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HISTORY OF EARTH SCIENCES

Thomas Henry Huxley, a stone tablet, coccoliths, and deep-sea sediments in the high Alps

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Abstract
In the mid-1850s, Thomas Henry Huxley, who coined the term 'coccolith', described their presence in oceanic sediments dredged from the sea floor. Subsequent recognition of their occurrence in the Upper Cretaceous English Chalk, largely unconsolidated pelagic sediment, and similar, more lithified limestones in the Jurassic of the Alps, led to their being considered major rock-forming elements through much of geological time, although they are now known to be limited to the Late Triassic–Recent interval. Unlike Charles Darwin, who did not travel abroad following the voyage of the *Beagle*, Huxley made a number of trips to Italy and Switzerland and is recorded as a guest in the exclusive Hotel Kursaal Maloja in the Engadin in 1893. While staying there, he made a number of excursions on foot and his presence was thought significant enough that it is recorded in an inscribed granitic stone tablet, erected in 1896, describing him as'the illustrious writer and naturalist'. His rambles would have led him past outcrops of tectonically emplaced true oceanic calcareous sediment of Early Cretaceous age, here shown to have originally contained coccoliths that were largely destroyed under the imprint of Alpine metamorphism of sub-greenschist to greenschist facies. To this extent, Huxley could have come close to recognizing true oceanic sediments exposed on land, but the dissimilarity between these Swiss Alpine deposits and the friable English Chalk would not obviously have led to the investigation of the former for the organisms he had christened as 'coccoliths'.

Keywords Thomas Henry Huxley · Huxley tablet · Hotel Kursaal Maloja · Coccoliths · Oceanic sediments · Alps

Introduction

In the nineteenth century, biology and geology were fashionable sciences just as astrophysics and cosmology are today. Both sciences were closely linked through palaeontology, and eminent biologists like Cuvier and Agassiz were leading figures in both disciplines. However, the nineteenth century also saw a fundamental change from Natural History, mainly concerned with description, classification and taxonomy (later dismissed by Ernest Rutherford as 'stamp collecting') to modern, process-oriented science, reconstructing Earth history by 'attempting to explain the former changes of the Earth's surface, by reference to causes now in operation' (Lyell 1830–1833). However, during this transitional period, geology and biology also remained closely linked through the exploration of ancient environments of life on Earth. Both Charles Darwin (b.1809–d.1882) and Thomas Henry Huxley (b.1825–d.1895, Fig. 1) were not only pioneering biologists but also eminent geologists even though, in the perception of the general public, their geological *oeuvre* is overshadowed by their work on the evolution of life. Indeed, in his early years, Darwin saw himself as a geologist rather than as a biologist (Herbert 2005). Also, both men were escaping from the Deist conception of natural theology and from a Divine plan of creation, thereby refuting Cuvier's theory of multiple destruction and recreation of life on Earth. They rather adhered to the uniformitarian concepts of gradual change and slow evolution of life and environment over immensely long periods of time. This viewpoint brought both of them into conflict with clerical institutions, a position that was fought mainly by Huxley, 'Darwin's bulldog', defending Darwin's Theory of Evolution as laid out in the *Origin of Species* (Darwin 1860). Huxley's was

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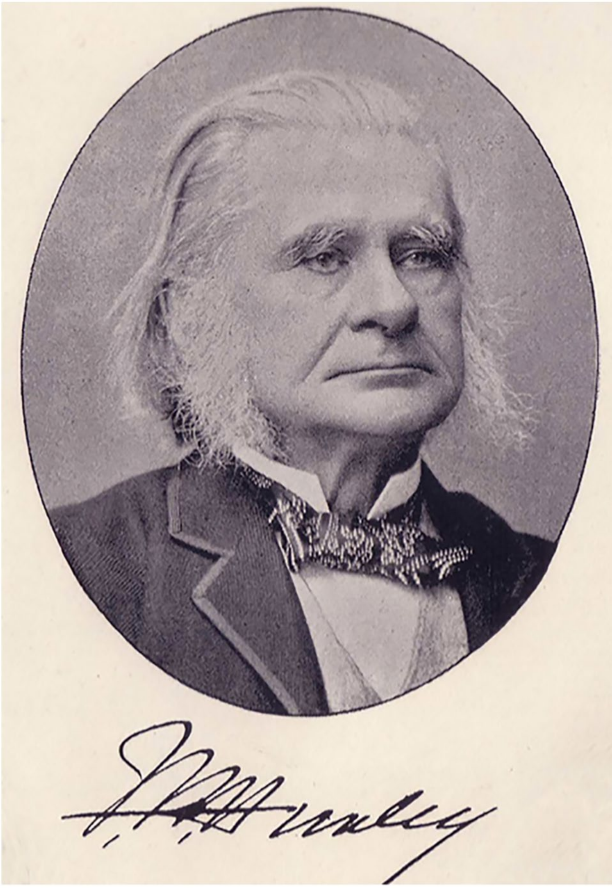

Fig. 1 Thomas Henry Huxley (b.1825–d.1895)

a life-long fight against obscurantism and bigotry following his famous debate in Oxford's University Museum with Samuel Wilberforce, Bishop of Oxford (e.g., Lucas 1979).

'It is a curious coincidence that, like two other leaders of science, Charles Darwin and Joseph Dalton Hooker, their close friend Huxley began his scientific career on board one of Her Majesty's ships' (Leonard Huxley 1900a: 31): namely, the *H.M.S. Rattlesnake* which from December 1846 to October 1850 was set to explore the Geography, Geology and Natural History of New Guinea. However, unlike Darwin who, after the Voyage of the *Beagle*, never left England again, Huxley travelled extensively in Europe, particularly to Italy and across the Swiss Alps. In this short note, we shall draw attention to a forgotten piece of rock remembering his travels to the Engadin in Switzerland and comment on some rocks of this area that relate to his work.

The Hotel Kursaal Maloja

Huxley travelled three times to the Engadin in the canton of Graubünden, south-east Switzerland usually on his way back from Italy (Huxley 1900b). His stays at the Hotel Kursaal Maloja (Figs. 2, 3) are documented in the weekly '*St. Moritz Post, Davos and Maloja News*' 1888, 1889, and in the Guest Book of the Hotel Kursaal, 1893 (Fig. 4). The hotel, built between 1880 and 1884 by the Belgian Count Camille de Renesse, became a fashionable and exclusive resort for European upper-class people, the 'cream of the aristocracy, the rich and beautiful' after the chaotic years between 1885 and 1887 caused by the closure of the Swiss borders because of cholera and Renesse's bankruptcy. The hotel offered many amenities: cinema, theatre, sports, a ski jump, an ice-skating rink and a number of steamships that had been purchased to offer trips on Lake Sils. 'The hotel [was] … about the most comfortable in Switzerland' (Thomas Huxley in Huxley 1900b: 215). Unsurprisingly, the list of guests included many celebrities such as Arthur Conan Doyle and Count Zeppelin. The hotel, renamed the Maloya Palace in 1898, competed successfully with the great hotels in St Moritz but declined in importance during the Great Depression in the 1930s (Böckli 1998). After use by the Swiss Army during the Second World War and as a summer holiday camp post-1945, the Maloja Palace reopened in 2009.

Huxley at Maloja

Although not mentioned in the history of the Maloja Palace Hotel as a guest (Böckli 1998), Huxley's presence in the hotel was recorded. He appeared to become 'the centre of the little society at Maloja …' (Huxley 1900b: 218). As his son, Leonard Huxley, continues: 'His diary still contains a note of occasional long walks; and once more he was the centre of a circle of friends, whose cordial recollections of their pleasant intercourse afterwards found expression in a lasting memorial. Beside one of his favorite walks, a narrow pathway skirting the blue lakelet of Sils, was placed a grey tablet or block of granite. The face of this was roughly smoothed, and upon it was cut the following inscription: "*In memory of the illustrious English Writer and Naturalist, Thomas Henry Huxley, who spent*[1] *many summers at the Kursaal [Hotel] Maloja, [Erected 1896]*"' (Huxley 1900b: 386; our Fig. 5).

The 'Huxley Tablet' is located along the dirt road from Capolago (Maloja) to Isola at 46°24′24″ N/09°42′27″ E (coordinates of Swiss National Map: 2774′430/1141′975). The field of the inscription on the stone is some 70 cm tall

[1] The inscription on the block says … *passed* many summers (Fig. 5).

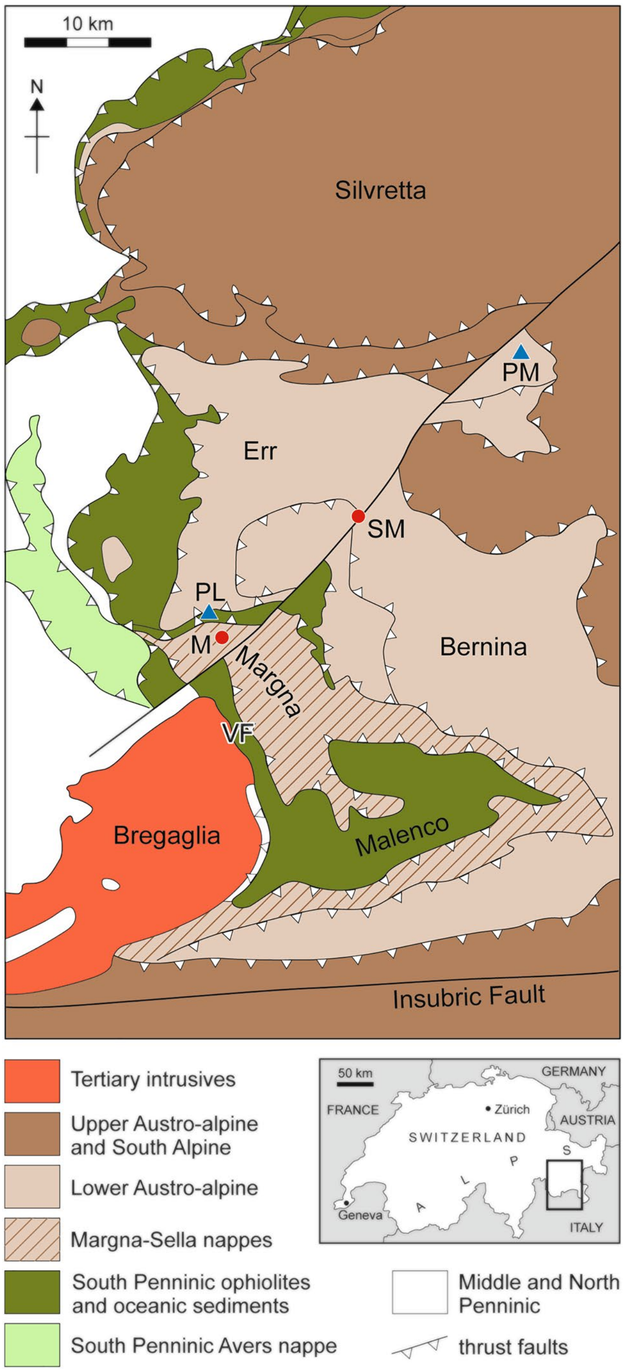

Fig. 2 Simplified tectonic map of the south-Penninic-Austroalpine boundary zone in southeastern Switzerland/northern Italy with locations: *PL* PiZ Lunghin, *PM* Piz Murtiröl, *M* Maloja, *SM* St Moritz, *VF* Val Forno

and about 80 cm wide (Fig. 5). Its surface is somewhat weathered and the inscription is not easy to read. The rock itself is a piece of the late Alpine Bregaglia granodiorite (32–31 Ma, Samperton et al. 2015), that crops out in the upper reaches of Val Forno (Cornelius 1913; Staub 1921; Wenk and Cornelius 1977), brought to the site by the late Pleistocene glacier that formerly occupied the valley.

Leonard Huxley notes a few specific occupations of his father at Maloja. One motivation of Huxley *père* to travel to the hotel was certainly the positive effect the stay in the Alps had on his fragile health. It seems that he occupied himself particularly with questions of botany and with his correspondence. One of his longer walks brought him to Lake Lunghin, 'about 2000 feet up' (Huxley 1900b: 215; Fig. 2). The area of Lake and Piz Lunghin are geologically interesting because north of Piz Lunghin sections of Mesozoic ophiolites and their overlying pelagic sedimentary cover are exposed (e.g., Weissert and Bernoulli 1985; Manatschal and Bernoulli 1999; Fig. 2; for local details see Liniger 1992, and the map by Cornelius 1932). Huxley had worked before on deep-sea sediments of present-day oceans, but the strong deformation and conspicuous metamorphism of the rocks, let alone their complex association with continental and oceanic basement, did not allow him to recognize them as examples of ancient deep-sea sediments that originally would have contained pelagic biota. Certainly, they did not closely resemble the soft and friable Upper Cretaceous English Chalk with which he was so familiar and had popularized in his lecture to 'working men' (Huxley 1868a). However, Huxley in the same article expressed the opinion that 'rocks of cretaceous or still later date have shared in the elevatory movements which gave rise to these mountain chains [Pyrenees, Alps, Himalayas, Andes…]; and may be found perched up, in some cases, many thousand feet high upon their flanks' (Huxley 1868a: 406).

Huxley's research on oceanic sediments

In the 1850s the first submarine telegraph cable was laid between England and France, and the further installation of deep-sea cables across the oceans brought a large increase in bathymetric data (e.g. Maury 1855). Prior to this time, sediments from deeper areas of the world ocean had been retrieved occasionally but following the middle of the century a significant amount of deep-sea material was collected. In 1857, H.M.S. *Cyclops* investigated the nature of the sea floor between Ireland and Newfoundland where the first trans-Atlantic telegraph cable was about to be laid (across the so-called Telegraph Plateau, now recognized as part of the mid-Atlantic Ridge). A sample of the calcareous mud recovered was sent to Huxley for examination in which he found tiny concentric calcareous bodies that he termed 'coccoliths' (Huxley in Dayman 1858; Huxley 1868b; Fig. 6a). Coccoliths had been observed *avant la lettre* in Cretaceous chalk from the island of Rügen in the Baltic Sea by Ehrenberg (1836, 1839, 1854) who, however, thought them to be tiny inorganic concretions. Indeed, at first Huxley (in

Fig. 3 The Maloja Palace Hotel, Postcard 1890. In the background (upper left) is the Bregaglia Granodiorite from which the Huxley Tablet is derived

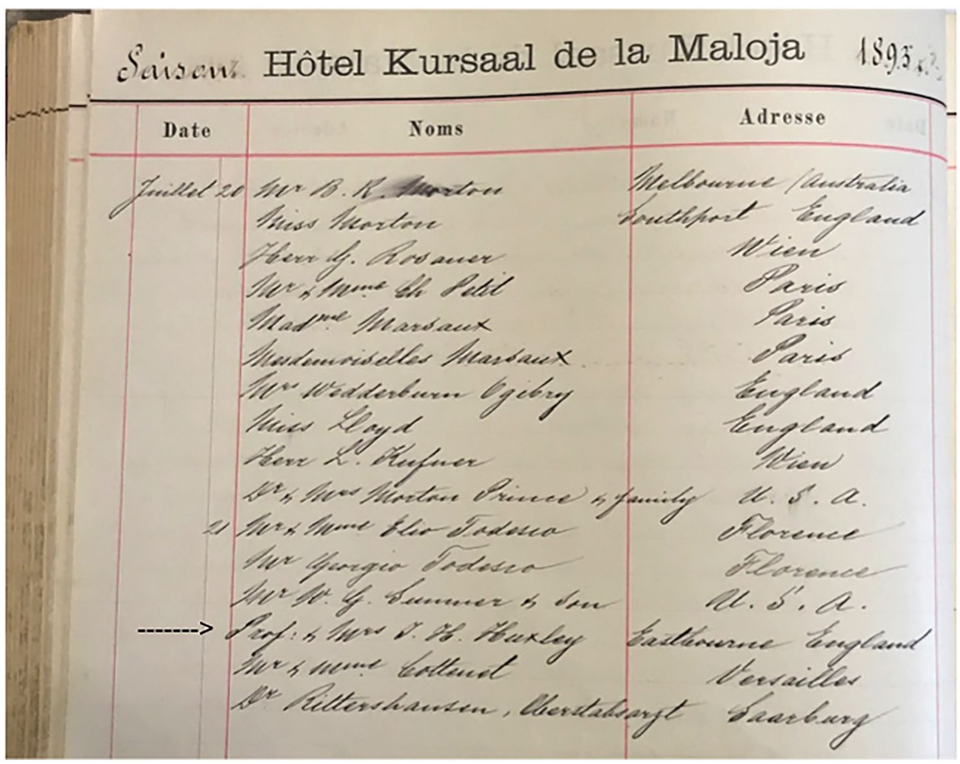

Fig. 4 Guest list of 'Hotel Kursaal de la Maloja, Saison 1893'. Courtesy Kulturarchiv Oberengadin, Samedan

Dayman 1858) also thought that coccoliths were inorganic in origin.

In 1860, an expedition by H.M.S. *Bulldog*, engaged in taking soundings for a transatlantic cable, retrieved more samples of calcareous deep-sea mud that contained coccoliths (in some cases forming minute coccospheres: Wallich 1861) that at the same time were also found in the English Chalk (Sorby 1861; Fig. 6b). By the early 1860s almost all biologists, including Wallich, and Sorby, accepted the view that coccoliths were of organic origin. It is now known that the most abundant coccolith found in present-day deep-sea carbonates, commonly forming coccospheres, is given the specific name of its discoverer: *Emiliania huxleyi* (Fig. 6c).

Fig. 5 The Huxley Tablet

IN
MEMORY OF
THE ILLUSTRIOUS ENGLISH
WRITER AND NATURALIST
THOMAS HENRY HUXLEY
WHO PASSED MANY SUMMERS AT
THE KURSAAL HOTEL MALOJA
ERECTED 1896

When, after the publications of Wallich (1861) and Sorby (1861), Huxley re-examined the *Cyclops* samples, he found 'innumerable lumps of a transparent gelatinous substance' including coccoliths and coccospheres (Huxley 1868b; Fig. 6a). He thought that the gelatinous substance was protoplasm including skeletal elements: namely, the coccoliths and the coccospheres. He further thought that he had found a particularly primitive form of life 'living at great depth in the ocean' which he named as a new species *Bathybius haeckelii*. Later investigations during the H.M.S. *Challenger* expedition (1872–1876) revealed that the 'protoplasm' of *Bathybius* was an artifact caused by the alcohol used for the preservation of the samples (Huxley 1875; Murray 1876; details in Rehbock 1975; Siesser 1994).

In 1870, Huxley had sent some of the deep-sea mud that had been collected by H.M.S. *Cyclops* to the Bavarian geologist Carl Wilhelm Gümbel for examination, who recorded coccoliths, together with diatoms, radiolarians, sponge spicules, foraminifera, dominantly *Globigerina*, ostracods and a certain amount of lithogenous material (Gümbel 1870a, b), sediment we would now routinely describe as foraminiferal-nannofossil ooze. Like Huxley (1868a), he noted that coccoliths were rock-forming in the Chalk, and emphasized the similarity between this characteristic Cretaceous deposit and *Globigerina* ooze. He further noted that coccoliths occur in the 'soft marls of the Jurassic and Liassic formations', and

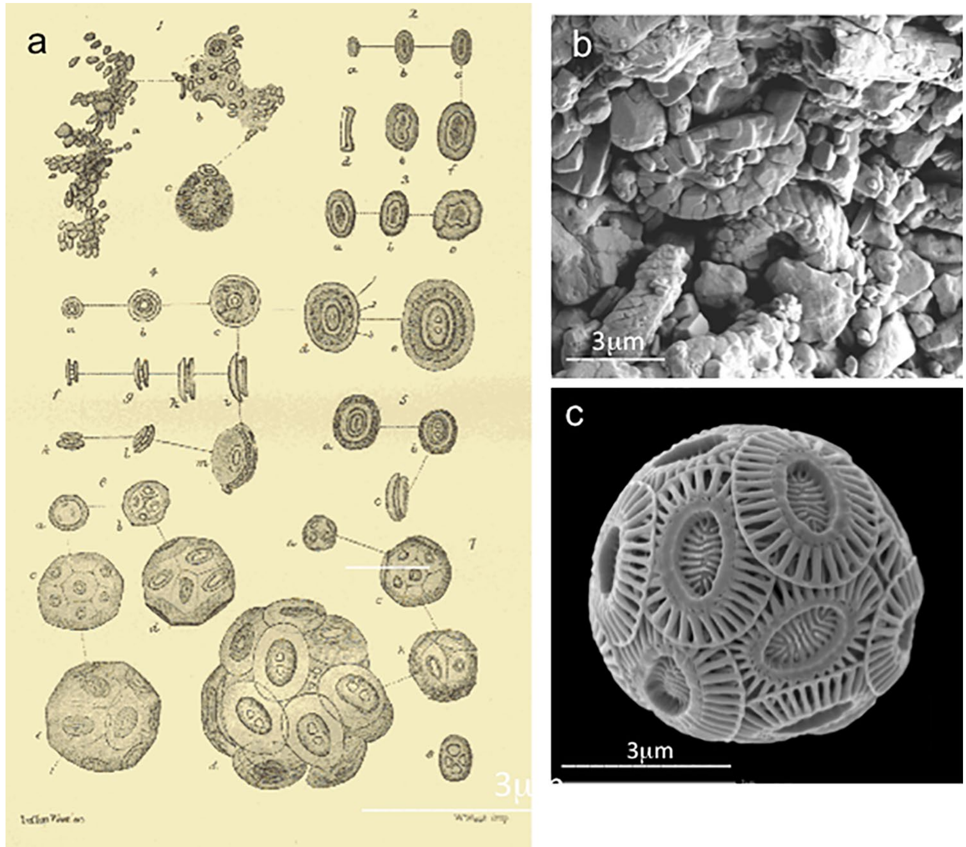

Fig. 6 **a** Coccoliths and coccospheres, from Huxley (1868b) **b** Coccoliths, with syntaxial overgrowths of calcite, in a sample of Upper Cretaceous Chalk from Eastbourne, Sussex (where Huxley lived from 1890 to 1895) **c** Recent coccosphere, *Emiliania huxleyi* (species name after TH Huxley). Coccospheres were so named by Wallich (1861)

commented on 'their astonishingly wide distribution and their vast numbers, which stamp them as one of the most essential members of rock-forming substances' (Gümbel 1870b). He also postulated that coccoliths and *Bathybius* occurred in all seas, at all depths, and 'at all times' (Gümbel 1870c). The *Challenger* Expedition (1872–1876), as well as dispelling the *Bathybius* myth, confirmed the ubiquity of coccoliths in the sediments of all major oceans: not, however, 'at all times', because coccoliths are now known to be widespread in open-marine sediments only since the Late Triassic (e.g., Bown 1987). In Huxley's time, the deep sea was effectively a 'black box' where direct observation was impossible (Alaniz 2020). Huxley, and with him most biologists, first thought that *Bathybius* lived in the abyss of the oceans; however, during the 1870s it became common knowledge that 'coccospheres were free-floating organisms in tropical seas' and that they were the skeletons of minute calcareous algae (Murray and Renard 1891).

Oceanic sediments in the Alps

A major scientific discussion took place in the late 19th and the early twentieth century: the question being 'are there ancient deep-sea deposits of geological significance?' (Steinmann 1925). The *Challenger* Expedition had mapped the distribution of Recent oceanic sediments in astonishing detail (Murray and Renard 1894, see Fig. 13 in Bernoulli and Jenkyns 2009), and found a general decrease in percentage carbonate with water depth (Thomson 1874) leading to the concept of the calcite compensation depth *avant la lettre*, where the rate of supply of calcareous micro- and nannoplankton as pelagic rain is balanced by the rate of solution (Bramlette 1961; Berger 1970).

Already before and in the wake of the *Challenger* Expedition, Alpine geologists (Gümbel 1870a, 1870b, 1878; Suess 1875; Fuchs 1883; Steinmann 1905) interpreted Alpine-mediterranean Jurassic red limestones and associated manganese nodules, Jurassic carbonate-free radiolarites, and the fine-grained Lower Cretaceous *Aptychus* limestones as deep-sea deposits, ancient counterparts of Recent radiolarian and *Globigerina* oozes. However, the presence of abyssal sediments on land appeared to undermine the concept of the permanency of continents and oceans to which most geologists adhered at that time and was in line with the concept of isostasy, introduced in the late nineteenth century (Dutton 1889). Before the acceptance of continental drift and plate tectonics, the occurrence of deep-sea sediments on land was thus thought possible only by a minority of geologists working in mountain ranges

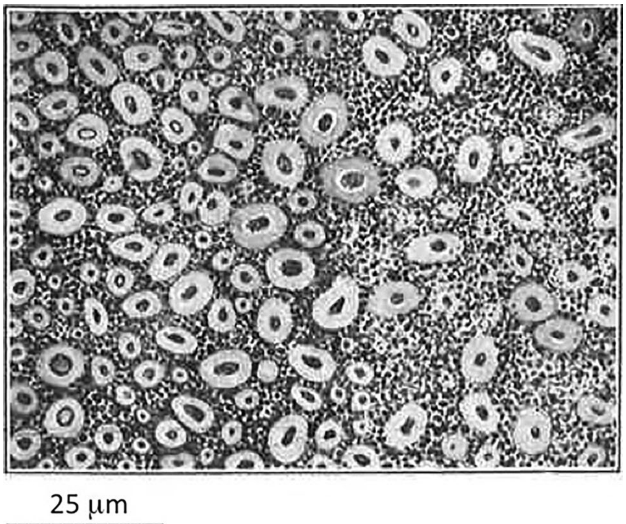

Fig. 7 'Kokkonit': Coccolith limestone of the Maiolica Veneta Formation (= Biancone), Lower Cretaceous, from Col Torond, Venetian Alps. From Steinmann (1925)

of the Alpine-mediterranean orogenic system (details in Bernoulli and Jenkyns 2009).

For the discussion as to whether ancient deep-sea deposits could occur on land, the area of Graubünden, including the Engadin, played a significant role. In the Engadin, cherts ('jaspis') with radiolarians were first observed by Gümbel (1892), who had always advocated the deep-water nature of radiolarites and the stratigraphically associated *Aptychus* limestones. However, in the early twentieth century, the local presence of sandstones and conglomerates intercalated with biogenic cherts seemed to contradict their deep-water origin. By contrast, all other arguments, such as the interpretation of such siliceous facies as an insoluble residue that accumulated below the level of carbonate solution, supported a deep-water origin, as did the presence of *Aptychus* limestones (whose aragonitic ammonite shells had been dissolved) overlying radiolarites in stratigraphic continuity. The apparent paradox of the interlayering of alleged deep-water sediments and shallow-water sandstones and conglomerates was resolved only in the middle of the twentieth century when it was recognized that turbidity currents could transport coarse terrigenous clastic material to the deep ocean (Kuenen and Migliorini 1950).

An illustration of suspected coccoliths from the so-called Biancone (= *Aptychus* limestones) of the Southern Alps was finally published by Steinmann (1925; Fig. 7). The circle closes with our illustration of recognizable coccoliths, unbeknownst to Huxley (Fig. 8a, b), in the Lower Cretaceous *Aptychus* limestones of Piz Murtiröl (Err nappe, Fig. 2), which are meta-sediments of sub-greenschist facies. It seems likely he would have seen similar outcrops at Piz Lunghin during his rambles, but the pelagic limestones in

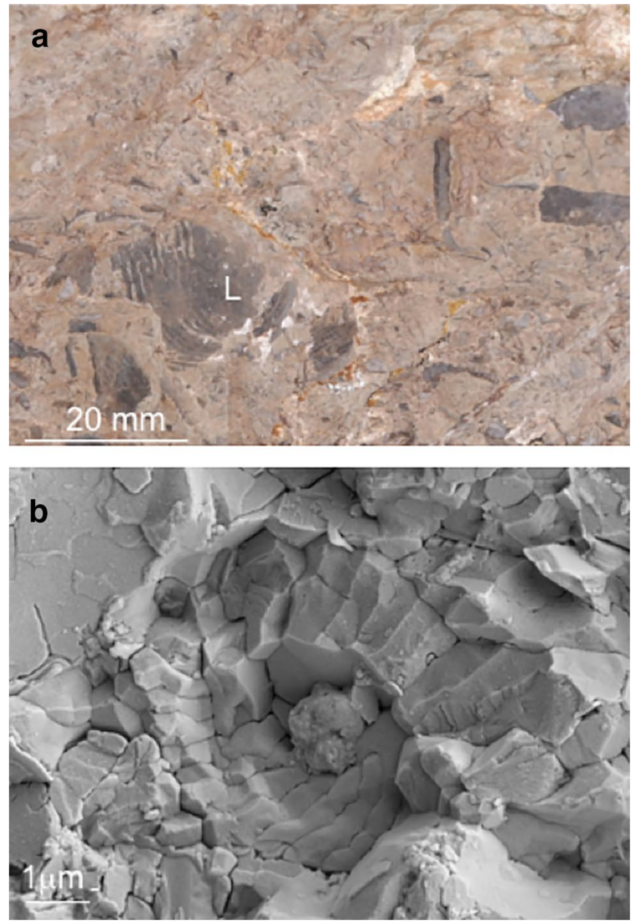

Fig. 8 *Aptychus* limestone, Lower Cretaceous, Lower Austro-alpine Err nappe (sub-greenschist facies), Piz Murtiröl (2660 m asl.), **a** Hand-specimen with *Lamellaptychus* (L) **b** Coccolith (*Watznaueria* sp.) in xenotopic calcite fabric. SEM photomicrograph of the fresh broken surface

this area have suffered Alpine metamorphism extending to greenschist facies (Bousquet et al. 2012), thereby likely destroying any original coccoliths: a history totally unlike that of the English Chalk, which has undergone only modest post-depositional change and is little more than a consolidated foraminiferal-nannofossil ooze (Fig. 6b).

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Author contributions Both authors contributed to the conception, data and literature analysis, elaboration of the illustrations and writing of the text.

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Declarations

Conflict of interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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