Salaziceras nigerianum n. sp. from southeast Nigeria: Faunal evidence for an open seaway between the northern and southern Atlantic in Late Albian times

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With 4 figures in the text

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Abstract: A condensed horizon in the basal part of the Odukpani Formation yielded a mixed fauna of Late Albian/Early Cenomanian age with a new species of the rare dwarf ammonite *Salaziceras*. The genus was previously known only from the Lower Vraconian of southeast France and from contemporaneous deposits of Hungaria, Tunisia and southern Morocco. The geographic distribution of *Salaziceras* and the strong similarities between Lower Cenomanian faunas from Nigeria, North Africa and West Europe support an open marine connection between the northern and southern Proto-Atlantic at this time.

K e y w o r d s : Cenomanian, Albian, palaeogeography, sea (Proto-Atlantic), Desmoceratida (*Salaziceras*), new description; Eastern region of Nigeria (Cross River State).

Zusammenfassung: Ein Kondensationshorizont im basalen Teil der Odukpani-Formation lieferte eine Mischfauna von Oberalb/Untercenoman-Alter mit einer neuen Art des seltenen Zwerg-Ammoniten *Salaziceras*. Die Gattung war bisher nur aus dem südostfranzösischen Vraconien sowie aus gleich alten Schichten Ungarns, Tunesiens und Südmarokkos bekannt. Die geographische Verbreitung von *Salaziceras* und die großen Ähnlichkeiten der nigerianischen Untercenoman-Faunen mit denen Nordafrikas und Europas stützen die Annahme, daß in dieser Zeit bereits eine offene Meeresverbindung zwischen nördlichem und südlichem Proto-Atlantik bestand.

Introduction

Since A. WEGENER presented his hypothesis on continental drift, the South Atlantic region has served as a favoured and persuasive example for the theory — not only on account of the congruity of the opposing coastlines. Particular efforts have been centred on the dating of the first opening of a southern proto-Atlantic and of a first passage between northern and southern Atlantic. Based on data from seafloor spreading, palaeomagnetism, the sedimentary history and the stratigraphy of the coastal basins it was suggested that the opening of the southern Atlantic began in the Early Cretaceous (LARSON & LADD 1973, HERZ 1977). An open seaway with free inter-

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change of faunas should not have been established until Lower Turonian (REYMENT & TAIT 1972), though temporary connections between north and south might have existed in Late Albian times (REYMENT & MÖRNER 1977). Several authors, however, argued for an earlier opening for biogeographic reasons (KENNEDY & COOPER 1975, WIEDMANN & NEUGEBAUER 1979, VAN ANDEL et al. 1977). Recently collected faunas from southeast Nigeria reveal a first passage in Late Albian times.

Geographic and geologic setting

The new faunas were collected at three localities in the Cross River State, southeast Nigeria, north of Calabar: road cuts along the main road north of Odukpani, the neostratotype (FAYOSE 1976) of the Odukpani Formation; road cuts along the new road (under construction) from Odukpani to Itu; the Mfamosing limestone quarry 30 km NE of Calabar. There, along the southwest flank of the Oban Massif, is the only place where marine Lower Cenomanian deposits are exposed in Nigeria and in the Gulf of Guinea.

Deposition has been controlled by NW-SE trending faults in close relation to the taphrogenesis of the SW-NE trending Benue trough, presumably a RRR junction (WRIGHT 1976), comparable to that of the Afar region in Ethiopia. Terrestrial conglomerates and sands — the detritus from the Oban Massif — rest directly on the deeply decomposed Precambrian basement, grading upward into silty shales with intercalated carbonaceous shales. These clastics of unknown but presumable Lower Cretaceous age (Awi Formation) are succeeded by a sequence of silty shales with thin shelly concretionary layers, hardground horizons, limestones and sandstones of Upper Albian to Lower Turonian age (Odukpani Formation), deposited in a marine, mainly shallow-water environment. These conditions persisted until Early Maestrichtian times with two major hiatus, one in the Upper Cenomanian, and another from Santonian to Early Campanian times.

The oldest fauna was collected in the Mfamosing limestone quarry, where a sequence of about 20 m has been exposed. Though hardly 25 km east of the type-section of the Odukpani-Formation situated, the sedimentary sequence is quite different. While limestones play an inferior role in the type-section at Odukpani with thin intercalated layers only, more than 100 meters of algal limestones and dolomites have been drilled in several boreholes at Mfamosing. The basal 14 m in the quarry consist of coarse to micritic algal limestones with stromatolitic bodies and interstitial sediments, such as bioclasts, ooids and foraminiferal-algal oncolites of a shallow-water environment. After a sharp sedimentary discontinuity they are followed by a sequence of biosparites (3 m), calcareous sandstones (1 m), coarse biosparites (1 m) and a slightly siliceous, pyritic, sometimes dolomitic

biosparite (1 m). This mainly calcareous sequence is overlain by pyritic shales with some rare intercalations of thin limestones.

The top of the limestones shows evidence of synsedimentary diagenesis and erosion. The light, slightly siliceous biosparitic limestone grades into a grey, more dolomitic, more siliceous and highly pyritic grainstone-packstone. The uppermost 30 cm are extensively tunneled by burrows of the *Thalassinoides* type. They are filled by the same grainstone, but with a much higher content of pyrite. The filling is usually strongly oxidized, obviously by Recent weathering and differs in colour from the surrounding matrix. The top surface seems to be a hardground which underwent a period of erosion. There is no direct indication of any boring activity or encrustation, but this can be concluded from reworked concretions and nodules in the condensed horizon at the top. In this horizon reworked concretions and nodules of pyrite and phosphorite have been mixed together with reworked shells of bivalves and phosphatic nuclei of gastropods and ammonites. The latter are often fragments only, but occasionally large specimens of *Puzosia* occur with a diameter up to 30 cm. The fauna is dominated by oysters but the composition is variable: thin drifted shell beds crowded with oysters and forming patches of some 20 m^2 and more, alternate with local clusters of small gastropods or of ammonites, usually embedded in a more marly matrix in holes and depressions of the surface of the top layer.

Large mortoniceratids of the *Mortoniceras rostratum* (SOWERBY) group from a level of 45 cm below the top surface and just beneath the *Thalassinoides* burrows indicate an age corresponding to the Late Albian *dispar* zone for the limestone. The ammonite fauna from the condensed horizon, however, is a mixture of uppermost Albian (*briacensis* subzone (SCHOLZ 1973)) and Lower Cenomanian elements. It is dominated by Lower Cenomanian Acanthoceratidae and Upper Albian/Lower Cenomanian Turrilitidae. Special weight has to be placed upon the occurrence of *Salaziceras*, which strongly supports the conception of an open connection and free faunal interchange between northern and southern Atlantic at this time.

Systematic description

Superfamily Acanthocerataceae HYATT 1900

Family Lyelliceratidae SPATH 1921

Genus *Salaziceras* BREISTROFFER 1936

Type species: *Ammonites salazacensis* HEBERT et MUNIER-CHALMAS 1875 from the "Lower Vraconian" of Salazac, southeast France.

Diagnosis: Small, moderately involute ammonites; whorl section slightly compressed to depressed, body chamber tending to scaphitoid coiling; slightly curved ribs crossing the rounded venter, but flattened and weakened on it. Ribbing varies from flat and rounded to acutely chevroned ribs on inner flanks; main ribs

alternating with one or two intercalatories or branching; rare umbilical bullae or (in subgenus *Noskytes* (Scholz in lit.)) conspicuous ventrolateral tubercles; suture with simplified saddles and slightly divided bifid or trifid lobes.

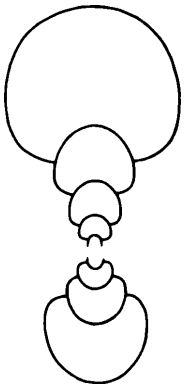

Fig. 1. *Salaziceras nigerianum* n. sp.; whorl sections (approximately × 2).

Subgenus *Salaziceras (Salaziceras)* Scholz (in lit.)

Diagnosis: *Salaziceras* with or without umbilical tubercles, but no ventrolateral tubercles.

Discussion: Breistroffer (1936) introduced the new name *Salaziceras* for some rare dwarf ammonites from the Upper Albian *(dispar* zone, *blancheti* subzone) with a restricted occurrence exclusively from the vicinity of Salazac, southeast France. He regarded them as degenerated representatives of the Lyelliceratidae in a restricted area. The recently recorded occurrence of *Salaziceras* in contemporaneous beds in the Bakony Mountains, Hungaria (Scholz in lit.) and in the Tarfaya Basin, southern Morocco (Wiedmann, pers. comm.) provided a basis for detailed comparative examination. On the basis of the abundant Hungarian material (about 100 specimens) Scholz (in lit.) was able to show not only a high intraspecific variability, but to distinguish three subspecies (*S. salazacense salazacense, S. salazacense peyrolasense, S. salazacense gracilicostatum)*, and a new species with one subspecies *(S. breistrofferi breistrofferi, S. breistrofferi pseudonodosum)*. Furthermore he established a new subgenus *(S. (Noskytes) bakonyense)* in which he included the problematic *Scaphites* (?) *thomasi* Pervinquière (1907) from the Upper Albian of Tunisia. The unique specimen of Pervinquière — type species of the subgenus *Scaphites (Metascaphites)* Wiedmann (1962) — is completely identical in its shape, ornament and suture with two specimens from Hungaria and was referred to the subgenus *Noskytes*. The diversity and the wide range of distribution indicates that the previously little known genus *Salaziceras* is an independent evolutionary line within the Lyelliceratidae parallel to that of the genus *Stoliczkaia*.

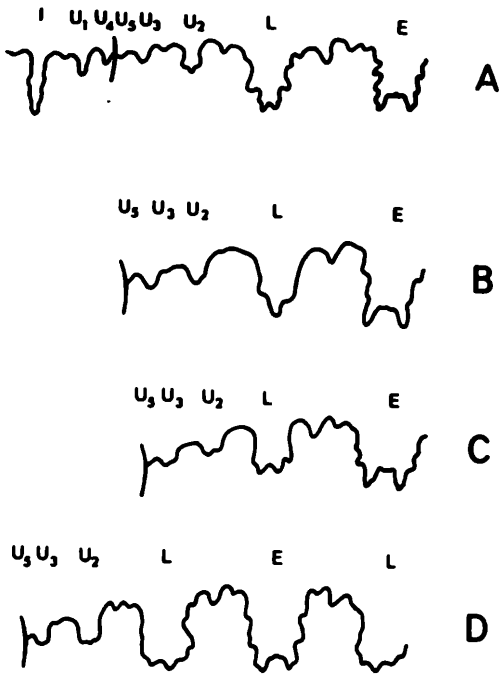

Fig. 2. *Salaziceras nigerianum* n. sp.; sutures.
A: Last suture before body chamber; BSP 1978 X 3; Wh 8,0 mm.
B: Holotype BSP 1978 X 1; Wh 7,5 mm.
C: Geol. B. A. Wien; Wh 7,2 mm.
D: BSP 1978 X 2; Wh 7,6 mm.

Salaziceras (Salaziceras) nigerianum n. sp.
Fig. 3, No. 1—5

Type data: Bayer. Staatsslg., Paläont., München BSP 1978 X 1 (Fig. 3, No. 5) from the uppermost Albian; horizon of condensation at the top of the limestone sequence in the Mfamosing quarry, 30 km northeast Calabar, southeast Nigeria.

Derivatio nominis: Named for its occurrence in Nigeria.

Material: 24 specimens, most of them fragments; all from Mfamosing quarry.

Dimensions (in mm):

	D	Wh	Wb	Wb:Wh	U	ribs
1978 X 4	~ 31,0	10,7 (35)	12,3 (40)	1,15	12,0 (39)	—
Holotype	~ 30,0	— —	— —	—	11,5 —	31
BA Vienna	26,0	10,6 (41)	12,0 (46)	1,13	9,0 (34)	30
1978 X 2	19,0	7,6 (40)	9,4 (49)	1,24	6,6 (35)	33
BA Vienna	17,5	6,5 (37)	10,2 (58)	1,57	6,3 (36)	—
1978 X 5	16,0	5,5 (35)	9,3 (58)	1,69	5,9 (37)	35
1978 X 6	10,5	3,7 (35)	5,8 (55)	1,57	4,0 (38)	—

Diagnosis: A depressed *Salaziceras* with slightly curved prorsiradiate ribs, bifurcating at prominent umbilical bullae.

Description: Coiling is moderately evolute, cadicone, with fairly deep umbilicus, which comprises 34—39 % of the diameter. The whorls are

depressed and much broader than high with a luniforme whorl-section on the inner whorls; they are less depressed, subcircular in intercostal section on the outer whorls and the scaphitoid coiled body chamber. The greatest breadth is at the umbilical bullae. The umbilical wall is fairly high, steep and rounded. Flanks and venter are equally rounded. The body chamber seems to attain about half a whorl similar to other species of *Salaziceras*.

Ornament of the inner whorls consists of 10—12 prominent umbilical bullae. At a diameter of 12 mm short ribs first appear, which arise at the bullae. During the ontogeny the ribs progressively pass across the flanks, while the umbilical bullae become less accentuated. On the outer whorls the ribs finally pass across the venter. The ribs are slightly curved, prorsiradiate, flattened and weakened on the venter. They bifurcate at the umbilical bullae. Main ribs may alternate with one, occasionally two intercalatories, which usually arise at the middle of the flanks, but sometimes may appear already at the umbilical shoulder. Altogether the ornament is very irregular.

The sutur (E L $U_2U_3U_5U_4U_1$ I) is simple, with massive bifid or rounded saddles and slightly divided bifid or trifid lobes (Fig. 2). The saddle E/L is the largest; it is usually divided. The smaller umbilical saddles and lobes are more or less entire or with few indentations only. The lateral lobe may be bifid or subtrifid-trifid. The deep internal lobe is simple and usually unfrilled.

Comparisons with other species

Salaziceras nigerianum n. sp. is the youngest representative of the genus. It differs from all known species by its prominent umbilical bullae, at which usually the ribs bifurcate.

S. salazacense salazacense has less depressed whorls. Ornament consists of subradiate ribs, alternating irregularly with shorter intercalatories, which are narrow on the inner flanks but widen and flatten across the venter. No umbilical bullae are developed, and ribs do not branch. *S. salazacense peyrolasense* (Scholz in lit.) does not develop any distinct ornament during growth and is virtually smooth. *S. salazacense gracilicostatum* (Scholz in lit.) occasionally shows bifurcating on the inner flanks, particularly on the body chamber, but does not develop any umbilical bullae. Ribs are straight and subradiate. *S. breistrofferi breistrofferi* (Scholz in lit.) shows a much denser ribbing: ribs sporadically bifurcate at the umbilical wall of inner whorls; they branch into two or three branches at the outer flanks on the outer whorls. It lacks the umbilical tubercle. *S. breistrofferi pseudonodosum* (Scholz in lit.) has very depressed whorls. Its ornament resembles that of *S. breistrofferi breistrofferi*, but shows prominent tubercle-like swellings of the ribs just before they branch, particularly on the outer flanks.

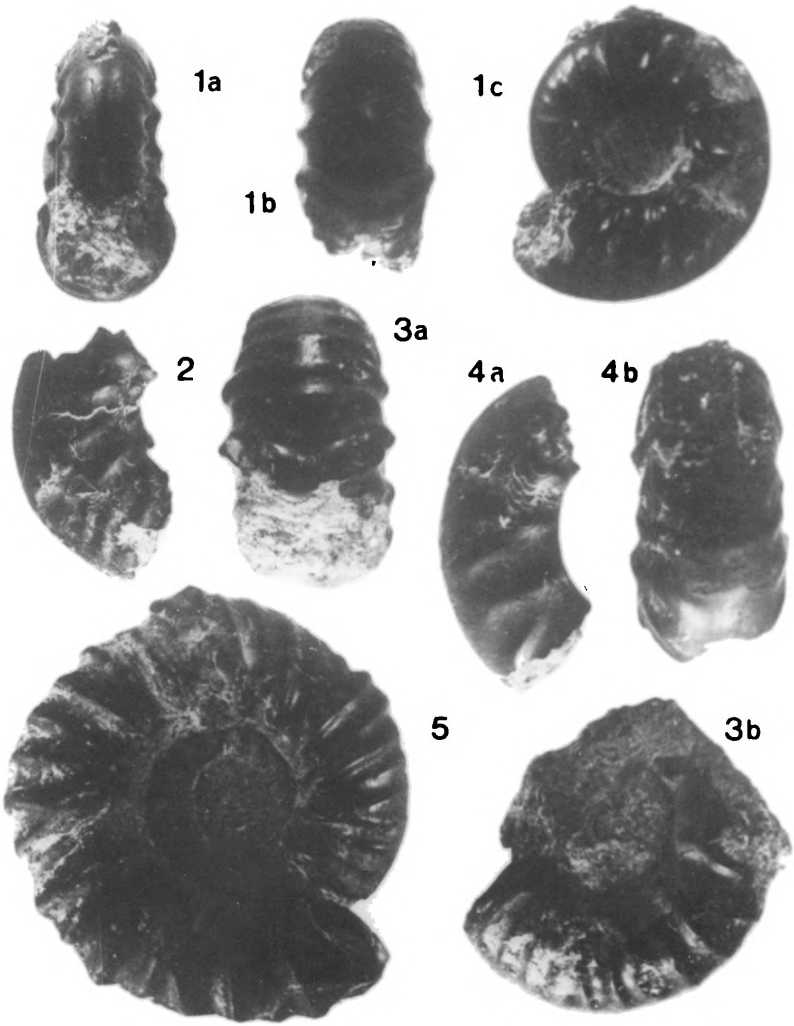

Fig. 3. *Salaziceras nigerianum* n. sp.: uppermost Albian (***dispar*** zone, *briacensis* subzone); Mfamosing quarry, 30 km northeast Calabar, southeast Nigeria; all figures · 2.

1 a—c: Bayer. Staatsslg. Paläont. hist. Geol. München; BSP 1978 X 2; inner whorls with prominent umbilical bullae and almost smooth venter.

2: Coll. Geol. Bundesanstalt Wien; whorl fragment showing the simplicity of the suture.

3 a—b: Coll. Geol. Bundesanstalt Wien; body chamber, ribs passing across the venter.

4 a—b: BSP 1978 X 3 München; whorl fragment with prominent umbilical bullae and almost smooth venter.

5: Holotype; BSP 1978 X 1 München; body chamber fragmentary only, without venter and outer flanks; ornament consisting of bifurcating ribs.

Discussion

The geographic distribution of the genus *Salaziceras* — its restriction to the western Mediterranean, to Morocco and Nigeria — strongly suggests a migration along an open proto-Atlantic seaway. This is more probable than a long migration route along the East African coast and via the Cape seaway, particularly considering that the rich Late Albian and Early Cenomanian faunas from Madagascar (COLLIGNON 1964), Mozambique (FÖRSTER 1975) and Zululand (KENNEDY & KLINGER 1978) yielded the lyelliceratid genera *Stoliczkaia* and *Flickia*, but no representative of the genus *Salaziceras*. There is no indication for a direct "trans-Saharan" passage at this time. The occurrence of *Dipoloceras*, *Neophlycticeras*, *Lyelliceras* and the endemic southern Atlantic genus *Elobiceras* in drilling cores from the Ivory Coast Basin (SPENGLER & DELTEIL 1966) suggests an even earlier, probably Middle Albian first connection between northern and southern proto-Atlantic.

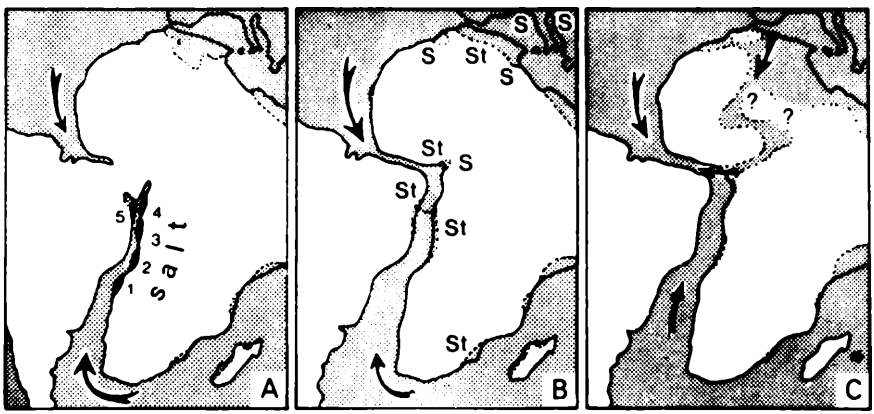

Fig. 4. Suggested paleogeography of the South Atlantic region during the Late Aptian (A), the Late Albian to Early Cenomanian (B), and the Lower Turonian (C). Occurrence of evaporites in the basins of Mossamedes (1) (Lower Aptian), Cuanza (2) (Lower to Middle Aptian), Cabinda (3) (Middle Aptian), Gabon (4) (Late Aptian), and Sergipe — Alagoas (5) (Upper Aptian to Lower Albian), demonstrating the progressively northward extension of the transgressing sea. Distribution of the genera *Salaziceras* (S) in southeast France, Hungaria, Tunisia, southern Morocco, and Nigeria, and *Stoliczkaia* (*S. africana* PERV. group) (St) in the Late Albian to Early Cenomanian of Tunisia, Algeria, Nigeria, Angola, Zululand and Brazil. Arrows indicate presumable routes of faunal migration.

The ammonite association from Mfamosing quarry and additional Lower to Middle Cenomanian faunas from southeast Nigeria and Angola (KENNEDY & COOPER 1975) confirm a continued connection.

The fauna of Mfamosing quarry is dominated by Early Cenomanian Acanthoceratidae (58 % of total 448 specimens) and Late Albian/Early Cenomanian Turrilitidae (30 %), associated with *Salaziceras* (7 %), *Puzosia* (6 %) and *Cymatoceras* (1 %), including the following species: *Mantelliceras* cf. *indianense* HYATT, *M. saxbii* (SHARPE), *Mantelliceras* of the *martimpreyi* group, "*Submantelliceras*" *aumalense* (COQUAND), *Acompsoceras sarthense* (GUERANGER), *A.* cf. *madjeurensis* (PERV.), *Paraturrilites (Bergericeras) quadrituberculatus* (BAYLE), *P.* cf. *essenensis* (GEINITZ), *Hypoturrilites mantelli submantelli* SCHOLZ, *H. mantelli mantelli* (SHARPE), *H. carcitanensis* (MATHERON), *Puzosia quenstedti* PARONA & BONARELLI, *P. furnitana* PERVINQUIÈRE. Though the Lower Cenomanian character dominates in number of specimens as well as in number of taxa, there is a significant percentage of Late Albian species like *H. mantelli submantelli* SCHOLZ (9 %), *P. quadrituberculatus* (= *Mariella oehlerti* (PERV.)) and smooth specimens of A. cf. *madjeurensis* (PERV.), which show on the inner whorls close relationships to *Stoliczkaia rhamnonota* SEELEY or *S. africana* PERVINQUIÈRE.

Nearly all of the listed species have been recorded from Tunisia in the classic study of PERVINQUIÈRE (1907). Additional faunas containing *Acompsoceras sarthense* (GUERANGER) and *Sharpeiceras laticlavium* (SHARPE), and faunas with *Euomphaloceras cunningtoni tuberculatum* (PERV.), *E. cunningtoni meridionale* (STOLICZKA), *E.* cf. *inerme* (PERV.), *Forbesiceras sculptum* CRICK, *F. obtectum* SHARPE, *Calycoceras* cf. *paucinodatum* CRICK, *Turrilites costatus* LAMARCK with all transitional forms to *T. acutus* PASSY and a small fauna with *Acanthoceras jukes-brownei* (SPATH) not only show strong links with faunas from Angola (COOPER 1973), but also with northern Africa and NW-Europe in Lower and Middle Cenomanian times, confirming a continued connection at this time. One of the reasons why Tethyan ammonites occurred earlier in time in greater quantity and variety farther to the south than southern Atlantic forms appeared in the Tethyan realm, might be the existence of unfavourable currents in the early Atlantic.

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References

COLLIGNON, M. (1963/64): Atlas des fossiles caracteristiques de Madagascar. — 10 & 11: 185 & 153 pp., Serv. Géol.; Tananarive.

COOPER, M. R. (1973): Cenomanian ammonites from Novo Redondo, Angola. — Ann. S. Afric. Mus., 62: 41—67, 13 figs.; Cape Town.

Fayose, E. A. & Dessauvagie, T. F. J. (1976): In Geol. Guide 7th African Micropaleont. Coll., Ile-Ife, 35—52; Ile-Ife.

Förster, R. (1975): Die geologische Entwicklung von Süd-Mozambique seit der Unterkreide und die Ammoniten-Fauna von Unterkreide und Cenoman. — Geol. Jb., B 12, 324 pp., 17 pl., 81 figs.; Hannover.

— (1978): Evidence for an open seaway between northern and southern proto-Atlantic in Albian times. — Nature, 272: 158—159, 1 fig.; London.

Herz, N. (1977): Timing of spreading in the South Atlantic: Information from Brazilian alkalic rocks. — Geol. Soc. America Bull. 88: 101—112, 4 figs.; Washington.

Kennedy, W. J. & Cooper, M. R. (1975): Cretaceous ammonite distributions and the opening of the South Atlantic. — J. geol. Soc. Lond., 131: 283—288, 1 fig.; London.

Kennedy, W. J. & Klinger, H. C. (1978): Cretaceous faunas from Zululand and Natal, South Africa. A *Flickia* from the Cenomanian of northern Zululand. — Ann. S. Afric. Mus., 74: 211—217, 2 figs.; Cape Town.

Larson, R. L. & Ladd, J. W. (1973): Evidence for the opening of the South Atlantic in the Early Cretaceous. — Nature, 246: 209—212; London.

Pervinquière, L. (1907): Études de Paléontologie Tunisienne, 1. Céphalopodes des terrains secondaires. — Mém. Carte géol. Tunisie, 438 pp., 27 pl., 158 figs.; Paris.

Reyment, R. A. & Tait, E. A. (1972): Biostratigraphical dating of the early history of the South Atlantic Ocean. — Phil. Trans. roy. Soc. London, B 264: 55—95; London.

Reyment, R. A. & Mörner, N. A. (1977): Cretaceous transgressions and regressions exemplified by the South Atlantic. — Palaeont. Soc. Japan, Spec. Pap., 21: 247—261, 5 figs.; Tokyo.

Scholz, G. (1973): Sur l'age de faune d'Ammonites au Château près de St-Martin-en-Vercors (Drôme) et quelques considérations sur l'évolution des Turrilitidés et des Hoplitidés vraconocénomaniens. — Geol. Alpine, 49: 119—129, 1 pl.; Grenoble.

Scholz, G. (1979): The ammonites of the Vraconian (Upper Albian, *dispar* zone) of the Bakony Mountains (Hungary), and a revision of the most important Vraconian species of the west Mediterranean faunal province. — Palaeontographica. [In press]

Spengler, A. de & Delteil, J. R. (1966): Le bassin secondaire-tertiaire de Côte d'Ivoire (Afrique Occidentale). — In: Reyre, D. (Ed.): Bassins Sédimentaires du Littoral Africain, Ass. Géol. Afr., 99—113, 5 figs.; Paris.

Van Andel, H. T.; Thiede, J.; Sclater, J. G. & Hay, W. W. (1977): Depositional history of the South Atlantic Ocean during the last 125 million years. — J. Geol., 85: 651—698, 22 figs.; Chicago.

Wiedmann, J. (1962): Ammoniten aus der Vascogotischen Kreide (Nordspanien) I. Phylloceratina, Lytoceratina. — Palaeontographica, A 118: 119—237, pl. 8—14; Stuttgart.

Wiedmann, J. & Neugebauer, J. (1979): Lower Cretaceous ammonites from the South Atlantic Leg 40 (DSDP), their stratigraphic value and sedimentologic properties. — Init. Rep. DSDP, 40; Washington. [In press]

WRIGHT, J. B. (1976): Origins of the Benue Trough — a critical review. — In: KOGBE, C. A. (Ed.): Geology of Nigeria, 309—317, 13 figs.; Eliz., Lagos.

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