Swiss Journal of Palaeontology

RESEARCH ARTICLE

Open Access

Scleractinian corals from the Lower Cretaceous of the Alpstein area (Anthozoa; Vitznau Marl; lower Valanginian) and a preliminary comparison with contemporaneous coral assemblages

Rosemarie Christine Baron-Szabo[1,2*], Karl Tschanz[3] and Peter Kürsteiner[4]

Abstract

From the Vitznau Marl (lower Valanginian) at the locality Wart in northeastern Switzerland (Alpstein area), 18 species from 17 genera and 13 families are described, including the genera *Actinaraea, Actinastrea, Adelocoenia, Aplosmilia, Axosmilia, Complexastrea, Cyathophora, Dermosmilia, Fungiastraea, Heterocoenia, Latiastrea, Montlivaltia, Placophyllia, Pleurophyllia, Stylophyllopsis, Thamnoseris*, and specimens showing affinities to solitary stylophyllids. The corals from the Vitznau Marl were derived from a limestone–marl alternation that is fossiliferous and clay-rich at the base (Vitznau Marl), containing crinoids, bryozoans, and sparse reworked corals and sponges. The coral fauna is distinctly dominated by forms belonging to the category of lowest to no polyp integration (50%), followed by species of the cerioid-plocoid group (33%) and forms having the highest polyp integration (thamnasterioid; 17%). With regard to polypar size, the Wart fauna is dominated by corals having large-size (> 9 mm) polyps (= 39%), followed by corals having medium- (> 2.5–9 mm; 33%) and small-size polyps (up to 2.5 mm; 28%). Based on morphological features, the fauna from the Vitznau Marl closely corresponds to coral assemblages that are subjected to near-chronic, moderate sediment-turbidity stress that is punctuated by high-stress events, and that are largely or entirely heterotrophic. No coral fabric was observed that would suggest a biohermal development. But in a very small number of places, structures are present which might be fragments of crusts of microbialites, pointing to the hypothesis that at least a few of the corals might have been a part of some kind of bioconstruction. At the species-level, the fauna of the Vitznau Marl shows either no or very little affinities to other Valanginian assemblages such as to the fauna of Hungary (4.3%), followed by the associations of Ukraine, Switzerland (non-Vitznau), Spain (SpII), and Bulgaria. At the genus-level, the Wart fauna shows low correspondence to the fauna of Spain (SpII) (14.5%), followed by the assemblages of Hungary, Bulgaria, and Ukraine. In addition to the Vitznau Marl corals, an account of all Valanginian coral faunas published before early 2021 is given, including their paleogeographic distribution, as well as their taxonomic and morphological characterization. For this preliminary study, a total of 206 coral species belonging to 97 genera found in the coral assemblages of the Valanginian were included. At both the genus- and the species-levels, colonial taxa are most abundant (colonial genera: 89%;

Editorial handling: Michael Hautmann.

*Correspondence: rbsz2020@yahoo.com
[1] Department of Invertebrate Zoology, Smithsonian Institution, MRC-163, Washington, DC 20013, USA
Full list of author information is available at the end of the article

colonial species 90%). The vast majority of the Valanginian genera already occurred in older strata. Only 11 genera (out of 97 = 11%) are newly recorded. The Valanginian faunas having the largest number of solitary taxa lived in both (sub-) paratropical to warm-temperate areas, and in arid regions. The coral faunas of the Valanginian are distinctly dominated by corals of well-established microstructural groups. Only 13% of the species from 24% of the genera belong to "modern" groups. Compared to the situation in the Berriasian which showed that 9% of the species and 17% of the genera belonged to modern microstructural groups, the occurrence of "modern" groups significantly increased during the Valanginian.

Keywords: Lower Cretaceous, Valanginian, Vitznau Marl, Switzerland, Taxonomy, Scleractinia, Paleoenvironment

Introduction

Lower Cretaceous scleractinian corals are known from a vast number of occurrences worldwide, especially for the period Hauterivian–middle Albian (e.g., Baron-Szabo, 1993, 1997, 2014, 2016, 2021a, 2021b; Baron-Szabo & Fernández-Mendiola, 1997; Baron-Szabo & González-León, 1999, 2003; Baron-Szabo & Steuber, 1996; Bover-Arnal, et al., 2012, Bugrova, 1990, 1999; Dietrich, 1926; Eguchi, 1951; Felix, 1891; Filkorn & Pantoja-Alor, 2009; Idakieva, 2007; Karakash, 1907; Koby, 1896, 1897, 1898; Kuzmicheva, 2002; Löser 2008; Löser, et al., 2015; Morycowa, 1964, 1971; Morycowa & Decrouez, 2006; Morycowa & Marcopoulou-Diacantoni, 2002; Morycowa & Masse, 1998; Pandey et al., 2007; Prinz, 1991; Reig Oriol, 1994; Reyeros de Castillo, 1983; Schöllhorn, 1998; Scholz, 1979, 1984; Shishlov, et al., 2020; Sikharulidze, 1977, 1979, 1985; Tomás et al., 2008; Toula, 1889; Turnšek, 1997; Turnšek & Buser, 1974, 1976; Turnšek & Mihajlović, 1981; Turnšek, et al., 1992; Von der Osten, 1957; Wells, 1932, 1933, 1944). For the lowermost Cretaceous, however, only a very small number of coral assemblages have been recorded, including European faunas of the Berriasian, e.g., southern Spain (Geyer & Rosendahl, 1985), Ukraine (Arkadiev & Bugrova, 1999; Kuzmicheva, 1972), western Austria and northeastern Switzerland (Baron-Szabo, 2018; Baron-Szabo & Furrer, 2018), as well as Asia (e.g., Tibet: Liao & Xia, 1994) and northern Africa (Beauvais & M'Rabet, 1977) (for discussions on Berriasian assemblages see Baron-Szabo, 2018). A small number of coral faunas from the Valanginian have been reported, including rare European and West Asian coral assemblages such as the ones from Bulgaria (Roniewicz, 2008), Hungary (Császár & Turnšek, 1996), and Ukraine (Kuzmicheva, 1967, 2002). Recently, the first works on the Lower Cretaceous corals from Argentina (Neuquén Basin) have been published, including material from the upper Valanginian (Agrio Formation) (Garberoglio et al., 2020, 2021). In addition, the first information on upper Valanginian material from northeastern Switzerland (Pygurus Member) has been reported from an ongoing study of the Pygurus coral fauna (Baron-Szabo & Furrer, 2018). While the results of these studies are yet to be finalized, they provide sufficient information to make some initial assessments. With regard to the latter study, the material found so far shows correspondence to some stylophyllid specimens of the assemblage of the Vitznau Marl. Regarding the Argentinian fauna, representatives of well-established microstructural groups such as actinastreids have been recorded (e.g., cf. *Enallocoenia* [referring to material assigned in Garberoglio, et al., 2020, to *Stelidioseris gibbosa*] and cf. *Columactinastraea* [referring to material assigned in Garberoglio, et al., 2021, to *Eocolumastrea octaviae*]).

With regard to Valanginian corals from Switzerland, only a very small number of occurrences have been known from central and western Switzerland (Haefeli, et al., 1965; Koby, 1896, 1897, 1898). Up to now, the only taxonomic descriptions and illustrations of Swiss scleractinian corals from this time period were published more than a century ago (Koby, 1896, 1897, 1898). Recently, as a part of a book project on fossils derived from the Cretaceous sediments in the Alpstein (Kürsteiner & Klug, 2018), the first Valanginian corals were collected from northeastern Switzerland. The purpose of this paper is to (i) taxonomically describe the first scleractinian coral assemblage from the lower Valanginian of the Vitznau Marl of northeastern Switzerland; (ii) provide both preliminary paleogeographic distributional patterns and paleoenvironmental occurrences, and (iii) provide a preliminary comparison of the coral fauna of the Vitznau Marl with contemporaneous scleractinian assemblages.

Materials, methods, abbreviations

Materials

In the current paper, 64 corals from the Vitznau Marl of northeastern Switzerland were identified by examining the corallum surface and using polished surfaces and thin sections. In general, the specimens are fragmented, their size ranging between several millimeters to around a decimeter. In most of the specimens, microstructural features are not preserved.

The material was collected by the coauthors Peter Kürsteiner (Nature Museum, St. Gallen), Karl Tschanz (Zurich) and Swiss collector Robin Näf (Wildhaus) during the years 2018 and 2020. Preparation of polished slabs

and thin sections was carried out by Karl Tschanz. Material used in the current study is housed at the Nature Museum St. Gallen (inventory acronym of the Kürsteiner collection is **NMSG Coll. PK**). Further material mentioned in the current work is housed at the following institutions: MNHN: Museum National d'Histoire Naturelle, Paris, France; NMNHS: Natural Museum of Natural History, Sofia, Bulgaria; SNSB-BSPG: Bayerische Staatssammlung für Paläontologie und historische Geologie, Munich, Germany.

Methods

Identifications in the literature without descriptions or illustrations which have not been subsequently confirmed in taxonomic publications are excluded from taxonomic evaluation in the current work. Also excluded from a detailed comparison with other Valanginian faunas is a small number of works in which the stratigraphic ranges of the coral-bearing strata are not clearly defined but only given as, e.g., upper Berriasian–Valanginian, Valanginian–Hauterivian. These works refer to studies in the USA (Texas, Knowles Limestone; Scott, 1984; see stratigraphic update in the report by the Bureau of Ocean Energy Management [BOEM], 2012, p. 19 at: www.boem.gov); Armenia (Papoyan, 1982, 1989); Norway (Baron-Szabo, 2005); Poland (Kołodziej, 2003); South Africa (Kitchin, 1908); and Spain (Geyer & Rosendahl, 1985). However, in order to provide an idea about taxa which might eventually turn out to be of Valanginian age, a list of these coral occurrences is given in Appendix Table 5.

With regard to the size of corallites, the mean value is used when ***polypar size*** overlapped two categories.

Abbreviations

*=first description of taxon to which the assignment of specimen refers; v=material was studied by one of the authors (RBS); (v)=material not examined by author but considered to be sufficiently documented to be reliably identified; **citation in italics in synonymy list**= taxon only listed in the work concerned (neither illustration nor description provided).

Northeastern Switzerland (Cantons of Appenzell Innerrhoden, Appenzell Ausserrhoden, and St. Gallen) (Fig. 1):

Alpstein (mountain chain stretching over the Cantons of Appenzell Innerrhoden, Appenzell Ausserrhoden, and St. Gallen): 20–25 km south of St. Gallen.
Rotsteinpass (mountain pass in the Alpstein; Cantons of Appenzell Innerrhoden and St. Gallen): located about 2 km south-southeast of Säntis.
Säntis (highest mountain of the Alpstein; located about 18 km south of St. Gallen.
Wart (Alp in the Alpstein): located about 4 km southwest of Säntis.

Lithology and sedimentary environment of the Vitznau Marl

The Vitznau Marl is characterized by a succession of hemipelagic marl containing quartz-sand turbidites (Burger, 1985, 1986; Burger & Strasser, 1981; Föllmi, et al., 2007). It is underlain by a mixed sedimentation phase

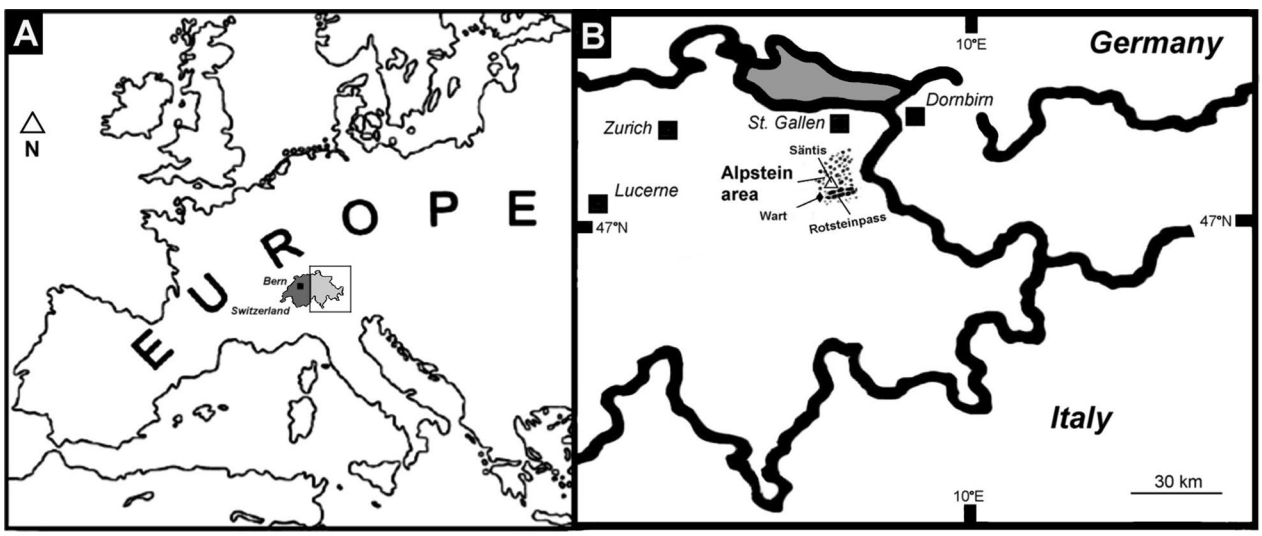

Fig. 1 **A** Map showing the general location of the study area; **B** map marking the locality in northeastern Switzerland, from which the material of the Vitznau Marl was collected. Triangle symbol = Säntis. Note that the coordinates of the collecting site are 47° 14′ 36″ N, 9° 21′ 55″ E

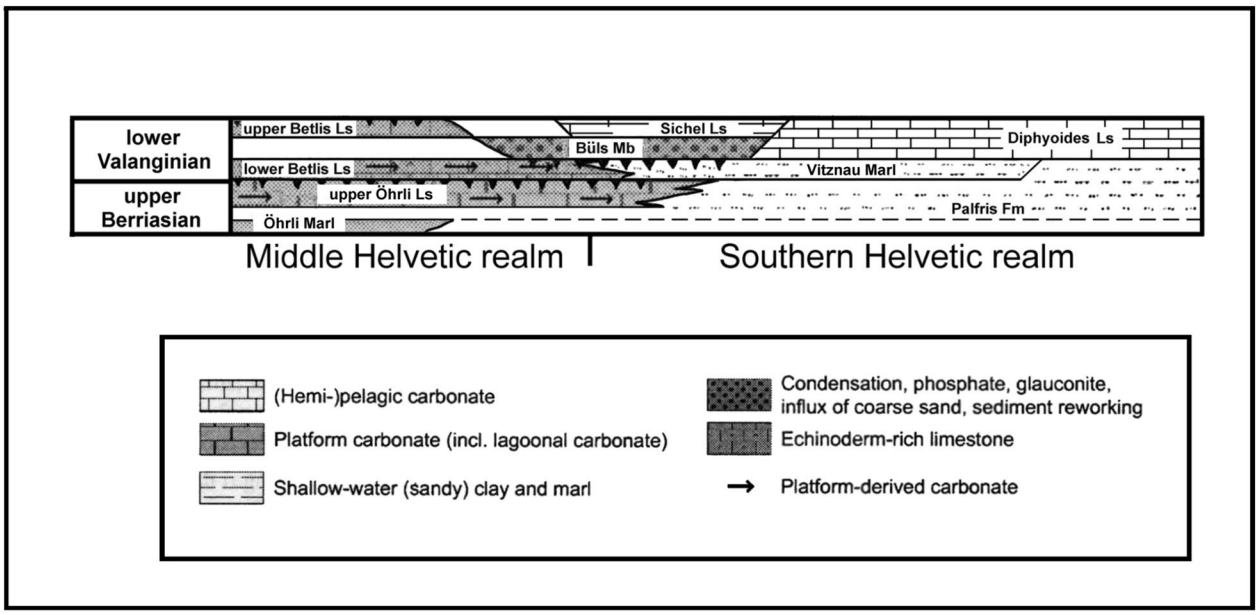

Fig. 2 Time–space diagram of the sedimentary succession of the upper Berriasian to lower Valanginian in the Helvetic Alps. The space axis represents approximately 30 km in its totality (modified from Föllmi et al., 2007). Ls = limestone; Mb = member; Fm = formation

(Palfris Formation and the upper part of the Őhrli Formation [upper Őhrli Limestone]) and overlain by purely calcareous sediments of the Betlis Formation and Diphyoides Limestone (Fig. 2). In northeastern Switzerland, the Vitznau Marl is represented by a 130 m thick limestone–marl alternation that is fossiliferous and clay-rich in its lower section, containing crinoids and bryozoans. In addition, sparse reworked corals and sponges were found. These layers are followed by quartz-sand-rich and fossil-poor beds (Funk, 1999; Morales, et al., 2013; Sala, et al., 2014). In the Alpstein area, the Vitznau Marl crops out south of the area of the Rotsteinpass (Sala,

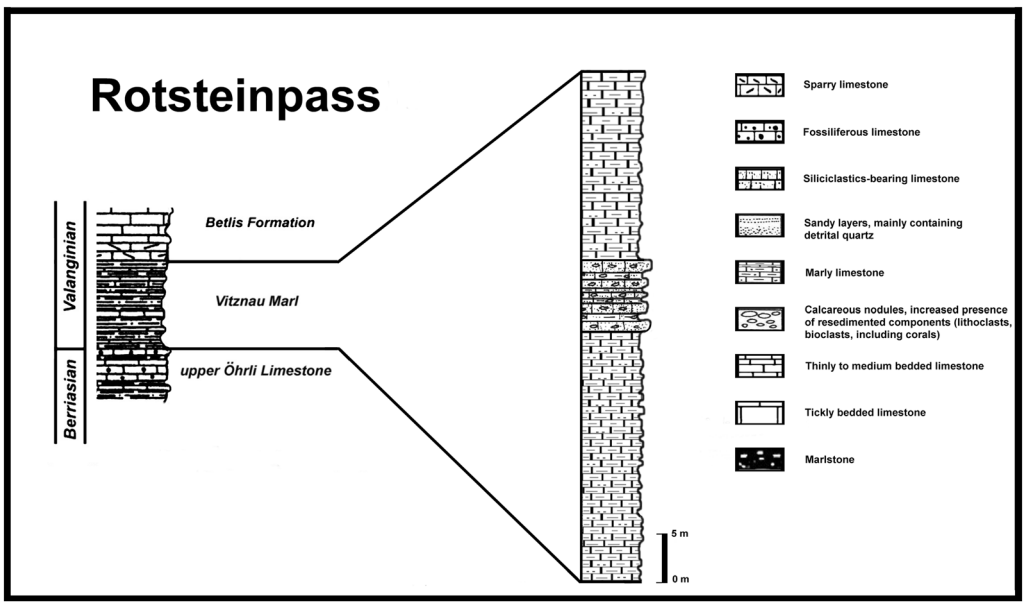

Fig. 3 Schematic lithostratigraphic section showing 130 m of the sediments of the Vitznau Marl in the Alpstein area (Rotsteinpass) in northeastern Switzerland (modified from Funk, 1999, and Burger & Strasser, 1981)

et al., 2014) (Fig. 3). The Vitznau Marl represents deposits of the distal shelf in the open marine area of a platform along the northern margin of the Tethys (Jordi, 2012) (Fig. 4). Geographically, the Vitznau Marl stretches from western Austria (Vorarlberg), over eastern Switzerland to the Bernese Highlands in central-western Switzerland.

The corals found in the Vitznau Marl are represented by fragmented coralla that were reworked and re-deposited. None of the specimens were found in situ. The coral material is embedded in a fine-grained matrix together with other mm- to cm-size bioclasts such as fragmented gastropods, serpulids, sponges, shell fragments, and others.

General attributes of the corals of the Vitznau Marl at Wart (Table 1)

Morphology

The coral material described in the current work comprises 64 specimens belonging to 18 species from 17 genera and 13 families. The fauna is distinctly dominated by forms belonging to the category of lowest to no polyp integration. Half of the fauna (50%) belong to this category (branching [6 species = 33%] and solitary [3 species = 17%]). This group is followed by species having types of polyp integration of the next higher integration arrangement (cerioid-plocoid group), to which a third of the coral species belong (6 species = 33%). The smallest group of colonial forms (3 species = 17%) consists of species having the highest polyp integration (thamnasterioid), including one showing mixed types of polyp integration combining high and lower integration arrangements (the cerio-thamnasterioid *Thamnoseris* cf. *carpathica*). The main morphotypes of non-branching corals from the Vitznau Marl are massive to subhemispherical. The branching species are phaceloid (Table 1).

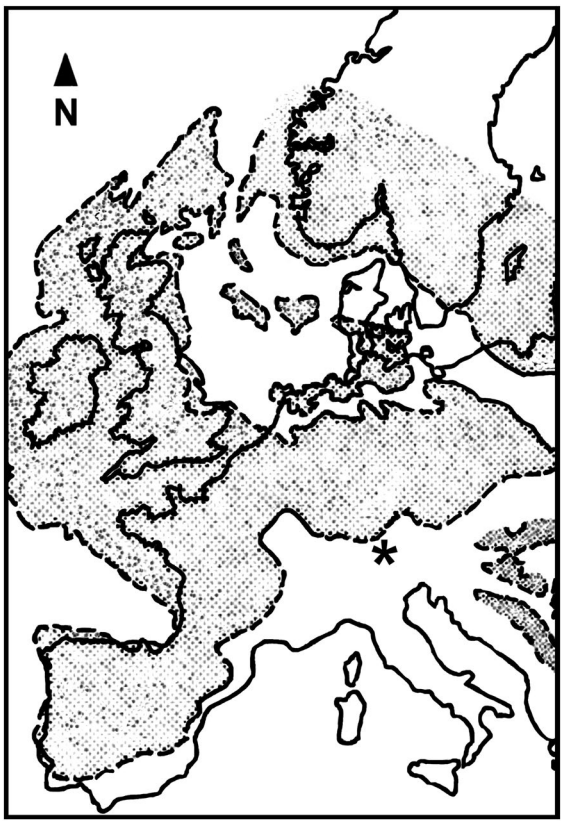

Fig. 4 European Valanginian shorelines. Stipple indicates land areas; asterisk = area from which the corals of the Vitznau Marl were derived (modified from Tyson & Funnell, 1987). The paleocoordinates of the collecting site are: 38° 11′ N, 18° 10′ E (paleocoordinates estimated using information available on Paleobiology Database [paleobiodb.org])

Corallite size and polyp integration

With regard to polypar size, the Wart fauna is almost equally distributed by species with large-size (> 9 mm) polyps (7 species; 39%) and medium-size (> 2.5–9 mm) polyped corals (6 species; 33%), followed by corals having small-size polyps (5 species = 28%). The group with large polyps is characterized by the category of corals having lowest to no polyp integration. All of the solitary corals (3 species: *Axosmilia villersensis, Montlivaltia truncata,* Stylophyllid indet. [questionably solitary]) and half of the branching types (3 species: *Aplosmilia semisulcata, Dermosmilia* sp., *Placophyllia* cf. *florosa*) belong to this group. The only species having a higher type of polyp integration in this group is *Complexastrea zolleriana* which belongs to the cerioid-plocoid category. No species having highly integrated polyps (thamnasterioid) has large polyps. It should be noted, however, that several representatives of the cerioid-plocoid species *Complexastrea zolleriana* found in the Vitznau Marl show growth forms that closely resemble the kinds of the lowest (branching) or no polyp integration, mimicking solitary, phaceloid, and subbranching-flabellate types. The medium-size group consists of branching (3 species: *Placophyllia* cf. *dianthus, Pleurophyllia* sp., *Stylophyllopsis silingensis*), cerioid-plocoid (2 species: *Cyathophora claudiensis, Latiastrea mucronata*), and thamnasterioid (1 species: *Thamnoseris* cf. *carpathica*) forms. Species having small-size corallites form the smallest group and belong to higher polyp integration categories, including 3 species of the cerioid-plocoid (*Actinastrea pseudominima, Adelocoenia parvistella, Heterocoenia inflexa*) and 2 species (*Actinaraea tenuis, Fungiastraea lamellosa*) of the thamnasterioid groups. Neither solitary nor branching species were found in the group having small-size polyps (Table 1).

Table 1 List of scleractinian corals from the Vitznau Marl, Alpstein area, northeastern Switzerland, characteristics of their skeletal elements, their stratigraphic and geographic ranges, and paleoenvironmental occurrences reported from localities of both the Vitznau marl and elsewhere; corallite size: small = 2.5 mm or less; medium = > 2.5 to 9 mm; large = > 9 mm

Vitznau species	Corallite size and integration; corallum shape	Paleoenvironmental occurrences	Other geographic and stratigraphic-distributions (see text for further details)
Actinaraea tenuis	Small, thamnasterioid; submassive to folios, subramose	Reef, buildup, bioherm, lagoonal or restricted shallow subtidal, open marine	Contemporaneous, and younger strata: Europe; younger strata: West Asia
Actinastrea pseudominima	Small; cerioid, cerio-plocoid; small massive to subramose	Reef, buildup, bioherm, perireef, subreef, shallow subtidal, lacustrine deltaic, shallow open marine	Older and younger strata: Europe; younger strata: Asia, North Africa
Adelocoenia parvistella	Small, plocoid; small massive	Reef, patch-reef, back-reef area, shallow open marine	Older strata: Asia, Europe
Aplosmilia semisulcata	Medium; branching	Reef, buildup, bioherm, shallow open marine	Older strata: Asia, Europe
Axosmilia villersensis	Large, solitary [no integration type]; conical	Shallow subtidal, shallow open marine	Contemporaneous and younger strata: Europe
Complexastrea zolleriana	Large, astreoid, thamnasterioid; cerio-plocoid; subflabellate, plocoid, submeandroid; massive	Reef, buildup, bioherm, shallow open marine	Older strata: Asia, Europe
Cyathophora claudiensis	Medium; plocoid, cerio-plocoid; massive	Reef, buildup, bioherm, shallow open marine	Older strata: Asia, Europe
Dermosmilia sp.	Large; branching	Genus known from reefal and non-reefal environments	–
Fungiastraea lamellosa	Small–medium; thamnasterioid-submeandroid; massive	Shallow subtidal, shallow open marine	Younger strata: Europe
Heterocoenia inflexa	Plocoid, cerio-plocoid; small; small submassive to subramose	Reef, buildup, bioherm, lacustrine deltaic, shallow open marine	Older, contemporaneous, younger strata: Europe
Latiastrea mucronata	Medium; cerioid; small massive	Reef, buildup, bioherm, shallow open marine, shallow subtidal, lacustrine deltaic	Older, contemporaneous strata: Europe; younger strata: Europe, Central America, Asia
Montlivaltia truncata	Large; solitary [no integration type]; conical	Reef, buildup, bioherm, shallow open marine, lacustrine deltaic	Older strata: Asia, Europe, North Africa
Placophyllia cf. *dianthus*	Medium; branching	Reef, buildup, bioherm, shallow open marine, lacustrine deltaic, shallow subtidal	Older strata: Asia, Europe; contemporaneous strata: ?Europe
Placophyllia cf. *florosa*	Large; branching	Reef, buildup, bioherm, shallow open marine	Older strata: Europe
Pleurophyllia ? *tobleri*	Medium; branching	Reef, buildup, bioherm, shallow open marine, lacustrine deltaic	Older and contemporaneous strata: Europe
Stylophyllid indet	Large; ?solitary [no integration type]; conical	–	–
Stylophyllopsis silingensis	Medium; branching	Shallow open marine	Younger strata: Asia
Thamnoseris cf. *carpathica*	Medium, (cerio)- thamnasterioid, massive	Platform or shelf margin reef, shallow subtidal, open shallow subtidal, shallow open marine	Younger strata: Asia, Europe

Paleoecology of the corals of the Vitznau Marl

Among other skeletal features, the corallite size found in corals has been used for paleoenvironmental interpretations (Baron-Szabo, 2021a, 2021b; Baron-Szabo & Sanders, 2020; Dimitrijević, et al., 2020; Sanders & Baron-Szabo, 2005 [and references therein]; Santodomingo, 2014). In the fauna of the Vitznau Marl, corallite size of the corals varies from less than 1 mm to more than 20 mm but smaller corallites are less common. Forms having medium- to large-size corallites are most abundant (13 species = 72%). Only 5 species (28%) belong to the small-polyp group. Furthermore, Wart corals belonging to the category consisting of forms having lowest to no polyp integration (solitary and branching types) form the most dominant group (50%), followed by species having types of polyp integration of the next higher integration arrangement (cerioid-plocoid group; 33%). Species having the highest polyp integration (thamnasterioid;

3 species = 17%) form the smallest group. Interestingly, several species belonging to the medium- and high-polyp integration groups show pseudo-branching morphotypes: (1) some specimens belonging to *Complexastrea zolleriana* (= cerioid-plocoid, large-polyp category) have growth forms closely resembling branching to uniserially flabellate types as are typical of genera such as *Thecosmilia* (= branching-phaceloid) and *Latiphyllia* (= sub-branching to flabellate, generally uniserial); and (2) some specimens belonging to the cerioid-plocoid (small- to medium-polyps; *Actinastrea* and *Latiastrea*) and thamnasterioid (*Actinaraea*) categories are ramose to subcolumnar. Recent zooxanthellate coral assemblages are characterized by high-integrated species predominantly having smaller corallite diameters (1–5 mm) (Coates & Jackson, 1987; Stafford-Smith, 1993), thus significantly differing from the Wart fauna. According to, e.g., Bak and Elgershuizen (1976), Logan (1988), and Stafford-Smith (1993), corals having large-size corallites effectively reject sediment up to fine gravel-size, whereas small-polyped corals can be effective in rejection of clay to silt. In the fossil record, coral faunas characterized by species with small polyps have been reported from, e.g., the marls of the Upper Cretaceous Gosau Group (e.g., Baron-Szabo, 1997, 2003, 2014; Beauvais, 1982), from marly sediments of the Maastrichtian of Jamaica (Baron-Szabo, 2008), and from the marly to sandy-marly strata of the Oligocene of Italy (Crosara-horizon; Pfister, 1980). Coral assemblages characterized by large-size corallites rejecting sediment up to fine gravel-size have been described from the Miocene of the Caribbean (Montebello Member, Lares Formation; Champagne, 2010). From that it can be said, as a trend, that the corals of the Vitznau Marl might have been predominantly affected by coarse, up to gravel-size sediment. Considering that (1) solitary forms together with half the number of the low-integrated taxa (branching types) form the largest group; (2) even corals belonging to taxa of higher types of polyp integration developed pseudo-branching growth forms (e.g., *Complexastrea zolleriana*); and (3) some specimens of the cerioid-plocoid *Complexastrea zolleriana* that correspond to the "*Coenotheca*-stage" show close resemblance to mobile forms which are known for their high resilience to ecostress (e.g., *Manicina areolata* (Linnaeus, 1758) (Ginsburg, 1972; cf. Sanders & Baron-Szabo, 2005), the Wart fauna closely corresponds to coral assemblages that are subjected to near-chronic, moderate sediment-turbidity stress that is punctuated by high-stress events, and that are largely or entirely heterotrophic (Dryer & Logan, 1978; Sanders & Baron-Szabo, 2005). Generally, no coral fabric was observed that would suggest a biohermal development but in a very small number of places, structures are present which might be fragments of crusts of microbialites, pointing to the hypothesis that at least some corals of the Vitznau Marl might have formed some kind of bioconstruction. This implies, as a hypothesis, that the Wart fauna might have been a non-reefal, azooxanthellate community with some indication that at least a small number of corals were involved in early biohermal developments ("pioneer stage"). This closely corresponds to earlier findings showing the great range of tolerance of most of the Wart taxa (Table 1). Coral assemblages that are comparable to the Swiss fauna have been reported from various time periods such as the middle Jurassic of east-central Iran (Baghamshah Formation, Bathonian–middle Callovian; Pandey & Fürsich, 2003) and the uppermost Lower Cretaceous of the USA (Smeltertown Formation, Albian; Turnšek, et al., 2003). At the Iranian locality, coral associations were reported from marly-silty to strongly silty-sandy sediments in mainly non-reefal and (one) biohermal development (patch-reef). The corals from the Albian Smeltertown Formation were derived from a sedimentary succession that gradually shallows from offshore marine conditions to a hyposaline lagoonal paleoenvironment with sedimentation shifting from dark-grey shale to clastic turbiditic material and resedimented carbonates. The corals were found at the base of a non-reefal shallowing-upward cycle.

Distribution of the corals of the Vitznau Marl

The corals of the Vitznau Marl are dominated by forms that are restricted to the Lower Cretaceous (9 taxa = 50%), followed by species that had their first occurrence in the Jurassic (7 taxa = 39%). Only 2 species (11%) have been known from Lower and Upper Cretaceous strata, both of which belong to the category of high-polyp integration (thamnasterioid group) (*Actinaraea tenuis, Thamnoseris carpathica*). No coral species of the new material occurred in strata that are both older and younger than the Lower Cretaceous (Table 2).

At the species-level, when compared to the six largest Valanginian faunas recorded, the fauna of the Vitznau Marl shows no or very little affinities to any of them (Hungary, followed by the associations of Ukraine, Switzerland [non-Vitznau Marl], of southern Spain [SpII; lower Valanginian], and Bulgaria [all between 1.3–4.3%]). None of the species are shared with the upper Valanginian fauna of southern Spain (SpI) (Table 3; Appendix Table 8).

At the genus-level, the fauna of the Vitznau Marl shows correspondence to all six Valanginian faunas that are used for more detailed comparison at very low to low ranges. The closest correspondence is to the fauna of Spain (SpII; 14.5%), followed by the assemblages of Hungary, Bulgaria, Ukraine, Switzerland (non-Vitznau Marl), and southern Spain (SpI) (all between 3.5–11.5%). Only

Table 2 Stratigraphic distribution of the corals of the Vitznau Marl at Wart

Wart corals	Jurassic					Cretaceous								
			Upper			Lower						Upper		
	Lower	Middle	Oxfordian	Kimmeridgian	Tithonian	Berriasian	Valanginian	Hauterivian	Barremian	Aptian	Albian	Cenomanian	Turonian	Coniacian
Actinaraea tenuis														
Actinastrea pseudominima														
Adelocoenia parvistella														
Aplosmilia semisulcata														
Axosmilia villersensis														
Complexastrea zolleriana														
Cyathophora claudiensis														
***Dermosmilia* sp.**														
Fungiastraea lamellosa														
Heterocoenia inflexa														
Latiastrea mucronata														
Montlivaltia truncata														
Placophyllia* cf. *dianthus							-?-							
Placophyllia* cf. *florosa														
Pleurophyllia* ? *tobleri														
Stylophyllid indet.														
Stylophyllopsis silingensis														
Thamnoseris* cf. *carpathica														

Table 3 Taxonomic affinities of the Vitznau Marl coral fauna (= 18 species) to other Valanginian coral assemblages, consisting of a similar number of species or higher (see Appendix Table 6 for assemblages excluded from this evaluation), using the Jaccard index (= number of shared species, divided by total number of species in two localities)

Valanginian coral-bearing locality	Number of species (recognized)	Percentage of species also occurring in the Vitznau Marl (SI)	Percentage of species also occurring in Bulgaria (B)	Percentage of species also occurring in Hungary (H)	Percentage of species also occurring in Spain (SpI)	Percentage of species also occurring in Spain (SpII)	Percentage of species also occurring in Switzerland (non-Vitznau Marl) (SII)	Percentage of species also occurring in Ukraine (U)	Valanginian species occurring in multiple contemporaneous assemblages (for further details see Appendix Tables 6 and 8)
Vitznau Marl (SI)	18	–	1.3% (1 species)	4.3% (2 species)	0%	1.7% (1 species)	2.6% (1 species)	2.8% (1 species)	*Actinaraea tenuis (H), Axosmilia villersensis (SpII, SII), Cyathophora claudiensis (B), Latiastrea mucronata (H, U)*
Bulgaria (B)	62	1.3% (1 species)	–	1.1% (1 species)	1.2% (1 species)	1% (1 species)	1.2% (1 species)	1.3% (1 species)	*Comoseris jireceki (SpI), Cyathophora claudiensis (SI), Cyathophora hexalobata (U), Periseris lorioli (SII), Synastrea bellula (H, SpII)*
Hungary (H)	29	4.3% (2 species)	1.1% (1 species)	–	0%	2.8% (2 species)	2% (1 species)	2.1% (1 species)	*Actinaraea tenuis (SI), Dimorphastrea explanata (SII), Latiastrea mucronata (SI, U), Stylina lamellosa (SpII), Synastrea bellula (B, SpII)*
Spain (SpI)	19	0%	1.2% (1 species)	0%	–	3.5% (2 species)	0%	0%	*Comoseris jireceki (B), Meandrophyllia corrugata (SpII), Periseris crassisepta (SpII)*

Table 3 (continued)

Valanginian coral-bearing locality	Number of species (recognized)	Percentage of species also occurring in the Vitznau Marl (SI)	Percentage of species also occurring in Bulgaria (B)	Percentage of species also occurring in Hungary (H)	Percentage of species also occurring in Spain (SpI)	Percentage of species also occurring in Spain (SpII)	Percentage of species also occurring in Switzerland (non-Vitznau Marl) (SII)	Percentage of species also occurring in Ukraine (U)	Valanginian species occurring in multiple contemporaneous assemblages (for further details see Appendix Tables 6 and 8)
Spain (SpII)	42	1.7% (1 species)	1% (1 species)	2.8% (2 species)	3.5% (2 species)	–	5% (3 species)	3.5% (2 species)	*Axosmilia villersensis (SI, SII), Comoseris fromenteli (SII), Comoseris meandroides (U), Meandrophyllia corrugata (SpI), Periseris crassisepta (SpI), Stereocoenia collinaria (SII), Stylina lamellosa (H), Synastrea bellula (B, H), Thalamocaeniopsis stricta (U)*
Switzerland (non-Vitznau Marl) (SII)	21	2.6% (1 species)	1.2% (1 species)	2% (1 species)	0%	5% (3 species)	–	0%	*Axosmilia villersensis (SI, SpII), Comoseris fromenteli (SpII), Dimorphastrea explanata (H), Periseris lorioli (B), Stereocoenia collinaria (SpII)*
Ukraine (U)	18	2.8% (1 species)	1.3% (1 species)	2.1% (1 species)	0%	3.5% (2 species)	0%	–	*Comoseris meandroides (SpII), Cyathophora hexalobata (B), Latiastrea mucronata (H, SI), Thalamocaeniopsis stricta (SpII)*

two genera are shared with the fauna of Switzerland (non-Vitznau Marl), both of which are solitary forms (*Axosmilia, Montlivaltia*) (Table 4).

Valanginian coral assemblages worldwide

Though scleractinian coral assemblages of the Valanginian have been reported from a rather small number of localities (probably less than two dozen), they, however, have been known worldwide (Fig. 5). In the current work, in addition to the Wart fauna, twelve Valanginian coral faunas are reviewed, six of which are compared in more detail with the coral fauna of the Vitznau Marl: Ukraine (Kuzmicheva, 1967, 1985, 2002); western-central Switzerland (non-Vitznau Marl; Fromentel, *in* Fischer, 1873; Haefeli, et al., 1965; Jaccard, 1893); southern Spain (two faunas [Sp (I) and Sp (II)]; Löser et al., 2019, Löser et al., 2021); Hungary (Császár & Turnšek, 1996); and Bulgaria (Roniewicz, 2008).

The number of species of each of these assemblages ranges from 18 (Ukraine) to 62 (Bulgaria) (Table 3). Taking into consideration the overall low numbers of both the Valanginian coral assemblages and coral taxa, as a trend it can be said as a preliminary conclusion that:

- a total of 206 coral species belonging to 97 genera were found in the coral assemblages of the Valanginian (Appendix Tables 7 and 8);
- at both the genus- and the species-levels, colonial taxa are most abundant during the Valanginian (colonial genera: 89%; colonial species 90%);
- the vast majority of the Valanginian genera already occurred in older strata. Only 11 genera (out of 97 = 11%) are newly recorded, eight of which are endemic during the Valanginian (marked by *; also see Appendix Table 7): *Agathelia*, Confusaforma*, Eugyra*, Lyubasha*, Microsolenastraea*, Palaeopsammia*, Paretallonia, Siderastreites*, Siderofungia*, Thalamocaeniopsis*, and *Tricassastraea* (Lathuilière, 1989; Paleobiology Database at paleobiodb.org; and updated herein);
- based on the succession of microstructural groups, Roniewicz and Morycowa (1993) distinguished four stages in the history of Scleractinia: I. Early Mesozoic stage; II. Middle Mesozoic stage; III. Late Mesozoic stage; and IV. Cenozoic stage. In this model, the Valanginian period belongs to phase 2 of the Middle Mesozoic stage (Oxfordian–Valanginian). This stage is characterized by (1) the continued presence of earlier microstructural types (types having rather thick trabeculae, such as haplaraeids, comoseriids, latomeandrids, and thecosmiliids; and small-to-medium size trabeculae forms, such as the actinastreids); (2) the diversification of auricular (stylinid) and amphiastreid corals; and (3) the appearance of new microstructural types such as minitrabeculae (as in *Myriophyllia*), as well as types forming densely branching trabeculae (as seen in neo-rhipidicanth and rhipidogyrid taxa), and groups having thick and horizontally (= parallel to corallum base) arranged trabeculae (heterocoeniids). According to Roniewicz and Morycowa (1993), a sharp limitation of microstructural development of all but newly established coral groups occurred after the Tithonian. From that it can be concluded that the scleractinian coral faunas of the Valanginian are distinctly dominated by corals of well-established microstructural groups: only 27 species (out of 206 = 13%) from 23 genera (out of 97 = 24%) belong to "modern" groups (Appendix Tables 7 and 8);
- in a recent work on the worldwide occurrence of Berriasian corals (Baron-Szabo, 2018), 113 species belonging to 57 genera were identified. It was found that 10 species (9%) from 10 genera (18%) were representatives of modern microstructural groups. From that it can be said that the number of "modern" taxa significantly increased in the Valanginian by 33% (genus-level) and 44% (species-level), respectively;
- all of the most-widespread genera during the Valanginian (= reported from three or more localities) belong to well-established microstructural groups (*Actinaraea*, Actinastrea*, Adelocoenia*, Ahrdorffia, Axosmilia*, Cladophyllia*, Comoseris*, Cyathophora*, Dimorphastrea*, Ellipsocoenia*, Heliocoenia*, Latiastrea*, Microphyllia, Microsolena, Montlivaltia*, Periseris*, Placophyllia*, Stylina, Stylosmilia*, Synastrea, Tricassastraea*) (Appendix Table 7), 15 of which (marked by *) were reported from a wide latitudinal range, including tropical to warm-temperate regions. The genera *Actinastrea, Dimorphastrea,* and *Montlivaltia* were additionally reported from arid areas (Fig. 6);
- the occurrence of taxa belonging to modern microstructural groups is nearly exclusively restricted to tropical–subtropical (= assemblages of Bulgaria, Hungary, Slovenia, Spain [I], Spain [II], Ukraine) and arid regions (Mexico). Only two modern-group taxa (the branching form *Aplosmilia semisulcata* and the cerio-plocoid *Heterocoenia inflexa*) were found in a (sub-) paratropical to warm-temperate region (Wart fauna, Vitznau Marl) (Appendix Tables 7 and 8);
- at the genus-level, taxa belonging to modern microstructural groups were nearly or completely isolated geographically: representatives of *Starostinia* only occurred in the fauna of Slovenia, forms of *Columnocoenia* and *Diplocoenia* occurred in the assemblages of both Hungary and Ukraine, and the faunas of Spain (SpI) and Mexico contain species of *Paretal-*

Table 4 Taxonomic affinities of the Vitznau Marl coral fauna (= 17 genera) to other Valanginian coral assemblages, consisting of a similar number of genera or higher (see Appendix Table 6 for assemblages excluded from this evaluation), using the Jaccard index (= number of shared genera, divided by total number of genera in two localities); [x] = number of shared genera. Note: percentages rounded off to nearest 0.5%

Valanginian coral-bearing locality	Number of genera (recognized)	Percentage of genera also occurring in the Vitznau Marl (SI)	Percentage of genera also occurring in Bulgaria (B)	Percentage of genera also occurring in Hungary (H)	Percentage of genera also occurring in Spain (SpI)	Percentage of genera also occurring in Spain (SpII)	Percentage of genera also occurring in Switzerland (non-Vitznau Marl) (SII)	Percentage of genera also occurring in Ukraine (U)	Valanginian genera occurring in multiple contemporaneous assemblages (for further details see Appendix Tabes 6 and 7)
Vitznau Marl (SI)	17	–-	9.5% [6]	11.5% [5]	3.5% [1]	14.5% [7]	6.5% [2]	9% [3]	*Actinaraea (H, SpI), Actinastrea (SpII), Adelocoenia (B, H, SpII), Axosmilia (B, SpII, SII), Complexastrea (SpII), Cyathophora (B, H, SpII, U), Heterocoenia (SpII), Latiastrea (H, SpII, U), Montlivaltia (B, SII), Placophyllia (B, H), Pleurophyllia (B), Thamnoseris (U),*

Table 4 (continued)

Valanginian coral-bearing locality	Number of genera (recognized)	Percentage of genera also occurring in the Vitznau Marl (SI)	Percentage of genera also occurring in Bulgaria (B)	Percentage of genera also occurring in Hungary (H)	Percentage of genera also occurring in Spain (SpI)	Percentage of genera also occurring in Spain (SpII)	Percentage of genera also occurring in Switzerland (non-Vitznau Marl) (SII)	Percentage of genera also occurring in Ukraine (U)	Valanginian genera occurring in multiple contemporaneous assemblages (for further details see Appendix Tabes 6 and 7)
Bulgaria (B)	46	9.5% [6]	–	15.5% [11]	10% [6]	13% [10]	15% [9]	11.5% [7]	*Adelocoenia (H, SpII, SI), Ahrdorffia (H, SpI), Axosmilia (SpII, SI, SII), Calamophylliopsis (U), Cladophyllia (SpI), Comoseris (SpI, SpII, SII, U), Cyathophora (H, SpII, SI, U), Dendraraea (H), Dimorphastrea (H, SII), Dimorphocoenia (U), Enallhelia (H), Epistreptum (U), Heliocoenia (H, SpII, SII, U), Latiphyllia- (U), Latomeandra (SpII), Microphyllia (H, SpI), Microsolena (H, SpI), Montlivaltia (SI, SII), Periseris (SpI, SpII, SII), Placophyllia (H, SI), Pleurophyllia (SI), Rhipidogyra (SpII), Stylosmilia (SII), Synastrea (H, SpII), Thecosmilia (SII), Tricassastraea (SpII, SII)*

Table 4 (continued)

Valanginian coral-bearing locality	Number of genera (recognized)	Percentage of genera also occurring in the Vitznau Marl (SI)	Percentage of genera also occurring in Bulgaria (B)	Percentage of genera also occurring in Hungary (H)	Percentage of genera also occurring in Spain (SpI)	Percentage of genera also occurring in Spain (SpII)	Percentage of genera also occurring in Switzerland (non-Vitznau Marl) (SII)	Percentage of genera also occurring in Ukraine (U)	Valanginian genera occurring in multiple contemporaneous assemblages (for further details see Appendix Tabes 6 and 7)
Hungary (H)	26	11.5% [6]	15.5% [11]	–-	18% [7]	12% [7]	10% [4]	14.5% [6]	*Actinaraea (SpI, SI), Adelocoenia (B, SpII, SI), Ahrdorffia (B, SpI), Baryhelia (Paronastraea) (SpII), Columnocoenia (U), Cyathophora (B, SpII, SI, U), Dendraraea (B), Dimorphastrea (B, SII), Diplocoenia (U), Ellipsocoenia (SpI, SII), Enallhelia (B), Epistreptophyllum (SII), Heliocoenia (B, SpII, SII, U), Latiastrea (SpII, SI, U), Microphyllia (B, SpI), Microsolena (B, SpI), Placophyllia (B, SI), Polyphylloseris (SpI), Stylina (SpI, SpII, U), Synastrea (B, SpII)*

Table 4 (continued)

Valanginian coral-bearing locality	Number of genera (recognized)	Percentage of genera also occurring in the Vitznau Marl (SI)	Percentage of genera also occurring in Bulgaria (B)	Percentage of genera also occurring in Hungary (H)	Percentage of genera also occurring in Spain (SpI)	Percentage of genera also occurring in Spain (SpII)	Percentage of genera also occurring in Switzerland (non-Vitznau Marl) (SII)	Percentage of genera also occurring in Ukraine (U)	Valanginian genera occurring in multiple contemporaneous assemblages (for further details see Appendix Tables 6 and 7)
Spain (SpI)	13	3.5% [1]	10% [6]	18% [7]	–	9% [4]	11% [3]	7% [2]	*Actinaraea (H, SI), Ahrdorffia (B, H), Cladophyllia (B), Comoseris (B, SpII, SII, U), Ellipsocoenia (H, SII), Meandrophyllia (SpII), Microphyllia (B, H), Microsolena (B, H), Periseris (B, SpII, SII), Polyphylloseris (H), Stylina (H, SpII, U)*
Spain (SpII)	32	14.5% [7]	13% [10]	12% [7]	9% [4]	–	13% [6]	14.5% [7]	*Actinastrea (SI), Adelocoenia (B, H, SI), Amphiastrea (U), Axosmilia (B, SI, SII), Baryhelia (Paronastraea) (H), Comoseris (B, SpI, SII, U), Complexastrea (SI), Cyathophora (B, H, SI, U), Heliocoenia (B, H, SII, U), Heterocoenia (SI), Latiastrea (H, SI, U), Latomeandra (B), Meandrophyllia (SpI), Periseris (B, SpI, SII), Rhipidogyra (B), Stereocoenia (SII), Stylina (H, SpI, U), Synastrea (B, H), Thalamocaeniopsis (U), Tricassastraea (B, SII)*

Table 4 (continued)

Valanginian coral-bearing locality	Number of genera (recognized)	Percentage of genera also occurring in the Vitznau Marl (SI)	Percentage of genera also occurring in Bulgaria (B)	Percentage of genera also occurring in Hungary (H)	Percentage of genera also occurring in Spain (SpI)	Percentage of genera also occurring in Spain (SpII)	Percentage of genera also occurring in Switzerland (non-Vitznau Marl) (SII)	Percentage of genera also occurring in Ukraine (U)	Valanginian genera occurring in multiple contemporaneous assemblages (for further details see Appendix Tables 6 and 7)
Switzerland (SII, (non-Vitznau Marl)	15	6.5% [2]	15% [9]	10% [4]	11% [3]	13% [6]	–	6.5% [2]	*Axosmilia (B, SpII, SI), Comoseris (B, SpI, SpII, U), Dimorphastrea (B, H), Ellipsocoenia (H, SpI), Epistreptophyllum (H), Heliocoenia (B, H, SpII, U), Montlivaltia (B, SI), Periseris (B, SpI, SpII), Stereocoenia (SpII), Stylosmilia (B), Thecosmilia (B), Tricassastraea (B, SpII)*
Ukraine (U)	16	9% [3]	11.5% [7]	14.5% [6]	7% [2]	14.5% [7]	6.5% [2]	–	*Amphiastrea (SpII), Calamophylliopsis (B), Columnocoenia (H), Comoseris (B, SpI, SpII, SII), Cyathophora (B, H, SpII, SI), Dimorphocoenia (B), Diplocoenia (H), Epistreptum (B), Heliocoenia (B, H, SpII, SII), Latiastrea (H, SpII, SI), Latiphyllia (B), Stylina (H, SpI, SpII), Thalamocaeniopsis (SpII), Thamnoseris (SI),*

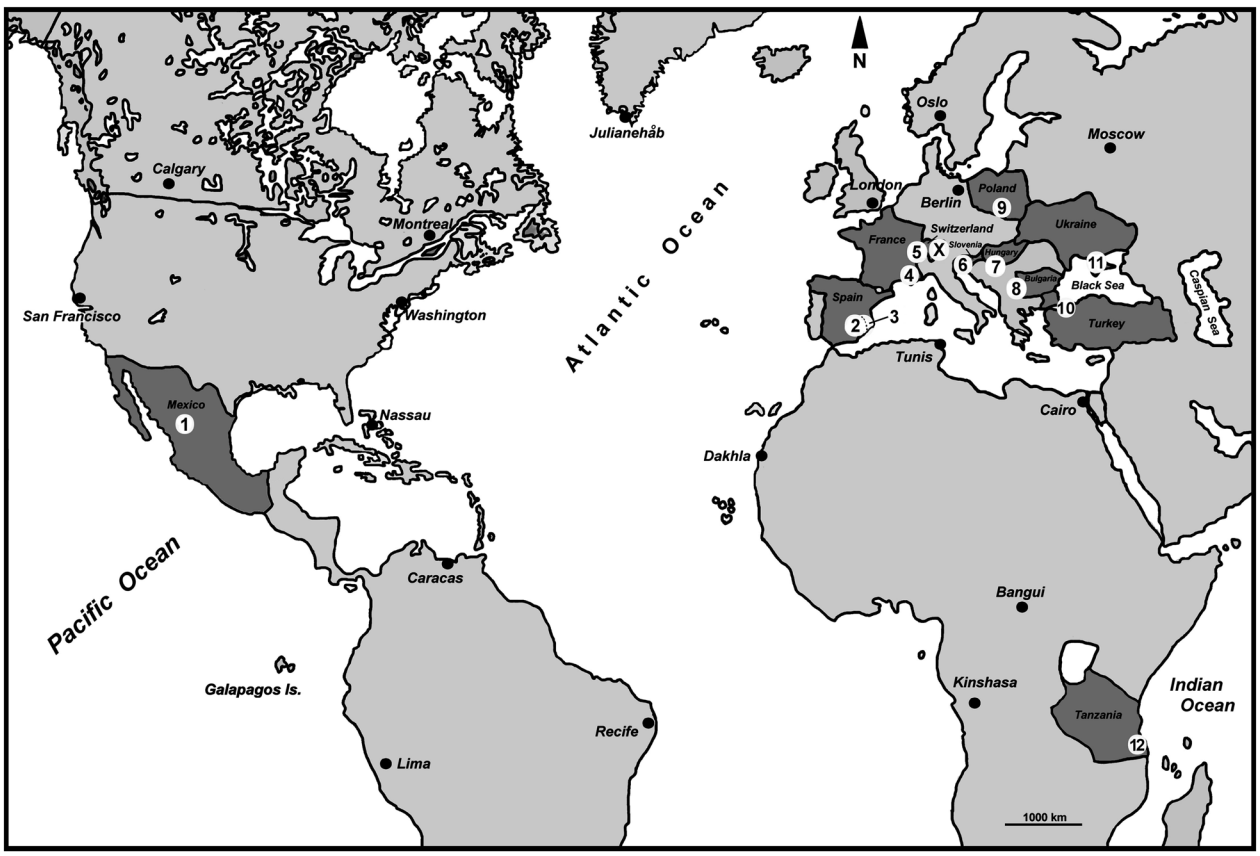

Fig. 5 Map showing localities of Valanginian coral faunas included in this study. ***X*** = Wart (Vitznau Marl) corals (current paper), 18 species; ***1*** = Mexico (Sandy, 1990; Wells, 1946), 3 species; ***2*** = Spain [II] (Löser, et al., 2021), 42 species; ***3*** = Spain [I] (Löser, et al., 2019), 19 species; ***4*** = France (Masse, et al., 2009), 2 species; ***5*** = Switzerland (non-Vitznau Marl) (de Fromentel, *in* Loriol, 1868; Haefeli, et al., 1965; Jaccard, 1893; Koby, 1896, 1897, 1898), 21 species; ***6*** = Slovenia (Turnšek, 1997; Turnšek & Buser, 1974), 3 species; ***7*** = Hungary (Császár & Turnšek, 1996), 29 species; ***8*** = Bulgaria (Roniewicz, 2008), 62 species; ***9*** = Poland (Lefeld, 1968), 1 species; ***10*** = Turkey (Kaya et al., 1987), 2 species; ***11*** = Ukraine (Kuzmicheva, 1967, 1985, 2002), 18 species; ***12*** = Tanzania (Dietrich, 1926; Löser, 2008), 7 species (for coordinates and paleocoordinates see caption of Fig. 6)

lonia. All of their respective species are endemic during the Valanginian (Appendix Table 8);

- at the species-level, all of the forms which occurred in more than one locality during the Valanginian belong to well-established microstructural groups (*Actinaraea tenuis, Ahrdorffia ornata, Axosmilia villersensis, Comoseris jireceki, Cyathophora claudiensis, Cyathophora hexalobata, Dimorphastrea explanata, Ellipsocoenia haimei, Latiastrea mucronata, Periseris lorioli*) (Appendix Tables 7 and 8);
- the Valanginian faunas having the largest numbers of solitary taxa lived in both (sub-) paratropical to warm-temperate areas (Switzerland [coral faunas of Wart [Vitznau Marl] and non-Vitznau Marl]; France) and in arid regions (Mexico, Tanzania) (paleogeography, paleoclimate, and paleoceanography data retrieved from Tennant, et al., 2017 and Paleomap project at www.scotese.com);
- with regard to the six Valanginian faunas used for more detailed comparison, they either completely consist of or are dominated by colonial coral genera/species, ranging from 67%/76% (western-central Switzerland [non-Vitznau Marl; SII]) to 100% (Spain [SpI]) (Appendix Table 6);
- at the species-level, the six Valanginian coral faunas from which the largest number of corals were recorded are distinctly dominated by taxa that are endemic in the Valanginian (Table 3; Appendix Tables 7 and 8), which is in great contrast to the distributional patterns of both the Upper Jurassic and most of the post-Valanginian Lower Cretaceous faunas (Hauterivian–Middle Albian). While many Jurassic and post-Valanginian assemblages are character-

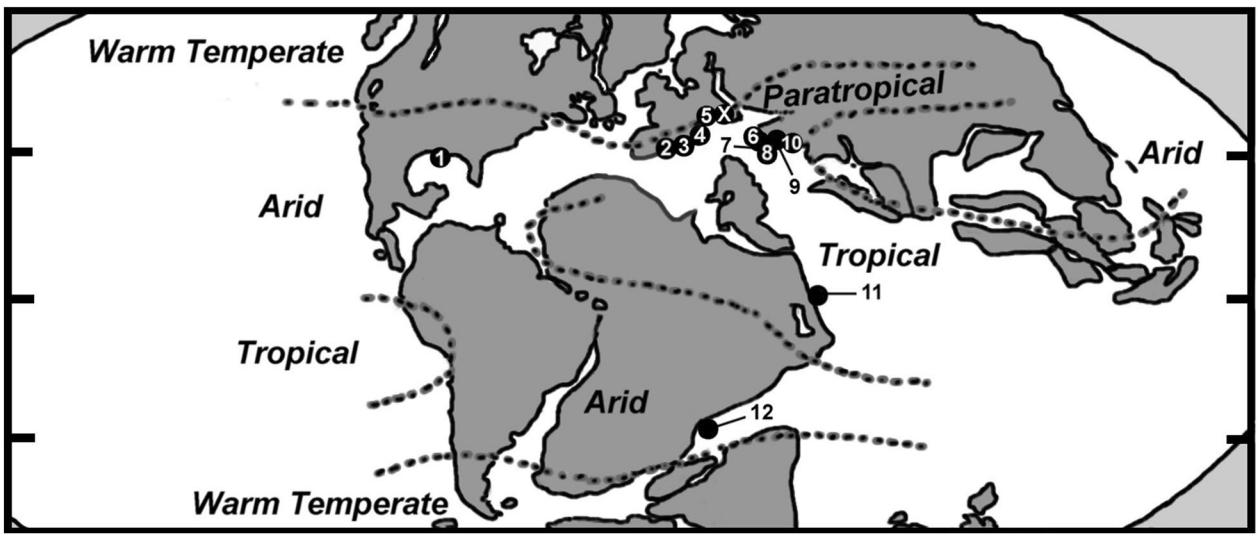

Fig. 6 Simplified Lower Cretaceous paleogeographic map showing the occurrences of species during the Valanginian: ***X*** = Wart (Vitznau Marl) corals (current paper); ***1*** = Mexico (Sandy, 1990; Wells, 1946); ***2*** = Spain [II] (Löser, et al., 2021); ***3*** = Spain [I] (Löser, et al., 2019); ***4*** = France (Masse, et al., 2009); ***5*** = Switzerland (non-Vitznau Marl) (de Fromentel, *in* Loriol, 1868; Haefeli, et al., 1965; Jaccard, 1893; Koby, 1896, 1897, 1898); ***6*** = Slovenia (Turnšek, 1997; Turnšek & Buser, 1974); ***7*** = Hungary (Császár & Turnšek, 1996); ***8*** = Bulgaria (Roniewicz, 2008); ***9*** = Poland (Lefeld, 1968); ***10*** = Turkey (Kaya, et al., 1987); ***11*** = Ukraine (Kuzmicheva, 1967, 1985, 2002); ***12*** = Tanzania (Dietrich, 1926; Löser, 2008). Note that the coordinates (and paleocoordinates) of the Valanginian localities are: ***1*** = 25° 30′ N, 103° 30′W (23° 6′N, 56° 30′ W); ***2*** = 38° N, 3° W (29° N, 2° E); ***3*** = 38° N, 1° W (29° N, 7° E); ***4*** = 43° 12′ N, 5° 24′E (34° 12′N, 14° 30 E); ***5*** = 47° N, 7° E (28° N, 16° E); ***6*** = 46° N, 13° 42′ E (31° 6′ N, 21° 6′ E); ***7*** = 46° 12′ N, 18° 18′ E (28° 24′ N, 24° 42′ E); ***8*** = 42° 48′ N, 22° 48′ E (24° 0′ N, 25° 24′ E); ***9*** = 50° 0′ N, 19° 48′ E (31° 0′ N, 28° 18′ E); ***10*** = 40° 48′ N, 29° 24′ E (36° 36′ N, 36° 54′ E); ***11*** = 44° 48′ N, 34° 30 E (0° 30′ S, 49° 30 E); ***12*** = 9° 42′ S, 39° 18′ E (31° 48′ S, 18° 48 E); ***X*** = 47° 14′ 36″ N, 9° 21′ 55″ E (38° 11′ N, 18° 10′ E). Paleomap modified from Paleomap project Scotese [2014] at www.scotese.com; and Tennant, et al., 2017). Paleocoordinates of the coral localities of Spain [I, II] and Vitznau Marl at Wart estimated based on information provided by Paleobiology Database (paleobiodb.org); all others retrieved from Paleobiology Database (paleobiodb.org)

ized by cosmopolitan to subcosmopolitan taxa (for the Jurassic, see, e.g., Beauvais, 1973, 1989; Errenst, 1990, 1991; Lathuilière, et al., 2020; Morycowa, 2012; Roniewicz, 1976; Turnšek, 1997; for the Lower Cretaceous, see e.g., Baron-Szabo, 2014, Baron-Szabo, 2021b; Baron-Szabo & González-León, 2003; Morycowa, 1971; Morycowa & Masse, 1998, 2009; Morycowa & Marcopoulou-Diacantoni, 2002; Pandey et al., 2007; Turnšek, 1997), the Valanginian faunas appear largely isolated (Table 3).

Systematic paleontology

The taxonomic framework applied here is based on the works by Milne Edwards and Haime (1857), Duncan (1884), Vaughan and Wells (1943), Alloiteau (1952, 1957), Wells (1956), Eliášová (1990), Baron-Szabo (2014, 2021c) for higher-level taxa (family), with updates on individual genera and species by Baron-Szabo (2014, 2021b) and Morycowa and Roniewicz (2016). Because the suborders of Vaughan and Wells (1943) are neither monophyletic nor do they conform with recent molecular results, they are no longer useful and are, therefore, excluded from the

(See figure on next page.)

Fig. 7 **A** *Actinastrea pseudominima* (Koby, 1897), NMSG Coll. PK 02.10.33c; calicular view of colony, thin section; scale bar: 1.5 mm. **B** *Complexastrea zolleriana* (Quenstedt, 1879), NMSG Coll. PK 02.10.20a; calicular view of colony in *Latiphyllia*-type stage, thin section; scale bar: 3.5 mm. **C** *Complexastrea zolleriana* (Quenstedt, 1879), NMSG Coll. PK 02.10.20a; upper surface of colony, lateral view; scale bar: 5 mm. **D** *Complexastrea zolleriana* (Quenstedt, 1879), NMSG Coll. PK 02.10.20b; calicular view of colony in *Coenotheca–Complexastrea*-type stage, thin section; scale bar: 4 mm. **E** *Complexastrea zolleriana* (Quenstedt, 1879), NMSG Coll. PK 02.10.36; calicular view of colony in *Montlivaltia–Coenotheca*-type stage, polished surface; scale bar: 5 mm. **F** *Complexastrea zolleriana* (Quenstedt, 1879), NMSG Coll. PK 02.10.36; calicular view of colony in *Montlivaltia–Coenotheca*-type stage, polished slab; scale bar: 5 mm. **G** *Montlivaltia truncata* (Defrance, 1817), NMSG Coll. PK 02.10.25a; calicular view, polished; scale bar: 3 mm. **H** *Montlivaltia truncata* (Defrance, 1817), NMSG Coll. PK 02.10.25a-l; calicular view, polished, slightly oblique; scale bar: 6.5 mm. **I** *Montlivaltia truncata* (Defrance, 1817), NMSG Coll. PK 02.10.22d; polished surface of oblique lateral-calicular view, polished; scale bar: 5 mm. **J** *Montlivaltia truncata* (Defrance, 1817), NMSG Coll. PK 02.10.25a (= 25a-l); upper surface of corallum, lateral view, slightly oblique; scale bar: 5 mm

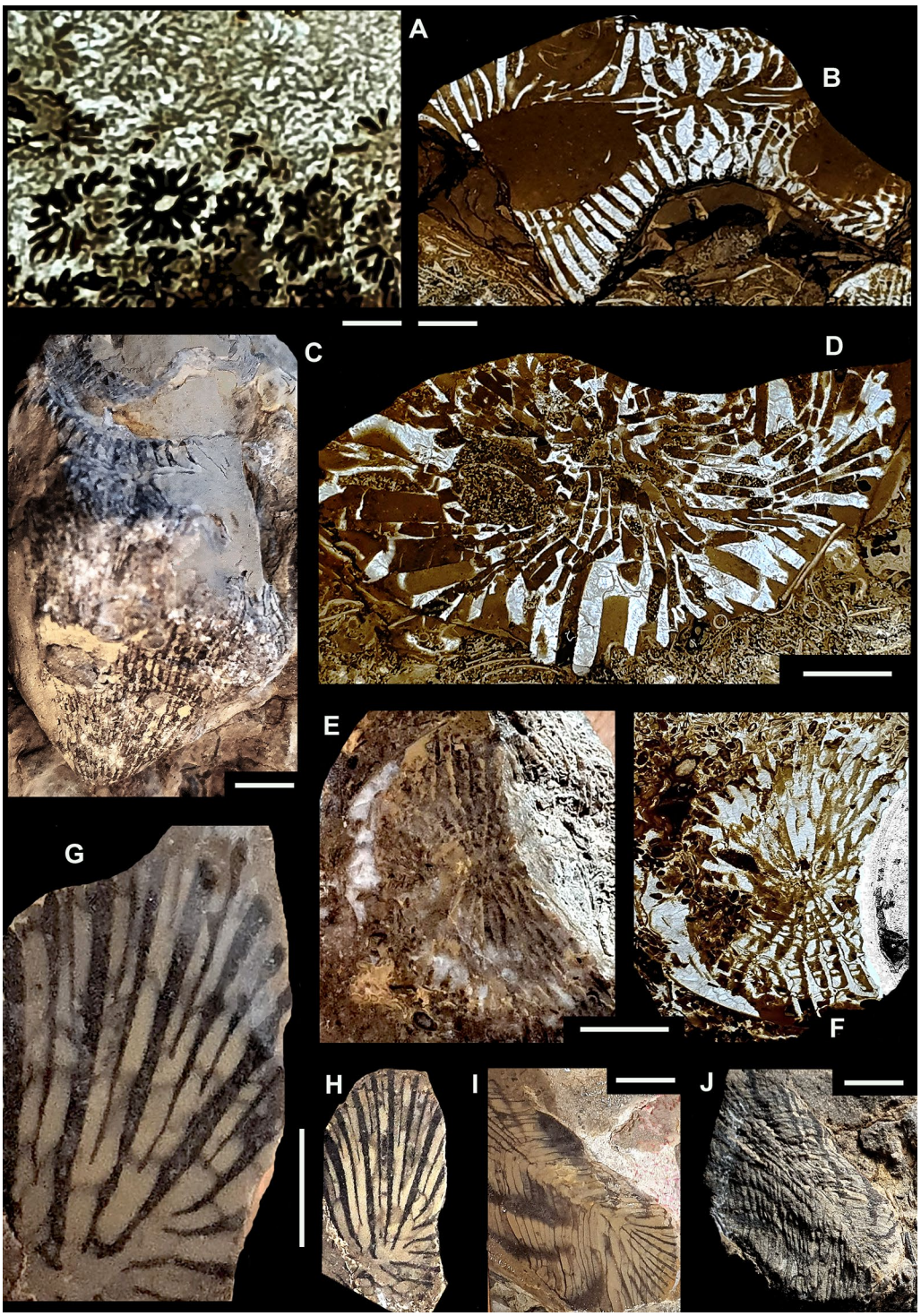

Fig. 7 (See legend on previous page.)

taxonomic framework. Because the taxonomy of scleractinian corals is in a transitional phase (Scleractinian Treatise is in progress; an increasing number of contradicting taxonomic approaches have been applied [see discussion in Kołodziej & Marian, 2021]; etc.), in the current work, the taxonomic framework is based on levels no higher than family (excluding superfamily and higher). For further information on excluded taxonomic frameworks of scleractinian corals see Baron-Szabo (2021b).

Family Actinastreidae Alloiteau, 1952

Remarks. In some recent publications (e.g., Garberoglio, et al., 2020; Löser, 2012), material was grouped with the family Actinastreidae that showed characteristics of families such as Columastreidae, Cladophylliidae, and others (e.g., Baron-Szabo, 2014, p. 20; and discussion in Baron-Szabo, 2021b under *Cladophyllia crenata*). Therefore, a combination of the family concepts by Alloiteau (1954) and Baron-Szabo (2014) is followed.

Genus *Actinastrea* d'Orbigny, 1849

Type species. *Actinastrea goldfussi* d'Orbigny, 1850a, 1850b, Maastrichtian of The Netherlands (Maastricht).

Diagnosis. Corallum colonial, often massive to subcolumnar, cerioid, cerio-plocoid. Budding extracalicular and extracalicular-marginal. Corallites small and prismatic in outline, often directly united by their walls. Columella styliform or short-lamellar. No intercalicinal coenosteum. Synapticular structures present peripherally. Paliform structures occasionally present. Endothecal dissepiments thin, sometimes arranged forming an innercorallite ring which is complete or incomplete. Septa compact, generally non-confluent, radially or bilaterally arranged, beaded marginally, and composed of a series of simple trabeculae, varying in diameter (up to 150 µm). Septal flanks covered by spiniform granulae. Wall septothecal to septoparathecal, with occasionally occurring pores (lacunes).

***Actinastrea pseudominima* (Koby,** 1897)

Fig. 7A

v*1897 *Astrocoenia pseudominima*, Koby, 1896: Koby, p. 59, Pl. 15, Figs. 4–4a [topotypes studied].
nonv1926 *Astrocoenia pseudominima* Koby: Dietrich, p. 93, Pl. 6, Fig. 9.
v1936 *Astrocoenia pseudominima* Koby, 1896: Hackemesser, 1936, p. 71, Pl. 7, Fig. 14.
non1961 *Actinastraea* cf. *pseudominima* Koby: Bendukidze, p. 8.
v1964 *Actinastraea pseudominima* (Koby, 1896): Morycowa, p. 18–20, Pl. 1, Fig. 2–5, Pl. 2, Fig. 2.
v1971 *Actinastraea pseudominima pseudominima* (Koby, 1896): Morycowa, p. 33–37, Pl. 1, Fig. 1–2, Pl. 3, Fig. 1, Pl. 4, Fig. 1, Pl. 5, Fig. 3, Text-Figs. 6A, 11–12.
1977 *Actinastrea* cf. *pseudominima* (Koby, 1896): Sikharulidze, p. 69–71, Pl. 7, Fig. 1.
non1985 *Actinastrea pseudominima* (Koby, 1897): Geyer & Rosendahl, p. 167, Pl. 2, Fig. 1.
1988 *Actinastraea pseudominima* (Koby, 1896): Kuzmicheva & Aliev, p. 154, Pl. 1, Fig. 1a–b.
nonv1989 *Actinastrea* cf. *pseudominima* (Koby, 1896): Löser, p. 98–99, Pl. 21, Fig. 1, Text-Fig. 3.
nonv1992b *Actinastraea pseudominima* (Koby, 1896): Eliášová, 1992b, p. 402, Pl. 5, Fig. 3.
v1995 *Actinastraea pseudominima* (Koby, 1896): Abdel-Gawad & Gameil, 1995, p. 8, Pl. 4, Figs. 3–6.
1998 *Actinastrea* aff. *pseudominima* (Koby, 1897): Morycowa & Masse, p. 738, Fig. 10.2.
v2003 *Actinastrea* aff. *pseudominima* (Koby, 1897): Baron-Szabo, et al., 2003 p. 201, Pl. 36, Figs. 5–6.
2009 *Actinastrea pseudominima* (Koby, 1897): Filkorn & Pantoja-Alor, p. 23–25, Figs. 9.1–8 (older synonyms cited therein).
v2018 *Actinastrea pseudominima* (Koby, 1897): Baron-Szabo, p. 30, Pl. 1, Fig. A.
v2021b *Actinastrea pseudominima* (Koby, 1897): Baron-Szabo, p. 31, Pl. 1, Fig. C–D.

Dimensions of skeletal elements. Diameter of corallites: 1–2.2 mm, in areas of intense budding it can be 0.8 mm; distance of corallite centers: 1.1–2.7 mm; septa/corallite: 24, in corallites in areas of intense budding: 12.

Description. Small massive to subramose, cerioid to cerio-plocoid colony with often prismatic corallites. Costosepta arranged in 3 complete cycles in 6 systems in largest corallites. Columella styliform or short-lamellar. Endothecal dissepiments thin. Wall paraseptothecal to septothecal.

Type locality of species. Aptian of Switzerland (Reignier).

Distribution. Upper Berriasian (upper Őhrli Formation; Rotsteinpass, Lisengrat, Alpstein area) and lower Valanginian of northeastern Switzerland (Vitznau Marl, Wart, this paper), lower Barremian of Georgia (in Caucasia) and Turkmenistan, Barremian of Azerbaijan and Poland, upper Barremian–lower Aptian of Switzerland (Schrattenkalk Formation, Tierwis area) and France, lower Aptian of Mexico and Romania, upper Aptian of Iran, Aptian of Switzerland (Reignier), Albian of Egypt.

Material. NMSG Coll. PK–02.10.33c.

Remarks. In having 10–12 septa, the material described as *A.* cf. *pseudominima* from the Hauterivian of Crimea in Bendukidze (1961) differs from Koby's species. In having corallite diameters that are significantly larger than 2 mm, the material described in Dietrich (1926, p. 93) from the Lower Cretaceous of Tanzania differs from the species *A. pseudominima.* The specimens described from the upper Cenomanian of Germany (Löser, 1989, p. 98–99) and from the upper Cenomanian–lower Turonian of the Czech Republic (Eliášová, 1992b, p. 402) are more closely related to *A. tourtiensis* (Bölsche, 1871). For additional synonyms of the species *A. pseudominima*, see Paleobiology Database (paleobiodb.org).

Family Thecosmiliidae Duncan, 1884

Genus *Complexastrea* d'Orbigny, 1850b

Type species. *Complexastrea subburgundiae* d'Orbigny, 1850b, Jurassic ('Corallien') of France.

Diagnosis. Colonial, often massive to subhemispherical, subbranching to subflabellate during various stages of astogeny, present or absent. Polyp integration astreoid, plocoid to cerio-plocoid; submeandroid to thamnasterioid integration during various stages of astogeny present or absent. Budding intracalicular and extracalicular. Costosepta compact, non-confluent to confluent, granulated and carinate laterally. Their axial ends can be rhopaloid. Columella absent or formed by weakly parietal structures. No pali. Synapticulae absent. Intertrabecular distance ranging between 200 and 1300 µm. Endothecal dissepiments pass from one corallite to the next, they are vesicular, cellular, or tabuloid. Wall absent or paraseptothecal.

***Complexastrea zolleriana* (Quenstedt,** 1879)

Figs. 7B–F

*1879 *Coenotheca zolleriana*: Quenstedt, p. 609, Pl. 165 figs. 36-43.
(v)1996 *Complexastrea zolleriana* (Quenstedt): Lathuilière, p. 597, Pl. 72, Fig. 1–18, Pl. 73, Fig. 1–13, Pl. 74, Fig. 1–4, Pl. 75, Fig. 1–7, Text-Figs. 5–6, 8–11 [older synonyms cited therein].
pars(v)2003 *Montlivaltia decipiens* (Goldfuss 1826): Pandey & Fürsich, p. 42–43, Pl. 10, Fig. 7–10, [?Pl. 8, Fig. 6].
(v)2003 *Latiphyllia* cf. *confluens* (Quenstedt, 1843): Pandey & Fürsich, p. 44–46, Pl. 11, Fig. 1.
(v)2003 *Coenotheca zolleriana* Quenstedt, 1881: Pandey & Fürsich, p. 46–48, Pl. 11, Fig. 2–6.

Dimensions. Great diameter of corallites: 10–30 mm; in areas of intense budding around 8 mm; septa/corallite: up to around 100, in corallites in areas of intense budding around 20; septa/mm: 3–9/5; distance of corallite centers: 5–21 mm; septal thickness ranges between 100 and 1300 µm.

Description. Individual specimens are in various transgeneric stages including (1) cerio-plocoid to astreoid corallites in subflabellate arrangement (resembling *Latiphyllia*); (2) small submassive clumps consisting of a few polyps in subplocoid to submeandroid-thamnasterioid arrangement (resembling *Coenotheca*); and (3) tall corallum with subplocoid corallites (resembling *Thecosmilia*); costosepta straight to very wavy; endothecal dissepiments numerous, large vesicular peripherally, cellular to vesicular in central areas of corallum.

Type locality of species. Middle Jurassic ("Brauner Jura gamma") of Germany (Hohenzollern).

Distribution. Middle Jurassic of France, Germany, and Iran, lower Valanginian of northeastern Switzerland (Vitznau Marl, Wart; this paper).

Material. NMSG Coll. PK–02.10.20a, 20b (=02.10.21a), and 20c; –02.10.21c; –02.10.25a-II; –02.10.27c-A. –02.10.27c-B; –02.10.27d; –02.10.36; ?–02.10.38.

Remarks. Based on a population study including Middle Jurassic thecosmiliid corals, Lathuilière (1996) established a morphogenesis framework for the genus *Complexastrea* using individuals that, with regard to the dimensions of their

(See figure on next page.)

Fig. 8 **A** *Placophyllia* cf. *dianthus* (Goldfuss, 1826), NMSG Coll. PK 02.10.26a; calicular view, polished surface; scale bar: 2.5 mm. **B** *Placophyllia* cf. *dianthus* (Goldfuss, 1826), NMSG Coll. PK 02.10.26a; calicular view, thin section; scale bar: 2.5 mm. **C** *Placophyllia* cf. *dianthus* (Goldfuss, 1826), NMSG Coll. PK 02.10.27a; calicular view, polished surface; scale bar: 2.5 mm. **D** *Placophyllia* cf. *florosa* Eliášová, 1976b, NMSG Coll. PK 02.10.28a; calicular view, polished surface; scale bar: 3 mm. **E** *Placophyllia* cf. *florosa* Eliášová, 1976b, NMSG Coll. PK 02.10.31a; calicular view, thin section; scale bar: 2.5 mm. **F** *Dermosmilia* sp., NMSG Coll. PK 02.10.32a; calicular view, thin section; scale bar: 3.5 mm. **G** *Fungiastraea lamellosa* (de Fromentel, 1857), NMSG Coll. PK 02.10.16b; upper surface of colony, calicular view; scale bar: 4 mm. **H** *Fungiastraea lamellosa* (de Fromentel, 1857), NMSG Coll. PK 02.10.28h; calicular view, thin section; scale bar: 2 mm. **I** *Actinaraea tenuis* Morycowa, 1971, NMSG Coll. PK 02.10.30e; calicular view of colony, thin section; scale bar: 2 mm. **J** *Actinaraea tenuis* Morycowa, 1971, NMSG Coll. PK 02.10.28e; calicular and longitudinal view of colony, polished surface; scale bar: 3.5 mm. **K** *Latiastrea mucronata* Sikharulidze, 1979, NMSG Coll. PK 02.10.22 g; calicular view of colony, polished surface; scale bar: 3 mm. **L** *Latiastrea mucronata* Sikharulidze, 1979, NMSG Coll. PK 02.10.22 g; close-up of Fig. M, scale bar: 1 mm. **M** *Latiastrea mucronata* Sikharulidze, 1979, NMSG Coll. PK 02.10.22 g; calicular view, thin section; scale bar: 2 mm

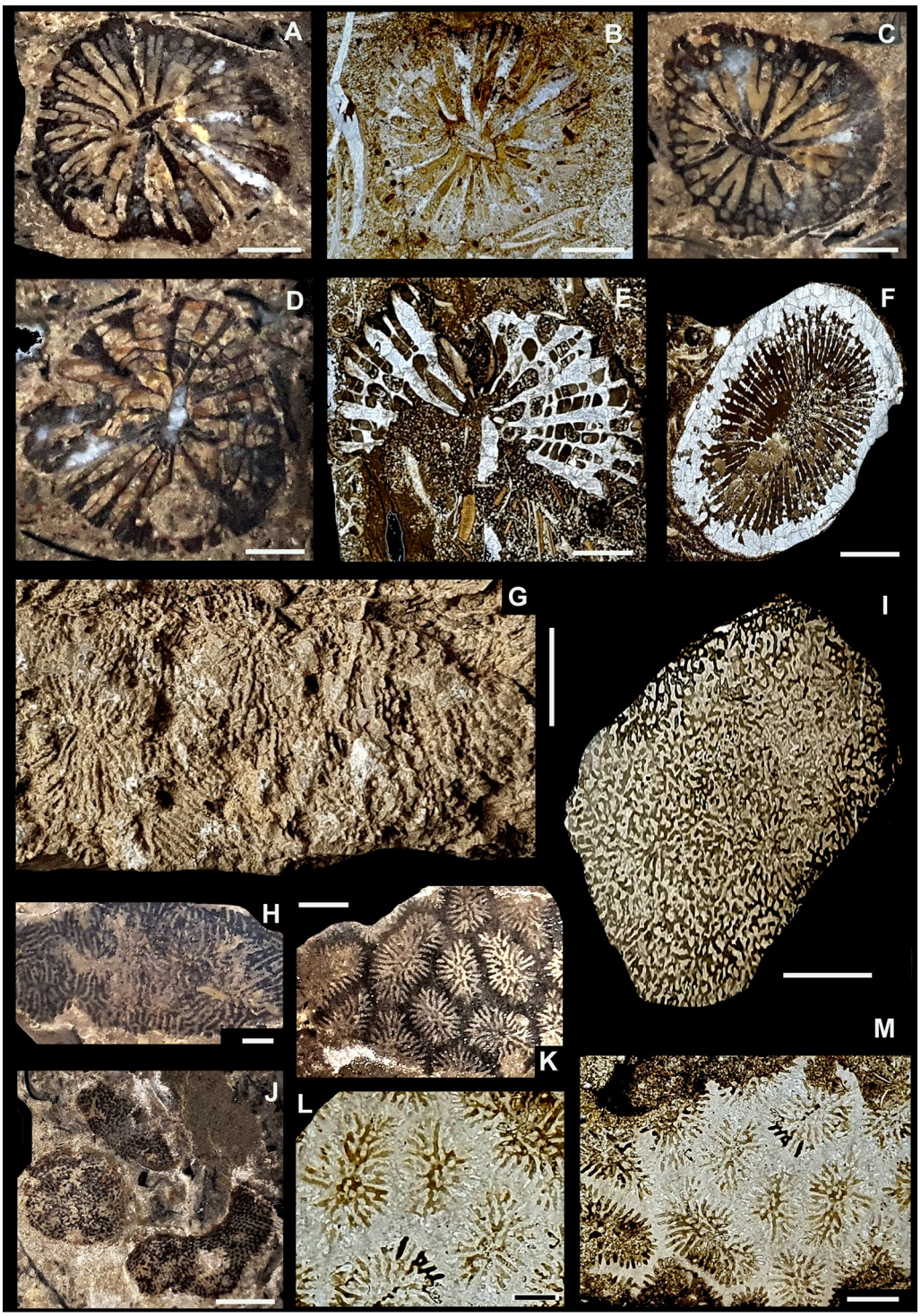

Fig. 8 (See legend on previous page.)

skeletal elements, correspond to the species *zolleriana*. He came to the conclusion that during various stages of astogeny forms of the genus *Complexastrea* show morphological overlaps with several other thecosmiliid genera such as *Coenotheca, Latiphyllia, Montlivaltia*, and *Thecosmilia*. As a result, specimens that might show close resemblance to one of these genera are grouped with *Complexastrea*. While this approach has not been accepted by some authors (e.g.,

Pandey & Fürsich, 2003), it is followed here based on the fact that the genus *Complexastrea* shows features that clearly distinguishes it from the genera with which it shows morphological convergence during different stages of astogeny. In having both extracalicular budding in addition to intracalicular multiplication and a paraseptothecal wall, *Complexastrea* differs from genera such as *Latiphyllia* and *Thecosmilia* (=characterized by intracalicular multiplication and the lack of septothecal thickenings). In its early ("solitary") stage, *Complexastrea* closely resembles the solitary genus *Montlivaltia* but shows features such as (1) cerio-plocoid shapes and often paraseptothecal developments in the peripheral areas; (2) a rather flat to cupolate corallum; and (3) the presence of budding spots ("generator septa" and "linking septa" sensu Lathuilière [1996, Text-Fig. 10A–B]) from which new corallites develop, closely corresponding to the situation in other genera such as the cunnolitid genus *Aspidastraea* which can be misinterpreted for the solitary genus *Cunnolites* in its early stages of astogeny (Baron-Szabo, 2003). In contrast to the "*Montlivaltia*"- stage of *Complexastrea*, the genus *Montlivaltia* is variably conical (rarely subdiscoidal-patellate in certain environments), and lacks both septothecal thickenings and budding spots. The genus *Coenotheca* very closely corresponds to the juvenile stage of *Complexastrea* and is, therefore, considered to be a junior synonym of *Complexastrea*.

Individual specimens from the Vitznau Marl correspond to different morphotypes of the species *C. zolleriana*. The specimen NMSG Coll. PK-02.10.20a resembles the "*Latiphyllia*" variation as shown in Lathuilière (1996, Pl. 72, Figs. 8 and 15, and Text-Fig. 10A–B); the specimens NMSG Coll. PK-02.10.20c, 02.10.25a-II, and 02.10.36 show close affinities to the "*Coenotheca*" morphotype as shown in Lathuilière (1996, Pl. 72, Figs. 7 and 10); the specimen NMSG Coll. PK-02.10.20b (=02.10.21a) resembles the "*Thecosmilia*" variation as shown in Lathuilière (1996, Pl. 72, Fig. 5); the specimen NMSG Coll. PK-02.10.21c corresponds to a mix of transgeneric stages including variation of "*Complexastrea–Coenotheca–Thecosmilia*" as shown in Lathuilière (1996, Pl. 73, Fig. 5–8); and the specimens NMSG Coll. PK-02.10.27c-A and B, and –02.10.27d show close affinities to early stages of astogeny of *Complexastrea*, corresponding to a mix of "*Coenotheca–Montlivaltia*" morphotypes as shown in Lathuilière (1996, Pl. 72, Figs. 3 and 6).

Genus *Montlivaltia* Lamouroux, 1821

Type species. *Montlivaltia caryophyllata* Lamouroux, 1821, Middle Jurassic (Upper Bathonian) of Calvados.

Diagnosis. Solitary, trochoid to subcylindrical, or turbinate, rarely (subdiscoidal-) patellate. Costosepta compact, thin to thick, exsert, in general numerous and crowded. Columella absent. Intertrabecular distance ranging between 200 and 1300 µm. Endothecal dissepiments abundant, vesicular. Epitheca sensu lato membraniform or absent.

***Montlivaltia truncata* (Defrance, 1817)**
Figs. 7G–J

*1817 *Caryophyllia truncata*: Defrance, vol. 7, p. 198.
v1954 *Montlivaltia truncata* (Defrance) 1817: Geyer, 1954, p. 174 [older synonyms cited therein].
(v)1977 *Montlivaltia truncata* Defrance, 1817: Beauvais, *in* Beauvais & M'Rabet, p. 109, Pl. 1, Fig. 3a–b, Pl. 2, Fig. 2 [older synonyms cited therein].
(v)1977 *Montlivaltia sioufensis* nov. sp.: Beauvais, *in* Beauvais & M'Rabet, p. 112, Pl. 3, Fig. 1.
(v)1994 *Montlivaltia xizangensis* Liao et Xia: Liao & Xia, p. 158, Pl. 43, Figs. 9–14 and 20–23.
v2018 *Montlivaltia truncata* (Defrance, 1817): Baron-Szabo, p. 38–39, Pl. 2, Figs. I–J [older synonyms cited therein].

Dimensions. Corallite diameter at top of corallum (d x D): 12 × 18 mm (estimated); d/D = 0.67; diameter at basal part of corallum (d x D): 10 × 12 mm (estimated); d/D = 0.83; septa at top of corallum; probably 96; septa at basal part: around 40; septa/mm (peripheral area of corallite): 7–10/5; height of corallum: at least 35 mm.

Description. Incomplete solitary, turbinate, corallum; septa straight, regularly alternate in length and thickness, probably developed in 5 complete cycles in 6 systems at top of corallum; endothecal dissepiments numerous, long, mainly vesicular; membraniform epitheca sensu lato present.

Type locality of species. Upper Jurassic of France.

Distribution. Upper Jurassic of France, Germany, and Switzerland, upper Oxfordian of Azerbaijan and Georgia (in Caucasus), upper Oxfordian–lower Tithonian of Russia, Kimmeridgian of Portugal, Berriasian of central Tibet, upper Berriasian of northern Tunisia and northeastern Switzerland (upper Őhrli Formation), lower Valanginian of northeastern Switzerland (Vitznau Marl, Wart; this paper).

Material. NMSG Coll. PK–02.10.25a (=02.10.22d).

Remarks. Because the specimen is incomplete the full range of its dimensions of skeletal elements can only be estimated. The dimensions found in the Swiss material closely correspond to the ones of *M. truncata*.

The species *M. truncata* was recently discussed and revised (Baron-Szabo, 2018). For further synonyms of the species *M. truncata*, see Paleobiology Database (paleobiodb.org).

Family Placophylliidae Eliášová, 1990
Genus *Placophyllia* d'Orbigny, 1849

Type species. *Lithodendron dianthus* Goldfuss, 1827, Upper Jurassic of Germany (Giengen).

Diagnosis. Colonial, mainly phaceloid, can be subdendroid or fasciculate with plocoid to cerioid polyp outlines in younger colonies. Budding extracalicular and intracalicular-marginal. Costosepta compact, septal flanks covered by small granules. Distal edge of septa smooth. In closely packed corallites costae may be subconfluent. Columella lamellar. Synapticulae and pali absent. Intertrabecular distance ranging between 40 and 130 µm in septa. Corallite wall parathecal, irregular. Septothecal thickenings present or absent. Endothecal dissepiments vesicular in peripheral corallite areas and subtabulate in axial corallite areas. Epithecal sensu lato wall folded.

***Placophyllia* cf. *dianthus* (Goldfuss, 1826)**
Figs. 8A–C

v*1826 *Lithodendron dianthus*: Goldfuss, p. 45, Pl. 3, Fig. 8.
v1876 *Placophyllia*? *rugosa* Beck.: Becker, p. 140, Pl. 38, Fig. 9a–b (older synonyms cited therein).
1985 *Placophyllia dianthus* (Goldfuss, 1826): Rosendahl, p. 49, Pl. 1, Fig. 10.
1989 *Placophyllia cf. dianthus (Goldfuss): Beauvais, p. 295.*
1990 *Placophyllia rugosa* Becker, 1876: Eliášová, p. 121, pl. 2, Fig. 1.
v1991 *Placophyllia dianthus* (Goldfuss, 1826): Lauxmann, p. 155, Text–Fig. 15.
v1997 *Placophyllia rugosa* Becker, 1876: Turnšek, p. 153, Figs. 153A–F.
2003 *Placophyllia dianthus* (Goldfuss, 1826): Kołodziej, p. 213, Fig. 27 [older synonyms cited therein].
2005 *Placophyllia* cf. *dianthus* (Goldfuss, 1826): Morycowa & Mišik, 2005, p. 420, Fig. 3.5.
2008 *Placophyllia rugosa* Becker, 1876: Roniewicz, p. 104, Figs. 6E–F.
v2018 *Placophyllia dianthus* (Goldfuss, 1826): Baron-Szabo, p. 48, Pl. 5, Fig. A–B, D–E [older synonyms cited therein].

Dimensions of skeletal elements. Diameter of corallites: 7–9 mm; number of septa: 32–36.

Description. Fragments of a phaceloid colony; corallites subcircular to subpolygonal in outline; costosepta developed in 3 to 4 size orders; lamellar columella generally attached to septa at either one or both ends of longer axis; septothecal thickenings present frequently but peripheral area of corallite often abraded.

Type locality of species. Upper Jurassic of Germany (Giengen).

Distribution. Upper Jurassic of Germany and Sumatra, Oxfordian of Slovakia, upper Oxfordian–lower Kimmeridgian of Poland, upper Oxfordian–Kimmeridgian of Georgia (in Caucasus), Russia, and Slovenia, lower Kimmeridgian of Portugal, Kimmeridgian of Croatia, Kimmeridgian–Berriasian of Bulgaria, upper Tithonian–lower Berriasian of the Czech Republic (Štramberk limestone) and Poland (Štramberk-type limestone), upper Berriasian (upper Őhrli Formation [=Oerfla Formation]) of western Austria and eastern Switzerland, lower Valanginian of northeastern Switzerland (Vitznau Marl, Wart; this paper), ?Valanginian of Poland (according to Kołodziej [2003, p. 213], material belonging to *P. dianthus* was collected from sediments of the Sub-Silesian Nappe, Outer Carpathians, which have a questionable Valanginian age).

Material. NMSG Coll. PK–02.10.22b; –02.10.23a (=02.10.29a); –02.10.26a; –02.10.27a.

Remarks. Because the Swiss material represents only small, fragmented colonies, the total dimensions of skeletal elements cannot be determined.

***Placophyllia* cf. *florosa* Eliášová,** *1976b*
Figs. 8D–E

v*1976b *Placophyllia florosa* n. sp: Eliášová, p. 339, Pl. 3, Figs. 1–2.
2018 *Placophyllia* cf. *florosa* Eliášová, 1976: Ricci, *et al.*, 2018, p. 451–453, Pl. 7, Fig. 1a–1c.

Dimensions of skeletal elements. Diameter of corallites: 14–19 mm; number of septa: up to around 48.

Description. Fragments of a phaceloid colony; corallites subcircular to subpolygonal in outline; costosepta developed in 3 to 4 size orders; lamellar columella often thick, generally attached to septa at either one or both ends of longer axis; septothecal thickenings present frequently but peripheral area of corallite often abraded.

Type locality of species. Tithonian–lower Berriasian of the Czech Republic (Štramberk limestone).

Distribution. Kimmeridgian–Tithonian of Italy, Tithonian–lower Berriasian of the Czech Republic (Štramberk

limestone), lower Valanginian of northeastern Switzerland (Vitznau Marl, Wart; this paper).

Material. NMSG Coll. PK–02.10.22c; –02.10.28a; –02.10.28b (=02.10.30b); –02.10.31a.

Remarks. Because the Swiss material represents only small, fragmented colonies, the total dimensions of skeletal elements cannot be determined.

Family Dermosmiliidae Koby, 1887
Genus *Dermosmilia* Koby, 1884

Type species. *Dermosmilia crassa* Dacqué, 1933, Upper Jurassic (Rauracian) of Switzerland (subsequent designation Dacqué, 1933).

Diagnosis. Colonial, dendroid, phaceloid, fasciculate, subflabellate. Corallites nearly circular to subflabellate in outline. Budding intracalicular, di- to polystomodaeal, complete. Corallites united only basally. Costosepta generally compact to subcompact, sometimes irregularly perforated, straight or irregularly wavy, laterally granulated. Anastomosis present or absent. When present, septa may be arranged during various stages of ontogeny in a pattern resembling the kinds seen in micrabaciid or dendrophylliid genera (similar to Pourtalès plan). Columella spongy-papillose or formed by fusion of trabecular prolongations of axial ends of septa. Synapticulae present. Intertrabecular distance ranging between 80 and 300 µm. Endothecal dissepiments thin, vesicular to subtabulate. Wall parathecal to parasynapticulothecal, often secondarily thickened.

Remarks. The above given diagnosis for *Dermosmilia* is based on both the study of material from Caquerelle and Sante-Ursanne strata from various localities of the Koby collections housed at the museums in Basel and Bern, and the information provided by Koby (1884, p. 194–195, Pl. 50, Figs. 1–6).

***Dermosmilia* sp.**
Fig. 8F

Dimensions. Diameter of corallite: 12 × 17 mm; septa/corallite: around 80.

Description. Fragment of a branching colony; corallite elongate in outline; septa thin, nearly equal in thickness, rather straight, developed in unclear size orders.

Material. NMSG Coll. PK–02.10.32a.

Remarks. Because only one corallite is available, the branching angle cannot be determined. Based on the dimensions seen in the Swiss material, it could belong to species such as *D. laxata*, *D. etalloni*, or *D. arborescens*.

Family Haplaraeidae Vaughan & Wells, 1943
Genus *Actinaraea* d'Orbigny, 1849

Type species. *Agaricia granulata* Münster, *in* Goldfuss, 1829, Upper Jurassic of Germany (Nattheim).

Diagnosis. Colonial, massive, folios, thamnasterioid, including ploco- to cerio-thamnasterioid. Budding intracalicular (-marginal). Corallites embedded in a coenosteum that is generally porous to reticulate. Costosepta few in number with irregular perforations, septal flanks granular. No paliform structures. Columella generally feebly developed, parietal, lamellar, substyliform. Synapticulae present. Intertrabecular distance ranging between 80 and 180 µm. Endothecal dissepiments thin, tabulate. Wall absent or incomplete synapticulothecal.

Subgenus. *Camptodocis* Dietrich, 1926 (*Type species. C. brancai* Dietrich, 1926, Barremian–lower Aptian of Tanzania): Having the characteristics of *Actinaraea* but calices are not independent from perithecal colony tissue (similar as in *Actinacis*), corallites therefore with variably ploco- to cerio-thamnasterioid integration types.

***Actinaraea tenuis* Morycowa,** 1971
Figs. 8I–J

(v)*1971 *Actinaraea tenuis* n. sp.: Morycowa, p. 128–130, Pl. 35, Fig. 1a–d, Pl. 36, 1a–c, Text-Fig. 37.
1980 *Actinaraea tenuis* Morycowa, 1971: Kuzmicheva, p. 106–107, Pl. 39, Fig. 4a–b.
non1984 *Actinaraea* sp. aff. *A. tenuis* Morycowa, 1971: Scott, p. 344, Pl. 2, Figs. 12–13.
1992 Actinaraea cf. A. tenuis Morycowa, 1971: *Turnšek,* 1992, *p. 164, Fig. 2 .*
v1996 *Actinaraea tenuis* Morycowa, 1971: Wilmsen, 1996, p. 361, Pl. 4, Fig. 3.
1996 *Actinaraea tenuis* Morycowa, 1971: Császár & Turnšek, p. 430, Fig. 7(6).
v1997 *Actinaraea tenuis* Morycowa, 1971: Baron-Szabo, p. 79, Pl. 12, Fig. 1–2 [older synonyms cited therein].
2003 *Actinaraea tenuis* Morycowa, 1971: Turnšek, *et al.,* p. 179, Figs. 12A–B.
v2014 *Actinaraea tenuis* Morycowa, 1971: Baron-Szabo, p. 53, Pl. 58, Fig. 3 Pl. 59, Fig. 1–2.
v2021b *Actinaraea tenuis* Morycowa, 1971: Baron-Szabo, p. 54, Pl. 8, Fig. A.

Dimensions. Corallite diameter: 1–1.7 mm; distance of corallite centers: 2.3–4.5 mm; septa/corallite: up to around 24; septa/mm: 6–8/2; synapticulae (longitudinal view)/mm: 3–4/1.

Description. Submassive to foliose, thamnasterioid colony; corallites subdistinct to indistinct, regularly

disposed over the colony; septa confluent to subconfluent; 6–8 septa reach corallite center; columella substyliform or made of a small number of thin, twisted segments.

Type locality of species. Lower Aptian of Romania (Valea Izvorul Alb).

Distribution. Lower Valanginian of northeastern Switzerland (Vitznau Marl, Wart; this paper), Valanginian of Hungary, Hauterivian of Georgia (in Caucasus), Barremian–lower Aptian of Serbia, Barremian–Aptian of Slovenia, upper Barremian–lower Aptian of western Austria (Schrattenkalk Formation, Vorarlberg), lower Aptian of Romania and southern Germany (Upper Schrattenkalk, Bavaria), middle Albian of the USA (New Mexico), lower Cenomanian of Spain, lower Coniacian of Austria (Gosau Group at Brandenberg).

Material. NMSG Coll. PK–02.10.14b; –?02.10.16a; –02.10.23e (=02.10.29e); –02.10.26c; –02.10.26c-1; –02.10.28e; –02.10.30e; –02.10.37a.

Remarks. Information regarding material of Scott (1984) see Appendix Table 5.

Family Latomeandridae Alloiteau, 1952

Genus *Fungiastraea* Alloiteau, 1952

Type species. *Fungiastraea laganum* Alloiteau, 1952, Upper Turonian of France (Uchaux, Vaucluse).

Diagnosis. Colonial, massive, thamnasterioid to submeandroid. Budding intracalicular, occasionally extracalicular. Corallite centers distinct. Septa compact to subcompact, confluent, moderately granulated and pennulated laterally. Sub- to non-confluent septa sparse, occurring in areas of extracalicular budding. Columella spongy, papillose, or variably shaped when columellar trabeculae fuse. Paliform structures absent. Synapticulae present. Intertrabecular distance ranging between 90 to around 350 µm. Endothecal dissepiments thin, vesicular to subtabulate. No wall between corallites but parasynapticulothecal developments circumscribing some parts of corallites sometimes present.

***Fungiastraea lamellosa* (de Fromentel,** 1857)

Figs. 8G–H

v*1857 *Thamnastraea lamellosa*: de Fromentel, p. 61.
v1887 *Centastraea lamellosa*: de Fromentel, 1887, p. 617, Pl. 187, Fig. 1–1c .
1914 *Centastraea lamellosa: de* Fromentel: Felix, 1914, *p. 55.*
non1998 *Fungiastraea lamellosa* (de Fromentel, 1857): Löser, p. 180.
non2001 *Dimorphastrea* cf. *lamellosa* (de Fromentel, 1857): Löser, p. 46.

Dimensions. Diameter of corallites (monocentric): 2–3 mm, in areas of intense budding around 1.5 mm; distance of corallite centers: 2–4 mm; septa/corallite: 18–24+s, in corallites in areas of intense budding around 12; septa/mm: 5–8/2.

Description. Thamnasterioid-submeandroid colony; corallites irregularly disposed or arranged in short-meandroid series; septa subequal in thickness; up to 6 septa reach corallite center; columella made of a small number of papillae or twisted segments.

Type locality of species. Lower Hauterivian of France (Yonne).

Distribution. Lower Valanginian of northeastern Switzerland (Vitznau Marl, Wart; this paper), lower Hauterivian of France (Yonne).

Material. NMSG Coll. PK–02.10.16b; –02.10.28h.

Remarks. In having larger dimensions of skeletal elements (corallite diameter: 2.5–4 mm; septa/corallite: 25–30; septa/mm: 8/2), the material from the lower Cenomanian of Germany provisionally assigned to *lamellosa* in Löser (1998) differs from de Fromentel's species. In forming a dimorphastreid corallum and having smaller dimensions of skeletal elements (septa/corallite: 16–20 (24); septa/mm: 5–6/2), the material from the lower Hauterivian of France provisionally assigned to the species *lamellosa* in Löser (2001) differs from de Fromentel's species. The Swiss material corresponds well to the syntype of the species *F. lamellosa* (MNHN.F.M03558).

Genus *Latiastrea* Beauvais, 1964

Type species. *Latiastrea foulassensis* Beauvais, 1964, Upper Jurassic (Kimmeridgian) of France (Valfin-les-Saint-Claude).

Diagnosis. Colonial, massive, cerioid to meandroid. Budding intracalicular. Corallites prismatic, elongate, monocentric, or temporarily dicentric (to ?polycentric) during budding processes, or arranged in meandroid series. Costosepta non-confluent to subconfluent, with rare perforations on axial ends of septa. Anastomosis present. Rudimentary young septa alternate with old ones. Septal flanks are ornamented with large, spiniform granulae. Pennulae present. Distal margins covered with small, regularly developed rounded denticles. Synapticulae present. Columella parietal-spongy, sometimes forming elongate segments. Intertrabecular distance ranging between 100 to around 200 µm. Endothecal dissepiments thin, vesicular. Wall synapticulothecal and septothecal.

***Latiastrea mucronata* Sikharulidze,** 1979

Figs. 8K–M.

(v)*1979 *Latiastraea mucronata* Sikh., sp. nov.: Sikharulidze, p. 37, Pl. 3, Fig. 4–4a, Pl. 23, Pl. 24, Fig. 1a–b.
1996 *Latiastraea mucronata* Sikharulidze, 1979: Császár & Turnšek, p. 434, Fig. 26.
v1999 *Latiastraea mucronata* Sikharulidze, 1979: Baron-Szabo & González-León, p. 490, Fig. 6e.
(v)2002 *Latiastrea mucronata* Sikharulidze, 1979: Morycowa & Marcopoulou-Diacantoni, p. 53, Figs. 34F, G.
v2003 *Latiastraea mucronata* Sikharulidze, 1979: Baron-Szabo & González-León, p. 220, Fig. 9D, F.
v2018 *Latiastrea mucronata* Sikharulidze, 1979: Baron-Szabo, p. 66, Pl. 9, Fig. A.

Dimensions of skeletal elements. Diameter of corallite (monocentric): 2–4 mm; distance of corallite centers: 2–4.5 mm; septa/corallite (monocentric): up to around 30; septa/mm: 7–8/2.

Description. Massive, cerioid colony; septa are subequal in thickness, irregularly alternate in length; columella often made of elongate segments.

Type locality of species. Albian of Georgia (in Caucasus).

Distribution. Upper Berriasian (upper Őhrli Formation [=Oerfla Formation]) of western Austria, lower Valanginian of northeastern Switzerland (Vitznau Marl, Wart; this paper), Valanginian of Hungary, upper Aptian–lower Albian of Mexico, Albian of Georgia (in Caucasus) and Greece.

Material. NMSG Coll. PK–02.10.22e (=02.10.30a); –02.10.22g.

Genus *Thamnoseris* de Fromentel, 1861

Type species. *Thamnoseris incrustans* de Fromentel, 1861, Middle Jurassic of France (Chaumont, Saint Claude, French Jura).

Diagnosis. Colonial, massive, hemispherical, cerio-thamnasterioid, corallites arranged in short-meandroid series present or absent. Budding extracalicular-marginal. Costosepta confluent, irregularly perforated, granulate and probably pennulate laterally. Anastomosis frequently present. Columella parietal-papillose. Synapticulae numerous. Endothecal dissepiments vesicular, thin. Intertrabecular distance ranging between 120 and ca. 240 µm. Wall synapticulothecal, incomplete.

Thamnoseris cf. *carpathica* Morycowa, 1971

Figs. 9A–B

v*1971? *Thamnoseris carpathica* n. sp.: Morycowa, p. 106–108, Pl. 28, Fig. 1a–e.
nonv1981 *Thamnoseris carpathica* Morycowa, 1971: Turnšek, in Turnšek & Mihajlović, p. 29, Pl. 31, Fig. 4–5.
1988 *Thamnoseris carpathica* Morycowa, 1971: Kuzmicheva & Aliev, 1988 p. 169, Pl. 5, Fig. 4a–b.
2006 *Thamnoseris carpathica* Morycowa, 1971: Morycowa & Decrouez, p. 810–812, Pl. 9, Figs. 5–7. [older synonyms cited therein]
2021b *Thamnoseris carpathica* Morycowa, 1971: Baron-Szabo, Appendix Tables 2–5, and 7–12.

Dimensions. Diameter of corallites: 2–4.5 mm, in areas of intense budding around 1.5 mm; distance of corallite centers: 2.5–5 mm, in areas of intense budding the distance is around 1.5 mm; septa/corallite: 20 to around 32, in corallites in areas of intense budding 12; septa/mm: 6–7/2.

Description. Fragment of a massive, cerio-thamnasterioid colony; corallites isolated or arranged in short-meandroid series; septa subequal in thickness; up to around 12 septa reach corallite center.

Type locality of species. Lower Aptian of Romania (Valea Izvorul Alb).

Distribution. Lower Valanginian of northeastern Switzerland (Vitznau Marl, Wart; this paper), Barremian of

(See figure on next page.)

Fig. 9 **A** *Thamnoseris* cf. *carpathica* Morycowa, 1971, NMSG Coll. PK 02.10.37b; calicular view of colony, polished surface; scale bar: 2 mm. **B** *Thamnoseris* cf. *carpathica* Morycowa, 1971, NMSG Coll. PK 02.10.37b; oblique longitudinal view of colony, polished surface; scale bar: 1 mm. **C** *Adelocoenia parvistella* Alloiteau, 1961, NMSG Coll. PK 02.10.29d (=23d); calicular view of colony, thin section; scale bar: 2 mm. **D** *Adelocoenia parvistella* Alloiteau, 1961, NMSG Coll. PK 02.10.29d (=23d); close-up of Fig. C; scale bar: 1 mm. **E** *Adelocoenia parvistella* Alloiteau, 1961, NMSG Coll. PK 02.10.23d (=29d); upper surface of colony, calicular view, partially polished; scale bar: 2 mm. **F** *Pleurophyllia* ? *tobleri* (Koby, 1896), NMSG Coll. PK 02.10.15; calicular view of corallum, polished surface; scale bar: 1 mm. **G** *Pleurophyllia* ? *tobleri* (Koby, 1896), NMSG Coll. PK 02.10.20d; calicular view of corallum, upper surface; scale bar: 1 mm. **H** *Cyathophora claudiensis* Étallon, 1859, NMSG Coll. PK 02.10.22a; calicular view of colony, thin section; scale bar: 4 mm. **I** *Cyathophora claudiensis* Étallon, 1859, NMSG Coll. PK 02.10.22a; upper surface of colony, calicular view; scale bar: 10 mm. **J** *Cyathophora claudiensis* Étallon, 1859, NMSG Coll. PK 02.10.29b (=23b); calicular view of colony, thin section; scale bar: 3 mm. **K** Stylophyllid indet., NMSG Coll. PK 02.10.14c (=13) longitudinal view of corallum, oblique, polished surface; green arrows indicate septa; orange arrow indicates corallite wall; scale bar: 4 mm. **L** *Stylophyllopsis silingensis* (Liao, 1982), NMSG Coll. PK 02.10.35l; calicular view of colony, thin section; scale bar: 2 mm

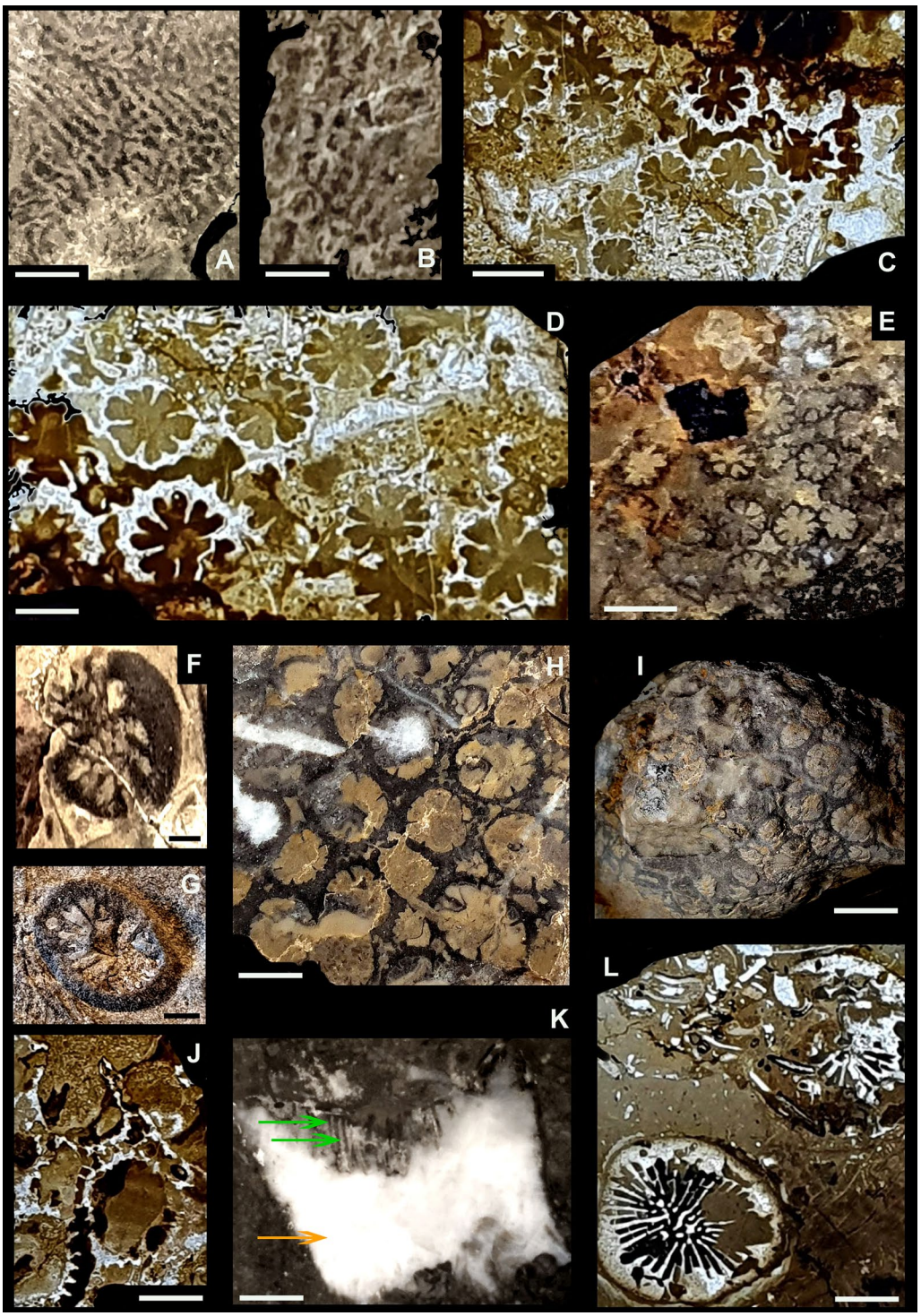

Fig. 9 (See legend on previous page.)

Azerbaijan, lower Aptian of Romania (Valea Izvorul Alb) and Switzerland (Upper Schrattenkalk of Hergiswil).

Material. NMSG Coll. PK–02.10.37b.

Remarks. The material described as *Thamnoseris carpathica* from the Barremian–lower Aptian of eastern Serbia (Turnšek & Mihajlović, 1981) has just recently been transferred to the genus *Thalamocaeniopsis,* grouping

it with the species *Th. stricta* (Milne Edwards & Haime) (see Baron-Szabo, 2021b). Because the Swiss material represents only a fragment of a colony, the total dimensions of the skeletal elements cannot be determined. The skeletal features observed correspond to the species *Th. carpathica*.

Family Stylinidae d'Orbigny, 1851
Genus *Adelocoenia* d'Orbigny, 1849

Type species. *Astrea castellum* Michelin, 1844, Upper Jurassic of France (neotype designation Lathuilière, et al., 2020).

Diagnosis. Colonial, massive to subhemispherical, small knobby, plocoid corallum. Septa compact, free, bicuneiform, costate, non-confluent, often straight, unequal in length, arranged mainly radially; bilateral arrangement might occur as a result of elongation of both calices and calicular fossae. Septal ornamentation very weak or smooth when covered by thickening deposits. Secondary trabecular axes irregularly emerge from the mid-septal plan toward the septal faces. Pali and synapticulae absent. Endotheca made of tabulae or tabuloid dissepiments, rarely vesicular. Peritheca made of vesicular dissepiments. Columella absent but a clear central subcircular fossa present (in neotype of type species, in one out of 32 corallites, however, structures are present which may or may not correspond to a columella). Intertrabecular distance up to around 100 µm. Wall parathecal, developed in continuity with thickening deposits of septa.

***Adelocoenia parvistella* Alloiteau,** 1961
Figs. 9C–E

v*1961 *Adelocoenia parvistella*: Alloiteau, p. 289, pl. 9 fig. 5; pl. 10 fig. 9.
v1972 *Pseudocoenia slovenica* n. sp.: Turnšek, 1972: p. 20 and 83, Pl. 4, Fig. 1–2, Pl. 5, Figs. 1–4.
1976 *Pseudocoenia slovenica* Turnšek, 1973: Roniewicz, p. 48, pl. 5 fig. 5.
1981 *Pseudocoenia slovenica* Turnšek, 1972: Eliášová, 1981 p. 125, pl. 8 figs. 3–4.
1985 *Pseudocoenia slovenica* Turnšek: Rosendahl, p. 34, pl. 3 fig. 2.
1990 *Pseudocoenia slovenica* Turnšek, 1972 Errenst, p. 168, pl. 3 fig. 1.
v1997 *Pseudocoenia slovenica* Turnšek, 1972: Turnšek, p. 171, Figs. A–F.
2001 *Pseudocoenia* cf. *slovenica* Turnšek, 1972: Laternser, 2001 p. 162.
2002 *Pseudocoenia slovenica* Turnšek, 1972 Kashiwagi, *et al*., 2002 p. 10, fig. 5.2.
pars?2003 *Pseudocoenia slovenica* Turnšek, 1972: Pandey & Fürsich, p. 27, pl. 5 fig. 5; pl. 6 fig. 1–6.
non2003 *Pseudocoenia* cf. *slovenica* Turnšek, 1972: Pandey & Fürsich, p. 27, pl. 4 fig. 4.
2015 *Pseudocoenia slovenica* Turnšek: Kołodziej, 2015, p. 182.
v2020 *Adelocoenia parvistella* Alloiteau, 1961: Lathuilière, *et al.*, p. 381–382, Figs. 15–16 [older synonyms cited therein]

Dimensions. Diameter of corallites: 1–1.8 mm; in areas of intense budding the diameter is around 0.8 mm; distance of corallite centers: 1.2–2 mm, in areas of intense budding the distance is around 0.8 mm; septa/corallite: 12 (6s1 + 6s2); costae/corallite: 12 and higher.

Description. Small massive to knobby colony; corallites circular to subcircular in outline, regularly disposed over the colony; costosepta developed in 2 complete cycles in 6 systems, regularly alternating in length and thickness; number of costae is equal to or slightly larger than number of septa; columella absent but in a small number of corallites trabecular extensions of axial ends of septa reach corallite center where they might fuse, forming a pseudo-columella.

Type locality of species. Upper Jurassic (Tithonian) of Spain (La Querola).

Distribution. Upper Jurassic of Armenia and Japan, Oxfordian of Germany and France, upper Oxfordian of Romania, Oxfordian–Kimmeridgian of Slovenia, lower Kimmeridgian of Romania, Kimmeridgian–Tithonian of Spain, Tithonian of Portugal, Tithonian–lower Berriasian of the Czech Republic and Poland, lower Valanginian of northeastern Switzerland (Vitznau Marl, Wart; new material this paper).

Material. NMSG Coll. PK–02.10.20f; –02.10.23d (= 02.10.29d); –02.10.27b; –02.10.28c and 28d; –02.10.29f; –02.10.30d; –02.10.32b.

Remarks. In *Adelocoenia parvistella,* auriculae are present which clearly distinguishes it from genera such as *Cyathophora* (including its junior synonym *Cryptocoenia*). This represents an important fact, since Alloiteau (1958) also erected a species *Cryptocoenia parvistella*, using material from the Cretaceous of Madagascar (MNHN.F.M05039; and thin sections). Because the latter is here considered to belong to *Cyathophora*, the species is not a junior homonym.

Some of the specimens from the Jurassic of Iran assigned to this species *A. slovenic*a by Pandey and Fürsich (2003, p. 27), are considered as *Solenocoenia* (such as material shown on their pl. 6, Fig. 5). In addition, it should be noted that these authors place within *A. slovenica*

material having dimensions that significantly differ from *A. slovenica* (e.g., specimen SNSB-BSPG 1999 VIII 874: corallite diameter: 1.5–2.3 mm; and specimen SNSB-BSPG 1999 VIII 1085: corallite diameter: 1.5–2.6 mm). The consequence of such a wide grouping would be a much wider stratigraphic range for this species.

Family Amphiastreidae Ogilvie, 1897
Genus *Pleurophyllia* De Fromentel, 1856

Type species. *Pleurophyllia trichotoma* De Fromentel, 1856, Upper Jurassic of France (Mantoche).

Diagnosis. Colonial, phaceloid. Budding intracalicinal. Septa compact, smooth laterally, arranged bilaterally. One major septum extends to the axial region of the corallite. Septal cycles indistinct. Costae and columella absent. Intertrabecular distance ranging between 90 and ca. 160 µm. Endothecal dissepiments thin. Multilamellate epithecal sensu lato wall possibly present.

***Pleurophyllia* ? *tobleri* (Koby,** 1896)
Figs. 9F–G

parsv*1896 *Cladophyllia Tobleri*, Koby, 1896: Koby, p. 42, Pl. 7, Fig. 5 (non Fig. 4–4a)
2008 *Pleurophyllia* aff. *cara* Eliášová, 1975: Roniewicz, p. 97, Fig. 3B.
v2014 *Pleurophyllia tobleri* (Koby, 1896): Baron-Szabo, p. 82, Text–Fig. 21.
v2018 *Pleurophyllia tobleri* (Koby, 1896): Baron-Szabo, p. 81, Pl. 12, Figs. C–D [older synonyms cited therein].

Dimensions. Corallite diameters: 4–6 mm; septa/corallite (monocentric): around 16.

Description. Fragments of a branching colony; corallites very elongate in outline; septa arranged bilaterally, irregularly alternate in length and thickness.

Type locality of species. Upper Berriasian (upper Őhrli Formation) of Switzerland (Canton Uri: Schöner Culm).

Distribution. Upper Berriasian (upper Őhrli Formation; Canton Uri: Schöner Culm)–lower Valanginian of northeastern Switzerland (Vitznau Marl, Wart; this paper), Valanginian of Bulgaria.

Material. NMSG Coll. PK–02.10.15; –02.10.20d.

Remarks. Because only colony fragments are available, the total range of dimensions of skeletal elements cannot be determined. The skeletal elements that are present correspond well to the species *P. tobleri*.

Family Cyathophoridae Vaughan & Wells, 1943
Genus *Cyathophora* Michelin, 1843

Type species. *Cyathophora richardi* Michelin, 1843, Upper Jurassic of France (lectotype designation Zaman & Lathuilière, 2014).

Diagnosis. Colonial, massive, columnar, hemispherical, knobby, plocoid, cerio-plocoid to cerioid in areas of closely spaced corallites. Budding extracalicular. Corallites circular to subpolygonal in outline, separated by a narrow costate peritheca. Costosepta compact, generally non-confluent to subconfluent, occasionally confluent, radially arranged. Sizes of septa range from very short (less of a quarter of the lumen size) to half the lumen size, in which case septa reach the axial region where they sometimes fuse. Axial ends of S1 are vertically discontinuous. No columella. No synapticulae. No pali. Endothecal and exothecal dissepiments tabulate, well-developed. Wall parathecal and septothecal.

***Cyathophora claudiensis* Étallon,** 1859
Figs. 9H–J

*1859 *Cyathophora claudiensis*: Étallon, p. 479.
1897 *Cyathophora claudiensis* Ét.: Ogilvie, p. 176, Pl. 16, Figs. 11–12.
v1954 *Cyathophora claudiensis* Étallon, 1859: Geyer, 1954 p. 137, Pl. 9, Fig. 12.
1970 *Amphiphora serannensis* nov. sp.: Alloiteau & Bernier, 1970 p. 926–927, Pl. 28, Figs. 1–3.
1976 *Cyathophora claudiensis* Étallon, 1859: Roniewicz, p. 44–45, Pl. 4, Fig. 1–b [older synonyms cited therein].

(See figure on next page.)
Fig. 10 **A** *Heterocoenia inflexa* (Eichwald, 1865–69), NMSG Coll. PK 02.10.31d; calicular view of colony, polished surface; scale bar: 1.25 mm. **B** *Heterocoenia inflexa* (Eichwald, 1865–69), NMSG Coll. PK 02.10.31d; upper surface of colony, calicular and oblique views; scale bar: 8 mm. **C** *Aplosmilia semisulcata* (Michelin, 1843), NMSG Coll. PK 02.10.29h; calicular view of branch, polished surface; scale bar: 3.5 mm. **D** *Aplosmilia semisulcata* (Michelin, 1843), NMSG Coll. PK 02.10.29h; calicular view of branch, thin section; scale bar: 3 mm. **E** *Aplosmilia semisulcata* (Michelin, 1843), NMSG Coll. PK 02.10.29h; calicular view of corallites in advanced budding stage, polished surface; scale bar: 3 mm. **F** *Stylophyllopsis silingensis* (Liao, 1982), NMSG Coll. PK 02.10.25b; calicular view of branch, slightly oblique, polished surface; scale bar: 2 mm. **G** *Stylophyllopsis silingensis* (Liao, 1982), NMSG Coll. PK 02.10.29c (= 23c); calicular view of branch, slightly oblique, polished surface; scale bar: 2 mm. **H** *Stylophyllopsis silingensis* (Liao, 1982), NMSG Coll. PK 02.10.35l; close-up of Pl. 3, Fig. L; scale bar: 6 mm. **I** *Axosmilia villersensis* (Koby, 1898), NMSG Coll. PK 02.10.10; calicular view of corallum, thin section; younger cycle septa are preserved in only some parts of the corallum; scale bar: 3 mm. **J** *Stylophyllopsis silingensis* (Liao, 1982), NMSG Coll. PK 02.10.35h; calicular view of juvenile corallite, thin section; scale bar: 1 mm

1982 *Cyathophora claudiensis* Étallon, 1859: Bendukidze, 1982 p. 7, Pl. 1, Fig. 5.
nonv1991 *Cyathophora claudiensis* Étallon, 1859: Lauxmann, p. 114–115.
(v)2008 *Cyathophora* sp. 1: Roniewicz, p. 128, Figs. 16A–D.
2015 Cyathophora claudiensis: *Kołodziej, 2015 p. 183.*

Dimensions. Great diameter of corallites: 4.5–7 mm, in areas of intense budding around 3.5 mm; distance of corallite centers: 6–9 mm, in areas of intense budding the distance is around 4 mm; septa/corallite: 6 + 6 + 12.

Description. Massive to subhemispherical, plocoid to cerio-plocoid colony; corallites are circular to elongate in outline; costosepta are very short and spine-like, developed in two to three complete cycles in 6 systems.

Type locality of species. Upper Jurassic of France (Valfin).

Distribution. Upper Jurassic of France, upper Oxfordian of Poland and Russia, lower Kimmeridgian of Romania, lower Tithonian of Russia, Tithonian–Berriasian of Germany, Tithonian–lower Berriasian of the Czech Republic and Poland (Štramberk-type limestones at Polish Outer Carpathians), Tithonian and Valanginian of Bulgaria, lower Valanginian of northeastern Switzerland (Vitznau Marl, Wart; this paper),

Material. NMSG Coll. PK–02.10.22a; –02.10.23b (= 02.10.29b); –02.10.28g; –02.10.30c; –02.10.34.

Remarks. The dimensions of skeletal elements in the material reported from the Tithonian and Valanginian of Bulgaria (Roniewicz, 2008, p. 128, Figs. 16A–D) seem to be slightly larger than given in the original description (= corallite diameter: 5–6 mm; septa: 6 + 6 + nS3; but material shown on Figs. 16A–D seems to have corallite diameters of up to 7 mm and 24 septa), thus closely corresponding to *C. claudiensis*.

In having septa developed in more than 3 complete cycles in 6 systems, the material described from the Upper Jurassic of southern Germany as *C. claudiensis* in Lauxmann (1991) differs from the species *claudiensis* and more closely corresponds to the species *C. bourgueti*.

Family Stylophyllidae Frech, 1890
Genus *Stylophyllopsis* Frech, 1890

Type species. *Stylophyllopsis polyactis* Frech, 1890, Upper Triassic of Austria (Rhaetian, Zlambach Beds) (lectotype designation Roniewicz, 1989).

Diagnosis. Solitary and phaceloid. Budding intracalicular. Septal spines long, connected by stereome, resulting in subcompact septal blades that have large pores. Additional stereome layers might fuse the septal spines and cover endothecal dissepiments. In the septal spines axial rods or lamellae are present. Axial ends of septa dissociate, forming septal spines. Distal edge of septa coarsely denticulate. Columella formed by isolated septal spines. Endothecal dissepiments vesicular to subtabulate; large and vesicular in peripheral area of corallite. Peripheral, large-vesicular dissepimentarium irregularly present. Microstructure made of bundles of fiber. Epitheca sensu lato present.

***Stylophyllopsis silingensis* (Liao, 1982)**
Fig. 9L, Figs. 10F–H, J

*1982 *Donacosmilia silingensis* Liao (sp. nov.): Liao, p. 166, Pl. 14, Figs. 1–2.
1994 *Donacosmilia silingensis* Liao: Liao & Xia, p. 78, Pl. 8, Figs. 5–6.

Dimensions. Great diameter of corallites: 6–11 mm; small diameter of corallites: 5–7 mm; septa/corallite: 32 to around 46.

Description. Phaceloid colony; corallites subcircular to elongate in outline; septa generally straight, arranged bilaterally in 4 to 5 size orders, irregularly alternating in length and thickness; up to around 20 septa reach corallite center; columella weakly developed.

Type locality of species. Hauterivian of Tibet (Xainza County; Toiba Formation).

Distribution. Lower Valanginian of northeastern Switzerland (Vitznau Marl, Wart; this paper), Hauterivian of Tibet.

Material. NMSG Coll. PK–02.10.23c (= 02.10.29c); –02.10.25b; –02.10.35c (= 02.10.35f and 35f-II); –02.10.35d (= 02.10.35g); –02.10.35e (= 02.10.35h); –02.10.35l.

Remarks. Study of the lectotype of the type species of *Stylophyllopsis* Frech (*S. polyactis* [SNSB-BSPG-AS-XII-53]) in 2020 by one of the authors (RBS) revealed that, in addition to previously reported skeletal features, it also shows a peripheral, large-vesicular dissepimentarium in some places.

In having (1) septa made of spines that are connected or dissociated; (2) large and vesicular dissepiments in the

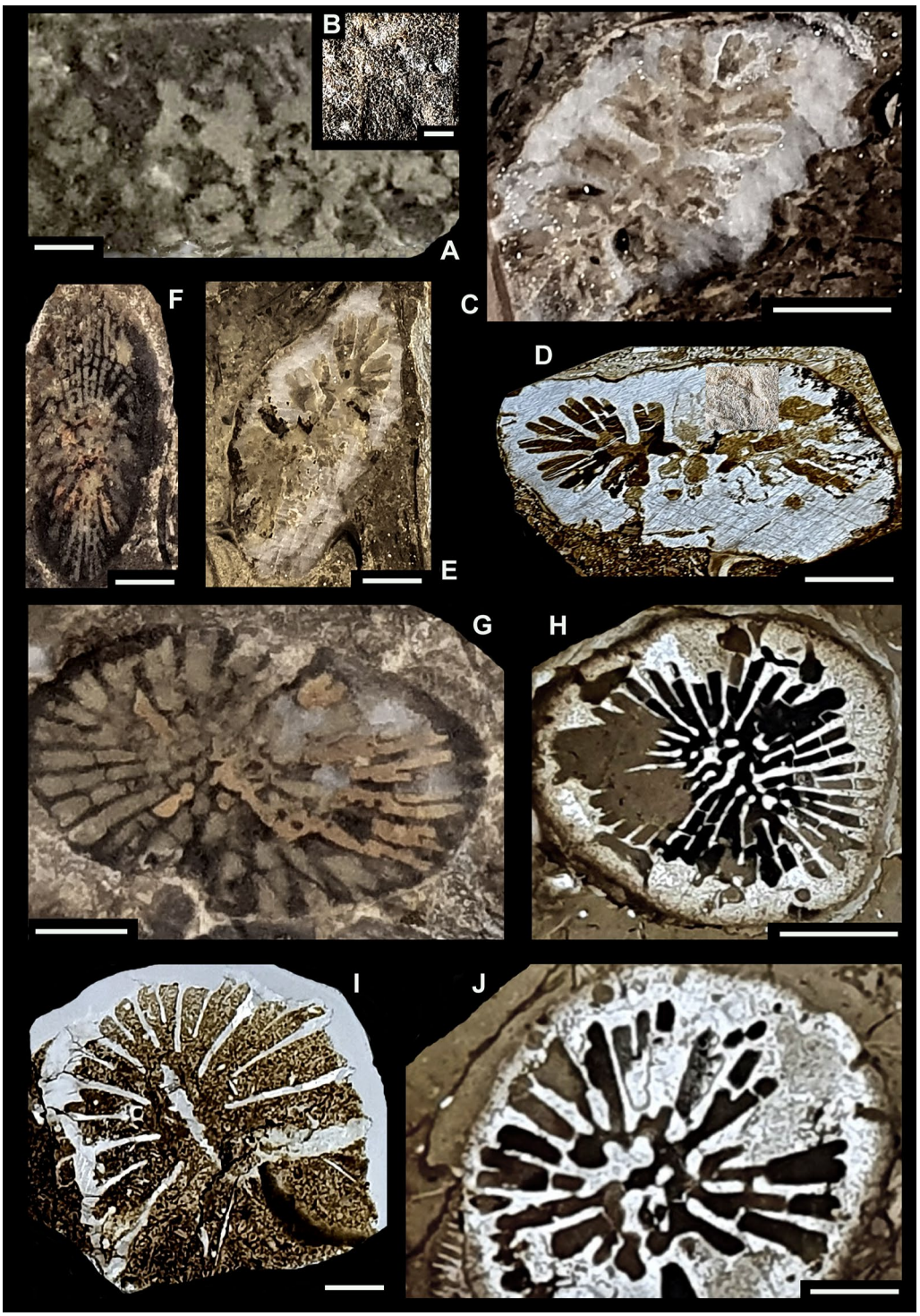

Fig. 10 (See legend on previous page.)

peripheral area of the corallite; (3) an epithecal sensu lato wall; (4) axial ends of septa that dissociate, forming septal spines; (5) a columella formed by isolated septal spines; and (6) lamellae that occur in some of the septal spines,

the material described as *Donacosmilia silingensis* from the Hauterivian of Tibet closely corresponds to the genus *Stylophyllopsis*. The Swiss specimens show very close resemblance to the Tibetan type material as presented in Liao (1982) and Liao and Xia (1994).

Stylophyllid indet.
Fig. 9K

Dimensions. ?Great diameter of corallum: 10–22 mm; septa/ mm: 6–7/2.

Description. Fragments of ?solitary coralla showing stylophyllid structures; corallites subcircular to elongate in outline; septa developed in probably 5 size orders which irregularly alternate in thickness; the material might belong to solitary genera such as *Macgeopsis*.

Material. NMSG Coll. PK–02.10.13 (=02.10.14a); –02.10.17; –02.10.18a (=02.10.19).

Remarks. Because only incomplete specimens are available, neither the full range of dimensions of skeletal elements nor whether they belong to solitary or colonial forms can be determined. However, based on characteristics that can be identified, the material shows correspondence to solitary taxa such as *Macgeopsis*.

Family Heterocoeniidae Oppenheim, 1930
Genus *Heterocoenia* Milne Edwards & Haime, 1848b

Type species. *Lithodendron exiguum* Michelin, 1847, Santonian of France.

Diagnosis. Colonial massive, hemispherical, foliose, encrusting, ramose, plocoid, cerio-plocoid, (sub-) fasciculate; subphaceloid to reptoid when developments of coenosteum reduced. Budding extracalicular, extracalicular-marginal, and by septal division often dividing the corallite in three new ones ("trinity-arrangement" sensu Baron-Szabo, 2014). Corallites circular to elongate or irregularly polygonal in outline. They are directly united by their walls, or separated by extensive vesicular to dense coenosteum, or loosely connected by fragments of exotheca in form of traverses. Septa compact, arranged in various symmetries (e.g., trimerally, hexamerally, bilaterally, indistinct). One main septum, with remaining septa sometimes reduced to rudimentary spines. Costate zone present, weakly developed, or absent. Colony surface granulated or smooth. Columella, synapticulae, and paliform structures absent. Intertrabecular distance ranging between 60 and 120 μm in septa. Endothecal dissepiments thin, mainly tabulate to subtabulate, vesicular (often in peripheral and thecal areas). Exothecal dissepiments large vesicular. Wall often thick, possibly septothecal and paraseptothecal. Corallite wall tends to become more flaky, "bubbly" (cf. sclerenchymal deposits sensu Kołodziej, 1995, p. 4), and disintegrated during the process of budding.

***Heterocoenia inflexa* (Eichwald, 1865–69)**
Figs. 10A–B

*1865–69 *Stereopsammia inflexa* m.: Eichwald, vol. 2, p. 164, Pl. 11, Fig. 2a–b.
1888 *Latusastraea provincialis*, d'Orb. sp.: Solomko, Geyer 1954 p. 76–77.
1907 *Latusastraea ? inflexa* Eichw.: Karakash, p. 262.
2002 *Latusastraea exigua* Fromentel, 1862: Kuzmicheva, p. 126, Pl. 8, Fig. 3.
v2018 *Heterocoenia* cf. *inflexa* (Eichwald, 1865–69): Baron-Szabo, p. 84, Pl. 12, Fig. G.
v2021b *Heterocoenia inflexa* (Eichwald, 1865–69): Baron-Szabo, p. 77, Pl. 13, Fig. F.

Dimensions of skeletal elements. Great diameter of corallites: 1–1.8 mm, up to around 3 mm when wall exceptionally thick (around 0.5 mm or larger); great diameter of corallites (lumen): 0.8–1.8 mm; septa/corallite: 1–12; distance of corallite centers: 1.2–3 mm, in areas of intense budding around 1 mm.

Description. Small submassive to subramose colony; corallites plocoid to cerio-plocoid, cerioid when crowded, oval to irregularly shaped in outline, regularly disposed over the colony; septa arranged bilaterally; in some corallites, septal arrangement in 3 systems present; one major septum present; remaining septa highly irregularly developed including very thin and half the length of major septum, or very short, spine-like; axial end of major septum rhopaloid or cuneiform; costae short and thin, up to twice the number of septa.

Type locality of species. Valanginian–lower Hauterivian of Ukraine.

Distribution. Upper Berriasian (upper Őhrli Formation [=Oerfla Formation]) of western Austria, lower Valanginian of northeastern Switzerland (Vitznau Marl, Wart; this paper), Valanginian–lower Hauterivian of Ukraine, upper Barremian–lower Aptian of western Austria (Schrattenkalk Formation, Vorarlberg), lower Aptian of southern Germany (Upper Schrattenkalk, Bavaria).

Material. NMSG Coll. PK–2.10.31d (=2.10.32b).

Family Aplosmiliidae de Fromentel, 1861
Genus *Aplosmilia* d'Orbigny, 1849

Type species. *Lobophyllia semisulcata* Michelin, 1843, Jurassic of France (Verdun).

Diagnosis. Colonial, phaceloid. Corallites cylindrical to elliptical in outline. Budding intracalicular and? extracalicular. Septa compact, radially or bilaterally arranged, smooth distally. Lateral flanks of septa covered by sharp granulae. Flabelliform auriculae present. Lonsdaleoid and apophysal septa present or absent. Columella lamellar. Wall septoparathecal and parathecal. Pali and synapticulae absent. Intertrabecular distance ranging between 90 to around 250 µm. Endothecal dissepiments vesicular, mainly occurring in the vicinity of the wall, sometimes forming a stereozone. Tectura present or absent.

Aplosmilia semisulcata **(Michelin,** 1843**)**
Figs. 10C–E

v*1843 *Lobophyllia semisulcata*. N.: Michelin, p. 89, Pl. 17, Fig. 8.
v1850 *Aplosmilia semisulcata* (Michelin, 1843): d'Orbigny, vol. 2, p. 37.
v1880 *Aplosmilia semisulcata*, Michelin, sp.: Koby, p. 50–51, Pl. 8, Figs. 3–4a, Pl. 14, Figs. 1–2a.
v1976 *Aplosmilia semisulcata* (Michelin, 1843): Roniewicz, p. 82–83, Pl. 20, Figs. 3a–d.
1985 *Aplosmilia semisulcata* (Michelin, 1843): Geyer & Rosendahl, p. 167, Pl. 2, Fig. 7.
1991 *Aplosmilia semisulcata* (Michelin, 1843): Errenst, p. 3–4, Pl. 13, Fig. 2a–b. [older synonyms cited therein]
1991 *Aplosmilia semisulcata* (Michelin, 1843): Lebanidze, 1991 p. 38–39, Pl. 14, Figs. 3a–b, Text-Fig. 8a–b.
2003 *Aplosmilia cf. semisulcata* Michelin, 1843: Pandey & Fürsich, p. 116–118, Pl. 16 Figs. 7–9.

Dimensions. Great diameter of corallites: 7–12 mm; small diameter of corallites: 6.5–8 mm; in areas of intense budding around 2 mm; septa/corallite: 24 to around 40, in corallites in areas of intense budding around 16; septa/mm: 2–3/2.

Description. Branches of a phaceloid colony; corallites subcircular to elongate in outline; septa developed in 3 to 4 size orders, regularly alternating in length and thickness; lamellar columella preserved deeper in corallum.

Type locality of species. Jurassic of France (Verdun).

Distribution. Jurassic of France, Bathonian–middle Callovian of Iran, Oxfordian of Montenegro, upper Oxfordian of Turkmenistan, upper Oxfordian–Kimmeridgian of Georgia (in Caucasus), lower Kimmeridgian of Portugal and Spain, Tithonian–lower Berriasian of the Czech Republic, upper Berriasian of southern Spain (Andalusia), lower Valanginian of northeastern Switzerland (Vitznau Marl, Wart; this paper).

Material. NMSG Coll. PK–02.10.29h; ?–02.10.35c-C.

Remarks. Because specimen 02.10.35c-C represents only a small fragment, the assignment to *A. semisulcata* is provisionally. For further synonyms of the species *A. semisulcata*, see Paleobiology Database (paleobiodb.org).

Family AxosmiliidaeGeyer, 1955
Genus *Axosmilia* Milne Edwards & Haime, 1848a

Type species. *Caryophyllia extinctorium* Michelin, 1841, Middle Jurassic (Bajocian) of France (Calvados).

Diagnosis. Solitary, attached by small base or free. Corallite variably conical, elliptical in outline. Costosepta compact, generally free and straight, arranged bilaterally, regularly developed in cycles, granulated laterally. One first cycle septum often fused to columella. Columella lamellar. Distal margin of septa weakly ornamented, showing a zigzag pattern, especially visible in thin septa. Endothecal dissepiments vesicular. Paliform structures and synapticulae absent. Intertrabecular distance ranging between 150 to around 500 µm. Wall made of stereozone and enlarged costae that are fused to each other. Microstructure characterized by mid-septal zigzag line. Epithecal *s.l.* wall folded.

Axosmilia villersensis **(Koby,** 1898**)**
Fig. 10I

*1898 *Pleurosmilia villersensis*, Koby, 1897: Koby, p. 89–90, Pl. 22, Figs. 2–7.
non1936 *Pleurosmilia villersensis* Koby: Alloiteau, p. 507, Pl. 36, Figs. 1–3.
1981 *Axosmilia villersensis* (Koby, 1898): Turnšek in Turnšek & Mihajlović, p. 22, Pl. 20, Figs. 1–6.
1992 Axosmilia villersensis (Koby, 1898): Turnšek, p. 164, Fig. 2.
nonv1993 *Axosmilia villersensis* (Koby, 1898): Baron-Szabo, p. 160–161, Pl. 4, Fig. 4.
v1996 *Axosmilia villersensis* (Koby, 1898): Baron-Szabo & Steuber, p. 16–17, Pl. 5, Fig. 6.
2021 *Miscellosmilia* sp.: Löser, et al., p. 34, Figs. 41.1–2.

Dimensions. Diameter of corallite (d/D): 18 × 20 mm; d/D: 0.9; septa: around 70.

Description. Solitary, corallum incomplete; costosepta straight, developed in 4 to 5 size orders; one septum of S1 connected to lamellar columella.

Type locality of species. Valanginian of Switzerland (Villers).

Distribution. Valanginian of Switzerland (Villers), lower Valanginian of southern Spain and northeastern

Switzerland (Vitznau Marl, Wart; this paper), Barremian–lower Aptian of eastern Serbia, lower Aptian of Greece.

Material. NMSG Coll. PK–02.10.10.

Remarks. Some authors have grouped the species *Axosmilia almerai* Angelis d'Ossat, 1905, with *A. villersensis*. However, based on the study of type material it can be said that, in having a corallite diameter of 25 × 30 mm and septa of a little over 48, the species *almerai* more closely corresponds to *A. kobyi*. The material from both the Lower Cretaceous of France described in Alloiteau (1936) as *Pleurosmilia villersensis* and the Aptian of Spain described as *A. villersensis* in Baron-Szabo (1993) differ from Koby's species in having 5 complete or nearly complete septal cycles and a corallite that is 12 × 20 mm (d/D: 0.6) in diameter. In having skeletal features closely corresponding to the genus *Axosmilia* and dimensions of skeletal elements of corallite diameter of 17 × 20 mm (estimated) and septa developed in 4 to 5 size orders (around 80 septa), the material described from the lower Valanginian of southern Spain (Löser et al., 2021) shows very close affinities to *A. villersensis*.

Appendix

See Tables 5, 6, 7, 8 and Figs. 7, 8, 9 and 10.

Table 5 List of scleractinian corals reported from localities having stratigraphic ranges of the coral-bearing strata that are not yet clearly defined: Armenia (*Tithonian–Valanginian; Papoyan, 1982; **Valanginian–Hauterivian; Papoyan, 1989); Norway (Valanginian–Hauterivian; Svalbard, "Spitsbergen; Baron-Szabo, 2005); Poland (Sub-Silesian Nappe, Outer Carpathians; questionable Valanginian age; Kołodziej, 2003); South Africa (upper Valanginian–lower Hauterivian; Uitenhage; Kitchin, 1908); Spain (Berriasian–Valanginian; Andalusia; Geyer & Rosendahl, 1985); USA (Texas, Knowles Limestone; upper Berriasian–Valanginian; Scott, 1984)

Armenia	Norway	Poland	Spain	South Africa	USA (Texas)	Remarks
***Agathelia asperella*						
	Arctangia nathorsti					
					Actinaraea tenuis	In having a septal density of 11–13 septa/2 mm, the Texan material differs from the species *A. tenuis*
			Aulastreaopora sp.			
**Dermoseris delgadoi*						
**Dimorpharaea lineata*						
***Fungiastraea tendagurensis*						
***Glenarea jurenensis*						Taxon is in need of revision
			Hydnophora sp.			
		?*Intersmilia* sp.				
			Latiastraea sp			
***Microphyllia undans*						
**Microsolena exigua*						
***Microsolena crassisepta*						
		Mitrodendron cf. *modicum*				
		Pachythecophyllia eliasovae				
		Placophyllia dianthus				
***Stylina elegans*						
			Stylosmilia gracilis			
				Thamnasteria sp.		
**Thecosmilia dichotoma*						

Table 6 Overview of scleractinian corals previously described from Valanginian localities, their general type of corallite integration, and remarks on their taxonomic position

[1] (refers to locality 1 in Fig. 6)	
Valanginian; Mexico (Durango); Wells (1946); Sandy (1990)	
Taxon [corallite integration]	**Remarks**
***Montlivaltia coahuilensis* Wells, 1946** [none; solitary; conical]	
***Paretallonia hispaniensis* (Imlay, 1940)** [cerioid to cerio-plocoid]	Refers to material originally described as *Astrocoenia hispaniensis* (for further information see Paleobiology Database [paleobiodb.org])
***Placocoenia* sp.** [plocoid]	

[2.1] (refers to locality 2 in Fig. 6)	
Lower Valanginian; Spain (Internal Prebetic); Löser, et al. (2021) ("SpII") (note that assignment is based on illustrated material when significantly differed from information in text)	
Taxon [corallite integration]	**Remarks**
***Acrosmilia clava* (de Fromentel, 1857)** [none; solitary; conical]	Refers to material described as *Placoseris poculum* but differs from the species *poculum* in having a much larger corallite diameter (16 x 23 mm) and smaller number of septa (around 140) (corallite diameter of 13 x 15 mm and around 170 septa in the holotype of *poculum* [MNHN F.M03546]), but closely corresponds to the holotype of the species *clava* (corallite diameter 16 x 24 mm and around 140 septa in the holotype of *clava* [MNHN F.M03544])
***Actinastrea colliculosa* (Trautschold, 1886)** [cerioid to cerio-plocoid]	Refers to material described as *Stelidioseris* sp., shows actinastreid structures, (monocentric) corallite diameters of 1–2 mm, and septal arrangements in 6 and 10 systems, thus closely corresponding to *A. colliculosa*
***Adelocoenia sp.* 2** [plocoid]	Refers to material described as *Bilaterocoenia* sp. but shows skeletal structures closely resembling *Adelocoenia* (*Adelocoenia* was recently revised, see Lathuilière, et al., 2020)
***Amphiastrea basaltiformis* Étallon, 1864** [cerioid]	Includes material described as *Amphiastrea basaltiformis, Amphiastrea* cf. *basaltiformis,* and *Amphiastrea* sp.
***Amphiastrea paronai* Prever, 1909** [cerioid]	Refers to material described as *Amphiastrea* cf. *woodiae*
***Axosmilia villersensis* (Koby, 1898)** [none; solitary; conical]	Refers to material described as *Miscellosmilia* sp. (also see text)
***Baryhelia (Paronastraea)* sp. 2** [plocoid to cerio-plocoid]	In having apophysal septa and thorns, and a corallite wall typical of the heterocoeniids *s.l.,* the material described as *Solenocoenia gracilis* more closely corresponds to the genus *Baryhelia (Paronastraea)* (also see remarks in Appendix Table 6[1.1]) (for discussion on *Baryhelia* see Baron-Szabo, 2014)
***Baryphyllia gregaria* (d'Orbigny, 1850)** [plocoid to subbranching (subreptoid)]	In having subbranching (subreptoid) corallites and an incomplete thecal stereozone, the material described as *Ovalastrea caryophylloides* differs from *Ovalastrea* but closely corresponds to *Baryphyllia*
***Comoseris fromenteli* (de Loriol, 1868)** [thamnasterioid to meandroid]	Refers to material described as *Microsolena* sp. 1 but has corallites in meandroid series separated by collines and dimensions of skeletal elements closely corresponding to the species *C. fromenteli* [also see Appendix Table 2[4])
***Comoseris meandroides* (Koby, 1898)** [thamnasterioid-meandroid]	Refers to material described as *Eocomoseris* sp. 2 and *E.* sp. 4 but show corallites in meandroid series as in *Comoseris*, and dimensions of skeletal elements that closely correspond to *C. meandroides*
***Comoseris sequana* (de Fromentel, 1856)** [(cerio-) thamnasterioid to submeandroid]	Refers to material described as *Eocomoseris* sp. 3, *Meandraraea miyakoensis*, *Microsolena interjecta* but show corallites (ranging between nearly 2 to around 4 mm) in (cerio-) thamnasterioid to submeandroid arrangement, and up to around 24 sub- to non-confluent septa (characteristic of *Comoseris*) in monocentric corallites (characteristic of species *sequana*)

Table 6 (continued)

[2.2] (refers to locality 2 in Fig. 6)	
Lower Valanginian; Spain (Internal Prebetic); Löser, et al. (2021) ("SpII") (note that assignment is based on illustrated material when significantly differed from information in text)	
Taxon [corallite integration]	**Remarks**
***Complexastrea* sp.** [astreoid, plocoid, thamnasterioid to meandroid]	Refers to material described as *Clausastrea bolzei* but shows plocoid and astreoid corallites, thus closely corresponding to *Complexastrea*
***Confusaforma weyeri* Löser, 1987** [plocoid to cerio-plocoid]	Refers to material described as *Confusaforma prima* n. sp., but shows dimensions of skeletal elements closely corresponding to the species *weyeri*. In Löser, et al. (2021), the dimensions of corallite lumina of *C. prima* n. sp. are incorrectly compared to the whole corallite dimensions (=lumen and corallite wall) of the species *weyeri*. When the exact same parameters are compared, there seem to be no differences between these two species
***Cyathophora neocomiensis* (d'Orbigny, 1850)** [plocoid]	Refers to material described as *Cryptocoenia neocomiensis*; genus *Cryptocoenia* regarded as junior synonym of *Cyathophora* (also see recent revision of *Cyathophora* by Lathuilière, et al., 2020)
***Enallocoenia* sp.** [cerioid]	Refers to material described as *Stelidioseris*? sp., has actinastreid features, free septa, and lacks paliform structures, thus closely corresponding to *Enallocoenia*
***Eocomoseris* sp.** [cerio-subthamnasterioid]	
***Heliocoenia carpathica* Morycowa, 1964** [plocoid]	Refers to material described as *Stylina inflata*
***Heliocoenia humberti* Étallon, 1859** [plocoid]	Refers to material described as *Alloiteaucoenia bernadina, Stylina* sp. 3, and *Stylina* sp. 4, but are all characterized by features typical of *Heliocoenia*, corallite lumen ranging around 1 mm, and septa arranged in highly variable systems (including e.g., 6, 7, and 8; but not in 10 systems as stated by Löser, et al., 2021), thus closely corresponding to the species *H. humberti* (species recently updated by Baron-Szabo, 2018)
***Heterocoenia* sp.** [cerioid to cerio-plocoid]	Refers to material described as *Comalia fasciculata* but shows close correspondence to the genus *Heterocoenia* (e.g., type of septal division)
***Hykeliphyllum* sp.** [cerioid]	
***Latiastrea somaensis* (Eguchi, 1951)** [cerioid-submeandroid]	
***Latomeandra plicata* (Goldfuss, 1826)** [branching]	Refers to material described as *Latomeandra isseli*
***Meandrophyllia corrugata* (Michelin, 1843)** [thamnasterioid to submeandroid]	Refers to material described as *Microsolena* sp. 2 but shows thamnasterioid to submeandroid polyp integration and haplaraeid *s.l.* structures, thus closely corresponding to *Meandrophylia*. Material belonging to this *Meandrophyllia*-group was already described by Geyer & Rosendahl (1985) from the lowermost Cretaceous of Spain (also see Appendix Table 6[6])
***Mixastraea polyseptata* Morycowa, *in* Mory. & M.-Diacantoni, 2002** [cerioid to cerio-plocoid]	Refers to material assigned to *Latiastrea* sp. but shows characteristics closely corresponding to *Mixastraea* (e.g., lamellar connections) and, in contrast to the description in Löser, et al. (2021), has up to around 80 septa/corallite, thus closely resembling the species *M. polyseptata* (species recently discussed in Baron-Szabo, 2018)
***Paraclausastrea* cf. *valclusensis* Morycowa & Masse, 19989** [cerio-thamnasterioid, submeandroid]	In having corallite walls, columellar structures, and mainly cerio-thamnasterioid to submeandroid corallite integration, the material described as *Dimorphocoenia multitabulata* closely corresponds to *Paraclausastrea*
***Periseris crassisepta* (Sikharulidze, 1985)** [thamnasterioid-submeandroid]	Incudes material described as *P. crassisepta* and *P. elegantula*, but the latter differs from *elegantula* in having larger corallites and a greater number of septa, thus more closely corresponding to *crassisepta*
***Periseris frondescens* (d'Orbigny, 1850)** [thamnasterioid-submeandroid]	
***Placogyra* cf. *hykeli* Eliášová, 1973** [meandroid]	
***Polypetalum llanoensis* (Löser, *in* Löser, et al. 2021)** [astreoid to subplocoid]	Refers to material described as the new genus *Eopreverastrea* Löser, *in* Löser, et al. (2021); it combines characteristics of *Preverastraea* and *Paraacanthogyra*, thus closely corresponding to *Polypetalum* Kuzmicheva, 2002

Table 6 (continued)

[2.3] (refers to locality 2 in Fig. 6)	
Lower Valanginian; Spain (Internal Prebetic); Löser, et al. (2021) ("SpII") (note that assignment is based on illustrated material when significantly differed from information in text)	
Taxon [corallite integration]	**Remarks**
***Rhipidogyra minima* Koby, 1880** [meandroid-flabelliform]	Refers to material described as *Rhipidogyra* sp., whose corallite series ranges between below 10 mm to around 12 mm and a septal density which is often less than 20 in 10 mm (width of entire series of 11.8 mm and nearly twice the number of septa given in Löser, et al., 2021), thus closely corresponding to the species *minima*
***Stereocoenia collinaria* (d'Orbigny, 1850b)** [(cerio-) thamnasterioid]	Refers to material described as *Holocoenia* cf. *micrantha* (Roemer)
***Stylina lamellosa* Trautschold, 1886** [plocoid]	
***Stylina regularis* de Fromentel, 1862** [plocoid]	Refers to material assigned to *Stylina digiformis* but has corallite diameters of up to over 2 mm (including corallite wall) and up to 24 septa in some corallites, thus closely corresponding to *S. regularis*
***Stylina tubulifera*(Phillips, 1829)** [plocoid]	Refers to material described as *Stylina* sp. 1
***Stylina valfinensis* Étallon, 1859** [plocoid]	Refers to material described as *Stylina* sp. 2
***Synastrea bellula* d'Orbigny, 1850b** [thamnasterioid]	In having intracalicular budding and synastreid features, the material described as *Astraeofungia tenochi* closely corresponds to the genus *Synastrea*
***Texastrea iberica* (Löser, *in* Löser, et al. 2021)** [cerioid to subplocoid]	Refers to material described as *Floriastrea iberica* n. sp.; based on study of holotypes of the type species of *Texastrea* (*T. catenata*) and *Floriastrea* (*Floria planinensis*) both genera show actinastreid structures, cerioid to subplocoid corallites arranged in concentric to wavy series, presence of di- to polymorphic corallites, and are, therefore, considered here to be synonymous
***Thalamocaeniopsis stricta* (M. Edwards & Haime, 1850)** [cerioid to cerio-meandroid]	Refers to material described as *Thalamocaeniopsis explanata*; species *T. stricta* was recently revised (Baron-Szabo, 2021b)
***Tricassastraea* sp. 1** [cerioid-submeandroid]	Refers to material described as ?*Actinastrea* sp. and *Stelidioseris melkarthi*; both show actinastreid structures, di- and tristomodaeal budding, and submeandroid arrangement in some places, thus closely corresponding to the genus *Tricassastraea*; in addition, they are all characterized by corallite diameters of 1 to around 2 mm and 12 to up to 24 septa.
***Tricassastraea* sp. 2** [cerioid-submeandroid]	Refers to material described as *Stylina arborea* but shows actinastreid structures, di- and tristomodaeal budding, and submeandroid arrangement in some places, thus closely corresponding to the genus *Tricassastraea*, it differs from *Tricassastraea* sp. 1 in having septa in 8 systems (8+8)
***Trigerastraea gourdani* (De Fromentel, 1856)** [cerioid, cerio-plocoid, meandroid]	In having latomeandrid structures and corallites arranged in mainly cerio-plocoid to short-meandroid integration separated by tholiform to tectiform collines and/ or ambulacra, the material described as *Latiastrea canavari* closely corresponds to *Trigerastraea*; *Trigerastraea gourdani* has recently been described from the upper Berriasian of central Europe (Baron-Szabo, 2018)
***Trigerastraea* cf. *haldonensis* (Duncan, 1870)** [cerioid, cerio-plocoid, meandroid]	In having latomeandrid structures and corallites arranged in mainly cerio-plocoid to short-meandroid integration separated by tholiform to tectiform collines and/ or ambulacra, the material described as *Astraeofungia diversisepta* closely corresponds to *Trigerastraea*; both the species *T. haldonensis* and the genus *Trigerastraea* have recently been revised (Baron-Szabo, 2021b)

Table 6 (continued)

[3] (refers to locality 3 in Fig. 6)	
Upper Valanginian; Spain (Sierra Larga, Prebetic zone); Löser, *et al.* (2019)	
Taxon [corallite integration]	**Remarks**
***Actinaraea* sp.** [thamnasterioid]	
***Agathelia urgonica* (Dietrich, 1926)** [plocoid]	Refers to material described as *Placophyllia charollaisi* and *Placophora urgonica*; both show dimensions of skeletal elements closely corresponding to *A. urgonica*
***Ahrdorffia excavata* (d'Orbigny, 1850b)** [thamnasterioid]	Refers to material described as *Thamnasteria excavata* but differs from the genus *Thamnasteria* in having septal granulations that differ from the kinds seen in the thamnasteriids but are typical of the curtoseriid genus *Ahrdorffia*
***Cladophyllia conybearei* Milne Edwards & Haime, 1851** [phaceloid]	Refers to material described as *Actinastraeopsis qiebulaensis*, recently (Baron-Szabo, 2021b) transferred to *C. conybearei* based on presence of major septum, auricular denticles, multiplication by both extracalicular budding and *Cladophyllia*-type septal division, and phaceloid corallite integration
***Comoseris jireceki* Toula, 1889** [thamnasterioid to meandroid]	Refers to material described as *Dimorpharaea* sp. and *Meandraraea* sp., but the former shows corallite series separated by tholiform to tectiform collines, thus closely corresponding to *Comoseris*; regarding the latter, in addition to having characteristics typical of the genus *Comoseri*s, and in contrast to the description by the authors, the images (Löser, et al., 2019, figs. 7.1–7.2) clearly show corallites that have less than 30 septa, thus closely corresponding to the species *jireceki*.
***Ellipsocoenia* sp.** [plocoid to cerio-plocoid]	Refers to material described as ?*Astraeofungia* sp. and *Eosiderastrea* sp.
***Meandrophyllia corrugata* (Michelin, 1843)** [thamnasterioid to submeandroid]	Refers to material originally described as *Larisolena* sp. but shows thamnasterioid to submeandroid polyp integration and haplaraeid *s.l.* structures, thus closely corresponding to *Meandrophyllia* (negoporid structures and mainly cerio-plocoid to astreoid integration in *Larisolena*; see Baron-Szabo, 2021a). Material belonging to this *Meandrophyllia*-group was already described by Geyer & Rosendahl (1985) from the lowermost Cretaceous of Spain (also see Baron-Szabo, 2018)
***Microphyllia gemina* Eliášová, 2004** [meandroid]	
***Microphyllia* sp.** [meandroid]	
***Microsolena* sp. 1** [thamnasterioid]	Refers to material described as *Microsolena* sp.
***Paretallonia bendukidzeae* Sikharulidze, 1972** [cerioid to cerio-plocoid]	Refers to material originally described as *Holocoenia collinaria* (d'Orbigny) and *Holocoenia micrantha* (Roemer) (see discussion in Baron-Szabo, 2021b)
***Periseris crassisepta* (Sikharulidze, 1985)** [thamnasterioid-submeandroid]	Includes material referred to as *Periseris* aff. *crassisepta* and *P. heterogenea* (Becker) but both show dimensions of skeletal elements (Löser, et al., 2019, figs. 5.4–5.6 and 6.5–6.6) that closely correspond to *P. crassisepta.* Furthermore, in *P. heterogenea* the distance of corallite centers is up to around twice that given by Löser, et al. (2019)
***Periseris* sp.** [thamnasterioid-submeandroid]	Refers to material described as *Dimorpharaea* sp. but shows latomeandrid rather than microsolenid structures, thus closely corresponding to *Periseris*
***Polyphylloseris icaunensis* (d'Orbigny, 1850b)** [thamnasterioid to cerio-plocoid]	Refers to material described as *Polyphylloseris* cf. *japonica*
***P. iwateensis* Eguchi, 1951** [thamnasterioid to subplocoid]	Includes material described as *Polyphylloseris simondsi* but differs from *simondsi* in having up to around twice the number of septa, thus more closely corresponding to *iwateensis*
***P. polymorpha* Felix, 1891** [thamnasterioid to subplocoid]	
***Polyphylloseris* sp.** [thamnasterioid-subplocoid]	
***Stylina pleionantha* Meneghini, *in* d'Achiardi, 1880** [plocoid]	Refers to material described as *Stylina inwaldensis*; in contrast to the description provided by the authors, the number of septa is larger than 16 in some corallites and some corallites have a diameter of up to around 2 mm (including perithecal wall), thus closely corresponding to *S. pleionantha*
***Stylina* sp.** [plocoid]	

Table 6 (continued)

[4] (refers to locality 4 in Fig. 6)	
Upper Valanginian; France; Masse, et al. (2009)	
Taxon [corallite integration]	**Remarks**
***Ellipsocoenia haimei* (de Fromentel, 1857)** [plocoid to cerio-plocoid]	Refers to material assigned to *Baryphyllia haimei* de From.; species recently grouped with *Ellipsocoenia* (see Baron-Szabo, 2021b)
***Stylosmilia* cf. *corallina* Koby, 1881** [phacelo-dendroid	

[5] (refers to locality 5 in Fig. 6)	
Valanginian; Switzerland (Arzier, Collaz, Twann, Valangin, Villers); de Fromentel, *in* Loriol (1868); Jaccard (1893); Koby (1896–1898); Haefeli, et al. (1965) (non-Vitznau Marl; SII)	
Taxon [corallite integration] (Swiss locality)	**Remarks**
***Axosmilia villersensis* (Koby, 1898)** [none; solitary; conical] (Villers)	Refers to material originally described as *Pleurosmilia villersensis* (also see discussion in Baron-Szabo, 2018; Remarks under *Peplosmilia stutzi*)
***Comoseris fromenteli* (de Loriol, 1868)** [thamnasterioid to meandroid] (Arzier)	Refers to material originally described as *Latimeandra fromenteli*; transferred to *Comoseris* herein
***Dimorphastrea bellula* d'Orbigny, 1850b** [thamnasterioid-circumoral] (Villers)	
***D. explanata* De Fr., 1857** [thamnasterioid-circumoral] (Arzier, Villers)	
***D. grandiflora* d'Orbigny, 1850b** [thamnasterioid-circumoral] (Arzier, Villers)	
***D. lorioli* K., 1898** [thamno-circumoral] (Villers)	
***D. tenustriata* de From., 1886** [thamnasterioid-circumoral] (Villers)	
***Ellipsocoenia baumbergeri* (Koby, 1897)** [plocoid to cerio-plocoid] (Twann)	Refers to material originally described as *Favia baumbergeri*
***Ellipsocoenia hemispherica* (de Fromentel, 1857)** [plocoid to cerio-plocoid] (Twann)	Refers to material originally described as *Favia hemispherica*;
***Epistreptophyllum baumbergeri* (Koby, 1898)** [none; solitary; subturbinate to patellate] (Valangin)	Originally assigned tos *Leptophyllia baumbergeri*, grouped with *Acrosmilia* by some authors; based on study of type material, transferred to *Epistreptophyllum* herein
***Heliocoenia* sp. 1** [plocoid] (Twann)	Refers to material originally described *Cyathophora neocomiensis* but shows resemblance to *Heliocoenia*
***Montlivaltia rugulosa* Koby, 1898** [none; solitary; conical] (Collaz)	
***Peplosmilia stutzi* (Koby, 1896)** [none; solitary; conical] (Twann)	Includes material originally assigned to *Pleurosmilia stutzi* and *Pleurosmilia neocomiensis* (see recent revision in Baron-Szabo, 2018)
***Periseris lorioli* (de Fromentel, *in* Loriol, 1868)** [thamnasterioid] (Arzier)	Originally described as *Microsolena lorioli*; transferred to *Periseris* herein
***Plesiomontlivaltia paucisepta* (Koby, 1898)** [none; solitary; conical] (Twann)	Originally described as *Montlivaltia paucisepta*, recently (Baron-Szabo, 2018) revised and grouped with *Plesiomontlivaltia*
***Stereocoenia collinaria* (d'Orbigny, 1850b)** [(cerio-) thamnasterioid] (Arzier)	
***Stylangia* cf. *laddi* Wells, 1944** [dendroid-reptoid] (Arzier)	Refers to material described as *Stylosmilia neocomiensis* de Fromentel, 1857; the type material of de Fromentel's species itself (MNHN R09996) closely corresponds to *Apocladophyllia*
***Stylosmilia gracilis* de F, 1857** [phacel] (Villers)	
***Thecosmilia* sp.** [branching] (Valangin)	No information about dimensions of material given
***Tricassastraea excavata* (de Fromentel, 1857)** [cerioid-submeandroid] (Twann)	Originally described as *Astrocoenia*; based on study of original and type material (MNHN.F.R10862), species *Astrocoenia excavata* transferred to genus *Tricassastraea* herein
***Tricassastraea magnifica* (de Fromentel, 1857)** [cerioid-submeandroid] (Collaz)	Originally described as *Astrocoenia magnifica*; species *magnifica* used to create the genus *Tricassastraea* by Alloiteau & Dercourt (1966)

Table 6 (continued)

[6] (refers to locality 6 in Fig. 6)	
Valanginian; Slovenia (Zavrh, Trnovski Gozd); Turnšek & Buser (1974); Turnšek (1997)	
Taxon [corallite integration]	**Remarks**
***Microphyllia bachmayeri* Geyer, 1955b** [meandroid]	Refers to material assigned to *Microphyllia* cf. *bachmayeri*
***Microphyllia undans* Étallon, 1858** [meandroid]	
***Starostinia giseldonensis* (Starostina & Krasnov, *in* Krasnov & Starostina, 1970).** [astreoid, plocoid]	Originally described as *Ironella* Starostina & Krasnov, 1970, which is a junior homonym of *Ironella* Cobb, 1920 (Nematoda). *Starostinia* Doweld, 2014, is used as the replacement taxon

[7.1] (refers to locality 7 in Fig. 6)	
Valanginian; Hungary (Mecsek Mountains); Császár & Turnšek (1996)	
Taxon [corallite integration]	**Remarks**
***Actinaraea tenuis* Morycowa, 1971** [thamnasterioid]	Species also found in the Vitznau Marl (see text)
***Adelocoenia* sp. 1** [plocoid]	Refers to material originally described as *Paretallonia bendukidzeae* Sikharulidze, but seems to be more closely related to *Adelocoenia* (see discussion in Baron-Szabo, 2021b)
***Ahrdorffia ornata* (Morycowa, 1971)** [thamnasterioid-submeandroid]	Originally assigned to *Mesomorpha* Pratz, 1882–1883, which is a junior homonym of *Mesomorpha* Hodgson, 1841 (a bird); *Ahrdorffia* Trauth is used as the replacement taxon
***Baryhelia (Paronastraea)* sp. 1** [plocoid to cerio-plocoid]	In having heterocoeniid thecal and septal microstructure, apophysal developments, and the type of intracalicular-marginal budding characteristic of the heterocoeniids *s.l.* (including the "paronastraeids"), the material described as *Confusaforma* sp. closely corresponds to *Baryhelia (Paronastraea)*
***Columnocoenia ksiazkiewiczi* Morycowa, 1964** [plocoid]	
***Cyathophora regularis* de Fromentel, 1884** [plocoid]	Refers to material described as *Adelocoenia biedai*; genus *Adelocoenia* was recently revised (Lathuilière, et al., 2020)
***Dendraraea mammelonata* (Turnšek, *in* Turnšek & Mihajlović, 1981)** [thamnasterioid]	Refers to material described as *Thamnaraea mammelonata*; genus *Thamnaraea* is considered to be a junior synonym of *Dendraraea* (also see discussion in Lathuilière & Gill, 1998)
***Dimorphastrea explanata* de Fromentel, 1857 [**thamnasterioid-circumoral]	In having latomeandrid corallites that are equal in size (around 6 mm) and in circumoral arrangement, the material described as *Dimorphastraeopsis patellaris* closely corresponds to *Dimorphastrea explanata* (transferred herein)
***Diplocoenia lobata* (Étallon, 1859)** [cerioid]	Refers to material described as *Diplocoenia decaseptata* Kuzmicheva, 1966. Based on the description and illustration by Kuzmicheva (1967, p. 53–54, Pl. 2, Fig. 7), the species *D. decaseptata* more closely corresponds to *Columnocoenia* (see below). The Hungarian material, however, shows features characteristic of *Diplocoenia*, corresponding to the syntype MNHN.F.M03057 of *D. lobata*
***Ellipsocoenia haimei* (de Fromentel, 1857)** [plocoid to cerio-plocoid]	Refers to material described as *Thamnasteria meandra* but seems to be a rather plocoid form (not thamnasterioid) with pennular developments, thus closely corresponding to *Ellipsocoenia*; dimensions of skeletal elements are in the range of the species *haimei* (see Baron-Szabo, 2021b)
***Enallhelia* sp. 1** [dendroid-sympodial]	Refers to material described as *Enallhelia* sp.
***Epistreptophyllum* sp.** [none; solitary; conical]	
***Eugyra pusilla* Koby, 1896 [**meandroid]	
***Heliocoenia rarauensis* Morycowa, 1971** [plocoid]	

Table 6 (continued)

[7.2] (refers to locality 7 in Fig. 6)	
Valanginian; Hungary (Mecsek Mountains); Császár & Turnšek (1996)	
Taxon [corallite integration]	**Remarks**
***Latiastrea mucronata* Sikharulidze 1979 [**cerioid (–submeandroid)]	
***Microphyllia* cf. *undans* (Koby, 1885)** [meandroid]	
***Microsolena exigua* Koby, 1887** [thamnasterioid]	
Microsolena guttata* Koby, 1898 *[thamnasterioid]	
***Microsolena* sp. (ex *distefanoi*)** [thamnasterioid]	Originally described as *Microsolena distefanoi* but the species *distefanoi* belongs to the genus *Polyphylloseris*
***Microsolenastraea balcanica* Turnšek, Turnšek & Mihajlović, 1981** [thamnasterioid to submeandroid]	
***Myriophyllia propria* Sikharulidze, 1979** [meandroid]	
***Palaeopsammia zljebinensis* Turnšek, Turnšek & Mihajlović, 1981** [none; solitary; conical]	
***Placophyllia curvata* Turnšek, *in* Turnšek & Buser, 1974** [phaceloid]	
***Polyphylloseris convexa* de Fromentel, 1857** [thamnasterioid to subplocoid]	
***Polyphylloseris mammillata* Eguchi, 1951** [thamnasterioid to subplocoid]	In having corallites in thamnasterioid to subplocoid integration, up to around 60 septa, a distance of corallite centers of up to around 8 mm, and showing developments of an incomplete synapticulotheca, the material described as *Dimorpharaea barcenai* closely corresponds to *Polyphylloseris mammillata* (see Baron-Szabo, 2021b)
***Siderofungia irregularis* Felix, 1891** [cerio-thamnasterioid]	
***Stylina lamellosa* Trautschold, 1886** [plocoid]	In having corallite diameters of 1.5 mm (lumen around 1 mm) and a distance of corallite centers of up to around 2.5 mm, the material described as *Stylina parvistella* more closely corresponds to *S. lamellosa. S. parvistella* has smaller dimensions
***Synastrea bellula* d'Orbigny, 1850a** [thamnasterioid {-submeandroid)]	
***Thamnasteria sinuosa* Morycowa, 1964** [thamnasterioid]	

[8.1] (refers to locality 8 in Fig. 6)	
Valanginian; Bulgaria (Lyubasha Mountain; Slivnitsa Formation); Roniewicz (2008)	
Taxon [corallite integration]	**Remarks**
***Adelocoenia castellum* (Michelin, 1844)** [plocoid]	Refers to material described as *Pseudocoenia suboctonis* and *P.* aff. *limbata* but both show skeletal structures closely resembling *Adelocoenia* (see Lathuilière, *et al*., 2020) and have corallites of around 3 mm and 16 septa (8+8), thus closely corresponding to A. *castellum*
***Ahrdorffia* aff. *simionescui* Roniewicz, 1976** [thamnasterioid]	Originally assigned to *Mesomorpha* Pratz, 1882–1883, which is a junior homonym of *Mesomorpha* Hodgson, 1841 (a bird); *Ahrdorffia* Trauth is used as the replacement taxon
***Amphiaulastrea* sp.** [cerioid]	
***Axosmilia* sp.** [none; solitary; conical]	Refers to material described as *Pleurosmilia* sp.; transferred to *Axosmilia* herein

Table 6 (continued)

[8.2] (refers to locality 8 in Fig. 6)	
Valanginian; Bulgaria (Lyubasha Mountain; Slivnitsa Formation); Roniewicz (2008)	
Taxon [corallite integration]	**Remarks**
***Bilaterocoenia* sp.** [plocoid]	
***Calamophylliopsis compacta* (Koby, 1884)** [branching]	
***Calamophylliopsis* cf. *stockesi* (M E & Haime, 1851)** [branching]	
***Cladophyllia clemencia* de Fromentel, 1857** [branching]	
***Cladophyllia* cf. *dichotoma* (Goldfuss, 1826)** [phaceloid]	Refers to material described as *Cladophyllia skuviensis*; because it has a larger number of septa and smaller corallite diameters (some corallites shown on Fig. 6A of Roniewicz, 2008, seem to be smaller than 2 mm), it seems to be more closely related to *C. dichotoma*
***Columnaphyllia* sp.** [branching]	
***Comoseris jireceki* Toula, 1889** [thamnasterioid to meandroid]	Refers to material described as *Comoseris cf. bargyensis*
***Cyathophora bangoinensis* Liao & Xia, 1985** [plocoid]	Refers to material described as *Pseudocoenia* aff. *baltovensis* but shows characteristics typical of *Cyathophora* (sensu Zaman & Lathuilière, 2014) and dimensions of skeletal elements corresponding to *C. bangoinensis*
***Cyathophora hexalobata* Kuzmicheva, 1972** [plocoid]	Refers to material described as *Cyathophora* sp. 2 and *Cyathophora* sp. 3, having dimensions of skeletal elements falling into the range of *C. hexalobata* (see Kuzmicheva, 2002, p. 163–164, Pl. 23, Fig. 1; corallite diameter: 5.5–8.5 mm; s: 6+6+S3; diss/mm: 10–14/10)
***Cyathophora claudiensis* Étallon, 1859** [plocoid]	Refers to material described as *Cyathophora* sp. 1 (see text)
***Dendraraea* sp.** [thamnasterioid]	Refers to material described as "*Thamnarea*" sp.; according to Lathuilière & Gill (1998), *Thamnarea* represents a junior synonym of *Dendraraea*
***Dermoseris delgadoi* Koby, 1905** [branching]	
***Dermoseris* sp.** [branching]	Refers to material described as *Dermoseris* sp. 2
***Dimorphastrea excavata* d'Orbigny, 1850b** [thamnasterioid-circumoral]	Refers to material described as *Dimorphastrea* cf. *dubia* (see Roniewicz, 2008, Fig. 14D) but shows dimensions of skeletal elements which differ from the ones given (Roniewicz, 2008, p. 126) (corallite diameter and number of septa are often smaller than covered by the range given; therefore, transferred to *D. excavata*; see Baron-Szabo, 2018)
***Dimorphastrea* cf. *heteromorpha* (Quenstedt, 1857)** [thamnasterioid-circumoral]	
***Dimorphocoenia* ? sp.** [thamnasterioid- circumoral to submeandroid]	
***Enallhelia* sp. 2** [dendroid-sympodial]	Refers to material described as *Enallhelia* sp.
***Epistreptum* cf. *communeformae* Ron., 2008** [none; solitary; conical]	
***Haplaraea* aff. *elegans* Milaschewitsch, 1876** [none; solitary; conical]	
***Heliocoenia* sp. 2** [plocoid]	
***Latiphyllia* cf. *suevica* (Quenstedt, 1857)** [phaceloid]	
***Latomeandra juettneri* Eliášová, 1990** [phaceloid-subdendroid]	
***Latomeandra obliqua* Roniewicz, 2008** [phaceloid-subdendroid]	
***Latomeandra ramosa* (Koby, 1884)** [phaceloid-subdendroid]	
***Latomeandra* sp.** [phaceloid-subdendroid]	Refers to material described as *Latomeandra* sp. 1
***Lyubasha gracilis* Roniewicz, 2008** [astreoid]	
***Microphyllia densecostata* Sikharulidze, 1979** [meandroid]	

Table 6 (continued)

[8.3] (refers to locality 8 in Fig. 6)	
Valanginian; Bulgaria (Lyubasha Mountain; Slivnitsa Formation); Roniewicz (2008)	
Taxon [corallite integration]	**Remarks**
***Microphyllia elevata* Roniewicz, 2008** [meandroid]	
***Microsolena agariciformis* Étallon, 1859** [thamnasterioid]	
***Microsolena* aff. *exigua* Koby, 1887** [thamnasterioid]	
***Microsolena tuberosa* (Michelin, 1843)** [thamnasterioid]	
***Misistella* cf. *carpathica* Eliášová, 1976** [dendroid-phaceloid]	
***Mitrodendron* sp. 1** [dendroid]	
***Mitrodendron* sp. 2** [dendroid]	
***Montlivaltia* sp. 2** [none; solitary; conical]	Refers to material described as *Montlivaltia* sp.
***Ogilvinella elegans* (Eliášová, 1973)** [plocoid]	
***Ovalastrea* sp.** [plocoid]	
***Periseris lorioli* (de From)** [thamnasterioid-meandroid)]	Refers to material described as *Periseris* sp. A
***Placophyllia* cf. *blastemon* Eliášová, 1976 [**phaceloid]	
***Pleurophyllia tobleri* (Koby, 1896) [**phaceloid-subfasciculate]	Refers to material assigned to *Pleurophyllia* aff. *cara*; recently transferred to *P. tobleri* (see Baron-Szabo, 2018; and text)
***Pleurostylina corallina* de Fromentel, 1861** [cerioid]	Refers to material described as *Latusastrea* sp. but is a rather cerioid colony having 1) inner corallites embedded in a dissepimentarium; 2) showing intracalicular budding; 3) having corallite diameters of around 5 mm; and 4) around 30 septa, thus closely corresponding to *Pleurostylina corallina*
***Preverastraea cretacea* (Roniewicz, 2008)** [cerioid (-subastreoid)]	Refers to the type material (holotype NMNHS F-30251) assigned to *Oedalmiopsis cretacea* but, in contrast to the original description, is most likely a rhipidogyrid form that has a rather cerioid (-subastreoid) (not thamnasterioid) corallum corresponding to the genus *Preversastraea*
***Protoseris* sp.** [thamnasterioid, mono- to multiserial]	
***Pruvostastraea crassisepta* (Sikharulidze, 1979)** [meandroid]	
***Psammogyra hykeli* (Eliášová, 1973)** [meandroid]	In having long meandroid series, both the type specimen from the Tithonian of the Czech Republic and the material described as *Placogyra hykeli* more closely correspond to the genus *Psammogyra*
***Rhipidogyra minima* Koby, 1880** [flabelliform]	Refers to material described as *Rhipidogyra* cf. *minima*
***Rhipidogyra* sp.** [flabelliform]	
***Siderastreites lyalintsensis* Ron., 2008** [cerioid (-submeandroid)]	
***Solenocoenia sexradiata* (Goldfuss, 1829)** [plocoid]	
?*Somalica* sp. [cerioid-subthamnasterioid]	Refers to material (NMNHS F-30252) assigned to *Oedalmiopsis cretacea* but, in slight contrast to the original description, is a rhipidogyrid form with cerioid to subthamnasterioid corallites which seems to have pruvostastraeid wall structures, thus corresponding to the genus *Somalica*
***Stylosmilia corallina* Koby, 1881 [**phaceloid-dendroid]	
***Stylosmilia octonaria* Roniewicz, 1976 [**phaceloid-dendroid]	
***Stylosmilia* sp. [**phaceloid]	
***Synastrea bellula* d'Orbigny, 1850a** [thamnasterioid (-submeandroid)]	In having septa ranging between 40–50 (in areas of intense budding around 28 [see Roniewicz, 2008, Fig. 12L]) and a distance of corallite centers of 4–7 mm, the material described as *Synastrea microsolenoides* very closely corresponds to the lectotype MNHN.F.R08338 of *Synastrea bellula*
***Thecosmilia dichotoma* Koby, 1884** [dendroid-phaceloid]	Refers to material described as *Thecosmilia pinguis*; recently transferred to *Th. dichotoma* (Baron-Szabo, 2018)

Table 6 (continued)

[8.3] (refers to locality 8 in Fig. 6)	
Valanginian; Bulgaria (Lyubasha Mountain; Slivnitsa Formation); Roniewicz (2008)	
Taxon [corallite integration]	**Remarks**
***Tiaradendron germinans* (Quenstedt, 1852)** [subsympodial]	
***Tricassastraea* sp.** [cerioid-submeandroid]	Refers to material described as Actinastreid indet.; which shows di- and tristomodaeal budding and some submeandroid arrangement, thus closely corresponding to the genus *Tricassastraea*
***Trocharea* sp.** [none; solitary; subcylindrical]	

[9] (refers to locality 9 in Fig. 6)	
Valanginian; Poland; Lefeld (1968)	
Taxon [corallite integration]	**Remarks**
***Montlivaltia* sp. 1** [none; solitary; conical]	Refers to material described as *Montlivaltia* sp.

[10] (refers to locality 10 in Fig. 6)	
Valanginian; Turkey (Çerkesli Fm.); Kaya, et al. (1987)	
Taxon [corallite integration]	**Remarks**
***Cladophyllia dichotoma* (Goldf., 1826)** [phaceloid]	
***Cladophyllia* sp.** [phaceloid]	

[11.1] (refers to locality 11 in Fig. 6)	
Valanginian; Ukraine (Belbek river); Kuzmicheva (1967; 1985; 2002), Kuzmicheva & Shalya (1962)	
Taxon [corallite integration]	**Remarks**
***Amphiastrea aethiopica* Dietrich, 1926** [cerioid]	
***Calamophylliopsis compressa* (d'Orb., 1850b)** [phaceloid]	
***Clausastrea lobachevae* Kuzmicheva, 2002** [thamno-submeandroid]	
***Columnocoenia decaseptata* (Kuzmicheva & Shalya, 1962)** [plocoid]	Refers to material assigned to *Diplocoenia decaseptata* but shows synapticulae, paliform structures, and trabeculae arranged in a zigzag pattern, thus closely corresponding to *Columnocoenia* (for taxonomic information provided see Kuzmicheva, 2002)
***Comoseris meandroides* (K, 1898)** [thamnasterioid-meandroid]	
***Cyathophora hexalobata* Kuzmicheva, 1972** [plocoid]	
***C. mirtschinkae* Kuz., 1972** [plocoid to cerio-plocoid]	
***Dimorphocoenia gigantea* (Kuzmicheva, 2002)** [thamnasterioid-circumoral]	In having corallites arranged in what seems to be thamnasterioid-circumoral (but not fungiform) integration, the material described as *Clausastrea gigantea* closely corresponds to *Dimorphocoenia*
Diplocoenia polygonalis* Kuzmicheva & Shalya, 1962, *nom. nud. [no information available; presumed cerioid]	This taxon represents both a junior homonym of *D. polygonalis* Prever, 1909, and a *nomen nudum*. Kuzmicheva & Shalya (1962, p. 30) introduced this name as a new species without giving any taxonomic characterization. Though it was later repeatedly mentioned by Kuzmicheva (e.g., 1966, Tab. 1; 2002, p. 91 and 93) neither a description nor illustration of this taxon was provided. Both its taxonomic and nomenclatural positions are unclear

Table 6 (continued)

[11.2] (refers to locality 11 in Fig. 6)	
Valanginian; Ukraine (Belbek river); Kuzmicheva (1967; 1985; 2002), Kuzmicheva & Shalya (1962)	
Taxon [corallite integration]	**Remarks**
***Epistreptum fotisalensis* (Kuzmicheva, 2002)** [none; solitary; conical]	Refers to material described as *Acrosmilia fotisalensis*; transferred to *Epistreptum* herein
***Heliocoenia octoseptata* (Kuzmicheva & Shalya, 1962)** [plocoid]	Refers to material originally only mentioned as *Diplocoenia octoseptata* but, based on the description and illustration of *D. octoseptata* by Kuzmicheva (1967, p. 52–53, Pl. 2, Fig. 6; with indication that she referred to the same previously mentioned material), more closely corresponds to *Heliocoenia*
***Heliocoenia variabilis* Étallon, 1859** [plocoid]	Refers to material described as *Stylina favrei*; transferred to *Heliocoenia variabilis* herein based on thecal and columellar developments, corallite diameter of up to around 2.3 mm (including wall), and septa arranged in 10 or irregular systems
***Latiastrea mucronata* Sikh., 1979 [**cerioid (–submeandroid)]	Refers to material described as *Latiastrea bella*; transferred to *L. mucronata* herein
***Latiphyllia ragaensis* Eguchi, 1951** [flabellate]	In forming a flabellate colony with monocentric corallites of up to around 25 mm and septa of 62–80, the material described as *Thecosmilia tobleri* differs from the branching-phaceloid *Thecosmilia* but shows close affinities to the genus *Latiphyllia*, corresponding well to *Latiphyllia ragaensis*
***Schizosmilia faceloides* Kuzmicheva, 1966, *nom. nud*.** [no information; presumed branching]	This taxon represents a *nomen nudum*. Kuzmicheva (1966, Tab. 1) introduced this name as a new species but never provided any characterization of it. The genus *Schizosmilia* itself was grouped as a junior synonym of *Cladophyllia* by Morycowa & Roniewicz (1990). However, given the fact that species of genera such as *Stylosmilia* or *Apocladophyllia* have also been transferred either from or to *Schizosmilia*, Kuzmicheva's taxon could be related to a genus other than *Cladophyllia*. Therefore, the taxonomic position of *S. faceloides* remains unclear
***Stylina pachystylina* Koby, 1896** [plocoid]	
***Thalamocaeniopsis stricta* (M. Edwards & Haime, 1850)** [cerioid to cerio-meandroid]	Refers to material described as *Latiastrea gracilis* (d'Orbigny); recently transferred to *T. stricta* (Baron-Szabo, 2021b)
***Thamnoseris arborescens* Felix, 1891** [cerio-thamnasterioid]	

[12] (refers to locality 12 in Fig. 6)	
***upper Valanginian; Tanzania (*Trigonia bornhardti*/ *Trigonia schwarzi* Member); Dietrich (1926); Löser (2008)**	
Taxon [corallite integration]	**Remarks**
***Actinastrea bellensis* (Wells, 1933)** [cerioid]	Refers to material originally described as *Astrocoenia colliculosa*
***Actinastrea retifera* (Stoliczka, 1873)** [cerioid to cerio-plocoid]	Refers to material described as *Astrocoenia subornata africana*
***Actinastrea tendagurensis* (D., 1926)** [cerioid to cerio-plocoid]	Refers to material described as *Astrocoenia tendagurensis*
***Dimorphastrea tendagurensis* (D., 1926)** [thamnasterioid-circumoral]	
***Kobyphyllia* cf. *acrisionae* (Felix, 1903)** [none; solitary; conical]	Refers to material originally described as *Pleurosmilia hennigi* which was later used to designate the paralectotype of the species *hennigi* (Löser, 2008, p. 54)
***Peplosmilia fromenteli* (Angelis d'Ossat, 1905)** [none; solitary; conical]	Refers to material originally described as *Pleurosmilia hennigi* which was later used to designate the lectotype of the species *hennigi* (Löser, 2008, p. 55), thus representing a junior synonym of *Peplosmilia fromenteli*
***Synhelia meyeri* (Koch & Dunker, 1837)** [dendroid-ramose]	Refers to material described as *Thamnastraea* sp. of Dietrich (1926) (*Diploastrea* sp. 1 of Löser [2008])

*Updated using information from Paleobiology Database (paleobiodb.org)

Table 7 Scleractinian genera recorded from Valanginian strata

[7.1]													
Valanginian localities / genera	Bulgaria	France	Hungary	Mexico	Poland	Slovenia	Spain (I)	Spain (II)	Switzerland (I)	Switzerland (II)	Tanzania	Turkey	Ukraine
Acrosmilia								X					
Actinaraea			X				X		X				
Actinastrea								X	X		X(3)		
Adelocoenia	X		X					X	X				
*^Agathelia (**)							X						
Ahrdorffia	X		X				X						
Amphiastrea								X(2)					X
Amphiaulastrea	X												
^Aplosmilia									X				
Axosmilia	X							X	X	X			
^Baryhelia			X					X					
Baryphyllia								X					
Bilaterocoenia	X												
Calamophylliopsis	X(2)												X
Cladophyllia	X(2)						X					X(2)	
Clausastrea													X
Columnaphyllia	X												
^Columnocoenia			X										X
Comoseris	X						X	X(3)		X			X
Complexastrea								X	X				
^Confusaforma								X					
Cyathophora	X(3)		X					X	X				X(2)
Dendraraea	X		X										
Dermoseris	X(2)												
Dermosmilia									X				
Dimorphastrea	X(2)		X							X(5)	X		
Dimorphocoenia	X												X
Diplocoenia			X										X
Ellipsocoenia		X	X				X			X(2)			
Enallhelia	X		X										
Enallocoenia								X					
Eocomoseris								X					
Epistreptophyllum			X							X			
Epistreptum	X												X
^Eugyra			X										
Fungiastraea									X				
Haplaraea	X												
Heliocoenia	X		X					X(2)		X			X(2)
^Heterocoenia								X	X				

Table 7 (continued)

[7.2]													
Valanginian localities / genera	Bulgaria	France	Hungary	Mexico	Poland	Slovenia	Spain (I)	Spain (II)	Switzerland (I)	Switzerland (II)	Tanzania	Turkey	Ukraine
Hykeliphyllum								X					
Kobyphyllia											X		
Latiastrea			X					X	X				X
Latiphyllia	X												X
Latomeandra	X(4)							X					
^Lyubasha	X												
Meandrophyllia							X	X					
Microphyllia	X(2)		X			X(2)	X(2)						
Microsolena	X(3)		X(3)				X(2)						
Microsolenastraea			X										
Misistella	X												
Mitrodendron	X(2)												
Mixastraea								X					
Montlivaltia	X			X	X				X	X			
^*Myriophyllia*			X										
^*Ogilvinella*	X												
Ovalastrea	X												
^Palaeopsammia			X										
Paraclausastrea								X					
^Paretallonia				X			X						
Peplosmilia										X	X		
Periseris	X						X	X(2)		X			
^*Placocoenia*				X									
^*Placogyra*								X					
Placophyllia	X		X						X(2)				
Plesiomontlivaltia										X			
Pleurophyllia	X								X				
Pleurostylina	X												
^*Polypetalum*								X					
Polyphylloseris			X(2)				X(4)						
^*Preverastraea*	X												
Protoseris	X												
^*Pruvostastraea*	X												
^*Psammogyra*	X												
^*Rhipidogyra*	X(2)							X					
Schizosmilia													X
^Siderastreites	X												
^Siderofungia			X										
Solenocoenia	X												
^?*Somalica*	X												
^*Starostinia*						X							
Stereocoenia								X		X			
Stylangia										X			
Stylina			X				X(2)	X(4)					X
Stylophyllid indet.									X				
Stylophyllopsis									X				

Table 7 (continued)

[7.3]													
Valanginian localities / genera	Bulgaria	France	Hungary	Mexico	Poland	Slovenia	Spain (I)	Spain (II)	Switzerland (I)	Switzerland (II)	Tanzania	Turkey	Ukraine
Stylosmilia	X(3)	X								X			
Synastrea	X		X					X					
Synhelia											X		
****Texastrea***								X					
*****Thalamocaeniopsis***								X					X
Thamnasteria			X										
Thamnoseris									X				X
Thecosmilia	X									X			
^***Tiaradendron***	X												
*****Tricassastraea***	X							X(2)		X(2)			
Trigerastraea								X(2)					
Trocharea	X												

(**)

---Because *Agathelia asperella* of Liao & Xia (1994) from the Berriasian of Tibet shows a type of pocket-budding (resembling 'Taschenknospung') which does not occur in the genus *Agathelia*, the Tibetan material is excluded from the occurrence of *Agathelia,* hence, considering the Valanginian record (Spain [SpI]) as the first appearance of this genus.

---The material described as *Latusastraea exiguis* from the upper Berriasian of Spain (Geyer & Rosendahl, 1985) is transferred to the genus *Texastrea* Wells herein, thus considering a pre-Valanginian first occurrence for this genus. In recent works (e.g., Baron-Szabo 2014, 2021c), *Texastrea* was considered to be a morpho-(sub-) genus of the genus *Actinastrea* d'Orbigny but might be more independent than previously assumed.

X=occurring genus; (number)=number of species of this genus recorded if more than one.*=genus having first appearance in the Valanginian. ^=taxon belonging to modern microstructural group. Switzerland (I)=Vitznau Marl at Wart; (II)=non-Vitznau Marl. For further details regarding recognized species in previously described works see Appendix Table 6. (**)=Information regarding taxon described from strata older than the Valanginian provided below

Table 8 List of 206 scleractinian coral taxa reported from Valanginian localities (including 159 identified species and 47 taxa in open nomenclature). Switzerland (SI) = Vitznau Marl; Switzerland (SII) = Swiss strata other than Vitznau Marl * = taxon belongs to modern microstructural group

[8.1]													
Valanginian localities / species	Bulgaria	France	Hungary	Mexico	Poland	Slovenia	Spain (I)	Spain (II)	Switzerland (I)	Switzerland (II)	Tanzania	Turkey	Ukraine
Acrosmilia clava								X					
***Actinaraea* sp.**							X						
Actinaraea tenuis			X						X				
Actinastrea bellensis											X		
Actinastrea colliculosa								X					
Actinastrea pseudominima									X				
Actinastrea retifera											X		
Actinastrea tendagurensis											X		
Adelocoenia castellum	X												
Adelocoenia parvistella									X				
***Adelocoenia* sp. 1**			X										
***Adelocoenia* sp. 2**								X					
****Agathelia urgonica***							X						
Ahrdorffia excavata							X						
Ahrdorffia ornata			X										
Ahrdorffia* aff. *simionescui	X												
Amphiastrea aethiopica													X
Amphiastrea basaltiformis								X					
Amphiastrea paronai								X					
***Amphiaulastrea* sp.**	X												
****Aplosmilia semisulcata***									X				
Axosmilia villersensis								X	X	X			
***Axosmilia* sp.**	X												
***Baryhelia (Parona.)* sp. 1**			X										
***Baryhelia (Parona.)* sp. 2**								X					
Baryphyllia gregaria								X					
***Bilaterocoenia* sp.**	X												
Calamophylliop. compacta	X												
Calamoph. compressa													X
Calamoph.* cf. *stockesi	X												
Cladophyllia clemencia	X												
Cladophyllia conybearei							X						
Cladophyllia dichotoma												X	
Cladophyllia* cf. *dichotoma	X												

Table 8 (continued)

[8.2]													
Valanginian localities / species	Bulgaria	France	Hungary	Mexico	Poland	Slovenia	Spain (I)	Spain (II)	Switzerland (I)	Switzerland (II)	Tanzania	Turkey	Ukraine
Cladophyllia sp.												X	
Clausastrea lobachevae													X
Columnaphyllia sp.	X												
**Columno. decaseptata*													X
**Columno. ksiazkiewiczi*			X										
Comoseris jireceki	X						X						
Comoseris fromenteli								X		X			
Comoseris meandroides								X					X
Comoseris sequana								X					
Complexastrea zolleriana									X				
Complexastrea sp.								X					
Confusaforma weyeri								X					
Cyathophora bangoinensis	X												
Cyathophora claudiensis	X								X				
Cyathophora hexalobata	X												X
Cyathophora mirtschinkae													X
Cyathophora neocomiensis								X					
Cyathophora regularis			X										
Dendraraea mammelonata			X										
Dendraraea sp.	X												
Dermoseris delgadoi	X												
Dermoseris sp.	X												
Dermosmilia sp.									X				
Dimorphastrea bellula										X			
Dimorphastrea excavata	X												
Dimorphastrea explanata			X							X			
Dimorphastrea grandiflora										X			
D. cf. *heteromorpha*	X												
Dimorphastrea lorioli										X			
Dimorph. tendagurensis											X		
Dimorphastrea tenustriata										X			
Dimorphocoenia gigantea													X
Dimorphocoenia ? sp.	X												
Diplocoenia lobata			X										
Diplocoenia polygonalis													X
Ellipsocoenia baumbergeri										X			

Table 8 (continued)

[8.3]													
Valanginian localities / species	**Bulgaria**	**France**	**Hungary**	**Mexico**	**Poland**	**Slovenia**	**Spain (I)**	**Spain (II)**	**Switzerland (I)**	**Switzerland (II)**	**Tanzania**	**Turkey**	**Ukraine**
Ellipsocoenia haimei		X	X										
Ellipsocoenia hemispherica										X			
***Ellipsocoenia* sp.**							X						
***Enallhelia* sp. 1**			X										
***Enallhelia* sp. 2**	X												
***Enallocoenia* sp.**								X					
***Eocomoseris* sp.**								X					
Epistrepto. baumbergeri										X			
***Epistreptophyllum* sp.**			X										
E.* cf. *communeformae	X												
Epistreptum fotisalensis													X
****Eugyra pusilla***			X										
Fungiastraea lamellosa									X				
Haplaraea* aff. *elegans	X												
Heliocoenia carpathica								X					
Heliocoenia humberti													
Heliocoenia octoseptata													X
Heliocoenia rarauensis			X										
Heliocoenia variabilis													X
***Heliocoenia* sp. 1**										X			
***Heliocoenia* sp. 2**	X												
****Heterocoenia inflexa***									X				
****Heterocoenia* sp.**								X					
***Hykeliphyllum* sp.**								X					
Kobyphyllia* cf. *acrisionae											X		
Latiastrea mucronata			X						X				X
Latiastrea somaensis								X					
Latiphyllia* cf. *suevica	X												
Latiphyllia ragaensis													X
Latomeandra juettneri	X												
Latomeandra obliqua	X												
Latomeandra plicata								X					
Latomeandra ramosa	X												
***Latomeandra* sp.**	X												
****Lyubasha gracilis***	X												
Meandrophyllia corrugata							X	X					

Table 8 (continued)

[8.4] Valanginian localities / species	Bulgaria	France	Hungary	Mexico	Poland	Slovenia	Spain (I)	Spain (II)	Switzerland (I)	Switzerland (II)	Tanzania	Turkey	Ukraine
Microphyllia bachmayeri						X							
Microphyllia densecostata	X												
Microphyllia elevata	X												
Microphyllia gemina							X						
Microphyllia undans						X							
Microphyllia* cf. *undans			X										
***Microphyllia* sp.**							X						
Microsolena agariciformis	X												
Microsolena exigua			X										
Microsolena* aff. *exigua	X												
Microsolena guttata			X										
***M.* sp. (ex *distefanoi*)**			X										
***Microsolena* sp. 1**							X						
Microsolena tuberosa	X												
Microsolenastr. balcanica			X										
Misistella* cf. *carpathica	X												
***Mitrodendron* sp. 1**	X												
***Mitrodendron* sp. 2**	X												
Mixastraea polyseptata								X					
Montlivaltia coahuilensis				X									
Montlivaltia rugulosa										X			
Montlivaltia truncata									X				
***Montlivaltia* sp. 1**					X								
***Montlivaltia* sp. 2**	X												
****Myriophyllia propria***			X										
****Ogilvinella elegans***	X												
***Ovalastrea* sp.**	X												
****Palaeops. zljebinensis***			X										
Paraclaus* cf. *valclusensis								X					
****Paretallonia bendukidzeae***							X						
****Paretallonia hispaniensis***				X									
Peplosmilia fromenteli											X		
Peplosmilia stutzi										X			
Periseris crassisepta							X	X					
Periseris frondescens								X					
Periseris lorioli	X									X			

Table 8 (continued)

[8.5]													
Valanginian localities / species	**Bulgaria**	**France**	**Hungary**	**Mexico**	**Poland**	**Slovenia**	**Spain (I)**	**Spain (II)**	**Switzerland (I)**	**Switzerland (II)**	**Tanzania**	**Turkey**	**Ukraine**
***Periseris* sp.**							X						
****Placocoenia* sp.**				X									
****Placogyra* cf. *hykeli***								X					
Placophyllia* cf. *blastemon	X												
Placophyllia curvata			X										
Placophyllia* cf. *dianthus									X				
Placophyllia* cf. *florosa									X				
Plesiomontli. paucisepta										X			
Pleurophyllia tobleri	X												
Pleurophyllia ? tobleri									X				
Pleurostylina corallina	X												
****Polypetalum llanoensis***								X					
Polyphylloseris convexa			X										
Polyphylloseris icaunensis							X						
Polyphylloseris iwateensis							X						
Polyphylloseris mammillata			X										
Polyphylloseris polymorpha							X						
***Polyphylloseris* sp.**							X						
****Preverastraea cretacea***	X												
***Protoseris* sp.**	X												
****Pruvostastraea crassisepta***	X												
****Psammogyra hykeli***	X												
****Rhipidogyra minima***	X							X					
****Rhipidogyra* sp.**	X												
Schizosmilia faceloides													X
****Siderastreites lyalintsensis***	X												
****Siderofungia irregularis***			X										
Solenocoenia sexradiata	X												
****Somalica* sp.**	?												
****Starostinia giseldonensis***						X							
Stereocoenia collinaria								X		X			
Stylangia* cf. *laddi										X			
Stylina lamellosa			X					X					
Stylina pachystylina													X
Stylina pleionantha							X						
Stylina regularis								X					

Table 8 (continued)

[8.6] Valanginian localities / species	Bulgaria	France	Hungary	Mexico	Poland	Slovenia	Spain (I)	Spain (II)	Switzerland (I)	Switzerland (II)	Tanzania	Turkey	Ukraine
Stylina tubulifera								X					
Stylina valfinensis								X					
***Stylina* sp.**							X						
Stylophyllopsis silingensis									X				
Stylophyllid indet.									X				
Stylosmilia corallina	X												
Stylosmilia* cf. *corallina		X											
Stylosmilia gracilis										X			
Stylosmilia octonaria	X												
***Stylosmilia* sp.**	X												
Synastrea bellula	X		X					X					
Synhelia meyeri											X		
Texastrea iberica								X					
Thalamocaeniopsis stricta								X					X
Thamnasteria sinuosa			X										
Thamnoseris arborescens													X
Thamnoseris* cf. *carpathica									X				
Thecosmilia dichotoma	X												
***Thecosmilia* sp.**										X			
****Tiaradendron germinans***	X												
Tricassastraea excavata										X			
Tricassastraea* cf. *excavata	X												
Tricassastraea magnifica										X			
***Tricassastraea* sp. 1**								X					
***Tricassastraea* sp. 2**								X					
Trigerastraea gourdani								X					
Triger.* cf. *haldonensis								X					
***Trocharea* sp.**	X												

Acknowledgements

Our thanks and gratitude go to Dennis Opresko (Knoxville, Tennessee) for his valuable suggestions on the manuscript, and, together with both Steve Cairns (Smithsonian Institution, Washington, DC, USA) and Bernard Lathuilière (Nancy, France), for many discussions on coral taxonomy. We are very grateful to two anonymous reviewers for their most helpful comments. Type material and additional study material was made accessible to us by Walter Etter (Naturhistorisches Museum Basel, Switzerland); Georg Friebe ("*Inatura*", Dornbirn, Austria); Heinz Furrer (University of Zurich, Switzerland); Andreas Kroh, Alexander Lukeneder, Oleg Mandic, and Thomas Nichterl (all Naturhistorisches Museum, Vienna, Austria); Hans Egger (Geologische Bundesanstalt, Wien; GBA, Vienna, Austria); Sylvain Charbonnier and Christine Perrin (both Museum d'Histoire Naturelle de Paris, France); Helena Eliášová (Prague, Czech Republic); Elžbieta Morycowa (University of Krakow, Poland); Ewa Roniewicz (Academy of Sciences, Warsaw, Poland); Winfried Werner and Martin Nose (both Bayerische Staatssammlung, Munich, Germany); Günter Schweigert (Staatliches Museum für Naturkunde, Stuttgart, Germany); Jill Darrell (The Natural History Museum, London, UK); Ursula Menkveld-Gfeller (Naturhistorisches Museum Bern, Switzerland); Dieter Korn (Naturhistorisches Museum Berlin, Germany). Special thanks go to Robin Näf (Wildhaus) who generously provided us with material that proved to be very valuable to our study. As a Research Associate of the Smithsonian Institution (SI) Washington, DC, USA, and an Honorary Researcher at the Research Institute Senckenberg, Frankfurt, Germany, the author RBS would like to express her deep appreciation for the continuing support from these institutions.

Authors' contributions
PK and KT discovered the specimens taxonomically described. KT prepared the material. RBS had the idea to describe the material. KT photographed the specimens. All authors contributed to the illustrations. RBS wrote most of the text. PK and KT wrote parts of the text on the origin of the material and sample location. All authors proofread, corrected, and approved of the entire text. All authors read and approved the final manuscript.

Funding
Open Access funding enabled and organized by Projekt DEAL. The authors received no funding by third parties and we have no competing interests.

Availability of data and materials
All specimens illustrated and taxonomically described are stored at the Naturmuseum St, Gallen, Switzerland.

Declarations

Competing interests
The authors declare that they have no competing interests.

Author details
[1]Department of Invertebrate Zoology, Smithsonian Institution, MRC-163, Washington, DC 20013, USA. [2]Research Institute Senckenberg, Senckenberganlage 25, 60325 Frankfurt/Main, Germany. [3]Palaeontological Institute and Museum, University of Zurich, Karl-Schmid-Strasse 4, 8006 Zürich, Switzerland. [4]Naturmuseum St. Gallen, Rorschacherstr. 263, 9016 St. Gallen, Switzerland.

Received: 28 April 2021 Accepted: 1 November 2021
Published online: 12 March 2022

References

Abdel-Gawad, G. L., & Gameil, M. (1995). Cretaceous and Palaeocene coral fauna in Egypt and Greece (2) Palaeontology. *Coral Research Bulletin, 4*, 6–36. 21 pls.

Alloiteau, J. (1936). Sur le présence, dans le calcaire a Spatangues de la Haute-Marne de, *Plesiosmilia villersensis* Koby. *Bulletin de la Société Géologique de France.* 5e série, 6, 507–510.

Alloiteau, J. (1952). Embranchment des Coelentérés. II. Madréporaires post-paléozoïques. In: Piveteau, J. (Ed.), *Traité de Paléontologie*, *Vol. 1*. Masson, Paris, pp. 539–684. Retrieved from http://sdrv.ms/RBacJ8.

Alloiteau, J. (1954). Le genre Actinastrea d'Orbigny, 1849 dans le Crétacé supérieur français. Annales Hébert et Haug, 8, 9–104, 10 pls

Alloiteau, J. (1957). *Contribution à la systématique des madréporaires fossiles* (p. 462). Centre National Recherche Scientifique.

Alloiteau, J. (1958). Monographie des Madréporaires fossiles de Madagascar. *Annales Géologiques de Madagascar, 25*, 1–218. 38 pls.

Alloiteau, J. (1961). Madréporaires portlandiens de la Querola près d'Alcoy (Espagne). *Bulletin de la Société Géologique De France, Paris, 7*(11), 288–299.

Alloiteau, J., & Bernier, P. (1970). Amphiphora serannensis nov. gen., nov. sp., nouveau genre de Madréporaire du Jurassique terminal de la bordure méridionale des Cévennes. *Bulletin de la Société Géologique de France Paris (7), 11*, 925–928. pl. 38 (1969).

Angelis d'Ossat, G. de (1905). Coralli del Cretacico inferiore della Catalogna. *Palaeontographica Italica*, 11, 169–251. Retrieved from http://archive.org/details/palaeontographia11pisa.

Arkadiev, V. V., & Bugrova, IYu. (1999). Facies of the Cretaceous (Berriasian) deposits from the River Belbek Area (Southwestern Crimea). *Facies, 40*, 71–80.

Bak, R. P. M., & Elgershuizen, J. H. B. W. (1976). Patterns of oil-sediment rejection in corals. *Marine Biology, 37*, 105–113.

Baron-Szabo, R. C. (1993). Korallen der höheren Unterkreide ("Urgon") von Nordspanien (Playa de Laga, Prov. Guernica). *Berliner Geowissenschaftliche Abhandlungen (E), 9*, 147–181.

Baron-Szabo, R.C. (1997). Zur Korallenfazies der ostalpinen Kreide (Helvetikum, Allgäuer Schrattenkalk; Nördliche Kalkalpen, Brandenberger Gosau), Taxonomie, Paläökologie. *Zitteliana*, 21, 3–98. Retrieved from http://archive.org/details/zitteliana212319972002baye.

Baron-Szabo, R. C. (2003). Taxonomie und ontogenie von scleractinen Korallen der ostalpinen Oberkreide (Hochmoos- und Grabenbachschichten, Gosau-Gruppe, Santon). *Jahrbuch der Geologischen Bundesanstalt,* 143, 107–201. Retrieved from http://www.landesmuseum.at/datenbanken/digilit/?litnr=34374.

Baron-Szabo, R. C. (2005). Remarks on the genus *Arctangia* Wells, 1937, with the re-description of the type species *Thecocyathus nathorsti* Lindström, 1900 (Anthozoa; Scleractinia) from the Lower Cretaceous of Norway (Spitzbergen). *Bulletin of the Biological Society of Washington, 118*, 479–482.

Baron-Szabo, R. C. (2008). Corals of the K/T-boundary: Scleractinian corals of the suborders Dendrophylliina, Caryophylliina, Fungiina, Microsolenina, and Stylinina. Zootaxa 1952, 1–244

Baron-Szabo, R. C. (2014). Scleractinian corals from the Cretaceous of the Alps and Northern Dinarides with remarks on related taxa. *Abhandlungen der Geologischen Bundesanstalt, 68*, 1–287. pls. 1–88, text–figs. 1–22.

Baron-Szabo, R. C. (2016). On the genus *Paraclausastrea* Zlatarski, 1968 (Scleractinia; Hauterivian–Albian). *Jahrbuch der Geologischen Bundesanstalt Wien, 155*(1–4), 199–208.

Baron-Szabo, R. C. (2018). Scleractinian corals from the upper Berriasian of central Europe and comparison with contemporaneous coral assemblages. *Zootaxa, 4383*, 1–98. https://doi.org/10.11646/zootaxa.4383.1.1 12 pls.

Baron-Szabo, R. C. (2021a). Systematic descriptions of the scleractinia family Negoporitidae. In P. A. Selden (Ed.), *Treatise on Invertebrate Paleontology, Part F, Revised, Volume 2, Chapter 15, Treatise Online 144* (pp. 1–6). KU Paleontological Institute The University of Kansas.

Baron-Szabo, R. C. (2021b). Upper Barremian–lower Aptian scleractinian corals of central Europe (Schrattenkalk Fm., Helvetic Zone, Austria, Germany, Switzerland). *Zootaxa, 4960*(1), 1–199. https://doi.org/10.11646/zootaxa.4960.1.

Baron-Szabo, R.C. (2021c). Scleractinian corals of the Albian (uppermost Lower Cretaceous)—overview, revision, evaluation. Proceedings of the Biological Society of Washington, 134(1), 363–406 and 74 pages (Appendices 1–8).

Baron-Szabo, R. C., & Fernández-Mendiola, P. A. (1997). Cretaceous scleractinian corals from the Albian of Cabo de Ajo (Cantabria Province, N-Spain*). Paläontologische Zeitschrift, 71*, 35–50.

Baron-Szabo, R. C., & Furrer, H. (2018). Korallen (Anthozoa). In P. Kürsteiner & C. Klug (Eds.), *Fossilien im Alpstein—Kreide und Eozän der Nordostschweiz* (pp. 113–143). Appenzeller Verlag.

Baron-Szabo, R.C. & González-León, C.M. (1999). Lower Cretaceous corals and stratigraphy of the Bisbee Group (Cerro de Oro and Lampazos areas), Sonora, Mexico. *Cretaceous Research*, 20, 465–497. Retrieved from http://www.sciencedirect.com/science/article/pii/S0195667199901593.

Baron-Szabo, R.C. & González-León, C.M. (2003). Late Aptian-Early Albian corals from the Mural Limestone of the Bisbee Group (Tuape and Cerro de Oro areas), Sonora, Mexico. In: Scott, R.W. (Ed.): Cretaceous Stratigraphy and paleoecology, Texas and Mexico: Bob F. Perkins Memorial Volume. *Golf Coast Section SEPM Foundation*, Special Publications in Geology, 1, CD book, 187–225.

Baron-Szabo, R. C., & Sanders, D. (2020). Scleractinian corals (Anthozoa) from the lower Oligocene (Rupelian) of the Eastern Alps, Austria. *Bollettino della Società Paleontologica Italiana*, *59*, 1–18.

Baron-Szabo, R. C., & Steuber, T. (1996). Korallen und Rudisten aus dem Apt im tertiären Flysch des Parnass-Gebirges bei Delphi-Arachowa (Mittelgriechenland). *Berliner Geowissenschaftliche Abhandlungen (E), 18*, 3–75.

Baron-Szabo, R. C., Hamedani, A., & Senowbari-Daryan, B. (2003). Scleractinian corals from Lower Cretaceous deposits north of Esfahan (central Iran). *Facies, 48*, 199–216. pls. 36–39.

Beauvais, M. (1982). Révision systématique des Madréporaires des couches de Gosau (Crétacé supérieur, Autriche). *Travaux du Laboratoire de Paléontologie des Invertébrés*, 1, 1–256; 2, 1–278; 3, 1–177; 4 (atlas), pls. 1–59; 5 (atlas), figs. 1–131.

Beauvais, L. (1964). Étude stratigraphique et paléontologique des formations à madréporaires du Jurassique supérieur du Jura et de l'Est du Bassin de Paris. *Mémoire de la Société géologique de France, 100*, 1–287. pls. 1–38.

Beauvais, L. (1973). Upper Jurassic hermatypic corals. In A. Hallam (Ed.), *Atlas of palaeobiography.* Elsevier Scientific Publishing Company.

Beauvais, L. (1989). Jurassic corals from the circum Pacific area. *Memoir of the Association of Australasian Palaeontologists, 8*, 291–302.
Beauvais, M., & M'Rabet, A. (1977). Les Madreporaires du Berriasien superieur du Djebel Siouf (Axe Nord-Sud, Tunisie Centrale). *Notes du Service Géologique de Tunisie, 43*, 103–137. pls. 1–7.
Becker, E. (1876). Die Korallen der Nattheimer Schichten (1). *Palaeontographica*, 21, 1–60, pls 1–4 and 40–42. Retrieved from http://archive.org/details/palaeontographic21cass.
Bendukidze, N. S. (1961). On the study of the Lower Cretaceous corals from the Crimea. *Trudy Geologicheskogo Instituta Akademiya Nauk Gruzinskoy SSR (seriya Geologiya), 12*, 5–40. pls. 1–7. in Russian.
Bendukidze, N. S. (1982). Pozdneyurskiye korally rifogennykh otlozheniy Kavkaza i Kryma [Upper Jurassic corals from the reef deposits of the Caucasus and Crimea]. *Akademiya Nauk Gruzinskoy SSR, Geologicheskiy Institut Imeni A 1 Dzhanelidze Trudy, 74*, 1–166. in Russian.
Bölsche, W. (1871). Die Korallen des unteren Pläners im Sächsischen Elbthale. *Palaeontographica,* 20, 45–59. Retrieved from http://archive.org/details/palaeontographic20cass.
Bover-Arnal, T., Löser, H., Moreno-Bedmar, J. A., Salas, R., & Strasser, A. (2012). Corals on the slope (Aptian, Maestrat Basin, Spain). *Cretaceous Research, 37*, 43–64.
Bugrova, IYu. (1990). The facies zonation and scleractinians of the Early Hauterivian reef complex of Bolshoy Balkhan. *Cretaceous Research, 11*, 229–236. https://doi.org/10.1016/S0195-6671(05)80006-0.
Bugrova, IYu. (1999). New data about the Scleractinia of the lower Barremian sediments of south-west Turkmenistan. In D. L. Stepanov & G. N. Kiselev (Eds.), *Voprosy paleontologii* (Vol. 11, pp. 33–42). Izd-vo Leningradskogo universiteta. 3 pls. in Russian.
Burger, H. (1985). *Palfris-Formation, Öhrli-Formation und Vitznau-Mergel (basale Kreide des Helvetikums) zwischen Reuss und Rhein*. Unpublished Ph.D. thesis, University of Zürich, 237 pp.
Burger, H. (1986). Fazielle Entwicklung und paläogeographische Rekonstruktion des helvetischen Schelfs während der untersten Kreide in der Zentral- und Ostschweiz. *Eclogae Geologicae Helvetiae, 79*, 561–615.
Burger, H., & Strasser, A. (1981). Lithostratigraphische Einheiten der untersten Helvetischen Kreide in der Zentral- und Ostschweiz. *Eclogae Geologicae Helvetiae, 74*(2), 529–560.
Champagne, T.A.N. (2010). *Oligocene coral evolution in Puerto Rico and Antigua: morphometric analysis of Agathiphyllia, Antiguastrea, and Montastraea*. MS (Master of Science) thesis, University of Iowa. https://doi.org/10.17077/etd.gl9af2pk.
Coates, A. G., & Jackson, J. B. C. (1987). Clonal growth, algal symbiosis, and reef formation in corals. *Paleobiology, 13*, 363–378.
Cobb, N. A. (1920). One hundred new names (type species of 100 new genera. *Contributions to a Sciences of Nematology, 9*, 217–343.
Császár, G., & Turnšek, D. (1996). Vestiges of atoll-like formations in the Lower Cretaceous of the Mecsek Mountains, Hungary. *Cretaceous Research, 17*, 419–442.
d'Achiardi, A. (1880). Coralli Giurassici dell'Italia Settentrionale: Memoria. *Atti della società toscana di scienze naturali residente in Pisa Memorie, 4*, 1–78.
d'Orbigny, A. (1849). *Prodrôme de Paléontologie stratigraphique universelle des animaux mollusques et rayonnés, Volume 1*. Masson, Paris, 394 pp. Retrieved from http://archive.org/details/prodromedepalo01orbiuoft.
d'Orbigny, A. (1850a). Catalogue des espèces fossiles de Mollusques, Bryozoaires, de Polypiers et d'Anamorphozoraires de l'étage néocomien. *Revue et Magasin de Zoologie pure et appliquée, sér. 2*, t. 2, p. 170–181.
d'Orbigny, A. (1850b). *Prodrôme de Paléontologie stratigraphique universelle des animaux mollusques et rayonnés* (Vol. 2, p. 428). Masson.
d'Orbigny, A. (1851). *Cours élémentaire de Paléontologie (3), Polypiers ou Zoophytes* (Vol. 2, pp. 151–189). Masson.
Dacqué, E. (1933). Wirbellose des Jura. *Leitfossilien, 7*, 1–582. pls 24.
Defrance, M. J. L. (1817). Caryophyllie. In M. J. L. Defrance (Ed.), *Dictionnaire des sciences naturelles* (Vol. 7, pp. 191–195). L.G. Levrault.
Dietrich, W. O. (1926). Steinkorallen des Malms und der Unterkreide im südlichen Deutsch-Ostafrika. *Palaeontographica, 1*(Supplement 7), 43–62.
Dimitrijević, D., Raja, B. & Kiessling, W. (2021). Corallite sizes and their link to extinction risk of scleractinian corals across the Triassic-Jurassic boundary. *Conference: GSA connects Online*. https://doi.org/10.1130/abs/2020AM-357201.
Doweld, A. B. (2014). Starostinia, a new replacement name for Ironella Starostina & Krasnow, 1970 (Anthozoa: Scleractinia: Rhipidogyridae) non Cobb 1920. *Zootaxa, 3815*(2), 299–300. https://doi.org/10.11646/zootaxa.3815.2.11.
Dryer, S., & Logan, A. (1978). Holocene reefs and sediments of Castle Harbour, Bermuda. *Journal of Marine Research, 36*, 399–425.
Duncan, P. M. (1870). A monograph of the British fossil corals (2, 2): Corals from the Upper Greensand of Haldon, from the Gault, and the Lower Greensand. *Palaeontographical Society Monographs, 23*, 45–73.
Duncan, P. M. (1884). A revision of the families and genera of the sclerodermic Zoantharia Edwards et Haime, or Madreporaria (M Rugosa excepted). *Journal of the Linnean Society of London, Zoology, 18*(104–105), 1–204. https://doi.org/10.1111/j.1096-3642.1884.tb02013.x.
Eguchi, M. (1951). Mesozoic hexacorals from Japan. *Science Reports of the Tôhoku Imperial University,* Second Series (Geology), 24, 1–96, pls. 1–28. Retrieved from http://jairo.nii.ac.jp/0085/00021417/en.
Eichwald, E. von (1865–69). *Lethea rossica ou Paléontologie de la Russie, Vol. 2, Période moyenne*. E Schweizerbart, 1288 (in French)
Eliášová, H. (1973). Sous-famille Rhipidogyrinae Koby, 1905 (Hexacorallia) des calcaires de Štramberk (Tithonien, Tchécoslovaquie). *Casopis pro Mineralogii a Geologii, 18*, 267–287. pls. 1–13.
Eliášová, H. (1976a). Nouvelle famille du sous-ordre Amphiastraeina Alloiteau, 1952 (Hexacorallia, Tithonien de Tchécoslovaquie). *Věstnik Ústedního Ústavu Geologického, 51*, 177–178. in French.
Eliášová, H. (1976b). Familles Placosmiliidae Alloiteau, 1952 et Misistellidae nov fam (Hexacorallia) des calcaires de Štramberk (Tithonien, Tchecoslovaquie). *Casopis pro Mineralogii a Geologii, 21*(4), 337–347.
Eliášová, H. (1981). The Tithonian reef of Štramberk Limestone (Czechoslovakia, West Carpathians). *Casopis pro Mineralogii a Geologii, 26*(2), 113–124.
Eliášová, H. (1990). Coraux des calcaires d'Ernstbrunn (Jurassique supérieur–Crétacé inférieur dans les Carpates externes, zone de Waschberg, Tchécoslovaquie). *Casopis pro Mineralogii a Geologii, 35*, 113–134. pls. 1–4.
Eliášová, H. (1992a). Rhipidogyridés (Scléractiniaires) du Crétacé de Bohême (Cénomanien supérieur–Turonien inférieur; Turonien supérieur, Tchécoslovaquie). *Věstník Českého Geologického Ústavu, 66*(3), 163–172. 8 pls. in French.
Eliášová, H. (1992b). Archaeocoeniina, Stylinina, Astraeoina, Meandriina et Siderastraeidae (Scléractiniaires) du Crétacé de Bohême (Cénomanien supérieur–Turonien inférieur; Turonien supérieur, Tchécoslovaquie). *Věstník Českého Geologického Ústavu, 67*(6), 399–416. 8 pls. in French.
Eliášová, H. (2004). Coraux solitaires (Zoantharia, Microsolenina) du Crétacé de Bohême (Cénomanien supérieur, République Tchèque) [Cretaceous solitary corals (Zoantharia, Microsolenina) from Bohemia (Late Cenomanian, Czech Republic)]. *Bulletin of Geosciences, 79*(3), 157–166. in French.
Errenst, Ch. (1990). Das korallenführende Kimmeridgium der nordwestlichen iberischen Ketten und angrenzender Gebiete (1). *Palaeontographica Serie A, 214*, 121–207. pls. 1–12.
Errenst, Ch. (1991). Das korallenführende Kimmeridgium der nordwestlichen iberischen Ketten und angrenzender Gebiete (2). *Palaeontographica Serie A, 215*, 1–42. pls. 13–21.
Étallon, A. (1858). Etudes paléontologiques sur le Haut-Jura. Rayonnés du Corallien. *Mémoires de la Société d'Émulation du Département du Doubs, 3e série*, 3, 401–553. Besançon. (in French)
Étallon, A. (1859). Études paléontologiques sur le Haut-Jura. Rayonnés du Corallien. *Mémoires de la Société d'Émulation du Département du Doubs,* 3e série, 6, 53–260. Retrieved from http://archive.org/details/mmoiresetcomptes03emul.
Felix, J. (1891). Versteinerungen aus der mexicanischen Jura- und Kreide-Formation. *Palaeontographica*, 37, 140–194. Retrieved from http://archive.org/details/palaeontographic37cass.
Felix, J. (1914). *Anthozoa Palaeocretacea. Fossilium Catalogus: Animalia (5–7)* (pp. 1–273). W. Junk.
Filkorn, H. F., & Pantoja-Alor, J. (2009). Cretaceous corals from the Huetamo region, Michoacan and Guerrero, southwestern Mexico. *Universidad Nacional Autonoma de Mexico, Instituto de Geologia, Boletin, 116*, 1–169.
Fischer, P. (1873). Sur le terrain jurassique de Madagascar. *Comptes Rendus de l'académie des Sciences, Paris, 76*, 111–114.
Föllmi, K. B., Bodin, S., Godet, A., Linder, P., & Van de Schootbrugge, B. (2007). Unlocking paleo-environmental information from Early Cretaceous shelf sediments in the Helvetic Alps: Stratigraphy is the key! *Swiss Journal of Geosciences, 100*(3), 349–369. https://doi.org/10.1007/s00015-007-1236-y.
Frech, F. (1890). Die Korallenfauna Der Trias. *Palaeontographica, 37*, 1–116.

Fromentel, E. de (1856). Note sur les polypiers fossiles de étage portiandien de la Haute-Saône. *Bulletin de la Société géologique de France,* Série 2, 13, 851–865. Retrieved from http://books.google.com/books?id=36obAAAAMAAJ.

Fromentel, E. de (1857). Description des Polypiers fossiles: Étage Nèocomien. *Bulletin de la Société des Sciences Historiques et Naturelles de l'Yonne*, 78 pp. Retrieved from http://books.google.com/books?id=EL8oAQAAMAAJ.

Fromentel, E. de (1861). Introduction à l'étude des Polypiers fossiles. *Mémoires de la Société d'Émulation du Département du Doubs*, 5, 1–357. Retrieved from http://archive.org/details/mmoiresetcomptes05emul.

Fromentel, E. de (1884). Zoophytes, terrains crétacés (14). In A. de d'Orbigny (Ed.), *Paléontologie Française* (Vol. 8, pp. 529–560). Masson. pls. 145–156.

Fromentel, E. de (1887). Zoophytes, terrains crétacés (16). In A. d'Orbigny (Ed.), *Paléontologie Française* (Vol. 8, pp. 609–624). Masson. pls. 181–192.

Funk, H. (1999). Kreide des Säntis. Exkursion H. 69. Jahrestagung der Paläontologischen Gesellschaft 20.9.–26.9.1999 Zürich. *Terra Nostra, 99*(9), 113–127.

Garberoglio, R. M., Löser, H., & Lazo, D. G. (2020). Lower Cretaceous corals from the Agrio Formation, Neuquén Basin, west-central Argentina: Family Actinastraeidae. *Cretaceous Research, 114*, 18. https://doi.org/10.1016/j.cretres2020.104503.

Garberoglio, R.M., Löser, H. & Lazo, D.G. (2021). Lower Cretaceous corals from the Agrio Formation, Neuquén Basin, west-central Argentina: Family Columastraeidae. *Cretaceous Research, 124*(suppl. 7), 104817, 1–19. https://doi.org/10.1016/j.cretres.2021.104817.

Geyer, O. (1954). Die oberjurassische Korallen-Fauna von Württemberg. *Palaeontographica Abteilung A: Paläozoologie, Stratigraphie, 104*, 121–220. pls. 9–16.

Geyer, O. F. (1955). Beiträge zur Korallenfauna des Štramberger Tithon. *Paläontologische Zeitschrift, 29*, 177–216. https://doi.org/10.1007/BF03041799 pls. 22–26.

Geyer, O. F., & Rosendahl, S. (1985). Stromatoporen, Korallen und Nerineen aus oberjurassischen und unterkretazischen Schichten des Präbetikums von Cazorla (Provinz Jaen, Spanien) [Upper Jurassic and Lower Cretaceous stromatoporoids, corals and nerineids from the Prebetic of Cazorla (Jaen, Spain)]. *Arbeiten aus dem Institut für Geologie und Paläontologie an der Universität Stuttgart, 82*, 161–179.

Ginsburg, R. N. (1972). South Florida Carbonate Sediments. *Sedimenta, 2*, 1–71.

Goldfuss, G.A. (1826–1829). *Petrefacta Germaniae. Volumes 1–2.* Arnz & Co., Düsseldorf, pp. 1–164. Retrieved from http://sdrv.ms/WzHwEL.

Hackemesser, M. (1936). Eine kretazische Korallenfauna aus Mittel-Griechenland und ihre paläobiologischen Beziehungen. *Palaeontographica, 84*, 1–97.

Haefeli, Ch., Maync, W., Oertli, H. J., & Rutsch, R. F. (1965). Die Typus-Profile des Valanginien und Hauterivien. *Bulletin der Vereinigung Schweiz Petroleum-Geologen und Ingenieure, 31*(81), 41–75.

Idakieva, V. (2007). Taxonomy of scleractinian corals from the Barremian-Lower Aptian of central north Bulgaria (Lovech Urgonian Group). *Godishnik na Sofiyskiya Universitet Sv. Kliment Okhridski, Geologo-Geografski Fakultet, Geologiya, 100*, 29–66.

Imlay, R. W. (1940). Neocomian fauna of northern Mexico. *Geological Society of America, Bulletin, 51*, 117–190.

Jaccard, A. (1893). Contributions à la géologie du Jura. *Bulletin de la Société des Sciences Naturelles de Neuchâtel, 21*, 51–87. Neuchâtel.

Jordi, H.A. (2012). *Blatt 1188 Eggiwil. Erläuterungen 75.* Geologischer Atlas der Schweiz, 1:25000, Bundesamt für Landestopografie, pp. 1–72, 2 pls.

Karakasch, N. I. (1907). Le crétacé inférieur de la Crimée et sa fauna. *Trudy Imperatorskogo St. Petersburgskago Obshchestva Estestvoispytateley, 32*, 1–484.

Kashiwagi, K., Yamagiwa, N., Yao, A., Ezaki, Y., Sakaori, Y., & Shoji, Y. (2002). Late Jurassic cnidarian and poriferan fossils from the Torinosu-type limestones in the Kurosegawa Terrane, western Kii Peninsula, southwest Japan and their geological significance. *Paleontological Society of Japan, Tokyo, 72*, 5–16.

Kaya, O., Wiedmann, J., Kozur, H., Özdemir, Ü., Özer, S., & Beauvais, L. (1987). A new discovery of the Lower Cretaceous in Istanbul-Turkey. *Bulletin of the Mineral Research and Exploration, 107*, 106–111.

Kitchin, F. L. (1908). The invertebrate fauna and palaeontological relations of the Uitenhage series. *Annals of the South African Museum, 7*, 21–250.

Koch, C. L., & Dunker, W. B. R. H. (1837). Beiträge zur Kenntniss des Norddeutschen Oolithgebildes und dessen Versteinerungen. Volume 4, 1–64; Oehme und Mülle, Braunschweig.

Koby, F. (1880). Monographie des polypiers jurassiques de la Suisse (4). *Mémoires de la Société Paléontologique Suisse (= Abhandlungen der Schweizerischen Paläontologischen Gesellschaft), 7*, 1–60. pls. 1–12 in French.

Koby, F. (1881). Monographie des polypiers jurassiques de la Suisse (4). Mémoires de la Société Paléontologique Suisse (= Abhandlungen der Schweizerischen Paläontologischen Gesellschaft), 8, 61–108, pls. 13–30. in French

Koby, F. (1884). Monographie des polypiers jurassiques de la Suisse (4). *Mémoires de la Société Paléontologique Suisse (= Abhandlungen der Schweizerischen Paläontologischen Gesellschaft)*, 11, 149–212, pls. 43–63. (in French) (http://sdrv.ms/RBjoNA).

Koby, F. (1885). Monographie des polypiers jurassiques de la Suisse (4). *Mémoires de la Société Paléontologique Suisse (= Abhandlungen der Schweizerischen Paläontologischen Gesellschaft), 12*, 213–304. pls. 64–81. in French.

Koby, F. (1887). Monographie des polypiers jurassiques de la Suisse (7). *Mémoires de la Société Paléontologique Suisse (= Abhandlungen der Schweizerischen Paläontologischen Gesellschaft,* 14, 353–400, pls. 99–108. (in French) Retrieved from http://books.google.com/books?id=xt8QAAAIAAJ.

Koby, F. (1896). Monographie des polypiers crétacés de la Suisse (1). *Mémoires de la Société Paléontologique Suisse (= Abhandlungen der Schweizerischen Paläontologischen Gesellschaft)*, 22, 1–28, pls. 1–8. (in French) Retrieved from http://sdrv.ms/RBjB3y.

Koby, F. (1897). Monographie des polypiers crétacés de la Suisse (2). *Mémoires de la Société Paléontologique Suisse (= Abhandlungen der Schweizerischen Paläontologischen Gesellschaft)*, 23, 29–62, pls. 9–16. (in French) Retrieved from http://sdrv.ms/RBjGUJ.

Koby, F. (1898). Monographie des polypiers crétacés de la Suisse (2). *Mémoires de la Société Paléontologique Suisse (= Abhandlungen der Schweizerischen Paläontologischen Gesellschaft), 24*, 63–100. pls. 17–22 in French.

Koby, F. (1905). Description de la faune jurassique du Portugal. Polypiers du Jurassique supérieur. *Commission du Service Géologique du Portugal*, 89–164, pls. 1–30. [in French] Retrieved from http://hdl.handle.net/2027/uc1.31822023452386).

Kołodziej, B. (1995). Microstructure and taxonomy of Amphiastraeina (Scleractinia). *Annales Societatis Geologorum Poloniae, 65*, 1–17.

Kołodziej, B. (2003). Scleractinian corals of suborders Pachythecaliina and Rhipidogyrina: discussion on similarities and description of species from Štramberk-type limestones, Polish Outer Carpathians. *Annales Societatis Geologorum Poloniae*, 73, 193–217. Retrieved from http://www.asgp.pl/73_3_193.

Kołodziej, B. (2015). Corals of the Štramberk-type limestone from Poland: Taxonomic and palaeoecological aspects. *Neues Jahrbuch für Geologie und Paläontologie Abhandlungen, 276*(2), 181–199.

Kołodziej, B., & Marian, V. A. (2021). Simplified, wall- based morphology of a new Aptian coral and discussion of contrasting opinions on the taxonomy of similar corals. *Neues Jahrbuch für Geologie und Paläontologie Abhandlungen, 300*(2), 201–213.

Krasnov, E.V. & Starostina, E.A. (1970). Late Jurassic scleractinians of northern Caucasus. In: Sokolov, B.S. (Ed.): *Mezozoyskie Korally SSSR (Trudy 2 Vsesoyuznogo simpoziuma po izucheniyu iskopaemykh korallov SSSR, 4) [Proceedings of the 2-Union Symposium on the study of fossil corals of the USSR]*, 75–80, Moskva (Nauka). (in Russian)

Kürsteiner, P., & Klug, C. (2018). *Fossilien im Alpstein – Kreide und Eozän der Nordostschweiz* (p. 376). Appenzeller Verlag.

Kuzmicheva, E.I. (1966). Stratigraphic and facial distribution of hexacorals (Scleractinia) in the Neocomian of the Mountain Crimea. *Prirodnye I trudovye resursy levoberezhnoy Ukrainy i ikh isolzovanie*, 58–63 (Moskva, Nedra) [in Russian]

Kuzmicheva, E. I. (1967). Morphology of Early Cretaceous scleractiniae. *Paleontologichesky Zhurnal, 4*, 48–55. in Russian.

Kuzmicheva, E. I. (1972). *Novye vidy rannemelovykh skleraktiniy gornogo Kryma [New species of Early Cretaceous scleractinians from the Mountain Crimea]* (pp. 106–110). Nauka. in Russian.

Kuzmicheva, E. I. (1980). Corals. In V. Chernov, B. Yanin, & M. Golovinova (Eds.), *Urgonskie Otlozheniya Sovetskikh Karpat* (pp. 90–108). Nauka. in Russian.

Kuzmicheva, E. I. (1985). Cretaceous and Paleogene corals of the Ukraine. *Moscow University Geology Bulletin, 40*(5), 30–35.
Kuzmicheva, E. I. (2002). Skeletal morphology, systematics and evolution of Scleractinia. *Trudy Paleontologicheskogo Instituta, 286*, 1–211. in Russian.
Kuzmicheva, E. I., & Aliev, O. B. (1988). Corals. In A. A. Ali-Zade, G. A. Aliev, M. M. Aliev, H. Aliujulla, & A. G. Halilov (Eds.), *Cretaceous fauna of Azerbaijan* (pp. 153–184). Akademia Nauk Azerbaidjana SSR. in Russian.
Kuzmicheva, E. I., & Shalya, A. A. (1962). Biogenic formations in the Neocomian deposits of the Central Crimea. *Izvestiya vysshikh uchebnykh zavedeny, geologiya i razvedka, 12*, 29–34.
Lamouroux, J.U.F. (1821). *Exposition méthodique des genres de l'ordre des polypiers*. Agasse, Paris, 115 pp. pls. 1–84. Retrieved from http://archive.org/details/expositionmtho00lamo.
Laternser, R. (2001). Oberjurassische Korallenriffe von Nordfrankreich (Lothringen) und Südwestdeutschland. PhD Thesis, University of Stuttgart, 298 pp.
Lathuilière, B. (1996). Itinéraires astogéniques chez des coraux simples et coloniaux montlivaltiides du Bajocien de France. *Geobios 29*, 577–603. Retrieved from http://www.sciencedirect.com/science/article/pii/S001669959680026X.
Lathuilière, B., Baron-Szabo, R.C., Charbonnier, S. & Pacaud, J.-M. (2020). The Mesozoic scleractinian genus *Adelocoenia* (Stylinidae) and its Jurassic species. *Carnets de Geologie*, 20 (19), 367–406, figs. 1–36. https://doi.org/10.2110/carnets.2020.2019.
Lathuilière, B., & Gill, G. (1998). *Dendraraea* corail scléractiniaire branchu jurassique: Structure, systématique, écologie. *Palaeontographica, 248*, 145–162.
Lauxmann, U. (1991). Revision der oberjurassischen Korallen von Württemberg (SW-Deutschland), exclusive Fungiina. *Palaeontographica Abteilung A: Paläozoologie, Stratigraphie, 219*, 107–175. pls. 1–7.
Lebanidze, Z. M. (1991). Pozdiejurskie korraly zapadnoj gruzii (Abkhazja). *Trudy Geologicheskogo Instituta Akademiya Nauk Gruzinskoy SSR (Seriya Geologiya), 105*, 1–65. in Russian.
Lefeld, J. (1968). Stratigraphy and paleogeography of the High-Tatric Lower Cretaceous in the Tatra Mountains. *Studia Geologica Polonica, 24*, 115. pls. 18 in Polish.
Liao, W. (1982). *Mesozoic scleractinian corals from Xizang (Tibet)* (pp. 151–183). Beijing: Science Press. in Chinese with English summary.
Liao, W.-H., & Xia, J.-B. (1985). Upper Jurassic and Lower Cretaceous Scleractinia from Bangoin district of northern Xizang (Tibet). *Memoirs of the Nanjing Institute of Geology and Palaeontology, 21*, 119–174. in Chinese with English summary.
Liao, W.-H., & Xia, J.-B. (1994). Mesozoic and Cenozoic scleractinian corals from Xizang. *Palaeontologia Sinica, 184*(31), 1–252.
Linnaeus, C. von (1758). *Systema naturæ per regna tria naturæ, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. Tomus I, pp. 824, Holmiæ [=Stockholm] (Laurentius Salvius). (in Latin)
Logan, A. (1988). Sediment-shifting capability in the recent solitary coral *Scolymia cubensis* (Milne-Edwards and Haime) from Bermuda. *Bulletin of Marine Science, 43*, 241–248.
Loriol, P. de (1868). Monographie des couches de l'Étage Valanginien des carrièrs d'Arzier (Vaud). *In:* Pictet, F.-J. (ed), *Matériaux pour la paleontology Suisse: ou recueil des monographies sur les fossils du Jura et des Alpes (4), 2*. H. Georg, Bale and Geneva, pp. 5–110, 9 pls.
Löser, H. (1989). Die Korallen der Sächsischen Oberkreide, Teil 1. *Abhandlungen des Staatlichen Museums für Mineralogie und Geologie Dresden, 36*, 88–154. 183–186, 209–215, pls. 21–27.
Löser, H. (1998). Die Korallen der Sächsichen Oberkreide—eine Zwischenbilanz und Bermerkungen zu Korallenfaunen des Cenomans. *Abhandlungen des Staatlichen Museums für Mineralogie und Geologie zu Dresden, 43*(44), 173–187.
Löser, H. (2001). Le site de Valliere (departement de l'Aube, France): resultats preliminaire sur des coraux de l'Hauterivien inferieur (Cretace). *Bulletin annuelle de l'Association geologique de l'Aube*, 22, 39–53 (Sainte Savine; Association geologique auboise).
Löser, H. (2008). Early Cretaceous coral faunas from East Africa (Tanzania, Kenya; Late Valanginian–Aptian) and revision of the Dietrich collection (Berlin, Germany). *Palaeontographica (Abteilung A), 285*(1–3), 23–75.
Löser, H. (2012). Revision of Actinastrea, the most common Cretaceous coral genus. Paläontologische Zeitschrift, 86, 15–22
Löser, H., Arias, C., & Vilas, L. (2015). Aptian-Albian coral faunas from the Sierra del Carche (Prebetic, Murcia, Southern Spain). *Spanish Journal of Palaeontology, 30*(1), 43–63.
Löser, H., Arias, C., & Vilas, L. (2019). Upper Valanginian to Lower Hauterivian coral faunas from the Sierra Larga (Prebetic zone, SE Spain). *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen, 292*(3), 259–290.
Löser, H., Nieto, L.M., Castro, J.M & Reolid, M. (2021). A Lower Valanginian coral faunas from the South Iberian Palaeomargin (Internal Prebetic, SE Spain). *Palaeontologia Electronica,* 21(1), 1–57 (a06). https://doi.org/10.26879/1030.
Masse, J.-P., Morycowa, E., & Fenerci-Masse, M. (2009). Valanginian-Hauterivian scleractinian coral communities from the Marseille region (SE France). *Cretaceous Research, 30*, 178–192.
Michelin, H. (1841). *Iconographie zoophytologique. Description par localités et terrains des polypiers fossiles de France* (Vol. 2, pp. 18–72). Paris: Bertrand.
Michelin, H. (1843). *Iconographie zoophytologique. Description par localités et terrains des polypiers fossiles de France* (Vol. 3, pp. 73–104). Bertrand.
Michelin, H. (1844). *Iconographie zoophytologique. Description par localités et terrains des polypiers fossiles de France* (Vol. 4, pp. 105–144). Bertrand.
Michelin, H. (1847). *Iconographie zoophytologique. Description par localités et terrains des polypiers fossiles de France* (Vol. 7, pp. 249–328). Bertrand.
Milaschewitsch, C. (1876). Die Korallen der Nattheimer Schichten (2). *Palaeontographica, 21*, 62–123. pls 43–51.
Milne Edwards, H., & Haime, J. (1848a). Note sur la classification de la deuxième tribu de la famille des astréides. *Comptes Rendus de l'académie des Sciences, 27*, 490–497.
Milne Edwards, H., & Haime, J. (1848b). Recherches sur les polypiers (4). Monographie des astréides (1) Eusmiliens. Annales des sciences naturelles, série 3. *Zoologie, 10*, 209–320. pls. 5–9.
Milne Edwards, H. & Haime, J. (1850). A monograph of the British fossil corals (1). Tertiary and Cretaceous. *Monographs of the Palaeontographical Society*, 3, i–lxxxv, 1–71, pls. 1–11.
Milne Edwards, H., & Haime, J. (1851). A monograph of the British fossil corals. Corals from the oolitic formations. *Monographs of the Palaeontographical Society, 5*, 73–146. pls. 12–30.
Milne Edwards, H. & Haime, J. (1857). *Histoire naturelle des Coralliaires ou polypes proprement dits. Volumes 1 and 2*. Librairie Encyclopédique de Roret, Paris, 633 pp. and atlas. Retrieved from http://books.google.com/books?id=W48-AAAAcAAJ&source=gbs_navlinks_s.
Morales, C., Gardin, S., Schnyder, J., Spangenberg, J., Arnaud-Vanneau, A., Arnaud, H., Adatte, T., & Föllmi, K. B. (2013). Berriasian and early Valanginian environmental change along a transect from the Jura platform to the Vocontian Basin. *Sedimentology, 60*(1), 36–63.
Morycowa, E. (1964). Hexacorallia des couches de Grodziszcze (Néocomien, Carpathes). *Acta Palaeontologica Polonica*, 9, 3–114, pls. 1–33. (in French) Retrieved from http://www.app.pan.pl/article/item/app09-003.html.
Morycowa, E. (1971). Hexacorallia et Octocorallia du Crétacé inférieur de Rarau (Carpathes orientales roumaines). *Acta Palaeontologica Polonica*, 16, 3–149. (in French). Retrieved from http://www.app.pan.pl/article/item/app16-003.html.
Morycowa, E. (2012). Corals from the Tithonian carbonate complex in the Dabrowa Tarnowska-Szczucin area (Polish Carpathian Foreland). *Annales Societatis Geologorum Poloniae, 82*, 1–38.
Morycowa, E. & Masse, J.-P. (1998). Les scléractiniaires du Barrémien–Aptien inférieur de Provence (SE de la France) [The Barremian–Early Aptian Scleractinia from Provence (SE France)]. *Géobios,* 31 (6), 725–766 (in French). Retrieved from http://www.sciencedirect.com/science/article/pii/S0016699598801071.
Morycowa, E. & Marcopoulou-Diacantoni, A. (2002). Albian corals from the subpelagonian zone of central Greece (Agrostylia, Parnassos region). *Annales Societatis Geologorum Poloniae*, 72, 1–65. Retrieved from http://www.asgp.pl/72_1_001.
Morycowa, E. & Roniewicz, E. (1990). Revision of the genus *Cladophyllia* and description of *Apocladophyllia* gen.n. (Cladophylliidae fam.n., Scleractinia). *Acta Palaeontologica Polonica,* 35, 165–190, pls. 15–22. Retrieved from http://www.app.pan.pl/article/item/app35-165.html.
Morycowa, E., & Decrouez, D. (2006). Early Aptian scleractinian corals from the Upper Schrattenkalk of Hergiswil (Lucerne region, Helvetic Zone of central Switzerland). *Revue de Paléobiologie, 25*(2), 791–838.

Morycowa, E., & Masse, J.-P. (2009). Lower Cretaceous Microsolenina (Scleractinia) from Provence (southern France). *Annales Societatis Geologorum Poloniae, 79*, 97–140.
Morycowa, E., & Roniewicz, E. (2016). Microstructural evidence of the stylophyllid affinity of the genus *Cyathophora* (Scleractinia, Mesozoic). *Annales Societatis Geologorum Poloniae, 86*, 1–16. https://doi.org/10.14241/asgp.2015.023.
Morycowa, M., & Mišik, M. (2005). Upper Jurrasic shallow-water scleractinian corals from the Pieniny Klippen Belt (Western Carpathians/Slovakia). *Geologica Carpathica, 56*(5), 415–432.
Ogilvie, M.M. (1897). Die Korrallen der Stramberger Schichten. *Palaeontographica*, 7A, 73–282. Retrieved from http://sdrv.ms/QWbjTX.
Oppenheim, P. (1930). *Die Anthozoen der Gosauschichten in den Ostalpen*. Oppenheim (privately published), Berlin-Lichterfelde, 604 pp.
Pandey, D. K., & Fürsich, F. T. (2003). Jurassic corals of east-central Iran. *Beringeria, 32*, 1–138.
Pandey, D.K., Fürsich, F.T., Baron-Szabo, R.C. & Wilmsen, M. (2007). Lower Cretaceous corals from the Koppeh Dagh, NE-Iran. *Zitteliana* A, 48–49, 13–37. Retrieved from http://epub.ub.uni-muenchen.de/11965/.
Papoyan, A. S. (1982). Biostratigrafi korallov iz pozdnejurskogo Neokomskogo kompleksa zangesura. *Izvestiya AN Armyanskoy SSR, Nauki o Zemle, Erevan, 35*(2), 65–67.
Papoyan, A. S. (1989). A biostratigraphic review of the Kaphan anticlinorium Upper Jurassic-Lower Cretaceous deposits by the coralline fauna. *Izvestiya AN Armyanskoy SSR, Nauki o Zemle, Erevan, 42*(2), 3–9. in Russian.
Pfister, T. (1980). Systematische und paläoökologische Untersuchungen an oligozänen Korallen der Umgebung von San Luca (Provinz Vicenza, Norditalien). *Schweizerische Paläontologische Abhandlungen (mémoires Suisses de Paléontologie), 103*, 1–121.
Phillips, J. (1829). *Illustrations of the Geology of Yorkshire; or, a Description of the Strata and Organic Remains of Yorkshire Coast*. York. Thomas Wilson and Sons, pp. 192, 25 pls. Retrieved from http://archive.org/details/illustrationsofg00phil rich.
Pratz, E. (1882–1883). Über die verwandtschaftlichen Beziehungen einiger Korallengattungen mit hauptsächlicher Berücksichtigung ihrer Septalstructur. *Palaeontographica, 29*, 81–124. [Cassel (=Kassel)]. Retrieved from http://sdrv.ms/TcfboO.
Prever, P.L. (1909). Anthozoa. *In:* Parona, C.F. (Ed.), *La Fauna Coralligena del Cretaceo dei Monti d'Ocre nell'Abruzzo Aquilano*. Springer, Roma, pp. 51–147. Roma. [in Italian]
Prinz, P. (1991). Mesozoische Korallen aus Nordchile. *Palaeontographica Abteilung A: Paläozoologie, Stratigraphie, 216*, 147–209.
Quenstedt, F.A. (1843). *Das Flözgebirge Würtembergs. Mit besonderer Rücksicht auf den Jura*. Tübingen: H. Laupp, XXXX pp. Retrieved from http://books.google.com/books?id=3fYTAAAAQAAJ.
Quenstedt, F.A. (1852). *Handbuch der Petrefaktenkunde*. H. Laupp, Tübingen, 796 pp.
Quenstedt, F.A. (1857). *Der Jura (Teil 3)*. H. Laup & Sieber, Tübingen, pp. 369–576. Retrieved from http://books.google.com/books?id=jCI-AAAAcAAJ.
Quenstedt, F. A. (1879). *Röhren- und Sternkorallen (Teil 1)* (pp. 1–624). Fues's Verlag.
Reig Oriol, J.M. (1994). *Madreporarios cretácicos de Cataluña*. José M Reig Oriol (privately published), Barcelona, 60 pp.
Reyeros de Castillo, M.M. (1983). Corales de algunas formaciones cretacicas del estado de Oaxaca. *Paleontologia Mexicana,* 47, 1–67. Retrieved from http://www.ojs-igl.unam.mx/index.php/Paleontologia/article/view/72.
Ricci, C., Lathuilière, B., & Rusciadelli, G. (2018). Coral communities, zonation and paleoecology of an Upper Jurassic reef complex (*Ellipsactinia* Limestones, central Apennines, Italy). *Rivista Italiana di Paleontologia e Stratigrafia, 124*(3), 433–508.
Roniewicz, E. (1976). Les scléractiniaires du Jurassique supérieur de la Dobrogea centrale Roumanie. *Palaeontologica Polonica*, 34, 17–121, pls. 1–34. (in French) Retrieved from http://www.palaeontologia.pan.pl/Archive/1976-34.pdf.
Roniewicz E. (1989). Triassic scleractinian corals of the Zlambach Beds, northern Calcareous Alps, Austria. *Denkschriften Österreichische Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Klasse* 126, 1–144.
Roniewicz, E. (2008). Kimmeridgian–Valanginian reef corals from the Moesian Platform from Bulgaria. *Annales Societatis Geologorum Poloniae*, 78, 91–134. Retrieved from http://www.asgp.pl/78_2_091_134.
Roniewicz, E., & Morycowa, E. (1993). Evolution of the Scleractinia in the light of microstructural data. *Courier Forschungsinstitut Senckenberg, 164*, 233–240.
Rosendahl, S. (1985). Die oberjurassische Korallenfazies von Algarve (Südportugal). *Arbeiten aus dem Institut für Geologie und Paläontologie der Universität Stuttgart Neue Folge, 82*, 1–125. pls. 1–11.
Sala, P., Pfiffner, A. O., & Frehner, M. (2014). The Alpstein in three dimensions: Fold-and-thrust belt visualization in the Helvetic zone, eastern Switzerland. *Swiss Journal of Geoscience*. https://doi.org/10.1007/s00015-014-0168-6.
Sanders, D. G., & Baron-Szabo, R. C. (2005). Scleractinian assemblages under sediment input: Their characteristics and relation to the nutrient input concept. *Palaeogeography, Palaeoclimatology, Palaeoecology, 216*, 139–181. https://doi.org/10.1016/j.palaeo.2204.10.008.
Sandy, M. R. (1990). Early Cretaceous brachiopods from Mexico and their paleobiogeographic significance. *Journal of Paleontology, 64*(6), 942–956.
Santodomingo, N. (2014). Miocene reef-coral diversity of Indonesia: unlocking the murky origins of the Coral Triangle. Utrecht studies in earth sciences, 63, 1–340
Schöllhorn, E. (1998). Geologie und Paläontologie des Oberapt im Becken von Organyà (Nordspanien). *Coral Research Bulletin, 6*, 1–139.
Scholz, H. (1979). *Paläontologie, Aufbau und Verbreitung der Bioherme und Biostrome im Allgäuer Schrattenkalk*. Unplublished PhD thesis, Technische Universität München, München, pp. 133
Scholz, H. (1984). Paläontologie, Aufbau und Verbreitung der Bioherme und Biostrome im Allgäuer Schrattenkalk (Helvetikum, Unterkreide). *Jahrbuch der Geologischen Bundesanstalt Wien, 127*(3), 471–499.
Scott, R.W. (1984). Significant fossils of the Knowles Limestone, Lower Cretaceous, Texas. In: Ventress, W.P.S. *et al.* (Eds.): *The Jurassic of the Gulf Rim: Gulf Coast Section, SEPM Foundation, Proceedings Third Annual Research Conference*, 333–346.
Shishlov, S. B., Dubkova, K. A., Arkadiev, V. V., Bugrova, I. Y., Bugrova, E. M., Trikolidi, F. A., & Zakrevskaya, E. Y. (2020). *Cretaceous and Paleogene of the Bodrak River Basin (South-Western Crimea)* (p. 9). Saint-Petersburg University Centre for Geology LLC, Saint-Petersburg State University, Institute of Earth Sciences. in Russian.
Sikharulidze, G. Y. (1972). The new genus *Paretallonia* (Hexacorallia) from Lower Cretaceous sediments in western Georgia. *Soobshcheniya Akademii Nauk Gruzinskoy SSR, 68*, 641–644.
Sikharulidze, G. Y. (1977). Lower Cretaceous hexacorals from Georgia. *Paleontologiya i Stratigraftya Mezozoyskikh Odozheniy Gruzii, 3*, 66–109. pls. 1–18 in Russian.
Sikharulidze, G. Y. (1979). Albiskie korally sela Tshanari [Albian corals from the village Tskhanari]. *Trudy Geologicheskogo Instituta Akademiya Nauk Gruzinskoy SSR (seriya Geologiya), 63*, 1–49. pls. 1–26 in Russian.
Sikharulidze, G. Y. (1985). Geksakorally urgonskoy fatsii dzirul'skogo massiva i ego severnogo obramleniya [Hexacorals from the Urgonian facies of the Dzirul Massif and its southern frame]. *Trudy Geologicheskogo Instituta Akademiya Nauk Gruzinskoy SSR (Seriya Geologiya), 88*, 1–110. pls. 1–31 in Russian.
Solomko, E. (1888). Die Jura- und Kreidekorallen der Krim. *Verhandlungen der Russisch-Kaiserlichen Mineralogischen Gesellschaft zu St. Petersburg* (2), 24, 67–232, pls. 1–8. Retrieved from http://archive.org/details/diejuraundkreid00sologoog.
Stafford-Smith, M. G. (1993). Sediment-rejection efficiency of 22 species of Australian scleractinian corals. *Marine Biology, 115*, 229–243.
Tomás, S., Löser, H., & Salas Roig, R. (2008). Low-light and nutrient-rich coral assemblages in an Upper Aptian carbonate platform of the southern Maestrat Basin (Iberian Chain, eastern Spain). *Cretaceous Research, 29*, 509–534.
Toula, F. (1889). Geologische Untersuchungen im centralen Balkan. *Denkschriften der Kaiserlichen Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Classe,* 55, 1–108. Retrieved from http://www.landesmuseum.at/datenbanken/digilit/?litnr=30464.
Trautschold, H. (1886). Le Néocomien de Sably en Crimée. *Trudy Imperatorskogo St.-Petersburgago Obshchestva Estestvoispytateley, 15*, 119–129.
Turnšek, D. (1972). Upper Jurassic corals of southern Slovenia. *Razprave Slovenska Akademija Znanosti in Umetnosti (4), 15*, 147–265. pls. 1–37.
Turnšek, D. (1992). Tethyan Cretaceous corals in Yugoslavia. *Österreichische Akademie der Wissenschaften, Schriftenreihe der Erdwissenschaftlichen Kommissionen*, 9, 155–170, Wien.

Turnšek, D. (1997). *Mesozoic corals of Slovenia* (p. 512). Znanstvenoraziskovalni Center SAZU.
Turnšek, D., & Buser, S. (1974). The Lower Cretaceous corals, hydrozoans and chaetetids of Banjska Planota and Trnovski Gozd. *Razprave Slovenska Akademija Znanosti in Umetnosti (4), 17*, 85–124. pls. 1–16.
Turnšek, D., & Buser, S. (1976). Knidarijska favna iz senonijske breče na Banjški planoti [Cnidarian fauna from the Senonian breccia of Banjska Planota (NW Yugoslavia)]. *Razprave Slovenska Akademija Znanosti in Umetnosti (4), 19*, 39–88. pls. 1–25.
Turnšek, D., & Mihajlović, M. (1981). Lower Cretaceous cnidarians from eastern Serbia. *Razprave Slovenska Akademija Znanosti in Umetnosti (4), 23*, 1–54. pls. 1–50.
Turnšek, D., Pleničar, M., & Šribar, L. (1992). Lower Cretaceous fauna from Slovenski Vrh near Koevje (South Slovenia). *Razprave Slovenska Akademija Znanosti in Umetnosti (4), 33*, 205–257.
Turnšek, D., LeMone, D.V. & Scott, R.W. (2003). Tethyan Albian corals, Cerro de Cristo Rey Uplift, Chihuahua and New Mexico. In: Scott, R.W. (Ed.). Cretaceous Stratigraphy and paleoecology, Texas and Mexico: Bob F. Perkins Memorial Volume. *Golf Coast Section SEPM Foundation*, *Special Publications in Geology*, 1, CD book, 147–185.
Tyson, R. V., & Funnell, B. M. (1987). European Cretaceous shorelines, stage by stage. *Palaeogeography, Palaeoclimatology, Palaeoecology, 59*, 69–91.
Vaughan, T.W. & Wells, J.W. (1943). Revision of the suborders, families and genera of the Scleractinia. *Geological Society of America, Special Paper*, 44, 1–363 [Boulder, Colorado]
Von der Osten, E. (1957). A fauna from the Lower Cretaceous Barranquín formation of Venezuela. *Journal of Paleontology, 31*, 571–590.
Wells, J. W. (1932). Corals of the trinity group of the comanchean of central texas. *Journal of Paleontology, 6*, 225–256.
Wells, J. W. (1933). Corals of the cretaceous of the Atlantic and Gulf coastal plains and western interior of the United States. *Bulletins of American Paleontology, 18*(67), 1–207.
Wells, J. W. (1944). Cretaceous, Tertiary and Recent corals, a sponge and an alga from Venezuela. *Journal of Paleontology, 18*, 429–447.
Wells, J. W. (1946). Some Jurassic and Cretaceous corals from Northern Mexico. *Journal of Paleontology, 20*(1), 1–7.
Wells, J. W. (1956). Part F, Coelenterata. In R. C. Moore (Ed.), *Treatise on invertebrate paleontology* (pp. F328–F444). University of Kansas Press.
Wilmsen, M. (1996). Flecken-Riffe in den Kalken der "Formación de Altamira" (Cenoman, Cobreces/Toñanes-Gebiet, Prov. Kantabrien, Nord-Spanien): Stratigraphische Position, fazielle Rahmenbedingungen und Sequenzstratigraphie. *Berliner Geowissenschaftliche Abhandlungen, Reihe E, 18*, 353–373.
Zaman, S., & Lathuilière, B. (2014). A lectotype for *Cyathophora richardi* Michelin 1843. *Zootaxa, 3795*(2), 198–200.

Publisher's Note