COCCOLITHOPHORE SPECIES DIVERSITY IN THE COASTAL NORTHERN ADRIATIC SEA

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INTRODUCTION

Coccolithophores are calcifying, unicellular eukaryotes and important primary producers in the marine ecosystem. They play a key role in ocean biogeochemistry, especially in global carbon and sulphur cycles, and thus also in climate regulation. Coccolithophores belong to the Phylum Haptophyta, comprising ~200 morphospecies (*1*). Their cells are covered by calcified scales (coccoliths) and the taxonomy of coccolithophores is based upon their ultrastructural morphology. They are found to produce two very different types of coccoliths: (i) heterococcoliths (HET), which are formed of a radial array of complex crystal-units and (ii) holococcoliths (HOL), which are formed of numerous minute (ca. 0.1 µm) euhedral crystallites. These were so different, that bearers of each were first described and named as separate species. We now know that both are products of haploid (HET) and diploid (HLO) life cycle phases formed via very different biomineralisation processes(2). This discovery further complicated studies of their diversity as most of the combinations are yet to be discovered, the same as the triggers between their transitions.

Classification of recorded species, following Young et. al (*1*):

WATZNAUERIALES

Watznaueriaceae **A)** *Tergestiella adriatica* Kamptner

ISOCHRYSIDALES

Noelaerhabdaceae **B)** *Emiliania huxleyi* (Lohmann) Hay & Mohler

ZYGODISCALES

Helicosphaeraceae *Helicosphaera carteri* (Wallich) Kamptner

SYRACOSPHAERALES

Calciopapus rigidus Hemidal

Ophiaster hydroideus (Lohmann) Manton & Oates

Syracosphaeraceae **C)** *Syracosphaera borealis* Okada & McIntyre

Syracosphaera bannockii (Borsetti & Catti) Cross

Syracosphaera molischii Schiller, type 1

Syracosphaera molischii Schiller, type 2

Syracosphaera nodosa Kamptner

D) *Syracosphaera ossa* (Lecal) Loeblich & Tapan

E) *Syracosphaera pulcha* Lohmann, HET

Syracosphaera sp. type D Kleijne

F) *Syracosphaera histrica* Kamptner

incertae sedis **G)** *Coronosphaera mediterranea* (Lohmann) Gaarder, HET

Calciosoleniaceae *Calciosolenia brasiliensis* (Lohmann) Young

Calciosolenia murrayi Gran

Rhabdosphaeraceae **H)** *Rhabdosphaera xiphos* (Deflan. & Fert) Norris

I) *Rhabdosphaera clavigera* Murray & Blackman

Pallusphaera vandelii (Lecal) Norris

Acanthoica quattrospina Lohmann

J) *Algirosphaera robusta* (Lohmann) Norris

HOLOCOCCOLITHS

K) *Anthosphaera fragaria* (Kamptner) Kleijne

Anthosphaera sp. cf. type C Cross & Fortuno

L) *Sphaerocalyptra quadridentata* (Schiller) Deflandre

Sphaerocalyptra sp.1 Cross & Fortuno

Calicasphaera blokii Kleijne

Calcidiscus leptoporus ssp. *quadriperforatus* HOL (Kamptner) Geisen

Corisphaera gracilis Kamptner

M) *Corisphaera strigilis* Kamptner

Calyptrolithophora papillifera (Halldal) Hemidal

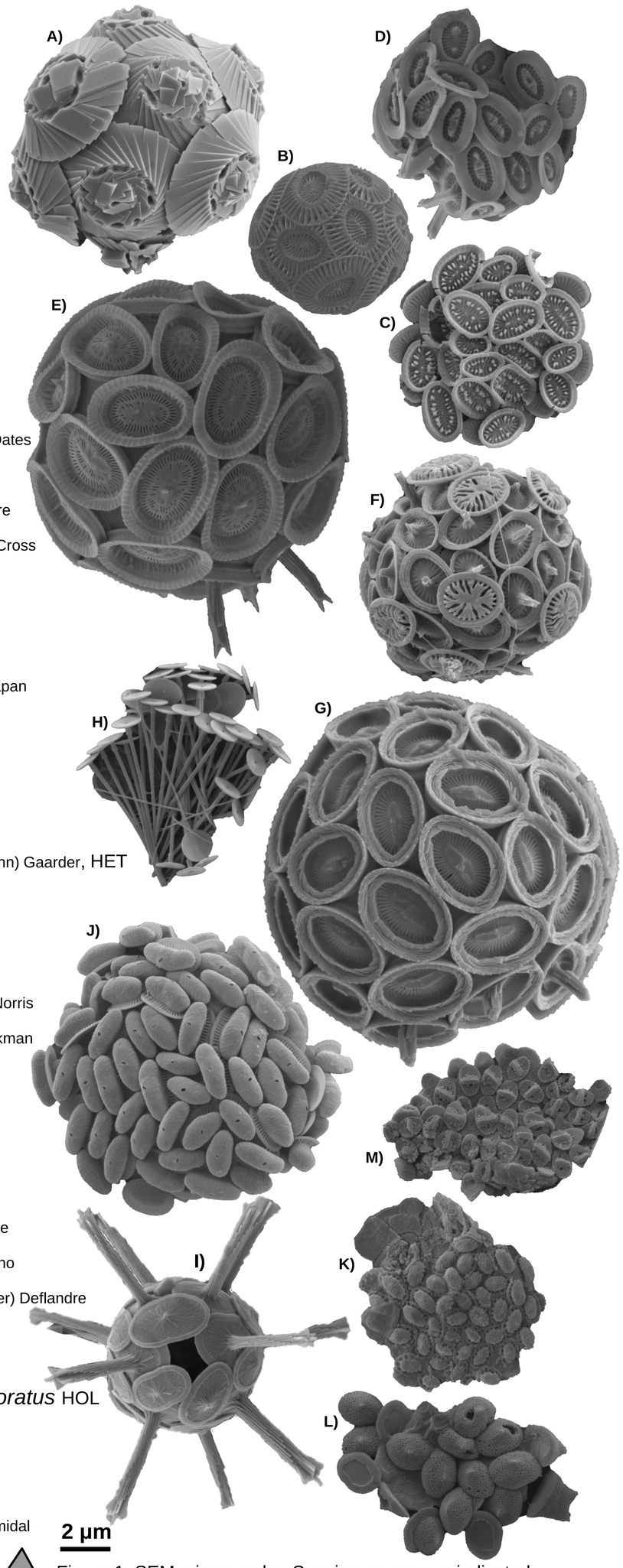

Figure 1. SEM micrographs. Species names are indicated, by letters in the classification list.

PROBLEM OUTLINE

During his phytoplankton surveys of the Adriatic Schiller (3, 4) described numerous species. The coccolithophore flora of the northern Adriatic (Rovinj) was studied in detail by Kamptner (5). During his taxonomic survey he recorded 44 coccolithophore taxa, of which 17 were new for science. Henceforth, there are only scarce subsequent records of diversity and ecology of coccolithophores in the northern Adriatic. Species lists were produced by Relevante (6) and Viličić (7), both of which were only based on literature data (81 species), containing many synonyms and taxonomic inaccuracies. Thus, we set out to determine the diversity of this important phytoplankton group as well as its dynamics throughout the year.

MATERIALS & METHODS

Species diversity was analysed in the coastal area of the northern Adriatic, 1 nm in front of Rovinj (45.13N, 14.12E). Samples were taken over a one year period (Oct/2008–Nov/2009) every ten days, thus covering the expected range of species in the succession time line. Samples were fixed with neutralised formaldehyde. Subsamples (50–100 mL) were filtered on polycarbonate filters (Whatman 110612). Pieces of air-dried filters were mounted on aluminium stub and sputter coated with gold-palladium (Cressington Scientific 208HR) for morphological and morphometric studies under SEM (Phillips XL30 FEG SEM). Additionally, cell counts were performed with inverted light microscope (Axiovert 200, Zeiss, Oberkochen, Germany) following Utermöhl (8).

RESULTS & CONCLUSIONS

Species spanning the whole of phylogenetic diversity of coccolithophores were recorded. A species list containing in total 31 morphospecies was assembled (Figure 1). We noted 21 hetero- and 10 holococcoltihophores, of which 4 were recorded in both life-cycle stages (*Syracosphaera pulcha* (HOL *Calyptrosphaera oblonga*), *Syracosphaera histrica* (HOL *Calyptrolithophora papillifera*), *Helicosphaera carteri* (HOL *Syracolithus catilliferus*) and *Coronosphaera mediterranea* (HOL *Calyptrolithina wettsteini*)). The dominating genus was *Syracosphaera*, represented by 10 species. Coccolithophores of both phases were present throughout the investigated period. Highest abundances (10^6 cells L^{-1}) were recorded in January during a monospecific bloom of *Emiliania huxleyi* (88% of whole phytoplankton community) (Figure 2). Seasonality in HET/HOL phases was observed for HET_*C. mediterranea* (autum) and HOL_*C. wettsteini* (spring). Higher contributions (>60% of coccolithophore assemblages) were noted during the Mar–Jun period.

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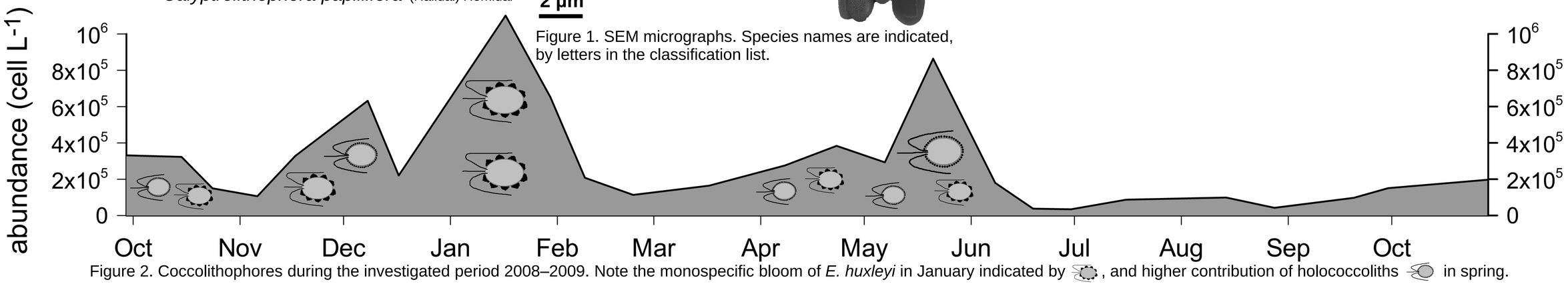

Figure 2. Coccolithophores during the investigated period 2008–2009. Note the monospecific bloom of *E. huxleyi* in January indicated by , and higher contribution of holococcoliths in spring.

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