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1 additional methods section, 4 additional figures, 1 additional table, and references.

Methods (details) DR1

Skeletal microstructural features were imaged with Philips XL 20 SEM. Specimens were observed intact (skeletal morphology) or as broken/polished and etched samples. Transverse or longitudinal polished or broken sections of septa were etched for ca. 5 minutes in Mutvei’s solution following procedures described elsewhere (Schöne et al., 2005). Similar effects were also obtained by etching for ca. 20 seconds in 0.1% formic acid solution, following Stolarski (2003). The etched samples were rinsed with with Milli-Q water and air-dried. Once dried, the samples were mounted on stubs with double-sided adhesive tape and sputter-coated with conductive platinum film. Ca. 30 µm thin and ultra-thin (2-12 µm) petrographic sections of skeletons were observed and photographed with a Nikon Eclipse 80i microscope.

A hot cathode luminescence (CL) Lumic HC1-LM microscope at the Institute of Paleobiology, Polish Academy of Sciences, was used to trace possible diagenetic alteration of fossil skeletons. All the samples were sputter-coated with carbon and observed with 14 keV electron energy and beam current density of 0.1 µA/mm².

Trace element analyses were performed at the Laboratory for Biological Geochemistry (EPFL, Lausanne, Switzerland) on polished (0.25 µm diamond suspension) and gold-coated (20 nm) skeletal surfaces embedded in Körapox® epoxy with the Cameca NanoSIMS 50L, following established procedures (Meibom et al., 2004, 2008). A primary beam of O⁻ (40-50 pA) produced secondary ions of ²⁴Mg⁺, ⁸⁸Sr⁺, and ⁴⁴Ca⁺ that were transferred to the multi-collection mass-spectrometer and detected simultaneously in electron multipliers at a mass resolving power of ~5000. At this mass-resolving power, the measured secondary ions are resolved from potential interferences. The data were obtained from a pre-sputtered surface in a series of line-scans with the primary ions focused to a spot-size of ~500 nm and the primary beam stepped across the sample surface with a step-size of 5 micrometers. The measured ²⁴Mg/⁴⁴Ca and ⁸⁸Sr/⁴⁴Ca ratios were calibrated against analysis of a carbonate standard of known composition (OKA-C, Bice et al., 2005). The chemical variations recorded in the coral skeletons are much larger than both the internal and external reproducibility of the standards, which are typically less than 3% for Mg/Ca and 2%
for Sr/Ca in this analysis mode (2 standard deviations). Qualitative images of the Mg/Ca and Sr/Ca distributions were also obtained, typically on a 40×40 mm² surface area with 256×256 pixels and a pixel dwell-time of 5000 microseconds.

Elemental X-ray maps and line scans were generated with Wavelength Dispersive Spectroscopy (WDS) using a Cameca SX-100 electron microprobe in the Micro-area analysis LAB in Polish Geological Institute (Warsaw, Poland). The following conditions were used during scan: 15 kV (accelerating voltage), 5 nA (for Ca) and 20nA (for other elements) beam current, ca. 5 µm beam diameter and 60 ms pixel dwelling time. Specimens were platinum-coated to ca. 2 nm thickness.

Raman analyses were performed in the Department of Chemistry, University of Warsaw with a LabRAM 800 HR Raman confocal microscope (Horiba Jobin Yvon) equipped with a LPF Iridia edge filter, a 600 or 1800 groove mm⁻¹ holographic grating and a 1024 x 256 pixel Peltier-cooled Synapse CCD detector. The microscope attachment was based on an Olympus BX41 system with a MPLN 100x objective and a motorized software-controlled x-y-z stage. The excitation source was the second harmonic of the diode-pumped Nd:YAG laser (Excelsior-532-100, Spectra-Physics) operating at 532.3 nm with ca. 2 mW power on the sample. The Raman maps were recorded with 1s integration time with 1 µm x 1 µm spatial resolution. Calcium carbonate polymorphs show several bands attributable to internal mode vibrations of the carbonate ion and rotational and translational lattice modes. The most distinct signals allowing identification of the polymorph are grouped in the 100 - 300 cm⁻¹ region. These peaks, associated with lattice vibrations, appear at 205 cm⁻¹ and 153 cm⁻¹ for aragonite and at 283 cm⁻¹ and 154 cm⁻¹ for calcite, respectively (Wehrmeister et al., 2010).

High-spatial resolution synchrotron µ-XRF mapping of sulfur content in polished samples were performed with the scanning X-ray microscope (SXM) operating in the X-ray fluorescence mode at the X-ray Microscopy beam-line ID21 of European Synchrotron Radiation Facility (Grenoble, France) following established procedures (Cuif et al., 2003; Janiszewska et al., 2011). The X-ray beam, monochromatized by means of a double-crystal (Si(111)), fixed-exit monochromator, was tuned to an energy just above the K-edge of sulfur. A Kirkpatrick-Baez mirror arrangement was employed to focus the X-ray beam down to size of 0.3 x 0.8 µm². The X-ray fluorescence spectra were recorded by HpGe detector placed at 90 deg scattering angle. A 2D image was obtained by point-by-point scan of the sample across the focal point of the beam, with typical exposure time of 150-300 ms per point.
Water temperatures for the coral sample localities were retrieved from the World Ocean Database 2013 (Boyer et al., 2013) (Table DR1), accessible in Ocean Data View 4.6.0 (Schlitzer, 2014).

All specimens studied in this paper were subject to destructive analyses and the resulting thin sections and skeletal fragments attached to microscope stubs are housed at the Institute of Paleobiology, Polish Academy of Sciences, Warsaw (ZPAL).
Fig. DR1. Cretaceous aragonite *Micrabacia* sp. (A, enlarged in B) and NanoSIMS maps of Mg/Ca (C) and Sr/Ca (D) distribution within septum (mapped regions of thin section 1-2-3 outlined in red in A and B). Similar to modern micrabaciids, and in contrast to other scleractinians, there is no layering in concentration of elements (growth layers are not distinct) within the septa. The spotty Mg enrichments in (C3) most likely results from slight diagenetic modification along septal margin.
Fig. DR2. Trace element distribution within calcitic skeleton of Cretaceous *Micrabacia* sp. Despite of skeletal recrystallization, some layered distribution of $S^{VI}$ (A) and Mg (B) resembles superimposed growth layers of modern corals, but in *Micrabacia* elemental oscillations have much wider spacing (5-20µm). Bright orange cathodoluminescence (C) correlates with variations in concentration of Mn (D). The relatively higher Mn content (not observed in recent Scleractinia and considered as diagenetical in origin) suggests that various parts of micrabaciid skeleton had different susceptibility to diagenesis (most likely containing different amount of organic components). Thus, laminar pattern of distribution of sulfur ($S^{VI}$) might suggests presence of some residues of original organic content, but, on the other hand, correlation of sulfur concentration (A) with bright orange cathodoluminescence (C) and enrichment in manganese (D) may indicate a diagenetic origin of $S^{VI}$ in fossil skeleton.
Fig. DR3. Average magnesium to calcium (A) and strontium to calcium (B) ratios of micrabaciid skeletons and other aragonite-preserved scleractinians for the last 100 Ma. Taxonomic attribution of micrabaciids illustrated in Fig. 3.
Fig. DR4. An average magnesium to calcium ratio of micrabaciid and non-micrabaciid coral skeletons in relation to sea-water temperature. Extant Micrabaciidae (red circles) Mg/Ca ratios average about 2.5 mmol/mol and seem uncorrelated with water temperature. Note the systematic compositional difference between Mg/Ca ratios of micrabaciids and non-micrabaciid corals collected at the same sites (connected by dashed lines).
<table>
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<th>Inventory number</th>
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<th>Geological Age</th>
<th>Locality</th>
<th>Figure numbers</th>
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<td>ZPAL II/11-449</td>
<td>Micrabacia sp. Milne Edwards and Haime, 1853</td>
<td>Upper Cretaceous</td>
<td>Ripley Fm. (Georgia, USA)</td>
<td>Fig. 2B</td>
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<td>ZPAL II/12-444</td>
<td>Micrabacia sp. Milne Edwards and Haime, 1854</td>
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<td>ZPAL II/26-480</td>
<td>Micrabacia rotatilis georgiana Stephenson, 1917</td>
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<td>ZPAL II/10-38</td>
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<td>ZPAL H.27/4-3</td>
<td>Stephanophyllia elegans (Bronn,1837)</td>
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<td>USNM 98551</td>
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<td>Recent</td>
<td>MUSORSTOM 7, South Pacific Ocean, North Fiji Basin, Tuscarora Bank; 11°48’1.08”S, 178°18’3.6”W; Depth (m): 600-608</td>
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<td>Recent</td>
<td>off New Caledonia; Bathus 4 DW918, 18°49’12”S, 163°16’12”E; Depth (m): 613-647</td>
<td>Fig. 2D, Fig. 3A,B, Fig. DR3A,B, Fig. DR4</td>
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<td>Recent</td>
<td>Bathus 4, Stn. CP 922; 163°18’5, 18°48’5; Depth (m): 600</td>
<td>Fig. 3, Fig. DR3A,B, Fig. DR4</td>
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<td>ZPAL H.25/32 (760)</td>
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<td>Recent</td>
<td>MUSORSTOM 6, DW459; 20.02.1989, 21°01’39”S, 167°31’47”E; Depth (m): 425</td>
<td>Fig. 3, Fig. DR3A,B, Fig. DR4</td>
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ZPAL H.25/33 (773)  Stephanophyllia neglecta Boschma, 1923  Recent  EBISCO, DW 2573, 14.10.2005; 20°21'S 158°46'E; Depth (m): 345-351  Fig. 3, Fig. DR3A,B, DR4

ZPAL H.25/113 (651)  Stephanophyllia fungulus Alcock, 1902  Recent  5°33'10''S 132°23'E; Depth (m): 245; (formerly Nationaal Natuurhistorisch Museum - Leiden Coll.nr. 22547)  Fig. 2G

ZPAL H.25/34 (1007)  Stephanophyllia fungulus Alcock, 1902  Recent  North Pacific Ocean, Japan, Honshu Island, Korea Strait, Off Agawa; 34°25´14.16"N 130°46´51.6"E; Vessel:Tansei Maru R/V, Cruise:KT9015, Depth (m): 86 – 87

ZPAL H.25/7 (576)  Leptopenus discus Moseley, 1881  Recent  Jean Charcot, 31.1.1979, 32°28'9"S 12°26'2"E; 32°28'6''S 13°24'0''E; Depth (m): 3675  Fig. 3, Fig. DR3A,B, DR4

ZPAL H.25/8 (496)  Letepsammia formosissima (Moseley, 1876)  Recent  Norfolk 2, DW 2095, off New Caledonia, 24°46'S, 168°10'E; Depth (m): 283 - 310  Fig. 2J,K

ZPAL H.25/9 (432)  Letepsammia formosissima (Moseley, 1876)  Recent  (formerly USNM 81881),Philippines; Albatross R/V Stat.5369, 24.2.1909; 11°48'0"N 121°43´1.2"E; Depth (m): 194m  Fig. 3, Fig. DR3A,B, DR4

ZPAL H.25/11 (554)  Rhombopsammia niphada Owens, 1986  Recent  Karubar Expedition 1991, Vessel: Baruna Jaya I R/V; 132°28'19.2"E 7°47'53.16"S; Depth (m): 442 to 468  Fig. 3, Fig. DR3A,B, DR4

ZPAL H.25/29 (174)  Conotrochus sp.  Recent  MUSORSTOM 6, DW459; 20.02.1989, 21°01'39"S 167°31'47"E; Depth (m): 425  Fig. DR4

ZPAL H.25/30 (243)  Gardineria alloiteaui  Recent  ORSTOM DW71; 27.10.1986; 168.09,52'E 24.42,26'S; Depth (m): 230  Fig. DR4

ZPAL H.25/35 (733)  Flabellum aotearoa Squires, 1964  Recent  EBISCO DW2573; 14.10.2005, 20°21'S 158°46'E; Depth (m): 345-351  Fig. DR4

ZPAL H.25/36 (891)  Astrangia rathbuni Vaughan, 1906  Recent  Ilha dos Buzios, Brazil, 23°47.437'S 45°08.653'W; Depth (m): 4-6  Fig. DR4
| ZPAL H.25/37 (900) | Phyllangia americana | Milne Edwards & Haime, 1949 | Recent | Ilha dos Buzios, Brazil, 23°47.437'S 45°08.653'E; Depth (m): 4-6 | Fig. DR4 |
| ZPAL H.25/38 (906) | Tubastrea tagusensis | Wells, 1982 | Recent | Ilha dos Buzios, Brazil, 23°47.437'S 45°08.653'E; Depth (m): 4-6 | Fig. DR4 |
| ZPAL H.25/39 (1004) | Balanophyllia cumingi | Milne Edwards & Haime | Recent | North Pacific Ocean, Japan, Honshu Island, Korea Strait, Off Agawa; 34°25´14.16"N 130°46´51.6"E; Vessel: Tansei Maru R/V, Cruise: KT9015, Depth (m): 86 – 87 | Fig. DR4 |
| ZPAL H.25/40 (1005) | Deltocyathoides orientalis (Duncan, 1876) | Recent | North Pacific Ocean, Japan, Honshu Island, Korea Strait, Off Agawa; 34°25´14.16"N 130°46´51.6"E; Vessel: Tansei Maru R/V, Cruise: KT9015, Depth (m): 86 – 87 | Fig. DR4 |
| ZPAL H.25/41 (1009) | Flabellum sp. | Recent | North Pacific Ocean, Japan, Honshu Island, Korea Strait, Off Agawa; 34°25´14.16"N 130°46´51.6"E; Vessel: Tansei Maru R/V, Cruise: KT9015, Depth (m): 86 – 87 | Fig. DR4 |

**DR References**


Raddatz, J., et al., 2013. Stable Sr-isotope, Sr/Ca, Mg/Ca, Li/Ca and Mg/Li ratios in the scleractinian cold-water coral Lophelia pertusa: Chemical Geology, v. 352, p. 143–152.


