

See also: **Paleoceanography. Paleoceanography, Biological Proxies:** Alkenone Paleothermometry from Coccoliths. **Paleoceanography, Physical and Chemical Proxies:** Mg/Ca and Sr/Ca Paleothermometry; Oxygen Isotope Stratigraphy of the Oceans. **Quaternary Stratigraphy:** Biostratigraphy.

## References

- Beaufort, L., Garidel-Thoron, T., Mix, A. C., and Pisias, N. G. (2001). ENSO-like forcing on oceanic primary production during the late Pleistocene. *Science* 293, 2440–2444.
- Bollmann, J., Baumann, K. H., and Thierstein, H. (1998). Global dominance of Gephyrocapsa coccoliths in the late Pleistocene: Selective dissolution, evolution, or global environmental change?. *Paleoceanography* 13, 517–529.
- Bown, P. R. (Ed.) (1998). *Calcareous Nannofossil Biostratigraphy*. Chapman and Hall, Cambridge.
- Colmenero-Hidalgo, E., Flores, J.-A., Sierro, F. J., et al. (2004). Ocean surface water response to short-term climate changes revealed by coccolithophores from the Gulf of Cadiz (NE Atlantic) and Alboran Sea (W Mediterranean). *Palaeogeography, Palaeoclimatology, Palaeoecology* 205(3–4), 317–336.
- Fischer, G., and Wefer, G. (Eds.) (1999). *Use of Proxies in Paleoclimatology, Examples from the South Atlantic*. Springer, Berlin.
- Flores, J.-A., Marino, M., Sierro, F. J., Hodell, D. A., and Charles, C. D. (2003). Calcareous plankton dissolution pattern and coccolithophore assemblages during the last 600 kyr at ODP Site 1089 (Cape Basin, South Atlantic): Paleoclimatological implications. *Palaeogeography, Palaeoclimatology, Palaeoecology* 196, 409–426.
- Geisen, M., Billard, C., Broerse, A. T. C., Cros, L., Probert, I., and Young, J. R. (2002). Life-cycle associations involving pairs of holococcolithophorid species: Intraspecific variation or cryptic speciation?. *European Journal of Phycology* 37, 531–550.
- Green, J. C., and Leadbeater, B. S. C. (1994). *The Haptophyte Algae*. Clarendon Press, Oxford.
- Hag, B. U. (1983). (Ed.) *Calcareous Nannoplankton*. Hutchinson Ross Publishing Co, Stroudsburg, PA.
- Hag, B. U., and Boersma, A. (1978). *Introduction to Marine Micropaleontology*. Elsevier, New York.
- Hendericks, J., and Bollmann, J. (2004). The Gephyrocapsa sea surface paleothermometer put to the test: Comparison with alkenone and foraminifera proxies of NW Africa. *Marine Micropaleontology* 50, 161–184.
- Honjo, S. (1976). Coccoliths: Production, transportation and sedimentation. *Marine Micropaleontology* 1(1), 65–79.
- Margalef, R. (1978). Life-forms of phytoplankton as survival alternatives in an unstable environment. *Oceanologica Acta* 1, 493–509.
- McIntyre, A. (1967). Coccoliths as paleoclimatic indicators of Pleistocene glaciation. *Science* 158, 1314–1317.
- McIntyre, A., and Bé, A. W. H. (1967). Modern Coccolithophoridae of the Atlantic Ocean. I: Placoliths and Cyrtoliths. *Deep-Sea Research* 14, 561–597.
- Molano, B., and McIntyre, A. (1990). Nutricline variations in the equatorial Atlantic coincident with the Younger-Dryas. *Paleoceanography* 5(6), 997–1008.
- Okada, H., and Honjo, S. (1973). The distribution of oceanic coccolithophores in the Pacific. *Deep-Sea Research* 20, 355–374.
- Raffi, I. (2002). Revision of the early-middle Pleistocene calcareous nannofossil biochronology (1.75–0.85 Ma). *Marine Micropaleontology* 45, 25–55.
- Sierro, F. J., Hodell, D. A., Curtis, J. H., et al. (2005). Impact of iceberg melting on Mediterranean thermohaline circulation during Heinrich events. *Paleoceanography* 20, 1029–1051.
- Stoll, H., Rosenthal, Y., and Falkowski, P. (2002). Climate proxies from Sr/Ca of coccolith calcite: Calibrations from continuous culture *Emiliania huxleyi*. *Geochemica et Cosmochimica Acta* 66, 927–936.
- Tappan, H. (1981). *The Paleobiology of Plant Protists*. W.H. Freeman and Co, New York.
- Thierstein, H., and Young, J. (2004). *Coccolithophores. from Molecular Processes to Global Impact*. Springer, Berlin.
- Wei, W. (1993). Calibration of Upper Pliocene–Lower Pleistocene nannofossil events with oxygen isotope stratigraphy. *Paleoceanography* 8, 85–99.
- Winter, A., and Siesser, W. (1994). *Coccolithophores*. Cambridge University Press, Cambridge.
- Young, J. R., Bergen, J. A., Bown, P. R., et al. (1997). Guidelines for coccolith and calcareous nannofossil terminology. *Palaeontology* 40/4, 875–912.
- Young, J., Geisen, M., Cros, L., et al. (2003). Special Issue: A Guide to Extant Coccolithophore Taxonomy. *Journal of Nannoplankton Research* 1.

## Relevant Websites

- <http://www.nhm.ac.uk/> – Natural History Museum (see International Nannoplankton Association).
- <http://oceancolor.gsfc.nasa.gov/> – SeaWiFS Project, NASA/Goddard Space Flight Center, and ORBIMAGE.

## Corals, Sclerosponges and Mollusks

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## Introduction

The early identification and understanding of the temporal significance of growth increments in many calcareous skeletons, but especially those in mollusks and corals, facilitated their use as a means to study environmental variability in the Quaternary. Armed with this understanding, geochemical studies of the skeletons of mollusks and corals, and later of sclerosponges, began in earnest. These early investigations established many of the fundamental principles that now form the foundation of nearly all studies using the skeletons of corals, sclerosponges, and mollusks to study environmental and climate change. In this article, we provide a general overview of the use of corals, sclerosponges, and mollusks as archives of variability in the Quaternary Earth system.