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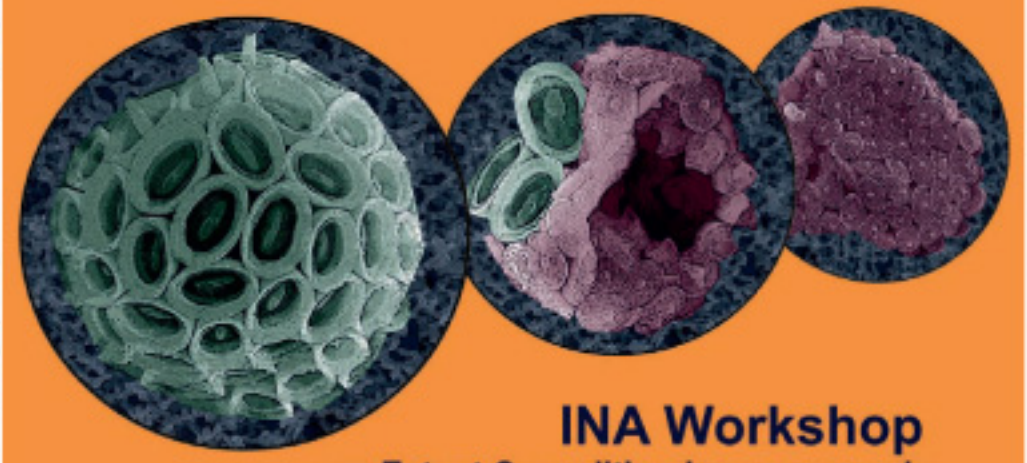

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First observation of *Navilithus altivelum* in the Gulf of Mexico

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Abstract: The coccolithophore *Navilithus altivelum* was first described by Young and Andruleit (2006) from samples collected in the Eastern Indian Ocean. There have been no other published observations of this species or it's preferential niche within the photic zone. It has recently been observed, however, in Gulf of Mexico (GOM) during September, 2013 from sampling on the RV Bellows during the Deep-C GOM sampling project. We present some variation in its previously observed ecological preference and aid in defining niche parameters with the initial description using in-situ CTD measurements as well as other coccolithophore species found alongside the *Navilithus altivelum* cells.

Introduction

Navilithus altivelum is a trimorphic deep photic coccolithophore species described by Young & Andruleit (2006) from samples found below the thermocline in the Indian Ocean and not recorded since. The three distinct types of coccoliths it produces are: circum-flagellar sail coccoliths, moderately elevated coccoliths, and body coccoliths with a basal structure similar to that of other species in the narrow-rimmed placoliths group of Young et al. (2003). For a more detailed description, see Young and Andruleit (2006). Here we discuss the preferential niche of *Navilithus altivelum* within the Gulf of Mexico using water-chemistry profiles from CTD readings that give temperature, salinity, and chlorophyll data for the observed *Navilithus altivelum* coccospheres. The samples were taken from station P7 off the Pensacola coast 40 miles from shore (29.75, -87.25) (Figure 1).

Material and Methods

Sampling has taken place every 2-4 months over the past four years along a North-South transect as part of the Deep-C project (http://deep-c.org). On station we collected a profile down to 200 m, at the lower limits to the photic zone. Samples were taken via Niskin-bottles attached to a rosette. The samples were extracted from 1-3 liters of water using 44-mm diameter polycarbonate filters with 0.6 μm pores and vacuum filtration.

The filters were oven-dried and stored in air tight containers for processing in the lab. The filters were then mounted on aluminum stubs and sputter-coated with gold-palladium for study in a scanning electron microscope (SEM). Quantitative species-cell counts were recorded in 210 SEM frames at 2500 X magnification at a working distance of about 15-mm. This method provided estimations of the filter area examined (Bown & Young 1998; Winter et al., 1994). Coccolithophores were identified using systematic definitions primarily from Winter and Siesser (1994), Young et al. (2003) and Young and Andruleit (2006).

Results - Species Assemblage and N. altivelum

Navilithus altivelum coccospheres were observed in only sample, collected from 50m depth at station P7 (29.75°N, 87.25°W) on 14th September 2013. By comparison *Florisphaera profunda* was found in 56 of the 283 samples studied. Fifteen coccospheres of *Navilithus* were recorded in this sample which gives a calculated abundance of 9100 cells/liter. The morphology of these was essentially identical to those described by Young & Andruleit (2006) with trimorphic coccospheres consisting of numerous short short-spined body coccoliths, a few moderately elevated coccoliths and a group of tall circum-flagellar sail coccoliths (Fig 2). The number of coccoliths per coccosphere, the arrangement of the different lith types on the cocco-

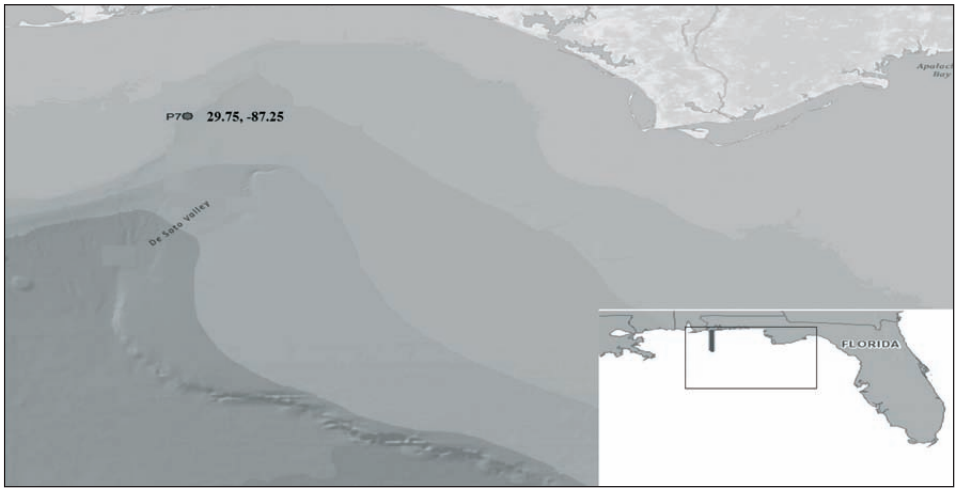

Figure 1. Map showing the study site in the Gulf of Mexico, inset is location map also showing the sampling transect.

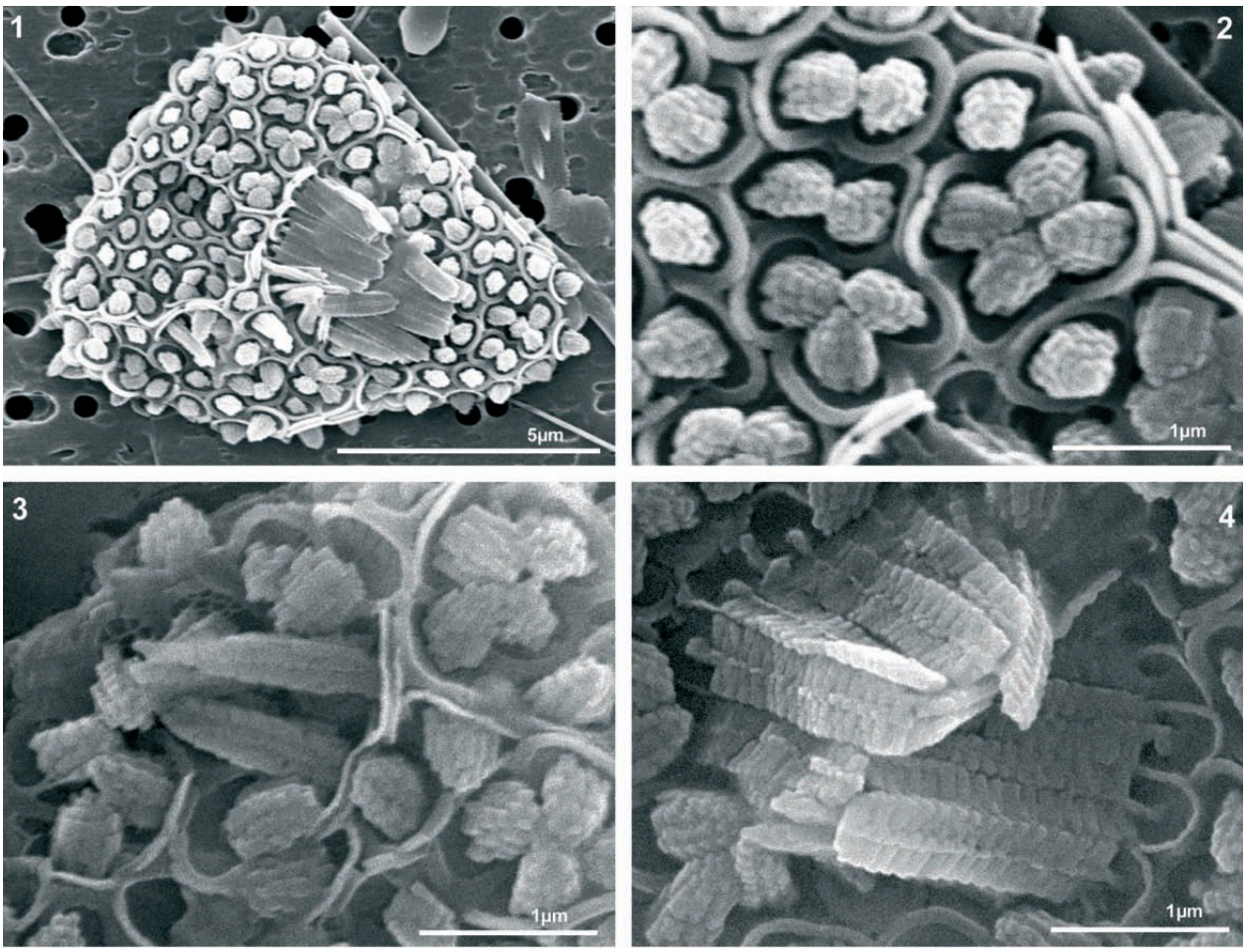

Figure 2. SEM images of *Navilithus altivelum*, all from sample P7-50m sept 2013. 1. Coccosphere; 2 Body coccoliths; 3 - moderately elevated coccoliths; 4 - Circum flagellar coccoliths with sail-like spines.

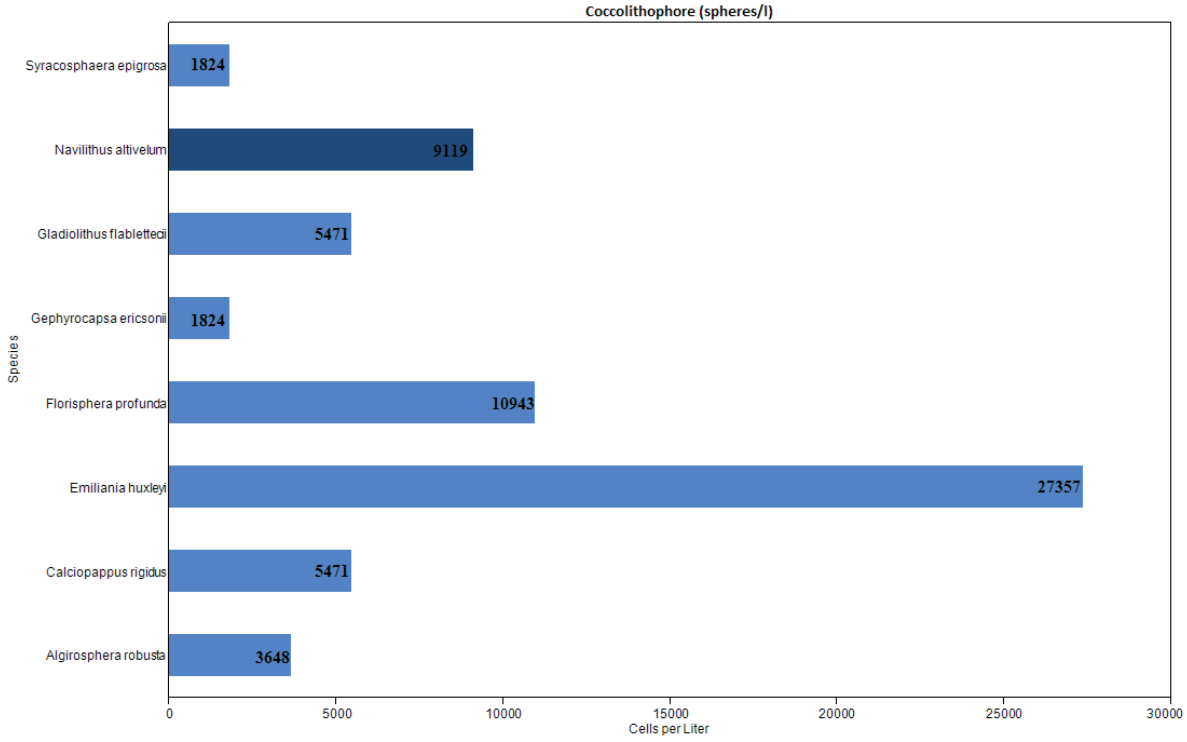

Figure 3. P7 50m depth: cells per liter counts.

sphere, their size, and detailed morphology are all essentially identical to that of the type material.

The *N. altivelum* specimens from station P7 in the GOM occurred in the lower part of the thermocline, below the deep chlorophyll maximum (Figure 4). The water temperature in the sample where the coccospheres were observed was 22.1 °C., and salinity level was 36.44 PSU. *Emiliania huxleyi* and *Gephyrocapsa oceanica* were present throughout the entire water column at station P7 with *E. huxleyi* present in major abundances within the surface waters. The surface waters also contained *Calciopappus rigidus, Algirosphaera robusta,* and *Ophiaster formosus*. At the 50-meter depth (Figure 3) where *Navilithus altivelum* was present, *Florisphaera profunda* and *Gladiolithus flabellatus* were also present. Deeper waters contained *Florisphaera profunda,* and *Gladiolithus flabellatus,* as well as *Calcidiscus leptoporus* and *Umbellosphaera irregularis* specimens which had probably sunk from surface waters.

Discussion

The species *N. altivelum* appears to occur in a similar position in the water column in the GOM as described by Young and Andruleit (2006) in the Indian Ocean. In both cases it occurs in the lower part of the thermocline below a well-developed deep chlorophyll maximum. It occurs with DCM species such as *Gladiolithus flabellatus* and *Florisphaera profunda* but does not extend as deep as they do. These observations and the absence of any records from the more intensively studied surface waters suggest that this species is a true deep-photic obligate, living in the zone of enhanced nutrients but low light below the deep chlorophyll maximum (Nutrient data was not available for either our sampling or that of Young & Andruleit (2006) but high nutrient levels can be inferred from the watr profile charactersitics). In terms of simple physico-chemical parameters, however, the sampled environment are strikingly different; the Indian Ocean specimens were found at 100-130 m, 10-12 °C and 34.7-34.9 psu in contrast to the Gulf of Mexico specimens which were found at 50m, 22°C and 36.4 psu. Clearly the distribution of the species is not closely tied to these parameters. This rare nannoplankton species *Navilithus altivelum* is also an excellent example of how elusive and diverse these deep-photic oligotrophic species can be. First observed in the Indian Ocean in 2006 and subsequently observed half way around the globe in the Gulf of Mexico in 2013, one could assume *Navilithus altivelum* is more widely distributed than presently known. This raises the question as to how diverse and widespread such deep-photic species are and how many more undiscovered nannoplankton taxa are out there.

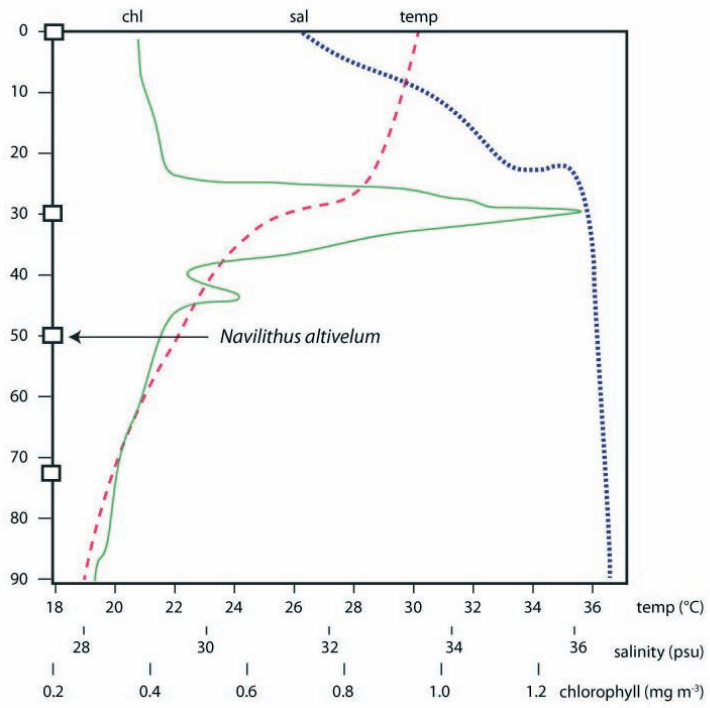

Figure 4. Temperature, salinity and chlorophyll data for Station P7, Sept 2013. Sampling depths indicated by squares on vertical axis.

Acknowledgments

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