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# RESEARCH ON CRETACEOUS AMMONITES OF BRAZIL IN THE 20TH CENTURY AND THE STATE OF THE ART*

## *PESQUISAS SOBRE OS AMONÓIDES DO CRETÁCEO DO BRASIL NO SÉCULO XX E O ESTADO DA ARTE*

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## *ABSTRACT*

*Cretaceous ammonites are likely to occur in all the South Atlantic marginal basins along the Brazilian coast where marine Cretaceous rocks are preserved. However, being macrofossils they are normally found only in outcrop, although occasional occurrences in cores have been reported. Exposed marine Cretaceous sequences are confined mainly to the Potiguar, Pernambuco-Paraíba and Sergipe basins, from where numerous species of ammonites have been described since the end of the last century. Extensive exposures and a nearly complete sedimentary record makes the Sergipe Basin the most important area for study of Cretaceous ammonites in Brazil. Current work on ammonites is focused on the Sergipe Basin; the Potiguar and Pernambuco-Paraíba basins are still largely unexplored. The history of research and current work on the Cretaceous ammonites of Brazil are reviewed and the most important publications listed.*

*Keywords: ammonites, history research, Cretaceous, Brazil.*

## RESUMO

Amonóides cretácicos provavelmente ocorrem em todas as bacias costeiras do Brasil que apresentam rochas cretácicas marinhas preservadas. Todavia, na condição de macrofósseis eles são apenas normalmente encontrados em afloramentos, muito embora tenham sido registradas ocasionais ocorrências em testemunhos. A exposição de seqüências cretácicas marinhas restringe-se principalmente às bacias de Sergipe, Pernambuco-Paraíba e Potiguar, de onde numerosas espécies de amonóides foram descritas desde o fim do século passado. Importantes afloramentos e um quase completo registro sedimentar torna a Bacia de Sergipe a mais importante área para o estudo dos amonóides cretácicos no Brasil. Atualmente, as pesquisas em desenvolvimento sobre amonóides estão focadas na Bacia de Sergipe; as bacias Potiguar

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e Pernambuco-Paraíba estão ainda amplamente inexploradas. A história da pesquisa e os trabalhos concernentes aos amonóides cretácicos do Brasil são revisadas e listadas a mais importantes publicações.

## INTRODUCTION

The sedimentary basins bordering the South Atlantic Ocean contain an exceptionally rich fauna of marine invertebrate macrofossils, the major part of which is of Cretaceous age. They represent the predominantly shallow-water biota of the early stages of development of the incipient South Atlantic, which was formed as a result of the splitting up of the former African-South American continent. On the African margin, in particular the faunas of the Nigerian and Angolan basins have been the subject of extensive studies, and on the South American side the northeast Brazilian basins have been the focus of similar attention.

Among the Cretaceous marine macroinvertebrates, the ammonites stand out as a particularly significant group. The reasons are not only their common occurrence in much of the South Atlantic successions but also that the ammonites provide the de-facto standard for the biostratigraphically based global chronostratigraphy of the Cretaceous, to which other biochronostratigraphic scales are calibrated. It is therefore not surprising that the ammonite faunas of the South Atlantic marginal basins have received considerable attention during the past century, which has resulted in a chronostratigraphic framework, albeit still in need of perfection, within which the early evolution of the South Atlantic Ocean can be interpreted and reconstructed.

The aim of this contribution is to review past research on the Cretaceous ammonites of Brazil and to present the current state of research, including ongoing and planned projects. Only studies based on actual specimens are considered in this review, i.e. the numerous bibliographic studies and taxonomic revisions based exclusively on literature comparison are not included.

## GEOLOGICAL BACKGROUND

It can be safely assumed that ammonites are present in the marine Cretaceous rocks of all Brazilian marginal basins, from the Foz do Amazonas Basin in the northwest to the Pelotas Basin in the extreme southeast. However, the great majority of occurrences have been reported from the three major basins in the northeastern part of the country, viz. the Potiguar, Pernambuco-Paraíba and Sergipe basins. These are the only basins that contain extensive surface exposures from which systematic collecting of ammonites is possible. In addition, scattered finds of ammonites, some of which as occasional finds in offshore drill cores, have been reported from the Barreirinhas, Alagoas, Camamu, Campos and Santos basins and from the Estância Platform south of the Sergipe Basin proper. In terms of number of specimens collected over the years, the Sergipe Basin has probably yielded more ammonites than all the other basins taken together, which reflects the fact that this basin possesses not only the most extensive outcrops but also a relatively complete marine Cretaceous succession, from the middle Aptian onwards.

## HISTORY OF RESEARCH

This paper focuses on research carried out on the Cretaceous ammonites of Brazil during the century that is soon to enter its last year. However, it would be unfair to exclude mention of pre-1900 studies, as these to a large extent laid the foundation for much of Cretaceous geological thinking in Brazil in the early 1900's.

The very first mention of Cretaceous ammonites from Brazil was by Hartt (1868), followed by descriptions of a few specimens collected from Sergipe (Hyatt 1870, 1875, 1903), from what was probably Albian and Cenomanian-Turonian boundary beds (P. Bengtson 1983a). White (1887) presented the first comprehensive study of the rich Cretaceous macrofaunas of Brazil collected by the "Commissão Geologica" and he was also the first to figure actual specimens. In his monograph, White described twelve ammonite species from the Albian to Turonian of Sergipe. The monograph was much cited and commented upon in Brazil and abroad and led to various interpretations of the Cretaceous biostratigraphy of the Sergipe Basin.

From the Camamu Basin Maury (1925, 1930) described a single specimen from the upper Albian.
Remarkably, after more than seventy years this is still the only ammonite ever described or reported from the Camamu Basin.

Despite an early report by Branner (1902) on the presence of Cretaceous ammonites in the Pernambuco-Paraíba Basin, it was not until 1930 that ammonites

of this basin were studied taxonomically (Maury 1930). In a monograph on the Campanian-Maastrichtian faunas Maury described 29 species of ammonites, all of which as new species. Her work also included a summary revision of White's (1887) material from Sergipe, which was followed by full taxonomic treatment, partly based on new specimens collected by geologists of the "Serviço Geologico e Mineralogico" (Maury 1937). Maury's monograph on the Sergipe faunas laid the cornerstone for ammonite work in Brazil in the decades to come and, although the nomenclature is now out-of-date, it is still today cited as an important source of information on the Cretaceous ammonites of Sergipe.

The collections of ammonites from the Albian-Turonian of Sergipe made in the early part of the century were reported on in several publications but not formally described. In 1940, the stratigraphic range of the Sergipe ammonites was extended, when Oliveira (1940) reported on a fragmentary specimen from the Campanian of the basin.

With the creation of the Conselho Nacional do Petróleo in 1938 and the initiation of prospecting activities in the marginal basins, a new phase began in the study of the Cretaceous of Brazil. Since then, there has been a flow of publications reporting on or describing ammonites from the various marginal basins, although predominantly from the Sergipe Basin. Authors were mainly palaeontologists of Petrobras (G. Beurlen) and the universities in Recife (K. Beurlen, G.C.B. Muniz) and Rio de Janeiro (I.M. Brito, P.E. de Oliveira) and from the 1970's onwards also of foreign universities (R.A. Reyment, P. Bengtson, S.I. Bengtson). Table 1 lists a selection of the most significant contributions to the study of ammonite faunas for each sedimentary basin.

## STATE OF THE ART

A large number of species of Cretaceous ammonites have been described or reported from Brazil on the basis of study of actual specimens. A considerable part of these species names were introduced during times when a typological approach in taxonomy was the norm. The concept of intraspecific variation was then not yet fully developed and morphological variation was often taken as an indication of a new species. Current work based largely on new collections has shown that the ammonite fauna of Brazil contains very few endemic species. In addition, as new and larger populations become available for study, the full range of morphological variation within species is revealed. The tendency today is towards a reduction in the number of species, and consequently very few new species are being described. This trend is general although more pronounced for mobile groups like ammonites. As an example, the 21 species of pachydiscids described by Maury (1930) from the Pernambuco-Paraíba Basin probably represent intraspecific variants of, at the most, three species which are also known from outside Brazil.

## ONGOING WORK

Current work on the Cretaceous ammonites of Brazil focuses on the Sergipe Basin; at present no major projects in other basins are known to the author. However, besides Sergipe the Potiguar Basin has a considerable potential for establishing a biostratigraphic zonation based on ammonites, a project that will require extensive and systematic field work. Much material from the Pernambuco-Paraíba Basin is available in collections and would form a basis for revision of the work by Maury (1930) and subsequent authors. A difficulty lies in the lack of precise stratigraphic control of museum specimens, a fact that may require additional, time-consuming collecting from the few outcrops available in the basin.

The single known ammonite-bearing outcrop in Alagoas has been thoroughly collected and the faunas described and redescribed. It is nevertheless possible that further outcrops exist. The Camamu Basin is a poorly known area, from where very few macrofossils have been described. The number of outcrops is limited and of difficult access.

Current ongoing and planned ammonite work in the Sergipe Basin covers the entire Cretaceous succession. Thus, for the Aptian-Albian Riachuelo Formation the Aptian fauna is being studied by P. Bengtson (University of Heidelberg). An ongoing PhD project by M.H. Zucon (Universidade Federal de Sergipe) concerns the Aptian-lower Albian ammonite succession. The middle-upper Albian faunas are the topic of a project in preparation by W. Souza-Lima (Petrobras, Aracaju). For the Cenomanian-Coniacian Cotinguiba Formation the Cenomanian faunas form a PhD project by S. Bengtson (University of Heidelberg) and the Turonian-Coniacian succession is being studied by P. Bengtson (University of Heidelberg). The Campanian-Maastrichtian Calumbi Formation is the subject of a PhD

*Table 1 - Selection of the most significant contribuitions to the study of amonite faunas for the Brazilian basins.*

| Author(s) | Formation(s) | Coverage |
|---|---|---|
| ***Barreirinhas Basin*** | | |
| Pamplona (1970) | Preguiças | Biostratigraphy |
| ***Potiguar Basin*** | | |
| Oliveira (1957a) | Jandaíra | Descriptions, figures |
| K. Beurlen (1961a) | Jandaíra | Descriptions |
| K. Beurlen (1961b) | Jandaíra | Biostratigraphy |
| K. Beurlen (1964) | Jandaíra | Descriptions, figures |
| Oliveira (1969) | Jandaíra | Description, figure |
| Muniz *et al.* (1984) | Jandaíra | Description, figure |
| Muniz & Bengtson (1987) | Jandaíra | Descriptions, figures |
| ***Pernambuco-Paraíba Basin*** | | |
| Maury (1930) | Gramame | Descriptions, figures |
| Oliveira & Santos (1950) | Gramame | Description, figure |
| Oliveira (1957b) | Gramame | Descriptions, figures |
| K. Beurlen (1961b) | Beberibe | Biostratigraphy |
| K. Beurlen (1967) | Beberibe,Gramame | Biostratigraphy |
| Muniz (1993) | Gramame | Descriptions, figures |
| ***Alagoas Basin*** | | |
| Muniz *et al.* (1975) | — | Descriptions, figures |
| P. Bengtson (1987) | — | Descriptions, figures |
| ***Sergipe Basin (incl. Estância Platform)*** | | |
| Hyatt (1870) | Riachuelo, Cotinguiba | Descriptions |
| White (1887) | Riachuelo, Cotinguiba | Descriptions, figures |
| Hyatt (1903) | Cotinguiba | Description, figure |
| Maury (1937) | Riachuelo, Cotinguiba | Descriptions, figures |
| K. Beurlen (1952) | Riachuelo | Descriptions, figures |
| Magalhães (1952) | Cotinguiba | Descriptions, figures |
| Magalhães (1953a) | Cotinguiba | Description, figure |
| Magalhães (1953b) | Cotinguiba | Description |
| K. Bender (1959) | Riachuelo, Cotinguiba | Biostratigraphy, figures |
| K. Beurlen (1961b) | Cotinguiba | Biostratigraphy |
| K. Beurlen (1961c) | Riachuelo | Biostratigraphy |
| G. Beurlen (1967) | Riachuelo | Descriptions, figures |
| Brito (1967) | Cotinguiba | Description, figure |
| Brito & Rodrigues (1967) | Riachuelo | Descriptions, figures |
| K. Beurlen (1968) | Riachuelo | Biostratigraphy |
| G. Beurlen (1969) | Riachuelo | Descriptions, figures |
| Oliveira & Brito (1969) | Cotinguiba | Descriptions, figures |
| Schaller (1970) | Riachuelo, Cotinguiba | Biostratigraphy |
| G. Beurlen (1970) | Cotinguiba | Descriptions, figures |
| Brito (1970) | Riachuelo | Descriptions, figures |
| Brito (1971) | Riachuelo, Cotinguiba | Descriptions, figures |
| Reyment (1971) | Riachuelo, Cotinguiba | Biostratigraphy |
| Reyment & Tait (1972) | Riachuelo, Cotinguiba | Biostratigraphy, figures |
| Reyment *et al.* (1976) | Cotinguiba | Biostratigraphy |
| P. Bengtson (1977) | Riachuelo, Cotinguiba | Biostratigraphy, figures |
| P. Bengtson (1979) | Cotinguiba | Biostratigraphy |
| P. Bengtson (1983a) | Cotinguiba | Biostratigraphy |
| P. Bengtson (1983b) | Cotinguiba | Biostratigraphy |
| Brito (1984) | Riachuelo | Biostratigraphy, figures |
| Koutsoukos & Bengtson (1993) | Cotinguiba | Biostratigraphy |
| S.I. Bengtson (1995) | Cotinguiba | Descriptions, figures |
| P. Bengtson *et al.* (1996) | Calumbi | Biostratigraphy |
| P. Bengtson (1998) | Cotinguiba | Biostratigraphy |
| Souza-Lima & Bengtson (1999) | Riachuelo | Biostratigraphy, figures |
| ***Camamu Basin*** | | |
| Maury (1925) | Algodões | Description, figure |
| Maury (1930) | Algodões | Biostratigraphy |
| ***Campos Basin*** | | |
| P. Bengtson (1996) | Macaé | Biostratigraphy |
| ***Santos Basin*** | | |
| P. Bengtson (1996) | Itajaí-Açu | Biostratigraphy |

project by W. Souza-Lima, where the ammonites are being studied jointly by P. Bengtson and W. Souza-Lima.

Despite the fairly large number of publications and a variety of ongoing projects, research on the Cretaceous ammonites of Brazil is still at an initial stage. Large parts of the faunas are yet to be described and/or revised. A solid taxonomy is a prerequisite for the successful use of ammonites in high-resolution biostratigraphy, biogeography and related areas. With the exception of the Sergipe Basin, the biostratigraphic potential of the Cretaceous ammonites of Brazil remains largely unexplored.

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