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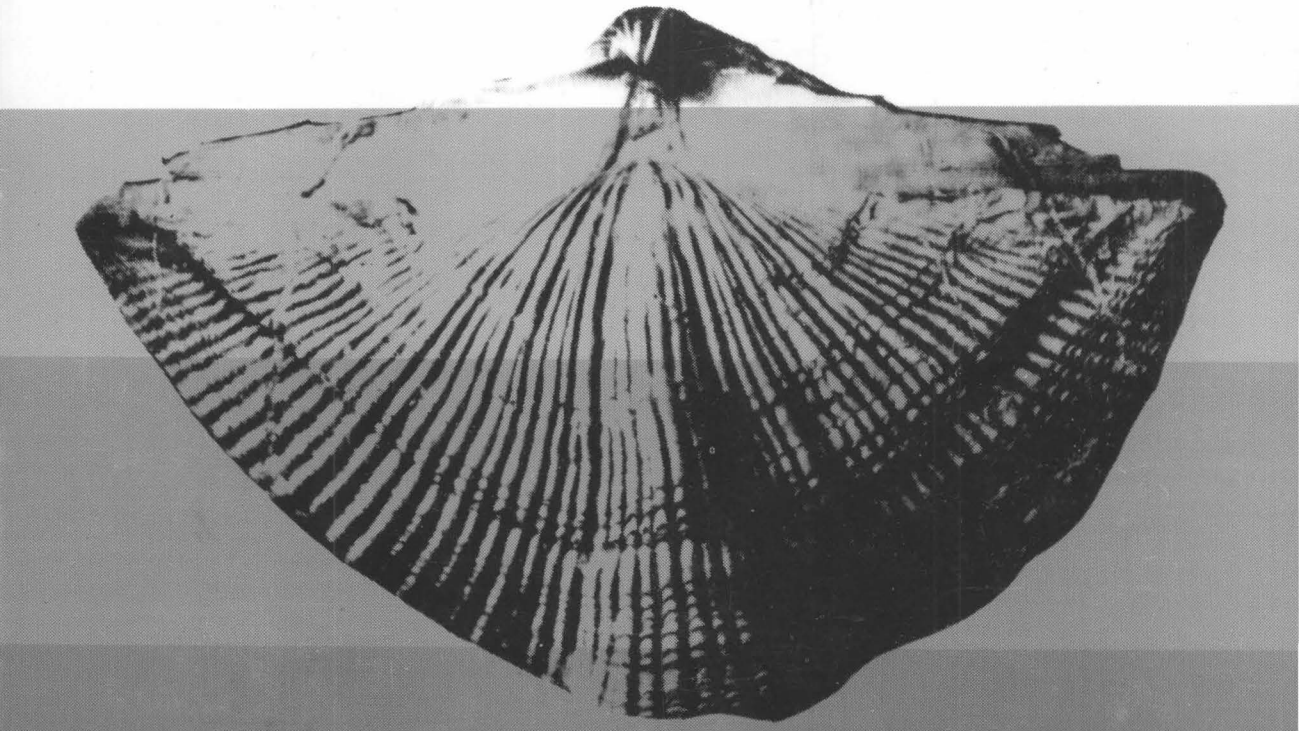

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REVISION OF HETEROMORPH AMMONOIDS. GEOGRAPHIC DISTRIBUTION OF *Emericiceras* SARKAR, 1954

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The most recent review of uncoiled Lower Cretaceous ammonoids, based on material collected during the last 150 years and housed in various universities and museums in France, and on the Astier collection in the British Museum of Natural History, London, was published 35 years ago [26]. Since then smaller studies on heteromorph ammonoids have been conducted in many countries [2, 6, 7, 10, 21, 33, 35, 37 and others].

A comprehensive critical review of available taxonomic concepts on heteromorph ammonoids requires reexamination of type specimens; this represents a special task arising from the framework of this work. I will focus on review of *Emericiceras* collected since 1955 in various parts of the world, which will shed new light on the geographic distribution, paleoecology and taxonomy of this genus.

Stratigraphic distribution of *Emericiceras* in France. Based on Goquand [8], Kilian [12, 13] and Paquier [22], the following zones in the Barremian stage were recognized: lower Barremian - the *Emericiceras emerici* and *Pulchellia compressissima* zones; upper Barremian - the *Macroscaphites yvani* and *Heteroceras astieri* zones. In other words, the *E. emerici* zone was placed in the lower Barremian. Busnardo

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[4, 5, table 1] presented a more detailed ammonoid-based subdivision of the Barremian based on field research. The existence of the Barremian stage is indicated by the presence of the following characteristic genera: *Pulchellia, Nicklesia, Heinzia, Barremites, Silesites, Holcodiscus, Hemihoplites, Emericiceras, Hamulina, Leptoceras* and *Heteroceras*. Busnardo concluded that the Barremian stage should be defined to include the *Emericiceras emerici* through *Heteroceras astieri* zones, and that the *Pseudothurmannia angulicostata* zone, which includes *Olcostephanus* and the highly diverse *Crioceratites,* belongs in the Hauterivian. Thus in France *Emericiceras* and *Crioceratites* are stratigraphically separated.

In the southern Alps the Barremian is represented by marly limestones that become siliceous toward the top of the section. The Hauterivian and Valanginian are represented by marly limestones. These terrigenous-carbonate facies contain a rich ammonoid fauna. I documented the evolution of *Emericiceras* [26, table 2] showing the succession of species of this and related genera from the upper Hauterivian to the Aptian in a continuous stratigraphic section. As suggested by Thieuloy and Thomel [34], *Emericiceras emerici* arose from *Crioceratites duvali*. These authors documented many intermediate stages between these two species, and some of these stages were described and illustrated by me [26]. The culmination of the evolution of *Emericiceras* occurs in layer 5 [26, table 2], which correlates well with the Vergona section, described by Busnardo [5, p. 110]. The genus went extinct during the late Barremian. Tectonics and sedimentation played critical roles in the evolution of the genus.

The largest accumulations of cephalopods, especially ammonoids, are confined to the marly facies of the limestones; according to Busnardo [4], these facies have no gastropods, brachiopods and echinoderms. In my opinion this is due to geochemical factors.

A more noteworthy representative of the genus is *Emericiceras thiollierei* (Astier), which in the upper Barremian of France attained large sizes - up to 1 m in diameter. This species has no stratigraphic value since according to Busnardo and Foury [7] it occurs in the lower Barremian and upper Hauterivian.

Stratigraphic distribution of *Emericiceras* in other parts of Europe. In Bulgaria [3, 21] a complex consisting of several species of this genus - *E. emerici* (Liev.), *E. thiollieri* (Ast.), *E. rasgradi* (Toula), and *E. berremense* (Kil.) - occurs in the upper part of the lower zone of the lower Barremian, above the basal deposits containing *Pulchellia compressissima* (Orb.). In Czechoslovakia the stratigraphic succession of species in boundary deposits of the Hauterivian and Barremian in the Krizno Nappe (western Carpathians) does not agree with that established in France [2, 22]. Thus the occurrence intervals of *E. emerici* and *Crioceratites nolani* almost overlap (horizons 34-37). At the same time *Acrioceras* sp. occurs in horizon 37, *Binelliceras* in horizon 34, and *Crioceratites majoricensis* in horizon 33. As noted by Borza et al., "practical application of taxa such as *Balearites, Pseudothurmannia, Crioceratites* and *Emericiceras* is difficult. Correct identification of these taxa depends on the quality of preservation of the sculpture, which would allow tracing its development through ontogeny" [2, p. 350].

In contrast to Bulgaria and France (in the latter country *E. emerici* occurs in the upper part of the *Niklesia pulchella* zone, above deposits containing *Spitidiscus hugii* and *Barremites vocontium*), in the southern part of the USSR, according to Drushchits and Gorbachik [9], *E. emerici* occurs in the basal part of the *Pulchellia compressissima* zone. In this region the succession of ammonoids is as follows:

Pulchellia compressissima zone:	*Nicklesia pulchella*
	Holocodiscus cailaudianus
	H. gastaldi
	Spitidiscus seunesi
	Barremites difficile
	Silesites vulpes
	Emericiceras emerici
Holcodiscus kiliani zone:	*Barremites vocontium*
	Hamulina subcylindrica

In Czechoslovakian sections the presence of *Pulchellia* and *Nicklesia* is not mentioned, making correlation difficult. Thus, the stratigraphic occurrence of *Emericiceras emerici* appears to be nonsynchronous in different regions, a fact noted by Breskovski [3], who studied sections in Bulgaria.

It is also essential to review recent material of other species of the genus *Emericiceras*. Established in 1954 this genus was accepted by researchers in many countries.

Thomel [35, 36] reviewed *Emericiceras*, in particular the subgenus *Crioceratites* and showed that there are a number of intermediates between these two taxa. Uhlig [38] and Sarasin and Schondelmayer [23] were the first to note the fundamental difference between *C. duvali* and *C. emerici* (the latter of which became the type species of *Emericiceras*). Although several students of Lower Cretaceous boreal ammonoids do not recognize the Tethyan genus *Emericiceras*, its distinctive morphology and stratigraphic significance support its independence, about which the present author has already written [28]. In the Soviet Fundamentals of Paleontology [1] *Emericiceras* is considered distinct and is shown as occurring in the southern USSR (Crimea), North Africa, and South America. In the American Treatise on Invertebrate Paleontology [19, p. 208] the genus is listed as a possible synonym of *Crioceratites*. C. W. Wright, author of the relevant section in the Treatise, wrote me on May 2, 1957, that he could not use my monograph for proper appraisal of the genus. As indicated above, *Emericiceras* have thus far been noted from the USSR, Bulgaria and Czechoslovakia, and in addition from Poland [15], Switzerland, Austria, West Germany and Italy. *E. bouladouxae* has been reported from Hungary [16, 20] and southwestern Albania. *Emericiceras* are also known outside of Europe. *E. emerici* var. *journoti* Sarkar, 1955 has been reported from lower-middle Barremian of arctic Canada [11]. *Emericiceras* is also known from South America. Imlay [10] described incomplete (two whorls) remains of uncoiled ammonoids from the Barremian of Trinidad. Judging from the fact that the sculpture of these ammonoids consists of primary and secondary ribs and is similar to the sculpture of *Ancyloceras vandenhecki* Astier, these specimens probably belong to *Emericiceras*. This genus occurs in the Paja Formation in the Villa de Leiva region of Colombia, where it occurs with other characteristic lower Barremian Tethyan genera [29]. Interestingly, *Crioceratites nolani* occurs below this level, and *Wicklesia* above it. This suggests that in Colombia *Emericiceras* probably occurs in the lowest known level, and it is possible that it arose from *C. nolani*. I would like to consider this question in the future.

Crioceratites have been found in Cuba and Chile, and it is possible that *Emericiceras* is also present there, though this cannot be stated with certainty.

Thompson [33] reported *Emericiceras* from the Lower Cretaceous of Antarctica, establishing the Barremian age of its deposits.

Related genera *Acrioceras* and *Dissimilites* are in the Barremian of Madagascar [17] and Mozambique [39], but *Emericiceras* is not there. Similarly, *Crioceratites matsumotoi* has been reported from Iran [30], and *Crioceras plicatulis* and *C. raricostatum* from Iraq [18].

Although, as noted already by Spath [32], the Speeton crioceratids are not identical to typical Tethyan *Crioceratites duvali* and *C. astierianum*, I studied several specimens that are nearly identical to French species such as *C. duvali*, *Emericiceras thiollieri*, *Acrioceras tabarelli* and *Binelliceras*. Also similar to the Tethyan forms are several of the diverse crioceratids described by Koenen [4] from northern West Germany. All of this supports my suggestion [27] of a possible migration of Tethyan species to boreal regions.

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