

3.2. Tethyan Cretaceous corals in Yugoslavia

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Abstract

The distribution of corals within the paleo-geotectonic units of Yugoslavia is varying during the Cretaceous period. Lower Cretaceous corals are restricted to the Dinarid Platform and to the Carpathian-Balkanid unit. Cenomanian-Turonian-Coniacian corals occur exclusively in the Drina-Ivanjica unit. The Santonian-Campanian and Maastrichtian corals are restricted to the northern part of the Inner Dinarids. The prosperity and obliteration of corals on the paleo-geotectonic units of Yugoslavia was caused by environmental changes due to tectonic activities.

1. Short review of Cretaceous corals in the Tethyan region

Corals played an important role in the formation of the Cretaceous sediments throughout the shallow Tethys (Fig. 1). Fossil remains of these organisms may be found in almost all Cretaceous intervals. From some stages recordings are rare; in others, however, corals are extraordinarily abundant. The total number of known coral genera from the Cretaceous is 362 (WELLS, 1986). The number of species exceeds 1200.

While corals are hardly known from Berriasian to Valanginian sediments the number of species recorded from the Hauterivian (and "Neocomian") is almost 300. In Barremian and Aptian times this group developed equally successfully in all shallow marine regions of the Tethys. A major crisis occurred at the end of the Aptian, when the number of species decreased to some tens. The largest number of species is known from the Cenomanian although coral faunas are only known from a small number of localities. In the Turonian, the number of species decreases again and reaches a minimum of 12 in the Coniacian. In the

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Santonian, the corals flourished again. They are spread all over the world, the number of species is more than 300. Due to an insufficient stratigraphic resolution many of the Santonian-Campanian corals are ascribed the Senonian in general. In the Maastrichtian, the number of genera and species decreases and only a few of them persists into the Paleocene.

A number of researchers have attempted to delineate the world-wide development of corals during the Cretaceous. The most accomplished presentation of species is given in the catalogue "Anthozoa Cretacea" by FELIX (1914). It reviews all species known up to this time. More recently, important revisions of corals were published by VAUGHAN & WELLS (1943), ALLOITEAU (1952), and WELLS (1956). The distribution of Upper Cretaceous corals in the entire Tethys was studied by M. and L. BEAUVAIS (1974), who presented all the localities and quoted some of the species important for individual horizons. TCHECHMEDJIEVA (1986) provided a review of the Upper Cretaceous corals of Bulgaria, KUZMICHIEVA (1986) for the Upper Cretaceous of the Soviet Union, SIHARULIDZE (1979) for the Urganian corals of Georgia, and TURNŠEK (1989) for the Mesozoic corals of NW Yugoslavia. Among others, monographic works on corals from the following localities are important: Upper Cretaceous localities of the Gosau Group, Austria (M. BEAUVAIS, 1982), Lower Cretaceous of the Polish and Romanian Carpathians (MORYCOWA 1964, 1971), Eastern Serbia (TURNŠEK & MIHAJLOVIČ 1981), Catalonia in Spain (BATTALER 1937), Texas, Mexico and other regions in North America (WELLS 1932, 1933), Madagascar (ALLOITEAU 1958).

The present paper deals with the stratigraphic distribution of corals in the territory of Yugoslavia and its relationship to paleogeography. A complete data base of Cretaceous coral species will be presented in the near future under the auspices of IGCP Project 262.

2. Geographic and stratigraphic distribution of Cretaceous corals in Yugoslavia

No corals have yet been found in the Berriasian.

Three species of Valanginian corals have been found in Banjska planota in western Slovenia; all three are known from Jurassic strata. They are accompanied by large tintinnids and the stromatopore *Milleporidium variocellatum* (TURNŠEK & BUSER, 1974).

In Hauterivan deposits of Ozren and Devica in eastern Serbia four coral species have been found together with various fossils such as *Cidaris*, *Rhynchonella*, *Terebratula*, and others (SUČIĆ, 1953). A locality with *Cladocoropsis cretica* in Montenegro is also ascribed to this stage (TURNŠEK, 1968).

In the Barremian-Aptian an extraordinary increase of coral species has been registered. 97 species have been found. Their localities are on Banjska planota in western Slovenia, where the stromatopore *Dehornella* occurs besides corals. They are accompanied by other fossils as *Chaetetopsis*, nerineacean gastropods as *Phanerophytaxis*, the foraminiferan genera *Orbitolina*, *Chofatella*, *Cosci-*

nolina, the algae *Macroporella*, *Triploporella*, and *Salpingoporella dinarica* (TURNŠEK & BUSER, 1974). Some corals of the same stratigraphic interval are mentioned from Montenegro (RADOIČIĆ, 1960). Corals are very numerous in eastern Serbia in the territory between the South Morava river and Stara Platinina (KOCHANSKY, 1951; MARKOVIĆ, 1951; TURNŠEK & MIHAJLOVIĆ, 1981). A review of the Urgonian facies of this territory was provided by JANKIČEVIĆ (1978), who cited in addition to corals 15 species of algae, 15 species of foraminifera, 29 brachiopod species, 83 bivalve species, 45 sea-urchin species, and 6 cephalopod species.

No corals have yet been found in the Albian of Yugoslavia.

Three coral species from the locality Duboki potok in western Serbia were ascribed to the Cenomanian (MAKSIMOVIĆ & MARKOVIĆ, 1953). Besides of corals this locality contains gastropods, sea-urchins, brachiopods, bivalves and other fossils.

Only two coral species have been found in Turonian strata. They have been discovered in Kosjerić in western Serbia, where the section continues into the Coniacian with 6 species of corals (PAŠIĆ, 1957). They are accompanied by the rudists *Requienia*, *Chondrophora*, *Sawagesia*, by gastropods and by other fossils. The stromatoporoid genera *Actinostromaria* and *Burgundostromaria* are also known from this stage and environment.

Most Upper Cretaceous corals are known from strata of Santonian-Campanian age. Corals from this interval have been found in Slovenia (TURNŠEK, 1978; TURNŠEK & BUSER, 1976), in northern Croatia (TURNŠEK & POLŠAK, 1978; PAŠIĆ, 1951a), and in eastern Serbia (MILOVANOVIĆ, 1939; PAŠIĆ, 1953). In some of these localities many other fossils occur together with corals: *Inoceramus*, *Acteonella*, *Hippurites*, *Gorjanovicia*, *Bournonia*, *Radiolites*, *Kuehnia*, but also *Globotruncana*, *Praeglobotruncana*, *Watznaueria*, *Coccolithus* and others (TURNŠEK, 1978).

Only three coral species have been mentioned so far in the Maastrichtian on the Fruška gora mountains where they are accompanied by *Inoceramus balticus*, *Loftusia morgani*, *Gryphaea vesicularis* (PAŠIĆ, 1951b).

A list of the corals with their stratigraphic and paleogeographic position is presented on Fig. 2.

3. Vertical distribution of coral genera in the Yugoslavian Cretaceous

The systematic analysis shows that the Valanginian coral species are equal to the terminal Jurassic ones, while the Hauterivian species are more similar to those of Barremian-Aptian age.

Among the 97 species of Barremian-Aptian age only 4 are the same as in the Upper Jurassic; not a single one ranges into the Upper Cretaceous.

Of the Upper Cretaceous species three are restricted to the Cenomanian and two to the Turonian. Seven species known from the Coniacian continue into the Santonian. The greatest number of species (58) is known from the Santo-

nian-Campanian. Eight species are restricted to the Campanian, 10 have been ascribed to the Campanian-Maastrichtian, and three to the Maastrichtian.

Changes on the species level took place at the beginning of the Hauterivian, at the end of the Aptian, and at the end of the Campanian.

An analysis shows changes at the generic level at different intervals. Of the 62 genera of Barremian-Aptian age, 24 are the same as in the Upper Jurassic, 10 of them continue into the Upper Cretaceous. In the Santonian-Campanian 36 genera occur first, only three of them continue into the Maastrichtian and two into the Tertiary. Major generic changes occurred at the end of the Aptian and again at the end of the Campanian.

4. Distribution of Cretaceous corals on the paleo-geotectonic units of Yugoslavia

The success of corals in the individual regions of the Tethys depends on the interaction of paleogeography, tectonics, water temperature and favorable water currents. Investigations on the present-day distribution of Cretaceous corals have to take into account that numerous reefs at platform margins have been eroded and deposited on secondary sites. It is also possible that soft corals prevailed in some intervals of the Cretaceous period which were not fossilized.

Cretaceous coral localities in Yugoslavia are restricted at different time intervals to certain geotectonic units (combined and re-arranged after HERAK, 1986; KARAMATA, 1988 and BUSER, 1989): Lower Cretaceous corals appear on the Dinaric carbonate platform and in the Carpathian-Balkanid unit. Cenomanian, Turonian and Coniacian corals are mainly restricted to the Drina-Ivanjica unit. Santonian-Campanian and Maastrichtian corals are known only from the northern part of the Inner Dinarids (Fig. 3).

The Dinaric carbonate platform sedimentation was continuous during the Mesozoic. Corals have been found in various Lower Cretaceous levels in patch reefs. On the margin of the platform, reefs must have been abundant. These have been eroded later, which is shown by the Lower Cretaceous corals found in breccias north of the platform. Nearly half of the Lower Cretaceous coral genera are the same as in the Upper Jurassic. It is therefore concluded that the sedimentary environment did not change essentially during this time interval.

The Carpathian-Balkanid unit represents a somewhat different sedimentary environment. The Lower Cretaceous corals are of the same age as those on the Dinaric platform. Species and fossils assemblages are similar. In eastern Serbia, however, numerous rich accumulations of corals have been found. The sediments are as well carbonates as terrigenous. JANKIĆEVIĆ (1978) considers this location to have been an unstable continental threshold, where local facies changed rapidly. Corals accumulated on platforms are frequently filled with terrigenous sediments. The facies of these sediments is comparable to the Urgonian facies of southern France and elsewhere.

Within the Inner Dinarids, the Drina-Ivanjica unit represents a shoal between the west Diabase-chert formation and the Vardar zone. It is interpreted by HERAK (1986) as "not persisting land bodies in the course of Alpine orogeny . . . but parts of the basement, subsequently uplifted through the ophiolitic nappe system . . .". In the Cenomanian, Turonian and Coniacian small patch coral and stromatoporoid reefs were flourishing temporarily on these shoals. The shape of the coral colonies is similar to those of the Dinaric platform, but the reefs are smaller. It can't be excluded that the reefs had been originally larger and were partly eroded after denudation.

In the Inner Dinarids Santonian-Campanian and Maastrichtian corals occur in rocks which are considered to have been deposited at somewhat deeper marine conditions than coral reefs usually occur. This environment was also spreading over the Slovenian trough (BUSER, 1988), the Supradinaricum and partly over the Paradinaricum (HERAK, 1986) where different types of corals have been found. Finally, it occurred in the Fruška gora mountains and in eastern Serbia (MILOVANOVIĆ, 1939; PAŠIĆ, 1951a, b).

The paleoenvironment of northern Slovenian and Croatian occurrences has been interpreted by TURNŠEK (1989). The isolated, biolithitic and brecciated types of coral occurrences are similar to those of the Gosau group in Austria. According to HÖFLING (1985) they were located in the shallow water environments of the back reef and also of the fore reef, where an influence of the open sea was possible. Some of these corals have probably been resedimented and accumulated in secondary sites (Fig. 4).

5. Coral shape and environment

Corals are classified into solitary, phaceloid and massive forms. Among the Lower and "Middle" Cretaceous corals of the Dinaric platform, of the Carpathian-Balkanids and of the Drina-Ivanjica unit, massive forms predominate. Here, solitary corals scarcely exceed 15% of the total assemblage. Among the Upper Cretaceous corals of the Inner Dinarids solitary corals prevail and represent more than 50% of the total assemblage (Fig. 5). The percentage of solitary corals in the Inner Dinarids would even be greater if the massive colonies found in breccias had been separated.

6. Conclusions

During the Cretaceous the geotectonic units described by HERAK (1986), KARAMATA (1988) and for Slovenia by BUSER (1989) have yielded various paleogeographic and sedimentary environments suitable for the growth of corals. The 195 coral species found so far belong to 98 genera and represent one fourth of all known Cretaceous Tethyan scleractinian genera. The highest rates of occurrences are in the Barremian-Aptian and Santonian-Campanian. In all other Cre-

taceous stages corals are rare, in the Berriasian and Albian no coral has yet been found.

All Lower Cretaceous corals are restricted to the Dinaric carbonate platform and to the Carpathian-Balkanid tectonic unit. Cenomanian, Turonian and Coniacian corals have been found in the Drina-Ivanjica unit. Santonian-Campanian and Maastrichtian corals are only known from the northern part of the Inner Dinarids, and as a whole they represent a Gosau assemblage. Some of them were resedimented.

The success and extinction of the corals can be explained by general environmental changes as well as by local paleogeographic tectonic changes.

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References

- ALLOITEAU, J. (1952): *Madréporaires post-paléozoïques*. In: PIVETAU, J. (ed.), *Traité de Paléontologie*, 1: 539–782. Paris.
- ALLOITEAU, J. (1958): *Monographie des Madréporaires fossiles de Madagascar*. – *Ann. geol. Madagascar*, 25: 1–218. Paris.
- BATALLER, J. R. (1937): *La fauna corallina del Cretacico de Catalunya i regions limitrofes*. – *Arxius de l'escola sup. agricult.*, N.S., 3: 1–299. Barcelona.
- BAUVAIS, L., & BEAUVAIS, M. (1974): *Studies on the world distribution of the Upper Cretaceous corals*. – *Second int. reef symposium. Proc. 1. Great Barriere Reef committee*, 475–494. Brisbane.
- BEAUVAIS, M. (1982): *Révision systematique des Madréporaires des couches de Gosau (Crétacé supérieur, Autriche)*. – *Trav. Lab. Paleont. Univ. P. & M. Curie*. 1–710. Paris.
- BUSER, S. (1989): *Development of the Dinaric and the Julian carbonate platforms and of the intermediate Slovenian Basin*. – *Mem. Soc. Geol. It.*, 40: 313–320. Roma.
- FELIX, J. (1914): *Fossilium Catalogus. I. Animalia: 5. Anthozoa palaeocretacea. 6. Anthozoa cenomanica. 7. Anthozoa neocretacea*. 1–273. Berlin.
- HERAK, M. (1986): *A new concept of geotectonics of the Dinarides*. – *Prirodoslovna istraživanja* 53, *Acta Geologica*, 16: 1–42. Zagreb.
- HÖFLING, R. (1985): *Faziesverteilung und Fossilvergesellschaftungen im karbonatischen Flachwasser-Milieu der alpinen Oberkreide (Gosau-Formation)*. *Münchener Geowiss. Abh.*, 3: 1–241. München.
- JANKIČEVIĆ, J. (1978): *Barrémien et Aptien des parties moyennes des Carpatho-Balcandes dans la Serbie Orientale au point de vue du développement d'Urgonien*. – *Geol. an. Balkanskog poluostrva*, 42: 103–194. Beograd.
- KARAMATA, S. (1988): *"The Diabase-Chert Formation" – some genetic aspects*. – *Bull. Acad. Serbe Sci. Arts, Cl. Sci. nat. mat.*, 28: 1–11. Beograd.
- KOCHANSKY-DEVIDÉ, V. (1951): *Aptian corals of Eastern Serbia*. – *Geol. an. Balkanskog poluostrva*, 19: 107–112. Beograd.

- KUZMICHEVA, E. I. (1986): Koralli verhnego mela SSSR (sistematičeski sostav, stratigrafičeskoe rasprostranenie i etapi razvitiya). – *Fanerozoiskie rifi i koralli SSSR*. Trudi 5. Vsesojuznogo simpoziuma po korallam i rifam, Dushanbe 1983, 100–103. Moskva.
- MAKSIMOVIĆ, B. V., & MARKOVIĆ, B. (1953): Nouvelle contribution à la connaissance de l'Albien et du Cénomaniien des environs de Kadina luka et de Rajac. – *Zbornik radova SAN 33, Geol. inst.*, **5**: 183–210. Beograd.
- MARKOVIĆ, O. (1951): Polypiers Mésozoïques de Serbie. – I. Polypiers de l'Aptien aux environs du village Sukovo (Serbie Orientale). – *Zbornik radova*, **16**: 181–193. Beograd.
- MILANOVIĆ, B. (1939): Sur les Polypiers du Senonien supérieur de Vrbovačka reka (Serbie Orientale). – *Geol. an. Balkanskog poluostrva*, **16**: 113–115. Beograd.
- MORYCOWA, E. (1964): Hexacorallia des couches de Grodziszczce (Neocomien, Carpathes). – *Acta Palaeont. Polon.*, **9**: 1–114. Warszawa.
- MORYCOWA, E. (1971): Hexacorallia et Octocorallia du Crétacé inférieur de Rarau (Carpathes Orientales Roumaines). – *Acta Palaeont. Polon.*, **16**: 1–149. Warszawa.
- PAŠIĆ, M. (1951 a): Contribution à la division stratigraphique des couches de Gosau de la Craie supérieur dans la zone des horsts du massif Croato-Slavonien et de Fruška gora. – *Geol. an. Balkanskog poluostrva*, **19**: 97–101. Beograd.
- PAŠIĆ, M. (1951): Quelques espèces de polypiers des couches sénoniennes à facies de Gosau de Fruška gora. – *Zbornik radova*, **16**: 173–179. Beograd.
- PAŠIĆ, M. (1953): Les polypiers du Crétacé supérieur en Serbie. I. Les polypiers indépendants – genre *Cunulites*. – *Zbornik radova SAN 22, Geol. inst.*, **5**: 95–110. Beograd.
- PAŠIĆ, M. (1957): Biostratigraphische Verhältnisse und Tektonik der Oberkreide in der weiteren Umgebung von Kosjerić (Westserbien). – *Posebna izdanja Geol. inst. Jovan Zujovic*, **7**: 1–208. Beograd.
- RADOIČIĆ, R. (1960): Microfacies du Crétacé et du Paléogène des Dinarides Externes de Yougoslavie. Paléontologie des Dinarides Yougoslaves. Ser. A: Micropaléontologie, **4/1**: 3–172. Titograd.
- SIHARULIDZE, G. (1979): The corals of the Urgonian facies of Georgia. – *Geobios, Mém. spéc.*, **3**: 301–304. Lyon.
- SUŠIĆ, Z. (1953): Contribution à la connaissance de la constitution géologique des montagnes Ozren et Devica (Serbie Orientale). – *Geol. an. Balkanskog poluostrva*, **21**: 77–123. Beograd.
- TCHHECHMEDJIEVA, V. (1986): Paléocéologie des Madréporaires du Crétacé supérieur dans le Srednegori de l'ouest (Bulgarie occidentale). – *Geol. Balcanica*, **16/5**: 55–81. Sofia.
- TURNŠEK, D. (1968): Some hydrozoans and corals from Jurassic and Cretaceous strata of southwestern Yugoslavia. – *Razprave SAZU, IV.*, **11**: 351–367. Ljubljana.
- TURNŠEK, D. (1970): Cretaceous Hydrozoa from the Zlatibor Mountain in western Serbia. – *Razprave SAZU, IV.*, **13**: 193–208. Ljubljana.
- TURNŠEK, D. (1978): Solitary Senonian corals from Stranice and Mt. Medvednica (NW Yugoslavia). – *Razprave SAZU, IV.*, **21**: 61–128. Ljubljana.
- TURNŠEK, D. (1989): Diversification of corals and coral reef associations in Mesozoic paleogeographic units of northwestern Yugoslavia. – *Mem. Ass. Australas. Palaeont.*, **8**: 283–289. Brisbane.
- TURNŠEK, D., & BUSER, S. (1974): The Lower Cretaceous corals, hydrozoans and chaetetics of Banjška planota and Trnovski gozd. – *Razprave SAZU, IV.*, **17**: 81–124. Ljubljana.
- TURNŠEK, D., & BUSER, S. (1976): Cnidarian fauna from the Senonian breccia of Banjška planota (NW Yugoslavia). – *Razprave SAZU, IV.*, **19**: 37–88. Ljubljana.

- TURNŠEK, D., & MIHAJLOVIĆ, M. (1981): Lower Cretaceous cnidarians from eastern Serbia. – Razprave SAZU. IV., **23**: 1–54. Ljubljana.
- TURNŠEK, D., & POLŠAK, A. (1978): Senonian colonial corals from Orešje on Mt. Medvednica (NW Yugoslavia). – Razprave SAZU. IV., **21**: 129–180. Ljubljana.
- VAUGHAN, T. W., & WELLS, J. W. (1943): Revision of the suborders, families, and genera of the Scleractinia. – Geol. Soc. Am., Spec. Pap., **44**: 1–363. Baltimore.
- WELLS, J. W. (1932): Corals of the Trinity Group of the Comanchean of Central Texas. – Journ. Pal., **6/3**: 225–256. Tulsa.
- WELLS, J. W. (1933): Corals of the Cretaceous of the Atlantic and Gulf Coastal Plains and Western Interior of the United States. – Bull. Amer. Paleont., **18/67**: 1–292. Tulsa.
- WELLS, J. W. (1956): Scleractinia. In: Moore, R. C. (ed.): Treatise on Invertebrate Paleontology, Part f, Coelenterata. F328–F444. Lawrence.
- WELLS, J. W. (1986): A list of scleractinian generic and subgeneric taxa, 1758–1985. Fossil Cnidaria, **15**: 1–69. Münster.

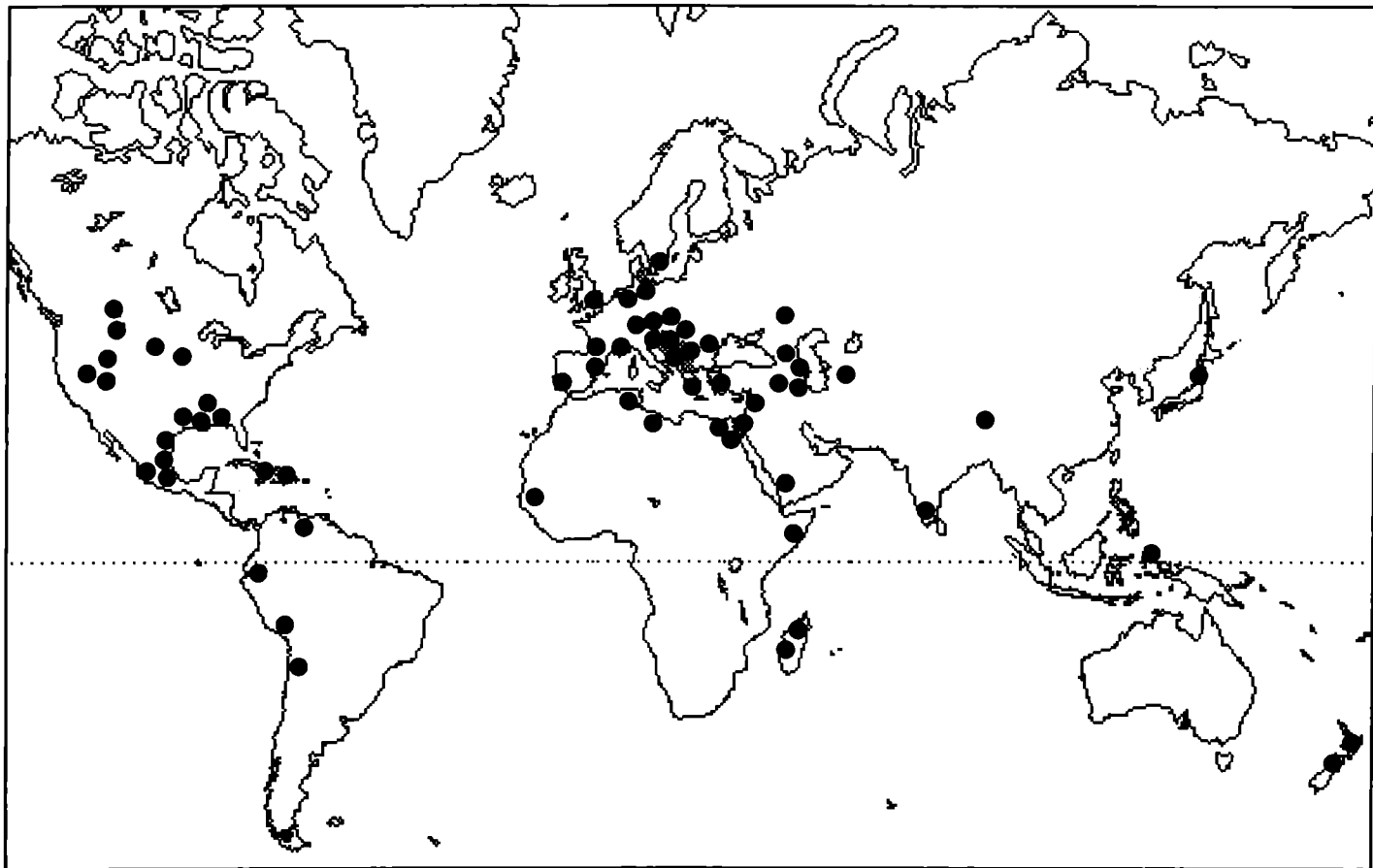


Fig. 1: Cretaceous coral localities in the Tethyan region (partly from BEAUVAIS & BEAUVAIS, 1974).

Lower Cretaceous Species	Paleogeographical units		Stratigraphical distribution		
	Dinarid platform Local. 1 7 8	Carpathian. Balcanid unit 2 4 5 9	Valang. Jurassic	Barr. Haute	Alb. Apt.
<i>Ironella giseldonensis</i> Starostina & Krasnov 1970	1	●		■	
<i>Microphyllia</i> cf. <i>M. bachmayeri</i> Geyer 1955	1	●		■	
<i>Microphyllia undans</i> Etallon 1858	1	●		■	
<i>Eohydnophora picteti</i> (Koby 1897)	2 4 5 7 8 9	●	●	■	■
<i>Latiastrea kaufmanni</i> (Koby 1898)	2 9	●		■	
<i>Mesomorpha sablensis</i> (Karakash 1907)	2	●		■	
<i>Axosmia</i> cf. <i>A. kobyi</i> (DeAngelis 1905)	2 5 9	●		■	
<i>Acanthogyra aptiana</i> Turnšek 1981	9	●			■
<i>Actinaraea</i> cf. <i>A. tenuis</i> Morycowa 1971	9	●			■
<i>Actinastraea pseudominima major</i> Morycowa 1971	9	●			■
<i>Amphiastraea aethiopica</i> Dietrich 1926	8	●			■
<i>Axosmia bofilli</i> DeAngelis 1905	9	●			■
<i>Axosmia villersensis</i> (Koby 1898)	9	●			■
<i>Baryphyllia haimei</i> Fromentel 1857	9	●			■
<i>Calamophylliopsis fotisalensis</i> (Bendukidze 1961)	8	●			■
<i>Calamophylliopsis</i> sp.	8	●			■
<i>Clausastraea bolzei</i> Alloiteau 1960	7 8 9	●	●		■
<i>Columnocoenia ksiazkiewiczzi</i> Morycowa 1971	9	●			■
<i>Cyathophora miyakoensis</i> (Eguchi 1936)	8	●			■
<i>Cyathophora pygmaea</i> Volz 1903	7 8 9	●	●		■
<i>Cyathophora steinmanni</i> Fritzche 1924	8 9	●	●		■
<i>Dermosmia cretatica</i> Turnšek 1974	7	●			■
<i>Diplocoenia saltensis major</i> Morycowa 1971	9	●			■
<i>Diplogyra lamellosa eguchii</i> Morycowa 1971	8	●			■
<i>Donacosmia</i> sp.	7	●			■
<i>Enallhelia</i> sp.	7	●			■
<i>Eohydnophora incerta</i> (Morycowa 1971)	8	●			■
<i>Eugyra cotteaui</i> Fromentel 1857	7 8 9	●	●		■
<i>Eugyra digitata</i> Koby 1896	4 5 9	●	●		■
<i>Eugyra lanckoronensis</i> (Morycowa 1964)	8 9	●	●		■
<i>Eugyra neocomiensis</i> Fromentel 1857	4 5 9	●	●		■
<i>Felixigyra patruleusi tenuiseptata</i> Morycowa 1971	7	●			■
<i>Floria planinensis</i> Turnšek 1981	9	●			■
<i>Fungiastraea tendagurensis</i> (Dietrich 1926)	8	●			■
<i>Fungiastraea</i> sp.	7	●			■
<i>Fungiastraeopsis subpolygonalis</i> Morycowa 1971	9	●			■
<i>Glenaraea cretatica</i> Pošta 1887	7	●			■
<i>Gyrodendron serbica</i> Turnšek 1981	9	●			■
<i>Heliocoenia actinastrae</i> Turnšek 1981	9	●			■
<i>Heliocoenia carpathica</i> Morycowa 1964	9	●			■
<i>Heliocoenia rozkowskiae</i> Morycowa 1964	9	●			■
<i>Holocystis bukowinensis</i> Volz 1903	9	●			■
<i>Latusastraea decipiens</i> (Prever 1909)	-7 9	●	●		■
<i>Latusastraea exiguis</i> (Fromentel 1862)	7	●			■
<i>Meandraraea duboisi</i> (Karakash 1907)	9	●			■
<i>Meandraraea meandroides</i> Koby 1898		●			■
<i>Meandrophyllia</i> cf. <i>M. lotharinga</i> (Michelin 1843)	9	●			■
<i>Meandroria pirotensis</i> (Toula 1884)	9 5	●			■
<i>Mesomorpha excavata</i> (d'Orbigny 1850)	9	●			■
<i>Microsolena distefanoi</i> (Prever 1909)	7	●			■
<i>Microsolena guttata</i> Koby 1898	7 9	●	●		■
<i>Microsolenastraea balcanica</i> Turnšek 1981	9	●			■
<i>Ovalastraea polygonalis</i> Alloiteau 1958	9	●			■

Fig. 2: Stratigraphic distribution and paleogeographic origin of Cretaceous coral species recorded from Yugoslavia. Part 1.

Lower Cretaceous Species	Paleogeographical units		Stratigraphical distribution		
	Dinarid platform Local. 1 7 8	Carpathianr. Balcanid unit 2 4 5 9	Valang.	Barr.	Alb.
			Jurassic	Haute	Apt.
<i>Palaeopsammia zljebinensis</i> Turnšek 1981	9		●		
<i>Peplosmia fromenteli</i> DeAngelis 1905	5 7 9	●	●		
<i>Peplosmia stutzi</i> (Koby 1896)	5 9		●		
<i>Phyllocoenia cotteai</i> Fromentel 1857	5 7	●	●		
<i>Placophyllia curvata</i> Turnšek 1974	7 9	●	●		
<i>Plesiofavia dubia</i> (Fromentel 1857)	9		●		
<i>Pleurophyllia skuviensis</i> Turnšek 1981	9		●		
<i>Polyphylloseris convexa</i> Fromentel 1857	7 8 9	●	●		
<i>Polytremacis edwardsana</i> (Stoliczka 1873)	9		●		
<i>Pseudocoenia annae</i> (Volz 1903)	4 9		●		
<i>Pseudocoenia hexaphyllia</i> (d'Orbigny 1850)	9		●		
<i>Pseudocoenia</i> cf. <i>P.subocfonis</i> d'Orbigny 1850	9		●		
<i>Pseudocoeniopsis jurassica</i> (Turnšek 1972)	9		●		
<i>Pseudopolytremacis spinoseptata</i> Morycowa 1971	7	●			
<i>Siderastraea senecta</i> Morycowa 1971	9	●			
<i>Siderofungia irregularis</i> Felix 1891	7		●		
<i>Smilotrochus tuberosus</i> (M.Edwards & Haime 1850)	9		●		
<i>Stylina parvistella</i> Volz 1903	9		●		
<i>Stylina regularis</i> Fromentel 1867	7 9	●	●		
<i>Stylosmia alpina</i> Koby 1897	9		●		
<i>Thamnaraea mammelonata</i> Turnšek 1981	9		●		
<i>Thamnaraea</i> sp.	9		●		
<i>Thamnasteria cotteai</i> Fromentel 1857	9		●		
<i>Thamnoseris carpathica</i> Morycowa 1971	9		●		
<i>Trochoidomeandra ovalis</i> Turnšek 1981	9		●		
<i>Truncoconus inclinatus</i> Turnšek 1981	9		●		
<i>Baryphyllia barotei</i> Fromentel 1864	5		●		
" <i>Convexastraea</i> " cf. <i>C.almerai</i> DeAngelis 1905	4		●		
" <i>Convexastraea</i> " <i>desori</i> Koby 1890	4		●		
" <i>Cryptocoenia</i> " <i>picteti</i> Koby 1898	4		●		
" <i>Cryptocoenia</i> " <i>ramosa</i> Toulia 1884	5		●		
<i>Dimorphastraea bellula</i> d'Orbigny 1849	4		●		
" <i>Elipsocoenia hemisphaerica</i> (Fromentel 1857)	4 5		●		
<i>Epismilia robusta</i> Koby 1898	5		●		
<i>Epismilia</i> sp.	4		●		
<i>Eugyra pussila</i> Koby 1898	4 5		●		
<i>Hydnophora</i> aff. <i>H.crassa</i> Fromentel 1862	5		●		
" <i>Phyllocoenia</i> " <i>exculpta</i> (Reuss 1854)	5		●		
" <i>Phyllocoenia</i> " <i>picteti</i> Koby 1898	5		●		
" <i>Phyllocoenia</i> " cf. <i>P.zlatarski</i> Toulia 1884	5		●		
" <i>Phyllocoenia</i> " sp.	4 5		●		
<i>Placosmia</i> cf. <i>P.arcuata</i> M.Edwards & Haime 1849	5		●		
<i>Polytremacis urgonensis</i> Koby 1898	4		●		
<i>Stylina</i> cf. <i>S.esmuni</i> Felix 1909	5		●		
<i>Stylina micropora</i> Koby 1898	4		●		
<i>Stylohelia</i> sp.	4		●		
<i>Thamnasteria urgonensis</i> Koby 1898	4		●		
" <i>Thecoseris</i> " <i>pumila</i> Koby 1898	4		●		
<i>Thecosmia tobleri</i> Koby 1898	4		●		
" <i>Trochosmia</i> " <i>neviani</i> DeAngelis 1905	5		●		

Fig. 2: Stratigraphic distribution and paleogeographic origin of Cretaceous coral species recorded from Yugoslavia. Part 2.

Upper Cretaceous Species	Paleogeographical units		Stratigraphical distribution		
	Drina Ivanjica belt 10 11 12	Inner Dinar. North. Jugosl. 8 14 15 16 17 18 19			
<i>Amphiastraea</i> cf. <i>A. paronai</i> Prever 1909. 10	●				
<i>Thamnoseria hoernesii</i> (Reuss 1854) 10 15	●	●	■		■
" <i>Trochosmia</i> " sp. 10	●		■		
<i>Thecosmia minor</i> Prever 1909 11	●			■	
" <i>Trochosmia</i> " <i>polymorpha</i> Prever 1909 11	●			■	
<i>Actinastraea orbignyana</i> (M-Edwards & Haime 1849)	●			■	
" <i>Heliastraea</i> " <i>lilli</i> Reuss 1854 11	●			■	
<i>Nefophyllia multicincta</i> (Reuss 1854) 11	●			■	
<i>Placocoenia dumortieri</i> Fromentel 1879 11 14 17 19	●	●		■	■
<i>Procladocora tenuis</i> (Reuss 1854) 11 15	●	●		■	■
<i>Corbariastraea junctiseptata</i> (Oppenheim 1930) 11	●			■	■
<i>Microsolena</i> aff. <i>M. distefanoi</i> (Prever 1909) 12	●			■	■
<i>Acrosmia conica</i> (d'Orbigny 1850) 16		●			■
<i>Actinacis martiniana</i> d'Orbigny 1849 12 15		●			■
<i>Actinacis remesi</i> Felix 1903 8 17		●			■
<i>Actinastraea ramosa</i> (Michelin 1847) 14 15 17		●			■
<i>Actinastraea octolamellosa</i> (Michelin 1846) 15		●			■
<i>Astraraea media</i> (Sowerby 1832) 15 17		●			■
<i>Aulosmia aspera</i> (Sowerby 1831) 16		●			■
<i>Aulosmia cuneiformis</i> (M-Edwards & Haime 1849) 16		●			■
<i>Aulosmia salisbergensis</i> (M-Edwards & Haime 1849) 14		●			■
<i>Columastinastraea pygmaea</i> (Felix 1903) 15		●			■
<i>Columastrea formosa</i> (Goldfuss 1826) 15		●			■
<i>Columastrea striata</i> (Goldfuss 1826) 15		●			■
<i>Columellogyra lomensis</i> Turnšek 1976 8		●			■
<i>Conicosmilotrochus dentatus</i> Turnšek 1978 16		●			■
<i>Conicosmilotrochus stranicensis</i> Turnšek 1978 16		●			■
<i>Conicosmilotrochus strictus</i> Turnšek 1978 16		●			■
<i>Cunulites (Cunulites) faecata</i> (Stoliczka 1873) 16 18		●			■
<i>C. (Cunulites) longifossata</i> Tchechmedjewa 1973 16		●			■
<i>C. (Cunulites) profunda</i> (Oppenheim 1930) 16 18		●			■
<i>C. (Cunulites) reussi</i> (Fromentel 1862) 16 18		●			■
<i>C. (Cunulites) sellata</i> (Quenstedt 1880) 16		●			■
<i>C. (Cunulites) undulata</i> (Goldfuss 1826) 14 16		●			■
<i>C. (Paracunulites) scutellum</i> (Reuss 1854) 16 18		●			■
<i>C. (Plesiocunulites) cycloides</i> (Felix 1903) 16		●			■
<i>C. (Plesiocunulites) dispar</i> (Quenstedt 1880) 16		●			■
<i>C. (Plesiocunulites) cf. P. depressa</i> (Reuss 1854) 16		●			■
<i>C. (Plesiocunulites) gosavicus</i> (Oppenheim 1930) 16		●			■
<i>C. (Plesiocunulites) nummulus</i> (Reuss 1854) 16 18		●			■
<i>C. (Plesiocunulites) orbignyi</i> (Fromentel 1864) 16		●			■
<i>C. (Plesiocunulitopsis) robusta</i> (Quenstedt 1880) 16		●			■
<i>Dasmiopsis lamellicostatus</i> (Reuss 1854) 16		●			■
<i>Dermosmiliopsis orbignyi</i> Alloiteau 1957 15		●			■
<i>Dermosmiliopsis tenuicosta</i> (Reuss 1854) 15		●			■
<i>Diploctenium ferrumeguinum</i> (Reuss 1854) 16		●			■
<i>Diploctenium</i> cf. <i>D. pavoninum</i> Reuss 1854 16		●			■
<i>Elasmophyllia deformis</i> (Reuss 1854) 15		●			■
<i>Ellipsosmia</i> sp. 15		●			■
<i>Heterocoenia grandis</i> Reuss 1854 8		●			■
<i>Hydnophora styriaca</i> (Michelin 1847) 8 17		●			■
<i>Meandrastraea antiqua</i> (Reuss 1854) 15		●			■
<i>Meandroria konincki</i> (M-Edwards & Haime 1849) 8 17		●			■
<i>Neocoeniopsis lepida</i> (Reuss 1854) 15 17		●			■

Fig. 2: Stratigraphic distribution and paleogeographic origin of Cretaceous coral species recorded from Yugoslavia. Part 3.

Upper Cretaceous Species	Paleogeographical units		Stratigraphical distribution		
	Drina Ivanjica belt 10 11 12	Inner Dinar. North. Jugosl. 8 14 15 16 17 18 19			
	<i>Phyllocoeniopsis pediculata</i> (Deshayes 1831) 15			●	
<i>Phyllocoeniopsis</i> sp. 15			●		
<i>Phyllosmilia</i> sp. 16			●		
<i>Phragmosmilia</i> sp. 16			●		
<i>Pleurocora (?Rhabdophyllia) crassa</i> (Reuss 1854) 15			●		
<i>Pleurocora haueri</i> (M. Edwards & Haime 1848) 15			●		
<i>Procladocora simonyi</i> (Reuss 1854) 8 15			●		
<i>Pseudofavia grandiflora</i> (Reuss 1854) 8			●		
<i>Rennensismilia complanata</i> (Goldfuss 1826) 16			●		
<i>Rennensismilia chondrophora</i> (Felix 1903) 14 19			●		
<i>Rennensismilia subinduta</i> (Reuss 1854) 16			●		
<i>Stephanosmilia polydectes</i> Kolosvary 1954 8			●		
<i>Synastraea procera</i> (Reuss 1854) 15			●		
<i>Thamnoseres morchella</i> (Reuss 1854) 8			●		
<i>Astrogyra voraccissima</i> (Oppenheim 1930) 17			●		
<i>Heterocoenia exigua</i> (Michelin 1847) 17			●		
<i>Hydnophora parviconus</i> (Oppenheim 1930) 17			●		
<i>Meandroria konincki typica</i> (Reuss 1854) 17			●		
<i>Placocoenia microcalix</i> Oppenheim 1930 17			●		
<i>Polytremacis paritschi</i> Reuss 1854 17			●		
<i>Psilogyra telleri</i> Felix 1903 17			●		
<i>Reussicoenia edwardsi</i> (Reuss 1854) 17			●		
<i>Cunolites barrerei</i> 18			●		
<i>Cunolites conoidea</i> (Stoliczka 1873) 18			●		
<i>Cunolites filamentosa</i> (Forbes 1846) 18			●		
<i>Cunolites gigantea</i> (d'Orbigny 1850) 18			●		
<i>Cunolites ligeriensis</i> (M. Edwards & Haime 1851) 18			●		
<i>Cunolites macrostomata</i> (Reuss 1854) 18			●		
<i>Cunolites numismalis</i> (Lamarck 1816) 18			●		
<i>Cunolites polymorphus</i> (Goldfuss 1826) 18			●		
<i>Cunolites quenstedti</i> (Oppenheim 1930) 18			●		
<i>Cunolites sororius</i> (Quenstedt 1880) 18			●		
<i>Cunolites ellipticus</i> (Guettard 1770) 19			●		
<i>Phragmosmilia psecadiophora</i> (Felix 1903) 19			●		
<i>Rennensismilia didyma</i> (Goldfuss 1826) 19			●		

Fig. 2: Stratigraphic distribution and paleogeographic origin of Cretaceous coral species recorded from Yugoslavia. Part 4.

Numbers together with species names refer to localities on Fig. 3.

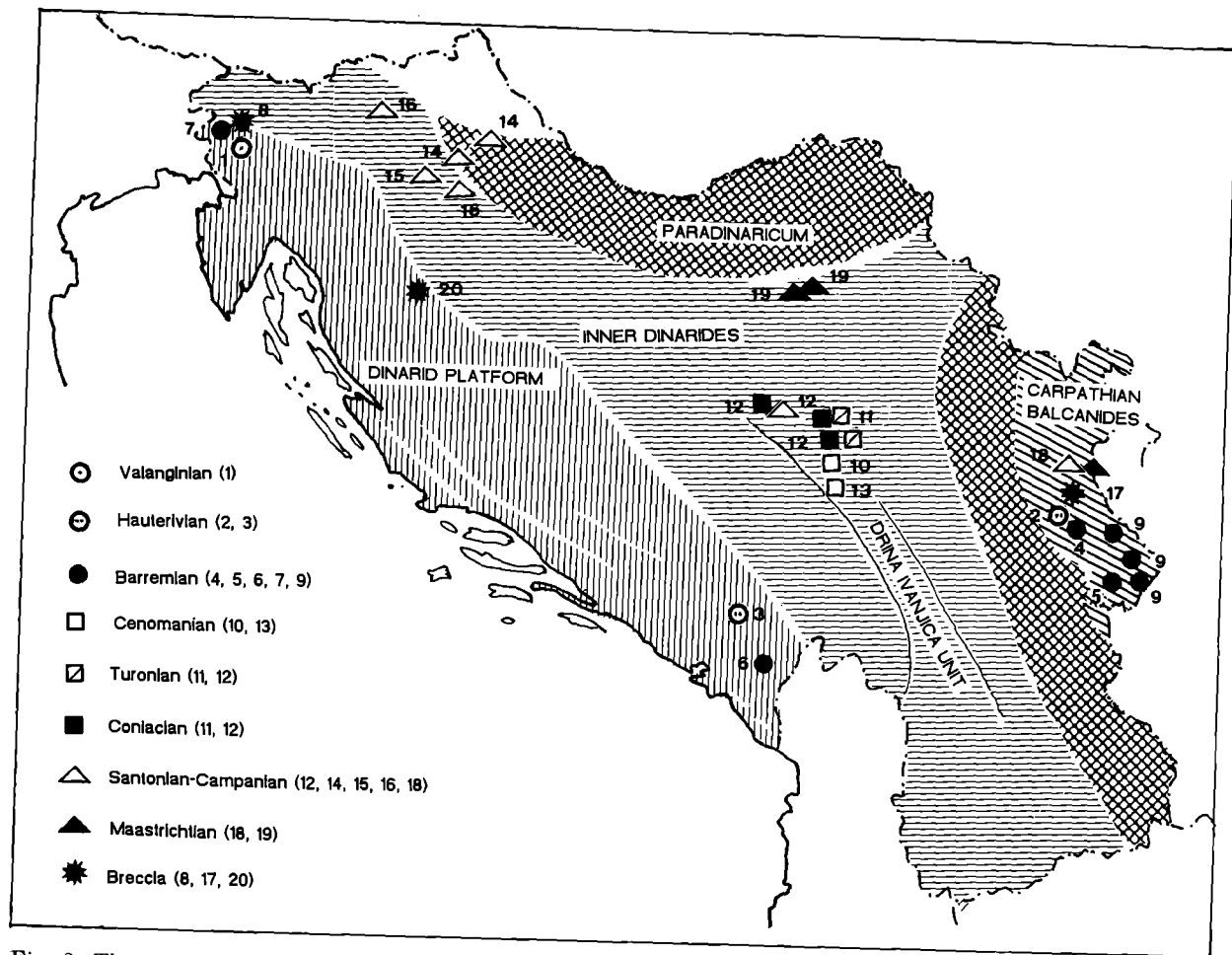


Fig. 3: The age and the distribution of the coral localities on the paleogeotectonic units of Yugoslavia. The numbers 1-19 refer to localities of Fig. 2. Paleogeotectonic units after HERAK (1986), KARAMATA (1988), BUSER (1989).

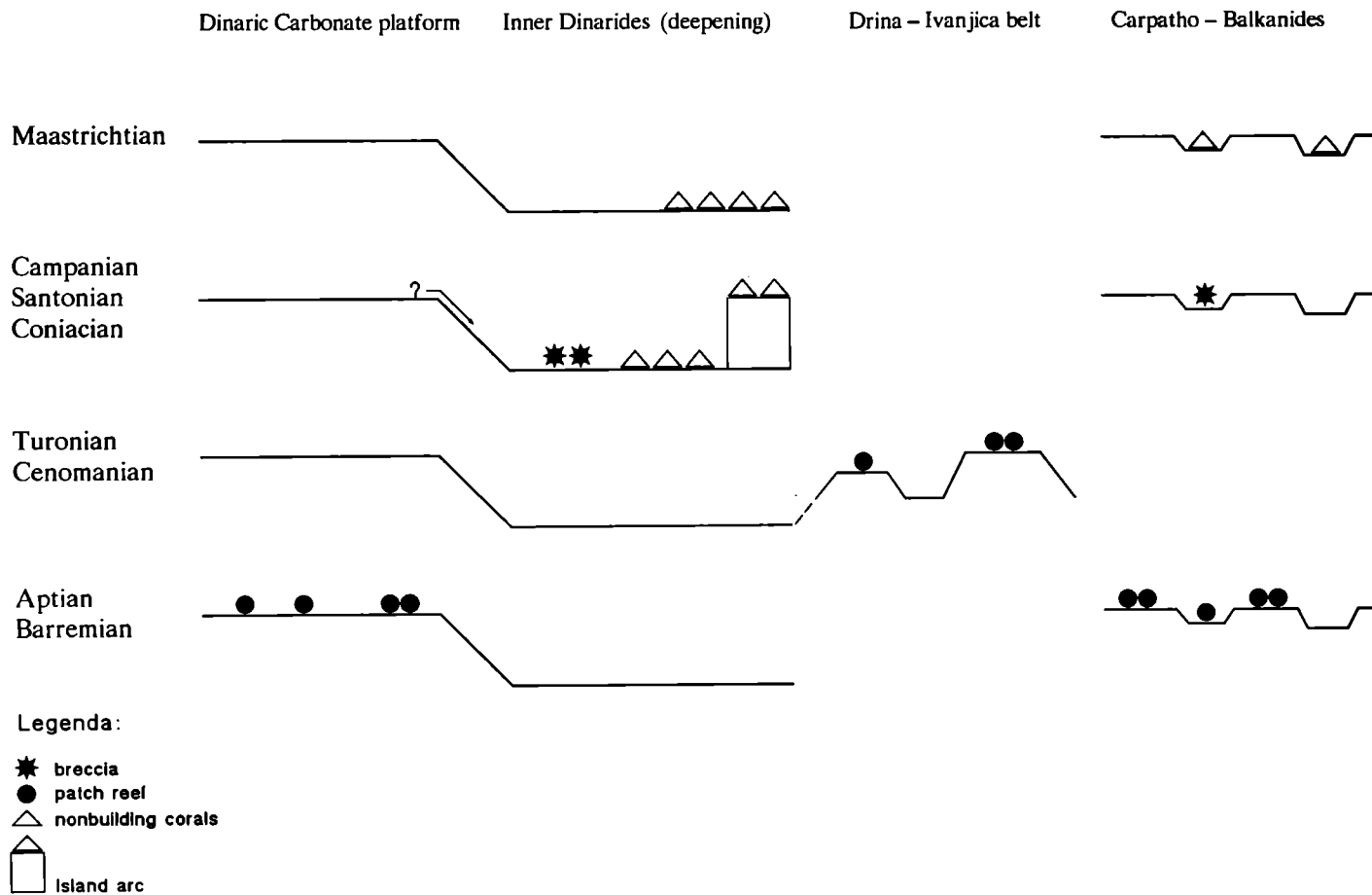
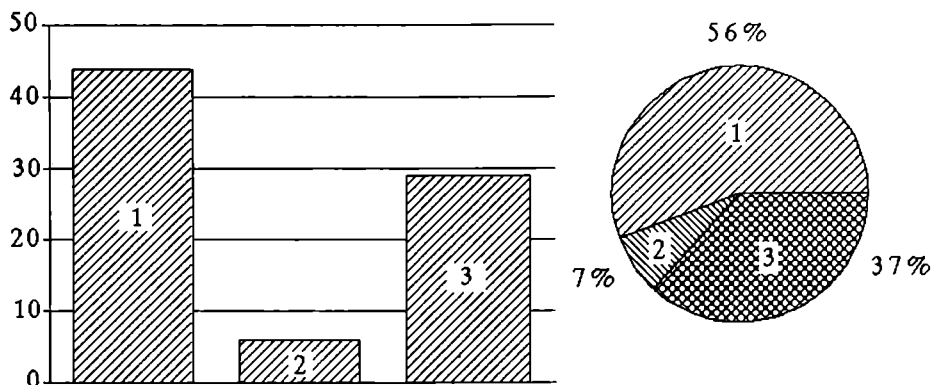
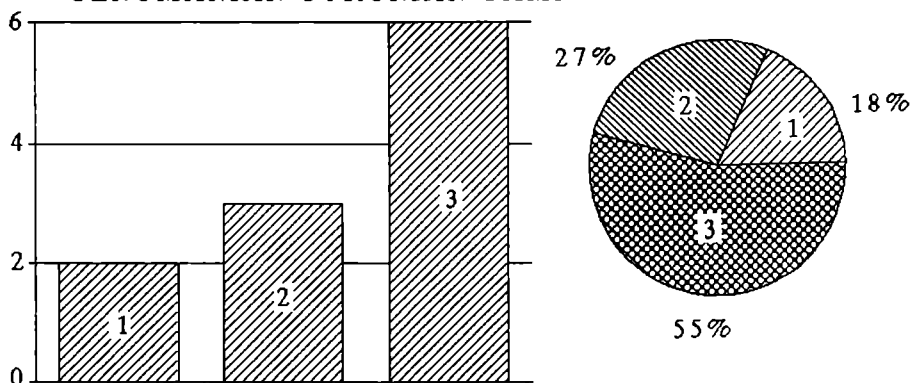


Fig. 4: Generalized palinspastic cross section of Yugoslavia showing the position of coral localities. Note the stable Dinaric Platform containing autochthonous localities, the Inner Dinarides with various forms of coral occurrences and the unstable Carpatho-Balkanid Platform with autochthonous occurrences and coral accumulations.

SANTONIAN-CAMPANIAN-MAASTRICHTIAN



CENOMANIAN-TURONIAN-CAMPANIAN



HAUTERIVIAN-BARREMIAN-APTIAN

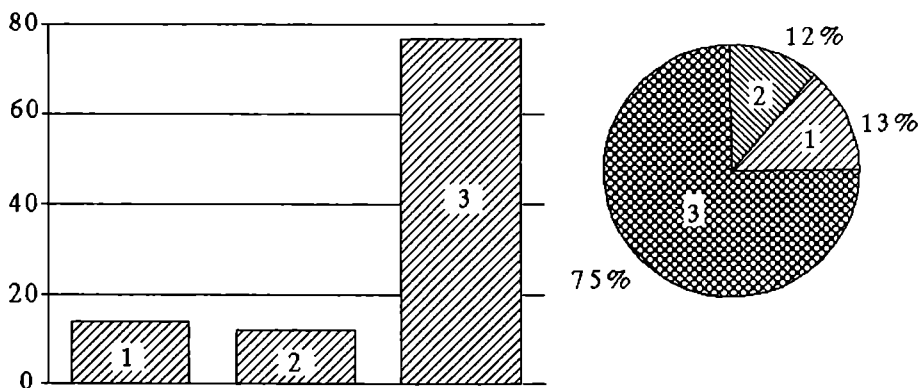


Fig. 5: Relationship between coral shape and environment. 1: solitary corals; 2: phaceloid corals; 3: massive corals. The diagrams on the left show the numbers of species, the diagrams on the right their percentage in the total assemblages. In the Lower and "middle" Cretaceous solitary corals represent scarcely 15% of the coral assemblages. In the Santonian-Campanian they represent more than 50% of the assemblages and indicate deeper water environments.