	<i>Alisphaera ordinata</i> (Kamptner) Heimdal, 1973
5	HET	<i>Acanthoica quattrosolina</i> Lohmann, 1903	<i>Acanthoica quattrosolina</i> Lohmann, 1903
6	-	<i>Acanthoica rubus</i> Kamptner, 1941	* ? line drawing of coccosphere inadequate to determine species
7	HOL	<i>Anthosphaera fragaria</i> Kamptner, 1937	<i>Syracosphaera molischii</i> Schiller, 1925 HOL
8	HET	<i>Anthosphaera robusta</i> (Lohmann) Kamptner, 1941	<i>Algirosphaera robusta</i> (Lohmann 1902) Norris, 1984
9	HET	<i>Calciosolenia granii</i> Schiller, 1925	<i>Calciosolenia brasiliensis</i> (Lohmann) Young, in Young et al. 2003
10	HET	<i>Calciosolenia granii</i> var. <i>cylindrothecaeformis</i> Schiller, 1925 emend Kamptner 1936	<i>Calciosolenia brasiliensis</i> (Lohmann) Young, in Young et al. 2003
11	HOL	<i>Calyptrosphaera</i> aff. <i>globosa</i> Lohmann in Borsetti & Cati, 1976	<i>Calyptrosphaera sphaeroidea</i> Schiller, 1913 HOL
12	HOL	<i>Calyptrosphaera gracillima</i> Kamptner, 1941	<i>Syracosphaera mediterranea</i> Lohmann 1902 HOL <i>gracillima</i> type, <i>sensu</i> Geisen et al., 2002
13	HOL	<i>Calyptrosphaera incisa</i> Schiller 1913	<i>Calyptrosphaera sphaeroidea</i> Schiller, 1913 HOL
14	HOL	<i>Calyptrosphaera oblonga</i> Lohmann, 1902	<i>Syracosphaera pulchra</i> Lohmann, 1902 HOL <i>oblonga</i> type, <i>sensu</i> Young et al., 2003
15	HOL	<i>Calyptrosphaera pirus</i> Kamptner, 1941	<i>Syracosphaera pulchra</i> Lohmann, 1902 HOL <i>pirus</i> type, <i>sensu</i> Young et al., 2003
16	HOL	<i>Calyptrosphaera pyriformis</i> Schiller 1913	<i>Calyptrosphaera sphaeroidea</i> Schiller, 1913 HOL

Table 2. Cont.

N	Type	Species Name (Revelante List)	Accepted Name with Comments (Indicated with *)
17	HOL	<i>Calyptosphaera quadridentata</i> Schiller, 1913	<i>Sphaerocalyptra quadridentata</i> (Schiller 1913) Deflandre, 1952
18	HOL	<i>Calyptosphaera sphaeroidea</i> Schiller 1913	<i>Calyptosphaera sphaeroidea</i> Schiller 1913
19	HOL	<i>Calyptosphaera tholifera</i> Kamptner, 1941	<i>Sphaerocalyptra quadridentata</i> (Schiller 1913) Deflandre, 1952
20	HET	<i>Coccolithus carteri</i> (Wallich) Kamptner, 1941	<i>Helicosphaera carteri</i> (Wallich 1877) Kamptner, 1954
21	HET	<i>Coccolithus leptoporus</i> (Murray & Blackman) Schiller, 1930	<i>Calcidiscus leptoporus</i> (Murray & Blackman 1898) Loeblich & Tappan, 1978
22	HET	<i>Coccolithus pelagicus</i> var. <i>carteri</i> Kamptner, 1927	<i>Helicosphaera carteri</i> (Wallich, 1877) Kamptner, 1954
23	HET	<i>Coccolithus wallichii</i> (Lohmann) Schiller, 1925	<i>Helicosphaera wallichii</i> (Lohmann 1902) Okada & McIntyre, 1977
24	HOL	<i>Corisphaera arethusae</i> Kamptner, 1941	<i>Syracosphaera arethusae</i> (Kamptner 1941) Triantaphyllou et al. 2016 HOL
25	HOL	<i>Corisphaera corona</i> Kamptner, 1941	<i>Syracosphaera</i> sp. HOL ( <i>Anthosphaera</i> type)
26	HOL	<i>Corisphaera gracilis</i> Kamptner, 1937	<i>Corisphaera gracilis</i> Kamptner, 1937
27	HOL	<i>Corisphaera ponticulifera</i> Kamptner, 1941	<i>Helicosphaera</i> HOL <i>ponticuliferus</i> type informal
28	HOL	<i>Corisphaera spinosa</i> Kamptner 1941	<i>Homozygosphaera spinosa</i> (Kamptner 1941) Deflandre, 1952
29	HOL	<i>Helladosphaera aurisinae</i> Kamptner, 1941	<i>Syracosphaera aurisinae</i> HOL (Kamptner 1941) Keuter et al., 2021
30	HOL	<i>Helladosphaera cornifera</i> (Schiller) Kamptner, 1937	<i>Helladosphaera cornifera</i> (Schiller 1913) Kamptner, 1937
31	HOL	<i>Lohmanosphaera adriatica</i> Schiller, 1913	? cf. <i>Sphaerocalyptra quadridentata</i> (Schiller 1913) Deflandre, 1952
32	-	<i>Najadea gloriosa</i> Schiller, 1913	* ? holotype is drawing with too little detail to allow identification
33	HOL	<i>Ophiaster formosus</i> Gran, 1912	<i>Ophiaster formosus</i> Gran, 1912
34	HOL	<i>Periphyllophora mirabilis</i> (Schiller) Kamptner, 1937	<i>Syracosphaera anthos</i> (Lohmann 1912) Janin, 1987 HOL
35	-	<i>Pontosphaera echinofera</i> Schiller (1913)	* ? holotype is drawing with too little detail to allow identification
36	-	<i>Pontosphaera haeckelii</i> Schiller, 1913	* ? holotype is drawing with too little detail to allow identification
37	HET	<i>Pontosphaera huxleyi</i> Lohmann, 1902	<i>Emiliania huxleyi</i> (Lohmann 1902) Hay & Mohler, in Hay et al. 1967
38	-	<i>Pontosphaera inermis</i> Schiller, 1913	* ? holotype is drawing with too little detail to allow identification
39	HET	<i>Pontosphaera nana</i> Kamptner, 1941	<i>Syracosphaera nana</i> (Kamptner 1941) Okada & McIntyre, 1977
40	-	<i>Pontosphaera ovalis</i> Schiller, 1913	* ? holotype is drawing with too little detail to allow identification
41	HOL	<i>Pontosphaera pietschmanni</i> Kamptner, 1937	* ? clearly a holococcolith but holotype is drawing with too little detail to allow identification
42	HET	<i>Pontosphaera steueri</i> Kamptner, 1937	* ? cf. <i>Hymenomonas globosa</i> (Magne 1954) Gayral & Fresnel, 1976
43	HET	<i>Rhabdosphaera clavigera</i> Murray & Blackman, 1898	<i>Rhabdosphaera clavigera</i> Murray & Blackman, 1898
44	-	<i>Rhabdosphaera erinaceus</i> Kamptner, 1937	* not a coccolithophore: <i>Scrippsiella acuminata</i> (Ehrenberg 1836) Kretschmann et al., 2015
45	HET	<i>Rhabdosphaera longistylis</i> Schiller, 1925	* cf. <i>Palusphaera vandellii</i> Lecal, 1965
46	-	<i>Rhabdosphaera nigra</i> Schiller, 1913	* not a coccolithophore: <i>Scrippsiella acuminata</i> (Ehrenberg 1836) Kretschmann et al. 2015
47	HET	<i>Rhabdosphaera stylifera</i> Lohmann, 1902	<i>Rhabdosphaera clavigera</i> Murray & Blackman, 1898
48	HET	<i>Rhabdosphaera tignifer</i> Schiller, 1913	<i>Rhabdosphaera clavigera</i> Murray & Blackman, 1898
49	-	<i>Rhabdosphaera hispida</i> Lohmann, 1912	* ?
50	-	<i>Syracosphaera adriatica</i> Schiller, 1913	* ? line drawing of coccosphere inadequate to determine species
51	-	<i>Syracosphaera bifenestrata</i> Schiller, 1913	* ? line drawing of coccosphere inadequate to determine species
52	HET	<i>Syracosphaera binodata</i> (Kamptner) Kamptner, 1937	<i>Syracosphaera mediterranea</i> Lohmann, 1902
53	HOL	<i>Syracosphaera catillifera</i> Kamptner, 1937	<i>Helicosphaera</i> HOL <i>catilliferus</i> type Young & Bown (2014)
54	HET	<i>Syracosphaera cori</i> Schiller in Heimdal & Gaarder, 1981	<i>Michaelsarsia adriaticus</i> (Schiller) Manton, Bremer & Oates, 1984
55	HOL	<i>Syracosphaera cornifera</i> Schiller 1913	<i>Helladosphaera cornifera</i> (Schiller 1913) Kamptner, 1937
56	HOL	<i>Syracosphaera cornus</i> Kamptner, 1941	<i>Helicosphaera</i> HOL <i>catilliferus</i> type Young & Bown (2014)

Table 2. Cont.

N	Type	Species Name (Revelante List)	Accepted Name with Comments (Indicated with *)
57	-	<i>Syracosphaera coronata</i> Schiller, 1913	* ? line drawing of coccosphere inadequate to determine species
58	-	<i>Syracosphaera cupulifera</i> Schiller, 1913	* ? line drawing of coccosphere inadequate to determine species
59	HOL	<i>Syracosphaera dalmatica</i> Kamptner, 1927	<i>Syracosphaera mediterranea</i> Lohmann 1902 HOL <i>wettsteinii</i> type, sensu Geisen et al., 2002
60	-	<i>Syracosphaera dentata</i> Schiller, 1913	* ? line drawing of coccosphere inadequate to determine species
61	-	<i>Syracosphaera grundii</i> Schiller, 1913	* ? line drawing of coccosphere inadequate to determine species
62	HET	<i>Syracosphaera histrica</i> Kamptner, 1941	<i>Syracosphaera histrica</i> Kamptner, 1941
63	-	<i>Syracosphaera lohmannii</i> Brunthaler, 1910	* ? line drawing of coccosphere inadequate to determine species
64	HET	<i>Syracosphaera mediterranea</i> Lohmann, 1902	<i>Syracosphaera mediterranea</i> Lohmann 1902
65	HET	<i>Syracosphaera mediterranea</i> var. <i>biondada</i> (Lohmann) Kamptner, 1927	<i>Syracosphaera mediterranea</i> Lohmann 1902
66	HET	<i>Syracosphaera molischii</i> Schiller, 1925	<i>Syracosphaera molischii</i> Schiller, 1925
67	HET	<i>Syracosphaera nodosa</i> Kamptner, 1941	<i>Syracosphaera nodosa</i> Kamptner, 1941
68	-	<i>Syracosphaera ovata</i> Schiller, 1925	* ? line drawing of coccosphere inadequate to determine species
69	HET	<i>Syracosphaera pulchra</i> Lohmann, 1902	<i>Syracosphaera pulchra</i> Lohmann, 1902
70	HOL	<i>Syracosphaera quadricornus</i> Schiller, 1925	<i>Algirosphaera robusta</i> (Lohmann 1902) Norris, 1984
71	HOL	<i>Syracosphaera quadriperforata</i> Kamptner, 1937	<i>Calcidiscus leptoporus</i> subsp. <i>quadriperforatus</i> (Kamptner 1937) Geisen et al., 2002 HOL
72	HET	<i>Syracosphaera robusta</i> Lohmann, 1902	<i>Algirosphaera robusta</i> (Lohmann 1902) Norris, 1984
73	HET	<i>Syracosphaera schilleri</i> Kamptner, 1927	<i>Scyphosphaera apsteinii</i> Lohmann, 1902 HOL
74	-	<i>Syracosphaera spinosa</i> Lohmann, 1902	* ? line drawing of coccosphere inadequate to determine species
75	-	<i>Syracosphaera tenuis</i> Lohmann, 1902	* ? line drawing of coccosphere inadequate to determine species
76	HET	<i>Syracosphaera tuberculata</i> Kamptner 1937	<i>Syracosphaera mediterranea</i> Lohmann 1902
77	HET	<i>Tergestiella adriatica</i> Kamptner, 1941	<i>Tergestiella adriatica</i> Kamptner, 1941
78	HET	<i>Thalassopapus pellucidus</i> Kamptner, 1941	* ? cf. <i>Calciopappus caudatus</i> Gaarder & Ramsfjell, 1954
79	HOL	<i>Zygosphaera debilis</i> Kamptner, 1941	<i>Zygosphaera amoena</i> Kamptner, 1937
80	HOL	<i>Zygosphaera hellenica</i> Kamptner, 1937	<i>Syracosphaera mediterranea</i> Lohmann 1902 HOL <i>hellenica</i> type, sensu Cros et al., 2000
81	HOL	<i>Zygosphaera wettsteinii</i> Kamptner, 1937	<i>Syracosphaera mediterranea</i> Lohmann 1902 HOL <i>wettsteinii</i> type, sensu Geisen et al., 2002

Finally, in our historic analysis we present the list of species compiled by Viličić et al. in 2002 [13] (Table 3). The list indicates the distribution of coccolithophore morphospecies for the eastern Adriatic, given as follows: N—Northern, M—Middle, S—Southern. A total of 95 species are listed. Although the text indicates that there are 101 species of prymnesiophytes (Prymnesiophyceae—class of haptophytes, including coccolithophores), we could not identify the 6 additional species in any of the tables in the paper. Going back to the original descriptions, again, some of the listed species cannot be determined to the specific species level due to the lack of information in species descriptions and the lack of features in some line drawings of the coccosphere. Additionally, due to taxonomic revisions, several of the listed species are duplicates [14]. We have marked all morphospecies that are not identifiable. Thus, we conclude that the Viličić et al. 2002 species list contains 51 morphotypes of coccolithophores from the revised eastern part of the Adriatic for which we are confident to give the currently accepted name.

**Table 3.** List of morphospecies compiled by Viličić et al. (2002) (Checklist of phytoplankton in the eastern Adriatic Sea. *Acta. Bot. Croat.* 61 (1), 57–91). HET and HOL indicate the life cycle stage, HET diploid and HOL haploid, and ‘-’ indicates an unidentifiable life cycle stage. Only one name per species is listed (additional synonyms are listed in Viličić et al. 2002). This paper lists morphospecies reported for the eastern Adriatic Sea, distribution is noted as: N—Northern, M—Middle, S—Southern, and \* registered by Revelante (1985), reportedly not found afterwards. Accepted names were updated following the recommendations of Young, J.R., Bown P.R., Lees J.A. (2022) Nannotax3 website. International Nannoplankton Association. Accessed 14 December 2022. URL: [www.mikrotax.org/Nannotax3](http://www.mikrotax.org/Nannotax3). Comments are indicated with \*.

N	Type	Species Name (Viličić et al. 2002 List)	Accepted Name with Comments (Indicated with *)	Distribution
1	HET	<i>Acanthoica acanthos</i> (Schiller) Deflandre	<i>Acanthoica acanthos</i> Schiller, 1925	N
2	HET	<i>Acanthoica monospina</i> Schiller	<i>Acanthoica acanthifera</i> Lohmann, 1912 ex Lohmann, 1913	N
3	HET	<i>Acanthoica quattrosolina</i> Lohmann	<i>Acanthoica quattrosolina</i> Lohmann, 1903	N, M, S
4	-	<i>Acanthoica rubus</i> Kamptner	* ? line drawing of coccosphere inadequate to determine species	N *
5	HOL	<i>Algirosphaera quadricorni</i> (Schiller) Norris	<i>Algirosphaera robusta</i> (Lohmann 1902) Norris, 1984	N, M, S
6	HET	<i>Algirosphaera robusta</i> (Lohmann) Norris	<i>Algirosphaera robusta</i> (Lohmann 1902) Norris, 1984	N *
7	HET	<i>Alisphaera ordinata</i> (Kamptner) Heimdal	<i>Alisphaera ordinata</i> (Kamptner) Heimdal, 1973	N *
8	HET	<i>Anoplosolenia brasiliensis</i> (Lohmann) Deflandre	<i>Calciosolenia brasiliensis</i> (Lohmann) Young, in Young et al. 2003	N, S
9	HOL	<i>Anthosphaera fragaria</i> Kamptner	<i>Syracosphaera molischii</i> Schiller, 1925 HOL	N *
10	HET	<i>Calcidiscus leptoporus</i> (Murray & Blackman) Loeblich Jr. & Tappan	<i>Calcidiscus leptoporus</i> (Murray & Blackman, 1898) Loeblich & Tappan, 1978	N *
11	HET	<i>Calciopappus caudatus</i> Gaarder & Ramsfjell	<i>Calciopappus caudatus</i> Gaarder & Ramsfjell, 1954	M, S
12	HET	<i>Calciopappus rigidus</i> Heimdal	<i>Calciopappus rigidus</i> Heimdal in Heimdal & Gaarder, 1981	N, M
13	HET	<i>Calciosolenia murrayi</i> Gran	<i>Calciosolenia murrayi</i> Gran, 1912	not reported
14	HOL	<i>Calyptrolithina wettsteinii</i> (Kamptner) Kleijne	<i>Syracosphaera mediterranea</i> Lohmann 1902 HOL <i>wettsteinii</i> type, sensu Geisen et al., 2002	N *
15	-	<i>Calyptrosphaera dalmatica</i> Schiller	* ?	N *
16	HOL	<i>Calyptrosphaera globosa</i> Lohmann	<i>Calyptrosphaera sphaeroidea</i> Schiller, 1913 HOL	N *, M
17	HOL	<i>Calyptrosphaera incisa</i> Schiller	<i>Calyptrosphaera sphaeroidea</i> Schiller, 1913 HOL	N *
18	HOL	<i>Calyptrosphaera oblonga</i> Lohmann	<i>Syracosphaera pulchra</i> Lohmann, 1902 HOL <i>oblonga</i> type, sensu Young et al., 2003	N, M, S
19	HOL	<i>Calyptrosphaera pirus</i> Kamptner	<i>Syracosphaera pulchra</i> Lohmann, 1902 HOL <i>pirus</i> type, sensu Young et al., 2003	N *
20	HOL	<i>Calyptrosphaera pyriformis</i> Schiller	<i>Calyptrosphaera sphaeroidea</i> Schiller, 1913 HOL	N *
21	HOL	<i>Calyptrosphaera quadridentata</i> Schiller	<i>Sphaerocalyptra quadridentata</i> (Schiller 1913) Deflandre, 1952	N *
22	HOL	<i>Calyptrosphaera sphaeroidea</i> Schiller	<i>Calyptrosphaera sphaeroidea</i> Schiller 1913 HOL	N *
23	-	<i>Calyptrosphaera uvella</i> Schiller	* ?	N *
24	HET	<i>Coccolithus pelagicus</i> (Wallich) Lohmann	<i>Helicosphaera carteri</i> (Wallich) Kamptner, 1954	N *
25	HET	<i>Coccolithus wallichii</i> (Lohmann) Schiller	<i>Helicosphaera wallichii</i> (Lohmann 1902) Okada & McIntyre, 1977	N *
26	HOL	<i>Corisphaera arethusae</i> Kamptner	<i>Syracosphaera arethusae</i> (Kamptner 1941) Triantaphyllou et al., 2016 HOL	N *
27	HOL	<i>Corisphaera corona</i> Kamptner	<i>Syracosphaera</i> Lohmann, 1902 HOL ( <i>Anthosphaera</i> type)	N *
28	HOL	<i>Corisphaera gracillis</i> Kamptner	<i>Corisphaera gracilis</i> Kamptner, 1937	N *
29	HOL	<i>Corisphaera spinosa</i> Kamptner	<i>Homozygosphaera spinosa</i> (Kamptner 1941) Deflandre, 1952	N *



Table 3. Cont.

N	Type	Species Name (Viličić et al. 2002 List)	Accepted Name with Comments (Indicated with *)	Distribution
30	HET	<i>Coronosphaera binodata</i> (Kamptner) Gaarder	<i>Syracosphaera mediterranea</i> Lohmann 1902	N *
31	HET	<i>Coronosphaera mediterranea</i>	<i>Syracosphaera mediterranea</i> Lohmann 1902	N *
32	HET	<i>Cyrtosphaera aculeata</i> (Kamptner) Kleijne	<i>Cyrtosphaera aculeata</i> (Kamptner) Kleijne, 1992	N *
33	HET	<i>Discosphaera thomsonii</i> Ostenfeld	<i>Discosphaera tubifera</i> (Murray & Blackman 1898) Ostenfeld, 1900	S
34	HET	<i>Discosphaera tubifera</i> (Murray & Blackman) Ostenfeld	<i>Discosphaera tubifera</i> (Murray & Blackman 1898) Ostenfeld, 1900	S
35	HET	<i>Emiliania huxleyi</i> (Lohmann) Hay & Mohler	<i>Emiliania huxleyi</i> (Lohmann 1902) Hay & Mohler, in Hay et al. 1967	N, M, S
36	HET	<i>Helicosphaera carteri</i> (Wallich) Kamptner	<i>Helicosphaera carteri</i> (Wallich 1877) Kamptner, 1954	N *
37	HOL	<i>Helladosphaera cornifera</i> (Schiller) Kamptner	<i>Helladosphaera cornifera</i> (Schiller 1913) Kamptner, 1937	N *
38	HOL	<i>Homozygosphaera ponticulifera</i> (Kamptner) Kamptner	<i>Syracosphaera mediterranea</i> Lohmann 1902 HOL <i>gracillima</i> type, <i>sensu</i> Geisen et al., 2002	N *
39	-	<i>Homozygosphaera tholifera</i> (Kamptner) Halldal & Markali	<i>Sphaerocalyptra quadridentata</i> (Schiller 1913) Deflandre, 1952	N *
40	HOL	<i>Lohmannosphaera adriatica</i> Schiller	<i>Sphaerocalyptra quadridentata</i> (Schiller 1913) Deflandre, 1952	N *
41	HET	<i>Lohmannosphaera paucoscyphos</i> Schiller	<i>Helicosphaera carteri</i> (Wallich) Kamptner, 1954	N *
42	HET	<i>Michaelsarsia adriatica</i> Schiller emend. Manton, Bremer & Bates	<i>Michaelsarsia adriaticus</i> (Schiller) Manton, Bremer & Oates, 1984	M, S
43	HET	<i>Michaelsarsia falklandica</i> Lohmann	<i>Michaelsarsia elegans</i> Gran, 1912	N *
44	-	<i>Najadea gloriosa</i> Schiller	* ? holotype is drawing with too little detail to allow identification	N *
45	HOL	<i>Ophiaster formosus</i> Gran	<i>Ophiaster formosus</i> Gran, 1912	N, S
46	HET	<i>Ophiaster hydroideus</i> (Lohmann) Lohmann +	<i>Ophiaster hydroideus</i> (Lohmann 1903) Lohmann, 1913	M
47	HOL	<i>Periphyllophora mirabilis</i> (Schiller) Kamptner	<i>Syracosphaera anthos</i> (Lohmann 1912) Janin, 1987 HOL	N *
48	HET	<i>Pontosphaera discopora</i> Schiller	<i>Pontosphaera discopora</i> Schiller, 1925	N *
49	-	<i>Pontosphaera echinophora</i> Schiller	* ? holotype is drawing with too little detail to allow identification	N *
50	-	<i>Pontosphaera haeckelii</i> Lohmann	* ? holotype is drawing with too little detail to allow identification	N *
51	-	<i>Pontosphaera hartmannii</i> Schiller	* ? holotype is drawing with too little detail to allow identification	N *
52	-	<i>Pontosphaera inermis</i> Lohmann	* ? holotype is drawing with too little detail to allow identification	N *, M
53	HET	<i>Pontosphaera nana</i> Kamptner	<i>Syracosphaera nana</i> (Kamptner 1941) Okada & McIntyre, 1977	N *
54	-	<i>Pontosphaera nigra</i> Schiller	* not a coccolithophore: <i>Scrippsiella acuminata</i> (Ehrenberg 1836) Kretschmann et al. 2015	N *
55	-	<i>Pontosphaera ovalis</i> Schiller	* ? holotype is drawing with too little detail to allow identification	N *, M
56	HOL	<i>Pontosphaera pietschmannii</i> Kamptner	* ? clearly a holococcolith but holotype is drawing with too little detail to allow identification	N *
57	HET	<i>Pontosphaera steueri</i> Kamptner	* ? cf. <i>Hymenomonas globosa</i> (Magne 1954) Gayral & Fresnel, 1976	N *
58	HOL	<i>Poricalyptra aurisinae</i> (Kamptner) Kleijne	<i>Syracosphaera aurisinae</i> HOL (Kamptner 1941) Keuter et al., 2021	N *
59	HET	<i>Rhabdosphaera clavigera</i> Murray & Blackman	<i>Rhabdosphaera clavigera</i> Murray & Blackman, 1898	N, M, S
60	-	<i>Rhabdosphaera erinacea</i> Kamptner	* not a coccolithophore: <i>Scrippsiella acuminata</i> (Ehrenberg 1836) Kretschmann et al. 2015	N *
61	HET	<i>Rhabdosphaera longistylis</i> Schiller	* cf. <i>Palusphaera vandellii</i> Lecal, 1965	N *, M
62	-	<i>Rhabdosphaera nigra</i> Schiller	* not a coccolithophore: <i>Scrippsiella acuminata</i> (Ehrenberg 1836) Kretschmann et al. 2015	N *
63	HET	<i>Rhabdosphaera tignifer</i> Schiller	<i>Rhabdosphaera clavigera</i> Murray & Blackman, 1898	N, M, S
64	-	<i>Rhabdosphaera tubulosa</i> Schiller	* not a coccolithophore: <i>Scrippsiella acuminata</i> (Ehrenberg 1836) Kretschmann et al. 2015	N *

Table 3. Cont.

N	Type	Species Name (Viličić et al. 2002 List)	Accepted Name with Comments (Indicated with *)	Distribution
65	-	<i>Rhabdothorax hispidus</i> (Lohmann) Kamptner	* ?	N, M, S
66	HET	<i>Scyphosphaera apsteinii</i> Lohmann	<i>Scyphosphaera apsteinii</i> Lohmann, 1902	
67	HOL	<i>Syracolithus catilliferus</i> (Kamptner) Deflandre	<i>Helicosphaera</i> HOL <i>catilliferus</i> type Young & Bown (2014)	N *
68	HOL	<i>Syracolithus catilliferus</i> (Kamptner) Deflandre	<i>Helicosphaera</i> HOL <i>catilliferus</i> type Young & Bown (2014)	N *
69	HOL	<i>Syracolithus dalmaticus</i> (Kamptner) Loeblich & Tappan	<i>Syracosphaera mediterranea</i> Lohmann 1902 HOL <i>wettsteinii</i> type, sensu Geisen et al., 2002	N *
70	HOL	<i>Syracolithus quadriperforatus</i> (Kamptner) Gaarder	<i>Calcidiscus leptoporus</i> subsp. <i>quadriperforatus</i> (Kamptner 1937) Geisen et al., 2002 HOL	N *
71	HET	<i>Syracolithus schilleri</i> (Kamptner) Kamptner	<i>Scyphosphaera apsteinii</i> Lohmann, 1902 HOL	N *
72	HOL	<i>Syracosphaera adriatica</i> Schiller	<i>Helicosphaera</i> HOL <i>ponticuliferus</i> type informal	N *, M
73	HOL	<i>Syracosphaera anthos</i> (Lohmann) Zanin	<i>Syracosphaera aurisinae</i> HOL (Kamptner 1941) Keuter et al., 2021	N *
74	-	<i>Syracosphaera bifenestrata</i> Schiller	* ? line drawing of coccosphere inadequate to determine species	N *
75	HOL	<i>Syracosphaera cordiformis</i> Schiller	? cf. <i>Sphaerocalyptra quadridentata</i> (Schiller 1913) Deflandre, 1952	M
76	HOL	<i>Syracosphaera cornifera</i> Schiller	<i>Helladosphaera cornifera</i> (Schiller 1913) Kamptner, 1937	N *
77	HOL	<i>Syracosphaera cornus</i> Kamptner	<i>Helicosphaera</i> HOL <i>catilliferus</i> type Young & Bown (2014)	N *
78	-	<i>Syracosphaera coronata</i> Schiller	*? line drawing of coccosphere inadequate to determine species	N *
79	-	<i>Syracosphaera cupulifera</i> Schiller	* ? line drawing of coccosphere inadequate to determine species	N *
80	-	<i>Syracosphaera dentata</i> Lohmann	* ? line drawing of coccosphere inadequate to determine species	N *
81	-	<i>Syracosphaera grundii</i> Schiller	* ? line drawing of coccosphere inadequate to determine species	N *
82	HET	<i>Syracosphaera halldalii</i> Gaarder ex Jordan & Green	<i>Syracosphaera halldalii</i> Gaarder, in Gaarder & Hasle 1971 ex Jordan, 1994	N, M
83	HET	<i>Syracosphaera histrica</i> Kamptner	<i>Syracosphaera histrica</i> Kamptner, 1941	N *
84	-	<i>Syracosphaera lohmannii</i> Brunthaler	* ? line drawing of coccosphere inadequate to determine species	N *
85	HET	<i>Syracosphaera molischii</i> Schiller	<i>Syracosphaera molischii</i> Schiller, 1925	N, M
86	-	<i>Syracosphaera ovata</i> Schiller	* ? line drawing of coccosphere inadequate to determine species	N, M
87	HET	<i>Syracosphaera pulchra</i> Lohmann	<i>Syracosphaera pulchra</i> Lohmann, 1902	N, M, S
88	-	<i>Syracosphaera radiata</i> Schiller	* ? line drawing of coccosphere inadequate to determine species	N *
89	-	<i>Syracosphaera spinosa</i> Lohmann	* ? line drawing of coccosphere inadequate to determine species	N *
90	-	<i>Syracosphaera tenuis</i> Lohmann	* ? line drawing of coccosphere inadequate to determine species	N *
91	HET	<i>Tergestiella adriatica</i> Kamptner	<i>Tergestiella adriatica</i> Kamptner, 1941	N *
92	HET	<i>Thalassopappus pellucidus</i> Kamptner	* ? cf. <i>Calciopappus caudatus</i> Gaarder & Ramsfjell, 1954	N *
93	HET	<i>Thorosphaera elegans</i> Ostenfeld	<i>Scyphosphaera porosa</i> Kamptner, 1967	S
94	HOL	<i>Zygosphaera debilis</i> Kamptner	<i>Zygosphaera amoena</i> Kamptner, 1937	N *
95	HOL	<i>Zygosphaera hellenica</i> Kamptner	<i>Syracosphaera mediterranea</i> Lohmann 1902 HOL <i>hellenica</i> type, sensu Cros et al., 2000	N *

### 3.2. Recent Studies on Coccolithophores in the Northern Adriatic

In the last 15 years, the coccolithophore assemblage has been studied in several publications covering the northern, central and southern Adriatic [24–33]. These publications reveal a great diversity of coccolithophores not only in the open sea, but also in coastal and estuarine waters.

Table 4 contains a list of 141 coccolithophores morphotypes published during last 15 years in the previously mentioned publications (combination coccospheres were not considered). Of these 141 morphotypes, 84 were recorded in the HET—diploid phase and the remaining 58 morphotypes in the haploid phase (including HOL, POL, NAN). Seventeen species were confirmed in both phases (HET-HOL), marked in bold in Table 4. The available images of coccolithophores from the northern and middle Adriatic Sea are listed in Figures 1–5.

**Table 4.** List of species compiled from recent publications studying coccolithophores diversity assemblage in the Adriatic Sea. HET, HOL, POL and CER indicate life cycle stages. HET-diploid phase; HOL, NAN, POL haploid phase. Species recorded in both phases (HET and HOL) are marked in bold.

N	Type	Species Name	Distribution
1	HET	<i>Acanthoica acanthos</i> Schiller, 1925	M
2	HET	<i>Acanthoica acantifera</i> Lochmann, 1912 ex Lochmann, 1913	S
3	<b>HET</b>	<b><i>Acanthoica quattrosolina</i> Lohmann, 1903</b>	N, M, S
4	<b>HOL</b>	<b><i>Acanthoica quattrosolina</i> Lohmann, 1903</b> HOL	N, M
5	<b>HET</b>	<b><i>Algirosphaera robusta</i> (Lohmann, 1902) Norris, 1984</b>	N, M, S
6	<b>HOL</b>	<b><i>Algirosphaera robusta</i> HOL (Lohman, 1902, Norris, 1984) Dimiza et al. 2008</b>	N, M, S
7	HET	<i>Alisphaera capulata</i> Heimdal in Heimdal & Gaarder, 1981	M
8	HET	<i>Alisphaera extenta</i> Kleijine, 2002	N, M
9	<b>HET</b>	<b><i>Alisphaera gaudii</i> Kleijine, 2002</b>	N, M
10	<b>POL</b>	<b><i>Alisphaera gaudii</i> Kleijine, 2002</b> POL	M
11	HET	<i>Alisphaera quadrilatera</i> Kleijine, 2002	M
12	<b>HET</b>	<b><i>Alisphaera unicornis</i> Okada &amp; McIntyre, 1977</b>	M, S
13	<b>POL</b>	<b><i>Alisphaera unicornis</i> Manton &amp; Oates, 1980</b> POL	M
14	HOL	<i>Anthosphaera</i> type C Cros	M
15	<b>HET</b>	<b><i>Calcidiscus leptoporus</i> (Murray &amp; Blackman, 1898) Loeblich &amp; Tappan, 1978</b>	N, M, S
16	<b>HET</b>	<b><i>Calcidiscus leptoporus</i> subsp. <i>quadriperforatus</i> (Kamptner, 1937) Geisen et al., 2002</b>	M, S
17	<b>HOL</b>	<b><i>Calcidiscus leptoporus</i> subsp. <i>quadriperforatus</i> (Kamptner 1937) Geisen et al., 2002</b> HOL	N, M, S
18	<b>HOL</b>	<b><i>Calcidiscus leptoporus</i> subsp. <i>leptoporus</i> (Murray &amp; Blackman 1898) Loeblich &amp; Tappan, 1978</b> HOL	S
19	HET	<i>Calciopappus caudatus</i> Gaarder & Ramsfjell, 1954 *	N
20	HET	<i>Calciopappus rigidus</i> Heimdal in Heimdal & Gaarder, 1981	N, M
21	HET	<i>Calciosolenia brasiliensis</i> (Lohmann, 1919) Young in Young et al., 2003	N, M, S
22	HET	<i>Calciosolenia corsellii</i> Malinverno, 2004	N, M
23	HET	<i>Calciosolenia murrayi</i> Gran, 1912	N, M, S
24	HOL	<i>Calicasphaera blokii</i> Kleijine, 1991	N, M
25	HOL	<i>Calyptrosphaera dentata</i> Kleijine, 1991	M, S
26	HOL	<i>Calyptrosphaera heimdaliae</i> Norris, 1985	M
27	HOL	<i>Calyptrosphaera sphaeroidea</i> Schiller, 1913 HOL	N, M
28	CER	<i>Ceratolithus cristatus</i> (Kamptner 1950) CER <i>cristatus</i> type <i>sensu</i> Young et al., 2003	M, S
29	HET	<i>Coccolithus pelagicus</i> (Wallich 1877) Schiller, 1930 *	N
30	HOL	<i>Corisphaera gracilis</i> Kamptner, 1937	N, M
31	HET	<i>Cyrtosphaera aculeata</i> (Kamptner 1941) Kleijine, 1992	N, M
32	HET	<i>Discosphaera tubifera</i> (Murray & Blackman 1898) Ostfeld, 1900	M, S
33	HET	<i>Emiliana huxleyi</i> (Lohmann, 1902) Hay & Mohler, in Hay et al. 1967	N, M, S
34	HET	<i>Emiliana huxleyi</i> type A (Lohmann, 1902) <i>sensu</i> Young & Westbroek, 1991	M
35	NAN	<i>Florisphaera profunda</i> Okada & Honjo, 1973	M
36	NAN	<i>Florisphaera profunda</i> var. <i>profunda</i> Okada & Honjo, 1973	S
37	HET	<i>Gephyrocapsa oceanica</i> Kamptner 1943	S
38	HET	<i>Gladiolithus flabelatus</i> (Halldal & Markali 1955) Jordan & Chamberlain, 1993	M, S
39	HOL	<i>Gliscolithus amikareniae</i> Norris, 1985	M
40	HET	<i>Helicosphaera carteri</i> (Wallich, 1877) Kamptner, 1954	N, M, S
41	HET	<i>Helicosphaera hyalina</i> Gaarder, 1970	M, S
42	<b>HET</b>	<b><i>Helicosphaera pavimentum</i> Okada &amp; McIntyre, 1977</b>	M, S
43	<b>HOL</b>	<b><i>Helicosphaera pavimentum</i> HOL (Kamptner, 1927) <i>sensu</i> Young et al., 2020</b>	N, M, S
44	HET	<i>Helicosphaera wallichii</i> (Lohmann, 1902) Okada & McIntyre, 1977	S
45	HOL	<i>Helicosphaera</i> HOL <i>catiliferus</i> type (Kamptner, 1937) <i>sensu</i> Young & Bown, 2014	N, S

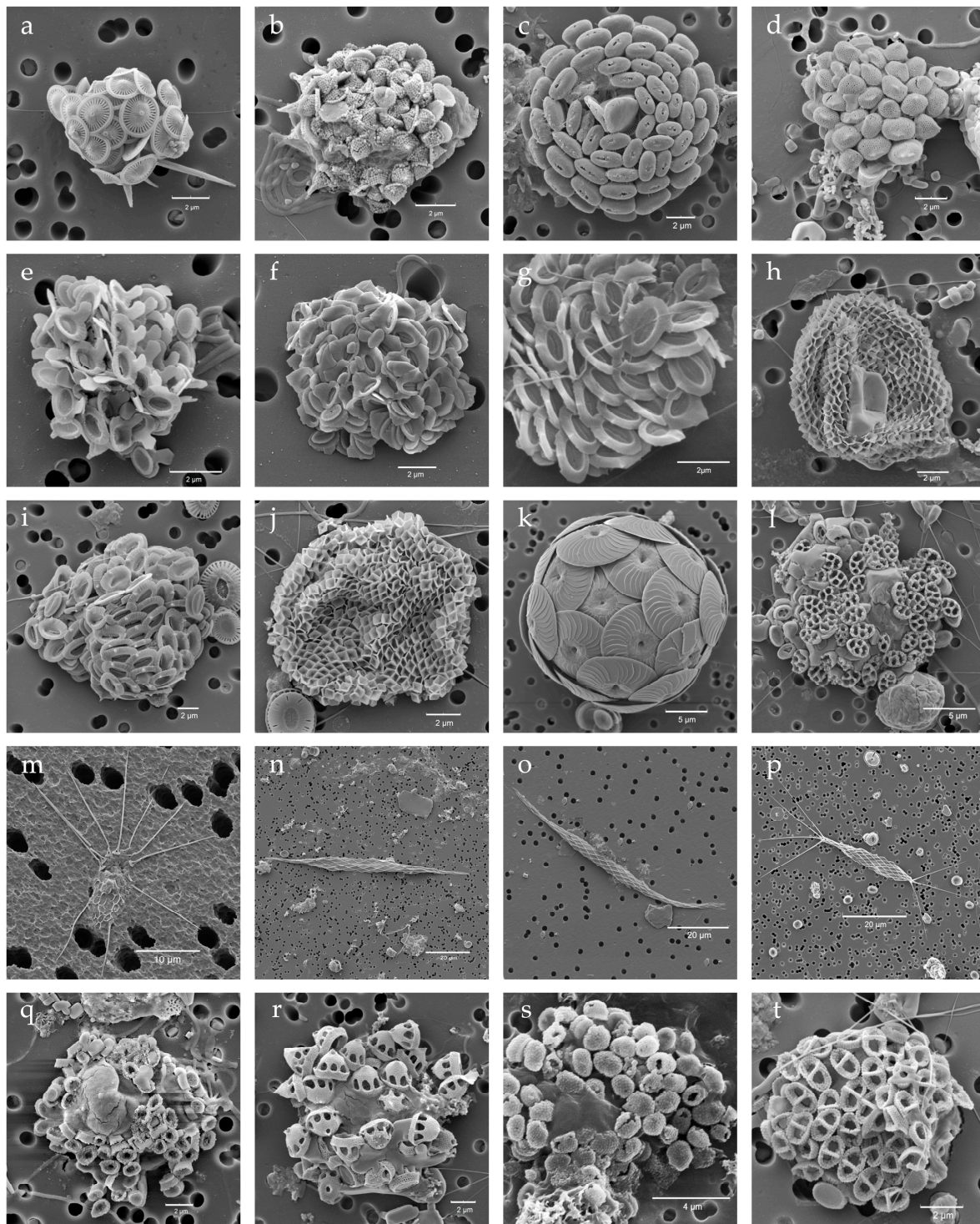
Table 4. Cont.

N	Type	Species Name	Distribution
46	HOL	<i>Helicosphaera</i> HOL <i>confusus</i> type (Kleijne, 1991) <i>sensu</i> Geisen et al. 2002	N, M, S
47	HOL	<i>Helladosphaera cornifera</i> (Schiller 1913) Kamptner, 1937	N, M
48	HOL	<i>Homozygosphaera spinosa</i> (Kamptner 1941) Deflandre, 1952	N, M
49	HET	<i>Hymenomonas roseola</i> Stein, 1878	M
50	HET	<i>Michaelsarsia adriaticus</i> (Schiller 1914) Manton et al., 1984 *	N
51	HET	<i>Michaelsarsia elegans</i> Gran, 1912	N, S
52	NAN	<i>Navilithus altivelum</i> Young & Andruleit, 2006	M
53	HET	<i>Oolithotus fragilis</i> (Lohmann 1912) Martini & Müller, 1972	S
54	HET	<i>Ophiaster formosus</i> Gran, 1912	M
55	HET	<i>Ophiaster hydroideus</i> (Lohmann 1903) Lohmann, 1913	N, M, S
56	HET	<i>Ophiaster minimus</i> Manton & Oates, 1983	M
57	HET	<i>Palusphaera crosiae</i> Archontikis & Young 2021	M °
58	HET	<i>Palusphaera vandellii</i> Lecal, 1965	N, M
59	HET	<i>Pappomonas</i> sp. Manton & Oates	M
60	HET	<i>Pappomonas</i> sp. type 1 Cros & Fortuno, 2002	M
61	HET	<i>Pappomonas</i> sp. type 3 Cros & Fortuno, 2002	M
62	HET	<i>Papposphaera lepida</i> Tangen, 1972	M
63	HET	<i>Papposphaera</i> sp. type 3 Cros & Fortuno, 2002	M
64	HET	<i>Papposphaera thomsenii</i> Norris, 1983	M
65	HOL	<i>Papposphaera</i> sp. HOL	M
66	HET	<i>Picarola margalefii</i> Cros & Estrada, 2004	M
67	NAN	<i>Pileolosphaera longistirpes</i> Meier, Kinkel & Young 2014	N, M *
68	POL	<i>Polycrater</i> sp. ladle-like Cros & Fortuño, 2002	M
69	HET	<i>Pontosphaera syracusana</i> Lohmann, 1902	S
70	HOL	<i>Poritectolithus poritectus</i> (Heimdal in Heimdal & Gaarder 1980) Kleijne, 1991	M
71	HET	<i>Reticulofenestra sessilis</i> (Lohmann 1912) Jordan & Young, 1990	S
72	HET	<i>Rhabdosphaera clavigera</i> Murray & Blackman, 1898	M, S
73	HET	<i>Rhabdosphaera clavigera</i> var. <i>stylifera</i> (Lohmann, 1902) Kleijne & Jordan, 1990	N, M
74	HET	<i>Rhabdosphaera xiphos</i> (Deflandre & Fert 1954) Norris, 1984	N, M, S
75	HET	<i>Scyphosphaera apsteinii</i> Lohmann, 1902	S
76	HOL	<i>Scyphosphaera apsteinii</i> Lohmann, 1902 HOL	M
77	HOL	<i>Sphaerocalyptra</i> cf. <i>adenensis</i> of Cros & Fortuño 2003	M
78	HOL	<i>Sphaerocalyptra</i> sp. 1 Cros & Fortuño, 2002	M
79	HOL	<i>Sphaerocalyptra</i> sp. 2 Cros & Fortuño, 2002	M
80	HOL	<i>Sphaerocalyptra</i> sp. 3 Cros & Fortuño, 2002	M
81	HOL	<i>Sphaerocalyptra</i> sp. 5 Cros & Fortuño, 2002	M
82	HOL	<i>Sphaerocalyptra</i> sp. 6 Cros & Fortuño, 2002	M
83	HOL	<i>Syracolithus</i> sp. type A Kleijne, 1991	M
84	HET	<i>Syracosphaera ampliara</i> Okada & McIntyre, 1977	N, M
85	HET	<i>Syracosphaera anthos</i> (Lohmann, 1912) Janin, 1987	M, S
86	HOL	<i>Syracosphaera anthos</i> (Lohmann 1912) Janin, 1987 HOL	M, S
87	HET	<i>Syracosphaera arethusae</i> (Kamptner, 1941) Triantaphyllou et al. 2016	N, M
88	HOL	<i>Syracosphaera arethusae</i> (Kamptner 1941) Triantaphyllou et al. 2016 HOL	N, M, S
89	HOL	<i>Syracosphaera aurisinae</i> HOL (Kamptner 1941) Keuter et al., 2021	M
90	HET	<i>Syracosphaera azureaplaneta</i> Young, 2018	M
91	HET	<i>Syracosphaera bannockii</i> (Borsetti & Cati 1976) Cros et al., 2000	N, M, S
92	HOL	<i>Syracosphaera bannockii</i> (Borsetti & Cati 1976) Cros et al., 2000 HOL	M
93	HET	<i>Syracosphaera corolla</i> Lecal, 1966 emend Young et al. 2018	N, M
94	HET	<i>Syracosphaera dilatata</i> Jordan et al., 1993	N, M
95	HOL	<i>Syracosphaera elevata</i> Archontikis, Young & Cros 2020 HOL	M *
96	HOL	<i>Syracosphaera gaarderae</i> (Borsetti & Cati 1976) Keuter, Young & Frada 2019 HOL	M
97	HET	<i>Syracosphaera halldalii</i> Gaarder, in Gaarder & Hasle 1971 ex Jordan, 1994	M, S
98	HOL	<i>Calyptrolithina divergens</i> (Halldal & Markali 1955) Heimdal, 1982, Triantaphyllou et al. 2004 ( <i>Syracosphaera halldalii</i> HOL)	N, M
99	HET	<i>Syracosphaera histrica</i> Kamptner, 1941	N, M, S
100	HOL	<i>Syracosphaera histrica</i> Kamptner, 1941 HOL	N, M

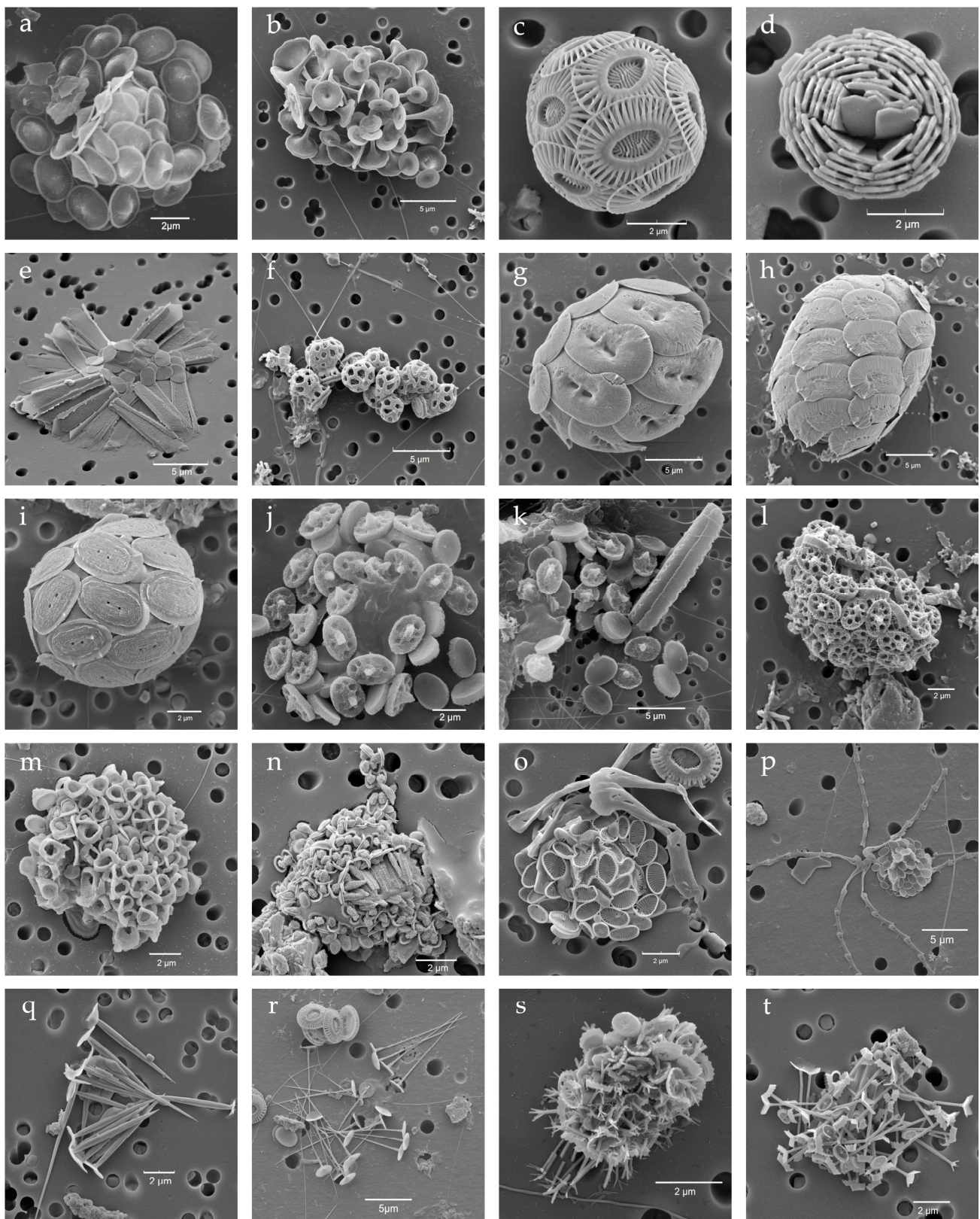
Table 4. Cont.

N	Type	Species Name	Distribution
101	HOL	<i>Syracosphaera lafourcadii</i> (Lecal 1967) Archontikis et al., 2020 HOL	M
102	HET	<i>Syracosphaera lamina</i> Lecal-Schlauder, 1951	M
103	HET	<i>Syracosphaera marginaporata</i> Knappertsbusch, 1993	N, M
104	HOL	<i>Syracosphaera marginiporata</i> Knappertsbusch 1993 HOL	M
105	HET	<i>Syracosphaera mediterranea</i> Lohmann, 1902	N, M, S
106	HET	<i>Syracosphaera mediterranea</i> var. <i>binodata</i> (Kamptner, 1927) sensu Triantaphyllou et al. (2016) & Young et al. (2020)	S
107	HOL	<i>Syracosphaera mediterranea</i> Lohmann 1902 HOL <i>gracillima</i> type, sensu Geisen et al., 2002	M
108	HOL	<i>Syracosphaera mediterranea</i> Lohmann 1902 HOL <i>hellenica</i> type, sensu Cros et al., 2000	M
109	HOL	<i>Syracosphaera mediterranea</i> Lohmann 1902 HOL <i>wettsteinii</i> type, sensu Geisen et al., 2002	N, M
110	HET	<i>Syracosphaera molischii</i> Schiller, 1925	N, M, S
111	HET	<i>Syracosphaera molischii</i> type 1 (Schiller, 1925) sensu Young et al. 2003	N
112	HET	<i>Syracosphaera molischii</i> type 2 (Schiller, 1925) sensu Young et al. 2003	N
113	HET	<i>Syracosphaera molischii</i> type 3 (Schiller, 1925) sensu Young et al. 2003	M
114	HET	<i>Syracosphaera molischii</i> type 4 (Schiller, 1925) sensu Young et al. 2003	M
115	HOL	<i>Syracosphaera molischii</i> Schiller, 1925 HOL	N, M
116	HET	<i>Syracosphaera nana</i> (Kamptner, 1941) Okada & McIntyre, 1977	M
117	HOL	<i>Syracosphaera nana</i> (Kamptner 1941) Okada & McIntyre, 1977 HOL	M
118	HET	<i>Syracosphaera nodosa</i> Kamptner, 1941	N, M
119	HET	<i>Syracosphaera orbiculus</i> Okada & McIntyre, 1977	M
120	HOL	<i>Syracosphaera origami</i> (Cros & McGrane 2014) Archontikis et al. 2020 HOL	M
121	HET	<i>Syracosphaera ossa</i> (Lecal 1966) Loeblich & Tappan, 1968	M
122	HET	<i>Syracosphaera ossa</i> type 1 (Lecal 1966) Loeblich & Tappan, 1968, of Young et al. 2003	M
123	HET	<i>Syracosphaera ossa</i> type 2 (Lecal 1966) Loeblich & Tappan, 1968, of Young et al. 2003	N, M
124	HOL	<i>Syracosphaera periperforata</i> (Kleijne 1991) Archontikis, Young & Cros 2020 HOL	M
125	HOL	<i>Syracosphaera periperforata</i> Kleijne 1991 var. <i>periperforata</i> HOL sensu Archontikis et al., 2020	N, M
126	HOL	<i>Syracosphaera periperforata</i> Kleijne 1991 var. <i>cylindrata</i> HOL sensu Archontikis et al., 2020	M
127	HET	<i>Syracosphaera prolongata</i> Gran 1912 ex Lohmann, 1913	M, S
128	HET	<i>Syracosphaera protrudens</i> Okada & McIntyre, 1977	N, M
129	HET	<i>Syracosphaera pulchra</i> Lohmann, 1902	N, M, S
130	HOL	<i>Syracosphaera pulchra</i> Lohmann, 1902 HOL <i>oblonga</i> type, sensu Young et al., 2003	N, M, S
131	HOL	<i>Syracosphaera pulchra</i> Lohmann, 1902 HOL <i>pirus</i> type, sensu Young et al., 2003	M
132	HOL	<i>Syracosphaera rotaconica</i> Archontikis, Young & Cros, in Archontikis et al., 2020 HOL	M
133	HET	<i>Syracosphaera rotula</i> Okada & McIntyre, 1977	M
134	HET	<i>Syracosphaera strigilis</i> (Gaarder 1962) Šupraha et al., 2018	N, M
135	HOL	<i>Syracosphaera strigilis</i> (Gaarder, 1962) Šupraha et al., 2018 HOL	N, M
136	HET	<i>Syracosphaera tumularis</i> Sánchez-Suárez, 1990	M
137	HET	<i>Tergestiella adriatica</i> Kamptner, 1941	N
138	HET	<i>Umbellosphaera tenuis</i> (Kamptner 1937) Paasche in Markali & Paasche, 1955	M, S
139	HET	<i>Umbilicosphaera foliosa</i> (Kamptner 1963) Geisen in Sáez et al., 2003	S
140	HET	<i>Umbilicosphaera sibogae</i> var. <i>sibogae</i> (Weber—van Bosse 1901) Gaarder, 1970	M, S
141	HOL	<i>Zygospaera amoena</i> Kamptner, 1937	M

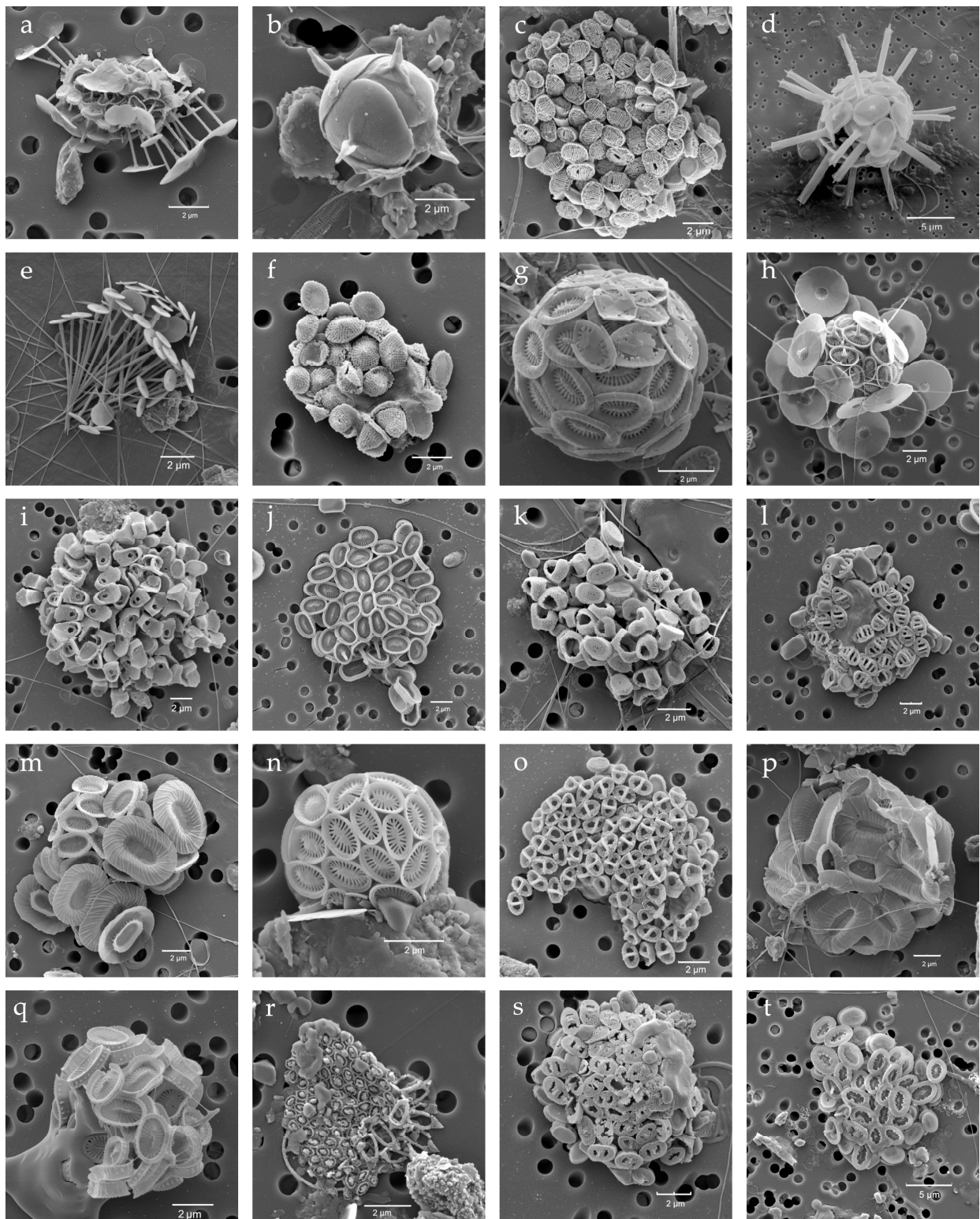
° *Palusphaera* sp. Cros & Fortuño, 2002—published in Skejić et al. 2018. has been confirmed as *Palusphaera crosiae* Archontikis & Young 2021. \* personal observation—unpublished species.



**Figure 1.** SEM images of coccolithophore morphotypes: (a) *Acanthoica quattropsina*; (b) *Acanthoica quattropsina* HOL; (c) *Algirosphaera robusta*; (d) *Algirosphaera robusta* HOL; (e) *Alisphaera capulata*; (f) *Alisphaera extensa*; (g) *Alisphaera gaudii*; (h) *Alisphaera gaudii* POL; (i) *Alisphaera unicornis*; (j) *Alisphaera unicornis* POL; (k) *Calcidiscus leptoporus* subsp. *quadriperforatus*; (l) *Calcidiscus leptoporus* subsp. *quadriperforatus* HOL; (m) *Calciopapus rigidus*; (n) *Calciosolenia brasiliensis*; (o) *Calciosolenia corsellii*; (p) *Calciosolenia murrayi*; (q) *Calicasphaera blokii*; (r) *Calyptosphaera heimdaliae*; (s) *Calyptosphaera sphaeroidea*; (t) *Corisphaera gracilis*; (scale bars: a–j,q,r,t = 2  $\mu$ m; s = 4  $\mu$ m; k,l = 5  $\mu$ m; m = 10  $\mu$ m; n–p = 20  $\mu$ m).

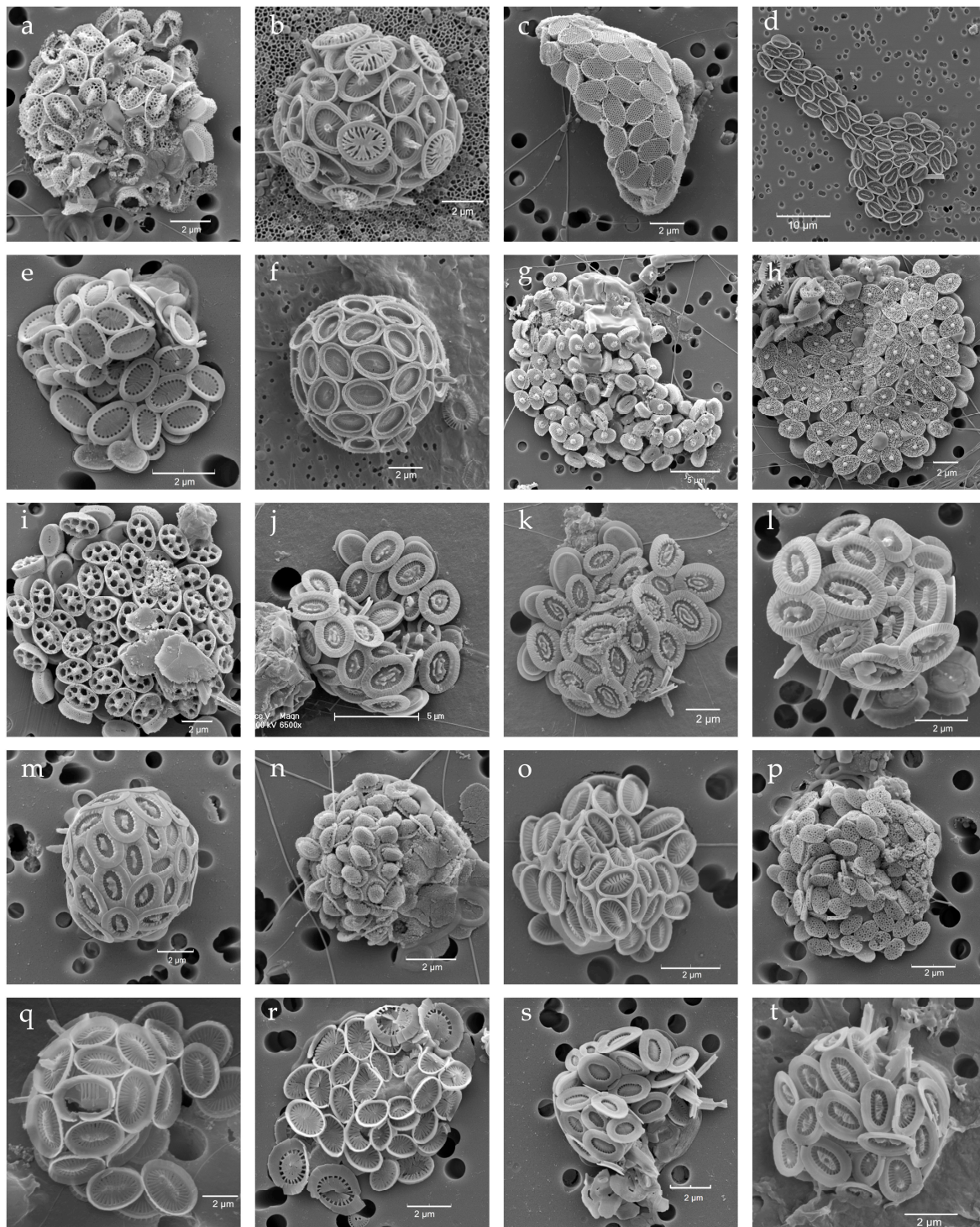


**Figure 2.** SEM images of coccolithophore morphotypes: (a) *Cyrtosphaera aculeata*; (b) *Discosphaera tubifera*; (c) *Emiliania huxleyi*; (d) *Florisphaera profunda*; (e) *Gladiolithus flabellatus*; (f) *Gliscolithus amittakareniae*; (g) *Helicosphaera carteri*; (h) *Helicosphaera hyalina*; (i) *Helicosphaera pavementum*; (j) *Helicosphaera pavementum* HOL; (k) *Helicosphaera* HOL *catilliferus* type; (l) *Helicosphaera* HOL *confusus* type; (m) *Homozygosphaera spinosa*; (n) *Navilithus altivelum*; (o) *Ophiaster formosus*; (p) *Ophiaster hydroideus*; (q) *Palusphaera crosiae*; (r) *Palusphaera vandellii*; (s) *Pappomonas* sp. type 1; (t) *Pappomonas* sp. type 3; (scale bars: a,c,d,i,j,l-o,q,s,t = 2  $\mu$ m; b,e-h,k,p,r = 5  $\mu$ m).

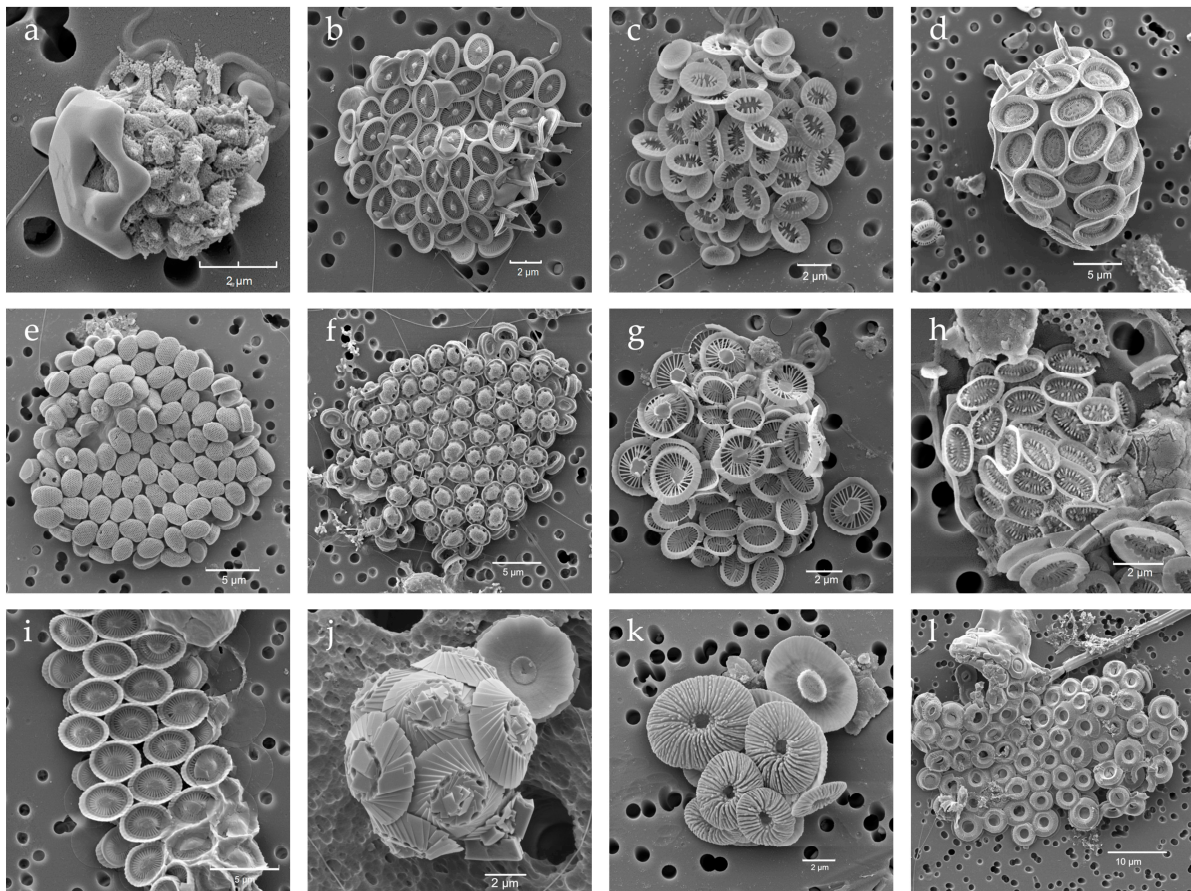


**Figure 3.** SEM images of coccolithophore morphotypes: (a) *Papposphaera lepida*; (b) *Pileosphaera longistirpes*; (c) *Poritectolithus poritectus*; (d) *Rhabdosphaera clavigera* var. *stylifera*; (e) *Rhabdosphaera xiphos*; (f) *Sphaerocalyptra* sp. 1 HOL; (g) *Syracosphaera ampliara*; (h) *Syracosphaera anthos*; (i) *Syracosphaera anthos* HOL; (j) *Syracosphaera arethusae*; (k) *Syracosphaera arethusae* HOL; (l) *Syracosphaera aurisinae* HOL; (m) *Syracosphaera azureaplaneta*; (n) *Syracosphaera bannockii*; (o) *Syracosphaera bannockii* HOL; (p) *Syracosphaera corolla*; (q) *Syracosphaera dilatata*; (r) *Syracosphaera elevata* HOL; (s) *Syracosphaera gaarderae* HOL; (t) *Syracosphaera halldalii*; (scale bars: a–c,e–s = 2 μm; d,t = 5 μm).





**Figure 4.** SEM images of coccolithophore morphotypes: (a) *Syracosphaera halldalii* HOL; (b) *Syracosphaera histrica*; (c) *Syracosphaera histrica* HOL; (d) *Syracosphaera lamina*; (e) *Syracosphaera marginaporrata*; (f) *Syracosphaera mediterranea*; (g) *Syracosphaera mediterranea* HOL *gracillima* type; (h) *Syracosphaera mediterranea* HOL *hellenica* type; (i) *Syracosphaera mediterranea* HOL *wettsteini* type; (j) *Syracosphaera molischii* type 1; (k) *Syracosphaera molischii* type 2; (l) *Syracosphaera mollischi* type 3; (m) *Syracosphaera mollischi* type 4; (n) *Syracosphaera mollischi* HOL; (o) *Syracosphaera nana*; (p) *Syracosphaera nana* HOL; (q) *Syracosphaera nodosa*; (r) *Syracosphaera orbiculus*; (s) *Syracosphaera ossa* type 1; (t) *Syracosphaera ossa* type 2; (scale bars: a–c,e,f,h,i,k–t = 2 μm; g,j = 5 μm; d = 10 μm).



**Figure 5.** SEM images of coccolithophore morphotypes: (a) *Syracosphaera periperforata* var. *periperforata*; (b) *Syracosphaera prolongata*; (c) *Syracosphaera protrudens*; (d) *Syracosphaera pulchra*; (e) *Syracosphaera pulchra* HOL *oblonga* type; (f) *Syracosphaera pulchra* HOL *pirus* type; (g) *Syracosphaera rotula*; (h) *Syracosphaera strigilis*; (i) *Syracosphaera tumularis*; (j) *Tergestiella adriatica*; (k) *Umbellosphaera tenuis*; (l) *Umbilicosphaera sibogae* var. *sibogae*; (scale bars: a–c,g,h,j,k = 2  $\mu\text{m}$ ; d–f,i = 5  $\mu\text{m}$ ; l = 10  $\mu\text{m}$ ).

The most diverse area was the middle Adriatic with 124 morphotypes, but this was probably the result of more intensive research efforts (six publications) compared to the northern (three) and southern parts (one). In addition, 54 morphotypes were found from the northern part and 48 from the southern part of the Adriatic.

The most frequently observed species is *E. huxleyi* throughout the Adriatic Sea [25,30,33]. However, the highest abundance of coccolithophores was observed for *Syracosphaera hall-dalii*, reaching  $2.51 \times 10^6$  cells  $\text{L}^{-1}$  in the middle Adriatic Sea [31].

Records of combination coccospheres (with HET-HOL coccoliths) are important for clarifying taxonomic questions due to the different morphological life cycle stages of coccolithophores. A review of the literature reveals that 11 combination coccospheres were reported in four publications: *Acanthoica quattrosphina*, *Alisphaera unicornis*, *Helicosphaera pavementum*, *Syracosphaera arethusae*, *Syracosphaera bannockii*, *Syracosphaera histrica*, *Syracosphaera marginaporata*, *Syracosphaera mediterranea*, *Syracosphaera molischii*, *Syracosphaera pulchra*, *Syracosphaera strigilis* [28–30,32].

In summary, we can state that in the past twenty years there has been a notable increase in the number of recorded species in the Adriatic. This increase is most likely due to the use of SEM, which allows a more detailed observation of species characteristics and thus more certain identification. The species lists by Revelante in 1985 [23] and by Viličić et al. in 2002 [13] were largely based on revisions of the older literature, with some species descriptions and associated drawings not being detailed enough to allow unambiguous identification, resulting in duplicate species records. Therefore, we would like to emphasize

the importance of including microscopic photographs with species lists, as this allows unambiguous recording of species.

**Author Contributions:** Conceptualization and writing—original draft preparation: J.G.; formal analysis: J.G., J.A. and S.S.; visualization: M.B.; data curation: J.G., S.S. and J.A.; writing—review and editing, M.B., S.S. and J.A.; funding acquisition, J.G., S.S. and J.A. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by the Croatian National Monitoring Program (Project “Jadran”) and by grants from the Croatian Science Foundation under projects UIP-2020-02-3249—Ecology and toxicity of the genus *Pseudo-nitzschia* in the coastal waters of the central and southern Adriatic Sea (Pseudotox).

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Not applicable.

**Acknowledgments:** We would like to thank everyone who participated in the collection of data sets used in this manuscript. We acknowledge the useful comments of anonymous reviewers.

**Conflicts of Interest:** The authors declare no conflict of interest.

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