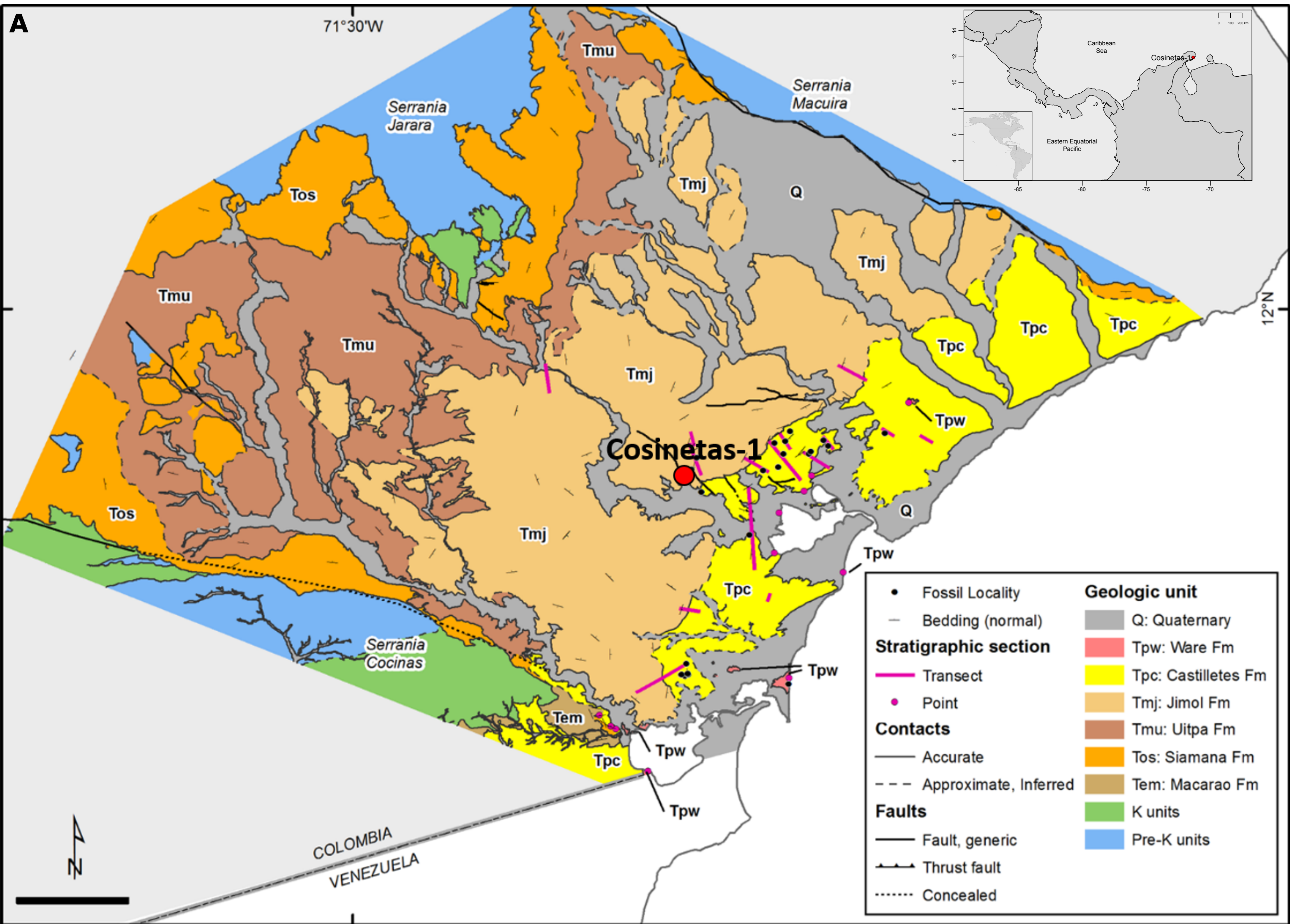


## Abstract

Dinoflagellate cysts and acritarchs are widely used to date and reconstruct paleoenvironments in shallow to marginal marine sequences, especially in the Neogene of temperate latitudes. However, little is known about tropical regions. Here, we present an early to middle Miocene assemblage of dinocysts and acritarchs from the Cosinetas-1 Well, northern Colombia. The abundance of *Spiniferites ramosus* and *Operculodinium centrocarpum*, along with the presence of *Lingulodinium machaerophorum*, *Spiniferites mirabilis*, *Polysphaeridium zoharyi*, *Selenopemphix nephroides* and *Tuberculodinium vancampoe*, indicates an accumulation in warm and shallow marine environments. The peridinioid versus gonyaulacoid (P/G) ratio suggests low nutrient availability in the Cocinetas Basin during the early Neogene. In contrast, modern shallow waters along the Guajira Peninsula are productive except in the eastern part where coastal upwelling is perturbed by warm water inflow from the Lake Maracaibo. In addition, the biostratigraphic range proposed for *Achomosphaera alcicornu* in equatorial latitudes is constrained to the Rupelian according to Williams et al. (2004); however, the continuous presence of *A. alcicornu* in the Cosinetas-1 Well extends its last appearance datum in the tropical Americas to at least the early Miocene.

## Geologic Framework

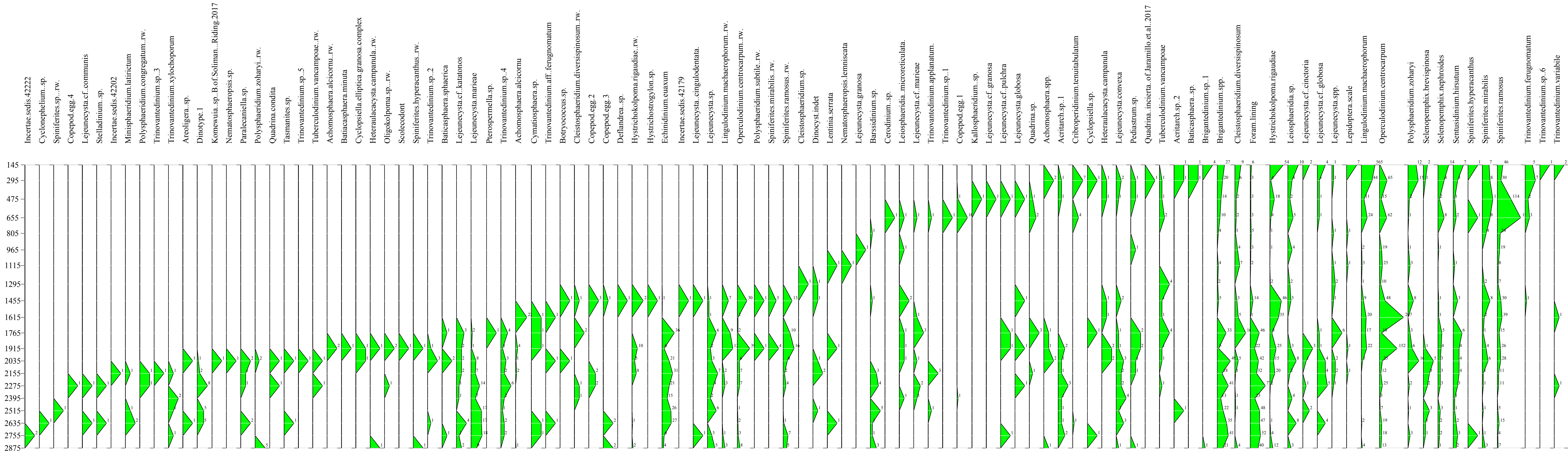


**Figure 1.** Regional location, geology and lithostratigraphy of the Cocinetas Basin and the Cosinetas-1 Well, La Guajira, northern Colombia. Modified from Moreno et al. (2015). **A** Geologic map of the Cocinetas Basin. **B** Lithostratigraphic column of the Cosinetas-1 Well. Intervals correspond to composite ditch-cutting samples.

## References

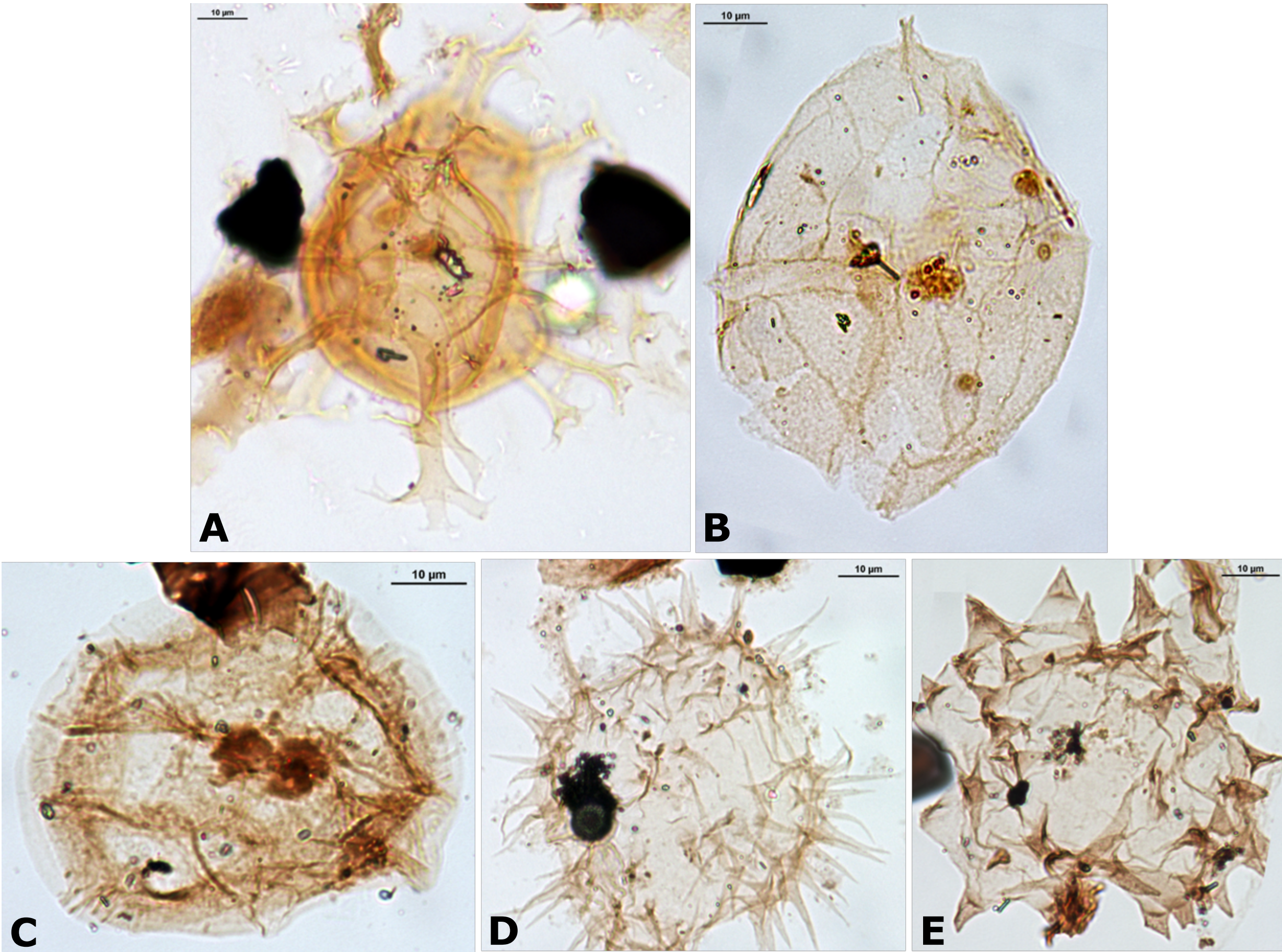
• Moreno et al., 2015. Revised stratigraphy of Neogene strata in the Cocinetas Basin, La Guajira, Colombia. Swiss J Paleontol 134: 5–43.  
• Jaramillo et al., 2017. Miocene flooding events of western Amazonia. Sci Adv 3: e1601693.  
• Perez et al., 2018. New records of Humiriaceae fossil fruits from the Oligocene and early Miocene of the western Azuero Peninsula, Panama. Bol Soc Geol Mex 70: 223–239.  
• Williams et al., 2014. Southern Ocean and global dinoflagellate cyst events compared: Index events for Late Cretaceous–Neogene. Proc Ocean Drill Prog Sci Results 189: 1–98.

## Biostratigraphy and Paleoproductivity



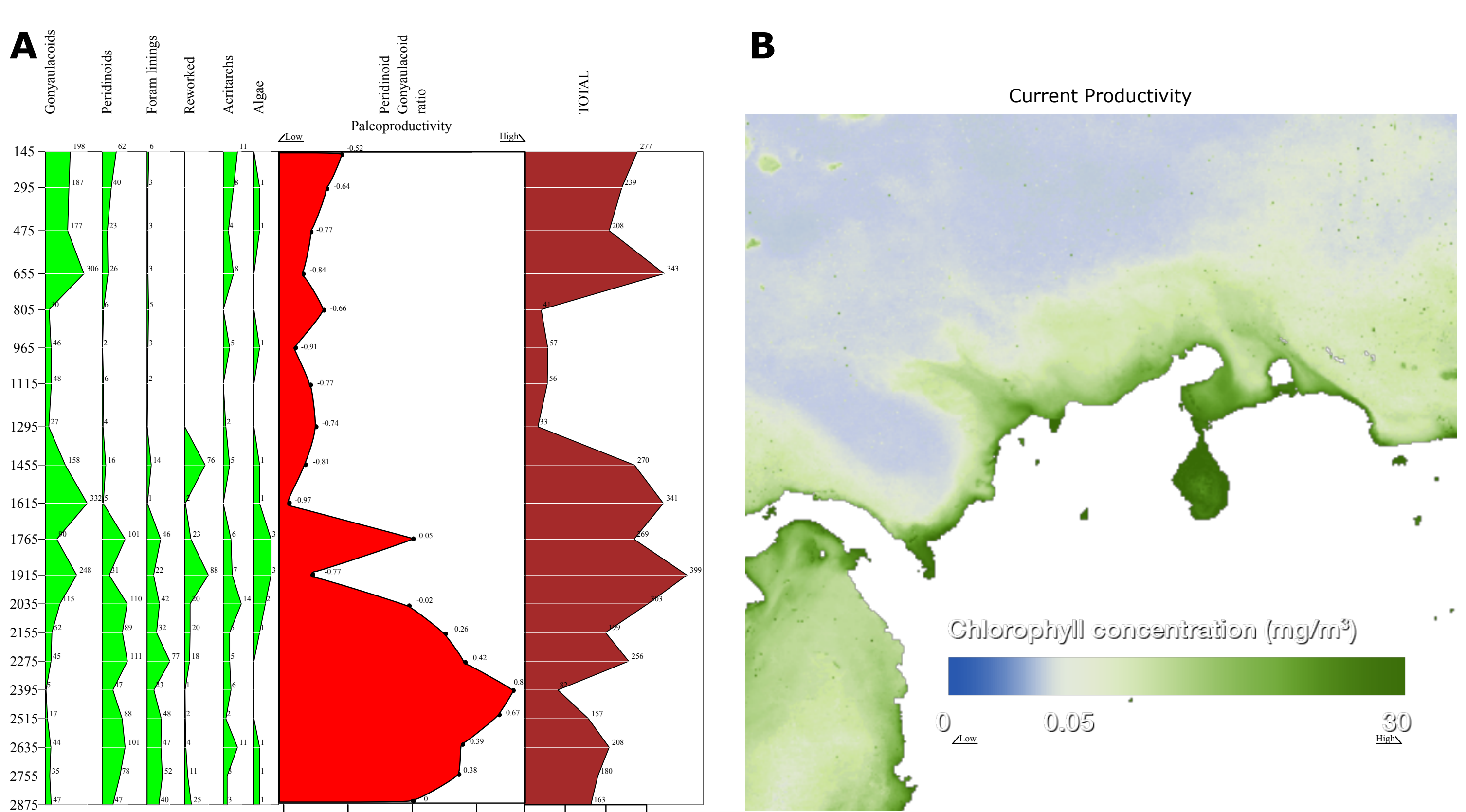
**Figure 2.** Palynostratigraphic chart of the marine palynomorphs recovered from the Cosinetas-1 Well.

## Biostratigraphic markers

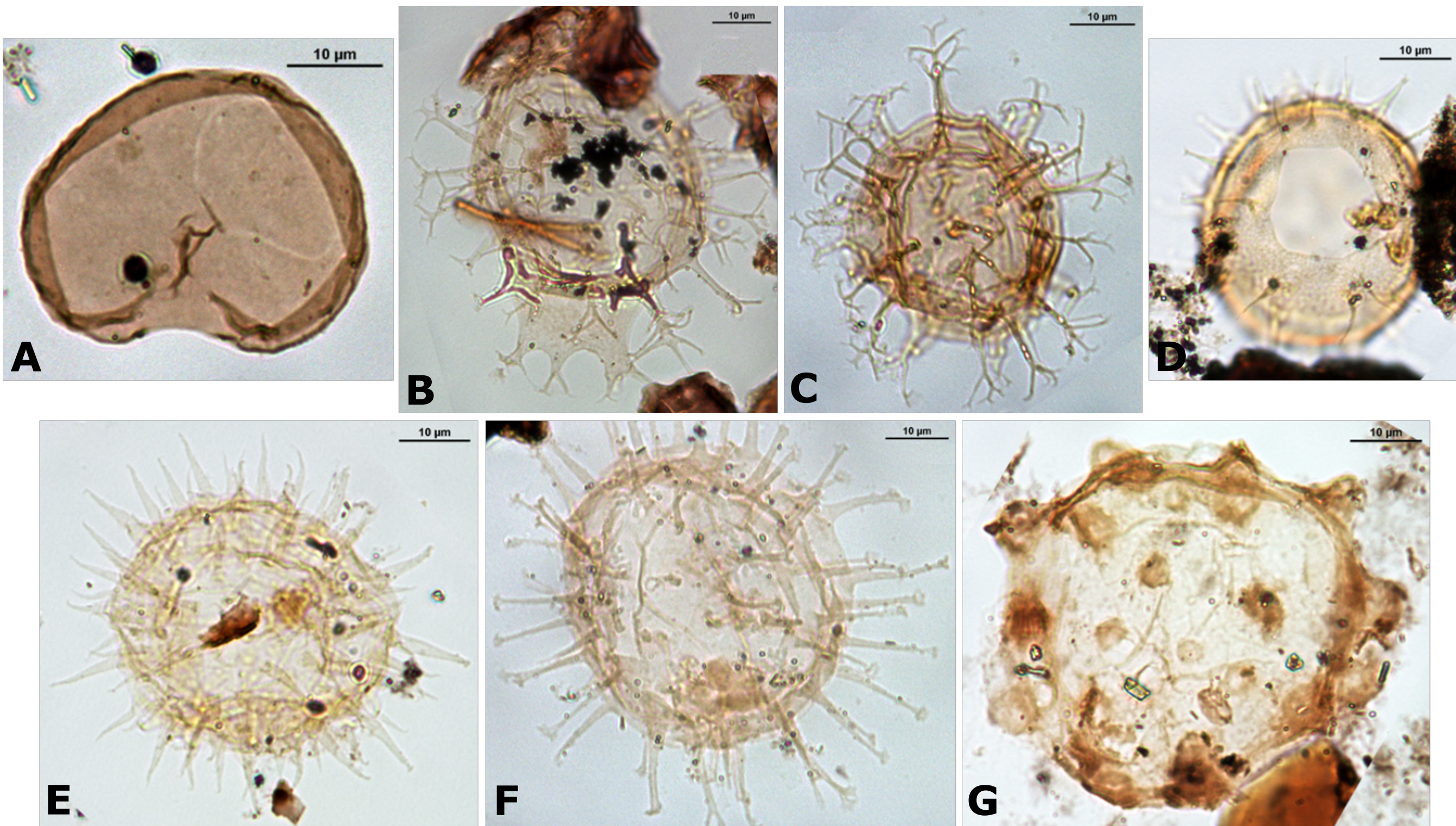


**Plate 1.** Microphotographs of key early to middle Miocene dinocysts and acritarchs from the Cosinetas-1 Well. **A.** *Achomosphaera alcicornu* **B.** *Cribroperidinium tenuitubulatum* **C.** *Heteraulacacysta campanula* **D.** *Quadrina condita* **E.** *Quadrina* "incerta" of Jaramillo et al. 2017.

## Paleoenvironmental indicators



**Figure 3.** Early to middle Miocene paleoproductivity reconstruction of the Cocinetas Basin (**A**) in relation to current productivity (**B**).



**Plate 2.** Microphotographs of shallow-, warm-water dinocysts from the Cosinetas-1 Well. **A.** *Selenopemphix nephroides* **B.** *Spiniferites mirabilis* **C.** *Spiniferites ramosus* **D.** *Operculodinium centrocarpum* **E.** *Lingulodinium machaerophorum* **F.** *Polysphaeridium subtile* **G.** *Tuberculodinium vancampoe*.

The stratigraphic range of *Achomosphaera alcicornu* in equatorial latitudes is restricted to the Rupelian (Williams et al. 2014); however, our results indicate that the LAD for this key biostratigraphic taxon in the Caribbean extends at least to the Aquitanian. Recent biostratigraphic analyses of the late Oligocene–early Miocene of Panama by Perez et al. (2018) support a younger *A. alcicornu* LAD for the tropical Americas. Further detailed palynological analyses of equatorial sections are needed to improve the stratigraphic ranges of marine palynomorphs in low latitudes.